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Food Technology in Action

4TH EDITION

PRELIMINARY AND HSC COURSES
STAGE 6 SYLLABUS

UPDATED FOR THE **2009 SYLLABUS** AMENDMENTS

Beverly BURNETT-FELL
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Michael WOOTTON
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In this book, the word ‘Aborigine’ rather than ‘Koori’ is used when referring to Indigenous Australians. The issues raised are not unique to the Indigenous people of New South Wales and so the Australia-wide reference has been maintained.

It is recommended that teachers should first preview resources on Aboriginal topics in relation to their suitability for the class level or situation. It is also suggested that Aboriginal parents or community members be invited to help assess the resources to be shown to Aboriginal children. At all times the guidelines laid down by the Department of Education should be followed.

CONTENTS

HOW TO USE THIS BOOK

Eating food is something we all have in common! *Food Technology in Action 4th edition* is a textbook about what we eat, what we should eat, how the food we eat affects our health, how we cook food, how food is processed and presented to us, how we shop for food and the impact of food on our lives and the environment. The text follows the requirements of the Stage 6 Food Technology Syllabus developed by the New South Wales Board of Studies for implementation in 2000.

The provision and consumption of food are activities that all humans throughout history have had to deal with. Today, considerable resources are devoted to producing food across domestic, commercial and industrial settings. Food issues are relevant to us all. Each chapter of this text shows Food Technology in real life situations. Blending theory with practical real-life examples captures students' interest and willingness to learn more. The authors hope to capture the excitement that the subject of food brings and conclude by leaving you with this conversation between Pooh Bear and Piglet …

'When you wake up in the morning, Pooh,' said Piglet at last, 'what's the first thing you say to yourself?'

'What's for breakfast?' said Pooh. 'What do *you* say, Piglet?'

'I say, I wonder what's going to happen exciting *today*?' said Piglet.

Pooh nodded thoughtfully.

'It's the same thing,' he said.

A. A. Milne, Winnie-The-Pooh

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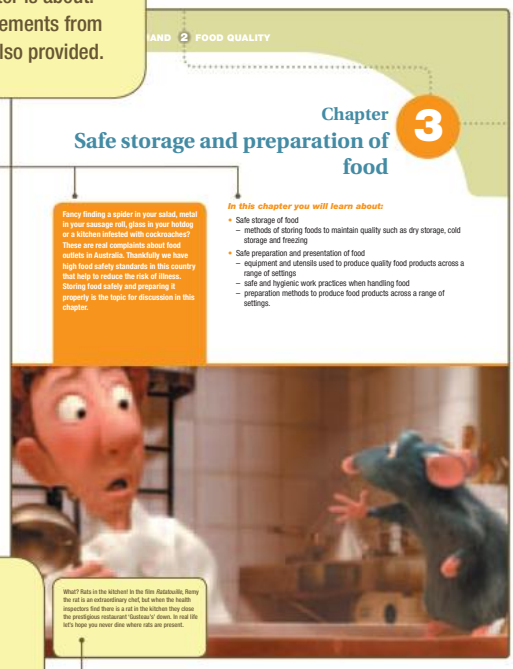

Engaging photos provide examples of the content covered, and informative captions are closely linked to the content.

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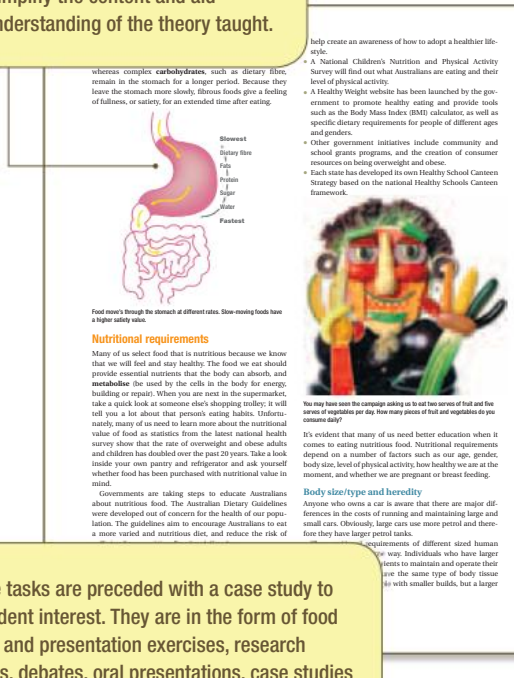

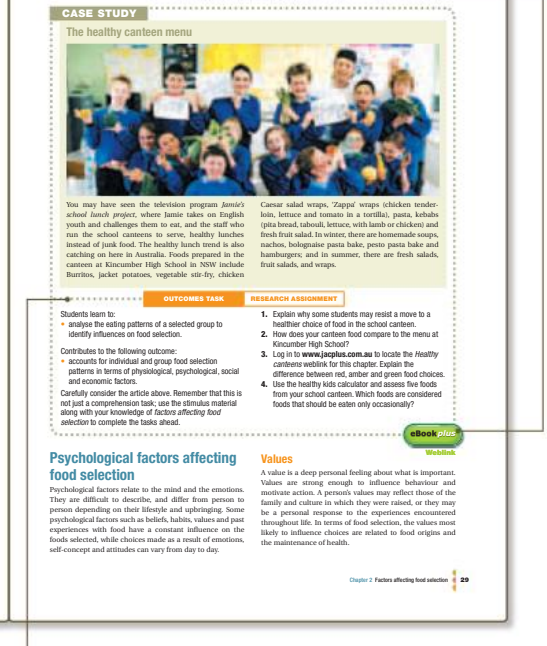

All outcome tasks are preceded with a case study to capture student interest. They are in the form of food preparation and presentation exercises, research assignments, debates, oral presentations, case studies and industry reports.

Sets of review questions at frequent intervals recap the content just covered. The questions require students to remember, apply knowledge and do an activity.

Key terms in the text are bolded and a definition is provided in the glossary section of the book.

Case studies highlight an application of the theory that has just been discussed in the text.

A summary of the chapter's key issues in dot-point form is included at the end of every chapter to aid revision.

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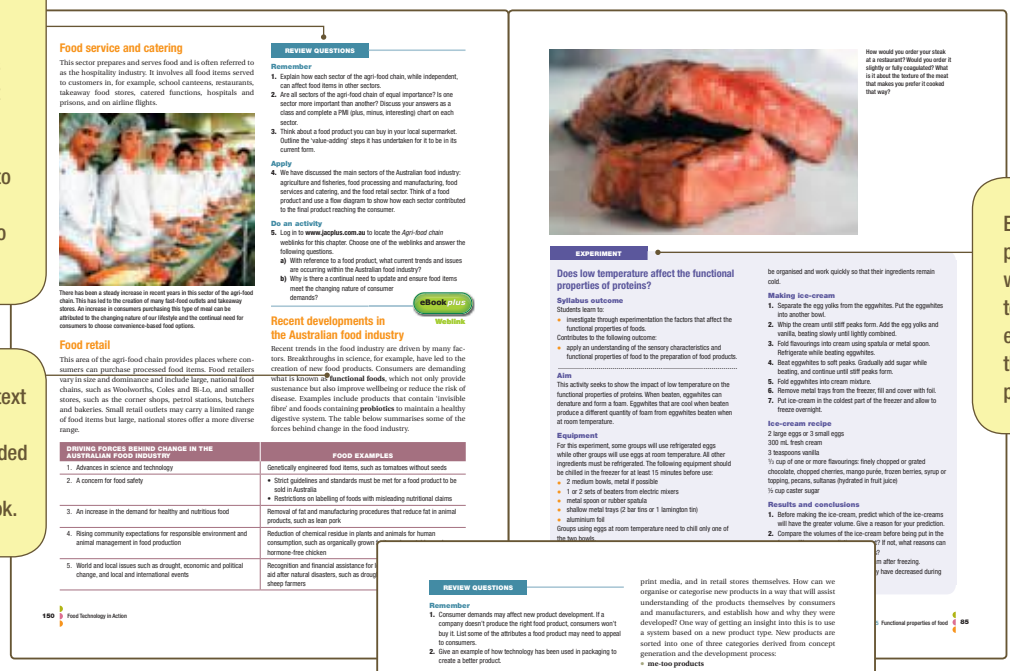

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The eBookPLUS of *Food Technology in Action, 4th edition* features a resource of recipes for students who are required to undertake practical activities. Preparing a range of recipes provides opportunities to develop learning abilities and competence in experimenting with food preparation. Students learn to:

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Asparagus and chicken risotto

Banana and chocolate swirls

Banana ice-cream

Basil crumbed veal schnitzel with bocconcini and red pepper caponata

Caramelised Spanish onion tart

Chocolate cupcakes

Chocolate self-saucing pudding

Chocolate sweet pastry

Chocolate tart filling

Coconut and lime mousse

Coconut battered flathead with lime mayonnaise and coleslaw

Crunchy Thai chicken balls

Escalivada pizza

Fish en papillote

Foccacia

Frittata

Gluten-free cake

Gravlax

Grilled polenta with ratatouille

Homemade yoghurt

Honeycomb

Hot cross buns

Jam fancies

Lemon ice-cream

Lemongrass, ginger and star anise poached peaches

Lentil burgers

Mandarine crème Saint Honoré cornettes

Mango smoothie

Mascarpone bavarois with espresso poached pears and chocolate ladyfinger biscuits

Master stock chicken with a lychee, coriander and chili peanut salad

Nori maki

Paella with chicken and seafood

Passionfruit meringue cones served with citrus curd and sherbet

Passionfruit soufflé

Preserved lemons

Pickled eggplant

Pork saltimbocca with a mushroom velouté and rice pilaf

Potato and pea samosa with a mint raita

Pumpkin and goat's cheese soufflé served with a rocket, pear and walnut salad

Pumpkin, feta, walnut and filo cigars

Red pepper caponata

Rice paper rolls

Semi-dried tomatoes

Spicy tomato chutney

Spinach and ricotta agnolotti with a brown butter, hazelnut and sage sauce

Sticky fig and date pudding

Strawberry and vanilla cream millefeuille

Strawberry jam

Strawberry taffy

Tomato and zucchini roulade

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Part 1

Stage 6 Preliminary course

Chapter 1
Influences on food availability

Did you know that you can buy a McDonald's hamburger in Russia, but not in Iran or Rwanda? Take a minute to think about why this might be the case.

For most of us, food availability is fairly simple — you just go to a shop and buy it. However, it is not always that simple. In this chapter, we will look at social, economic and political influences on food availability, and advances in technology that make many foods available, even out of season. We will also look back to a time when food wasn't always readily available.

In this chapter you will learn about:

Influences on food availability

- Historical changes to food availability, including:
  - global migration of cultural groups
  - use of foods native to Australia
- Technological developments influential on food availability, including:
  - production and manufacturing processes, and equipment techniques
  - storage and distribution techniques
  - marketplace practices
- Social, economic and political influences on food availability, including:
  - effects of poverty and affluence
  - type and state of the economy
  - government policy e.g. taxation, tariffs, embargoes, subsidies, war and export strategies.

For this grizzly bear, making the most of salmon when it's available is a must. Thankfully, in Australia, food is plentiful and of a wide variety, no matter what the season.

Staple foods around the globe

The type and amount of food that people eat depends upon a variety of factors. Where people live is important because food produced in the local area will be more plentiful and cheaper than food transported long distances. Available income to buy food is another major factor affecting what people eat, along with the level of technology available in producing and processing food; government policies concerning local industry and imports; and the strength of the country's economy.

When people move from one country to another or to another part of their own country, they bring the desire for and knowledge of the foods they already know. In this way, the adopted location may gradually introduce the newcomers' most-preferred foods into the local diet.

Foods that are commonly eaten as part of the daily diet are called **staple foods**. To be classed as a staple, the food must be readily available to most of the population and must provide the major source of energy in the diet of a particular group. Staples are often the most important source of protein in the diet, simply as a result of the quantities in which they are eaten. Staples may be of plant or animal origin and vary from region to region. They are generally inexpensive and more plentiful than other food sources.

Most cultures throughout the world have at least one staple plant food. Cereals are the most common plant staple, but root crops and legumes are basic to the diets of many people. **Cereals** are edible grains, root crops are plants whose edible portion develops beneath the ground's surface, and **legumes** are the seeds within the seed pods of specific plants. The four main plant staples are wheat, rice and maize, which are cereals, and potatoes, which are a root crop. Other staples include millet, sorghum, cassava, taro and soya beans.

Plant foods are an excellent source of complex carbohydrates (starch and dietary fibre). In developing countries the consumption of plant staples may provide around 75 per cent of the energy in a person's diet. Staples may also contribute 40 to 70 per cent of the protein intake in these countries, so staples' nutritional quality is important. The amount and quality of the protein present varies depending on the staple. Cereals provide significantly higher quantities of protein than root crops, while legumes are nutritionally the best source of plant protein.

Staple plant foods

We will now look at the basic staple plant foods: wheat, rice and cassava.

Wheat

Wheat is the staple crop eaten in more countries of the world than any other staple. Growing conditions for wheat vary depending on the variety of wheat, but most varieties prefer cool, wet conditions during the growing season and warm, dry conditions during ripening.

Wheat is thought to have been first cultivated around the Middle East and the Nile valley between 15 000 and 10 000 BC. Gradually, as people from these areas moved and settled in new lands, the production of wheat became more widespread. The migrating people introduced wheat to people in other areas who then began including it in some of their own food products.

Wheat became a popular cereal because it is versatile as a food source. Wheat can be:

- cracked (known as burghul) and eaten in soups and salads such as Lebanese tabouli
- coarsely ground to produce semolina, and used in products such as sweet Indian cakes and some varieties of gnocchi
- ground into flour and used to produce breads, cakes, pasta, tortillas, pancakes and noodles.

Rice

Rice is the staple food of Asia and, given the high population density within the Asian nations, it is the most commonly eaten staple in the world. Rice is thought to have originated in the monsoonal areas of South-East Asia and to have been a staple food in the area since 5000 BC. It needs a warm climate and large quantities of water in which to grow. Fields are flooded to allow the rice to grow in water, and flat land and a clay-based soil is needed for this process to be really effective.

The manner in which rice is prepared and consumed depends on where it is being served.

- In Asia steamed or boiled rice is eaten at all meals.
- In Europe rice is served as a summer salad and a winter pudding.
- In the Middle East rice is used in the savoury dish pilaf, which accompanies the main part of the meal.
- In England rice flour is used in the making of shortbread.

CASE STUDY

Cassava — a plant staple

Cassava tubers being harvested — the cassava plant looks more like a tree than a normal vegetable crop.

Cassava is a root vegetable (**tuber**), thought to have originated from the Amazon Basin, and is the staple food in Central and Northern Africa, and South America. Other common names for this root crop are yucca, manioc and tapioca. The tubers are about 5 cm across and 25 cm long, and the white flesh is covered by a brownish skin which resembles bark. There are two types of cassava:

- the bitter variety, which is poisonous when raw due to the hydrocyanic acid present; consequently, the toxic juice needs to be squeezed out. Once the juice is removed, this type of cassava is used to make tapioca, and in the West Indies it is made into starch.
- the sweet variety is the most widely used in cooking, where it is peeled and boiled much like a potato.

TABLE 1.1 Nutritional value of cassava

NUTRIENT	PER 100 GRAMS
Carbohydrates	19 g
Fat	0.3 g
Protein	2 g

Unfortunately, cassava provides little protein — only 1 per cent of its nutritional value, compared to 11.5 per cent in wheat and 6.5 per cent in rice. Since it is the staple food in these countries, the occurrence of protein deficiency diseases is quite high.

When buying cassava, the tuber should be clean, firm and dry, and should be stored in a cool, dark place for several days. Cooking with cassava is more complicated than with many root vegetables because it is hard to peel, and the woody centre piece needs to be cut out before the cassava can be chopped into small pieces. Boiling for 20 minutes, steaming, braising and sautéing are suitable cooking methods.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *staple foods* to complete the tasks ahead.

1. Is the cassava plant a staple food in your household? Give reasons why or why not.

2. Log in to **www.jacplus.com.au** and locate the *Plant staples* weblink for this chapter.
- **a)** Identify four ways in which cassava is used in different parts of the world.
- **b)** Find the three recipes listed for cassava.
- **c)** Divide the class into small groups and make one or more of the dishes given.

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Weblink

Meat and fish as staple foods

Animal staples have also moved throughout the world as people have migrated. Australia is a prime example; the animal foods that form our staples today did not exist on this continent 250 years ago. Our current meat staples came to us as a result of migration. Lamb was the staple of colonial Australia, but over the years beef has replaced lamb as the most commonly consumed meat. The increased demand for beef is linked to the popularity of dishes from various cultural backgrounds — for example, lasagne, hamburgers and stir-fries.

People living in coastal areas or countries surrounded by water (such as the Pacific Islands and Japan) have ready access to fish and other seafoods. As a result, these foods frequently appear in the diet of people in these areas. Some people of other cultures, such as the Australian Aborigines, used native plants and animals as a staple food. The lean, nutritious flesh of the kangaroo was once the staple of the Aboriginal people living in inland Australia, while coastal communities more heavily relied on fish and seafood.

REVIEW QUESTIONS

Remember

1. True or false?
   - **a)** A staple food is one we eat all the time, such as chocolate.
   - **b)** The legume, soya bean, is a plant staple.
   - **c)** Compared to cereals, root crops are a better source of protein.

Apply

2. In 1–2 paragraphs, explain how the climate of a region affects the traditional foods eaten there. Give three examples to assist with your explanation.
3. Explain the differences between cereals, legumes and root vegetables.

Do an activity

4. Using food composition tables or food analysis software, compare the nutrient content of the following staple foods: sorghum, corn, soya beans, potatoes and a cold-water fish.

Foods native to Australia

Before Europeans arrived here, Australian Aborigines had a nutritious and varied food supply. They did not have a staple food as such because the animals they hunted and the plants they gathered varied from coastal regions to inland regions. They normally ate food as they collected it, but some vegetables contained a poison that had to be removed by soaking them in running water. Food toxicity occurs through eating food that contains small amounts of a harmful substance, which accumulates faster than the body can eliminate it. Toxicity builds up over a long period of time and can cause death if the toxic food continues to be eaten. Because Aborigines moved from place to place, food-related toxicities were unlikely to develop.

Traditional Aboriginal animal foods

The foods obtained from animals included:

- marine life and shellfish — fish, small sharks, stingrays, pippies, clams, crayfish, freshwater mussels, dugongs, eels and trepang (sea-cucumber)
- reptiles — lizards, snakes, frogs, long-necked turtles, turtle eggs, goannas
- birds — mutton-birds, wild geese, emus, mallee fowl, swans
- insects — witchetty grubs, bogong moths, honey ants, green ants, plague locust
- marsupials — wallabies, kangaroos, possums, flying foxes, echidnas.

The amount of flesh on many of these animals is much lower than that of the beef, lamb and pork we eat, and the ratio of polyunsaturated fats is higher. The insect foods are high in fat, energy and protein.

So, how did Aborigines obtain their food? Fish and eels were fed into weirs (often quite large) where fishing was done from canoes using hooks and line or nets, while spearing larger fish was done from the rocks. Sea turtles, dugongs and any whales stranded on the beach were much prized. Hunters would swim under water and catch water birds by the feet, or they would throw nets over birds drinking at a waterhole. Pits were dug to catch emus, or poisonous leaves were spread out for the emus to eat, which slowed them down, making them easier to catch. Swans were caught and eaten during their moulting season because they were slower and therefore easier to catch.

Some other clever hunting methods traditionally used by the Aborigines included:

- coating tree branches with wattle gum, which glued the bird's feet to the branch
- burning off grasses in the dry season in the Kakadu region to expose land turtles (which were then roasted in hot ashes)
- laying trip wire on the ground — once kangaroos, emus or wallabies touched the wire a net would fall from above
- using boomerangs to catch water birds
- catching flying foxes during the day while they were sleeping.

Did you know that because they are reptiles, goannas hibernate in cold weather? Aborigines could find their sleeping places and catch them easily. In warmer weather, goannas were caught by nooses made from lawyer cane, or brought down with sticks after they fled up a tree.

Plant sources

Many different parts of the plant were eaten, including:

- roots — yams, waterlily roots, bush onion, bulbs from bulrushes
- fruit and vegetables — bush raisins, wild figs, quandongs, bush beans, bush oranges, bush tomatoes, bush potatoes, bush bananas, wild plums, bush apples, yam daisy, bush fruit, Indian gooseberry, bush berries, waterlily pods
- stems — pigweed and mulga grasses, waterlily stalks
- seeds and nuts — pandanus nuts, bunya nuts, cycad nuts, millet, Moreton Bay chestnuts, bush nuts (or water chestnuts), waterlily seeds, pigweed seeds.

Green leafy vegetables are not included on this list, and fruits played a very small part in traditional Aboriginal diets. A tropical fruit, the billygoat plum, is the highest food source of vitamin C that exists (3000–5000 milligrams per 100 grams). Aboriginal groups dried fruits by leaving them on the bush or ground where they grew, naturally preserving the fruits through dehydration.

Yams were soaked, sliced and sun dried, then reconstituted when they were required. Suitable foods were grated with woven pandanus leaves. The leaves were draped over a coolamon and used to grate roots. The coolamon was also used to separate grains from their husks.

Fruit was mostly picked and eaten on the move. Occasionally it was taken back to the camp and shared with others.

The extremely poisonous quandong nut was used by the Aborigines after it had undergone a rather unique processing. The cassowary (a large bird) can eat these nuts without being affected by the poison. The nuts pass through the bird's body and are detoxified in the digestion process before being excreted. Aborigines collected the detoxified nuts from cassowary faeces, then carefully washed and roasted them. Cycad nuts also are extremely toxic if eaten unprocessed. They were hulled, roasted and soaked for a number of weeks in a creek, then ground up and made into a white porridge. Sometimes the porridge was made into small cakes which could be kept for days. These cycad nut cakes were often used at ceremonial and trade gatherings which occurred at various times of the year.

Native foods today — bush tucker

Bush food refers to the plants and animals eaten by Aborigines when the colonists arrived. These days, bush food is more commonly called bush tucker and includes edible plants and animals native to Australia.

CASE STUDY

FINDING THE RIGHT BUSH TUCKER

by NATASCHA MIROSCH

More than 200 years ago the first ships arrived from England stocked with plants and seeds from the UK to propagate and provide food for the new settlers.

. . . the representatives of the king claimed the land to be empty of food . . .

It was even said by some settlers that the Aborigines 'didn't eat anything at all'. Over the past decade or so, we've started to respect the native owners of the land and their understanding of bush tucker and to acknowledge that if we don't take an interest that expertise is in danger of being lost.

'There's so much we don't know,' says horticulturist Joanna Roberts.

'For example, there are plants that are toxic, but indigenous people knew ways of leaching out that toxicity and making them edible. As yet we don't have that knowledge but I hope there is someone out there who still does . . .'

. . .

These days it is native plants, particularly the ones supplying food, that excite her. 'I don't really understand why there hasn't been the interest before. I guess it's because it was a hunter-gatherer society we ousted, but things are changing and people seem really interested,' she says.

This year Roberts introduced her bush tucker course . . . 'Bush food is very interesting, particularly locally . . . an area of exceptionally high biodiversity . . . where the northern and southern faunas and floras of Australia meet . . . allowing us to grow both temperate and tropical plants.' . . .

. . .

Roberts has restricted her own study to the area around south-east Queensland and the edible bush plants of Brisbane, in particular. Take a walk, she suggests, and we will discover a veritable fruit and salad bowl at our doorstep. 'Wombat berries, for example, are everywhere. They are little climbers with orange berries and edible tubers. The berries are not that great, but the tubers you can eat raw as part of a salad. You just dig them up and cut up as part of a salad. It's a bit like a mild-tasting radish . . .'

. . . 'Native violets are edible, the leaves and the stalks are very pleasant in a salad and look very pretty. Lemon myrtle grow in a lot of backyards too, and are even used as street trees.'

Growing in popularity both as an ornamental plant and for its edible fruit is the lilly pilly. 'At the moment the lilly pilly are just coming into fruit, with a pretty pink fruit that is completely edible. You can make a jam, stewing them with sugar. I chill them, then add to champagne for an adult flavour. You can eat the berries raw, too, in a rainforest salad.'

The hibiscus flower is another plant she recommends for keen native cooks. 'The more common ones we are used to seeing are Hawaiian, but the native hibiscus has a really huge flower. . . . I take the petals off and press between paper then freeze and use just like vine leaves to wrap things. If I'm doing a real south-east Queensland dinner, I might mix macadamias with bunya nuts and a bit of cooked Moreton Bay bug or prawn, wrap them up then pop in the microwave for 20 seconds to "shrink wrap" them.'

Roberts also uses the blossom from the wattle to make a wattle blossom cake. 'Wattle seed cake has become popular but you can also use the blossom,' she says. You can freeze the flowers for up to a year, Roberts says, and simply substitute for the quantity of flour in the recipe . . .

Source: The Courier-Mail, 3 December 2007.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *foods native to Australia* to complete the tasks ahead.

1. What kinds of native foods are creating the most interest these days?
2. How does Joanna Roberts suggest native violets, lemon myrtle, lilly pillies and wattle blossoms could be used in cooking?
3. Why would the hibiscus flower act like 'shrink wrap' when filled with food and rolled?

The Lilly Pilly Bellini is a novel way to make a champagne cocktail.

Recipe for the Lilly Pilly Bellini

1 cup lilly pillies, seeds removed
½ cup sugar
½ cup water
2–4 mature lemon myrtle leaves
glass of champagne, sparkling wine or soda water

1. Poach the lilly pillies in sugar and water with the lemon myrtle leaves.
2. Remove leaves and allow to cool.
3. Spoon some of the poached fruit plus syrup into a champagne flute, and top up with rose champagne, sparkling wine or soda water. Stir gently.

REVIEW QUESTIONS

Remember

1. Aborigines dried fruit by _____ .
2. Yams and bush onions are from the _____ part of the plant, while bush apples and wild plums are from the _____ .

Apply

3. Why did the Aborigines have such a varied diet?

Do an activity

4. Log in to **www.jacplus.com.au** and locate the *Bush food* weblink for this chapter.
   a) Use the weblink provided or use a search engine such as Google to find out about dugong. Describe what a dugong looks like and how it moves. Why were the Aborigines able to catch such a large animal?
   b) List six native food sources.

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Weblink

Global migration of cultural groups to Australia

Throughout Australia's history, each arrival of large groups of people resulted in increased food availability because each group introduced, grew and prepared the familiar foods of their homeland.

Colonial food production

When early European settlers came to Australia, they expected to eat the foods they knew. The plants and animals they saw Aborigines eating were unlike anything they had ever seen. So, at first, the settlers relied on staple foods brought from their homeland. Every ship's arrival brought rations of beef and salted pork, biscuits, dried peas, butter, wheat flour or grain, and rum or gin.

As time passed, attempts to cultivate foods failed and supplies ran short. Medical officers were sent to investigate native supplies and were able to add a few native plant and animal species to the food rations. Native spinach, native celery, native parsley, wild currants, the edible heart of the cabbage palm, fish and game such as brush turkeys were added to the settlers' diet. However, the range was nowhere near the varied and nutritious diet of the Aborigines. The settlers' poor health was the result of a diet distinctly lacking in fresh fruits and vegetables.

Many governors of the colony took steps to increase the local food supply. These actions laid the foundations for the Australian food industry as we know it today.

Vegetables and fruit

Early attempts to grow fruit and vegetables in Sydney Cove were not successful. A government farm was established on the rich soil at Parramatta in 1789, and the resulting crops were used to supplement the rations given out from the military stores. Fruit and vegetable production involved largely human labour because there were not enough animals to pull the ploughs. This made the process slow and tiring.

The lack of food in the colony between 1788 and 1791 forced Governor Phillip to bend the original rule which banned convicts from growing their own produce. As a result, convicts were given garden allotments and were permitted to eat anything they grew to supplement their meagre rations. Previously, it had been mandatory to give any food grown in the colony to the military stores for distribution as part of rations. Australia's first market gardens and orchards developed from grants of land given to convicts.

Milk and milk products

A few officials were able to keep a house cow, but there were few dairies in the early colony. In 1805 a dairy was established at Ultimo in Sydney. Those who were able to obtain milk produced a range of milk products, mainly butter and cheese.

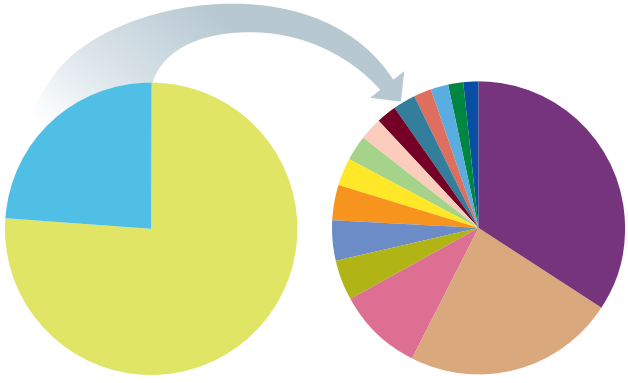
Fish

Fishing was done on a casual basis until the early 1800s, when Sydney fishermen began to meet at the Hospital Wharf (now Circular Quay) or at Cowper's Wharf at Wooloomooloo. Fishmongers bought the fish and sold it from their carts in the street.

Cereals

From 1789 wheat and barley were grown at Parramatta and given to military stores for use as rations. Some free settlers also grew grain for their own use, or fed it to animals, because there was no free marketplace in which to sell the surplus. The only market was the government, which bought grain from settlers to supplement supplies from Government Farm. Excess produce could not be exported because of the charter (a legal agreement) signed with the East India Trade Company which prevented trade with or by any other shipping company in the colony. By 1793 Parramatta and the Hawkesbury River areas were the largest producers of grain in Australia.

Migrant groups to Australia 1830–present



Australia's population, 2006

Main countries of birth of those born overseas

Things are constantly changing. If you were to look at the make-up of Australia's population in ten years' time, you would find a change in the percentages of different migrant groups to those shown in this graph.

Source: ABS, Migration Australia 3412.0.

Since 1830 large groups of people have migrated to Australia bringing their staple food preferences and their traditional methods of preparing food. After several generations, the national dishes of various cultures have become part of the overall Australian cuisine. Most people in migrant cultures are not first-generation migrants, but have parents or grandparents who were born overseas.

The following timeline may help you understand the role of migrants in the changing diet of Australians.

- *1830* — Germans migrated to South Australia, particularly around the Barossa Valley. They established vineyards for winemaking.
- *1850s* — The Australian Gold Rush brought people from all over the world. The idea of wealth may have attracted the migrants in the first place, but many liked the climate and found too many opportunities to make a good living, so they chose not to return to their native lands where times were hard.
  - Chinese migrants stayed on as labourers, shepherds and shearers in Queensland and New South Wales. They also operated laundries, stores and restaurants. Many staple vegetables of the Chinese community were not available, so they began to grow vegetables such as bok choy and bean sprouts. The Chinese stir-fry meals, cooked using a small amount of oil and quick heating, were very different from the roast dinner and heavier meals that the English and Irish settlers were used to eating.
  - Scandinavians settled in Victoria and were responsible for setting up the dairy industry, starting with butter and cheese. The Scandinavians' love of crispbreads, cheesecake and smorgasbords was new to the British settlers.
  - A large Greek community established in Victoria, mainly in the Melbourne area. Their love of vine leaves, fetta cheese and filo pastry intrigued the other residents.
  - The first wave of Americans brought implements for farming and cooking, rather than distinct foods or methods of meal preparation.
- *1880s* — A large number of Italians came to work in the sugarcane fields and timber mills in Queensland. Many eventually settled near Sydney and Melbourne. They grew fruits and vegetables, and established a flourishing cheese industry (especially in ricotta cheese).
- *1920s* — The second significant group of Americans arrived and set up factories producing cereal products (Kellogg's), soups (Heinz) and cheese products (Kraft).
- *1940s* — The Americans based in Australia during World War II brought Coca-Cola, hamburgers, tinned sweetcorn, dried vegetables and some frozen foods. A significant number of Lebanese came to join family members who had migrated here at the end of the previous century. Many opened milk bars and the introduction of Lebanese traditional dishes such as tabouli, falafel and hummus increased.
- *1960* — The American fast-food chains of McDonald's, KFC and Pizza Hut were introduced to Australia.
- *1970s* — Australia opened its doors to a large number of Asian migrants from Cambodia, Thailand, Vietnam and

South Korea, who introduced noodles as a staple alternative to boiled rice.

- *2000s* — In 2005–06, 24 per cent of the Australian population was born overseas. Persons born in the United Kingdom continued to be the largest group of overseas-born residents, followed by New Zealand. In the last 10 years, to 2007, of the 75 most common countries of birth, there was a 22 per cent increase in the number of Sudanese coming to Australia. By the beginning of 2008, the Australian Bureau of Statistics expected that there would be one international migrant arrival for every 3 minutes and 5 seconds.

REVIEW QUESTIONS

Remember

1. In the 1850s, _____ brought people from all over the world to Australia. Many did not become rich but decided to stay, such as the _____, _____ and _____. During the 1940s, Americans brought _____, _____ and _____.

Apply

2. Below are the ingredients for a mixed salad. Identify the culture responsible for each ingredient.

Cultivated salad

a) Spinach
b) Cubes of fetta cheese
c) Bean sprouts
d) Sweet corn
e) Crisp fried noodles
f) Finger limes
g) Bacon bits
h) Red wine and oil salad dressing

Do an activity

3. a) Draw a pie chart showing the statistic that one in four people were born overseas in 2006.
b) Draw a bar graph showing that in 2005–06, there were 180 000 permanent additions of migrants, 72 per cent more than the number in 1996–97 (105 000).
c) In a diagram of your choice, show that in 2005–06 through the Migration Program, 50 per cent of permanent migrants entered because their skills were needed in Australia, 25 per cent for family reasons, 10 per cent for humanitarian reasons, and 15 per cent for other reasons.

Technology and food

Technology influences the amount and type of food available. Technology applies to the following in the food industry:

- processes, for example, sterilisation of canned food
- machines, for example, microwave ovens
- tools such as a whisk, sifter, vegetable peeler
- systems, for example, ordering, shipping and distribution of products for a supermarket
- products, for example, the making of yoghurt
- resources, for example, coal burned to produce electricity; water used to wash salad ingredients.

In the late 1700s colonial settlers used simple technology; the processing of food such as the grinding of wheat and salting of pork was done the same way it had been for hundreds of years. Until the Industrial Revolution made its way to Australia, in the early to mid 1800s, machines were powered by manual labour; tools were only as good as the smith who made them; the transportation system was limited by the roads built; and the range of products available was just beginning to expand with the inclusion of native foods. The first processing industry to be established was flour milling, followed quickly by a brewery (you might know that rum was used in the early settlement as a form of currency).

Even from the earliest times, food has been processed in some way to make it more suitable for human consumption. The difference is that now we have harnessed technology to help us produce a wider variety of food that can also be stored for longer periods. Changes or improvements in one area of technology have also led to benefits in other areas. For instance, it is now possible through gene manipulation (genetic modification) for some plants grown on land to produce omega-3 oils. Omega-3 oils are considered healthy oils and are normally found only in fish. Technology has also made it possible to:

- preserve food so it can be stored for long periods and still be safe to eat
- maintain a constant food supply that is generally wholesome and constantly changing
- eat foods that are out of season
- eat foods produced in other parts of the world
- produce foods that bear little resemblance to the foods from which they were made
- transform one raw food into numerous products
- have an endless variety of food in our daily diets.

Today's food industry uses large-scale, highly technical machinery to mass produce foods similar to those that used to be made by a good cook in a domestic kitchen. Many of the changes made to food processing equipment have occurred in the food industry and these are discussed in chapters 11 and 14. We will, however, look briefly at the important changes technology has brought to commercial food processing over the past 150 years.

Food technology allows us to produce many new and innovative products — even chocolate soccer balls.

Technological change and equipment

Modern large-scale milking is done by machines in minutes (dairy farmers get about 30 cents per litre so speed is essential) and the comfort of the cow is ensured by Animal Rights groups. Milking by hand is time consuming and is a difficult skill to learn.

The following factors have led to dramatic changes in the way our food is processed:

- The availability of electricity opened the door to a whole new way of life. It brought about changes in production methods in industry and in domestic life. Electricity allowed for the development of many of the appliances and equipment used in food preparation.
- World War I and World War II required large amounts of food to be produced and preserved quickly. The food also had to maintain its quality during transportation. New equipment and methods of food manufacture were invented in response to this need.
- Plastics became widely available and were used in the production of new equipment and packaging.
- Manufacturing methods were streamlined to increase the speed of production. Automated machinery, assembly-line production techniques and computer technology have all increased the rate at which goods are produced. This has improved efficiency, making goods cheaper and within the reach of the average consumer.

Technology used in food storage and distribution

For a food industry to be successful, it must be able to supply consumers with food products of acceptable quality whenever and wherever they want them. This means that facilities must be designed and built to protect foods from contamination and spoilage before processing and distribution. Technology has enabled the development of sophisticated storage systems such as those used for apples and other fruit. The environment for storing apples, for example, must be carefully controlled to stop them from ripening too early and to stop micro-organisms from growing. Levels of oxygen, carbon dioxide and ethylene (gas given off by many fruits during ripening), as well as moisture content, are controlled in the storage environment.

Fresh foods are normally transported in refrigerated containers set at the temperature that the food requires to stay at its best. The refrigerated container comes in a variety of sizes and can be loaded onto trucks, trains or ships. What would happen if the temperature was set too low or the refrigeration compressor broke down?

Distribution networks are essential for processed foods to reach their point of sale. Food may be transported by road, rail, sea or air. The type of transportation used is determined by the physical qualities of the food, the quantity, and the distance to be travelled. The cost of transportation is included in the price that consumers pay for the food, so it is in the best interests of the company to use the cheapest effective method of distribution.

Foreign-aid workers in developing countries have recognised that one of the biggest problems in providing famine relief is getting food to the people in need. Unfortunately, many countries do not have efficient road or rail systems, so the distribution of food is very difficult.

Technology in the marketplace

A marketplace is the location or environment where consumers purchase the products they need. Once, people sold goods only within their local area, but today many companies sell their goods internationally.

The international marketplace exists because countries try to sell products to other countries as a means of bringing money into their economies. It means that we are able to buy foods from all over the world in our local supermarkets. Goods may be imported as a raw product, for example, strawberries brought in from the USA to be sold when they are out of season here; or a product (such as canned pumpkin) may be processed overseas and then imported. When goods are processed to increase their selling price they are said to have **value added**. Most companies and countries try to sell value-added products because this increases the selling price of the product and therefore the profit. It also means consumers are able to purchase foods which require less preparation.

Before the 1930s Australians shopped in small stores such as the butcher's shop and the bakery, which specialised in only a few items. Food was fresh as storage conditions were limited. The general store sold basic items but usually there was just one brand name available for each item. Store owners allowed regular customers to keep a store account and pay for food purchases at the end of the month. Delivery boys were employed to help customers take the products home. The whole manner of shopping was slower and less complicated.

However, there were drawbacks to this system:

- Small shopkeepers could not afford to keep a large variety of similar products.
- Customers had limited opportunity to purchase sale items.
- Foods were weighed on scales or counted by hand and put into paper bags, so shopping was time consuming.
- Shopping involved frequent trips to the store because the purchaser often had to carry bags home rather than drive home in the family car.

During the 1930s supermarkets began to appear in Australia. The variety of products available grew rapidly and, today, products that consumers want can be made by several companies. For example, strawberry jam is made by Cottees, IXL and Dick Smith to name just a few. Larger supermarkets can display more products from a range of different producers and many supermarkets now also produce their own generic brands.

Many people like to do their shopping quickly, without feeling the need to have a long, friendly conversation with the cashier. The range of products from which to choose is varied, and many supermarkets also include specialty sections with meat, seafood, bread and so on under the one roof.

The use of modern technology is prevalent in our present marketplace. Electronic scanning devices read product barcodes, register the price and record product sales. Store credit is no longer available, but most large supermarkets allow customers to pay by credit card or by EFTPOS (electronic funds transfer — point of sale). Some stores offer a 'shopping by phone' facility whereby customers phone their order through to the supermarket and make arrangements to either collect the food themselves or have it home-delivered.

Since the 1970s, opening hours for convenience stores and supermarkets have been increasing to the point that, today, these shops can be open till late at night most days of the year, or even 24 hours a day and 7 days a week. The popularity of shopping online is increasing, given it saves time. This method of shopping is useful for housebound, disabled or elderly people with no transport because food is chosen from an electronic list via the internet and paid for electronically, removing the need to leave home to go shopping.

CASE STUDY

MANY VINTAGES ON AND STILL BEARING FINE FRUIT

by LIA TIMSON

Brown Brothers' IT system is best when conservatively tended.

Like wine, technology matures with age and should be plied for its subtleties. Changing the blend for change's sake is unwise. At least that has been the IT philosophy at Brown Brothers, which has had one enterprise software supplier for eight years.

'Back in 1998, we realised we needed to expand our thinking to the ways the business might change in the future,' says Cam Saunders, chief information officer at the 150-year-old family owned winery. 'One focus was IT and the need to look into ERP (enterprise resource planning) because we needed the infrastructure to grow and be dynamic.'

Back then Brown Brothers produced much less than today's one million cases of premium wine a year. Then it catered only to liquor stores and its own cellar door. Today its output goes to retail stores, the hospitality sector, and 20 export markets. Five company-owned vineyards in Victoria split fruit production with dozens of outsourced growers who demand careful management.

'We realised a few green (screen) PCs weren't going to scale to meet demand in 10 years (time),' Mr Saunders says. The company appointed JD Edwards to supply the ERP system on the understanding that both companies would grow together.

Eight years and two take-overs later — JD Edwards was bought by Peoplesoft and recently Oracle — that commitment still stands, says Mr Saunders. 'They flagged to us that they wanted to go into the beverage industry and CRM, so we had first chance to get a look into new modules.'

JD Edwards' EnterpriseOne works in conjunction with a winery management system the company has had for years from Total Systems for Management. It administers the fruit and other component supply, and the process of winemaking. EnterpriseOne takes over when the wine is bottled. It manages the data process from packaging to delivery and financials.

Above both sits Cognos, which aggregates data from the two systems and produces supply and demand reports.

In the eight years since implementation, there hasn't been a new initiative, new pricing or trading terms that we haven't been able to accommodate. And that's significant because we've grown a lot,' Mr Saunders says, citing an 80 per cent revenue rise in that time but only 10 per cent increase in staff. Brown Brothers has about 250 employees.

Remarkably, the winery has stuck to its no modification dictum, handed down by three generations of Browns. It has adopted each software upgrade without altering a single line of code.

'We don't even have developers on staff. For our size, it's not affordable to modify code and reapply the modifications every time there's an upgrade. I like to beat my chest about this because while it may sound like a constraint, it works for us. Even though we are complex and diverse, there's nothing particularly unique about our business. Someone else . . . is doing this. Sometimes we can learn from that.'

Mr Saunders is planning for the next upgrade in September, when EnterpriseOne will become web-enabled. 'The web-browser interface will be different for our users but there are a number of positives in terms of maintaining (the data) on the system. We will move from thick Windows applications to thin web-browser applications.'

It will also offer new modules that the company has not yet decided to adopt, such as supply management and data collection. For now it prefers to concentrate on the complexity of managing long grape growing lead times in a market where demand trends can change almost overnight.

'Our role in IT is to make sure we're continuing to enable our competitive advantage through good reliable systems that deliver trusted information. The key here is that you can have systems but you always have to do things for the right reasons and out of passion for the brand.'

Next lessons

Problem: Ten years ago, Brown Brothers was an emerging boutique winery with only a few DOS PCs.

Process: A 10-year plan saw JD Edwards appointed as enterprise resource planning supplier on the understanding that both companies would perfect their businesses and grow together.

Possibilities: A new web-enabled ERP version will allow faster data maintenance and analysis from September.

Source: The Age, 2 August 2007.

OUTCOME TASK **RESEARCH ASSIGNMENT**

Students learn to:

- outline the historical changes to food availability in Australia.

Contributes to the following outcome:

- identifies and discusses a range of historical and contemporary factors which influence the availability of particular foods.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of the *influences on food availability* to complete the tasks ahead.

1. Enterprise resource planning can assist businesses such as Brown Brothers to manage their business successfully, such as when application software is used, for example, to assist the business in product planning, purchasing, maintaining inventories, interacting with suppliers, providing customer service and tracking orders. Explain how technology is used to advantage at Brown Brothers winery.
2. Interview an elderly person or someone who has worked in the food industry for many years, for example, a milk-bar owner, greengrocer, butcher, restaurateur, caterer or factory worker. Focus your interview questions on:
   a) technological changes that have occurred in the interviewee's lifetime or during their employment
   b) how these technological changes have altered the quantity and variety of foods available.
3. Arrange a class excursion (or go by yourself) to a supermarket and another store of your choice such as a gourmet food shop.
   a) Copy and complete the table below on different aspects of each shop.
   b) Produce a list of the advantages and disadvantages of shopping in each type of store.

POINTS OF COMPARISON	SUPERMARKET	STORE OF YOUR CHOICE
How is food stored before the consumer purchases it? What technology is used to ensure it is safe for consumption?		
How is technology used to ensure the consumer is served quickly?		
Was the business clean? What steps has the business taken to ensure the food is not contaminated before you buy it?		
Does this business also operate an online food business?		
Are there a variety of different brands sold? Name some of these.		
What systems are in place to ensure consumers are served promptly?		
Comment on whether the shopping experience was personal or impersonal. For example, was the staff friendly and helpful?		
Other observations		

Influences on food availability

We often hear the words 'politics' and 'economy' on the news, or read them in headlines in newspapers. These topics are often discussed, but what do they mean? You probably know that they both have something to do with money and government. Politics refers to our system of public administration or government. The economy is the framework that the government establishes and uses to regulate the production, distribution and consumption of goods and services so that it can satisfy the needs of the population.

Economic influences on food availability

An economy that is strong means consumers have enough money to purchase goods and services. Consumer spending sends a message to producers to produce more, thus increasing the selection of items available to the consumer. Australia has a **market economy**, which means that the production and distribution of goods and services take place largely through private enterprise, and price is determined by demand and supply. It is, therefore, producers and consumers who are dictating what food is produced, how it is distributed and how much we will pay for it. The government does play a role, however, by regulating the economy to ensure we continue to prosper, and by ensuring that private enterprise abides by legislation pertaining to the proper supply and distribution of food in our economy.

Large, stable economies, like Australia, attract the interest and investment of foreign companies that wish to secure a share of a profitable market. The economy then attracts more consumers and continues to grow. Most developed countries have fairly strong, stable economies, particularly when compared with the economies of many developing nations.

In Australia our economy is dominated by the services sector, but our agricultural and mining sectors account for 65 per cent of our exports (see chapter 8 for more detail about our economy). Australia is a prosperous country and **absolute poverty** is not prevalent. In contrast, economies that are weak produce barely enough food for their people. These countries usually have:

- large populations and larger families
- poor medical services
- little technology
- few manufacturing industries
- unstable governments.

Countries relying on agriculture are often developing countries with low levels of technology. Often there is not a surplus of food produced, and what is grown tends to be shared among the people in the local community. This is called **subsistence agriculture**, and the simple economy based on it may be referred to as a subsistence economy. Countries with agriculturally based frameworks depend on the weather for the maintenance of their economy, so natural occurrences such as too little or too much rain can affect economic growth over a few years.

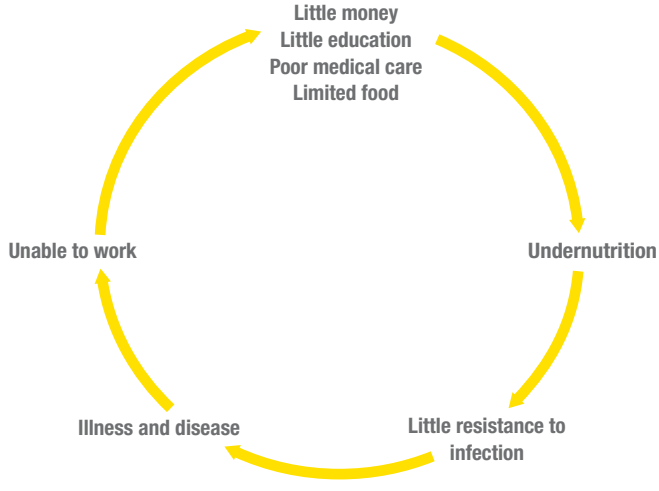
Some developing countries rely on the production of one major crop to support their economies — for example, coffee, sugar, tea or bananas. (The reasons behind this limited agriculture are discussed later.) Countries with such a limited economic base rely on world commodity prices for their standard of living. They suffer if there is any lowering of the prices paid for that agricultural product on the world market.

Poverty and its effects

Quality of life refers to the extent to which a person has their basic needs for food, clothing and shelter met. Some people also interpret quality of life to include personal happiness. Money can make the difference between living comfortably where a person's basic needs are met, or living in **relative poverty** where one or more of a person's basic needs are not met due to lack of money. Those living in relative poverty have a standard of living below the rest of the community. In affluent countries like Australia, where there is a plentiful supply of material goods and the economy is prosperous, there will always be a percentage of people who struggle in relative poverty.

In contrast, absolute poverty exists where individuals and communities are unable to supply any of their basic needs for long periods of time. This constant lack of money to buy the basics is common in developing nations.

Developing countries struggle to feed their populations and their life expectancy is lower as a result of **undernutrition**. Without a nutritious diet the body is unable to function to its full capacity. It is more susceptible to disease and has greater difficulty fighting infections and regaining optimum health. The body's energy levels are lowered as a result of the continual infections and insufficient food. Consequently, an individual's ability to complete physically demanding work such as ploughing and sowing crops is greatly reduced. In the subsistence economies of developing countries, such physical incapacity means that the year's food supply is greatly reduced. This chain of events is referred to as the **poverty cycle**.



Poverty is a vicious cycle that is hard to escape.

Producing food in developing nations

The United Nations World Food Programme (WFP) uses money donated by wealthy countries to feed the hungry and those people suffering because of natural disasters such as tsunamis, earthquakes and hurricanes. The WFP money buys food from the farmers in developing nations. The food is then distributed (through non-government channels) to those in need — often people in other parts of the same country or those in neighbouring countries. With the money the farmers earn, new equipment can be purchased, better irrigation systems can be put in place and improvements can be made to storage facilities. Corporations are set up to trade internationally on the global market.

Because plant staples provide the bulk of their dietary intake, people in developing countries need their crops to produce a high yield to survive. Most people in these countries lead a subsistence existence; that is, they rely on the annual crops that their family or community produces to supply their food needs for that year. If their farming yield is low, famine and malnutrition result.

The yields produced in developing countries are much lower than those attained in developed countries, because of one or more of the following situations:

- Over-cropping of soils — the soil is not allowed to lay fallow for a year because often there is limited land available for a family to grow food. Crops are planted year in and year out without giving the soil a chance to replace the nutrients lost. Faced with the choice of low yield or no yield, farmers plant continuous crops so that there is at least some food to feed their families.
- Low levels of technology
  - technology is required to produce good quality fertilisers to improve every kind of soil, and specific fertilisers are chosen depending on what plants are to be grown. There are different types of fertilisers for acidic, alkaline, sandy, clay, rocky, weak or rich soils. Fertiliser can be further divided into organic and chemical types. Using fertiliser adds to the expense of producing food.
  - the types of machinery available for tilling, planting and harvesting by subsistence farmers are basic, requiring animal or human labour to operate them. Even if a farmer does have a tractor, for example, getting the fuel to operate it can be difficult.
  - incorrect storage of grains for the next season's planting can result in damage by insects, rodents and moulds or fungi.
- After a few years of drought, a flood or some other natural disaster, many people are forced to leave their land, and they drift to towns or cities looking for food and work. A subsistence economy does not have large reserves of food for when crops fail, so a life and death situation occurs. Aid organisations set up famine relief in an effort to help the starving people.

Social justice

Social justice is a loose term that is open to interpretation. One important factor is the provision to all members of the community all that they require to sustain a mentally and physically healthy lifestyle. In relation to food and nutrition, as you read earlier in this chapter, a stable society should meet basic human needs such as access to clean water, food and shelter. The issues surrounding poverty and developing nations have been addressed in some detail, but what about the over-availability of food in developed nations? Is there such a thing as food being *too* available?

The growing problem of obesity in Australia indicates that most of us have ready access to the foods we want. However, we have access not only to fresh produce and grains that benefit us nutritionally, but also to highly processed foods in our supermarkets and fast-food outlets. This can result in our consuming more than is nutritionally required. Just as being underfed, and therefore missing out on important nutrients, is bad for your health, so is overeating and an excess of particular nutrients. Both are described as malnutrition.

This over-consumption has an economic impact on the community, as it creates health problems for individuals, who may then require health care. It also creates a need for expensive government initiatives to address the issue of unhealthy lifestyles. One such initiative is the NSW government's Live Life Well scheme, launched in 2009. This broad initiative focuses on many aspects of social health issues such as child obesity prevention, health through fitness, and legislation to encourage healthier food choices, like banning soft drinks in school canteens. Obesity sometimes has hidden social costs. Overweight individuals are susceptible to low self-esteem, increased anxiety, lack of motivation and depression. Each of these effects can require health care interventions, such as psychological or psychiatric assistance, or even surgical measures. Cosmetic surgery, for example, is increasingly popular but does not solve the underlying nutrition and health issues. It is a quick fix that does not always educate people on how best to live a healthy lifestyle supplemented by good nutrition; it is also an expense to the nation's economy.

It is interesting to compare the ways different cultures view weight issues. In India, for example, obesity can

indicate high status within the social hierarchy or caste system. India has a huge gap between rich and poor, and a relatively small middle class. Millions of poor people with limited access to food are nutritionally disadvantaged. In this context, to carry extra weight is to display your wealth. This affects the society in terms of the citizen's ability to function, psychologically and physically, as a member of the community.

As the world population grows, demand on food crops increases. At the same time, in developing countries the middle class consumes more meat in their diet. This creates tensions, as farmers and governments decide what type of food to produce. Social justice needs to balance the rights of the local community to access basic foods with the benefits of trade offered by the export market.

There are aid schemes in place in developed nations to assist developing nations with food growth and education on the benefits of nutrition that may be achievable in the community. These schemes attempt to bridge the gap of inequality between nations, but the gap is a substantial one.

REVIEW QUESTIONS

Remember

1. Identify reasons why world hunger has decreased and the figures for overweight people have increased in recent years.

Apply

2. Investigate Australia's statistics on obesity. How do these compare with America's statistics in the World Watch article?
3. Explain why each of the following is a contributing factor in child malnutrition:
   - level of education for women
   - access to health care
   - gender discrimination.

Do an activity

4. Create a proposal for a new health initiative to educate adults on healthy eating and nutrition. Include food and meal suggestions and ideas on where best to source fresh produce.
5. Do you consider food availability to be a contributing factor in malnutrition? Discuss this with consideration for underweight and overweight individuals, also keeping their environments in mind.

Political influences on food availability

As stated earlier in this chapter, the government of a country establishes and uses a framework to regulate production, distribution and consumption of goods and services in a way that the government thinks best suits the needs of the population. For a government to function, it must have the resources to implement strategies and policies. Governments raise funds through a number of ways:

- overseas loans (called the foreign deficit)
- the sale of assets (such as crown land)
- taxes.

Countries with stable economies can borrow money on the world market. If a deficit becomes too large, taxes may be raised to help repay loans. Increasing taxes mean consumers have less disposable income, and inflation may occur because producers react to higher taxes by increasing prices. The number of people living in relative poverty is likely to increase because of declining living standards. Those on lower incomes must resort to buying cheaper food and luxury items are forgone.

The economy of a developing country is usually less stable and with high inflation rates because of the interest rates on foreign debts. There are more people on low incomes and the overall standard of living falls to a level that we in Australia find hard to imagine (absolute poverty). Foreign aid and international assistance with debt relief on money already borrowed are external resources that help to stabilise the economies of developing countries. Internally, the corporations set up with the help of the World Food Programme, are selling food commodities in the global marketplace and are taxed by the government.

In developing countries, people are often divided into two categories: very rich or very poor. Those with the power to make political decisions are among the rich, and often their decisions assist the wealthy sectors of the population rather than the population as a whole. Misdirected government priorities (for example, India's nuclear weapons programme) mean that a country may spend its limited amount of money on projects that do not improve the conditions and lifestyles of the poor.

Many governments in developing countries have also allowed multinational corporations to use their agricultural land for the production of non-food crops. (**Multinationals** are large companies that have businesses spread throughout the world, which means that no single government holds them responsible for their business dealings.) Prime farmland is made available to these companies for the production of **cash crops** such as coffee, tea and tobacco. At first, cash cropping may seem like a good idea. The multinational company is seen as bringing money into the local economy. Local people receive an income for working the land, and they can use that income to purchase food grown by others. But in countries where food shortages are common, this sale of the land for non-food crops is a serious concern.

It is not unusual for a developing country to experience civil unrest. Internal fighting within the country or wars with neighbouring nations directly affect the production of food. Not only are crops damaged during the fighting, but fewer crops are planted because adult males are taken from the farms and put into military service. Much of the food that is produced is allocated as rations to feed the troops, so many communities are faced with even greater food shortages.

REVIEW QUESTIONS

Remember

1. True or false?

a) Technology allows us to have a wide variety of food to choose from each day.

b) Processing a food in some way before sale is called value adding.

c) Inflation improves people's living standards.

d) Over-cropping can result in more income for the farmer.

e) A market economy exists when a government owns most basic industries.

Apply

2. What is the difference between absolute and relative poverty?

3. Explain why Australia cannot be called a developing nation.

Do an activity

4. Collect three small crusty bread rolls and re-heat them using the following forms of technology:

Bread roll no. 1 — heated in the oven for 8 minutes at 180 °C

Bread roll no. 2 — heated for 45 seconds in the microwave on medium low

Bread roll no. 3 — heated by placing it in direct sunlight for 20 minutes.

a) Compare the rolls by completing the chart below.

WHAT TO EXAMINE	ROLL 1	ROLL 2	ROLL 3
Outside crust			
Inside temperature			
Inside texture			
Taste			

b) Which is the best form of technology to re-heat a crusty bread roll? Would the same be true for a soft bread roll?

The influence of the Australian government on food availability

Australia is a small but multicultural country. Given our relatively small population, it would be impossible for our food industry to produce the variety of foods on our supermarket shelves and still be economically viable. To cater for the food preferences of our varied population we import products from all over the world. Almost any food you wish to eat can be purchased here in Australia, as long as it complies with our food safety standards.

In recent years the Australian government has departed from its policy of protection. Protection can be defined as any action a country takes to give domestic producers an advantage over imported goods. This means that the government, through a system of **tariffs**, **embargoes** and **subsidies**, is able to regulate the movement of foreign products onto our supermarket shelves. The terms are explained in more detail below.

TRADE RESTRICTION	EXAMPLE
Embargo — a ban or restriction put on good(s) from a particular country for health reasons or because of its political actions	Imported fish could be stopped if it was found to have high mercury levels which would harm a foetus.
Subsidy — a cash payment made by the government to a local producer who can then charge the customer less and compete with cheaper imports	No subsidies are given to the Australian food industry at the moment; however, some countries provide subsidies for their local industries. For example, the United States gives a subsidy to its lamb producers, which makes it more difficult for Australian lamb producers to export to the US.

The Australian government has moved towards a policy of 'trade liberalisation', meaning that it has sought to lower the protection offered to Australian industry in the hope that this will make our companies more competitive on the world market. It is also hoped that if Australia removes its trade restrictions on imported goods, then other countries will do the same and our export markets will thrive. In fact, most other countries around the world have lowered their tariffs and Australia now exports to 150 countries worldwide without having trade restrictions imposed. According to the Australian Department of Foreign Affairs and Trade, over the past 25 years, manufacturing output has risen by around 40 per cent and the volume of exports has risen fivefold despite declining tariffs. Removing trade restrictions also means imports are cheaper. For example, as a result of a **free trade agreement** with New Zealand, NZ beef can be sold in Australia without a tax (the downside is that Australian beef producers are not enthusiastic about this).

It is important to note that governments can give local producers assistance in the form of a financial payment when disaster strikes. For example, the Australian government offered assistance to wheat farmers during the last drought.

In 1995, the **World Trade Organization (WTO)** was set up to enforce the general rules regarding the volume of and reduction of the amount of trade protection in world trade. Each country that became a member of the WTO agreed to work towards fair and easy movements of goods from one country to another. At that time the aim was to have free world trade by 2020 by:

- reducing agricultural subsidies
- reducing the percentage of products a country can offer protection

- eliminating quotas (the quantity or volume of a product allowed into the country)
- reducing tariffs
- opening markets that have been closed (opening up trade with countries formerly in the Soviet Union).

The 2006 Doha round of negotiations at the World Trade Organization centred on freeing up the trade in industrial goods, services and most importantly in agriculture. On average, agricultural tariffs are more than three times higher than tariffs on non-agricultural goods. It was hoped that Australia could increase the value of its major agricultural exports by 15 per cent by 2011. Such an increase could also lift 32 million people in the developing world out of poverty. The negotiations were suspended because the discussions on agriculture broke down.

Negotiating trade agreements between countries can be a slow process, mainly because local producers want to be able to compete with imports, and with no tariff the import can be priced below the Australian product. Australia has free trade agreements with New Zealand, Fiji and Singapore, and up to 75 per cent free trade with the European Economic Communities and the United States. Currently negotiations are underway with China, Thailand and Malaysia.

Import and export strategies

For an economy to survive there must be a balance between the amount of goods imported into and exported from the country. Australia is consistently ranked in the world's top twenty trading nations. It has previously exported products mainly from primary industry, with wheat, wool and beef sales being very important. But agricultural exports are decreasing. Minerals and fuels are now the largest export sector, followed by the service sector.

Countries choose who they will trade with and who they will not. For a decade, the European Union (EU) wanted to trade between themselves so they placed high tariffs on Australian exports. In response to the EU policy, the Asia Pacific Economic Cooperation Group (APEC) was established. Nineteen nations are involved, the most important ones being Australia, the United States, Japan, China, New Zealand, Hong Kong, Taiwan and South Korea. The aim of APEC is to achieve free trade between member countries. Trade between APEC countries has grown steadily over the past two decades.

If an industry wants to win export markets, it must be competitive on world markets. Since the 1980s, businesses have been thinking of the regional or global market rather than just the local market. An industry must be able to produce a quality product at a price that other countries are prepared to pay. The production quality must then be maintained at a consistently high level so markets are maintained. Government encouragement and support goes a long way towards helping industries achieve these goals of efficiency and quality assurance.

Governments can also assist in the export of food products by funding the research and development of new products and marketing strategies. For example, the Australian government provides Export Market Development Grants to give financial assistance to new and current exporters.

Governments are also able to revise current policies and pass legislative reforms that encourage the efficiency and productivity of industries. They may review taxation policies or implement incentive programs that lower production costs or provide direction for company reforms. They can ensure the establishment of positive industrial relations so that raw foods and processed items reach their markets on time rather than being delayed through industrial disputes. No buyer wants to deal with a supplier that cannot guarantee the delivery of the purchased products.

Taxation

The cost and therefore the availability of food can be influenced by the government's taxation policies. Of particular interest in this area is the Goods and Services Tax (GST), where the government charges a tax on many goods and services at a rate of 10 per cent. Food that is GST free includes most basic foods we eat, for example:

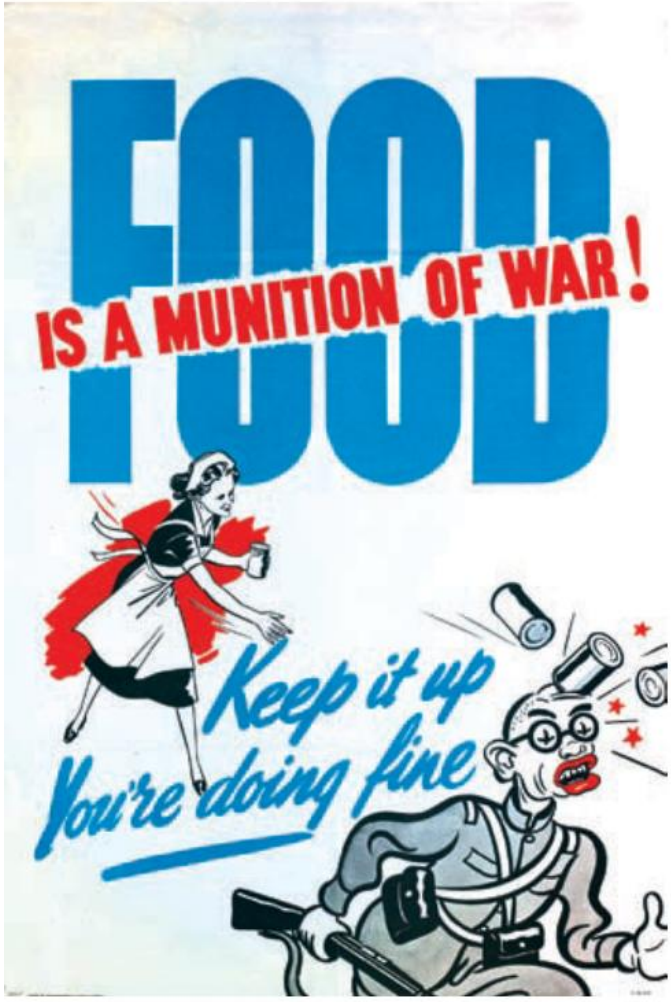
- fruit and vegetables
- meat
- eggs
- bread
- cheese
- soup
- milk, tea, coffee, fruit and vegetable juices (with 90% minimum by volume of juice)
- breakfast cereals
- flour
- infant formula
- sugar.

Ingredients used to make food for human consumption are also GST-free including:

- some beverages and beverage ingredients
- fats and oils marketed for culinary or for cooking purposes.

War

During a war, the government may become more directly involved in the availability and distribution of food. When trade between nations stops during a war, products that are imported are no longer available and there is an over-abundance of the products that are normally exported. Depending on the length of the war and the damage done to food production facilities, the government can take control of food production and distribution. This process is called rationing and it occurred in Australia during World War II.



Food shopping was quite a different prospect during wartime. Even if you had the money to buy the item, you needed a ration coupon to buy the product. It was everyone's responsibility to help the war effort by conserving food. Women were encouraged to grow their own vegetables during wartime.

Source: Australian War Memorial (ART 02127).

REVIEW QUESTIONS

Remember

1. Match the terms with their meanings:
1. subsidy 2. free trade 3. embargo
   a) a restriction or ban on imported products
   b) money paid to help a local producer compete with imports
   c) no taxes on goods between countries.

Apply

2. Open your fridge at home and make a list of ten items that did not have GST applied and five items that had GST applied.

Do an activity

3. Log in to **www.jacplus.com.au** and locate the *Trade* weblink for this chapter. Is Australia importing less, as much, or more food and live animals, beverages and tobacco, now, compared to what it previously imported? (See the table below.)

TABLE 1.2 International Merchandise Imports, Australia, November 2007

	SEPT 2007 $M	OCT 2007 $M	NOV 2007 $M
Food and live animals	608	623	699
Beverages and tobacco	123	160	158
Crude materials, inedible, except fuels	195	268	169
Mineral fuels, lubricants and related materials	2042	2329	2385
Animal and vegetable oils, fats and waxes	38	50	54
Chemicals and related products	1624	1891	1604
Manufactured goods classified chiefly by material	1654	1957	1927
Machinery and transport equipment	6660	7132	7580
Miscellaneous manufactured articles	2133	2353	2278
Commodities and transactions not classified elsewhere in the SITC	482	622	574
TOTAL	**15 559**	**17 383**	**17 428**

Source: Data derived from ABS.

Additional case study

eBook*plus*

Weblink

CHAPTER 1 SUMMARY

- The staple food of a culture is dictated by local growing conditions, the level of technology available, the strength of the economy and government policies.
- Native plants and animal foods in Australia (called bush foods these days) are abundant, varied and nutritious, but were not to the liking of early colonists who brought their food staples with them.
- Each new large group of immigrants to Australia gradually increased the variety of foods grown and sold here.
- In colonial times, farming was a labour intensive, tiring and long process because the technology was very simple and required animal or human energy to operate.
- Food processing uses technology to preserve food that is perishable and makes it easier to transport. Also, it can take one raw food and turn it into a variety of other products that may look nothing like the original food.
- Consumers use supermarkets because they can purchase a wide variety of food in a relatively short period of time.
- In Australia we have a market economy, which means private enterprise largely makes the decision of what to produce, how to produce and to whom production will go.
- Economies may be described as strong or weak. Subsistence agriculture is often the basis for a weak agricultural economy.
- The poverty cycle describes the situation in which a person or a group of people have insufficient money to buy healthy food.
- Over-cropping does not give the soil a chance to replace the nutrients it has given the plants grown in it.
- When taxes go up, it costs more to live. In an affluent society, the number of people in relative poverty may increase.
- An embargo prevents a product from being imported into the country.
- Subsidies are payments given by governments to help local producers charge less for what they make.
- Free trade is an agreement in which country A exports to and imports from country B without any tariffs being charged by the other country.

KEY TERMS

absolute poverty
bush food
cash crops
cereals
embargo
free trade agreement
legumes
market economy
multinationals
poverty cycle
quality of life
relative poverty
staple food
subsidy
subsistence agriculture
tariff
tuber
undernutrition
value added
World Trade Organization (WTO)

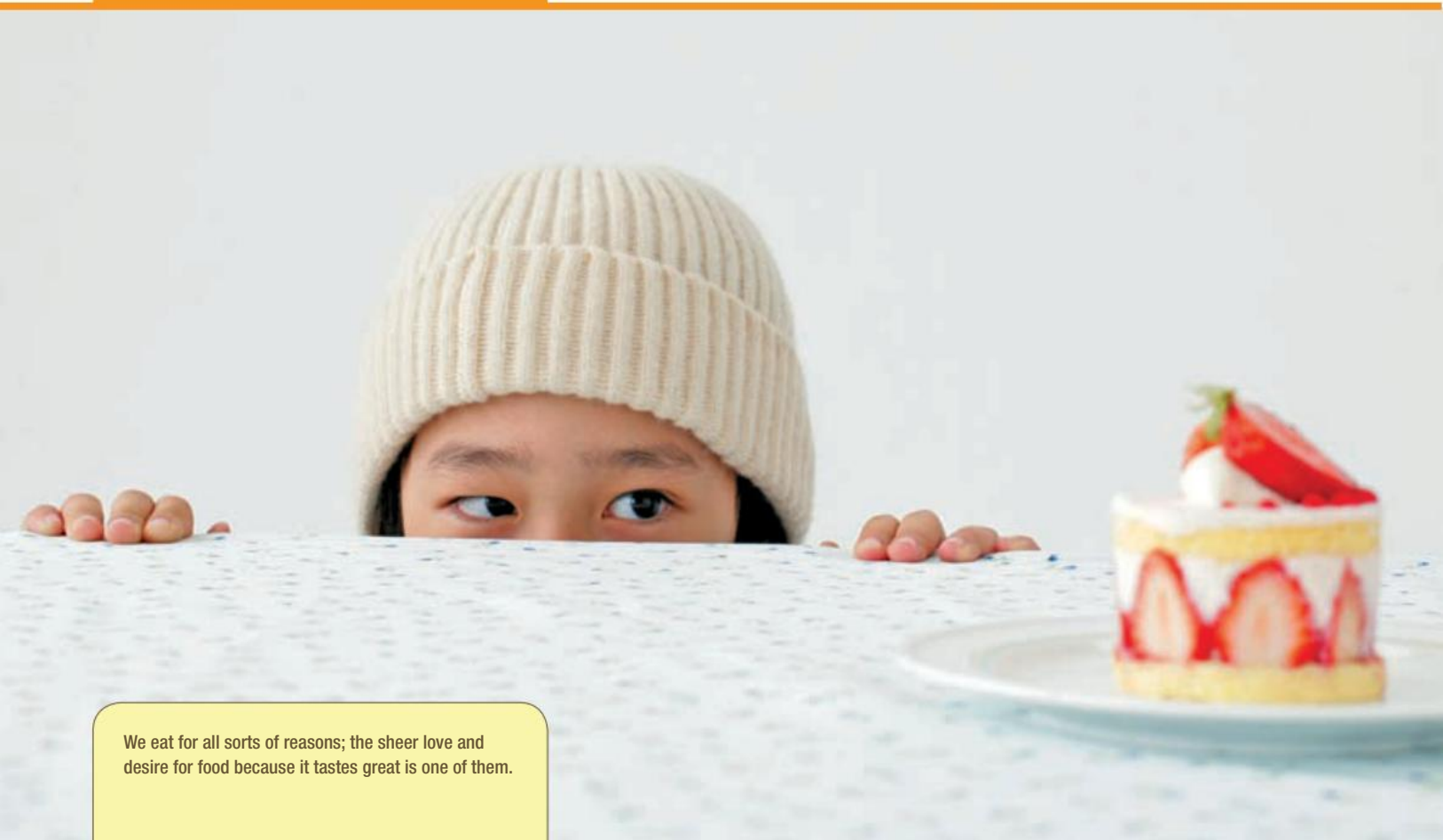
Chapter 2
Factors affecting food selection

Have you ever heard the song 'Food Glorious Food' that was sung in the Broadway musical *Oliver*? Oliver and his friends were always hungry but when they closed their eyes and imagined 'Hot sausage and mustard' and 'Cold jelly and custard' they didn't feel quite as bad. Most of us don't ever go truly hungry, though, as Oliver and his friends did. We have access to food and in many cases plenty of it. So what determines our food choices?

In this chapter you will learn about:

Factors affecting food selection

- physiological factors, including: hunger, appetite, satiety; nutritional requirements, e.g. age, gender, size, activity level; reactions to food, e.g. appearance, odour, taste, allergy
- psychological factors, including: values, beliefs, habits, attitudes, emotions, self-concept, experiences
- social factors, including: traditions and culture; lifestyle, e.g. employment, education, household structures, roles, geographic location, interests; social interaction, e.g. peer group, family hospitality; media
- economic factors, including: the marketplace (retail and purchasing practices); resource availability such as food processing equipment and food preparation skills, occupation and finances.

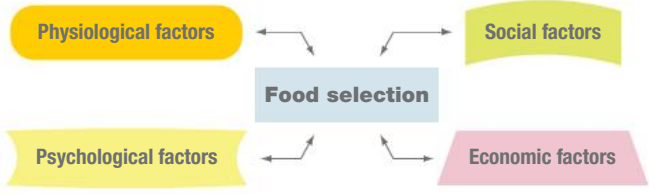


We eat for all sorts of reasons; the sheer love and desire for food because it tastes great is one of them.

When was the last time you felt *really* hungry — your stomach grumbled and had an empty feeling; you felt tired; you had difficulty concentrating; and maybe you had a dull headache? Perhaps it was when you signed up for World Vision's 40 Hour Famine, went on a diet or you may have fasted to observe religious customs. Some of us are so accustomed to regularly eating food that we may not know the true signs of hunger. There are a variety of reasons why we eat food and hunger is just one of them.

So why do we eat if we are not truly hungry? For most of us the answer is fairly simple; food tastes great! Eating is so enjoyable that food forms a basis of many celebrations and social gatherings. Some of us can also think back to a time when we have eaten out of boredom, or perhaps because food has a soothing effect and makes up for something that is missing in our lives.

Food is essential for life, and informed decisions when selecting food are essential for a happy and healthy life. Food choices are influenced by physiological factors, social factors, economic factors and psychological factors.



Factors affecting food selection

Physiological factors affecting our selection of food

Physiological factors affect the body's need and desire for food. If the body is to remain healthy and function correctly it must have adequate amounts of food containing the essential nutrients. The amount of nutrients required depends on an individual's age, sex, build, health and level of activity. But the quality and quantity of nutrients the body receives are often determined by our lifestyle, emotions and appetite.

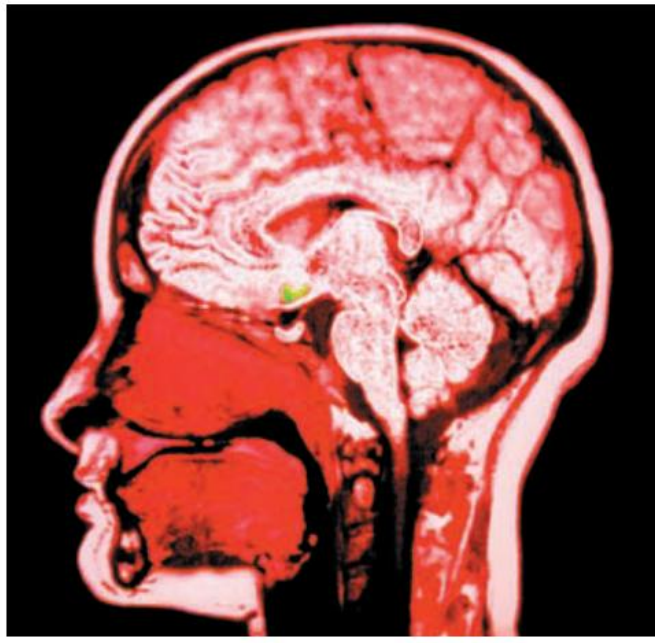
Hunger, appetite and satiety

Hunger

Hunger may be defined as that feeling of emptiness, weakness or pain caused by a lack of food. It becomes more intense as time passes, until we are able to think of little else but food. For those suffering extreme hunger, relieving the body of this pain is the focus of life.

Hunger is controlled by a small gland in the base of the brain called the **hypothalamus**. The hypothalamus has a number of functions in the body, and works closely with the pituitary gland to:

- control body temperature
- regulate appetite, thirst and body fluids
- induce sleep and wakefulness
- control the release of growth and sex hormones from various glands throughout the body.



The hypothalamus (highlighted in green) is a small, specialised part of the brain that, among other things, lets us know when we are hungry.

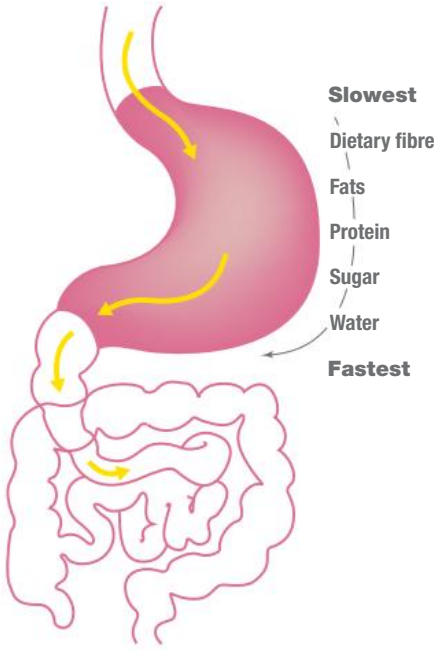
Appetite

People often confuse appetite with hunger, but the two are very different. **Appetite** is the desire for food even when the body is not hungry. Appetite can be triggered by the sight of appetising food, the aroma of food in preparation, and even the mention of food in conversation. The hypothalamus registers these cues from the senses and sends messages to the brain which encourage you to think about food. The salivary glands are stimulated and produce extra fluid: your mouth then begins to water. Unlike hunger, if appetite is not satisfied it will eventually go away.

Satiety

Satiety is the feeling of fullness that comes with eating adequate amounts of food. The body digests foods at differing

rates, so different foods remain in the stomach for varying lengths of time. Simple **carbohydrates**, such as sugar, are easily digested and move through the stomach fairly quickly, whereas complex carbohydrates, such as dietary fibre, remain in the stomach for a longer period. Because they leave the stomach more slowly, fibrous foods give a feeling of fullness, or satiety, for an extended time after eating.



Food moves through the stomach at different rates. Slow-moving foods have a higher satiety value.

Nutritional requirements

Many of us select food that is nutritious because we know that we will feel and stay healthy. The food we eat should provide essential nutrients that the body can absorb, and **metabolise** (be used by the cells in the body for energy, building or repair). When you are next in the supermarket, take a quick look at someone else's shopping trolley; it will tell you a lot about that person's eating habits. Unfortunately, many of us need to learn more about the nutritional value of food as statistics from the latest national health survey show that the rate of overweight and obese adults and children has doubled over the past 20 years. Take a look inside your own pantry and refrigerator and ask yourself whether food has been purchased with nutritional value in mind.

Governments are taking steps to educate Australians about nutritious food. The Australian Dietary Guidelines were developed out of concern for the health of our population. The guidelines aim to encourage Australians to eat a more varied and nutritious diet, and reduce the risk of suffering from nutritionally related disorders.

In addition, the Australian government has introduced new initiatives:

- The Healthy Active Ambassadors Program invites well-known people who live a healthy life to speak publicly to help create an awareness of how to adopt a healthier lifestyle.
- A National Children's Nutrition and Physical Activity Survey will find out what Australians are eating and their level of physical activity.
- A Healthy Weight website has been launched by the government to promote healthy eating and provide tools such as the Body Mass Index (BMI) calculator, as well as specific dietary requirements for people of different ages and genders.
- Other government initiatives include community and school grants programs, and the creation of consumer resources on being overweight and obese.
- Each state has developed its own Healthy School Canteen Strategy based on the national Healthy Schools Canteen framework.

You may have seen the campaign asking us to eat two serves of fruit and five serves of vegetables per day. How many pieces of fruit and vegetables do you consume daily?

It's evident that many of us need better education when it comes to eating nutritious food. Nutritional requirements depend on a number of factors such as our age, gender, body size, level of physical activity, how healthy we are at the moment, and whether we are pregnant or breast feeding.

Body size/type and heredity

Anyone who owns a car is aware that there are major differences in the costs of running and maintaining large and small cars. Obviously, large cars use more petrol and therefore they have larger petrol tanks.

The nutritional requirements of different sized human bodies vary in the same way. Individuals who have larger builds require more nutrients to maintain and operate their body processes. They have the same type of body tissue and organs as have people with smaller builds, but a larger

person requires more carbohydrates because they need the extra energy to move a larger body mass and to maintain normal body functions. Similarly, those with a smaller body size require less **protein** for the maintenance and repair of body tissues because their body mass is less.

Each person can be described according to their body type, regardless of age. Body type is identified according to a person's:

- skeleton size (height and overall size of the body frame)
- amount of body fat
- weight
- amount of muscle.

Heredity controls the skeleton shape, but a person can control their fat and muscle levels, and their weight. The correct types of exercise will allow you to change your body shape to some extent, which could be endomorph, mesomorph or ectomorph.

Which body type are you? Endomorphs have a large skeletal frame with a high percentage of body fat centred on the waist, buttocks, hips and thighs. Mesomorphs have a medium to large frame with a low level of body fat and well-developed muscles. Ectomorphs have a light skeletal frame and may be any height. They have a low percentage of body fat and not much muscle development. Which body type do you think this Sumo wrestler has?

Age

The human body undergoes specific growth stages throughout life. An infant's body has an enlarged head, and the arms and legs are short in relation to the rest of the body. Early childhood sees dramatic changes in body proportions. The arms increase in length and muscle tone, which allows for greater movement and coordination, and the legs extend to make up half the body's height. The period of growth and development continues throughout adolescence until the body attains a more adult form.

Because nutrients carry out specific functions within the body, the amount of nutrients needed by an individual is regulated by the growth processes.

3 to 19 years — more calcium + protein for growth of bones and tissues + carbohydrates for energy

↓

20 to 40–50 years — genetically predetermined height and build achieved, muscle tone and amount of fatty tissue varies, depending on diet and exercise

↓

40+ years — basal metabolic rate (BMR) slows down (BMR is the rate at which the body uses energy). Intake of energy-rich foods needs to be lowered and exercise increased or the 'middle-age spread' commonly occurs.

Individual nutrient needs change throughout a person's life; sensible food choices and adequate exercise can keep the body healthy and enable people to do what they want to do.

Table 2.1 below shows the estimated energy requirements for children and adolescents in terms of megajoules (MJ) per day (1000 kilojoules = 1 MJ). Energy requirements vary with age, gender, body size and especially activity levels. A 16-year-old male undertaking heavy physical activity will need 39 per cent more energy than a 16-year-old male prescribed bed rest. More detail about **basal metabolic rate (BMR)** can be found in chapter seven.

TABLE 2.1 Estimated energy requirements* for children and adolescents (MJ/day)

		PHYSICAL ACTIVITY LEVELS						
	AGE	REFERENCE WEIGHT**	REFERENCE HEIGHT (M)	BMR*** (MJ/DAY)	BED REST	LIGHT ACTIVITY	MODERATE ACTIVITY	HEAVY ACTIVITY
Boy	8	25.6	1.28	4.5	5.5	7.3	8.2	9.2
Boy	16	60.9	1.74	7.3	8.9	11.8	13.2	14.7
Girl	8	25.6	1.28	4.2	5.2	6.9	7.7	8.6
Girl	16	53.9	1.63	5.9	7.2	9.5	10.7	11.9

* Estimated energy requirements were calculated using BMR predicted from weight, height and age

** Reference weights from Kuczmarski et al. (2000) (see also FNB:IOM 2002)

*** Estimated using Schofield et al. (1985) equations for weight, height and age groups 3–10, 10–18

Source: Data derived from Nutrient Reference Values for Australia and New Zealand, 2005, pp. 298–9

Level of activity

An individual who is physically active needs to consume more energy-giving foods than an individual who leads a sedentary (less active) life. A sedentary person requires less of all nutrients than an active person.

If an individual consumes large quantities of energy but does not move around much, the body stores the excess as **adipose tissue** (fat).

A sedentary person's requirement for protein is also lower because the protein is needed only for the maintenance of muscle tissue, and not for the development of muscle fibres that occurs with physical activity.

Many athletes believe they require greatly increased protein intakes to build additional muscle, but some research does not support this belief. The body can use only a certain amount of protein on a daily basis, and any excess is chemically altered and stored as adipose tissue for future energy use.

Gender

The sex of an individual also determines their nutrient requirements. Biological activities such as menstruation and childbirth mean that women need to have a higher dietary intake of iron and calcium. Men have a higher proportion of muscle tissue on their bodies, so they require a higher intake of protein than women.

Gender will also affect the parts of the body where adipose tissue is stored. Women are most likely to find extra adipose tissue on their upper arms, bust, waist, hips and thighs. During middle age, an individual's metabolic rate slows; if the person does not reduce their energy intake, they will gain weight. Women normally experience an increase in adipose tissue around the buttocks, hips and thighs, and they become pear shaped. Men continue to have more muscle tissue than women through middle age, but their basal metabolic rate also slows. Men's extra adipose tissue can quickly build up, usually around the waist and midriff region so they become more apple shaped.

REVIEW QUESTIONS

Remember

1. What is the difference between appetite and hunger?
2. Why do people with more muscle require more protein?

Apply

3. Explain why a breakfast of a glass of juice, Weet-Bix with milk, and a piece of toast with butter and jam will keep you satisfied until lunch.

Do an activity

4. Each person in the class collects five pictures of food that he or she likes. Label each picture according to what it is. Sort the pictures by placing any similar food items together (for example, if three people have named pizza as their favourite food, these pictures all go together). Can you identify a general theme? Are these foods high in salt and/or fat? Are the foods popular with one sex more than another, or to other age groups?

Health status

We have conversations like this nearly every day — 'How are you?' . . . 'Oh, very well thanks'. Some people are so well it shows; their hair shines, their skin is rosy, their nails are strong and they exude vitality. Others are unwell and require specific nutrients to aid their recovery. Nobel Prize winner Sir Frederick Gowland Hopkins (1861–1947) discovered in the early 1900s that mice fed a diet of pure carbohydrate, pure protein, fats and salts would stop growing unless their diet was supplemented with milk. He realised that milk must contain vitamins that lead to growth and help maintain good health. Hopkins went on to study the nutritional value of margarine, which was lacking in Vitamins A and D, and this led to vitamins being added to margarine.

Some diseases that may be related to poor diet include beri-beri, pellagra, **rickets**, scurvy, osteoporosis and anaemia. **Anaemia** (meaning *without blood* in Greek) is a deficiency disease where the person affected is deficient in red blood cells and/or haemoglobin. The common symptoms of anaemia are tiredness and fatigue. If the anaemia is caused by an iron deficiency, consumption of food rich in iron may be recommended along with other treatments. Canned clams, fortified dry cereals, cooked oysters and organ meat such as liver or giblets are rich sources of iron.

A person's state of health may lead them to consume certain types of food and/or less of other types of food. If, for example, a person has high cholesterol (that could eventually lead to heart disease), they may opt to reduce the amount of animal fat in their diet, which may reduce cholesterol by as much as 10 per cent, according to research undertaken by the CSIRO.

Pregnancy and lactation

The nutrient needs of a pregnant woman will obviously increase, because the foetus shares the nutrients supplied in the mother's bloodstream. Nature always makes sure that the nutritional requirements of the foetus are met. Therefore, if the mother's dietary intake of a nutrient is not increased during pregnancy, the baby's needs for that nutrient will be met, but the mother will develop a deficiency.

To ensure both the mother and the child receive the nutrients they need, careful selection of food is required. Pregnant women should choose a variety of nutritious foods daily, including:

- bread, cereals, rice, pasta and noodles (wholegrain or wholemeal is best)
- vegetables and **legumes** (plants that bear their seeds in a double-seamed pod such as peas, beans, lentils, soy beans and peanuts)
- fruit
- milk, yoghurt and hard cheese (low fat preferred)
- meat, fish, poultry, cooked eggs and nuts.

It is common to gain weight during pregnancy (as much as 12–14 kg), so pregnancy is not the time to diet or skip meals. Many women in the first three months of pregnancy take

Protein, calcium and iron are important nutrients. Protein is required to build new cells and repair any damaged tissues; the body cannot function without it and muscle development would be poor. Calcium is needed to make our bones and teeth strong, and iron is required to build red blood cells and carry oxygen to cells. Iron in the diet is important to prevent disease such as iron-deficient anaemia. There are Recommended Dietary Intakes (RDIs) for these nutrients established by the National Health and Medical Research Council and the Department of Health and Ageing. As you can see, boys and girls aged 9 to 13 need the same amount of calcium and iron, but the RDI for protein differs between boys and girls. What are the major differences in RDIs of protein, calcium and iron for males and females aged 31 to 50?

folic acid supplements to prevent birth abnormalities such as spina bifida. Foods that are naturally rich in folate include green leafy vegetables, chick peas, nuts and orange juice, as well as some fruits. It is also important to remember that during pregnancy the need for iron increases. Good sources of iron include lean beef, duck with the skin removed, chicken, fish, green vegetables and cooked legumes such as chick peas or lentils. Calcium is also extremely important during pregnancy. The RDI for calcium is 1100 mg or 300 mg above the requirements for a woman of that age. Dairy products, especially cheese, tofu and tahini are good sources of calcium.

REVIEW QUESTIONS

Remember

1. The hypothalamus part of the brain controls:
- **A.** hunger, thirst, breathing, appetite
- **B.** body temperature, sleep, thirst, appetite
- **C.** release of sex hormones, heartbeat, hunger, sleep
- **D.** release of growth hormones, pain, body temperature, breathing

Apply

2. Why would an under-12s soccer team player use more energy than a 45-year-old weekend cricket player?

Do an activity

3. For a person of your age and sex, use food composition tables or software to identify your calcium, iron and fibre needs.

Reactions to food

Our personal perceptions have a major influence on our food selection. Individuals select or reject food based on their reaction to the food's physical appearance, its

presentation, smell, and texture. We use our senses to gauge the quality and appeal of food, and judgements based on these reactions are called **sensory perceptions**.

The perception of food plays an important role in food selection, as any restaurateur or gourmet takeaway operator will tell you. These businesses often rely on food displays to encourage the impulse purchase of food by passing customers. Attractive colours and the creative arrangement of food stimulates the appetite and the salivary glands, creating the desire for specific foods that may not otherwise have been chosen. Food preparers also take care in the placement of food on the plate because they are aware that the aesthetic appearance of the meal can enhance or retard the appetite of those to whom it is served.

Appearance

Colour

Colour, as well as shape and **turgor** (explained later), is an important part of the appearance of food.

The colour of food indicates its quality and nutritional value. Foods such as fruits and vegetables display their most desirable colours when they are at their peak, both texturally and nutritionally. As fruit and vegetables become over-ripe, their turgor (crispness) and nutritive value decrease, as does the intensity and desirability of their colour.

Alterations in colour are one of the first signs of food spoilage. When shopping for food, perception of colour acts as a primary guide for purchase. If the colour of a food is dull or unnatural, we reject that food in favour of others with 'better' colour. Even in our own homes we use colour to gauge acceptability. Green spots on a bread crust, brown patches on fruit, or a white film on the edge of cheese encourage us to inspect the food to determine whether it is fit to eat.

Some colours rarely occur naturally in foods, so their use in manufactured foods is limited. The colours blue and pink are used mainly in confectionery because the end result is not designed to look like natural food. It is for this reason that kerosene and petrol are coloured blue and pink respectively. It is hoped that colouring them these unnatural shades will make it obvious they are not natural beverages and reduce the risk of them being accidentally consumed by children.

Shape

The shape of food influences its appeal. Pictures in recipe books show how important shape is in the presentation of a meal. A simple carrot can be sliced into rings or elongated ovals, julienned, grated or diced to create interesting shapes. Manufacturers in the food industry are also aware

EXPERIMENT

Sensory reactions to colour

Syllabus outcome

Students learn to:

- prepare foods that reflect various factors influencing food selection.

Contributes to the following outcome:

- plans, prepares and presents foods which reflect a range of influences on food selection.

Aim

To determine the effect of colour on the acceptability and appeal of food

Equipment

1 butter cake mix (and the ingredients to add to it)
5 mixing bowls
electric mixer
5 spoons
patty cake papers and tins
4 food colours (e.g. red, blue, green and black)

Method

1. Prepare the cake batter according to instructions on the packet.
2. Divide the batter into five separate bowls.
3. Set one bowl of batter aside to act as a 'control' for later colour comparison. Add food colours to each of the four remaining bowls and mix well.
4. Place mixture from the five bowls into lined patty tins, and bake as directed.
5. When the cakes are cool, ask up to ten people not connected with the experiment to:
   a) rank the five different coloured cakes in order of visual appeal, with 1 being the most appealing and 5 being the least appealing
   b) explain why they find cake 1 more appealing than cake 5.

Results

1. Record the responses of the people surveyed. Add your own opinions to the survey results.
2. Copy the table below and present tallies of your results.

Number of people giving the response

	CONTROL	RED	BLUE	GREEN	BLACK
Most appealing colour					
Second most appealing colour					

Conclusions

1. Which two colours were considered the most appealing? Why?
2. Which colours were considered undesirable? Why?

Note: This experiment could also be carried out using other foods — for example, ice-cream, custard or rice.

of the impact of shape on consumer approval. One of the recent innovations in the shape of food is the change in portion size for well-known products. Consumers feel that they are eating what they like, but eating less of it, and thereby reducing their kilojoule intake.

The chocolate looks glossy and smooth, and the manufacturer has even catered for those who are watching their waistlines by creating mini-Magnums. Marketing gurus have turned the Magnum into more than just an ice-cream though. You may have seen Liz Hurley seductively bite into an ice-cream and, in fact, the company released an edition of the ice-cream named after the senses: Magnum Aroma, Magnum Touch, Magnum Sound, Magnum Taste and Magnum Vision.

Turgor

Turgor refers to the pressure placed on cell walls or membranes by fluids within the cell. Turgor gives many foods a full, fresh appearance, a firm texture and a crisp mouth-feel. Wilted greens and soft vegetables have lost some of their turgor and are visually unappealing, as well as having a lower nutritional value.

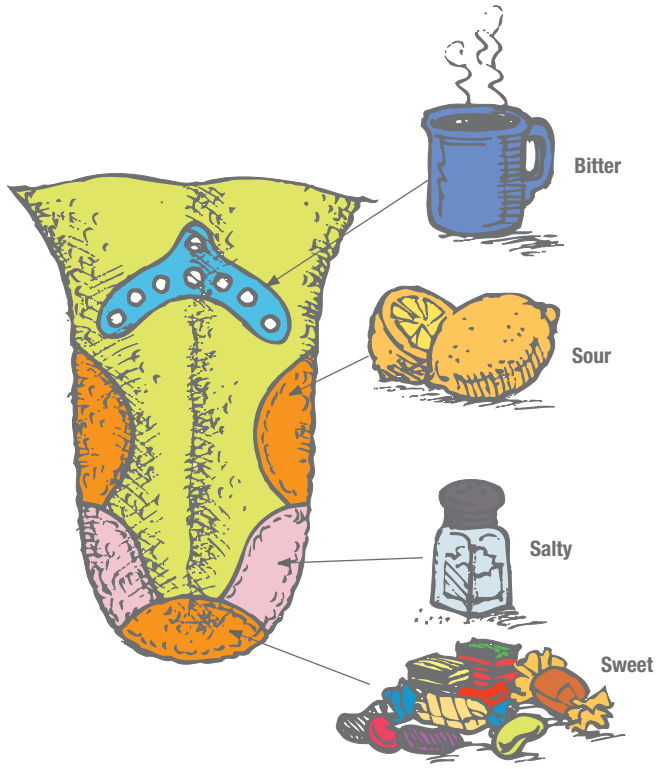
Textural differences in foods create interest in meals and stimulate the appetite. Firm textures are complemented by foods with softer textures — for example, cheddar cheese on biscuits. Creamy textures are contrasted by crunchy mouth feel — for example, a vanilla slice with its puffy pastry and custard filling.

Flavour

Flavour is a sensory impression of food based on its taste and smell. Our body uses taste sensors on the tongue to detect differences in flavour, with the help of the sense of smell. You may know from personal experience that when you have a cold and your nose is blocked, it is harder to taste the flavours in foods.

The human mouth contains approximately 9000 to 10 000 taste receptors or 'tastebuds'. Most of these are located on the tongue, but some are also on the roof of the mouth (the soft palate) and the back of the epiglottis (at the top of the throat). Tastebuds have a short life span in the body, lasting only about ten days before dying and being replaced. The number of active tastebuds also decreases with age. Young children have a good sense of taste and do not need foods to be highly flavoured to be acceptable. However, ageing adults have a decreased sensitivity to taste as their tastebuds gradually die and are not replaced. Thus, many adults are unable to distinguish subtle flavours in foods, and they compensate for this by eating foods that are highly spiced, salted or sweetened.

There are four types of tastebuds (located in different areas of the mouth) which taste different flavours. The four taste sensations that these receptors register are sweet, salty, sour and bitter. The sites of these taste receptors are shown in the diagram below.



Can you determine which parts of the tongue will react to the following: Pepsi Max, corn chips, orange and poppy seed muffin, fetta cheese?

To be tasted, the flavouring substance must be dissolved in a liquid. This liquid may be present in the food or it may be provided by the saliva of the mouth. If a person has a dry mouth, as is often the case when someone is suffering from an illness (particularly if the person is on medication), the ability to taste is reduced. When the tastebud has been stimulated, it sends a nerve impulse to the brain, which registers that particular taste sensation.

Aroma

Aroma describes how something smells. In our nose there are odour receptor nerves that transmit signals to the hypothalamus in the brain. Taste and aroma are related; many foods give off aromas that can be smelled before the food is eaten, as well as when the food is being eaten. We associate some aromas and tastes with the dishes of specific cultures, such as Indian and Italian foods.

Some people have a keen sense of smell and can identify subtle differences in aromas. For example, experienced winemakers have to learn to identify the right time to bottle their wine. Another word used to describe the smell of something is *odour*. Normally when we describe a food as having an odour, it indicates a lack of freshness as in sour milk, or ripeness as in the ripeness of a pineapple.

CASE STUDY

The electronic nose

Electronic noses, sophisticated sensors that create digital fingerprints of smells, are being used by an increasing number of industries for quality control and product development. Food manufacturers may now be able to follow suit.

One of the most important objectives of food production is to achieve a uniform, high quality of both raw materials and the final product … Engineers have recently devised an 'electronic nose' that will help both the food producers and ordinary shoppers solve the perennial problem of how to determine the ripeness of fruit consistently.

… the electronic nose calculates the exact ripeness of fruit by its smell. Once it has been 'trained' on a particular fruit it does not require a skilled operator and can obtain the results in a few seconds with over 92 per cent accuracy.

Of all the human senses, smell has always been the most arbitrary to define … The odour of food comprises many chemical substances that give it its unique quality and character. The ability to reliably measure and identify optimal flavour development and constant taste characteristics is therefore crucial in the development of many products. Traditionally, this difficult task has been the main prerogative of sensory panels, people whose individual assessments will always include personal appreciation.

… Measurement by the electronic nose is by contrast objective, repeatable, highly accurate and relatively cheap. Interpretation is simple, quick and in real time. Like the human sense of smell, the electronic smell learns by experience and improves the more it is used. It is designed to analyse, recognise and identify volatile chemicals at low (parts per billion) levels. The technology is based on the absorption and desorption (passing through) of volatile chemicals onto an array of sensors, which exhibit specific changes in electrical resistance, measurable across each sensor element, on exposure to different odours and aromas.

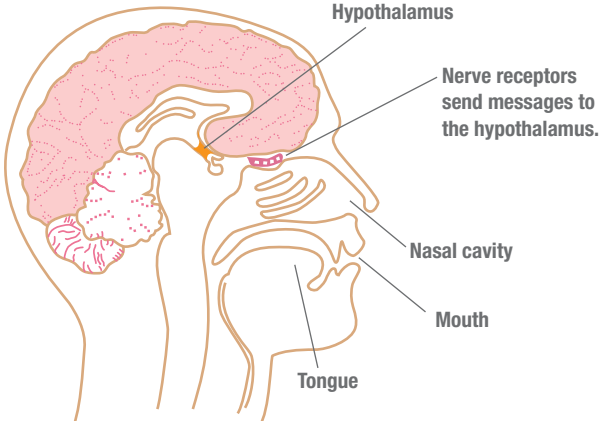
Work in this area has concentrated on the ripeness of bananas and apples, but the technology can easily be applied to most other fruits. It has also been used to test the quality of coffee, beer and wine. This could be just a scent of things to come.

Source: Extract from *European Food Information Council*, www.eufic.org

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *the sense of smell* to complete the tasks ahead.

1. What does an electronic nose do?
2. Does the electronic nose require a person skilled in assessing a particular food to operate it?
3. What does a sensory panel do? Why isn't a sensory panel an objective way to judge smells?
4. Identify five foods that would benefit from an electronic nose.



Have you noticed that after you have been in a bread shop or a chocolate shop for a few minutes, you stop smelling the aroma of the food sold there? The hypothalamus will react to a smell for only a minute or two, and then will stop responding to it. If you leave the shop for a few minutes and then go back in, you would sense the smell again.

Allergies

Some people's food choices are limited because they have a physical reaction to specific foods or ingredients. The reactions vary between individuals but may include abdominal swelling, vomiting, diarrhoea, itches and skin rashes, wheezing, headaches and disturbed sleep. The foods commonly associated with food allergies are cow's milk, shellfish, eggs, peanuts, wheat and soy. (See chapter 19 for more information on allergies and food intolerances.)

People who suffer from reactions to food must be cautious in their food selection. They must read labels and menus carefully so that they are aware of what they are actually eating. You may have seen labels on foods that say 'nut free' or heard of kindergartens and schools having a 'nut-free zone'. This is because some individuals are so sensitive to nuts that they will react when near a food that contains them or even when their food is cooked in a visibly clean pot that was previously used for something containing nuts, for example to heat peanut oil.

CASE STUDY

The healthy canteen menu

You may have seen the television program *Jamie's school lunch project*, where Jamie takes on English youth and challenges them to eat, and the staff who run the school canteens to serve, healthy lunches instead of junk food. The healthy lunch trend is also catching on here in Australia. Foods prepared in the canteen at Kincumber High School in NSW include Burritos, jacket potatoes, vegetable stir-fry, chicken Caesar salad wraps, 'Zappa' wraps (chicken tenderloin, lettuce and tomato in a tortilla), pasta, kebabs (pita bread, tabouli, lettuce, with lamb or chicken) and fresh fruit salad. In winter, there are homemade soups, nachos, bolognaise pasta bake, pesto pasta bake and hamburgers; and in summer, there are fresh salads, fruit salads, and wraps.

OUTCOME TASK | **RESEARCH ASSIGNMENT**

Students learn to:

- analyse the eating patterns of a selected group to identify influences on food selection.

Contributes to the following outcome:

- accounts for individual and group food selection patterns in terms of physiological, psychological, social and economic factors.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *factors affecting food selection* to complete the tasks ahead.

1. Explain why some students may resist a move to a healthier choice of food in the school canteen.
2. How does your canteen food compare to the menu at Kincumber High School?
3. Log in to **www.jacplus.com.au** and locate the *Healthy canteens* weblink for this chapter. Explain the difference between red, amber and green food choices.
4. Use the healthy kids calculator and assess five foods from your school canteen. Which foods are considered foods that should be eaten only occasionally?

eBook*plus*

Weblink

Psychological factors affecting food selection

Psychological factors relate to the mind and the emotions. They are difficult to describe, and differ from person to person depending on their lifestyle and upbringing. Some psychological factors such as beliefs, habits, values and past experiences with food have a constant influence on the foods selected, while choices made as a result of emotions, self-concept and attitudes can vary from day to day.

Values

A value is a deep personal feeling about what is important. Values are strong enough to influence behaviour and motivate action. A person's values may reflect those of the family and culture in which they were raised, or they may be a personal response to the experiences encountered throughout life. In terms of food selection, the values most likely to influence choices are related to food origins and the maintenance of health.

Most people value life very highly. They respect the rights of all living things to exist in peace, free from pain. Vegetarianism is often a reflection of value-based food selection. A person may find the thought of killing and eating an animal revolting, or they may disagree with the conditions under which some animals are raised as a food source. Some people value an animal's right to freedom so highly that they do not agree with the consumption of any animal products, including eggs, milk or other dairy products. Other individuals become vegetarians for reasons other than the values suggested here.

Beliefs

Beliefs about what is acceptable to eat vary throughout the world and are often related to religion and cultural heritage. A belief is an opinion or conviction which need not be based on positive scientific proof. Beliefs can be challenged and changed, unlike values that remain fixed. Many religions have food customs and impose restrictions on what their followers eat. Buddhists, for example, are partial **vegetarians**. They may eat fish, eggs and dairy products but are not allowed red meat. (They believe it is wrong to kill or injure living things other than fish.) Hindus, on the other hand, are allowed to eat all forms of meat except beef, because the cow is sacred in their religion.

Many religion-based food restrictions were originally imposed to protect people from diseases related to poor food safety and hygiene. For example, in the past many people were infected by diseased pork and shellfish and died, but nowadays advances in the processing of food and medicine mean that observance of such restrictions is no longer necessary. As well as religious customs, some social groups and cultures have specific beliefs about food. Many of these beliefs cannot be substantiated and have little, if any, nutritional basis; many of the fad-diets published in popular magazines targeting women are examples of this.

Some cultural beliefs often prohibit the eating of specific foods and lead to food taboos. Such taboos are most common in primitive cultures and they may, unfortunately, restrict the consumption of animal products that are good sources of complete protein.

- In an area of mid-Africa, people believe that animal milk is a repulsive body secretion similar to urine. Consequently it is not consumed, despite its nutritional value.
- Some people in remote areas of South-East Asia avoid eating eggs or chicken because they are believed to destroy human fertility.
- In parts of Africa, fish are believed to be unclean or possessed by evil spirits. Eating them is thought to invite disaster.
- For Australians, the eating of dog is taboo because it is considered 'man's best friend'. However, in countries such as Indonesia, dog has the same status as other meat sources and is considered acceptable.

Attitudes and experiences

An attitude is the way in which a person views something and behaves towards it, usually after evaluating its merit.

Our attitudes or views towards food are based on one or more of the following:

- *the origin of the food.* For example, some people believe that if food is organically grown, it must be better; also, snails and crocodile meat do not appeal to many people because of their habitat.
- *our culture.* For example, eating raw meat and fish is part of the Japanese culture.
- *personal history*. For example, being made to eat spinach as a child could result in someone avoiding all foods containing spinach as an adult.
- *travel experiences.* For example, eating the cuisine in foreign places is part of the cultural experience, but that cuisine would not necessarily be eaten at home.
- *perceived status (the position of something in relation to other things).* For example, lobster, truffles and filet mignon have a higher status than flake fish, turnips and chuck steak.
- *economic depression and war.* For example, older Australians and many new migrants, who have gone through major depressions and wars with rationing and food shortages, eat more **offal** (animal organs such as beef liver and tongue), and feel it is wasteful not to eat everything served on your plate.

Habits

Many of the food choices we make are routine. A habit is something that we do regularly without thinking. Food habits are the same and, like all habits, are difficult to break. Look at the chart below and ask yourself whether or not you have the following food habits. How many of these habits do you share with your classmates?

DO YOU	YES	NO
Swipe a thick layer of butter or margarine on your toast?		
Put tomato sauce on a meat pie?		
Eat the same cereal each morning?		
Drink soft drinks instead of water?		
Sprinkle salt on food before you taste it?		
Buy the same type of bread?		
Have dressing on your green salad?		
Eat something as soon as you get home from school or work?		
Eat something sweet at the end of each meal?		

Food habits, like the ones described, are sometimes unhealthy and need to be identified if you want or need to change your overall diet.

Emotions

Many people use food as a means of relieving emotional stress. For some people this means they reject food until the time of stress is over; for others it means they gain comfort from eating specific foods and may overeat when anxious. People who consume *comfort* foods tend to select foods with a high-energy value, such as chocolate. It may be that the sugar, fat and caffeine in these foods act as a stimulant and restore flagging energy levels. Or it may be that individuals associate these foods with more pleasant experiences than those at the time. For example, many homesick travellers crave foods from home as a means of lessening their loneliness.

Self-concept

Self-concept is a word used to describe how we feel about ourselves (self-esteem) and the way we see our personal appearance including the size, shape and weight of our body (body image). Each of us has a picture in our minds of:

- how we look physically — strengths and weaknesses
- how well-coordinated we are
- whether or not we are smart
- whether we are lucky or unlucky
- how shy or outgoing we are
- how well we manage our money
- whether or not we have good dress sense
- how talented we are at art, music, dance
- our importance as a brother or sister, son or daughter.

Self-concept develops during childhood and it is interesting that these days dissatisfaction with body image increases from the age of 11 years to the mid twenties, especially in females. Also, our self-concept is not static; it can change gradually over time or even several times a day! Some reasons for a change in self-concept could include:

- how we feel physically. For example, a dose of the flu makes us feel lethargic and miserable.
- what our friends and family say to and about us. For example, a compliment or a negative criticism can lift or crush self-esteem.
- gaining weight. Weight gain can make a person feel muscular if they have been training or unattractive if they haven't.
- messages presented by the media. For example, idealised images for both females and males make us feel unattractive.

The media present us with physically beautiful, successful, talented people who eat, drink or use a certain product. Even though we are not aware of it, we may think to ourselves, 'Maybe that product will help me to be more like them'. Did you know that while, on average, people weigh more than they did 20 years ago, the body type the media encourage as 'ideal' is getting thinner?

Organisations such as the Australian Medical Association (AMA) and many parenting groups are working towards better educating young people regarding the messages that the media send about body image. The next time you are watching television with someone (an older person can be helpful with this) really look at the message behind the ads. Can you see what the ad is trying to say, what the underlying messages might be and how the ad makes you feel? Use the questions below to help guide your analysis of the sometimes hidden messages behind advertising.

1. What age and sex is being targeted? How can you tell?
2. Is the aim of the ad or program to amuse, entertain and/or persuade?
3. Are stereotypes (labels or typecasting) used on purpose?
4. How does the advertisement make you feel? Why would they use the product being advertised?
5. Who is responsible for this song, commercial, television show, or movie?
6. Why did they choose to portray the product in this way? Was anything left out?

In late 2002, the AMA made a public statement about body image and what needed to be done to assist Australians to maintain a better body image and their health at the same time. In this statement, recommendations were made in the areas of the role of the practitioner, weight management, cosmetic procedures, fitness and health, eating disorders, education and schools, and research and funding. The following excerpt is from the recommendations given to the Marketing, Advertising and Media.

AMA guidelines — body image

4.1 While acknowledging the impact of other social pressures to conform to idealised body types, the AMA recommends that publishers, programmers and advertisers promote a more realistic range of body images and role models.

4.2 Articles should not portray the wide range of normal bodily changes as pathological or be used to advertise body image products in ways that target younger audiences, as found in child and adolescent magazines.

4.3 Direct to consumer advertising of pharmaceutical products designed to play on body image and weight concerns is an unacceptable practice.

4.4 The teaching of critical literacy and advocacy skills to children and adolescents is essential to encourage constructive analysis of media content.

CASE STUDY

YOUNG AUSTRALIANS CONCERNED BY BODY IMAGE, ENVIRONMENT ISSUES

by ANDREW LOWCOCK

Body image has topped the list of issues that concern young Australians, with the environment also featuring prominently, according to a comprehensive new report.

Mission Australia's annual national survey of young Australians found body image (32.3 per cent) overtook family conflict (29.3 per cent) as the number one issue concerning 11 to 24-year-olds.

The issue ranked number one for both 11 to 14 and 15 to 19-year-olds, and third for 20 to 24-year-olds, behind coping with stress and depression.

And both young females (34.9 per cent) and males (27.9 per cent) put body image issues at the top of their list of concerns.

'We've got much more of a focus as a nation on the number of Australians who are overweight, including young Australians,' Mission Australia's Anne Hampshire told ABC News Online on 4 December.

'At the other end of the spectrum we've got an increasing focus, I think, on body beautiful and what constitutes an acceptable and a healthy body.

'In fact, what's been presented as ultra thin probably isn't a healthy body for most of us. So, I think young people are getting a bit caught in between these two potentially conflicting messages.

...

Young people are still overwhelmingly turning to three sources for advice and support: friends, parents and other relatives, with community agencies ranking alongside magazines and behind the internet.

...

Family and friends were most commonly seen as figures of admiration, followed by entertainers and sporting stars, while family relationships, friendship and physical and mental health were most valued.

'I think what we find when we look at the values of young people, we actually get a different image than we often hear in the media,' Ms Hampshire said.

Mission Australia also compiled a summary of the nearly 1700 responses received from young indigenous Australians. Body image also topped the list of concerns, while alcohol ranked much higher among the indigenous population (31.8 per cent) than the non-indigenous population (19.6 per cent).

Source: Infoxchange, 5 December 2007.

OUTCOME TASK **RESEARCH ASSIGNMENT**

Students learn to:

- analyse the eating patterns of a selected group to identify influences on food selection.

Contributes to the following outcome:

- accounts for individual and group food selection patterns in terms of physiological, psychological, social and economic factors.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *psychological factors and food selection* to complete the tasks ahead.

1. Were you surprised at Mission Australia's findings in their recent national survey of young Australians? Explain why or why not.
2. Explain why the campaign to highlight the problem of being overweight may actually contribute to concerns about a person's body image.
3. Working in pairs, produce a PowerPoint slide show on any THREE of the psychological factors affecting food selection. The slide show is designed to make students in Years 6 to 8 more aware of what they eat.

   Please note, if you give poor nutritional examples, you must give a nutritious alternative.
4. a) Identify two current examples of how different media promote a certain body image, one for females and one for males.
   b) Describe the body image being promoted.
   c) Is the body image achievable for the average male or female? Justify your answer.

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Additional case study

Weblink

Social factors affecting food selection

The cultures or societies that people live in, along with the type of contact that individuals have with one another (social factors), influence food choices. The importance of beliefs, traditions and taboos was discussed earlier in this chapter and we have observed that the media, as part of everyday life, influence us to make certain food choices. The type of lifestyle, job and education, size of the family and the importance of hospitality within the social group are also important when we make food choices.

Culture and traditions

Traditions are customs that are repeated at specific times by members of a group or society. Many traditions relating to special occasions involve food. Festive and social occasions always involve food to some degree, and the meal is often the focus of the event. Family traditions often revolve around food, as do major social and cultural customs in most societies, for example:

- Easter — a time of giving and receiving painted hard-boiled eggs, or confectionery and chocolate eggs
- Chinese New Year — celebration with displays of special foods such as rice cakes

- the Aboriginal ceremony of initiation — a celebration with feasts of meat and traditional dancing.

Traditions relating to food are usually maintained even when the individual changes social groups or societies.

Lifestyle

In general, lifestyle factors that influence food selection relate to:

- the type of employment a person has
- the structure of their family (size and whether they live with one or both parents)
- where they live (geographic location)
- travel and other interests.

Let's take a closer look at all the above factors.

Employment

What you choose to eat may depend on the physical demands of your job. For example, construction work requires more energy than working in a video store does. Active jobs require the worker to eat more carbohydrate-rich foods for energy, while people who do sedentary work (a task that requires little bodily movement) need to be careful not to overeat. Because of the pressure to meet deadlines, recent research has found that up to 40 per cent of office workers eat lunch while working at their desk, and an increasing number of people just snack through the work day instead of taking a break for lunch.

Some occupations combine social occasions with work. Meeting for a meal at a café or restaurant is a common event and the temptation to indulge in energy-rich foods is ever present — even ordering a salad can mean a high-fat dressing is eaten.

Whether people work or not also impacts on food selection because when a person is employed it usually means that there is more money to spend on food, but it may also mean there is less time to prepare it. More pre-prepared meals or parts of meals may be purchased, and there may be more interest in using tools and equipment that make cooking easier and quicker.

Education

Obviously, wiser choices come from having more information about the options. All students in early high school learn about nutrients in food, digestion and the main food groups. The Food Technology course teaches students even more — food preparation, meal planning, food safety and food presentation, to name but a few areas. This information allows them to make wiser decisions when selecting food.

People also become better informed about **nutrition** and food choices through government programs, reading magazines, watching various television shows, food store handouts and fast food brochures. The better informed a person is about the nutrient content of foods, dietary requirements and food preparation, the greater the likelihood of wiser food selections. See chapter 7 for more information on guidelines to healthy eating.

REVIEW QUESTIONS

Remember

1. The aspects of a person's culture that will affect individual food choices are:
   - **A.** beliefs, traditions, celebrations
   - **B.** type of work, taboos, religion
   - **C.** celebrations, type of work, unemployment rates
   - **D.** food preparation tools, traditions, beliefs

Apply

2. Log in to **www.jacplus.com.au** and locate the *Healthy canteens* weblink for this chapter. Keep a diary for two days during the school week and refer back to the healthy kids calculator to determine whether your food choices should be classified as red, amber or green.

Do an activity

3. Not including your peers, ask five people who work what they have for morning and afternoon tea, and lunch. Do your findings support the information just covered on lifestyle factors and food selection?

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Weblink

Household structures and roles

The make-up of the family unit determines the variety, quality and quantity of food consumed in a meal. For example, young children who have very sensitive tastebuds prefer less spicy foods, while elderly people may have a reduced sense of taste and often like more heavily flavoured (especially salty and sweet) foods. Personal likes and dislikes are often the most important factor in food selection within a household. Leading by example is a method of setting up healthy eating habits in the family. Nowadays there is a wide range of cookbooks aimed at serving up healthier meals to children. There is also information available to tailor food to specific dietary requirements. For example, if a family member cannot tolerate **gluten** (protein found in grains including wheat, rye, oats and barley), there are many gluten-free products and cookbooks on the market. Catering to different dietary needs within the family may mean that more care needs to be taken to prepare food in an attractive and enjoyable way.

Another factor affecting food selection is each family member's commitment to work, sport or leisure. This often means that family members eat at different times — for example, getting home from soccer training at 7.30 pm, when the rest of the family has already eaten dinner at 6.00 pm, can result in the latecomer having to reheat a meal or prepare a meal themselves. The role of each person in the family can affect food selection as well. In many homes it is considered the mother's role to prepare meals. If she works, the chances of the family having pre-prepared, partially

prepared or takeaway food increase because she may not have either the time or energy to cook a meal from scratch after working all day.

Climate and geographic location

As already discussed in chapter 1, the **staple food** of a country will most likely depend on whether it can be grown given the geography and climatic conditions. If the climate is tropical, then growing sugar cane, pineapples, bananas and coconuts is perfect and these foods will be cheaper, more plentiful and often used in a variety of culinary ways. While we import a wide variety of food, it should be noted that locally grown food is cheaper and fresher. In developing nations, however, this is not the case where modern production methods and equipment, cold and dry storage, and refrigerated transport are not readily available. Yields are usually low and food losses due to poor storage and lack of transport mean a limited choice of available foods.

Climate affects not only the types of food grown in an area but also the food choices people make. Summer brings the desire for bright, fresh, light foods — fresh fruit salads, juices and smoothies, cold quiches and crispy salads, ice-creams and barbecues. Winter is the season of porridge and thick soups, meat pies and lunchtime pastas, warm drinks and hot desserts. This difference in food choice is closely related to the physiological and psychological factors mentioned earlier in the chapter.

Travel and other interests

Most countries are now open to tourists; the internet allows us to make purchases from faraway places; and trade agreements between nations have meant that major events in one part of the world can be felt throughout the rest of the world. When travelling, we experience a wide range of foods, some of which we like and seek out upon returning home. Personal interests and the interests of close personal friends can also influence food choices. For example, an interest in environmental issues such as free range chickens, organically grown fruit and vegetables, and less-processed foods will affect choices made in the supermarket and at restaurants.

A spice store in Marrakesh, Morocco. Travel can widen our horizons and open us up to new experiences and taste sensations.

Social interaction

Food has long been a symbol of friendship and hospitality. When friends enter your home one of the first things you do is offer them something to eat and drink.

Food helps to create a relaxed atmosphere in which even a shy person can be part of the group by busying themselves with preparing or serving food. Alcohol can also form part of this social interaction. The food served at a social gathering is often controlled by social expectations. An invitation to a traditional Aussie barbecue would bring with it expectations of freshly cooked steak and sausages, accompanied by a salad or two. If the invitation was to a cocktail party in aid of Cancer Research at the Opera House, such things as smoked salmon canapés, stuffed mushrooms and vegetable crudités might be expected. Even sharing a meal with workmates or friends can influence food choices. For example, if your friend orders a Caesar salad you might think twice about ordering a chicken burger and fries.

The media as a social influence on food choice

In an affluent country like Australia, the media play a big role in the food selections we make. Advertising of food is everywhere — each day we are exposed to thousands of advertising text, images and sounds from magazines, billboards, the radio, cinemas, the internet and television. Promotion by well-known celebrities, scientific experts and restaurant reviewers try to interest us in new snack foods, never-fail exercise machines, amazing weight loss schemes or new restaurants.

Much of the food advertised through the media is lower in nutritional value than its unprocessed or less refined alternatives. However, these products are presented as if they are the very basis of a healthy and happy lifestyle. The models who appear in food commercials are always the picture of health and have the body type that our society idealises. Food manufacturers do not specifically claim that their products will help people achieve this body image, but the association is subconsciously made and the products are bought and consumed.

Peer group

An individual's **peers** are people in roughly the same age group with the same social status. By interacting with the peer group and the family, a person develops their own food-related beliefs, attitudes and habits.

The influence of the peer group is strongest during adolescence. The need for acceptance makes teenagers eat what and when their friends eat rather than what their parents think they should eat and what is nutritionally sound. Trying new things is safer in a peer group, and sharing food is a good way to get to know people and cement friendships. Peer pressure can encourage fad dieting

in order to be thin in the way the media portray beautiful and popular people.

Hospitality at home

Welcoming people into the family home for a visit and a drink or meal is called family hospitality. In some families having many friends and family over at the one time happens often, while in others an occasional small dinner party is more usual. The table setting and food served at such times depends on the money and food available, the skill and time the cook has, and who the guests are.

Family entertaining in the home environment is becoming more informal and less frequent. People's lives are busier and, with the increasing range of takeaway food outlets and restaurants, it is often easier to have others do the cooking. Working parents do not have the time to shop and cook for a dinner party; it is easier to use takeaway meals or go to a restaurant where the washing up is done by others.

REVIEW QUESTIONS

Remember

1. Three factors that influence the food served in a household are _____, _____ and _____.

Apply

2. Explain why most Australians have a wide range of foods to choose from, while many people living in middle African countries do not.

Do an activity

3. Prepare a survey of six to eight questions to determine the cultural background of your neighbours and what they eat. Prepare questions on the following topics.
   a) Was the person born in Australia and, if not, how long they have lived here?
   b) What foods do they eat most often and how are they prepared?
   c) When they go out to eat, what types of restaurant do they like to go to?
   d) Do they have a favourite family dish that is served on special occasions, if so what is it?

Economic factors affecting food selection

Cost of food

Cost is one of the most important factors when we select food. It is particularly important for low-income families, students and the elderly; it is not uncommon for these groups to spend 33 per cent of their total income on food.

The cost of food varies according to:

- how much is bought at once — if there is storage space, large quantities are a better buy
- whether the food is in season or locally produced
- how much processing the food has undergone — pre-prepared marinated chicken skewers or bags of salad cost more. Surprisingly, less-processed foods, for example, freshly squeezed orange juice from the greengrocer, can also cost more than the regular product.
- the ripeness or use-by date — very ripe, fresh produce is often sold more cheaply, as is meat and dairy products that are close to their use-by dates
- place of purchase — if chosen carefully, food bought at a market or roadside stall can save money, but there is usually no money-back guarantee
- store specials and purchase of **generic brands** (large supermarkets have their own label).

CASE STUDY

Average weekly household expenditure for food and non-alcoholic beverages totalled $152.87 according to figures from a household expenditure survey that the Australian Bureau of Statistics conducted in 2003–04. As a proportion of total expenditure, 17.3 per cent is spent on food and non-alcoholic beverages.

TABLE 2.2 Gross household income quintile, 2003–04

		GROSS HOUSEHOLD INCOME QUINTILE					
		LOWEST	SECOND	THIRD	FOURTH	HIGHEST	ALL HOUSEHOLDS
		AVERAGE WEEKLY EXPENDITURE					
Food and non-alcoholic beverages	$	78.36	111.72	145.73	181.56	247.25	152.87
Alcoholic beverages	$	8.77	14.15	22.61	27.03	44.08	23.32

PROPORTION OF TOTAL GOODS AND SERVICES EXPENDITURE

Broad expenditure group							
Goods and services							
Current housing costs (selected dwelling)	%	18.4	16.5	16.8	14.1	13.9	15.3
Domestic fuel and power	%	4.0	3.4	2.8	2.4	2.2	2.7
Food and non-alcoholic beverages	%	19.0	18.6	17.2	16.9	16.7	17.3
Alcoholic beverages	%	2.1	2.4	2.7	2.5	3.0	2.6
Tobacco products	%	1.8	1.9	1.6	1.3	0.8	1.3
Clothing and footwear	%	3.1	3.2	3.6	4.3	4.5	4.0
Household furnishings and equipment	%	6.1	6.0	6.0	5.8	5.8	5.9
Household services and operation	%	7.7	6.9	6.4	6.1	6.0	6.4
Medical care and health expenses	%	5.3	5.4	5.4	4.9	5.2	5.2
Transport	%	13.9	15.0	15.7	17.2	15.6	15.8
Recreation	%	10.1	12.3	11.5	13.2	14.1	12.8
Personal care	%	1.8	1.8	1.8	2.0	2.1	1.9
Miscellaneous goods and services	%	6.7	6.8	8.6	9.4	10.2	8.9
Total goods and services expenditure	**%**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

*Estimate has a relative standard error of 25% to 50% and should be used with caution

Source: ABS.

OUTCOME TASK **HOUSEHOLD EXPENDITURE**

Students learn to:
- investigate current food consumption and expenditure patterns in Australia.

Contributes to the following outcome:
- accounts for individual and group food selection patterns in terms of physiological, psychological, social and economic factors.

Carefully consider the table above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food consumption and expenditure patterns* to complete the tasks ahead.

1. Compare the percentage of money spent on food and non-alcoholic beverages by a low-income family in one week to that of a middle-income earner (a quintile equals 20 per cent of people).
2. What is the greatest expense for middle-income earners? Is it the same for all households?
3. Name three goods or services that low-income households spend less on as a proportion of their total expenditure each week.
4. Is there any good or service that low-income households spend more on as a proportion of their total expenditure than the other groups? Can you explain why?

The marketplace

The **marketplace** refers to the place where consumers purchase food. It may be the corner store, the small local supermarket, the suburban shopping centre, or the buying and selling of goods on world markets. Generally, the smaller the selling venue is, the more expensive the food items are. Small stores buy their food items from larger stores or wholesalers, and increase the selling price to cover their costs.

Even the largest supermarket cannot sell every brand of every product made in Australia, let alone what is made overseas. In order to make a profit, the food retailer has to

know the products and brands that people who live in the area want. In this way the food store influences the food selection we have; we can request a certain product and/or brand but unless there are many requests for the same thing, we have to shop elsewhere (even perhaps on the internet).

Many supermarkets have their own delicatessen, meat section, bakery, pre-prepared chilled foods, and fruit and vegetable section, making it easy for customers to shop for all their food requirements at the one time. Generally, supermarkets are situated within large shopping centres, along with other food specialty stores which give customers a wide range of services and choices.

Available resources

A **resource** is something that we use to achieve our goals, such as time, money or our skill levels.

As varied as our resources may be, the supply of each is limited. For example, money once spent is gone until you make or are given more; and equipment wears out or technology makes it obsolete. Time is a resource that commonly limits what we buy and prepare for meals, while our knowledge of and skills in cooking may become rusty over time without use. Some Australians with limited money need to use the resources of government agencies and charity groups to obtain food parcels and vouchers.

Resources can be interchangeable. If you have the money you can choose to go to a restaurant for a meal, but if money is short you can use your skills, knowledge and food ingredients to make a meal. If you don't have time to cook a meal from scratch, you can use a frozen meal or pre-packaged stir-fry sauce with pre-chopped meat and vegetables.

Recipe books and leaflets on display at the butcher, greengrocer, seafood and poultry shops can provide meal ideas with information about the ingredients and equipment needed to make a dish. So, in effect, they are a resource we use that affects the food we eat. Another resource required is the equipment to prepare a meal at home, such as a fridge, freezer or microwave. Time and money can be used wisely by freezing and safely storing foods that are in season, on sale, or in larger quantities than can be used immediately. The microwave can defrost foods quickly and is cheaper to run than a conventional oven. (See Case study below).

Occupation and finances

As discussed previously, the type of job a person does influences their food selection. The physical demands of the job and its social expectations are reflected in food choices. The income received from employment also determines the quality and quantity of food chosen. For many Australian families, and many other individuals throughout the world, economic factors are the most important consideration when purchasing food. The expenses incurred in raising a family, paying for accommodation, getting to and from work, and so on, often add up to more money than many families earn. When cutting costs, these families often have little option but to cut back on their food expenditure. What they would like to eat and what they can afford to eat are two different things.

CASE STUDY

Elissia is a working single mum with two children, Brett, aged 7, and Felicity, aged 13. Elissia is a good cook and has planned a menu for her daughter's upcoming birthday dinner that includes Felicity's favourites — sausage rolls, chicken burritos and a flourless chocolate roll for her birthday cake. Because of an unexpected car repair, money is tight and Elissia has to work extra shifts to pay for the repair. She needs some advice on how to make the foods identified as cheaply as possible, and in the least amount of time.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *the effects of resource availability* to complete the tasks ahead.

1. Log in to **www.jacplus.com.au** and locate the *Australian Women's Weekly recipes* weblink for this chapter. Visit the site to find the recipes for sausage rolls, chicken burritos and a flourless chocolate roll. Make a list of the ingredients needed for each dish and how long it will take to make.
2. Identify the most expensive ingredients (check them out in your local food store).
3. Substitute a cheaper ingredient where you can (check local newspapers or junk mail for specials). Will this substitute increase or decrease the time needed to make the food?
4. Identify the preparations that Elissia could make ahead of time.
5. Divide into groups and make each of these products.

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Weblink

Compared with many other countries in the world, Australia's food supply is very reasonably priced. We have an excellent supply of nutritious food, both fresh and processed, that is priced within the reach of most people.

Every five years the Australian Bureau of Statistics conducts a Household Expenditure Survey to determine how people in different income groups are spending their money. (See table 2.2 on pages 35–6.)

CASE STUDY

Ozzies skip lunch!

While most Australians think that eating a substantial, healthy lunch is important, one in three skip this vital meal at least once a week, and one in ten rarely or never have it.

A new AC Nielsen Omnibus poll of 1400 Australians shows that people engaged in home duties are most likely to skip lunch; with almost half those surveyed (46%) doing so at least once in the past week.

Too busy is the catch-cry of lunch-skippers — 43% said they didn't have time to go out or make themselves something to eat. A further 20% said they weren't hungry at lunchtime while another one in ten (11%) said they had too many personal tasks to do to fit food into their break.

The more work responsibilities people have, the more likely they are to claim they can't do lunch. More than half the respondents on annual salaries of $60 000 or more said they were simply too busy.

Only a handful of those surveyed blamed their lack of lunch on takeaways being too expensive, fattening or unavailable in their area. Nor were they worried about being perceived as slacking off at work if they take time out. One in five men who don't lunch (21%) think skipping lunch helps them lose weight compared to only 13% of women. Of the one in ten people who rarely eat lunch, more than half (55%) don't think it's important as long as they have a good dinner.

Sanitarium dietitian, Cathy McDonald, said the research shows that many Australians are clearly not making lunch — and their health — a priority.

'It's essential that we all make time to put our health — and our children's health — first,' said Ms McDonald. 'Eating lunch assists in ensuring you get all the vitamins, minerals and other nutrients you need each day to keep healthy.

'A lunch that is high in fibre, low in fat, and is based on low GI foods also provides the long-lasting energy to help avoid the mid-afternoon slump and keep us feeling good through the day.

'Taking time out can also help improve concentration levels, enable time for building relationships and even build fitness levels if you do some exercise during your break.

More concerning is what people are actually eating for lunch. Almost two-thirds (61%) eat takeaways during the week, with hot chips (24%), hamburgers (19%) and meat pies (19%) top of the menu.

More 18 to 24 year olds eat takeaway food than any other age group. About once a week more than half (52%) eat snack food for lunch, 46% munch on toasted foccacia, 44% a hamburger, 43% hot chips, 41% a chicken burger, 29% sausage rolls and 26% meat pies and Chinese takeaway.

Men outnumber women in the fast food stakes with 28% of men having hot chips and meat pies once a week compared to 19% of women eating hot chips and 11% meat pies.

Blue-collar workers are more likely than white-collar workers to eat unhealthy lunch options.

Almost a third (30%) of people on home duties eat hot chips every week, with a further 20% biting into burgers, 18% kebabs and 17% sausage rolls.

The AC Nielsen Omnibus poll shows only 16% of Australians take between 45 minutes and an hour for lunch. One in three people have a 20 to 30 minute lunch break with a further one in five spending less than 20 minutes. Five per cent don't stop for lunch at all.

And one in five Australians eat their lunch while at their desk or on the move.

Cathy McDonald said the study confirms that few people are taking the traditional lunch hour and many have a rushed lunch break.

'This might seem great for productivity, but a rushed lunch-time means people are missing out on important health benefits both from a nutritional, stress management and a relaxation perspective,' she said.

'It's important for us to realise that taking time to eat lunch is critical to maintaining health. A healthy lunch is important in controlling weight, boosting energy and concentration levels, as well as feeling better overall.'

Source: News-Medical.Net, 3 May 2006.

CASE STUDY QUESTIONS

Carefully consider the article opposite. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *the factors affecting food selection* to complete the tasks ahead.

1. What percentage of people skip lunch at least once a week?
2. What reason did men often give for skipping lunch?
3. What are the advantages of having a high-fibre, low-fat lunch?
4. Which age group eats the most takeaway food for lunch?
5. What percentage of Australians eat their lunch at their desks or on the move?

REVIEW QUESTIONS

Remember

1. The most common resource in short supply is _____ _____. In many situations it is possible to substitute the resource of _____ instead.

Apply

2. Read the following scenario and identify the resources available to ensure that Ed has proper meals. Ed is 81 and lives by himself in the family home in the central part of a medium-sized town. He reads a lot and friends collect him (because he can't drive anymore) twice a week to play cards. A new kitchen was installed just before his wife died two years ago, and as much as he loves food and has a good appetite, Ed doesn't know much about cooking.

Do an activity

3. Basic food ingredients are available under the label of generic brands.
   - **a)** As a class, make a list of what foods would be included under the heading of basic ingredients.
   - **b)** Organise for each class member to have five of the ingredients.
   - **c)** Using the internet, a store visit or newspapers compare the price of a generic brand of the ingredients to a brand name.
   - **d)** How much more is the brand name than the generic brand?

CHAPTER 2 SUMMARY

- Physical, psychological, social and economic factors affect what we eat.
- Nutrient needs depend upon a person's age, sex, body size, level of physical activity, health status and whether or not the person is pregnant or lactating.
- Body type is dictated by height and overall body frame, amount of body fat, weight and amount of muscle.
- BMR (basal metabolic rate) decreases in middle age.
- Active people need more energy than those who are sedentary.
- Pregnancy requires increased amounts of energy, folic acid, calcium and iron.
- Colour, shape and turgor are important to the appearance of food.
- Aroma and taste work together to give food flavour.
- A value is a deep feeling about something; a belief is an opinion; while an attitude is a way of looking at something.
- A food habit is easily and sometimes unconsciously picked up, and is hard to change.
- Depending on the person, emotional times can cause someone to eat food for comfort or even stop eating altogether.
- Body image is greatly influenced by the media's concept of beauty.
- All cultures have traditions that include food either before, during or after the event.
- Lifestyle describes the things you do each day — at work and in leisure time. Lifestyle is dictated by financial resources, education, travel opportunities and where you live.
- The age, sex, number of people in the household, who works and when, all affect food choices.
- Peer pressure is a factor in deciding what to eat when you are with your friends.
- The cost of food depends on the type of retailer and your geographical location.
- Available resources to purchase and prepare foods will vary from household to household.
- Time, money and skills are most often the resources in short supply in our busy lifestyles.

KEY TERMS

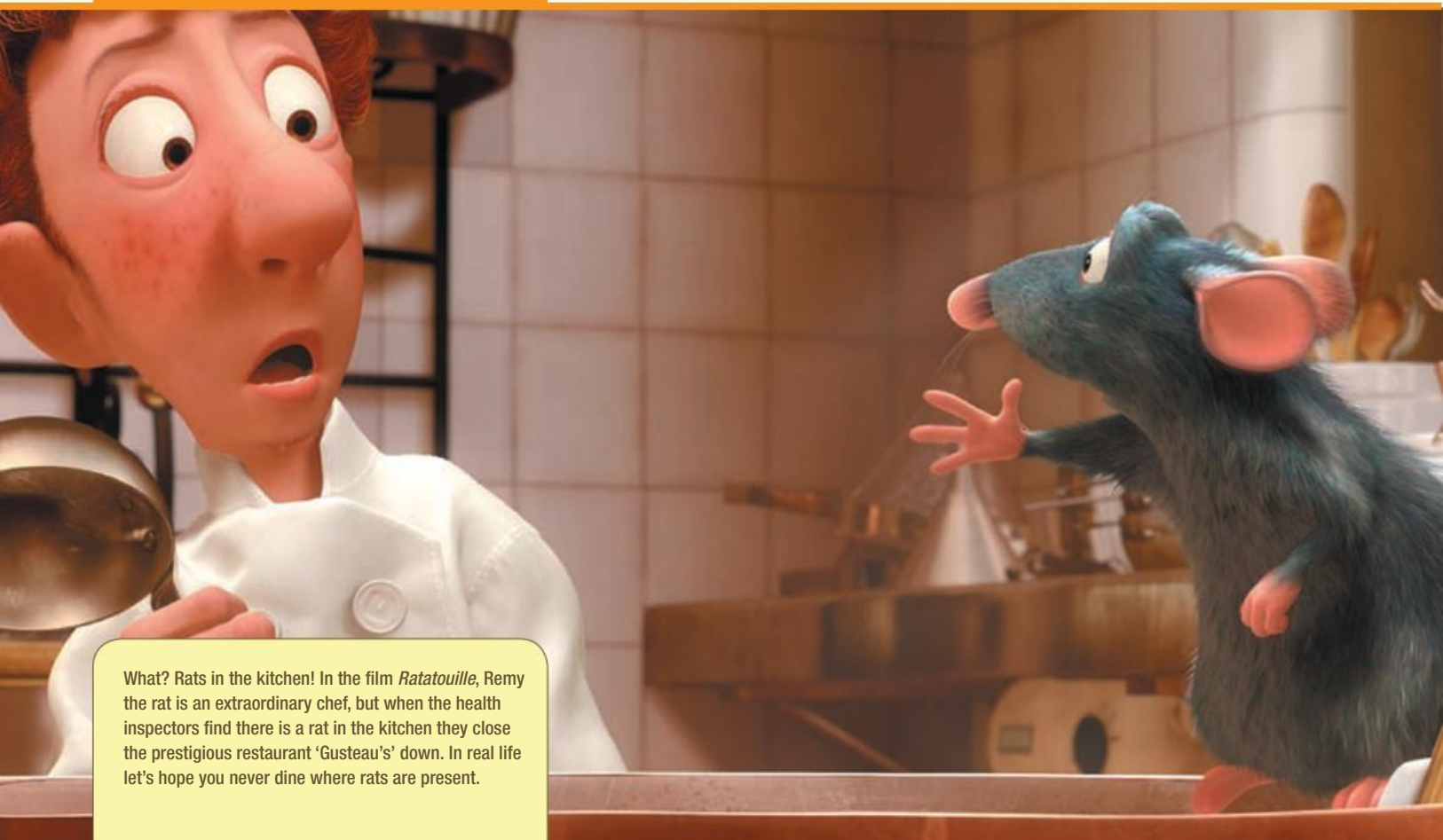
adipose tissue
anaemia
appetite
aroma
basal metabolic rate (BMR)
carbohydrate
flavour
generic brands
gluten
hunger
hypothalamus
legumes
marketplace
metabolise
nutrition
offal
peers
protein
resource
rickets
satiety
sensory perception
staple food
turgor
vegetarian

Chapter 3
Safe storage and preparation of food

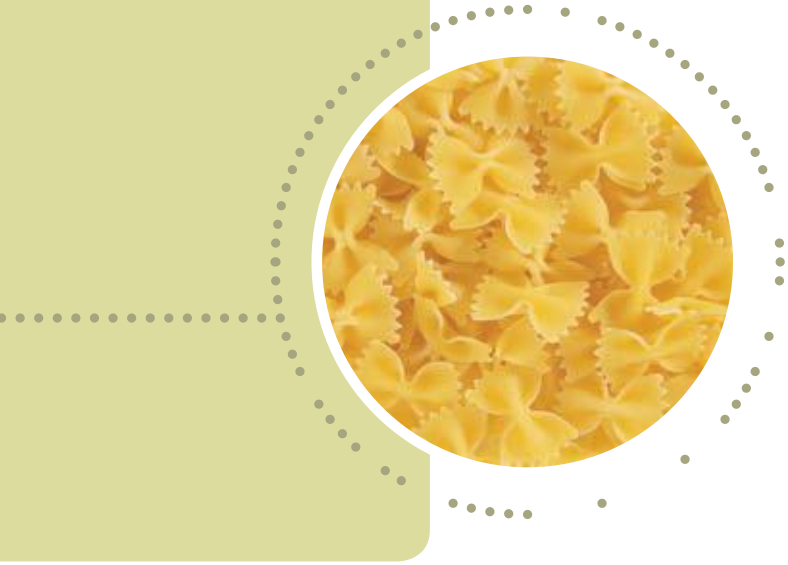
Fancy finding a spider in your salad, metal in your sausage roll, glass in your hotdog or a kitchen infested with cockroaches? These are real complaints about food outlets in Australia. Thankfully we have high food safety standards in this country that help to reduce the risk of illness. Storing food safely and preparing it properly is the topic for discussion in this chapter.

In this chapter you will learn about:

- Safe storage of food
  - methods of storing foods to maintain quality such as dry storage, cold storage and freezing
- Safe preparation and presentation of food
  - equipment and utensils used to produce quality food products across a range of settings
  - safe and hygienic work practices when handling food
  - preparation methods to produce food products across a range of settings.



What? Rats in the kitchen! In the film *Ratatouille*, Remy the rat is an extraordinary chef, but when the health inspectors find there is a rat in the kitchen they close the prestigious restaurant 'Gusteau's' down. In real life let's hope you never dine where rats are present.



In recent years there has been a tremendous change in lifestyle with more and more people going out to eat meals prepared in restaurants, canteens and fast food outlets. There has been a boom in the food service industry, and manufacturers and retailers of food products work hard to provide high quality food to the consumer. Australia has food safety standards that are considered to be of a very high standard. But, nonetheless, **food-borne illness** and disease are reported to be increasing. Approximately 5.4 million people experience food-borne illness each year in Australia, causing 18 000 hospitalisations and resulting in over 2 million lost days of work. Consequently, the cost of food-borne illness is in the millions of dollars each year. This illness is dangerous and can be fatal in some cases.

Health hazards associated with food

Before looking at safe storage and preparation of food, it is important that we understand the science behind what makes food safe. The United States Food and Drug Administration (FDA) ranked the relative importance of health hazards associated with food in the following descending order of seriousness:

- microbial contamination
- inappropriate eating habits
- environmental contamination
- natural toxic constituents
- pesticide residues
- food additives.

There are some components of foodstuffs that are not good for people to consume and these are classified as 'undesirables'. They can occur naturally within foods, they could be **microbial** in origin (a microbe is a minute living organism such as bacteria or a fungus), or could be environmental contaminants.

Food contamination can be caused by chemicals — for example, cleaning chemicals or there may be some residues as a result of agricultural or industrial processes; physical — for example, foreign objects such as glass, metal fragments or stones; biological — such as micro-organisms or toxins/poisons produced by micro-organisms; or caused by other substances that make food unsafe or unsuitable for consumption.

Natural toxins may be either plant- or animal-derived. For example:

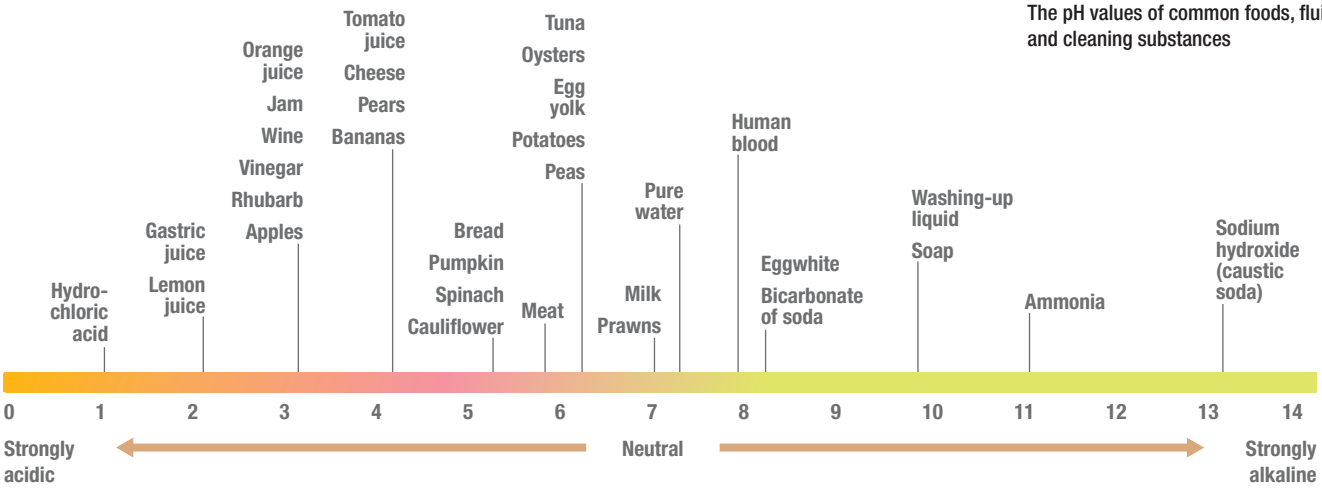
- *Solanine* is a toxin that is found in green potato skin and is known to inhibit the action of neurotransmitters.
- *Tetrodotoxin* is a toxin that causes respiratory paralysis and is known to be carried by the puffer fish within several of its bodily organs. Cooks may be required to be licensed to cook puffer fish to ensure safe handling and preparation.

The FDA ranking of health hazards associated with food has shown you that microbial contamination is the major health hazard associated with food. Food can become contaminated at any stage of the food production chain. Food poisoning caused by micro-organisms is referred to as being 'food-borne'. Various micro-organisms such as bacteria, fungi, moulds, viruses and protozoa can cause food-borne illness. In total, approximately 290 different micro-organisms have been identified as being potential causes of food-borne illness. Many of these micro-organisms are commonly found in soil, water and in our own bodies. For example, the micro-organism *Escherichia coli* is normally found in the human intestines without causing disease, and yet some strains of this bacterium are pathogenic because they can cause disease. Micro-organisms that cause food-borne illness can be transferred from a contaminated food item to a person's gastrointestinal tract and produce some very unpleasant symptoms, and may even be fatal in some cases. Correct hygiene practices during the storage and handling of food can make a significant difference in reducing the risk of food poisoning.

Factors affecting microbial growth

Microbial activity (that is bacteria, viruses, yeasts and mould), present in food or in the environment surrounding food, can cause food to deteriorate. Many factors affect the growth and survival of micro-organisms including the availability of nutrients, water, preferred pH, temperature and atmosphere.

Do you like blue vein cheese? Not all micro-organisms are bad for you, but there are some 290 types that are, and they are classified as pathogens.



The pH values of common foods, fluids and cleaning substances

pH

The types of micro-organisms that grow on food are determined by the pH of the food. pH refers to the acidity or alkalinity of a substance. Different micro-organisms have different optimal pH for growth — a slightly acidic or a neutral pH 7 is needed for optimal growth for most bacteria; yeasts prefer a more acidic environment of pH 4.5; and moulds prefer pH 3.0.

Temperature

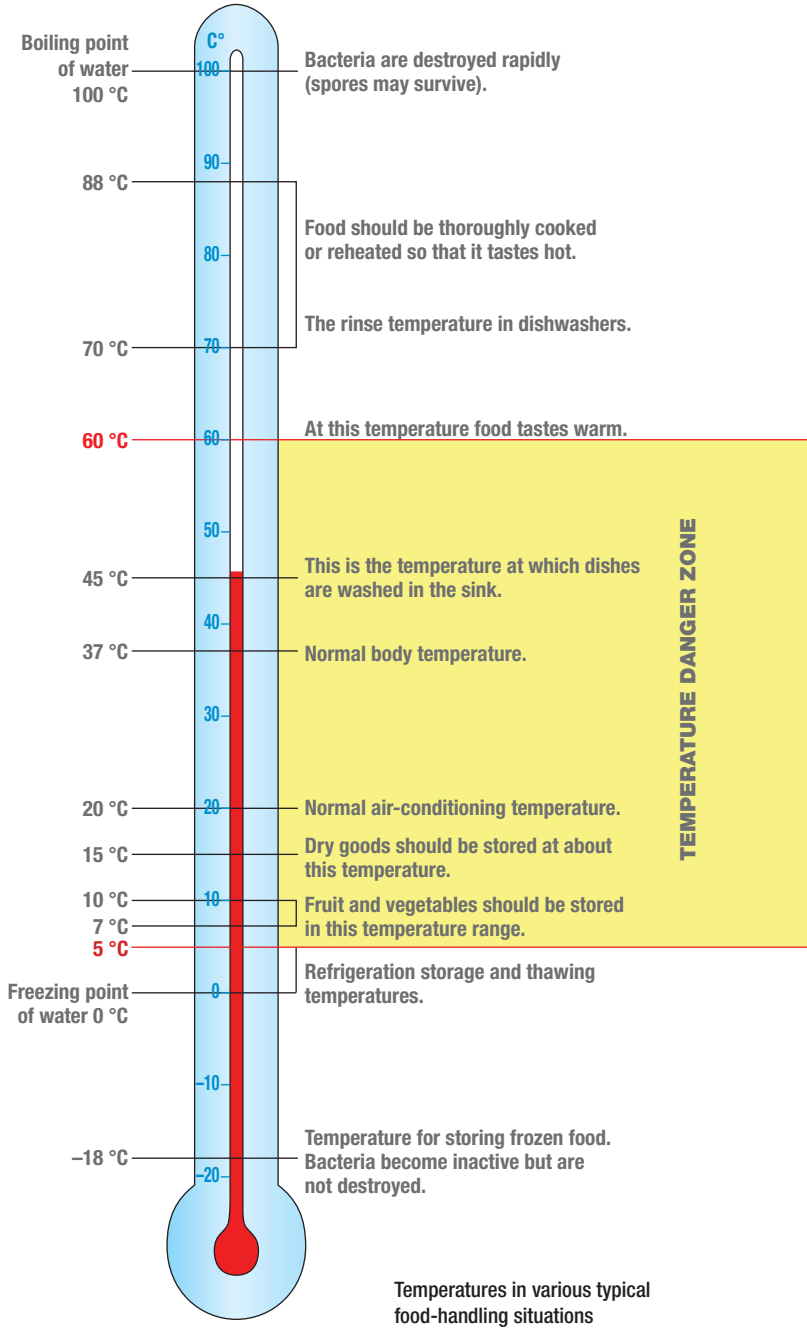
Micro-organisms can be broadly classified based on their temperature requirements. Micro-organisms that prefer low, medium or high temperature are called psychrophiles, mesophiles and thermophiles, respectively. Some bacteria can thrive at refrigeration temperatures (for example the bacterium *Listeria monocytogenes*). Most bacteria that are responsible for food-borne illness grow well at temperatures between 5 °C and 60 °C. This is called the **temperature danger zone**. Below 5 °C the food poisoning micro-organisms become less active, but on reaching warmer temperatures they begin to grow and multiply again; freezing does not destroy all bacteria. At temperatures above 60 °C microbial growth is slowed down, and most microbes are destroyed at temperatures above 80 °C.

Gas atmosphere

Both oxygen and carbon dioxide affect microbial activity. Micro-organisms can be classified according to their gaseous requirements. An aerobe requires oxygen for growth, an anaerobe prefers an oxygen-free atmosphere and a facultative can grow in either the presence or absence of oxygen. Moulds are aerobic, which explains why they grow best on the surfaces of food. Yeasts are aerobes but some are facultative anaerobes. Bacteria such as *Bacillus cereus* can be aerobic, whereas *Clostridium* is anaerobic and *Salmonella* and *Staphylococcus* are facultative.

Moisture

Micro-organisms need water to survive well, although some can tolerate dry conditions. Water that is not bound in food



Temperatures in various typical food-handling situations

is measured in terms of **water activity (A_w)**. This water is available for microbial growth. Water activity is not the same as the moisture content of the food. Water activity ranges from 0 to 1.0 and pure water has a water activity of 1.0. Water activity of food is used to predict growth of micro-organisms such as bacteria, yeasts and moulds. Most micro-organisms do not survive well at low water activities and so drying food or adding salt or sugar are used as food preservation methods because these processes affect the water activity of food. Dry foods such as breakfast cereals and dried fruits have a low water activity that will not support growth of micro-organisms easily, whereas foods such as fresh fruit, vegetables, meat and fish have high water activities and are more perishable.

In general:

A minimum A_w = 0.9 for most bacteria (can be 0.85–1.0)

A minimum A_w = 0.8 for yeasts (can be 0.87–0.91 and 0.60–0.75)

A minimum A_w = 0.7 for moulds (can be 0.80–0.87 and 0.60–0.75).

Adverse conditions

Under adverse conditions, some micro-organisms can survive by producing **spores** with a protective coating that enable them to survive in a dormant state for long periods. These spores are very resistant to heat (some may survive up to 4 hours of boiling!) and some can tolerate many months (or even years!) of dry or frozen conditions. Under favourable environmental conditions the spores will germinate and become active micro-organisms again that will grow and increase in number. Spores can be prevented from germinating by keeping food hot (60 °C), cold (below 5 °C) or by rapidly heating or cooling food.

REVIEW QUESTIONS

Remember

1. True or false?
   - **a)** Pesticide residue is the single most important health hazard associated with food.
   - **b)** Some micro-organisms found in food do not cause disease.
2. List two substances occurring naturally in food that are regarded as 'natural toxins'.
3. At what temperature do most micro-organisms become less active?

Apply

4. Explain why dry foods are not as susceptible to the growth of micro-organisms compared to foods such as fresh fruit.
5. Why does keeping food hot (60 °C) or cold (below 5 °C) help to prevent bacteria in food?

Do an activity

6. Log in to **www.jacplus.com.au** and locate the *Puffer fish* weblinks for this chapter.
   - **a)** What is a puffer fish?
   - **b)** Why it is important to cook them correctly?

eBook*plus*

Weblink

Food-borne illness

Unfortunately, eating Christmas dinner could put an end to your Christmas cheer. Many people around this time of the year become sick because food is not handled correctly. The combination of warmer weather, over-full fridges and cooking for larger crowds can lead to food poisoning. Food poisoning is a serious problem. Symptoms of food-borne illness can vary from diarrhoea, vomiting, nausea, fever and abdominal pain to life-threatening conditions that affect the kidneys, liver and the nervous system. Food-borne illness may even result in death.

Protozoa

In Australia, some metropolitan water supplies have been reported to be contaminated with *Giardia lamblia* and *Cryptosporidium parvum*. Outbreaks have also been reported in day-care centres. Both giardia and *C. parvum* are protozoans (single cell microscopic or near microscopic organisms) that attach firmly to the intestinal wall and cause diarrhoea, which can last for many weeks.

Fungi and moulds

Some fungi and moulds secrete toxins called **mycotoxins** that are harmful to man. For example, the mould *Aspergillus flavus* produces a toxin called aflatoxin, which has been linked with contaminated peanuts, wheat, corn, rice and other crops, and has resulted in illness in both humans and livestock. Some other fungi and moulds also produce mycotoxins that are harmful to man. The presence of mycotoxins in food poses such a great public health problem that up to 60 countries have regulations to control the levels of mycotoxins in food and animal feed.

Viruses

Viruses do not grow in or on food because they need a living host cell in which they can reproduce. Therefore, eating food that is contaminated with viruses enables these micro-organisms to enter the person's body, where they will reproduce within the cells of the host. A virus takes over the cell it enters and reproduces until there are so many viruses within the cell that the cell membrane breaks. The viruses then escape to invade other cells. Hepatitis A and Norwalk

virus are two examples of viruses that cause food-borne illness because they can be transmitted by an infected food handler to food. In this way others can also become infected after eating the contaminated food.

Bacteria

Bacteria (tiny one-celled organisms) can cause two types of food poisoning — infective food poisoning and toxic food poisoning:

- Infective food poisoning occurs as a result of eating live bacteria that is in the food. The best way to prevent this type of food poisoning is to prevent the growth of the micro-organisms. Examples of bacteria that cause infective food poisoning are *Salmonella*, *Listeria* and *Escherichia coli*.
- In contrast, toxic food poisoning results from toxins that are produced by some bacteria and it is these toxins that cause illness. In general, the toxins cannot be removed or inactivated by cooking. The main food poisoning bacteria that produce toxins are *Staphylococcus aureus*, *Clostridium perfringens* and some types of *Escherichia coli*. An example of an extremely potent toxin is that produced by the bacterium *Clostridium botulinum* that causes botulism, which is a very dangerous form of food poisoning. *Clostridium botulinum* forms spores that can be found in soils and aquatic sediments. The spores are heat-resistant and under anaerobic conditions they can germinate and allow the growth of the bacteria. Cases have been reported that were caused by eating incorrectly home-processed foods, canned low-acid vegetables, smoked or pickled fish or meat, and home-processed honey. It has been estimated that as little as 0.01 µg (µg =microgram) will kill an adult. The best way to prevent toxic food poisoning is to prevent the growth of micro-organisms in the first place. See chapter 10 for further information.

TABLE 3.1 Diseases caused by bacteria

SALMONELLOSIS
Bacteria: *Salmonella*
Source: Spread when contaminated food (meat, poultry, eggs or milk) is eaten raw or undercooked. Also, when cooked food comes in contact with contaminated raw food, or when an infected person prepares food.
Symptoms: Onset 6–48 hours after eating; nausea, fever, headache, abdominal cramps, diarrhoea and vomiting lasting 2–7 days. Can be fatal to infants and the elderly.
Prevention: Separate raw foods from cooked foods. Thoroughly cook meat, poultry and eggs. Do not leave food for over two hours at room temperature. Refrigerate food at below 5 °C.

STAPHYLOCOCCAL FOOD POISONING
Bacteria: *Staphylococcus aureus*
Source: Carried by people on skin in boils, pimples and throat infections; spread when carriers handle food. Staph bacteria produce toxins (poisons) at warm temperatures. Found in meat, poultry, salads, dressings, gravies, cream sauces, cheese, eggs, custards and cream-filled desserts.
Symptoms: Onset 1–8 hours after eating; vomiting, diarrhoea, nausea and abdominal cramps lasting 1–2 days. Rarely fatal.
Prevention: Cooking will not destroy staph poison, so practise good personal hygiene and sanitary food handling. Do not leave perishable food unrefrigerated for over two hours. For quick cooling, place hot food in small containers no more than two centimetres deep, cover when cool and refrigerate.

BOTULISM
Bacteria: *Clostridium botulinum*
Source: Most common in low-acid foods canned improperly at home. The presence of these bacteria or their poisons is sometimes signalled by clear liquids turning milky, cracked jars, loose or dented lids, swollen or dented cans, or an 'off' odour. Found in meat and fish.
Symptoms: Onset 4–72 hours after eating; nervous system disturbances such as double vision, droopy eyelids, trouble speaking, swallowing or breathing. Untreated botulism can be fatal.
Prevention: Carefully examine canned goods and do not use any that show danger signs. Also, cook and reheat foods thoroughly, keep cooked foods hot (above 60 °C) and cold (below 5 °C), and divide larger portions of cooked food into smaller portions for serving and cooling.

PERFRINGENS FOOD POISONING
Bacteria: *Clostridium perfringens*
Source: Called the 'buffet germ', it grows rapidly in large portions of food that cool slowly. It grows in warming dishes, which may not keep food sufficiently hot, and in the refrigerator if food is stored in portions that are too large to cool quickly. Found in meat and poultry.
Symptoms: Onset 8–12 hours after eating; diarrhoea, abdominal cramps, headache, chills.
Prevention: Keep food hot or cold. Reheat food carefully, especially soups and casseroles.

CAMPYLOBACTERIOSIS
Bacteria: *Campylobacter jejuni*
Source: Found in raw milk, eggs, poultry, raw beef, cake icing and water.
Symptoms: Onset 2–10 days after eating; severe diarrhoea, cramps, fever and headache.
Prevention: Pasteurise milk, cook foods properly.

LISTERIOSIS
Bacteria: *Listeria monocytogenes*
Source: Common in food-processing environments and digestive tracts of humans. Found in untreated water and milk, dairy products, raw meat and seafood.
Symptoms: Onset 2–30 days after eating; fever, flu-like symptoms. Infants may vomit, have trouble breathing; pregnant women, in particular, are at risk.
Prevention: Avoid foods that are not pasteurised.

SHIGELLOSIS
Bacteria: *Shigella*
Source: Poor sanitary habits spread by touching moist foods. Bacteria multiply at room temperature. Found in poultry, salads and foods that require mixing but not heating.
Symptoms: Onset 1–7 days after eating; abdominal pain, fever and vomiting.
Prevention: Good personal hygiene; refrigerate perishable foods.

***BACILLUS CEREUS* FOOD POISONING**
Bacteria: *Bacillus cereus*
Source: Found in cooked rice that was not refrigerated and then consumed; pasta, potatoes, meat, milk.
Symptoms: Diarrhoea and vomiting.
Prevention: Refrigerate perishable foods.

HAEMORRHAGIC COLITIS
Bacteria: *Escherichia coli*
Source: Drinking water contaminated by sewage transmitted to raw food.
Symptoms: Onset 3–4 days after eating; severe abdominal cramps, diarrhoea, vomiting and fever.
Prevention: Do not consume untreated water; thoroughly cook food.

Food-borne disease outbreaks

A survey of state and territory health departments by OzFoodNet investigating food-borne disease outbreaks in Australia from 1995 to 2000 reported the following key findings:

- A total of 20 deaths were attributed to food-borne illness.
- **Outbreaks** in hospitals and aged care facilities were responsible for 35 per cent of deaths.
- 293 outbreaks were identified and, of these, 214 were of food-borne origin.
- Of the 214 outbreaks identified, bacterial disease was responsible for 61 per cent of the outbreaks and 95 per cent of the deaths.
- Most of the bacterial outbreaks were due to *Salmonella* and *Clostridium perfringens*.
- Infection with *Salmonella* and *Listeria monocytogenes* were the main cause of the number of deaths.
- Restaurants and commercial caterers were associated with the highest number of outbreak reports and cases.

The most frequently implicated foods were in the following order: meat, fish, seafood, salad, sandwiches and eggs. In the meat group, chicken was the most frequently implicated meat.

Between 2000 and 2005, there has been an increase in the number of food-borne diseases and it has been reported that *Salmonella* was the most frequent cause of food poisoning. Recent reports also indicate that many cases of food poisoning are linked to practices in the home. Some reports say that men's and young adult's overall knowledge of food safety is low. Do you think that this is an issue considering many more men and young adults cook these days?

Pathogens of concern in recent years

Pathogens causing food-borne illness that are recognised as posing increasing health concerns include *Campylobacter jejuni*, *Salmonella*, *Escherichia coli O157:H7,* and *Listeria monocytogenes*. Let's take a closer look at some of these.

Campylobacter jejuni

This micro-organism is now recognised as a major cause of gastroenteritis in humans, despite being well recognised in veterinary medicine for many years. The main cause of infection in humans is from the consumption of raw milk (milk that is not pasteurised), raw or undercooked poultry, or from cross-contamination, and symptoms include severe abdominal pain, fever, nausea and diarrhoea. This bacterium is considered to be a major health problem to the same magnitude as *Salmonella*.

Salmonella

There are many species of *Salmonella*. Food poisoning caused by *Salmonella* is considered a major health problem in most countries. Symptoms are fever, headache, nausea, vomiting, abdominal pain and diarrhoea. Foods that have been involved in outbreaks are eggs, chicken and other meats, raw milk and chocolate. In 1996 in Australia an outbreak of *Salmonella* poisoning involved peanut butter processed from contaminated roasted peanuts.

Escherichia coli

Many strains of *E. coli* are harmless to man but some strains such as *E. coli O157:H7* can cause severe food poisoning. The effects of an infection can range from having diarrhoea with blood in the stools (this is called haemorrhagic colitis) to a condition known as haemolytic uraemic syndrome (HUS), which can result in kidney damage. Infection with *E. coli O157:H7* has also resulted in some deaths. In Australia, *E. coli 0111* survived the inadequate fermentation process used at the time for the manufacture of mettwurst; 18 children under 14 years of age developed HUS; one child, aged four, died; and some adults also became ill.

Listeria monocytogenes

L. monocytogenes is widely distributed in the environment, in soil, water and vegetation; some exposure to this micro-organism is unavoidable.

L. monocytogenes has the ability to grow over a wide temperature range, from 0 °C to 45 °C, and this makes it different to other micro-organisms because it can grow and multiply at temperatures in most refrigerators. *Listeria* can also survive freezing for long periods of time. At any one time, one in 20 people carry this life-threatening bacterium in their gut without any apparent side-effects. Life-threatening infection with *Listeria* is usually not common, although in recent years there has been an increase in the number of cases. The people at risk are those with lowered immune systems and pregnant women. The infection can be fatal and has caused the death of some elderly people. The illness has been linked to the consumption of contaminated patés, milk, soft cheeses such as brie and camembert, undercooked chicken, raw seafood, packaged ready-to-eat salads, pre-cooked salads (including fruit salads), cold delicatessen meats and pre-cooked chicken.

REVIEW QUESTIONS

Remember

1. Guess the food-borne illness/s that would result in the following situations.
   - **A.** I developed this form of virus through eating food handled by someone who was infected with the same virus.
   - **B.** I ate food that had a food bacterium which produced toxins, and I nearly died.
   - **C.** I went swimming and drank some of the water, which was later found to have a protozoan parasite in it.
2. Mycotoxins are naturally occurring chemical compounds that are toxic to people and animals when ingested and they are produced by
   - **A.** aerobic bacteria
   - **B.** a pathogenic protozoan
   - **C.** anaerobic bacteria
   - **D.** fungi.

Apply

3. Explain the difference between infective food poisoning and toxic food poisoning.

Do an activity

4. Log in to **www.jacplus.com.au** and locate the *Food-related illness* weblinks for this chapter. Choose one food-related illness and research its cause, symptoms and how to avoid it.

eBook*plus*

Weblink

Safe storage of food

Once the food product has been harvested, slaughtered and/or processed, the aim of the food manufacturer, wholesaler and retailer is to maintain the quality and safety of the food until the consumer purchases the product. Correct storage means placing food in an environment that will maintain the best colour, flavour, texture and nutritional value of the food, and ensure safety from harmful micro-organisms.

Food spoilage

It is not possible to determine whether a food is safe to eat just by looking at it, tasting it or smelling it. However, in some cases there may be indications to tell if a food is unfit to eat — for example, you can check whether there has been a change in the colour, smell or the texture of the food or drink item. You can also see if there is any evidence of slime or mouldy growth.

Food can deteriorate due to various factors and result in **food spoilage**. Usually the spoilage is due to non-microbial factors such as enzymes in the food. However, food spoilage can also be due to microbial contamination, and this may result in unpleasant flavours or odours, colour changes, alterations in texture, or there may be a release of gases that cause the food packaging to swell. In general, these foods are not safe to eat because the decomposition process may promote the growth of more harmful micro-organisms.

TABLE 3.2 Action with suspect foods

FOOD	ACTION
Apple with brown spot/blemish	Cut away spot/blemish
Banana with spots of mould/very soft black skin	Discard
Fruit juice tastes 'different'	Discard
Potato has areas of green tinge	Cut away green areas
Carrot is soft and mushy	Discard
Cooked or raw meat has mould/looks slimy	Discard
Fish smells very 'fishy', eyes are cloudy	Discard
Eggs have cracked shells	Discard

Shelf-life of food

Food usually cannot be stored indefinitely, and over a period of time there is a loss of quality with regard to flavour, texture, and overall general appearance. **Shelf-life** refers to the expected time for which a food will retain its quality and applies to unopened food items.

The most important factors in predicting the shelf-life of a particular food are growth of micro-organisms, changes in moisture, and chemical or biochemical changes. Some guidelines that you may see on food items:

- the *use-by date* means that after this date, the food should not be consumed because of safety concerns. You may see a use-by date on products such as packed fresh vegetables and fresh cream.
- the *best-before date* means that the food is at its highest quality before that date and is commonly used for fresh milk, fresh eggs, mayonnaise, tomato sauce, packaged breadcrumbs, breakfast cereals, cooking oil, frozen vegetables and ice-cream; a *baked on date* or *use-by date* is used on bakery items such as bread and bread rolls.

Some food may be acceptable past its shelf-life provided it is stored according to the instructions provided by the manufacturer but, on the whole, it is best to follow the dates indicated on the food items. The retailers or manufacturers are responsible for replacing any food item or should refund the cost if there are any complaints from a customer.

Perishable foods such as fresh milk and other dairy items, meat, fish, bread, and fruit such as strawberries, have a short shelf-life of a few days and, therefore, correct storage (usually in a cool or cold environment) is essential to maintain quality. **Semi-perishable** foods such as frozen foods, potatoes, other fresh root vegetables and packaged cereals can usually be expected to last from several weeks to a few months if stored correctly.

Non-perishable foods generally have a long shelf-life and items such as canned foods, some bottled foods and dried foods will last for several months, with some lasting over a year due to the fact that they have undergone processing and have special packaging. (See Case study below).

Commercial storage

Food manufacturers and retailers make every effort to carry out correct storage procedures so the food will be at its best for the consumer. The three types of commercial food storage are cold storage, dry storage and freezing.

Cold storage

Foods kept in cold storage are held at temperatures of 0–5 °C. (You may think that the food would freeze, but it does not. Pure water will freeze at 0 °C, but other substances dissolved in the water in food actually prevent freezing until about –15 °C.) At the reduced temperatures, microbial and

CASE STUDY

Use this canned meat by next century!

'Yes, I'll have the 100-year-old roasted veal thanks …'

It's difficult to imagine, but a can of roasted veal that was packed for an arctic expedition by Sir William Edward Parry in the 1820s was actually still edible when opened — 100 years later. The can was on display in a museum in America but was opened in 1938 and chemically analysed. The result of the analysis was that the veal was still moist and in good condition. The final taste test, however, was not conducted by a human but by a cat who thankfully suffered no ill effects.

Canning was introduced in the nineteenth century, and was revolutionary because it allowed many perishable foods to be preserved for long periods of time. Explorers of new lands were able to embark on longer expeditions than ever before because the can assured their supply of food.

Next time you are in the supermarket take a look around at all the products that are canned. At home look in your pantry and you will most likely be able to confirm that canning is still very important in preserving food today. While some canned food can remain edible for many years, according to the CSIRO it is best not to keep canned food for more than a year in your pantry cupboard. If there is a best-before date, always be guided by that.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *the shelf-life of food* to complete the tasks ahead.

1. Why do you think the introduction of cans at the turn of the nineteenth century would have been a 'revolutionary concept'?
2. Outline the history behind the 100-year-old can of meat and whether it was edible.
3. Can you suggest reasons for why the meat remained edible after all those years?

enzyme activity slows considerably, so food quality is maintained and shelf-life is extended.

Cold storage is a cheap and safe way to store fresh and cured flesh foods, dairy products, and fresh fruits and vegetables.

Fruits

Fruits are often picked before they are ripe, and are kept in cold storage until there is a demand for them. The low temperature slows the enzymes responsible for ripening, although some ripening will take place. During the ripening process, the fruits give off **ethylene gas**. As soon as one piece of fruit starts to produce ethylene gas, the surrounding fruits also start to ripen and produce the gas. (It is rather like when one person in an audience starts to applaud and the rest of the audience joins them.) It is therefore important to control the level of ethylene gas wherever fruits are stored in large quantities.

Reusable, recyclable bins that have vented side panels for maximum air flow are now being used by the Coles and Woolworths supermarket chains. The produce is packed in the crates at the farm and taken directly to the point of sale.

Ethylene gas will also destroy chlorophyll, the green pigment in green fruits such as apples, kiwifruit and grapes. This causes an undesirable colour change from the usual green colour to a brown colour.

To keep fresh fruits from ripening before they are needed, cold storage is usually combined with controlled atmosphere storage. In a controlled atmosphere, the air that surrounds the fruit is monitored for its ethylene gas, moisture, oxygen and carbon dioxide levels; when the ethylene and oxygen levels rise, fruits ripen. Thus, the air is removed and replaced with air that is low in oxygen and high in carbon dioxide.

Humidity or water vapour in the air must also be controlled because lack of moisture will dry out the fruit (and vegetables), while too much will encourage micro-organisms to grow.

Vegetables

Vegetables are also kept in cold storage, although the temperature is held at slightly above 0 °C. This slightly higher temperature helps to maintain the sweetness level. Once a vegetable (particularly one high in starch such as corn) has been harvested, it starts to lose its sweetness. In an effort to keep this sweetness the vegetable must be kept cool, but not too cold.

As with fruits, controlled atmosphere storage restricts the ripening or maturing of vegetables by controlling the levels of ethylene gas and oxygen.

The skin of vegetables is often thinner than that of fruits, so dehydration can be a problem in cold storage. To prevent wilting and loss of **turgor**, the water vapour in the air in the cold store is carefully controlled. With just the right amount of moisture and the right temperature, the vegetable's turgor will be maintained, and mould will not grow and spoil the food.

When the season for the fruit or vegetable is over, the produce in cold storage is allowed to ripen. The storage controller does this by gradually increasing the temperature and allowing the ethylene gas and oxygen levels to rise. Some common fruits and vegetables that are available all year, such as apples, oranges, potatoes and carrots, will have been kept in cold storage for several months. When the supply runs low, they are brought out of cold storage and appear in the fresh produce sections of supermarkets and greengrocers. The consumer needs to be careful when choosing vegetables, if it is not their natural harvesting season, because prolonged cold storage can reduce the quality of the food. Apples with brown centres, for example, have been stored too long.

Flesh foods

Fresh flesh foods also contain enzymes that cause the flesh to change or age. In addition, flesh foods have a high water content, which provides a perfect growth environment for the bacteria that live on the surface of the food. Cold storage slows enzymatic ageing and bacteria growth.

Dry storage

All foods contain at least a small amount of water; without water, food would be just fine dust particles. Water also helps to give a food its distinctive texture. Could you imagine a watermelon without its 93 per cent water content? Table 3.3 lists the water content of some common foods.

TABLE 3.3 Water content of several common foods

TYPE OF FOOD	MOISTURE CONTENT
Fruits and vegetables	75–95%
Tomatoes	94%
Green beans	90%
Strawberries	90%
Milk	87%
Fish	75–80%
Meats	64–70%
Cream	65%
Bread	35–40%
Dried prunes	28%
Margarine	19%
Flour	15%
Dried beans	11%
Rolled oats	8%

Foods with a low A_w, such as rolled oats, flour and dried beans, must be stored in an environment that has circulating air and controlled humidity or water vapour. This kind of storage is referred to as dry storage.

If even a small amount of extra moisture is present, a low-A_w food will absorb it, micro-organisms will start to multiply, and the food's quality will drop. In addition, the increased moisture could activate enzymes, causing ripening or browning.

Several groups of foods require dry storage to maintain their quality:

- very low A_w foods that will be reconstituted (that is, have water or some other liquid added to them before being eaten) — for example, dried beans, dried soup mixes and sauces, cereals, flour, cake mixes, tomato paste and jelly crystals
- moderately low A_w foods with a crisp texture that will be lost if moisture is allowed to come in contact with the food — for example, crackers and packaged biscuits
- freeze-dried foods — for example, coffee and herbs
- some fresh vegetables — for example, onions and potatoes
- frozen foods (see notes on freezer storage).

Special attention is usually given to the packaging that surrounds foods with a low-A_w content. Airtight packages would be ideal, but they are too expensive and impractical. Food manufacturers store raw materials in bulk, and it would be impossible to maintain an airtight seal in a container of several tonnes of flour that is regularly opened to provide quantities for commercial bakeries.

However, for the convenience of the individual consumer, many low-moisture foods such as dried fruits and breakfast cereals are sold in airtight packages. (Potatoes are an exception; they will become slimy if packaged in airtight wrapping.) Several foods (such as flour and dried pastas) are not packed in airtight packaging because it is too expensive, so these foods must be stored in a cool, dry place in the home.

Freezer storage

Providing the freezing process is quick, freezing is an effective storage method used to maintain the quality of food for long periods.

You will recall that cool or cold temperatures reduce microbial and enzyme activity, and can extend the shelf-life of food for many weeks. The process of freezing involves holding food at very cold temperatures of between –18 °C and –30 °C, so it is an even more effective way of extending the shelf-life of food. Frozen food usually lasts between three and twelve months. The low temperatures maintained during freezer storage cause the micro-organisms to become less active and enzyme activity in the food is also reduced.

If the drop in temperature is fast enough, the ice crystals that form will be small, and cell structures will suffer a limited amount of damage. There is little loss of nutrients and general quality if the food is carefully wrapped. If frozen food is not properly wrapped to keep out the cold dry air, the air will remove water from the exposed surface, resulting in **freezer burn**. The dried out spot where freezer burn has occurred is a brownish grey colour and spongy in texture.

REVIEW QUESTIONS

Remember

1. Look at the situations below and decide what you would do.

WOULD YOU EAT . . .	YES	NO
Fish that felt slimy		
Food after the use-by date		
A tub of yoghurt where the packaging has expanded		
Juice that doesn't taste quite right		

Apply

2. Give reasons for either eating or not eating the items in the table above.

3. Foods, such as crackers, often become stale quickly after the airtight wrapping is opened. Explain whether crackers have a high or low water activity and what would be the most effective way of storing them.

Do an activity

4. Make a list of all the foods in your home that are perishable and semi-perishable, and describe how these items are stored. Explain any changes you would recommend to make sure that the foods are stored correctly.

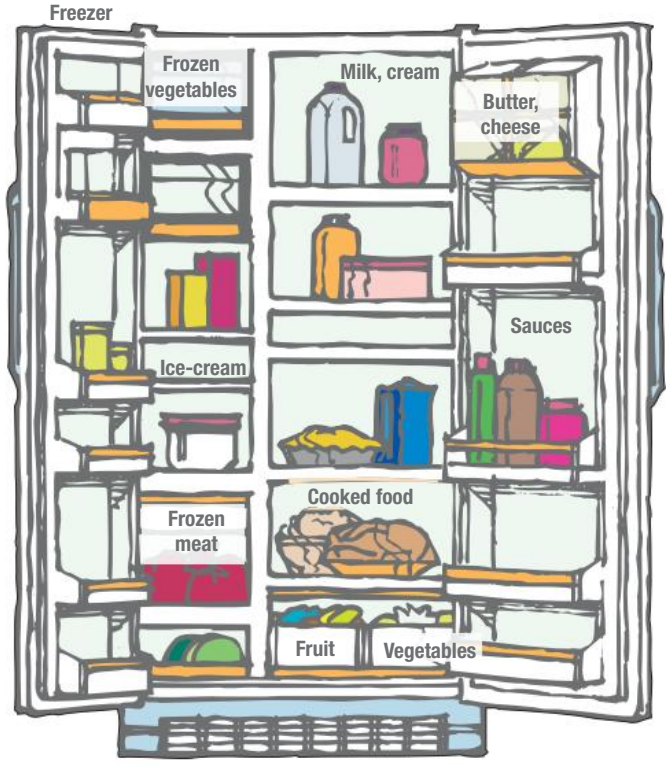
Domestic food storage

Food can be easily ruined through incorrect storage even though it may have been very carefully selected when bought. Some examples in table 3.4 show how the quality of food can be altered by incorrect storage.

A food item's *freshness* can be affected by temperature changes and this, in turn, may affect the susceptibility to increased microbial growth. Food deterioration can be reduced considerably by keeping the food at low temperatures that will slow down the growth of micro-organisms and also reduce the rate of chemical changes in the food. The refrigerator is the most important storage site for perishable foods in the home, but many people are unaware of the correct placement of food within the refrigerator. Some foods such as raw meat, particularly minced meat, chicken and seafood, need to be stored with extra care because these items are prone to spoilage easily and can carry or contain harmful micro-organisms.

Tips for keeping food refrigerated

- Meat should not be kept wrapped up because unwrapped meat keeps longer; however, the meat surface will probably become a little dry and result in some change in colour, and there may also be some loss of flavour.
- Foods with strong odours such as seafood should be wrapped and kept away from other foods such as milk, which may become tainted.
- Cooked food should be covered.
- Raw food, particularly meat and seafood, should be placed below other foods so that any juices that drip do not land in other foods.



Where to place food in a domestic refrigerator

Safe food preparation

Food preparation refers to the cleaning, cutting, combining or cooking of food before it is served. Food preparation can take hours, such as when making a casserole or stew, or just a few seconds, when washing a piece of fruit just before eating it. Special equipment and preparation techniques may be involved when making a cake, for example, whereas only minimal skill and equipment is required to chop vegetables and put them into a saucepan. However, food can be unsuitable to eat because contaminants may have been introduced, or because of inadequate cooking. This can happen at any time or stage of the food preparation process. Consequently, no matter who does the preparation, whether it is you, someone you know, the food manufacturer, the restaurateur or the vendor in a food court — it is important that the food is prepared so that it is safe to eat.

TABLE 3.4 Judging the quality of food stored in the home

FOOD	INCORRECT STORAGE	CHANGE THAT OCCURS	CORRECT STORAGE
General appearance			
Potato	Warm, sunlit, moist area	Green colour	Dark, cool, dry area
Celery	Room temperature	Wilting and dehydration (Providing the dehydration is not too severe, the celery will rehydrate in cold water.)	Refrigerator with daily rinsing
Aroma			
Ripe mango	Warm bench	Increased aroma	Cool area
Flavour			
Cheese	Unwrapped in refrigerator	Absorption of odours and flavours from other foods (as well as drying out)	Airtight container in refrigerator
Texture			
Apples	Room temperature	Floury texture	Refrigerator
Pancake mix	Cupboard over the stove	Lumpy texture	Dry place

Five keys to safer food

Keep clean

- Wash your hands before handling food and often during food preparation
- Wash your hands after going to the toilet
- Wash and sanitize all surfaces and equipment used for food preparation
- Protect kitchen areas and food from insects, pests and other animals

Why?

While most microorganisms do not cause disease, dangerous microorganisms are widely found in soil, water, animals and people. These microorganisms are carried on hands, wiping cloths and utensils, especially cutting boards and the slightest contact can transfer them to food and cause foodborne diseases.

Separate raw and cooked

- Separate raw meat, poultry and seafood from other foods
- Use separate equipment and utensils such as knives and cutting boards for handling raw foods
- Store food in containers to avoid contact between raw and prepared foods

Why?

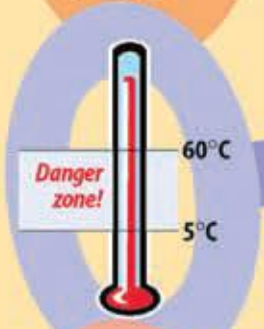
Raw food, especially meat, poultry and seafood, and their juices, can contain dangerous microorganisms which may be transferred onto other foods during food preparation and storage.

Cook thoroughly

- Cook food thoroughly, especially meat, poultry, eggs and seafood
- Bring foods like soups and stews to boiling to make sure that they have reached 70°C. For meat and poultry, make sure that juices are clear, not pink. Ideally, use a thermometer
- Reheat cooked food thoroughly

Why?

Proper cooking kills almost all dangerous microorganisms. Studies have shown that cooking food to a temperature of 70°C can help ensure it is safe for consumption. Foods that require special attention include minced meats, rolled roasts, large joints of meat and whole poultry.



Keep food at safe temperatures

- Do not leave cooked food at room temperature for more than 2 hours
- Refrigerate promptly all cooked and perishable food (preferably below 5°C)
- Keep cooked food piping hot (more than 60°C) prior to serving
- Do not store food too long even in the refrigerator
- Do not thaw frozen food at room temperature

Why?

Microorganisms can multiply very quickly if food is stored at room temperature. By holding at temperatures below 5°C or above 60°C, the growth of microorganisms is slowed down or stopped. Some dangerous microorganisms still grow below 5°C.

Use safe water and raw materials

- Use safe water or treat it to make it safe
- Select fresh and wholesome foods
- Choose foods processed for safety, such as pasteurized milk
- Wash fruits and vegetables, especially if eaten raw
- Do not use food beyond its expiry date

Why?

Raw materials, including water and ice, may be contaminated with dangerous microorganisms and chemicals. Toxic chemicals may be formed in damaged and mouldy foods. Care in selection of raw materials and simple measures such as washing and peeling may reduce the risk.

Food Safety
World Health Organization

Knowledge = Prevention

Safe food handling

The most frequently identified practices contributing to food poisoning incidents:

- improper cooling of food
- lapses of 12 hours or more between preparing food and eating it
- contamination by food handlers
- contaminated raw foods or ingredients.

To prevent food poisoning during the handling of food, whether in the home or commercially, the following factors must be considered: temperature control, prevention of cross-contamination, personal hygiene and a clean work environment.

Temperature control

Food should not be kept at temperatures in the temperature danger zone (temperatures between 5 °C and 60 °C) for any length of time. As a rule, moulds grow best below 37 °C, yeasts at 24–47 °C and bacteria at 15–45 °C. You can see that a number of micro-organisms are capable of growing well in the temperature danger zone. It is important, therefore, to maintain temperature control at all times, even during transportation, for both foods that are cooked or raw. The temperature inside a refrigerated truck should remain constant so that cold or frozen foods are kept at the correct temperature. In the transport of foods that are hot, the temperature of the food should be kept above 60 °C until delivery is made, to reduce the risk of food poisoning. The rule is to keep hot foods hot (above 60 °C) and cold foods cold (below 5 °C).

Prevention of cross-contamination

Cross-contamination is the transfer of micro-organisms from one item or source to another. Cross-contamination of food can occur during any stage — during transport, storage, preparation or when food is served or displayed.

There are numerous points when cross-contamination could occur in food that is on display for self-service, such as at a buffet:

- several people may handle the food
- serving cutlery for specific dishes may be put back into different dishes
- serving tongs may not be used and instead people may use their hands to pick up foods such as bread rolls, sliced fruit and sandwiches.

Personal hygiene

Good personal hygiene habits can prevent people from cross-contaminating food. Hygiene is defined as the idea and practice of cleanliness and the preservation of health. Food poisoning is often caused by the unhygienic habits of food handlers. The person who serves you is not the only food handler who may cause cross-contamination of food. The truck driver or delivery person who handles the food during the loading and unloading of a vehicle is also a food handler. This person can infect food directly, or can store foods in a way that also allows cross-contamination to take place. Any food handler who is ill or has a gastric upset should not touch food. This rule applies whether the person is the dishwasher, the chef, the waiter or the person who clears the tables. *Staphylococcus* bacteria can be found in human nasal passages, boils and infected cuts, and on hands, skin and pimples. *Salmonella* can survive on fingertips, preparation surfaces, utensils and equipment for at least 10 minutes.

A well-known case in which people died as a result of food that was unwittingly contaminated by a human occurred in the 1930s. Mary Mallon (1869–1938), now commonly referred to as 'Typhoid Mary', was a cook in the United States. She was responsible for infecting 47 people with typhoid fever, three of whom actually died from the disease. Mary was a healthy carrier of typhoid fever and refused to believe that she was responsible for infecting others with the disease. She was placed in quarantine, where she eventually died.

Ideally, hands should never touch the food being sold to consumers from delicatessens, restaurants, fast food outlets, food stalls or supermarkets. Hands that look clean may be heavily contaminated by micro-organisms. Hand washing is compulsory before starting work, between handling different types of food, after using the toilet, and after using a tissue or handkerchief. Just wetting the fingertips is not enough.

Toilets must be separate from the food-handling and storage areas. Each rest room must have a sink with soap and both hot and cold water for the washing of hands. As well as careful hand washing, any reduction of human contact means that the micro-organisms are not able to be moved around. The use of utensils helps prevent contact, but only if they are clean and reserved for use with only one type of food (no cross-contamination). Disposable gloves can be used if tongs are too awkward, but the gloves need to be changed when the food handler starts a new task; for example, one pair of gloves should be worn for chopping fresh vegetables for a salad, then a clean pair put on for making sandwiches.

Any wounds or cuts to hands should be covered with a coloured, waterproof dressing and then covered with clean gloves. Food handlers must exercise good personal hygiene at all times.

Clean work environment

A routine should be established in which cleaning is carried out during preparation (tidy as you go), in addition to a thorough cleaning after preparation. Washed dishes should be air-dried because this method is less likely to re-contaminate surfaces, compared with other methods such as drying them with a tea towel. Cleaning materials and equipment must be stored away from the food. The correct

detergent and sanitisers need to be used for the type of dirt being removed. Special attention should be paid to:

- the correct concentration of detergent in water
- the length of time for which the detergent should remain on the surface being cleaned
- the temperature needed to kill micro-organisms.

Insects, rodents and other vermin need to be eliminated by professional exterminators. Doors and windows should be insect proof. Food waste, which attracts vermin, must be stored away from the food preparation area, and disposed of as quickly as possible.

The rule is to keep equipment, storage areas and preparation areas clean at all times.

Commercial food preparation

The premises and equipment must meet safety requirements regarding design and layout.

There are basically two ways to maintain food hygiene:

- prevent contamination of food during storage, handling and transportation
- design all the equipment and the food storage rooms in a way that encourages good hygiene practices, and makes it easy for them to be carried out.

Food storage rooms

Storage rooms must be well ventilated, easy to clean and well lit. Good ventilation reduces condensation, and therefore reduces the number of air-borne micro-organisms.

Ventilation can be natural, through open windows (with mesh over them), or provided by mechanical extractor fans. It can be difficult to keep the temperature constant in a refrigerated storage room: people open and close the door when making deliveries or removing food for preparation. To save energy and to keep the cold room below 5 °C, cold rooms open onto a small entry, creating an airlock. People walk through the entry and between strips of thick plastic which hang over the opening to the actual cold room.

Work flow in the kitchen

All commercial kitchens have a formal work-flow pattern. The pattern describes the path food takes as it travels through food preparation and serving. A good pattern saves the food handler time and steps, but also prevents cross-contamination of food.

In general, raw food is prepared in one area, passed on to the cooking section, and then finally sent to the hot or cold holding area before serving.

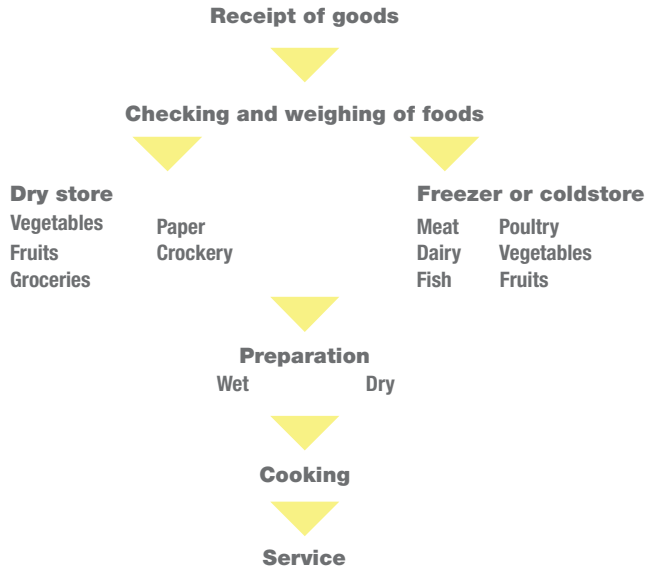
The food-flow pattern organises work into separate areas, and locates the necessary equipment in that area. The diagram above right shows an efficient food-flow pattern in a restaurant.

There are four work areas in a kitchen:

- the basic preparation area
- the cooking area
- the service area
- the cleaning and washing-up area.

The basic preparation area is divided into two or more separate sections:

- a wet kitchen area for:
  - fruits and vegetables
  - flesh foods
- a dry kitchen area for:
  - pastry (in the coolest part of the kitchen)
  - ready-to-eat foods.



A typical restaurant work-flow pattern

In the wet area you would expect to find sinks, of course, but this is also where stainless steel benches, food mincers, peelers, chippers, slicers and shredders are used. Raw vegetables should be prepared away from other foods because they are often covered in soil that contains bacterial spores. The spores can be transferred to other food very easily, and food poisoning can result.

The cooking area has equipment grouped into islands, with benches between them or on either side. The equipment that cooks with steam (pressure steamers and stockpots) is placed near a drain, while short-order cooking equipment such as griddles and frying pans (for food that will be cooked quickly) are located together under a fume hood. The fume hood extracts heat, condensation and fumes from the cooking area. The filters on these hoods must be cleaned frequently to remain effective.

The service area is where the prepared food is kept before or after being arranged on plates. Hot foods are kept in *bain-maries* (food warmers) or under hot lights, while cold foods are kept in refrigerated cases where the temperature must be 1–5 °C.

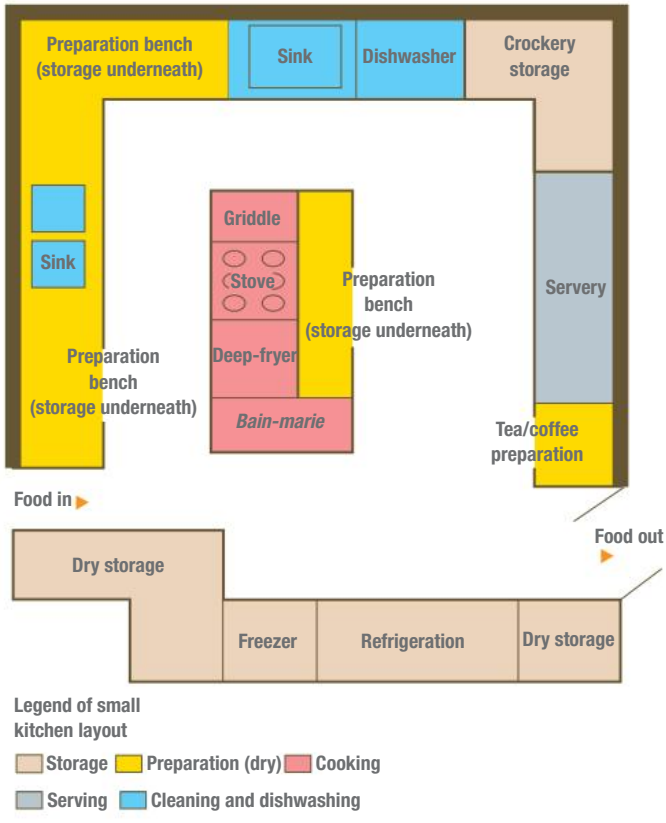
The coldest section is the area towards the back of the cabinet, away from the doors; here, cooked meats, chicken and eggs should be kept. Oysters, filled sandwiches and any

food using fresh cream also need to be kept at a steady cold temperature. With many different kinds of food in the one refrigerated case, it is important to separate and cover the food so odours and flavours do not transfer from one food to another.

When food is being kept hot using *bain-maries* or hot lights, the temperature must be above 60 °C for the food to be safe to eat. The food needs to be hot before being put in the heated cabinet. Further, foods in heated cabinets should not be topped up: the small amount of remaining food should be removed, to be replaced by a full fresh tray.

There are two cleaning and washing areas in a commercial kitchen. One area is located close to the service area; it has a dishwasher and food-disposal unit for cleaning cutlery, plates and glasses. The other area is near the wet or dry areas where pots and pans are used. The commercial kitchen layout below shows how the food-flow pattern and work areas are organised in a small kitchen.

The layout of a large kitchen is not very different from that of a small one except that the large kitchen has separate storage areas for vegetables and dry goods, as well as for meat and for general cold storage.



Work areas and food-flow pattern in a small commercial kitchen

Walls, ceiling, floor and bench surfaces

The materials used for walls, ceiling, floor and bench tops must be:

- easy to clean
- undamaged by fats, water and cleaning agents
- resistant to bumps from trolleys
- non-absorbent
- smooth, with as few joints as possible
- fitted with curved edges rather than sharp corners.

Walls

To enable the walls to withstand bumps, aluminium sheeting can be used up to the point at which walls are likely to be knocked.

Floors

Ideally, people should work on non-slip floors. But food handlers must work on floors that are smooth, because non-slip surfaces are rough and therefore difficult to clean. For this reason, tiles are not as suitable as heavy duty vinyl for use in a commercial kitchen, because dirt gets in the grout between the tiles. To prevent accidents, food handlers are required to wear closed-in shoes with soles that grip.

Ceilings

Ceilings need to be heat resistant, as well as slightly absorbent. Some absorbency is required so condensation will not build up and fall on the food below. However, the ceiling must dry out quickly, to prevent the growth of mould.

Equipment

Certain characteristics in food-preparation equipment are desirable.

- Large equipment should:
  - be self-emptying/easy draining
  - placed so that workers can move around it easily when operating or cleaning it.
- Design features should include:
  - smooth surfaces, both inside and outside
  - no sharp corners, gaps, cracks or other areas where micro-organisms, insects or vermin could feed on trapped food
  - visible edges and corners (of the equipment) that can be easily disassembled for thorough cleaning.
- Materials used to make the equipment should:
  - be non-absorbent
  - be unable to react chemically with food.

The most common materials used in food preparation equipment are stainless steel and plastic. Overall, equipment should be selected that is easy to clean and maintain. Care needs to be taken with plastic equipment because most plastic can be made rough with cutting and scrubbing. Glass should not be used unless it is unbreakable and heat resistant.

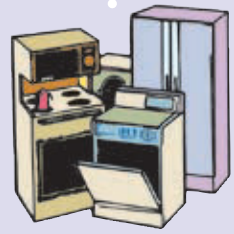
Food preparation equipment should be:

- reliable and maintained in good working condition at all times
- an appropriate size for catering for the number of people eating
- suitable for the type of food to be prepared
- able to be cleaned thoroughly.

1. PREMISES

- maintain cleanliness of interior and exterior of buildings
- ensure proper lighting, ventilation, toilet facilities
- clear external premises of debris
- cover garbage bins and empty regularly to ensure no foul odours
- deny pests entry points
- maintain in accordance with the *Food (Amendment) Act 2001* and Building Code of Australia

2. EQUIPMENT PERFORMANCE AND MAINTENANCE



- use equipment made from smooth, durable, impervious (cannot be penetrated), easy-to-clean material
- ensure cleaning access to areas around fixed equipment
- include maintenance and service program for continuous upkeep of equipment in Food Safety Program
- ensure accurate operating temperatures on equipment (freezers, refrigerators, deep fryers)

3. CLEANING AND SANITATION

- remove soil from all surfaces, fixtures, utensils and equipment
- select cleaning products appropriate to the cleaning task
- use detergents to remove soil by breaking down grease and improving contact of water (*note:* detergents do not destroy bacteria)
- use sanitisers to reduce levels of micro-organisms through steam, immersion in hot water (100 °C for 30 seconds), chlorine, iodine or quaternary ammonium chemicals (QATS)
- use cleaning products according to manufacturer's instructions (concentration, temperature, contact time and safety)
- never combine cleaning chemicals
- follow cleaning schedules for all equipment and premises
- control pests, such as rats, mice, flies, cockroaches, moths and weevils through cleanliness and good housekeeping

4. STAFF TRAINING

- ensure staff are aware that people are potential carriers of food-poisoning micro-organisms, such as Golden Staph (*Staphylococcus aureus*), hepatitis A and typhoid (*Salmonella typhi*)
- ensure staff maintain personal hygiene
- ensure food handlers are aware of conscious and unconscious habits (rubbing nose, licking fingers) that may affect food safety
- ensure staff wash hands after using the toilet, using a handkerchief, smoking, eating, handling raw food, handling rubbish, etc.

5. TRANSPORT, RECEIVING AND STORAGE OF FOOD

- keep food transport vehicles hygienically clean
- ensure temperature controls are appropriate to foods being carried
- purchase from reputable suppliers
- check condition of goods on arrival, transfer to appropriate storage
- store food at correct temperature, clearly labelled, covered or in containers, free from pests
- separate raw and cooked foods
- rotate stock on first-in-first-out (FIFO) basis (items longest in storage should be used first)
- store cleaning products separately from food and never re-use food containers to store chemicals

6. THE PRODUCTION PROCESS

- minimise risks of cross-contamination during preparation by following guidelines in sections 2, 3, 4 and 5, washing fruit and vegetables before use, and not preparing food too far in advance
- cook potentially hazardous foods to correct internal temperatures
- reheat food quickly, and never more than once, to 75 °C for 2 minutes
- ensure hot-holding equipment is operating effectively (internal food temperature above 60 °C)
- cool cooked foods for refrigerated storage quickly, cover and refrigerate
- thaw foods in a microwave oven or on a tray on the lowest shelf of refrigerator or coolroom (*note:* never thaw overnight on a bench and never re-freeze a thawed product)
- protect self-serve foods with sneeze guards
- replace used containers of self-serve foods with fresh containers (do not 'top up')
- store straws and take-away food containers hygienically

Good Hygiene Practices (GHPs) are achieved through development and implementation of standard hygiene procedures in six key areas of a food business.

Standard operating procedures

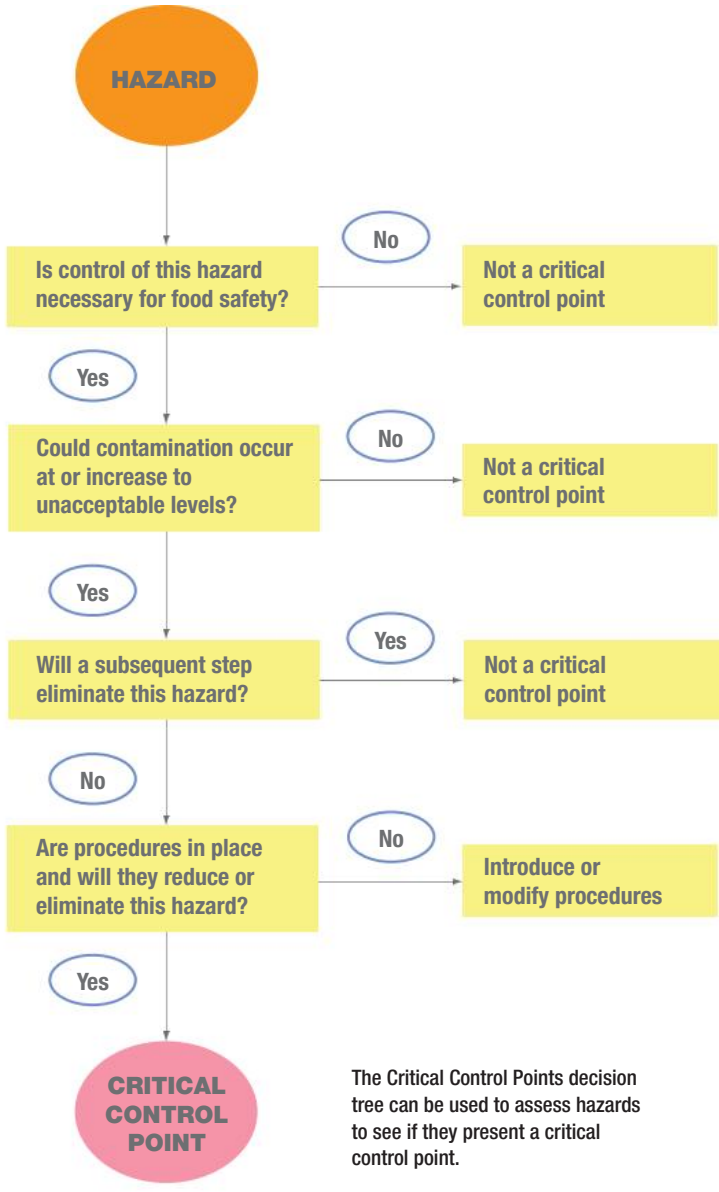
Good hygiene practices at all stages in the handling of food — during transportation, receiving and storage, preparation and other processes, through to the serving of foods — are aimed at reducing, controlling and preventing food safety hazards (remember these may be physical, chemical or biological).

There is a requirement for formal training of all food handlers to apply good hygiene practices which must be incorporated into standard operating procedures. Standard operating procedures are the basis for **food safety programs** that use **Hazard Analysis Critical Control Points (HACCP)**. HACCP is an internationally recognised food safety system. It is a preventative approach to the identification of potential hazards and their control points. It systematically assesses all the stages, including the ingredients, of the food product, as well as the conditions of its processing, handling, storage, transport and packing before it gets to the consumer. The mandatory components of a food safety program are based on the seven HACCP principles:

1. Assess the hazards — the hazards are identified and their severity and risk is determined.
2. Determine the Critical Control Points (CCP) for controlling the identified hazards. These are points in the food production system at which a loss of control may result in unacceptable health risk (for example, wherever contaminants could enter) and include transportation, processing, purchasing, storage, sanitation, preparation, cooking/production, holding and point of service. The best way of managing this process is by using flow charts, where the precise steps are identified.
3. Establish the limits (critical limits) at each critical point. Critical limits can be thought of as boundaries of safety for each CCP. Some may already be defined by regulatory standards or guidelines shown in the flow chart (at right).
4. Monitor Critical Control Points. Monitoring is needed to verify that CCP are kept within the limits set above in Principle 3.
5. Establish corrective action(s). Corrective actions are needed when monitoring indicates that a particular CCP is not under control.
6. Verify that the preventive/corrective measures have been taken and that the HACCP plan is operating effectively through regular inspections.
7. Establish documentation and record-keeping systems of monitoring. These should be kept for all procedures and records to verify that the system is working.

Examples of guidelines and procedures from HACCP:

- Employees to thoroughly wash their hands and the exposed portions of their arms with soap and warm water before starting work.
- Cloths used for wiping food spills on tableware, such as plates or bowls being served to the client, shall be clean, dry and used for no other purpose.



The Critical Control Points decision tree can be used to assess hazards to see if they present a critical control point.

- Raw fruits and vegetables shall be thoroughly washed with potable water before being cooked or served.
- Potentially hazardous foods that have been cooked and then refrigerated shall be reheated rapidly to 70 °C or higher throughout before being served or before being placed in a hot food storage facility.
- Food on display shall be protected from client contamination by the use of packaging, easily cleanable counters, serving lines, salad bar protector devices, display cases or other effective means.

Food safety programs

There are compulsory requirements for receiving, storage, preparation, processing, packaging and distribution of food. It is a legislative requirement for all food businesses to develop and implement a food safety program which has to be kept on the premises in written form.

REVIEW QUESTIONS

Remember

1. List the main reasons for food poisoning.

Apply

2. A sausage roll has been sitting in a *bain-marie* for six hours and is lukewarm. Should you or should you not eat it? Why?
3. Jessica was enjoying herself at the buffet — the food was just delicious. She thought she would like another bread roll, but then had second thoughts and put it back in the basket (even though she had already buttered it). Advise Jessica about why her actions could cause others to become ill with food poisoning.
4. Stan delivers homemade pasta to a local delicatessen. He parks the car and has a cigarette before unpacking his van. When Stan parks the car he turns the engine off and the air conditioner shuts down also. Identify the Critical Control Point in this situation and what can be done to rectify the problem.

Do an activity

5. Do you, or someone you know, work in the food service industry? If so, ascertain whether the establishment has a clean work environment, giving reasons for your answer.
6. Conduct further research into Typhoid Mary.
   a) Investigate the causes and symptoms of typhoid fever, and how it is spread.
   b) Comment on whether you think Mary acted responsibly, given the circumstances.
   c) What lessons can be learned nowadays from Typhoid Mary's story?

Food preparation in the home

We can all appreciate how important it is to use hygienic methods when storing and preparing food that is to be sold. None of us wants to come down with a case of food poisoning, so it makes sense to apply these same methods when preparing meals in the home.

Remember, the control of micro-organisms depends on temperature control, prevention of cross-contamination, and the cleanliness of the food handler and equipment. Let's look at how each of these factors is controlled in the home.

Temperature control

The time that potentially hazardous foods are kept in the temperature danger zone should be kept to a minimum to reduce the opportunity for rapid growth of micro-organisms. Foods that need to be kept hot must be held at a **core temperature** above 60 °C and foods that need to be kept cold must be held at a core temperature below 5 °C.

- Allow cooked foods to stand only until they reach a little above room temperature, before storing them in the refrigerator. Do not leave soups or casseroles on the stove overnight to cool down.
- Heat leftovers to at least 60 °C before eating.
- Avoid frequent warming and cooling of foods, as happens when people come home at different times to eat.
- Cook food to at least 75 °C or the point of being steaming hot. Take special care when cooking rolled or stuffed meats, sausages and whole poultry to make sure the internal temperature reaches this minimum. A meat thermometer is a simple way to check.
- When cooking large batches of food to eat at other times, subdivide the food into smaller containers and refrigerate immediately.

Thawing frozen food

Some frozen foods need to be thawed before cooking. It is best to thaw the frozen food by placing it in a refrigerator, to stop the growth of harmful micro-organisms. Thawed food is not usually re-frozen.

Prevention of cross-contamination

- Place raw food in the refrigerator below and well away from cooked/prepared foods.
- Wrap foods.
- Thoroughly clean the chopping board and other utensils after preparing raw food, especially chicken.

Cleanliness

Ants, weevils, spiders, cockroaches and sometimes even mice can find their way into the cleanest of domestic kitchens. Insect repellents should be sprayed around areas where food is being stored or prepared only when the food and equipment have been removed. Adequate time needs to be allowed for the poison to destroy the bugs. (This should be given on the product package.) The sprayed surfaces and equipment then need to be thoroughly washed in hot soapy water to remove the poison residue.

One type of potentially dangerous animal contact that can occur in the home comes from the family pet. Cats, dogs, birds and other animals should not be allowed on food-preparation surfaces, and should not be allowed to lick bowls and other utensils. If such contact does occur, a good wash with disinfectant and hot water is required.

The equipment used in the average home is usually a collection of items gathered over the years. Some pieces are old and worn, and others are new. Some are well designed, and easy to use and clean, while others have many corners and edges that cannot be properly cleaned.

Some of the most commonly used pieces of equipment in the domestic kitchen can be the cause of food-borne illness. Here are a few potentially dangerous situations to avoid.

- A wooden or plastic cutting board with deep cuts and chips provides a perfect home for micro-organisms. The food trapped there can also attract ants and cockroaches.
- A glass measuring cup that is not made of pyrex glass could break or chip when dropped or crack when heated.

- The washing-up cloth, brush and tea towel that are damp and contain food particles encourage unwanted pests.
- The oven, griller and stove top are often difficult to clean. Food spills that are left attract undesirable micro-organisms.

The most difficult factor to control in food preparation in the home is the hygiene of the person who stores and prepares the food. How often have you seen any of the following unsafe food preparation practices in your own or somebody else's home? Some situations described here cannot be avoided, but others certainly can:

- failure to wear a cap or hairnet while preparing food
- failure to wear a clean apron
- failure to clean up spills
- licking spoons and sampling food with fingers
- failure to wash hands after sneezing or coughing
- preparing food when sick
- handling food when the person has open sores or pimples.

Food handling tips

- If in doubt throw it out.
- Cooked food should be handled as little as possible.
- Use disposable plastic gloves if handling food and particularly food which is not to be cooked such as fruit salad or sandwiches.
- Use serving tongs where possible.
- Keep cooked food away from raw food to avoid cross-contamination.
- Store cooked food above raw food.
- Cooking utensils should be clean, and any cracked or broken crockery should be discarded.
- Clean all spillages and keep work surfaces clean.
- Maintain storage areas in good condition.

REVIEW QUESTIONS

Remember

1. Take the following quiz on food preparation in the home.

	YES	NO
Is it OK to leave food that has just been cooked in the saucepan overnight, as long as you put it in the fridge in the morning?		
Is eating leftover pizza from the fridge the next day OK?		
Is it OK to reheat the same food several times?		
Is it OK if the family pet sits on the kitchen bench while you cook?		
Should wooden or plastic chopping boards be replaced fairly frequently?		
The sign of a good cook is one who tastes the flavours of their cooking (a finger will do) and adds necessary spices to achieve just the right flavour.		

Apply

2. Give reasons for each answer you gave in the quiz.

Do an activity

3. How hygienic are you when you prepare a sandwich at home? Give yourself one point for every factor listed that applies to you. See how close you get to ten points.

a) Did you wash your hands before starting?
b) Are the cutting board, knife and other implements clean and dry?
c) Are you wearing jewellery (rings, bracelets and watches) that can carry microbes?
d) Is your hair likely to fall into the food you are preparing?
e) Are your fingernails short and clean and free from nail polish that could chip and fall into the food?
f) Are you wearing clean clothes that will not dangle in the food?
g) Are any bandaids on your hands clean and waterproof?
h) Do you have a cold?
i) Are you in the habit of washing your hands after you sneeze, blow your nose or scratch your face or hair?

Basic principles of cooking

Regardless of whether food is being cooked in the home, in a restaurant or in an institution such as a hospital, at least one of the following methods of transferring heat is used.

- **Conduction**. The food or its cooking container comes onto direct contact with a hot surface. Examples include prawns cooked on a grill or barbecue grate, a stir-fry cooking in a frying pan or wok, and a saucepan of soup heating on a hotplate.
- **Convection**. The food is heated by the hot air or liquid moving around the food. Examples include pasta boiling in a pot, potatoes baking in the oven, and spring rolls cooking in a deep-fryer. Some conduction of heat also takes place in each of these situations — for example, the saucepan holding the boiling pasta is sitting on the hotplate, but the boiling water is actually doing the cooking.
- **Radiation**. The food is cooked by heat waves which bounce off the sides and top of the heating chamber. Microwaves fall into this category because high-frequency energy waves penetrate food and heat the water in the food. Examples include bread being cooked on both sides in a toaster and an omelette browning in a salamander (which grills from the top down to the surface of the food).

The choice of heating methods largely depends on the type, style and quantity of food being prepared.

1. *Type of food*

Tougher cuts of meat and poultry require long, slow, moist cooking, while fish is usually cooked quickly on a grill or barbecue, or in a deep-fryer.

2. *Style of food*

Foods that are to be served with a crisp outer layer need to be baked in the oven or fried. The delicate flavours found in dishes such as minestrone soup are sometimes achieved only through simmering.

3. *Quantity of food*
Custard for two can be quickly made in a microwave, while cooking spaghetti bolognaise for 50 people requires a piece of equipment like a brattpan.

Cooking methods

There are a myriad of ways to cook food, as shown in the table below.

The golden rule about cooking is that dry heat methods of cooking are more suitable for:

- tender cuts of meat
- fruits or vegetables that require a crisp outer surface
- cakes, bread and pastries.

Moist heat methods of cooking are used for longer cooking times and/or a blending of delicate flavours.

TABLE 3.5: Cooking methods

DRY HEAT COOKING METHODS	MOIST HEAT COOKING METHODS
Grilling/barbecuing A quick method of cooking food by radiant heat under or over grill plates. Char-grilling using charcoal burners can also be used. Grilling is best for small tender pieces of food. Food cannot be kept hot or reheated easily because of juices escaping, causing the food to dry out.	*Braising* This method of cooking combines frying (dry heat cooking method) and stewing (moist heat cooking method).
Baking Heating food by hot air in an oven.	*Boiling* The food may be almost covered with liquid. Foods are usually boiled initially and followed by simmering until cooked.
Roasting Similar to baking.	*Stewing/casseroling* Long and slow method of cooking using a small amount of liquid in a covered container.
Frying Quick method that uses hot oil or fat to seal the food. Frying techniques include: • dry frying — fat is not used • shallow frying — uses very little fat • stir-frying — uses very little fat • deep-frying — food is completely covered with fat.	*Poaching* Food is simmered in a shallow container of water or stock. This method is often used for eggs and fish for which it provides a gentle heat. Fruit can also be poached in syrup.
	Steaming Foods cook in steam that rises from a small amount of boiling water in the pan.
	Microwave cooking This is considered either dry or moist depending on the dish being prepared.

CASE STUDY

The great Aussie barbie

Mike is a coach for the under-16s soccer team and at the end of the season he likes to invite all the team to a BBQ. This year Mike's two teenage sons, Paul and Duncan, offered to help with the shopping and the cooking for the BBQ.

Mike's schedule looked like this:

Thursday, 8 pm: Mike purchased all the steaks, burgers and sausages while late-night shopping. Paul bought packaged, ready-to-serve shredded lettuce, fresh bread rolls and margarine for the rolls. Duncan bought fresh cucumbers and tomatoes from the local market. When the family arrived home, Mike put the steaks, burgers and sausages on plates on various shelves in the refrigerator. The margarine and salad items were placed near the bottom shelf of the refrigerator and the bread rolls were stored in the pantry.

Friday, 7 am: Before leaving for work, Mike placed all the steaks in a bowl with some marinade sauce and returned the bowl to the middle shelf of the refrigerator. When he returned from work at 6 pm, he prepared the salad and placed the salad bowl in the refrigerator above the bowl of steaks.

Saturday, midday: Mike, Paul and Duncan arrived at the soccer club carrying the bread rolls in plastic bags, with the salad and meat bowls placed in cardboard boxes. Mike started the BBQ and Paul and Duncan took turns to help Mike cook the food.

OUTCOME TASK | **FOOD PREPARATION AND PRESENTATION EXERCISE**

Students learn to:

- describe methods of storing foods to maintain sensory characteristics and ensure safety
- implement safe and hygienic work practices when handling food.

Contributes to the following outcome:

- selects appropriate equipment, applies suitable techniques and utilises safe and hygienic practices when handling food.

Carefully consider the article on the previous page. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food safety* to complete the tasks ahead.

1. What advice would you give to Mike, Paul and Duncan on the safe storage and handling of the foods when at home, during transportation to the soccer club, and when cooking the food?
2. Log in to **www.jacplus.com.au** and locate the *FSANZ* weblink for this chapter. Read the information on the FSANZ website about barbecues and make a checklist for Mike to follow the next time he plans one.
3. Organise a class BBQ and appoint five students to be 'health inspectors'. They must observe the preparation and cooking procedure using a checklist, and then provide feedback on whether the BBQ was conducted in a manner that would ensure all food eaten was safe.

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Weblink

Producing high-quality food

Food is prepared in several basic situations: on a small scale in the home, on a larger scale in a small- to medium-sized restaurant, and on an institutional scale such as in a military mess hall or hospital.

Cafeterias
Canteens — school, sport/factory
Milk bars
Takeaway food outlets
Restaurants
Kitchens
Catering services
Hospital/hostel catering
Clubs and bistros

Types of food service operations

Here are some steps to ensure high-quality, appealing food no matter what the scale of production.

1. Choose the best quality ingredients. Throw away wilted vegetables and oils that are slightly rancid.
2. If appropriate, carefully and thoroughly clean the food.
3. Avoid overhandling of food during preparation; foods such as bananas will turn to mush if overhandled.
4. Season the food with care. A casserole that has too much salt will overcome more delicate flavours.
5. Use the cooking technique that best suits the particular food. Do not try to barbecue a skinned chicken breast without brushing it with oil first before and during cooking, otherwise it will dry out and toughen.
6. Use the proper equipment for the task; for example, use a container that is safe for use in the microwave.
7. If you are using a standard recipe, measure ingredients as you go. Few people can just toss in a bit of this or that and have the meal turn out well.
8. Experiment with different textures and tastes a little bit at a time.
9. Serve food attractively with suitable garnishes in/on nice-looking dishes.
10. Serve hot food hot and cold food cold.
11. Consider the tastes and needs of the individuals for whom the food is being cooked.

It is useful to mention standardised recipes which are used in most commercial cooking situations. A standardised recipe produces the same result every time for a known price per serve, if all the ingredients are measured accurately and the steps of preparation are followed. Consistent quality and quantity are ensured, and this type of recipe even shows how the food is to be served. You can standardise any recipe by first determining the standard and quantity of key ingredients, then making the recipe and determining the number of servings it will make, and finally calculating the cost per serve.

Plating meals for service

Plating for service means arranging food on the plate of a customer. This is most often done in the kitchen of a commercial establishment but there are three other alternatives:

- semi-silver service, whereby the main item is arranged on the plate and garnished, while the accompanying foods are served by the waiter
- silver service, whereby a clean plate is put before the customer and the waiter serves the entire meal

- gueridon service, whereby a chef prepares the entire meal and serves it in front of the customer. In Japanese restaurants this style of service is called *teppanyaki*.

In commercial food preparation portion control is very important. Portion control standardises the size of the meal. The size of a portion in a commercial setting depends on the:

- customer's expectations
- number of courses served — that is, the more courses, the smaller the portions
- overall presentation of the meal, including the size and type of garnish and the foods served with the main food
- nutritional requirements and health of the customer (for example, in hospitals and schools)
- size of the plate and other crockery
- type of plating for service.

It is possible for commercial cooking establishments to purchase certain foods already prepared in portion size — for example, steaks, potatoes, individually wrapped butter and sauce. Scales and automatic dispensers also ensure equal-sized portions.

CASE STUDY

FLYING HIGH

by STEVE MEACHAM

The sky's the limit when it comes to preparing meals for airline passengers, unless you are in economy class.

Head chef Janell Millington is putting the finishing touches to a plate of baby barramundi served with saffron rice and blanched snow peas.

She has worked in some of Australia's leading hotels — including Broome's Cable Beach Club and Sydney's InterContinental — and the dish she's serving now could easily grace a table at any smart restaurant around town.

Behind her, a team of kitchen staff is busily preparing sumptuous sauces and salads, appetisers and entrées. And yet the food Millington is garnishing is perhaps the most maligned form of cuisine in the world — airline food — the culinary equivalent of the mother-in-law joke. Something to be endured, ridiculed, survived.

Not that Millington, 32, sees it that way. Now based in Bahrain, she is one of Gulf Air's new corps of Sky Chefs — 100 restaurant-trained experts from 23 nations who do their cooking 9000 metres in the air, catering for the whims of Gulf's first-class passengers.

Millington and her fellow Sky Chefs are the most dramatic sign that airline food is undergoing a revolution. To some, the future looks exciting — a world where we'll be able to order nutritious meals of our choice online a few hours before take-off. More immediately, expect the gap between business class and economy to grow wider.

Put simply, the world's leading airlines are splitting into three groups. At the top end, oil-subsidised airlines such as Gulf and Emirates are sparing no expense, pitching themselves as exclusive restaurants-in-the-sky with on-board chefs to seduce those businessmen and women whose companies pick up the tab.

At the bottom, low-cost domestic carriers have cut out hot meals altogether for short flights. Some, such as Virgin Blue, sell a basic range of cold snacks on board. Others, such as Delta's low-cost US airline, Song, allow customers to order 'gourmet' wraps, fajitas, salads and focaccias from an online menu up to 12 hours in advance.

And in the middle? The majority of international airlines, including Qantas, British Airways, Cathay Pacific, Singapore Airlines, Thai and Swiss, are desperately seeking ways to keep the cost of economy meals under control while upgrading their business and first-class cabin service with menus designed by 'signature chefs' such as Neil Perry, of Rockpool, who has worked with Qantas since 1997.

Behind the scenes

Millington has invited me to a massive, high-tech food processing centre in Mascot, a cathedral of stainless steel and cold stores — the Sydney headquarters of Caterair, one of the three big airline catering companies which ring the airport.

Caterair supplies meals to Thai, JAL, Malaysia Airlines, Philippine Airlines and Air Canada, as well as Gulf. Now owned by Qantas, Caterair is managed separately from Qantas Flight Catering, which supplies meals to Qantas, British Airways, Singapore Airlines, Air New Zealand and Emirates. Its main rival is Swiss-based Gate Gourmet, whose clients include United Airlines, Cathay Pacific, China Airways, Lauda Air and Asian.

Most airline passengers don't realise the food served by competing airlines is often prepared in the same kitchens. As Millington walks me through Caterair's enormous open-plan kitchens, we watch an army of white-coated, hair-netted workers assembling meals for competing airlines. Each one has a coloured photo of what their particular finished meal should look like, issued by the airline's chefs at head office.

There's no room for improvisation. Each airline's menu is designed and refined according to the airline's specifications. Even if the kitchen is communal, the food itself is prepared precisely as the client airline demands.

That's why Millington is in Sydney today. Her primary job is to cook individual in-flight meals for the 10 passengers in Gulf Air's first class. But menus in business and economy change every few months, so a Sky Chef is despatched to show the on-ground caterers exactly how the meals should be when they're served on the plane.

We head to the segregated halal enclosure, a self-contained commercial kitchen where the food for Gulf Air and Malaysia Airlines is prepared according to Islamic dietary requirements. 'We like to work with the caterer's chefs for two or three days, show them exactly what we want,' says Millington.

In some ways the increasing luxury at the top end of the airline industry is a return to the early days of the jet set age. Look back at evocative photographs of planes in the 1940s and you'll see the service standard revived and updated in business class today — fine tablecloths, good quality glassware and cutlery, extensive wine lists and individual plating.

. . .

Keep it clean

The big issue is hygiene. As Sheriff Khair [Gate Gourmet's business development director] says: 'You are far more likely to get sick in a five-star restaurant than you are on a plane. Airline food is one of the safest forms of food there is. And when people complain about being sick, it's usually because of something they ate on the ground.'

Certain ingredients are automatically ruled out: oysters and any raw fish or meat (it has to be seared before it is allowed on board).

Gate Gourmet never uses raw bean sprouts, because they're considered high-risk. Or peanuts or peanut oil because so many passengers are allergic to them.

Finally, says Khair, 'airline catering is 90 per cent logistics and only 10 per cent about the food'. Apart from the huge volume of meals which have to be produced each day, 'the penalties for delaying an aircraft, even for a few minutes, are phenomenal'.

Traditionally the answer to this logistical nightmare has been a process called cook-chill. Meals are cooked on the ground a few hours before a plane's departure, assembled in plastic or foil dishes, refrigerated for

a minimum of three hours at five degrees, loaded onto the planes, then put into convection ovens by the cabin crew and served. The result, says Michael Kent, 'is all the flavours move together and become muted'.

However, two things have changed recently. Aircraft ovens have improved with computerisation and more airlines are switching to the new generation of quick-frozen meals for their economy cabins.

According to Vanessa Hudson, Qantas's general manager of in-flight services, 'Better ovens have had a big impact, particularly in economy. Now across our fleet we're introducing steamer oven technology which allows food to be cooked under dry heat or wet heat. It makes sure certain food retains moisture and doesn't dry out like it did in the past.'

...

Flights of fancy

Ever wondered about the sheer volume of food which has to be loaded onto departing planes?

According to Qantas, its seven QFCL (Qantas Flight Catering Ltd) and Caterair catering centres around Australia produce 770 000 meals each year. In addition, the airline's frozen food arm, Snapfresh, in Brisbane, produced more than 7 million meals in 2002–03 (destined for other airlines, hospitals and industrial canteens as well as Qantas planes). Qantas estimates that in a typical week it serves:

Wine	16 950 litres
Beer	9500 litres
Bottled water	86 150 litres
Soft drinks	171 250 litres
Ice-cream	13 050 kg
Coffee	2640 kg
Meat	14 000 kg
Chicken	19 600 kg
Eggs	30 700
Vegetables	46 150 kg
Salad leaves	3860 kg
Fruit	25 200 kg
Cheese	5700 kg

Plane sailing

Anyone who dislikes 'normal' airline food, can always order the special meals on offer to those with dietary, medical, cultural or religious requirements.

Qantas, for example, offers diabetic, non-lactose, gluten-free, lacto-ovo-vegetarian, Hindu, halal and kosher alternatives. The special meals must be requested at time of booking and the airlines do not guarantee their availability.

Source: The Sydney Morning Herald, 18 February 2004.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *producing high quality food* to complete the tasks ahead.

1. Explain what a 'Sky Chef' does.
2. Food served by all airlines is often served in the same kitchens, but does the food differ from one airline to the other and, if so, why?
3. Why are certain foods ruled out for airline food?
4. Explain the cook–chill method described in the article.
5. How has technology changed the methods of airline food preparation?

CHAPTER 3 SUMMARY

- Food contamination can be by chemical, physical, biological or other substances that make food unsafe for consumption.
- Microbial contamination is the major health hazard associated with food. Bacteria, fungi/moulds, viruses, and protozoa/parasites can cause food-borne illness.
- Growth and survival of micro-organisms are affected by various factors including pH, temperature, gas atmosphere, and the availability of water and nutrients.
- Most bacteria that are responsible for food-borne illness grow well at temperatures between 5 °C and 60 °C. This is called the temperature danger zone.
- Food can deteriorate due to various factors and result in food spoilage. This process can promote the growth of more harmful micro-organisms.
- Usually food cannot be stored indefinitely and a food item's shelf-life indicates the expected time for which the food will maintain its best quality.
- The most frequently identified factors contributing to food poisoning incidents are improper cooling of food, extended time periods between preparing and eating the food, contamination by food handlers, and contaminated raw foods or ingredients.
- For safe food preparation, factors such as temperature control, prevention of cross-contamination, personal hygiene and the cleanliness of the work environment, need to be considered.
- Australia has high food safety standards and there are compulsory requirements for the transport, receiving, storage, preparation, processing, packaging, and distribution of food. Standard operating procedures are the basis for food safety programs that use Hazard Analysis Critical Control Points (HACCP), an internationally recognised food safety system. All food businesses are required to have written food safety programs in place.
- Food can be cooked by any of a number of methods including conduction, convection, and radiation, where the transfer of heat is used in the process. Cooking methods can be mostly considered as dry heat cooking or moist heat cooking. In some circumstances these may be combined in the process of food preparation.
- Food can be prepared to cater for different scales of the food services operation ranging from small-scale to mass catering. No matter what the scale of production, the aim should always be to deliver safe and high-quality food.

KEY TERMS

bacteria
conduction
convection
core temperature
ethylene gas
food-borne illness
food safety program
food spoilage
freezer burn
Hazard Analysis Critical Control Points (HACCP)
microbial
mycotoxins
natural toxins
non-perishable
outbreak
perishable
radiation
semi-perishable
shelf-life
spores
temperature danger zone
turgor
viruses
water activity (A_w)

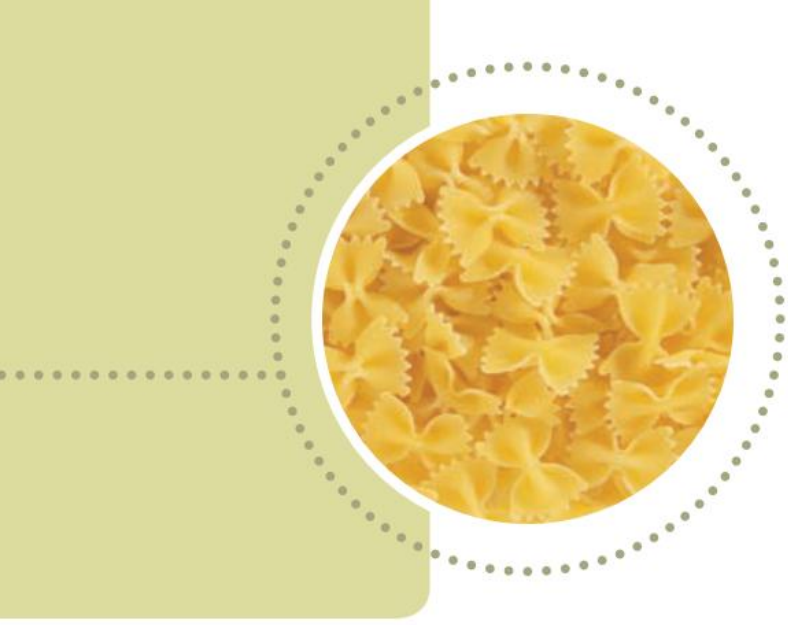
Chapter 4
Sensory characteristics of food and food presentation

What's your favourite food? Hold the excitement . . . what food don't you like? Each person is different and what some consider a delicacy, others would feel ill at the thought of eating. Our food preferences are influenced by various factors, including our experiences with food and eating. We assess food quality, whether consciously or unconsciously, and factors such as ingredients and cooking methods can enhance the quality of meals. We select one food over another by using informal sensory assessments with our five senses of perception: taste, smell, feel, hearing and sight. Food presentation plays a vital role in the acceptance of food.

In this chapter you will learn about:

- layout of food for visual appeal, including styling for photography and plating for service
- sensory characteristics of foods, including appearance, odour, taste (flavour) and texture (mouth feel)
- sensory assessment of a variety of foods.

What was your first reaction when you saw this picture? You might have imagined that you could smell the chocolate and imagined what it would taste like. That's your senses at work sending messages to the brain saying, 'Yes, I want cake.' Presentation, preparation and processing of food should activate the senses and increase our enjoyment of food.



Why do we select one food over another?

Imagine you are going to the local takeaway to get something for dinner. If you are well informed and health conscious, you may choose a tabouli salad, a grilled chicken burger and mineral water. But if the smell of cooking chips and the sight of someone else's takeaway are just too much for you, you may order a serving of chips, a bacon-and-cheese burger and a thickshake.

Our food preferences are influenced by our experiences with food and eating, and sometimes food choices can be influenced by other factors:

- A doctor may instruct you to eat a particular food — for example, an adolescent girl may eat more green leafy vegetables or red meat to improve the iron level in her blood.
- You may avoid a particular food because you are allergic to it or have an intolerance to a chemical found in a group of foods — for example, a person with an allergy to gluten (coeliac disease) avoids wheat products.
- Your strong desire for a healthy body may motivate you to follow the Australian dietary guidelines and avoid any unnecessary fat, sugar and salt.

Even when these factors limit what you can eat, the final choice — which green vegetable, which wheat substitute, which low-fat, high-calcium dairy product — depends on the five senses.

Sensory characteristics of food

Sensory methods are used to evaluate what senses are affected when we eat certain food. Food triggers our senses and all these factors combine to help us make the decision about whether we want to eat a particular food item.

Flavour

The perception of **flavour**, texture and visual appeal of foods is very important in determining a food's acceptability and quality. Our perception of flavour in a food is a product of the assessment of taste and aroma (smell). Other properties of food, such as temperature and texture, are also very important to the perceived flavour. The best temperature range for flavour evaluation is 20 to 30 °C, although this is not appropriate for foods that should be served either hot or cold (such as ice-cream).

Taste

Chilli crab, a popular dish in Singapore. Is this dish likely to cause a feeling of heat or coolness?

A taste sensation occurs when chemicals in the food stimulate taste receptors (tastebuds) in the mouth. The primary sensations of taste are sweet, salty, sour and bitter. Specific areas of the tongue can detect these tastes, as discussed on page 27. We taste food because the tastebuds on our tongue respond to salty, sweet, bitter and sour flavours.

Food appeals to many of our senses.

In addition to the four basic tastes, **umami** can also be detected by the tastebuds. These compounds (such as monosodium glutamate, MSG) are known as flavour enhancers. Other components in food such as tannins (as in tea that has been brewed for a long time) can contribute to taste by creating a characteristic sensation. This sensation is called **astringency**. Some chemicals in food can create a feeling of heat or coolness in the mouth; for example, peppermint makes the mouth feel cool.

Texture

Texture describes how a food actually feels in the mouth — between the lips, against the teeth, on the tongue and roof of the mouth (called **mouth feel**) — or in the hand. This is sometimes called tactile texture. Can you recall how a crinkle-cut potato crisp feels in your mouth?

A food also has visual texture. Have you ever been surprised when a wrapped salad roll from the school canteen turns out to be soft when it looked crispy?

Some of the most common ways to describe the texture of foods are listed in the table below.

TABLE 4.1 Texture of foods

CHARACTERISTIC	FOODS
Hardness Softness	Fresh stick of celery Ripe avocado
Brittleness Smoothness	Peanut brittle Chocolate bar
Cohesiveness Crumbliness	Sticky caramel bun Sponge cake
Viscosity (thickness) • high • low	 Thick cheese sauce Thin gravy
Elasticity Chewiness	Grilled round steak Baked potato skins

Aroma

Everyone knows that hot food has more aroma than cold food. Steam rising off the food carries volatile aromatic substances that contribute to both aroma and flavour. The more the food is heated, the stronger its aroma becomes. (Some cooks depend on the smell of cooking food to know when it is ready.) The next time you use lemon-scented dishwashing detergent, put a small drop in the palm of your hand and smell it. Run some warm water over your hand, then smell the bubbles; despite the detergent now being less concentrated, the smell of lemon is stronger.

Sometimes food is served covered on a dish at the table. As the cover is lifted, the wonderful aroma of the food underneath is released. Cold foods too can have aromas. Many fresh fruits, such as strawberries, pawpaws and mangoes, have distinct aromas that deepen as the fruit ripens.

In recent years, technology has been used to develop machines with 'electronic sensing' similar to the human senses that can detect and analyse volatile chemicals at low levels (see page 28).

Sound

Although not people's first thought when selecting a food, sound does play a part in the overall enjoyment of it. There is no doubt that the sound of food sizzling on a platter adds to the food's appeal. Sound can also create a negative impression; for example, if an apple does not crunch when we first bite into it, we know it is not fresh.

Visual appeal

Several factors influence the visual appeal of a food, but colour is one of the most important. The food industry uses many colours in its products because of consumer expectations. The consumer expects certain colours to be associated with certain flavours. For example, an orange-coloured jelly is expected to have an orange taste, cooked meat should look brown, and baked bread should have a golden brown crust. The appearance of a product can also influence the acceptability; for example, scrambled eggs that are very dry and crumbly are not as appealing as scrambled eggs that look moist, and lumpy gravy is usually not acceptable.

Let's look at the sensory properties of milk and cheese to summarise what we've learned so far.

TABLE 4.2 Sensory properties of milk and cheese

MILK			
Appearance	**Flavour**	**Texture**	**Aroma**
White liquid; colour affected by the amount of butterfat (cream)	Bland	Smooth liquid	Faint creamy aroma when fresh
CHEESE			
Appearance	**Flavour**	**Texture**	**Aroma**
Varies from white to yellow, and to almost blue or green in some blue vein types	Varies from cream cheese to strong blue cheese and cheddar	Varies from moist, smooth, spreadable cream to firm, sliceable cheddar; some, such as brie or camembert, when fully ripe, are firm on the outside with a viscous, almost liquid, centre	Varies from almost undetectable, such as brie, to very strong

Sensory tests

Sensory testing is a **subjective evaluation** of how people perceive a product by using their senses. On the other hand,

the food industry also measures physical properties, such as height and weight of food, and chemical properties, such as **pH**. A full picture of the properties of a food can be determined by using a combination of these tests.

Most purchased food has been processed in some way, so we will first look at the sensory tests conducted by the food manufacturer. Then we will look at the sensory tests that consumers can conduct in the store or at home before selecting a certain food.

Sensory analysis is the analysis of a food's aroma, taste, overall appearance and texture. It can be done to test the development of a new product or as a way to improve an existing product.

Sensory tests can measure:

- consumer preference for one food over another. Why is the competitor's product selling more? Does it have a better flavour or colour?
- consumer acceptance or rejection of certain flavours, textures or aromas. Does the new coffee-flavoured biscuit taste the way customers expect it to taste?
- the difference between processing or storing procedures. Does a waxed-paper liner within the box preserve cereal texture more than a foil-lined pouch? Did the increase of temperature by 3 °C during the canning process for chicken have any undesirable effects on colour, texture or flavour?

This kind of information is important to the food manufacturer. It helps manufacturers improve the food being developed or already being produced. The more sensory characteristics of the food that the consumer likes, the greater product sales will be.

Various types of sensory evaluation or tests can be done, depending on what the manufacturer wants to know. But during any type of sensory test, certain guidelines need to be followed to achieve useful results.

Guidelines for conducting sensory tests

General organisation

- Each test should evaluate only one characteristic of a food, such as saltiness.
- No more than five different samples should be tested at any one time. The stronger the flavour of the food is, the fewer samples should be given, because the senses tire quickly and cannot detect differences as easily and accurately. Five different samples should be used only if the foods to be tested are bland or mild in flavour.
- A sensory evaluation sheet should be provided so each panellist carries out the same tests. With some types of test, the panellists can key their choices directly into a computer.
- The product samples should be labelled in a way that prevents the panellist from ranking them in a suggested order. (See the diagrams above right that demonstrate acceptable labelling.)
- Each sample's random number should be recorded so that the samples are not confused.
- When comparing similar products (such as spaghetti sauce) check the ingredients list on the packages to identify any differences. It would be more accurate to obtain a contents list designed by the manufacturer, but food companies seldom make known their recipes and processing steps.

Sample labelling that should *not* be used because it may indicate that sample 1 is better than sample 3.

Acceptable sample labelling — numbers are chosen at random because they mean nothing to the panellist.

Panellists/tasters

The testers are called panellists or tasters. Panellists can be average consumers who are chosen as typical users of the product or who have volunteered to take part in the test. At other times, experts who have been trained to taste for specific things, such as the taste of vinegar in a salad dressing, are used.

- Tasters should not have a cold because this will dull their senses.
- Testing should occur neither when the taster is hungry nor when they have just finished a meal.

- Panellists should take two or three bites or sips of the food for taste and texture tests.
- Panellists should rinse their mouths with water after each tasting so the flavour of each sample is not affected by the previous sample.
- Differences between products can sometimes be described or explained in the panellist's own words. Some tests insist that tasters choose one product over another, even if they cannot sense a difference.
- Panellists should not discuss their evaluations with other panellists, because this will influence their answers.
- Individual results should not be given, although group results may be shown.

Presentation of food

- The water for tasters should be at room temperature, because cold water will dull the sense of taste.
- The food should be presented at the correct temperature for eating; hot foods are sampled hot and cold foods are sampled cold.
- The environment surrounding the testing area should be controlled so that testers cannot see or smell the food before they test, because this may affect the results.
- Panellists should be separated from one another by dividers. (See chapter 15, page 288 for more detail.)

Types of sensory tests

Various marketing departments in the food industry conduct their own sensory evaluations and others use independent marketing agencies. There are many tests that can be used for sensory evaluation. Quality testing is done to evaluate the overall characteristics of a food, and to rank a specific quality, by comparing that food with similar foods.

Hedonic scales

Hedonic scales or pleasure scales are used to rate products for acceptability. A simple form of the hedonic scale uses faces that indicate the amount of pleasure gained from a food. This scale can also be useful when children are testing food.

The hedonic scale using face pictures

Hedonic scales can also use words in a series of boxes (or a numerical scale) with comments that indicate the different levels of satisfaction about a food. Here is an example of a hedonic scale using words.

Overall, how would you rate the taste?
Circle the number that best applies to you.

1	2	3	4	5
Very poor	Poor	Fair	Good	Very good

A word hedonic scale where panellists rate the food according to a word association

Descriptive tests

Descriptive tests provide information about certain selected sensory characteristics of food samples. A list of words that describe the characteristics being assessed is presented on a scorecard and the taster selects the most appropriate description based on those words (see table 4.3 below).

Ranking

In **ranking** tests, several foods of the same kind are assessed together and then placed in order of preference for the characteristic being tested. For example, suppose a food manufacturer wants to produce a cinnamon-flavoured apple pie for older people. A ranking test could use several older people as tasters. Each person could be asked to taste samples of apple pie, each with a different amount of cinnamon flavouring. The tasters would rank the pie samples in descending order, according to their taste appeal.

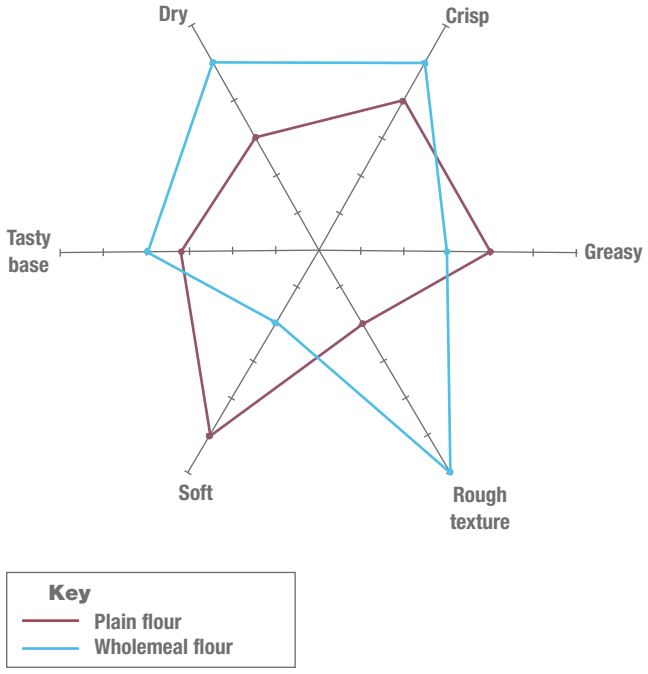
Several characteristics can be assessed in ranking tests. The ranking system can also be used with **descriptive words** in the evaluation.

Profiling food

Profiling is a more complex process that ranks descriptive words to create a **food profile** of the product. The results are presented on a star diagram (see page 71) that has a few or many points, depending on the number of qualities being tested. A star diagram can be used to compare similar products. It could also be used to compare the results of several tasters.

TABLE 4.3 Classification of different qualities of a banana cake using a reduced-fat butter blend instead of butter. Testers are asked to circle a description for each quality, such as texture and appearance.

PROPERTY	DESCRIPTION (CIRCLE THE DESCRIPTION THAT YOU THINK IS MOST APPROPRIATE.)			
Texture	Heavy and doughy; no airholes	Moist and not crumbly; small airholes	Some moisture; uneven airholes	Dry and crumbly; large, uneven airholes
Appearance	Dark brown	Golden brown	Speckled brown	Pale



Star diagram for two pizza bases, one using plain flour and one using one-quarter wholemeal flour. Which pizza base would you prefer based on this profile?

Difference sensory testing

Difference testing is used to test the perceived or recognised differences between products. The differences can be in appearance, flavour, texture or aroma. At least twenty panellists are needed to ensure the results of a difference test are worthwhile in predicting consumer preference.

It is reasonably easy to identify the difference between just two samples. A taster has a 50 per cent chance of guessing correctly even without tasting! These odds are too high for a food manufacturer to work with, so other comparisons are used to make sure the results of a sensory test indicate more than 50 per cent accuracy.

Paired comparison test

In a **paired test**, the samples are presented in pairs, but there is more than one pair to taste. Imagine that sample 327 (which we will shorten to P) is a reduced-fat margarine, and sample 881 (shortened to H) is an ordinary margarine. The taster will taste:

- sample P + sample P (first pair)
- sample P + sample H (second pair)
- sample H + sample H (third pair).

With three paired samples, if the taster recognises any difference between the two margarines, it is more likely to be the result of an actual taste difference rather than just chance. If the number of panellists is large enough, the statistics should indicate how noticeable the taste difference will be to the average consumer.

Triangular comparison test

A **triangular test** is the most common of all difference sensory tests. Remember, the aim is to determine if the tasters can recognise any differences between similar foods.

Only two *different* samples are tested but they are presented in threes, as the name suggests. The taster is asked to identify the odd one out.

They will taste:

- sample P + sample H + sample P
- then P + H + H
- and so on to P + P + H, H + P + H, H + P + P
- and finally H + H + P.

Sometimes the taster will be permitted to indicate 'no perceivable difference' if they are absolutely unable to detect a difference.

A variation of the triangular test is called the **duo-trio test**. In this test, one of the samples is identified for the taster and acts as a control. The remaining two samples are tasted and compared with the control. They will either taste similar to or different from the control.

Two-out-of-five comparison test

The **two-out-of-five test** is the most reliable difference test for showing the average consumer's ability to detect a difference in a food's appearance and texture. Panellists taste five samples, of which two are the same. They are asked to identify those two samples.

Using the results of the two-out-of-five test, a manufacturer can predict how 90 per cent of consumers will feel about the food. The test is not used for testing taste or aroma, because a large number of samples need to be tested at the one time. Only appearance and texture can be tested.

EXPERIMENT

Sensory test for flavour differences

Syllabus outcome

Students learn to:

- evaluate the appeal of foods using sensory assessment.

Contributes to the following outcome:

- identifies and explains the sensory characteristics of food.

Aim

To determine the effects of colour on flavour recognition, using a triangular comparison test

Equipment

12 small fruit bowls
4 large bowls
4 wooden spoons
4 × 10 g unflavoured powdered gelatin
4 × 100 g sugar
4 × 500 mL hot (but not boiling) water
orange, red, yellow and blue food colourings
strawberry, lemon and orange food flavourings

Method

As a class, divide into four groups.

1. Each group makes a batch of the basic jelly recipe in a large bowl (using gelatin, sugar and water).
2. Divide each batch among *three* small bowls. Add one drop of the colours (as shown below) to each small bowl:
   Group 1 — orange, in bowls numbered 1–3
   Group 2 — red, in bowls numbered 4–6
   Group 3 — yellow, in bowls numbered 7–9
   Group 4 — blue, in bowls numbered 10–12.
3. Add two drops of orange flavouring to bowls 1, 4, 7 and 10.
4. Add two drops of lemon flavouring to bowls 2, 5, 8 and 11.
5. Add two drops of strawberry flavouring to bowls 3, 6, 9 and 12.
6. Label each of the small bowls with a random three-digit number. Make a chart to record what is actually in each bowl. If you have a computer available, you could produce a spreadsheet similar to the one below.

ORIGINAL BOWL NUMBER	RANDOM NUMBER	COLOUR	FLAVOURING
1	751	Orange	Orange
2	349	Orange	Lemon
3			

7. Allow the jellies to set, preferably overnight.
8. Set out the dishes attractively and clearly labelled with the random number.
9. Give each panellist:
   - a spoon (and somewhere to rinse it in hot water between samples, to prevent contamination)
   - a glass of water (and somewhere to fill it when necessary)
   - a pen
   - four sets of samples to test (original numbers 1–3, 4–6, 7–9 and 10–12)
   - a response sheet.
10. Ask the panellist to fill in the following response sheet.

SAMPLE CODE NUMBER	WHAT IS THE FLAVOUR OF THE JELLY?

11. After the panellists have completed the tests, record the responses in a table of results like the one below or on a computer spreadsheet.

FLAVOUR	COLOUR	CORRECT	INCORRECT
Orange	Red		
	Orange		
	Yellow		
	Blue		
Strawberry	Red		
	Orange		
	Yellow		
	Blue		
Lemon	Red		
	Orange		
	Yellow		
	Blue		

Conclusions

1. How often was the flavour choice correct for:
   a) the orange-flavoured jelly
   b) the lemon-flavoured jelly
   c) the strawberry-flavoured jelly?
2. What was the overall response by panellists to the blue jelly? Why do you think this occurred?
3. What reasons can you give for so few colourless food products being on the market today?

CASE STUDY

Consumer taste testing gone wrong

Christine and Ed, hungry after a long day at work, walked into the conference room of the Allgo Food Company for taste testing. They were the last of the 20 people to sit down at the large table in the middle of the room. Visible in the centre of the otherwise empty table were five trays of the new dips the tasters were to sample.

The trays were labelled: (1) hot and spicy, (2) cajun, (3) curry (Ed shuddered because he hates curry of any kind), (4) satay and (5) Szechuan. A food technologist explained to everyone that they were to sample each dip in order to identify which flavour they liked best and which texture was the most appealing. Everyone was given a score sheet to complete. The technologist said he would return in 20 minutes to see how people were going. In an effort to make the correct choices, Chris and Ed talked freely with the people sitting beside them.

CASE STUDY QUESTIONS

Carefully consider the article on the previous page. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *sensory testing* to complete the tasks ahead.

1. What kind of sensory test is being used in this case?
2. What correct testing procedures are being used?
3. What factors would interfere with the reliability of this food test?
4. What would be a more reliable test (or tests) for the Allgo Food Company to conduct?

REVIEW QUESTIONS

Remember

1. Name the senses triggered in the following examples.
   a) Sally closed her eyes and savoured the creamy, velvety chocolate.
   b) Amy remembers that she loves hearing the snap, crackle and pop of rice bubbles.
   c) Lee knew what was on the menu for tonight's dinner as soon as he opened the front door.
   d) The meringue fresh out of the oven looked golden and delicious.

Apply

2. What kind of information are food manufacturers looking for when they do sensory tests?
3. What went wrong in the following sensory tests.
   a) The panellist had to choose which of chocolate bars 1, 2 and 3 tasted the best.
   b) Betty just finished a big heavy meal before she took part in some taste tests.
   c) Adrian had a heavy dose of the flu but didn't want to let anyone down so he went along to be a taste tester.
   d) Josey and Julie were doing some taste testing together and both agreed they liked sample A best.
4. Explain how different sensory tests should be conducted to ensure accurate results.

Do an activity

5. Working in pairs, test how well your nose detects the aroma of foods. Each student brings three different foods to school. Blindfolded, everyone guesses what the food is. After the experiment, write a paragraph about why the aroma of food is an important factor in helping us decide whether we want to eat certain foods.

Consumer sensory assessment

Consumers conduct their own sensory tests every time they make a food choice. Although they do not have the time, money or experience to carry out elaborate sensory tests as food manufacturers do, they do make choices based on what their senses tell them. Consumers choose most of the food they eat from supermarkets, but they also make food choices in restaurants (especially smorgasbords and take-aways), cinemas, sports arenas and clubs. Food is available at virtually every function and social occasion these days.

Supermarket shopping — sensory assessment

When buying food, as well as considering the nutritional content of the food and the money available, consumers make critical judgements on the following characteristics:

- unwanted extras — garnishes, extra liquid and so on
- overall physical appearance — the food's colour, general shape, **turgor** and amount of fat
- smell or aroma
- anticipated taste (Remember that taste is a combination of smell and taste.)
- known texture or anticipated texture — consistency, moisture content and mouth feel.

Consumers getting exactly what they want — value for their money!

Choosing fresh flesh foods

Flesh foods include meat, poultry and fish.

Meat

In general, the type and age of an animal determines the quality of its meat. For example, the meat of older animals is considered more flavoursome. Expensive cuts of meat are usually more tender than less expensive cuts, and this may affect the cooking time.

Meat will be at its best quality if:

- it does not look stringy and does not have too much visible connective tissue or gristle, unless stewing or casseroling is planned
- the flesh is moist and bright red in colour, with a fresh appearance. Butchers sometimes use special lights in their windows to make meat look a brighter red.
- not too much fat is visible on the outer edges
- the amount of bone is suitable. For example, a large bone is desirable when making soup.
- a 'packed' date is clearly visible on pre-packed meat.

In general, you can judge meat to some degree by its appearance. Beef should be bright red, firm and finely grained. There may be **marbling**, as indicated by flecks of fat through it. Lamb should be a light reddish-pink colour and very tender, with an even edging of firm white or pink fat. Pork should be pale pink, firm and moist, with pearly white fat, and may have finely grained flesh. Veal should be very pale pink and usually with no or very little fat.

Poultry

Poultry includes domestic birds such as chickens, turkeys and ducks. Chicken is one of the most popular foods and its consumption has been increasing over the past 50 years. It can be purchased fresh or frozen. Whole birds are available, as well as separate components that may be sold with or without skin and bones. Examples of different cuts of chicken include whole or halved breasts, breast fillet, drumsticks and thighs. The method of cooking and the cooking time are largely dependent on the bird's age and the size of the piece.

In general chicken can be classed as:

- poussin or spatchcock (aged about 6 weeks old)
- spring chicken (aged about 8 weeks old)
- roaster (under 6 months old)
- boilers (at least 18 months old), which usually have tougher meat and need moist methods of cooking to tenderise the flesh.

When selecting fresh poultry, the following characteristics should be considered:

- plump with a fresh, clean smell
- no broken bones
- fresh-looking, unmarked (no tears, cuts or bruises), with moist, light cream-coloured skin
- pink flesh with no bruising
- firm, plump breast and thighs.

Fish

A large variety of good quality seafood is available in Australia today. However, seafood is a very perishable food, so take great care when buying it. When selecting prepacked seafood of any kind, check the 'packed' date.

The main types of seafood are fish and shellfish. There are two types of fish:

- white fish, such as haddock, whiting and cod
- oily fish, such as herrings, sardines and salmon.

The freshness of fish is indicated by:

- bright, bulging and clear eyes
- bright skin or scales
- red-pink gills
- a body surface free of dirt and thick slime
- firm flesh (leaving no imprint after being pressed)
- no browning or drying around the edges
- an odour of sea water or seaweed (avoid if it has a strong fishy odour or smells of ammonia).

There are two types of shellfish:

- **crustaceans**, such as lobster, prawns and crabs
- molluscs, such as oysters, scallops and mussels.

When buying seafood, check that the product is packed in ice and not lying in a pool of water. Mollusc shells should be firm and tightly closed, or if open, should close when tapped gently. Feelers on crustaceans should be long; broken feelers may indicate that the product was at least partly frozen before sale.

Choosing fresh fruits

The fruit you choose depends on whether you want to preserve it, cook it immediately or eat it raw. But as a general rule, fruit should be:

- a bright colour, typical of that fruit
- free from cuts and bruises
- the correct degree of ripeness (Buy bananas slightly green if they are to be kept for a few days, or buy a soft ripe avocado for tonight's salad.)
- clean
- free from visible mould, decay and dark spots on the skin
- plump, not dehydrated.

Sometimes wax is sprayed on fruit to help it keep in cold storage and to give the fruit a shiny surface that is more appealing to the customer.

Choosing fresh vegetables

The choice of vegetable depends on what you are going to do with it. However, vegetables should be:

- generally uniform in size
- firm to the touch
- an appropriate colour for the vegetable (The darker the colour of green or orange vegetables, the higher the vitamin and mineral content is.)
- free from visible mould, decay, cuts and bruises
- exhibiting the appropriate turgor. (Leafy vegetables should not be brown around the edges or limp.)

Choosing frozen foods

When selecting frozen foods, look for:

- packaging that has no cuts or tears
- a reasonable use-by date
- no build-up of frost on the outside of the package
- no crushed edges

- no dried spots visible through the packaging, which could indicate freezer burn
- movement of small foods within their package. If the food is a solid block, it may mean the food has been allowed to thaw and refreeze.
- storage below the freezer line in open freezers. If the food is above the storage line of the freezer, the temperature will not be low enough to prevent partial thawing. When the food is refrozen at home, more damage will be done, as more crystals form and more liquid is lost from cells.

REVIEW QUESTIONS

Remember

1. Make a list of the factors that influence a consumer's decision to put a food product in their supermarket trolley.

Apply

2. Would you buy any of the food items described below? Give reasons for your answer.
   a) The fish looked a bit slimy and the eyes were missing.
   b) The meat was a dark brown colour.
   c) There was no use-by date on the fish.

Do an activity

3. Visit a supermarket and describe how the store design and layout of food appeals to consumer senses.

Layout of food for visual appeal

Food presentation describes how food is arranged, decorated and garnished on plates, platters, trolleys, and buffet or smorgasbord tables. When a person chooses and eats food, all the senses are operating, so it is important when preparing food to keep the presentation in mind.

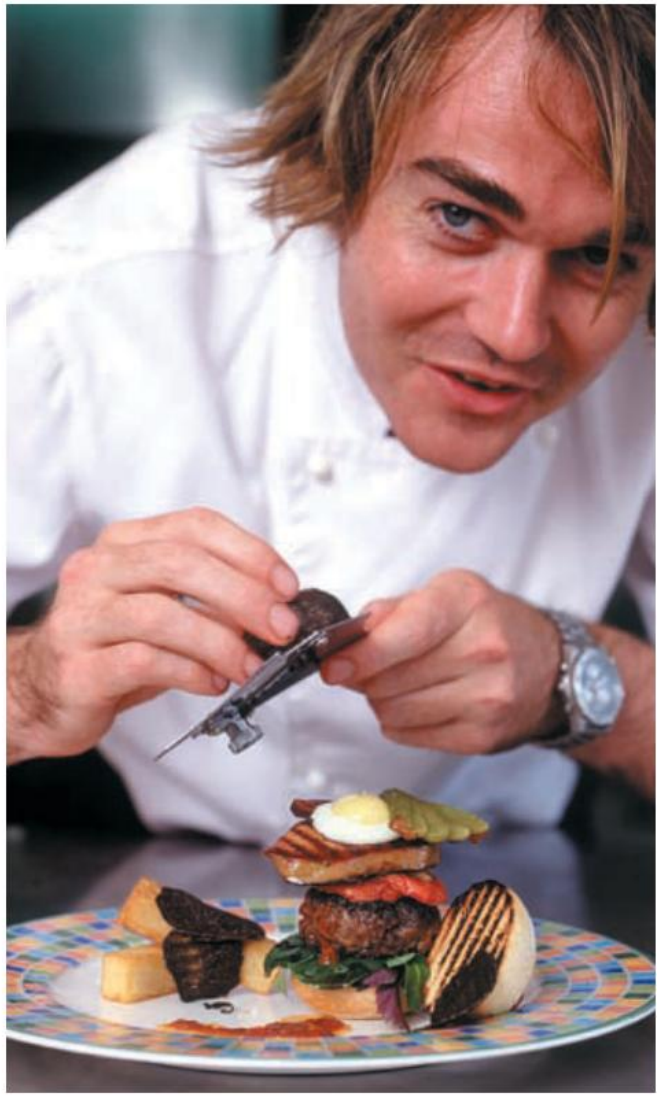
The most successful cooks realise the importance of presentation and spend much time on suitable garnishes, the arrangement of food on serving dishes, and the table decorations.

You might ask why food presentation is important at all. If people are hungry, they will eat whatever is put in front of them. But food should look good as well as just filling the stomach.

Plate presentation

The visual appeal of a meal can be enhanced by taking care in plating and serving. Here are some handy hints.

1. Use good quality plates that are not chipped or cracked. Damaged plates can be unsightly and may harbour undesirable micro-organisms in the cracks.
2. Plate food neatly so that colours, textures and flavours are coordinated.
3. Don't overcrowd the plate and have food spilling out to its rim.
4. Avoid stacking food so high it topples over before it reaches your guest.
5. Don't smother food in sauce. Try using a squeeze bottle so you can control the amount of sauce you add.
6. Use a garnish only if it improves the appearance of the meal.
7. After plating the food, make sure that the plate edges are clean and do not have fingermarks, drips or crumbs of food.
8. Serve a portion size appropriate to the person who is to eat the meal.



Some think that plating food is an art. Simplicity often works best.

Garnishes

Garnishing refers to the trimmings applied to a savoury dish to improve its appearance — for example, a sprig of parsley added to the side of a roast chicken platter or radishes cut into roses for the top of a salad. Decorating usually refers to the brightening up and enhancing of pastries and sweets by using interesting shapes and contrasting colours and/or textures — for example, decorating the top of a pavlova with strawberries, kiwifruit and whipped cream. For convenience we will use the word 'garnish' to represent both processes.

Garnishes are used for one or more of the following reasons:

- to add a focus of interest
- to add colour
- to add contrasting textures
- to add contrasting shapes
- to show the ingredients used in the dish — for example, a lemon wedge served with a fish casserole helps to identify the dish
- to add a theme.

Garnishes can be used to good effect but it is often wise to keep them simple. A sprig of parsley can look more sophisticated than an elaborate garnish.

A little extra time and effort spent decorating food can turn the already attractive meal into an experience to remember — a visual masterpiece. Garnishes can brighten up even the most basic of meals.

Garnishes are made using either raw or cooked food. (Most fruits and vegetables can be used as garnishes for a variety of dishes.) Foods can be:

- sliced — smoothly (lengthwise, crosswise, wedges) or crinkled (fanned, spiralled, twisted)
- shredded — julienne, thinly
- scored
- curled
- piped through a bag
- carved or turned.

Like any form of decoration, garnishes should be used in moderation. Too many different types used on the same plate will look messy.

Several classic garnishes are easy to do and will liven up a meal: butter curls, dashes of paprika, pieces of parsley and grated cheese, for example, on savoury food, and a sprinkle of icing sugar, whipped cream roses, and curls of chocolate (caraque) on sweets.

Practise making some of the garnishes mentioned below in table 4.4, using a flex knife or sharp paring knife. Remember to wash the vegetable or fruit before turning it into a garnish, because people often eat garnishes!

Food styling

A **food stylist** has the task of creating pictures and moods with foods that are on display. The display may be for an actual function, such as a buffet, or for photography. The food stylist may be a trained chef or a person who has worked with food and has a lot of creative ability. The stylist does not usually make the food to be displayed, but decorates or arranges it so it looks appealing.

The food stylist works with a theme in mind. A stylist preparing a display for the Heart Foundation, for instance, would have to consider the low-fat approach when selecting and arranging food. Obviously, a trim lamb dish would not be served with a rich bernaise sauce for such a client.

In general, there are three tasks for the food stylist. First, keeping the theme in mind, all of the pieces necessary for the table setting are collected and arranged. This can include:

- a tablecloth or mats, and napkins
- table decorations that reflect the theme of the presentation

TABLE 4.4 Garnishes and the foods they decorate

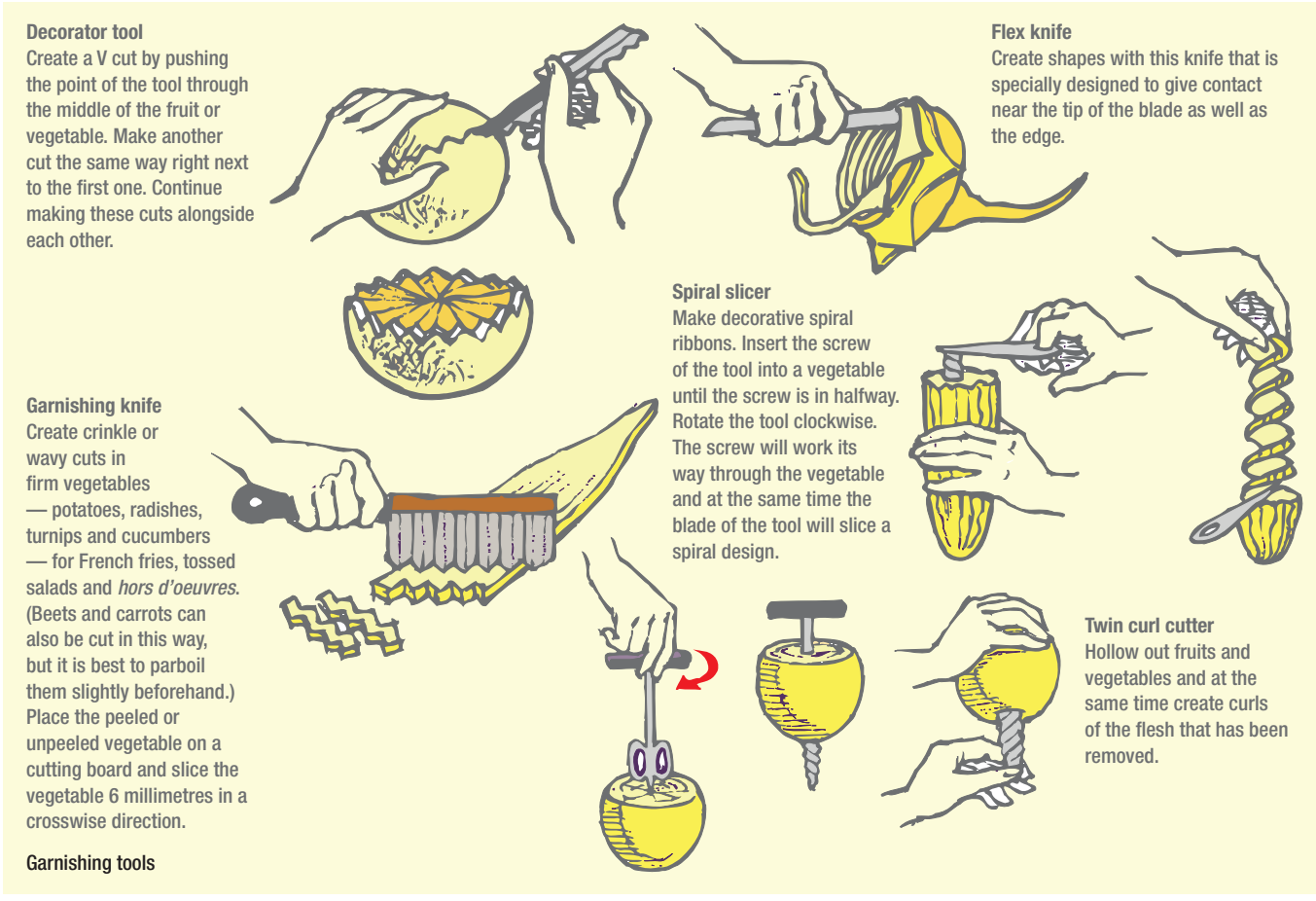
FOOD TO BE GARNISHED	INTERESTING GARNISHES
Savoury salads	Edible flowers such as pansies and nasturtiums, croutons, whole or chopped nuts, olives, hard-boiled eggs, cooked prawns, sundried vegetables such as capsicum and eggplant
Fruit desserts and salads	Unsalted nuts, cooked citrus peel, mandarin or orange segments, flaked chocolate, puréed berries such as strawberries and blueberries
Meat dishes	Dried tomatoes, hard-boiled eggs, green or pink peppercorns, carrots, sprigs of herbs such as rosemary and watercress
Seafood	Avocado wedges, chives and parsley, olives, lemon wedges
Poultry	Whole or puréed fruits, carrots, cooked citrus peel, mandarins or oranges, green or pink peppercorns

- plates, bowls and serving dishes
- serving utensils, such as spoons and tongs
- cutlery and glassware.

All of these items are hired, bought or perhaps loaned by the manufacturer. As you can imagine, this collection takes a lot of time to organise, and good contacts are needed.

The second task of the food stylist is to decorate the food to be presented. This could involve piping whipped cream on a cake or combining two different coloured soups in a swirled pattern in a soup terrine.

The third task of the stylist is to arrange the food on or in the dish in an attractive manner. Garnishes are important in this task.



Garnishing tools

CASE STUDY

FOOD FASHION

Stylists can present food that looks good, even if its taste doesn't match its looks. Bridie Smith reports.

When Pamela Stevens prepares a roast chicken, she needs about half a litre of dish-washing liquid and a couple of packets of Chux wipes. And that's before the washing up.

These kitchen staples — along with blowtorches, paint brushes and tampons — are among the tools food stylists and photographers use to create the mouth-watering images that adorn food packaging in supermarket fridges, freezers and shelves.

Stevens, a Melbourne food stylist and corporate chef, has been in the business for 10 years. She can transform a pasty-coloured chook with pimply skin into

a mouth-watering, got-to-have-it-now roast chicken fit for any ad campaign. All she needs are a few unconventional ingredients.

'We stuff the raw chicken with Chux wipes and coat it quite heavily with parisian essence and dishwashing liquid, which makes it look like it's crackling, while the essence gives it a really golden colour', says Stevens, who also teaches food presentation and styling at Swinburne University's Prahran campus. 'A chicken looks much better when it is raw, as it's got all its moisture in it and it's plumper.'

Better for the camera, that is.

Likewise, a gooey caramel topping dribbling over balls of ice-cream is likely to be concocted from coloured liquid plaster. And lasagne, which is prone to collapsing at the wrong moment, is often uncooked and layered with cardboard, which is hidden by the meaty sauce.

'You have to be able to stabilise the layers without showing the cardboard, which holds it up and stops its layers running into each other', Stevens says.

And getting rice to hold its steam for the camera? Look no further than a couple of tampons soaked in cold water and microwaved. Once hidden in a mound of rice, the tampons are a stylist's best friend, providing steam long after the camera has stopped clicking.

But food stylists insist their job is to enhance, not misrepresent, products. Yarraville food photographer James Vlahogiannis says the days when ice-cream was replaced with mashed potato for a shoot are largely gone.

'Now the look is very natural, not too staid, not too contrived, not too perfect', he says. 'Our job basically is to make the food look as good as we can, given the brief.'

Where does the line between true representation and misleading labelling begin and end? Often it is the message, rather than the methods, that catch the attention of consumers and authorities.

In March this year Cadbury Schweppes was ordered to re-label its Cottee's banana mango cordial after the Australian Competition and Consumer Commission complained that the label — bursting with pictures of ripe mangos and bananas — was misleading, given the cordial had not come within coo-ee of either fruit.

The Federal Court rejected Cadbury Schweppes' argument that the words 'flavoured cordial' were enough to tell consumers the cordial didn't contain any fruit. The cordial has since been removed from sale.

A Cadbury Schweppes spokesman said the company was always looking at new ways to help consumers make informed choices when selecting products, and that 'correct labelling at all times across our entire product range is one of the company's highest priorities'.

The Food Standards Code requires manufacturers to present a truthful representation of the product on packaging. However, this can be open to interpretation. A Consumer Affairs Victoria spokeswoman said the authority would act on significant, provable misrepresentations.

'For example, if they didn't tell you there were peanuts in a product it would be a concern for us', she said.

Legal loopholes are often defined by two words in fine print on the pack: 'serving suggestion'. Vlahogiannis describes the phrase as a safety net.

'It's giving consumers a suggestion but also, because of the strict laws, the term 'serving suggestion' is there to protect manufacturers', he says.

Source: The Age, 27 November 2004.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food styling* to complete the tasks ahead.

1. Describe some typical items in the food stylist's tool box.
2. What are some of the food stylist's tricks of trade?
3. Do you think it is misleading the consumer to use such tricks?
4. What look are food stylists currently trying to capture according to photographer James Vlahogiannis?

Food photography

Job opportunities for food stylists occur mainly in situations where food is to be photographed, such as in the production of cookbooks, magazines, posters and television advertisements.

Television advertisements sometimes present food in ways that can be achieved only using special effects. We know we could not get cooked rice to take the shape of a rack of lamb without the use of hairspray and glue, but it is a catchy gimmick. The television advertisements are designed to gain our attention and encourage us to buy a certain product, not always to show us what a finished product actually looks like. This is the task of the cookbook.

Publishers of cookbooks and magazines realise they have to show pictures of food that can be made and eaten in the home. While we can never hope to match the art of the food stylist, we can present a close approximation of food from a photograph. If we take the time to wipe the drops of sauce off the plate, to brush dried-out parts of the food with oil, or to spray wilted food with water, our food presentation will certainly improve.

Food photography requires special skills and equipment, as well as considerable patience.

With digital photography, the effect of a food display can be viewed within minutes. Most food photographers work with an SLR digital camera, zoom lens, computer software, such as Adobe Photoshop CS2, and a laptop computer. With digital photography, an unsightly blemish or bruise on a food can be edited out.

As with any photography, lighting is very important. The food should be evenly lit from the sides and top. If an undesirable shadow appears (on the inside of a pie that has had a slice removed, for example), a mirror can be used to focus light on the shadowed area. This creates a three-dimensional feel or depth.

Food photography these days is about simplicity and freshness. Donna Hays has been the trend setter in this area with white plates and single dishes that are not overcrowded with food. The food just looks crisp and fresh with the minimum of fuss. Colour in food photography may be added with the props, such as placemats, glasses or napkins.

Several general rules when photographing food include the following.

Control the colour of the food.

- Bright colours indicate the freshness of the food — for example, dark green broccoli with no yellow patches, and bright red tomatoes with no brown spots or blemishes.
- Colours should contrast — for example, light and dark, patterns and plain, subtle colours for softer foods and bright colours in turgid foods.
- Cooked food looks darker and overcooked, so only partly cook the food to be photographed.

Make hot food look 'hot' or cold food look 'cold'.

- Put partly cooked food about to be photographed into the microwave on high for 30 seconds to produce steam.
- To make a food appear golden brown, brush the surface of the food with paprika and brown food colouring, or brush with oil or a sugar and water syrup.
- To make food look chilled, spray cold water on its surface. To photograph a cold drink, place ice cubes in the container then spray the outside with a fine mist of water until the drops roll down the glass. Plastic ice cubes may be used to avoid having to replace melted cubes.

Make the food look 'life sized'. (Cameras tend to flatten food and reduce its overall size.)

- Create height by arranging food in uneven layers, not laying it flat on the plate.
- Make decorations taller than the food — for example, handles on baskets that show above the food.
- Use glasses with medium-sized stems as part of the shot.
- Use different heights in the plates, bowls and serving dishes.
- Cut or make food pieces larger than you normally would — for example, make large, uneven-sized biscuits.

REVIEW QUESTIONS

Remember

1. What is the name of the garnishing tool that:
   - **a)** cuts fruits or vegetables into a continuous curled ribbon
   - **b)** creates wavy cuts
   - **c)** scoops the soft inside out of fruits and vegetables?
2. What does a food stylist do?

Apply

3. Discuss the value of using garnishes in meal presentation.

Do an activity

4. Create a food photography album with at least five photographs of food. Beside each photograph describe the methods you used to make the food look more appealing.

CASE STUDY

PLATE OF ORIGIN

by JOHN NEWTON

Dots, dashes, stacks and garnishes. To some chefs, presentation is a food fad. To others, it's an art form.

Plating — how food is presented to the diner — has been a universal preoccupation of chefs. They know that how food looks is, if not as important as its taste and smell, then well worth fussing over. And fuss they do.

'I hate patterned plates', says Peter Gilmore of Quay. 'I hate brightly coloured plates. The only thing I'd consider other than white is Japanese ceramic.'

Just as there are fads in ingredients — from sun-dried tomatoes to truffle oil — so there are in how those ingredients appear. Think dots and dashes, froths and foams, the kiwifruit garnish, the stack and the turned vegetable. An anything-goes approach currently reigns, which is another way of saying there's no way of telling what your food's going to look like when you're eating out.

If there are no rules, then there are schools, represented by the French food-as-fashion approach at one end of the spectrum and the Japanese seasonal and minimal style at the other.

For some, the plate is the canvas, the food the medium. The resultant work of art should create involuntary gasps of admiration as it's set down in front of the diner. For others, the plate is the flat thing that carries food to the table so the customer can eat it.

Gilmore sits at the artistic end of the spectrum. His plating might be described as geometric but, he says, 'I've edged away from being so strict.

'A lot of my dishes are a bit more free form — but still precise.

'I love textures and flavours. I love people to look at something that is elegant and beautiful on the plate. The idea of form comes first — there are textures and flavours I want to achieve — then comes how I want to fit those ideas onto a plate.'

In the other corner is Icebergs' Robert Marchetti. 'I did about six years on the floor', he says, 'so the last thing I think of is how the food looks. The first thing is how it tastes. Then how it goes on the plate. When my staff ask me, 'How do we plate it?' I ask them, 'How do you eat it?'

'I don't get [when] you get a pasta bowl and there's a steak in it. You put a fork on the side and it slides into the bowl. I'll change the plating of a dish if I find it awkward to eat. The other day I did a squid ink risotto and I put it on a big plate so you don't get it all over yourself. I don't do aesthetic food. I'm a humble wog, so my food's a bit daggy.'

There are some who elevate daggy to great heights. Consultant chef Diana Thompson remembers River Café co-owners Ruth Rogers and Rose Gray launching one of their cookbooks at The Bathers' Pavilion when she was working there. 'They insisted we drop the food from at least 30 centimetres onto the plate so it would look "natural".'

There is an old joke: what's the difference between Sydney and Melbourne restaurants? Answer: about 6 centimetres. Stacking began in the '80s and continued through to the '90s and just occasionally you'll still see tall food being served.

Stacking heads the list of no-nos for Tony Bilson (of Bilson's). 'It comes out of hamburger culture', he sneers. 'It's an American invention and it's silly.'

Bilson says that a lot of the decoration on a plate is culturally based. For example, 'There are two reasons we turn vegetables — one is to reduce the original to bite-sized and the second is to display kitchen skills, highly regarded by the French. Another example would be the use of pineapple and glacé cherries on Chinese plates — the colours represent good luck'.

The '60s

Heavy brown Arabia ware plates to match huge helpings of brown glazed food napped (that was the word) with heavily reduced sauces. Prawn tails swooped out of parfait glasses.

The '70s

Nouvelle Cuisine explodes in France, given impetus by the publication in 1977

of *The Nouvelle Cuisine* of Jean and Pierre Troisgros, which alerted Australian chefs to this new way of cooking. Meanwhile, plates here were patterned Limoges, portions still generous, vegetables were turned for garnishes or departed the plate to be served separately. Duck breasts were first fanned.

The '80s

Along with Nouvelle Cuisine, the virginal white plate entered the scene — reigning supreme (at least in Australia) ever since. This new style whipped local Francophile chefs into a frenzy of invention and decoration. As the decade progressed, plates expanded and servings shrank. Nouvelle Cuisine emerged as Cuisine Mean. Proliferation of the kiwifruit garnish. Until about '86, food was often scored and striped from the grill or barbecue.

The '90s

The stack hit and food shot skywards. Dots and dashes appeared (tales are told of dishes taking 5 minutes to dress before arriving at table, tepid). Mid-decade, foams and froths roll in from Spain and France. Counter to all this frippery, the first glimmerings of the real food revolution appeared. Vogue food director Joan Campbell's no-nonsense plating style ('just bung it on') influences British chefs such as Jamie Oliver.

Today

Anything goes. The return of real food means a more casual attitude or a lot more individual artistic expression that won't be dictated to.

Source: The Sydney Morning Herald, 31 May 2005.

OUTCOME TASK — FOOD PREPARATION AND PRESENTATION EXERCISE

Students learn to:

- select appropriate equipment and utensils to produce quality food products across a range of settings
- implement safe and hygienic work practices when handling food
- select and apply suitable preparation methods to produce quality food products and plate meals for service across a range of settings
- style foods for photography.

Contributes to the following outcomes:

- selects appropriate equipment, applies suitable techniques and utilises safe and hygienic practices when handling food
- applies an understanding of the sensory characteristics and functional properties of food to the preparation of food products.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food preparation and presentation* to complete the tasks ahead.

1. What is current thinking with regard to plating food attractively? Are there strict rules to adhere to?
2. Describe at least three different techniques of plating food.
3. Draw a timeline that depicts 'plating fashion' from the 1960s to the present day. You may want to either describe the fashion or draw it.
4. Your school's food technology department probably has few resources available to assist in the presentation of visually appealing food. The number and variety of serving dishes and platters is probably limited. The dinnerware is usually a basic solid white, yellow or green colour, and the cutlery is of various sizes and designs. Work in pairs or groups of three (depending on the kitchen space available) to:
   a) design and prepare a two- or three-course menu that can be made in two lessons as close together in the week as possible
   b) present the food using only the preparation and serving resources of the school
   c) photograph the finished product.

Below are some guidelines to help you plan the activity.

Choice of food for the menu

1. Your teacher will tell you the budget. (Remember that foods out of season will be expensive.)
2. Keep in mind the length of the lesson. Foods that take longer to prepare than the lesson-time cannot be included.
3. Consider the cooking experience of each person in the group. Giving a beginner a complicated dish to make is not good use of resources.
4. Choose dishes you already know how to make, because this will save time.
5. Remember the importance of garnishes.

Planning your time

1. Plan your time carefully so all the courses will be ready for serving at the same time.
2. Include time for arranging the food and making garnishes.

CHAPTER 4 SUMMARY

- The messages sent to our brains when eating food determine whether the experience is enjoyable.
- Our enjoyment of food is based on the sensory properties of food; the senses are smell, sight, hearing, touch and taste (including mouth feel).
- In all aspects of food preparation, cooking and serving, it is essential to activate all the senses associated with the enjoyment of eating.
- Tasting and evaluating food can be based on subjective and objective judgements.
- Sensory evaluation uses subjective tests such as hedonic scales, descriptive words, ranking, preferences, profiling and difference testing.
- Good quality ingredients and appropriate cooking methods contribute to the overall quality of a meal.
- The presentation of the food is important to enhance food acceptability.

KEY TERMS

astringency
crustacean
descriptive tests
descriptive words
difference testing
duo-trio test
flavour
food profile
food stylist
garnishing
hedonic scale
marbling
mouth feel
paired test
pH
profiling
ranking
sensory analysis
subjective evaluation
triangular test
turgor
two-out-of five test
umami
viscosity

Chapter 5
Functional properties of food

Have you ever wondered how so many different and interesting foods can be made using the same basic ingredients? Combine flour, butter, eggs, milk and sugar in different ways and you could end up with Portuguese tarts, soufflés, brownies or bread. What happens to food when it is prepared or cooked is controlled by its functional properties. Understanding the functional properties of food will enable you to interpret recipes and assist you in creating better quality foods. Knowing why is as important in food preparation as knowing how!

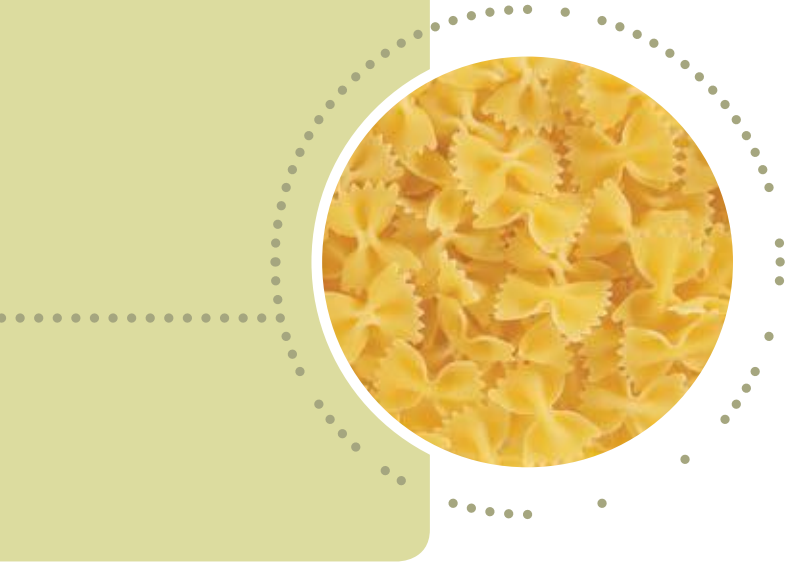
In this chapter you will learn about:

- the role of proteins in denaturation, coagulation, gelation, foaming and browning
- the role of carbohydrates in gelatinising, dextrinising, caramelising and crystallising
- the role of fats in emulsifying and aerating.

You will also learn about the factors that can affect the functional properties of food, including:

- oxygen
- temperature
- acidity
- agitation
- enzymes
- addition of other ingredients.

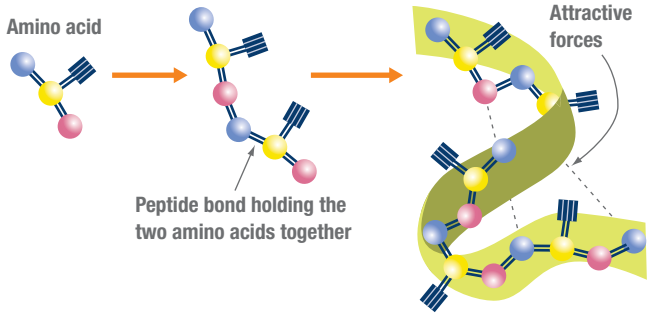
Making food look this good is a skill. As with all skills, practice makes perfect. Understanding what is happening to the ingredients as they are prepared increases the chance of creating a masterpiece. Do you ever go to a specific shop and buy a particular food because they make it so well there? Try analysing the characteristics of the food, and use the information in this chapter to assess why another shop's product is not as good.



Given that nutrients determine the way a food looks, tastes and feels, this chapter investigates the main nutrients and the changes that each one undergoes.

Proteins

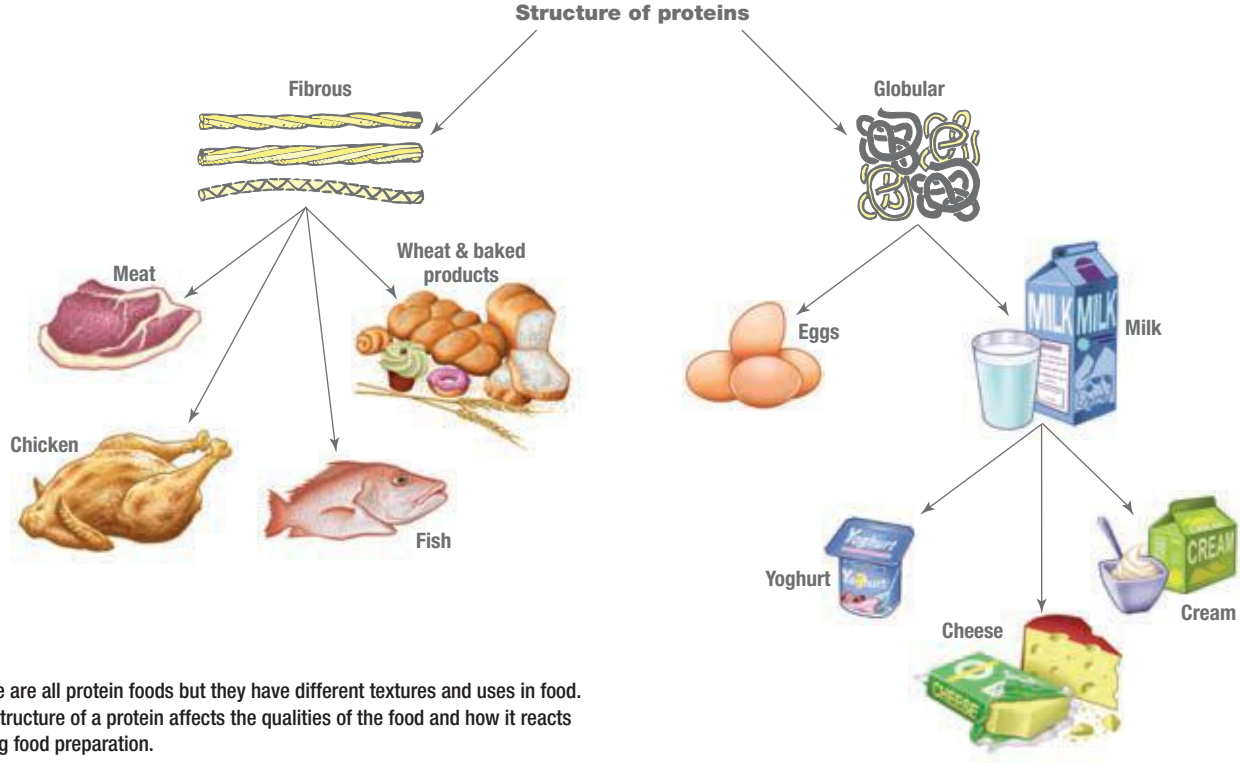
We all know that **protein** is essential to our diet and can be obtained from foods such as meat, fish, dairy products and eggs. But, scientifically, what is a protein? Proteins are made up of individual building blocks called **amino acids**. There are 22 amino acids, which can be combined in many ways to produce thousands of different proteins. Our bodies contain about 30 000 different proteins, of which only 2 per cent have been accurately described. Individual amino acids are joined together by **peptide bonds** to form polypeptide chains, much like a single strand of beads. Each strand twists back on itself to form a coil or spring shape because one part of the amino acid attracts another. These attractions usually occur between hydrogen atoms or wherever sulfur occurs as part of an amino acid.



The polypeptide structure of a protein is coiled because attractive forces exist between one amino acid and another.

The shape of a protein chain determines the characteristics of the foods in which it is found. Which do you think would be stronger: a protein with a twisted strand structure or one with a rounded structure? Which structure do you think would be the easier to alter during food preparation?

Strands of protein always arrange themselves in groups of three or four in a coiled or **helix** shape. Attractive forces not only operate along a single protein strand, causing it to coil, but also exist between protein strands. If the sulfur or hydrogen atoms in one protein chain are positioned close to the equivalent in another protein chain, they either react to form a disulfide bridge (often called a salt bridge) or are attracted and form a hydrogen bond (or H bond).



These are all protein foods but they have different textures and uses in food. The structure of a protein affects the qualities of the food and how it reacts during food preparation.

These attractions and reactions determine the shape of the protein, which can be in one of two basic structural forms:

1. fibrous proteins, where the coiled helix structure is elongated to form a strand. Fibrous proteins are found in the muscle fibres of meat, poultry and fish, and also in products made from flour that contain the protein gluten.
2. globular proteins, where the protein stands are twisted into a rounded, compact shape. Globular proteins are found in:

- eggs — albumin in eggwhite, and vitellin and vitellenin in egg yolk
- milk and dairy products — caseinogen, lactalbumin and lactoglobulin
- enzymes — present in the cells of all living things. The presence of enzymes in foods is most easily seen in fruits and vegetables; they are responsible for the process of ripening and for the browning reaction that takes place when fruits are cut and exposed to air (**enzymic browning**). Enzymes are also used by food processors, such as cheesemakers, to create specific reactions in foods.

What happens to proteins during food preparation and processing?

Each protein has its own combination of amino acids — its own fingerprint. This means each protein is slightly different from all other proteins, has specific functions and undergoes specific reactions. However, there are some reactions common to *all* proteins, the two most important in food being **denaturation** and **coagulation**. These changes occur when the structure of a protein is altered by:

- the application of heat
- mechanical action (agitation)
- the presence of acids or salt
- enzymic action.

Denaturation occurs when the bonds holding the helix shape are broken and the strands of the helix separate and unravel. Whether this change is visible in food depends on the protein type. Globular proteins denature very easily and denaturation is easier to see. Add some lemon juice to a glass of milk and observe the change in the texture of the milk. The foam created when beating eggwhites is also a visible sign of denaturation. Acidophilus (acid-producing) bacteria are present in yoghurt for more than just their nutritional benefits; they denature milk protein to make it more digestible.

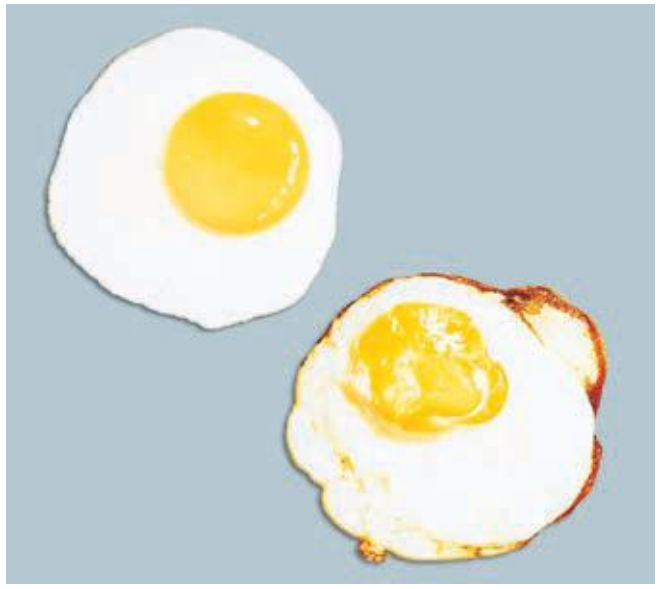
The denaturation of fibrous proteins, however, is less visible. The structure of the protein is stronger and therefore less affected by factors that easily alter the structure of globular proteins. Given time, however, fibrous proteins denature and the process is identifiable. For example, tough cuts of meat are often marinaded overnight in acid ingredients to make them more tender. The acids denature the collagen, reducing its strength and reducing the amount of pressure needed to break it apart, thereby giving the meat a more tender mouth feel.

Coagulation is a more visible process than denaturation; it occurs when denatured proteins separate from other nutrients and solidify. When denaturation continues to the point that the unravelled protein strands begin to rejoin with other strands, a solid mass is formed. These coagulated protein strands can bind liquids to form soft, elastic solids **(gels)**; for example, mixtures containing gelatin thicken when they cool. However, if proteins overcoagulate, they shrink and toughen, forcing liquid out from within the proteins.

Factors contributing to denaturation and coagulation

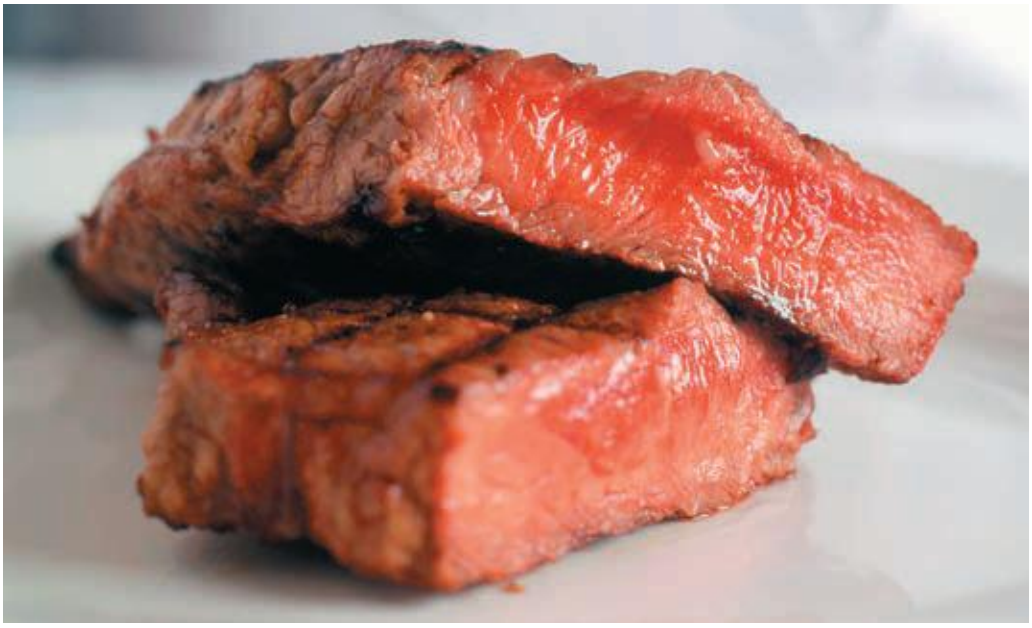
Temperature

Heat causes proteins to denature or unravel. The higher the temperature is, the more quickly proteins denature and then coagulate or clot. Even the temperatures during preparation can affect the functional properties of proteins. For example, beating eggwhites that are at room temperature gives a different volume of foam than eggs taken straight from the fridge. Which do you think would give you more foam?



The difference between an enjoyable breakfast and a disappointing one! Time and temperature control are important to maintain the quality of proteins. When an egg cooks, the clear eggwhite (which is mainly protein) starts to coagulate at 60 °C and the yolk is firm when the temperature reaches 68 °C. If you continue to cook the egg, the protein shrinks.

Cooking meat also illustrates the effect of temperature on proteins. Whenever you order steak at a restaurant and are asked how you would like it cooked, you are actually advising the chef whether you would like all the proteins in the steak coagulated (a 'well done' steak) or partially denatured and coagulated (such as 'medium rare'). As the internal temperature of the meat increases during cooking, so does the degree of coagulation.



How would you order your steak at a restaurant? Would you order it slightly or fully coagulated? What is it about the texture of the meat that makes you prefer it cooked that way?

EXPERIMENT

Does low temperature affect the functional properties of proteins?

Syllabus outcome

Students learn to:

- investigate through experimentation the factors that affect the functional properties of foods.

Contributes to the following outcome:

- apply an understanding of the sensory characteristics and functional properties of food to the preparation of food products.

Aim

This activity seeks to show the impact of low temperature on the functional properties of proteins. When beaten, eggwhites can denature and form a foam. Eggwhites that are cool when beaten produce a different quantity of foam from eggwhites beaten when at room temperature.

Equipment

For this experiment, some groups will use refrigerated eggs while other groups will use eggs at room temperature. All other ingredients must be refrigerated. The following equipment should be chilled in the freezer for at least 15 minutes before use:

- 2 medium bowls, metal if possible
- 1 or 2 sets of beaters from electric mixers
- metal spoon or rubber spatula
- shallow metal trays (2 bar tins or 1 lamington tin)
- aluminium foil

Groups using eggs at room temperature need to chill only one of the two bowls.

Method

All factors relating to the production of the ice-cream should be the same, including the same size and shape of equipment. The quality of the ice-cream depends on the speed of preparation; groups must be organised and work quickly so that their ingredients remain cold.

Making ice-cream

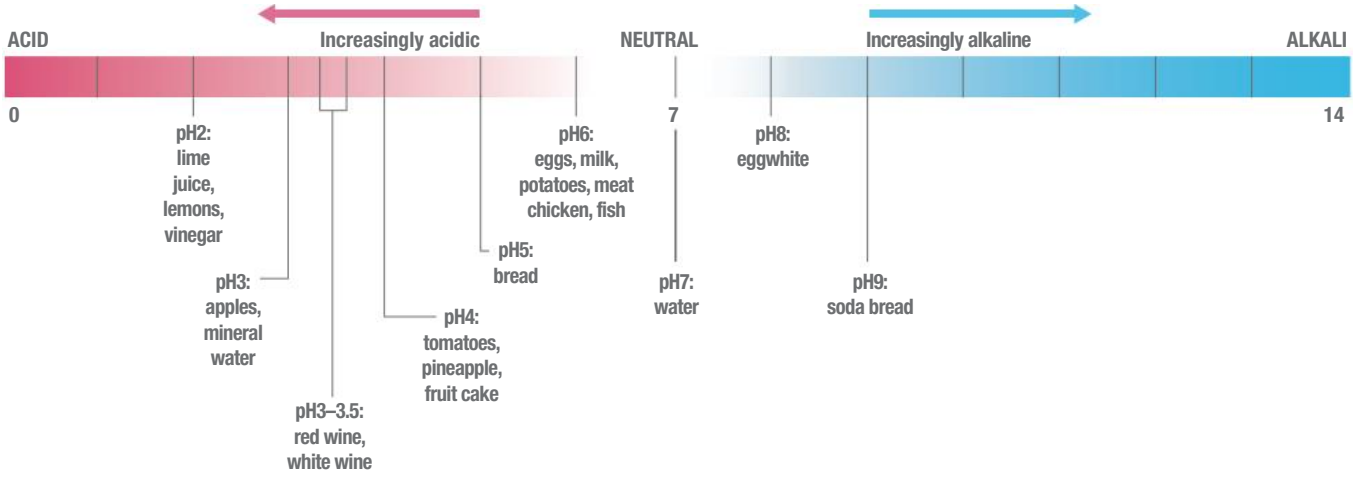
1. Separate the egg yolks from the eggwhites. Put the eggwhites into another bowl.
2. Whip the cream until stiff peaks form. Add the egg yolks and vanilla, beating slowly until lightly combined.
3. Fold flavourings into cream using spatula or metal spoon. Refrigerate while beating eggwhites.
4. Beat eggwhites to soft peaks. Gradually add sugar while beating, and continue until stiff peaks form.
5. Fold eggwhites into cream mixture.
6. Remove metal trays from the freezer, fill and cover with foil.
7. Put ice-cream in the coldest part of the freezer and allow to freeze overnight.

Ice-cream recipe

2 large eggs or 3 small eggs
300 mL fresh cream
3 teaspoons vanilla
⅓ cup of one or more flavourings: finely chopped or grated chocolate, chopped cherries, mango purée, frozen berries, syrup or topping, pecans, sultanas (hydrated in fruit juice)
½ cup caster sugar

Results and conclusions

1. Before making the ice-cream, predict which of the ice-creams will have the greater volume. Give a reason for your prediction.
2. Compare the volumes of the ice-cream before being put in the freezer. Were your predictions correct? If not, what reasons can you suggest for the different volumes?
3. Compare the volumes of the ice-cream after freezing. Suggest reasons why the volume may have decreased during freezing.



The pH scale of common foods and liquids

Acidity

When the pH is less than 7 (indicating acidity), proteins will denature. **pH** refers to the acidity or alkalinity of a substance and is measured on a scale of 1–14. A substance with a pH of 7 is considered to be neutral — neither acid nor alkaline.

Acids cause proteins to denature by attacking and breaking the salt bridges between amino acid strands. We use this to our advantage when we marinade meats in acidic marinades or create a range of thickened dairy products. Sour cream and yoghurt are both made by adding lactic acid-producing **bacteria**, in a **bacterial culture**, to pasteurised milk. During processing, the bacteria produce lactic acid, which causes the protein caseinogen in milk to coagulate and the product to develop a slightly sour taste. It should be noted, however, that food manufacturers are simply recreating a natural process in a controlled environment. Milk has always contained these bacteria; they are responsible for the souring of milk and the accompanying physical changes. The curdling of soured milk is simply coagulation and the odour is a by-product of the bacteria present. The souring of milk occurs more quickly at temperatures above 5 °C as bacteria are more active in warm environments.

Acids have a sour taste and a pH reading below 7. Common acids found naturally in foods include citric acid (from citrus fruits such as lemon and limes) and acetic acid (found in vinegar). All of these acids are considered weak acids because their pH is above 2.0. Lemons and limes have a pH of 2.0–2.2. (See table 5.1 for common acids in foods.)

Alkalis have a bitter taste, feel slippery in the mouth and have a pH above 7. Alkalis also denature proteins, but they are not commonly found in food, except for sodium bicarbonate (baking soda).

Agitation

Agitation causes proteins to denature. Agitation in food handling is usually in the form of kneading, mixing, whipping or beating. Such mechanical action during food handling causes the protein strands to stretch. This is clearly desirable when making ice-cream, bread and most cakes.

TABLE 5.1 Some common acids found in foods

ACID	FOOD SOURCES
Citric acid	Citrus fruits (oranges, grapefruits, lemons, limes), cranberries, raspberries
Malic acid	Apples, peaches, grapes, rhubarb, cherries, apricots, strawberries
Oxalic acid	Rhubarb, ripe pineapples
Acetic acid	Vinegar
Tartaric acid	Grapes, baking powders
Benzoic acid	Cranberries

Acids are essential ingredients in many foods and they contribute to the specific characteristics of the food. Acids may also be added by manufacturers to give specific characteristics. An additive number code listed on a label does not mean the additive is artificial; it may just mean that it does not occur naturally in the food in the quantities needed to provide the desired characteristics. Brainstorm some reasons why manufacturers may add acids to foods.

However, too much mixing or beating stretches the strands until they break and denatures the protein. Overbeating eggwhites causes them to clot, which is not acceptable for products requiring a smooth, fluffy texture such as a pavlova.

Enzymes

Enzymes are chemical substances that act as catalysts in chemical reactions. **Catalysts** assist chemical changes without actually becoming involved in the reaction.

Human digestion would not be possible without enzymes. Enzymes make it possible for the body to break down large molecules, such as protein molecules, into smaller units so they can be absorbed and used by the cells. The protein-splitting enzymes that assist with the digestion of protein break the strands of amino acids apart. The destruction of the peptide bonds then breaks each strand into its individual amino acids.

It is also possible to use enzymes when preparing food. Enzymes can be used to tenderise meat. Enzymes found naturally in the meat can denature the tough protein elastin, but this **ageing process** takes a number of days. Soaking meat in a marinade containing one or more protein-splitting enzymes can speed up denaturation. A marinade containing pineapple juice, for example, contains the enzyme bromelin. The bromelin denatures the protein myosin on the outside of the meat muscle, as well as the elastin and collagen in connective tissue surrounding the muscle. If a fork is used to pierce the meat, the enzyme can act on inner layers as well. Denaturation speeds up when heat is added, so marinades work better at room temperature than in the refrigerator. Two other common tenderisers are papain (made from unripe pawpaw) and ficin (from figs).

The enzyme rennin is sometimes used to coagulate milk in cheesemaking. Rennin, which occurs naturally in the stomachs of calves and human infants, is commercially available in the form of a powder called rennet. The function of rennin in the body is to clot milk for digestion into a soft solid coagulated mass, called a curd. In cheesemaking, the clotted mass is cut with fine wires to break the curd, releasing a liquid called whey. The curd is then processed further with heat, agitation, salt and other ingredients to produce a variety of cheeses. The whey is heated again to coagulate any remaining proteins, producing ricotta cheese.

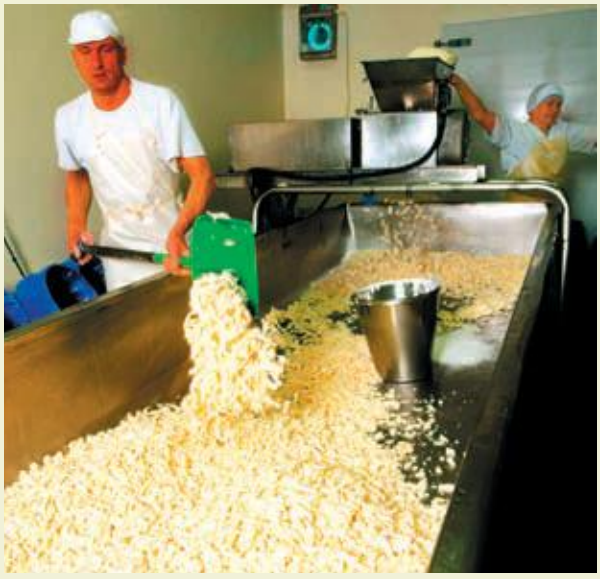
Have you ever thought of making your own cottage cheese or yoghurt? These foods have been made traditionally by hand for centuries. Why not give it a go? You can buy junket powder and yoghurt starter kits from the supermarket. Research some recipe ideas in cookbooks or on the internet.

Salt

Sodium chloride or salt can denature and coagulate proteins. Have you ever wondered why recipes for boiled eggs state they should be cooked in salted water? If the eggshell cracks during cooking, the salt in the water helps minimise the loss of white from the shell by increasing its rate of coagulation and sealing the hole with solid eggwhite. Salt is added when making cheese to increase the firmness of the curd; it does this by increasing coagulation of the curd and forcing water out from within the proteins. Salt also helps protect the cheese from the growth of micro-organisms.

CASE STUDY

Making cheddar cheese



1. Raw milk entering the factory is tested for quality, including microbial levels, chemical residues (medications given to cows) and cream content.
2. The milk is pasteurised (heat treated) to destroy harmful bacteria before being cooled and poured into large containers called vats, each holding around 20 000 litres.
3. Lactic-acid-producing bacteria and rennet are added to the milk to coagulate the proteins. The bacteria also contribute to the flavour of the cheese, while the rennet is responsible for setting the milk as junket (thickened protein curd holding liquid whey). The mixture is warmed slightly and agitated so that coagulation occurs quickly.
4. The curd is cut using wires to release the whey. The mixture is then agitated gently and heated to 37 °C for around 2 hours to allow the curd to shrink and become denser as more whey is forced out from the proteins.
5. The whey is drained from the curd and the small particles of curd are fused with pressure and warmth into blocks. The blocks are turned every 10 minutes for an hour to ensure removal of the whey and the development of an even consistency within the cheese. During this process (called cheddaring), the lactic acid level within the cheese increases, providing cheese with its characteristic flavour.

6. The cheese curd is then milled, salted and mellowed. During milling, the cheese is cut into small lengths resembling French fries. This ensures that the salt added in the salting process has access to all parts of the curd. Once salted, the cheese curd is rested, or mellowed, for about 20 minutes to allow the salt to penetrate the curd.
7. The cheese curd is then formed into large blocks weighing about 20 kilograms. This is done by placing the curd into a block-forming tower where it is compressed, using its own weight and a vacuum. At the bottom of the tower, the blocks are vacuum-sealed in plastic, weighed and labelled, and then boxed for storage.
8. The cheese is cooled and stored at 8 °C for specific lengths of time, depending on the type of cheese. This process is called maturing. Mild cheeses are matured for 3 months, tasty cheeses for up to 9 months, and vintage cheeses for 15 to 24 months.

OUTCOME TASK

Students learn to:
- explain some of the functional properties of food
- identify the factors that affect the functional properties of food.

Contributes to the following outcome:
- identifies and explains the sensory characteristics and functional properties of food.

Carefully consider the case study above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *the factors affecting the functional properties of food* to complete the tasks ahead.

1. In the first stage of processing, the milk is heated (pasteurised) to destroy bacteria. Suggest why this might be done when the process of cheesemaking then requires bacteria to be added to the milk.
2. Explain the effects that lactic-acid-producing bacteria and rennet have on the milk. How would adding both to the milk affect the consistency of the cheese curd?
3. Why would agitation of the milk be important during the heating process?
4. From your knowledge of bacteria and enzymes, explain why the milk is heated to 37 °C and not 65 °C.
5. When the curd reaches the mellowing stage, it is still soft and moist. Describe how the salt affects the consistency of the curd during mellowing, giving factual reasons to support your answer.

The influence of sugar on protein structure

If sugar is near protein when heat is added, the protein can tolerate higher temperatures before denaturing and coagulating; in other words, sugar protects the protein structure. In custard, for example, the presence of sugar means that more heat is needed to coagulate the protein in the milk and eggs to thicken the custard. A runny custard means that not all the protein has coagulated. For the same reason, a custard gel with a high sugar content may not be very stable and may weep.

Another example of sugar protecting the protein structure is the honey glaze on baked ham, which prevents the outer layer from becoming tough.

Formation of protein gels

Gelation is the process of gel formation. You may recall that gels have been described as elastic solids. Gelation can occur when protein or carbohydrate reacts in certain conditions. We will discuss the gelation of proteins here; the gelation of carbohydrates will be discussed later in this chapter.

Gelation of proteins occurs when tiny droplets of liquid are trapped within coagulated proteins, forming soft, elastic products such as custard, junket and cheese. The presence of heat, acids or enzymes are necessary for the formation of these gels. Once coagulation has occurred, gelation occurs more quickly if both the pH and temperature of the mixture are low.

It's easy to make jelly! Empty contents of packet into a 500 mL jug and add 1 cup boiling water. Stir and dissolve well. Add 200 mL cold water and stir. Pour into bowl. Refrigerate until firm (minimum 4 hours). Makes 500 mL of jelly. Do not add fresh pineapple, kiwifruit or pawpaw or jelly will not set.

The ingredients found in jelly of this type could include sugar, gelatin, food acids (297, 331), flavour and colours (in this packet it is 122, 133). Can you explain why each of these ingredients would have been added? Can you explain the reasons for each step of the recipe? If you're unsure, revise the concepts on the previous pages.

When most people think of food gels they think of jelly. Do you realise that the gelatin used to create jelly is actually a protein? Gelatin is a globular protein that denatures and unravels in the presence of moisture and heat. As the temperature drops, the strands of gelatin trap the surrounding liquids, forming a gel. If the pH of the gel is around 2.8, the gel sets at room temperature.

Summary

In summary, the causes of protein denaturation and coagulation are:

- the application of heat — for example, the toughening of meat as it cooks
- an acidic pH — for example, when lactic acid is added to milk in cheesemaking
- agitation — for example, whipped eggwhites
- enzymes — for example, marinaded meat
- salt — for example, when poaching eggs.

The texture of a coagulated protein product is influenced by:

- the speed of coagulation. For example, cooking meat too quickly causes the proteins to overcoagulate and become dry and tough.
- the presence of sugar. Sugar supports and stabilises protein gels in small quantities.
- the presence of fat. Fat surrounds proteins such as gluten and ovomucin and limits their interaction with other proteins.

REVIEW QUESTIONS

Remember

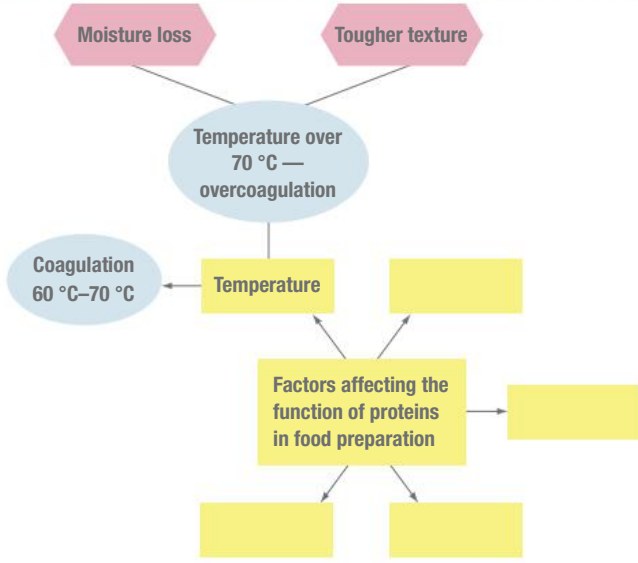
1. Outline the two different structures of proteins and give at least two food sources of each.
2. Identify the five factors that affect the physical qualities and functional properties of protein foods.

Apply

3. Describe how the coagulation of proteins differs from denaturation.
4. Identify both the functional properties used in the preparation of the following foods and the factors that affect them. (*Note:* More than one functional property or factor may contribute to the characteristics of the product.)
   a) Pavlova and meringue
   b) Fetta cheese
   c) Marinated meat
   d) Grilled meat
   e) Baked custard

Do an activity

5. Using the following diagram as a starting point, create a concept map identifying the different factors that affect the functional properties of proteins, include examples of how each property is affected. Compare your concept map with your classmates, and then work together to create a concept map poster for display in the classroom.



6. Log in to **www.jacplus.com.au** and locate the *Make your own cottage cheese* weblink for this chapter. Make some of your own cheese and apply your understanding of the functional properties of proteins as you do.

eBookplus
Weblink

Functional properties of specific proteins

We have just examined the two properties that all proteins possess — the ability to denature and coagulate. Now we will examine specific proteins to identify the additional function(s) that each can carry out during food preparation and processing.

Aeration of eggwhites

The process of adding air to a substance is called **aeration**. When eggwhites are beaten to make meringues, soufflés and certain cakes, air is mixed into the protein of the eggwhite, creating a foam.

The protein ovomucin in eggwhite separates from the rest of the eggwhite when it is beaten. As it denatures, it coils and traps air, creating large bubbles. Continued beating causes the bubbles to become smaller and the foam becomes whiter and finer in texture. The film of liquid protein around the bubbles becomes thinner, while the proteins within the film become more solid. Eventually, the foam holds its shape when the beaters are removed, forming stiff white peaks. How the foam is handled now determines the quality of the food item produced:

- If the foam is beaten for too long, the denatured protein coagulates, the surface shrinks, and liquid weeps from the clumps of protein.
- The foam must be used immediately. For example, it could be spread on a baking sheet or piped onto a pie, and put into the oven. The foam is fragile and, after a few minutes,

the stretched protein loses elasticity, the air bubbles collapse under the weight of the foam, and liquid collects at the base of the mixture.

- If the foam is heated, the trapped air rises, and the protein stretches to give structure to the food. The protein coagulates between 60 and 65 °C and the food takes on its permanent shape.

The aeration of eggwhites is affected by the following factors, which change the functional properties of nutrients.

1. *Temperature*. Eggwhites aerate more rapidly and produce foams of a higher volume at room temperature. Refrigerated eggwhites are less elastic and produce smaller and fewer air bubbles, resulting in a smaller volume of foam.
2. *Acids*. Small amounts of acid, such as lemon juice and cream of tartar, may slow the formation of foam but increase its stability, giving slightly more time to handle the foam before cooking.
3. *Agitation*. The greater the rate of agitation, the greater the volume of foam produced. Also, if finer blades, like those of a wire whisk, are used, the volume of foam is greater and the texture of the foam finer.
4. Addition of other ingredients:
   - Fat (even small amounts of yolk in a bowl or on beaters) prevents eggwhites forming a foam. For this reason, ensure that the bowl and beaters are clean and free from grease.
   - Water (up to 40 per cent of the volume) increases the volume of beaten eggwhites but makes them less stable.
   - Sugar added towards the end of beating makes the foam shinier, finer in texture, more stable and, therefore, less likely to weep.

Globular proteins visibly denature and partially coagulate when aerated to a foam. Specific conditions are required for foams to occur. Complete the following experiment to examine which conditions assist in producing a stable eggwhite foam, and which conditions reduce this functional property.

EXPERIMENT

The effect of various additives on eggwhite foams

Syllabus outcome

Students learn to:

- investigate through experimentation the factors that affect the functional properties of foods.

Aim

To determine the effects of salt, cream of tartar, oil, lemon juice and water on the volume, beating time and colour of beaten eggwhites

Equipment

5 eggwhites
5 small bowls of same size
electric mixer
¼ teaspoon salt
¼ teaspoon cream of tartar
¼ teaspoon lemon juice
¼ teaspoon oil
2 teaspoons water

Method

Divide the class into five groups. Each group observes the effects of one of the additives on eggwhite.

Group 1 — ¼ teaspoon salt
Group 2 — ¼ teaspoon cream of tartar
Group 3 — ¼ teaspoon lemon juice
Group 4 — ¼ teaspoon oil
Group 5 — 2 teaspoons water

1. Put one eggwhite in a small bowl. Record the time.
2. Beat on medium speed until foamy. Record the time.
3. Place the additive in the foam. Record the time.
4. Start beating again and beat until stiff peaks form.
5. Compare the appearance, volume and texture of each whipped eggwhite. Record your observations in a table like the one at the top of page 91.

Conclusions

Which additives:

a) increased the time needed to beat the eggwhites to the stiff-peak stage
b) increased the overall volume
c) altered the colour of the eggwhite?

Results

ADDITIVE	TIME						
	START	SOFT PEAKS	STIFF PEAKS	COLOUR	LUSTRE	VOLUME	SMOOTHNESS OF SURFACE
Salt							
Cream of tartar							
Lemon juice							
Oil							
Water							

Gluten

Gluten is a type of protein found in wheat, and it gives flour products their structure. Gluten is actually made from the two proteins glutenin and gliadin. When moistened and mixed with a small amount of fat, glutenin and gliadin stretch to form gluten strands; these gluten strands stretch and become elastic.

When making bread, for example, your kneading motion gently stretches and folds the protein, fat and water mass. This causes the protein molecules glutenin and gliadin to slide past one another. Physical and chemical cross-linking of the amino acid strands takes place. The two proteins join with the fat to form gluten strands.

In the oven, the air trapped inside the gluten strands rises, while the water turns to steam and also rises. The elastic dough stretches and the bread expands upwards in the tin. This upward motion continues until the outside layer of the dough reaches the temperature at which protein denatures, coagulates and hardens, and a crust forms.

If a flour product is removed from the oven before all the gluten solidifies, the product will collapse. This explains why cakes sink in the middle if they are taken out of the oven before they are cooked. The middle of the cake is the last part to cook, so this is where to test whether the cooking process is complete.

The actual amount of gluten protein in a product depends on the class of wheat used. The five classes of wheat are shown in table 5.2.

TABLE 5.2 Protein content of various types of wheat

TYPE OF WHEAT	AMOUNT OF PROTEIN	USES
Prime hard	Highest protein content (13–15%)	Bread, Chinese noodles
Hard	Slightly lower protein content	Pita bread and flat breads such as Lebanese bread
Australian durum	High protein content	Pasta products
Australian standard white (the most commonly grown wheat)	Average protein content	Bread, cakes, confectionery
Soft (produces a fine crumb)	Lowest protein content (10%)	Cakes, pastries, biscuits

The actual protein content of flour is only one of the factors affecting the development of gluten in a flour product. Agitation and the presence of other ingredients also affect the functional properties of this protein.

- Agitation encourages the development of gluten strands. The more a flour mixture is kneaded or stirred, the stronger and less elastic the gluten strands become.
- Presence of fats such as butter can prevent water coming in contact with the flour, thus preventing the glutenin and gliadin from joining to form gluten and developing into elastic strands. When a recipe requires that butter be 'rubbed in' to flour, the process coats the flour particles to 'shorten' the gluten strands created during preparation, making the finished product more crumbly. If large amounts of fat are used, such as in puff pastry, the gluten strands will be so short that the product will 'melt in the mouth'. The fat forms an impervious layer between the layers of gluten and the air trapped during pastry making lifts the layers when it heats and rises.
- Sugar in baked products, such as cakes and brownies, gives them a softer, more crumbly texture. Sugar is highly absorbent and competes with the flour for water, thereby limiting the amount available for the formation of gluten.

Gluten strands give baked products their structure. Gluten is strong and elastic, stretching as the air and steam inside a mixture expand during baking. When gluten reaches 60 °C, it begins to denature and then coagulate, setting its structure and maintaining the new shape of the baked food.

Protein browning

Foods containing protein turn brown during cooking for three reasons — oxidation, application of heat and the Maillard reaction (explained on page 92).

Oxidative browning of red meat

Myoglobin and haemoglobin are the proteins that give red meat its bright red colour. Myoglobin also causes colour

changes in meat. When myoglobin is exposed to the air (for example, when meat is left uncovered in the refrigerator or cold room), oxygen changes the iron present in myoglobin, and a new substance called oxymyoglobin is formed. The meat remains red for a short time, but the oxymyoglobin on the surface of the meat gradually turns into metmyoglobin, which is brown in colour.

myoglobin (bright red) ⟶ oxymyoglobin (red) ⟶ metmyoglobin (brown)

Despite the brown outer surface, the inside would still be red.

High temperatures, freezing temperatures, ultraviolet light, certain metals and the presence of bacteria speed up this oxidative browning. Many people in Australia will not buy red meat that has turned even slightly brown because the meat has a stronger flavour when cooked. Supermarkets in Australia reduce the price of slightly brown meat, while people in other countries are prepared to pay more for it.

To reduce oxidative browning, carefully wrap meat or remove oxygen from the package.

Non-enzymic browning of red meat

During non-enzymic browning, heat must be applied. (Oxygen is not involved as part of the reaction.) When the blood protein myoglobin in meat is heated, it denatures, changing the colour from pink to brown to grey. Because the outside of the meat experiences the heat first, the colour change happens from the outside to the inside. Thus meat can be quite brown on the outside (even black if the heat is high enough, as can happen on a barbecue) and pink on the inside. The colour change is complete when the internal temperature of the meat is 82 °C. At this temperature, all pinkness in the meat is gone, and the meat is described as being 'well done'.

Maillard reaction

The **Maillard reaction** takes place when dry heat is applied to a food that contains both a protein and a sugar. The formation of a dark yellow to brown crust on cooked food — such as roast meat, cakes, bread, custard, fried chips and ready-to-eat cereals — is a result of the Maillard reaction, and it is part of the overall appeal of these foods.

The type of heat is important. Dry-heat cooking methods include baking, roasting, barbecuing, grilling and frying. Moist-heat methods of cooking (such as steaming, boiling and casseroling) and microwave cooking do not produce the Maillard reaction.

The Maillard reaction also occurs when it is unwanted. The process of drying milk or eggs, for example, can produce the reaction; the product becomes slightly brown in colour and has an 'off' taste. If stored food containing both protein and sugar is allowed to heat above normal room temperature, the Maillard reaction can again cause undesirable colour changes. The higher the storage temperature is, the greater the reaction will be.

REVIEW QUESTIONS

Remember

1. Define 'denaturation' and 'coagulation'.
2. **a)** State whether the proteins in eggwhites are globular or fibrous.
   b) What is gluten? Is it a globular or fibrous protein?
3. Why does meat brown when it is cooked?

Apply

4. Aeration is a specific functional property of eggwhites. What factors affect the ability of the eggwhite proteins to form and hold a foam?
5. Apply your knowledge of the functional properties of gluten to explain the following scenarios.
   a) Scone dough is kneaded for 3 minutes when the recipe said to knead it lightly. The resulting scones are dense and flat.
   b) A cake is placed in the oven at too high a temperature. When removed from the oven, its surface is cracked.
   c) When a cake is taken out of the oven, it sinks in the middle.
6. Complete the following table as a summary of the specific reactions proteins undergo during the preparation, storage or presentation of food items.

FUNCTIONAL PROPERTY OF PROTEIN	OCCURS WHEN...	EFFECT ON FOOD (FUNCTION)
Denaturation		Irreversible; may be visible (eggwhites) or invisible (marinaded meats)
Coagulation		
Aeration		
Gelation	Globular proteins unravel and bind liquids, forming soft semi-solids.	
Gluten formation		
Maillard reaction	Proteins are exposed to dry heat in the presence of carbohydrates.	Browning and crisping, with slight caramelisation, also providing flavour change
Myoglobin browning		
Oxidative browning		Dull brown colour, stronger flavour

Do an activity

7. Cappuccinos are popular beverages that rely on the functional properties of protein to create the product. In groups, discuss whether the creation of the foam is a demonstration of denaturation or coagulation? Using the specific terminology relating to this topic, outline the reasons for your opinion.

Carbohydrates

Now that we have learned about proteins, let's look at the functional properties of another of the main nutrients in foods: **carbohydrates**. You will remember that there are three types of carbohydrate found in foods: polysaccharides, disaccharides and monosaccharides. Polysaccharides include starches, pectin and dietary fibre, while mono- and disaccharides are sugars. You would recognise that foods containing a lot of sugar taste different from those made up mainly of starch — but taste is not the only difference the carbohydrates provide in the food. Polysaccharides undergo different reactions from sugars during preparation and cooking. It is therefore necessary to discuss the functional properties of polysaccharides (starch and pectin) separately from those of sugars (mono- and disaccharides).

Functional properties of starch

Starch is a common polysaccharide found in grains such as rice and wheat and the products made from them, and in vegetables such as potatoes and cassava (tapioca). The size of the starch granules found in these foods can vary, as can their specific components. Starch molecules are made up of two substances: amylose and amylopectin. The ratio of amylose to amylopectin varies and this creates different qualities in starches from different sources. Most starches contain around 25 per cent amylose, but some selectively bred varieties of corn contain more than 50 per cent. When starches with a higher proportion of amylose are used in food preparation, they produce foods with different qualities from those with higher proportions of amylopectin. For example, starches containing more amylose are used to produce semi-solid, opaque gels, whereas those with more amylopectin produce clearer gels that are more a thick liquid ('viscous') than solid. High-amylose cornstarch and rice starch are used to make edible packaging films, such as those used on some lollies and sweets.

Gelatinisation of starch

Starch can thicken mixtures by absorbing liquid in the presence of heat. This process is called **gelatinisation** and takes place regardless of the type of starch. The physical qualities of the gel produced, however, are determined by the ratio of amylose to amylopectin and the method used to prepare the food.

Plain wheat flour, cornflour and arrowroot are the most common ingredients used to thicken liquids (thickening agents) in a domestic kitchen. Wheat flour contains a high proportion of amylose and produces thick but very cloudy gels. However, plain flour also contains 10 to 15 per cent gluten, so it has less starch per tablespoon than the other thickening agents. Cornflour contains a higher proportion of amylose than arrowroot so it produces a thicker and cloudier sauce than arrowroot. In the hospitality industry, potato starch is often used to give soups a slightly thicker consistency; because it has a higher proportion of amylopectin, it does not form lumps or a gel. Food manufacturers also use a variety of modified starches to produce the specific consistencies they desire in their products.

Factors that affect the gelatinisation of starch

Like proteins, the functional properties of carbohydrates are affected by changes in temperature, pH, agitation and the presence of other ingredients. Let's look at how each of these factors affects the way starch reacts during food preparation and cooking.

Temperature

Gelatinisation requires warm, moist conditions. Starch can not thicken cool liquids as it is not soluble in cold water. In order for starch to absorb liquid, the outside of the starch granule needs to be softened by heating. At 64–72 °C, the outer shell of the starch granule softens, allowing it to gradually swell up with water. When the temperature reaches 86–90 °C, the swollen starch granules burst and the amylose and amylopectin they contain are released, capturing the liquid and causing it to thicken and form a gel. Gelatinised mixtures should be boiled for at least 1 minute to ensure that all the starch has reached the desired temperature; any ungelatinised starch will give the finished product a 'pasty taste'. If all the starch has fully gelatinised, the sauce should look smooth and shiny.

When a gelatinised mixture cools, it forms a more rigid gel. Some cold gels, such as custard made from custard powder, rupture and 'weep' liquid when cut or stirred. Also, gels break when reheated; that is why lumps appear when flour-thickened gravy is reheated.

A **roux** made from wheat flour is often used in the preparation of sauces and gravies. When making a roux, heat equal quantities of melted fat and flour in a pan for 1 to 2 minutes to soften the outer shell of the starch granules. (Such heating of starch in the absence of water produces **dextrins**, as discussed on page 94.) Remove the roux from the heat and allow it to cool slightly before adding cold liquid; stir the mixture constantly while adding the liquid to prevent lumps forming.

Agitation

Agitation is essential for the creation of a smooth, gelatinised sauce. Gelatinisation takes place within a specific temperature range in the presence of liquids; if only some granules of starch are exposed to the liquid at the right temperature, they burst and trap the liquid around them, preventing it from reaching other starch granules. This results in visible lumps of starch throughout the mixture.

To prevent lumps forming in a sauce thickened with starch:

- mix flour with cold water in a cup rather than adding dry flour to a warm mixture, such as when thickening a stew.

Gradually adding dry flour to the cold liquid, rather than adding liquid to the flour, minimises the risk of lumps forming. The cold water–flour mixture should be stirred immediately before adding it to the warm liquid, because starch is insoluble in cold water and settles to the bottom of the cup. This cold starch mixture should be added slowly to the warm liquid while stirring.

- add only cold liquid to a starch mixture. Adding a hot liquid causes some starch molecules to gelatinise on contact with the liquid, forming lumps.
- cool roux mixtures before adding cold liquids so that none of the starch molecules is at a temperature over 86 °C when the liquid is added. The mixture should be stirred while the liquid is added so that all starch molecules have equal access to the liquid.
- stir roux mixtures constantly from the time the liquid is added until the sauce boils. If the mixture is not stirred, the starch molecules closest to the bottom of the pan gelatinise before those at the top, which are not as hot. Stirring the mixture disperses lumps throughout the mixture. Whisking the sauce may help remove the lumps and improve the texture of the sauce.

The impact of other ingredients and pH

The gelatinisation process can be affected by several additives, particularly sugar and acid. Sugar competes with the starch for water, so not as much water is available for the starch to absorb. Also, the sugar raises the temperature at which the starch granules start gelatinising. This makes the mixture more liquid and less likely to remain stable.

- Acids such as those found in vinegar, lemon juice and other fruit juices have an even greater effect on the thickness of the final mixture. In the presence of heat, acids break down the large starch molecules into smaller molecules of dextrin, which have much less thickening power than starch. When preparing a starch-thickened mixture that requires the addition of an acid (a lemon pie filling, for example), add the acid to the starch paste *after* gelatinisation has occurred. In other words, add the lemon juice after the mixture has thickened and boiled.
- Equal quantities of fat and flour in a roux ensures that there is adequate fat to disperse the starch and minimise the risk of lumps forming.
- The addition of sugar to a mixture, such as custard, results in a softer, less stable gel.

Dextrinisation of starch — 'browning reaction'

Dextrinisation is defined as the process in which starch breaks down into dextrins. One of the most common examples occurs when bread is toasted.

The polysaccharide starch can undergo a partial chemical breakdown into shorter glucose chains called dextrins. Dextrins are the halfway point in the complete breakdown of a starch molecule into the monosaccharide glucose.

starch (polysaccharide) → dextrins → maltose (disaccharide) → glucose (monosaccharide)

The chemical structure of dextrins is different from that of starch, giving dextrins several characteristics that are quite different from those of starch.

1. Starch does not dissolve in cold water but dextrins do.
2. Starch has a floury taste, and dextrins are sweet.
3. Starch gelatinises, but dextrins are poor thickening agents.

Dextrinisation can be caused by:

- exposure of the starch granules to dry heat (the most common method)
- the action of acids
- the action of certain enzymes.

The dextrinisation process is the reason for:

- bread turning brown during toasting
- toasted commercial breakfast cereals being brown and having a sweeter taste than raw cereals
- the brown crust forming when bread or pastries are baked
- gravies being brown
- the brown crust forming on baked starchy vegetables such as potatoes and carrots.

Dextrins are used commercially as both a colouring agent and a sweetening agent.

Functional property of pectin

Pectin is a polysaccharide found in the liquid extract of many fleshy fruits. It is used to create fruit gels such as jams and jellies.

Fruits with a high pectin content include lemons, limes, cumquats, apples, blackberries, cranberries, currants, grapes, guavas and sour plums. Fruits with a moderate pectin content include oranges and quinces. The more overripe a fruit is, the less pectin it contains.

When making fruit pectin gels, cut the fresh ripe fruit into small pieces. If the fruit has a moderate or low pectin content, add acid or use a commercially produced pectin concentrate. Simmer the fruit, so the softened fruit releases its pectin. Unlike starch, pectin dissolves easily in water, so no lumps form during the thickening process. Add sugar and boil the mixture rapidly to evaporate some of the water and concentrate the sugar until the setting point is reached.

To determine the point at which the pectin concentration is high enough to form a gel on cooling, two methods are used. By the time the mixture reaches 103–105 °C (when tested with a cooking thermometer), the jam or jelly should be ready. To make sure, scoop a small amount of the mixture onto a cold metal spoon and allow to cool a little. Tilt the spoon slightly and allow the mixture to drip. The jam or jelly is ready when the mixture drips in heavy, separate drops.

Pectin is responsible for the gelled qualities of jam. Acid must be present for pectin to gel. Test the level of gelling by placing a small quantity of jam on a saucer and cooling it slightly. If the surface wrinkles and leaves a path when a finger is dragged through it, the jam is ready for bottling.

If the jelly fails to give a positive test at 105 °C, add a small amount of lemon juice. Care needs to be taken to avoid overcooking, which destroys the pectin and prevents the product from thickening. The gel may also develop an undesirable colour and flavour when overcooked.

REVIEW QUESTIONS

Remember

1. Outline the physical and chemical differences between starches, dextrins and sugars.
2. Describe what pectin is and identify three sources of pectin.

Apply

3. Suggest reasons why cornflour is commonly used as a thickening agent when preparing sauces and stews.
4. **a)** Define the term 'roux' and give examples of its use in food preparation.
   b) Consider the process used to make a roux.
      i. Different types of roux are described by their colours: white, blonde and brown. How is the process of making the roux altered to achieve these different colours?
      ii. Does the colour or type of roux affect other characteristics of the sauce? Explain your answer.

Do an activity

5. Do you think you can thicken stews with pectin or use starch to make jam? In pairs, compare and contrast the gelatinisation of starch and gelation of pectin. Consider the carbohydrates used, the methods of preparation and the characteristics of the end result.

Functional properties of other carbohydrates: sugars

Crystallisation of disaccharides

The three kinds of disaccharides are sucrose, lactose and maltose. By far the most common type of disaccharide used in making foods is sucrose, (common table sugar). Disaccharides are crystalline in structure, sweet to taste, and dissolve easily in water. Monosaccharides (glucose, fructose and galactose) have similar characteristics but take a long time to produce very small crystals.

Crystallisation is a functional property of sugar related to its ability to dissolve and reform crystals. This property is used in the making of confectionery such as toffee, brittle, fudge and caramel. The sugar is dissolved in a liquid and heated, during which time the liquid evaporates, concentrating (supersaturating) the sugar solution. As the solution cools, the sugar re-forms into crystals. If the solution is not stirred and cools quickly, the crystals will be very small and the texture of the product smooth. Movement and slow cooling encourage the development of larger crystals, altering the texture of the product.

Factors affecting the crystallisation of disaccharides

As with proteins and starch, the functional properties of sugar are influenced by temperature, pH, agitation and the presence of other ingredients. These factors each have a specific effect on qualities of foods that rely on sugar crystallisation.

Temperature

The hotter the water is, the greater the amount of sucrose that can dissolve in it. For example, water at 40 °C dissolves 238 grams of sugar, while water at 115 °C dissolves 669 grams. Also, if there is more sucrose in a solution, more crystals can form. When more crystals form, the product is more solid. The product's solidity is also determined by the length of time the solution is exposed to heat. As a solution boils, liquid evaporates, increasing the concentration of sugar (becoming supersaturated) and the temperature of the solution. Extremely high temperatures (above 150 °C) produce brittle crystalline products that also show signs of caramelisation.

TABLE 5.3 The heating of sugar

TEMPERATURE	TERM	FOOD PRODUCT
106–113 °C	Thread	Cake decoration
112–116 °C	Soft ball	Fudge, fondant
118–121 °C	Firm ball	Toffee, soft caramels
121–130 °C	Hard ball	Hard toffees and caramels
132–143 °C	Soft crack	Butterscotch, nougat
149–154 °C	Hard crack	Barley sugar
160–177 °C	Caramel	Nut brittle, praline

Sugar thermometers are used to accurately measure the temperature of sugar solutions and help control the solidity of confectionery products. Consistency can also be measured by dropping small quantities of sugar solution in cold water. The colder the water is, the faster the sugar solidifies (crystallises) and the more accurately the texture of the finished product can be managed. Be extremely careful with molten sugar as the temperatures reached are dangerous. What would you do if some molten sugar came in contact with your skin?

Acidity

Disaccharides are formed when two monosaccharides chemically join to create a new sugar molecule. Monosaccharides can be purchased from the supermarket in the form of liquid glucose and honey, which contains glucose and fructose. They can also be made during the crystallisation process by adding an acid to the liquid, dissolving the sugar. The acid, commonly vinegar or cream of tartar, splits the bond joining the disaccharide, creating separate monosaccharides, referred to as 'invert sugars'. Monosaccharides crystallise less readily than disaccharides and so inhibit the development of large crystals in a solution; this gives the confectionery a smoother texture. If present in large quantities, however, the product remains runny rather than solidifying.

Agitation

Stirring sugar solutions encourages crystals to develop. If a solution is stirred while hot, crystallisation starts too soon, giving the product a grainy texture. It is, therefore, essential that sugar is stirred into a liquid and fully dissolved before the mixture boils. Stirring after boiling point is reached encourages crystals to form.

Some products, such as fudge, require beating to develop their characteristic textures. Waiting until the solution has cooled to at least 40 °C before stirring or beating encourages small crystals to form, giving the product a smooth texture. Beating should continue until crystallisation is complete and the product becomes solid. When fudge is made commercially, the beating is done by machines and the final texture is usually much better than can be achieved with hand beating.

Other products, such as caramel, require beating while heating. Caramel is made by adding other ingredients, such as milk products and butter. The butter helps to minimise the size of the crystals (the reason is discussed later in this section) and the milk product contributes to the flavour of the caramel. Because the combination of ingredients results in a thick mixture, it must be stirred throughout the cooking process to ensure that the mixture heats evenly and does not burn at the base of the pan.

Presence of other ingredients

Additives can have a dramatic effect on the crystallisation process.

- Sugar in crystal form attracts molten sugar, encouraging the development of large crystals and giving the product an unappealing grainy texture that is similar to candied honey.
- Monosaccharides, added as glucose, honey or created by adding acidic ingredients, are often included to ensure a smooth consistency in the final product. As previously discussed, monosaccharides prevent the development of large crystals and, if added in excess, prevent all crystal development, resulting in a liquefied rather than crystalline structure.
- Fat (such as butter or cream) surrounds small sugar crystals as soon as they form, preventing large crystals from forming. This ensures the smooth texture of, for example, butterscotch and caramel.

Sucrose melts at 186 °C. Above that temperature, acids form and the molten sugar turns a light brown, or caramelises. If the heat is not removed, the liquid sugar

EXPERIMENT

Caramelisation of sugar

Syllabus outcome

Students learn to:

- investigate through experimentation the factors that affect the functional properties of foods.

Contributes to outcome:

- applies an understanding of the sensory characteristics and functional properties of food to the preparation of food products.

Aim

To caramelise sugar to produce barley sugar and violet crumble

Equipment

2 cups white sugar
2 small heavy saucepans
2 metal oven trays
measuring spoons
pinch bicarbonate of soda

Method

1. Pour the sugar into the saucepan.
2. Put saucepan on low heat and shake the pan gently so the sugar does not stick to the bottom of the pan. Continue shaking until all the sugar has melted.
3. After the sugar has melted, leave the pan undisturbed on the heat.
4. Continue heating until the molten sugar turns a golden brown.
5. Pour the liquid onto a metal oven tray to cool. Leave undisturbed until completely solidified. Observe what happens as the liquid solidifies. Record your observations in an appropriate form.
6. Repeat steps 1–5, but add a pinch of bicarbonate of soda to the molten sugar just before pouring the liquid onto the metal tray.

Note: Place water into saucepan after sugar is removed and return to heat. (This dissolves the remaining sugar and makes the saucepan easier to clean.)

Conclusions

Which confectionery product has:

a) the greatest volume
b) the darkest colour
c) the lightest texture
d) the most lustrous surface?

becomes darker and darker until it is black. The breakdown of sucrose occurs in this way:

sucrose + heat → glucose + fructose + water →

acids + glucose

This process occurs *without* water. Water may have originally been present (as when making confectionery products) but it evaporates before caramelisation takes place.

Caramelised sugar adds a distinctive flavour to foods. You will often see caramel flavouring listed as an ingredient of commercially produced flavoured milks, cakes, breakfast cereals and ice-creams. 'Burnt sugar' is a variety of frosting that involves caramelising sugar and adding it to butter.

Summary

Table 5.4 summarises the reactions of carbohydrates and the function of each reaction in food preparation, storage and presentation.

TABLE 5.4 Carbohydrate reactions

CARBOHYDRATE	FUNCTIONAL PROPERTY	FUNCTION IN FOOD
Starch	Gelatinisation	Thickening agent
Starch	Gelation	Formation of gels
Starch	Dextrinisation	Browning and sweetening
Pectin	Gelation	Formation of fruit gels
Sucrose	Crystallisation	Making of confectionery
Sucrose	Caramelisation	Browning and flavouring

Lipids

Lipids include all fats and oils. The two important reactions that lipids undergo during preparation are emulsification and aeration.

Functional properties of lipids

Emulsification

Lipids do not naturally mix with water. They can be shaken to form a temporary mixture, as when you make an oil and vinegar salad dressing, but, after a short time, the oil floats to the surface of the vinegar.

An **emulsion** is a stable combination of oil and water. Emulsification is the process that produces an emulsion. To form a permanent emulsion, the following techniques are used.

- The fat globules are reduced in size to a small uniform diameter and evenly distributed throughout the water. This process is called **homogenisation** and is used in the production of regular and low-fat milk. Skim milk has no fat present, so homogenisation is not needed.

Homogenisation is an emulsifying process that distributes lipids evenly throughout a liquid, improving the product's flavour, texture and saleability. Would you buy a food product with a layer of oil sitting on top of it?

REVIEW QUESTIONS

Remember

1. Write a definition for each of the functional properties of carbohydrates in your own words. Include the type of carbohydrate that displays the property, and give two food examples that use the property.
2. Copy and complete the table below in your workbook to compare the effects of different factors on the functional properties of carbohydrates.

Apply

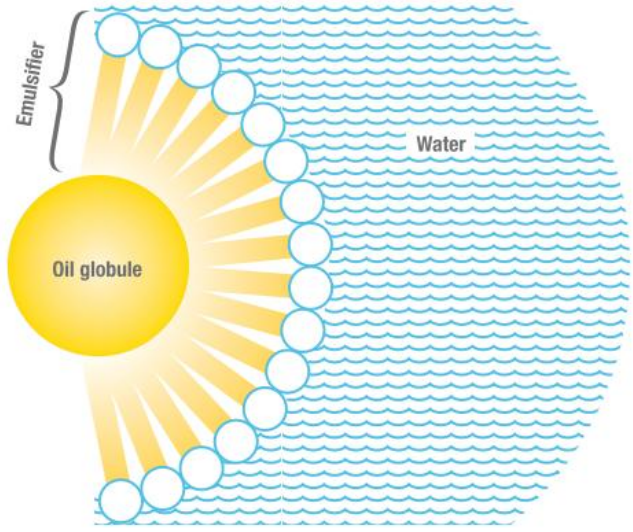
3. Identify the functional properties relating to the browning of carbohydrates. For each property, list the characteristics that these reactions develop in the food.
4. Crystallisation and caramelisation are both used in making confectionery.
   a) Outline the differences between them.
   b) Explain whether it is possible for one to occur without the other.

Do an activity

5. Find a recipe for making caramel.
   a) Identify factors in the recipe that encourage the development of larger sugar crystals.
   b) Identify factors that encourage the development of small sugar crystals.
   c) Explain why a darker colour affects the hardness of the product.
   d) Make the recipe, heating the mixture long enough to produce a firm, chewy caramel.

FACTOR	DEXTRINISATION	GELATINISATION	GELATION	CRYSTALLISATION	CARAMELISATION
Temperature					
pH					
Agitation					
Presence of other ingredients					

- A special ingredient is added to stop the separation of lipid and water. These agents are called emulsifiers or emulsifying agents. An **emulsifier** is a substance that has an attraction for both the lipid and the water, acting as a bridge.



One end of an emulsifier is attracted to oil, while the other is attracted to water. Emulsifiers allow oils to be dispersed within foods, providing foods with the necessary characteristics without appearing oily. Would consumers make healthier food choices if they could see more of the fat present in their foods?

Emulsions, although stable, can be destroyed under certain conditions. High temperatures, freezing, agitation after formation and the addition of salt break down an emulsion. If the emulsifier bridge breaks, the lipid and water separate.

Factors affecting the emulsification of lipids

The functional property of emulsification is affected by:

- *temperature*
  - High temperatures cause lipids to become more fluid and water to move more rapidly, making it harder for the emulsifier to hold them together.
  - Freezing changes the state of both water and oil; crystallisation causes the connections with the emulsifying agent to break. When the product defrosts, the oil and emulsifier float to the top.
- *agitation*
  - When adding oil for emulsification, the mixture must be beaten rapidly so that the oil has access to the emulsifier. The general rule is to beat the mixture while adding oil slowly, and to add no more oil at any time than the amount already in the mixture.
  - Beating or continuous jarring of an emulsified mixture can break the connections between the emulsifier and the oil, destroying the emulsion.
- *addition of salt*
  - The chemical attraction between water and salt is greater than the chemical attraction between water and the emulsifier. Therefore, adding salt to an emulsion causes water in the emulsion to separate and move towards the salt.

Emulsifiers can be found naturally in foods. Examples of natural emulsifying agents are lecithin in egg yolk, and gelatin. Synthetic emulsifiers such as glyceryl monostearate, SPANS and TWEENS can be manufactured in a laboratory.

Parts of an emulsion

An emulsion has three parts: the dispersed phase, the continuous phase and the emulsifier. The make-up of margarine demonstrates these three parts. Margarine contains:

- no more than 20 per cent water, called the dispersed phase because it is the substance present in the smallest quantity, and it is suspended as droplets
- no more than 80 per cent lipid content, called the continuous phase because it is the substance in the largest proportion in the emulsion
- emulsifier(s), which are able to mix with both the lipid and water components.

Types of emulsions

There are basically two kinds of emulsions. One has more lipid than water — 'water in oil' emulsion — and is found in butter and margarine. The other has more water than lipid — 'oil in water' emulsion — and is found in mayonnaise, salad dressings, gravies, cream soups and pie fillings.

Aeration of fats

Aeration occurs when air is added to a mixture, affecting its consistency and texture. The plasticity of saturated fats makes them more effective at aerating mixtures than unsaturated oils. Here are some examples of how fat is used to aerate products:

- creaming butter and sugar together when preparing cake batters — the texture of the mixture becomes light and fluffy, and the colour of the fat changes from a solid yellow to a light cream colour. This occurs because, as the sugar crystals are pressed into the fat, a small quantity of air is included in each indentation.
- 'rubbing in' (discussed on page 91) — this process also introduces air into a mixture
- layering fat between layers of gluten in the making of puff pastry
- whipping cream to form a foam.

Foams

Foams are formed when air is whipped or beaten into a liquid. Whipped cream is an example of a foam in which a film of fat and protein surrounds the air bubbles. The whipping action partly solidifies the fat and partly denatures the protein. After these two changes occur, the liquid becomes a fairly stable solid.

The fat content of cream needs to be 22 to 35 per cent before it can be whipped. Evaporated milk has a higher concentration of protein and fat than that of ordinary milk,

as a result of having 60 per cent of its water removed, and therefore it can be whipped if thoroughly chilled first.

Factors that affect the foaming of cream are:

- *the age of the cream* — Cream whips better if it is 2 to 3 days old.
- *temperature* — At 1–7 °C, the cream has a thicker, less runny consistency and whips more easily.
- *amount of beating* — When overbeaten, the fat globules clump on the surface of the air bubbles and the whipped cream takes on a curdled appearance.
- *addition of gelatin* — Gelatin makes the cream less runny so a thicker foam is produced. Thickened cream bought in shops contains 1 per cent gelatin, as well as alginate or another substance that makes the cream foam more quickly and that prevents overbeating.
- *addition of sugar* — This decreases the volume of the foam but, if added towards the end of beating, decreases the likelihood of the cream curdling and gives the cream a more lustrous appearance. Icing sugar is generally used.

When oxygen reacts with food

Another significant reaction is oxidation. Oxidative reactions affect the quality of the food.

- Some proteins undergo oxidative reactions. For example, the surface of red meat turns brown when exposed to air for a long time (see page 91).
- Lipids undergo 'oxidative rancidity' if exposed to air for a long time, especially in high temperatures. Oxygen reacts at double bonds along the carbon chain of a fatty acid; this means that oils are more likely to go **rancid** than fats. The reaction with oxygen causes the lipid to spoil, creating odours, a bitter taste and a lower smoking point. Oxidative reactions in oils, and products containing them, may be prevented by adding an **antioxidant** (see page 185 for examples). Antioxidants are substances that react readily with oxygen, delaying oxidative reactions with the food.
- Carbohydrates are not affected by oxidative reactions.
- Fruit and vegetables are susceptible to oxidative reactions because, when cut, their enzymes are exposed and react easily with air, causing the surface of the food to brown. Sometimes this reaction is desirable, such as in the making of cider, but more often it is not. Enzymic oxidation can be reduced or prevented by:
  - packaging the food to eliminate as much air as possible
  - coating food with an acid, such as lemon juice, to denature the enzymes
  - coating the food with an antioxidant, such as citrus juices (containing the highly reactive ascorbic acid) and pineapple juice (containing a sulfur compound and sugar solution).

REVIEW QUESTIONS

Remember

1. Define the term 'emulsion' and give three examples of food products that are stable emulsions.
2. Most milk in cartons sold in Australia has been 'homogenised'. What does this term mean and what benefit, if any, does it provide consumers?
3. Explain, using examples, how emulsifying agents work.

Apply

4. Many different types of cream are available to consumers, including fresh cream, thickened cream, light cream, double cream and sour cream.
   a) Explain the difference in characteristics between these products.
   b) Which of these products does not aerate or foam when beaten? Explain why.

Do an activity

5. Earlier in the chapter we discussed how gluten strands are created. Predict what differences would occur in the flour (gluten) if you were to
   a) place some flour in a loosely woven fabric and hold it under cold running water until the water ran clear
   b) rub some butter into the flour before placing it into the fabric, then hold it under cold running water.

   Conduct a comparative experiment to see if your predictions were correct.

CHAPTER 5 SUMMARY

- The functional properties of nutrients determine the physical characteristics of foods.
- The physical characteristics created in the food are influenced by specific factors such as temperature, pH, agitation and the presence of oxygen, enzymes and other ingredients (such as sugar, salt, fat and water).
- Under certain conditions, proteins denature, coagulate, form gels and foams, and become brown in colour (via the Maillard reaction, oxidation and non-enzymic reactions.
- The shape of a protein influences the speed at which it denatures.
- Because of their significant structural differences, different types of carbohydrates have different functional properties in foods. Pectins form gels, starches dextrinise, gelatinise and form gels, while sugars crystallise and caramelise.
- The size and type of a carbohydrate chain determines the textural qualities of the final product.
- Lipids can aerate and be emulsified, thereby significantly affecting the physical (especially textural) qualities of the foods that contain them.
- Plastic fats, such as solid butter and cream, are more effective at providing aeration than oils.
- Enzymes that occur naturally in foods can react with oxygen, causing enzymic browning. This type of browning reaction can be prevented by excluding oxygen, adding substances that react with air and minimise similar reactions in the food, and temperatures above 60 °C, which denature the enzyme so that it cannot function effectively.

KEY TERMS

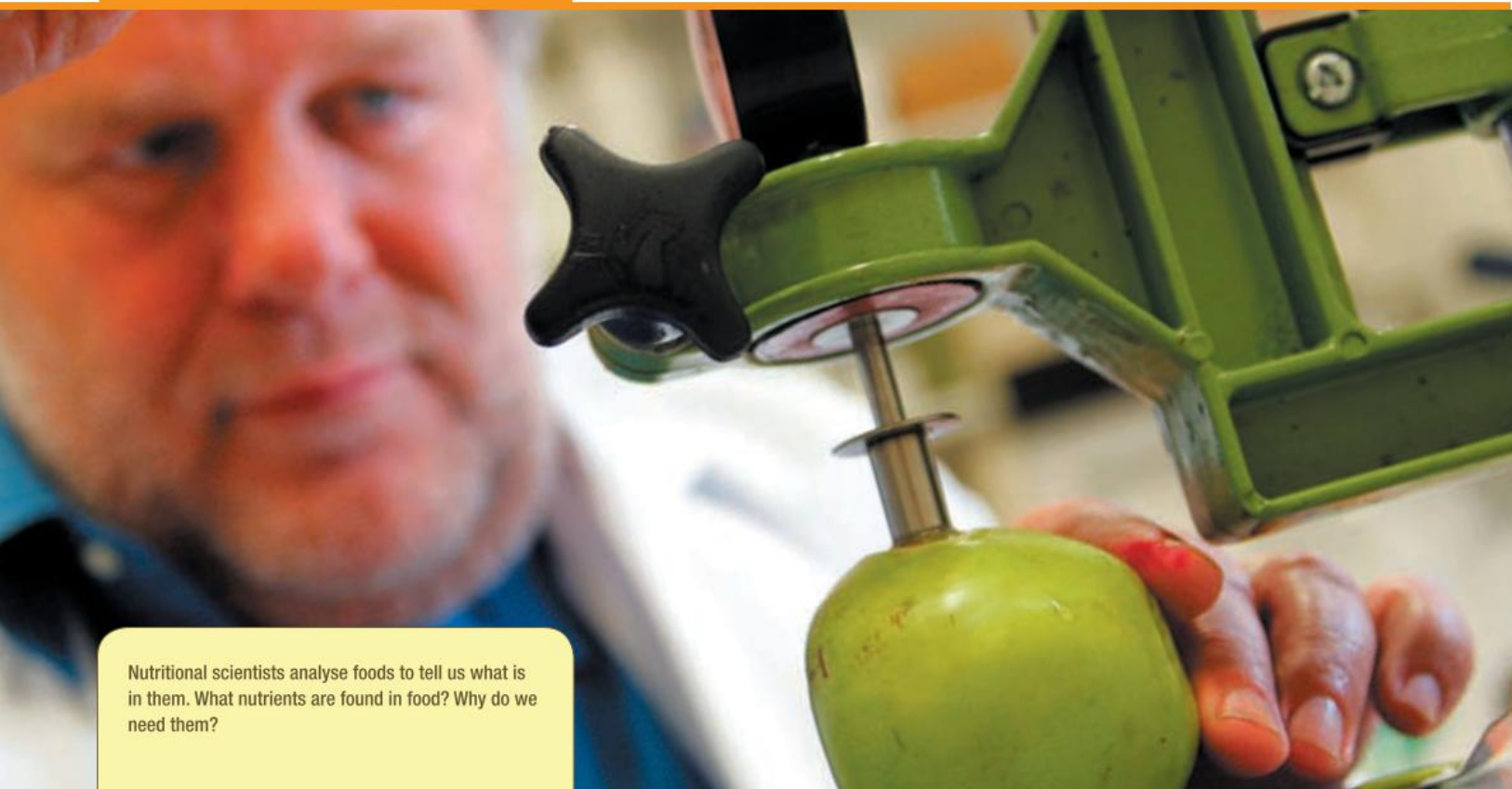
aeration
ageing process
amino acids
antioxidant
bacteria
bacterial culture
carbohydrate
catalyst
coagulation
crystallisation
denaturation
dextrin
dextrinisation
emulsifier
emulsion
enzyme
enzymic browning
foam
gel
gelatinisation
gelation
gluten
helix
homogenisation
lipids
Maillard reaction
pectin
peptide bond
pH
protein
rancid
roux
starch

Chapter 6
Food nutrients

Is it true that 'you are what you eat'? How is your food transformed into the substances that keep your body working normally and feeling well? This chapter will look at the structure, function and common food sources of the nutrients, how they interact with one another, and how they are digested, absorbed and metabolised in your body.

In this chapter you will learn about:

- food nutrients: carbohydrates, proteins, lipids, vitamins, minerals and water
- structure of carbohydrates, proteins and lipids
- sources of carbohydrates, proteins, lipids, vitamins, minerals and water
- functions of carbohydrates, proteins, lipids, vitamins, minerals and water in the body
- significant interrelationships between nutrients, including:
  - iron and vitamin C
  - iron and fibre
  - calcium and phosphorus
  - calcium and vitamin D
  - calcium and fibre
  - calcium and lactose
  - folate and vitamin B_{12}
  - sodium and potassium
- digestion, absorption and metabolism of food.



Nutritional scientists analyse foods to tell us what is in them. What nutrients are found in food? Why do we need them?

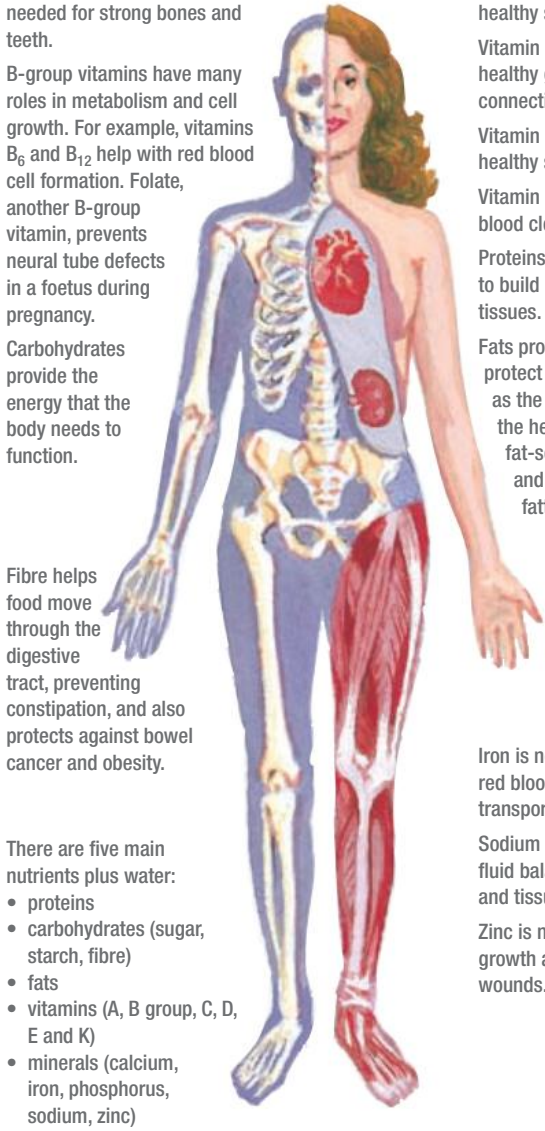
Nutrition

Nutrition is the scientific study of our consumption and use of nutrients.

Your body is a complex machine that needs regular maintenance to keep it working well. At every minute of every day, many different processes are occurring in your body to keep you alive. These include:

- digesting and absorbing food
- breathing
- pumping blood around your body
- filtering blood
- growing and repairing body tissue
- defending your body against infection.

If any of these processes stops working properly, your body can become sick or even die. Nutrients are substances that your body is unable to make for itself and that are needed to keep these processes working. The **macronutrients** are the nutrients that provide energy in the diet, that is, the proteins, lipids and carbohydrates. The **micronutrients** include the vitamins, minerals and trace elements that we require in only very small amounts. We also need water.



Proteins

Your body is made of **protein**. Every cell, in every part of your body, has protein in its cell structure as well as inside the cell. This means that you need protein to keep your cells healthy, to repair them when they are damaged, and for growth. Protein performs lots of other functions too. Here is a list of the ways that protein works in your body:

1. Proteins make up the structure of the body. All your cells have protein in them, even fat cells and bone cells. To do different jobs, protein can form different shapes, such as long chains (in muscle) or flat sheets and networks (in skin, hair and nails).
2. New protein is needed for growth and for repairing body cells when they are old or damaged. Some cells, such as those lining the inside of your gut, live for only a few days before being replaced by new ones, and this requires protein.
3. Inside your body, there are lots of proteins that are used as messengers and workers in the body system. Antibodies are proteins in the immune system that work to fight germs to stop you getting sick. **Enzymes** are proteins that help to make a reaction happen in your body, such as breaking down food in your gut or converting one substance to another. **Hormones** are proteins that carry messages from one part of your body to another, to increase or decrease different body processes.
4. Protein can be used for fuel if other sources of energy are running out; it provides 17 kilojoules of energy per gram. Without enough food, your body's proteins are broken down for energy and this can mean that they are unable to do their other jobs. Starving or malnourished people have less strength (because of muscle breakdown) and are more likely to become sick (because of reduced

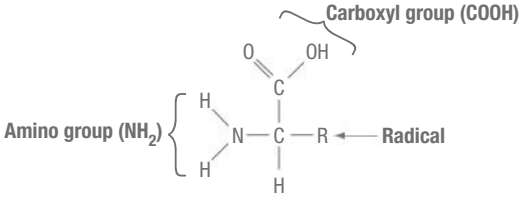
immunity). They may notice problems with skin, hair and nail condition and may find it difficult to digest and absorb food properly. Children have stunted growth if they do not have enough food.

What are proteins?

Proteins are molecules made up of atoms of carbon (C), hydrogen (H), oxygen (O), nitrogen (N) and sulfur (S). Each protein consists mostly of chains of carbon atoms, joined by branches, in groups called **amino acids**. The amino acids are like building blocks that can combine in different ways to build different types of proteins.

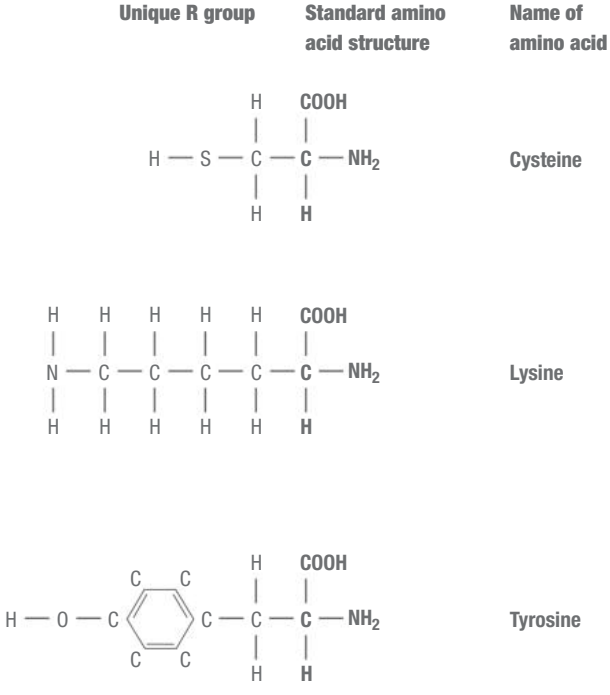
Structure of proteins

There are 22 different amino acids. They all have the same basic structure, which always includes an **amino group** (written as NH_2) and a **carboxyl group** (written as COOH).



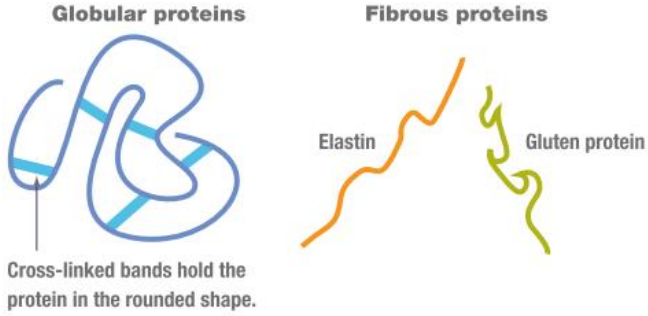
A simple representation of an amino acid

The 'R' stands for 'radical', which is the part of the amino acid that makes it different from other amino acids. Each amino acid has a unique side chain attached in that place. Examples of three different amino acids and their different radicals are shown below.



Three examples of different amino acids

The amino acids can join together in long chains. These chains can form a crumpled three-dimensional shape (called **globular proteins**) or stay in long strands (called **fibrous proteins)** as either stretchy, spring-like, elastic extended proteins or straight, inelastic extended proteins. All three types can be found in food; eggwhite contains globular proteins; the gluten in wheat is an elastic extended protein; gristle in meat is an inelastic extended protein called elastin.



Globular and fibrous proteins

Food sources of protein

Protein foods

Many foods contain protein, but they vary widely in how much protein they have (protein quantity) and how useful it is for your body (protein quality). Whether a food is considered to be an important source of protein depends on the quality of its protein and on how much of the food you would normally eat.

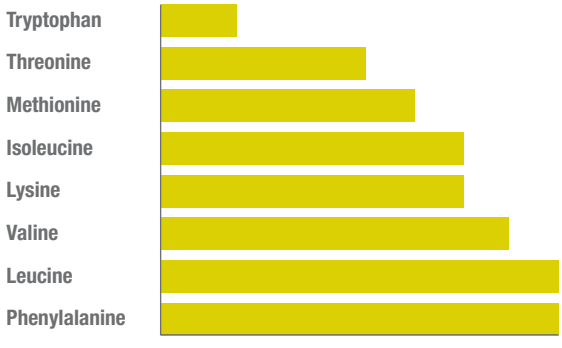
Your body needs some of each amino acid to carry out all the protein functions properly. Some amino acids cannot be synthesised by your body so, if your diet is lacking these **essential amino acids**, a deficiency may develop. Other amino acids can be synthesised by your body and do not need to be supplied by your diet; these are called **non-essential amino acids**. Of the 22 different amino acids, eight are essential for adults and nine are essential for children. The quality of a protein source depends on whether all of the essential amino acids are provided.

TABLE 6.1 Essential and non-essential amino acids

ESSENTIAL AMINO ACIDS	NON-ESSENTIAL AMINO ACIDS
Isoleucine	Alanine
Leucine	Arginine
Lysine	Asparagine
Methionine	Aspartic acid
Phenylalanine	Cysteine
Threonine	Cystine
Tryptophan	Glutamic acid
Valine	Glutamine
Histidine (infancy only)	Glycine
	Hydroxyproline
	Proline
	Serine
	Tyrosine
	Histidine (adulthood only)

Foods are considered to provide 'complete' protein if they contain adequate amounts of all eight essential amino acids. 'Incomplete' protein foods are missing one or more of the essential amino acids.

The flesh foods of animals (including both the muscles and the organs) are sources of **complete protein**. Because the amino acids are present in a ratio that matches human requirements, these foods are described as being of high biological value. The graph below shows the ideal proportions of essential amino acids.

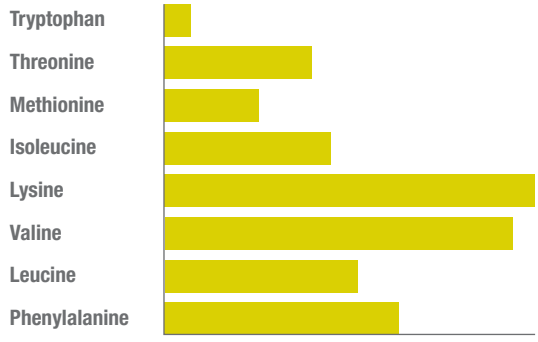


To make new protein, your body needs the essential amino acids in the right proportions.

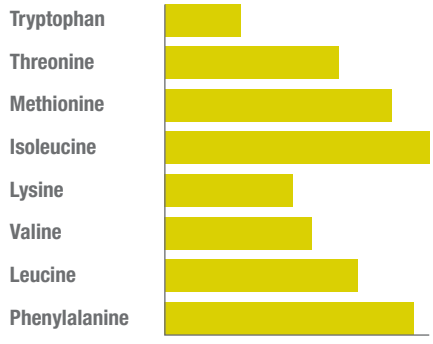
Examples of complete protein foods are beef, veal, lamb, pork, chicken and fish. Eggs, milk and other dairy foods are also valuable sources of complete protein. Soy protein is an example of a complete protein from a plant source.

Incomplete protein foods lack one or more essential amino acids. Many plant foods provide incomplete protein. The term **limiting amino acid** refers to the amino acid that is in shortest supply in an incomplete protein food. For example, wheat, corn and rice are all incomplete protein foods because the amount of lysine is low. Lysine is therefore their limiting amino acid. In many legumes, including peas, kidney beans and chickpeas, the limiting amino acid is methionine. If a diet is low in animal protein and depends on a single plant food for protein, a deficiency may develop. For example, a diet consisting of mostly rice, with little animal protein, may result in a deficiency of lysine, and a reduced capacity for growth and healing due to inadequate protein for the body's essential processes.

Combining two different sources of plant protein allows the amino acids to complement one another, so that the limiting amino acid from one source is provided by the other source. The following graphs show amino acid profiles for two different plant foods, similar to legumes and rice.



Sample amino acid profile for the protein in food A (a legume)



Sample amino acid profile for the protein in food B (a grain)

Compare these with the ideal proportions of essential amino acids shown. Food A is rich in lysine and valine, but it has too little tryptophan, threonine, methionine, isoleucine, leucine and phenylalanine to meet the body's requirements. Food B has moderate levels of all essential amino acids except tryptophan. Clearly neither of these foods supplies enough of all the essential amino acids, but when they are eaten together

they act as **complementary proteins** and make a valuable contribution to protein intake. Nuts, cereal grains and legumes all provide incomplete protein, but can complement one another effectively in combinations such as:

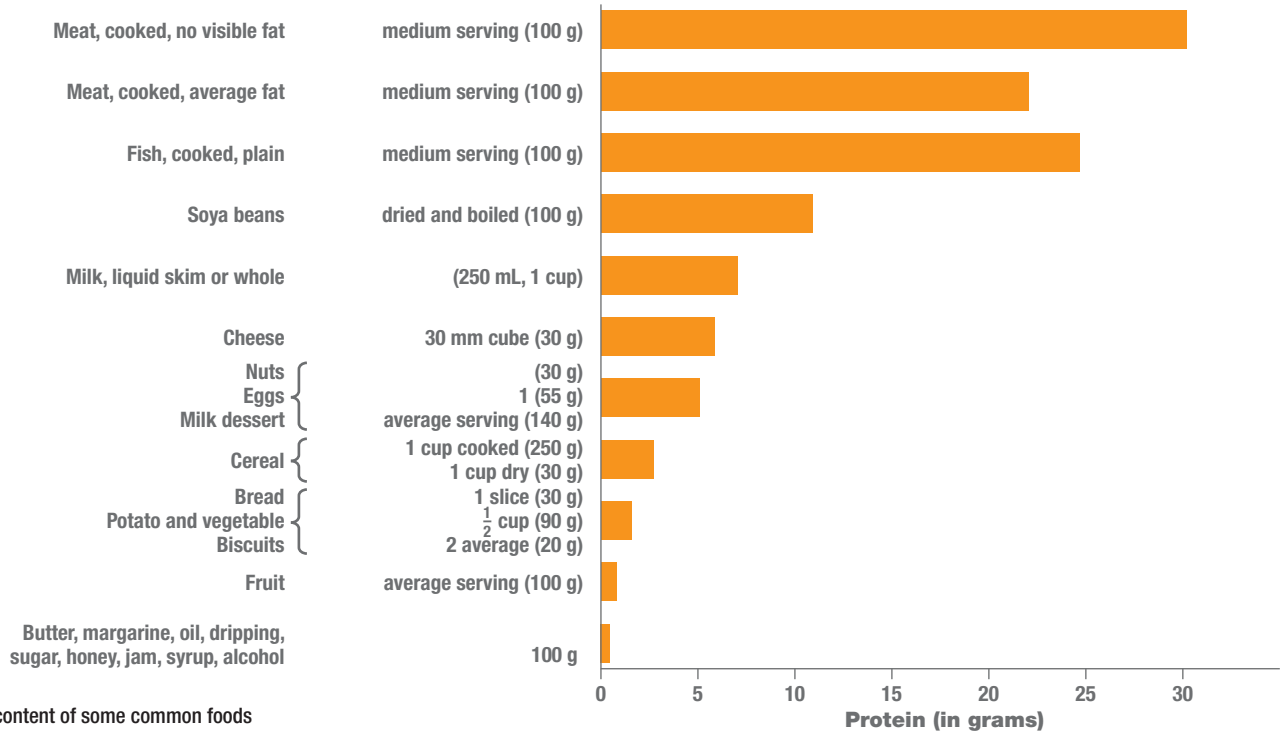
- rice with peas or lentils
- bread with peanut butter
- corn tortillas with kidney beans.

Unlike other plant foods, soya beans provide complete protein. They contain much less protein than animal foods do, but the protein can be extracted and concentrated as soy protein isolate, which is manufactured into simulated meat products such as textured vegetable protein (TVP). These are used in many **vegetarian** food products.

Vegetarianism

Some people in the community may choose to exclude animal products from their diet, for personal, religious or environmental reasons. A diet based solely on fruits, vegetables and cereal grains, avoiding all foods of animal origin, is called a **vegan** diet. Other vegetarians may choose to include dairy products (a **lacto-vegetarian** diet) or both dairy products and eggs (a **lacto-ovo-vegetarian** diet).

With careful planning, it is possible to maintain a healthy and balanced vegetarian diet. Complementary proteins may be important in this. Because healthy adults usually store amino acids, they do not need to consume complementary protein foods at the same meal. Over the day, the amino acids from different foods are held in the body's amino acid pool, to be combined according to the body's needs. However, older people may not store amino acids in the same way and may need to combine protein foods within the same meal to ensure that their intake is adequate. This may also be important for those with a higher protein requirement, such as growing children and pregnant women, or during illness, when close attention should be paid to the quality and amount of protein foods consumed.



Protein content of some common foods

REVIEW QUESTIONS

Remember

1. List four functions that protein performs in your body. For each function, suggest what would happen if you did not eat enough protein to keep this function working properly.
2. Copy the three amino acids shown on page 104. Using three different coloured pens, identify the carboxyl group, the amino group and the side (radical) group on each.

Apply

3. Why is it more difficult to ensure adequate protein intake in a vegan diet? What suggestions would you make to a person who was considering changing to a vegan diet?
4. Write down all the protein foods that you have eaten over the last 24 hours, using two columns to divide them into animal and plant foods. Compare your list with your classmates.

Do an activity

5. As a class, break into small groups. Each group prepares a different dish using tofu, TVP or nut meat as the main protein source instead of meat. Compare the taste, texture and flavour of each dish.
6. Plan and prepare a main meal suitable for:
   a) lacto-ovo-vegetarians
   b) lacto-vegetarians
   c) vegans

Carbohydrates

Carbohydrates provide the fuel that keeps your body going. Every cell in your body consumes energy, even while you are asleep. Energy is needed to work the muscles that you use for breathing, to keep your heart pumping and to keep you warm. More energy is required by the muscles during activity. Most of the energy you use every day comes from the sugars that are produced when carbohydrates are broken down in your gut. Your blood carries the sugars around your body to where they are needed. Carbohydrates are the only source of energy that is used by the brain and red blood cells. They provide 16 kilojoules of energy per gram.

What are carbohydrates?

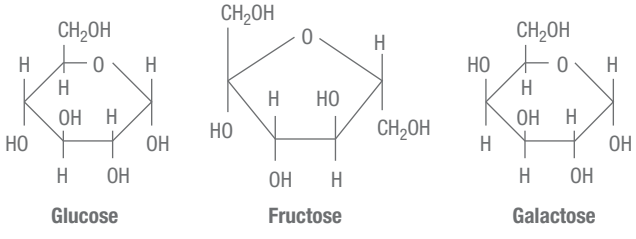
The term 'carbohydrate' refers to a wide range of sugars and starches that are found in many different foods.

Structure of carbohydrates

Carbohydrates are usually classified into three groups: **monosaccharides**, **disaccharides** and **polysaccharides**. 'Saccharide' means 'sugar', so these terms mean 'one sugar', 'two sugars' and 'many sugars', respectively.

Monosaccharides

Glucose, fructose and galactose are the three sugars that make up all the other carbohydrates in our food. These are monosaccharides — that is, they are single-sugar molecules with very similar structures, as shown below.

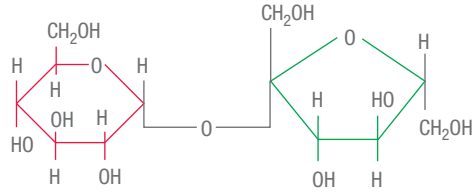


Chemical structures of the monosaccharides

Disaccharides

Sucrose, lactose and maltose are two-sugar molecules that are made up of different pairs of monosaccharides.

- Sucrose consists of a glucose molecule bonded to a fructose molecule.
- Lactose consists of a glucose molecule bonded to a galactose molecule.
- Maltose consists of two glucose molecules bonded together.



Sucrose is made up of glucose and fructose bonded together.

Sugars are found naturally in many foods, such as fructose in fruits and honey, lactose in milk and maltose in malt. The common sugar that we buy in shops is sucrose. The sugar added to processed foods is usually sucrose or glucose. The bar graph below shows the sugar content of some foods.

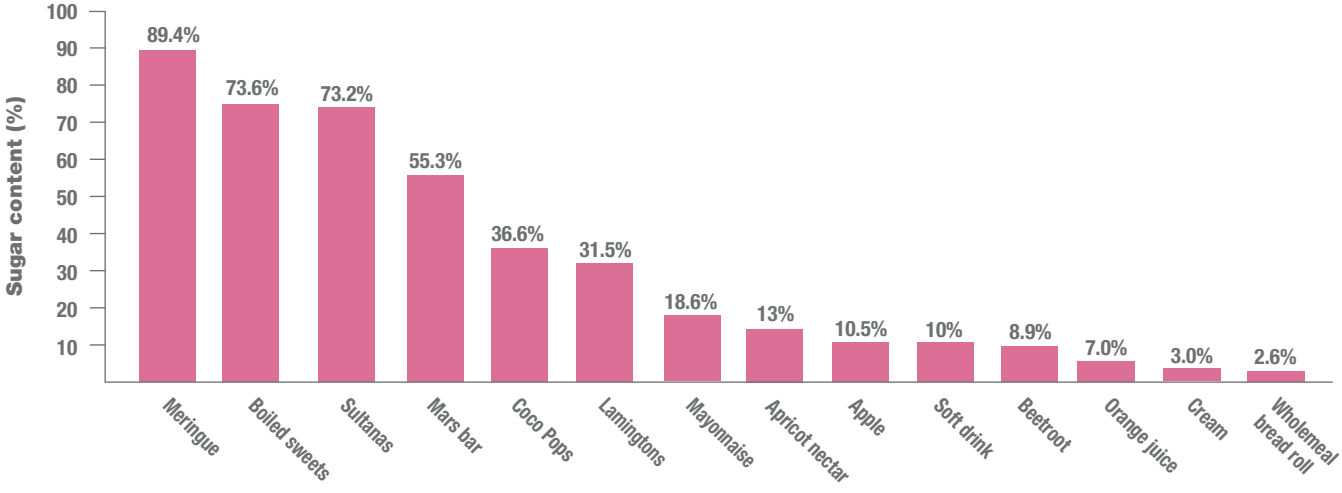
Polysaccharides

Monosaccharides can be joined together in long chains called polysaccharides to make a variety of starches and fibres.

Starch is a glucose polysaccharide found in plants that is broken down to glucose in the gut. Starch is found in two different forms: amylose (long straight chains of glucose) and amylopectin (branched chains of glucose).

Glycogen is a glucose polysaccharide that your body makes to store glucose in the liver and muscles for use when extra glucose is needed, such as overnight, between meals and for exercise.

Pectin is a polysaccharide found in the cells (especially the seeds, pith and peel) of fruits and some vegetables. It is an essential component of jams that helps them set to a gel.

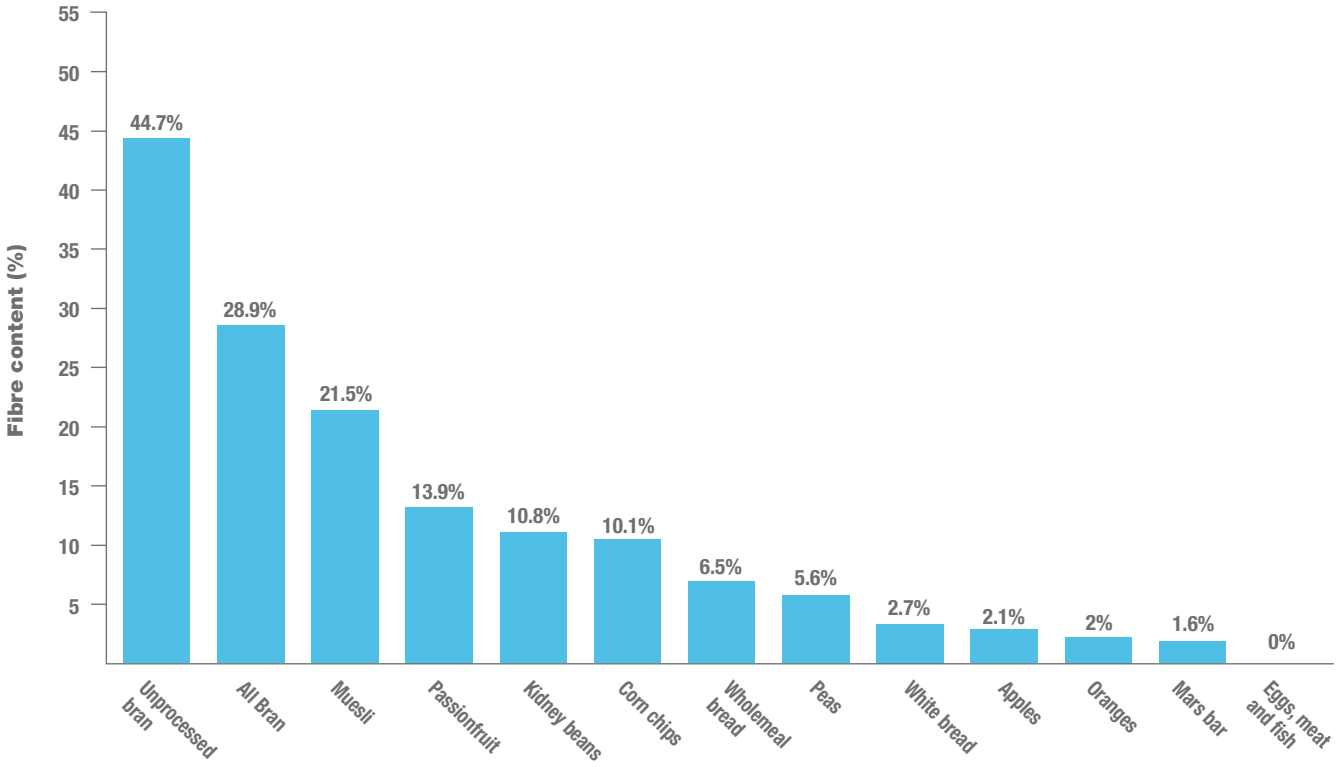


Sugar content of some common foods. Why do sultanas have a higher sugar content than fresh grapes?

Cellulose is also called dietary fibre. It is a glucose polysaccharide that cannot be broken down to glucose in the human gut due to its special structure. The bar graph below shows the fibre content of some foods.

Fibre

Fibre is not considered a nutrient because it passes through your body without being absorbed. However, it is still important because it helps to keep your gut working well. Fibre absorbs moisture in your gut, swelling to create a larger and softer mass to stimulate the intestinal muscle contractions (called **peristalsis**) that keep your gut contents moving. This prevents constipation and may even reduce cell damage from any harmful substances in the food. Fibre also provides extra bulk in your diet, making food more satisfying.



Fibre content of some common foods

REVIEW QUESTIONS

Remember

1. What are the three classes of carbohydrates? Give three examples of each class.
2. Complete the following.

   Sucrose consists of glucose and _____.

   Lactose consists of glucose and _____.

   Maltose consists of glucose and _____.

Apply

3. Starch and cellulose are both polysaccharides made up of glucose. Why is the body able to break down starch but not cellulose?
4. Which of the following foods would you expect to contain carbohydrates? For each food, write out the ingredients you would expect it to contain, and underline the ingredients that contain carbohydrates.
   chocolate
   cake mix
   tomato sauce
   potato chips
   omelette
   yoghurt
   ice-cream
   apple pie
   cottage cheese
   plain sweet biscuits
   jelly crystals

Do an activity

5. List all the foods and drinks that you have consumed in the last 24 hours. Use three different colours to highlight the sources of sugar, starch and dietary fibre.

Lipids

The **lipid** or fat cells (**adipose tissue**) in your body are an important store of energy, and also help to retain your body's heat, like an insulating blanket. Lipids perform other important functions in your body including:

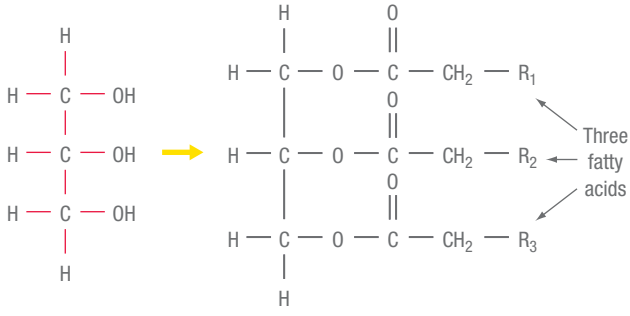
- providing a soft outer layer that protects your body surface and your internal organs from injury
- carrying, in your blood, some of the vitamins that are not soluble in water (the fat-soluble vitamins — A, D, E and K)
- providing essential **fatty acids** that are important for normal nerve and brain function
- keeping your skin and hair soft and smooth
- contributing to the structure of body cells
- acting as part of your body's messenger system, forming part of the structure of hormones and **prostaglandins**.

What are lipids?

Lipids are a group of substances that include fats, oils, fatty acids, phospholipids, sterols, glycolipids and waxes. Lipids are used by your body to store large amounts of energy in a small volume; they provide 37 kilojoules per gram, which is double the energy content of the same weight of carbohydrate or protein.

Structure of lipids

The most common form of lipid in the diet is the triglyceride. A triglyceride consists of a 'backbone' of **glycerol**, attached to three fatty acid molecules. Glycerol has a three-carbon chain, and each fatty acid is connected to one of these carbon atoms, as shown below.

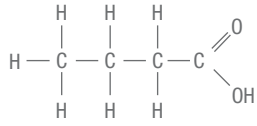


Triglycerides are made by joining three fatty acids onto a 'backbone' of glycerol.

The three fatty acids can be three identical fatty acids, or, more commonly, a mixture of different fatty acids.

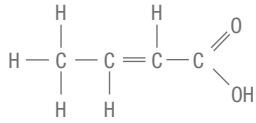
Fatty acids are carbon chains with a carboxyl group on one end. The chains vary in length from two to 24 carbon atoms, and they also vary in the number of hydrogen atoms that are attached.

Saturated fatty acids have as many hydrogen atoms as can fit on the following chain.



Structure of a saturated fatty acid: butyric (or butanoic) acid

Unsaturated fatty acids do not contain the maximum number of hydrogen atoms. Instead, some places have a double bond, as shown below.



2–butenoic acid

Structure of an unsaturated fatty acid: 2-butenoic acid

The double bonds can be broken and more hydrogen atoms inserted at that place; this process is called **hydrogenation** and is used to make solid fats out of vegetable oils, as in margarine production. A fat with only one double bond is called **monounsaturated**; a fat with two or more double bonds is called **polyunsaturated**.

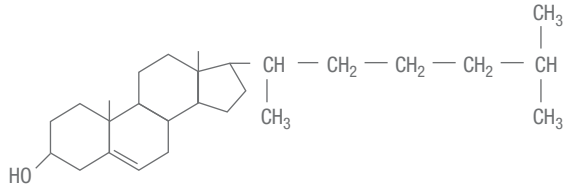
The type of fatty acid determines whether a lipid is solid or liquid at room temperature. Saturated fatty acids, and longer chain fatty acids tend to be solid at room temperature, while unsaturated fatty acids and short chain fatty acids are more likely to be soft fats or liquid oils.

Essential fatty acids

Essential fatty acids are needed for normal growth but cannot be synthesised by the body. The three essential fatty acids are linoleic acid, linolenic acid and arachidonic acid. These **omega-3** and **omega-6** fatty acids are found in fish and other seafood, nuts and seeds, and green vegetables.

Cholesterol

Cholesterol is another type of lipid — it is a sterol, with a molecular structure very different from that of a triglyceride.



Chemical structure of cholesterol

All your body cells contain cholesterol. It is needed in your body for:

- making bile acids, which are used to break down lipids in your gut during digestion
- absorbing and using lipids from your food
- making some important hormones.

Your body can make its own cholesterol in the liver. Other animals also make their own cholesterol, and so it is found in varying amounts in animal foods. If you eat a lot of cholesterol in your diet, the amount made in your body usually decreases. A high intake of saturated fat, however, promotes higher levels of cholesterol in the blood, which is associated with heart disease (see chapter 19).

Food sources of lipids

Lipids are found in a variety of foods. Both animal and plant sources provide lipids in the diet.

Animal sources of lipids

Foods of animal origin provide most of the saturated fats and all of the cholesterol in an average diet.

Meat	
Visible and invisible fat Bacon fat	Mostly saturated fatty acids Cholesterol
Fish	
Fish liver and fish liver oil Oily fish (tuna and salmon)	Mostly unsaturated fatty acids Cholesterol Essential fatty acids
Dairy products	
Milk Butter and cream Cheese	Mixture of saturated and unsaturated fatty acids Cholesterol

Plant sources of lipids

Plant foods are generally lower in fat than animal foods, but there are some exceptions. The fat in nuts and seeds can be extracted to make oils and margarines, which are a much more concentrated source of lipids.

Fruits and vegetables	
Avocado Olive	Mostly monounsaturated fatty acids No cholesterol
Nuts Brazil nuts Walnuts *Legumes* Peanuts *Seeds* Sesame Sunflower	Mostly polyunsaturated fatty acids No cholesterol Essential fatty acids
Other	
Palm kernel Coconut	Mostly saturated fatty acids No cholesterol

Visible fats are those present in the food as an obvious fat component, such as the layer on the outside of a cut of meat, butter on a slice of bread, and cream used as the filling in a cake. These are easy to see in food. Invisible fat, such as that in some kinds of cakes, biscuits and pastry, is more difficult to identify.

Invisible fat — some kinds of pastry may be as much as 50 per cent fat, but many people are unaware of this fact.

REVIEW QUESTIONS

Remember

1. Name four functions of lipids in the body.
2. What are the names of the essential fatty acids? What makes them 'essential'?
3. What are the components of the structure of lipids?

Apply

4. What is the difference between a fat and an oil? Name two foods that are sources of hard fats and two that are sources of oils.
5. Look at the following list and circle the foods that you think contain cholesterol:
   canned baked beans in tomato sauce
   lamb chop
   margarine
   oysters
   cream of potato soup
   chicken nuggets
   bananas
   tuna and lettuce sandwich on wholegrain bread

Do an activity

6. The Australian Dietary Guidelines recommend a diet that is low in fat and, in particular, low in saturated fat. Write out a meal that you have eaten this week and list five changes that you could make to the meal to follow this guideline more closely.

Vitamins

Vitamins are substances that your body is unable to make for itself, and which are needed for normal healthy functioning. Only small amounts of each vitamin are needed, but they are all essential. Vitamins are generally classified as being either water soluble (those that dissolve in water, such as B-group vitamins and vitamin C) or fat soluble (those that do not dissolve in water, such as vitamins A, D, E and K). This solubility is important because it determines which foods are good sources, and how the vitamin can be absorbed, transported and stored in your body. Fat-soluble vitamins can be stored readily in your body, but the

water-soluble vitamins need to be supplied daily because any excess is excreted in the urine. A diet that does not provide enough of a particular vitamin can lead to a deficiency.

Fat-soluble vitamins

Your body can store significant amounts of the fat-soluble vitamins in your liver and adipose tissue. If you are healthy and well nourished, this store can meet your fat-soluble vitamin needs for several months. Table 6.2 shows the fat-soluble vitamins.

Good sources of carotenoids

TABLE 6.2 The fat-soluble vitamins

VITAMIN	WHAT IT DOES IN THE BODY	SIGNS OF DEFICIENCY	WHERE IT IS FOUND IN THE DIET	COMMENTS
Vitamin A (retinol)	• forms part of the rod and cone cells in the retina of your eye, which are needed for normal vision (for night vision in particular) • helps maintain the mucus-secreting cells in many tissues of the body, such as the linings of the gut, lungs, nose, throat and eyes	• poor vision, especially in low light • linings of gut, lungs, eyes, and so on, do not stay moist and slippery. In particular, the eyeball can dry out and become damaged and infected, causing blindness.	• Vitamin A can be obtained from food either as retinol or as its **precursor**, carotene. • Retinol is found only in animal foods, in liver (where it is stored in animals and humans), as well as in the lipid part of meat, poultry, fish, eggs and dairy foods. • Carotenoids are found in the coloured parts of red, orange, yellow and green vegetables.	• The body can convert carotene to retinol in the gut. • There are over 400 different substances in the carotene family, which are called carotenoids, and all convert to different amounts of retinol. • The most powerful carotenoid is beta-carotene, but all carotenoids have some retinol-producing effect.
Vitamin D (ergocalciferol and cholecalciferol)	• is the vitamin in charge of your bones, which get their strength from calcium phosphate • controls turnover rate of calcium and phosphate into and out of the bone • promotes calcium and phosphate absorption from food in the gut, and controls the amount that the kidneys allow to be lost in the urine	• abnormal bones. In growing children, vitamin D deficiency causes **rickets**, where the bones are weak and develop in a bent shape. In adults, vitamin D deficiency causes **osteomalacia**, where the bones are prone to breaking and pain.	• The body can make vitamin D in skin that has been exposed to UV light from the sun. • In Australia, most of our vitamin D is made in the skin, as only short periods of exposure to sunlight are required. • Large amounts are found in fish liver oils (such as cod liver oil); small amounts are found in oily fish, egg yolk and dairy fats.	• People who are not regularly exposed to sunlight are at risk of deficiency. This includes elderly and frail people who are confined indoors, and those who, for religious or modesty reasons, choose clothing that keeps their skin well covered. Dietary sources are more important for these people. • Whether it comes from sunlight or from food, vitamin D has to be converted to its active form in the body.
Vitamin E (alpha-tocopherol)	• acts throughout the body as an **antioxidant**, protecting the cells, and other nutrients, from oxidative damage • captures and disarms **free radicals**, reducing the impact of some of these processes	• higher risk of damage from free radicals, toxins, ageing and, perhaps, even cancer	• Vitamin E is usually found in the fat in plant foods such as nuts and seeds, vegetable oil, margarine and wheatgerm.	• Vitamin E is a group of eight different compounds called the **tocopherols**. The most active form is alpha-tocopherol. • Free radicals are molecules that can travel around the body causing damage to membranes; they are suspected to be involved in the processes of ageing, cancer formation and toxin damage to the body.
Vitamin K (phylloquinone and menaquinone)	• is involved in the process of blood clotting by controlling four of the proteins that are needed for clotting	• deficiency rare, but occasionally occurs in newborn babies resulting in excessive bleeding	• Vitamin K is found in large amounts in green leafy vegetables and in smaller amounts in other vegetables, fruit, cereal grain foods and seeds.	• Vitamin K deficiency is rare because it is produced by bacteria living in the gut and this is absorbed, supplementing the amounts in the diet. • Newborn babies are more vulnerable because they do not yet have bacteria in their gut.

Water-soluble vitamins

Water-soluble vitamins are not stored in your body and need to be continually replenished from your diet. Any water-soluble vitamins in excess of your needs are excreted in your urine. The water-soluble vitamins include the B group of vitamins and vitamin C.

Why are pirates often shown with missing teeth and terrible scars?
The seventeenth and eighteenth centuries were a time of great exploration by European sailors. For the first time, ships could make long voyages, staying at sea for weeks or months at a time. Surviving on salted meat and dried salty biscuits, with little access to fruit or vegetables, meant that scurvy (caused by a lack of vitamin C) became a serious problem for anyone living at sea. It killed large numbers of sailors on some of the early voyages, and caused widespread problems with tooth loss and poor wound healing. Later, it became known that scurvy could be prevented by including preserved lime juice as part of sailors' rations.

B-group vitamins

The B-group vitamins do not provide any energy to your body, yet without them you would not be able to get any energy from your food. They all work together to release energy from the carbohydrates, proteins and fats that you eat. They include:

- thiamin (sometimes called B_1)
- riboflavin (sometimes called B_2)
- niacin (sometimes called B_3)
- pantothenic acid (sometimes called B_5)
- pyridoxine (sometimes called B_6)
- biotin (sometimes called B_7 or B_8)
- folate (sometimes called B_9)
- cobalamin (known as B_{12}).

You will notice that most of these are called by name rather than by number; this prevents confusion (particularly where the numbers changed over time). Table 6.3 shows the water-soluble vitamins.

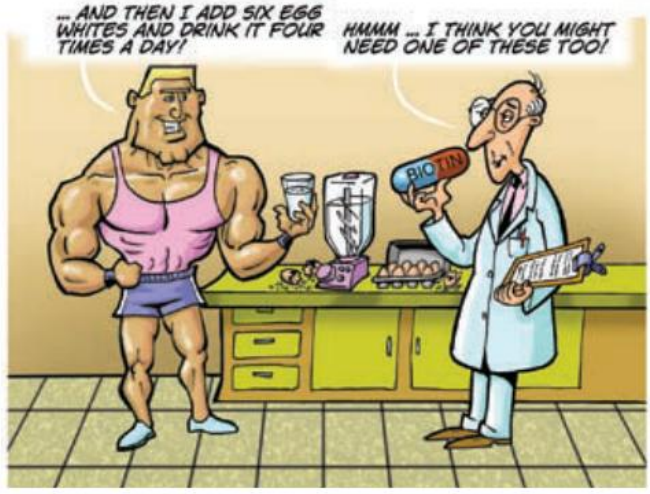


TABLE 6.3 The water-soluble vitamins

VITAMIN	WHAT IT DOES IN YOUR BODY	SIGNS OF DEFICIENCY	FOOD SOURCES	COMMENTS
Thiamin	• is an essential part of the process of releasing energy from carbohydrates and lipids	• Symptoms of deficiency are very general and usually accompanied by other deficiencies because thiamin is important throughout the body. • Thiamin deficiency is called beri-beri and it causes loss of appetite, vomiting, irritability and depression. Eventually nerves are unable to work properly, leading to muscle cramps. • Someone with 'dry' beri-beri becomes very thin, with mental confusion. • Someone suffering from 'wet' beri-beri also has oedema (fluid swelling in their body tissues), which can eventually cause heart failure and death. • Wernicke's encephalopathy (confusion, delirium and muscle dysfunction) is another deficiency condition seen mostly in alcoholics.	• Thiamin is found in all plants and animals, so there is a wide variety of food sources, particularly meats, organ meats (such as liver and kidney), poultry, fish, wholegrain cereal foods, legumes, nuts and seeds, and yeast (including yeast extracts such as Vegemite®)	• Highly processed foods are usually lower in thiamin. Thiamin deficiencies usually occur in poor countries where a processed grain (such as rice) is the main food, particularly in growing children who have higher energy needs.

VITAMIN	WHAT IT DOES IN YOUR BODY	SIGNS OF DEFICIENCY	FOOD SOURCES	COMMENTS
Riboflavin	• is an essential part of the process of releasing energy from carbohydrates, protein and lipids	• Symptoms of deficiency are very general and usually accompanied by other deficiencies because riboflavin is important throughout the body. • A key symptom is deep cracking and redness at the corners of the mouth and eyes. • Other symptoms include sore throat and eyes, and an inflamed sore tongue.	• Riboflavin is found in all plants and animals, so there is a wide variety of food sources, particularly milk and dairy foods, meats, organ meats (such as liver and kidney), wholegrain cereal foods, vegetables, eggs and yeast.	
Niacin	• is responsible for the continual supply of energy to the cells • is an essential part of the process of releasing energy from carbohydrates, proteins and lipids	• Niacin deficiency is called pellagra. • Deficiency is sometimes known as the disease of the 'three Ds': diarrhoea, dementia and dermatitis. • Dementia occurs rapidly, giving rise to irritability, insomnia and poor memory. • Pellagric dermatitis is distinctive because it is a symmetrical rash and occurs mainly on areas of the skin that are exposed to sunlight.	• Niacin is present in high levels in complete protein foods, particularly meats, organ meats (such as liver and kidney), fish, wholegrain cereal foods, vegetables, dairy foods and yeast.	• Niacin can be synthesised in the body from one of the essential amino acids, tryptophan. However, the process is not very efficient and requires adequate amounts of thiamin, riboflavin and pyridoxine to be present, so is not a good substitute for adequate dietary intake of niacin.
Pantothenic acid	• is involved in many of the reactions that metabolise carbohydrates, proteins and lipids	• Symptoms of deficiency are very general because pantothenic acid is important throughout the body. • Symptoms include immunity problems, dermatitis, and nerve changes causing irritability, weakness, and tingling or numbness in the hands and feet.	• Pantothenic acid is found in almost all foods, particularly organ meats, wholegrain cereals and yeast.	• Pantothenic acid is also made by bacteria in the gut.
Pyridoxine	• is involved in the synthesis of important body proteins such as porphyrin (part of haemoglobin in the blood), hormones, antibodies and enzymes	• Deficiency of pyridoxine on its own is rare. It occurs more commonly with other B-group deficiencies. • Symptoms include sore mouth, skin rash and sore, inflamed tongue. Nerve abnormalities may occur, causing convulsive fits.	• Excellent sources include meats, organ meats, eggs. • Good sources include wholegrain cereal foods and legumes. • Fruit and vegetables also contain small amounts.	
Biotin	• is required for the metabolism of carbohydrates, proteins and lipids	• Deficiency is very rare. However, it can occur in people consuming large amounts of raw eggwhite as this contains the protein avidin that captures biotin, preventing the body from using it. • Symptoms include loss of appetite, nausea and vomiting, dry scaly dermatitis, sore inflamed tongue and depression.	• Biotin is found in cereals, egg yolk, yeast and organ meats.	• More biotin is made by bacteria in the gut than you eat in your food.
Folate (also known as folic acid or folacin)	• is essential for the production and maintenance of your body's cells (including the blood cells) and the genetic material inside cells	• Deficiency causes reduced growth rate and anaemia. • More general symptoms are loss of appetite, diarrhoea, weakness, irritability and sore tongue. • If inadequate folate is provided during pregnancy, there is an increased risk of prematurity and neural tube defects.	• Folate is found in nearly all foods, but particularly good sources are green leafy vegetables, organ meats and yeast.	• Requirements are highest during periods of growth, such as in childhood and in pregnancy, because of folate's role in the production of cells.

(continued)

TABLE 6.3 *(continued)*

VITAMIN	WHAT IT DOES IN YOUR BODY	SIGNS OF DEFICIENCY	FOOD SOURCES	COMMENTS
Cobalamin (B_{12}, also known as cyanocobalamin)	• works together with folate in protein synthesis and production of red blood cells	• Deficiency causes pernicious anaemia, where abnormally large red blood cells are made, which do not work normally. • Deficiency can also cause serious brain and nerve damage.	• Active vitamin B_{12} is found only in animal foods, including meat, poultry, fish, eggs and dairy foods. • There is no reliable evidence of true vitamin B_{12} activity in plant foods. Some plant foods, such as seaweed and **spirulina**, and fermented soy foods, such as tempeh, contain inactive substances that are similar to vitamin B_{12}, which in large amounts may interfere with true B_{12} activity. • People who do not eat any animal foods (vegans) need to eat foods fortified with vitamin B_{12} (such as soy milk and some special vegan food products) or take vitamin B_{12} supplements.	• Vitamin B_{12} is a group of related substances known as cobalamins. • Digesting and absorbing vitamin B_{12} is very complicated. The vitamin is released from the food by substances in the stomach. A substance called intrinsic factor in the stomach attaches to B_{12} to act as a carrier; this allows the B_{12} to be absorbed later in the gut. • Gut bacteria can make vitamin B_{12}, but in humans this occurs too far down the gut for us to absorb it.
Vitamin C (also called **ascorbic acid**)	• is involved in the formation of collagen, (a protein in connective tissue). Collagen helps to maintain the strength of cell walls and of body tissues such as skin.	• Vitamin C deficiency causes a disease called scurvy. • Body tissues become weak and break down, causing swelling, bleeding and tenderness of skin, muscles and joints. • Gums bleed and teeth may fall out. • Scars may turn back into fresh wounds. • Bruising and nosebleeds are common.	• Plant foods are the main source of vitamin C. • Citrus fruits (lemons, limes, oranges), berries, red capsicum, tomatoes and green leafy vegetables are all particularly good sources.	

CASE STUDY

THE EYES HAVE IT

by CATHERINE SAXELBY

Warming vegie-packed soups and winter casseroles present the ideal opportunity to eat for eye health.

When you were a kid, did your mum tell you to eat up your carrots so you would see better? The latest research suggests that she may have been right. The nutrients in orange, green and yellow produce — all antioxidants that belong to a large family of more than 600 carotenoids — are the magic ingredients that can slow the progression of age-related macular degeneration (AMD), a debilitating loss of vision in older people. Just as there are optimum ways of eating for a healthy heart, liver, skin, brain and kidneys, so there is now one for the eyes.

AMD affects one in four Australians over 75, and is responsible for around 80 per cent of blindness. As the population ages, more and more cases of AMD will emerge so anything we can do to prevent or limit this eye affliction is of enormous benefit. The macula is the sensitive central part of the retina (the inside lining of the eye), responsible for the fine central vision that allows us to read, recognise faces and drive. With age the macula can deteriorate, which results in blurred vision, letters missing when reading, straight lines appearing wavy and even a black 'emptiness' in the centre of vision.

Exactly what causes AMD is still not fully understood. But if you have a parent with AMD, you have a 50 per cent risk of suffering from it yourself. Smokers have a four times greater risk than non-smokers, and those with high blood pressure, obesity or high cholesterol are also likely to suffer from it.

Lutein and zeaxanthin are two carotenoid pigments in the eye that are most concentrated in the macula. They absorb damaging UV and blue light, and protect individual cells in the retina. Dark leafy greens are rich in lutein and zeaxanthin, while colourful fruits and vegetables are also good sources (so remember to

'eat by the rainbow' — lots of colour is a good rule of thumb). So are egg yolks, and some brands of eggs are now fortified with lutein.

Cooking oils recently came under scrutiny after a research paper suggested a link to AMD and urged consumers not to use oil and go back to butter. Associate Professor Robyn Guymer, head of the Macular Research Unit at the Centre for Eye Research Australia at the University of Melbourne, denies a firm link between any type of fat and AMD exists.

'When you look at the research published to date, there is not enough evidence to suggest one fat or another,' she explains. 'The notion that oils were to blame came from one research finding in the US where the type of fats eaten are very different to those consumed by Australians — soybean oil is used extensively in the US and many of their margarines are high in trans fats, unlike ours. There are many other studies — including an Australian one, The Blue Mountains Eye Study — which found no association with fat. So why just pick out one study?' she added.

On the other hand fish, or rather their omega-3s, are reported to protect against the development and progression of AMD. Until definitive research appears, Professor Guymer advises her patients to follow a healthy low-fat diet that favours monounsaturated and polyunsaturated fats, which are pivotal in reducing cholesterol and heart disease.

Source: acpsyndication.com.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *vitamin A* to complete the tasks ahead.

1. Give three examples of foods that may contain carotenoids.
2. Explain what AMD is and possible causes of this disease.
3. Describe the type of diet you should follow to reduce the chances of getting AMD.

'Why are there so many B vitamins? What happened to vitamins F, G and H?' The value of a balanced diet was known in many human cultures long before the discovery of the vitamins. Ancient Egyptians rubbed the juices from cooked liver on their eyes to help them see in the dark, without knowing why this worked! As the vitamins were identified one by one, they were given alphabetical names. Some vitamins turned out to be more than one substance. For example, vitamin B_2 is actually a complex of riboflavin, niacin and pyridoxine. Once it was clear that the B group of vitamins work together, they were given a group name. At this point, vitamin G, which is riboflavin, and vitamin H, which is biotin, were moved into the B group and renamed. Vitamin F, the essential fatty acids, lost their 'vitamin' title and were grouped with fats. Vitamin J is not a vitamin at all because the body can synthesise it in small amounts and it is present throughout the food supply; it is actually choline, one of the vitamin-like molecules.

Minerals

Like vitamins, minerals are substances that your body cannot make for itself. They are involved in many of your body's important reactions. Some are needed in fairly large amounts, such as calcium, phosphorus, iron, sodium, potassium, magnesium and sulfur. Others are required in only tiny amounts and these are called **trace elements**. They include iodine, zinc, copper, cobalt, manganese, molybdenum, chromium, selenium, nickel, vanadium and tin. Just like the vitamins, the minerals are essential for health; if the diet provides inadequate amounts, deficiency symptoms can occur.

Calcium

Nearly all the calcium in your body is in your bones and teeth; it binds with phosphorus to provide the calcium phosphate that makes bones and teeth strong. Calcium phosphate forms a hard chalky complex that is laid down within a network of bone cells. Because of this role in bone, calcium needs are much higher during periods of growth. Calcium is also involved in nerve and muscle functioning and in clotting of the blood. When inadequate calcium is obtained from the diet, calcium is released from your bones to meet these needs; this may weaken the bones. Severe calcium deficiency has symptoms similar to vitamin D deficiency: rickets in children and osteomalacia in adults. Loss of calcium from the bones can also result in osteoporosis (see chapter 7).

Food sources of calcium

You need quite large amounts of calcium to maintain strong bones. Dairy foods are excellent sources of calcium; low-fat dairy foods usually have more calcium than the full-fat

types. Other good sources are canned sardines and salmon, and whitebait (which are all fish that are normally eaten with the bones), tofu, tahini (sesame seed paste) and some green vegetables.

Phosphorus

As discussed above, phosphorus binds with calcium to provide the calcium phosphate that makes bones and teeth strong. The rest of the phosphorus in your body is also very important because it forms part of the energy system of the body. All the energy that you get from your food, whether it is from carbohydrate, protein or fat, ends up as molecules called **ATP (adenosine triphosphate)**. This is the form of energy that your body cells use every minute of the day. If inadequate phosphate is available in the blood, the muscles and nerves run out of energy and cells may die; the heart and breathing muscles cannot work normally and may fail, leading to death. Normally, phosphate is released from the bones to maintain phosphate levels in the blood, so a poor intake of phosphate can result in osteomalacia.

Food sources of phosphorus

Phosphorus is found in many foods. Good sources of phosphorus include meat, poultry, fish, eggs, dairy foods, wholegrain cereal foods, legumes, nuts and seeds.

Iron

Iron has an important role in some reactions in the body, such as converting carotene to retinol, and in forming collagen. However, most of the iron in your body is involved in carrying oxygen to the cells where it is needed for making energy. Iron forms part of two oxygen-carrying proteins: haemoglobin (the protein that carries oxygen in the blood) and myoglobin (the protein that carries oxygen in the muscles). When the cells come to the end of their life, your body breaks down these proteins and re-uses the iron. In this way, most of the iron is conserved, being lost from the body only by bleeding (in injury or during menstruation). The iron stores in your body are tightly controlled, too. When body stores of iron are getting low, more iron is absorbed from food. When stores are full, less iron is absorbed from food. Iron deficiency can occur if too little iron is obtained from food, if it is not absorbed properly or if there is too much blood loss (such as with a severe injury or heavy menstruation). This can result in anaemia (see chapter 17).

Food sources of iron

Blood is rich in iron, so meat and organ meat are the foods with the most iron. This is called **haem iron**, meaning that the iron is from the blood. Other sources of haem iron include fish that are eaten whole (like sardines) and egg yolk. **Non-haem iron** is found in plant foods. Legumes, nuts and seeds, wholegrain cereal foods and green leafy vegetables are good sources of non-haem iron.

Sodium and potassium

Sodium and potassium are involved in many critical body processes. They work closely together in the body and are discussed together here because they depend on each other. The amount of sodium and potassium in the body needs to be very carefully controlled because together they are responsible for the following important processes:

- keeping the right amount of fluid in each body cell. Sodium is mostly found outside the cell, and potassium is mostly found inside the cell. Little pumps in the cell membrane allow sodium and potassium to swap places. If more sodium moves into the cell, it drags water in with it. If sodium moves out of the cell, water moves out. If this process is not controlled, sodium may flow into the cell, bringing too much water in and the cell can burst and die.
- keeping the right acid–base balance (pH) in the body. Many of your body's processes do not work if their environment is too acidic or too alkaline. Sodium and potassium help to keep it just right.
- making muscles contract and relax, and transferring nerve impulses. Sodium and potassium are responsible for the contraction and relaxation of both the voluntary and involuntary muscles in your body, and for transmitting electrical messages along the nerves. This means that sodium and potassium keep all your muscles working normally. If there is not enough potassium available, the muscles of the heart can stop beating, leading to cardiac arrest. If there is too much potassium, muscle weakness can cause abnormal heart rhythm, which can lead to a heart attack.

While sodium and potassium work together, they also have their own individual jobs. Sodium is involved in the uptake of glucose, both into the gut and into body cells, where it is used for energy. Sodium is also important in the work of the pancreas. Potassium helps to release energy from carbohydrates, protein and fat, and is also needed for storing glucose (as glycogen) in the body and for making new proteins. The amount of sodium and potassium in the body is mostly controlled by the kidneys, which make sure that the right amount is excreted in the urine, or kept in the body if needed. Some sodium is also lost in sweat.

Food sources of sodium

Sodium is found naturally in nearly all foods, especially meat, fish and seafood, eggs, dairy foods and green vegetables. We also add sodium to our foods in the form of salt (sodium chloride: NaCl) during cooking or at the table. However, nearly all the sodium in your diet probably comes from salt and other sodium compounds that have been added to foods during processing. Some foods contain very large amounts and are noticeably salty in taste, such as anchovies and other canned fish, bacon, ham, powdered soup and noodle mixes, salted nuts and crisps, and takeaway foods. Other foods may provide surprisingly large

amounts of sodium without tasting particularly salty; most of the sodium in your diet probably comes from foods such as breakfast cereal, bread and spreads, biscuits and cheese.

Food sources of potassium

All foods contain potassium, and, unlike sodium, the amount of potassium usually *decreases* during processing. The highest amounts of potassium are found in fresh fruits and vegetables and their juices, especially tomatoes, potatoes, bananas and oranges. Meat, fish, cereal grain foods and chocolate also contain significant amounts of potassium.

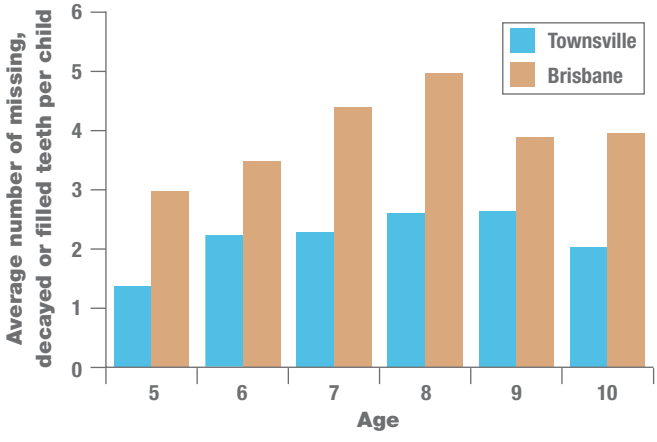
Zinc

Zinc is found in many enzymes and acts as a co-factor for other enzymes. (A co-factor is a substance that an enzyme needs to help it carry out a reaction.) In this way, zinc is essential for obtaining energy from carbohydrates, protein and fat. It is also very important for making proteins, so is essential for growth and maturation, for wound healing and for maintaining healthy skin, hair and nails. Zinc deficiency causes growth retardation, hair and skin problems (including poor wound healing) and loss of taste sensitivity.

Food sources of zinc

Good amounts of zinc are found in oysters and other shellfish, liver, meat, chicken, cheese, wholegrain cereals and nuts. Zinc is more easily absorbed from animal foods because fibre can bind with zinc, making it unavailable for absorption.

Fluorine



In 1992, dentists examined the teeth of nearly 20 000 children who were living in Townsville (where the water had added fluoride) and Brisbane (where fluoride was not added to water). This graph shows the difference in rates of tooth decay in the two cities. Similarly, the Child Dental Health Survey 2002 confirmed that children aged 5–15 who lived in areas where there was a higher concentration of fluoride in drinking water had fewer decayed, missing or filled teeth than children living in areas where there was a lower concentration of fluoride in the water.

Fluorine contributes to the strength of the calcium phosphate in bones and teeth. Its presence in teeth hardens the enamel, helping to prevent dental caries (tooth decay). It is found in some foods, such as seafood and tea, but the amount required for healthy teeth is easily obtained from tap water in towns and cities where fluoride has been added to the water supply.

Water

One of water's important functions occurs when it leaves the body. Perspiration helps to avoid overheating.

Even though water provides no energy, it is still counted as a nutrient because we cannot live without it. Without water, dehydration causes death in only a few days. Over half your weight is water; it is in your cells, between your cells, and in your blood and the other fluids in your body, such as spinal fluid. Most of your body processes cannot work properly if there is too little water in the body. Here are some of the important functions of water:

- Water acts as a solvent and transportation medium. Water-soluble substances dissolve in water and this is how they are carried around your body. Nutrients flow in the watery

environment of the gut, into the gut wall cells and then into the blood. Maintenance of the sodium–potassium balance needs water to allow the flow of sodium and potassium into and out of the cells.

- Water acts as a lubricant. The lubricants throughout your body are kept moist by water. These include saliva and other digestive system lubricants that allow food to slip easily through your gut. Saliva also keeps your mouth moist and rinses your teeth, helping to protect against decay. Water acts as a shock absorber in your joints.
- Water helps to control your body temperature. Perspiration, or sweat, on your skin can evaporate when it absorbs enough body heat, thus helping to cool your body.

The kidneys help to control how much water is kept in the body and how much is lost in urine. Water is also lost from the skin surface through sweating, from the lungs (as water vapour) during breathing, and in the faeces.

Food sources of water

Apart from the water you drink on its own, water is the main ingredient in all other beverages including tea, coffee, juices, soft drinks, milk and even alcoholic drinks. Many foods, such as fruits and vegetables, contain a lot of water in their cells, and many of the metabolic reactions that occur in your body also produce water.

Important interrelationships between nutrients

There are many times when one nutrient depends on another nutrient to be absorbed by the body or to carry out a particular task. For example, folate and vitamin B_{12} work together, so a deficiency of one means that the other cannot work properly. Similarly, the body needs a balance of both sodium and potassium to work properly. Table 6.4 shows some other examples.

REVIEW QUESTIONS

Remember

1. What substance is the precursor of vitamin A?
2. What is another name for vitamin B_{12}? What is the main function of this vitamin?
3. Match each of the following nutrients with a symptom of deficiency.

A deficiency of . . .	may cause . . .
fibre	weak, bendy bones
retinol	bleeding gums and bruising
protein	constipation
vitamin C	difficulty seeing in the dark
vitamin D	poor immune function and weakness

Apply

4. Which of the following statements best describes the interrelationship between iron and fibre?
   - **A.** Fibre and vitamin C assist with the absorption of iron.
   - **B.** Fibre acts as a bridge to help carry iron across the gut wall and into the blood.
   - **C.** Iron is needed to produce collagen, which is made up of fibre and elastin, and makes skin strong.
   - **D.** Fibre binds with iron to prevent absorption.
5. Why does the body become deficient in water-soluble vitamins more quickly than in fat-soluble vitamins?

Do an activity

6. Log in to **www.jacplus.com.au** and locate the *Folate* weblink for this chapter.
   - **a)** Why is folate supplementation now routinely recommended for pregnant women?
   - **b)** When should a pregnant woman start taking extra folate?
   - **c)** What are some barriers to this behaviour change?
7. Choose a vegetable and create a colourful poster advertising its nutritional value. You might like to include a catchy slogan and some tempting ideas for preparing your chosen vegetable.

eBook*plus*

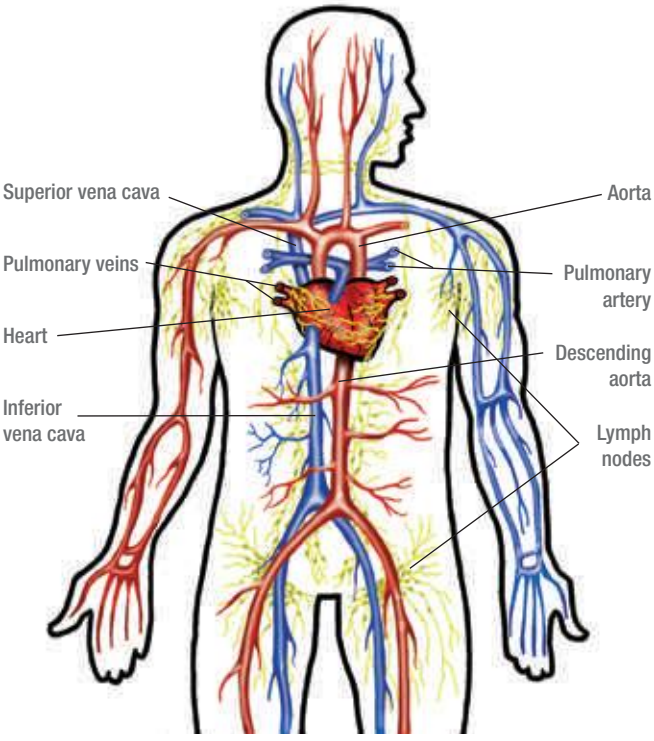
Weblink

TABLE 6.4 Interrelationships between nutrients

NUTRIENT	POSITIVE INTERRELATIONSHIPS	NEGATIVE INTERRELATIONSHIPS	PRACTICAL APPLICATION
Iron	• Vitamin C helps increase non-haem iron absorption by converting it to a more absorbable form. • Haem iron helps in absorption of non-haem iron.	• Zinc decreases absorption. • Calcium decreases absorption. • Fibre decreases absorption.	• Have some salad or fruit with your main iron-containing meal to boost iron absorption. • Iron supplements should not be taken at breakfast if you are eating a bran-based cereal. • Although breakfast cereals and powdered drink flavourings often have added iron, they are unlikely to meet your complete iron needs because of the interaction with calcium in the milk. It is important to have other sources of iron.
Calcium	• Phosphorus increases absorption. • Vitamin D promotes absorption. • Lactose increases absorption.	• Fibre may decrease absorption.	• Dairy foods are the best sources of calcium as they contain phosphorus and lactose. • Dairy foods make good between-meal snacks if you avoid eating high-fibre foods at the same time — they protect the teeth between meals too.

Digestion, absorption and metabolism of food

The gut, or gastrointestinal tract, is a tube, up to about 8 metres long, which starts at the mouth and finishes at the anus. Digestion and absorption occur along this tract. **Digestion** is the mechanical and chemical breakdown of food to its smaller nutritional components. Absorption is the movement of these components from the gut into the blood and lymphatic systems of the body, which are shown below. These systems deliver the nutrients to the cells for use in metabolic processes.

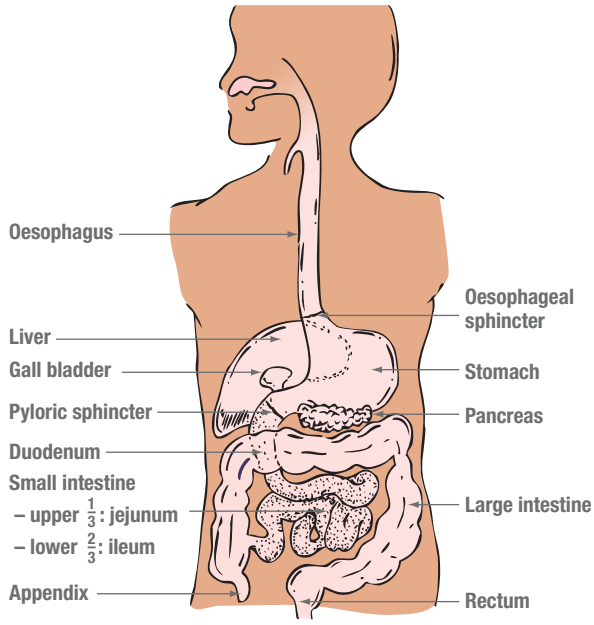


Blood is pumped around the body by the heart. The fatty lymph liquid, or chyle, flows along similar pathways without any pumping; it relies on gravity and the movements of the body. Here, arteries are shown in red, veins in blue, and the lymph system in yellow.

Metabolism includes all chemical processes that use nutrients to make other substances. The two main types of metabolism are catabolism and anabolism. **Catabolism** occurs when nutrients are broken down to their components, usually for energy or to make other substances. Starvation may result in muscles being broken down to produce energy; this is an example of catabolism. **Anabolism** occurs when new molecules are produced from substances released by catabolism. Recovering from injury involves anabolism as new protein is formed to repair and replace the damaged body tissue. Body builders use repetitive heavy weightlifting to achieve anabolism for increased muscle bulk. Anabolic steroids are chemicals that promote anabolism, sometimes used in body building to increase muscle, despite their undesirable side effects.

Organs of digestion

Digestion involves a long chain of processes, with the different organs shown below doing their individual jobs along the way.



The organs of digestion

Mouth, tongue and salivary glands

Both mechanical and chemical breakdown of food occur in the mouth. Chewing, or **mastication**, grinds the food between the teeth, coordinated by the tongue's movements, while the salivary glands produce saliva. Saliva is a watery mixture of mucin (a slimy substance that makes saliva sticky) and **amylase** (an enzyme that triggers the digestion of starch).

Salivary amylase has only a very small effect during chewing unless you eat slowly and chew your food very well.

starch (polysaccharide) $\xrightarrow{\text{amylase}}$ maltose (disaccharide)

Oesophagus

The oesophagus is the tube that joins the mouth to the stomach. The wave-like action of the smooth muscles lining the oesophagus moves food from the mouth, through the lower oesophageal **sphincter**, to the stomach. This action is called peristalsis and is responsible for the way in which foods and wastes are moved through the entire gastrointestinal tract. There is no breakdown of food in the oesophagus. Its main function is to prevent the acidic mixture in the stomach from splashing back up into the mouth.

Stomach

The stomach is a large, bag-like organ. The muscles lining the stomach grind the food (with an action similar to a pepper grinder), mixing it with the gastric juices to produce **chyme**, a watery paste. Chyme is released slowly into the small intestine, controlled by the pyloric sphincter.

Gastric juices are a combination of hydrochloric acid and enzymes. Hydrochloric acid acts on all the proteins in chyme, including salivary amylase, starting the process of breakdown. A gastric enzyme, pepsin, breaks the proteins into smaller polypeptide chains, or **peptones**.

Small intestine

The small intestine is divided into three distinct areas: duodenum, jejunum, and ileum. The majority of the digestion and absorption of food occurs along this 6-metre section of the gastrointestinal tract.

Once the chyme enters the duodenum, it comes in contact with digestive juices from three different sources — the pancreas, the gall bladder and the walls of the small intestine itself. The alkaline environment of the small intestine neutralises the hydrochloric acid from the stomach.

Digestion of protein

Proteins enter the duodenum in the form of peptones. They are broken down into amino acids by the protein-splitting enzymes trypsin, chymotrypsin, carboxypeptidases, aminopeptidases and erepsin.

Digestion of carbohydrates

Pancreatic amylase, produced by the pancreas, breaks down the remaining starch into the disaccharide maltose in the duodenum. Once the chyme has passed into the jejunum, it comes in contact with the enzymes maltase, lactase and sucrase (also known as invertase.) The disaccharides are broken down into their respective monosaccharides, making them available for absorption.

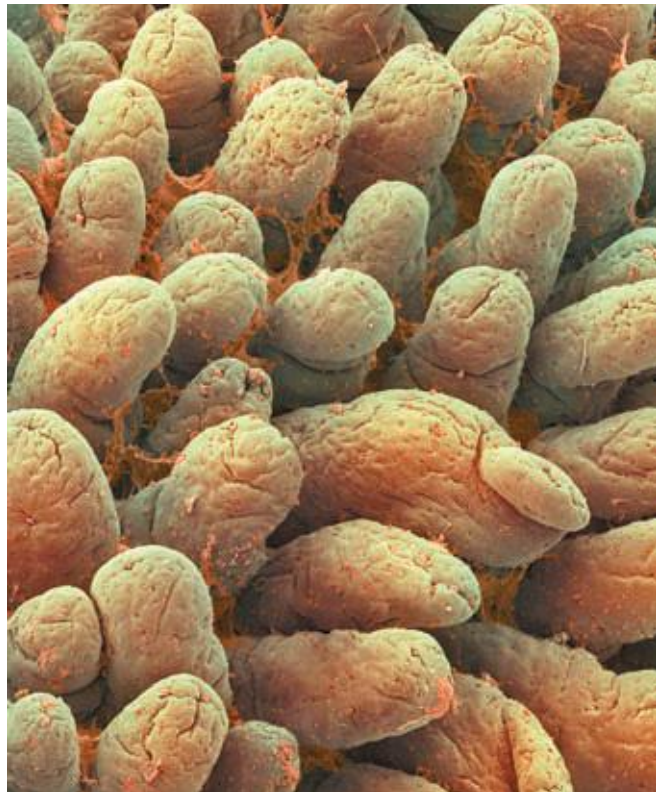
Disaccharide	*Enzyme*	*Monosaccharides*
maltose	maltase →	glucose + glucose
lactose	lactase →	glucose + galactose
sucrose	sucrase →	glucose + fructose

Digestion of lipids

Lipases are enzymes, produced in the pancreas, that break the triglycerides of lipids into monoglycerides. **Bile** is produced in the liver but is stored in and released from the gall bladder. It does not contain enzymes, but instead acts as a detergent to **emulsify** lipids into small droplets in the chyme liquid. This makes it easier for the lipases to reach them. Lipases break triglycerides into glycerol and fatty acids, which are then absorbed through the ileum wall.

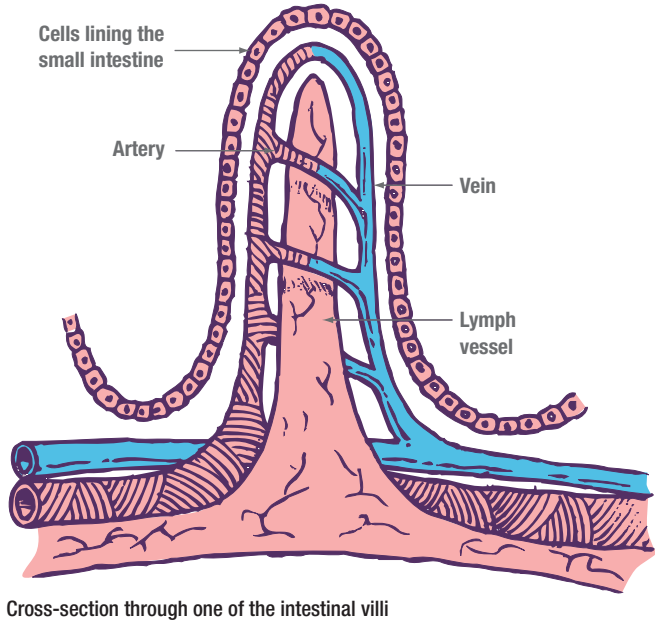
The absorption of nutrients

The walls of the small intestine are covered in tiny finger-like projections called villi that capture substances flowing through the intestine — much as a sea-anemone catches its food.



Intestinal villi

The villi greatly increase the surface area of the small intestine, thus creating a greater area over which nutrients can be absorbed. All of the nutrients absorbed in your gut go into the cells lining the villi. A cross-sectional view through a villus is shown below.



Cross-section through one of the intestinal villi

Glucose, amino acids, water-soluble vitamins and minerals all flow from the intestinal cells into the bloodstream. The blood then takes them to the liver, which coordinates their use, storage or transport to other parts of the body.

Fat takes a very different path. The glycerol and fatty acids that are absorbed into the gut wall are re-formed into triglycerides while they are in the gut cell. These triglycerides, along with fat-soluble vitamins, do not pass into the blood immediately. Instead, they travel into the lymph system in the form of **chyle**, a creamy-looking, fatty liquid. Chyle is released into the bloodstream from an opening inside the chest called the thoracic duct. This process is slow, as lymphatic flow is passive. The fat then travels through the bloodstream, from which it can be taken up by cells for energy.

Any substances remaining in the gut, such as unabsorbed water and fibre, enter the large intestine in preparation for excretion.

Large intestine and rectum

The large intestine (or colon) and the rectum make up the final 1.5 metres of the gastrointestinal tract. The large intestine is about four times thicker than the small intestine. Its main function is to remove food residues and wastes from the body. These enter the large intestine in a liquid form but the majority of the water is absorbed in the colon, leaving a semi-solid mass.

The large intestine produces no enzymes, but some digestion still occurs thanks to a large number of bacteria that are present. There are many beneficial types of bacteria that play a role in keeping your gut healthy. These act on the undigested matter by attacking the fibre and other components, producing a small amount of energy as well as vitamin K and some of the B-group vitamins. These are then absorbed into your bloodstream. Some bacteria produce gases, which can also be absorbed into the bloodstream. The remaining food residues, combined with waste products of the digestion process, dead intestinal cells and bacteria, are passed from the body through the rectum in the form of stools or faeces.

REVIEW QUESTIONS

Remember

1. For each of the three main energy-giving nutrients, describe:
- **a)** the enzymes that are required for digestion
- **b)** where in the body the enzymes are produced
- **c)** where in the gut the nutrients are absorbed.

2. What factors affect the absorption of calcium, phosphorus, zinc and iron? List them, and then note which ones *increase* absorption and which ones *decrease* it.

3. Which one of the following statements is correct?
- **A.** Calcium and vitamin D are responsible for blood clotting.
- **B.** Vitamins D and E increase calcium absorption.
- **C.** Zinc must be present for carotene to be changed into retinol.
- **D.** Vitamin A increases the rate of iron absorption.

Apply

4. Why does food need to be digested?

5. Match each of the following terms with its meaning.

metabolism	chewing
catabolism	eating
anabolism	converting one substance into another
mastication	breaking down a nutrient into its parts
absorption	breaking down body tissue to use as energy
digestion	taking nutrients into a cell
consumption	building up body tissue

Do an activity

6. Take a small piece of plain white bread and chew it very thoroughly without swallowing it, to allow salivary amylase to start breaking down the starch in the bread. See if you can taste the sugars being released by the amylase. Use a stopwatch to time yourself from when you put the bread in your mouth, to see how long it takes to notice the taste.

7. In small groups, prepare a short presentation on each of the different organs involved in digestion and absorption. These can be presented, in order, to the class as a 'Tour of the gastrointestinal tract'. The organs presented could include: mouth, tongue and teeth, stomach, liver and gall bladder, pancreas, small intestine, large intestine, rectum and anus.

CASE STUDY

Interview

Dietitian: Good morning. Thanks for being on time for your appointment. Everyone else has been late today! Now, the referral letter from your GP says that you have been suffering from fatigue. Can you tell me a bit more about what's been happening?

Sally: Well, I've just been finding it really hard lately. I just don't seem to have the energy to do all my normal stuff and I'm tired all the time. I live on my own now, because my flatmate moved out to go overseas, so I have all the housework to do and nobody to share the shopping and cooking with. Lately it's all just seemed too hard. I'm not concentrating well at work, either. I'm usually pretty active and healthy. I have really heavy periods, but other than that I don't ever have anything wrong with me.

Dietitian: Well, what I'd like to do now is go through a normal sort of day, and look at what you normally eat and drink. Let's start with the morning; what time do you usually get up and what do you eat for breakfast?

Sally: I normally get up around seven, and I have breakfast at half past seven. That's usually just some toast and jam — white bread, I don't like brown bread. And a few cups of tea.

Dietitian: And then what's the next time that you would have something to eat or drink?

Sally: I have a few biscuits with coffee at morning tea time, and then I have lunch at work. That's usually a salad sandwich from the shop and a banana or something like that. I eat quite a bit of fruit during the day, too. Then I make dinner at home, but lately I've found it a bit boring cooking for myself so sometimes I get some fried rice or a noodle stir-fry as a takeaway. Last night I just had pumpkin soup and some toast. Oh, and a rice pudding I bought. Or I might make cheese and tomato on toast. Sometimes I have lollies if I'm watching television in the evenings — marshmallows or jelly snakes. But usually I'm pretty good; I try to have fruit instead, or yoghurt.

Dietitian: Well, I think I know what the problem is, and I can definitely help you! I think you might not have been getting enough iron in your diet.

OUTCOME TASK **ORAL PRESENTATION**

Students learn to:

- identify the nutrient composition of various foods
- explain the functions of food nutrients in human nutrition
- combine foods to demonstrate nutritionally beneficial interrelationships between foods.

Contributes to the following outcomes:

- explains the role of food nutrients in human nutrition
- communicates ideas in written, graphic and oral form using computer software where appropriate.

Carefully consider the interview above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food nutrients* to complete the tasks ahead.

1. Why might Sally have increased iron requirements?
2. How would you explain to Sally, in your own words, the role of iron in the body, and why she has been feeling tired?
3. What factors have contributed to Sally's iron-deficient diet?
4. Suggest three changes that Sally could make to her diet to improve her iron intake. Remember to take into account the way in which iron might interact with other nutrients.
5. In pairs, plan a role-play. One of you plays the dietitian and the other plays a person suffering from a vitamin or mineral deficiency. Work out what symptoms to report and what kinds of factors to include that might have contributed to the deficiency. What advice will the dietitian give to this person to increase their intake of the relevant vitamin or mineral?

CHAPTER 6 SUMMARY

- Nutrients are the substances that we need for many essential body processes.
- Proteins are the basic building blocks of the body.
- Proteins are made from 22 different amino acids, some of which (essential amino acids) cannot be made by the body.
- Complete proteins provide the right proportions of all the essential amino acids to meet our needs; incomplete proteins can meet our requirements if they are combined with one another to balance their amino acids.
- Carbohydrates are the main energy source for the body.
- Carbohydrates — sugars and starches — are made from three simple sugars, which can be combined in pairs and chains.
- Lipids are a concentrated energy store for the body and also have some other functions.
- Vitamins carry out specific essential roles in the body.
- Vitamins may be classified as water-soluble or fat-soluble.
- Excess water-soluble vitamins are excreted, while excess fat-soluble vitamins are stored in the body.
- Many nutrients interact with one another in ways that may have a positive or negative effect. For example, one nutrient may help another do its job, or one nutrient may interfere with the absorption of another.
- Deficiency diseases result when the diet contains inadequate amounts of vitamins and minerals.
- Digestion is the breakdown of food to its components, by mechanical or chemical processes.
- Absorption is the process of nutrient components moving from the gut into the gut cells and then into the bloodstream or lymph system.

KEY TERMS

ATP (adenosine triphosphate)
adipose tissue
amino acids
amino group
amylase
anabolism
antioxidant
ascorbic acid
bile
carboxyl group
catabolism
cellulose
cholesterol
chyle
chyme
complementary protein
complete protein
digestion
disaccharides
emulsify
enzyme
essential amino acids
fatty acids
fibrous proteins
free radicals
globular proteins
glycerol
glycogen
haem iron
hormones
hydrogenation
incomplete protein
lacto-ovo-vegetarian
lacto-vegetarian
limiting amino acid
lipid
macronutrients
mastication
metabolism
micronutrients
monosaccharides
monounsaturated
non-essential amino acids
non-haem iron
nutrition
omega-3
omega-6
osteomalacia
pectin
peptones
peristalsis
polysaccharides
polyunsaturated
precursor
prostaglandins
protein
rickets
saturated fatty acids
sphincter
spirulina
starch
tocopherols
trace elements
unsaturated fatty acids
vegan
vegetarian
vitamins

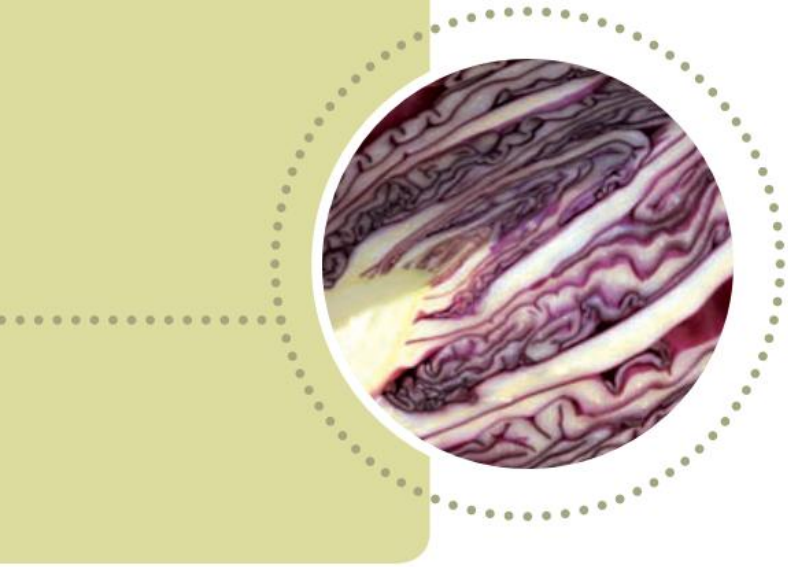
Chapter 7
Diets for optimum nutrition

What's for dinner? A small bowl of chicken and potato purée, a few spoonfuls of mashed banana and a big drink of milk. The baby may be happy, but the rest of the family is left feeling a bit hungry! Yet the same ingredients, used differently, could form the basis of a meal that would meet the needs of everyone in the family. Some members of the family may need more energy or protein, while others need extra fibre, iron or calcium. Selecting the right ingredients is just the beginning — the way in which they are prepared, cooked and combined into meals are all important factors in ensuring optimum nutrition throughout your life.

In this chapter you will learn about:

- nutritional requirements throughout the life cycle
- current food selection guides and nutritional information that assist in planning and evaluating meals and diets
- preparation techniques to produce nutritious food.

How can a family meal meet the nutritional needs of all its members? Nutritional requirements change throughout a person's life, and this means that the diet must change to supply these nutrients.



Chapter 2 outlined the physiological factors affecting our food selection. To summarise, nutritional requirements are affected by an individual's:

- age
- body size
- gender
- body composition (amounts of muscle and fat tissue)
- health status
- physical demands on the body, such as level of activity and whether a woman is pregnant or lactating.

This chapter will look at how these requirements vary throughout the life cycle, and how to plan and assess meals or diets to make sure that these requirements are met.

Adequate **nutrition** is important to supply the energy and nutrients that you need for growth and repair. Rapid growth occurs during infancy, adolescence, pregnancy and lactation, so extra nutrients are needed at these times. Requirements are lower in an adult who is no longer growing, providing only what is needed for routine body maintenance and repair. Although energy requirements decrease with ageing, older people may need other nutrients in larger amounts.

Energy

Your body needs energy to maintain all its essential processes. Chapter 6 looked at the macronutrients (proteins, lipids and carbohydrates), which can be used by your body for energy. We will now look at the factors that affect how much energy you need.

Factors influencing energy requirements

Everyone knows that you need extra energy when you exercise, but what about when you are just lying quietly doing nothing? The minimum amount of energy that your body needs to maintain normal body processes is called the **basal metabolic rate (BMR)**. This is the amount of energy that keeps your body working normally when you are lying awake, but totally relaxed and still, in a comfortably warm room, having not eaten for 10 to 12 hours. The BMR is the lowest energy expenditure that you would have while awake. Your energy expenditure is slightly lower than BMR when you are asleep and higher after you have eaten. When you eat, your body gets to work converting the food to nutrients and making heat. This extra energy expenditure is called the **thermic effect of food (TEF)**. The energy you need every day is the sum of your BMR, TEF and the energy required for activity and exercise.

Even though your total energy expenditure changes from moment to moment, your BMR stays fairly constant, with only moderate changes over your lifetime. The main factor affecting your BMR is the amount of lean muscle and organ tissue, since these are the parts of the body with the most metabolic activity. As these change, the BMR changes. Growth also increases the BMR. Muscle mass and growth explain most of the variation in BMR. Other influences on BMR generally relate to these two factors, and we will look at some of these now.

1. Body composition — People who have more lean muscle tissue have a higher BMR than those with more **adipose tissue**. Body fat has very low metabolic activity and does not contribute significantly to the BMR.
2. Body size — Generally, a larger body has a higher BMR because a larger body usually has more lean tissue. If the extra weight is mostly adipose tissue, it has less effect on the BMR.
3. Gender — The main reason why gender affects BMR is that men usually have more muscle and less fat than women, due to their different hormone patterns.
4. Age — The BMR increases during times of rapid growth, such as childhood and adolescence, when the amount of lean tissue, and the size of organs, is increasing. As an adult gets older, there is a gradual decrease in the energy requirements, mainly because the amount of lean tissue decreases with age.
5. Pregnancy and lactation — Because they are stages of growth, pregnancy and lactation both increase the BMR.
6. Illness and fever — Many illnesses increase the BMR because inflammation and the immune response increase the metabolic activity of the body tissues. Fever causes an increase in heat production and this also increases the BMR.
7. Physical activity — Energy needed during physical activity is not part of the BMR, which measures energy expenditure at rest. However, people who are very active usually have more lean muscle, and this means that their BMR is higher. Also, energy expenditure stays higher for a significant time *after* exercising, so even at rest the BMR is measurably higher for a while after exercise. These two effects mean that BMR may be significantly higher in someone who exercises regularly or works in a physically demanding job.

Despite all of these factors that help to predict BMR, there are big differences between individuals; a group of healthy

These two men are a similar age, and both weigh about 95 kilograms. Do they have the same energy expenditure?

people of the same age and gender, with similar weight and body composition, will not have identical BMRs, even with the same food intake and activity level. The variation within such a group may be as much as 10 per cent.

Energy balance

Your body can be very economical with energy. In times of starvation, your body uses energy far more efficiently, reducing requirements to make fuels last as long as possible.

Energy is measured in kilojoules (kJ) and is obtained from the energy-containing nutrients in the diet.

TABLE 7.1

NUTRIENT	ENERGY SUPPLIED, PER GRAM
Lipids/fats	37 kJ
Alcohol[(a)]	29 kJ
Protein	17 kJ
Carbohydrates	16 kJ

[(a)] Although not technically a nutrient, alcohol supplies energy.

Your blood brings the energy to your body cells in the form of amino acids, glucose or fatty acids. These may have come from the food you have just eaten, or from your body's stores of protein, glycogen or triglycerides. The basic energy balance equation is expressed as:

energy intake (obtained from the diet) = energy expenditure (metabolism + physical activity) + stored energy (adipose tissue and cellular stores)

According to this equation, for weight to remain constant, the energy intake should equal the energy expended. If intake is less than expenditure, some energy is used from the body stores and weight loss will occur. Significantly inadequate intake is recognised by the body as starvation, and several processes start to occur to conserve energy:

- reduction in BMR
- reduction in activity level and loss of interest in exercising
- reduction in body temperature, blood pressure and heart rate
- change in the body's use of different nutrients to conserve body protein.

If energy intake is higher than expenditure, the unused part of the intake is directed to storage, so body weight increases. Unused fat from the diet is easily stored as triglycerides in adipose tissue. Unused carbohydrate is usually stored as glycogen in the liver and muscle tissues. However, there is a limit to the amount of glycogen that can be stored. If there is a very large excess of carbohydrate in the diet, some may be converted to fat. This is an inefficient process, however, and body fat usually comes from fat in the diet rather than carbohydrate. Eating too much of any **macronutrient** will cause this fat to be stored.

How does the body use energy?

Getting energy from food is complicated, involving many stages and many different enzymes and co-factors. Proteins, lipids and carbohydrates each follow a different pathway of chemical reactions. The B-group vitamins are important in these reactions (see page 112 in chapter 6).

The main fuel for your body is glucose. Glucose is transported through the blood, along with oxygen from your lungs, to the cells that need energy. Glucose is oxidised (burned) to release energy, also producing water and carbon dioxide, which is taken back to the lungs so you can breathe it out. The process can be greatly simplified in this equation:

$$\underset{(C_6H_{12}O_6)}{\text{glucose}} + \underset{(O_2)}{\text{oxygen}} \longrightarrow \text{energy} + \underset{(CO_2)}{\text{carbon dioxide}} + \underset{(H_2O)}{\text{water}}$$

The energy is used by your body for different purposes including:

- mechanical energy, for movement. Both the voluntary muscles (such as your arm and leg muscles) and the involuntary muscles (such as the muscles that move food through your gut) need energy for movement.
- chemical energy, to make reactions occur in your body. Energy is needed to convert one substance to another, and to build body tissue out of its components.
- electrical energy, to send messages along nerves and muscles
- heat energy, to keep your body warm.

When there is not enough glucose present to meet your cells' energy needs, glycogen stores can be broken down to produce more energy. Alternatively, your body can use fat as a fuel, or it can break down protein. The main purpose of fat in the body is as an energy source, so it is better for your body to use this. In contrast with fat, protein has many important jobs in your body, so it is best if this can be conserved rather than used for fuel.

Recommended energy intakes

We have seen that many different factors affect an individual's energy expenditure. Average energy requirements for different groups have been calculated by the National Health and Medical Research Council to provide general recommendations for Australians (tables 7.2 and 7.3). These

TABLE 7.2 Recommended energy intake for adolescents aged 12–18 years (kilojoules per day)

AGE (YEARS)	MALES		FEMALES	
	VERY SEDENTARY	MODERATELY ACTIVE	VERY SEDENTARY	MODERATELY ACTIVE
12	8 200	10 500	7 400	9 500
13	8 700	11 200	7 800	10 000
14	9 300	11 900	8 100	10 300
15	9 900	12 600	8 200	10 600
16	10 300	13 200	8 400	10 700
17	10 700	13 700	8 400	10 800
18	10 900	14 000	8 500	10 900

Source: Data derived from National Health and Medical Research Council.

TABLE 7.3 Recommended energy intake for adults (kilojoules per day)

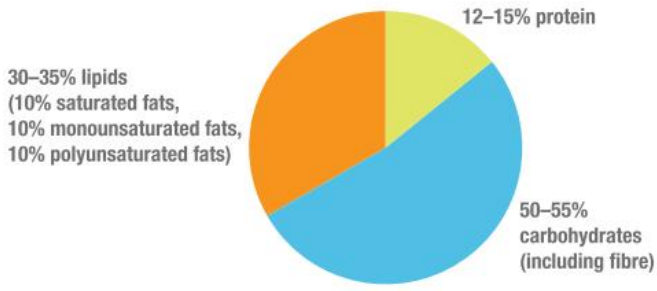
AGE (YEARS)	HEIGHT (CM)	WEIGHT (KG)	MALES		FEMALES	
			VERY SEDENTARY	MODERATELY ACTIVE	VERY SEDENTARY	MODERATELY ACTIVE
19–30	150	50	–	–	7 100	9 200
	170	64	9 700	12 400	8 400	10 800
	190	79	11 100	14 200	9 700	12 500
31–50	150	50	–	–	7 300	9 400
	170	64	9 400	12 100	8 000	10 300
	190	79	10 400	13 400	8 700	11 200
51–70	150	50	–	–	6 900	8 900
	170	64	8 600	11 100	7 600	9 800
	190	79	9 600	12 400	8 400	10 800

Source: Data derived from National Health and Medical Research Council.

are classified according to activity level, ranging from very **sedentary** (inactive), to light activity, moderate activity and heavy or vigorous activity.

It is recommended that energy intake be obtained from protein, carbohydrates and lipids in the ratios as shown in the diagram below.

Ideal proportions of macronutrients in diet



REVIEW QUESTIONS

Remember

1. Define BMR in your own words.
2. List four factors that affect BMR.
3. Draw connecting lines between these three columns to match the following:

Macronutrient	Energy yield (per gram)	Stored as
Carbohydrate	37	Glycogen
Alcohol	29	Muscle
Fat	17	Not stored (toxic)
Protein	16	Adipose tissue

Apply

4. Carol is a 45-year-old woman, with a total daily energy expenditure of 7000 kilojoules, who wants to lose 3 kilograms in weight. She decides to do this by fasting (eating nothing and drinking only water) for a few days. She reads that 1 kilogram of adipose tissue (including the cells and proteins as well as the fat content) is equivalent to 32 200 kilojoules.
   - **a)** Calculate how long it would take Carol to reach a negative energy balance of 32 200 kJ, if her energy expenditure stays the same.
   - **b)** Carol does not lose 1 kilogram in weight when she fasts for this length of time. Why not?
   - **c)** What other processes will occur or not occur in Carol's body during this time?
   - **d)** What are some reasons why this might not be a good way to lose weight?
5. Write down all the foods you ate yesterday, classifying them into protein, lipid and carbohydrate foods. Compare your list with the pie chart above. How did your intake compare with the recommended proportions of macronutrients?

Do an activity

6. Find out how an individual's BMR is measured.
7. Log in to **www.jacplus.com.au** and locate the *Weight loss diets* weblink for this chapter.
   Encouraged by claims made in advertising for weight loss products, people trying to lose weight often forget the energy balance equation. Usually such advertising promotes the idea that there is a 'magic' ingredient or formula that makes the weight loss happen. Look at the diet featured on this web page and answer the following questions.
   - **a)** What is the 'magic' part of this diet?
   - **b)** How much does this programme cost?
   - **c)** What is the real reason that people are likely to lose weight on this diet?
   - **d)** Diets like this usually claim amazing weight loss results. How much weight could be lost in a week, according to this web page?
   - **e)** Is this amount of weight loss likely to be adipose tissue? Explain. (You may need to do a calculation to obtain your answer.)
   - **f)** List some of the disadvantages of this diet.

eBook*plus*
Weblink

Nutrient requirements throughout the life cycle

Nutritional requirements change throughout life. People of different ages need different amounts and types of food to meet their individual needs.

Pregnancy and lactation

A pregnant woman needs to eat the right foods to keep herself healthy, as well as providing for the growth and development of the foetus. If she does not have enough of particular nutrients in her diet, her body stores are used to meet the foetus's needs, and her health may suffer. If her stores are inadequate, the baby may have an increased chance of low birth weight and even some birth defects. These extra requirements mean that a pregnant woman needs to increase her intake of a number of nutrients. It is also important to avoid substances that are toxic to the foetus, such as alcohol, nicotine and other drugs. Pregnancy during the teenage years poses a special risk to health, because the mother's body has not completed its own development. Her diet therefore needs to provide for growth and development in both the mother and the foetus, and teenage pregnancy requires close medical supervision.

Nutritional requirements during pregnancy

Protein

Protein is required for growth of the foetus and placenta. The uterus, breasts and blood supply also increase in size and this requires extra protein. The protein must be complete protein for all these processes to occur normally. A woman who follows a **vegetarian** or **vegan** diet may need to take care to combine complementary proteins so that she gets enough complete protein in her diet.

Energy

A pregnant woman experiences an increase in her BMR due to the increased metabolic activity in her own body and because of the growth and development of the foetus. This

CASE STUDY

TWO A DAY SAFE LIMIT ON DRINKS

by JILL STARK

Adults will be advised that more than two drinks a day is a health risk, and teenagers and pregnant women will be warned not to drink at all under sweeping changes to Australia's alcohol guidelines.

Amid estimates that 2 million Australians are risking brain damage through dangerous drinking, the new Federal Government advice will be released today. Anti-alcohol campaigners have heralded the changes as 'the most stringent safe-drinking guidelines in the world'.

Until now, men have been told they could have six drinks a day, and women four, without risking long-term harm.

But the National Health and Medical Research Council's revised guidelines say both men and women should limit themselves to two drinks a day.

Expectant mothers, who were previously advised that up to seven drinks a week was safe, will now be warned there is no safe level of alcohol consumption.

The same advice will be given to women trying to conceive.

And, for the first time, explicit advice will be given for under-15s not to drink at all. The council says 15- to 17-year-olds should only drink under parental supervision. Its advice comes amid growing concern over foetal alcohol syndrome and the effects of drinking on the adolescent brain.

A committee of medical experts has analysed scientific research from around the world over the past year to draft the three new guidelines, which have been reduced from 11 in 2001.

The chairman of the committee, Jon Currie, said the pregnancy advice brought Australia into line with Britain and the US.

'We know alcohol is a toxin and we cannot find a limit at which it is safe during pregnancy, because even at relatively low levels there are still some studies showing developmental changes,' said Professor Currie, director of addiction medicine at St Vincent's Hospital, Melbourne. 'Not drinking provides you with the safest option.'

Source: The Sydney Morning Herald, 13 October 2007.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *nutritional requirements during pregnancy* to complete the tasks ahead.

1. What is a *safe* quantity of alcohol for a woman to drink leading up to and during her pregnancy?
2. What are the risks of consuming alcohol in pregnancy?
3. What other health problems can occur with excessive alcohol intake?

increase in BMR is often balanced by a decrease in activity during pregnancy, so that it is not usually necessary to increase energy intake significantly.

Vitamins

The increased metabolic activity means that greater amounts of B-group vitamins are needed, as these are all involved in releasing energy from proteins, lipids and carbohydrates. Vitamin C is important for forming strong healthy tissue in the foetus, as well as helping with iron absorption. Folate and B_{12} are both involved in forming normal blood cells.

Minerals

Anaemia is common in pregnancy because requirements for iron are more than doubled due to the need for iron in forming new red blood cells. To compensate for this, the body's ability to absorb iron increases during pregnancy. Despite this, many pregnant women may still need an iron supplement to meet their needs. Calcium requirements also increase during pregnancy for the development of bones and teeth in the foetus.

Nutritional requirements during lactation

Producing breast milk (**lactation**) is nutritionally more demanding than pregnancy, requiring increases in nearly all nutrients. Milk is the infant's energy source, and the mother's body requires energy to produce it. Breast milk is an energy-rich source of nutrition for the infant, so considerable amounts of energy are required by the woman's body to produce it. As in pregnancy, complete protein is important.

TABLE 7.4 Recommended dietary intake of important nutrients for pregnant or lactating women (amounts per day)

NUTRIENT	AMOUNT REQUIRED BY WOMEN DURING:		
	ADULTHOOD	PREGNANCY	LACTATION
Energy	about 7000–10 000 kJ	extra 0–2000 kJ	extra 2000–2100 kJ
Protein	46 g	60 g	67 g
Vitamin C	45 mg	60 mg	85 mg
B-group vitamins: thiamin	1.1 mg	1.4 mg	1.6 mg
niacin	14 mg	18 mg	17 mg
riboflavin	1.1 mg	1.4 mg	1.6 mg
pyridoxine (B_6)	1.3 mg	1.9 mg	2.0 mg
folate	400 µg	600 µg	500 µg
vitamin B_{12}	2.4 µg	2.6 µg	2.8 µg
Iron	18 mg	27 mg	9 mg
Phosphorus	1000 mg	1000 mg	1000 mg
Calcium	1000 mg	1000 mg	1000 mg

Source: Data derived from National Health and Medical Research Council.

REVIEW QUESTIONS

Remember

1. Why is an inadequate diet dangerous for a pregnant woman?
2. List three reasons why protein requirements increase during pregnancy.

Apply

3. Look at table 7.4 and note the vitamins for which the requirement is higher for pregnancy than for lactation. Suggest why the requirement is higher in pregnancy but not lactation. (*Hint:* Look back at chapter 6 to recall what these vitamins do in the body.)
4. A woman may need to eat an extra 14 grams of protein during pregnancy, and an extra 21 grams during lactation. What sorts of foods would provide this much protein? Using tables of food composition, work out how a woman could obtain this extra protein, using some common protein foods.

Do an activity

5. Devise a fact sheet for pregnant women that:
   a) explains how and why their nutritional requirements are different
   b) offers five main-meal ideas that meet their nutritional needs.

Infancy

Infancy is the period between birth and two years of age. This is a period of dramatic growth and development, in which nutritional requirements also change markedly.

Birth to 6 months

An infant doubles its birth weight within the first six months of life, so it needs adequate nutrition for this growth, to form new muscle, bone, blood and body tissues. Normal development cannot occur if the infant does not receive the right nutrients. Breast milk is the ideal way to provide these, although breast milk alternatives (infant formulas) also promote optimal nutrition when used correctly.

Breast milk

Breast milk is the best food for infants because it provides all the required nutrients in the correct proportions for a human baby, in forms that are easily digested and absorbed by an immature digestive system. Unlike formula, breast milk changes its composition to meet the needs of the infant:

- Days 1–3: **Colostrum** is produced. This is a sticky yellow liquid containing large amounts of antibodies to help the infant fight infections while its immune system is still developing. Colostrum is high in protein and low in fat, and acts as a **laxative**, starting the infant's gut working normally.
- Days 3–10: After about three days, transitional milk is produced. Between the third and tenth days, transitional milk thins out as colostrum production decreases and mature milk is produced.
- After day 10: Colostrum production ceases and mature milk is produced. Mature milk allows for the optimal growth of the infant by providing all the nutrients in appropriate amounts and in a readily available form. The main protein in mature breast milk is lactalbumin. Breast milk proteins form a soft curd in the stomach that is easily digested. The lipids in breast milk are a mixture of saturated, monounsaturated and polyunsaturated fats, as well as essential fatty acids. The carbohydrate in breast milk is lactose. Breast milk supplies all the vitamins and minerals, but some, such as vitamin D and iron, are present only in low levels and are affected by the mother's vitamin and mineral intake. However, an infant's absorption of the vitamins and minerals from breast milk is very efficient.

As we have seen, lactating women require increased amounts of many nutrients to produce breast milk. Information and encouragement are also important, since breastfeeding is a skill that has to be learned, and a lack of support (particularly early on) can lead to ceasing breastfeeding unnecessarily.

The composition of breast milk also changes during each feeding session. The milk is more watery to begin with and becomes richer and creamier as the infant continues to feed. This allows the infant's intake to adjust according to its needs, having a shorter feed just to quench thirst or a longer feed to satisfy hunger. In this way, breast milk provides for the complete food and fluid needs of the infant.

Breast milk alternatives

Cow's milk is not suitable for human babies. The composition of cow's milk provides for the needs of a baby cow, which are very different from those of human infants; for example, newborn calves can stand and walk shortly after birth, so their energy and nutrient needs are very different from human babies' needs.

TABLE 7.5 Comparison of breast milk and cow's milk

BREAST MILK	COW'S MILK
• Provides immunoglobulin proteins	• Does not provide immunoglobulin proteins. These are destroyed by pasteurisation.
• Has appropriate amounts of calcium and phosphorus for a human baby	• Has four times more calcium and six times more phosphorus than breast milk
• Has more carbohydrate (as lactose) and less protein than cow's milk	• Has less carbohydrate and more protein than breast milk
• Is sterile and already warm when fed from the breast	• Is not sterile or warm
• Composition of the milk changes over time and during each feed	• Composition does not change
• Flavour of the milk changes according to the mother's diet. This variety may help the infant accept new foods when starting on solids.	• Flavour does not change

Many different infant formulas are available when a mother is unable to, or decides not to, breastfeed. These are based on either cow's milk or soy milk, modified to meet the needs of a human infant. They provide complete nutrition as long as they are prepared correctly. The equipment used in preparation, and the water used to mix the formula, must be sterilised before use. The formula needs to be refrigerated if it is not to be used immediately, and discarded after 24 hours. Formulas should not be reheated.

Weaning

After about six months of age, an infant's needs can no longer be met by breast milk alone, and solid foods are introduced. Ideally, breast milk, rather than other drinks, remains the main fluid in the diet for at least the first year of life. **Weaning** is the process of reducing milk intake as an infant progresses to a varied solid diet.

First foods

Semi-solid foods that are smooth in consistency and bland in flavour are introduced in small quantities when the infant seems ready. Signs of readiness include good control of the head and neck, willingness to take food into the mouth without pushing the tongue forwards, and interest in other family members' food. Baby cereals, puréed fruits and puréed vegetables are usually the first foods introduced. Rice-based, ready-made cereal products are useful because of the low chance of **food allergy** or **intolerance**. These consist of a powder that is mixed with a little water, breast milk or formula to make a smooth wet paste. Other common first foods are puréed apple or pear, mashed banana or avocado, or puréed pumpkin or potato. Then new foods — other vegetables, fruits and cereals, puréed meats, cooked egg yolk, and dairy foods — are introduced one at a time, so that the parents can easily see which ones the infant likes and so that any allergy or intolerance can be identified.

Smooth, bland foods are introduced around six months of age, when the baby shows signs of readiness to start solids.

Foods that are more commonly associated with allergy are not introduced until later in the first year of life (usually at 9–12 months of age). These include nut products, cooked eggwhites, and seafood. The infant gradually manages lumpier textures and larger pieces of food, including finger

TABLE 7.6 Recommended dietary intake of important nutrients for infants (amounts per day)

NUTRIENT	AMOUNT REQUIRED FOR INFANTS AGED:	
	0–6 MONTHS	7–12 MONTHS
Energy	about 1800–2700 kJ	about 2500–3500 kJ
Protein	10 g	14 g
B-group vitamins: thiamin	0.2 mg	0.3 mg
niacin	2 mg	4 mg
riboflavin	0.3 mg	0.4 mg
Iron	0.2 mg	11 mg
Phosphorus	100 mg	275 mg
Calcium	210 mg	270 mg

Source: Data derived from National Health and Medical Research Council.

foods. At 12 months, an infant can generally enjoy the same variety of foods as the rest of the family. Salt, sugar and other flavour enhancers are not recommended for infants.

Table 7.6 shows some of the recommended dietary intake (RDI) values for infants. The RDIs for infants aged 0–6 months are based on the composition of breast milk. For infants aged 7–12 months, values are based on a diet of breast milk plus other foods. Note that the RDI for iron is much lower for infants whose nutrition comes only from breast milk, because iron absorption from breast milk is so efficient, and because the baby's body stores of iron contribute significantly for the first few months. If formula is providing all of the nutrition, or when iron is obtained from other foods, the requirement for iron is much higher because much less of it is absorbed. For this reason, infant formula contains much more iron than breast milk.

Adolescence

Adolescence is a time of rapid growth and major physical change, from child to mature adult. The nutritional demands of the adolescent are greatly increased during this time to provide for the growth of bones, muscles and tissues and an increase in the volume of blood.

Nutritional requirements of adolescents

Adolescents need adequate nutrition to maintain good health and to allow for growth and a high activity level. This means that intakes of all nutrients need to increase, particularly proteins, B-group vitamins, calcium and iron.

Energy

Energy requirements are higher in adolescence, due to an increase in the BMR (due to growth) and often a higher activity

REVIEW QUESTIONS

Remember

1. What are three signs that an infant is ready to start on 'first foods'?
2. Ideally, until what age should an infant receive only breast milk?
3. Why is the RDI for iron so low in breast-fed infants?

Apply

4. Look at the statements below and identify whether they are true about breast milk or formula, or both, or neither.

Expensive	breast milk / formula / neither
Needs to be warmed before use	breast milk / formula / neither
Requires skill and information for successful use	breast milk / formula / neither
May be difficult to obtain	breast milk / formula / neither
Is a wrong way to feed an infant	breast milk / formula / neither
Contains antibodies	breast milk / formula / neither
Contains all the necessary nutrients for growth	breast milk / formula / neither
Is sterile	breast milk / formula / neither

5. List some factors that need to be considered when designing the meal plan of an infant who has started on 'first foods'.

Do an activity

6. Find a commercially available baby food product suitable for an infant aged 9–12 months. Using similar ingredients, prepare a homemade version.
   - **a)** Compare the cost of the commercial baby food with the same weight of the homemade dish.
   - **b)** Using food tables, analyse the nutrient content (protein, thiamine, riboflavin, niacin, iron and calcium) of your homemade dish, and compare this with the commercial product. How do they compare with the RDIs in table 7.6?
   - **c)** Compare the appearance, flavour and texture of both meals.
   - **d)** What are some factors that determine whether parents choose to buy or make foods at home for their infant?

level. Once an individual has stopped growing, a lower energy intake is needed to prevent sudden weight gain.

Protein and B-group vitamins

Protein is required for building new body tissue, such as muscles, during growth. This increases the demand for the B-group vitamins because they are involved in protein synthesis and in releasing energy from proteins, lipids and carbohydrates.

Minerals

Adolescents require higher intakes of some minerals, particularly calcium, phophorus and iron. Calcium and phosphorus are required for bones to grow longer and thicker; inadequate intake at this time may affect future bone strength. Additional iron is needed to supply the increased blood volume and muscle mass. Iron requirements are further increased in girls when they start menstruating.

TABLE 7.7 **Recommended dietary intake of important nutrients for adolescents (amounts per day)**

NUTRIENT	AMOUNT REQUIRED FOR:			
	FEMALES		MALES	
	9–13 YEARS	14–18 YEARS	9–13 YEARS	14–18 YEARS
Protein	35 g	45 g	40 g	65 g
B-group vitamins: thiamin	0.9 mg	1.1 mg	0.9 mg	1.2 mg
niacin	12 mg	14 mg	12 mg	16 mg
riboflavin	0.9 mg	1.1 mg	0.9 mg	1.3 mg
Iron	8 mg	15 mg	8 mg	11 mg
Phosphorus	1250 mg	1250 mg	1250 mg	1250 mg
Calcium	1000–1300 mg	1300 mg	1000–1300 mg	1300 mg

Source: Data derived from National Health and Medical Research Council.

CASE STUDY

POOR DIET PUTS TEENAGERS' HEALTH AT RISK

A quarter of Australian teenagers eat fast food every day and more than a third hardly ever eat fruit, a Deakin University study has found.

Researchers with Deakin's Centre for Physical Activity and Nutrition Research surveyed more than 3800 secondary school students aged 12–15 years to evaluate their food intake patterns. They found that the diets of a significant number of adolescents fell short of the recommendations outlined in the Australian Guide to Healthy Eating.

'Teenagers need to be eating a variety of foods from the five food groups — breads/cereals, lean meat and meat substitutes, vegetables, fruit and dairy — every day,' Professor David Crawford said.

'Our study found that most teenagers are far from having diets that will provide their growing bodies with the nutrients they need to ensure their long term health and wellbeing.'

Extra foods — such as fast foods, energy-dense snacks and sugar-sweetened drinks — were consumed by nearly 90 per cent of the teenagers on a daily basis.

Professor Crawford said that this finding was of particular concern.

'The daily inclusion of fast foods coupled with the omission of a variety of healthy foods is setting many teenagers up for serious health problems such as obesity and the psychosocial and other health-related consequences associated with this condition such as diabetes,' he said.

The study found that only one third of teenagers ate at least one food from each of the five food groups every day and just over half ate from each food group 'most days'.

From the five food groups, bread and cereals were the most commonly consumed food group. These were followed by vegetables, dairy foods, meat/eggs/nuts/legumes with fruit the least consumed.

Teenagers in regional areas tended to eat more vegetables and less fast foods than their metropolitan counterparts. Girls' diets included more fruit and less fast food and sweetened drinks than boys, with boys consuming more meat and meat alternatives. On the positive side, 87 per cent of the adolescents drank water (including low energy-dense drinks) every day.

Professor Crawford said that the results of the study highlight the need for more public health initiatives targeted at adolescents.

'The next phase of the research, which is currently underway, will explore the key influences on teenagers' eating habits, and will be crucial to inform efforts to promote healthy eating in this group,' he said.

The study was funded by the Australian Research Council and the William Buckland Foundation. The results will be published in the *Asia–Pacific Journal of Clinical Nutrition* later this year.

Source: Deakin University, 11 April 2007.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *nutritional requirements during adolescence* to complete the tasks ahead.

1. Which food groups are most likely to be left out of adolescents' diets? Suggest three reasons why this might be the case.

CASE STUDY QUESTIONS

2. Why is there a gender difference in adolescents' eating habits? Is there a difference in social influences (whether in the peer group or at home) on girls and boys that might explain this?
3. The article implies that 'extra foods' (fast foods, energy-dense snacks and sugar-sweetened drinks) are replacing healthy foods in adolescents' diets. See if you can suggest ways of reversing this process — choose four of the 'extra foods' that you or your friends eat most often. Think about when and where you are most likely to eat these foods, and complete the following table to identify alternative food choices — two examples have been done for you.

'EXTRA FOOD'	WHERE EATEN/WHERE OBTAINED	A HEALTHIER ALTERNATIVE AVAILABLE IN THAT SITUATION	KEY NUTRIENTS THAT THIS PROVIDES
Cola drink	Out with friends, bought from shop	Flavoured milk	Calcium, protein
Chocolate biscuits	Morning tea break, brought from home	Fruit	Fibre, water-soluble vitamins

Nutritional requirements of adults

The nutritional requirements of adult men change very little between the ages of 19 and 70 years. This is also true for women for most nutrients; **menopause** alters women's requirements for some nutrients. When menstruation ceases, iron requirements are decreased, but the risk of osteoporosis increases so calcium requirements are higher. Looking back at table 7.3 on page 127, you can see that energy requirements decrease through middle age, and weight gain can become a problem if intake does not decrease too.

Nutritional requirements of elderly people

Ageing involves some physical changes that can affect nutritional intake. Requirements increase for some nutrients, while requirements for others may decrease. Elderly people experience a further reduction in BMR, and energy intake must decrease to avoid weight gain. Protein requirements increase slightly, and it becomes more important to ensure that the protein is complete, since the elderly may not store amino acids as effectively as younger people.

As in other stages of the life cycle, the calcium and iron intakes of both men and women must be maintained to avoid osteoporosis and anaemia. All other minerals and most vitamins are adequately supplied by a balanced and varied diet, but sometimes folate and vitamin C deficiencies develop in the elderly.

Some problems are common in ageing and these can affect nutrition. Reduced mobility and eyesight may make it more difficult to cook and to shop regularly for fresh food. Reduced taste sensitivity can lead to a loss of interest in

TABLE 7.8 Recommended dietary intake of important nutrients for men and women (amounts per day)

NUTRIENT	AMOUNT REQUIRED FOR:		
	FEMALES		MALES
	19–50 YEARS	AFTER MENOPAUSE	19–70 YEARS
Protein	46 g	46 g	64 g
B-group vitamins: thiamin niacin riboflavin	1.1 mg 14 mg 1.1 mg	1.1 mg 14 mg 1.1 mg	1.2 mg 16 mg 1.3 mg
Iron	18 mg	8 mg	8 mg
Calcium	1000 mg	1300 mg	1000 mg

Source: Data derived from National Health and Medical Research Council.

eating, so ensuring adequate variety and flavour becomes much more important. Eating alone can also reduce motivation to cook and eat a healthy diet. Constipation is more common in the elderly due to changes in the gut, reduced fluid intake (due to changes in the thirst urge) and reduced activity level. It is important to maintain an adequate intake of fluid and fibre to avoid this, but tooth loss and dentures can make it difficult to chew hard or fibrous foods such as raw apples, carrots and salad vegetables. Avoiding these foods may lead to an inadequate fibre intake, increasing the risk of constipation.

Good nutrition can help to optimise the wellbeing of older people. Nutrient-dense foods, with increased variety and flavour, are important. Companionship during shopping and cooking, and at mealtimes, also helps to encourage healthy eating.

TABLE 7.9 Recommended dietary intakes of important nutrients for elderly men and women (amounts per day)

NUTRIENT	AMOUNT REQUIRED FOR:	
	FEMALES > 70 YEARS	MALES > 70 YEARS
Protein	57 g	81 g
B-group vitamins:		
thiamin	1.1 mg	1.2 mg
niacin	14 mg	16 mg
riboflavin	1.3 mg	1.6 mg
Iron	8 mg	8 mg
Calcium	1300 mg	1300 mg

Source: Data derived from National Health and Medical Research Council.

REVIEW QUESTIONS

Remember

1. Why do energy requirements decrease after adolescence, in middle age and again for the elderly?
2. List six reasons why the elderly might have a poor diet.

Apply

3. 'The nutritional needs of adolescents differ from those of children.' Write a paragraph to discuss this statement, mentioning particular nutrients.
4. Decide whether each of the following statements is true or false.
   - **a)** Adolescent boys do not have an increased iron requirement because they do not menstruate.
   - **b)** Older people use protein differently.
   - **c)** Calcium is important for bone strength throughout life.
   - **d)** B-group vitamins are needed in larger amounts when energy intake increases.
   - **e)** Adults have a relatively low protein requirement, needing it only for body maintenance.
   - **f)** Calcium requirements are affected by hormones.

Do an activity

5. Elderly people may require changes to their diets to meet their needs as they age. Prepare and present a two-course meal rich in iron, calcium and fibre. Explain why you chose each food. (You might like to invite several grandparents or elderly neighbours to the school to share the meal.)

Planning and evaluating nutritious meals through the life cycle

It is important that all individuals are provided with the essential nutrients necessary for their particular requirements. Planning diets and meals involves thinking ahead. Here are some factors to consider when planning a meal:

1. Who will be eating the meal? Consider their nutritional needs. For example, older people, or those wishing to lose weight, may need smaller serves of more nutrient-dense foods. Those who are growing, or who have a high level of activity, may need larger amounts of food to meet their energy needs.
2. What resources are available for this meal? Consider how much time is available for shopping and meal preparation. Seasonal availability of particular ingredients is another factor. How much money is available? Are there any limitations on the food preparation facilities? For example, if the kitchen lacks an oven, this will affect what cooking techniques can be used. All of these factors help in choosing the foods and the cooking methods.
3. When will the meal be prepared? When and where will it be eaten? For example, a meal might be cooked in advance, or it might be eaten immediately after it is prepared. Foods might be eaten at home, or while travelling, or for lunch at school or work.

4. What will be eaten? This brings together all of the previous factors. It is also important to take into account the personal likes and dislikes of the individuals who will eat the meal. Foods not eaten have no nutritional value at all!

There are several tools that can be used in ensuring that a meal or diet is nutritionally balanced. These include the official Nutrient Reference Values, and various food selection guides.

Nutrient Reference Values tables

Log in to **www.jacplus.com.au** and locate the *Nutrient Reference Values for Australia and New Zealand* weblink for this chapter.

eBookplus Weblink

Tables of Nutrient Reference Values (NRVs) for Australia and New Zealand cover 38 nutrients: energy, protein, fats, carbohydrates, water, 14 vitamins and 14 essential minerals and **trace elements**. The tables are updated by the National Health and Medical Research Council to include the latest research data from around the world and information gathered through large surveys such as the National Nutrition Survey.

The NRVs provide information on:

- The RDI (Recommended Dietary Intake), which is the amount of a nutrient that should be adequate for the majority of people in a particular group.
- The EAR (Estimated Average Requirement) is the amount of a nutrient that is estimated to meet the needs of about half of the healthy individuals in a particular group.
- The AI (Adequate Intake) is an average daily nutrient intake value that is used when it is not possible to determine an RDI. For example, it may be based on observations of the intakes of normal people, which seem to be adequate for maintaining good health.
- The UL (Upper Level) is the highest average intake of a nutrient that is thought to be safe, without any risk of adverse effects on health.
- The SDT (Suggested Dietary Target) is a daily average intake of a nutrient that may help to prevent disease, because of protective effects on the body.

To assess whether an individual's dietary intake is adequate, the food composition tables and the nutritional information on food packages can be compared with the NRVs to indicate whether nutritional needs are being met. Computer software is available to make this easier.

Current food selection guides

Rather than analysing your food intake every day using the NRVs, there are some simpler ways to make sure that your diet is healthy. NHMRC's Dietary Guidelines for Australians are a set of general recommendations about healthy eating, based on scientific evidence about key health issues. Following these recommendations is a simple way to ensure that a diet is nutritious and balanced.

In the 1950s, nutritionists developed the idea of the Five Food Groups to make it easier for people to see whether they were achieving a balanced diet. Each of the groups was defined by particular essential nutrients; for a balanced diet it was necessary to have only some food from each group.

The five groups were:

- meat/poultry/fish/eggs
- dairy foods
- fruits/vegetables
- breads/cereals
- butter/margarine.

Later, these groups were rearranged into a pyramid form, to express the idea that some groups were required in larger amounts than others.

The current official food selection guide for Australia is the Australian Guide to Healthy Eating, which was developed by the Commonwealth Department of Health and Ageing in 1998 to reflect the multicultural nature of our population and food habits. It is shown as a pie chart to indicate how much of each food group to eat. It also incorporates recommendations from the Dietary Guidelines.

TABLE 7.10 Examples of different NRVs for retinol (vitamin A)

	ESTIMATED AVERAGE REQUIREMENT	RECOMMENDED DIETARY INTAKE	UPPER LEVEL	SUGGESTED DIETARY TARGET
Women	500 µg	700 µg	3000 µg	1220 µg
Men	625 µg	900 µg	3000 µg	1500 µg
Reasoning	• average amount required to maintain normal retinol levels in healthy people	• increased value to allow for individual variations in requirements	• high intakes may cause liver problems • birth defects occur with high intakes in pregnant women	• may reduce risk of heart disease, cancer and eye conditions • to obtain this effect, increase should be by replacing unhealthy foods with red or yellow vegetables, fruits, reduced-fat dairy foods and small amounts of vegetable oils

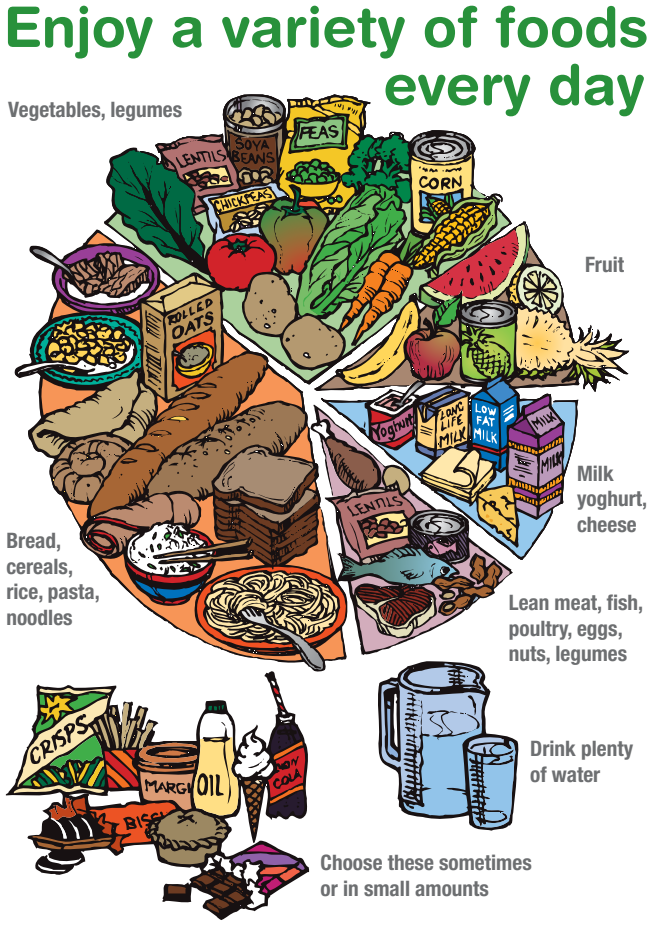
Source: Data derived from National Health and Medical Research Council.
Note: An AI is not included because an RDI value is available.

DIETARY GUIDELINES FOR AUSTRALIAN ADULTS	DIETARY GUIDELINES FOR CHILDREN AND ADOLESCENTS IN AUSTRALIA
Enjoy a wide variety of nutritious foods. • Eat plenty of vegetables, legumes and fruits. • Eat plenty of cereals (including breads, rice, pasta and noodles), preferably wholegrain. • Include lean meat, fish, poultry and/or alternatives. • Include milks, yoghurts, cheeses and/or alternatives. Reduced-fat varieties should be chosen, where possible. • Drink plenty of water. • Limit saturated fat and moderate total fat intake. • Choose foods low in salt. • Limit your alcohol intake if you choose to drink. • Consume only moderate amounts of sugars and foods containing added sugars. Prevent weight gain — be physically active and eat according to your energy needs. Care for your food — prepare and store it safely. Encourage and support breastfeeding.	Encourage and support breastfeeding. Children and adolescents need sufficient nutritious foods to grow and develop normally. • Growth should be checked regularly for young children. • Physical activity is important for all children and adolescents. Enjoy a wide variety of nutritious foods. Children and adolescents should be encouraged to: • eat plenty of vegetables, legumes and fruit • eat plenty of cereals (including breads, rice, pasta and noodles), preferably wholegrain. • include lean meat, fish, poultry and/or alternatives. • include milks, yoghurts, cheeses and/or alternatives. – Reduced-fat milks are not suitable for young children under 2 years, because of their high energy needs, but reduced-fat varieties should be encouraged for older children and adolescents. • choose water as a drink. – Alcohol is not recommended for children. • limit saturated fat and moderate total fat intake. – Low-fat diets are not suitable for infants. • choose foods low in salt. • consume only moderate amounts of sugars and foods containing added sugars. Care for your child's food — prepare and store it safely.

Source: Dietary Guidelines for Children and Adolescents in Australia and *Dietary Guidelines for Australian Adults,* National Health And Medical Research Council, 2003 (*Note:* Guidelines are not given in order of importance.)

Healthy Living Pyramid

Source: © The Australian Nutrition Foundation, Inc. (Nutrition Australia).



Australian Guide to Healthy Eating

Source: Australian Guide to Healthy Eating, prepared by the Children's Health Development Foundation, South Australia and Deakin University, Victoria, 1998. © Commonwealth of Australia. Reproduced by permission.

The Australian Guide to Healthy Eating does not suggest a number of serves from each food group. Instead, it shows the different groups as a proportion of an individual's total intake. This prevents confusion about what a serving size is for a particular food (although information on the number and size of serves is provided in other materials that are available to accompany the guide — see tables 7.11 and 7.12).

Other sources of information on healthy eating

Log in to **www.jacplus.com.au** and locate the *Information on healthy eating* weblinks for this chapter.

eBook*plus*
Weblink

TABLE 7.11 Sample serving sizes for foods in each of the five food groups

BREAD, CEREAL, RICE, PASTA	VEGETABLES AND LEGUMES	FRUIT	MILK, YOGHURT, CHEESE	MEAT, POULTRY, FISH, EGGS, NUTS, LEGUMES
• 2 slices bread • 1 medium bread roll • 1 cup cooked rice, pasta or noodles • 1 cup porridge • 1⅓ cups breakfast cereal flakes • ½ cup muesli	• 75 g fresh or ½ cup cooked vegetables • 75 g uncooked or ½ cup cooked dried beans, peas or lentils • 1 cup salad vegetables • 1 medium potato	• 1 medium piece of fruit (apple, banana, pear etc.) • 2 small pieces of fruit (apricot, kiwifruit, plum etc.) • 1 cup diced canned fruit • ½ cup juice • 1 tablespoon dried fruit (sultanas etc.)	• 250 mL milk (fresh or reconstituted) • ½ cup evaporated milk • 40 g (2 slices) cheese • 200 g (1 tub) yoghurt • 250 mL custard	• 65–100 g cooked meat or chicken • ½ cup cooked mince • 2 small chops • 2 slices roast meat • 75 g uncooked or ½ cup cooked dried beans, peas or lentils • 80–100 g cooked fish fillet • 2 small eggs • ⅓ cup nuts • ¼ cup seeds

TABLE 7.12 Number of daily servings recommended to achieve a healthy diet

	ENERGY REQUIREMENT	BREAD, CEREAL, RICE, PASTA, NOODLES	VEGETABLES	FRUIT	MILK, YOGHURT, CHEESE	MEAT, FISH, POULTRY, EGGS, NUTS, LEGUMES	EXTRAS
Children 4–7 years	6400–8300 kJ	3–4	4	2	3	0.5–1	1–2
Children 8–11 years	7700–9800 kJ	4–6	4–5	1–2	3	1–1.5	1–2
Adolescents 12–18 years	8100–13 500 kJ	4–7	5–9	3–4	3–5	1–2	1–3
Women 19–60 years	7200–11 300 kJ	4–6	4–7	2–3	2–3	1–1.5	0–2.5
Pregnant women	8100–10 900 kJ	4–6	5–6	4	2	1.5	0–2.5
Lactating women	9200–12 300 kJ	5–7	7	5	2	2	0–2.5
Women > 60 years	6500–9300 kJ	3–5	4–6	2–3	2–3	1–1.5	0–2
Men 19–60 years	9000–13 700 kJ	5–7	6–8	3–4	2–4	1.5–2	0–3
Men > 60 years	7400–11 000 kJ	4–6	4–7	2–3	2–3	1–1.5	0–2.5

Source: Data derived from the Australian Guide to Healthy Eating.

Information on nutrition is available from a wide variety of sources. Some good places to look include:

- recognised nutrition associations, such as Nutrition Australia and the Dietitians Association of Australia
- groups that are directly linked to food research, such as the National Heart Foundation and the Cancer Council
- publications by well-known Australian dietitians and nutritionists, such as Rosemary Stanton or Catherine Saxelby
- nutrition composition databases available online such as:
  - NUTTAB, the Australian food composition database
  - Food and nutrient calculator, based in the USA. This has a wider range of data than NUTTAB, but watch out for foods that may have a different composition or serving size.

Information from sources like these is usually accurate and well-researched. However, it is important to take care when you obtain information from other sources, such as the media (newspapers, magazines, television and internet) as it may be incomplete or incorrect. Food labelling contains nutrition information that is regulated by law, but is sometimes difficult to interpret correctly. Many people without appropriate qualifications provide nutritional advice, and nutrition is an area where a lot of false claims are made in order to make money.

Preparation techniques to produce nutritious food

Your ability to produce nutritious food depends on several factors:

- your understanding of basic nutrition concepts, such as the variety of foods needed for a healthy diet
- selection and correct storage of fresh, good-quality produce to maximise the nutritional value of your ingredients (see pages 48–52 in chapter 3)
- your knowledge of preparation and cooking techniques to prevent the ingredients losing their nutritional value.

Variety of foods

We saw in chapter 6 that foods contain six types of nutrient: protein, carbohydrates, lipids, vitamins, minerals and water. No single food contains all of the nutrients in the right amounts, so a healthy diet has to provide a variety of different foods. The amounts of the different foods need to be balanced to provide enough of each nutrient.

Retaining the nutritional value of food: preparation techniques

Preparation of ingredients can make a big difference to the nutritional value of the resulting meal. Some simple but effective strategies include:

- making sure that fruit and vegetables are fresh and appropriately stored, particularly those to be eaten raw
- peeling fruit and vegetables only thinly, if at all, because the skin and surface layers contain valuable vitamins, minerals and fibre
- using larger pieces of fruit and vegetables if boiling them, because nutrients leach into cooking water in greater amounts when pieces are small
- avoiding overcooking, especially with vegetables
- removing excess fat from meats, or selecting lean cuts
- removing skin and fat from chicken.

Overcooking can cause changes in colour, texture and taste, which may also reflect a significant loss of nutrients.

Retaining the nutritional value of food: cooking methods

Many foods can be eaten raw, but cooking can:

- provide more variety in the diet, with different cooking methods or combinations of ingredients
- increase the palatability of foods
- improve the availability of some nutrients (they may be easier to digest or absorb if cooked)
- improve the safety of the food by killing bacteria that can cause illness
- lengthen the shelf-life of food by killing bacteria and enzymes that can spoil the food.

Cooking means applying heat to food to achieve a particular result. The different methods of cooking can be classified according to how that heat is applied. These methods — moist-heat cooking, dry-heat cooking and microwaving — have already been mentioned on page 61 in chapter 3, but here we discuss their impact on the nutritional value of the food.

TABLE 7.13 Nutritional aspects of moist-heat cooking methods

METHOD OF COOKING	HOW IT IS DONE	THINGS TO REMEMBER	NUTRIENTS AFFECTED
Boiling	A liquid, generally water, is heated to boiling point before the foodstuff is immersed. The liquid is then returned to a simmer.	• Do not add salt because it is unnecessary in the diet. • Do not add bicarbonate of soda because it speeds up vitamin C destruction and mineral leaching. • Keep cooking time to a minimum. • Use a small amount of water. • Use the cooking medium for stock.	• When fruits and vegetables are boiled, the water-soluble B-group vitamins and vitamin C will dissolve in the cooking water. Up to 25 per cent of the vitamin C will be lost. • Some minerals will also be leached into the cooking medium.
Parboiling	The food is partly cooked in boiling water for a short period (to soften the product). It can then be drained and cooked or frozen (for example, oven fries).	• Minimal cooking time for frozen vegetables is required because they have already been parboiled. • Excessive cooking will lead to continued loss of nutrients.	This process is relatively quick, so the loss of nutrients brought about by prolonged heating is reduced.
Steaming	Food is placed in a perforated container which is suspended above boiling water. The heat generated by the steam is responsible for cooking the foods.	Keep cooking time to a minimum to reduce the loss of heat-sensitive vitamin C.	Nutrient loss is reduced because the food is not in contact with the cooking medium.
Stewing	Food is cooked in a small amount of liquid — a long, slow process which occurs in a covered saucepan or casserole dish. Stewing can occur on the stove top or in the oven.	• Retain the cooking liquid as a sauce to retain leached minerals. • Stewing will make the protein of tougher, cheaper cuts of meat more tender and palatable. No loss of protein will occur.	• The presence of acids such as those found in tomatoes and citrus fruits can reduce vitamin C loss. • B-group vitamins will dissolve into the cooking medium. • The leaching of minerals will also occur.
Braising	This involves a combination of stewing and roasting. The foods are usually browned first, being fried in a little oil, then cooked slowly in a small amount of liquid. Meats and some starchy vegetables are cooked in this way.	• Use low heat, making sure the product is not overcooked. • Do not use excessive fat in the browning process.	• Nutrient losses due to the leaching of minerals and the dissolving of water-soluble vitamins will occur, but this is not a concern because the cooking liquid is usually served as an accompanying sauce.
Poaching	Food is slowly simmered in an open, shallow pan with a little water or milk.	Loss of water-soluble nutrients is minimised if the cooking medium is used to make a sauce.	Water-soluble nutrients are lost into the cooking medium.

TABLE 7.14 Nutritional aspects of dry-heat cooking methods

METHOD OF COOKING	HOW IT IS DONE	THINGS TO REMEMBER	NUTRIENTS AFFECTED
Baking	Food is cooked in dry heat in an oven — a prolonged and even method of cooking whereby the food is left in one position and does not need attending during the cooking process.	Unnecessary fat can be added to the diet if excessive fat is used in the baking process.	• Heat-sensitive vitamins such as vitamin C can be destroyed. • Protein will be denatured and coagulate, but will not be lost.
Roasting	True roasting involves cooking foods either over or under a fire, such as on a spit. However, roasting is now seen as cooking meats, fish or vegetables in hot fat in an oven.	• The addition of fat in the cooking process can significantly add to the fat content of the diet. • Keep the cooking time short.	• B-group vitamins and vitamin C can be destroyed as a result of the pronged time required for roasting. • Fat-soluble vitamins (A, D, E and K) can be lost when the fat content of the food dissolves and drips away.

METHOD OF COOKING	HOW IT IS DONE	THINGS TO REMEMBER	NUTRIENTS AFFECTED
Grilling	The food is placed under or over a source of radiant heat, cooking quickly.	Fat will be added to the diet if the food product is basted with oil during the cooking process.	Fat-soluble vitamins can be lost through the melting of invisible fat which drips away.
Frying	Frying is considered to be a form of dry cooking because high temperatures are involved. Frying can involve shallow-frying, stir-frying or deep-frying.	• Excessive fat can be added to the diet if the food product is fried in a large quantity of fat or oil. Cooking oils and fats can be either saturated or unsaturated. Avoiding animal fats containing saturated fats as a cooking medium is recommended. • Stir-frying is the most nutritious method of frying.	Fat-soluble vitamins (A, D, E and K) can be lost. The B-group vitamins and vitamin C are safe because they do not come in contact with water in the frying process.

TABLE 7.15 Nutritional aspects of microwave cooking methods

METHOD OF COOKING	HOW IT IS DONE	NUTRIENTS AFFECTED
Microwaving	This is a unique method of cooking because the microwave oven produces no heat. Instead, the oven emits microwave energy that can penetrate up to 5 centimetres into the food. These microwaves cause the water molecules in the food to become agitated and move at more than 2000 million times per second. This process generates the heat which then cooks the food.	• Vitamin C loss is limited because long exposure to heat is reduced. • Water-soluble vitamins (B-group vitamins and vitamin C) can be lost. • Mineral leaching can occur if excessive liquid is lost during the cooking process.

Moist-heat cooking

Moist-heat cooking methods use liquid to apply the heat. This liquid might be water, milk, stock or steam. Examples of this method of cooking include boiling, poaching, parboiling, steaming, stewing and braising. Each of these methods has an effect on the nutritional values of the foods being cooked.

Dry-heat cooking

Dry-heat cooking involves applying heat directly to the food. Examples include baking, roasting, grilling and frying.

Microwave cooking

Microwave cooking uses lower energy waves to cook food. If the food is cooked in a liquid, nutrient losses are similar to those of moist-heat cooking. If no liquid is used, nutrient losses are much less.

When planning nutritious meals and diets, important factors to consider are:

- ingredients selected
- cooking methods used
- frequency and amount of the food consumed.

Look back at the Australian Dietary Guidelines discussed on page 137.

You can apply these recommendations when planning nutritious meals. Here are some ideas:

- Try different ingredients and new recipes to increase variety.
- Regularly choose wholegrain bread and pasta, and brown rice.
- Add some fruit or vegetables to each meal, and choose them as snacks, to increase fruit and vegetable intake.
- If vegetables are cooked using moist-heat methods, water-soluble vitamins may be lost into the cooking liquid. Use the cooking liquid in a sauce or soup so that the vitamins are not lost.
- Avoid deep-frying and basting with fats, and use cooking methods that do not add excess fat to the food. For many dishes, small amounts of oil can be used with a non-stick pan instead. Fat-soluble vitamins are retained better this way as they may otherwise dissolve in the frying fat.
- Use vegetable-based sauces (such as tomato) as a low-fat alternative to creamy sauces.
- Use reduced-fat substitutes for cream and sour cream; yoghurt or skim evaporated milk can work well in some recipes.
- Low-fat cheese can be used instead of full-fat cheese in many recipes.
- Use herbs, spices, garlic or lemon juice instead of salt to liven up the flavour of a dish.

REVIEW QUESTIONS

Remember

1. List four advantages of cooking foods rather than eating them raw.
2. Describe, in your own words, the meaning of EAR, RDI, UL and SDT.
3. How does the Healthy Living Pyramid differ from the current Australian Guide to Healthy Eating? List four differences and suggest a reason why each change was made.

Apply

4. Suggest two different ways of preparing each of the following foods. Choose one method that follows the recommendations of the Australian Dietary Guidelines (such as increasing fibre intake) and one that does not (such as increasing fat or salt intake). The first two are completed for you.

FOOD	RECOMMENDED	NOT RECOMMENDED
Potato	• Baked in its jacket and topped with grated low-fat cheese	• Thickly peeled, cut into thin strips, deep-fried and served with plenty of salt
Apple pie	• Made with sheets of filo pastry thinly brushed with oil • Filled with lightly cooked, thinly peeled, lightly sweetened apple • Served with low-fat yoghurt	• Made with rich, shortcrust pastry • Filling cooked to a purée, thickened with cornstarch, and sweetened with plenty of sugar • Served with double cream
Chicken		
Spaghetti		
Omelette		
Lamb cutlets		
Pumpkin soup		
Pavlova		

5. The grid below has eight words hidden in it: four are components of the diet that the Australian Dietary Guidelines suggest should be reduced; four are components that should be increased. The letters left over spell a message for you.

S	A	U	S	T	R	A
E	L	I	A	N	D	I
L	E	T	A	R	Y	G
B	U	I	D	E	L	T
A	L	C	O	H	O	L
T	I	U	R	F	I	A
E	N	R	A	G	U	S
G	E	F	I	B	R	E
E	S	A	R	O	C	K
V	I	T	A	M	I	N

Do an activity

6. Write down all the foods that you have eaten so far today. Using food composition tables, work out how much iron you have eaten. Take care to compare the amounts you ate with the standard serving sizes in the food composition tables, and make sure that you have not left any foods out. How does this compare with the RDI of iron for your age and gender?

CASE STUDY

FOOD TYPE	CHOICES FOR SATURDAY	CHOICES FOR SUNDAY
Breakfast		
Cereals and grains (choose one)	• Bowl of corn flakes (1½ cups), sugar • Two slices of white toast, margarine, honey • Two halves of an English fruit muffin, margarine	• Bowl of rice bubbles (1½ cups), sugar • Two slices of white toast, margarine, jam • Two crumpets, margarine, honey
Dairy food (choose one)	• Milk (150 mL) for cereal or to drink • Fruit yoghurt (100 g tub)	• Milk (150 mL) for cereal or to drink • Fruit yoghurt (100 g tub)
Fruit (choose one)	• Canned pear halves (100 g) • Apple (medium) • Orange juice (100 mL)	• Canned peach halves (100 g) • Banana (medium) • Pineapple juice (100 mL)
Hot item (choose one)	• One-egg omelette with ham and mushroom pieces • Baked beans (50 g)	• Poached egg with small piece of bacon and grilled tomato half • Baked beans (50 g)

FOOD TYPE	CHOICES FOR SATURDAY	CHOICES FOR SUNDAY
Lunch		
Sandwiches on two slices of white bread (choose one)	• Egg and lettuce • Ham and tomato	• Salmon and lettuce • Cheese and tomato
Fruit (choose one)	• Banana (medium) • Pineapple juice (100 mL)	• Pear (medium) • Apple juice (100 mL)
Dinner		
Hot item (choose one)	• Grilled lamb chop (small) • Baked fish fillet (80 g)	• Roast chicken (50 g) • Bolognese sauce (with 50 g minced beef)
Starchy food (choose one)	• Baked potato wedges (50 g) • Boiled white rice (½ cup)	• Mashed potato (50 g) • Penne pasta (½ cup)
Vegetables (choose one)	• Peas and corn (100 g) • Green salad (100 g)	• Beans and carrots (100 g) • Green salad (100 g)
Fruit (choose one)	• Apricot crumble (100 g canned apricots with thin sprinkling of crumble mix) • Canned two fruits (100 g)	• Baked apple (100 g apple stuffed with sultanas and small amount of breadcrumbs with butter) • Canned pear halves (100 g)
Dairy foods (choose one)	• Custard (100 mL) • Milk (150 mL) to drink	• Ice-cream (100 mL) • Milk (150 mL) to drink

OUTCOME TASK **RESEARCH ASSIGNMENT**

Students learn to:

- investigate the recommended dietary intake of energy, protein, vitamins and minerals for particular individuals and groups using appropriate data such as NRV tables in print or electronic format
- select foods to provide a balanced intake of nutrients for particular individuals and groups to meet a variety of nutritional needs
- use suitable preparation methods to optimise the nutritional value of foods.

Contributes to the following outcomes:

- presents ideas in written, graphic and oral form using computer software where appropriate
- selects foods, plans and prepares meals and diets to achieve optimum nutrition for individuals and groups
- generates ideas and develops solutions to a range of food situations.

Carefully consider the menu above, planned for a Year 7 weekend camp. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *recommended dietary intakes for adolescents* to complete the tasks ahead.

1. Look at the Year 7 camp menu. Use food tables or food composition software to estimate the energy, protein and calcium intake of a 12-year-old student who chooses and consumes one item from each group in the Saturday menu. You might like to ask a 12 year old to circle the item they would choose from each group. Compare this with the energy, protein and calcium requirements of 12 year olds.
2. Use a food guide (such as the Healthy Living Pyramid or the Australian Guide to Healthy Eating) to evaluate the menu and identify areas that could be improved for a healthier diet.
3. Morning and afternoon tea will be eaten during the camp activities and may be carried for long periods in hot weather. Suggest some between-meal snacks that help the menu to meet healthy eating recommendations (and provide any extra energy, protein or calcium needed to reach daily targets for 12 year olds).
4. Prepare a written report for the camp organisers, suggesting changes to the menu, listing your between-meal snack ideas, and justifying each of your suggestions.

CHAPTER 7 SUMMARY

- Nutritional requirements vary substantially throughout life.
- Energy is required for all body processes, in the form of mechanical, chemical or electrical energy, or heat.
- Total energy requirements consist of the basal metabolic rate, the thermic effect of food and the energy needed for physical activity.
- Energy requirements are mainly determined by body size, lean muscle and organ tissue, activity and physical condition (including growth and illness).
- The body can obtain energy from carbohydrate, fat, protein and alcohol, and maintains a balance between intake, expenditure and storage.
- Increased amounts of protein and micronutrients are required in pregnancy for normal growth and development of the foetus without depleting the mother's nutrient stores.
- Increased energy, protein and micronutrients are required during lactation to produce breast milk without depleting the mother's nutrient stores.
- Breast milk provides all the nutritional needs of an infant aged up to six months, although formula is an appropriate substitute if breastfeeding is not possible.
- Solid foods are introduced gradually from about six months of age. Food groups are introduced in a particular order, to reach a full variety of foods at around one year of age.
- Requirements for all nutrients are increased during adolescence due to a high rate of growth and development and increased physical activity.
- Elderly people have special nutritional needs as their energy requirements decrease with ageing. Requirements of some nutrients (such as protein and calcium) increase and they may experience difficulties with eating or preparing an adequate diet.
- Nutrient reference values provide guidance on the requirements of different nutrients at various stages in life.
- Food selection guides are a simple way of assessing a diet for nutritional adequacy.
- Food preparation and cooking techniques can have a powerful effect on the nutritional value of the resulting meal.
- Planning nutritious meals requires a knowledge of nutritional needs, as well as information on the available time, resources and skills.

KEY TERMS

adipose tissue
anaemia
basal metabolic rate (BMR)
colostrum
dry-heat cooking
food allergy
food intolerance
lactation
laxative
macronutrient
menopause
moist-heat cooking
nutrition
protein
sedentary
thermic effect of food (TEF)
trace elements
vegan
vegetarian
weaning

Part 2

Stage 6 HSC course

Chapter 8
Sectors and aspects of the Australian food industry

Sometimes it is easier to appreciate the importance of something if it is taken away from us. Without the Australian food industry we would all have difficulty meeting one of our most basic needs — food! Also, spare a thought for all those who earn a living working in the food industry, including the supermarket staff, chefs, waiters, farmers and factory workers. The Australian food industry is a major employer and has contributed to Australia's overall gross domestic product. In this chapter we will examine the sectors of the Australian food industry and how it has addressed issues such as quality assurance, the environment and the impact of food production on society.

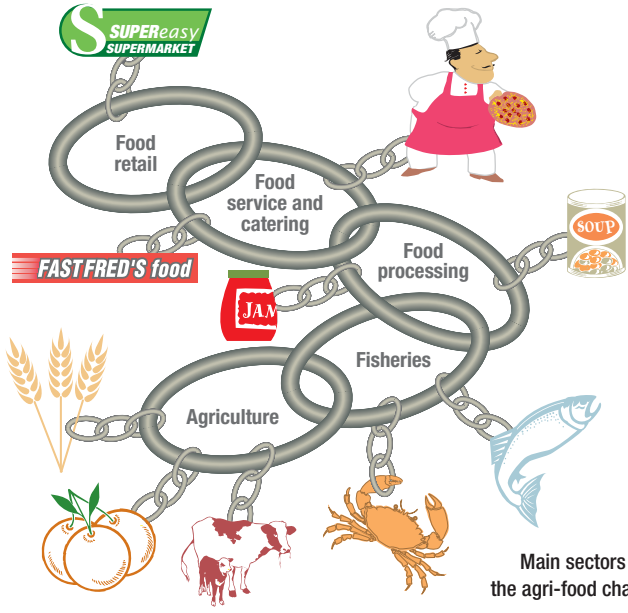
In this chapter you will learn about:

- sectors of the agri-food chain in the Australian food industry, including agriculture and fisheries, food processing/manufacturing, food service and catering, and food retail
- operation of organisations within the Australian food industry with particular attention to:
  - levels of operation and mechanisation, including household, small business, large business companies and multinationals
  - research and development
  - quality assurance
  - consumer influences
  - impact on the environment, economy and society
  - career opportunities and working conditions.

The Australian food industry is made up of a variety of sectors. The agricultural sector is just one of them. Here, graingrower Brenton Kluge surveys his canola crop.

The Australian food industry includes the organised production, processing, storage and marketing of food products. When we look at the production of food in Australia, it is clear we have several advantages. Australia is a continent that experiences many different climates ranging from northern tropical areas through to arid environments and high rainfall coastal regions. Due to the diversity of our environment, we can produce a range of raw materials, resulting in a variety of readily available food. We can also take advantage of living in the southern hemisphere; because of the seasonal differences, we can supply food products to our trading nations 'out of season'. Australia has also developed new technologies such as breeding programs, improved genetics, farm management, innovative packaging and transportation systems to improve our long-term competitiveness. Low levels of pollution in Australia means better quality agricultural products. In addition, the Australian government has provided financial support for research and development.

The agri-food chain



Main sectors of the agri-food chain

The production and supply of food for individual and consumer use is called the **agri-food chain**, which consists of four main sectors:

- **agriculture** and **fisheries**
- **food processing/manufacturing**
- food service and catering
- food retail.

The agri-food chain relies on each sector so no sector is independent. This means that a problem in one sector of the agri-food chain can have a significant impact on the other sectors, affecting production, manufacturing and ultimately sales and income. Consider the effect of cyclone Larry in 2006 where 80 per cent of Australia's banana crop was destroyed.

CASE STUDY

NO BANANAS FOR NINE MONTHS

by JASON KOUTSOUKIS

You may soon have to fly to New Zealand to satisfy your craving for the nation's top-selling grocery item, the banana.

Coles and Woolworths said yesterday supplies would run out in days, after cyclone Larry last week wiped out 90 per cent of the banana crop.

As prices raced towards $6 a kilogram, Coles spokesman Jim Cooper said supplies were dwindling fast.

'We're still trying to get an accurate assessment of the damage from our suppliers, but we know a lot of them have been wiped out and we don't expect supplies to last beyond the end of the week,' he said.

Woolworths spokeswoman Claire Buchanan said that supplies at Safeway supermarkets would not last more than a few days.

And the Federal Government's ban on banana imports means Australians face going without their favourite food for the next nine months.

With Australians consuming 15 million bananas a week, the supply crisis is expected to put pressure on the Government to overturn the ban, a move opposed by the nation's 1850 banana growers.

The growers and their employees wield a huge influence in a string of marginal Coalition-held seats along the Queensland and NSW coasts, a constituency the Howard Government is keen to protect.

But with such high consumer demand for bananas, lobbying has begun to overturn the ban.

At least one major supermarket chain requested imports be allowed on the same day cyclone Larry hit.

On Wednesday morning, the Philippines — which produces 12 per cent of world banana exports — also approached the Government, offering help to make sure Australians did not go without their bananas. Both requests were rejected.

Banana imports are banned because of the risk of exotic pests. Federal Agriculture Minister Peter McGauran said there was 'absolutely no prospect' of the ban being lifted. He said banana lovers should show sympathy for growers ruined by cyclone Larry.

'People will have to understand that their unsatisfied yearnings for bananas are infinitesimal compared to the suffering and

hardship of the banana growers of north Queensland. We all have to put it into that context and bear the pain for the next nine to 12 months.'

The banana supply crisis is even threatening relations between Australia and the Philippines, which has been trying since 1999 to export bananas to Australia.

Quarantine agency Biosecurity Australia is expected to release another draft import risk analysis report on Philippines bananas later this year.

Philippines agriculture attaché Maria Albarece told *The Sunday Age* it was 'time Australians be allowed to enjoy the most delicious bananas in the world'.

'This has been an extremely frustrating process, but we continue to try and be patient and comply with the Australian Government's strict procedures,' she said. 'Hopefully, one day soon, we will be able to win the argument.'

Centre for International Economics economist Brent Borrell, an expert on the world banana market, said it was widely believed Australia was using the quarantine argument as a non-tariff trade barrier.

Mr Borrell successfully represented Ecuador in its fight before the World Trade Organization to open up the European banana market.

'It is true that there is a lot of sniggering in Geneva (WTO headquarters) whenever Australia speaks up in favour of free trade yet maintains these effective trade barriers to products such as apples and bananas,' he said.

He said Australia had among the most expensive bananas in the world, and countries such as the Philippines and Ecuador could put the fruit on Australian tables for half price.

Australian Banana Growers Council chief executive Tony Heidrich said consumers should not yet panic.

'Bananas will be available, albeit in very, very small quantities,' he said.

'They will definitely become a luxury, but I just urge everyone to support our growers … and be assured that all of them are working to get bananas back as soon as possible.'

Source: The Age, 26 March 2006.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *the agri-food chain* to complete the tasks ahead.

1. Outline the impact of cyclone Larry on each sector of the agri-food chain.
2. What financial assistance did the Australian government provide to affected farmers?
3. Discuss how easily natural disasters can ruin sectors of the agri-food chain.
4. Why is it necessary to protect Australia's banana-growing industry from imported bananas?
5. Analyse the long-term impact if the government allowed imported bananas on the shelves of supermarkets.

Agriculture and fisheries

In 2005, 58 per cent of Australian land was used for agriculture but agricultural sectors have contributed only 3 per cent to **gross domestic product** (GDP) in recent years.

Agriculture is the cultivation of land to produce food derived from plants and animals. Plant production involves:

- preparing soil for planting
- selecting seed
- sowing
- fertilising
- irrigating
- harvesting
- storage
- transporting food to various locations.

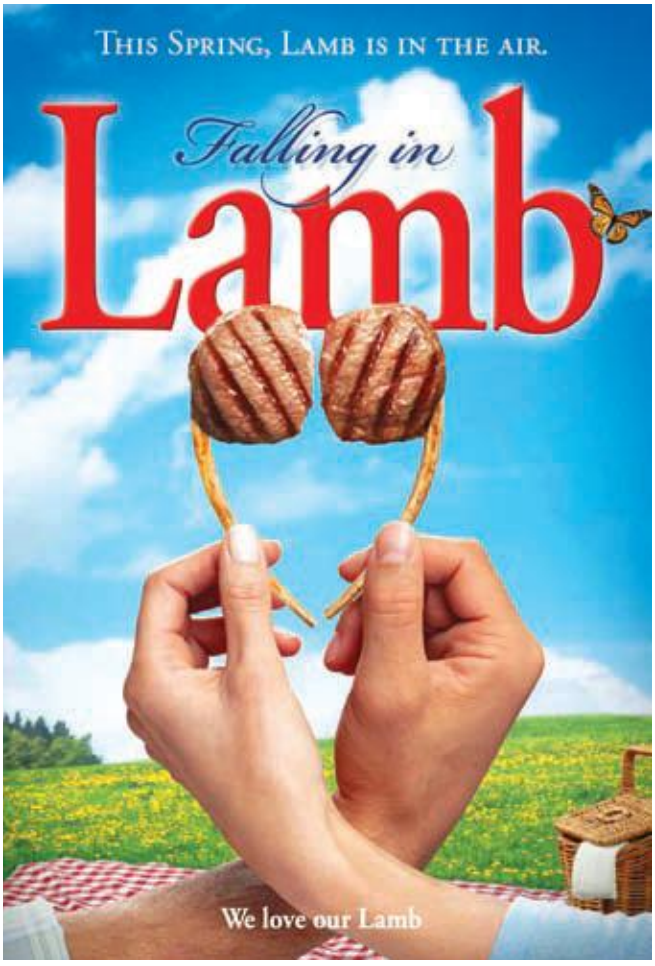
Production of animal meat involves:

- producing or supplying fodder/feed and water
- breeding
- treating illnesses and disease
- transporting the animals to saleyards, abattoirs and other food processing locations.

Nearly 90 per cent of the total value of Australian agricultural production comes from food. Cereals, dairy and meat are the most significant products in the agri-food chain. Our main cereal crops are wheat, oats, barley, rice, maize and sorghum. Australia's dairy industry ranks third in the world, and it is the largest processed-food industry in Australia. It is estimated that 2 million dairy cows produce 10 billion litres of milk each year, and milk and related products exported to world markets total around 3 billion dollars. The majority of milk in Australia is exported in the form of cheese, milk powder, butter and less well-known products such as casein and whey powder. Asian countries buy the majority of our food exports.

The Australian meat industry is well established, contributing to around $7 billion in export earnings. Beef, lamb, pork and poultry are our main exports, and there has been some growth in game and exotic meats. Our meat is exported to a range of countries including Europe, Russia,

Japan, Korea, Middle East, New Zealand, America, Asia and Mexico. Internationally Australia is the second largest exporter of beef and, in 2005–06, we exported 65 per cent of our beef production, furthering our trade relations with other countries. At home, chicken is the most popular meat among consumers, followed by beef (an average Australian consuming 35.6 kg of beef per year). Australian consumers are favouring healthier cuts of meat that are lower in fat. Farmers have responded to this trend by delivering products such as lean pork and lean beef.



To promote the consumption of red meat, Meat and Livestock Australia (MLA) has used a number of campaigns, including those based on the slogans 'Kids love beef', 'We love our lamb', and 'Red meat. We were meant to eat it.' From 1998 to 2007 consumer spending on domestic red meat grew from $4.9 billion to $8.1 billion, an increase of 65 per cent.

Fisheries are also part of the agri-food chain and include commercial catching of fish or any other aquatic species. Industrial fisheries catch fish that are destined for products such as fish oil and fish fertiliser for the garden, rather than for human consumption. **Aquaculture** is an area growing in popularity and involves cultivating and harvesting aquatic plants (such as seaweed and marine algae) or animals (such as clams, oysters and salmon).

The harvesting and cultivation of fish for retail sale has been a popular and successful business for many Australian producers.

Food processing/manufacturing

Most food produced in the agriculture and fisheries sector undergoes some form of processing before being sold to the consumer. This includes '**value adding** steps' such as packaging apples in convenient 3 kg bags for the busy consumer, and producing rice crackers in a variety of different flavours. Value adding may mean that the original food ingredient undergoes significant changes such as heating, cooling, grinding, milling and separating. The value-adding sector is the largest sector of the agri-food chain, perhaps because most food items are not suitable for consumption in their raw form.

Mass production of food items occurs in the food processing and manufacturing sector, and some manufacturing plants operate 24 hours a day, seven days a week. Why is the process worker wearing that particular uniform and what do you think she is doing?

Food service and catering

This sector prepares and serves food and is often referred to as the hospitality industry. It involves all food items served to customers in, for example, school canteens, restaurants, takeaway food stores, catered functions, hospitals and prisons, and on airline flights.

There has been a steady increase in recent years in this sector of the agri-food chain. This has led to the creation of many fast-food outlets and takeaway stores. An increase in consumers purchasing this type of meal can be attributed to the changing nature of our lifestyle and the continual need for consumers to choose convenience-based food options.

Food retail

This area of the agri-food chain provides places where consumers can purchase processed food items. Food retailers vary in size and dominance and include large, national food chains, such as Woolworths, Coles and Bi-Lo, and smaller stores, such as the corner shops, petrol stations, butchers and bakeries. Small retail outlets may carry a limited range of food items but large, national stores offer a more diverse range.

REVIEW QUESTIONS

Remember

1. Explain how each sector of the agri-food chain, while independent, can affect food items in other sectors.
2. Are all sectors of the agri-food chain of equal importance? Is one sector more important than another? Discuss your answers as a class and complete a PMI (plus, minus, interesting) chart on each sector.
3. Think about a food product you can buy in your local supermarket. Outline the 'value-adding' steps it has undertaken for it to be in its current form.

Apply

4. We have discussed the main sectors of the Australian food industry: agriculture and fisheries, food processing and manufacturing, food services and catering, and the food retail sector. Think of a food product and use a flow diagram to show how each sector contributed to the final product reaching the consumer.

Do an activity

5. Log in to **www.jacplus.com.au** and locate the *Agri-food chain* weblinks for this chapter. Choose one of the weblinks and answer the following questions.
   - **a)** With reference to a food product, what current trends and issues are occurring within the Australian food industry?
   - **b)** Why is there a continual need to update and ensure food items meet the changing nature of consumer demands?

eBook*plus*

Weblink

Recent developments in the Australian food industry

Recent trends in the food industry are driven by many factors. Breakthroughs in science, for example, have led to the creation of new food products. Consumers are demanding what is known as **functional foods**, which not only provide sustenance but also improve wellbeing or reduce the risk of disease. Examples include products that contain 'invisible fibre' and foods containing **probiotics** to maintain a healthy digestive system. The table below summarises some of the forces behind change in the food industry.

DRIVING FORCES BEHIND CHANGE IN THE AUSTRALIAN FOOD INDUSTRY	FOOD EXAMPLES
1. Advances in science and technology	Genetically engineered food items, such as tomatoes without seeds
2. A concern for food safety	• Strict guidelines and standards must be met for a food product to be sold in Australia • Restrictions on labelling of foods with misleading nutritional claims
3. An increase in the demand for healthy and nutritious food	Removal of fat and manufacturing procedures that reduce fat in animal products, such as lean pork
4. Rising community expectations for responsible environment and animal management in food production	Reduction of chemical residue in plants and animals for human consumption, such as organically grown fruits and vegetables and hormone-free chicken
5. World and local issues such as drought, economic and political change, and local and international events	Recognition and financial assistance for local farmers and humanitarian aid after natural disasters, such as drought assistance for wheat and sheep farmers

CASE STUDY

WE'RE SWEET ON OUR POTATOES

Whether you bake, sauté, barbecue, fry or microwave it, there's no doubt that the humble sweet potato is a popular choice at dinner time.

And thanks to new virus-fighting technology developed by scientists at the Queensland Department of Primary Industries and Fisheries' (DPI&F) Gatton Research Station, we can look forward to it becoming even more popular.

DPI&F's new technology is producing virus-free seed-root material that is delivering higher yields of sweet potatoes that are also less susceptible to disease.

And it has also recently earned international praise, being awarded a world's best practice ranking by renowned Peruvian virologist Dr Segundo Fuentes.

DPI&F's 10-year project represented a real shot in the arm for the industry, which had gone into decline because of the sweet potato viral disease.

The $40 million industry now boasts some 1200 hectares of sweet potatoes, grown from the Cudgen district in northern NSW, through to Mareeba in north Queensland.

Ninety per cent of Australia's 40 000 tonne crop is now grown from rootstock material produced at DPI&F's Gatton research facility.

And with further improvements in flavour and size, and its low Glycemic Index (GI) dietary benefits, the popularity of the sweet potato is set to continue.

There may also be future opportunities for our producers to tap into important overseas markets, such as Korea and Japan.

Source: Food News Bulletin, June 2007.

OUTCOME TASK | **RESEARCH ASSIGNMENT**

Students learn to:

- identify sectors within the Australian food industry and investigate recent developments in one specific sector
- describe the activities carried out in one organisation within the food industry.

Contributes to the following outcomes:

- examines the nature and extent of the Australian food industry
- investigates operations of one organisation within the Australian food industry.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of sectors of the Australian *food industry* to complete the tasks ahead.

1. Explain the new breakthrough in scientific research that has helped sweet potato farmers.
2. What are the dietary benefits of sweet potatoes that may attract the health-conscious consumer?
3. Research another recent development in one of the sectors of the agri-food chain. In your research, answer the following questions:
   - What is the recent development?
   - How did the need for the development arise?
   - What impact has the development had?
   - What are the future prospects for the development?
   - Is the development sustainable and how will it contribute to the economy?

A key issue currently facing the Australian food industry is **globalisation**. This means that the countries of the world trade with each other. Globalisation of the food trade means that we have access to a variety of foods that can be imported from various parts of the world and we, in turn, export our food products to other countries. The opening up of new global markets is a great opportunity for the Australian food industry. These markets will develop further with an increase in the sophistication of information and communication technology, advances in **biotechnology** and also through the **free trade agreements** that we have with other countries. The Australian food industry's response to both our domestic and international customers will be crucial if the industry is to prosper.

Aspects of the Australian food industry

Depending on the size of a business in the Australian food industry, it may have a large or small voice in contributing to the development of government policy and regulation within the food sector. It may also influence how the community sees the sector. As in many other areas of business, it is often in the best interests of a food company for it to become a member of an organisation that can represent its views to the government and the consumer. These organisations are discussed in more detail in chapter 9.

One of the most important factors affecting businesses in the food industry is government policy and legislation (discussed in chapter 9). Here we examine the other factors.

Levels of operation and mechanisation

The term 'level of operation' refers to the scale of food production, as well as the amount of sophistication of the technology used. The various levels of operation area are:

1. *Household.* At this level, food production is very basic and the quantity of an item produced is minimal, such as making a batch of lemon butter to sell at a local craft market. Equipment used is restricted to home appliances.
2. *Small business.* Food is produced on a small scale. Examples include boutique cake shops and gourmet butcher shops. Equipment used is not usually industrial.

3. *Large company*. A company may operate several stores or processing plants and the quantity of food produced or sold is on a large scale. Many of the tasks involved in the production process are automated and require less hands-on labour. For example, Greens makes a range of packet cake mixes, which are produced on a large scale for later redistribution to retail outlets such as Coles and Woolworths. Many of the processes used are mechanised.
4. *Multinational.* A multinational food organisation or company operates all over the world. These companies use highly sophisticated technology and have a large product output or yield.

As a rule, the larger a business is, the more people it employs, the larger the volume it produces and the more mechanisation and computerisation it uses. Mechanisation (sometimes called **automation**) reduces the need for human labour and can ensure that processes (such as measuring ingredients to meet recipe standards) are consistent. But a larger company also has more opportunities for problems to develop, such as broken glass in a production line or pieces of metal falling into the product. Special machines have been developed to watch for such problems. For example, metal detectors are installed on some production lines.

The seasonal nature of agricultural products poses no problem for larger companies because they have appropriate storage for the products they use. The capacity of their commercial equipment means they can make large batches or production runs, and operation can be 24 hours a day, seven days a week. Household operations and small businesses find the seasonal nature of their raw product supply more troublesome because they have limited storage facilities, small-scale processing equipment and too few employees to allow for continuous production.

Large, high-profile multinational companies have many benefits due to **economies of scale**. Examples of multinationals that produce food products in Australia include Coca-Cola, Cadbury-Schweppes, Kellogg's, Heinz, Sara Lee, Kraft, Nestlé and Unilever. Food industry ownership became more concentrated during the 1990s, when many medium-sized companies merged and larger companies were taken over by multinationals. Now, 85 per cent of our food products are made by foreign-owned companies.

The following table outlines some of the advantages and disadvantages of operating at the household, small business, large company and multinational levels.

LEVEL OF OPERATION AND MECHANISATION	ADVANTAGES	DISADVANTAGES
Household	• Can specialise, often producing gourmet items • May be able to satisfy niche markets leading to greater opportunities if item is successful in the market • Can allow person to work from home and work more flexible hours • Operating costs are reduced because no rental of factory premises are required	• Cannot take advantage of state-of-the-art production equipment • Low yield or output • May not be financially viable • Hard to maintain consistency and quality of produce • Production affected by seasonal nature of supplies
Small business	• Greater flexibility to diversify and switch to making different products • Access to small-scale commercial equipment • Good local customer base	• Unable to store large quantities of ingredients or goods • Limited opportunity to source different suppliers due to small scale • Must be profitable to remain competitive with larger companies • Need to be in an ideal location
Large company	• Large-scale production possible • Provides employment to many • Large profit • Enjoys the benefits of automation • Can run continually, often '24/7' • Exerts greater influence in food sector, with larger voice when dealing with government • Leads the way in technology, quality assurance, research and development and career opportunities	• Less likely to produce boutique, specialised items • Higher likelihood of technical problems given large-scale production methods used • High cost of machinery and maintenance • Open to extortion attempts • More removed from the customer • Possibility of industrial action and intervention of unions during disputes • Expensive to buy into company
Multinational	• High volume of produce • Provides employment to many • Potential for higher profit given advantages of large-scale production • Consistent quality of product and standards worldwide • High degree of computerisation and technology • Often run 24 hours a day, 7 days a week	• Open to extortion attempts • Negative media felt worldwide • Must adhere to standards set by multinational company • No opportunity to diversify or to create unique products due to corporate nature of company

Research and development in the Australian food industry

Research and development in the Australian food industry is costly but necessary to ensure it remains up to date and competitive on a world scale. Businesses need to spend money on research and development related to their products. The government also provides funding to assist in research and development and some of this is done by the **Commonwealth Scientific and Industrial Research Organisation (CSIRO)**. The CSIRO does research in all sectors of the food industry and has recently established six national research flagships, one of which is called Food Futures, aimed at transforming the Australian agri-food sector. The CSIRO is working with farmers, the government and research teams to develop innovative agri-food and processing technologies to increase prosperity and **sustainability** in Australia's agribusiness sector. The long-term benefits of research and development include increased exports, production of healthier and safer foods and improved farm profitability.

Government bodies such as **Food Standards Australia New Zealand (FSANZ)** also conduct consumer and industry research and this is discussed in detail in chapter 9.

Quality assurance

Quality assurance is a process of ensuring that set standards are met. In relation to the food industry, quality assurance is needed to ensure consistency in products. Food organisations adopt measures of **quality control** to maintain their standards. They create the optimum product (sometimes called a prototype) and then compare all other products with the optimum to ensure that they consistently meet their quality standards. Quality assurance is the responsibility of everyone, from the development of raw materials to the processed product, and even through to the food retailer. Most food procedures use a system called **Hazard Analysis Critical Control Point (HACCP)**, which looks at problem areas in food production and aims to control or minimise hazards. They establish procedures to deal with any issues that arise; this helps to maintain a high-quality product. This system of management was discussed in more detail in chapter 3.

Certain industries within the agri-food chain follow a compulsory management system, and state government inspectors check regularly to ensure that the system is being used correctly. For example, the meat and poultry industries have developed a standard HACCP plan for all farmers and producers. Independent auditors ensure that these HACCP principles and systems are met. Other organisations that have developed standard HACCP measurements for the production of their goods include McDonald's, Woolworths and Coles.

There are also other methods of checking whether a product meets acceptable standards. In recent years, more organisations within the food industry have introduced a customer complaint procedure, with many offering a 'money back' guarantee on their products. Consumers also have the support of various government agencies such as the Office of Fair Trading to ensure product satisfaction.

REVIEW QUESTIONS

Remember

1. Classify the following businesses as household, small business, large company or multinational.
   - **a)** Sally makes biscuits and sells them at Christmas time.
   - **b)** Jodie has rented a shop and has set up her own business selling gourmet dog food.
   - **c)** Matt buys into the local Subway franchise.
   - **d)** Lynne goes into partnership with her best friend and takes over the local café.
   - **e)** Alex gains a promotion as the representative for Bega Cheese quality management team leader.
   - **f)** Andrew sets up a Gloria Jean's coffee store in his local Melbourne suburb.
2. Match the following terms to their definitions.
   - **a)** Research and development
   - **b)** Quality assurance
   - **c)** Quality control
     - **i.** Planned activity aimed at discovering new knowledge with the hope of developing new or improved products and services
     - **ii.** Confirming the degree of excellence of a product or service, measured against its defined purpose
     - **iii.** The process of making sure that products or services are made to consistently high standards

Apply

3. Why is it necessary to develop systems such as HACCP for food production and manufacturing?
4. Can the quality of a food product really be controlled? Outline an argument for this statement and an argument against it.
5. Would quality inspection of a product take place at all stages of production? Justify your answer and compare responses by other class members.

Do an activity

6. Log in to **www.jacplus.com.au** and locate the *Food Standards* weblink for this chapter.

   FSANZ often puts out media releases to inform business and community of changes to its standards. Choose a recent media release and outline the major change and its likely impact on the Australian food industry.

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Weblink

Consumer influences on food industry organisations

The changing nature of Australian society has resulted in demands for a range of different foods. The demographics of a population, such as age, income and ethnicity, change over time, and this has a great influence on the food that consumers demand. Geographic location may also play a role in the type of food consumers demand. Those in the food industry must ensure that food products reflect consumers' needs and wants. The following table outlines some recent consumer trends and the industry's response to these trends.

Changes in food products reflect changing consumer tastes and behaviours, advances in technology, changing market structures throughout the agri-food chain, new food legislation and regulations, environmental concerns, globalisation issues and political decisions. In the last 50 years, about 28 000 new food products have emerged on our supermarket shelves, about one new product or brand item every week. Some products have remained and some products have disappeared.

To some extent, consumer demand drives manufacturers' decisions on what is produced. McDonald's is an example of a multinational retail food chain that changed its menu and marketing in response to consumer demand. Their 'healthy

CONSUMER TREND	EFFECT ON THE FOOD INDUSTRY	EXAMPLES OF FOOD PRODUCTS PRODUCED
Trend towards home meal replacement and convenient food products that save the consumer time	More convenience products	• Microwavable meals • Pasta packs to which you just add water
Decrease in cooking skills	More partially prepared and home meal replacement products	• Packet cake mixes • Full meals ready to heat
Increase in food-related appliances in the average household and home	Frozen and precooked meals that can be heated in a microwave oven, with packaging materials that endure the effects of microwaves	• Microwavable popcorn • Coffee beans for home coffee machines
Ageing population	Increased promotion of products for older people	Chewing gum for people with dentures
Increased desire for healthy, nutritious foods	Increased production of products that can be promoted as healthy	• Milk with enriched calcium • Bread with extra fibre • Juice with extra vitamin C • Low-fat, low-sugar and low-salt options
Trend towards smaller households and an increasing number of people living on their own	Packaging items in single serves and a move away from large family packs	Cheese packaged as 12-packs of single slices to 3 kg bulk packs
Increased willingness to try new products	Increase in the range of food from other countries	Frozen Indian meals; prepared Indian breads
More breakfasts eaten away from home	More convenient breakfast items provided by fast-food outlets and food manufacturers	Breakfast cereals in bowls with fruit, ready to eat; also options with bran and wholegrain cereals
Desire for foods without chemical residues	More organic and hydroponic food items in large supermarket chains	Organic fruit and vegetables
More single-parent families and single-person households	Product sizes and packaging to cater for all family structures and budgets	• Cheaper cuts of meats • Increase in generic brand items • Pasta servings for one person
Consumers eating out more and 'eating on the run'	Longer opening hours; increase in takeaway food	• Crackers packaged with dip • Coffee in a can (can trigger heating mechanism)
Higher education standards	More healthy and diet-related foods	Low-fat milk and yoghurt
Greater concern for environmental issues	More environmentally friendly production methods; recyclable packaging	• 'Dolphin-free' tuna • Organic fruit and vegetables • Free range eggs and chickens
Increased concern for special dietary needs	More food for individuals with special dietary needs; also dietary options on menus	• Gluten-free flour • Chocolate for diabetics

choice' range of items appeals to those who want fast food but without the fat.

To earn the Heart Foundation Tick on its healthier meals, McDonald's had to make several changes, including reducing serving sizes to more realistic portions, reducing the salt content of rolls by 43 per cent, and changing its oil to a blend of canola and sunflower oils with 85 per cent less trans fat.

Impact of the food industry on the environment

Conventional farming uses chemicals to control weeds and pests, prevent diseases, regulate growth in animals and fertilise the land. The long-term damage done to the environment by years of chemical use and land clearing is becoming apparent. It is estimated that over half of Australia's farmland needs some kind of treatment to overcome infertility, salinity and acidification of the soil, repair erosion, and eliminate the pesticide poisoning of wildlife and toxic algae in waterways (see chapter 12).

Without synthetic agricultural chemicals, however, a significant proportion of the world's agriculture would be lost. Over 2500 different farm chemicals are available to

CASE STUDY

BEWARE OF CLING WRAP, CHOICE SAYS

Beware of that cling wrap. Consumer group Choice suggests we start avoiding plastic packaging for fear it could be potentially hazardous.

Of concern are materials containing polycarbonate — used to make food storage containers and bottles — and epoxy resins, used to line tin cans, Choice said.

Both have the potential to release bisphenol A, which has been linked to increased risk of heart disease and diabetes.

Choice has called on the industry to phase out the use of such materials and, until then, introduce mandatory labelling.

'PVC is used to make the gaskets that seal glass jars used for foods such as pasta sauces,' Choice spokesman Christopher Zinn said.

'There are safer alternatives, which should be used instead.

'There is vigorous debate about the various risks. Choice believes the evidence, while far from conclusive, can no longer be ignored.'

Many retailers still use PVC cling wrap to package meat and other produce, Choice said.

Concerned consumers should avoid food packaging and baby products with the voluntary identification code three (for PVC) and seven (a catch-all category that includes polycarbonate and plastics that can't be easily identified).

The consumer advocate is meanwhile hoping to lobby the federal government to make some changes.

Anyone wishing to contribute can send rinsed examples of plastic food packaging they are concerned about, along with baby products, to Choice's Sydney office. These will be forwarded to Health Minister Nicola Roxon.

For more information, visit www.choice.com.au/plastics.

Choice, 11 January 2010, © AAP

OUTCOME TASK **RESEARCH ASSIGNMENT**

1. Open a bottle of pasta sauce to identify a PVC ring. After inspecting **open** bottles, jars or tins in the fridge and pantry at home, each student makes a list of any items with a PVC ring. Back at school they share their findings with the rest of the class.
2. Investigate how prevalent is PVC and epoxy resins packaging in your community.

   Separate the class into groups. Each group will focus on one of the following types of stores, itemising the use of PVR wrap there:
   - large supermarket (e.g. Coles, Bi-Lo, Franklins, Woolworths)
   - local convenience store (e.g. IGA, Horsley convenience store, 7-Eleven)
   - local deli, café or sandwich shop
   - fast-food outlets.

   Combine the findings of all groups into a list under the following headings:
   - meat/fish/poultry
   - fruit and vegetables (include pre-prepared salads)
   - bakery items
   - dairy products
   - other.
3. Identify two impacts food packaging has on the environment in your community. Write a proposal to your local council suggesting ways to minimise or combat these impacts.
4. List some examples of food packaging that are environmentally friendly. Explore how these products could be used to reduce food packaging waste.
5. Discuss the pros and cons of mandatory labelling and the effect it could have on businesses and on consumers.
6. Ask a parent, grandparent or carer what sorts of packaging were used for takeaway food items in the past. How have these kinds of packaging changed and what benefits have the changes had on our environment?

Australian farmers; the most frequently used are synthetic herbicides and insecticides.

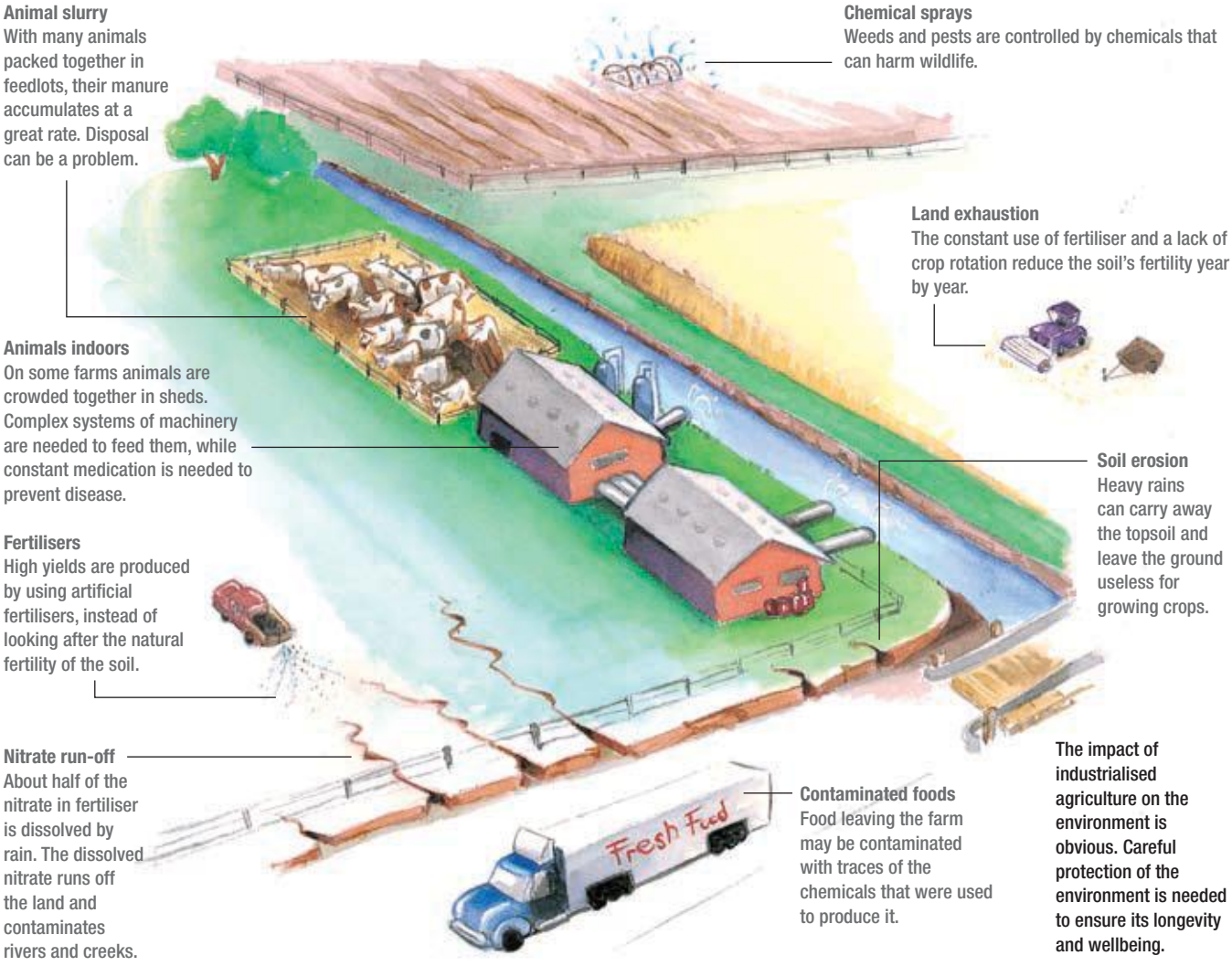
Organic farming is an alternative to using synthetic chemicals that has increased in popularity over recent years. It uses chemical-free plant and animal production techniques that aim to maintain or improve soil fertility and organic matter. Organic farmers must consider all aspects of the environment in their production processes.

Certain requirements must be met before any food item or produce can be labelled as 'organic'. In Australia, organic produce is certified by several organisations that are accredited by the **Australian Quarantine and Inspection Service (AQIS)** under the National Standard for Organic and Biodynamic Produce. All certifying organisations must ensure that their members comply with this standard.

Organic farming has less impact on the environment but there are some issues associated with this method of production.

- Yields from organic farms are often lower than those achieved by conventional farming with chemical pest control.
- Organic foods may cost more because of the higher production costs.
- Organic farms are usually smaller.
- Organic farmers must pay to have their soil tested and farming practices evaluated before their products can be certified 'organic'.

While there is a growing demand for organic foods in Australia (many large supermarkets now stock organic products), only 10 per cent of the population regularly buys them, perhaps because organic produce usually costs more. At present, organic food is still considered to be a **niche market** fulfilling the needs of a minority of the population.



These logos represent the seven AQIS-approved organic certifying organisations in Australia. They are: a. Organic Growers of Australia (OGA), b. the Bio-Dynamic Research Institute (Demeter), c. Tasmanian Organic-Dynamic producers (TOP), d. Organic Food Chain (OFC), e. Safe Food Queensland (SFQ), f. Australian Certified Organic (ACO, a subsidiary of Biological Farmers of Australia) and g. the National Association for Sustainable Agriculture Australia (NASAA).

CASE STUDY

ORGANIC FOOD

by GEOFF AMBLER

Not too long ago you had to go to special shops if you wanted organic food. Now you can find plenty in supermarkets, but mostly you'll pay a pretty high premium over the cost of standard produce. Is it really worth it?

The answer's not clear-cut. While organic farming can be better for the environment, the jury's still out on whether organic food is more nutritious and tastes better. Research is ongoing.

It is possible that organic fruit and vegetables contain less water and more concentrated vitamins, minerals and other plant chemicals. Circumstantial evidence suggests they could have more beneficial phytochemicals, such as antioxidants. Plants produce phytochemicals to defend themselves, and without pesticides to protect them, organic plants might produce more. But the research is complex and results aren't definitive.

Research from the US and Europe suggests good things about the nutritional value of some organic animal produce. However, it's not clear whether this translates to Australian farming practices, which are often very different.

In this report, we take a look at some typical organic foods now available in many local supermarkets — how much more you'll pay and what is known about any differences between the organic and standard versions.

'Certified organic' produce is the best guarantee you'll get what you pay for. Wherever we talk about organic food in this article, we mean certified organic.

What's organic?

Organic agriculture methods can be better for the environment than conventional methods because they don't use synthetic chemicals like pesticides or herbicides. There are no genetically modified inputs, and the philosophy incorporates a respect for the natural order of seasons and animal behaviour.

Organic animals are free-range and there's no use of growth promoters such as steroids or hormones. And you may find a wider range of varieties of fruit and vegetables than with conventional produce.

However, organic produce isn't guaranteed free of all chemical residues (they can drift in from other areas or persist in the soil). But independent testing consistently finds fewer, and lower, levels of residues of pesticides, herbicides and other farming chemicals than in conventional produce. That said, the jury is still out about whether it's in fact safer than conventional produce.

On the global scale, there's debate about whether organic agriculture can produce enough food to feed the world.

One thing's certain: organic food does cost more — our survey of supermarkets found it often costs two or even three times as much.

Source: Choice online, www.choice.com.au, July 2007.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *the impact of food production on the environment* to complete the tasks ahead.

1. What scientific evidence exists to suggest organic foods are healthier for consumers than conventionally produced foods?
2. Define the term 'certified organic'. How does this relate to food products?
3. Log in to **www.jacplus.com.au** and locate the *Organic farming* weblink for this chapter.
   a) Use a map of Australia and a key to show the percentage of organic farms in each state.
   b) Choose an organic food business as a case study. Outline what the business produces, what methods are used to ensure that produce is organic and how successful the business has been.

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Additional case study

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Weblink

REVIEW QUESTIONS

Remember

1. Outline some of the problems associated with organic farming.

Apply

2. Why must food manufacturers and producers consider the impact of their produce on the environment? Predict what would happen if they ignored the impact.
3. To what extent do you think consumers influence the Australian food industry?

Do an activity

4. Select five food products in your pantry and explain how they reflect current trends in consumer demand.

Impact of the food industry on society

For most of us, getting food and consuming it is fairly easy; we have a vast array of food to choose from and outlets to purchase it from. Consumers are well catered for; most people do not produce their own food but rely on the food industry to supply them with necessary items. The eating and lifestyle patterns of Australian consumers have changed dramatically over the past 50 years. This can be attributed to several factors, but one of the biggest influences has been the changing mix of Australian society. Migration and travel have given us the opportunity to sample a variety of food from different cultures, so much so that it is difficult to identify an 'Australian cuisine'. Our cuisine today is heavily influenced by European and Asian influences, and this is reflected in our food options in supermarkets.

The food industry caters for our needs, allowing us to concentrate on other roles in society — but has there been an overall cost to society? Some would say that, through advertising, many businesses can dictate what is on our supermarket shelves and in our fast-food outlets. The fact that the top two supermarket chains make over 74 per cent of national grocery sales means that these multinationals are in a position of power, controlling what is produced, how much is produced and when it is produced.

Many have suggested that the impact of the food industry on society can be judged by the bathroom scales! There is a cost to society in terms of obesity and health-related issues, as well as growing unease among consumers about added preservatives and colours in their foods. The impact of the food industry on our environment also affects the health of the nation. At a time when more people are conscious of reducing their ecological footprint, the production of food is only just coming under the spotlight. The food industry uses vast amounts of fossil fuels and produces poisonous wastes at all levels of the food production chain; this can lead to water pollution, damage to our ecosystems, soil degradation and water shortages.

Impact of the food industry on the economy

The Australian food industry is vital to Australia's economy, accounting for 46 per cent of the country's total retail turnover in 2003–04. The food industry provides employment to almost half a million people in Australia.

Internationally, our export performance has been favourable, with food taking up a 2.7 per cent share of the world food trade in 2005–06. Total food exports averaged a 6 per cent increase over the decade to 2002, and our total food exports were worth $23.3 billion in the year ending June 2006. Free trade agreements (see pages 15–16), which have increased trading opportunities for Australia, have contributed to this growth.

Australia has gained a reputation overseas for producing high-quality products and being a reliable supplier. **Quality management** and attention to food safety compare favourably with some of the highest international standards, and this has contributed to the growth of our export industry. According to a survey undertaken in Los Angeles in 2005, the two strongest attributes of Australian products according to consumers were 'pure and natural' and 'unique'.

The 'Australian made' logo could benefit both distribution and retail sales overseas if it was included on all Australian products. For example, a recent survey showed that 79 per cent of Thai people who responded are more likely to purchase items with this logo attached as they believe it signifies high quality.

The late 1980s and 1990s saw many new food industries emerge. Non-traditional food crops such as Asian vegetables were planted, and fruits such as nashi pears and lychees were grown. New developments in aquaculture, including Atlantic salmon farms, also emerged. Our 'bush food' industry has become more popular in recent years (see page 6), and new meat products such as kangaroo are growing in popularity and are now accepted meat products.

REVIEW QUESTIONS

Remember

1. What food products does Australia export, and what impact does this have on Australian society?
2. Why is the 'Australian made' logo displayed on some exported products?

Apply

3. Explain how important the food industry is to Australia's economy.
4. 'The food industry cannot be responsible for people eating too much — that is a personal choice.' Do you agree or disagree with this statement? Provide reasons to support your opinion.

Do an activity

5. Ask a parent, grandparent or carer what food they eat nowadays that they did not eat in the past. Discuss why foods commonly chosen today may be different from foods eaten in the past.
6. Log in to **www.jacplus.com.au** and locate the *Food and the environment* weblinks for this chapter. Give a one-minute presentation about the environmental costs of the food industry and how consumer action (for example, using reusable shopping bags) can reduce the environmental impact caused.

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Weblink

Career opportunities and working conditions

There is a wide variety of employment opportunities in the food industry for unskilled to semi-skilled and highly skilled workers. As the industry becomes more highly automated, the need for unskilled workers will decline. The Australian food industry is currently facing a major skills shortage in its workforce. The industry must look to streamline and simplify its training packages and develop regional services. Attracting young workers to the industry requires establishing strong partnerships with the government, industry associations and the community.

Shift work is common in the Australian food industry, especially in the food service and catering sector. Also, many large organisations operate 24 hours a day, 7 days a week to achieve continuous production. Work may be casual or part-time, especially for those employed in the agriculture and fisheries sectors where work is seasonal. As in all areas of employment, wages in the food industry depend on skill level and the nature of the work. In some instances, employment conditions and salary are negotiated directly with the business owner.

Each sector of the food industry has a range of career opportunities and jobs that vary in entry level. Some careers require university or TAFE qualifications, while others require no previous experience or qualifications. Many jobs today involve on-the-job training and re-skilling. The table on page 159 shows examples of the range of jobs that exist in each sector of the agri-food chain.

Working conditions in the food industry depend on the nature of the business, but some of the following characteristics are quite common.

- Remuneration (wages/salaries) depends on skill level and the nature of the work.
- In many large organisations, a high proportion of employees belong to a trade union.
- There has been an increase in enterprise bargaining, enabling employees to negotiate directly with the employer.
- Promotion and wage increases are linked to performance reviews.
- Some jobs may require employees to work in unusual conditions. For example, an employee in a food storage warehouse may have to work at low temperatures.
- Workers may be required to wear specialised personal protective equipment while doing their jobs.

Gender issues within the food industry

Various sectors of the food industry face a gender imbalance in their workforce. For example, very few women are employed in the agriculture and fisheries sector. Many jobs in this sector are physically demanding, involve long hours, are sometimes dangerous, are often seasonal and generally offer lower pay than other sectors. In all sectors, upper management and physically demanding jobs are dominated by men; however, an average of 59 per cent of workers in the food retail sector are female.

The food industry in general is failing to attract young, female workers. While the food industry adopts equal employment opportunity policies, career decisions are often affected by employment entitlements, working conditions, image and available career pathways. Therefore, some types of work continue to attract a particular gender.

AGRICULTURE AND FISHERIES	FOOD PROCESSING	FOOD RETAIL, INCLUDING CATERING
Animal geneticist	Accountant	Cookery demonstrator
Plant breeder	Business consultant	Confectioner
Computer modeller	Food technologist	Chef
Stock buyer	Human resource manager	Bar attendant
Fisherman	Abattoir worker	Waiting staff
Fruit and vegetable picker	Forklift operator	Cleaner
Truck driver	Food inspector	Shop assistant
Slaughterer	Laboratory technician	Grocer
Export clerk	Food process worker	Butcher
Grain buyer	Maintenance worker	Food stylist
Mechanic	Poultry processor	Baker
Farm worker	Food production manager	Smallgoods maker

CASE STUDY

GROWING APART: WHERE THE FOOD GIANTS SOURCE SUPPLIES

by ARJUN RAMACHANDRAN, *The Sydney Morning Herald*, 9 November 2009

Veteran fruiterer Vince Carlino felt the imminent threat of a supermarket giant, up-close and personal.

The North Balgowlah fruit shop owner was doing his daily early morning rounds at Sydney Markets in Flemington — buying up fresh fruit for his shop — when he was stunned to see a 'buyer' he recognised as being from a nearby Coles.

'Once upon a time you would never see [a supermarket buyer at the markets] … they'd only do orders for their produce by phone, fax or computer and would never go on the floor to see what's around,' said Mr Carlino's wife and store partner, Maggie.

As it turned out, the Coles buyer was purchasing products for a 'concept Coles' store in Balgowlah — an 'innovative market-feel store', Mrs Carlino said.

The buyer's actions reflected a new push by Coles and Woolworths to capture a reputation for quality fresh produce, Mrs Carlino believes.

It comes as consumer and industry groups have accused supermarket giants of lowering standards of fresh produce, particularly by shunning local growers in favour of cheaper, imported produce.

Richard Mulcah, CEO of AusVeg, which represents Australian vegetable and potato growers, recently said he was dismayed he could not find an Australian packet of frozen vegetables at a Woolworths store.

'That sort of thing is increasingly happening,' said AusVeg spokesman Hugh Tobin. 'If you go into Woolworths or Coles, the generic brands are generally coming from the Netherlands, China or New Zealand, which is a fairly significant thing.

'Imports have increased since 2004 by about 80 per cent.'

A strong Australian dollar and cheaper labour have made the cost of overseas produce more attractive.

Craig Kelly, president of the Southern Sydney Retailers Association, said he had come across potatoes being sourced from the Netherlands and navel oranges from California.

Mrs Carlino said she had heard of plans by supermarkets to source bananas from South America, while Choice spokesman Christopher Zinn said the example of asparagus from Peru was evidence of 'stuff coming a long way' before it hit supermarket shelves.

Fruit and vegetables from overseas were inferior in quality and freshness, Mr Tobin said.

'Australian products have strict safety regulations; if the consumer buys products that are from China, I can't guarantee the same level of quality as if it was from Australia.

'[This is] especially [true] in regard to fresh — the longer it stays on ships on the way to Australia the less nutrients in the product when we buy them.'

Coles and Woolworths hold about half the market share for fresh produce, according to the ACCC's grocery inquiry last year.

They were successful because they offered the convenience of a variety of products, Choice spokesman Christopher Zinn said.

'There's a cost to that convenience, part of which is that you can pay more, and also it might not be of as good quality,' he said.

'For some people price is crucial and the only thing they are concerned with.

'But some people are prepared to pay extra for Australian products. We have done specific research that highlights that.'

Mrs Carlino said her customers were willing to pay more for a consistently good product. She regularly encountered complaints from customers about the quality of produce sold at the supermarket giants.

'We get the complaints because there's no-one on the floor at Woolworths — things like "I bought strawberries and they are all soggy".

'But it's almost like they are expecting them to be like that, that they accept that it's pot luck, whereas we are under pressure to always perform.'

The desire for better quality produce could be an opportunity for smaller retailers, Mr Zinn said.

But Mrs Carlino said her store had not experienced a significant increase in customers of late. It relied on a steady base of customers built up over many years.

Craig Kelly, president of the Southern Sydney Retailers Association, which represents a handful of smaller greengrocers, said there was no doubt the 'small independent fruiter or greengrocer does fruit and vegetables better than Coles or Woolworths'.

But ultimately independents were 'fighting a losing battle' unless there were legislative changes that forced changes in the supermarket industry, he said.

The giants were able to undercut and drive out any smaller operators that posed a threat, he said.

He cited Blacktown in north-west Sydney, where a member of his association told him the 16 or so independent fruit and vegetable shops had all given way to big supermarkets.

Mr Tobin said while surveys consistently showed Australians preferred to buy Australian produce, the pricing hurdle was hard to overcome.

'We hope that people will choose Australian products,' he said.

'But the key driver is going to be price, and the smaller chains need to be competitive with the bigger retailers [who are importing].'

OUTCOME TASK | **ASPECTS OF THE AUSTRALIAN FOOD INDUSTRY**

Carefully consider the article. Remember that this is not a comprehension task; use the stimulus material along with your knowledge of the *sectors and aspects of the Australian food industry* to complete the tasks ahead.

1. In the article you have just read, AusVeg is an organisation that represents the Australian vegetable and potato growers. AusVeg is part of the agriculture and fisheries sector of the Australian food industry. Select ONE sector of the Australian food industry:
   - agriculture and fisheries sector
   - food processing/manufacturing sector
   - food service and catering sector
   - food retail sector.

   Choose one organisation that is part of the Australian food industry and evaluate the impact of the organisation on the following groups:
   - **a)** single wage earners
   - **b)** the elderly
   - **c)** parents of young families
   - **d)** low-income earners.
2. Describe any environmental issues (waste management, packaging practices, production techniques, transportation) that have occurred, or are likely to occur, in relation to the organisation and its practices.

CHAPTER 8 SUMMARY

- Sectors of the agri-food chain include agriculture and fisheries, food processing/manufacturing, food service, and catering and food retail. These sectors are not independent but, rather, are linked like a chain, with each sector being affected by issues faced by other sectors.
- The Australian food industry involves the organised production, processing, storage and marketing of a range of food products.
- To date, Australia has had a very profitable food industry with a strong international export focus.
- All sectors of the agri-food chain are developing, with changing consumer demands and trends, as well as technology, being some of the biggest driving forces.
- Research and development in the Australian food industry is encouraged and supported by organisations such as the CSIRO and FSANZ.
- Quality assurance is a priority in the Australian food industry and manufacturers implement strict standards of quality control, often using the HACCP system.
- Organic farming is gaining in popularity, mainly due to its positive effect on the environment.
- The Australian food industry is a significant contributor to our overall economy. It not only provides a large portion of the population with employment but also brings billions of dollars into the country each year.
- There is a wide range of career options, from unskilled to specialised positions, available to those choosing to work in the food industry.

KEY TERMS

agriculture
agri-food chain
aquaculture
Australian Quarantine and Inspection Service (AQIS)
automation
biotechnology
Commonwealth Scientific and Industrial Research Organisation (CSIRO)
economies of scale
fisheries
food processing/manufacturing
Food Standards Australia New Zealand (FSANZ)
free trade agreement
functional foods
globalisation
gross domestic product
Hazard Analysis Critical Control Point (HACCP)
niche market
organic farming
probiotics
quality control
quality management
sustainability
value adding

Chapter 9
Policy and legislation

Well, it was the meal like no other! I just couldn't eat it because I was pretty sure I'd be sick. I sat there drinking my water, hoping no-one would notice, and pondered the pitfalls of travelling and eating in faraway places. At least, perhaps I could eat the slice of Swiss roll at the end of the meal. I was about to take a bite and a fellow traveller sang out: 'It's mouldy — don't eat it!'

Have you ever had an experience like that, at home or while travelling? In Australia, legislation and standards exist to minimise such occurrences but sometimes problems still occur despite this legislative framework.

In this chapter you will learn about:

- advisory groups that have a role in formulating and implementing policy and legislation
- government policies and legislation (local, state, federal) that impact on the Australian food industry.

Legislation relating to the food industry exists at various levels of government to protect consumers and to ensure that standards are met.

Policy and legislation in the Australian food industry: why are they important?

Legislation and **policy** within the food industry are crucial to ensure that food is acceptable for human consumption and that Australia's reputation for producing safe food for export remains intact. Before discussing specific government policies, let's take a moment to look at the difference between policy and legislation.

A food policy is a strategy that provides the overall philosophy of the government on a particular issue related to the food industry, such as the government's policy on **genetically modified** foods or its policy on importing certain food products. Policy may change, particularly when a new government is elected to office.

The policy of a government is reflected in its parliamentary acts. Legislation (laws) passed by governments at the local, state and federal levels can be amended (changed) or repealed (cancelled), but the law must first be put before Parliament and this can be a lengthy process. Businesses in the food industry must adhere to laws; otherwise, they can be fined or even put out of business. In some instances, failure to follow the law could result in jail penalties, depending on the severity of the offence.

Some food producers and businesses are **self-regulated**, meaning they have their own **codes of practice** for areas such as food safety, **product recall** procedures and promotion. All of these areas are monitored and controlled by an industry body. In a self-regulated industry, all producers of a particular product must adhere to guidelines. An example of a self-regulated industry is the dairy industry in which all farmers and producers must adhere to the guidelines and procedures set up by the Australian Dairy Corporation.

Advisory groups

Various independent organisations are set up to guide or advise governments in the development of their policies and law. These are called **advisory groups** and include:

- business groups within a food sector, such as Australian Pork Limited, which supports and promotes the pork industry
- groups that advise on specific health issues, such as the National Heart Foundation
- independent bodies that can make and change laws relating to food, such as **Food Standards Australia New Zealand (FSANZ)**, to be discussed on page 168.
- groups that protect the local food supply, such as the **Australian Quarantine and Inspection Service (AQIS)**, which protects our agriculture industries and the environment against exotic pests and diseases.

Many of these advisory groups lobby various levels of government hoping to encourage the development of policies and legislation that benefit their organisation and the consumer alike. Some advisory groups are self-regulating, while others are responsible to a particular organisation such as the Department of Agriculture, Fisheries and Forestry. Table 9.1 outlines some state and federal advisory bodies pertaining to the food industry.

TABLE 9.1 National and state advisory bodies in the Australian Food Industry

Advisory group (national)	EXAMPLE OF IMPACT OF ADVISORY GROUP ON THE AUSTRALIAN FOOD INDUSTRY
Australian Citrus Growers Incorporated represents all citrus growers around Australia. They assist farmers in managing issues such as fruit fly and provide assistance for other issues as they arise, such as drought.	Australian Citrus Growers, along with the federal government, has been working to assist drought-stricken citrus growers. Funding has allowed Australian producers to remain competitive and ensure that consumers have a choice of citrus fruit to purchase.
Australian Chicken Meat Federation (ACMF) promotes and protects the interests of the chicken meat industry by conducting research, securing representation on appropriate committees, boards and commissions and approaching government bodies on all matters of concern to the industry.	ACMF worked with the Australian government on preparations for avian flu and planning a response if avian flu were to enter Australia.
Australian Beverages Council Limited represents the interests of the manufacturers, distributors and importers of non-alcoholic beverages.	This advisory group has worked with the Australian Food and Grocery Council to standardise nutritional labelling on beverage products so consumers can make informed choices.

(continued)

TABLE 9.1 *(continued)*

Advisory group (state)	EXAMPLE OF IMPACT OF ADVISORY GROUP ON THE AUSTRALIAN FOOD INDUSTRY
NSW Food Authority (NFA) was set up to ensure food safety across the entire food chain from primary production to retail sales.	NFA commissioned a report that showed that almost half of all pregnant women ignore serious risks associated with *Listeria* bacteria, which if transmitted to an unborn can lead to miscarriage, infection or stillbirth. As a result, an education campaign was launched about the dangers of *Listeria* and how it can be avoided.
Peak Oyster Advisory Group (POAG) represents farmers in the oyster industry.	POAG has worked specifically with local governments in the Hunter and Macleay river regions to reduce water pollution from specific estuaries. This ultimately improves the quality of oysters available to consumers.
CSIRO Crusader Meat Rabbit Advisory Group represents farmers and processors of rabbit meat used for human consumption.	Government grants from the CSIRO have assisted this advisory group to undertake research and development on rabbits, which has resulted in Crusader rabbits being developed and exported.

CASE STUDY

JUNK FAST-FOOD ADS, PARENTS SAY

Food companies that market junk food to children could soon have their advertising banned.

by CLARE MASTERS

Almost 90 per cent of parents are calling for a blanket ban on junk food advertising during children's television time, a new national survey reveals.

Just a month before the Australian Communications and Media Authority (ACMA) is to release a topical discussion paper, powerful health groups are lobbying the federal government to make sweeping changes to the marketing of junk food to children.

The survey of almost 400 parents across the country was done for the Coalition on Food Advertising to Children (CFAC) and the Cancer Council — other members include the Australian Medical Association (AMA), the Royal Australasian College of General Practitioners and Nutrition Australia.

The survey found 86.2 per cent of parents supported a ban on advertising of unhealthy foods at times when children watched TV, 88.7 per cent wanted stronger restrictions on food advertising in these time slots and 74.6 per cent were worried about the use of toys and giveaways.

Health Minister Tony Abbott believes it is a parent's responsibility to monitor children's diets and in February this year rejected a review of junk food advertising.

But the health heavyweights are hoping the pending election and increasing pressure from parenting groups will sway the Minister.

Cancer Council nutritionist and CFAC chair Kathy Chapman said 6000 voters had signed up to CFAC's Pull The Plug campaign calling for stricter regulations.

'It is an issue they have to listen to — it's silly of them to ignore it', she said.

Mother-of-two Anna Moffat, 32, of St Clair, agreed it was a parent's job to act as junk food gatekeeper but said restrictions on advertising would make a big difference.

She said free toys and giveaways were especially difficult with her two sons Rylan, 5, and Ben, 8, who often pestered her for a popular snack which came with free football cards.

'They whinge and nag and it is a battle to say no', she said. 'Parents are busy and they are pressured by their children to buy the foods they want.'

Communications watchdog ACMA is currently reviewing TV standards, with a discussion paper due for release next month.

A recent landmark British decision banned junk food ads during children's TV time, but the Australian lobbyists believe the UK regulations don't go far enough and want the Australian Government to consider strict restrictions on promotional fundraisers as well as junk food advertising during children's sporting events.

'We believe ACMA is obliged to respond to parents' concerns that junk-food companies are profiting at the expense of their children's health', Ms Chapman said.

Source: Daily Telegraph, 16 May 2007.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *advisory groups* to complete the tasks ahead.

1. Suggest why parents have been lobbying the government about the marketing of junk food to children.
2. Outline marketing tools that food companies have used to encourage children to buy their food products.
3. Who are the advisory groups mentioned in the article and what role have they played in highlighting this issue?
4. Do you think there should be a ban on marketing junk food to children? Give reasons for your answer.

REVIEW QUESTIONS

Remember

1. Use the clues to find six words in the word search puzzle below right. (The starting letter and number of letters in the answer are shown after each clue.)
   - **a)** Type of food producer or industry that has its own code of practice (S, 13)
   - **b)** A set of guidelines to achieve and adhere to (S, 9)
   - **c)** Advice or guide (P, 6)
   - **d)** Body that represents people with a disease that relates to blood sugar levels (D, 8 and A, 9)
   - **e)** Failure to follow this could result in fines, imprisonment or being shut down. (L, 3)
   - **f)** A group that inspects food coming into Australia and going out to ensure it meets legal standards (A, 4)
2. What is the difference between food policy and food legislation?
3. Name the advisory groups in the following examples.
   - **a)** We provide advice to the government and the general public on how to avoid heart disease and stroke.
   - **b)** We are determined to protect agriculture against pests and diseases that may enter the country.
   - **c)** We represent all butchers and farmers in the pig industry.
   - **d)** We are an independent state body that was set up to make and change laws relating to food.

Apply

4. What are the benefits of having advisory groups in the food industry?
5. Discuss what would happen if there were no legislation on important issues such as the labelling of food. Predict the long-term consequences.

Do an activity

6. Log in to **www.jacplus.com.au** and locate the *Advisory groups* weblinks for this chapter. Open this weblink to research an advisory group that represents the views of the general public.
   - **a)** Who does the advisory group represent?
   - **b)** What does the advisory group do?
   - **c)** Outline any current issues that are facing the advisory group at the moment.
   - **d)** Why do you think this advisory group was initially set up?

F	K	F	Z	T	O	S	F	T	B	G	A	E	I	O	A
S	A	O	K	T	W	W	Y	A	S	Z	E	V	U	F	I
H	E	O	S	I	Q	A	W	T	D	L	K	N	D	T	L
Y	A	L	W	F	U	R	F	A	F	W	O	N	X	L	A
J	U	C	F	S	B	O	N	O	L	M	P	S	W	Q	R
I	C	M	N	R	P	I	C	J	J	V	E	T	Y	L	T
F	F	Q	M	O	E	D	O	H	P	Q	N	A	D	C	S
O	Z	R	L	A	E	G	C	H	H	K	U	N	O	X	U
S	U	I	E	M	S	L	U	C	C	Z	R	D	U	E	A
R	C	Z	U	U	E	V	Q	L	G	C	L	A	W	T	S
Y	J	N	H	O	X	N	T	A	A	Z	X	R	V	J	E
Q	Y	V	H	K	M	H	A	C	C	T	N	D	N	I	T
N	I	D	P	H	E	H	J	Q	M	L	E	S	R	O	E
H	L	P	I	Y	B	M	Z	G	O	W	I	D	V	Z	B
H	D	Q	H	M	I	V	V	Z	U	U	D	R	F	O	A
A	S	F	H	S	Y	T	F	N	D	T	P	K	U	B	I
J	H	E	L	O	A	R	I	A	D	I	T	B	O	P	D

eBookplus

Weblink

Government policies and the food industry

The government establishes policy in many areas. In this chapter, we will discuss policy relating to national health and nutrition as well as trade policy. See chapter 20 (page 354) for recent policy on genetically modified foods.

National health and nutrition policies

Policy on health and nutrition should educate Australians about wise food choices, in order to limit the incidence of diet-related diseases and ultimately reduce the cost of health care. The Department of Health and Ageing is responsible for developing and evaluating the national policy, assisting in developing resources and initiatives in the areas of nutrition, healthy eating and physical activity, and promoting healthy weight.

There have been many government initiatives over the years to improve the health and nutrition levels of individuals, including the target on healthy eating, the Five Food Groups, the 12345+ Food and Nutrition Plan, the Healthy Living Pyramid, the Recommended Dietary Intake scheme and the Dietary Guidelines for Australians (see page 137). All these programs are designed to raise awareness to make Australians more responsible for their eating patterns and eating choices.

One extremely important policy on nutrition was a ten-year plan called National Public Health Partnership's Nutrition Strategy and Action plan — Eat Well Australia, 2000–2010. This strategy focused on the following four key nutrition priorities:

1. preventing people from becoming overweight and obese
2. encouraging increased consumption of vegetables and fruit
3. optimising nutrition for women, infants and children
4. helping vulnerable groups to improve nutrition.

The Strategic Inter-Governmental Nutrition Alliance (SIGNAL) was responsible for this policy, which aims to develop a national approach to public health nutrition and ensure greater consistency and better coordination of government policy and strategy development across Australia. SIGNAL provided a government forum for public health nutrition in Australia and acted as a first 'port of call' for industry groups, professional associations, nongovernment organisations and consumer groups wishing to work cooperatively with government.

SIGNAL also developed a separate action plan specifically for Aboriginal and Torres Strait Islander people, called the National Aboriginal and Torres Strait Islander Nutrition Strategy and Action Plan 2000–2010. The purpose of this strategy was to provide a framework for action to improve the health and wellbeing of Aboriginals and Torres Strait Islanders. Its seven key areas for action were:

1. food supply in remote and rural communities
2. food security and socioeconomic status
3. family-focused nutrition promotion
4. nutrition issues in urban areas
5. the environment and household infrastructure
6. Aboriginal and Torres Strait nutrition workforce
7. national food and nutrition information systems.

Trade policy

Australia trades with many countries worldwide, importing and exporting food products. The Minister for Trade, in conjunction with the Department of Foreign Affairs and Trade, is responsible for negotiating with foreign governments to ensure better trade conditions for Australia. As discussed on page 158, since the mid 1970s there has been a general shift in policy towards freer trade. This has seen a gradual reduction in import restrictions; for example, the **tariff** rates or taxes added to the cost of imported goods have generally been reduced. Financial assistance to firms in the form of **subsidies** has also been removed. The move towards freer trade has been adopted by many of our trading partners, so now there is much more competition from abroad.

The federal government has sought to boost Australia's export opportunities by promoting exports of **value-added** products of all kinds to Asia, and by promoting the benefits of Australian agri-food products in the Asian region. Australia no longer exports just agricultural products and, since the 1990s, has also developed different markets with a growing emphasis on Asia rather than Europe.

Australian exporters seek not only new markets but also new products to export. Here, a two-year-old crocodile is being prepared for export to Taiwan.

Free trade agreements have opened up opportunities for export and have also increased the quantities of imported goods. In 2005, imports rose by 47 per cent, with most of the products being in the form of processed meats, dairy and processed fruit and vegetables. The demand for imported food has increased, partly because of the benefits of free trade but also due to consumer demand for ethnic and speciality foods as the tastes of Australians have broadened. In addition, demand for imported products has risen because of the drought. Many Australian farmers are facing a long-term problem with a lack of rainfall, which has significantly reduced the yield of crops and animal

products. The government has provided financial assistance to many farmers to help ease the dramatic financial problems that many families face.

Trade policy is subject to the views of the government of the day. The government's policy at the time of writing included:

- establishing a Commonwealth authority called Infrastructure Australia to overcome the infrastructure problems (problems with communication and transport networks) experienced by many export industries in Australia
- establishing a new national broadband network to increase the speed of internet connections and improve communication between exporters and customers around the world
- a commitment to Skilling Australia by providing extra funding for more skilled training places
- reducing the administrative problems and red tape experienced by exporters
- increasing funding to foster new ideas and technologies in Australian business.

CASE STUDY

$233 BILLION AND GROWING; INDIA'S DEMAND FOR AUSSIE FOOD SET TO BOOM

The Australian Government is urging Australia's food producers to take a good look at the burgeoning demand in India for food products and position themselves to take advantage of the predicted boom.

India is rapidly emerging as a critical market for Australia's food industry, according to a new Australian Government-funded report just launched in New Delhi.

Minister for Trade, Warren Truss, and Minister for Agriculture, Fisheries and Forestry, Peter McGauran, said the report, *Strengthening the India–Australia corridor in select food and agribusiness sectors*, showed increasing consumer demand among the sub-continent's burgeoning middle class.

Mr Truss said that this demand was creating huge opportunities for businesses in the Australian food sector.

'Indian food retail is a multi-billion dollar industry, estimated to be worth around $233 billion, with food being the largest category of consumer spending', said Mr Truss.

'The sub-continent's 300-million-strong middle class, with its growing affluence and changing lifestyle, is driving growth in organised food retail and food services, with organised retail expected to increase by 30 per cent over the next five years' he said.

Mr McGauran said that the size and the rapid growth of India's food sector were creating enormous potential for Australian food producers and food services suppliers.

'Australia's expertise in food production, combined with high-quality ingredients and cutting edge technology, places us in an ideal position to make greater inroads into India', Mr McGauran said.

'The increasing demand for food, including higher value products in countries such as India presents significant opportunities for the Australian food industry to expand its export markets.

'Australia can also supply the expertise in retail services, supply chain and cold chain logistics, agricultural technology, and food production and processing, that India needs to develop its food industry', he said.

Source: Hospitality Magazine, 15 October 2007.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *trade policy* to complete the tasks ahead.

1. Why are there suddenly opportunities for the Australian food industry in India?
2. According to Mr McGauren, why is Australia likely to be successful if it exports food to India?
3. Outline the benefits of exporting food products to India.
4. Besides actual food products, what else can Australia export to assist India develop its food industry?

REVIEW QUESTIONS

Remember

1. Discuss the benefits of trade and relate your answer to both the importation and exportation of food.
2. Match the following terms to their definitions.
   - **a)** Import
   - **b)** Export
   - **c)** Trade liberalisation
   - **d)** Tariff
   - **e)** Subsidy
     - **i.** A payment, generally by the government or a public sector agency, to the producer or consumer of a product or service, intended to encourage its production and reduce its cost to consumers
     - **ii.** Elimination or reduction of trade barriers such as quotas and tariffs
     - **iii.** Product from overseas being sold in Australia
     - **iv.** A tax levied on imports
     - **v.** An Australian product being sold overseas

Apply

3. What are the costs and benefits of free trade for Australian producers?

Do an activity

4. Imagine you are an Australian cattle producer and you are trying to export your meat to another country. Create a PowerPoint presentation aimed at convincing another country to adopt a **free trade agreement**. What are the benefits for both countries?

Food Standards Australia New Zealand (FSANZ)

Now that we've looked at advisory groups and policy, let's turn our attention to the main agency that sets the standards (regulations) that must be met before food is sold. FSANZ is an independent statutory agency (which means that it has law-making power) and was established by the *Food Standards Australia New Zealand Act 1991 (Commonwealth)*. FSANZ works with the governments of Australia and New Zealand to develop standards for what is in our food and how it is labelled. In addition, FSANZ sets standards for Australia on food safety issues. FSANZ works with a council of health ministers from all states and territories and also works with the Australian Quarantine Inspection Service (AQIS). FSANZ plays an important role in keeping consumers well informed about various issues that may arise in relation to food and food products.

It carries out the following tasks:

- development and review of the Food Standards Code (see discussion below)
- development of risk assessment policies for imported foods
- surveillance of food available in Australia
- monitoring and control of food safety education
- food product recalls
- research into food standards
- national and international networks to keep abreast of international trends in food standards.

Australia New Zealand Food Standards Code

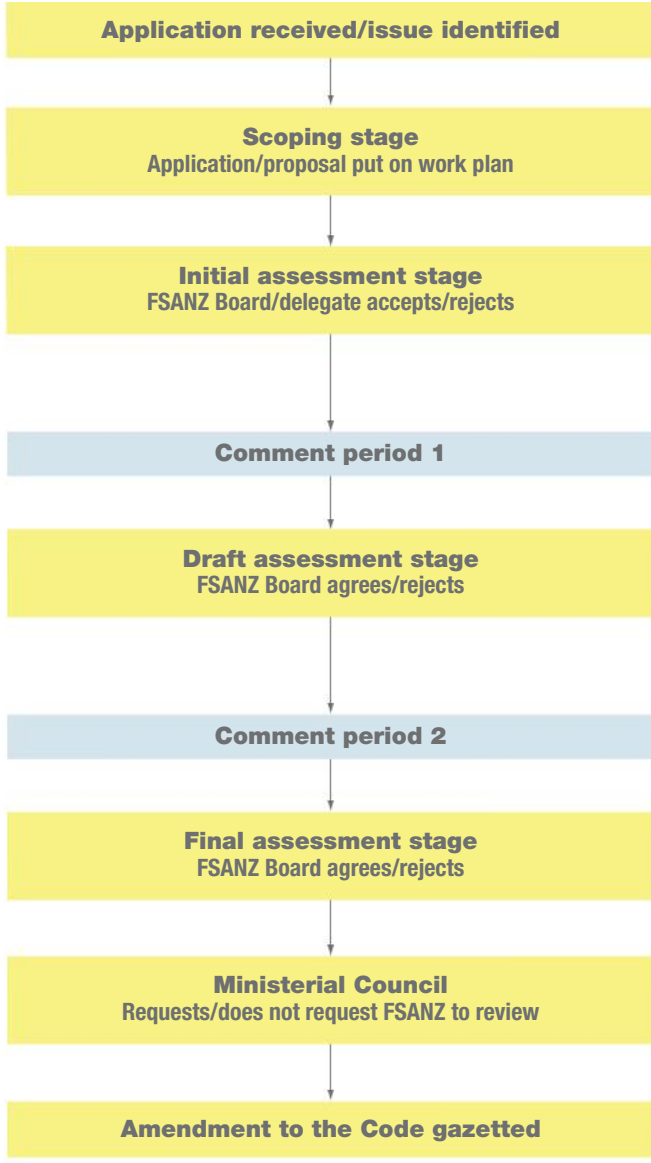
The **Food Standards Code** (the Code) ensures that a manufacturer cannot make a new food product available to consumers without first adhering to rigorous standards. The Code is a collection of individual food standards that are divided into four chapters:

- Chapter 1 covers general standards such as labelling requirements, use-by dates and nutritional information. This chapter also covers food additives and the acceptable levels of contaminants and residues.
- Chapter 2 deals with standards affecting particular classes of foods, including specific standards for cereals, meat, eggs, fish, fruits and vegetables.
- Chapter 3 covers the food safety standards.
- Chapter 4 contains standards dealing with the primary production of food in Australia, including individual standards for seafood, poultry meat, meat, dairy products and specific cheeses.

Food standards user guidelines have been developed to help interpret and apply the Code. These incorporate extensive interpretation and compliance advice for manufacturers and retailers, and describe the intent of the provisions.

In addition to the Code, FSANZ develops codes of practice which are non-binding agreements that businesses and industries within a particular sector are encouraged to follow. These codes of practice often 'fill in the gaps' covering areas that are not set out in the Food Standards Code. For example, FSANZ is developing a Code of Practice (CoP) to accompany the Poultry Meat Primary Production and Processing Standard of the Code. It is hoped that this CoP will help further explain the legal requirements of the Code, translate it into plain English and help those in the industry to understand how to comply with it.

The Code is constantly undergoing change. An application may be made by an individual or an organisation to amend the Code, and FSANZ itself may also change the Code by raising a proposal. Each application and proposal goes through a complex process of assessment and public consultation.



Changing a Food Standard Code is a complex and lengthy process that may take many months. Here you can see the various stages of the drafting process before the Ministerial Council amends the Code.

Pressure for changes to the Code can come from either the food industry itself or consumers. Recently, for example, there has been controversy over the required meat content in a meat pie, necessitating a change to the Code.

The Code now states that meat pies must contain no less than 250 g/kg of 'meat flesh'.

Product recall

A pharmacist covers vitamins for sale after a product recall notice has been issued.

FSANZ has overall responsibility for product recalls. When a food product is recalled, it is removed from sale, distribution and consumption because it may pose a risk to consumers. For example, a food may be recalled due to the presence of harmful micro-organisms, toxic chemicals or harmful foreign bodies, which could cause ill health or death. While

CASE STUDY

Meat pie tests

They're one of our great Aussie icons. In fact, apparently per capita we're the world's largest consumers of meat pies. But how many of us know what's really inside?

Des Sibraa, a former food inspector turned lawyer says under current laws a standard pie must contain at least 25% meat. But if you're thinking steak, think again.

'Meat is a very broad definition and that's the real problem here', he said.

'Nobody would expect to find things like tongue roots or rendered trimmings or pigs ears in a meat pie. That absolute rubbishy stuff that's not even fit for an animal.'

But that's not all. To cut costs, Des says some manufacturers are now substituting meat with soy protein. It looks like meat, it can even taste like meat, the only problem is, it's not meat at all.

Analysts only check for protein so it's possible to pass the test with absolutely no meat, in a meat pie.

'You can go around and buy six frozen pies for something like three dollars or less … So there's a lot of competition, especially those very cheap pies. I would expect them to contain all sorts of things to reduce the cost of making them', Des said.

So, to find out how much real meat is in a meat pie we called on the experts at a Melbourne food laboratory.

We sent over a dozen or so stock standard meat pies — almost every brand you can think of — from the cheapest to the most expensive, and we threw in a few party pies as well.

The pies tested were: IGA traditional pies, Coles/Farmland meat pies, Balfours footy pies, Balfours traditional pies, Big Ben pies, Four'n Twenty meat pies, Woolworths pies, Black & Gold pies, Mrs Mac's Famous Beef pies, Snowy River pies, Vili's gourmet beef pies, Woolworths party pies, Balfours party pies, Four'n Twenty party pies, Coles/Farmland party pies.

Our team of experts carefully tested each pie to determine how much meat it had, what type of meat was used, and how much soy protein there was.

An alarming number of our pies not only disappointed, they weren't even fit to be on the market.

'Five of the 11 meat pies that were tested didn't comply with the minimum standard requirement of 25% meat in the meat pie', said Lab Manager, Len Davies.

In fact one pie had less than half the minimum meat content required.

Two of the pies that failed almost got away with it by substituting soy. Our initial protein tests gave the impression there was the required 25% meat. But we then found over 2% of this was in fact not meat at all, but soy.

'There's nothing surprising in those results. The big pie manufacturers have been competing for price on pies so they've gotta put all sorts of cheap ingredients in there, to get over the competition', Des said.

And the kids get short changed the most. The party pies in general, had less meat than the standard pies. One had as little as 11%, but according to Len Davies, they can get away with it.

'There's no standard for party pies but they must declare the amount of meat on the label', Len said.

So overall, which pies had the highest genuine meat content?

Mrs Mac's beef pie 29.8%

Vili's gourmet beef pie 28.9%

Coles/Farmland 27.5%

The winners of our taste test were:

1. Vili's gourmet beef pie
2. Woolworths meat pie
3. Balfours footy pie

'The general rule is, don't buy those very cheap pies because they're certain to have a lot of rubbish in them', Des said.

Source: Today Tonight, Channel 7, 23 August 2003.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *the Code* to complete the tasks ahead.

1. Why do you think it necessary to state that a meat pie contain a certain amount of meat in it?
2. Which pies investigated in the article meet the standard set out by FSANZ in the Code?
3. Bakewell Foods Pty, Ltd lodged an application with FSANZ to verify the definition of what constituted meat in a meat pie. In 2007, the Code was changed to state clearly what is meant by the word 'meat'. It now clearly states that a meat pie should contain no less than 250 g/kg of 'meat flesh'. Why do you think Bakewell Foods Pty, Ltd (trading under the name of Mrs Mac's Pty, Ltd) wanted this particular section of the Code amended?

FSANZ has overall responsibility, each business in the food industry is responsible for having an up-to-date food recall plan. FSANZ must notify the producer, manufacturer or importer that the food item is being recalled. Products may be recalled for two main reasons:

- a defect in the quality of a food item that does not present a risk to public health and safety
- a defect in the quality of a food item that could threaten the safety of consumers because of a production fault or tampering.

If quality assurance procedures fail, food products containing harmful micro-organisms, toxic chemicals or harmful foreign bodies could reach the consumer. The safety procedures are the responsibility of the producer, manufacturer or food service business. However, FSANZ oversees food products that are available to consumers and can recall a product if it poses a risk.

When a food product is recalled, it may be permanently or temporarily removed from the market. The food product may be returned to the market once the problem or issue has been resolved. As mentioned, a product may be recalled because it has been tampered with or contaminated after production or sale. Threats may be made to tamper with production in an effort to blackmail a business **(extortion)** or cause adverse publicity. In these cases, police and relevant authorities are also called to deal with the matter. Complete the Case study on the opposite page.

Australian Quarantine Inspection Service (AQIS)

AQIS is part of the Department of Agriculture, Fisheries and Forestry and it works with the Australian Customs Service and Australia Post to protect Australian agriculture from contamination. AQIS's responsibilities include:

- protecting Australian primary producers and the community from exotic pests that may be intentionally or unintentionally brought into Australia
- inspecting legally imported animals, plants and their products
- ensuring **quarantine** status of international travellers by making sure they do not bring in restricted plants, animals or their products
- certifying agricultural exports for competition in the global market
- negotiating national and international agreements and **protocols** on behalf of the industries that require it. For example, AQIS would be required to deal with the importation of food beyond the normal commercial allowance.

CASE STUDY

CHOCOLATE BARS POISONED

by DAVID CRAWSHAW

Retailers cleared thousands of Snickers and Mars bars from New South Wales stores today as police investigations continued into a chocolate contamination scare.

NSW Police and chocolate manufacturer MasterFoods yesterday revealed three threatening letters had been sent to the company since May, including one letter containing a Snickers bar which had been laced with an unknown contaminant.

The massive product recall was ordered after a third letter was received at MasterFoods' head office in Ballarat, claiming seven Snickers and Mars bars had been contaminated in the Sydney area.

The extortionist had made various demands but was not trying to extort money from MasterFoods and instead was targeting a third party, police said.

MasterFoods today said there was no evidence to suggest consumers in states other than NSW were at risk from contaminated chocolates.

'We have consulted very carefully with the police and the health authorities who agree . . . that the threat is specific to Sydney', MasterFoods Australia–New Zealand president Andy Weston-Webb said.

As police worked to identify the mystery contaminant and catch the offender making the demands, the lobby group representing food makers warned food companies were particularly vulnerable to extortion attempts and contamination scares.

Australian Food and Grocery Council deputy CEO Harris Boulton said food manufacturers were an easy target for extortionists because of the type of product they made and their high profile across Australia.

In the case of the chocolate bar recall, a third party was the target of the contamination scare, not manufacturer MasterFoods.

Mr Boulton said it was not unheard of for extortionists to use a food company to make demands on a third party, even though the food maker was not the target.

'The food product is being used as a vehicle for some other political action or retribution against a third party for whatever reason', he said.

'It's because these brands are so high profile, it's a way of getting attention.'

Food manufacturers had implemented new safety measures after several extortion bids in recent years, and consumers should be confident food companies would not risk public safety, Mr Boulton said.

'What we've done is develop a set of guidelines for companies as to the things they should do to prevent this', he said.

'A lot of these sort of things they're doing as part of normal testing of products to make sure everything they make is as safe as possible and doesn't pose a health risk to the public.

'What we've also done is establish guidelines as to who to contact within the police force because these things are criminal offences, and we've worked with governments to get legislation to increase the severity of penalties for extortion and contamination of food products.'

All Australian states now had maximum sentences of at least 10 years in jail for people convicted of contaminating or attempting to contaminate food supplies, Mr Boulton said.

NSW Police today said there had been no new developments in the investigation.

'The investigation remains open but at this stage there are no new developments', State Crime Command spokeswoman Dani Ongaro said.

Source: AAP/*Sun Herald*, 2 July 2005.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *product recall* to complete the tasks ahead.

1. Why were the chocolate bars recalled?
2. Discuss the importance of taking all extortion attempts seriously.
3. Outline why you think food companies are easy targets of extortion attempts.
4. What is the role of FSANZ in an extortion attempt?
5. Undertake research into food companies that have received extortion attempts. What happened with the food items? Predict the long-term consequences of a food company experiencing an extortion attempt.
6. How can food companies be protected from attempted extortion?

Let's now look at some of AQIS's responsibilities in more detail. To fulfil the task of protecting Australia from exotic pests and disease, AQIS runs the following programs:

- an airport program. Inspectors use dogs and luggage X-rays to detect prohibited foodstuffs.
- an international mail program. Officers use detector dogs and X-ray units to scan mail coming into Australia.
- a seaport program. Australian inspectors board visiting vessels and check cargo.
- a **ballast water** program to monitor where visiting water vessels have taken on ballast water. Ballast water (water that is carried in unladen ships to provide stability) may cause a problem if dumped in our waters.
- a plant quarantine station. Imported exotic plants are kept for inspection.
- quarantine stations for imported animals. Commonly quarantined animals include pigeons, cats, dogs, horses, alpaca, cattle and bees.

AQIS officers inspect imported foods according to categories set by FSANZ. The three main categories are risk, active surveillance and random surveillance. A 'risk' food is one that can potentially harm public health. The Australian Customs Service refers all risk category foods to AQIS for inspection and testing. AQIS uses a list of potential hazards including micro-organisms, contaminants and pesticide residues proscribed by FSANZ to check whether food is a public health risk. 'Risk' foods are not released for sale until test results are known (this process is referred to as 'test and hold').

'Active surveillance' foods are those that may be a potential risk; about 10 per cent of foods in this category are

AQIS dogs are used to ensure that luggage brought into Australia does not contain undeclared foodstuffs that might carry pests or diseases that could destroy our food industry.

sent to AQIS for inspection. All other foods are categorised as 'random surveillance' foods (5 per cent of foods in this category are referred to AQIS). Active and random surveillance foods are tested against a published list of potential hazards, based on advice from FSANZ. FSANZ then receives the test results and assesses the level of risk the item carries. AQIS is empowered to inspect and sample food items by undertaking complex scientific tests and experiments to ensure foods comply with laws such as the *Imported Food Control Act 1992 (Commonwealth)* and the Australia New Zealand Food Standards Code. Imported food failing to meet these standards must be re-exported, destroyed, treated if possible or used for another purpose such as stock feed. Special import permits must be obtained for commercial importers wishing to import:

- fresh fruit and vegetables
- food containing milk, egg, meat or other animal products.

REVIEW QUESTIONS

Remember

1. In each of the following scenarios, describe why the manufacturer may be in breach of the Food Standards Code.
   - **a)** Bevelish Foods produces a savoury pie that does not show a use-by date.
   - **b)** Colour Free Foods Limited produces children's confectionery, but some of their products have been found to contain colours.
   - **c)** Sweet N Sour is a sauce imported from China. The label does not list the ingredients.
   - **d)** A pallet of unlabelled carbonated soft drinks has arrived from the United States of America.
2. Give two reasons why the Food Standards Code may need to be changed.

Apply

3. Pick any three food products. Compare the ingredients list with the name of the product. Are you surprised at the ingredients included and the amounts of particular ingredients in the food product? Do you think the Food Standards Code should be more detailed?
4. Joseph runs a franchise sandwich store. He receives an anonymous letter saying that eating a salad sandwich at the shop could turn out to be deadly. He throws the paper in the bin and does nothing about it. Do you think Joseph has broken the law?

Do an activity

5. Log in to **www.jacplus.com.au** and locate the *AQIS* weblink for this chapter. Open the weblink to investigate the following:
   - **a)** What food products cannot be mailed to Australia?
   - **b)** Outline the requirements for importing and exporting food into and from Australia.
   - **c)** Find out what happens to seized items and what treatment is available.
   - **d)** Who does AQIS work with to ensure Australia has a safe supply of food?
6. Log in to **www.jacplus.com.au** and locate the *Product recall* weblink for this chapter. Open the weblink to investigate the following:
   - **a)** Make a list of food items and outline why they were recalled.
   - **b)** Considering what you have learned about the role of FSANZ, how do you feel about the safety of our food supply?

eBook*plus*

Weblink

Food legislation: who makes it?

Food regulation is a fact of life worldwide. Relationships with international food experts and regulatory bodies have been established so that food issues in Australia reflect world's best practice. Australian regulatory agencies are active participants in ***Codex Alimentarius*** (Codex for short), as well as other international food agencies such as the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and the World Trade Organization (WTO).

Codex is a body established by the FAO and WHO, coordinating input from over 160 countries to create and endorse an international food code. In particular, this code was set up to protect consumer health and promote fair practices in world food trade.

At a national level, we have seen that FSANZ is responsible for reviewing standards and developing codes of conduct for the Australian and New Zealand food industries. While FSANZ was set up under a Commonwealth Act, it is up to the states to enforce their own Food Acts. There are numerous state laws related to food but generally each state has its own legislation. For example, NSW has the *Food Act 2003* (see page 176). The New South Wales Food Authority (NSWFA) is the state government agency that is responsible for food safety across the entire food industry. The NSWFA works with local government, supporting their role in food regulation.

Let's now take a closer look at our federal, state and local food laws.

Federal food laws

There are many federal laws pertaining to the Australian food industry. Some of them are summarised in table 9.2. A more in-depth discussion of the *Trade Practices Act 1974* is provided below.

Trade Practices Act 1974 (Commonwealth)

The *Trade Practices Act 1974* aims to promote competition to ensure fair trading and protect the consumer. This is a federal Act and generally applies to the business activities of most corporations, as well as sole traders and partnerships that cross state boundaries or are conducted by telephone, post, radio or television. However, the *Trade Practices Act* is more far reaching than that because each state has legislation that virtually mirrors the fair trading provisions of the Act. For example, in NSW the *Fair Trading Act 1987* complements the *Trade Practices Act*.

Safeway paid the price for fixing the price of bread and misusing market power and was penalised $8.9 million in 2003.

The Act addresses four broad areas:

1. restrictive trade practice, a practice that hinders competition in some way
2. unconscionable conduct, such as selling a product that the supplier knows does not meet food standards (it might be out of date or not meet labelling requirements)

TABLE 9.2 Federal food laws

NAME OF ACT	PURPOSE
Food Standards Australia New Zealand Act 1991	FSANZ was established under this legislation to: • ensure consumers are confident in the quality and safety of food produced here or imported from overseas • provide a regulatory framework for the food industry • provide information to consumers about food so they can make informed food choices • establish common rules for both countries to promote consistency between domestic and international trade.
Gene Technology Act 2000	The objective of the Act is to ensure public health and safety and to protect the environment by identifying and managing potential risks associated with genetically modified organisms. In the food industry, this Act covers genetically modified animals that are sold for human consumption as well as genetically modified fruits, vegetables and grain.
Dairy Produce Act 1986	This Act covers both the marketing and export of dairy produce as well as collection of certain levies in the dairy industry.
Imported Food Control Act 1992	The object of this Act is to ensure all food imported into Australia meets Australian food standards and the requirements of public health and safety. It lists specific requirements that all imported food items must meet, including the areas of packaging, labelling and the use of additives and **preservatives**.
Export Control Act 1982	This Act covers federal regulations regarding the export of food items.
Fisheries Management Act 1991	This Act and the Australian Fisheries Management Authority aim to prevent the exploitation of fisheries resources and assist in maintaining ecologically sustainable development. In addition, the Act aims to ensure that the economic return from Australian fisheries is maximised and that the fishing industry is accountable for its actions.

3. consumer protection, including unfair practices such as false or misleading conduct, offering gifts or prizes without intending to supply them, **bait advertising** and **referral selling**. This area also covers product safety, where supplied goods must meet certain safety standards, and conditions and warranties in consumer transactions.
4. liability of manufacturers and importers to pay compensation if goods are defective. For example, if a customer contracts food poisoning from a meal in a restaurant, the restaurant owner is obliged to pay the doctor's bill.

Let's look at how the Act addresses restrictive trade practices in particular.

TABLE 9.3 Restrictive trade practices

RESTRICTIVE TRADE PRACTICE	EXAMPLE PERTAINING TO THE FOOD INDUSTRY
Misuse of market power	A company with a large market share for a particular food product tries to damage or eliminate its competitors by making incorrect statements about a competitor's product.
Exclusive dealings	A company that supplies fresh seafood insists that a restaurant purchases their stock only. Such 'exclusive dealing' is illegal as it reduces competition.
Resale price maintenance	The supplier of fresh eggs tells the local corner shop that they must sell their eggs at $3.00 a dozen. A supplier can suggest a recommended retail price, but a retailer can sell the product at whatever price it chooses.
Price discrimination	A bakery sells a loaf of bread to a takeaway shop at a certain price, and then sells it for a higher price to a café. The supplier of a product must sell produce at the same price to any company.

CASE STUDY

In two separate instances within the past 12 months, the ACCC has investigated and sought undertakings from food manufacturers for conduct which it considered contravened Part V of the TPA [*Trade Practices Act 1974*].

Uncle Tobys

In September 2006, the ACCC accepted undertakings from Uncle Tobys Foods regarding claims they made about their fruit roll-ups. These claims included:

- representations on the product packaging and promotional material that the roll-ups were 'Made with 65% real fruit'
- representations on the ingredients panel that the fruit content of the product was equivalent to a specified percentage of fresh fruit
- television advertisements with images of an apple being flattened into a roll-up and an associated description.

Upon reviewing information provided by Uncle Tobys, the ACCC expressed concern that the representations were likely to mislead or deceive consumers in accordance with the provisions above. Uncle Tobys offered specific undertakings under s87B of the TPA to remove or alter the misleading representations, including changing aspects of its packaging, ingredients list and advertising.

Just Squeezed Fruit Juices

In March 2006, the ACCC accepted undertakings from the Just Squeezed Fruit Juices Group in relation to representations made regarding the content of its fruit juice products on the product labels. The ACCC formed the view that the prominent placement of the words 'just Squeezed' on the labels, coupled with the images of fruit and words such as 'Orange Juice' and 'Apple Juice', created the overall impression to consumers that each product was produced directly from the fruit shown on the labels and did not contain reconstituted juice. The juices in question did in fact contain varying portions of reconstituted juice.

In its s87B undertakings, Just Squeezed undertook to refrain from making any further false representations, rectify their current packaging, including changing the words 'just Squeezed' to 'just Delicious', publish an apology in a national newspaper, and implement a trade practices compliance program.

A lesson to be learned

These examples provide a timely reminder to food producers and manufacturers to be alert as to the factual correctness of, and overall impression given by, the claims they make on packaging and promotional material. Any consideration of such claims should now be made in light of the information provided in the Guideline.

In both of these cases, which arose prior to the release of the Guideline, the companies involved chose to cooperate with the regulator and rectify the conduct in question, rather than challenge the ACCC's views in court. As was seen in the Uncle Tobys case in particular, whether the representations made were factually misleading was not in fact tested. The mere perception that the representations could be misleading were of sufficient concern to the ACCC for it to take action. A desire to curb any potential public relations fallout may have contributed to these companies' cooperation with the ACCC, without the validity of their representations being judicially considered.

Source: www.aar.com.au, December 2006.

CASE STUDY QUESTIONS

Carefully consider the article on page 174. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of the *Trade Practices Act 1974* to complete the tasks ahead.

1. How was Uncle Tobys in breach of the *Trade Practices Act 1974*?
2. Why was Just Squeezed Fruit Juices also in breach of the Act?
3. Outline the impact on consumers if food manufacturers could deliberately mislead the consumer.
4. Could it be possible that such companies had 'accidentally' misled consumers? Discuss and debate these issues as a class.

State government legislation

If waterways are not protected, pollution from factories can have serious consequences for the environment in which we live. For example, water pollution can have a long-term negative effect on the fishing industry.

The state government also passes legislation that affects the food industry. Some legislation aims to protect the environment while other laws concentrate on correct food safety and handling. Here are some examples of NSW legislation.

Protection of the Environment Operations Act 1997

This Act applies to the noise produced during food processing and is enforced by the Environment Protection Authority. Noise under the Act refers to both sound and vibration. Any premises that makes undue or offensive noise is required to use noise-control equipment.

Fertilisers Act 1985

The object of this Act is to regulate the sale of soil-improving agents and trace element products to:

- ensure that unsafe levels of heavy metals and other soil contaminants do not infiltrate foods consumed by humans
- ensure that agricultural products to be exported comply with the requirements of our international trading partners in terms of the presence of heavy metals and other contaminants
- protect the environment by communicating to purchasers the composition of improving agents and trace elements.

Fisheries Management Act 1994

This Act seeks to protect and develop fishery resources in NSW for the benefit of present and future generations. It aims to stop the depletion of fish stocks, protect threatened fish species and promote ecologically sustainable development.

Trade Measurement Act 1989

This Act ensures that measurement instruments used in transactions bear a trade measurement authority inspector's mark or a licensee mark. Measurement instruments must be fair and accurate, and any person who uses an unjust measurement instrument is guilty of an offence. Where a measuring instrument is found to be inaccurate and the licensee does not correct the problem, an inspector may issue a notice forbidding the proprietor from using the instrument and penalties may apply for noncompliance.

Measurements are to be made where the customer can observe the process. Misleading a customer about the measurement given or incorrectly calculating the cost is an offence. It is also an offence to supply less than the quantity specified in a sale offer. For example, supplying a customer 450 grams of fruit when the customer has paid for 500 grams is an offence. However, it is acceptable to supply 520 grams but charge for only 500 grams.

Manufacturers, as part of their quality control, check the weights of their products. For example, Arnott's Biscuits Ltd uses an electronic weighing system that rejects underweight packets.

Fair Trading Act 1987

This Act covers fair and honest business practices protecting both the consumer and traders. It enforces sanctions against a wide range of unfair trading practices. It also provides safety and information standards to be set between suppliers and customers.

Occupational Health and Safety Act 2000

This Act aims to protect the health, safety and welfare of employees in the workplace, mainly by reducing work-related accidents and eliminating risks. This legislation is particularly important to the food industry, where many employees face danger when using equipment. Employers are required to follow a code of practice to ensure they comply with occupational health and safety (OH&S) requirements in the workplace. For example, employees must be given appropriate training for operating certain pieces of equipment and must also be given protective clothing, such as earmuffs to reduce the impact of noise.

There is a multitude of laws pertaining to food, but let's take a closer look at the *Food Act 2003*.

Food Act 2003 (NSW)

The *Food Act 2003* is an important piece of legislation not just for the food industry but also for consumers and the public. The main aims of this act are to:

(a) ensure food for sale is both safe and suitable for human consumption

(b) prevent misleading conduct in connection with the sale of food

(c) provide for the application in NSW of the Food Standards Code.

The table below provides a summary of some serious offences relating to food outlined in the Act. For more information on the Act, you should go to the Parliamentary Counsel's Office website.

TABLE 9.4 Serious offences related to food under the *Food Act 2003* (*NSW*)

SECTION OF ACT	LAW	PENALTY[a]
Handling of food in an unsafe manner (section 13)	The law states that food intended to be sold must not be handled in a manner that could result in the food being unsafe. The Act makes a distinction between whether the person knew that handling the food in such a way would make it unsafe (or was likely to make it unsafe) or ought reasonably to have known that handling food in this way would make it unsafe. *Examples:* • A farm worker has a dangerous insecticide on his hands but continues to handle food as it is loaded into a truck. • A proprietor knows that chicken meat was not refrigerated overnight but still takes the risk and cooks it for others to eat.	• If it is established that food was sold by an individual with the knowledge that its handling was unsafe, the maximum penalty is 1000 penalty units or imprisonment for 2 years, or both. The maximum fine for a corporation is 5000 penalty units. • For the lesser offence where the offender ought to have known that its handling would make food unsafe, or was likely to be unsafe, the maximum penalty is 750 penalty units for an individual and 3750 penalty units for a corporation.
Sale of unsafe food (section 14) — Food that is unsafe under the Act is said to be likely to cause physical harm to a person who might later consume it.	The law states that food must not be sold if a person knows it is unsafe or ought reasonably to have known it was unsafe. *Example:* Despite a customer complaining that they suffered food poisoning as a result of eating sausages sold at a butcher's shop, the butcher continued to sell the rest of his stock.	• If food was sold by an individual with the knowledge that it was unsafe, the maximum penalty is 1000 penalty units or imprisonment for 2 years, or both. The maximum fine for a corporation is 5000 penalty units. • For the lesser offence where the offender ought to have known that they were selling unsafe food, the penalty is 750 penalty units for an individual and 3750 penalty units for a corporation.
False description of food (section 15)	The law states that an individual must not falsely describe food intended for sale if they know the consumer of that food will rely on that description and will or is likely to suffer physical harm as a result of the false description. The law also makes it an offence if the individual selling the food ought reasonably to have known that the description was false. *Example:* A gourmet kitchen proprietor labels cookies as 'gluten free' even though they contain wheat.	• If the false description is made by an individual selling the food, the maximum penalty is 1000 penalty units or imprisonment for 2 years, or both. The maximum fine for a corporation is 5000 penalty units. • For the lesser offence where the offender ought to have known that the description of the food was false, the maximum penalty is 750 penalty units for an individual and 3750 penalty units for a corporation.
	The law also covers the situation where the person selling the food knew it was falsely described (or ought reasonably to have known), even though they were not responsible for the false description. *Example:* Sam, the wholesaler, tells Fred, the retailer, that the cakes have nuts in them, even though the label says that the cakes do not contain nuts. Fred still sells the cakes.	• If an individual sells food knowing that it is falsely described, the maximum penalty is 1000 penalty units or imprisonment for 2 years, or both. The maximum fine for a corporation is 5000 penalty units. • For the lesser offence where the offender ought to have known that they were selling food that was falsely described, the maximum penalty is 750 penalty units for an individual and 3750 penalty units for a corporation.

[a] At the time of writing, the value of a penalty unit was $110.

CASE STUDY

'NAME-AND-SHAME' CAMPAIGN

The Minister for Primary Industries Ian McDonald has given approval for the NSW Food Authority to name food outlets on its website that have failed to meet basic hygiene and food regulations standards. It is hoped that publicly naming the restaurants on its website will ensure all food producers take food hygiene and safety more seriously. The authority has permission to publish a notification that the food producer has been convicted of an offence under the *Food Act 2003*.

While the minister believes that the majority of NSW food outlets are adhering to standards, there is still a small percentage of outlets that put the health of the consumer at risk. The website will help consumers choose appropriate places to eat and shop, and those who are listed on the site will lose customers very quickly.

Food producers who do not do the right thing could be prosecuted. For example, a butcher was prosecuted for selling minced meat with sulfur dioxide in it — a preservative that is illegal. In another prosecution, a fish shop proprietor had falsely described seafood and failed to display notices that five products were imported.

OUTCOME TASK **RESEARCH ASSIGNMENT**

Students learn to:

- identify significant government policies and legislation and explain their impact upon the Australian food industry.

Contributes to the following outcomes:

- examines the nature and extent of the Australian food industry
- investigates operations of one organisation within the Australian food industry.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of the *Food Act 2003* to complete the tasks ahead.

1. What is the purpose of the 'name-and-shame' campaign?
2. Do you think a campaign like this will work? Justify your answer.
3. Think of local food suppliers in your area. Do any of them deserve to be 'named and shamed'. Why?
4. Would you consider giving a business 'a second chance' before they were to be named and shamed? Discuss this as a class.
5. Interview a small business owner in the food industry. Compile a set of questions that covers the following points and present your findings in a report:
   - specific legislation and regulations pertaining to their business
   - how safety and hygiene standards are monitored both in the business and by external organisations
   - whether there are any organisations that assist the business to comply with food safety and hygiene requirements and promote their business.

State food inspectors

'Since we closed that restaurant downtown due to infestation, I've had this eerie feeling that I'm being followed!'

Under the *Food Act 2003*, the NSW Food Authority aims to ensure food safety by conducting **audits** of licensed businesses. These audits ensure compliance with the *Food Regulation 2004 (NSW)*. Any business that is licensed to handle or process food should have an audit completed. Only high-risk businesses and industries are inspected; other food businesses are known as 'notifiable'. During an audit, the audit officer checks that there is a **food safety program** and policy and that the business has supervisors. Responsibilities of all workers should be clearly defined. The auditor also ensures that the business keeps records of all food products it handles and that procedures are documented. Checks are also made to ensure that there are systems in place for hygiene, chemical storage, pest control, training, product recall, internal reviews and customer complaint handling.

Local government's role in food safety

Many local governments are now working with the NSW Food Authority to ensure food safety and hygiene. At the

local government level, each suburb, district and council is responsible for:

- appointing an **environmental health officer (EHO)** who specialises in food surveillance
- inspecting food and food premises
- building requirements, such as the construction and alteration of food premises.

EHOs are given authority under the *Food Act 2003* to do routine inspections of all food premises in their local area. They work for the local government, and, while their role may vary slightly according to the council they work in, their responsibilities generally include:

- investigating complaints about food premises (such as shops, cafés, food processing factories and dairies), ensuring that the preparation of food is hygienic and that food is stored and served according to the correct standards. Food samples may be collected for chemical and **microbial** analysis.
- educating those in the industry about food safety and hygiene
- inspecting a registered food business at any time, but this does not include viewing or requesting financial information about the food business
- checking the supplier of goods
- compiling reports after inspecting premises and recommending that businesses be prosecuted if they fail to meet standards and legislative requirements
- issuing improvement notices and orders
- working with the NSW Food Authority to ensure that all food goods sold meet labelling and other legal requirements.

EHOs have a significant role to play in maintaining food safety at the local government level. Without inspection of premises and food safety education programs, the general public's health may be put at risk.

Codes for inspection of food and food premises

Local councils are responsible for developing a code to follow when inspecting food premises. The code covers areas such as how often an inspection is done. The code also states which food premises are exempt from inspection. For example, some councils choose not to inspect premises such as fruit and vegetable shops as these represent a low health risk to the public. In a routine inspection, EHOs look at the food, food storage facilities and equipment used in food preparation. They investigate the state of the building that food is being prepared in and look at overall cleanliness and hygiene.

Codes for the construction and alteration of food premises

Each council develops its own code for the construction and alteration of premises that sell and supply food and food products. Codes vary slightly but generally they are established in consultation with experts in the field, including food surveillance officers, architects, builders, contractors, shopfitters, manufacturers and other people who assist in the planning and construction of premises. The aim of the code is to achieve high hygiene standards during the production and sale of a food item, including cleaning and overall maintenance. Codes outline and recommend:

- suitable materials for walls, floors, ceilings, windows, doors, openings, servery hatches, service pipes, vermin proofing and servery bars
- guidelines for the installation of fixtures, fittings and equipment including refrigerators, freezers, heating appliances, counters, bars, cupboards, cabinets and shelving
- guidelines for washing and other facilities including food conveyors, oyster-opening bays, window displays, butcher shops, staff dressing areas, staff toilets and ventilation.

REVIEW QUESTIONS

Remember

1. Name the legislation that has most likely been contravened in the following examples.
   - **a)** Kevin ran a fast-food business and advertised nationwide that you could expect to feel sick if you ate anywhere else.
   - **b)** Matt advertised that he had barramundi on the menu at his takeaway fish and chip shop but instead supplied a cheaper alternative without telling consumers.
   - **c)** Mia started a new job at the local deli, and on her first day on the job she had to use the meat slicer. She was told briefly how to use it but wasn't given a demonstration nor was she provided with the personal protective equipment needed to operate it.
   - **d)** Alex is a local fisherman who supplies prawns to the local fish markets. During a prawning expedition, he released a large amount of used waste into the ocean thinking that it could not hurt anyone as he was away from the shore.
   - **e)** Zoe was working at the local café. She was in a rush as she closed up one day and left the ham used for sandwiches out of the fridge overnight. The next day she knew she should have thrown out the ham but had no more to replace it. She decided to run the risk and use the unrefrigerated ham in sandwiches.
   - **f)** Addison was responsible for packing 1 kg of licorice into paper bags, which were then sealed and sold. She received an urgent order but couldn't find her scales so she estimated the amount of licorice put in each bag and sealed the bags without weighing them.
2. What does the NSW Food Authority do?

Apply

3. Outline the impact of the *Food Act 2003* on local food businesses.
4. Discuss the importance of occupational health and safety for food businesses and food producers.

Do an activity

5. Ask your local environmental health officer to come to your school to talk about food safety. Prepare a list of questions to ask.
6. Create a way of informing and reminding local food businesses of the importance of food safety. You may like to do this though a radio jingle, PowerPoint presentation, poster or another suitable method to get your message across.

CHAPTER 9 SUMMARY

- The difference between legislation and policy is that policy provides an overall framework for the food industry whereas legislation sets out prescribed laws.
- Advisory groups play an important role in influencing policy and legislation.
- Some food industries are self-regulated.
- State government legislation plays an important role in ensuring that food items are safe and suitable for human consumption. Legislation such as the *Food Act 2003* helps to reinforce the importance of food safety.
- FSANZ is an independent statutory agency that plays a fundamental role in the food industry. It implements food standards and codes of practice, and issues food product recalls.
- The Food Standards Code describes standards for food producers and manufacturers regarding food safety and the composition of food. It includes the use of additives and preservatives and how products should be labelled.
- The Australian Quarantine Inspection Service (AQIS) helps to protect our food industry by inspecting imported food and certifiying exported food.
- The federal government assists the Australian food industry by developing policies that apply to food manufacturers, producers and consumers. Current policies that pertain to the food industry include various trade policies and health and nutrition policies.
- Free trade agreements have had a significant impact on the food industry by reducing trade barriers, tariffs and subsidies, making our food industry more competitive and diverse.

KEY TERMS

advisory groups
audit
Australian Quarantine and Inspection Service (AQIS)
bait advertising
ballast water
codes of practice
Codex Alimentarius
environmental health officer (EHO)
extortion
food safety program
Food Standards Australia New Zealand (FSANZ)
Food Standards Code
free trade agreement
genetically modified
legislation
microbial
policy
preservatives
product recall
protocols
quarantine
referral selling
self-regulated
subsidies
tariff
value-added

HSC PRACTICE EXAM QUESTIONS

Multiple-choice questions

1. Which of the following is the most significant social implication of increased mechanisation in the food industry?
   - **A.** Decreased environmental pollution
   - **B.** Increased range of convenience foods
   - **C.** Increased range of products for consumers
   - **D.** Decreased employment opportunities for unskilled workers
2. Which of the following best describes food retailing in Australia?
   - **A.** Selling food to the consumer in small quantities
   - **B.** Displaying food in refrigerated cabinets
   - **C.** Selling food for immediate consumption
   - **D.** Developing convenience food for consumers
3. The main reason why the Australian food industry responds to consumer influences is to
   - **A.** expand export sales.
   - **B.** minimise industrial action.
   - **C.** maintain market share and profitability.
   - **D.** address issues relating to community nutrition.
4. Which legislation enforces food standards and hygiene regulations in the NSW food industry?
   - **A.** *Trade Practices Act 1974 (Commonwealth)*
   - **B.** *Food Act 2003 (NSW)*
   - **C.** *Fair Trading Act 1987 (NSW)*
   - **D.** HACCP
5. What is the main role of an environmental health officer under the *Food Act 2003 (NSW)*?
   - **A.** To inspect food premises
   - **B.** To audit financial status of the company
   - **C.** To control the use of imported and exported foods
   - **D.** To guard against unfair trade

Short structured items

1. Identify each sector of the Australian food industry and briefly describe its function.
2. The percentage of Australian farmers now participating in organic farming has increased in recent years. Outline the advantages and disadvantages of organic farming.
3. Choose one sector of the Australian food industry. With reference to this sector:
   - **a)** outline two recent developments within the sector
   - **b)** describe the impact of these recent developments on the consumer
   - **c)** describe the impact of the sector on the environment
   - **d)** discuss the types of career opportunities available in the sector.
4. Explain how government policies and legislation have affected the Australian food industry. Use three examples of government policies and legislation to support your answer.
5. What role do advisory groups play in shaping policy and legislation? Give two examples of how advisory groups have influenced policy and legislation.

Chapter 10
Production, processing and preservation

Have you ever considered that foods produced by food manufacturers are basically the same as what you would make at home, just produced on a much larger scale? In order to supply consumers with a constant and consistent food supply, food manufacturers have developed processing systems that allow for the hygienic mass-production of foods. Their main aim is to physically and chemically alter raw ingredients into packaged food and beverage products that are desirable to consumers, safe for consumption over a long period of time, maintain their quality during storage, are cost effective to produce, and generate a minimum of waste in production.

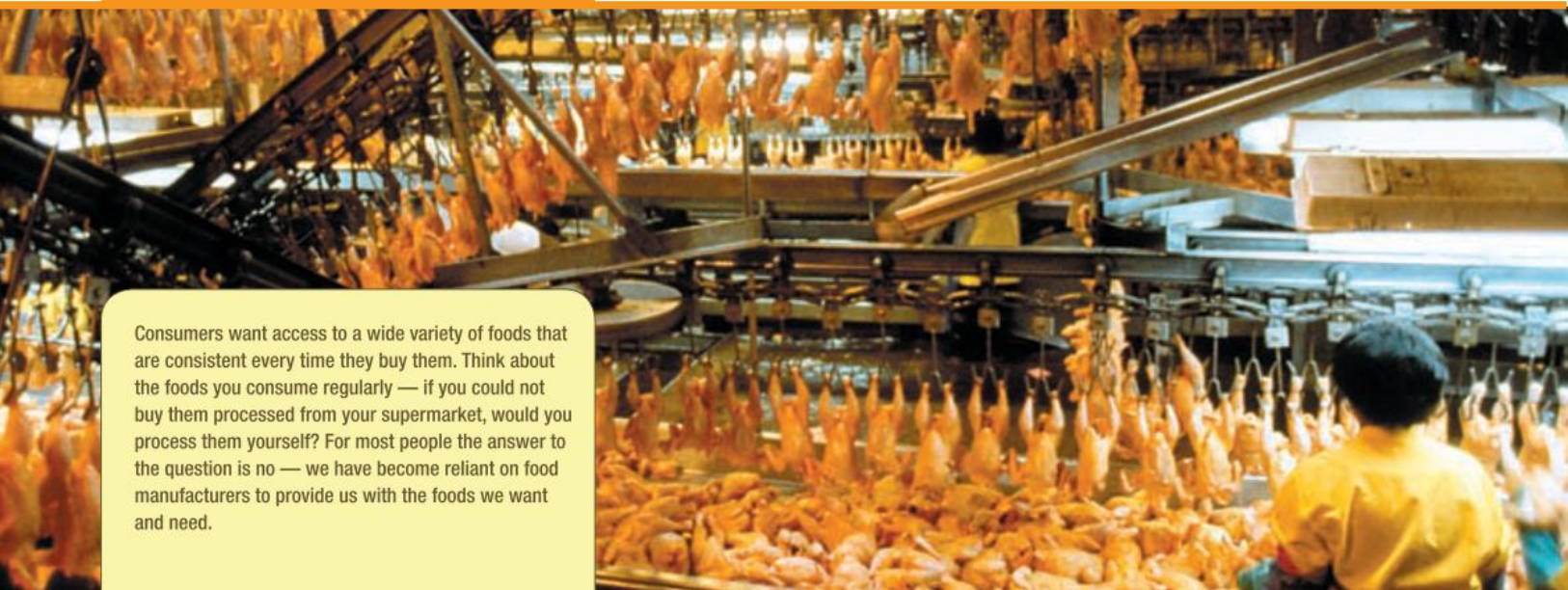
In this chapter you will learn about:

Production and processing of food

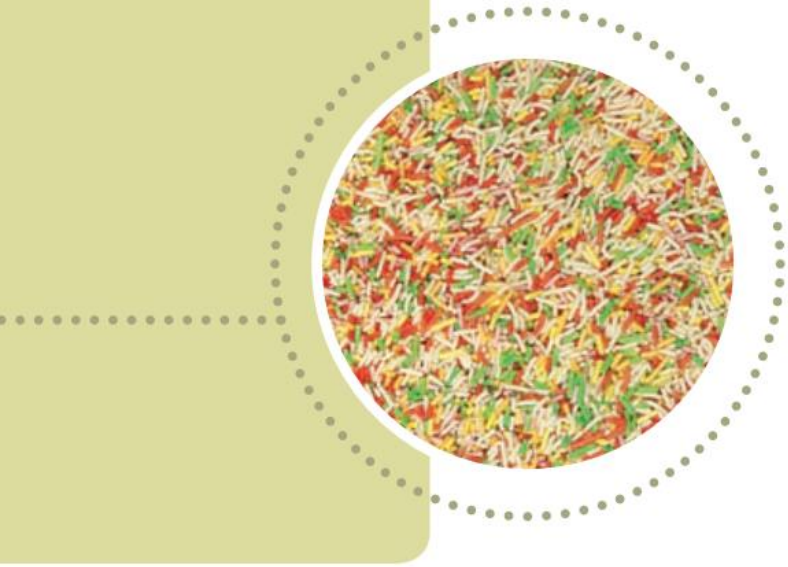
- quality and quantity control in the selection of raw materials for food processing
- role of food additives in the manufacturing process
- characteristics of equipment used in different types of production and the factors influencing their selection
- production systems used in the manufacture of food, e.g. small scale, large scale, manual, automated, computerised
  - quality management considerations in industrial practices to achieve safe foods for public consumption, e.g. Hazard Analysis Critical Control Points (HACCP), occupational health and safety, and hygiene

Preservation

- reasons for preserving foods, e.g. safety, acceptability, nutritive value, availability and economic viability
- causes of food deterioration and spoilage
  - environmental factors (infestation, oxygen, light and water)
  - enzymatic activity
  - microbial contamination (mould, yeast and bacteria)
- principles behind food preservation techniques, such as temperature control and restriction of moisture
- preservation processes, including canning, drying, pasteurising, freezing and fermenting.



Consumers want access to a wide variety of foods that are consistent every time they buy them. Think about the foods you consume regularly — if you could not buy them processed from your supermarket, would you process them yourself? For most people the answer to the question is no — we have become reliant on food manufacturers to provide us with the foods we want and need.



Raw materials

To achieve its aims, a food manufacturing company has to:

- purchase good quality raw materials
- process them in a well-designed plant with hygienic equipment
- follow good manufacturing practices.

A **raw material** can be defined as any product that is used in the manufacture of another processed good. Raw materials used in food processing are:

- product ingredients, such as fruits and vegetables
- processing materials, such as steam and water
- food additives, such as emulsifiers, starches, colours and flavours
- packaging materials, such as cans, bottles and fibreboard containers.

All raw materials are processed in one way or another. Flour, sugar, salt, meat, margarine and even eggs have all undergone some type of processing before being delivered in bulk to the factory floor of a food manufacturer.

Quality control of raw materials

A large area of expenditure for any food manufacturer is raw materials, and for this reason manufacturers spend a great deal of time and effort to ensure that they receive raw materials of a very high standard. Research is undertaken when choosing suppliers to ensure not only that they can supply an adequate quantity of raw materials, but also that they are of the right quality and type. The raw materials supplied must:

- be free of contaminants
- meet the criteria for the specific characteristics required by the manufacturer such as size, colour, level of moisture, presence of a specific nutritional factor. These requirements are called the 'raw materials specifications'.

Purchasing raw materials from a reputable supplier helps manufacturers assure the quality of their product to consumers. No raw material is accepted onto a production site unless it has been tested and confirmed as having met the company's specifications discussed below. These tests are referred to as **quality control** and are carried out by specialised quality control technicians. Larger production sites have their own quality control departments, but smaller manufacturers often rely on the supplier to carry out these tests and provide documentation along with the delivery. All raw materials must meet strict guidelines, because just one delivery of contaminated material can mean the spoilage and rejection of a complete **production run**. A production run is the process of taking raw materials and making them into a finished product within a certain time period.

Raw materials are rejected and returned to the supplier if they have not met the stated specifications. In the manufacture of fruit cakes, for example, the dried fruit needs to be free of sticks, stones and all other foreign matter, so the manufacturers have specific guidelines on the acceptability of dried fruit. If these specifications are not met, the manufacturer will reject the fruit and find another supplier. An inferior batch of dried fruit will result in an inferior end product. An inferior end product will lead to dissatisfied consumers and damage to the company's reputation.

Setting up raw material specifications

Quality control laboratories follow certain criteria when setting up a raw material specification. They develop a separate list of all the raw materials for each production line involved in making a product in the factory. The following information is prepared for each material:

- *a description of the raw material*. All tolerances and standards need to be specified: standards for physical characteristics (size, shape, etc.), sensory characteristics (colour and aroma), chemical characteristics (moisture content, pH level) and tolerances in microbiological limits.
- *a sampling method for the material*. This method should specify the exact number of samples to be treated to give the required assurance of quality, at a minimum sampling cost.
- *a test for each specified characteristic*. There is no value in specifying a characteristic unless it can be tested.
- *action to be taken when the tests have produced a result*. The manufacturer can do one of three things with the results obtained from the testing procedures.
  (a) Accept the material if it is within the set standards.
  (b) Reject the material if it does not comply with company standards.
  (c) Start methods of controlling the problem if the material is not outside the set standards, but looks as if it may be deteriorating to that level.

Similar types of specifications are used to detail the quality of the final product.

REVIEW QUESTIONS

Remember

1. What is a raw material? Give at least four examples.

Apply

2. What are four important factors that need to be considered when setting up a quality control program for raw materials?
3. Why is the quality of raw materials entering the production plant so important? What are the consequences if the quality does not match specifications?
4. Suggest reasons why smaller manufacturers might not conduct their own quality control tests.

Do an activity

5. Imagine you are the manufacturer of fish fingers. What types of raw material would you be buying? Remember to include packaging. List the tests you would need to conduct on the raw materials to ensure you produced a high-quality product.

Food additives

Food additives are substances added to food that are not normally consumed by themselves. They are primarily used in processed foods, and in relatively small quantities. Food additives are necessary to provide the consumer with wholesome, safe, convenient and nutritious foods. Without these additives, the modern practices of food preparation and distribution would be impossible. The problem is that some people have adverse reactions — maybe an allergy or food intolerance — to some additives.

Additives and consumer safety

Food Standards Australia New Zealand (FSANZ) controls the use of additives in manufactured products sold in Australia and New Zealand. FSANZ has a list of approved additives that may be included in foods sold here, whether locally produced or imported. If a manufacturer wishes to use an alternative substance, they must apply to FSANZ for approval. This system is designed to safeguard consumer health by regulating what can be used in foods. Many manufacturers feel the system is restrictive, especially when compared to those foreign countries that monitor their additive use in the opposite way — by issuing a list of substances that cannot be used, meaning that anything else is acceptable.

If additives are used they must be included on the product label. The listing of long names on food labels required excessive space, so the code numbering system for food additives was developed. Since 1986, additives in Australia have been identified by their class name and by an individual name or code number. The numbering system used in Australia is based on an international system used to identify all food additives. In practical terms this means, for example, that even the safest of artificial colours, such as allura red, cannot be listed simply as 'colour'. The manufacturer could list the class name 'colour', and the specific name of the additive:

COLOUR (ALLURA RED AC [C1 16035])

or simplify it by using the number for allura red instead:

COLOUR (129)

With this system, someone who has an intolerance for allura red can choose whether they will purchase a product containing the additive. Information on which additive has what number is available from FSANZ.

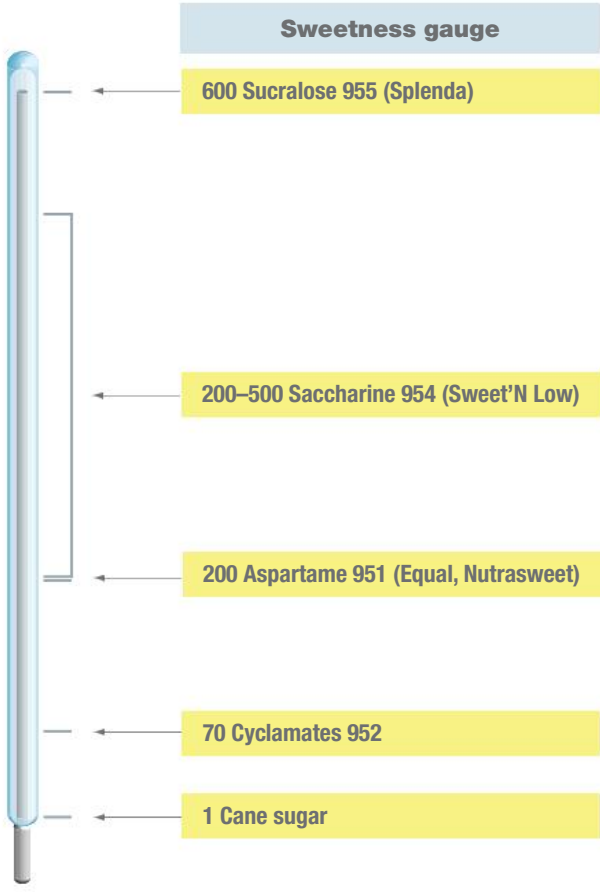
Uses of food additives

There are a wide variety of uses for food additives. They can be used to:

- improve the stability or the keeping quality of a food
- restore or improve taste or appearance of processed food
- provide foods for special dietary needs
- extend the **shelf-life** of the product.

Food additives can be placed in classes or functional groups. Examples of the most common are given in table 10.1.

Food additives can be purchased at the supermarket (baking aisle) for inclusion in domestic recipes — for example, food colouring, flavours, food acids and artificial sweeteners. Try substituting some food additives into a standard recipe to determine the impact on the product's quality.



A variety of artificial sweeteners are used in manufactured food products to provide sweetness without energy (kJ). Can you taste the difference between artificially sweetened foods and foods sweetened with sugar? Is there a difference in taste between the different brands of artificial sweetener?

TABLE 10.1 **Food additives and their uses**

ADDITIVE	GENERAL INFORMATION	EXAMPLES	CODE NUMBERS	TYPICAL PRODUCTS
Antioxidants (Preservatives)	• Added to prolong the shelf-life of a product by preventing oxidation, which can cause rancidity and severe colour changes • Also added to some fruits to prevent the discolouration caused by oxidation	Ascorbic acid (300) Sodium ascorbate (301) Octyl gallate (311)	300–322	Frozen cooked prawns Margarine Edible fats
Preservatives	Used to inhibit the growth of moulds, bacteria, yeasts and viruses in foods and thus prevent deterioration and spoilage	Sulfur dioxide (220) Sorbic acid (200) Nisin (234)	200–283	Tomato products Brewed soft drinks Pickles
Colours (Twenty-two are permitted in Australia.) (Colouring agents)	• Derived from oil or coal • Used in a food product to either restore colour lost during processing or to enhance the physical appearance of the food	Tartrazine (102) Amaranth (123) Food green S (142) Caramel (150)	100–172	Confectionery Jellies Jams Soft drinks
Flavouring (Taste modifier)	• The largest group of food additives • Restore flavour and odour lost through processing, maintain uniformity, and make food more palatable	1. Those that are totally natural and are extracted from plants and animals 2. Those made in the laboratory which are identical to the natural flavours 3. Those that are completely artificial and cannot be found in nature (e.g. bubblegum flavouring)	Flavours have not been given a code numbering system. Any flavours added to a food product will be described as 'Flavour' on product labels.	Ice confectionery Soups Biscuits
Flavour enhancers (Taste modifiers)	Improve the existing flavour or aroma of a food without imparting any flavour of their own	Glutamic acid (620) Maltol (636) Monosodium glutamate (621)	620–637	Soup Snack foods Flavoured noodles
Food acids (Flavours and preservatives)	• Used to help maintain a constant level of acidity • Also used to produce a sharp or sour flavour	Acetic acid (260) Tartaric acid (334) Malic acid (296)	260–380	Processed cheese Fruit juice drinks Packet spaghetti sauce mix
Artificial sweeteners (Taste modifiers)	Used primarily in low-joule products as a substitute for sugar, and to impart a sweet taste while containing fewer kilojoules	Cyclamates (952) Saccharine (954) Aspartame (951) Sucralose (955)	950–968	Diet soft drinks Diet jellies Sugarless chewing gum
Mineral salts (Texture modifiers)	Used to enhance the texture and mouth feel of foods such as processed meats, which may lose their meat juices during processing	Sodium carbonate (500) Magnesium carbonate (504) Potassium chloride (508)	500–529	Low-sodium salt Soda water Mayonnaise Processed meats

(continued)

TABLE 10.1 *(continued)*

Humectants (Preservatives)	Used to absorb moisture from the atmosphere and prevent food from drying out and becoming hard and unpalatable	Sorbitol (420) Glycerine (422) Poly-dextrose (1200) Hydrogenated glucose Syrup (965)	These humectants are the only four approved for use in Australia.	Pastries Mixed dried fruit Pre-packaged cakes Chocolate bars
Anti-caking agents (Texture modifiers)	Added to powdered products to ensure that no clumping occurs and the product flows freely	Silicon dioxide (551) Talc (553b) Calcium carbonate (170)	536–572 (A few anti-caking agents do not fall between these numbers.)	Salt Polished rice Beverage whitener
Emulsifiers (Texture modifiers)	Used to allow oil and water to be combined in a product, while ensuring that they do not separate on storage	Lecithin (322) Polysorbate 80 (433) Sorbitan monostearate (491)	322–491	Salad dressings Bread Ice-cream
Thickeners (Texture modifiers and processing agents)	Used to make a food more viscous and ensure a consistent texture. Thickeners are based on starch and modified starches.	Starch acetate (1420) Dextrins (1400) Bleached starch (1403)	1400–1442	Casserole mixes Instant puddings Desserts and sauces
Vegetable gums (Texture modifiers and processing agents)	• Used to ensure consistency of foods so they do not break into separate parts • Also used to add texture and structure to food	Xanthan gum (415) Calcium alginate (404) Pectin (440)	400–466	Cocoa Dessert mixes Jam
Bleaching agents (Processing agents)	Used to whiten foods	Chlorine (925) Chlorine dioxide (926) Benzoyl peroxide (928)		These three bleaching agents are the only three approved for use in Australia and approval has been given only for use in flour.
Vitamins and minerals (Nutritional agents)	• Added to certain foods to make up for nutritional losses incurred in processing and storage • Also added to supplement dietary intake • Sometimes act as preservatives or other additives	Vitamin B_2 (101) Vitamin C (300) Niacin (375)	300–375	Fruit juices Processed cheeses Margarine

Consumers need to know what is in their food. Not only must additives and allergens be identified, but also the percentage of major ingredients.

CASE STUDY

Food additives

Researchers continue to test the effects of additive levels in foods and the effects they may have on the human body. To be accepted as safe for use in Australia, an additive may not create an adverse reaction in more than 1 per cent of the population. FSANZ requires research, conducted here or overseas, to accompany any request for proposed additives being considered for approval.

ADDITIVES CONTRIBUTE TO CREATING HYPER KIDS

by MANOJ JAIN, MD, MPH
8 October 2007

Nearly every kid's food is 'decorated' — or 'tainted' — with artificial food colour and additives. While they make food look pretty, there may be a downside. Can our children's daily consumption of juices, candy, and soft drinks with these additives be fuelling disruptive behaviour, restlessness, lack of concentration, fidgeting, and recurrent interrupting?

Over the past 40 years, the United States Food and Drug Administration (FDA), British authorities and researchers have insisted that there was little or no link between hyperactivity and food preservatives like sodium benzoate or artificial colouring like sunset yellow food dyes. Yet a study published last month in the British journal *Lancet* has brought this under question.

Jim Stevenson, a psychologist at England's University of Southampton, recruited 300 children, aged 3, 8 and 9, and spiked their juices with differing quantities of additives and food colour. The first group gulped down the usual amount of food with dye that a British child drinks, the second group had half as much, while the third group received no food additives or dye in their juices. Then, Stevenson had parents, teachers and a computer measure the children's level of hyperactivity.

To the surprise of the researchers, food industry and government officials (but not to the surprise of teachers and parents) the children consuming the drinks with either amount of preservatives and dye exhibited higher levels of hyperactivity. Some symptoms were seen within one hour of taking the drink.

The study was complex and rigorous in its research methods: all parties were unaware of which drink was being consumed by which child. Also, children were switched from taking one type of drink for one week to another the following week, after a wash-out period.

The hyperactivity level in the kids drinking the spiked juice was not at the level to be defined as ADHD (attention-deficit hyperactivity disorder), which is an illness common in nearly 9 per cent of American kids with symptoms of extreme disruptive behaviour. However, previous studies have shown that children who do have ADHD can benefit from removing food colour and additives from their diet.

Interestingly, the effect of additives was more pronounced in the 3-year-olds and a select group of children. Scientists believe there may be a genetic link between food and release of histamines causing hyperactivity. Some kids with the genetic predisposition may be super-sensitive to food additives, just like certain individuals respond more significantly to caffeine.

The study was powerful enough to have the UK Food Standards Agency issue new advice for parents to curtail the intake of additives if their kids show signs of hyperactivity. The FDA is still pondering the issue.

The bottom line: We need to pay attention to our children's foods and consider tapering down the additives and preservatives, especially if hyperactive behaviour is a problem. (Or else, as a parent, maybe I could increase the additives in my own diet to keep up with my 8-, 11- and 15- year-old kids!)

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food additives* to complete the tasks ahead.

1. Is there any evidence to suggest that there is a link between food preservatives and hyperactivity?
2. How was research conducted to test the theory that food preservatives and colours do lead to hyperactive behaviour in children?
3. Think of the party foods usually served at children's parties. A group of parents has asked you to serve food that has no added colours or preservatives. What foods could you serve?

REVIEW QUESTIONS

Remember

1. Define what an additive is and state the four main functions of using additives in food.
2. Are substances such as sugar and salt additives or ingredients? Give a reason to support your opinion.

Apply

3. Explain why the following foods might contain these additives:
   - **a)** chocolate bars, e.g. Cherry Ripe – humectants
   - **b)** salad dressings – emulsifiers
   - **c)** margarine – antioxidants
   - **d)** salt – anti-caking agents
   - **e)** strawberry yoghurt containing fruit – colours

Do an activity

4. Collect a variety of snack foods of a similar type.
   - **a)** Identify the additive classes and codes present in all the foods. State their functions in the foods.
   - **b)** List any additives unique to one particular food. What qualities do they add or improve in the food?

5. Do you think the food additive code numbering system is a good idea? What are some of the advantages and disadvantages of the system?
6. Some people have an adverse reaction to food additives.
   a) Log in to **www.jacplus.com.au** and locate the *Food additives* weblink for this chapter.
   b) Investigate the following in relation to reactions to food additives:
      i. What symptoms do people display when adversely affected by additives?
      ii. Are some classes of additives more likely to produce a reaction than others? If so, give specific examples.
      iii. What should an individual do if they suffer an adverse reaction to an additive?

eBook*plus*

Weblink

EXPERIMENT

Frozen food emulsion

Frozen desserts such as ice-cream contain both water and fat in the form of cream. In a frozen dessert that contains cream, the water droplets need to be very small, because large droplets of water form large crystals and when frozen give the product a grainy texture. To make the product as smooth as possible an emulsifier is added to keep the water particles very small.

Syllabus outcome

Students learn to:

- describe processes that transform raw materials into manufactured food products.

Contributes to the following outcome:

- explains manufacturing processes and technologies used in the production of food products.

Aim

To observe the action of emulsifiers in a frozen dessert

Equipment

approximately 200 g fruit
1 tsp unflavoured gelatine
3 tsp boiling water
2–3 tbsp cold water
200 g sugar
2 tsp lemon juice
430 mL thickened cream
small dish or cup
3 small bowls
2 half-litre containers
spoons, spatula
egg beater or electric mixer

Method

1. Place the gelatine in a small bowl with 3 teaspoons of cold water.
2. When the gelatine has softened and absorbed all the cold water, add 3 teaspoons of boiling water, and stir well until all the gelatine has dissolved.
3. Place into another bowl the fruit, sugar and lemon juice. Mix thoroughly.
4. Put half of the mixture into another bowl.
5. Add the dissolved gelatine to one of the bowls of fruit mixture, and stir in well.
6. To the remaining bowl of fruit mixture add 1½ tablespoons of cold water. This bowl will act as the control for later comparisons.
7. Label the bowls clearly so you will be able to recognise the bowl that contains the gelatine.
8. Refrigerate both mixtures until the mixture containing the gelatine begins to thicken. The mixture should be just slightly set, not firm.
9. Whip the cream, and place equal amounts of cream into the fruit mixtures. Gently fold the cream and the fruit using the spatula until ingredients are thoroughly mixed.
10. Wet the half-litre containers with water, and add the dessert into each mould. Again, remember to label the containers.
11. Place the containers in the freezer, and leave for at least 12 hours.
12. When the desserts are frozen, taste them and record your results on a table similar to the following.

PRODUCT	TEXTURE/ MOUTH FEEL	COLOUR	FLAVOUR	VISUAL APPEARANCE
With gelatine emulsifier				
Control				

Conclusions

1. Was there any textural difference between the two desserts?
2. Which ingredient acted as the emulsifier in this experiment?
3. Would there be a significant difference in the appearance of the product? Why?

Levels of production

Food manufacturing is the processing of food for sale. The food manufacturing industry differs from the hospitality industry in the amount of human labour used in production, the scale of the equipment used, and the timing of consumption by the purchaser. All food manufacturers process and package foods so that it may safely be consumed days/months/years later. The organisations manufacturing packaged food products vary in their scale of production and the extent to which their systems are **automated**.

The food processing industry has been one of the slowest industries to adopt computerised systems. The major reason for the delay is cost. The cost of designing new equipment to complete each operation within a business,

and replacing the old equipment with the new, is prohibitive for many companies.

Bread is mass produced using computerised, automated processing systems. This bread is being cooled before being sliced and bagged — the movement of the conveyors is timed to ensure that the bread is the correct temperature before these processes occur.

Processing equipment

Food manufacturing equipment varies in size and shape depending on the amount of food to be produced. The equipment used in food manufacturing plants completes the same tasks as appliances and utensils in a domestic kitchen — just on a much larger scale! The design of the equipment therefore needs to be:

- stronger — to work continuously with large quantities
- durable — reliability is very important so production is not held up by breakages
- hygienic — easily cleaned, non-reactive, scratch resistant surfaces
- efficient — many industrial machines are automated with conveyors transporting the product from one set of processing equipment to the next. As industrial equipment may operate 24 hours a day, it also needs to be energy efficient. Gas is primarily used as a heating source as it is both efficient and cost effective.

CASE STUDY

It's really just a matter of size! Food manufacturers need large-scale processing equipment to handle the quantity of raw materials needing to be processed each day. Why not visit a store selling large hospitality appliances and compare the characteristics of smaller scale commercial equipment with what you use at home? Imagine how the features of these items would change for processing on an industrial scale.

OUTCOME TASK

Students learn to:

- compare the processing techniques, equipment, storage and distribution systems used in industry with those used domestically.

Contributes to the following outcome:

- explains manufacturing processes and technologies used in the production of food products.

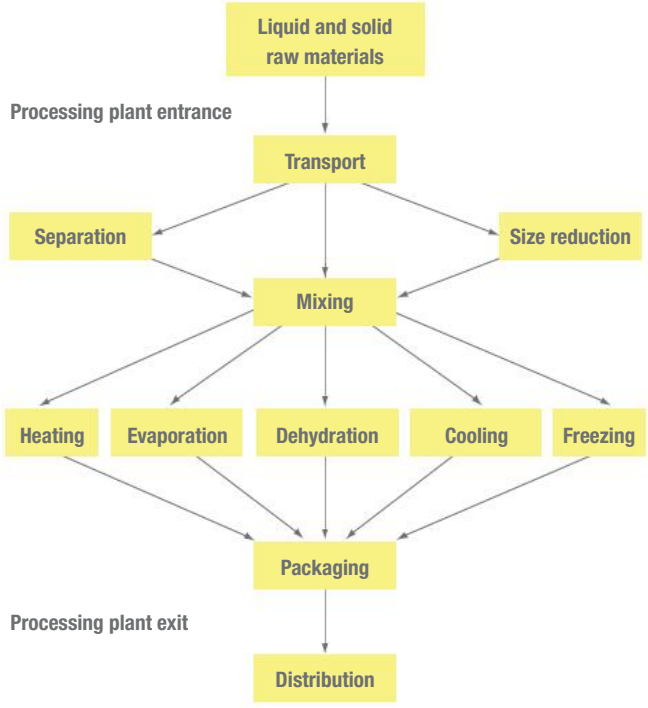
Carefully consider the images above. Use the stimulus material, along with your knowledge of *food manufacturing processes and equipment,* to complete the tasks ahead.

1. Create three columns on a page, placing the headings 'Industrial', 'Unit Processes', and 'Domestic' in each column.
2. Watch a video showing the mass production of a manufactured food item.
   a) List the steps of production in the middle column headed 'Unit processes'.
   b) Detail any information about how those processes are completed and the equipment used in the column headed 'Industrial'.
3. Find a domestic recipe for that food item and describe the processes and equipment required in the 'Domestic' column of your table.
4. Compare and contrast the production equipment and processes used industrially with those used domestically.

The management of the processes along the production line is the responsibility of the food technologist. Food technologists design the production flow so that the food is produced safely to the standard required. Food technologists need an adequate knowledge of the chemical, microbiological, and **biochemical** characteristics of food products. (*Biochemical* relates to the natural changes that occur in food.) Equipment is designed or modified to complete the production processes, called **unit operations**, required at each stage of production. Skilled tradespeople (e.g. fitters, machinists, electricians) work on the production floor, monitoring the operation of equipment. As the new equipment and processing in food manufacturing becomes more sophisticated and automated, the number and variety of jobs available becomes more limited, especially for unskilled workers.

Unit operations

It is impossible to describe a single type of food processing plant that would incorporate all unit operations involved for all products. Unit operations are the specific processes the food undergoes during production — for example, heating, mixing and transportation. The modern processing plant has too many combinations of types of material, types of unit operation and types of product to cover here. However, some of the more important unit operations involved in the modern food processing industry will be described.



Processes that may occur in a food manufacturing plant

Internal transport of raw materials

Handling of raw materials is the first important unit operation performed in a food processing plant. Different handling systems are required depending on the level of production and the characteristics of the raw materials. Small-scale manufacturers have raw materials delivered in portioned containers that are then manually transported for each batch. Manufacturers processing foods on an industrial scale receive their raw materials in bulk, for example, a tanker of flour. These raw materials are transported by suction through stainless steel pipes into storage vats, and a computer controls the pumping of the correct quantities for each batch being made. This method of transporting ingredients is efficient and hygienic, but expensive to set up.

Transporting liquid, powdered or lightweight solids via stainless steel pipes minimises the risk of contamination. These transport systems are sealed so nothing can get in. They also have built-in cleaning systems that can be activated by the computer. As stated, they are efficient and hygienic, but expensive.

Separation processes

Separation can be:

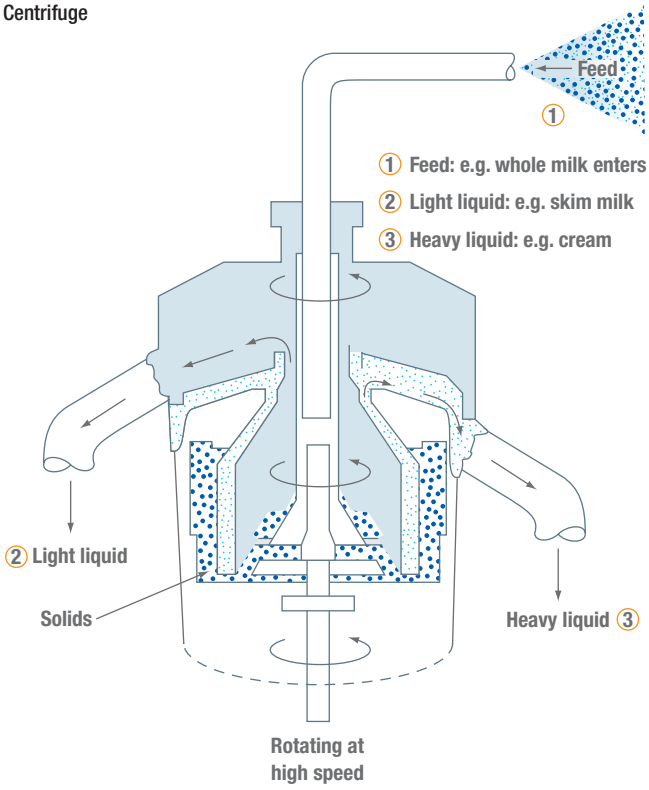
1. physical separation of the components of food — for example, removing the skin from an orange
2. chemical separation of components in foods — for example, adding chemicals for the separation of whey from the fat and protein in the making of cheese (see chapter 5).

The processes used for the separation of foods in manufacturing are mainly to do with physical separation, and include sieving, filtration and centrifuging.

Sieving is the process of shaking loose solids through a mesh, allowing particles of desired size to fall through while capturing larger particles. Sieving is used to separate foreign objects, such as stones from cereal grains and pods from shelled peas. Sieving is also used to separate larger particles produced during some unit operations, for example, flour is sieved after milling to separate the white flour from the bran. Powders are sieved during production processes to ensure that all ingredients are evenly distributed.

Filtration involves the process of passing a liquid through a filter to remove any solid particles. Filtering systems are used in the separation of cheese curd from water in the manufacture of cheese, and microbial air filters are used in dryers in the production of powdered products such as milk.

Centrifuge



A **centrifuge** is based on the principle that if a liquid containing particles of different densities is placed in a rotating bowl, the heavier particles will move to the outside of the bowl as a result of the greater centrifugal force acting on them. This will result in a movement of the lighter particles towards the centre of the bowl. Centrifugation is often used in the food industry, particularly in the separation of cream from whole milk, and the removal of pulp from orange juice.

Can you relate to this feeling? The force of a centrifuge means solid particles have no choice but to move to the furthest extreme of the machine. This process causes lighter substances to move upwards with the force and they are separated off from the denser substances. Try the gravitron ride next time you are at a show or theme park . . . if only to apply your knowledge of food technology!

Size reduction processes

The basic purpose of chopping, grinding or milling any raw material is to reduce its size. A reduction in size may be necessary for a variety of reasons:

- to make the raw material easier to handle — for example, grinding salt to a fine powder so it can be mixed more easily into food products
- to decrease the size of the raw material to make it more suitable for the final product — for example, grinding peanuts rather than using whole peanuts for the manufacture of peanut butter, or dicing fruit for canning
- to make a completely new product — for example, making flour from wheat, or ground sausage mince from steak.

A machine that crushes raw materials between rollers or rotating plates is called a mill. The style of mill used depends upon the characteristics of the raw material, the characteristics desired of the milled product, and the size of the batch being processed. Often a raw material will go through a series of different mills to produce the products required. Separation processes, such as sieving, may also be used to separate out large particles that are not required in the finished product. Milling of flour occurs on an industrial level. The machinery is totally computerised, with all quality control detectors/tests completed online. These mills generally run 24 hours a day, 7 days a week, and mill thousands of kilograms of wheat each day. The products produced from the milling process include flour, bran, pollard and semolina. The machinery is rested for only one shift per week to allow for general maintenance.

The Summer Hill flour mill in NSW

Mixing

Mixing is a process that ensures all the ingredients are evenly distributed throughout a batch of product. Mixers vary from highly computerised systems in places such as bakeries to manually operated mixers in the food laboratory. The type of mixer used depends on the size of the batch and the materials being mixed. Mixers used for dough, for example, will require different mixing arms from those needed for powdered products, such as cake mixes and custard powder.

REVIEW QUESTIONS

Remember

1. What are the three ways that food is separated during the manufacturing process?
2. Describe the differences between organisations operating at a commercial and an industrial level. Give an example of an organisation operating at each level.

Apply

3. Outline some advantages and disadvantages of automated processing.
4. Describe how filtration differs from centrifuging.

Do an activity

5. **a)** Measure and record the length and width of a rectangular plain biscuit. Place it in a clear plastic bag and roll it gently in one direction with a rolling pin. Measure its dimensions again. Describe how the characteristics of the biscuit changed in the process.
   b) Using the above activity as a stimulus, describe the impact of milling on a wheat grain.
   c) Grains of wheat pass between a series of twin rollers during the milling process. Try and deduce the impact of each of the following:
      i. the top roller moving more slowly than the bottom roller
      ii. the gap between the rollers narrowing with each series of rollers.

Heating processes

Heat can be transferred to food in three different ways:

1. conduction — food is heated or cooled by direct contact with a hot or cold surface
2. convection — food is heated or cooled by the movement of liquids or gases, around the food
3. radiation — a heat source directly above the food heats the food without touching it.

Heating of food products using steam is probably the most frequently occurring process in the food production plant. The type of heating equipment used depends on the nature of the raw materials, and on the intensity of the heat treatment required. Let's take a look at the methods of heating products.

Blanching

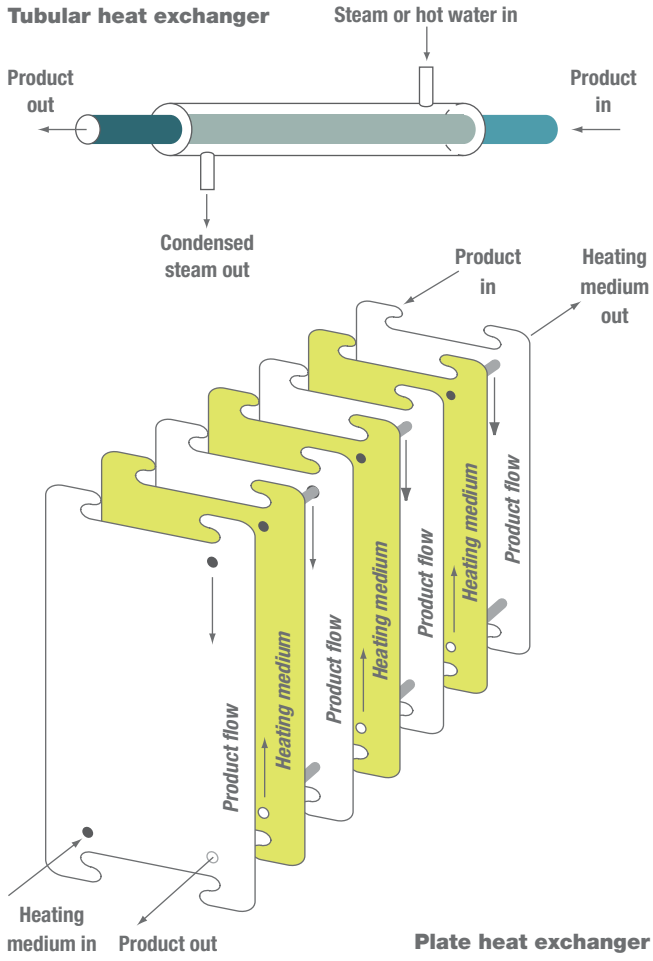
Blanching is used for low-intensity heat-transfer methods. For example, equipment such as blanching tanks are generally used for cut vegetables prior to freezing. The vegetables are blasted with steam or passed through hot water (88–100 °C) to destroy the surface **enzymes** in order to prevent enzymatic browning occurring during storage. The advantage of using steam is that it is effective in destroying enzymes and does not add an unnecessary level of water to the product prior to freezing. Blanching is a processing method, not a cooking method.

HTST style processes

HTST is a process where food is heated to a high temperature for a short time in order to destroy **pathogenic bacteria**, for example, in the pasteurisation of milk. If all bacteria present are to be destroyed, the liquid is sterilised by exposure to ultra high temperatures (UHT) for a very short time before being placed in specialised packages. (See page 207 for further information on HTST and UHT processes.) These processes require a greater degree of heat and are completed using equipment called **heat exchangers**. Heat exchangers allow liquid foods to reach high temperatures within seconds, significantly reducing processing times and minimising the impact that exposure to heat has on ingredients. Two of the most commonly used heat exchangers include the tubular heat exchanger and the plate heat exchanger.

In a tubular heat exchanger the hot water or steam flows through the outer jacket, while the liquid product flows through the inside tube. Examples of products cooked in this type of heat exchanger include chutneys and sauces.

In a plate heat exchanger the product flows between two heated surfaces in a very thin film, resulting in a rapid increase in temperature of the product. Again, only liquid products are suitable for use in this type of heat exchanger Examples include milk, fruit juices and beer. Heat exchangers are also used to rapidly cool liquid foods.



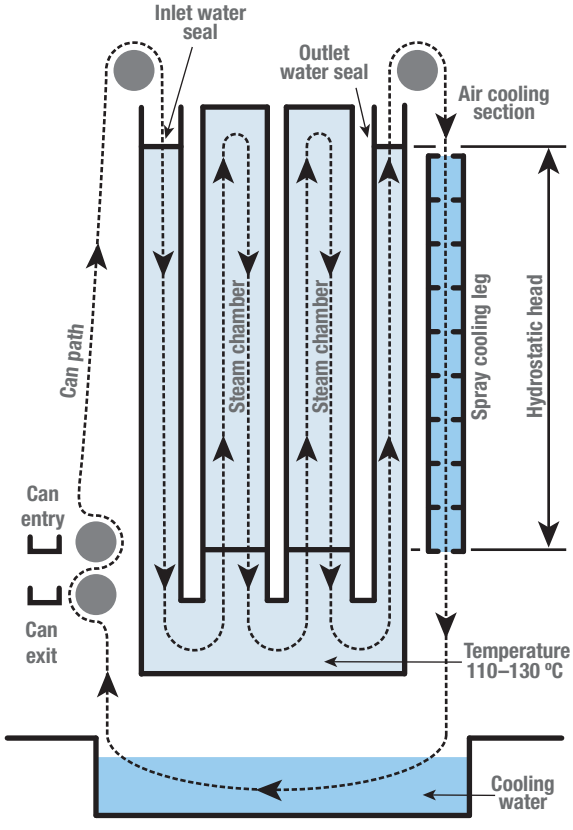
Heat exchangers rapidly alter the temperature of products passing through them. They may be used for both heating and cooling foods, and enable the temperature to alter 100 °C in a matter of seconds. Heat exchangers are found on **continuous flow**, computer-controlled production lines.

Canning

Canning involves preserving food in metal containers, while bottling involves the use of glass or plastic containers. The process for both is the same though. Canning is a heat process which sterilises the food within the package, giving it a shelf-life of more than two years. Traditional canning methods use equipment called retorts to heat the sealed packages. Static retorts were used both commercially and domestically (for home bottling). The cans/bottles were filled and sealed, then placed in a vat (called a retort) of boiling water for the required period of time. The time for processing varied according to the bacterial risks associated with the food being preserved.

Static retorts required labour to load and unload the equipment, so the process was redesigned to enable it to be incorporated onto automated production lines. Hydrostatic retorts are more efficient as the product moves continuously through the process from the packaging line. Hydrostatic retorts use steam to heat the cans as they move through the retort's chamber. As the cans constantly move during this process, the food rotates within the package, lowering the cooking times required. Cans are cooled and their seals checked before being dried and labelled.

Hydrostatic retort



Some companies can their products using a rotary cooker — a large cylindrical machine which heats rows of canned products as it rotates. The speed of rotation is determined by the variety of food being processed.

Baking

The use of radiant heat in an oven is another method of heat processing used extensively in the food industry. The most commonly used type of oven for baking bread, cakes and biscuits is the tunnel oven. The baking chamber in some cases is over 100 metres long but is relatively narrow and shallow. The oven may be heated by gas-fired burners above and below the conveyor, or by indirect heating from a heating unit outside the oven which feeds hot gases into the oven chamber. Some commercial bakeries also use microwave heating to remove the last remaining moisture from cracker biscuits after they have been baked in a conventional oven.

Evaporation

Evaporation in food processing is used to concentrate or increase the solids concentration of a liquid food. Evaporation involves the changing of the liquid in the food to steam or vapour. The temperature of the product is raised to boiling point and held at this temperature until the desired concentration is reached. Four basic components are required for evaporation:

- an evaporation vessel
- a heat source
- a condenser, which converts steam to water
- a method of removing the vapour.

An evaporator is used in the production of concentrated fruit juices, in the conversion of tomato juice into tomato paste, and when making condensed milk. Milk is also evaporated prior to spray drying.

Cooling processes

Chilling

Cooling is the reduction of temperature of a product. It is used to slow down or stop the activity of micro-organisms and enzymes, and therefore the spoilage of food. Products can be cooled by using heat exchangers in which the steam has been replaced by chilled water or other cooling liquids known as refrigerants.

The other commonly used cooling equipment is the refrigerator. Refrigerators simply lower the temperature of the product during processing and storage. Cooling systems are commonly used in confectionery manufacture and in fruit and vegetable cold-storage warehouses. Blast chillers are also used by manufacturers to rapidly reduce the temperature of products prior to refrigerated storage or freezing.

Freezing

The rate of freezing determines the size of ice crystals that are formed: the slower the freezing, the larger the ice crystals. For this reason, the most rapid rate of freezing is desirable, so that product quality is not sacrificed.

In general, there are four categories of freezing equipment for food products:

- air blast freezers
- plate freezers

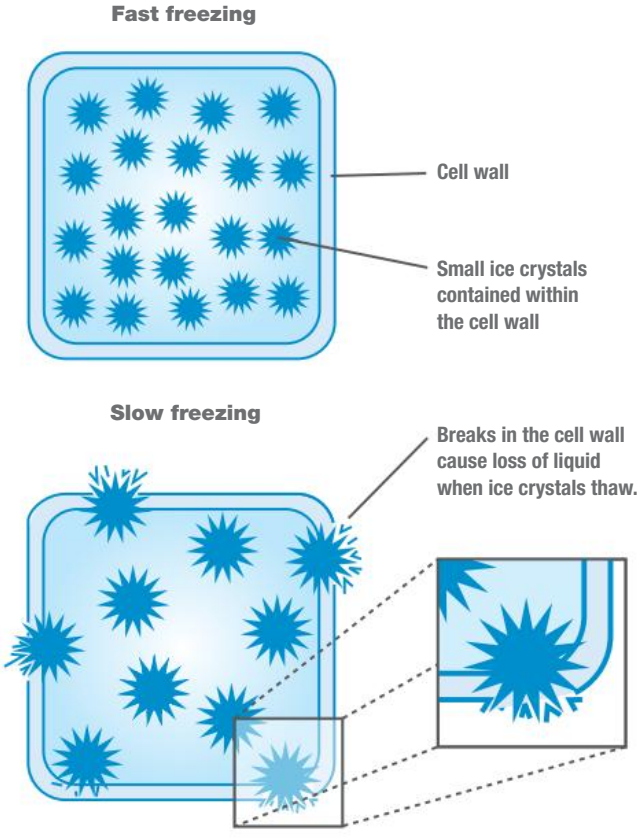
- tunnel freezers
- immersion freezers.

Air blast freezers are freezing systems that use cold air at high velocities. The design of the freezer depends on the type, size and density of the product being frozen. Air blast freezing is used on small volume batch products such as meat, frozen meals and cakes.

Plate freezing involves bringing the food product into direct contact with plates that are maintained at the desired freezing temperature. Plate freezers are widely used for freezing fish, meat products and vegetables.

Tunnel freezing is a continuous operation for quick freezing on a production line. Food is placed on a mesh belt or into a fluidised bed moving through a tunnel where it is blasted with cold air. It is used for high volume products on automated production lines.

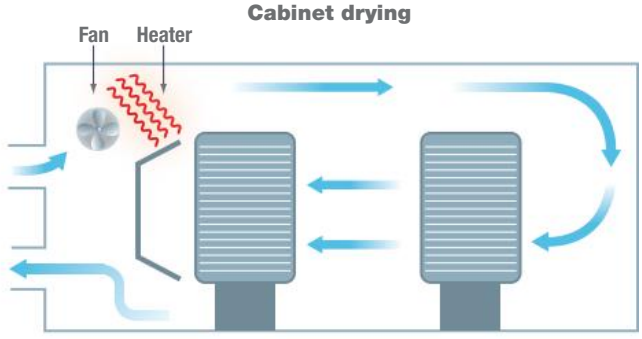
Immersion freezing involves bringing the product into direct contact with a low-temperature refrigerant, such as brine or liquid nitrogen. The freezing temperature for liquid nitrogen is so low (–196 °C) that processes using it are referred to as snap freezing. Stick ice-creams are immersed in brine to quick freeze, while summer berries are snap frozen in liquid nitrogen.



Slow freezing allows for the development of large ice crystals between cells that puncture cell walls and destroy texture upon thawing. Fast freezing results in the formation of tiny crystals, which allow cell walls to remain intact. Try freezing some berries at home and comparing them to a purchased frozen product — the texture will be noticeably different, particularly when thawed.

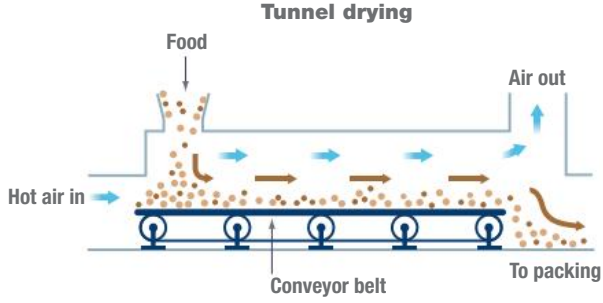
Dehydration

Dehydration has a direct effect on the final volume of the food, providing both the consumer and the food manufacturer with a product that is convenient to use. Dehydration reduces the moisture content of the product to a level that limits microbiological growth or other reactions. The moisture is removed by heating the product. The type of dryer used depends on the characteristics of the product being dried, the size of the batch, and the characteristics desired in the finished product for marketing, e.g. sun-dried or semi-dried. All foods must be in optimum condition before drying or their colour and flavour will be distorted as a result of enzyme activity during processing. Most fruits and vegetables are blanched prior to drying to deactivate surface enzymes and preserve colour.



Hot air drying in a cabinet

Cabinet drying involves placing foods such as herbs, fruits and vegetables on latticed wooden trays into a confined space where hot air is circulated. The process is slow and the food remains stationary. Drying foods in a domestic oven is an example of cabinet drying.



Hot air dries food in an enclosed tunnel

Tunnel dryers are used in automated production lines. Food moves along a conveyor through a narrow, enclosed space, with the time in the tunnel regulated according to the characteristics of the raw material used. Tunnel drying is used for fruits, vegetables and meats.

Sun drying is the oldest form of drying and is still used in many countries to domestically preserve food. Because sun drying is a slower method of processing, the enzymes in the food are active for longer and the food develops a stronger flavour and darker appearance. The aroma of ripening food is also attractive to insects and care must be taken to

prevent infestation during processing. Sun drying is also more labour intensive as the food may need to be turned during the process. The process is effective only in areas with a dry, hot climate as humid conditions slow the rate of drying and increase the risk of mould developing on the surface of the food.

Two other methods of drying are spray drying and freeze drying. Spray drying is a technique in which the product being dried must be in the form of a liquid. The liquid food is forced through an **atomiser** that emits a fine spray of liquid into a hot draught. Instant drying occurs and fine powders are formed. Instant coffee, powdered milk and food additives (flavours) are produced in this way.

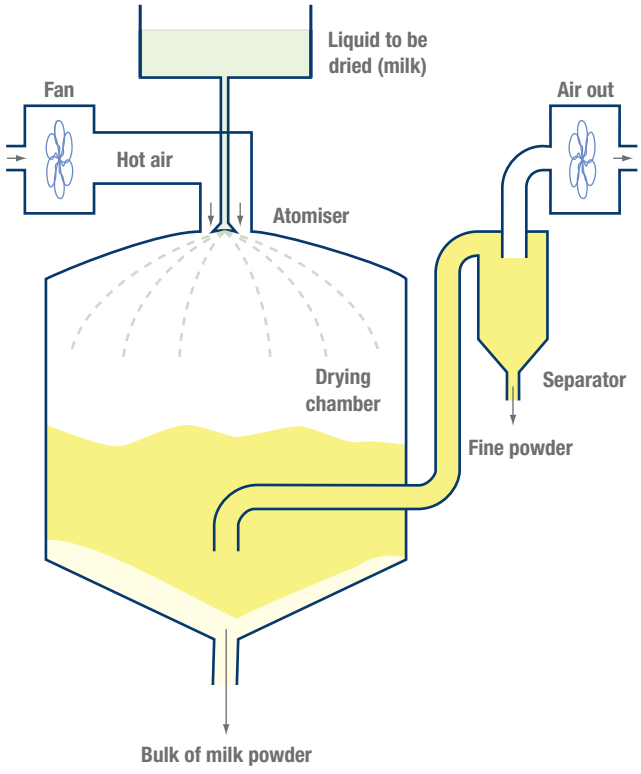


Diagram of a spray dryer used to make powdered milk

Freeze drying is more expensive than most other drying techniques because it is carried out in two different stages. In the first stage, food is frozen using normal fast freezing techniques. In the second stage, the temperature of the food is gradually raised under low pressure. This causes the ice to sublime. **Sublimation** is the conversion of a solid directly into gas without going through the liquid phase. When ice sublimes it is changed directly into water vapour.

Freeze drying has a number of advantages. The food is lighter and easier to transport and it does not require cold storage. This type of drying also has the advantage of maintaining the texture of the food. It is, however, uncommon due to the cost.

Examples of products that are dried in this way are some coffees, teas and herbs, meats, milk, some soups and vegetables.

Packaging

All foods that have gone through one or more of these processes are ultimately put into a package. The many types and styles of packaging for particular foods are discussed in chapter 11.

REVIEW QUESTIONS

Remember

1. What is meant by the term *process?* Is a frozen chicken processed? If it is, list the processes it has undergone.
2. List the unit operations that can be performed on:
   a) solid foods
   b) liquid foods.
3. Identify the three ways that heat can be transferred to food? Give examples of food products heated by each method.
4. Name three products that use heat exchangers as part of their processing.
5. For what type of food is evaporation used?
6. Outline the types of cooling systems commonly used. What is the purpose of cooling a product?

Apply

7. Compare the uses, advantages and disadvantages of different methods of dehydration.
8. Why would a tubular heat exchanger be used in the production of ice-cream?
9. What are the advantages of fast freezing methods over slow freezing methods?

Do an activity

10. Try dehydrating foods such as tomatoes, apples or slices of marinated steak in the oven on a very low heat. Write down your observations on whether this method is desirable in terms of the taste and texture of the food.

Flow process charts

A flow process chart is a diagrammatic representation of production processes involved in the manufacture of a specific product. It is closely linked to the **quality assurance** plan. It provides an index of the entire process in such a way that:

- new staff can quickly become familiar with each step of the process and assess the importance of that step to the overall production line
- each step of a process can be analysed to determine how effective each step is and how it contributes to product standards, quality, yields and costs
- critical control points can be identified. Critical control points are those points that could result in a risk to public health or significant financial loss.

A flow process chart is constructed with the use of five basic symbols. These symbols can be used individually or in combination with each other to describe as clearly as possible the process that is occurring.

All flows occurs vertically down the page of a process chart. The appropriate symbol is placed on the left-hand side of the page and the relevant details concerning that particular symbol are placed to the right of it. All symbols should be joined by vertical lines.

The extent of the details on any flow process chart depends on the purpose of that specific chart. If the chart is for production-line purposes only, for example, then only production steps need to be included. If the process chart is for the use of quality control, more details (such as critical control points and specification details) are required.

Operation

An operation occurs when a material is:

- deliberately changed in any of its physical, chemical or microbiological characteristics
- assembled or disassembled from another material
- arranged or prepared for another operation
- prepared for transportation, inspection or storage.

An operation normally requires labour and/or equipment, and is the only activity that may add value to the product. Examples of an operation in food processing are mixing, drying, freezing and baking.

Inspection

An inspection occurs when a material is inspected, sampled, counted, examined, identified, measured or compared with a standard in terms of quantity, quality and other characteristics. An inspection usually requires labour and/or equipment, and provides control over the process. The inspection verifies that an operation has been carried out correctly in terms of its quality or quantity. Examples of inspection in a flow process chart would be recording the pasteurisation temperature of milk in the holding tube of a heat exchanger, or measuring the viscosity of tomato sauce before bottling.

Transportation

Transportation occurs when labour or equipment are used to move a material from one place to another without changing the nature of the material. Examples of transportation in food processing would be pumping milk from a holding tank to a homogeniser, shifting potato chips from a fryer to a packing station, or moving a pallet of apples by fork-lift from the peelers and corer to a cooking pan.

D Delay

A delay or a temporary stoppage occurs when conditions do not (other than those involved in the actual processing) allow the next step of the process to take place. Delay steps are usually rare and are generally the result of shortcomings in the process design or the plant layout. Time costs money.

Storage

Storage occurs when a product is kept under controlled or permanent storage and protected against unauthorised removal. Storage can also be used when a product is kept for reference purposes, such as shelf-life analysis. Examples of storage would be placing frozen goods in freezers, or keeping canned products on laboratory shelves in case of future consumer complaints.

Inspection and processing

When two operations occur at the same time, such as simultaneous inspection and processing, the symbols are simply put one on top of the other. An example is when a sample is taken for a quality control check from a continuous process line.

A process flow chart for packaged flour would look like this:

Wheat is delivered to the flour mill.
Quality control — condition and grade of wheat

Wheat is adjusted to a specific moisture content (conditioning).
Quality control check — moisture content before milling

Conditioned wheat is transferred to the mill.

Wheat is milled.

Flour is sifted into different parts — that is, flour, semolina, pollard and bran.
Quality control check — dough making properties of the flour, moisture and protein analysis

Flour is stored in a hopper.

Flour is packed into packets.
Quality control check — weights and condition of packaging

Flour is stored in warehouse ready to be sold.

Quality assurance and quality control

Quality is the ability to meet requirements. The quality of a product can really be assessed only by the user of that product. Manufacturers set a quality standard for their products and they organise their processes, from design through to distribution, with the focus of achieving the standards set. This system of managing processes to ensure that standards in quality are achieved and maintained is called quality assurance. Potential problems are identified and steps are taken to rectify any problems. Tests are conducted before, during, and after processing to determine the characteristics of the raw materials and processed goods, to ensure that standards are consistently maintained. These tests are referred to as quality control as they are the processes by which characteristics are measured, compared

CASE STUDY

Making potato crisps crisp

OUTCOME TASK **RESEARCH AND ANALYSIS**

Students learn to:

- describe processes that transform raw materials into manufactured food products.

Contributes to the following outcome:

- explains manufacturing processes and technologies used in the production of food products.

Consider the diagram above. Use the stimulus material, along with your knowledge of *processes used in food manufacturing,* to complete the tasks ahead.

1. List the raw materials needed for the manufacturing of potato crisps and, for each, identify the characteristic the manufacturer might note on their raw materials specifications.
2. Transfer the information from the flow chart above to another flow chart using the standard industry symbols. Identify the type of unit operation occurring at each stage.

Write a one- to two-page explanation of the processing of potato crisps to show your understanding of the processes and concepts involved in the manufacturing of a specific food product.

Extension questions

1. Research the production process for another product of your choice. Complete the activities given for the above task.
2. Compare and contrast the processes used to complete two different manufactured food products. Explain why the unit operations are similar or different in reference to the raw materials used and the characteristics of the products created.

CASE STUDY

Salad Fresh

Established in the early 1990s, Salad Fresh is a business that produces home meal replacements. Every day, they produce about seventeen different products, mainly salads — for example, coleslaw, Mediterranean salads and continental salads — and pre-prepared fresh vegetables for soups (particularly minestrone and country casserole). Woolworths is Salad Fresh's largest customer, so Salad Fresh must follow the Woolworths Vendor Quality Management Standard to ensure safe products. This standard is similar to the HACCP system.

Processing

The vegetables are inspected on arrival, the dirt and bugs are removed, then the vegetables are inspected again. A sanitising wash containing citric acid and sodium hypochlorite removes harmful bacteria. A zero pathogen level (no harmful bacteria) must be obtained before the vegetables are processed. *Salmonella, Coliform, E. coli* and *Listeria* bacteria are the more common pathogens found on fresh vegetables. *Listeria* is the most dangerous because it is found naturally in the soil in which vegetables grow. A refrigerated water wash is used to neutralise the sanitising wash. A food technologist takes samples from each batch of product and monitors the sanitising bath. Vegetables are prepared at 4 °C, and the production line is thoroughly cleaned between different products.

Packaging

The packaging used (either modified atmosphere or controlled atmosphere packaging) depends on the product to be packaged. Modified atmosphere packaging uses a film that matches the respiration rate of the product, keeping the oxygen and carbon dioxide levels in the correct proportion. Controlled atmosphere packaging uses one layer of impervious plastic film that lets nothing in or out once nitrogen has flushed out the lighter oxygen and carbon dioxide gases before sealing (see pages 221–2, chapter 11). The salads or soup mixes are boxed and taken to a cool room, where they are kept at 1 °C. Refrigerated transport moves the product to the retailer, where it is on the supermarket shelves within 36 hours.

All staff are trained to know the critical control points to ensure product safety and eliminate contamination. They also wear gloves and sleeve protectors, rubber boots and head coverings.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *HACCP* to complete the tasks ahead.

1. Identify the raw materials used to create Salad Fresh products.
2. Identify potential hazards or problems that could affect the quality of Salad Fresh products.
3. Prepare a flow chart for the Salad Fresh coleslaw. What are the critical control points at which an inspection should be done?
4. What could be done at each critical point to ensure problems do not arise?

to a standard, and any differences that occur may be acted upon. Quality assurance and quality control requires all members of an organisation working together to achieve quality standards.

Setting up a quality management system

Consumers expect all processed foods to be appealing, nutritious and safe to eat. The quality management system involves the planning and management activities that ensure a product meets the expectations indirectly dictated by the consumer. Guidelines for quality assurance activities usually include the following matters.

1. A clear final product specification statement of the level of quality that is expected and that can be achieved at the price the customer is prepared to pay.
2. Methods for assessing and measuring the quality of the material to the specifications set out and agreed to by the supplier and purchaser. Any materials that do not comply with the set specifications can be rejected.
3. Specifications for the processing areas involved. The raw materials and the surroundings in which the food is processed must be free of any contaminants, especially micro-organisms.
4. Sampling and testing of the finished product, after packaging and labelling, to ensure that all specification standards were met.

Quality assurance technicians must be constantly available to periodically check product lines to ensure all products meet the required specifications. All workers on a factory floor must also be aware of the importance of quality control and the impact on the finished product of failing to meet these quality standards. This responsibility

includes accurate recording of all relevant information on the production line, and a quick response to any problems that arise during the course of production. Everyone must understand and comply with the set standards to protect the quality of the finished product.

Food safety is a major quality assurance problem facing all sectors of the agri-food chain. The threat of food poisoning is a major concern for the whole industry; if one producer is careless and an outbreak occurs, it affects all companies in that market sector. To maximise food safety, it is essential to:

1. identify possible points in production when contamination can occur, or times when undesirable microbiological growth can take place
2. set up preventative measures to control what happens during these critical times.

One of the best known techniques used to deal with hazards in food production is the **Hazard Analysis Critical Control Point (HACCP)** system. (See page 58.) Many businesses use the HACCP system, while others use similar quality management systems. Woolworths, for example, insists that its fresh food suppliers follow the Vendor Quality Management Standard. HACCP or another system is compulsory in some sectors of the food industry, but only voluntary in other sectors.

The producer can find many advantages in using a quality management system such as HACCP.

1. The business makes more profit because it wastes less product and has to re-do less work.
2. The product has an edge over the competition.
3. Problems are prevented rather than responded to when they happen.
4. Consumers feel confidence in the safety of the product.
5. Employees feel more in control of the work environment, and job security is improved.

The HACCP system is used all around the world because it is scientifically sound and can be adapted to individual producers. Wherever it is used, all staff must be trained in the system so they feel responsibility for the products they are making.

Occupational health and safety

The food industry is unique, in that many different types of processes are carried out in the one general area. The number of accidents and the seriousness of the accidents is quite high compared with other workplaces. The following examples could easily happen.

- A food worker accidentally drops a knife and automatically reaches out to catch it.
- A worker drops wet food into a deep-fryer and is scalded when the hot fat spits.
- An untrained worker operates a mincing machine and uses their hand to push the meat into the mincer.

Accidents are most often caused by the worker being unskilled at the job, the worker being rushed during very busy times, or the equipment being poorly maintained.

The employer in the food industry must, by law, provide basic working conditions. These include:

- instruction or training about safety issues
- equipment that operates correctly when used in the right way
- a safe environment according to the *Occupational Health and Safety Act 2000*.

A safe environment provides such things as clean air and adequate ventilation, appropriate lighting, correct storage of dangerous chemicals and training in how to use them, and adequate toilet facilities. To make sure that such working

Order and cleanliness
(Check for clutter, dirt, grease spills, tools and material out of place, unnecessary items)
☐ Floors, aisles
☐ Stairways, exits
☐ Windows
☐ Ceilings, walls
☐ Storage areas
☐ Corners, out of the way places
☐ Supervisor's office
☐ Machines
☐ Work tables, benches
☐ Supply cupboards
☐ Washrooms and fountains
☐ Lockers — personal
☐ Yard areas
☐ Noise control
☐ Emergency exits
☐ Safety signs

Safety
☐ Safety cans for flammable liquids
☐ Colour coding
☐ Fire extinguishers accessible
☐ Fire extinguishers inspected regularly
☐ First-aid boxes filled, labelled and accessible

Materials
☐ Properly piled and secured
☐ Identified or ticketed
☐ Disposed of as necessary

Light, heat, ventilation
☐ Adequate light and clean fixtures
☐ Adequate heating and/or cooling
☐ Adequate ventilation
☐ Fans, blowers, hoods, fixtures in good condition

Maintenance
(Repairs, overhauls, replacements)
☐ Floors, doors, walls, windows, stairways
☐ Electrical wiring
☐ Machines
☐ Cranes, conveyors
☐ Trucks, trailers
☐ Tables, benches, stands
☐ Racks, trays, platforms

Scrap and rubbish
☐ Enough containers
☐ Rubbish in containers
☐ Containers emptied regularly
☐ Separate containers for different classes of scrap
☐ Supplies stored properly

Tools and supplies
☐ Correct tools for jobs
☐ Tools in good condition
☐ Tools stored properly
☐ Supplies stored properly

Mark the appropriate letter in front of each item.
S — Satisfactory (needs no attention)
A — Acceptable (needs some attention)
U — Unsatisfactory (needs immediate attention)

Occupational health and safety checklist

environments exist for workers, the Occupational Health and Safety Act and Regulations were brought into force by both state and federal governments.

WorkCover oversees workplace safety issues and investigates work-related deaths and injuries. Fines can be given to employers who are found to be ignoring the law.

An **occupational health and safety (OH&S)** committee must be established if there are 20 or more employees in an organisation. The committee prepares a plan or checklist of the areas where accidents are likely to occur, devises an accident report form, and decides on a course of action when an accident occurs.

Complaints by employees regarding safety issues are investigated and the employer receives a report on the situation. The problem is usually cleared up in a reasonable length of time. However, if the employer does nothing or attempts to lay off the person who made the complaint, a WorkCover inspector is appointed to resolve the problem.

Employees also have responsibilities. Because the food production environment is filled with potential hazards, everyone working in a production area must be aware of the dangers and know how to avoid them. Employees are to:

- take reasonable care for the health and safety of others in the workplace
- use equipment as instructed and in a safe manner
- notify the employer in writing of accidents that occur
- wear necessary protective clothing and use safety equipment provided.

Many of the requirements for keeping food free from contamination also provide a safer environment for the worker — for example, adequate ventilation and lighting, design of equipment and so on.

REVIEW QUESTIONS

Remember

1. Place the following principles in the HACCP system in the correct order by placing a number next to each principle.
   - — Verification of the system
   - — Keeping of accurate records to identify variations from the standard
   - — Assessment of hazards
   - — Identification of critical control points
   - — Description of clear procedures for prompt action if the standards are not met
   - — Monitoring of critical control points

Apply

2. Why are flow process charts drawn up for each product for manufacture?
3. Quality assurance and quality control are closely linked. What is the difference between the two?
4. What is HACCP? How does it help manufacturers to maintain their quality assurance?
5. What is OH&S? How is it related to food manufacturing?

Do an activity

6. Consider the following process for the making of bread.

   The ingredients of flour, salt, bread improvers, yeast and water are mixed to form a dough. The dough is then rested in a warm environment to allow the yeast to rise. Once the mixture has doubled in size, the dough is kneaded and rolled, and cut into 4 pieces before being placed in a tin (this gives the bread a better structure than if the piece were placed in whole). The bread is then allowed to rise again in a warm environment (this process is called proving) for about 45 minutes, then it is baked for about 20 minutes in a very hot oven. The bread is cooled before slicing and packaging.

   Using the standard industry symbols, create a flow chart showing the processing of bread.
7. Assess the major hazards that may impact on the quality of packaged bread purchased by the consumer. Describe strategies the bakery could follow to minimise the impact of these hazards on their products. Identify which of these strategies relates to quality control and which relate to HACCP.
8. Refer to the general checklist for OH&S. Use this checklist to evaluate safety aspects relating to the food technology room in your school. If there are any items that you feel rate an A or a U, what reasonable and constructive suggestions can you make to bring them up to an S rating?

Preservation of food

Unless special methods are used to preserve them, the majority of foods available to us are quick to decompose or rot — a result of the action of micro-organisms and enzymes. Preserving food from natural deterioration following harvest or slaughter dates back to prehistoric times. Some of the oldest forms of preservation include cold storage, fermentation and drying. Dried foods such as dates and figs were well known to the ancient hunters and gatherers, who also used the deep recesses of caves and other cold places for the storage of their food. The early Egyptians carried out the processes of fermentation and pickling. We know this from archaeological evidence found in the tombs of the Pharaohs.

In the industrialised society of today, we have moved away from the farming cycle of planting and harvesting. With a great percentage of the population living in an urban environment, there is a need to preserve and process our food to allow for easier distribution and transport.

Raw foods are quick to spoil as a result of the action of food spoilage organisms, enzymic reactions within the food, or environmental conditions. Whatever the cause, spoilage will surely occur unless some preservative action is taken to slow or stop the progress of the spoilage.

The main reasons for preserving foods are to:

- promote safety
- keep foods in a form acceptable to the consumer and therefore prevent waste

- retain the nutritional value of the food
- make perishable foods available all year round
- achieve economies for the production company.

Let us discuss this last reason in more detail by looking at an example. If corn was sold in stores only as fresh corn on the cob, rather than as preserved corn that has been frozen, canned or dried, corn farmers would have to reduce the quantity of corn grown and charge more for it. Judging exactly how much to grow would be difficult, and more than likely there would be either a shortage or an oversupply that would rot. It is cheaper to produce a large amount of something than a small amount: this is referred to as the **economies of scale**. To go back to the corn example, given that the same pieces of equipment are used to plant, water, fertilise and harvest both a small amount and a large amount of corn, it is more economical to keep the machines working for longer periods.

Causes of food spoilage

Spoilage of a food product is caused by one or more of the following.

1. Physical damage can occur when a product is being transported or moved. Examples include the bruising of fruit, denting of cans and wilting of vegetables.
2. Enzymic activity is involved in the ripening and eventual breakdown of fruit and vegetables, and the decomposition of meat. Enzymes exist naturally in both plants and animals and have important functions while the organism is alive. However, once the fruit has been picked, the vegetable harvested and the animal slaughtered, enzymes continue to work, causing spoilage of the food. When fruits are physically damaged, the bruise is the result of enzymes being released from their cells and causing reactions with the cells around them, and with the air.
3. **Microbial** activity by bacteria, **viruses**, yeasts and moulds (already present on the product or from the surrounding environment) causes food to spoil. Examples are mould on old bread and sliminess on ageing meat. Microbes will be discussed in depth shortly.
4. Rodent activity or the infestation of bugs and other animals. Good examples are weevils in flour and grain, and mice and rats chewing through food packaging.
5. Environmental factors include warm temperatures, air, moisture and light. These factors speed up the rate of spoilage from other causes, for example, in warm environments enzymes and microbes are more active and oxidative reactions occur quickly.

Growth of micro-organisms

Enzymes may result in the physical deterioration of food, but they do not affect the safety of the food if consumed. Micro-organisms, however, may be pathogenic (meaning they have the potential to make the consumer very ill) and so need to be controlled through food manufacturing and preservation processes. When micro-organisms are added to or come in contact with a food under favourable conditions, they begin to multiply.

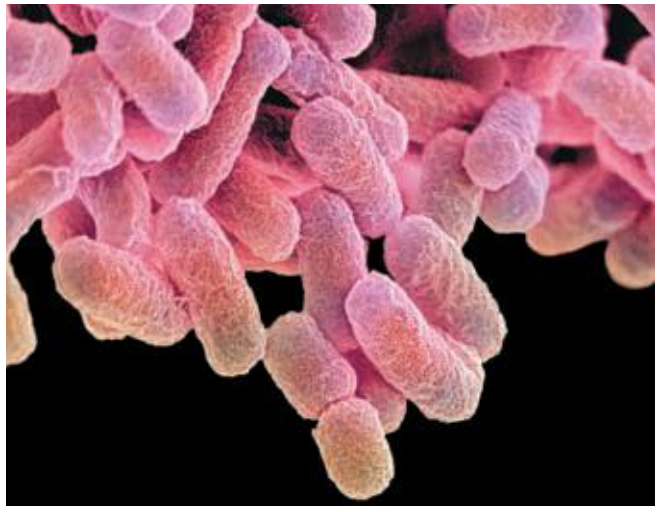
As micro-organisms grow, they pass through a series of phases.

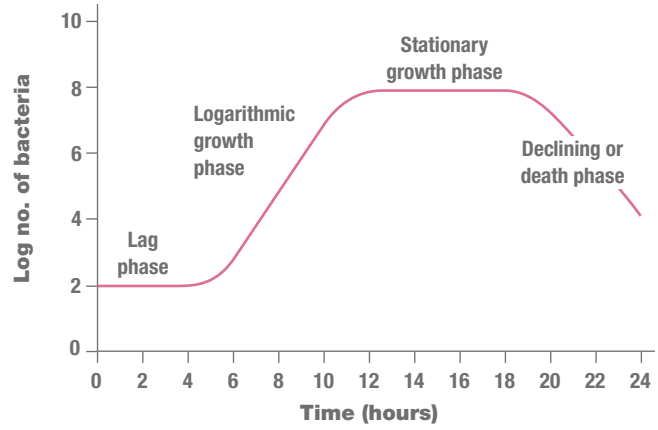
The first part of the growth curve is the **lag phase**. This is the time required for the bacteria to become adjusted to the new environment. The length of this phase is affected by the number of micro-organisms initially present — that is, the greater the number of bacteria present, the shorter the lag time.

During the next stage, the **logarithmic phase**, the bacteria cells grow and multiply because they have adjusted to the environment and are encouraged by the ideal conditions needed for rapid growth.

The logarithmic phase levels off to the **stationary phase**. During this period, the number of bacteria remains constant. In other words, the number of cells being formed is equal to the number of cells that die.

During the **death phase**, the food needed by the bacteria is usually all gone and the bacteria die of starvation. Death





Providing favourable conditions for microbes means that many more will follow. Microbes can double in number every 20 minutes if conditions are right. What conditions would microbes find unfavourable? How might manufacturers create these conditions for their foods?

may also be due to the build-up of substances given off during reproduction of the micro-organisms.

Especially important in food preservation is the lengthening of the lag phase of micro-organisms as much as possible. This can be accomplished in different ways.

- Limiting the number of spoilage organisms will reduce the amount of contamination — that is, the fewer organisms present, the longer the lag time. This can be achieved by avoiding unclean containers, equipment, or utensils used in the preparation of food.
- The micro-organisms will take longer to begin multiplying in an unfavourable environment. Such an environment can be produced by changing the moisture, temperature or pH level, or by introducing inhibitors.
- Putting the food through processes such as heating to high temperatures or irradiation actually damages the organisms or (better still) kills them. By using lower heating temperatures, microbial growth can be delayed, the quality of the food can remain high and the product can have a more extended shelf-life than that of the fresh product.

The time it takes for a single cell to divide and grow into two new cells is called the generation time. This time shortens as conditions become more favourable, and lengthens as conditions become less favourable. If the food is chilled, for example, the generation time will lengthen. Any change in the environment that increases the generation time (for example, a drop in temperature) will lengthen the shelf-life of the food.

The growth of bacteria in food can be rapid. If the conditions for growth are good, a single bacterium can reproduce every 20 minutes. Therefore, if we start with a single bacterium cell and it divides every 20 minutes, there will be over two million bacterium cells present in only seven hours.

TABLE 10.2 Multiplication of bacteria

TIME	NO. OF BACTERIA	TIME	NO. OF BACTERIA
12.00	1	3.40	2 048
12.20	2	4.00	4 096
12.40	4	4.20	8 192
1.00	8	4.40	16 384
1.20	16	5.00	32 768
1.40	32	5.20	65 536
2.00	64	5.40	131 072
2.20	128	6.00	262 144
2.40	256	6.20	524 288
3.00	512	6.40	1 048 576
3.20	1024	7.00	2 097 152

However, if food was changed so environmental conditions were not as favourable (for example, by reducing the

EXPERIMENT

Sources for cross-contamination in the kitchen

Syllabus outcome

Students learn to:

- identify food safety hazards and risks.

Contributes to the following outcome:

- applies principles of food preservation to extend the life of food and maintain safety.

Aim

To identify sources of micro-organisms in a kitchen that may cross-contaminate foods

Note: Encouraging the growth of dangerous bacteria is prohibited because of the dangers it poses for staff who handle the Petri dishes. You are not allowed to cultivate bacteria present from body fluids or bathroom surfaces.

Equipment

1 agar plate (Petri dish with agar nutrient) for each member of the class (request these from your science department a few days in advance)
no-rinse sanitising solution for hands
clear cellotape
black waterproof marker
incubator (set at 35–37 °C)
selection of the following for sampling, for example:

- hair, acrylic fingernails, unwashed hands, sanitised hands
- jewellery, e.g. watchband, ring
- kitchen equipment, e.g. knife handles, cutting boards, bench tops
- fabrics used in kitchen, e.g. sponges, towels, dirty aprons
- surfaces which may not get regularly cleaned, e.g. tap handles, stove knobs
- unwashed and uncut vegetables (potatoes and mushrooms work particularly well but any vegetable will do)

3 copies of the results table for students to record their findings for the class after each observation

Method

1. As a class, identify possible sources of cross-contamination likely to occur in your kitchen environment. Write a list of contamination sources on the board.
2. Select a specific source to sample and write your choice in black marker on the side of the agar plate, being careful not to open the agar plate while doing so.
3. Any student testing unwashed hands or fingernails should gently press the surface of the agar, being careful not to break the surface, and then seal the Petri dish with cellotape.

4. All other students should wash, dry and sanitise their hands thoroughly before placing their samples. If collecting samples from a poorly accessible surface, e.g. a bench top, wipe a newly sanitised finger over the surface then press it onto the agar.
5. Seal all Petri dishes and place in a warmed incubator (upside down so that no condensation will drip onto the agar and dissolve it).
6. Check the agar plates two or three times in the next five days to monitor the development of bacterial colonies. Each student is to record the number, size (in mm) and colour of the colonies that have grown for their agar plate on the class results table.

Predictions

Each student is to predict the three sources they think will provide the greater sources of contamination, and the least contamination. These should be recorded in rank order in their experiment report.

Results

1. Record your results in a class table of results similar to the one following.
2. Determine which agar plates you feel showed the greatest signs of microbial growth, and which showed the least, at the end of the five days. State the reasons for your decisions.

DATE	SOURCE	DESCRIPTION OF COLONIES (SIZE, COLOUR, NUMBER)	NO. OF COLONIES	GENERAL OVERVIEW OF GROWTH LIMITED – FAIR – A LOT

3. How many different types of microbes were present on each plate?
4. Were these the same agar plates that displayed the most/least growth on earlier observations?
5. Record the microbe growths for the six agar plates identified in your predictions.

Conclusions

1. Discuss the growth patterns of the six agar plates that showed the most and least growth over the five days. Did you expect these to be the final six after the first observation? Why or why not?
2. What does the microbe growth indicate about the cleanliness of the item sampled?
3. How did the final results compare with your initial predictions? Were you surprised by the results? Why or why not?

temperature), the generation time would increase and the cell division would not occur as rapidly.

The decomposition of foods caused by micro-organisms will be prevented only if all the spoilage organisms are killed (or removed) and re-contamination is prevented. Stopping the multiplication of micro-organisms does not necessarily prevent the decomposition of a food. In the process of freezing, for example, the micro-organisms are not actually destroyed: they remain dormant until the food is thawed. Once thawing has occurred, they are free again to cause deterioration in the product.

The importance of preventing the contamination of a food cannot be stressed enough. The greater the number of micro-organisms, the more difficult it becomes to destroy them.

Minimising **cross-contamination** is essential if foods are to remain safe. Cross-contamination is the transfer of microbes to food via other items — for example, hands, knives, cutting boards and poor storage conditions. Minimising cross-contamination is particularly important when handling perishable foods.

All foods will spoil, but some foods are more quick to 'go off' than others. Foods that are quickest to perish are:

- poultry
- fish
- shellfish
- crustaceans
- meats
- eggs
- boiled rice
- milk and milk-based products

You may recall that these foods are most likely to cause food poisoning. See table 3.1 on pages 46–7 for a summary of the most important bacteria related to food poisoning.

REVIEW QUESTIONS

Remember

1. List the four main reasons for preserving food.
2. Outline the conditions that bacteria consider favourable. How long does it take for bacteria to reproduce if the conditions are favourable?
3. Outline five ways in which foods may spoil. Give an example of each, using a specific type of food.
4. Define cross-contamination. Give examples of how it occurs.

Apply

5. Which type of food poisoning bacteria is linked to the following?
   a) acne
   b) undercooked chicken
   c) paralysis of vital organs

Do an activity

6. Food poisoning occurs every day and is often reported in the media. Find a newspaper article discussing food poisoning and explain the following in relation to the article.
   a) What type of food poisoning is discussed in the article? What foods were consumed?
   b) What symptoms did the consumer suffer? How soon after eating the food did the symptoms appear? How long did they last?
   c) Discuss any other information about food poisoning identified in the article.
7. Test your knowledge in an interactive quiz. Log in to **www.jacplus.com.au** and locate the *Safe food handling* weblink for this chapter. Complete the food safety quiz and read through the explanations given. When finished, record five aspects about safe food handling that you learned or focused on as a result of doing the quiz.

eBookplus Weblink

Preserving food safely

You will recall that the conditions that encourage food spoilage by microbes and enzymes include:

- warm temperatures
- available water
- oxygen
- a suitable pH
- a suitable food source.

In order to preserve food and ensure the safety of the consumers who eat it, manufacturers must ensure basic hygiene procedures and apply the principles of preservation.

Basic hygiene procedures

1. Clean handling

There are numerous examples of the way in which nature preserves food. The inner tissues of healthy plants and animals are usually free from micro-organisms, and any micro-organisms that are present are unlikely to cause spoilage. If there is a protective covering around food, microbial action and enzymic browning is delayed or prevented. Examples of such coverings are the shells of nuts, the skins of fruit and vegetables, the husks of corn, the shells of eggs and the skin on meat animals such as beef cattle, lamb and fish. It is only when the protective covering becomes damaged or decomposes that micro-organisms spread from the outer surface to the inner tissue, and enzymic browning occurs. Hygienic handling, appropriate storage and sturdy packaging are therefore essential to minimise spoilage through cross-contamination and physical damage.

2. Removal of micro-organisms

Removal of micro-organisms is not an effective method of preservation, and can be used only under special conditions. Such removal can be accomplished by filtration, washing or trimming. Filtration is the only successful method of completely removing the organisms. Its use is limited to clear liquids such as fruit juices, beer, soft drinks, wine and water.

Washing foods, particularly fruit and vegetables, can remove soil and insects that may cause spoilage. However, washing may be dangerous if the water is contaminated and adds spoilage organisms. Also, if the food is washed for too long, or not dried quickly, the growth of spoilage organisms is encouraged. Trimming away spoiled portions of food or discarding the spoiled sections can extend the keeping time of the remaining food. Strawberries are a good example of food that can be kept in this way.

Principles of preservation

Applying one principle of preservation to a food will extend its shelf-life for a short time, applying multiple principles will ensure the safe shelf-life for a long time. There are four main principles required to preserve food.

1. Exclusion of air

Most microbes require oxygen to be active. By removing air from around the food, the environment becomes unfavourable and microbes become dormant. Some bacteria are anaerobic, and care must be taken with processing and packaging options for susceptible foods or food poisoning may result. Manufacturers exclude air from packaging such as cans and bottles by hot filling processes — the steam rising off the product before sealing forces air from the package, creating a vacuum when the product cools. **Vacuum packing** and gas flushing (inserting gases other than oxygen into the package) are among other methods

TABLE 10.3 Uses of chemical preservatives

CHEMICAL PRESERVATIVE	USES
Benzoic acid	An anti-microbial agent, used to inhibit yeasts and moulds, which is often added to fruit juices, jams and some high-acid food such as pickled vegetables.
Sorbic acid (Sodium sorbate)	Another anti-microbial agent that is used in cheese manufacture and in cakes and sponges. Its main use is to inhibit mould, and it is often sprayed on plastic wrap or impregnated in wrapping material to inhibit surface mould on cheese products.
Nitrates and nitrites	These chemicals have a limited effect on the growth of a number of organisms and are not often used. They have been traditionally used as a preservative in curing and pickling foods such as bacon and processed ham. Their use is being reviewed.
Antioxidants	These are used to reduce the level of oxidation of fats. Unsaturated fatty acids are prone to oxidation and tend to go rancid. Antioxidants are often added to margarine, oil, and cooking fats. Permitted antioxidants include propyl, octyl, and dodecyl gallate butylated hydroxytoluene (BHT).
Sulfur dioxide	This general food preservative is used as a dip or spray to control enzymic browning in pre-sliced carrots and apples.
Propionic acid (propionates)	This anti-microbial agent is used to inhibit moulds and a few bacteria. It is extensively used to inhibit moulds in bakery products.
Parabens	These anti-microbial agents are used as microbial preservatives in baked goods, soft drinks, jams and jellies. The parabens are similar to benzoic acid, and they are often used together.

manufacturers use to exclude air from packages — these methods will be discussed in depth in chapter 11. Vacuum packing does not prevent enzyme activity but it can minimise non-enzymic oxidative reactions. The substitution of nitrogen and other gases in modified atmosphere packages does reduce enzyme activity.

2. Removal of moisture

Processes which remove moisture from food, such as dehydration and evaporation, are effective in preventing the actions of both enzymes and micro-organisms. This is because both enzymes and microbes need water to be active — and not just any water: clean, liquid water. If the water is not pure or if it is ice, it is unavailable to microbes. Enzymes can still be active in freezing conditions, but their activity occurs very slowly — this is the reason why foods cannot be stored in the freezer indefinitely. Evaporated foods still contain quite a high moisture content and so may be susceptible to mould growth.

3. Control of pH

Dissolving other substances in water, such as salt and sugar, chemically alters the water, making it unavailable to microbes and enzymes. Adding acids to foods can minimise spoilage by denaturing enzymes and destroying micro-organisms. The presence of acids also reduces the time and temperature of heat processing needed to preserve food. Additives, in the form of chemical preservatives, food acids and smoke, can be used to help retard or destroy micro-organisms depending on the concentrations used. Bacon, tomato salsa, jam and dill pickles are just a few of the foods eaten daily that use chemicals to inhibit microbe growth. The additives commonly added as preservatives are included in table 10.3.

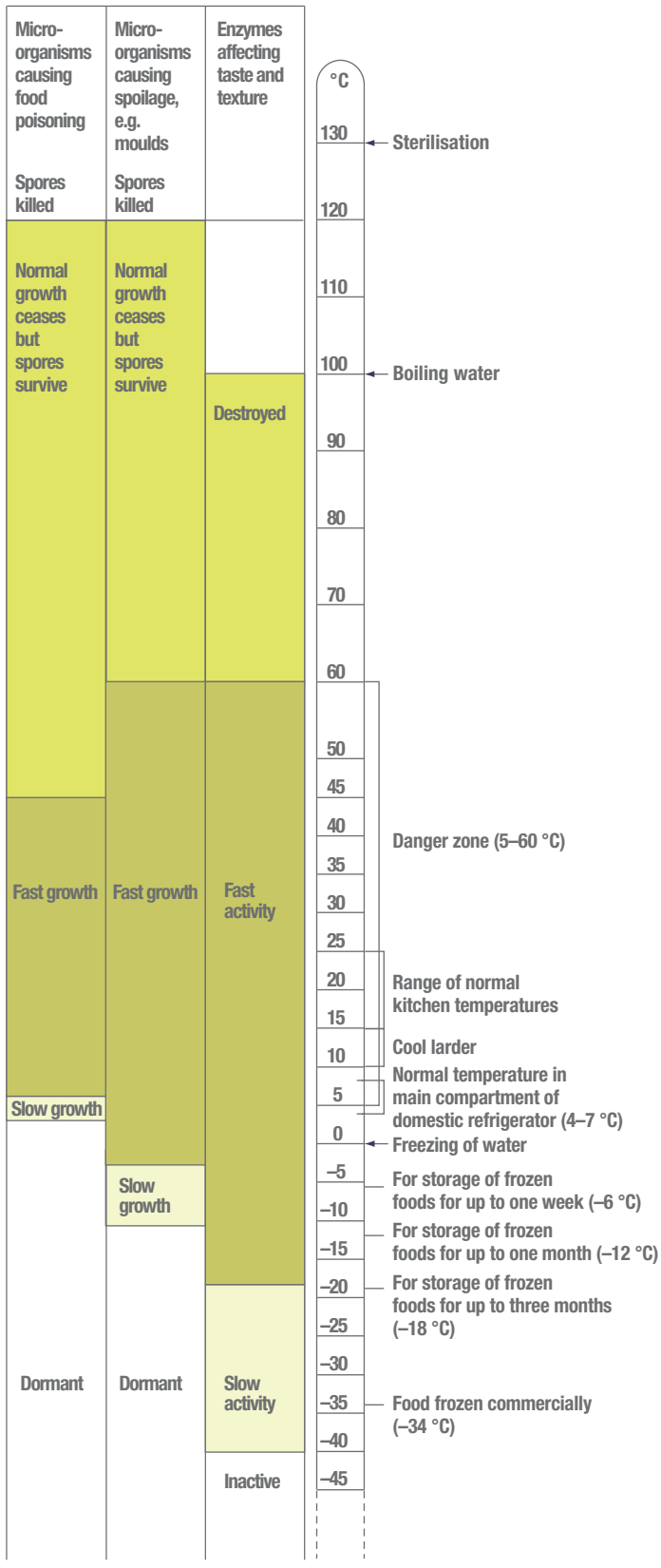
4. Control of temperature

Cooking a food by heating is probably the simplest and most commonly used method of food preservation. When a food is cooked, the process normally involves three specific stages.

1. The food is warmed as the cooking begins.
2. The food is held at its cooking temperature for a certain period of time.
3. The food is cooled or eaten hot.

As food is warmed, two important events occur. Enzymic reaction rates begin to increase and micro-organisms can be activated. As the temperature rises, enzymic reaction rates begin to slow, and then fall rapidly as the optimum temperature for that enzyme (20–40 °C) is exceeded. Micro-organisms have a similar optimum temperature, and when this temperature is exceeded their metabolism will slow; eventually the heat will kill them.

Enzymes and microbes are damaged by temperatures over 60 °C, and a few minutes at 100 °C will destroy all enzymes and kill most forms of bacteria. However, some spore-forming micro-organisms, such as *Clostridium botulinum*, can survive at 100 °C for up to five hours.



The temperature requirements for micro-organism and enzyme growth and destruction are fairly static. It is critical that perishable foods not be stored in the 'danger zone' or spoilage will occur.

The effectiveness of the heat treatment depends not only on the correct temperature being achieved, but also on the pH level of the particular food. Generally, bacteria and their spores can resist more heat when the environment is neutral or near neutral in pH. The higher the acidity of a particular food is, the less time and the lower the temperature it will take to kill any bacteria present.

Every part of the food must receive an adequate heat treatment to prevent spoilage and to kill food poisoning organisms, so the heat achieved at the centre of the food is critical. Factors that affect the rate of heat transfer to the centre of a food are:

- the container (size, shape and type of material)
- temperature of the food before heating starts
- cooking temperature
- consistency of the food, and the size and shape of the pieces.

Cooling of the food after cooking is also an important factor in preventing the growth of bacteria. If the food is not eaten hot and is allowed to cool slowly, this can cause a serious food poisoning hazard (see chapter 3). Even when a foodstuff is cooked to a point at which all the bacteria present are killed, recontamination through poor handling procedures can occur. For example, cross-contamination can occur from human handling, dirty utensils and exposure to airborne particles.

REVIEW QUESTIONS

Remember

1. List the factors that cause food spoilage.
2. Create a mind map outlining four principles of preservation.

Apply

3. Many manufactured food producers apply a variety of the principles of preservation to ensure the stable shelf-life of their products. Suggest which principles of preservation are being used when the following foods are manufactured.
   - **a)** bottled jam
   - **b)** bacon and salami
   - **c)** pasteurised milk
   - **d)** beef jerky
   - **e)** canned fruit
4. Using your knowledge about micro-organisms and their conditions for growth, discuss the validity of the following statement: 'Micro-organisms need to be controlled in order to ensure the safety of food. If the principles of preservation are applied, perishable foods can attain a shelf-life of several months.'

Do an activity

5. What methods of preservation used today were not commonly used 50 years ago? Ask some older people what means of food preservation were available to them when they were young, and what changes have occurred in food preservation during their lifetime.

pH levels activity

6. Rank the following foods according to how acidic or bland they taste.
   - **a)** Apple
   - **b)** Sweet corn
   - **c)** Beetroot
   - **d)** Orange
   - **e)** Mango
   - **f)** Mushrooms
   - **g)** Pineapple
   - **h)** Banana

Log in to **www.jacplus.com.au** and locate the *pH Levels* weblink for this chapter. Compare your estimations and descriptions of these foods with the pH levels figures and information there.

Preservation processes

Canning

Conventional canning involves two preservation principles:

- control of temperature — the heating of the food inside the container creates a temperature that will destroy all micro-organisms and their spores
- exclusion of air — the vacuum created inside the sealed container prevents micro-organisms from reaching the food inside.

With these two principles, conventional canning combines both cooking and vacuum sealing.

In traditional canning, the cans are filled with the food product and a liquid (syrup, juice, brine, oil) is added to force air out of the package. The air above the food is removed using either steam or a vacuum chamber. The lid is placed on the can and sealed. The filled cans are then heated for the time required to kill the micro-organisms known to exist in the type of food being canned. The can is then quickly cooled.

Some cooking times need to be fairly long to make sure that the heat has penetrated to the centre of the food, and that sterility has been achieved. Certain foods are not suitable for canning, because their quality suffers in the canning process in terms of texture and colour.

Aseptic canning is another method of canning. Instead of the can and the food both being heated to the required temperature, the food is heated to the correct temperature then put in a sterile can. Canning speeds are faster using this method because the already sterile food in the can does not need to be re-heated. As well, the aseptic process ensures that all food has been evenly heated and that **sterilisation** has occurred.

When buying cans of food in the supermarket, the ends of the cans should be slightly concave. This indicates that there is a vacuum inside the can, which is the reason for the sound when the can is pierced and air rushes in. If the

end of the can bulges, one of three scenarios could have happened:

- *microbial action*. Bacteria may be present because poor can-closing procedures were used, or because the food was underprocessed and thus the bacteria were not killed. The bacteria produces acid and gas in the can, which exerts pressure in the can.
- *physical action*. Over-filling the can at a low temperature causes permanent bulging of the can after heating. There is usually a small amount of space left in all containers (called **head space**) to allow for expansion caused by heat.
- *chemical action*. Acid foods can corrode containers and cause a chemical reaction that produces hydrogen gas. Cans used for high-acid food have lacquered insides to stop this reaction. Have you seen the white lining inside tins of apricots and asparagus?

Pasteurisation

Pasteurisation refers to a specific type of heat treatment of a food. The process will either kill all specific heat-sensitive micro-organisms, or simply reduce the number present to an acceptable level. However, this process does not completely sterilise the food. Milk is the most well-known product that undergoes the pasteurisation process. Many other products such as fruit juices, beer, wine and dried fruits are also pasteurised. The simplest form of milk pasteurisation is known as the 'holder process method', in which the milk is quickly heated to a temperature of 65 °C, held at this temperature for 30 minutes, then quickly cooled.

Today the most common pasteurisation method is the HTST (high temperature, short time) method, using a heat exchanger, in which the milk is heated very quickly to 72 °C and held at that temperature for 15 seconds, using a heat exchanger.

Ultra-high temperature treatment

Another important process used in the preservation of milk is ultra-high temperature (UHT) processing. This process gives us UHT milk which does not require refrigeration for storage. The milk is heated to about 140 °C for a few seconds to kill all heat-resistant bacteria, but some cooked flavours may be detected in the product. Even allowing for the slight loss in flavour, UHT milk is still a product of high quality, which can be stored in the cupboard unopened for up to six months without spoilage occurring. Once opened, it must be refrigerated.

TABLE 10.4 **Methods of heat treatment used for milk**

TYPE OF PROCESS	TEMPERATURE	TIME
Holder process	65 °C	30 minutes
HTST	72 °C	15 seconds
UHT	140 °C	3–5 seconds

Refrigeration

Chilling

Chilling slows the growth and activity of enzymes and the growth of micro-organisms. Thus refrigeration is probably the most often used preservative method for storing perishable food. The lower the temperature is, the slower the chemical changes occur in the food and the slower the microbial growth happens.

Cooling of food has various effects on micro-organisms. Some moulds and cold-living bacteria can tolerate very low temperatures and often cause spoilage even under cooler conditions.

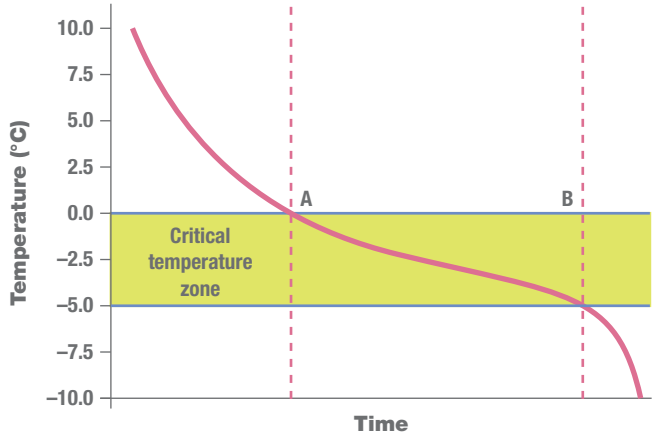
Chilling or cooling a food has no effect on the number of bacteria present. Once a foodstuff has been returned to room temperature, the micro-organisms will be reactivated and will continue the spoilage of that food.

Freezing

Freezing involves the storage of food at temperatures below –18 °C. Freezing prevents the spoilage of food in two ways:

- enzyme activity occurs more slowly due to the low temperatures
- micro-organism numbers are somewhat reduced by the freezing process, and those that do survive cease to be active or multiply at this temperature.

Micro-organisms that survive the freezing process can recover rapidly after thawing and begin multiplying as soon as the conditions are favourable. For this reason, foods should be defrosted slowly in the refrigerator (out of the danger zone) or using the microwave. Foods should be fully thawed before cooking and they should be cooked immediately. Food poisoning is likely to occur if a defrosted food is refrozen without being cooked — the increased number of bacteria produced during defrosting will create an unacceptable number of bacteria when the food is next thawed.



Freezing curve

Enzymes, despite being slowed by sub-zero temperatures, are still slightly active in the freezer, even to temperatures

of –73 °C. The colder the freezer, the slower the enzyme activity, and the longer the food will maintain quality. Manufacturers try to minimise the impact of enzymes in a number of ways.

1. Vegetables are blanched in hot water or with steam at around 95 °C for 1–5 minutes to destroy enzymes close to the surface of the food — this assists in minimising oxidative reactions and maintaining the colour of the food.
2. The maximum amount of air is removed from within the package to prevent an enzymic reaction called 'freezer burn', which results in the desiccation of the food surface.
3. 'Best before' dates are placed on packages as a guide to quality maintenance — the food is still safe to eat beyond this date, but enzymes may have begun to alter the physical qualities of the food. Domestic freezers generally have a guide printed inside to advise the shelf-life of varying frozen food types.

The quality of a frozen food is determined by the amount of time that the food spends in the critical temperature zone (0 to –5 °C). The reason is that the time spent in this zone will determine the size of the ice crystals that are formed — the longer the time in this zone, the larger the crystals, and therefore the greater the damage to the structure on thawing.

Drying (dehydration)

Dehydration is one of the oldest methods of food preservation, and many cultures still dry food in the sun. Foods such as grains are dry enough when harvested, or after a small amount of additional drying, and will not spoil for a long time if the storage conditions are favourable. However, most foods contain enough moisture to allow enzymic and microbial activity that results in food spoilage.

A method of drying fish that is still used today

Drying is usually accomplished by the evaporation of water, but any method that decreases the amount of water activity in a food is a form of drying. Heavy salting of fish, for example, will draw moisture from the flesh. Sugar will also achieve the same result — for example, in glacé fruit.

Moulds and bacteria will grow in a food when there is as little as 13 to 20 per cent moisture content in the food. For this reason, manufacturers aim to dry products to the point at which the moisture content is around 5 to 6 per cent. This level will also prevent the chemical reactions that tend to occur at higher moisture levels.

TABLE 10.5 Moisture content of various foods before and after drying

FOOD	MOISTURE BEFORE DRYING %	MOISTURE AFTER DRYING %
Milk		
Whole	87	5.0
Non-fat	90	5.0
Egg		
Whole	74	2.9
White	88	7.3
Yolk	51	1.1
Beef, lean, roasted	60	1.5
Beans, cooked	92	11.5
Corn, cooked	76	3.2
Potatoes, boiled	80	4.0
Apple juice	86	6.2
Figs, raw	78	3.6
Parsley, raw	84	5.3

Freeze drying

Freeze drying is not a commonly used manufacturing process because it is expensive. It is used in the manufacture of some tea, instant coffee, soup and dried meat.

In modern freeze-drying, the product is quickly frozen (the solids may be broken into small fragments) then placed on shallow trays. On these trays, in a vacuum environment and with gentle heat, ice crystals sublimate, leaving dehydrated particles. The quality of freeze-dried foods is very good but the process is far too expensive to be used on most foods suitable for drying.

Fermentation

Fermentation occurs when carbohydrates are converted to acids or alcohol through the action of micro-organisms.

The oldest and most widely known use of fermentation is the production of alcoholic beverages. Beverages such as mead, wine, beer and cider are created when yeasts act

upon the sugars in honey, grapes, grains or fruits, converting them to alcohol. Carbon dioxide gas is given off as a by-product of this process.

The fermentation of yeast is also important in the production of bread, where the gas is desired to make the bread rise. However, the amount of alcohol created is minimal and it is destroyed during baking, so breads are not classed as fermented products. Sour dough breads do require fermentation processes to create their characteristic flavour, so they are made using lactic acid-producing bacteria and special varieties of yeasts that can cope with acidic conditions.

Fermentation has been used throughout history as a means of creating and preserving foods by lactic acid-producing bacteria being added or allowed to develop within the food. The bacteria feeds on the carbohydrates (notably sugars), multiplies and creates lactic acid. The pH of the food lowers, the flavour sours, and the environment becomes unfavourable for other microbes, which therefore preserves the food. This process may take a few hours, as in the case of manufacturing yoghurt, or a few months, as when producing salami. (Cured meats such as salami are also salted, smoked and air dried.) Other fermented food products include: sauerkraut (German fermented cabbage), tempeh (Indonesian mix of fermented soya beans and grains), and kimchi (Korean side dish of fermented cabbage and spices). Other cultures preserve some foods, for example cucumbers, by packing them in dry salt or placing them in vinegar to deter microbial spoilage; allowing natural fermentation processes to take place.

REVIEW QUESTIONS

Remember

1. What factors influence the amount of time food needs to be heated for when canning?
2. What is the difference between UHT milk and pasteurised milk? How should each type of milk be stored?

Apply

3. Look at the list of dehydrated foods in table 10.5. Many of these products would be used as raw materials for other manufactured foods.
   a) Select three of these dehydrated products and suggest other manufactured foods in which they may be used.
   b) What would happen to these other foods if dehydrated products did not meet the moisture levels stated in the raw materials specification?
4. Select a raw food material and identify the various preservation processes that can be used to extend its shelf-life. For each process, state examples of food products and identify their storage requirements after processing.
   For example:
   milk → HTST → requires refrigeration

Do an activity

5. Find a recipe and create your own yoghurt. Explain the fermentation process in the making of yoghurt.

EXPERIMENT — PRACTICAL ACTIVITY

Food preservation: tomato sauce

Syllabus outcome

Students learn to:

- prepare food using the principles of food preservation to ensure a safe food product
- describe processes that transform raw materials into manufactured food products
- compare the processing techniques, equipment, storage and distribution systems in industry with those used domestically
- identify critical control points and describe quality control procedures in food production systems.

Contributes to the following outcomes:

- applies principles of food preservation to extend the life of food and maintain safety
- explains manufacturing processes and technologies used in the production of food products.

Aim

Processes demonstrated: canning/bottling, pickling, aseptic processing

Principles demonstrated: use of high temperatures, addition of chemicals, exclusion of air (hot fill)

Ingredients

Quantity between 2 students (approx. 500 mL)

650 g tomatoes
100 g onions
1 clove
100 g apples
¼ tsp powdered ginger
1½ tsp salt
100 g sugar
20 mL Ezi-sauce

Equipment

chopping board and knife
medium saucepan
bowl
metal spoon
food processor
sieve
2 × 250 mL glass bottles or jars
stock pot or oven
measuring equipment

Method

1. Bring saucepan of water to a rolling boil with lid on.
2. Using a sharp knife, place a cross in either end of the tomatoes. Blanch each tomato for about 20 seconds. Remove and place in bowl of cold water. Remove skins by peeling — do not worry if not all the skin comes away. (For added flavour, the skins can be tied in muslin and added to the tomatoes.)
3. Chop onions and tomatoes, combine in a bowl, cover and leave overnight in the refrigerator.

The following day:

4. Sterilise jars using one of the methods below.**
5. Boil onions, tomatoes, peeled apples, ginger and garlic for 30 minutes over a medium heat with the lid on.
6. Add Ezi-sauce, sugar and salt.
7. Boil for a further 15–20 minutes with lid off, stirring frequently.
8. Boil kettle and fill food processor. Let stand for 10 minutes. Empty water, add sauce and process till smooth (if needed).
9. Force sauce through a strainer using sterilised spoon.
10. Pour hot sauce into hot clean bottles (reheat on stove if sauce has cooled significantly).
    (Makes about 500 mL.)

**Methods for sterilising jars:

1. Preheat oven to 150 °C. Wash jars in warm soapy water, rinse and allow to drip dry upside down on oven shelves for at least 30 minutes. Lids should be placed in boiling water for 10 minutes. (If lids are placed in oven, the rubber lining in the lid will dry out and not hold the seal on the jar.) Leave jars in oven till ready to use.
2. Place jars *and* lids in warm water, bring to boil. Boil for 20 minutes. Tongs, spoon and strainer to be used later in the process should also be sterilised for 10 minutes. Sterilised jars should be drained upside down on a cooling rack when removed from the stockpot.

   Note: Bottles should still be hot when the sauce is added.

Conclusions

1. What is the difference between canning and bottling?
2. Explain the purpose of heating the bottles prior to filling. What would be the result of heating them for a shorter period of time?
3. Why should jars be stored upside down while waiting to be filled?
4. Explain what is happening to the food during each major stage of processing.
5. Read the food label on the bottle of Ezi-sauce. What is it and why is it a necessary ingredient in the above recipe?
6. Describe how the production equipment and processing methods used for mass-production of tomato sauce would differ from this domestic process.
7. Identify the hazards that could cause contamination in this product and explain how and where they are to be controlled (CCP — critical control points).

CHAPTER 10 SUMMARY

- Raw materials include ingredients, processing materials, additives and packaging.
- Manufacturers specify the exact characteristics required of the raw materials and conduct quality control tests before accepting them.
- Food additive use is regulated by FSANZ.
- Additives may be used in foods to restore or improve taste and appearance, improve keeping quality and extend shelf-life, and provide foods for special needs.
- The greater the 'level of production', the more technology used in the manufacturing plant and the less manual labour.
- Manufacturing equipment completes similar tasks to domestic equipment, just on a much larger scale.
- Internal transportation of ingredients in large-scale manufacturing plants is via stainless steel pipes connecting storage areas with the production line.
- Filtration, sieving and centrifuging are examples of separation processes.
- Grinding, milling and chopping are examples of size reduction processes.
- Heating processes include baking, evaporation, HTST pasteurisation and UHT sterilisation. The equipment used include tunnel ovens, evaporators and heat exchangers.
- Cooling processes include refrigeration, blast chilling and freezing. The equipment used for these unit operations include blast chillers and freezers, plate and tunnel freezers, and immersion freezing units. Freezing can be used along with dehydration to create freeze-dried products.
- Dehydration processes can be applied to liquids and solids. The equipment used includes tunnel and cabinet dryers, and spray dryers.
- Production processes are produced in flow charts to allow easier analysis of each stage of processing and for HACCP.
- HACCP involves seven stages and assists in ensuring the production of safe foods.
- The *Occupational Health and Safety Act* focuses on safe production environments for employees.
- Food preservation is an essential goal of the food industry.
- Food spoilage occurs as a result of micro-organisms, enzymes, rodents and insects, and environmental factors such as warm temperatures, air, moisture, light.
- In favourable conditions micro-organisms will double in number every 20 minutes.
- Common food poisoning bacteria include *Salmonella*, *Staphylococci*, and *Clostridium perfringens*. *Clostridium botulinum* is less common but more deadly.
- The procedures and principles of preservation that are applied in all preservation processes are
  - hygienic handling to prevent cross-contamination
  - removal of visual contamination
  - exclusion of air
  - removal of moisture
  - addition of chemical substances
  - controlling of temperature.

  The more principles applied to any one food, the greater the shelf-life of the food.
- Examples of preservation processes include pasteurisation, canning, pickling, freezing, dehydration and fermentation.
- Manufactured foods must be effectively packaged to ensure that preservation goals created by processing are achieved and maintained.
- Each food has a limited time (shelf-life) when it is nutritionally at its best, safe to eat and appealing to look at. This is achieved by using one or more principles of preservation such as temperature control, the removal of moisture, the exclusion of air and the control of pH levels.

KEY TERMS

aseptic
atomiser
automated
biochemical
blanching
centrifuge
continuous flow
cross-contamination
death phase
dehydration
economies of scale
enzyme
fermentation
filtration
food additive
Food Standards Australia New Zealand (FSANZ)
Hazard Analysis Critical Control Point (HACCP)
head space
heat exchanger
lag phase
logarithmic phase
microbial
occupational health and safety (OH&S)
pasteurisation
pathogenic bacteria
production run
quality assurance
quality control
raw material
shelf-life
sieving
stationary phase
sterilisation
sublimation
unit operation
vacuum packing
viruses

Chapter 11
Packaging, storage and distribution

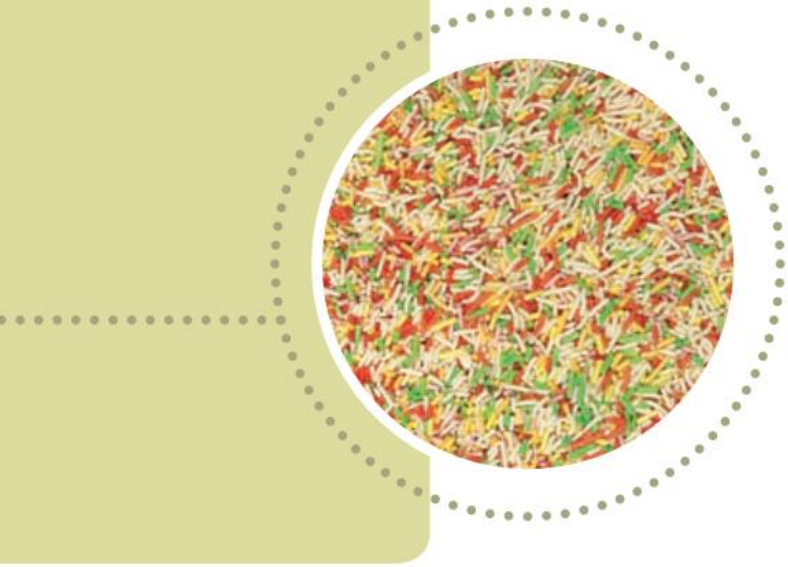
Have you ever picked up a product to find out more about it purely because of the packaging? Making food packaging 'better' and more interesting is a full-time job for some people. Food manufacturers and marketers know that consumers often decide to purchase products in the blink of an eye. Creating colourful, innovative packages for a product will get consumers interested; however, the packaging material must be appropriate for the product if quality is to be maintained. Research is constantly being undertaken to develop new packaging materials and processes, and without this ongoing research, the quality and variety of foods would be more limited.

In this chapter you will learn about:

Packaging, storage and distribution

- functions of packaging and types of materials available
- current developments in packaging
- legislative requirements for packaging and labelling
- storage conditions and distribution systems at various stages of food manufacture.

If it didn't fizz when you opened it, you would be extremely disappointed. Companies can manufacture a product with fizz — but if the packaging design is not correct for the product, it, and you, will be very flat. Packaging is a cornerstone in the development of 'good' products. Good packaging is one aspect that makes a product better.



Functions of packaging

Packaging has five major functions.

1. Packaging contains product.

The majority of foods need to be put in some sort of container for easy storage and distribution.

2. Packaging protects products.

Packaging must protect the product from physical and mechanical damage. Consumers are unlikely to accept goods that are broken, scratched, dented or chipped. Sturdy boxes are often used to protect product packaging.

Manufacturers must choose packaging that not only contains the product, but protects it from damage. The greatest danger of damage to a product during transport comes from horizontal impact. This occurs when loads are subjected to rail shunting, emergency road braking or even the pitching and rolling motion of ships. In the warehouse and in the loading and unloading of products, the main danger is vertical impact. This occurs when the load is dropped.

Compression can occur when other goods are placed on top of a product causing unnecessary pressure.

The type of packaging used must provide protection against all these forms of mechanical damage, so the product reaches the consumer in the condition it left the manufacturer's factory.

Excess moisture and rain will also cause irreversible damage to a product, so the packaging must be designed to withstand high levels of moisture if the product may be exposed to such conditions.

A product's packaging also protects the food from physical damage during storage within the home, for example, packages designed to hold food in the freezer are laminated with wax or plastic film to prevent deterioration by moisture. Tamperproof packaging designs also provide consumers with a sense of security regarding the safety of their food.

3. Packaging preserves foods.

Packaging plays a very important role in preventing or at least hampering the spoilage of food products. All foods are different, so the role of packaging in the preservation of food is quite complex.

Packaging must:

- decrease the chances of, or prevent contamination by, micro-organisms that cause food poisoning, especially in dairy foods and seafoods
- prevent moisture entering dry food products
- prevent loss of moisture from products that contain water
- allow products such as fresh fruits and vegetables to breathe (or respire)
- prevent the process of rancidity of fats, which needs oxygen
- protect light-sensitive products from ultraviolet light.

No single packaging material is able to perform all these functions, which helps to explain why many types of packaging are used for food.

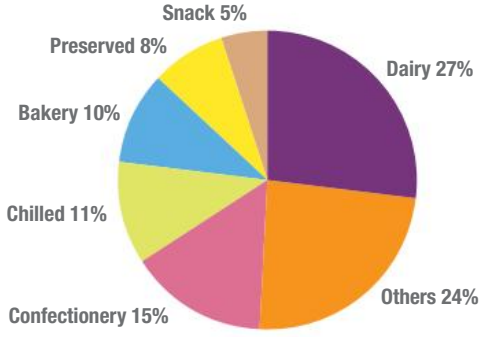
4. Packaging informs the consumer and promotes the product.

The package is usually the only contact between the consumer and the manufacturer. The packaging used on a specific product acts as a beacon by which the consumer recognises that product (for example, the parrot emblem on Arnott's biscuits). For this reason, the packaging of a product can build up or destroy the image of a brand of product.

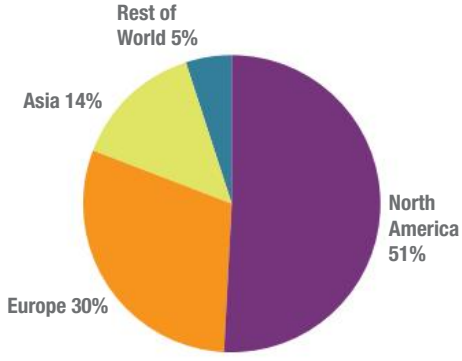
Packaging helps the consumers to use and choose the products they buy. The package:

- identifies the product and brand (shape, colour, brand name and logo)

Global food packaging product distribution



Geographical breakdown of food packaging



Manufacturers of food packaging forecast an annual increase of 5 per cent per year, with sales expected to reach US$190 billion by 2008. Food packaging accounts for nearly 40 per cent of all global packaging. Can you think of any food products that you buy that are not packaged in any way?

- displays the quantity and price
- explains the product's features
- provides directions for use (and may offer recipes and serving suggestions)
- provides health and consumer-protection information required by law (use-by dates, nutritional information, warnings, ingredients list, and the name and address of the manufacturer).

5. Packaging provides convenience.

Many packages allow the consumer to use the product directly from the package (for example, microwavable containers) or save the consumer effort in preparation (for example, whipped cream in a can). Recent packaging designs also include features that allow the consumer to use the product anywhere it is convenient to them (for example, ring pull cans and salad bowls with forks).

Determining the best packaging for the job

Manufacturers must choose a packaging that fulfils all these functions — but no one packaging style or material is suitable for all foods. Consideration must be given to the following when designing and selecting packages:

- characteristics of the food such as its level of moisture and how fragile it is
- likely causes of spoilage or loss of quality — for example, physical damage (bruising, crushing), **microbial** growth and **enzyme** activity
- shelf-life requirements of the food — for example, sauces require a more durable package than bread
- intended usage by consumers — the package must be a suitable shape, size and weight for handling and storage. For example, pepper and spices in small canisters that allow for sprinkling
- company image — the shape and choice of packaging material can create expectations of a superior product in consumers' minds — for example, oils and gourmet dressings in long slender bottles, or gourmet jams in hexagonal jars. Also, because consumers recognise the packaging of particular brands, using similar packages for new product lines can assist sales of that new product.
- cost — packaging contributes significantly to the cost of a product, sometimes surpassing the cost of the ingredients it contains. Manufacturers consider the effect the package will have on consumer purchase and evaluate this in terms of the total product costs. Standard packages that are mass produced by packaging companies, such as round glass jars or moulded soft drink bottles, are cheaper than manufacturers developing their own customised packaging.
- production facilities — choosing a package that is compatible with existing production machinery will minimise problems during processing. Selecting a package that is used for a variety of products makes ordering and storage of packaging materials more cost and space effective.
- legal requirements — the food must not react with the packaging material, and the size of the package should not misrepresent the volume of food within
- ethical considerations such as the environmental impact of materials used:
  - can the package be reused or recycled?
  - what is the ratio of packaging used to maintain the quality of the food compared with those packaging features included solely for presentation purposes?
  - are there alternatives available that produce less of a long-term environmental impact?
- consumer wants and expectations.

Get into the habit of analysing food products and applying the theory you have learnt. There is nothing accidental about the design of food products and packages — everything about them has been included for a reason.

REVIEW QUESTIONS

Remember

1. Outline the five main functions of packaging.
2. Identify four factors that influence a manufacturer's choice of packaging.

Apply

3. Select a packaged food product. Apply the functions of packaging to the specific food, identifying relevant information (for example, the likely causes of spoilage) where appropriate.

Do an activity

4. Ask your grandparents or an elderly person to describe the types of food available when they were young, and how the foods were packaged.

CASE STUDY

OUTCOME TASK | **RESEARCH ASSIGNMENT**

Students learn to:

- investigate, through experimentation, the suitability of packaging materials for different food products.

Contributes to the following outcome:

- evaluates the relationship between food, its production, consumption, promotion and health.

Carefully consider the image above. Use the stimulus material, along with your knowledge of *packaging,* to complete the tasks ahead.

1. Consider the five functions of packaging. Assess whether each of the products above fulfils all of these functions in its design.
2. Imagine that each of these packages contained identical juices. Which of the packages would you buy? Explain the reasons that influenced your choice.
3. Analyse the features and qualities of each package. Compare and contrast the packages to determine possible reasons why the manufacturers may have selected that package for the marketing of their product.
4. Visit your local supermarket and find out the price of similar fruit juices packaged in each of the above styles. Divide the price of the juice by the number of millilitres contained in the package to calculate the cost per millilitre of product. Discuss reasons for the difference in the cost of the juices.

Types of packaging material

Many different types of material are available for food packaging. The main types used in the food industry are:

- cans
- glass containers
- rigid plastic containers (plastic bottles and moulded tubs)
- flexible plastic packaging (plastic films and bags)
- paper and board products (moulded packaging, cardboard boxes, composite containers)
- aluminium foil and laminates
- styrofoam (cups and trays).

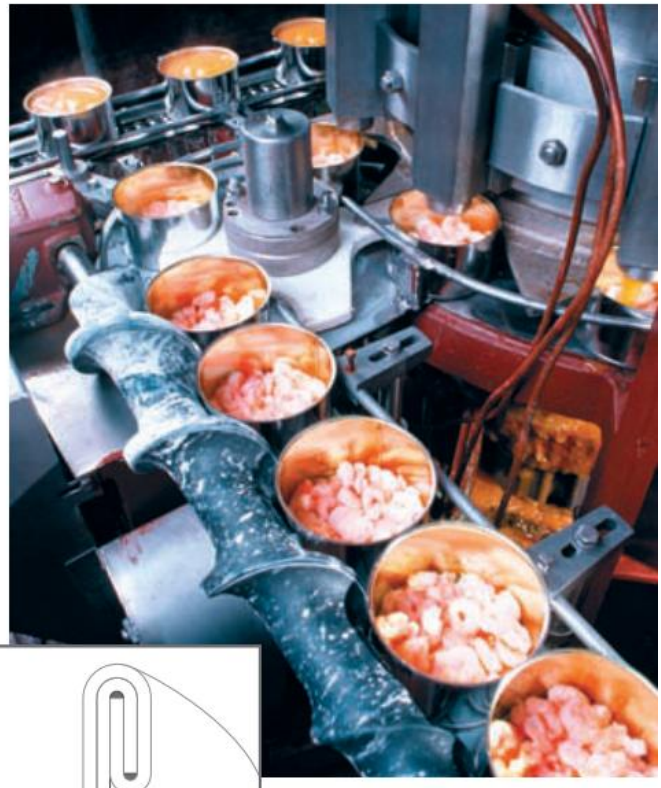
Cans

The metal can is one of the cheapest and most widely used types of packaging in Australia. The advantages of the metal can to the consumer are that it provides good protection for the contents and prevents undesirable gains or losses in moisture content. In terms of manufacturing and selling canned food, there are also other advantages.

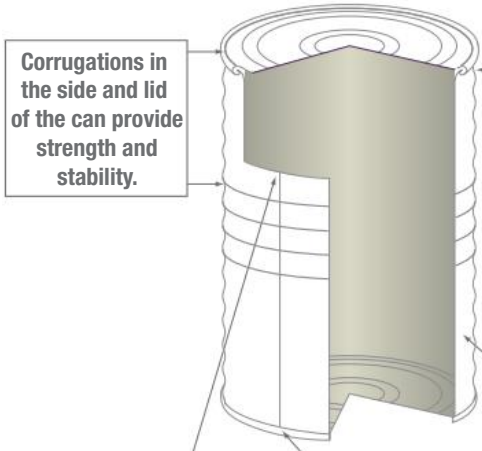
- Cans are relatively easy to handle, in terms of filling, sealing and packing. High speeds can be achieved during production.
- Cans are generally standard sizes and shapes so that they can be displayed easily and stack neatly onto shelves.
- Cans can be stored for long periods.
- The steel can is impact resistant and virtually unbreakable.

The two most common types of can used in the food industry are the steel can and the aluminium can. Steel cans are extensively used for solid and semi-solid foods, while aluminium cans are used to contain soft drink and beer. The steel can is generally coated with a thin layer of tin which acts as a barrier between the steel and the food to minimise the risk of the food reacting with the steel. Foods with a low protein content and a high acid content require cans with special coatings to ensure the package is **inert**. Canned foods are able to be stored for long periods, so at times a coating of lacquer or plastic is needed on top of the tin to stop the chemical reaction between the food and the tin coating.

It is not advisable to use the contents of dented or damaged cans because microscopic holes may be present. Air and microbes can enter through these holes and react with or grow on the contents. The lacquer may also be damaged, and food will react with the metal, causing food deterioration.

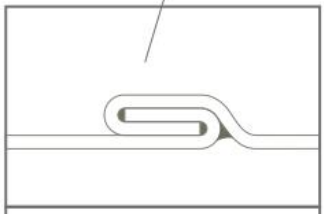


Cans provide an extended shelf-life for a range of foods. The strong, rigid can is filled with the required portion of food, filled with liquid to exhaust the air, sealed and then heated. The can enables the food to remain sterile indefinitely.



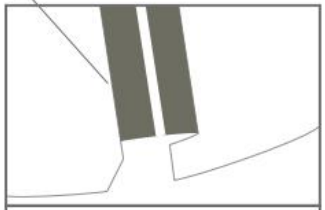
The double seam

The curl on the can end containing sealing compound and the flange on the can body are rolled flat, forming five folds of metal. The sealing compound between the folds gives an airtight seal.



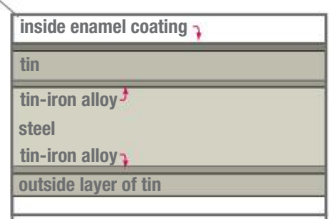
The side seam

The edges of the can body are first hooked then flattened together.
A final sealing is accomplished by soldering the outside of the side seam.



The notch

If the side seam were extended to the end of the can, there would be four folds of the metal to be included in the seam area. However, the body blank is notched, so only a double layer of metal extends into the double seam. This permits tighter sealing.



The tin plate

This cross-section shows the relative thicknesses of component layers of tin plate. Steel is the large segment. The first layer on either side is tin-iron alloy, and the second is tin. The inside surface is enamel coating.

Canned foods do not have use-by dates printed on their labels as they are required only on foods with a shelf-life of less than two years. This long shelf-life is due in part to the structure of a steel can, which tightly seals the contents of the food in a vacuum and prevents the entry of air and bacteria. Compare the strength of steel cans with the aluminium cans used for beverages. Determine which areas of the aluminium can are strongest.

TABLE 11.1 Different cans used for various foods

CLASS OF FOOD	CHARACTERISTICS	EXAMPLE
Strongly corrosive (often packaged in lacquered cans)	Highly or moderately acidic products	Berries and cherries, apple juice, tomatoes
Moderately corrosive (the can may sometimes be wholly or partially lacquered)	Mildly acidic products, often containing fruit products	Apricots and peaches, baked beans in tomato sauce
Mildly corrosive (food reacts with can only when stored in can after opening)	Low acid products or high protein products	Peas, corn, fish, meat

The qualities of the food affect the characteristics of the cans used to package them. These days a number of products that were once sold in cans are now packaged in glass.

Glass containers

Glass containers are selected for a variety of reasons. Glass:

- is chemically inert, and does not react with foods to produce flavour changes
- is impermeable and non-porous
- is odourless and hygienic
- is usually transparent, which permits the contents to be inspected at the time of packing and at the point of purchase
- has great strength, and is being made stronger, lighter and thinner each year
- is easy to open and to reseal to store unused contents
- comes in a wide variety of shapes, sizes and colours
- provides a means of long-term storage and extended shelf-life
- can be recycled or re-used.

Glass is used for a wide selection of semi-liquid, liquid and solid foods. Each individual product has its own special requirements, but some general processes are followed when using glass packaging. It is common practice, for example, to prepare glass containers by air blowing, rinsing with warm water or washing with detergent solution. Some food manufacturers invert the bottles as part of the cleaning operation to remove any foreign bodies that may be present prior to filling (making the package **aseptic**).

Care must be taken when conveying glass through the filling process from one stage to another to prevent surface damage or breakage of the container. Many conveying systems are controlled by electronic eyes that automatically stop the progress of glass containers down the conveyors when a breakage occurs.

Once full, a glass container is closed. Different types of closure are used for glass containers, depending on the product. Bottles for soft drink and other carbonated products need to retain internal pressure. Bottled baby foods need a vacuum, tamper-proof lid. Contents such as peanut butter simply need to be secure. The types of product packed in glass containers generally need the container to be resealable, so the containers are often re-usable.

The use of glass packaging allows for differences in processing to canned products. Glass packages are usually aseptically sterilised and hot-filled, allowing for vacuum sealing without retorting. If the product has not been hot-filled, **pasteurisation** of high-acid food such as fruits and pickles is required. The contents of the glass container need to reach temperatures of at least 85 °C to destroy micro-organisms. Low-acid foods such as fish, meat and baby-food products need to undergo **sterilisation**, and are required to be heated to much higher temperatures, so that all the micro-organisms are destroyed.

Once the glass container has been filled, it is labelled. The choice of which type of label to use depends on the type of equipment available and the desired effect of the label.

Paper and cardboard

Paper packaging is used for a wide range of products because it is versatile and cost effective. Different types of paper can be made into packaging of different shapes, textures and thicknesses, depending on the needs of the product. It is possible to treat paper to suit the type of product being packed. When packaging food products such as confectionery and butter, greaseproof papers are used because they offer a barrier to unwanted odours and moisture. Waxed papers are tasteless, odourless, non-toxic and inert, and can be used for many foods. Thicker paper-based packaging (paperboard) can be **laminated** with other materials to produce strength and moisture resistance, for example, boxes for frozen meals and the Tetra Paks used for long-life products such as fruit juices. Pulped fibreboard offers protection for fragile foods such as eggs and fruit because air spaces are present between the particles of paper/fibre.

Match your product knowledge with the information listed in table 11.2, by naming at least two specific product brands that use each type of paper packaging listed.

Rigid plastic packaging

Plastic has advantages over other types of packaging because it:

- is lightweight yet strong
- has a high resistance to breakage. Some plastic bottles have high impact resistance, being able to withstand a 1- to 2-metre drop onto a hard surface without damage to the bottle.
- is available in a large variety of colours, shapes and sizes
- adds to the sales appeal of the product
- is relatively cheap to produce compared with other methods of packaging.

TABLE 11.2 Types of paper packaging and the products for which they may be used

TYPE OF PACKAGING	GENERAL INFORMATION	EXAMPLES OF PRODUCTS
Paper bags	The paper bag is one of the oldest and cheapest forms of packaging available. It is secure and provides protection from light and dust when sealed. One disadvantage is that it does not stand neatly on supermarket shelves without some type of support.	Cookies Sugar Flour
Paper sacks	The difference between paper bags and paper sacks is simply that paper sacks are made from thicker paper, which allows them to carry heavier weights.	Bulk flour Bulk rice Bulk bread rolls
Moulded fibreboard cartons	Paper is first pulped, then deposited into moulds and allowed to dry. A dense and hard container results. The containers can be moulded into different shapes, to suit the product being packed.	Egg cartons Dividers in fruit distribution Boxes Biodegradable trays
Board-based products	This type of packaging is made from board 0.5–1.0 millimetres thick. The carton provides a solid structure for the contents and has the benefit of easy stacking.	Cereals Cake mixes Biscuit boxes
Paperboard bricks	These bricks are made from wood pulp, layers of polyethylene and sometimes aluminium. Used with aseptic packaging, they contain processed food. They have an airtight seal and are unbreakable, but they are difficult to recycle.	Long-life milk Juice and other fruit drinks
Paperboard cartons	Cartons are made from wood pulp with a plastic lining. They cannot be reused.	Fresh milk Custards and other milk products
Composite containers	These containers use more than one material. The most common type used in food packaging is one that uses a paper body and a metal lid.	Milo containers Gravy canisters Snack food canisters
Corrugated boards	This is the most widely used form of packaging in the food industry. In most cases it is used as a secondary package to hold multiples of a prepackaged food.	Boxes used for bulk buying Boxes in which products are delivered

In a food processing factory, rigid plastic bottles are handled in the same way as glass bottles. Plastic bottles do not break as easily if dropped, but they are more likely to deform if exposed to high heat.

Many different types of plastics can be used for rigid packaging. The two most commonly used in food packaging are polyethylene terephthalate (PET) and high-density polyethylene (HDPE). These plastics are versatile, being used to create both rigid and flexible plastics. PET is most commonly used as a clear packaging, as colouring has an impact on its strength. HDPE, however, is stronger when coloured, so rigid HDPE packages are opaque. PET is stronger and provides better long-term barrier protection in rigid packages, being used to package soft drinks, water, oils, sauces and spreads. HDPE is used for products with a shorter shelf-life, such as milk. Some packages use a combination of plastics in their structures — for example, a PET bottle with a HDPE lid or nozzle.

Other rigid plastic packaging includes polypropylene (PP), which has a high melting point and is, therefore, useful for packaging products requiring a hot fill — for example, aseptically filled fruits in syrup and sauces. Polypropylene is also used for moulded tub containers for products such as ice-cream and yoghurt, and for takeaway containers. Polystyrene (PS) is generally foamed before being made into rigid containers such as trays and cups. The aerated texture of polystyrene enables the package to cushion foods from physical damage, as well as providing good thermal retention properties.

All plastics carrying a recycling symbol have the potential to be recycled (see table 11.3 opposite); however, not all councils collect every type for recycling due to cost.

Flexible plastic packaging

Flexible plastic packaging is any plastic material that is formed into a sheet or reel, having a thickness of up to 0.375 millimetres. Let's look at films, bags and laminations.

Plastic film and bags

Some common plastics used to make plastic films and bags:

- polyethylene (PET) — used for cling wrap
- high-density polyethylene (HDPE) — used for sturdier flexible packages; for example, some cereal box liners (e.g. Vogels), shopping bags

TABLE 11.3 Recycling symbols for each type of plastic

RECYCLING SYMBOL	PLASTIC TYPE	USES
	PET — polyethylene terephthalate	• Clear rigid bottles — e.g. water and soft drink bottles • Films — e.g. cling wrap
	HDPE — high-density polyethylene	• Opaque rigid bottles — e.g. 2 L milk bottles • Flexible sheets — e.g. cereal box liners
	PVC — Polyvinyl chloride UPVC — unplasticised polyvinyl chloride	Rigid bottles — not commonly used because of dangers when recycling
	LDPE — low-density polyethylene	Flexible packaging — e.g. films, shrink wrap, bags
	PP — Polypropylene	• Rigid moulded containers, jars and trays — heat stable so used for hot fills and *sous vide* • Flexible sheets for outer packages — e.g. biscuits
	PS — Polystyrene	• Insulating cups, trays and boxes (hot and cold) • Protective packaging
 OTHER	Includes all other resins and multi materials (e.g. laminates) able to be recycled from cars, aircraft and boats, furniture and electrical appliances	Major uses — agricultural piping, furniture fittings, wheels and castors, outdoor furniture, fence posts, pallets and marine structures

- low-density polyethylene (LDPE) — used in thinner flexible packages for cake and cereal box liners, shrink wraps, for example, **secondary packaging** holding multiple packages such as cheese wrappings together
- polypropylene (PP) — used for packing snack foods such as chips, biscuits, and 2-minute noodles.

Plastics are made by melting the raw materials of the plastic — for example, small pellets of PET — and forcing it out into the desired shape through a process known as **extrusion**. As the plastic cools, it becomes solid and holds its new shape. Sometimes composite plastics (called laminations) are made, where two different plastics are co-extruded and bonded together to create a new plastic that displays the properties the manufacturer needs to maximise their products' quality. For example, the breakfast cereal displayed on page 214 has an inner bag with a seal that separates easily and does not require scissors to open neatly. This bag, which is a co-extrusion of HDPE and another plastic, is slightly more expensive to produce and purchase, but the manufacturer feels that it helps maintain an impression of quality when consumers are using the product.

Laminations

Lamination involves the combining of two or more materials from separate reels that are stuck together with the use of an adhesive or heat. Most plastic packaging materials are laminations.

Retortable plastics are an example of laminated plastic packaging. The layers of plastic are extruded at the same time and held together with adhesive. The number of outer layers of polypropylene varies, depending on the food and how flexible the package needs to be. An impenetrable plastic such as ethylene-vinyl alcohol is used on the inside.

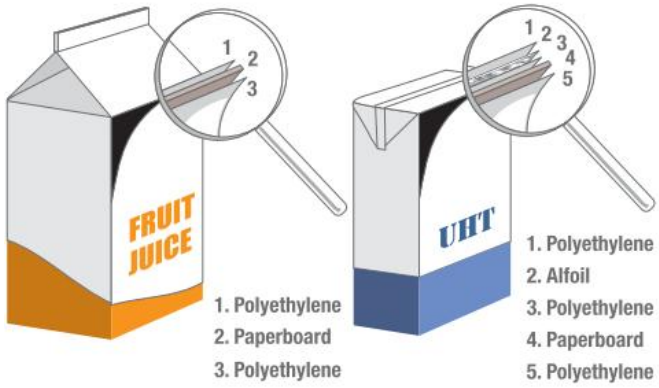
The shrinkable bags and film for **vacuum packing** are another example of laminates. The plastic must be able to shrink without cracking, and must be strong enough to prevent punctures (for example, punctures from bone-in ham). When modified atmosphere packaging and controlled atmosphere packing are required (see page 221), the laminates are made with three to 11 layers. These layers can filter or control gas, moisture and aroma, as well as provide strength and sealing requirements. Most common shrink film is made from polyolefin D-film, while the wrap used

to contain crisp rolls (called 'crispy wrap') is also polyolefin. Shrinkable film is used to hold together such items as six-packs of cans.

Different plastics are suited to different packaging styles and uses. Remember to look for the recycling symbol and recycle when possible. Sadly not all products have recycling information on the package — what reasons could there be for its absence?

Aluminium foils and laminations

Most of the foils used for packaging these days are made from aluminium. Foils are light, flexible and, depending on their thickness, strong and able to withstand and moderate variations in heat. They are used to create packaging for a variety of products such as trays for frozen pastry products; tubes for long-life products, for example, condensed milk; and product seals on heat-sensitive items such as yoghurt and butter. Foils less than 0.15 millimetres thick are quite weak and tear easily; for example, the foil wrap surrounding Cadbury 250 g blocks of chocolate. For this reason thin foil is usually combined with other materials such as plastic and paper to add strength and stiffness. This process is known as lamination. An example of this process is the muesli-bar wrapper, which uses paper, foil and plastic combined into the one wrapping material. The laminated packaging materials used to create packaging known as Tetra Paks are multilayered laminations or **composite packages**.



Laminations provide protection for both the product and the package. Get a Tetra Pak and try to peel the layers to separate the different packaging materials: each layer has been included for a different purpose. Think carefully about characteristics of each packaging material and see if you can determine why each of the layers has been included.

Metallising plastics is a process of coating a plastic film with a fine layer of metal. The benefit of metallising over foil laminating is that the metallising process can use a far thinner coat of metal. This makes the process cheaper, yet still results in good barrier properties, and gives an appearance somewhat similar to that of foil. The packaging used by most chocolate bars and potato crisp manufacturers is metallised plastic.

Other classifications of packages

Sometimes manufacturers use combination packages to contain their products. Combination packages consist of two or more separate packaging materials that function independently of each other. For example, breakfast cereal is packaged in an HDPE bag to protect against humidity and oxidation, and a paperboard box for ease of handling and marketing.

Manufacturers may also use multiple levels of packaging to protect their products. These are referred to as primary, secondary, and tertiary packaging. **Primary packaging** is the package in which the food is sold to the consumer. Some products are sold to the consumer with a secondary layer of packaging, for example, six tetra packs of juice sold as one unit; however, for most products the secondary packaging is the corrugated cardboard carton which holds multiple primary packages and makes handling within warehouses and stores easier. Tertiary packaging is used to secure multiples of secondary packaging for ease of bulk handling and distribution, for example, **shrink wrapping** of pallets.

REVIEW QUESTIONS

Remember

1. List the advantages and disadvantages of using the following packaging materials:
   - **a)** glass
   - **b)** steel cans
   - **c)** aluminium foil.
2. Why are some cans lacquered?
3. Describe the differences between rigid and flexible plastics.

Apply

4. Create a table classifying the different types of materials used to create food packages. In your table, state the name of the material, its recycling code number and its uses.
5. Why might a manufacturer choose to use a laminated paperboard rather than paper packaging for a product?
6. Explain, using examples, the difference between
   - **a)** composite and combination packaging
   - **b)** primary and secondary packaging.

Do an activity

7. List five food products that you use every day and analyse the reasons behind the manufacturer's choice of packaging. Suggest a possible alternative the manufacturers could have used and a reason for why they did not.

Current developments in packaging

The range and quality of foods available today is due in part to advances in packaging technologies. Packaging materials that have been around for centuries are being modified with new technologies to make them more environmentally sustainable. Other innovations in packaging extend the shelf-life of fresh foods, allowing the creation of a range of semi-processed, perishable foods whose production was not possible 20 years ago. Biodegradable packaging is also being developed and may become more prominent as a packaging material in the future.

Cans

Cans were developed as a packaging material in the eighteenth century and have been relatively unchanged in their basic concept. Steel alloys developed over the past ten years have allowed the production of cans with thinner walls (with thickness requirements reduced by 10 to 20 per cent). Thus ring pull lids became possible for products such as canned vegetables, fruits and soups. The shapes of cans have also altered, with moulded bases narrowing slightly so that cans may be stacked easily, reducing space requirements and costs in transport, storage and handling.

The process of canning has changed a great deal in the past twenty years with the introduction of the aseptic canning method. The cooked and/or sterilised product is placed in a sterilised can, then the air above the product is removed by a vacuum and the can is sealed.

Packages that modify the food's environment

A **modified atmosphere packaging (MAP)** has had the airspace around the food altered by the manufacturer so that the most ideal mix of gases maximises the shelf-life of the food. **Active packaging**, however, is able to alter the environment within the package as it changes during storage.

Modified atmosphere packaging (MAP)

For modified atmosphere packaging to be effective, a packaging material is needed that will not allow gases to pass through it once it is sealed. The atmosphere within the package can be modified in two ways.

1. The gases within the package are adjusted to provide a mix of gases that will maximise the shelf-life of the food it contains. The *air space* within a package is technically called the ***head space*** because in many packages it does not actually contain air. In the case of modified atmosphere packaging, a vacuum removes the air from the package and the head space is flushed with the gases required to maintain shelf-life before the package is sealed. This process is known as *gas flushing* and the gases commonly used include nitrogen and carbon dioxide, although sulfur dioxide is sometimes used to prevent discolouration in packages of dried fruit. Gas flushing with carbon dioxide extends the shelf-life of fresh meat from three to 21 days, and fresh pasta from three to 60 days (which is why it is often used by chefs and retailers when storing fresh products). Using high ratios of carbon dioxide to oxygen inhibits the activity of enzymes and microbes in fresh salad packs. Nitrogen can be used to replace the air in bags of potato crisps, thus preventing the oil reacting with oxygen to give an unpleasant (**rancid**) flavour. A combination of carbon dioxide (70 per cent) and nitrogen (30 per cent) keeps baked products fresh; for example, specialty breads such as tortillas, naan and roti. At times, the MAP also uses an active package to ensure that the correct gas mix is maintained.
2. The other form of MAP occurs when the air within the package is completely removed; causing the package to shrink tightly around the contents of food, and then the package is sealed. This process is called *vacuum (vac) packing* or *cryovacing* (after the company who manufactures MAP machines). Sometimes an active packaging material (such as the scavenger sachet, page 222) is used within the vacuumed package to ensure the removal of all traces of oxygen. Foods commonly sold using this form of modified atmosphere packaging include fresh pasta, organic dried fruits, cheeses and coffee.

Active packaging

Active packaging not only provides a barrier to outside influences, but can also control and react to the environment within the package. Fresh foods held inside a package are still biologically active, so they give off water and gases. The humidity in the container increases, which encourages microbial growth. Plant foods produce ethylene gas during their respiration which, if trapped within the package, increases the rate at which ripening occurs. Ripening also alters the gas levels within a package, reducing the amount of oxygen and increasing carbon dioxide levels. This change in the gases around fresh produce encourages anaerobic bacteria and the rapid rotting of food.

As stated, active packaging is able to modify the environment inside the package, maintaining the ideal environment to maximise the shelf-life of the food. Sometimes a sachet containing a chemical scavenger is used to absorb undesirable gases that can form as the product ages. Ethylene, oxygen or carbon dioxide scavengers can be used, depending on what is needed. The chemical agent can be incorporated into a packaging film which, when wrapped around the product, allows for the movement of specific gases and water in and out of the package.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) developed an active packaging film in 2000 that manages the environment created by plant

respiration. The packaging film was developed to assist Australian farmers, notably broccoli growers, in the export of their produce to Japan. Instead of flying the product to Japan so it stays in prime condition, the producers can send the broccoli by ship because the film-wrapped product will still arrive in a very good condition. The new packaging uses a semi-permeable polyethylene film impregnated with additives to surround the broccoli. The oxygen is let in and carbon dioxide is let out. The broccoli's respiration rate slows and the film absorbs ethylene. Products packaged in this film require refrigeration at 0–1 °C. Corrugated cardboard boxes containing the ethylene scavenger within the cardboard are also used in Japan.

Make a list of food products that may contain scavenging sachets or pads, and outline the likely reasons for their use. Visit your local supermarket and look closely at packages — observe which products include active packaging materials.

EXPERIMENT

Experimenting with packaging innovations

Syllabus outcome

Students learn to:

- investigate, through experimentation, the suitability of packaging materials for different food products.

Contributes to the following outcome:

- explains manufacturing processes and technologies used in the production of food products.

Aim

To determine the impact that modified atmosphere and active packaging has on the food they contain

Part A: Packaging innovations for minimally processed foods

Equipment

1 unused moisture absorbing pad (request from staff at a supermarket deli)
2 Styrofoam trays
4 small fresh chicken fillets, skin off
2 packets fresh salad mix
cling wrap
refrigerator

Method

1. Place the moisture absorbing pad on one of the Styrofoam trays. Place two chicken fillets on each tray and cover with cling wrap. Evaluate the chicken in terms of its colour, texture, aroma and signs of visible moisture. Store both trays in the refrigerator.
2. Create a small opening in ONE of the salad mix packets. Remove some salad leaves and evaluate their colour, texture, aroma and signs of visible moisture. Leave the other packet sealed till Day 10 as a 'control' package. Place both packets in the refrigerator.
3. Monitor both portions of chicken and the salad greens every second day to compare the signs of quality, and record your observations. Discard chicken when the signs of spoilage become too great. Monitor the salad greens for up to ten days. Then, on Day 10 open the sealed packet and compare the characteristics of the food inside with those from the packet opened on Day 1.

STORAGE RESULTS FOR CHICKEN FILLETS WITH ACTIVE PACKAGING AND SALAD GREENS IN MAP

		WITH MOISTURE ABSORBING SACHET	WITHOUT MOISTURE ABSORBING SACHET	VEGETABLES IN OPENED BAG	VEGETABLES IN SEALED BAG
Day 1	a) Colour b) Texture c) Smell d) Visible moisture				
Day 3	a) Colour b) Texture c) Smell d) Visible moisture				
Day 5	a) Colour b) Texture c) Smell d) Visible moisture				
Day 7	a) Colour b) Texture c) Smell d) Visible moisture				

(*continued*)

STORAGE RESULTS FOR CHICKEN FILLETS WITH ACTIVE PACKAGING AND SALAD GREENS IN MAP					
		WITH MOISTURE ABSORBING SACHET	WITHOUT MOISTURE ABSORBING SACHET	VEGETABLES IN OPENED BAG	VEGETABLES IN SEALED BAG
Day 10 (or day discarded)	a) Colour b) Texture c) Smell d) Visible moisture				

Part B: Packaging innovations for highly-processed food products

Equipment

2 packets of bread products containing an oxygen scavenging sachet, e.g. tortillas or naan bread
2 packets of dried products containing a moisture scavenging sachet, e.g. dried mushrooms or nori (seaweed) wrappers
2 packets potato crisps

Method

Create a small opening in ONE of each packaged product. Store them in a cool, dry place out of direct sunlight. Leave the other packets sealed until Day 10 as the 'control' packages. Assess changes in the quality of the opened packets at regular intervals over a ten-day period.

STORAGE RESULTS MAP AND ACTIVE SCAVENGING SACHETS IN SELECTED FOODS				
		MAP – CRISPS	ACTIVE – TORTILLAS	ACTIVE – DRIED
Day 1	a) Colour b) Texture c) Smell d) Signs of microbial activity			
Day 4	a) Colour b) Texture c) Smell d) Signs of microbial activity			
Day 7	a) Colour b) Texture c) Smell d) Signs of microbial activity			
Day 10	a) Colour b) Texture c) Smell d) Signs of microbial activity			
Control packages Day 10	a) Colour b) Texture c) Smell d) Signs of microbial activity			

Conclusions

1. What causes of food spoilage are food manufacturers aiming to control when using the above styles of packaging?
2. Were the packaging materials effective in controlling these causes of spoilage?
3. Were the results as you expected? If not, what could have caused the differences to occur?

Sous vide

The ***sous vide* process** (sometimes called the cook–chill process) started off as a catering system in hospitals, nursing homes and restaurant chains. The perishable food was cooked, rapidly chilled, vacuum packed and stored at a low temperature (0–3 °C) to extend its shelf-life for several days, or frozen until needed. When required, the bag was placed in boiling water for reheating. The packaging material was polyester film because it was able to withstand freezing as well as the heat of reheating. However, it was not biodegradable.

The process has been improved and *sous vide* products are now available to the general consumer. Cooked foods are still vacuum packed then blast chilled to 3 °C, but the actual materials used have been improved. The use of polypropylene, nylon and polyethylene laminates means the

prepared foods have a shelf-life of six weeks. High quality 'close to fresh' products are available to consumers and the hospitality industry in retortable plastic pouches.

Sous vide saves time and labour costs for the hospitality industry. Why not try some *sous vide* products and compare their taste to UHT or canned varieties?

The advantages of *sous vide* for consumers are obvious. The package is:

- easily opened
- lightweight
- low in cost
- transparent
- easily stored
- used when reheating the food.

Packaging innovations

Research into new packaging technologies is a long and expensive process. In order to make new packaging cost effective, it must be able to be used for a range of food products. The cost of research and development needs to be passed onto consumers by adding it into the cost of the product. For this reason, Australian consumers are often behind the rest of the world in their access to innovations — even technologies developed here may be utilised overseas first so that the company may recover their costs in the larger markets of Europe, Asia and the USA.

Biodegradable packaging

Research is underway globally to create new biodegradable packaging materials from a variety of organic products. Researchers have been successful in developing bioplastic trays and films from corn and wheat starch. The ethics of growing food crops for packaging (and other purposes such as ethanol for fuel) is currently being questioned around the world. Some snack food companies in Australia are using cornstarch trays to hold their confectionery and biscuits, and more companies may adopt this innovative packaging form in the future.

Companies overseas have developed packaging trays using cellulose residues from agricultural production, such as cotton residue, rice straw and oil palm production residue. The materials used in creating these packages are leftovers from the harvesting of crops. Food crops are not planted and harvested solely to create this form of biodegradable packaging. These trays are currently used with organic vegetable produce in some Australian supermarkets.

Intelligent packaging

Intelligent packaging is able to respond in some way to the changing conditions within the package. For example, a New Zealand-based company has developed a smart labelling system that advises consumers on the ripeness of fresh fruits within the package. The ethylene gas given off by fruit as it ripens reacts with a component in the packaging label, altering its colour. A colour guide on the front of the package tells consumers what level of crispness the fruit inside should have, when the label shows particular colours.

A similar system has been developed in Europe to advise customers on the freshness of packaged seafood. As seafood spoils, its odour increases as proteins are broken down. Consumers are alerted to the fact that the quality of the seafood is lowered, as the seafood ages, when the pink colour of the chemical sensor in the package becomes brighter.

Another current trend in packages is the use of radio waves to transmit information about a product to a computer. RFID (radio frequency identification) technology is currently used to provide information about bulk packages. RFID tags storing information about product codes and handling requirements are placed into cartons or pallets containing food products and act as a database for the product. Some tags are able to also collect valuable information about the product; for example, registering the temperature and times at given intervals. The silicon chips in RFID tags can be read by radio waves and do not need to be directly scanned in order to access their information, making handling and distribution processes more efficient. In the future it may become viable to include these tags in individual products, allowing consumers with internet-linked refrigerators to be advised when products are nearing their use-by dates and need reordering.

Another packaging innovation being developed in Europe is intelligent tamper-proof packaging. Designers hope to create a packaging that irreversibly changes colour when the light or gas mix within the package alters — the colour change would alert customers that the seal on the food has gone or that attempts had been made to open or pierce the package.

Packages providing greater levels of convenience

The range of innovative packaging designed to assist consumers is ever-increasing. You may see products in your supermarket that are in self-heating or self-chilling packages. Easy-opening packages have also been developed and researchers are looking into alternative packaging designs and materials that will be easier for people with limited dexterity, flexibility or strength to open. So far developments have been made in low peel-force adhesives and packaging structures.

CASE STUDY

Packaging innovations

If you like chocolate, you may well have eaten Lindt Lindor Balls before. Lindor Balls require various layers of packaging to protect the product during distribution and storage. The balls are held in a moulded plastic tray made from the recyclable material PET. In an effort to alter their environmental footprint, Lindt has begun using fully biodegradable trays in their department store range of Lindor Balls. The trays are manufactured from corn starch by Plantic Technologies Limited, and Lindt displays the Plantic logo on the base of the package.

The corn starch material is water-soluble and will dissolve when disposed of in landfill. Lindt will assess the cost and viability of Plantic trays before introducing them into other product lines. So, next time you are in a department store and see Lindt Lindor Balls with a Plantic logo, treat yourself to a box and discover the mysteries of the packaging, as well as the chocolates!

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *innovations in packaging technologies* to complete the tasks ahead.

1. The trays holding Lindt Lindor Balls were previously made from a recyclable packaging material. Why might the company have perceived that they needed to change to a biodegradable packaging material?
2. **a)** What is the Lindt Lindor Balls biodegradable packaging made from and how long does it take to degrade?
   b) Under what conditions will this type of packaging degrade?
   c) Lindt are using this packaging with their Lindor Balls product range. Would it be a suitable packaging material for any confectionery product?
3. The corn starch used to make biodegradable packaging is from a crop grown specifically for the production of packaging rather than food. Analyse the advantages and disadvantages of this practice, and evaluate the sustainability of biodegradable packages such as the ones Lindt are using.
4. Log in to **www.jacplus.com.au** and locate the *Packaging innovations* weblink for this chapter. Each year the Packaging Council of Australia awards innovation in packaging design. Open this weblink to browse through the range of food packaging nominated for environmental sustainability awards. Select three products featuring different styles of innovation, and evaluate the impact you think such innovations will have on the environment.

eBook*plus*

Weblink

CASE STUDY

Pick me!

A product either grabs your attention or it doesn't. Mark Green, an award-winning food package designer says, 'I've always looked at package design as the billboard on the highway of grocery store aisles … You have about three seconds to communicate "pick me up and buy me" to busy shoppers.' Recent winner of the Amcor Design Innovation Award was Visy Industrial Packaging and Nestlé Australia Ltd for their new product Nescafé Short Black. According to the judges, keeping it simple is the basis of good design and it's not only about visual appeal. This product makes you want to pick it up; it's great to feel and also features the latest in technology, being made from flexible polypropylene giving it a snap-on and -off seal. It's also easy for the consumer to grip and rates highly in terms of on-shelf stackability. And, as if that wasn't enough, the designers have also managed to give the product an air of mystery with the dark tinted glass, encouraging consumers to at least trial the product out of curiosity. We can all feel secure in using the product too because a paper seal is placed on the side of the lid making it tamper free.

OUTCOME TASK | **RESEARCH ASSIGNMENT**

Students learn to:

- investigate, through experimentation, the suitability of packaging materials for different food products.

Contributes to the following outcomes:

- explains manufacturing processes and technologies used in the production of food products
- evaluates the impact of food manufacture on the individual, society and environment.

Carefully consider the article on page 225. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food packaging* to complete the tasks ahead.

1. 'Food packaging is really just there to contain the product and keep it from spoiling.' Comment on this statement in relation to the information regarding Nescafé Short Black.
2. Try your hand at designing a package and label for a cake mix. The manufacturer intends to launch this new product containing a sachet of real fruit that can be added to the cake when it is being made. You can choose from the following flavours: Blueberry Ripple, Tropical Hawaiian, Orange and Mango or Blackcurrant Swirl.

   Begin by conducting a survey of cake mixes on sale in the supermarket. Take note of the packet size, net weight, packaging types and materials, and serving size.

   a) From the information you have gathered and the information in this book, design a package and label that will meet all the necessary legal requirements. Make sure that the type of package you choose is suitable for the contents of the cake mix.

   b) Compare the package you have designed with cake-mix packets already on the market. What features of your package would encourage a consumer to pick your product over the others available? What other advantages do your package and label have over those of the existing cake mixes?

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Additional case study

Weblink

Storage and distribution during food manufacture

Storage in food manufacture takes place:

- after raw materials arrive at the factory — for example, controlled atmosphere storage of fruits and vegetables, and dry storage of flour for baking
- when a product is held while it changes — for example, bread dough rising or wine fermenting
- after the final product has been packaged but before it is distributed (sometimes called warehousing).

Storage conditions during food manufacture include: cold storage where the raw material or food product is kept at temperatures of 0–5 °C; freezer storage where food products are kept at –18 to –30 °C; and dry storage where foods are kept at room temperature (below 24 °C) with the humidity controlled. Exposure to sunlight should be avoided in all storage conditions. (See pages 49–51, chapter 3, for more detailed information.)

The container used to hold the product or raw material during storage depends on the product, what is happening to it at the time, and the scale of production. Ingredients to be used in manufacture are usually stored in large stainless steel vats or **hoppers** after delivery to the factory. Stainless steel is used because it is strong and inert (that is, it does not react with the food). Smaller quantities of ingredients are stored in plastic containers. No glass is used for storage in food manufacturing because of the danger of breakages.

To illustrate the process of storage and distribution, let us take the example of a can of tomatoes.

After harvesting, the tomatoes are placed in bulk pallets and stored in refrigerated conditions while waiting to be delivered to the food manufacturer. Transport of the tomatoes to the manufacturing site is also under refrigerated conditions. This ensures that tomatoes do not ripen any further. The food manufacturer, on receiving the tomatoes, may also place them in a cool room to await processing. Once the tomatoes are cooked and canned, they are no longer in danger of spoilage from hot conditions and, therefore, can be stored at room temperature in the warehouse.

After processing, the cans are packed into a carton which may contain a dozen cans. Cartons enable cans to be moved in multiples rather than individually. They reduce the floor space needed, and allow for easy stacking of the product. The product is then moved into the manufacturer's warehouse. To make transportation easier, the manufacturer places a number of cartons on a pallet and finally shrink wraps the load to stabilise and protect it.

Manufacturers often have very little storage space for products in their factories. They manufacture products 'just-in-time' for them to be collected and distributed to warehouses. The **distribution** of a product refers to the movement of goods once the product has undergone the required processing. Packaging is an important consideration when choosing the method of distribution. For this reason, the shape of the finished product container is

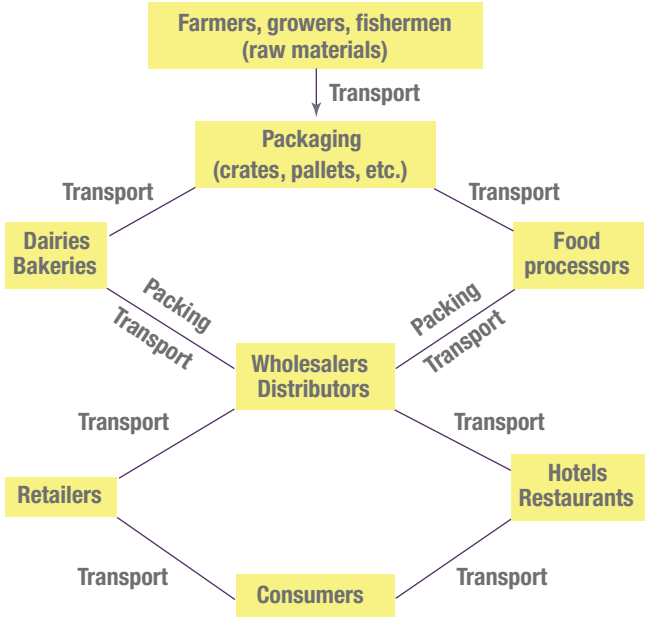
important. During warehousing, transport and distribution, empty space costs money. Putting round tins into a square carton, for example, wastes more space than putting square boxes into a square carton. Secondary and tertiary packaging are important in preventing damage to the product's primary package, and in making the handling of the product during distribution easier.

Transport and distribution after manufacture

From the central warehouse, the manufacturer sends the canned tomatoes to food wholesalers, supermarket chains or interstate warehouses by rail or road transport.

Food distributors, wholesalers or warehouses for food chains need to be able to handle goods efficiently, so they demand packaging that suits the system used in their warehousing operations. The packaging must be able to stand up to the handling involved in physical distribution so that losses resulting from damage are minimised. Damage results from poor packaging and other inadequacies in the movement of goods, particularly horizontal and vertical damage involved during transport (see page 213).

In the warehouses the cartons are removed from the pallets and regrouped to make up orders for individual stores. This exercise may involve remaking a pallet from cartons from several different manufacturers. The product is then delivered to the supermarket or store where the cartons are opened and the cans are displayed on the shelves.



The movement of manufactured food from the producer to the consumer is called the 'food manufacturing chain'. Appropriate packaging is essential for the safe storage and handling of all items. Keep in mind that the consumer at different stages along this manufacturing chain may be another manufacturer or commercial processor.

REVIEW QUESTIONS

Remember

1. Define the following terms to show how they are different:
   - **a)** storage
   - **b)** handling
   - **c)** distribution.
2. Identify the three main storage environments for food, and state the temperatures at which each operates.
3. What is a warehouse?

Apply

4. What are pallets? Why are they used for food storage and distribution?
5. Some manufacturers produce foods 'just-in-time'. Explain what this means and identify advantages and disadvantages of this manufacturing practice.
6. Why would manufacturers send their products to a distribution warehouse rather than sending them directly to supermarket venues?

Do an activity

7. Using a company you have researched or visited, or from a video shown at school, prepare a report analysing the company's processing techniques and equipment, major packaging selections, storage facilities and distribution systems.
8. Design and create a package to contain and protect three raw eggs if they were to be dropped from a height of 2 metres. Test your designs in a class challenge.

Japan is the home of an innovation in food manufacture: the square watermelon. A Japanese farmer realised that he could solve the problem of difficult to cut watermelons and maximise space in the fridge by manufacturing square watermelons.

Implications of recent trends in food packaging, storage and distribution

There is no doubt that advances in food packaging, storage and distribution have meant that foods have a longer shelf-life and food safety and availability has improved — but is it all good?

TABLE 11.4 Recent uses of technology in food storage and transport

INNOVATION	EXAMPLE
Improvements to refrigerated transport of food	The Smart-Trace™ card is a cost-effective and disposable tag used for sensing temperature conditions during transport. This data logger is available to cargo owners virtually straight away.
Radio frequency identification (RFID) is used to help track products in a warehouse. The theory is similar to the use of a barcode but there is no need to site the barcode first in order to read it. This eliminates the problem of misplaced boxes in overcrowded warehouses.	These tags are now being used in Australia to track sheep and also to track shipping containers.

TABLE 11.5 The implications of improved storage and transport

TYPE OF IMPACT	ADVANTAGES	DISADVANTAGES
Environmental impact	Proper storage facilities and improved transportation could be said to reduce food wastage as food can now be stored correctly for longer periods than ever before.	Only 30 per cent of the food in NSW is produced in NSW. The trend towards sourcing food from near and far means that food can be transported long distances and it is this transportation that can be detrimental to the environment. This is sometimes referred to as **food miles**, which measures the amount of fossil fuel used to transport food from where it is grown to where it is eaten.
Social impact	Improved storage and transport facilities help to ensure there is food available in our supermarkets all year round and that it is in reasonably good condition when it arrives in the stores.	Some say improvements in the storage of food products mean that food is stored too long. Reports in the media point to apples months old before we eat them.
Economic impact	Delivering food which is not bruised and battered to stores in a fit condition is crucial as it ensures that there is an actual product to sell.	New technology such as data loggers only adds to the cost of the final product.

TABLE 11.6 The implications of food packaging

TYPE OF IMPACT	ADVANTAGES	DISADVANTAGES
Environmental impact	The National Packaging Covenant provides a code of practice and guide for managing the impact of packaging on the environment. Packaging reduces wastage as it prevents food from spoiling quickly. Some companies such as Visy (a packaging and recycling company) have developed 100 per cent recyclable and biodegradable food packaging.	At the moment, intelligent or interactive packaging is not biodegradable.
Social impact	Food that is fresher with a longer shelf-life	Lack of interest in preserving food at home
	Packaging, especially tamper-proof packaging, helps keep food safe to eat.	Packaging is a health and safety issue. According to Environment Victoria, 8000 children are treated annually in public hospitals for injuries suffered from littered glass. Packaging is also a threat to marine life when marine creatures become entangled in packaging.
	Convenience — packaging is used to contain foods and it is convenient that consumers are able to quickly purchase products that will not spill or spoil before they consume them.	Reliance on packaging and addiction to wrapping everything, including school lunches in plastic

TYPE OF IMPACT	ADVANTAGES	DISADVANTAGES
	Packaging provides consumers with the information they need about what is in the food they buy.	Packaging is used as a vehicle to advertise the product, enticing consumers to buy food products they may not need or that are not good for them.
Economic impact	Packaging serves the purpose of protecting the product so that it is fit for sale and has a longer shelf-life. Both of these factors affect company profits.	Packaging adds to the cost of the food. *Food Science Australia* estimates that packaging adds about 25 per cent to the cost of food.

Ethical issues:

- Packaging impacts on the environment and is a moral issue if you consider that we need to preserve our environment for future generations. Packaging contributes to deforestation and pollution, caused by the waste created when packaging is disposed of.
- Packaging may entice the consumer to buy products they may not need.

REVIEW QUESTIONS

Remember

1. List three new innovations in food packaging and describe the environmental, social and economic implications of these new innovations.

Apply

2. Give examples of how technology has been used to advantage in the food storage and transport industry.

Do an activity

3. Log in to **www.jacplus.com.au** and locate the *Food miles* weblink for this chapter. What are food miles? Discuss whether producers should be made to state the food miles on the label of their products.

Weblink

CHAPTER 11 SUMMARY

- Packaging has five major functions — to contain, protect, preserve, inform/market the product, and provide convenience to consumers.
- Manufacturers consider a wide range of factors when selecting packaging for a new food product, ranging from the physical characteristics of the food and the factors that will hasten loss of quality, to the production facilities and the image of the product that the company wishes to portray, as well as economic and environmental factors.
- There is a range of packaging materials available, each with its own strengths and weaknesses, that must be evaluated in terms of the individual product requirements.
- Technological developments in packaging have brought about huge changes in the variety of foods available to consumers. Many of the current developments focus on maintaining the physical quality of fresh foods and extending their shelf-life.
- Modern packages often involve the creation of new packaging materials through laminations or the inclusion of a specific substance into the packaging mix. The packaging materials created increase the options for processing and distribution available to manufacturers.
- Packaging technologies will continue to develop, providing a constant range of new product features for consumers.
- The safety of consumers in relation to packaging and labelling is ensured by several laws.
- Storage considerations apply to all stages of the food manufacturing process — from the time food is harvested, during processing, transportation and distribution, to when consumers purchase and use it. Therefore the packaging requirements of the food also change throughout these different stages. Appropriate packaging is essential for the maintenance of quality and minimisation of waste.
- Emerging technology in the food transport and storage sector include more-efficient refrigerated transport and better ways of tracking food such as Radio Frequency Identification.
- Recent uses of technology in food packaging include: packaging that is part of the product (for example, Sippah straws), nanotechnology, experimentation with new materials such as metallocene polymers, and improvements in biodegradable packaging.
- Nutritional claims may be made on labels so long as they are true, but health claims are subject to more stringent regulation.

KEY TERMS

active packaging
aseptic
composite packages
distribution
enzyme
extrusion
food miles
head space
hoppers
inert
laminated
microbial
modified atmosphere packaging (MAP)
pasteurisation
primary packaging
rancid
secondary packaging
shrink wrapping
***sous vide* process**
sterilisation
vacuum packing

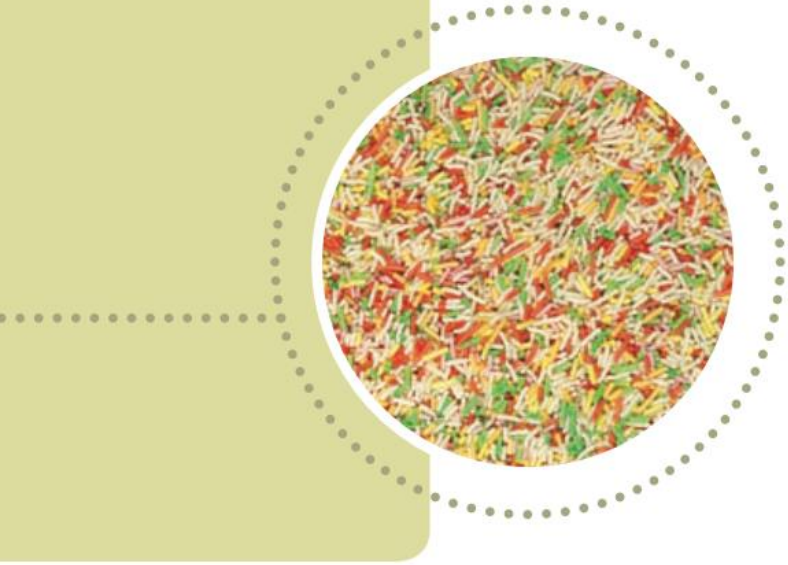
Chapter 12
Food manufacturing and consumers

We live in a society where we rely on other people to provide us with the food we need, packaged attractively and hygienically, and in a form convenient for our use. While food manufacturing makes our lives easier; it also has a huge impact on the environment, our lifestyle and our health. We hear a lot about the need to live more sustainably and to recycle more. But consumers are only part of the process — manufacturers must also take positive action to minimise the impact of their practices at all stages of design, production, packaging and use of their products.

In this chapter you will learn about:

- environmental issues, e.g. waste management, packaging practices, production techniques
- social implications, e.g. lifestyle changes, employment opportunities
- nutritional implications
- appropriate use of technology
- commercial practices in terms of a company's response to the environment movement.

We enjoy the convenience of manufactured foods, but it leaves us with rubbish that needs to be disposed of carefully. Many people are careless with their handling of packaging materials and not only does the waste damage our environment, it wastes a valuable resource that could be re-used.



Impact of food manufacturing technologies on the environment

Packaging practices

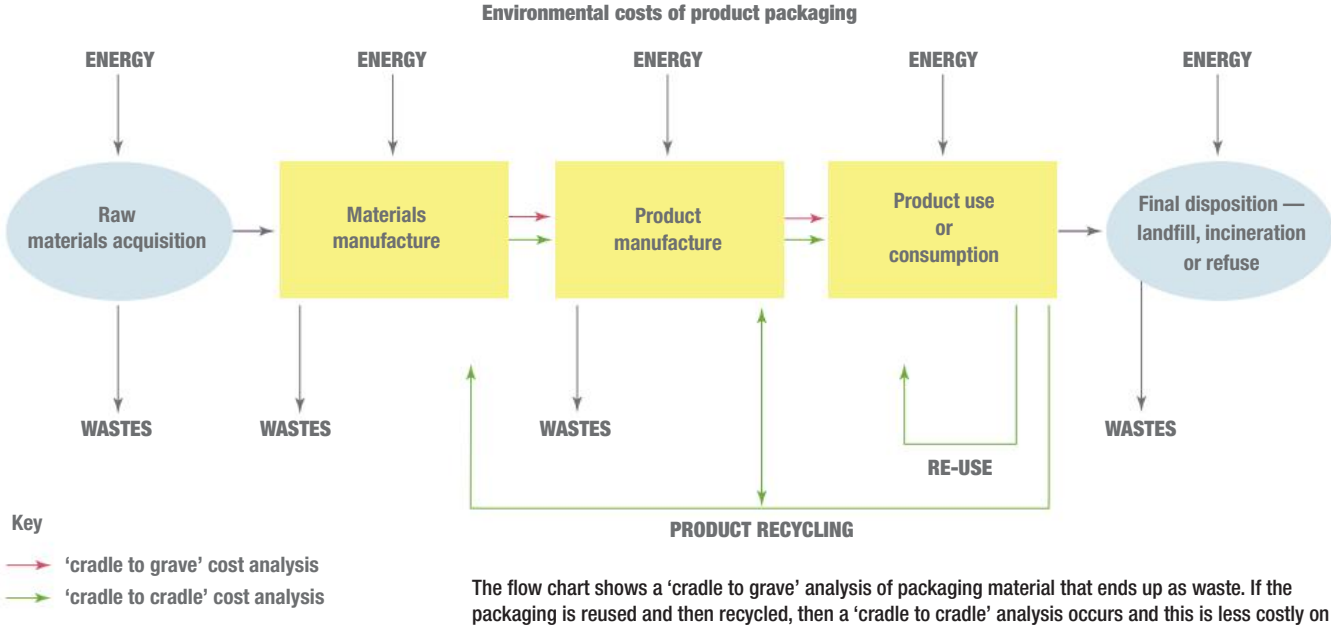
Packaging provides protection for the product, convenience for the consumer and a marketing opportunity for the manufacturer. But another factor in the choice of packaging is its effect on the environment. The flow chart below illustrates how energy and time are spent in making, handling, re-using, recycling and disposing of packaging materials. The manufacturer factors these expenses into the final price to the consumer.

Some people feel that recycling will save us from too much landfill; for example, many people believe glass containers are economical and environmentally friendly packaging because they can be re-used. A 'cradle to grave' cost analysis shows that large amounts of energy are used to shape the glass containers and handle their heavy weight. Recycling of broken glass does save some energy, but a lot of energy is used in shaping the bottle. The more energy used, the more carbon dioxide is produced and the greater is the damage to the environment through the greenhouse effect. Glass containers have to be re-used ten times to be as environmentally friendly as laminated or plastic packaging.

To respond to environmental concerns and to cut costs, food manufacturers are now using lighter and more environmentally friendly packaging. The environmental cost of glass containers was especially important to Coca-Cola, because the feel and shape of the bottle was an important product symbol. But the Coca-Cola bottle is expensive to produce and handle, so Coca-Cola has had to use cans and plastic bottles to be competitive. The company re-designed the Coca-Cola name so the curve associated with the shape of the classic bottle can be symbolically associated with Coca-Cola packaged in cans and plastic bottles.

If the packaging of a particular food satisfies the Australian Food Standards, the manufacturer can choose the packaging materials and shape. Numerous environmental package design checklists are available to assist with these choices.

The government's National Packaging Covenant explains specific requirements for manufacturers to become more environmentally accountable. When these requirements are examined along with the environmental design considerations, a useful and responsible type of package can be created.



The flow chart shows a 'cradle to grave' analysis of packaging material that ends up as waste. If the packaging is reused and then recycled, then a 'cradle to cradle' analysis occurs and this is less costly on the environment. Think about the handling of packaging materials in your household — do you encourage a 'cradle to cradle' use of packaging materials?

Environmental design considerations

The following Environmental Code of Practice for Packaging design can be applied to any product's packaging. Practise your evaluation and critical analysis skills by applying this Code to a variety of food packages. Develop your compare and contrast skills by recording your evaluations in a written response.

COMPOSITION

Is the package a composite of more than one material?

Are the inks, lacquer coatings and varnishes solvent based, UV cured or water based?

PROBABLE SIZE OF MARKET

What effect will the market size have on the litter stream?

Is the existing market currently met by other packages, or is the market entirely new?

DESIGN CHANGES

Has the distribution been designed to take into account energy use during transportation?

AVOIDANCE

Can overall packaging volume be reduced by using a different package or container?

Does a product or package change cause an increase in solid waste in other areas (for example, an increase in the amount of food spoiled)?

RE-USE

Can the package or any of its components be designed to be safely re-filled or re-used by the consumers?

Can it be re-used by the manufacturer for the same or similar purpose?

RECYCLING

Does the technology exist to collect packaging from consumers and recycle it commercially?

If so, is there an established system for collection?

DEGRADABILITY

Is the package technically biodegradable or photodegradable?

Will degradability produce any by-products which are harmful to the environment?

DISPOSAL

Can the energy content of the package be recovered by incineration?

Has the package been designed to be easily compressed prior to disposal to minimise its volume to landfill?

TABLE 12.1 Positive and negative food packaging practices

POSITIVE PRACTICES	HOW PRACTICE AFFECTS THE ENVIRONMENT
Major glass manufacturers recycle glass to make new products.	• Use of fewer raw materials • Reduction in landfill
Many plastic bags are resealable.	Use of less plastic film to rewrap products once they are opened
Lightweight plastic is being used instead of glass for packaging foods such as honey and peanut butter.	• Ability to recycle plastic • Less energy required to make plastic than to make glass
Tetra Pak laminates can be recycled: the cardboard portion is repulped and used for household papers, and the aluminum and polyethylene layers are returned to the suppliers.	• Production of less air and water pollution during processing • Use of less energy in production, distribution (because packaging is lightweight) and waste handling
NEGATIVE PRACTICES	**HOW PRACTICE AFFECTS THE ENVIRONMENT**
Food manufacturers continue to overpackage items.	• Increased landfill • Need for more resources to produce extra layers of packaging
Foods are prepackaged. In this situation, the consumer may find it hard to judge the quality and quantity of food. Further, more packaging materials than necessary are used — for example, putting mushrooms in a recycled paper bag is better than using a shrink-wrapped, Styrofoam tray.	Food wastage (because the consumer may not be able to use all the product before it goes off)
The packaging may be too large for the product it holds. Some foods, such as MAP snack foods (e.g. corn chips), have a great deal of **head space**.	Wastage of more packaging materials and resources creating them

Production techniques

Consumers expect food companies to promote ecological sustainability — that is, to use the least amount of natural resources necessary to make their products, and to replenish these resources in whatever ways possible for future generations.

The production requirements of the food industry also impact on the agricultural sector. Farmers, orchardists and other producers on the land grow the varieties of produce they will most readily sell. This limits the natural diversity of plant species, as well as limiting consumer options in the **marketplace**; for example, until recently there was only one variety of pineapple available in fruit markets because the majority of pineapple producers had planted that variety — the one required by Golden Circle for their canning operation. Similarly, there are many different varieties of tomatoes but only a few species are grown commercially — the ones with a bright red colour, firm flesh and skins which are easily removed.

The design of a product must also be considered in terms of its impact on the environment. All products will generate waste in their production, but the amount of waste created must be considered in terms of ecological sustainability before a commitment is made to manufacture the product. Manufacturers seeking a competitive sales edge often redesign an existing product into a new style, hoping to capture consumer interest through producing an original novel product. Ideally the wastes generated during production will become the raw materials in another product. This process of waste minimisation during production is common within the hospitality industry, where, for example, misshapen strawberries that are not suitable for a fruit platter or dessert are puréed for use as an ingredient in ice-cream or sauces.

Curly fries are available in some chain food outlets as a novel variation on regular potato fries. The method of production requires vast quantities of raw potatoes and generates huge amounts of waste as a whole potato is used to make just one curly fry. If your school has a spiral garnishing tool, your teacher may be able to demonstrate the basics of curly fry production. What foods could the potato waste be used to create? What processing steps would the manufacturer need to include to ensure the potato waste was of a suitable standard for use in another food product?

The food manufacturing industry tends to sell its waste ingredients on to other companies. Without adequate processing steps and controls, however, the waste produced during manufacture may not be suitable for another food manufacturer as a raw material, and the waste is then sold on to manufacturers of animal feeds.

REVIEW QUESTIONS

Remember

1. What is the difference between packaging 're-use' and 'recycling'? Which is better for the environment? Why?
2. Outline ways manufacturers have tried to modify the design of their product packages to have less of an impact on the environment.
3. Explain why food manufacturing is so costly in terms of its energy use.

Apply

4. Suggest ways in which food manufacturers may minimise the impact of their processing practices on the environment.

Do an activity

5. Design an environmentally friendly package for a food or beverage which fulfils the Environmental Code of Practice for Packaging. Label the main features of the package, including the packaging materials used, and highlight how they fit the Code.
6. Debate the topics: 'Consumers should pay more for food and beverages in glass packaging' and 'It is unethical for food manufacturers to design and produce products that generate a large amount of waste'.

Waste management

Many large cities do not have land nearby that is suitable for landfill. Such cities contract neighbouring towns to dispose of their waste. The garbage is trucked, shipped or railed to its final destination.

One of the world's leading environmentalists, David Suzuki, said 'We have used the land, the air and the water as our garbage dump, and the dump is full.' Try the following experiment to learn how much waste we can create from even the most simple food processing.

In the home, we discard large amounts of skin, trimmings and other inedible portions of food in the garbage. Similar waste occurs in large volumes in food manufacturing companies, but it is economical to use such large amounts to make other products. Cattle and poultry feed, fertiliser, pet food and composting material are all by-products of food manufacture (see table 12.3 on page 237).

In the ideal situation, food would be completely used or recycled, and there would be no need for waste removal and waste water treatment.

Nature has its own waste management system. Water is recycled, as are carbon, nitrogen and phosphorus. Trouble occurs when we overload the natural system's ecological balance. Industry has developed **biodegradable** wastes that are not harmful to the environment in the long term.

EXPERIMENT

Measuring waste from vegetable and fruit preparation

Most fruits and vegetables have some parts removed before being cooked and eaten, and the amount of waste varies according to the type of fruit or vegetable.

Syllabus outcome

Students learn to:

- analyse the impact of food manufacturing technologies on individuals, groups and society.

Contributes to the following outcome:

- evaluates the impact of food manufacture on the individual, society and the environment.

Aim

To determine the amount of waste in the preparation of potatoes

Equipment

1 kilogram of unwashed, old potatoes
scales
2 knives
2 vegetable peelers
2 scrubbing brushes
stopwatch

Method

1. Divide the class into two groups.
2. Separate the potatoes into two equal portions. One group will peel the potatoes with a peeler while the other group use a knife.
3. Each group needs to weigh the unwashed potatoes and record this weight.
4. Both groups wash and scrub the potatoes to remove all dirt. Dry the potatoes, then reweigh. Record this weight.
5. One group remove the peel and any blemishes on the potatoes, using only the peeler. Save all the scraps for weighing, and record the time taken to use this peeling technique.
6. The other group repeat step 5, using the knives. Again, weigh the scraps and record the time taken.

Results

Record your results in a table similar to the one provided below:

WEIGHT OF POTATOES BEFORE SCRUBBING	WEIGHT OF POTATOES AFTER SCRUBBING	WEIGHT OF PEELED POTATOES	WEIGHT OF PEELINGS	TOOL USED	TIME TAKEN
Group 1					
Group 2					

Calculate the percentage of potatoes wasted by each method, using the following formula.

$$\frac{\text{weight of washed potato} - \text{weight of peeled potato}}{\text{weight of washed potato}} \times \frac{100}{1} = \% \text{ waste}$$

Conclusions

1. Which method of peeling gave the best yield (the lowest proportion of waste)?
2. How does this compare to the wastage found with some other vegetables (as shown in the table below)?

TABLE 12.2 Wasted proportion of fruit and vegetables during preparation

FRUIT OR VEGETABLE	% WASTE
Broad beans	75
Peas	60
Bananas	40
Cauliflower	30
Oranges	25
Brussels sprouts	25
Apples	20
Potatoes (old)	14
Potatoes (new)	3
Carrots	14

3. Which method resulted in the greatest proportion of waste? Why was this the case?
4. Which peeling method was the quickest? Do you think this is a useful measurement to make? Give reasons for your answer.
5. Why is there such a great difference in the percentage of waste between old and new potatoes?
6. Can you think of a way to reduce the amount of waste caused when peeling potatoes?

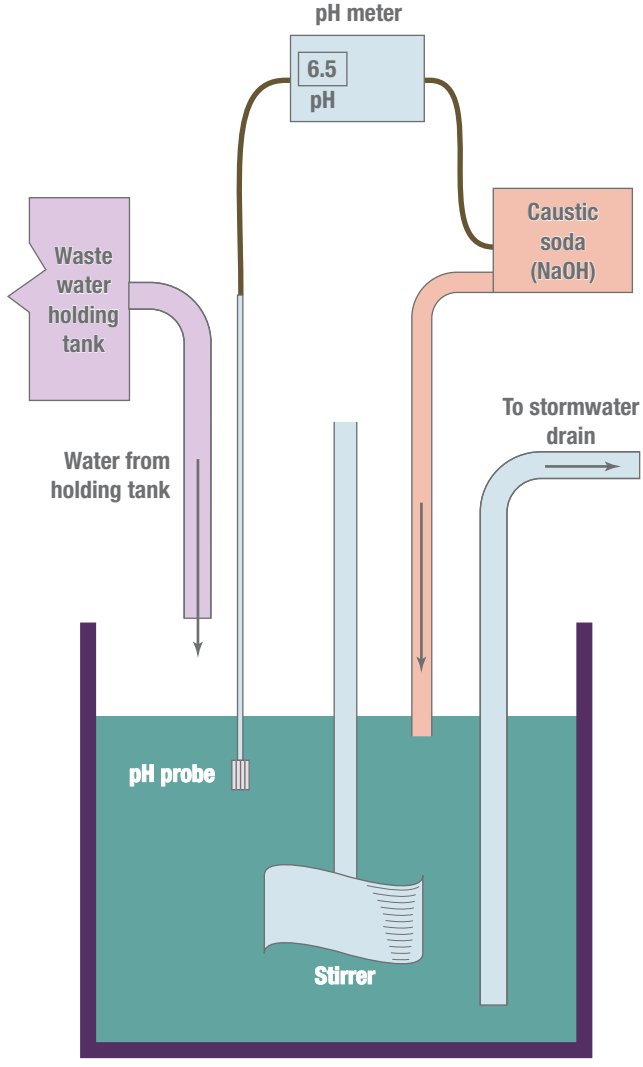
TABLE 12.3 **Typical by-products created from the processing and packaging of food**

FOOD CATEGORY	PROCESSED PRODUCT	WASTE GENERATED	APPLICATION OF WASTE
Fruit	Orange juice	Peel	Cattle feed
Vegetables	Canned or frozen corn Frozen peas	Husks and cobs Pods, stalks	Cattle feed Fertiliser
Meat	Vacuum-packaged beef	Trimmings	Pie and hamburger manufacture
Fish	Frozen fillets	Heads, viscera	Fishing bait Pet food ingredient
Poultry	Frozen chickens	Heads, viscera Feet	Poultry feed Gelatine
Nuts	Packaged peanuts	Shells	Mulch for mushroom growing; fertiliser ingredient
Vegetable oils	Cooking oils, margarine	Seed husks	Animal feed

Most food wastes are considered to be biodegradable, but when these wastes are gathered from hundreds of industries and discharged into a small area such as a tip, nature has trouble dealing with it. The ecological balance will be upset, and the situation could become irreversible if this concentration of waste continues.

We can help with waste management by recycling as much material as possible.

Waste management involves controlling possible pollutants that may occur on a production site. The drainage layout of a site affects the tasks that can be completed in an area. The above signage and coding of drainage systems was relevant to a cooking oil production plant — trucks containing oils for refining were not allowed in any areas where blue drains existed in case of accidental damage to the nearby river.



The diagram shows a simple waste water treatment facility for treating waste water on-site. Manufacturers are responsible for managing the by-products of their processes to minimise the effect on the environment.

EXPERIMENT

Analysing our rubbish

Note: **To obtain significant results, you need to place a clean bin or bucket in the Food Technology kitchen at the start of the day, and conduct the experiment near the end of the day. Students should know that rubbish must be placed in only that bin.**

Syllabus outcome

Students learn to:

- investigate through experimentation the suitability of packaging materials for different food products.

Aim

To determine the type of waste and materials accumulated during one day in the Food Technology classroom

Equipment

newspaper
plastic garbage bags
a large empty bin
a large plastic sheet or newspaper
rubber gloves
bathroom scales

Method

1. Put on the rubber gloves.
2. Empty the contents of the bin onto the plastic sheet or newspaper.
3. Separate the day's waste into the following five groups:
   glass
   paper
   metal
   plastic
   organic material (for example, food scraps, bones, etc.)
4. Wrap each group in newspaper and weigh it. Record the weights of each group.
5. Dispose of the waste in an appropriate manner.

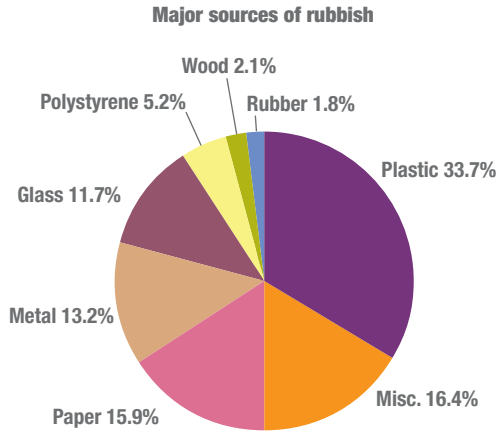
Results

Calculate what percentage of the whole day's waste comes from each group. Draw a bar graph to show these results.

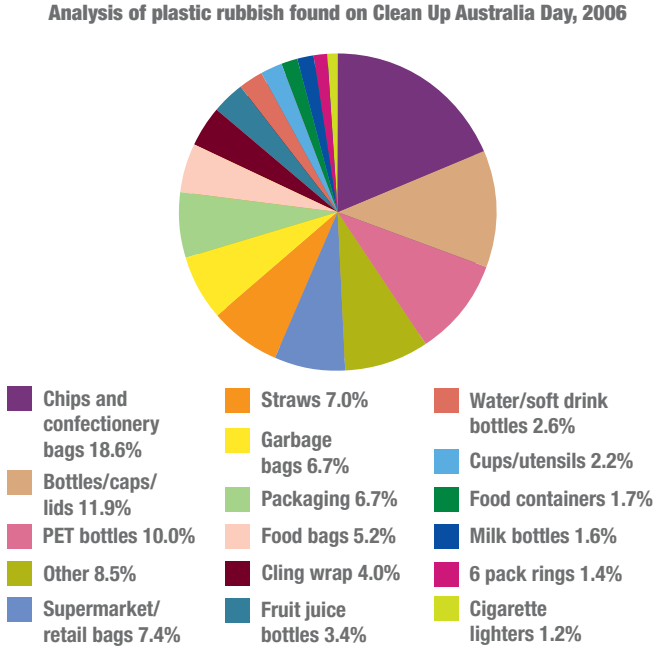
Conclusions

1. Which group provided the highest proportion of waste?
2. Which packaging material provided the highest proportion of waste, by weight?
3. What would be an appropriate and environmentally friendly way of disposing of each group of rubbish?

Packaging waste from domestic garbage ends up in landfill.



Analysis of rubbish collected in the 2006 Clean Up Australia Day shows that food packaging materials form a significant proportion of the waste in each category (apart from rubber and miscellaneous). Can you think of examples of food and beverage packaging materials that would have been collected from each of the other categories represented above?



Plastic was analysed to contribute 33.7 per cent of litter collected in the 2006 Clean Up Australia Day. Of the plastic items collected, chips and confectionery bags, PET bottles and lids accounted for approximately 40 per cent. If you look around the school playground at the end of lunch, you will probably see evidence to support these nationwide statistics.

Packaging waste

Most packaging manufactured today is designed to be used only once, although many forms of packaging are re-usable and recyclable. Once the packaging has performed its function, it is usually put into the general garbage system to be taken to the local rubbish tip.

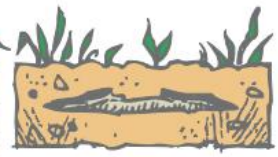
In Australia, we dispose of most waste by taking it to the local tip. These tips use the **sanitary landfill** method, which involves filling natural depressions and quarries with successive layers of waste and soil. This method often converts mining pits and swamp lands into useful recreation areas for the local community once the tip is full.

What happens to discarded rubbish?

Aluminium
Aluminium in cans reacts with oxygen in the atmosphere but forms a layer of oxide which protects it from decomposition. Aluminium rubbish takes many years to decompose.

AFTER ONE YEAR
Most of the paint has dissolved, but otherwise the can is intact.

AFTER FIVE YEARS
The can has been flattened and has sunk into the soil.



AFTER TEN YEARS
The can is very slowly being decomposed by contact with wet soil.

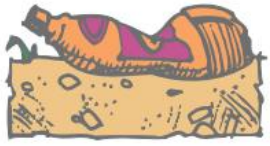
Glass
Glass is a harmless and wholly **inert** substance. It does not chemically decompose at all. However, it does disintegrate, although this process more or less stops after burial.

AFTER ONE YEAR
The bottle is still intact on the surface.

AFTER FIVE YEARS
The bottle has broken into large fragments.

AFTER TEN YEARS
The glass, now in small fragments, lies buried harmlessly in the soil.

Plastic
Many plastics are broken down by ultraviolet light. This makes them brittle. However, once underground most buried plastics do not decompose at all.



AFTER ONE YEAR
The bottle is in much the same state as when it was thrown away.

AFTER FIVE YEARS
Sunlight has partly decomposed the plastic but the bottle is intact.

AFTER TEN YEARS
Once buried, the plastic will remain intact almost indefinitely.

Breakdown of some forms of packaging

An example of the need to dispose of waste responsibly involves the plastic rings used to hold container lids and to indicate tampering. The rings should be cut open before discarding so birds and small animals do not choke on them or become strangled.

Many packaging materials are non-biodegradable and cannot be broken down by natural factors. If not disposed of properly, these materials litter the countryside and look unsightly. The diagram above shows the action of the atmosphere on three types of non-biodegradable packaging.

As you can see, plastics hardly decompose at all. In contrast, paper products can break down in a matter of months, especially if moisture is available.

Traditional packaging materials have different decomposition rates, with some, such as soft drink bottles, never decomposing. In the past, plastic shopping bags were also a long-lasting source of waste. Modern developments in plastics have allowed for the production of biodegradable shopping bags, but as these are more expensive for retailers to purchase, not all stores use them. Most still use regular plastic bags and rely on customers to bring their own reusable 'green' bags. Do you always remember to take your green bags with you when you shop?

REVIEW QUESTIONS

Remember

1. **a)** Outline the difference between biodegradable packaging and recyclable packaging.
   b) Classify the following manufacturing wastes in terms of their being biodegradable and recyclable: plastics, glass, paper board, metal.

Apply

2. Describe, with examples, how companies can encourage responsible patterns of consumption.
3. Compare the environmental advantages and disadvantages of glass and plastic packaging.
4. Copy and complete the following chart, to identify the environmental problems associated with sectors of the food industry in Australia. Consider the cause of the problems and the solutions which may be undertaken to deal with the problems.

FOOD SECTOR	DESCRIPTION OF PROBLEM	CAUSES	SOLUTIONS
Agriculture and fisheries			
Processing			
Food Service and catering			
Retail			
Consumers			

Do an activity

5. Log in to **www.jacplus.com.au** and locate the *Clean Up Australia* weblink for this chapter. Open this weblink and answer the following.

a) According to the rubbish report analysing the Clean Up Australia initiative, have the amounts of food packaging materials discarded as litter increased or decreased in recent years?

b) Look at the information related to all food packaging materials and identify the three areas where litter is most likely to be discarded. Suggest reasons why these venues might become heavily littered.

c) Some areas, for example, bushland or rivers, show larger quantities of specific packaging materials being collected. Suggest reasons to account for these increased rates of litter.

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Weblink

Consumer choice and food manufacturing

It is sometimes difficult to say whether food manufacturing technology has changed our lifestyles or whether the consumer's way of living has changed manufacturing technologies. The fact that more women now work away from the home, for example, has resulted in:

- more modern aids in the kitchen, such as fan-forced ovens
- more efficient cooking methods, such as microwaves
- convenience foods, such as **home meal replacements (HMR)**.

Here are some other examples of consumer behaviour that influences food manufacturing.

1. *Independence for everyone in the family.* Not all family members are expected to be present at meals because busy lifestyles lead to clashes of schedules. Family members who are old enough may prepare more of their own meals. When family members do gather for a meal, they may eat different foods. Television advertisements use this scenario to sell convenience foods that suit different food preferences. It is expected and accepted that busy people will use such foods in these situations, and manufacturers are creating an endless array of food solutions.
2. *An increased focus on health, fitness and physical well-being.* Everyone knows that certain foods are good, natural and nourishing for you — for example, fresh fruit and bran. But it is also generally accepted that people eat too much of the wrong food — for example, food that is fattening or that contains ingredients (such as cholesterol, salt and sugar) which should be eaten only occasionally. Manufacturers have produced a multitude of foods that are low fat and/or high fibre, low salt or low sugar, or cholesterol reduced. They have also begun to alter the styles of products available to consumers, with the production of fresh salads, white breads containing fibre and added minerals, unsweetened yoghurts with fruit, and breakfast cereals with fruit as the major sweetening ingredient. Of course the choice of 'treat' foods — rewards for eating healthily most of the time — is also growing. New technologies have allowed manufacturers to develop 'healthier' treats, for example, lite ice-creams, aerated chocolates and muesli bars for an adult palate.
3. *Increased acceptance of disorder and change.* The number of family meals has decreased, and the traditional patterns of eating (for example, the Sunday lunchtime roast) can no longer be taken for granted. Self-service and self-catering are becoming normal at meal times. The food manufacturers have responded with dishes and whole meals that ensure even those with few cooking skills will not go hungry. Most people are also eager to try new products, and food manufacturers accommodate us by offering a variety of new flavours, shapes and packaging options.
4. *Concern about the 'naturalness' of our food.* Consumers are becoming increasingly concerned about the level of scientific adjustment which occurs in their food. Many manufacturers have addressed this concern through their ingredient choice — selecting or developing natural alternatives such as concentrated citrus juices or egg yolks over their virtually identical chemical additives citric acid and lecithin. Such choices require the manufacturer to modify recipes and production processes, but allows them to target concerned consumers with their 'all natural ingredients'.

   While consumers want a steady, safe supply of food; they also want food free of chemical residues resulting from crop sprays, drenches, and anti-bacterial and anti-fungal agents. The **organic farming** sector is satisfying the demand to some extent, and processes have now been implemented in the agricultural sector to allow tracking of meat from farm to manufacturer.

   Consumers also want to know if their food is **genetically modified** (often referred to as GM). Currently 22 countries produce GM crops; however, because of public concern about the safety of GM foods, only a relatively small proportion of the yields ends up in products for human consumption. Although GM cotton has been grown in NSW for several years, other crops have not been permitted until recently — a nationwide moratorium meant that farmers were not allowed to even plant them. In November 2007, Victoria and New South Wales opted to permit the growing of GM canola, the products of which will be used in food (see chapter 20 for further detail).
5. *A decline in or lack of food preparation skills.* Because food manufacturers do so much food preparation for us, our need for preparation skills and equipment is decreasing. Some residential units are even being built without a

kitchen. Real estate developers are relying on the fact that the modern family or individual needs only a microwave oven and refrigerator/freezer to prepare meals.

Employment opportunities

The food and beverage sector accounts for more than 17 per cent of Australian manufacturing sector employment. The number of people employed in a business depends on the business's level of operation. A small-level operation tends to be more labour intensive because the cost of machinery is high. It is cheaper to pay workers when they are needed than to invest in an expensive piece of equipment that will operate for only short periods. As sales increase, small businesses can improve their level of mechanisation. This can mean that some workers will lose their jobs, while other types of employee (for example, quality assurance and marketing personnel) will be hired.

The number of employees in a company also depends on the product being produced, because certain tasks are more labour intensive than others. A large number of butchers are needed in a meat processing plant, for example, because deboning meat and preparing specialty racks of lamb requires skilled people. A machine has not yet been invented that can perform these kinds of butchering task. On the other hand, few people are needed in an automated flour mill.

When production demands become too much for one factory, it can expand on the existing location or set up another factory. A new factory may need more people to operate it, and it can create an employment flow on to other industries (for example, to suppliers, transport firms and businesses nearby). Unfortunately, the reverse occurs when business declines.

Large companies employ many staff to produce many product lines. Goodman Fielder, for example, is a food company, producing brand names such as White Wings, Meadow Lea, Buttercup (bread), Praise, Pampas, Helgas and Asia @ Home. Goodman Fielder also produces products and ingredients for the food manufacture and food service and catering sectors, both in Australia and on the global market. The company employs 5000 people in 60 plants throughout Australia, New Zealand and the Pacific Islands.

CASE STUDY

Currently the law prevents the importation of dairy products from China, so jobs in the Australian dairy industry are secure for the moment. In Australia food manufacturers do, however, find it difficult to compete as wages are much higher in Australia than in emerging economies.

MADE IN CHINA

by HAMISH McDONALD

When Australian mums and dads buy their kids a Paddle Pop or Calippo Frost at the beach this summer, few will bother to read the fine print on the wrapper. If they do, they will see, close to the seam or under a fold, the words 'Made in China'. For the past three years, all iceblocks sold under the venerable Australian brand 'Streets' have been made in a Shanghai factory. The owner of Streets, the Anglo-Dutch food and detergent giant Unilever, says no jobs were lost in the move. It's just that it was difficult and expensive to produce such 'seasonal innovations' in Australia.

After three years, Unilever is evidently content with Chinese production — and why not? Industry sources in China say it has cut costs on these iceblocks by 40 per cent, even allowing for shipping to Australia.

The same sources say it would be technically possible to do the same with Streets' milk-based ice-creams like the Cornetto without changing the taste or reducing food safety standards. The Shanghai factory would not even need to import the milk powder: the Chinese Government is vigorously promoting a dairy company named Yili in Mongolia as the domestic answer to Nestlé, in an economy-wide drive to build 'famous Chinese brands'.

The only things stopping Unilever are consumer acceptance of a Chinese-made milk product and Australian food import rules that do not permit milk-based ice-creams from China.

But for the 200 workers making Streets ice-cream at the Unilever plant in Minto, on Sydney's outer south-west, and another 60 workers at the Norco factory in Lismore making Streets brands under contract, China is the threat constantly being waved by management to get them to sign individual contracts and sign away conditions won by the Australian Manufacturing Workers' Union. 'They're told that if they don't become more competitive in respect of labour costs, the company will have to look at sourcing their ice-cream elsewhere,' says an AMWU organiser, Jennifer Dowell, who is also hearing about possible relaxation of the import regulations.

Who can compete with China on labour costs? The fear being expressed in Minto is echoed around the world, and not just in affluent western countries like Australia. Even Mexico, the cheap labour neighbour of the United States, says it has lost 218 000 jobs to China since 2001, and more are going.

Source: The Sydney Morning Herald, 18 October 2003.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *employment opportunities* to complete the tasks ahead.

1. **a)** Where are the Streets' brand iceblocks actually made?
   b) Where are Streets' milk-based ice-creams made?
2. Why are some companies such as Unilever able to produce food more cheaply overseas compared to within Australia?
3. What implications does outsourcing food production to other countries have in Australia?

Nutritional implications of food manufacturing technologies

The Australian food industry uses new knowledge and modern technology to produce the safe and varied products we have today. Raw products from farms are processed using methods that retain as much nutritional value as possible while providing a wide range of food choices that meet varying consumer demands. But even as recently as a decade ago, nutritionists, consumer groups and regulatory authorities criticised food manufacturers for not paying enough attention to the nutritional aspects of the food they produced. People still believed the myth that processed foods were not as good for us as raw foodstuffs prepared in the home.

The pendulum has certainly swung the other way today. Most large food companies have developed a **corporate nutrition policy** which is available to the public. Such a policy explains the company's strategies when developing food products, conducting research and development, and meeting consumer needs.

Simplot Australia provides brand food products to the retail and food service sectors in the Asia–Pacific region. You may have heard of their brands such as Edgell, Birds Eye, John West and Leggos. Here is a modified extract from their nutrition policy.

Simplot Australia is committed to enhancing well-being through:

- Offering a wide variety of healthy and nutritious foods to meet consumer needs through the use of high quality ingredients and production methods which maximise nutrient retention and taste.
  For example, The Captain Birds Eye range of products for children has been reformulated and does not contain added preservatives, artificial colours or flavours.
- Utilising current nutrition research and guidelines to create new products and continually improve existing products.
  For example, Simplot is currently developing a range of products specifically for children and adolescents in line with the NSW School Canteen Association's Healthy Kids nutrient criteria.
- Enhancing nutrient content by limiting energy, fat, saturated fat, added sugar and sodium levels, and increasing dietary fibre wherever possible.
  For example, Birds Eye frozen potato product range is now healthier. The saturated fat content has been decreased by changing to healthier cooking oils.
- Developing appropriate portion or serving sizes, serving instructions, suggestions and recipes that are consistent with a balanced diet.

Appropriate use of technology in food manufacture

Remember that 'technology' refers to much more than equipment, computers and tools. Technology includes the resources available to make the product (land, air, water and energy) and the processes and systems used to move raw products from the start of the manufacturing process to the retailers' shelves. The appropriate use of technology in the food industry means to use technology to produce a variety of safe and nutritious foods in ways that are environmentally friendly and efficient.

Energy and water resources

Large manufacturing plants operate 24 hours a day, 7 days a week. They use a lot of energy in production processes and maintaining a safe, functioning work environment for their staff. Large food plants are well lit, heated or cooled to an appropriate temperature, and their extensive computer systems are rarely shut down. The food processing equipment and storage facilities also operate consistently, heating or cooling foods as needed. Once foods are manufactured, they are distributed to warehouses and retailers.

The major sources of energy used by the food manufacturing industry are electricity, gas and fossil fuels. Gas and steam are commonly used as heating mediums because they are efficient and cheaper than the alternatives.

Energy use may be minimised by:

- installing newer, more energy efficient equipment (may not be economically viable for some companies)
- using lightweight packaging to lower transport fuel costs
- streamlining production to ensure products are distributed from the factory quickly after processing, minimising the need for cooling such large storage areas.

Water is an essential part of many processing operations. Its use can be minimised by:

- sealed processing systems — where water is trapped inside the processing equipment and continuously re-used for the operation of that equipment, for example, steam in tubular heat exchangers
- water being treated and re-used on site, for example, to water gardens and lawns around the factory site.

Consumers concerned about their green footprint are putting pressure on food manufacturers to use technology appropriately. Many companies have developed an environmental policy, in the same way that they developed corporate nutrition policies. Companies often promote their green credentials as part of their marketing campaigns.

CASE STUDY

Biodegradable packaging

Packaging materials made from renewable raw materials will become cheaper in future as the market for them becomes greater. Fossil fuels are still needed for the agricultural production of the grains, and considerable wastage occurs as only the endosperm of the grains is used in the packaging. Questions have been raised about the ethics of growing food to create packaging when so many people are starving in the world.

Aussies exploring new packaging methods

Global concerns over landfill and waste management has seen Australian organic retailers explore biodegradable packaging methods.

So says Richard Fine, CEO of BioPak, which sells biodegradable film for the storage of FMCGs.

Packaging is primarily derived from natural corn or potato starch and allows for immediate breakdown when treated in a composting system.

Fine says interest in biodegradable products has increased due to burgeoning environmental awareness from consumers, and a rise in the cost of crude oil in petrochemical-based plastics, but that interest from some conventional business has lagged.

'The market wants to protect the environment, but not at any cost,' said Fine.

'The organic industry is undoubtedly the sector we see the most interest from. Organic producers and their consumers have a vested interest in sustainability and a greater level of environmental awareness.

'The organic sector is currently the primary source of our sales to retailers who are essential to the growth of the industry — we supply them with biodegradable trays and film for their fresh organic produce.'

Steve Skopilianos, GM of BFA/ACO certified organic business Ladybird Organics, packages his salads and vegetables in biodegradable film.

He launched his business six months ago and attributes its success in part to his packaging choices and the ethical value they add.

'To me, organic and biodegradable packaging goes hand in hand,' he said.

'Approximately 95% of our produce is packaged in biodegradable material, it has increased its shelf-life by 30%, we continue to add to our environmental integrity — a primary reason for organic production — and the response from our customers is unbelievably positive.'

Neil Thomson, director of biodegradable packaging company Ausasia, says they registered for organic certification to better cater to organic farmers.

'Our biodegradable agricultural mulch film, which also exists in a smaller variety for home gardens, is registered as an allowed input making it a highly attractive option to sustainable farmers,' he said.

'It solves the problem of disposing of soiled plastic film — you can just till any remaining pieces into the soil and there is no waste problem after ploughing.'

Ausasia also produces a range of biodegradable doggy-bags, providing dog walkers with an eco-friendly solution to dog litter.

'This is particularly useful in areas of environmental sensitivity — for example, along the coast. Our dog-bags will biodegrade in water and are digestible by marine creatures,' he said.

Andrew Monk, Standards Committee chair of BFA said under organic standards all packaging that reduces environmental impact — be it recycled materials, biodegradable, compostable — is encouraged.

'We always welcome, and in future will be making mandatory, leading packaging solutions such as biodegradable and compostable packaging that delivers reduction of the environmental footprint of organics,' he said.

Fine said for the full environmental benefits of biodegradable packaging to be realised, the growth of industrial compost facilities is necessary and requires local authority participation.

Source: FOODweek.com.au, 17 January 2008.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *technology in food manufacture* to complete the tasks ahead.

1. Describe the latest trends in biodegradable packaging.
2. Give one reason why biodegradable packaging might actually become cheaper than regular plastic packaging in years to come.
3. Give an example of a company that is using biodegradable packaging and for what the packaging is being used.

CASE STUDY

Ecoeggs

'Normal' eggs are a good source of protein but take a look in your supermarket at the range of eggs available and you will soon see that the business world has transformed the humble egg. One recent egg development is the 'Ecoegg'. Hens laying Ecoeggs have been given a special diet boosted with natural supplements rich in omega fats and essential vitamins (the hen's diet is now patented!). Ecoeggs are targeted at sports people, pregnant women and people who are health conscious. An egg's not just an egg any more...

Omega-3
Ecoeggs contain an excellent balance of the two good omega-3 and omega-6 fats with a 300% increase in omega-3 over ordinary eggs.

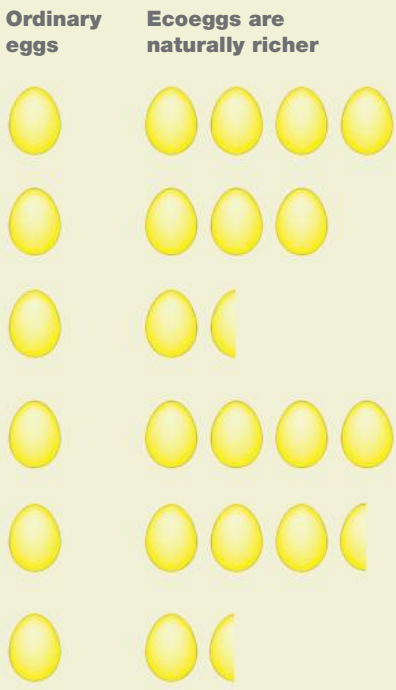
EPA, DHA
Ecoeggs contain a 200% increase in EPA and DHA over ordinary eggs.

Selenium
Ecoeggs contain a 50% increase in selenium over ordinary eggs.

Vitamin E
Ecoeggs contain a 300% increase in vitamin E over ordinary eggs.

B_{12}
Ecoeggs contain a 250% increase in vitamin B_{12} over ordinary eggs.

Folate
Ecoeggs contain a 60% increase in folate over ordinary eggs.



OUTCOME TASK | **RESEARCH ASSIGNMENT**

Students learn to:

- analyse the impact of food manufacturing technologies on individuals, groups and society.

Contributes to the following outcome:

- evaluates the impact of food manufacture on the individual, society and the environment.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *technology in food manufacture* to complete the task ahead.

Using the knowledge you have gained from a factory visit to at least one food manufacturing company (or from a video), research two new uses of technology. Prepare a report covering the topics listed here.

a) When the technology was first used by the company
b) What the technology does (Use diagrams where possible.)
c) How the technology is an improvement over what had been used before
d) Whether any other improvements resulted from the new use of technology
e) What impact the technology has had on:
  i. the environment
  ii. employment opportunities
  iii. the nutritional wellbeing of consumers
  iv. the eating patterns of Australians
  v. meal preparation

Technological processes

Another example of an appropriate use of technology is a development in the aseptic canning process. The OMIX system, developed in England, pumps the uncooked food up a column while an electric current passes through it. This technique takes the food to the sterilisation temperature in 90 seconds rather than the 90 minutes normally required to cook a similar volume of food. The cooked food is then processed in the same way as regular aseptically canned food. The nutritional quality and texture of the food is retained, and the colour and flavour are better. The reduction in the time required to sterilise the food means less energy is used.

Research and development

Manufacturers, industry organisations (for example, the Australian Dairy Corporation and the Packaging Council of Australia), and government bodies (for example, the CSIRO) conduct research with the aim of improving product design and production methods. As new discoveries are made, for example, in nutrition, they are able to be incorporated into food product design, such as the introduction of omega-3 nutrients into a variety of foods.

New compounds have been developed to replace ones in short supply — for example, we can now buy imitation vanilla rather than pure vanilla. Research and development can also lead to new ways of using an existing food;

for example, grains, seeds, legumes, under-ripe bananas and potatoes that have been cooked and cooled contain starch (called resistant starch) that the body cannot digest. Research has found that the body uses resistant starch in much the same way it uses fibre to maintain the bacteria level in the bowel.

REVIEW QUESTIONS

Remember

1. **a)** Create a mind map identifying the consumer choices that have influenced/been influenced by food manufacturing technologies.
   b) Give examples to illustrate each factor.
   c) Identify food products relevant to each example.

Apply

2. List four areas relating to food manufacturing where efforts need to be made to ensure the responsible use of technology. Give an example to illustrate each area.
3. Explain how the employment opportunities in large and small food factories differ.
4. Create a table outlining:
   a) the nutritional concerns of consumers relating to manufactured foods
   b) the ways that manufacturers can/have addressed those concerns using technology.

Do an activity

5. Log in to **www.jacplus.com.au** and locate the *Australian Consumers Association (Choice)* weblink for this chapter. Open this weblink to investigate food-related research conducted by the Australian Consumers Association, publishers of *Choice* magazine.
   a) Find an article relating to manufactured food products which you feel highlights issues for consumers' health or lifestyle, and/or the environment. Evaluate the article in a one-page summary.
   b) Share your findings and opinions with others in your class.

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Weblink

CHAPTER 12 SUMMARY

- Manufacturers' packaging choices have a significant impact on resource and energy usage, and landfill. The selection of recyclable materials is desirable, but some materials are more eco-friendly than others.
- Recycling of packaging still uses energy but reduces raw material use. A 'cradle to cradle' approach to a package's life cycle is preferable to a 'cradle to grave' approach.
- Environmental codes of practice exist for packaging design. The Packaging Council of Australia encourages the use of such codes when designing product packaging.
- Production processes use significant amounts of energy and water. Managing production systems to avoid waste is the responsibility of each business.
- Wastes are generated at all stages of food processing. Manufacturers need to responsibly manage:
  - solid wastes, so that they are suitable as raw materials for other industries
  - the treatment of liquid wastes on site to prevent pollution.
- Packaging wastes, if not recycled, may never biodegrade.
- Technology is advancing all the time. Manufacturers need to ensure that they use the technology available to enhance the lives of consumers and to sustain the environment.

KEY TERMS

biodegradable
corporate nutrition policy
genetically modified
head space
home meal replacements (HMR)
inert
marketplace
organic farming
sanitary landfill

HSC PRACTICE EXAM QUESTIONS

Multiple-choice questions

1. A disadvantage of continuous flow processing for manufacturers is that

- **A.** the consistency of product cannot be guaranteed.
- **B.** 24-hour production leads to higher staff costs.
- **C.** equipment is expensive to install and operate.
- **D.** equipment made by different manufacturers cannot be linked.

2. The major reason food is preserved is to

- **A.** provide consumers with a variety of foods.
- **B.** ensure that seasonal foods are not wasted.
- **C.** enhance the flavour and physical qualities of the food.
- **D.** ensure that food is safe to eat.

3. The critical temperature range for microbial activity is

- **A.** –18 to –36 °C.
- **B.** 0 to 4 °C.
- **C.** 5 to 60 °C.
- **D.** 95 to 140 °C.

4. Canning primarily preserves food by

- **A.** sterilising foods at high temperatures.
- **B.** adding other ingredients (chemical) such as sugar to reduce water activity.
- **C.** excluding air.
- **D.** removing moisture from foods.

5. Modified-atmosphere packaging is used to

- **A.** make food packaging look better.
- **B.** extend the shelf-life of food.
- **C.** protect food from damage during transit.
- **D.** ensure that no-one tampers with the food product.

Short structured items

1. **a)** Identify three factors that cause food to spoil.

b) Outline the four reasons why food is processed.

c) Select a processed food.

i. Outline the steps undertaken in processing the selected food.

ii. Describe two unit operations and explain their importance in maintaining the quality of the processed food.

2. **a)** Identify three factors that cause food to spoil.

b) Outline the four principles of food preservation.

c) Select a food that is commonly preserved.

i. Explain a process used to preserve the food.

ii. Identify the principles of preservation applied in the process.

3. **a)** Outline four reasons for packaging food.

b) Suggest three factors that could influence a manufacturer's decision when selecting packaging for a product.

c) Select and name a processed, packaged food. Describe the package and explain how it maintains the quality of the food.

Extended structured response

1. Quality assurance and quality control are essential aspects of modern food manufacturing. Discuss the role of quality management in ensuring that food standards and consumer expectations are met.

2. **a)** Explain the principles of food preservation.

b) With reference to one food preservation technique, justify how the processing methods used apply to the relevant principles of preservation.

Chapter 13
Factors that affect food product development

Kellogg's cornflakes, Mars bars, Magnum ice-creams, Vegemite — the list of popular food products is long! These products have stood the test of time, but many new food products do not survive for more than two years. Therefore, most food manufacturers must continually develop new products to stay in business. Consumers are constantly seeking new and different foods. Manufacturers maximise their chances of continued and successful operation by recognising and developing products to meet consumer expectations.

In this chapter you will learn about:

Factors that impact on food product development:

- external factors (macro-environment) that impact on food product development, including the:
  – economic environment
  – political environment
  – ecological environment
  – technological environment
- internal factors (micro-environment) that impact on food product development including:
  – personnel expertise
  – production facilities
  – financial position
  – company image.

Can you pick which products are new to the market? Take a look in your pantry or refrigerator and make a list of those food items that are new or enhanced in some way.

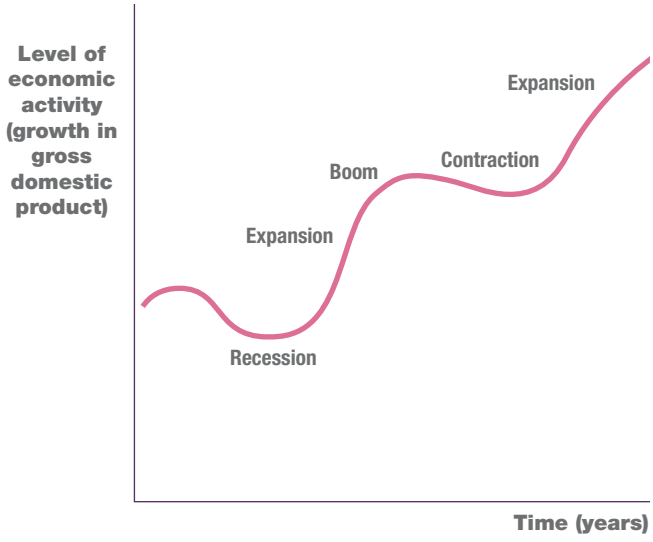
External factors that affect food product development

External factors such as the economic, political, ecological and technological environment often affect food product development. Consider a company that produces luxury food items in tough economic times or a manufacturer that suddenly finds its fish supply is no longer available due to environmental concerns. These factors that relate to the **macro-environment** are generally outside the manufacturer's control and must be considered in proper decision-making processes.

Economic environment

The state of the economy can affect food product development. A great new food product idea may work well when consumers have a high income level and the economic outlook is prosperous, but the idea may fail in tougher economic times. All economies experience changes in the level of activity and these are described below.

- *Recession.* A **recession** is a downturn in the economy, resulting in less disposable income as well as a lower capacity to pay for goods and services, especially imported items. Decreased employment and increased reliance on social services mean that people spend less money. Interest rates rise and inflation increases. Consumers purchase less food; they may continue to eat out, but they patronise fast-food outlets and cheaper restaurants. Consumers may be less willing to try new food products. Business running costs increase and profits decline; some companies go bankrupt and close down. During recession periods, new product development generally declines and the range of products available to consumers may also decrease.
- *Expansion.* During periods of **expansion**, the economy grows in terms of production, employment opportunities and introduction of new products. Levels of prosperity increase and more items, including high-value foods, become available for consumers. The economic climate improves during expansion while unemployment, interest rates and inflation decrease. Consumers start to buy more products because they feel more secure financially and have more money to spend.
- *Boom.* A **boom** occurs when consumers spend more money, eat at better restaurants and try more new products. People travel more and buy more luxury products, while companies become sufficiently confident to expand their operations and product ranges. New businesses appear and unemployment rates are low. During a boom phase, a country's economy grows too fast. Measures, including raising interest rates, may be introduced by government to control economic growth. Such measures, in turn, cause companies to decrease expansion of their operations, including new product development.
- *Contraction.* **Contraction** occurs in the economic cycle with effects similar to, but less severe than, those during periods of recession. Disposable income, consumer spending, business activity and new product development are all adversely affected during contraction.



Sometimes a downturn in the economy can affect food producers. It might not be the right time to launch a new product, particularly if there is already competition in the marketplace and consumers are struggling with lower disposable incomes.

Specifically, the following economic factors may affect food product development:

- *changes in inflation rates.* These cause changes in costs of ingredients, equipment, wages and processing. Manufacturers may pass the extra costs of increased inflation on to consumers by raising their prices.
- *changes in interest rates.* Companies frequently need to borrow money to enable them to buy new equipment and technology or to upgrade existing operations in other ways. To cover these higher costs, the producer may raise the price of its products.
- *exchange rates.* Australian food manufacturers frequently import materials and technology from overseas. If the

Australian dollar is stronger than foreign currencies, the imported goods cost less; if the Australian dollar is weaker, the imported goods cost more.

- *tax rates.* Company taxes can change, usually more often when a new government is elected at either state or federal level. Such changes affect company profit margins and are reflected in the prices paid by consumers.
- *import and export tariffs.* These **tariffs** may be altered by federal governments and this can affect the retail prices of food products. It is important to note that such changes by overseas governments also occur and can affect food prices in Australia.
- *wage agreements and salary levels.* If a food manufacturer has to pay its employees higher wages, these costs are usually passed on to consumers. On the other hand, as consumers earn more, they have more disposable income and may buy more food.
- *level of unemployment.* Low levels of unemployment place less strain on government social services, and taxes can remain low, so many consumers have more disposable income to buy food.
- *drought.* Australia is a dry continent because of its low rainfall and the arid nature of many areas of the continent. We experience periods of drought that lead to a decline in agricultural and horticultural production. This decreases the availability of many foods and ingredients (such as grains, fruits and meat) and increases prices for these commodities. Australian farmers face the challenge of restricted water supply for crop irrigation and livestock. During periods of drought, food manufacturers and suppliers often import these commodities at prices higher than for the local products. As a result, consumers face reduced availability and higher retail prices for food.
- *natural disasters.* Crop and animal production in Australia are sometimes disrupted by natural disasters, including floods, hailstorms and cyclones, which devastate the production of specific commodities such as fruit, vegetables and grain crops. Natural disasters generally affect smaller regional areas for shorter periods than drought, but the consequences for availability and prices of affected commodities are similar.

Political environment

Australian manufacturers, producers and distributors of food are all subject to regulations made by federal, state and local governments. This subject is discussed more fully in chapter 9. At the federal level, the most prominent regulatory body is **Food Standards Australia New Zealand (FSANZ)**, which, in principle, coordinates and oversees food regulation throughout Australia and New Zealand. In addition, there is also some overlap between FSANZ and the Therapeutic Goods Authority (TGA), which oversees foods or other products that are promoted and advertised on the basis of claimed health-related benefits. In NSW, regulation is more direct at the state government level via the NSW Food Authority. Local government in NSW acts in partnership with the NSW Food Authority on food regulation. Local government deals specifically with local issues relating to foods, such as zoning laws, planning permits and health inspection matters. The responsibilities associated with all three levels of government are shown in table 13.1.

TABLE 13.1 Areas of federal, state and local government responsibility related to food company operations

LEVEL OF GOVERNMENT	RESPONSIBILITIES
Federal government	• Control of amount and type of protection for Australian industry • Control of the company and income tax systems • Control of wage scales
State government	• Control of payroll tax • Maintenance of roads and transport facilities • Establishment and enforcement of environmental protection measures • Occupational health and safety law in the workplace • Consumer protection • Trading hours • Attracting new industries to the state • Education and training • Enforcement of the *Trade Practices Act 1974* • Licensing of fresh food outlets and restaurants
Local government	• Zoning laws, including residential, light commercial, heavy commercial, light industrial, heavy industrial • Planning permits • Health inspection to enforce the Australian Food Standards Code

Other political influences arise from non-government sources such as lobby groups; the Australian Consumers Association and the National Farmers' Federation (NFF) are good examples. The NFF represents a broad cross-section of Australian agriculture, and much of its lobbying activity has considerable importance to Australian national interests. Recently, the NFF lobbied the government extensively to work more closely with farmers to deal with the drought and adopt strategies to ensure enough water for their crops in the future.

Some lobby and special-interest groups run candidates for political office to promote their views and interests. For instance the Australian Greens has parliamentary members at all levels of government in Australia.

In addition to political influences from home governments, similar pressure from overseas countries can also

Natasha Stott-Despoja led the Australian Democrats and was a member of the Australian Senate. She has been active in campaigns against genetically modified food.

affect domestic food manufacturers. For instance, tariff barriers, trade restrictions, and factors relating to food inspection, quality and safety can restrict the ability of local manufacturers to trade in some export markets.

Ecological environment

The ecological environment includes the air we breathe, the food we eat, our waterways, biodiversity in both plant and animal species, and the land itself. Today there is concern about endangerment of species and environmental damage because of issues such as pollution, land degradation, inadequate waste disposal and conservation of natural resources. These issues affect consumer attitudes to such things as recycling, biodegradability of packaging, pollution of the atmosphere and waterways, use of pesticides and waste disposal. Environmental quality and its conservation are addressed by many international conventions and treaties, such as the Kyoto Protocol, which Australia signed in 2007.

Companies have developed a range of strategies to address consumer concerns and enhance the marketability of their products. These strategies include the use of biodegradable and recyclable packaging, better air pollution control, environmentally friendly processing and transport for their products, and more efficient energy use and waste disposal in their processing operations. This needs to be supported by the development of new products, packaging and processing technology.

A selection of organic dairy foods developed in response to consumer demand for pesticide- and fertiliser-free foods

Technological environment

'It's not what you do, it's the way that you do it' are words from an old song. These words are especially relevant to food product development. Changes in science and technology affect the development of new food products. These include new processes such as **extrusion** techniques, ultra-high temperature (UHT) processes, new packaging technology such as modified atmosphere, computer control in food processing, automated equipment, improved distribution systems and **genetic engineering** (genetically modified materials are probably the most controversial of new food ingredients). Technological developments lead to new foods and food components. This includes **food additives**, such as those contributing to food flavour and texture, fat and sugar replacements and processing aids. New ingredients offer specific opportunities for new foods, such as reduced energy content, better storage life and superior quality.

Developments in processing technology often arise from research and development (R&D) activities by private or government-sponsored organisations, such as universities and research organisations other than those within companies. New technology offers food manufacturers the benefits of improved production efficiency, expanded product range and increased market share, as well as lower costs and labour requirements. The bottom line is greater profits!

One of the biggest technological issues in the food industry is **genetically modified** (GM) foods. GM plants and animals offer advantages such as increased yields, improved handling and processing properties, greater disease and insect resistance, higher growth rates and

CASE STUDY

Disease ravaging NT banana crop

by ANNE BARKER

Nineteen months ago Australia's banana industry was in crisis after the devastation of Cyclone Larry, in far north Queensland.

Northern Territory farmers were the big winners as banana prices went through the roof and demand outstripped supply.

Now the Northern Territory industry, which had such bright prospects, is now itself facing collapse from the exotic Panama Disease.

The Borsato Company runs the biggest banana plantation in the Top End.

It supplies two-thirds of the NT market and as the recent harvest of firm ripe fruit is packed into boxes, you would never think the industry here was on its knees.

But look closer at the trees themselves and manager Mark Smith sees all the telltale signs of the devastating Panama Disease — stunted growth, wilting yellow leaves and discoloured stalks.

'Basically, it just invades the banana plant and the plant blocks off the vascular tubes that feed the nutrients around the tree and basically the banana plant kills itself', he said.

First detected in Australia 10 years ago, this soil fungus has already destroyed other plantations and is now crippling this one.

It has left Borsato with no choice but to shut down its entire NT operation.

'It's now down to virtually we're going to finish up. We had 300 acres of bananas here with prospects of expanding — we're down to 40 acres now, which says it all', he said.

'We haven't planted any more so we'll probably get another 12 months out of this 40 acres and then shut up shop as far as bananas go.'

The only hope now of saving the NT industry is to find or develop a Panama-resistant variety of bananas.

Mr Smith blames the Territory Government for not doing better research to achieve that and control the disease from spreading between farms.

'It just seemed strange that all the growers got it within 12 months of them finding it here in the Territory, and there have been people growing bananas for a long time up here that didn't have any problems with Panama', he said.

But Northern Territory Primary Industries Minister Chris Natt denies the industry is about to fold.

'We are undertaking quite a bit of research at the moment to find out whether there are species or varieties of bananas that are immune to the disease', he said.

'We understand that there is probably three or four that are immune to the disease and to see if we can increase the industry within the Northern Territory.

'I don't think it's a collapse. It's probably a little hiccup but we would like to think that we can get on top of that and find some other varieties that can be used in the market in the future.'

Source: ABC, 17 October 2007.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *external factors that affect food product development* to complete the tasks ahead.

1. Why is the Northern Territory banana industry in trouble?
2. Is there anything that the Borsato company could have done to prevent its crop from being destroyed?
3. Why did Mr Smith blame the Northern Territory government for the exotic Panama disease?
4. Explain how technology can be harnessed to assist businesses in the Australian food industry.

improved sensory properties (including aroma, flavour and texture). Consumers benefit from most of these, in particular through new product availability, reduced food prices, convenience and food quality. There is, however, strong consumer resistance to GM foods. Such resistance may relate to worry about safety, beliefs that such foods are not natural, cultural and religious issues concerning their 'unnatural' nature, and allergy concerns, all of which affect market acceptability. For example, **vegetarians** may be concerned if genetic material from an animal is introduced into a vegetable crop. Cultural and religious beliefs can also lead to objections; consumers who do not eat pork may object to GM foods containing genetic material from pigs.

Changes in food technology, whether it be the introduction of new GM foods or simply better **automation** in the factory, may have some disadvantages such as decreased employment opportunities, staff retrenchments, and the need for staff to be retrained to operate advanced processing and storage facilities. These issues increase manufacturers' costs, which must be balanced against potential improved profitability.

REVIEW QUESTIONS

Remember

1. Name the external factors affecting new food product development in the following scenarios, and outline decisions available to the manufacturer to alter business plans and overcome possible problems.
   - **a)** Cassy decides it's not the right time to develop and export her kiwifruit wine because the Australian dollar has just risen in value against the US dollar, and the US looks like it's heading for a recession.
   - **b)** Ho Chi is taking advantage of the trend towards buying foods from local regions to reduce the effects of food production on the environment. He opens up a food store selling only food produced locally.
   - **c)** In response to customer demands, Bill has developed a frozen meat pie specifically for reheating in a microwave oven, and he will sell the pies in his small cake shop.
   - **d)** The Smith family are macadamia nut farmers and their harvest has been greatly decreased by a hailstorm. They decide to import macadamia nuts from Hawaii to meet their commitments to customers' orders.

e) Emad processes and roasts imported coffee beans for sale to his customers. He is faced with the options of either closing down his business or cutting back production because of decreases in the value of the Australian dollar in relation to currencies of the coffee-exporting countries.

Apply

2. Explain whether a food manufacturer can control external factors.

3. List the benefits and problems for a food manufacturer associated with the introduction of each of the following technological advances.
- **a)** New packaging technology
- **b)** GM foods
- **c)** Computer control in food processing
- **d)** Automated equipment

4. Which stage of the economic cycle is described by each of the following situations in a nation's economy? For each situation, summarise the positive and negative consequences for consumers and manufacturers.
- **a)** There is a period of growth in food production, employment opportunities and introduction of new products. Levels of prosperity are increasing, and higher value foods are available to consumers. The economic climate improves while unemployment, interest rates and inflation decrease. Consumers start to buy more products because they feel more secure financially.
- **b)** Consumers have less disposable income and lower capacity to pay for goods and services, especially imports. Employment has declined, reliance on social services has increased and people have less disposable income. Interest rates rise and inflation has increased.

5. List the political factors that can affect the operations of a food manufacturer.

Do an activity

6. Log in to **www.jacplus.com.au** and locate the *Environment and food* weblinks for this chapter.
- **a)** Find out how the way we produce food can damage the environment.
- **b)** Use the internet and research a company that has endeavoured to produce food in an environmentally friendly way. Describe the methods they use to produce food to minimise the impact on the environment.
- **c)** 'Genetically modified food should be banned.' Comment on both sides of this argument.

eBook*plus*

Weblink

How companies respond to external factors

How can companies respond to external factors — economic, political, ecological and technological — that affect food product development? As noted on previous pages, these factors are largely beyond the control of individual companies. Despite this, there are measures that companies can adopt to minimise the negative impacts arising from the macro-environment. To a large degree, the capacity of a company to do this is related to its individual characteristics, including:

- *size* — whether it is a large or small enterprise
- *structure* — whether it is a **private company** or **public company**, and whether it is a franchising operation
- *markets* — whether the food producer is local or multinational
- *resource base* — including the number and size of assets, financial resources and shareholders.

The measures that individual companies can take to minimise the effects of external factors depend on the characteristics listed above. Some possible measures are listed below for each external factor.

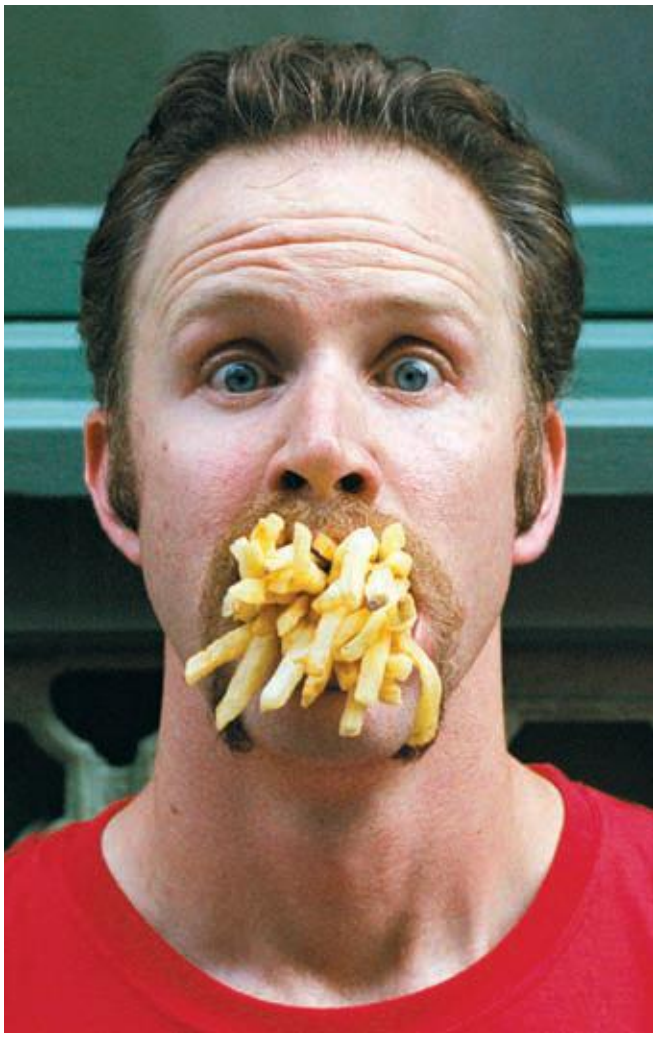
Economic environment

The simplest and most practical measure is to be aware that changes in the national and international economies will occur, and to have company strategies in place to adjust for both positive and negative effects from such economic changes. For example, a company may plan to expand its operations during economic boom and expansion phases, and to scale down its operations in times of economic contraction and recession. This could include changes to numbers of employees, scope of operations (such as the range of products manufactured and R&D activities) and asset levels. A company should be aware of sources of loan finance and have good estimates of interest rates. In good economic times with low interest rates, companies may wish to borrow money for expansion. In all economic times, especially bad times, it is important to borrow money at the lowest rates for continuation of operations. Large public companies and **multinationals** are generally better resourced than smaller ones to implement such measures.

Political environment

Changes to the political environment generally occur when a new government is elected. Companies should have up-to-date information about economic, industrial, environmental and technological policies of political groups contesting any elections, especially at state and federal levels. This allows them to develop contingency plans to minimise changes in political climate that could occur with a newly elected government.

A newly elected government may change food regulations, industrial relations, import and export policies (such as tariffs) and environmental policy (such as laws related to pollution). Large manufacturers, multinationals and public companies, individually, have greater influence on the policies of political groups than smaller ones. This is primarily because they have more employees who may face retrenchment as a result of policy adverse to the company; the companies may also face losses in export earnings, resulting in a decrease in the balance of payments. Also, political favour may possibly be obtained by donating money to political parties. Another measure relating to political change is the formation and activity of lobby groups. These offer smaller companies the opportunity to be represented in their negotiations with political groups.



The political environment a company operates in is not restricted to who is in office. Consumer activists can influence whether a product is bought or sold and may lead the crusade for change in, for example, healthier eating. The movie *Super Size Me* is about a man who ate McDonald's food exclusively for 30 days. It chronicles his physical and psychological wellbeing and delves into the fast-food industry's corporate influence.

Ecological environment

Food manufacturers and producers can have many different effects on the environment, some of which have arisen, or have been identified, comparatively recently. These problems include pollution of water, air (including greenhouse gases) and land by processing and farming operations, waste disposal, packaging that is neither recyclable nor biodegradable, noise, odour and transport problems. An understanding of the ecological environment by food companies is vital to avoid negative consumer responses.

Equally important is a company's ability to anticipate problems related to ecology. While they should avoid creating problems, they should have strategies in place to rectify them should they arise. Food manufacturers should also be aware of consumer activism and attitudes regarding the environment, although these may be difficult to predict. Awareness of consumer activities should include changes in focus and intensity. Consumer activities depend on several factors, including scientific knowledge, spread of information about specific ecological issues, and levels of consumer concern about perceived environmental problems that might arise from food manufacture, storage and distribution. Larger food companies are better resourced than smaller ones to develop substantial levels of awareness about potential environmental problems.

Environmental problems are best addressed by developing strategies such as improved processing technology, introduction of biodegradable or, at least, recyclable packaging, more efficient processing technology and better effluent control. Larger companies are better resourced to implement developmental strategies because they have more staff and more capital to cover the cost.

Technological environment

The technological environment generally changes because of developments by researchers in non-industry organisations (such as the CSIRO and universities), although there are exceptions. Non-industry groups tend to have a broader-based and more pro-active approach to R&D, rather than one more directly related to specific company interests and in response to immediate problems affecting the company. Some companies may even fund research by non-industry groups. Company strategies to exploit technological change include having staff who keep up to date with technological developments worldwide by interacting with researchers, maintaining knowledge of the scientific literature, attending appropriate technological and scientific conferences and having an active, broadly based R&D department within the company. Better resourced companies are best able to implement measures to counteract and even exploit technological change.

The Botanical Food Company made the most of 'cold capture' technology when it produced its range of gourmet herbs and spices in a tube. Using this new technology, the herbs and spices are not precooked or dried when they are processed so they retain their flavour.

REVIEW QUESTIONS

Remember

1. Summarise the responses to technological change that food manufacturers may make in relation to their food product development activities.

Apply

2. In the following scenarios, state how the company could have prepared better for these external influences.
   a) Janette borrowed a lot of money to set up a manufacturing business making gourmet dog food. The economy was at the end of a boom period. The Reserve Bank raised interest rates to curb spending in the economy. Janette passed the extra interest rate costs on to consumers in the form of higher prices for her dog food, but there was only so much consumers were willing to pay. Janette's business nearly went bankrupt.
   b) John ran a food manufacturing plant and resisted local calls to stop the plant emitting so much smoke into the atmosphere. In the end, locals raised media awareness of the issue and called for John's food products to be boycotted on the supermarket shelves.

Do an activity

3. Log in to **www.jacplus.com.au** and locate the *Food business and environment* weblink for this chapter. Search the internet or look in newspapers for an example of a business in the food industry that has tried to ensure its practices are more environmentally friendly.

eBookplus

Weblink

Internal factors that affect food product development

Internal factors relate to the **micro-environments** and are mostly within the manufacturer's control. These internal factors include the expertise of personnel, production facilities, the company's financial position and company image. Such factors can have a major impact on the success or failure of a company's new products. It is also important to remember that internal factors, such as staff or production facilities that were used in the past, may not be easily adapted to suit every new product concept. Control of micro-environmental factors is generally achievable but is often costly. A company must be aware of its own status regarding each internal factor and carefully consider its likely impact on the success or failure of any new product concept.

Now we will examine each factor and its importance to company decisions about introducing new products.

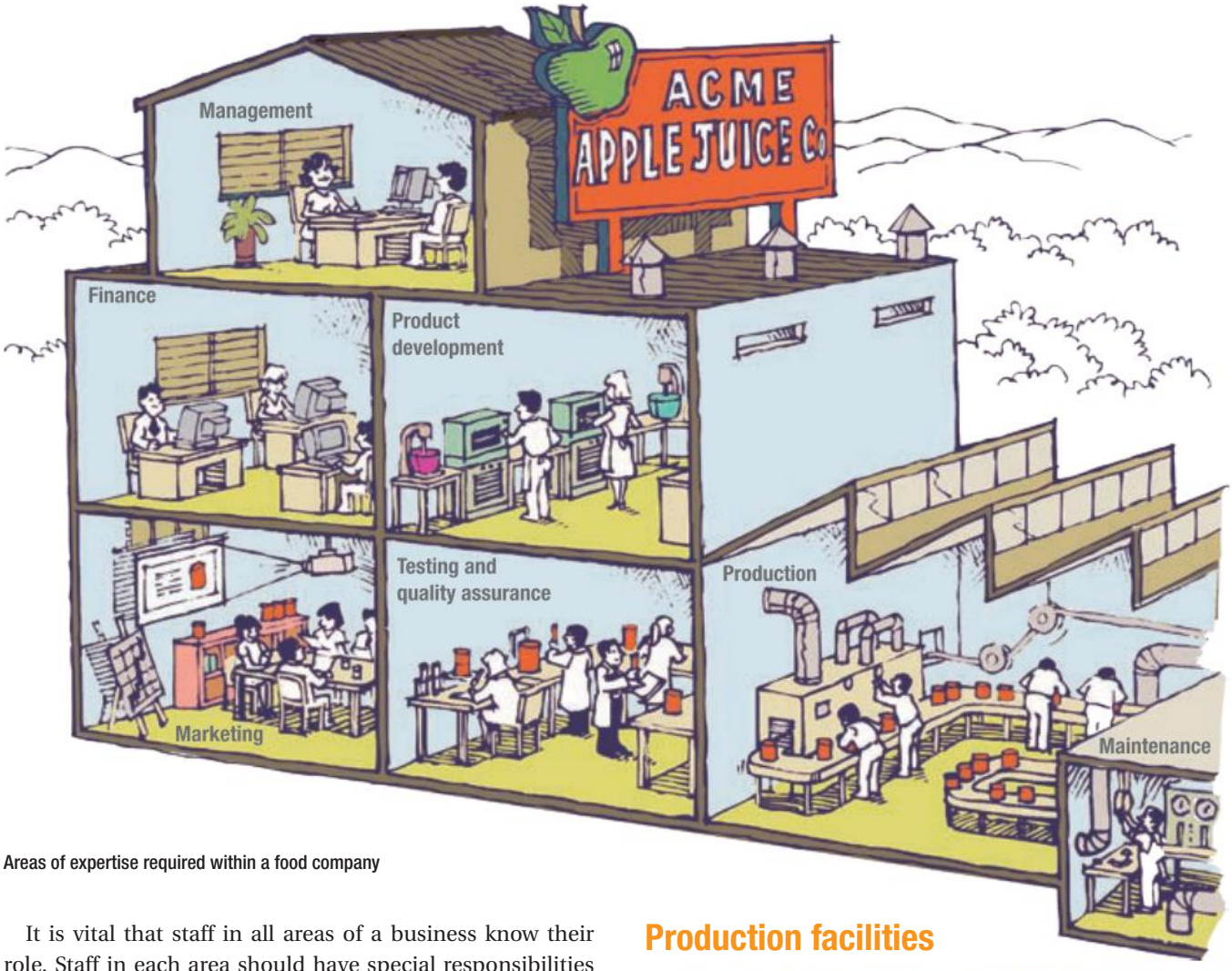
Personnel expertise

The expertise of staff is crucial to the operation and development of a business. The personnel (staff or human resources) employed by a food company include some or all of the following:

- production staff on the factory floor
- financial staff
- marketing and sales staff
- purchasing staff
- product development staff (sometimes called R&D staff)
- product testing and quality assurance staff
- maintenance and engineering staff
- management staff
- company directors
- product distribution staff
- warehouse staff.

Food technologists help in the development of new food products. They not only need to know the technical aspects of food manufacture, but they also consider a range of factors such as available technology, convenience, media coverage, regulation and global competition.

The skill levels of workers have a direct effect on what can be produced. These days, many workers are required to be **multi-skilled**; this allows greater mobility within and between staff categories and greater flexibility within company operations, with related advantages for both the company and its staff. It should also be recognised that, while competence in hands-on tasks is crucial, other skills such as leadership, planning and operation, decision making, task management, written and oral communication, initiative, integrity, company loyalty and the ability to work collaboratively with other staff are very important, especially among more senior staff. While formal training can provide a broad outline of these skills, experience, capabilities and personality characteristics dictate the level of these skills for individual employees.



Areas of expertise required within a food company

It is vital that staff in all areas of a business know their role. Staff in each area should have special responsibilities and functions as well as specialised knowledge, experience and training at a sufficient level to allow optimum performance. Training may be achieved by courses at educational institutions (such as schools, TAFE and universities) or by internal company training. It is increasingly common that training requirements for individual employees change due to issues such as technological advances, changes in position within a company (promotion), career path shifts, and movements within and between companies.

The impact of any change on what is produced or the production process may affect staff in the following ways:

- Production workers need to be able to work with new technology to manufacture new products.
- **Quality assurance** staff need to develop specifications for new raw materials, quality standards for new products and processes, and new analytical methods.
- Marketing staff must have the versatility to promote new products, often to new and different markets.
- When making decisions about new products, a company must be aware of existing staff strengths and weaknesses and address any shortcomings either by training or by employing new, appropriately qualified personnel. Should the company decide not take this sort of action, it may be advisable not to introduce the new product.

Production facilities

Peas being packaged in foil containers. The production facilities needed to present food for aeroplane passengers are different from those needed for serving meals at a local cafeteria.

Production is the mechanism whereby raw materials are converted into final products for the market. It is very difficult to produce any food product with the wrong equipment — try cooking a gourmet meal at a campsite and you'll experience the problem! Production facilities vary in

complexity, level of technology, output capacity and also expense. The levels of technology and complexity vary from very simple (such as fruit and vegetables packed into nets or plastic bags) to quite advanced (such as frozen meals, extrusion and ultra-heat treatment). Larger companies often use a mixture of production technologies, while smaller ones may depend on just one, often simple, process. In general, the complexity of equipment is related to specific products and processes, output volume and the financial status of the company.

Several types of processes are used for commercial food production. Each of these requires certain labour skills and technology. Decisions to introduce a particular method of production should take into account issues such as production technology complexity and market size. These are listed in table 13.2.

Financial position

A company's financial position is a major factor in the type of equipment it can afford and hence its product range and new product development activities. The financial position of any company includes the value of its assets (cash, property, equipment), its cash flow, profit-and-loss balance, value of its shares (for public companies), amount of borrowings or loans to others, interest rates, equity in other companies and property, value of stock on hand, market share, product range and other aspects that vary between companies. Financial position is an important factor affecting the ability of a company to compete in the **marketplace**. A strong financial position gives a company an advantage over its competitors in marketing, advertising, product range, its ability to counteract macro-environmental factors, and product development.

Company image

Public perception of a food company is a result of the company's image, which generally evolves over years of operation. It is often a result of strategies, products and market that were chosen deliberately by the company, but it may also develop as an unintended outcome of long-term operation. Company image is reflected mainly in its market segment and consumer attitudes towards the company. It may develop through some of the following factors:

- consumer perceptions of product quality
- prices
- form and convenience of products and packaging
- market availability
- labelling.

Before trying to change its image, a company should consider carefully any possible consequences. For example, a company with an image as the producer of expensive, high-quality products should investigate the possible effects of marketing cheaper products before attempting to do so. Conversely, a company with an image relating to cheaper products should evaluate possible effects of trying to enter the luxury product market. Any misinterpretation of potential outcomes of changes to company image could lead to new product failure and reduced profits.

TABLE 13.2 Food production methods

TYPE OF PRODUCTION	DESCRIPTION	ADVANTAGES
Continuous production	• Used by many multinational and larger companies • Continues 24 hours a day, 7 days a week • Generally uses expensive, high-technology equipment.	• Fewer production staff needed • Consistent quality maintained by automation.
Mass production	• Used for foods where production technology is simple, such as simple mixing and packaging of ingredients • Used where assembly of pre-made components is required to make the product • Generally uses equipment based on advanced technology and highly trained production staff.	• Fewer production staff needed • Consistent quality maintained by automation.
Batch production	• Commonly used by Australian food manufacturers because local market requirements are small by international standards • A batch is the quantity produced in a single production run (generally in small quantities) • Example products include canned meat and vegetables, baked beans, spaghetti, jam, ice-cream, sauces and cheese • Disadvantages include low production volumes, low process efficiency and relatively high costs.	• Uses general-purpose, versatile equipment and medium-skilled staff.
One-off production	• For single item or few items made for specific customers (sometimes called 'jobbing') — for example, specified confectionery product, birthday cake designed specifically for the customer • Viability depends on compatibility of product with existing products and equipment, in-house expertise and costs.	• Custom-made product may fetch a high price.

Company responses to internal factors

Internal factors are within the control of individual companies who can adopt measures to minimise the impact of changes to the micro-environment. To a large degree, the capacity of a company to do this is related to its size, structure (product range, number of employees, private company or public company, local or multinational, part of a franchising operation), nature of its operations, product range and resource base (number and size of assets, financial resources, shareholders). Given these parameters, what can companies do to minimise the effects of internal factors? This varies between companies and depends on the factors listed on page 257.

Possible measures for each internal factor are listed below.

- *Personnel expertise.* The level of necessary training and technological skills for personnel varies between companies. Even where the required skill levels are relatively low, the impact of advances in processing technology, ingredients, new products and processes, government regulation, marketing strategies, product distribution, packaging materials and equipment, and consumer expectations and demands, mean that company personnel may need to improve their skills. A company can address this issue by two main methods. First, it could recruit better trained, qualified staff experienced in current technology relevant to the company's products and processes. A company adopting this strategy should be aware of potential industrial problems and have contingency plans in place. For example, replacement of existing staff by better qualified personnel, and possible impacts on salary and working conditions, must be considered.

  The second strategy for improving technical skills involves further training of existing staff. This may be achieved through courses at educational institutions (schools, TAFE and universities) or by internal company training initiatives. Both approaches have implications for salary, working conditions and lost production during training. These issues must be considered when training alternatives are explored by a company.

  The important points regarding improving staff skills are that this is necessary for all categories of staff (management, R&D, marketing, purchasing, production workers etc.) and that there are significant economic factors, including costs of training programs, to be considered. Hence, the financial status of the company is a major determinant of decisions about the subject matter, the duration and the means of delivery of training programs.
- *Production facilities.* Advances in processing technology, processing output, increased production efficiency and changes to product range and government regulation may need to be addressed by the acquisition of newer, improved facilities. These facilities include production equipment, factory area and its quality, storage, transport vehicles and office area. This applies especially to new products that require the company to improve its facilities, and it has serious economic implications since it requires a large financial commitment. Obviously, companies in a good financial position will be better able to improve facilities.

  Companies have several options for improving their facilities. These include purchasing new facilities funded by internal company finances, borrowing or leasing of facilities, and outsourcing production to an external organisation with the required facilities. Before selecting the method for acquiring new facilities, a company must evaluate the costs and benefits involved. If the benefits are small and the costs are high, it may be better to defer improving facilities. Should there be large benefits, a company must identify the most suitable method of acquiring better, or expanded, facilities. Direct purchase with company finance may be a resource drain in the short term, but the company will own the asset. Borrowing to buy facilities alleviates the immediate drain on company finances but leaves it with an asset that is encumbered by debt and the obligation to repay that debt plus interest; this represents a continual and often long-term drain on company funds. Leasing facilities is usually a cheaper option than purchase, but the company never owns the facility and it has a recurring lease payment obligation. The advantage of leasing is that often the owner of the leased facility is responsible for its repairs and maintenance. Outsourcing applies mainly to transport of goods or their manufacture. This may be economically better for a company in that the external organisation is responsible for payment and management of its staff. On the other hand, the company must recognise that the manufacture of its products is, in varying degrees, outside its immediate control.
- *Financial position.* Most companies wish to improve their financial position. Achieving this needs fairly drastic action involving at least one of several strategies. The feasibility of such strategies depends very much on the company itself, and some strategies will not be suitable in all instances. A company may seek to improve its financial position by increasing profitability by, for example, increasing market share (by introducing new products and using stronger marketing initiatives), increasing efficiency (through upgraded equipment and technology, and staff training), reducing staff and taking other cost-cutting measures. A second approach is to borrow money, which has to be repaid. Other strategies include mergers or takeovers involving other companies, generating funds through the release of more shares (public companies only) and seeking extra capital inputs from new or existing business partners. Another strategy is the sale of unneeded assets. All such approaches to improving financial position have associated problems, and the company needs to decide if it is necessary. Careful consideration of individual strategies

is necessary to determine which strategy, or combination of strategies, best suits the company. A company may do a **SWOT** analysis of ways to improve its financial position (see table below).

Coca-Cola has an image that is recognised around the world.

- *Company image*. The image of a company is within its control but changing it has a number of associated risks. For example, the existing market for a company is largely dictated by its image; if the market is seriously compromised by a drastic change to company image, it must replace this market with another group of consumers. A company needs to analyse the effect of an image change on profitability, market share and market opportunity and determine whether it would be beneficial. It then needs to select the appropriate strategy. A company might move into entirely new markets by changing its product lines; the difficulty here is that consumers relate to a company via its established product lines and often do not accept a different product category. Success with this strategy ultimately relies on aggressive marketing and promotional action by the company. A company may decide to release new products that differ radically from its existing ones. These new products may come from internal development or by some form of licensing of products already in existence. Other examples of changes to company image include moving from supplying ingredients to selling finished products, and expanding from chilled products to frozen goods.

Company image may also be altered by mergers with, or takeovers of, other food companies. In this case, changes in company image will generally reflect the image of the company that has been taken over or merged with. The key to changing company image relies on careful analysis of company needs, selection of the lowest risk strategies to achieve the change and careful assessment of possible impacts of change on existing company markets.

SWOT analysis of factors that affect food product development

Strengths, **weaknesses**, **opportunities** and **threats** (SWOT) analysis is the single most useful and relevant way of assessing the likely success or failure of a new product concept. It may be applied to a broad range of situations, such as transport to and from work and purchase of new homes and cars, as well as to more complex issues. Since this chapter deals with factors affecting new food product development, discussion will focus on this aspect of company operation. Following the definition of SWOT components, we will examine a case study.

TABLE 13.3 SWOT analysis

STRENGTH OR WEAKNESS (HAS THE COMPANY GOT AN ADVANTAGE OR DISADVANTAGE?)	OPPORTUNITIES	THREATS
• Marketing/company image • Financial resources • Size and skill of workforce • Production facilities and costs • Distribution and storage methods • Innovative new product • Capacity to do research and development • Time required to produce and launch product • Competing companies	• Potential market for the new product • Consumer trends that assist promotion of the new product (e.g. health concerns) • Competitors' success in market • Technological developments related to processing methods • New ingredients and raw materials (e.g. genetically modified animals and plants, imported raw materials) • Factors related to borrowing for equipment and extra staff needed to manufacture the new product	• Symptoms of economic downturn • Impending changes in government policy regarding such issues as taxation, industrial relations, import/export tariffs and food regulation • Nature of competitor companies

Company responses to SWOT analysis

Bush tucker is now an industry in its own right. Here, bush food pioneer Vic Cherikoff shows his range of bush food products. A SWOT analysis should be done before developing any new product, and this might include an analysis of an entire industry, such as the bush food industry.

How can a company respond to the results of a SWOT analysis on a specific new product concept? A quick, easy and obvious response may be that the company abandons the new product concept completely. The impact of a poor SWOT analysis outcome on a new product concept must be seen in the context of the company's need for new products. If continued operation of the company is under threat without an expanded product range, then a company should review all factors involved in the SWOT analysis, as well as the new food product concept itself.

Major parts of the individual SWOT components relate to both internal and external factors affecting new food product development. Therefore, close consideration of the SWOT components may identify company responses that would improve the analysis. These responses may change the original new product concept or lead to further responses involving both external and internal factors. The SWOT analysis below (table 13.4) was prepared for the Australian bush food industry by the Rural Industries Research and Development Corporation.

REVIEW QUESTIONS

Remember

1. List the internal factors that can affect food product development.

Apply

2. Identify the internal factors affecting food product development in each of the following examples. State how any internal problems can be fixed.

a) A new cafeteria has been opened in a busy local shopping centre. The food is organic and made on the premises. An 'outsider' is given the task of checking quality. The meals looked fantastic and the claim that only organic produce was used was true. However, it took over 20 minutes for an ordered meal to be served.

TABLE 13.4 SWOT analysis for the Australian bush food industry

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
• No need for pesticides — clean and green advantage • Functional food aspects of many products and perception of products as healthy • Strong links to value adding • Industry members strongly engage with research as being important for the industry development • Establishment of an industry peak body • Breadth of products which can be produced from Australian native foods	• Consumption by a sub-set of the population is not recognised as evidence for GRAS (Generally Recognised as Safe) listing • HACCP is inconsistent with organic certification • Association of native food cuisine with bush tucker and traditional indigenous diet rather than as new tastes for Australian cuisine — lack of awareness in the market of the products available, no shelf presence • The difficulty of getting consistent test results from laboratories • Lack of agreed standards for the products • Breadth of products which can be produced from Australian native foods • Current fragmentation of the industry • High cost of bringing new products to market	• Food manufacturers and chefs seek innovation and product differentiation • Current EU ruling on novel foods is being revised — may provide scope to include native foods as traditional not novel • DAFF action on listing native foods in the CODEX • Engaging with indigenous communities to better explore opportunities and functional food properties • There is a considerable amount of knowledge on how to grow native foods that is not being shared and could be • Seasonality of overseas producers	• Need for testing to meet regulatory requirements and general emphasis that other foods in long-term use have not been subjected to • Potential for greater market access requirements in the future • Concerns about the sustainability of wild harvest • Potential for states to enforce royalties on use of germplasm and wild harvest • Access to native title lands for cultivation e.g. bush tomato • Australian native plants are being produced in other countries e.g. Wattleseed in Africa • Food safety concerns with processed and fresh product — a 'scare' episode impacts on all producers • Need to manage perceptions of resources used per kilogram of edible product; it is important not to create unrealistic expectations

Source: Rural Industries Research and Development Corporation.

b) A new product called a cheesy scroll has just been developed and marketed. Large billboards show an elderly man biting into the scroll with cheese oozing out of it. He is smiling and says: 'you only live once'. The new product is aimed at the teenage market.

c) Jessica wants to produce a luxury chocolate ice-cream for a niche market in her local area. She investigates the equipment required and, even though it's expensive, she wants to invest in equipment so she can use the continuous method of production.

3. Explain why the right equipment is crucial for food product development.

Do an activity

4. Choose a company and describe how it creates an image around a particular food product. State what market the company is targeting and what marketing methods have been used to create the image. Do you think this food product will remain in the market for the next 10 years? Provide a reason for your answer.

5. Log in to **www.jacplus.com.au** and locate the *SWOT analysis* weblinks for this chapter. Use a SWOT analysis that has already been compiled to answer the following questions.

a) State why the SWOT analysis was done.

b) Give examples of two strengths and two weaknesses described in the SWOT analysis.

c) Explain why it is crucial to consider both opportunities and threats when deciding to produce a new food product.

eBook*plus*

Weblink

CASE STUDY

NEW FOOD PRODUCTS

A few years ago, one of Australia's biggest food companies, Goodman Fielder, produced a new margarine that included an ingredient they called Logicol. The company started with margarine, and having had success with that decided to produce muesli bars, yoghurt and salad dressing. There was good evidence to support the benefits of the margarine product and it got the tick of approval from the Heart Foundation. The other products, however, relied on 'post-market approval', riding on a wave of success from the margarine, but were taken off the supermarket shelves because Goodman Fielder had failed to recognise recently introduced food standards.

Each year hundreds of new products make it on to supermarket shelves and some become household names, but others become discontinued lines for many reasons. While developing new food products is a risky business, according to editor Julian Mellentin of the English magazine *New Nutrition Business*, Australia makes a great test market for lots of companies, '. . . because it's a fairly westernised country with a westernised diet, but it is physically isolated, and therefore you can try out a product there. You can work perhaps just in two or three big cities, and not have any risk of overspill into your main markets back home in Europe or the United States'. Mr Mellentin also says that Australians are [more] willing to try new tastes and ideas and are prepared to experiment with new brands compared to people in parts of Europe where they have a more conservative food culture.

OUTCOME TASK

Students learn to:

- analyse commercial practices in terms of a food company's response to the macro- and micro-environments
- conduct a SWOT analysis to identify strengths, weaknesses, opportunities and threats.

Contributes to the following outcome:

- justifies processes of food product development and manufacture in terms of market, technological and environmental considerations.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food product development* to complete the tasks ahead.

Choose one of the following outcome tasks.

Outcome task 1

1. Undertake some research on the internet and describe the advertised benefits to consumers offered by Logicol. Explain why you think Logicol has been so successful when many new food products fail within the first two years.

2. Summarise how both the product Logicol and the company may have been affected by the four external factors: economic, political, ecological and technological environment.

3. Visit a supermarket and identify a recently introduced food product.

a) Describe the product and name its manufacturer and brand name. Is the manufacturer a local, overseas, multinational, private, public, large, medium or small company?

b) Name any existing similar competing products and list characteristics of the new product that distinguish it from its competitors (such as price, packaging, convenience and claimed health benefits).

c) List the ingredients of the product, the process involved in its manufacture, its recommended storage conditions (such as temperature) and its packaging form (such as can, carton and plastic film).

d) Is the product manufactured locally or imported? Are its ingredients from local sources or imported?

e) List external and internal factors that could have affected the development and release of the new product.

f) List possible company responses to the external and internal factors that could have affected the development and release of the new product.

g) Draw up a table identifying what you think may be the strengths, weaknesses, opportunities and threats involved in producing the new food product you have chosen to investigate. Briefly discuss the responses the company may have made in response to the SWOT analysis to maximise success of this new product.

Outcome task 2

The following activity involves visiting a website to gather information about a food manufacturer, with specific reference to external and internal factors affecting food product development, manufacturers' responses to these factors and SWOT analyses. During this activity, students may work alone or in groups of not more than three.

Log in to **www.jacplus.com.au** and locate the *Food manufacturers* weblinks for this chapter. Select a company from the weblinks, or any other you may wish to learn more about.

Report the name of the company and its website. Provide the following specific information about the chosen company from its website:

a) Is the company Australian or foreign owned?

b) Is it a private or public company?

c) Is the company aiming to expand its market share?

d) What are its product range and production levels?

e) What are its brand names?

f) Does it import products or are all of its products manufactured in Australia?

g) Does it use local or imported ingredients?

h) Does it manufacture all its products itself?

i) What company image is suggested by the website?

j) What company policies regarding environmental issues, training for its staff, employment (including salaries, working conditions, equal opportunity and gender equity issues), marketing, product distribution and advertising were indicated on its website?

k) What are the financial status and size of the company?

l) What is the nature of its new product activity?

m) Does it use SWOT analysis in its decision-making procedures for developing new products?

Note: All these details may not be available from a company's website, so you may need to find this information elsewhere.

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Weblink

CHAPTER 13 SUMMARY

- New food product development is affected by external factors (macro-environment) and internal factors (micro-environment). A company should have strategies in place to respond to internal factors, which are more within the company's control, and external factors, which are more difficult to plan for.
- The following external factors can affect product development:
  - *economic environment.* The state of the economy can affect product development. Changes in interest rates and inflation rates, foreign exchange and tax rates as well as wage agreements, salary levels, drought and natural disaster can influence new product development.
  - *political environment.* Federal, state and local laws affect food product development. Lobby groups and consumer activism are also external factors the company needs to be aware of.
  - *ecological environment.* Pollution, land degradation and inadequate waste disposal are problems that need to be taken into consideration when producing food.
  - *technological environment.* Advances in science, such as genetically modified foods, can affect new food product development.
- Internal factors that affect food product development include personnel expertise, production facilities, financial position and company image.
- Both external and internal factors affecting food product development depend on the size of the company, the company structure (private or public company) and the resource base of the company.
- It is crucial that a food manufacturer can assess the likely consumer acceptability, technological and economic feasibility and market success of a new food product.

KEY TERMS

automation
boom
contraction
expansion
external factors
extrusion
food additive
Food Standards Australia New Zealand (FSANZ)
genetic engineering
genetically modified
internal factors
macro-environment
marketplace
micro-environment
multinationals
multi-skilled
opportunities
private company
public company
quality assurance
recession
strengths
SWOT
tariff
threats
vegetarian
weaknesses

Chapter 14
Reasons for and types of food product development

Imagine you entered a time warp and found yourself living in the 1960s. Fashion, television programs and schools were different then, and so was the food that was eaten. Trends in food produce change — just like fashion, there is a constant stream of new food products on supermarket shelves every year. What factors convince food manufacturers of the need to develop new products?

In this chapter you will learn about:

Reasons for and types of food product development

- drivers of the development of food products:
  - market concerns such as health and the environment
  - consumer demands such as convenience and cost
  - technological developments such as processing equipment and packaging materials
  - company profitability such as increasing market share and entering new and non-traditional markets such as Asia
  - specialised applications such as military purposes and space missions
- types of food product development:
  - line extensions
  - me-toos
  - new-to-the-world.

Do you recognise any of these beverages? How many of these can be classed as new products? Can you identify reasons why the new beverage products were successful or not on the consumer market?

Trends within the Australian community

What is a trend? A trend is a swing in community attitudes which defines current styles of preference. Community trends arise from different causes. A good food manufacturer will recognise and understand these trends, and apply them to the process of development and the marketing of new food product concepts. Changes in the following may be considered when developing and marketing new food products:

- Australia has an ageing population.
- Australians are eating outside the home more.
- Australians are consuming more home-delivered meals, for example, pizza.
- The awareness of health and diet-related issues is increasing.
- Community environmental awareness is increasing.
- We live in a multicultural society which increases our exposure to foods eaten within different cultures (see chapter 1, page 8).
- Changes in lifestyle are leading to altered levels of physical activity and exercise.
- Busier lifestyles lead to less time for food preparation in the home.
- Australians are becoming more adventurous with the types of food and the range of flavours being consumed (for example, Asian, Middle-Eastern, Indian).
- Households are becoming smaller, with more people living alone.

The availability of sushi, a Japanese delicacy, has increased throughout Australia. This is a direct consequence of multicultural and adventurous trends occurring within contemporary Australian society.

Manufacturers of new food products try to target certain groups in the community. This may be based on demographic features, such as our age or the amount of income we earn, or it may be based on psychological factors as described in the table below.

TABLE 14.1 Target markets for Australian consumers and some of their characteristics

TYPE OF TARGET MARKET	CHARACTERISTICS OF TARGET GROUPS
Demographic (measurable statistics)	Age Income Occupation Gender breakdown Education levels Purchasing power and spending habits
Psychological (likes/dislikes)	Lifestyle preferences such as city or urban Reactions to a similar product Products they demand Taste preferences Product presentation preferences Decision-making responsibility Importance of convenience and time-saving options Unmet needs Media exposure
Benefit (advantages for the consumer)	Product may offer luxury, comfort, value for money, pleasure, health benefits
Geographic	Residential or business location of target group

The table below shows how age can reflect the type of food products desired.

TABLE 14.2 Australian consumer market segments based on age group and appropriate food types for each

MARKET SEGMENT	FOOD TYPES
Babies	Small serves, soft foods
Children	Play foods and interesting food snacks
Adolescents	Social foods, snacks, convenience foods
Adults	Convenience foods, health foods, new food concepts
Elderly	Foods high in calcium, easy-to-prepare foods

How have food manufacturers responded to the needs and concerns of individual **market segments** in Australia? This can be answered by studying the table below which lists the market segments, the specific needs and concerns of each segment, and the foods developed to address them.

REVIEW QUESTIONS

Remember

1. Name one food item that you ate when you were younger but do not eat any more. Explain why you do not consume it any more.

Apply

2. Circle the segment of the market that the food manufacturer is trying to target by selling caviar.
   Budget-conscious consumers Mothers High-income earners
3. Which segment/s of the market is being targeted by manufacturers of each of these products?
   a) Foods that contain less fat, salt and sugar
   b) Frozen meals
   c) Generic (No Brand) foods
   d) Breads enriched with Hi-maize

Do an activity

4. Visit a supermarket and select three products that you believe were developed in response to the trend towards busier lifestyles. Explain how each of these represents a food manufacturer's response to this trend.
5. Interview three people on how they feel about trying new foods. Ideally, one person should be around your own age, one about your

TABLE 14.3 Australian market segment needs and expectations, and foods developed by manufacturers to meet these needs

SPECIAL NEED	MARKET SEGMENT	FOOD SOLUTION
Weight reduction	Obese people	Low-fat food, low-energy food, 'lite' foods
Diabetic food	Diabetics	Sugar substitutes
Lactose-free food	Lactose-sensitive people	Lactose-reduced milk
Milk substitutes	People with allergic reactions to milk	Soy milk
Food that minimises heart attack risk	People with high cholesterol	Low-cholesterol food, low-salt food, food low in saturated fat, high-fibre foods
Food for people with gluten sensitivity	People with coeliac disease	Gluten-free food
Food in keeping with religious values	Moslems	Animals killed according to Islamic law
'Clean' food	Jews, Moslems	Pork-free food
Kosher foods	Orthodox Jews	Food prepared according to Jewish law
Meat-free meals	Vegetarians	Meat analogues
Ethnic foods	Ethnic groups	Indian food, Italian food, Chinese food, Thai food
Conservation of forests	Professional people who lead busy lives	Recyclable packaging
Safety of baby food	Mothers	Tamper-evident seals
Microwave food	Professional people who lead busy lives	Precooked frozen dinners
Economy food lines	Budget consumers	Generic foods, house brands, promotional deals
Party food	Socialisers, home entertainers	Multishot packs, party packs
Caffeine-free diet	Health-aware people	Decaffeinated coffee, coffee substitutes, caffeine-free drinks

parents' age and one about your grandparents' age. In your interview find out:

- what types of food they currently eat
- if their diet has recently changed significantly
- if they are likely to consume different foods
- what new types of food they would like to consume.

a) What differences in eating habits were apparent between the three age groups?

b) How could a food manufacturer use the information above when selecting a new product concept for development?

Reasons for the development of new food products

A successful manufacturer will know why a product is being developed for markets. There are various reasons or 'drivers' of new food product development.

Market concerns such as health and the environment

An examination of supermarket shelves shows many food products that are marketed on the basis of health-related claims. Special products of this type are called **functional foods**, which are designed to promote various aspects of consumer health — these may include products such as yoghurt or foods fortified with vitamins or other nutrients. Manufacturers may also change packaging types in response to consumer concerns about environmental pollution, convenience, non-biodegradability and non-recyclable properties. Any food manufacturer who does not respond to such consumer concerns does so at their own risk!

Consumer demands

Most people want convenient foods at a low price. Hence, price and convenience are useful new product characteristics that assist food manufacturers with competitiveness and marketing. To some degree, these two characteristics may cancel each other out since a product with in-built convenience usually costs more to manufacture, while lower cost products generally have no, or limited, in-built convenience. So, a manufacturer needs to assess carefully its target market before designing convenience features into a new food product. Alternatively, some compromise may be reached between the level of convenience and retail price. Other consumer demands include dietary preferences, preparation methods, different packaging sizes, the use of organically grown ingredients, local as opposed to overseas products and ingredients, and cultural preferences.

Technological developments

Technological developments include novel ingredients and raw materials, advances in processing equipment and methods, biodegradable or recyclable packaging and

A range of functional foods are available on supermarket shelves in Australia. Have you tried any of these products?

active packaging (see chapter 11, page 221). Technological developments present food manufacturers with a range of new product opportunities, greater efficiency, economic advantages, and products of greater appeal and acceptability to consumers.

Novel ingredients used in Australian food products include fat and sugar replacements, fibre supplements such as Hi-maize, and indigenous, or bush, foods such as kangaroo, emu and crocodile meat. One novel ingredient, Logicol, was discussed in chapter 13. It should be noted that approval from FSANZ must be obtained before new ingredients are used in commercial food production. Of recent interest is a fat replacement know as 'olestra'. It has been approved for use in the USA but is yet to be approved for use in Australian foods. Olestra is a good example of the problems, real or merely perceived, which may arise with new ingredients.

Advances in processing equipment and technology have included **extrusion** and ultra-heat treatment (UHT, especially for milk products). It should be noted that in Australia, new manufacturing processes also require approval from FSANZ before they are used to produce food for consumers; one example is the use of irradiation in food processing. Past, present and future developments in food processing technology are summarised in table 14.4. As a reference point in time, the canning process was developed for food processing by Nicolas Appert and published in his book in 1810. Clearly then, recorded developments in food processing technology have been in progress for about 200 years.

CASE STUDY

ARE THOSE CHIPS THE PROBLEM?

Food manufacturers are keen to offer low-fat alternatives to health conscious consumers, so it is not surprising that 'olestra', a substitute for fat that contains no calories, was used in the making of potato chips and various other snack foods in America. The Food and Drug Administrator (FDA), however, received around 20 000 complaints from consumers who claimed that they suffered gastrointestinal discomfort after consuming products containing olestra.

The FDA's response to the complaints was that all foods containing olestra had to contain a warning on the package stating that consuming olestra may result in stomach cramps and diarrhoea. Not surprisingly, this warning reduced sales. The company which makes olestra, Procter & Gamble, claimed their product was safe and that it was a coincidence that so many consumers fell ill after eating the product.

The FDA commissioned a study of the effects of olestra by monitoring 3000 chip eaters over six weeks. Half the chip eaters ate chips containing olestra and half ate chips that did not contain the fake fat. While it was found that the group who ate the chips containing olestra did have more frequent bowel movements, the difference was so slight it was clear that there was little evidence to suggest the health warning on foods containing olestra was warranted. The requirement that all products containing olestra display a warning on the packet was lifted in 2003.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *novel foods to Australia* to complete the tasks ahead.

1. List and describe health-related problems that have been attributed to olestra.
2. Despite the assurances that olestra is fine to eat, would you eat it? Why or why not?
3. Using the internet, search for information under the title of 'olestra' or its commercial name 'olestan'. From the information you find, answer the following questions:
   a) What is the chemical nature of olestra?
   b) What are its function and benefits in foods?
   c) What are its proposed uses in foods?

TABLE 14.4 Past, present and future developments in food processing technology

PAST DEVELOPMENT (FOOD PROCESSING BEFORE THE NINETEENTH CENTURY)	BRIEF DESCRIPTION
Chilling	Storage of foods between 0–4 °C to discourage microbial growth
Dehydration	Moisture removal to discourage microbial growth
Anti-microbial additives	Chemical agents kill or inhibit microbes in food
Infusion techniques	Use of water or oil, in which herbs and spices have been soaked, to give desirable flavours to foods
PAST DEVELOPMENT	**BRIEF DESCRIPTION**
Canning	Hermetic sealing of food in a can to keep out oxygen; food sterilised by heating to kill micro-organisms

PAST DEVELOPMENT	BRIEF DESCRIPTION
Pasteurisation	Preservation of foods by heating and cooling to decrease microbial numbers; products protected by packaging in some form of container
Freezing	Prevention of microbial growth by storage of food below –15 °C
Freeze-drying	Dehydration using a combination of freezing and high vacuum
Aseptic processing	Packaging of sterilised food in a sterile container to preserve it by ensuring the microbial numbers are very low; frequently stored at refrigerator temperatures
Retortable pouches	Similar to canning but using flexible packaging containers
Flash heat treatment or ultra-heat treatment	Heating of foods at high temperatures for short times, to destroy micro-organisms; allows storage at room temperature for six months or more
PRESENT DEVELOPMENT	**BRIEF DESCRIPTION**
Microwave technology	Ovens used to generate microwaves from electricity to heat foods to destroy microbes
Extrusion	Forcing of foods through small holes under pressure to decrease microbial numbers through heat; the foods are also shaped
Irradiation	Use of radiation from radioactive elements to preserve foods by killing micro-organisms
Biosensors	Sensitive devices used to determine substances and food properties in minute amounts
Chemical markers	Chemical barcodes used to identify food characteristics, to help control processes, logistics and inventory, and to check quality control and product authenticity
Robotics	Automated robot systems used for food processing and packaging operations; providing more reliability, greater speed and efficiency, and a reduced need for factory staff
Computerised processing	Computer control and monitoring of machine and worker performance, measuring devices, quality standards, production efficiency, and product safety during the process
Genetic modification	Development of new or improved plant and animal food sources by genetic modification (GM foods)
FUTURE DEVELOPMENT	**BRIEF DESCRIPTION**
High-pressure processing	Very high pressures used to destroy micro-organisms and retain product quality
Pulsed field technology	Use of short bursts of electricity for destruction of micro-organisms with minimal loss of food quality
Pulsed light technology	Short bursts of light used on the surfaces of foods and packaging to destroy micro-organisms with minimal loss of food quality
Radiofrequency fields	Radiofrequency fields used to heat foods for pasteurising and drying with little or no impact on quality
Biotechnology	Application of biological principles to processing and production situations

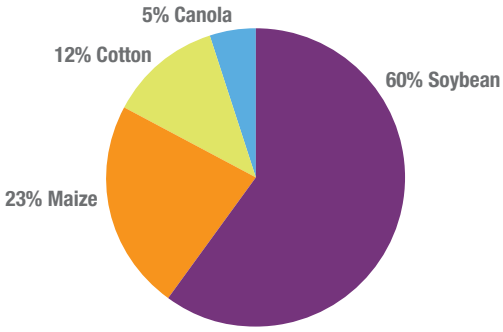
These disposable coffee cup lids change colour when they come into contact with steam or hot liquids; one of the many changes in packaging brought about by advances in technology.

New packaging technology has enabled faster, more consistent packaging of products, along with greater efficiency, decreased staffing requirements, improved **shelf-life** and quality maintenance, greater appeal and more convenience for consumers, and decreased environmental impact. Although it is perhaps more costly, active and **modified atmosphere packaging (MAP)** offers special benefits for extended quality maintenance and greater shelf-life, especially for fruit and vegetables.

Genetically modified foods

Of recent technological developments, **genetically modified** (GM) foods are the highest in profile and certainly have raised the greatest controversy. See the following chart showing the percentage of total GM crops grown, and traits introduced into crops by genetic modification (the data

refer only to the major GM crops currently produced; there appear to be no GM animals grown for the Australian consumer market yet).



Type of GM crop as percentage of total GM crop production in 2004

Source: Agrifood Awareness Australia, Biotech Bulletin 12, 2004.

The marketing of GM foods is subject to regulation in Australia. It is required that applications be lodged with FSANZ to gain approval to market GM foods. This is covered by Standard 18 of the **Food Standards Code**, which relates to the foods derived from genetically modified crops. Applications for approval of foods derived from GM crops are listed in table 14.5.

Recent technological developments

Although they have been recognised for many years, **organic farming**, **hydroponics** and **free range eggs** are three comparatively recent technological developments now used during on-farm food production. Organic farming involves plant and animal ingredients that are produced without the use of pesticides, hormones or artificial fertilisers. Hydroponics, developed recently compared to other growing

TABLE 14.5 Applications to FSANZ for use of GM crops and their potential food uses, the trait incorporated by GM technology and the identity of the applicant

CROP AND POTENTIAL FOOD USE	TRAIT	APPLICANT
Soya beans Soy foods, including soy beverages, tofu, soy oil, soy flour, lecithin. Other products may include breads, pastries, snack foods, baked products, fried products, edible oil products and special-purpose foods.	• herbicide tolerance: glyphosate • high oleic soya beans	Monsanto Optimum Quality Grains (Dupont/Pioneer)
Canola (rapeseed oil) Canola oil; may include edible oil products, fried foods, baked products, snack food.	Herbicide tolerance: • glufosinate ammonium and hybrid traits • glyphosate • bromoxynil	 AgrEvo Monsanto Rhone Poulenc
Corn Corn oil, flour, sugar syrup; may include snack foods, baked goods, fried foods, edible oil products, confectionery, special-purpose foods, soft drinks.	Insect resistance: • Bt Herbicide tolerance: • glufosinate ammonium • glufosinate ammonium (DLL25) • glyphosate Herbicide tolerance and insect resistance: • glufosinate ammonium and Bt (DBT418) • Bt-176 maize • Bt-11 maize	 Monsanto AgrEvo Monsanto Monsanto Monsanto Novartis Novartis
Potato May include snack foods, processed potato products and other processed food.	Insect resistance: • Bt Insect resistance and virus resistance: • Bt and potato virus Y (PVY) resistant (known as New Leaf Y) • Bt and Potato leaf roll virus (PLRV) resistant (known as New Leaf Plus)	 Monsanto Monsanto Monsanto
Sugarbeet May include any processed foods containing sugar.	Herbicide tolerance: • glyphosate	 Monsanto/Novartis
Cotton Cottonseed oil and linters. Products may include blended vegetable oil fried foods, baked foods, snack foods, edible oil products, small goods casings.	Insect resistance: • Bt-Cry 1 Ac gene Herbicide tolerance: • glyphosate • bromoxynil	 Monsanto Monsanto Monsanto/Rhone Poulenc

methods, is a method for growing plants, such as tomatoes, in nutrient solutions rather than in the ground with irrigation. Free range eggs are from hens that are allowed to remain in the open during the day rather than being kept constantly in battery cages.

These technologies have consumer appeal principally because of issues such as health, the environment and animal welfare. Food manufacturers and retailers often use this sort of technology to promote sales of traditional products such as eggs, fruit and vegetables.

Company profitability

All companies seek to improve profitability and usually can best achieve this by increasing market share. To do this, they may develop new products or enter new, non-traditional markets such as Asia. Other options include greater automation in production, reduced energy consumption, cheaper ingredients, aggressive marketing and advertising, staff reductions, and finding new markets for existing products. New product development is a very attractive way of increasing company profitability and is an important reason for companies to carry on this activity. The case study below discusses a company that has created unique products.

Despite rumours continuing for over 200 years, a US study has shown that Napoleon Bonaparte was not killed in a British assassination plot, but died of stomach cancer attributed to the bad food he consumed while in military service.

CASE STUDY

The Food Forest

A company named The Food Forest won the annual SA Premier's Food Awards in 2004. A major justification for them receiving the award was the company's record relating to its profitability. The company devised a model for sustainable land use, growing and harvesting a mixture of crops such as organic pistachio nuts and carob beans. Their other products include cider, wine, olive oil, free range geese, honey, and organic fruit and vegetables. The company owners attributed the profitability of their company to the development of value-adding systems and environmentally responsible equipment for storage facilities and energy generation. For example, the energy required by The Food Forest in producing 1 kilogram of food is about 20 per cent of the conventional benchmark. This arises from greater efficiency throughout company operations. The focus of the company has been on health and natural foods and, therefore, marketing has focused on targeting consumers who are health conscious.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *company profitability, special consumer market requirements and innovative food product development* to complete the tasks ahead.

1. List and explain aspects of company production and manufacturing operations that enable a good level of profitability.
2. Visit a supermarket or other retail outlet and choose one recently released product from two food manufacturers.
   a) List and describe your two chosen products, and name their manufacturers.
   b) Are the selected products similar to, or quite different from, each manufacturer's other products? In what ways are they different from the other products?
   c) Do you believe that the new products will have a major effect on the profitability of each company? Justify your opinion by describing how the new product will improve company profitability.

REVIEW QUESTIONS

Remember

1. Consumer demands may affect new product development. If a company doesn't produce the right food product, consumers won't buy it. List some of the attributes a food product may need to appeal to consumers.
2. Give an example of how technology has been used in packaging to create a better product.

Apply

3. Why does FSANZ need to approve GM products before they are marketed in Australia?

Types of food product development

When you visit retail outlets, especially supermarkets, the range of new, or recently released, food products can be overwhelming and confusing. This confusion is often increased by the bewildering range of advertising and marketing devoted to new food products on television, in the print media, and in retail stores themselves. How can we organise or categorise new products in a way that will assist understanding of the products themselves by consumers and manufacturers, and establish how and why they were developed? One way of getting an insight into this is to use a system based on a new product type. New products are sorted into one of three categories derived from concept generation and the development process:

- **me-too products**
- **line extensions**
- **new-to-the-world products**.

It is not always easy to put a new food product into one of these three categories — personal and company opinions, market perception, and the nature of the new product will affect the allocation of a new product into one of these types.

Me-too products

Me-too products are essentially direct copies, or with minor modifications, of existing products available on the market and manufactured by other companies. Probably the most prominent and successful example of this type of new

CASE STUDY

Space food

Astronauts do not have to eat specially formulated and packaged rations all the time.

Imagine going camping for over a week with several of your close friends. You would make sure you have plenty of food and the gear to cook and eat it with. The food would have to be stored properly and be non-perishable to avoid spoilage. After finishing your meal, or at the end of your camping trip, you would then stow all your gear and dispose of your trash properly just before the ride home.

Astronauts basically do the same thing when they go into space. Preparation varies with the food type. Some foods can be eaten in their natural form, such as brownies and fruit. Other foods require adding water, such as macaroni and cheese or spaghetti. Of course, an oven is provided in the space shuttle and the space station to heat foods to the proper temperature. There are no refrigerators in space, so **space food** must be stored and prepared properly to avoid spoilage, especially on longer missions.

Condiments are provided such as ketchup, mustard and mayonnaise. Salt and pepper are available but only in a liquid form. This is because astronauts can't sprinkle salt and pepper on their food in space. The salt and pepper would simply float away. There is a danger they could clog air vents, contaminate equipment or get stuck in an astronaut's eyes, mouth or nose.

Astronauts eat three meals a day — breakfast, lunch and dinner. Nutritionists ensure the food they eat provides them with a balanced supply of vitamins and

minerals. Calorie requirements differ for astronauts. For instance, a small woman would require only about 1900 calories a day, while a large man would require about 3200 calories. There are also many types of foods an astronaut can choose from such as fruit, nuts, peanut butter, chicken, beef, seafood, candy, brownies, and so on. Drinks range from coffee, tea, orange juice, fruit punches and lemonade.

As on Earth, space food comes in packages that must be disposed of. Astronauts must throw their packages away in a trash compactor inside the space shuttle when they are done eating. Some packaging actually prevents food from flying away. The food packaging is designed to be flexible, easier to use, as well as maximize space when stowing or disposing of food containers.

Source: Human Space Flight, National Aeronautics and Space Administration.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food for space missions* to complete the tasks ahead.

1. List the range of foods that may be available for consumption by astronauts during space missions.
2. List and briefly describe the foods that may be specially manufactured and packaged for consumption during space missions.
3. Discuss the main problems that astronauts would encounter regarding the disposal of food waste and food packaging.
4. A NASA-related research organisation has been asked to develop foods for consumption by astronauts going on space missions of three months' duration. There will be no refrigeration but temperatures and relative humidity are expected to be low during the mission. Remember, there will be low to zero gravity during this mission and, hence, when eating the rations.
   a) What food items would you include for the space mission?
   b) List the special characteristics of each item in the ration pack.
   c) What packaging forms would work best for this specialised application?

product is Pepsi Cola, which is a me-too of Coca-Cola. More commonly seen on supermarket shelves are the generic or no-brand product ranges. There are numerous other examples of where me-too products are labelled with the manufacturer's name and branded accordingly.

For me-too products such as Pepsi Cola, the manufacturer was attempting to exploit a successful product with an established market. The new manufacturer had identified a market opening that they could fill with the release of a similar product. The manufacturer of this type of me-too product will generally seek to compete with the original product head on, that is, in the same market and at a similar price and quality. This approach relies heavily on aggressive marketing, advertising and promotional activities, all of which are expensive and risky undertakings.

For the second class of me-too products, manufacturers may try to exploit a market currently filled by another company's product range, usually with a cheaper, or generic, product. Common instances of this include canned vegetables and soups, frozen desserts, soft drinks, snack foods and certain biscuit products. The development of these me-too products is generally easy and inexpensive since the processing methods are well known and ingredients must be listed on labels of existing products; it is usually only necessary to 'fine tune' the basic recipe on the label.

Manufacturers should also already have the appropriate equipment and staff for processing the me-too product. If they don't, then they need to either access the appropriate facilities by purchasing or leasing them, or by contracting another company to manufacture the product for them. The costs regarding these manufacturing options must be carefully assessed before a decision is made regarding access to processing equipment.

Manufacturers may also minimise costs by using less expensive ingredients, lower quality packaging, low-cost promotion and labelling (compare generic brand labels with those of established products), and by incorporating fewer convenience features in this class of product.

The greatest challenge for manufacturers of me-too products is that of marketing them against established successful 'originals'. In general, the marketing strategies employed are based on lower retail prices. To achieve these lower prices, it is essential that marketing, advertising and other promotional activities are kept at a low level for me-too products. As discussed above, exceptions to this include such products as Pepsi Cola where extensive and aggressive marketing action is in place.

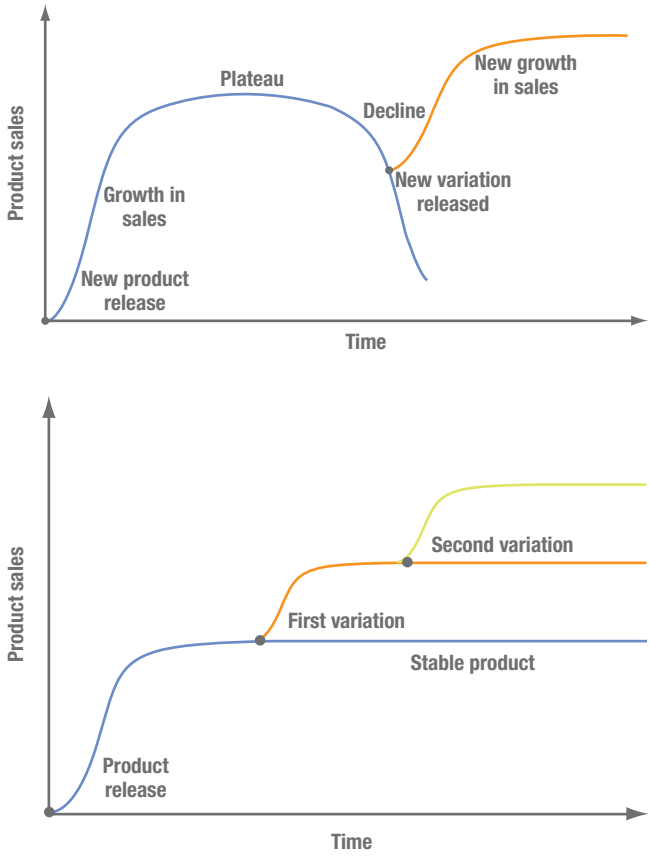
Line extensions

Line extensions involve relatively minor changes to extend the range of a company's existing products by

incorporating features such as new flavours, colours, health and diet-related variations, new forms of packaging and different serving sizes. It is not uncommon for a manufacturer to use a number of line extension strategies for the same basic product (for example, product X, product X with added Y, product X with added Y and extra Z). Why are line extensions of existing products developed by food manufacturers? There are several possible reasons, including:

- the market share of existing products declining over time, and changes to their characteristics may address this issue
- as a response to marketplace trends
- in recognition of new consumer demands and as a response to them
- the identification of a new market segment for the product
- the emergence of new processing technology and packaging
- the availability of new ingredients such as flavours, colours and health-related additives
- value-adding strategies for existing products.

This list is not exhaustive but shows factors that indicate to manufacturers the need for line extensions and how they may be created.



Product sales vs time on the market (life cycle) before and after introduction of line extension strategies

The charts below left show the beneficial effects of line extension developments on the sales of two different food products. The sales price history of the two food products is shown. For the first of these, product sales have gone into a decline and only then have been revived by line extension strategy. In the second example, a series of line extensions have been introduced at stages where product sales have reached their maximum and remained at this level. These line extensions have increased the volume of sales and, therefore, have been beneficial for the manufacturer on two occasions. The sales history of a food product is often referred to as **product life cycle**. This traces the growth, stationary and decline phases of a product's sales generation life on the retail market. A product's life cycle reflects its lifespan on the market and should not be confused with a 'cradle-to-grave' analysis. Once a food product is no longer profitable for a manufacturer, it is regarded as 'dead' and decisions need to be made as to whether it should be taken off the market or revived by actions such as development of line extensions, identification of new markets or strong promotional activity.

For most line extension products, food manufacturers are seeking to improve the sales and market share of their products (they want to increase their profits!). There are instances where manufacturers may apply line extensions to the products of other companies for their own purposes. Once a manufacturer has identified a suitable strategy, the development of line extension products is generally quite easy and inexpensive, since processing methods and basic formulations are similar to those used with the manufacturer's own products. Once the nature of the line extension has been selected, it is usually only necessary to adapt existing recipes, processing and packaging into its development. Manufacturers usually already have the appropriate equipment and staff expertise for manufacturing the line extension.

Some caution is required in the selection of changes to specific products for line extension purposes, especially in regards to sensory properties. Sensory properties include appearance, flavour (aroma and taste) and texture. The appearance of a food product involves such features as colour, size and shape. Consumers have definite expectations about each of these and these expectations tend to be specific for different product categories; for example, consumers have a definite preference and expectation of potato crisps having a crisp, crunchy texture, while a smoother, chewy texture is preferred in many confectionery and dessert products. Products which do not meet these expectations will almost certainly be rejected by consumers.

Another food property that can cause problems with consumer acceptance is colour. Colour impacts on the visual perception of foods. If the colour of a specific food type is very different to consumer expectations, it is likely

to be rejected by consumers. For example, the blue strawberries shown at right are unlikely to be a market success.

It is also hazardous to base a line extension strategy on the use of different flavours in familiar food products. For example, adding a fishy flavour to a canned vegetable product is not likely to increase market share because it will probably be rejected by most consumers. It is important to remember that acceptance or rejection of a food item will occur across all age groups. Children, for example, may show their dislike, and then likely rejection, of a food product on the basis of its flavour. This highlights the importance of age-based market segments in the design and development of line extension products.

New-to-the-world products

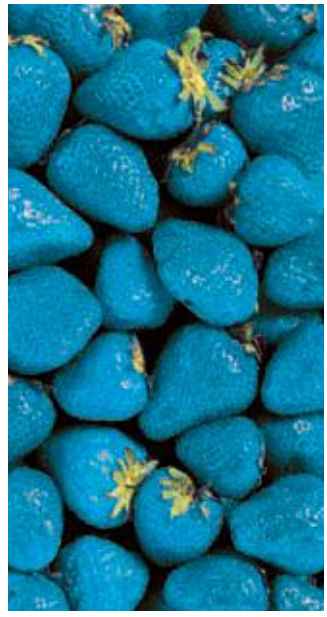
New-to-the-world products are those which are completely new and different to pre-existing products, and have not been on the market before. Genuine new-to-the-world food products are far less common than me-too and line extension types. It is difficult to develop and market new-to-the-world concepts and actual products since neither consumers nor food manufacturers have encountered them before.

Where do concepts and products which can be classed as new-to-the-world come from? Because the human race has been eating different foods over the millennia, and with increasing **globalisation**, new-to-the-world food products and concepts are difficult to develop. These days, new-to-the-world food products arise mainly from new technologies and new ingredients. Examples of each of these are listed in the following table.

TABLE 14.6 New-to-the-world products based on technological advances and new-found ingredients

NEW TECHNOLOGIES	NEW INGREDIENTS
• Biotechnology (e.g. GM foods) • Packaging developments • Extrusion • Domestic appliances such as microwave ovens	• Soy derivatives • Traditional indigenous foods (e.g. kangaroo, emu and crocodile meat) • GM ingredients • Food additives such as olestra

Once developed, new-to-the-world food products are more likely to be successful in the marketplace than me-too products or line extensions, simply on the basis of their novelty to consumers. However, their development and promotional costs can be much greater than those of me-too and line extensions. Also, manufacturers may need to obtain new processing equipment, provide up-dated staff development and training, and any new ingredients must be identified and sourced.



Marketing of new and different food concepts also requires strong, well designed marketing and promotional strategies. There is a frequent overlap between perceptions as to what actually is involved with me-too, line extensions and new-to-the-world products. An example is where an established form of product may be manufactured from novel ingredients; for example, there are now many extruded soy-based snack foods on the market as opposed to those derived from other materials such as corn, wheat and starches. To some people, such products are line extensions but others may categorise them as being new-to-the-world.

A much older, but still prominent, example of difficulties associated with assigning a product as a line extension, new-to-the-world, or me-too product type is margarine, which was first developed over 100 years ago. What is margarine? It is a product, usually based on vegetable oils, that simulates butter in its role as an edible spread. Cases can be made for defining it as a me-too, line extension or new-to-the-world product type. Into which new product type does margarine fit?

CASE STUDY

The mighty mango

Imagine merging the delicious taste of the Kensington Pride mango with the best characteristics of other varieties to create the perfect mango.

That's the aim of a Queensland Department of Primary Industries and Fisheries (DPI&F) research team and its Mango Genomics Initiative.

The team, which is headed by Dr Ralf Dietzgen, is working to produce a mango that not only looks and tastes good, but could also position the State's mango industry at the top of the international market.

'Custom-designing mangoes to meet consumer expectations regarding taste, colour, texture and nutrition, will help boost the value of Queensland's $100 million mango industry,' Dr Dietzgen said.

Traditional approaches to genetically improving mangoes can take up to 25 years to develop a new variety.

'However, our work in mango genomics will lead to rapid advances in quality and breeding efficiency through the early selection of improved varieties at the seedling stage, using molecular marker technologies.'

The Queensland mango industry is mainly based on a single variety — the Kensington Pride.

And while there is no doubt it has an excellent flavour, it has poor yields, averaging between five and seven tonnes per hectare.

However, there is enough genetic diversity within the Kensington Pride's gene pool to achieve yields of at least 60 tonnes per hectare.

'High diversity in the gene pool helps breeders by giving them a wider choice of genes to make an improved variety,' Dr Dietzgen said.

The Mango Genomics Initiative is a partnership between DPI&F and the University of Queensland's Centre for Nutrition and Food Sciences and School of Pharmacy, the Queensland Facility for Advanced Bioinformatics and the Australian Genome Research Facility.

Source: Food News Bulletin, August 2007.

OUTCOME TASK

Students learn to:

- identify different reasons for and types of food product development.

Contributes to the following outcome:

- justifies processes of food product development and manufacture in terms of market, technological and environmental considerations.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *reasons for and types of food product development* to complete the tasks ahead.

1. How would you classify the new Kensington Pride mango? Is it a me-too product, a line extension or a new-to-the-world product? Justify your answer.
2. How have consumer influences played a role in the development of this potential new mango?
3. How has new technology been harnessed to produce the new Kensington Pride mango?

OUTCOME TASK

4. Log in to **www.jacplus.com.au** and locate the *New product releases* weblink for this chapter.
   a) Select one new food product that has been developed and try to classify it according to whether it is a me-too product, a line extension or a new-to-the-world product. Give reasons for your answer.
   b) Identify why this new product was developed and explain whether or not you think it will be successful.

eBook*plus*

Weblink

REVIEW QUESTIONS

Remember

1. True or false?
   a) A me-too product is a product that has never been produced before.
   b) A line extension is a product that has been produced before but may have more features such as flavour, colour, or health and diet-related benefits.

Apply

2. Give three examples of me-too products.
3. Why are line extensions used by food manufacturers?
4. Why can kangaroo meat be classed as a new-to-the-world product?
5. To which of the three product types do you feel the concept of margarine belongs? Justify your selected new product type.

Do an activity

6. It is your task to come up with an idea for a me-too product. Briefly describe what the product is and what differentiates it from the original product. Explain why you think your me-too product might be successful, and identify any potential threats to its success. Once this task is complete, a list of the answers to this question should be compiled and distributed to each class member to assess, on a scale of 1 to 3, whether the product is likely to be a success (1 = Yes, it should be a success; 2 = It has potential; 3 = Try another idea!).

CHAPTER 14 SUMMARY

- There is a constant stream of new food products on supermarket shelves because consumers lose interest in existing foods and want new ones. Manufacturers must develop new foods to remain profitable.
- Food manufacturers must identify trends in the Australian community and in particular market segments.
- Health and environment, consumer demands, changes in technology and the need to produce a product that is commercially viable are all factors that may affect new food product development.
- Food manufacturers may select from three types of new food products: me-too, line extensions and new-to-the-world.

KEY TERMS

active packaging
extrusion
Food Standards Code
free range eggs
functional foods
genetically modified
globalisation
hydroponics
line extensions
market segments
me-too products
modified atmosphere packaging (MAP)
new-to-the-world products
organic farming
product life cycle
shelf-life
space food

Chapter 15
Steps in food product development

Fancy chocolate-flavoured, cinnamon-flavoured or blue-coloured French fries? Sounds odd, doesn't it? An American food company tried it earlier this decade and it was a complete and utter flop. What went wrong? Sometimes manufacturers can't be certain that a new product will succeed, but with careful planning and by following the correct steps they can increase the likelihood of consumers buying their product.

In this chapter you will learn about:

Steps in food product development

- design brief based on project aims and development criteria:
  - idea generation and screening
  - market research
  - product specifications
  - feasibility study
  - production process development
  - development of a prototype
  - testing product prototype, e.g. sensory evaluation, consumer testing, packaging tests, storage trials.

Consumer taste tests are an important part of food product development.

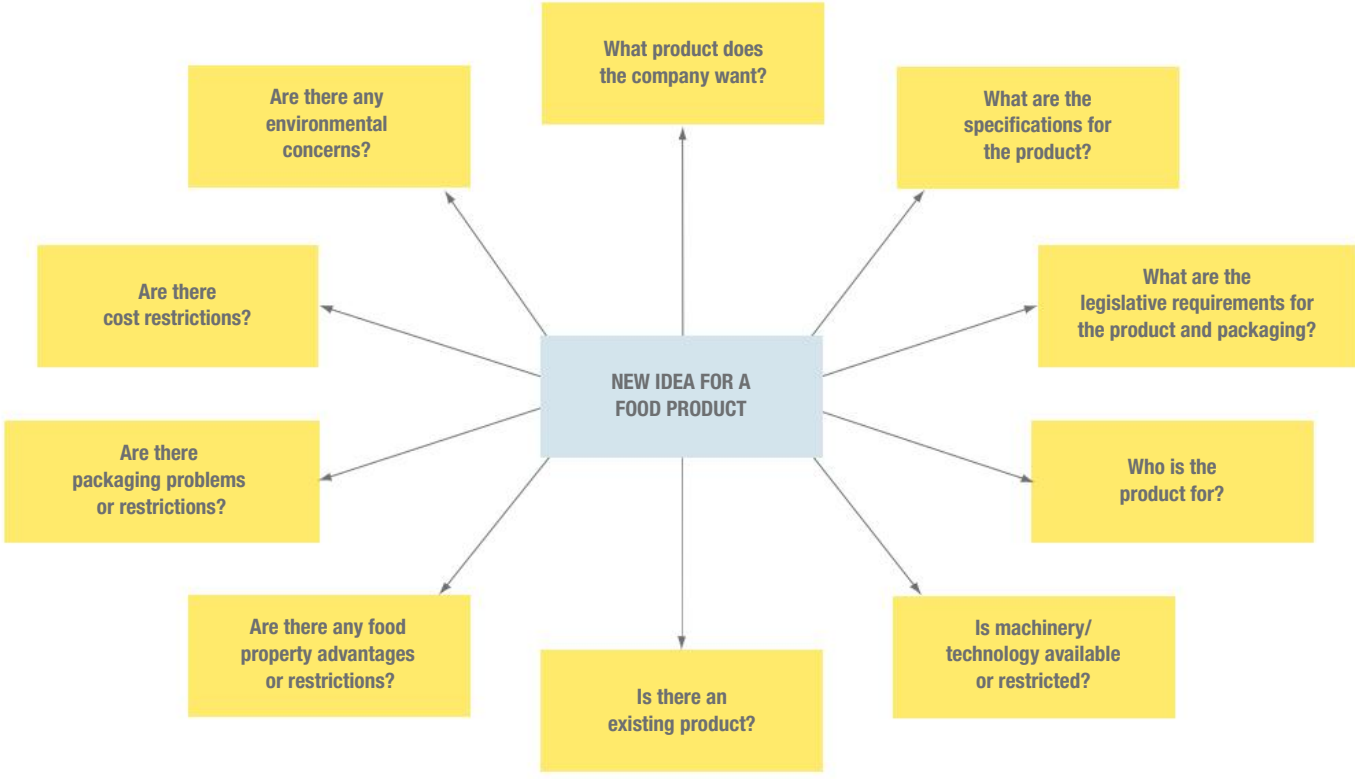
New food products vary in their complexity and likely appeal to consumers. It is important for any new product to be assessed in combination with any other product chosen for consumption alongside it; for example, a chocolate cake is frequently served with side dishes such as a flavoured sauce, fresh or processed fruits, cream or ice-cream. Therefore it is not just the product that is being assessed, it is the product's potential to be purchased with complementary products that also needs to be considered. Although market research is only one step in the development process, it is a vital component of new food product development, as it provides valuable information for decision making and market segment selection for the product.

Design brief

A **design brief** should be established for individual new products once concepts for these are developed. Without a design brief, product development staff would be like explorers without a compass. A useful design brief will enable a food manufacturer to define consumer market requirements and the price the market will pay for a specific food product.

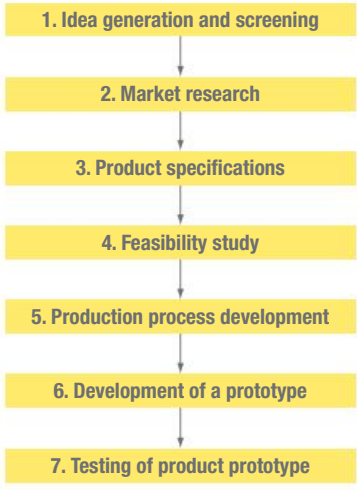
A key component of the design brief is a manufacturer's **mission statement**. In general terms, the mission statement of a company sets out corporate goals and policies, and provides guidance for new food product development. Mission statements are relatively brief and relate to company policy, product range and target markets. Larger companies, and smaller ones, may make their mission statements accessible to consumers on their web sites. You can check company websites to investigate this; for example, try to find the mission statement of Darrell Lea chocolates.

In addition to providing direction to product development teams, design briefs help decision-making about whether the development project should be continued or should be stopped at the early stages. This is very important because new product development is a costly activity and manufacturers need to minimise needless expenditure on new products that are likely to fail on the retail market. It will also ensure that specific company goals are addressed by a new product. It is essential that these two issues be addressed. The features included in a design brief for a new food product are in the diagram below.



A generalised version of a design brief embodying company and product-related issues

It is vital that any food product development team be familiar, not only with the steps of the design brief, but also with the order in which they should be carried out, as shown in the following flow chart.



These seven steps are those that are specified in the HSC Food Technology syllabus. However, some companies also consider that the development of a design brief should be included as a second step, and issues such as factory trials, test marketing and product launch should be included towards the end of the development process.

As an application of these steps, students of Food Technology need to develop a product which meets a consumer need. Each step above is considered in turn, with an explanation given for what is involved in each, and the importance of each step to the entire food product development process.

Idea generation

New food products don't just happen — they must be carefully planned and then tested before they reach the consumer.

Where do new food product ideas come from? Sometimes they will arise from market research, where feedback from consumers can provide useful insights into market needs, and gaps in the food product ranges available. Large companies often employ market research firms to inform them about consumer preferences and eating habits. For example, industry analyst and forecaster, BIS Shrapnel regularly analyses the Australian fast food market and has recently found that what motivates consumers the most when choosing fast food is the overall flavour or taste of ethnic foods. This piece of research may give a food company some basis for an idea to create a new type of takeaway food with Middle-Eastern spices, for example.

Sometimes new product ideas can originate from sources as commonplace as recipe books or media items about foods in general. Other frequently used sources of new ideas are internal company brainstorming sessions. These sessions ideally should involve not only research and development staff, but also production, purchasing, marketing and management personnel. It is the intuitive skills, cooking expertise, production technology, consumer market knowledge and artistic traits of staff involved in the brainstorming sessions which combine to create successful brainstorming sessions. Ideas from these sessions will include the obvious, the ridiculous, technically impractical and those which are potentially useful. All ideas, even the ridiculous and impractical, should be recorded. These may be of interest and have greater potential later when, for example, advanced technology becomes available.

Idea screening

Idea screening of new product concepts involves assessing the feasibility of developing a specific new product as early as possible in the process. There are a number of factors that can interfere with food product development. Some of these constraints are shown in table 15.1, along with related examples.

The factors listed are largely related to the company itself, and the contributions from all participants in the brainstorming sessions are useful for the screening of new food concepts. In addition, there are issues relating to screening new food product concepts in the context of the type of food product being considered. These can be seen in table 15.2, which also shows that there are fewer constraints for development of me-too products. Line extensions have more constraints, while new-to-the-world products present the greatest number of development problems for most companies. The screening process at this stage of development is largely based on the information in tables 15.1 and 15.2.

Market research

Market research is a very useful tool for assessing the likelihood of consumer acceptance of those new food product concepts that have been considered worthy enough to

TABLE 15.1 Constraints on product development

TYPE OF CONSTRAINT	EXAMPLES
Financial	Does the company have enough money to start and run the project? Will the product sales cover the costs of development?
Processing	Does the company have enough skilled employees to carry out the production process? Is the right equipment available? Will any processing waste harm the environment?
Product	Does the product have the characteristics that consumers want (colour, appearance, taste, shelf-life, convenience, texture, etc.)?
Marketing	Is there a suitable distribution network to deliver the product to the consumer?
Company	Does the company know about the market the product will enter? Does the company have enough technical knowledge to make the product, or will it need to employ specialised staff?
Ethical and legislative	Will the product be safe? Will it be sold in an honest and fair way? Will it meet all food legislation requirements?

TABLE 15.2 Some constraints to development of new concepts based on the type of new food product being considered

FACTORS THAT COULD PRESENT A CONSTRAINT IF ABSENT	IDEA 1 LINE EXTENSION	IDEA 2 NEW-TO-WORLD	IDEA 3 ME-TOO
Skills	✓	✓	✓
Recipe for making	✗	✗	✓
Equipment that can produce the desired characteristics	✓	✗	✓
Availability of appropriate package	✓	✓	✗
Ingredients supplier	✓	✗	✓
Time for development	✓	✗	✗
A market	✓	✓	✓
A marketing strategy to overcome competitors	✗	✗	✓
Familiarity with legislation requirements	✓	✗	✓
Distribution network	✓	✓	✓

continue to this next stage of the product development process. Market research involves asking consumers what they want and whether they would accept the new product being considered by the manufacturer. In a very real sense, manufacturers should then be able to decide whether to go ahead with the development of a new product concept, whether they should consider modifying the concept or whether they should discontinue with the entire project at this early stage. What aspects are investigated during market research and how is this important activity conducted?

Dealing first with how it is conducted, market research usually involves market surveys. These surveys may use organised consumer discussion groups, or focus groups as they are often called. Field reports may be undertaken; for example, interviews with salespeople who can advise about what products consumers are buying from retail outlets, and levels of market acceptance and satisfaction with existing similar product ranges. Market research may also involve taste panels and consumer testing of specific products in places like supermarkets and major shopping centres.

In-store market research involves consumers evaluating a new food product concept. No doubt you have all seen and been involved in this sort of consumer testing of new food product concepts.

Aspects investigated by market research during this second step in new food product development include:

1. Consumer market characteristics such as the size of the market for the new product, demographics of the targeted consumer market (age, gender, family size, economic status and level of education), and geographical location of points of sale (for example, urban, suburban, rural, remote locations).
2. Reasons behind consumer purchasing patterns including reasons for purchasing the product category, cultural and social pressures, times and frequency of shopping, location and type of retail outlets used by the targeted consumer market, real or perceived benefits of the food (prestige, price, convenience, quality, nutrition and health characteristics), frequency and occasion of product use, and issues such as the consumers' loyalty to current brands.

Companies often have their own marketing staff or employ external, independent market research companies to carry out market research during the second step of new product development. Whether internal company staff or independent marketing personnel are used for this step, their functions and outputs are essentially the same:

- identifying consumer wants and needs for new food products
- design of methods for data collection
- managing and organising data collection
- analysis of market research results
- communication of their findings to the manufacturer.

It is customary to classify market research as either primary research or secondary research. These two classes of market research differ in that **primary market research** involves collection of original data by market research personnel, while **secondary market research** involves investigating what others found during primary research. For example, a company may analyse research undertaken by the Australian Bureau of Statistics and that would be considered secondary research. Secondary market research is less expensive than primary market research because design and implementation of survey methods are not required as they are in the case of primary market research. Secondary market research can often be best achieved, for example, through internet-based surveys or from public sources such as library resources. Government publications are also excellent sources of market information regarding specific product types. However, when dealing with new-to-the-world products, primary research is the more useful technique for the collection and generation of useful, relevant, consumer market information.

One vital component and major problem of market research is ensuring that a sufficient number of consumers are interviewed so as to be statistically meaningful. This is not always feasible and, therefore, sampling methods are of two main types: non-probability sampling and probability sampling. The procedures used for each sampling procedure and the main specific methods used are shown in table 15.3 below.

Once market research is undertaken, a company may use a marketing information system in order to gather the data and draw the appropriate conclusions from it. The four basic components of marketing information systems are:

1. Collection of internal company data including information systems such as accounting and sales records
2. Market intelligence regarding competitor products such as retail sales and prices
3. Market research using primary and secondary data
4. Effectiveness of promotional strategies currently in the marketplace, for example, the success of products already on the market.

Properly designed market research will reveal factors that a company can use for decisions to proceed with, or discontinue the development of, a new product idea. For example, development of new products may be discontinued if the market research reveals one or more of the following:

- the size of the market for a new product idea is too small
- there are many companies already competing to market a new food product

TABLE 15.3 **Types of market research sampling and procedures used for each**

TYPE OF CONSUMER SAMPLING PROCEDURE	NAME OF SAMPLING METHODS	NATURE OF CONSUMERS INTERVIEWED
Non-probability sampling	Convenience sampling	Consumers such as friends, relatives or neighbours
	Volunteer sampling	Consumers who volunteer to provide information
	Judgemental sampling	Consumers selected because they have desired characteristics which make them suitable for the survey
	Quota sampling	Consumers in numbers selected to reflect the size of specific characteristics such as market sector, age bracket, and socio-economic status within a specific consumer market
Probability sampling	Simple random sampling	May be based on location and method of interview, e.g. shopping centres, random telephone interviews, door-to-door interviews
	Stratified random sampling	Random sampling is refined to become more selective in the nature of consumer interviews and design of questions. More specific market information may be gathered using this method.

- the development costs are higher than the company can afford
- the product requires marketing in an area which is outside the company's previous experience.

REVIEW QUESTIONS

Remember

1. List five possible sources of where an idea for a new product will come from.
2. Explain the difference between primary and secondary research.

Apply

3. Refer to table 15.2 on page 283. Which idea for a new product would be the most successful, and why?
4. A design brief for a new chocolate biscuit states that each packet of biscuits will cost $10.00 and that the company wants to produce a luxury chocolate biscuit. The company's mission statement, however, states that the company endeavours to produce biscuits affordable to the average Australian. Explain whether you think this new product will proceed to the next stage in the product development process.
5. Which sampling method is being used in the following cases?
   a) The Candy Cane Company puts an online survey on its web site asking for feedback about its brand.
   b) Chefs working at some of Sydney's most prestigious restaurants are asked to sample a new brand of mustard.

Do an activity

6. Log in to **www.jacplus.com.au** and locate the *Food companies* weblinks for this chapter. Use the links to find the food companies from the list below which have a mission statement on their internet sites.
   Goodman Fielder Ltd
   George Weston Foods Ltd
   Dollar Sweets Pty Ltd
   Mars group of companies
   Arnott's Biscuits Pty Ltd
   Campbell's Soups Ltd
   So Natural Foods Australia Pty Ltd
   Total Package Pty Ltd
   Heimann Foodmaker Group Pty Ltd
   Hakka Pty Ltd
   Sanitarium Health Foods
   a) List features of the mission statements you have located and describe factors that are present in these mission statements such as environmental issues, product quality, company policies and company resources.
   b) Do you think the food product/s reflect the company's mission statement? Justify your answer using specific product examples.

eBook*plus*

Weblink

Product specifications

Product specifications are precise descriptions of the characteristics the manufacturer is planning to incorporate into the new product. These are derived from the outcomes of the first two steps in the new product development process. Surprisingly, these specifications are for the manufacturer's benefit rather than directly addressing consumer requirements. The specifications will depend very much on internal company factors such as financial status, manufacturing capabilities, equipment and technology. Product specifications can be complicated to establish; they may include formulations, processing methods, packaging, sensory characteristics such as colour, flavour, texture, portion size and storage life, the form of packaging, quality assurance and quality control, costs to consumers and even the target market.

Feasibility study

A **feasibility study** is conducted after product specifications have been established. The purpose of this is to determine whether the new product idea will be profitable and if its manufacture is technologically possible. If the answer to either or both of these aspects is negative, then it would be sensible to discontinue development of the new product idea.

A vital component of financial feasibility studies is the determination of a **break-even point** based on costs of development, marketing, production and delivery of a product versus the volume of sales needed to generate enough income for the company to recover its costs and to make a profit. One particular problem here is estimating a realistic level of sales. Issues such as market demand, likely market share and competing products already on sale must be assessed and used in decisions about this aspect.

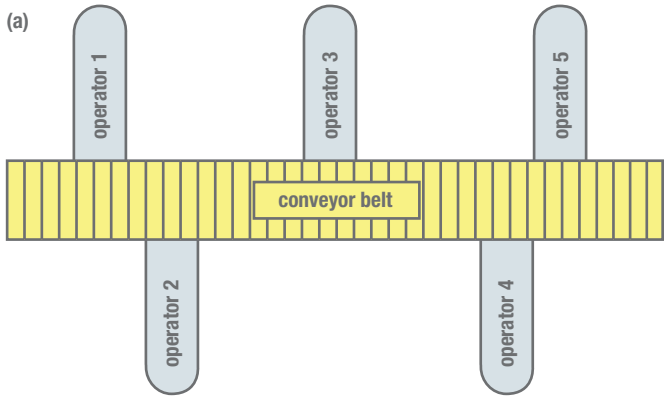
Technical feasibility assessment requires knowledge of whether processing methods and equipment for the product exist at the time of developing the new food product, and an objective assessment of the company's capacity to manufacture it using its current staff and technological resources. It therefore involves both internal and external factors for the company (see chapter 13). Specific issues which must be analysed include:

- availability of and access to a supply of ingredients
- if the company possesses, or can access, appropriate staff, manufacturing technology and equipment
- if it is necessary to develop new technology or equipment
- expenditure of time and money to obtain approval for ingredients and processes
- costs and time to develop and establish quality assurance procedures regarding the quality and safety of the new product.

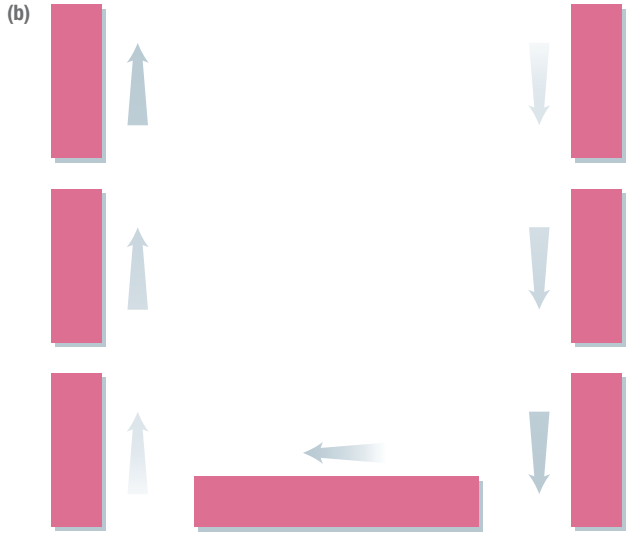
Production process development

Production process development is the next step in development of the new product idea. This step involves the changes necessary to adapt the manufacturing resources to produce the new product. For some new product types, changes required will be minimal. For instance, line extensions based on such things as new flavours may require only

minimal changes; however, the required changes can be extensive and expensive for the manufacturer who wishes to introduce new products quite different from those in its existing range. Changes to production facilities may involve factory layout, processing equipment and methods, as well as production staff and their level of training. Two different factory layouts are shown below.



Conveyor line factory layout



Work cells factory layout

Conveyor line and work cells factory layouts

The exact nature of the changes required to manufacture a new food product must be determined on a case-by-case basis, taking into consideration the new product type and internal factors relating to a specific company. During the planning and implementation of the development of production processes for a new product idea, both research and development staff, and production personnel, should be conscious of the five following components and derivations of the infamous Murphy's laws:

- Whatever can go wrong, will go wrong.
- If unattended, things always go from bad to worse.
- When several things can go wrong, the thing that does go wrong will be most damaging.
- The normal course of events will always involve the hidden flaw.
- If things are going well, you have probably overlooked something.

The simplest and most common precautions against Murphy's laws occurring are **quality control** and **quality assurance**. Quality control broadly involves ensuring that the correct ingredients, staff and processing equipment are at the right place at the right time. Quality assurance ensures quality of factory output.

Development of a prototype

Development of a **prototype** involves the creation of a model of the new product concept for broad-based market testing. At this stage, extensive product and market research can establish whether the ingredients will perform satisfactorily under the proposed manufacturing conditions. Any modifications needed to formulations and processing conditions should become apparent during this step. There is a big difference between producing small batches under kitchen conditions and those needed for larger production batches. During this step, the aim is to convert the smaller scale production to commercial batch sizes. This will enable sufficient product to allow for widespread testing of the new food product concept by consumers, and aid the optimisation of ingredient formulation, processing conditions, product specification, and related matters such as form of package and portion size, and storage conditions.

CASE STUDY

Developing a prototype

Deakin University has developed a prototype tasty snack food with special health benefits.

Dr Russell Keast, a senior lecturer in the School of Exercise and Nutrition Sciences, has developed a new snack food with a parmesan cheese cracker, organic mashed potato and special healthy additives.

He said, 'This new snack has natural additives such as an anti-inflammatory agent, omega-3 fatty acids and zinc to improve brain and heart function, boost male virility and improve immunity.'

Dr Keast said it was the first time the anti-inflammatory agent oleocanthal had been included in a manufactured food and research was continuing into its flavour and health promoting properties.

A natural appetite suppressant which makes the consumer feel fuller for longer, and a natural compound to increase liking for a product, have also been added to the snack food.

Samples of the snack are being presented to the food industry at a workshop at Deakin University to point the way to healthy snacks of the future.

'Overall, the snack is a vehicle for these health promoting compounds. However, it must be flavoursome and popular so people will want to eat it repeatedly,' Dr Keast said.

'An agent in the snack will help prevent overeating it.

'While it is not a natural food, it is an innovative food.'

Source: press release by Deakin University, School of Exercise & Nutrition Sciences, 22 June 2006.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *product prototypes* to complete the tasks ahead.

1. Describe the prototype snack food being developed by Deakin University and its perceived benefits.
2. Describe the market research that should be undertaken before a product such as this is released to the market.

EXPERIMENT

Experimenting with a prototype

Syllabus outcome

Students learn to:

- develop a product that meets a consumer need.

Contributes to the following outcome:

- develops, prepares and presents food using product development processes.

1. Find a recipe for a simple chocolate biscuit.
2. The aim of this experiment is to establish the optimum number of walnuts for a chocolate nut biscuit product.
3. You are to use the usual experimental procedures, based on the outline provided, to make the variations and assess consumers' likes/dislikes.

Aim

To determine the optimum level of walnuts for a basic chocolate biscuit, using a consumer panel

Equipment

oven (brand name, type, power in kilowatts, fan-forced or not)
mixer (brand, size)
mixing bowl
measuring cup(s) (and so on)

Method

1. List the steps in the production of the basic chocolate biscuits (include ingredients and quantities of each used, baking time, temperature).

   Note: Include 1/3 cup of coarsely chopped walnuts to the first batch of biscuits made. Make three more batches of biscuits, varying the number of walnuts so that you have four types of biscuits for the sensory testing.
2. Set up a sensory test (see chapter 4, pages 70–2) with suitable questions. Select six consumers to try each of your batches.

Results

Prepare a table to show the number of positive and negative responses from the consumers about the nut content of the chocolate biscuits.

Conclusions

Were the results meaningful? Give reasons for your answer. What was the optimum walnut content of the chocolate biscuits?

Testing of product prototype

Testing of product prototype occurs after development of the product when commercial batches of prototype become available for broader and deeper consumer and market evaluation. Relatively few new product concepts reach this step because their development may be discontinued after any of the earlier steps for a variety of reasons.

During this final step, the prototype is tested to ensure that it satisfies Australian Food Standards requirements, export regulations (AQIS), as well as consumer and market needs. At this stage, the new product concept is now available in a tangible form which can be seen, felt and tasted in consumer evaluation, and subjected to laboratory testing and modification if required, as shown in the photo on page 288. During prototype testing, there may be the need for many decisions. This requires consideration of many factors as well as a broad and deep knowledge of the market, consumers and the product concept itself.

Wine makers are constantly involved in new product development. Each year the grapes will be slightly different from the next year, and the very best wine depends on the skills of the winemaker at the product development stage.

During this step, packaging and label design can be refined, nutrition and ingredient information panels are formulated, the ability of the packaging to preserve the product and protect it from physical damage during storage and distribution is confirmed, and storage conditions regarding temperature and shelf-life are established. Consumers evaluate the full range of sensory properties and general satisfaction with the product, usually by small group (focus groups) assessment.

When it comes to food we all have our likes and dislikes. Our senses will tell us how food tastes, what it feels like to handle and to eat, and how it looks.

Manufacturers of food products must understand consumer perceptions of products and their packaging if they are to be successful. On an annual basis it is estimated that $15 million is spent outsourcing sensory testing for the cosmetics, food and beverage industries. The CSIRO is now assisting companies to gain a better insight into consumer preferences by developing better sensory testing procedures.

Frequently, manufacturers will use a small-scale product launch to perform larger-scale consumer testing and estimation of market acceptance of the new product. During this step, the appropriateness of the selected target market is confirmed or revised and manufacturers may fine tune formulations, packaging and sensory properties of the product. After successful prototype testing, the next step is full national market launch. Along with commercialisation of the new product, a final marketing/promotional strategy is chosen to assist continued success in terms of competitiveness and sales in the consumer market.

REVIEW QUESTIONS

Remember

1. You have an idea to produce a new cereal for children. List the product specifications you will need to consider.

Apply

2. Look at the following scenarios and identify what steps went wrong in developing this new product.
- **a)** Garry decided to produce a new chocolate bar. It tasted great and he undertook sensory testing that indicated he had a good product. When the product hit the shelves though, no-one knew about it and it just sat there with the 50 other different chocolate bars available for sale.
- **b)** Jessica's food company produces cakes for sale in supermarkets. Consumers are saying that each time they buy Jessica's brand of cake it tastes different.
- **c)** Helga's Hams weren't a success. The product tasted great but the packaging showed a pig being slaughtered so customers were reluctant to purchase the product.
- **d)** Cassy's chewy caramel treats were a bit too chewy. Customers complained that they didn't have time to chew the product and had to remove it from their mouths before they could finish it.

3. Why does a manufacturer of a new food item have to think carefully about staff expertise and facilities before going ahead with a new product idea?

4. What legal requirements must be satisfied before a new food product can safely be put on the shelves of our supermarkets?

Do an activity

5. It is estimated that it will take a food technologist ten weeks to develop a new microwave browning sauce. The food technologist is paid $1000 per week and the materials for the experimental work involved in developing this new sauce will be $15 000. These are the investment costs of developing the prototype product.

The marketing team estimates that sales of the sauce will be:

Year 1 10 000
Year 2 20 000
Year 3 6 000
Year 4 4 000 (maybe).

The food technologist estimates the cost of producing each packet of sauce to be around $1, and the marketing people estimate the selling price for this level of sales to be $1.50.

The general manager asks the people in finance to calculate if a 'Go' or 'No go' decision should be made for the project. The criterion for a 'Go' decision is that the total profit margin must exceed the investment in development by 10 per cent.

To make a decision about the feasibility of this project you will need to calculate:

1. the investment in development of the prototype:
   labour cost (wages × number of weeks) + cost of materials
2. the profit margin per packet of sauce:
   selling price – production cost
3. the total profit:
   sales × profit margin per packet
4. return on investment (ROI):
   total profit – investment
5. percentage ROI:

$$\% \text{ ROI} = \frac{\text{ROI} \times 100}{\text{investment}}$$

Should a 'Go' or 'No go' recommendation be made? Would your decision change if estimated sales in Year 4 were 10 000 packages?

CASE STUDY

PIZZA HUT PROVIDES FOOD FOR THOUGHT

by PHILIP HOPKINS

Not even the most ardent Pizza Hut fan would describe the popular franchise's fare as haute cuisine. But beauty is in the eye of the beholder.

'In China, Pizza Hut is a high-value, deluxe brand. One pizza costs the equivalent in China of $30,' said senior Austrade executive Barbara Hilder, a former trade commissioner in China and Japan.

'It's considered a status symbol and is highly regarded,' said Mark Sutherland, managing director of Melbourne trade consultancy 2gro international.

The lesson, delivered to a gathering of small-business people in Melbourne, is that would-be exporters should do their homework. Mr Sutherland, who has a masters in international business, said exporters had to research the most basic information about their markets, including the age of the population, the standard of living, education levels, gross domestic product per capita, and how the government came to power. These factors indicated the development stage of the country. 'The political structure — how the government came to power — indicates risk,' he said. Business should ponder: 'Can the government seize my investment?'

Mr Sutherland said understanding the target culture was crucial, including psychographic patterns — lifestyles and trends — and patriotism.

'Does my product suit this culture or jar with tradition?' he said. McDonald's had learnt this lesson. In Germany it sold its hamburgers with beer, it sold lamb-burgers in India, not beefburgers, and riceburgers in Japan.

Mr Sutherland said exporters needed to do an in-depth screening of their product. Creative marketing could create a new use for what they wanted to sell.

In Taiwan, for example, Coca-Cola managed to associate its drink with traditional Chinese food. Mr Sutherland said exporters should investigate where the target market was serviced from, locally or by imports, or the belief system surrounding the product. In China, for example, he said there was not much interest in brands. 'The focus is on country of origin,' he said.

Mr Sutherland also said products had their own life cycle. A product, such as a refrigerator, could be out-of-date for one market but ideal for another.

Source: The Age, 5 August 2005.

OUTCOME TASK **RESEARCH ASSIGNMENT**

Students learn to:

- develop a product that meets a consumer need.

Contributes to the following outcome:

- justifies processes of food product development and manufacture in terms of market, technological and environmental considerations.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *steps to food product development* to complete the tasks ahead.

1. According to Austrade executive Barbara Hilder, why are some Chinese customers willing to pay reasonably high prices for pizza?
2. Explain why it is important to research basic information about a market before launching a new product.
3. Describe how the fast food chain, McDonald's, created new food products to meet the needs of consumers in various countries.
4. Create a new product and describe the seven steps you would use to ensure its success in a design brief. You may create a virtual product using appropriate software or you could create a prototype, just like you did when you conducted your chocolate biscuit experiment earlier.

CHAPTER 15 SUMMARY

- The seven steps in food product development are:
  1. idea generation and screening, taking into consideration such things as finances, processing equipment, staff expertise, the attributes of the product itself and marketing strategies
  2. market research needs to be undertaken to ascertain whether consumers are likely to buy the new product. Primary and secondary market research should be analysed carefully.
  3. product specifications
  4. feasibility study
  5. production process development
  6. development of a prototype
  7. testing product prototype, e.g. sensory evaluation, consumer testing, packaging tests, storage trials.

KEY TERMS

break-even point
design brief
feasibility study
mission statement
primary market research
product specifications
production process development
prototype
quality assurance
quality control
secondary market research

Chapter 16
Marketing plans

One of the challenges of everyday life for most people relates to finding out about goods and services — what are available, where to look, who to contact and what prices are involved. How can consumers be made aware of new foods, their availability, their characteristics and their prices? The main strategy used by food manufacturers is via marketing plans, especially during the launch of new products, and also on a continuing basis to remain competitive in the consumer market.

In this chapter you will learn about:

Marketing plans

- product planning
- price structure
- place and distribution system.

Sometimes it is not just about the food product — making sure your food product is well known can lead to success. A good marketing plan will help to link the food product to the correct target market, with the aim of selling a product. Bakers Delight has developed a distinctive brand. Here, a well-known sporting identity, Andrew Gaze, helps promote sport at the grassroots level. Cash grants are provided to schools and clubs by Bakers Delight. This serves the dual purpose of supporting the local community while also increasing brand awareness.

The marketing process

The previous chapter addressed the importance of a food company's goals in relation to the development of new food product ideas. A company mission statement should be a major contributor to defining these goals. Also described were the steps in new food product development and how the outcomes from each step should guide decisions about the continued development or rejection of a given concept. In this chapter, we will discuss another area which manufacturers must develop to help ensure a successful market launch. This area relates to marketing strategies and may be described as the **marketing process** for new food products.

Marketing plans have either a product-orientation approach or a sales-orientation approach, as outlined in the table below.

TABLE 16.1 Approaches, goals and strategies regarding company marketing strategies

MARKETING APPROACH	COMPANY GOALS	COMPANY STRATEGY
Product orientation	Better products than competitors	Company spends more time and money on product component of the marketing mix
Sales orientation	Encouraging more consumers to buy the product	Company spends more time, effort and money on price structure, promotion and placement activities in the marketing mix

A marketing plan frequently focuses on just one new product but may also be applicable to a range of new products. Marketing plans for a specific product may be changed as different opportunities are identified or the business environment alters. All marketing plans should focus on meeting specific consumer wants and needs, although some may try to convince consumers that they *need* a new food product. This latter feature is especially important where the product being launched is different from those that consumers are familiar with, for example, **new-to-the-world** products and **line extensions** will frequently be unfamiliar to the consumer market. In addition to a consumer focus, marketing plans also provide company staff with clear goals as to what they need to achieve in relation to development, manufacture, distribution and promotion of new and existing products. In essence, marketing plans will foster teamwork and cooperation between company staff at all levels, and specific roles in the areas mentioned above.

The marketing process involves many stages and is a continuous cycle. Marketing is cyclical because most products eventually become outdated and there is a constant demand for new products.

Changes in the macro- and micro-environments lead to changes in the marketing process.

Marketing mix

Marketing plans identify target markets (for example, alphabet soup might be marketed to parents and children), predict demand for the product and organise the activities of the **marketing mix**. The marketing mix is made up of four organised activities:

- product planning
- price structure

- placement or distribution
- promotion.

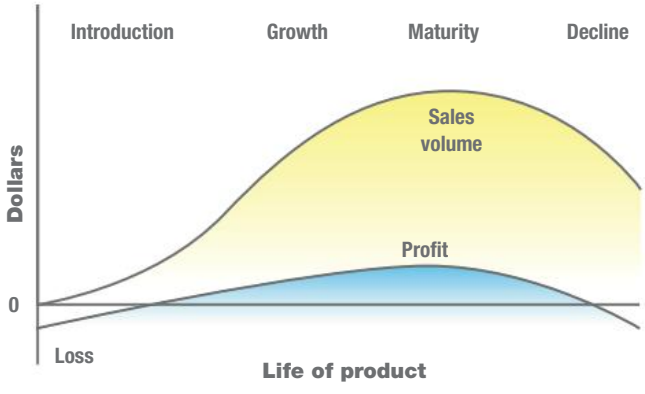
For a new product to succeed or an existing product to continue selling, a company must use all areas in the marketing mix. A mistake or delay in one area results in an unsuccessful product. Imagine a company develops a new fast-acting marinade that tenderises as well as flavours tough cuts of meat and makes them suitable for grilling. Market research indicates there will be demand for the product if it is released before a similar product is developed by a competitor. The new marinade will fail if:

- the product development team is slow
- the promotional campaign does not target the right market or is not ready for the product launch
- distribution of the product to appropriate retail outlets is not finalised
- the price of the marinade is too high for the target market.

The marketing mix aims to create a product with the tangible and intangible characteristics that the target market wants or needs. Tangible characteristics include product size, colour, flavour and packaging. Intangible characteristics involve the consumer's perception of brand names, product image relating to quality, features, design and styling, environmental friendliness, guarantees and after-sales service.

Product planning

Product life-cycle theory was originally developed for product categories, rather than specific brands. The life cycle of a product refers to its sales history. The concept of **product life cycle** was also discussed on page 274. The diagram below illustrates one example of a product life cycle, showing how its income generation for a company changes as it progresses through the market phases of introduction, growth, maturity and decline, leading to its ultimate failure.



Stages in the product life cycle, showing sales volume and profits

Let's take a closer look at each of these product life-cycle phases.

- *Introduction* — The time during which a new product is being introduced to the market frequently involves attempts to develop a demand for the product category, rather than involve the brand name. This is particularly so if the new product differs from the categories normally used by consumers. This phase tends to involve intense, and costly, marketing and promotional strategies compared to subsequent phases.
- *Growth phase* — The period where sales of the product grow rapidly and, accordingly, its income generation also increases. Marketing strategies during this phase tend to be more focused on brand name rather than product category, and must try to counteract actions of other manufacturers. For example, similar products may be placed on the market and there may be increasing pressure on sales, prices and market share because of competition from other manufacturers.
- *Maturity* — The term used to describe the life-cycle phase when market share is stable, growth in sales slows down and many smaller, or less committed, competitor companies have ceased to market their versions of the product. Although the number of competitors may decrease, the level of competition becomes more intense. Marketing strategies during this phase tend to relate to brand name, company image, pricing and more emotive aspects.
- *Decline* — Decline or, in fact, failure of a product category on the market occurs when sales decline and generation of sales income decreases. At this time less marketing effort is expended on the product, and distribution and promotional efforts decrease. Manufacturers should recognise that they would be 'flogging a dead horse' and any efforts are probably going to be wasted at this phase of product life. There is not much that a company can do in terms of marketing strategies to revive a product which is in decline without some radical improvements, or at least changes. These improvements and changes are mostly focused on line extensions, for example, new flavours, colours, sizes, packaging or adapting the existing product for new market segments or new applications.

It is important for manufacturers to understand and recognise the onset of product failure and the reasons for it. The reasons for product failure are varied but many failures have been attributed to marketing mistakes. This is probably an oversimplification as several reasons have been identified in US surveys, by experts in the field, on the basis of interviews with various food manufacturers. These reasons are summarised in table 16.2.

As table 16.2 shows, more than one reason may have been given for specific examples of product failure (this is why the 'times blamed' column totals more than 100 per cent). It is also important to recognise that whatever the specified reason, the product was probably launched on the recommendation of company management and that this frequently related to poor market research data or to disregarding negative results, especially in relation to market and consumer feedback.

TABLE 16.2 Reasons for new food product failure and percentage of time they were blamed

REASON FOR FAILURE	TIMES BLAMED FOR FAILURE (%)
Vague consumer point of difference with existing products	36
Poor product positioning	32
No point of difference with existing products	20
Bad timing of market launch	16
Poor product performance	12
Wrong market for company	8

Source: Why new products fail, *Food Technology*, Sloan A. E., 1994.

Whatever its cause, how can a company recognise the onset of failure, in other words, identify a 'sick product', as a product in decline is sometimes described? The single most obvious and reliable indication is that its sales decline and profits drop. What specific actions can a company take with a sick product? Remedial actions include:

1. Discontinue manufacturing the product.
2. Sell the product to another company. This may be problematic. How can you sell a failed product?
3. Revise marketing strategies, for example, market the product at a discounted price, try another market segment or market on the basis of a new application.
4. Gradually decrease distribution and manufacture of the product.

Price structures

Pricing is an integral part of the marketing plan. Some people are prepared to pay more for a product than others are; it depends on the value they place on it. The best pricing policy allows for consumers to pay more if they see more value in a product — for example, selling the best-quality king prawns for $29.00 per kilogram while school prawns are $10.00 per kilogram.

The product price depends on what the target market is prepared to pay. We have identified certain characteristics of the target market, the most important being age, gender, socioeconomic level, family size and education.

Marketing and other groups have developed shorthand ways of identifying different target markets based on income, age and number of household members. These abbreviated terms are largely acronyms (based on the initials of individual title words). The group names, acronyms and brief descriptions are presented in table 16.3. While these distinctions may appear comical, they do serve a purpose in determining what price a particular target market may be prepared to pay.

If you produced a new food product, how would you set a price? There is no clear formula to follow because there are so many variables to consider. Successful pricing decisions often appear to be based on intuition rather than on hard research or past experience. Prices reflect consumers' needs and wants and may be adjusted upwards (but more often downwards) if the market reaction is not as expected.

However, some factors can assist in deciding a product's price.

- It is generally assumed that the lower the price is, the higher the demand will be.
- The market share the company wishes to gain is important. To encourage more people to buy the product, the price must be lower than the competition's price.
- A company's policies may restrict prices. A company with a prestige image may not wish to have its product discounted because this could hurt the brand's association with luxury.

TABLE 16.3 Names, acronyms and explanations of some target markets

TARGET MARKET	ACRONYM	DESCRIPTION	COMMENTS
Dual income, no kids	DINKS	Two people in household, both bringing in incomes	
Dual income with kids	DEWKS	Two people with incomes, with kids	Assume 2 children, 4 household occupants
Poor urban professionals	PUPPIES	Two incomes, low incomes	Assume 2 occupants
Young upwardly mobile urban professionals	YUPPIES	Two people, advancing in career with good incomes	Assume 2 occupants
Well-off older folk	WOOFS	Two people, probably retired, living off proceeds of superannuation, investments etc.	Assume 2 occupants, no dependants, good combined income
Single occupants low income	SOLI	One person, living alone, low income	1 occupant only
Single occupants good income	SOGI	Single occupant living alone, good income	1 occupant only

In the table above, seven target markets are described. Can you think of any others which might be used?

- The anticipated reactions of competitors are important. A food producer will be reluctant to raise prices higher than a competitor's unless it is believed that the competitor will also raise its price.

It is important to note that businesses rarely, if ever, see price as the sole reason for the success of their product. This is because companies are not only concerned with immediate income. Most have, or should have, long-term goals in their marketing and pricing strategies.

All products have a basic list price or suggested selling price based on the **break-even point**. The profit margin ranges between 5 per cent and 20 per cent of fixed costs (materials, labour, packaging, utilities, depreciation of machinery, rent and rates, and maintenance costs), depending on the pricing strategy used. It is normal for a food producer to charge less than the list price for their products if:

- the purchase is large. Some large stores can buy in large enough quantities that the manufacturer will produce a product just for them.
- payment is made in cash within thirty or sixty days
- orders are placed out of season — for example, winter orders for soft drinks are discounted
- the customer is a wholesaler or franchiser who then on-sells the product.

Regardless of the discount offered, the manufacturer still makes a profit.

The break-even point (see chapter 15, page 285) is the obvious place to start when deciding on a product's price. But this break-even point may not arrive until the maturity phase of the product life cycle. Exactly when the profits start to occur depends on the pricing tactic used.

Penetration pricing means the product price is below that of competitors for long enough to obtain a foothold in the market. This pricing tactic is used when a company enters a new market segment for the first time, when a **me-too product** is being launched, or when it is hoped the product will be around for a long time.

Another pricing tactic is **price skimming**, where a product or service is sold at a relatively high price at first, and then the price falls over time. It is used when the product is:

- new-to-the-world or a line extension that has no other competition
- the only one on the market and without a substitute. You may be aware that the profits at a cinema come from candy bar sales rather than the cost of the tickets. Another example is a drink on a hot summer day, when it has more value and therefore attracts a higher price.
- 'positioned' as an exclusive, high-status brand. Consumers assume that a high price means high quality.
- not expected to have a long life cycle.

The third pricing strategy is **competitive pricing** or **status-quo pricing**, whereby the price is set to match that of the competition. This pricing strategy is used by market leaders and at places like Paddy's Market where all the fruit and vegetable sellers charge much the same price for their goods.

More information appears later in this chapter to help you understand pricing as a factor in the promotion of a product and in the placement and distribution system of food products.

CASE STUDY

1.2 MILLION AUSTRALIANS GO THROUGH MCDONALD'S GOLDEN ARCHES EVERY DAY

by HANNAH TATTERSALL

The reinvented fast-food chain McDonald's has bounced back from the *Super Size Me* controversy to serve a record number of Australians in the past year.

An average of 1.2 million Australians a day walked through the golden arches in 2007.

The franchise, which has 762 restaurants across the nation, notched double-digit growth over the calendar year, a McDonald's Australia spokeswoman said.

But only 15 per cent of sales were its healthy eating options such as salads and fruit juices. The top seller was the cheeseburger.

The fast-food giant has prevailed despite the negative publicity generated by Morgan Spurlock's 2004 documentary *Super Size Me*, which highlighted the filmmaker's 11-kilogram weight gain and associated health problems after he ate nothing but McDonald's for 30 days.

'There's no doubt that there was huge media coverage given to *Super Size Me* but it applied more to the US than here,' Ms Farquhar said.

'The claims made in that film were untrue in Australia because we were already on a journey of reinvention and had already expanded our menu … and put nutritional labelling on our products when that [film] came out in Australia.'

A report from the Organisation for Economic Co-operation and Development revealed last year that Australia had the fifth highest adult obesity rate behind the US, Mexico, Britain and Greece.

Dr Schachter said while some people might choose healthier options at McDonald's, the fact was many still ordered fries, which were high in fat.

'Society is getting more overweight and obese and it's disappointing to think that nearly 5 per cent of Australians are eating McDonald's every day,' she said.

Ms Farquhar said the reason for strong business growth was because McDonald's was 'not just about burgers and fries any more.

'We've broadened our appeal and are responding to consumers who are demanding high-quality products,' she said.

The $2.5 billion company has been transformed over the past six years after a decade of declining sales. Its menu now features lighter options such as salads and sandwich wraps and food is cooked in an oil blend that has 85 per cent less trans fatty acids.

Since 2006 McDonald's has had 'percentage daily intake' information on its packaging, so that customers can see the energy content and nutrients in its food.

Andrew Koch, director of independent Sydney agency The Marketing Factor, said McDonald's had repositioned itself in the fast-food market by addressing the issues of fatty food and obesity.

'Their advertising used to be aimed at kids, whereas now they offer a broader range of products and are bringing the whole family in. They've convinced the parents too now,' he said.

Source: The Sydney Morning Herald, 27 January 2008.

CASE STUDY QUESTIONS

Carefully consider the article on the previous page. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *product planning and price structures* to complete the tasks ahead.

1. Do you think McDonald's has a product orientation approach or a sales orientation approach?
2. Explain how McDonald's responded to bad publicity about the nutritional value of its food. Why is this analysis of the market important for continued success?
3. Describe how McDonald's has selected different target markets for its products in recent years.
4. McDonald's has been a successful fast food restaurant for a variety of reasons. How important do you think its pricing of products has been to its success?
5. Look at table 16.3 on page 295. Describe McDonald's main target market.
6. Log in to **www.jacplus.com.au** and locate the *Business case study* weblink for this chapter. Describe why Oliver's Real Food has been a successful food business.

eBook*plus*

Additional case study

Weblink

REVIEW QUESTIONS

Remember

1. What is the purpose of having a marketing plan?

Apply

2. An American breakfast cereal manufacturer developed the concept of a product based on a crisp cereal with added freeze-dried fruit pieces. The concept was based on consumers wanting a crisp cereal-based breakfast food with added fruit pieces which would re-hydrate rapidly when milk was added. Freeze-dried fruit re-hydrate more rapidly than other dried fruit forms and it was felt that this would happen rapidly when milk was added, providing consumers with delicious fruit pieces in a crisp cereal product, which was convenient and rapid to prepare. The main problem was that the freeze-dried fruit re-hydrated faster than conventional dried fruit, but by the time it had re-hydrated, the cereal had already become soggy. Research and development had reported this to management who, nevertheless, decided that market launch of this food product should go ahead.
   a) In relation to the crisp cereal with added freeze-dried fruit pieces, predict the likelihood of its successful marketplace launch and explain reasons for your prediction.
   b) What do you think was the target market for the product?
3. Explain the reason for the use of 'penetration pricing'.
4. What type of pricing policy is being used in the following situations and do you think consumers would be happy to pay the price for this product?
   a) A soft drink company that sells its products through vending machines that can detect temperature. On a hot day the price of a can of soft drink can increase by 50 per cent.
   b) The price of truffles was set high because no other truffles were available in Australia, and this was considered a luxury product.
   c) John said that organic potatoes sold at the other market were much cheaper and the shop owner matched the price.

Do an activity

5. Visit a retail outlet such as a supermarket. Choose one food product that has at least four different brands and is the same size (for example, canned salmon). Identify which target market each product is targeting (see table 16.3, page 295) and record the price of the item. Do you think consumers are paying more for a higher quality item in each case or not? Give reasons for your answer.

How many times today have you seen food advertising? Perhaps it was that vending machine showing a picture of caramel oozing out of the chocolate bar or an invitation to sample a food product, some junk mail telling you about the latest deals or a television advertisement that made you want to eat the product straight away.

Promotion

Promotion informs consumers about new products, and persuades customers to buy a new product or buy more of an existing one. Promotional activities teach us to be consumers. The types of activity include:

- advertising
- personal selling
- publicity and public relations
- sales promotions (sales, in-store sample testing, product giveaways and demonstrations).

To select the right type or combination of activities to promote a product, a company has several important considerations:

- the promotion budget
- the size and maturity of the target market
- the stage of the product's life cycle.

Advertising

When most people think of product promotion they think of advertising. And why not? We are bombarded with an average of 1500 advertisements per day. Advertisements tell us who we are or should be, and suggest that happiness can be obtained from buying this product or looking this way. They tell us that a product can fulfil our every desire and provide instant solutions to life's problems. Regardless of our willingness to acknowledge it, advertising affects our lives.

Types of advertising

The most obvious advertising appears in magazines and newspapers, and on television, radio and the internet. The marketing team uses market research to identify the physical and buying behaviour of its target market, then selects the media outlet that best delivers the advertising message to the consumer.

When choosing a magazine in which to advertise a product, a company can choose different categories of magazines that have different markets:

- consumer — for example, *Australian Women's Weekly*
- class — for example, a magazine for a select group interested in a particular item, such as gourmet cooking
- trade — for example, hospitality industry magazines such as *Open House*
- technical and professional — for example, the monthly publications by the Australian Institute of Food Science and Technology.

Advertising can target a specific market.
Why might food companies advertise in this type of magazine?

Even newspapers are aimed at different target markets. There are Sunday, regional, suburban and country newspapers, and metropolitan dailies. An advantage of the printed media is that consumers can digest material at their own pace, whereas the electronic media of radio and television do not allow consumers much time to receive and understand the advertising message.

However, there is no doubt that television advertising is effective, with one survey showing that the overwhelming majority of advertising on television at prime time is food advertising. Several other forms of advertising have been found to be very effective because they are visible, long lived and often absorbed at a subconscious level. The first form is outdoor advertising on buses, trains and taxis. This also includes posters and billboards of all sizes located on buildings, bus shelters and sports fields, or by the side of the road.

The second form is point-of-purchase promotion. This category includes posters in retail outlets (signs on walls and in window displays), display racks and vending machines. A third form is the package in which the food product is sold. Every product we buy attempts to advertise itself through its packaging. Think of the Coke bottle. The Coca-Cola Company considered not using the curvaceous bottles any longer, because containers with straight sides can be processed more quickly. But market research showed that consumers perceive the shape as part of the overall appeal of the product and that it helps them distinguish the product from other soft drinks.

Advertising and product positioning

We have learned that positioning refers to the image of a particular product in the mind of a consumer. As an example, if we were asked what beverage most people drink at breakfast, the answer would be orange juice. Orange juice has this position in the mind of many consumers. But orange juice could be advertised as a refreshing drink at any time during the day; in other words, the consumer could be made to see the product in a different way. Coca-Cola is a famous example of how promotion can change the position of a product. It was originally sold as a brain tonic for all nervous conditions. It was meant to be able to cure everything from depression to anxiety, and was positioned as an over-the-counter medicine. Effective marketing soon positioned Coca-Cola as a soft drink that quenched thirst.

Milk is a more recent example of product positioning. As a class, discuss the old and new images of milk in the minds of consumers.

Sales promotions and demonstrations

Sales promotions include contests, free samples, coupons and cash-back offers. Exhibitions of new products at trade shows can be in the form of demonstrations or promotions in which you pay less for the product if you buy it at the show. Large supermarkets also have demonstrations in which people can sample a food product. Gondolas located at the ends of supermarket aisles, floor bins in a store's

CASE STUDY

AND YOU THOUGHT YOU WERE JUST WATCHING TELEVISION...

It's 8 pm and you are watching your favourite television show. Suddenly, it attacks from out of nowhere! Yes, it's the desire to eat food triggered by the latest scrumptious food advertisement. This time they are advertising chocolate that looks smooth and creamy. The sight of caramel ejects you from your couch in pursuit of more food before your program resumes.

NSW Health commissioned a report to analyse food and drink advertising on commercial television in Sydney in 2006. A single week was chosen to conduct the study which focused on children's viewing hours on weeknights and weekends. It was found that 26.2 per cent of all advertising was food advertising. Put another way, the study found that children were subjected to 7.3 food advertisements per hour. Advertising food is no crime, of course, but the study did find that of all food advertising, core foods comprised 36 per cent and high fat/high sugar food comprised 43 per cent.

Fast food restaurants and confectionery companies advertise the most frequently. If you had been watching television during the week of the study (weeknights and weekends), you would have seen 177 Cadbury ads, 109 McDonald's ads, 88 KFC ads, 78 Domino's ads, 61 Nestlé Nesquik chocolate cereal ads and 33 ads for Pizza Hut.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food promotion in Australia* to complete the tasks ahead.

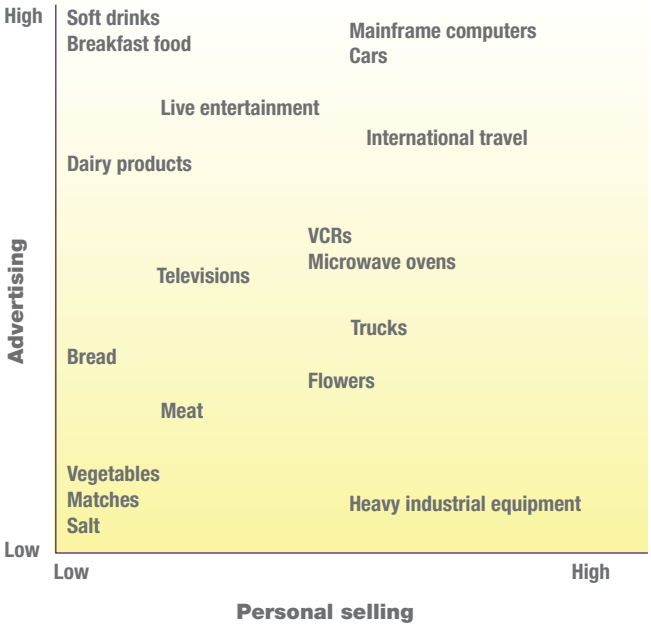
1. Draw a pie chart which shows the percentage of food television advertising on commercial free-to-air television stations, according to the study. Illustrate what percentage of food advertising could be classified as 'unhealthy/non-core food' and 'healthy-core food'.
2. Of the food advertised, which food categories were the most frequently advertised?
3. Watch television for 30 minutes one evening and list the advertisements shown. Note details of the ones that were advertising food. Identify which food advertisements were advertising 'unhealthy' food. What are the repercussions of advertising unhealthy food regularly on television? Do you think anything should be done about it?

busiest areas (called hot spots) and other 'off location' displays (such as a display box of sauces next to the barbecue cuts of meat) are other forms of sales promotions.

One of the most frequent forms of sales promotions occurs when a product is 'on sale'. Sales used to occur once or twice a year, but now they are ongoing. Often sales items are described as being offered 'for a limited time only' but the wise consumer should check because sale items are sometimes the same price as the regular price. Often the salespeople compare items that are not 'on sale' with sale items, helping to sell the sale items.

Personal selling

Personal selling is a major promotional tool, although it is mostly invisible to the average consumer. A retail salesperson helping a customer choose one product over another, travelling salespeople who deal with wholesalers and large retailers, and the drivers delivering to retail outlets are all examples of personal selling. Some products are promoted best through advertising while others are promoted best through personal selling.



Products promotion through personal selling and advertising

Publicity and public relations

Publicity is the unpaid use of media to broaden the public's knowledge and recognition of a product. It is free advertising for a company, such as when a company's wine wins a prize at an annual wine show.

A celebrity who wears the company logo when playing sport or attending a function, or who is seen eating or drinking the company's product is another example of publicity. The company usually pays the celebrity for wearing the company logo, but not for any publicity the celebrity generates.

Public relations is a communication tool to build or maintain a favourable image with the public. Sponsorship of sporting activities and teams, school activities and charity drives contribute to building a positive company image.

Place and distribution systems

Place in the marketing mix refers to where the product will be sold geographically and to the kinds of outlet in which it will be sold. **Distribution** refers to the process of moving the product from the producer to the consumer.

Place

Place is where the target market lives, works, plays and shops. Marketers have several tactics to consider when placing a product to reach the target market.

1. **Intensive distribution** — means when products are available at every possible outlet (for example, chocolate bars are sold in small shops, service stations, grocery stores, newsagents, bakery shops, vending machines and online)
2. **Selective distribution** — this is when there is a wide but not intensive distribution (for example, some types of cheese are available at delicatessen chains such as Cut Price Delis rather than Woolworths or Coles)
3. **Exclusive distribution** — means when a limited supply of a product is sold in only a few retail outlets, usually because the product is expensive (for example, handmade chocolates) and has an elite image in the consumer's mind.

Retailers

A company that sells something to the consumer by telephone, mail, vending machine, on the internet or face-to-face is making a retail sale. Most of us buy our food from retailers. The main function of a retailer is to sell goods and services to consumers who will use the products for their own use.

Retail food stores may be small-scale or large-scale operations, depending on the volume of sales. Ownership may be:

- a corporate chain — for example, Coles
- an independent owner — for example, a sole proprietor's corner store
- groups of voluntary associations of independent owners
- a cooperative. A cooperative is a business that is owned, controlled and used by its members for their own mutual benefit. Primary producers such as farmers and fishing operators sometimes form cooperatives.

According to researchers (The Nielsen Company), there seems to be a swing back to fresh food outlets such as the greengrocers, fish markets, butchers and bakeries that is threatening supermarkets because consumers are increasingly shopping around for the freshest food. While supermarkets are still dominant (98 per cent of those surveyed

CASE STUDY

FOOD FIGHT: SAM TAKES ON MISSY

by CHRISTINE SAMS

With Sam Neill spruiking the benefits of eating meat, Missy Higgins telling people to go vegetarian and John Farnham plugging milk, celebrity-fronted food campaigns are the hottest trend in advertising.

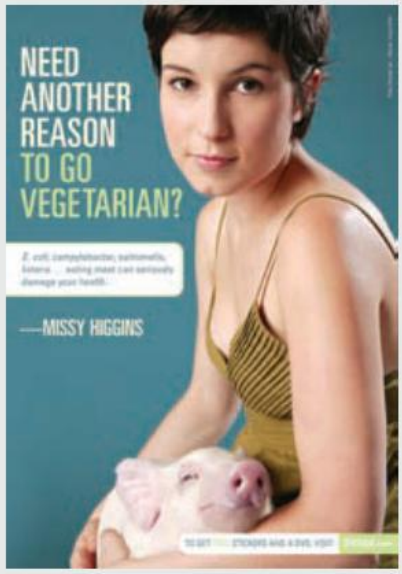
Neill has filmed his first-ever advertising campaign, to promote red meat as part of a deal with Meat and Livestock Australia. In the big-budget advertisement due to appear on Australian television screens for the first time tonight, Neill uses the slogan: 'Red meat; we were meant to eat it'.

'Lean meat, three or four times a week, is still an essential part of the diet of the most highly developed species on the planet,' he tells audiences as part of a five-week meat campaign.

The high-profile involvement of Neill is a coup for meat producers, who are trying to fight claims that there should be less red meat in the Australian diet.

'I think Sam brings a unique combination of great trust and credibility because he's viewed not just as a celebrity, but as a person in the public eye with credibility,' said David Thomason, general manager of marketing at Meat and Livestock Australia. 'It's also his role as an actor which brings warmth and humour to the whole thing.

'This is the first advertising Sam's ever been involved in, so we're delighted,' he said. 'But it's down to the fact we're not a commercial enterprise but we're representing an industry . . . one that's very important, particularly in regional Australia.'



Neill's involvement also signals a battle of celebrity loyalties regarding meat-eating and vegetarianism, which is becoming more pronounced in Australian advertising. After comedian Sam Kekovich's notorious campaign for lamb, celebrities including Missy Higgins threw their support behind giving up meat all together.

In her advertising campaign for People for the Ethical Treatment of Animals (PETA), Higgins nursed a baby pig under the slogan 'Need Another Reason to Go Vegetarian?'

'I much prefer eating green vegetables to meat anyway,' Higgins told reporters. It was also the first time the vegetarian singer-songwriter had so publicly supported a cause.

Mr Thomason said: 'We haven't thought of it as being a war of celebrities, but the important part for us is about getting the message across.

'Red meat certainly has its critics out there who argue that we should be eating much less (or none at all), but our campaign is really about putting that back into context.'

Neill's fee for the meat campaign has not been revealed.

Source: The Age, 12 March 2006.

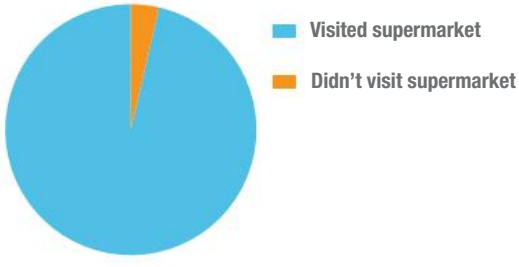
CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *publicity and public relations* to complete the tasks ahead.

1. **a)** Why do you think food companies use celebrities to advertise their products?
   b) What are the advantages of using celebrities over non-celebrities?
2. Give two other examples of advertising involving celebrities or where a celebrity has set up their own food company or food product line.

claimed they had visited a supermarket in the last seven days), 35 per cent said they had purchased their fruit and vegetables in a traditional greengrocer and 32 per cent said they had purchased their fresh meat, chicken and seafood in a butcher or fish shop.

Percentage of respondents who had visited a supermarket in the last seven days



Supermarkets beware the growing trend to shop for produce where it is freshest.

Source: The 2006 AC Nielsen Shopper Trends Report.

Fresh food purchased from a specialty shop in the last seven days

The table below outlines a separate report conducted by The Nielsen Company that asked consumers why they chose to most frequently purchase their fresh produce outside the supermarket.

TABLE 16.4 Why consumers purchase fresh produce outside the supermarket

REASON	PERCENTAGE (%)
Quality	80
Price	39
Location	39
Range/choice	35
Service	12

Note: Consumers may have given several reasons why they shop outside a supermarket.

As mentioned in chapter 1, online shopping is also an option for food shopping. Food and groceries can be purchased online from retailers ranging from large supermarkets to small online businesses selling specialty items such as organic food. One of the advantages of online shopping is the convenience; however, most deliveries are restricted to major cities and metropolitan areas.

Distribution systems

Once a company has chosen its placement strategy, the physical distribution of the product takes place. Distribution involves moving the product from the manufacturer to the point of sale. The longer the distribution chain is, the less efficient it is. Distribution is an important part of customer service; if mistakes or delays occur, the total marketing mix can be unsuccessful. It is interesting to note that only 30 per cent of Sydney's food is still grown in NSW. Our distribution systems, therefore, need to be extremely efficient and involve the following activities.

1. *Warehousing*. The correct storage of goods means the consumer receives the product in the best and safest possible condition (see chapter 3, pages 49–52, for a discussion of types of storage). Depending on the location of customers, warehouses can be located at one central place or in different parts of the State and/or country. To give you an idea of the size of these warehouses, one Woolworths fresh-food distribution centre located in NSW has a loading area the size of three football fields, processing 25 000 boxes of fresh fruit and vegetables each day. The 80 staff who work there dress for winter all year round as the temperature inside never rises above 14 °C.
2. *Materials handling*. This refers to the forklifts, conveyor belts and other methods that move the cartons of product from the storage area to pallets ready for shipping.
3. *Inventory control*. This is essential because it ensures the quality of the product and quick filling of orders. Holding too much stock is expensive, not only because the product takes up space in the warehouse, but also because the chances of theft, fire and water damage increase while the product is held longer before shipment. One recent development concerning checking the quality of food is the practice of taking digital photos of rejected produce which can be emailed to growers within hours.
4. *Order processing*. This involves the handling and filling of orders, processing of accounts and collection of credit payments. Portable data, entered by retailers, identifies when stock is low and automatically re-orders the product. In other words, order processing makes sure the customer receives what they order, when they want it.
5. *Transportation*. The type of transportation used — air, water, rail or road — depends on the type of product, the urgency of the delivery, the distances to be covered, and the nature of the product.

REVIEW QUESTIONS

Remember

1. True or false?
- **a)** Promoting a product refers only to how it is advertised.
- **b)** Product position refers to the target market for a product.
- **c)** Place in the marketing mix refers to where the product is sold.

Apply

2. Explain why personal selling techniques would be more important when selling cars than dairy products, for example.

3. Give three examples of how food companies use public relations to build a favourable image of themselves among consumers.

4. Discuss the problems associated with the fact that only 30 per cent of food in Sydney is produced in NSW.

Do an activity

5. Choose a food product you like and search the internet, magazines or newspapers for sample advertising of that product.
- **a)** What is the product's target market and what tactics does it use to appeal to that target market?
- **b)** Explain why those marketing the product would have used that particular medium to advertise its products.

6. Log in to **www.jacplus.com.au** and locate the *Food franchise* weblink for this chapter. Describe why Mr Whippy is a proven success among consumers.

eBook*plus*
Weblink

CASE STUDY

Marketing successes

Look at table 16.5. At least eight of the top 30 most admired brands in 2007 were food brands. What drives admiration of a brand? How did the marketers do it? Having a quality product, giving great service and pricing your product fair and reasonably are all factors which lead to brand admiration; however, being socially and environmentally responsible are factors that are becoming more important among consumers.

TABLE 16.5 The top 30 most admired brands in Australia

BRAND ADMIRATION RANK	BRAND	MAIN INDUSTRY
1	Cadbury	food
2	Dick Smith	various
3	Sony	electronics
4	Nestlé	food
5	Coles	retail
6	Virgin	various
7	Woolworths	retail
8	Microsoft	IT
9	Coca-Cola	beverage
10	Arnott's	food
11	Kellogg's	food
12	Toyota	automotive
13	Sanitarium	food
14	Holden	automotive
15	LG	electronics
16	BHP	industrial
17	Nike	clothing and footwear
18	Heinz	food
19	Apple	IT
20	Myer	retail
21	Qantas	airline
22	Target	retail
23	Dairy Farmers	food
24	Golden Circle	food
25	McDonald's	quick-service restaurant
26	Johnson & Johnson	consumer products
27	Nokia	telecommunications
28	Ford	automotive
29	Panasonic	electronics
30	Big W	retail

OUTCOME TASK **CASE STUDY**

Students learn to:

- plan suitable strategies for the marketing of a specific food product.

Contributes to the following outcome:

- develops, prepares and presents food using product development processes.

Carefully consider the article and table above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *marketing plans* to complete the tasks ahead.

1. Choose one of the admired food brands above and explain in your own words why it has been successful.
2. Now that you know what factors drive brand admiration you can develop your own marketing plan for a food product of your choosing, using the four activities that make up the marketing mix. Use the following headings and subheadings to form the basis of your presentation.

Product planning

Make sure you understand your food product in terms of its packaging and benefits and outline its target market. Undertake some market research to gain some idea of whether the product is likely to be a success.

Price structure

a) Describe the pricing strategy you would use, and why you have chosen it.

b) Suggest a list price and a selling price in a large supermarket for your product.

Promotional program

a) Identify two promotional activities you would use for your target market. One must be a form of advertising and the other must be an activity that you think will appeal to your target market.

b) For the advertising activity, develop an advertisement for your product. The advertisement can be suitable for the print media or the electronic media.

c) For your other promotional activity, outline how the activity would be implemented and why it should appeal to your market.

Place and distribution system

a) Describe the type of distribution you intend for your product, and why you have chosen it. Give examples of retailers who would be included in your distribution system.

b) State the method of transport you would use for your product, and why you have chosen it.

CHAPTER 16 SUMMARY

- Marketing plans may be product oriented or sales oriented.
- Product planning, price structure, placement, distribution and promotion make up the marketing mix.
- The target market is important when determining price.
- Promotion not only includes advertising, but also personal selling, public relations and sales promotion. The type of promotion chosen will depend on the budget, target market and product life cycle.
- Place refers to where consumers are able to get access to a product, and distribution refers to the process used to move the product from the producer to the retailer.

KEY TERMS

break-even point
competitive pricing
distribution
exclusive distribution
intensive distribution
line extensions
marketing mix
marketing plans
marketing process
me-too product
new-to-the-world products
penetration pricing
price skimming
product life cycle
public relations
publicity
selective distribution
status-quo pricing

HSC PRACTICE EXAM QUESTIONS

Multiple-choice questions

1. Which of the following is an external factor affecting new food product development?
   - **A.** Company image
   - **B.** Ecological environment
   - **C.** Production facilities
   - **D.** Financial position
2. SWOT analysis may be used by a food company to assess which of the following?
   - **A.** Success or failure of new product concepts
   - **B.** Ingredients for new product formulations
   - **C.** Staff development programs
   - **D.** Salary levels for senior staff
3. Which of the following is a type of new food product?
   - **A.** New-to-the-world
   - **B.** Carbonated soft drinks
   - **C.** Low-cost convenience foods
   - **D.** Ultra-heat treatment equipment
4. Which of the following is a form of secondary market research?
   - **A.** Focus group interviews
   - **B.** Information from government publications
   - **C.** Brainstorming sessions
   - **D.** Shopping centre surveys
5. The publicity component of a marketing plan for a new food product is designed to meet which one of the following roles?
   - **A.** Industrial problems within the company
   - **B.** Political affiliations of the company
   - **C.** Informing consumers about a new food product
   - **D.** Company profitability

Short structured items

1. **a)** Define the term SWOT analysis.
   b) Read the following case and conduct a SWOT analysis of the development of this new food product by BrekkieFoods, given this limited information.

   BrekkieFoods is a multinational company based in Australia. The company has had a large share of the breakfast cereal market over many years. Its personnel have a high level of skills and the company uses a range of local and imported ingredients.

   BrekkieFoods wants to expand its market share by increasing its product range and is currently developing a new product based on the concept of a flavoured yoghurt bar coated with chocolate and fruity muesli. To manufacture this product the company plans to purchase advanced technology and equipment by means of a bank loan.
2. Discuss the reasons why a food manufacturer may select 'me-too' products as the basis for its new food product development activities.
3. **a)** Describe the features of a marketing plan for a new food product.
   b) Explain, using examples, how market concerns and consumer demands lead to development of new food products and how these concerns and needs may be used in marketing plans.

Extended structured response

1. **a)** List the internal and external factors affecting new food product development. Explain the impact of each factor on new food product development activities of food manufacturers.
   b) Explain the actions which food manufacturers may take in response to each factor listed in your answer to (a).
2. List and explain the types of new food products. Discuss the factors that food manufacturers need to consider in deciding which type of new food product they should develop.
3. List in their correct order the steps in new food product development and explain the details of activities involved in each step.
4. Explain the characteristics of THREE target markets. Analyse how the differences between these target markets will be reflected in the price, type and portion size of a new food product, which best meets the requirements of each target market.
5. Describe how a product prototype is tested before commercialisation takes place. Use specific examples to assist with your explanation.

Chapter 17
Diet and health in Australia

What does the word *malnutrition* mean to you? This question probably made you think about someone who is sick because they do not have enough food to eat. You may be surprised to find that malnutrition can refer to any situation where an inappropriate diet causes health problems. Just as eating too little can cause nutritional problems, so can eating too much or eating the wrong foods for your body's needs. A poor diet can contribute to a variety of different health disorders that might otherwise be preventable. Diet-related illnesses cost our health system billions of dollars per year — money that could be saved with better attention to nutrition.

In this chapter you will learn about:

- physical effects and economic costs of malnutrition (undernutrition and overnutrition) and diet-related disorders
- nutritional considerations for specific groups.

Indigenous children in the Northern Territory eating oranges that have been made available cheaply as part of a program to improve nutrition. The cost of fresh fruit and vegetables is much higher in remote areas, making it much more difficult to eat a healthy diet.

Good health

The United Nations World Health Organization has defined good health as 'a state of complete physical, mental and social wellbeing, and not merely the absence of disease and infirmity'. Note that this definition focuses not just on the physical wellbeing of the individual, but also on the mental and social wellbeing. This means that we would not describe as 'healthy' someone who is physically in very good shape, but who is depressed, anxious or lonely. See the following survey for some indicators of good health.

Check these indicators of good health.

Is your hair shiny and in good condition?	Yes ☐	No ☐
Do you have adequate energy for both work and recreation?	Yes ☐	No ☐
Is your weight in the normal range for your height?	Yes ☐	No ☐
Are your teeth free of discolouration?	Yes ☐	No ☐
Are your bones straight and strong?	Yes ☐	No ☐
Do you enjoy spending time with family or friends?	Yes ☐	No ☐
Is your mind active and alert, and are you able to concentrate for long periods of time?	Yes ☐	No ☐
Is your skin in good condition?	Yes ☐	No ☐
Do you spend at least 30 minutes, most days, on physical activity?	Yes ☐	No ☐
Do you have good posture?	Yes ☐	No ☐

Give yourself a point for each time you ticked 'yes'.
Score: 8–10 You are in excellent health.
5–8 There is room for improvement.
1–5 There is definitely room for improvement.

Health is affected by:

- nutrition, including alcohol intake
- self-care behaviour, such as:
  - hygiene
  - safety
  - habits (such as smoking)
  - use or misuse of medications
  - spiritual practices
- physical and social functioning (ability to carry out daily activities and participate in relationships)
- level of social support (friends and family)
- amount and regularity of physical activity
- balance between stresses and relaxation/recreation (sleep, hobbies, holidays)
- socioeconomic status: occupation and education level.

The list above covers most aspects of a person's lifestyle, but only one item on the list is essential for survival: **nutrition**. No matter what else is happening in life, it is not possible to live well without adequate nutrition. In Australia, most people do not have any difficulty obtaining a wide range of foods. Not all of these foods are good for your health, however, and what you choose to eat can make a big difference to your wellbeing. In the short term, an inappropriate diet can make you feel less energetic, less alert or even unwell. As time goes on, you would notice deterioration in the condition of your skin, hair, nails and teeth. Your body shape might start to change. In the long term, a poor diet could increase your chance of developing a condition that threatens your wellbeing or even your life, such as high blood pressure, heart disease, diabetes, anaemia, diverticulitis or osteoporosis.

Malnutrition

Malnutrition occurs when one or more nutrients are not supplied to the body in the correct amounts. This can cause **overnutrition** or **undernutrition**.

- Overnutrition results when the diet contains too much of one or more nutrients. The most common form of overnutrition is the result of an energy imbalance that causes weight gain, where energy intake is higher than energy used through activity. **Adipose tissue** increases, and eventually the person becomes **overweight** or **obese**. This is more likely to occur with foods that are very energy dense (high in fats or sugars) because these make it easy to consume large amounts of energy quickly.

  Consuming too much sugar, particularly in forms that stick to the teeth, can also lead to the development of dental caries (tooth decay) unless careful attention is paid to dental hygiene. Consuming too much sodium is also very common and can lead to high blood pressure or **hypertension**. Other forms of overnutrition are not so common. Excesses of vitamins or minerals are not very likely with normal diets, but they can occur with the overuse of supplements, leading to toxic levels in the body.

- Undernutrition results when the diet contains too little of one or more nutrients. Inadequate energy intake due to poverty is rare in Australia, but eating disorders such as anorexia nervosa also result in undernutrition. The most common forms of undernutrition in Australia are due to inadequate intakes of specific nutrients, such as dietary fibre, iron, calcium or thiamine. Inadequate fluid intake is also common in some groups.

The conditions mentioned above will now be discussed in more detail.

Conditions linked with overnutrition — obesity

Obesity occurs when the energy intake is greater than the energy expenditure through physical activity; the excess energy is stored in the body as adipose tissue. Adipose tissue has some essential functions, as we saw on page 109, but problems arise when the amount of adipose tissue is excessive. A body weighing 10 to 19 per cent above the ideal weight is classified as overweight. A body weighing 20 per cent or more above the ideal weight is classified as obese. Obesity has both short-term and long-term health consequences that become more severe as the condition worsens.

Causes of obesity

Obesity is not caused just by eating too much. Other factors determine whether excess energy intake will lead to excess adipose tissue.

- *Hormones.* For a few people, obesity may be due to defective hormone production in their thyroid, pituitary or sex glands or hypothalamus, changing how the body stores or burns energy. Also, some diseases are treated with medications (such as steroids) that can mimic the effects of some hormones and promote weight gain. Other medical conditions can cause a disturbance in the appetite centre of the brain, leading to inappropriate hunger signals (such as after a large meal).
- *Heredity.* Some strong genetic factors can affect how the body stores or burns energy.
- *Activity level.* A reduction in energy expenditure without a reduction in energy intake will lead to weight gain. Eating habits are difficult to change, so weight gain is common in those times where energy expenditure decreases suddenly, such as at the end of adolescence when growth ceases, or when an injury prevents normal activity.

Overeating behaviour is often believed to be a sign of a lazy or undisciplined person, when in fact most of us overeat at one time or another. Many factors influence food intake, and we do not eat only when we are hungry. Food is used in many other situations: as part of a social occasion, to care for someone, to cheer someone up, as a reward or to celebrate. Food intake is affected by:

- *psychological factors.* Food can cause many pleasurable feelings. A habit of using food as a comfort or a reward can lead to problems in some people, particularly when energy-dense foods are chosen. Depression, stress and loneliness can result in overeating more frequently, and the resulting weight gain may form part of a vicious cycle where being overweight causes greater depression and continued overeating. To prevent this pattern developing, it may be helpful early in life to emphasise other kinds of rewards and treats, such as outings, toys, books and fun activities.
- *environmental factors.* An individual's environment can make a big difference to their food behaviour. It is easier to eat well when fresh, healthy food is readily available and when you have enough money to buy it and the skills and equipment to prepare it in a tempting way. If you lack money, skills or cooking facilities, or if you live far from food shops, it is difficult to make tasty food at home, and so takeaway foods become much more attractive. Similarly, you are more likely to get plenty of exercise if you have easy access to parks, sporting groups and pleasant walking tracks. A lack of exercise facilities, or living where the streets are poorly lit or where there is a high crime rate, tends to discourage physical activity. Your household's eating and exercise behaviour, and the habits that you learned early in life, can also be important environmental factors.

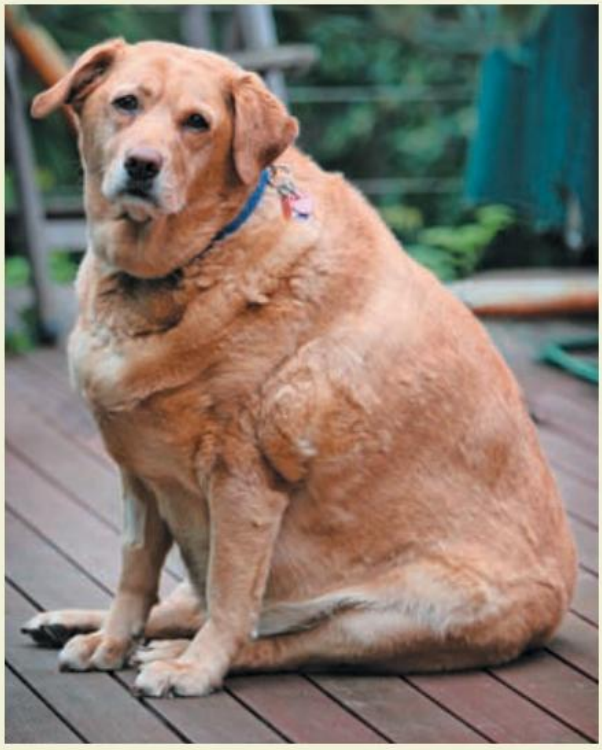
Assessment of obesity

It is normal to have some adipose tissue. In women, this is usually distributed more evenly over the body, including the hips, thighs, bust, waist and upper arms. In men, it is more common for the adipose tissue to be concentrated around the waist. Too much adipose tissue is associated with health problems. Many tests have been developed to determine how much is too much.

- *Subjective tests.* Just observing a person's body shape and their overall appearance can give a rough idea of how much adipose tissue they have. This has possible bias because:
  - someone can look big because they have lots of extra muscle as well as fat, and so may be fit and healthy
  - a taller person can gain an unhealthy amount of fat and still appear to be of normal proportions due to their extra height
  - your assessment of your own appearance can be affected by your body image. People who are worried about their weight, even if they are within a healthy weight range, often focus on any fat they see and overestimate the amount.
  - excessive adipose tissue can start to look 'normal' as the general population becomes more overweight. For example, look at old family photographs from when your grandparents were young and note how young people seem quite thin by today's standards. Photographs from old newspapers are another good place to look to make this comparison.

CASE STUDY

The great debate



What determines your body weight? There is a 'nature versus nurture' debate about the factors that contribute to being overweight. One side of this debate says that obesity runs in families and is mostly genetically determined ('nature'). The other side says that lifestyle behaviours ('nurture'), such as eating and exercising, are more important. Scientists have been gathering evidence to answer this question.

For the 'nurture' side of the debate, it is often observed that overweight families have overweight dogs. Obviously, this is an effect of the family's eating and exercise behaviour rather than genetic effects.

For the 'nature' side of the debate, experiments have shown that identical twins gain similar amounts of weight when they are deliberately overfed by the same amount, whereas there is a wide variation in weight gain in people who are unrelated. In one study, 16 unrelated volunteers were each fed an extra 4200 kilojoules per day in a closely supervised environment. The weight gained by the volunteers ranged from 1.4 to 7.2 kilograms, and body composition tests showed an even wider variation in the amount of fat gained, ranging from 360 grams to 4.3 kilograms. The researchers concluded that there are very important individual differences in how our bodies respond to overfeeding. Their observations suggested that some people gained less weight because they increased their non-exercise activity (such as fidgeting, standing rather than sitting, performing usual activities more quickly) and body heat production. Others did not experience these changes and gained more weight.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *factors affecting body weight* to complete the tasks ahead.

1. List the environmental factors that affect your own eating and exercise behaviours. Divide them into factors that are helpful in improving your lifestyle, and those that are unhelpful. Consider where you live, your family's habits and the resources available to you.
2. Think about your food intake over the last few days. For each occasion when you ate or drank something, identify the main reason and enter it in the table below. Some examples are shown.

I WAS REALLY HUNGRY/ THIRSTY	IT WAS JUST THE NORMAL TIME TO EAT/DRINK	I WAS REWARDING MYSELF/TAKING A BREAK	I WAS CHEERING MYSELF/SOMEONE ELSE UP	IT WAS A SOCIAL OCCASION
Breakfast — I was ravenous! Lunch	Recess — I ate my apple but was not really hungry. After school — I always have some water when I get home.	I had some snacks while studying for the exam.	I had chocolate with my friends after the exam.	Dinner — We went out for Mum's birthday.

Weighing yourself, or just assessing how tight your clothes feel, are some other common ways of monitoring your own body shape.

- *Waist circumference and waist-to-hip ratio.* These methods look only at someone's body shape and do not assess overall body fatness. Fat around the middle of the body, where the organs are, is called **central obesity** and is associated with a higher risk of health problems. Waist circumference can be measured and compared with standard values; in both children and adults, a large waist circumference indicates central obesity.

Waist-to-hip ratio is used mainly to assess body shape in adults. The ratio is calculated as follows:

$$\text{waist-to-hip ratio} = \frac{\text{waist circumference}}{\text{hip circumference}}$$

Using a tape measure, the waist circumference is measured at the narrowest point between the bottom of the ribs and the top of the hip bone, after breathing out. The hip circumference is measured around the widest point of the buttocks.

An ideal waist-to-hip ratio is about 0.7 for women and 0.9 for men. A ratio of greater than 0.9 in women or 1.0 in men is considered to indicate central obesity, but this can be misleading in thin people who have a 'straight up-and-down' shape and little body fat. For best results, this method needs to be combined with other ways of assessing body fatness and health.

- *Skinfold tests.* Special calipers are used by professionals to measure the thickness of skin folds at particular sites on the body; these measurements are then compared with tables of normal values. This makes it possible to estimate how much of a person's weight is adipose tissue. In men, adipose tissue is normally around 15 to 20 per cent of their total body weight; in women, it is about 20 to 25 per cent of body weight. Obesity-related health problems generally occur when adipose tissue is more than 25 per cent of body weight in men, or more than 30 per cent of body weight in women.

Measuring skinfold thickness to assess body composition

- *Body mass index (BMI).* The BMI is calculated as follows:

$$\text{BMI} = \frac{\text{weight (kilograms)}}{\text{height} \times \text{height (metres)}}$$

For children, tables of standard BMI-for-age values are available to identify the healthy weight range and underweight and overweight ranges for each age group. For adults, the BMI can be interpreted according to the following classifications, which are based on World Health Organization data.

CLASSIFICATION	BMI
Severely underweight	<17.9
Underweight	18–19.9
Acceptable weight	20–24.9
Overweight (grade I obesity)	25–29.9
Obese (grade II obesity)	30–34.9
Morbidly obese (grade III obesity)	40 or more

These classifications indicate different levels of health risk. Because the risk is different for people with different body types, some alternative classifications have been suggested. For example, Asian and Aboriginal people experience obesity-related health problems at lower weights than do Pacific Islander people. For this reason, it has been suggested that a BMI range of 18.5 to 23 is more appropriate as an 'acceptable weight' range for the former group, and a range of 22 to 27 is more appropriate for the latter. A similarly higher range is also recommended for people aged over 65 years. The limitation of BMI as an assessment method is that it is based on average health risks of a whole group, rather than of individuals. Exceptions might include a fit, lean person who has an *overweight* or even *obese* BMI due to having extra muscle. It is important to look at other factors such as body shape and waist-to-hip ratio to assess an individual's level of health risk.

Incidence of obesity

A significant proportion of the Australian population is classified as overweight or obese (see table 17.1 opposite). The prevalence may be even higher in adults than these figures suggest, as studies have shown that people tend to over-report their heights and under-report their weights, leading to a significantly lower calculated BMI.

Overweight and obesity increase with age (see the graph opposite). From adulthood onwards, men are more likely than women to be overweight or obese.

Physical effects of obesity

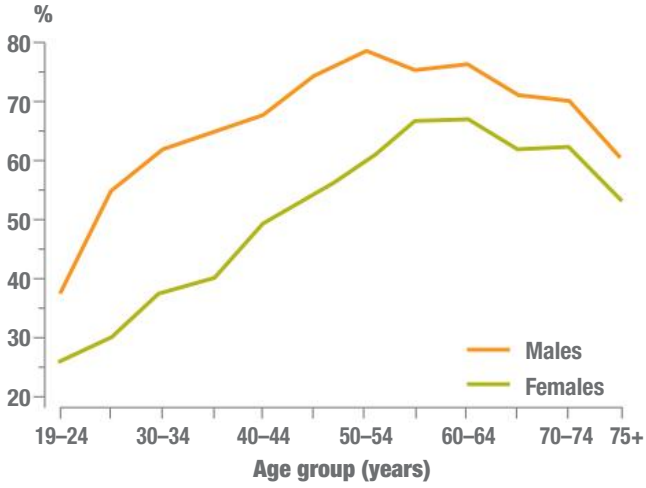
The physical effects of obesity are not simply the result of excess adipose tissue. Other factors that determine the effects of obesity on health include:

- where on the body the extra adipose tissue is distributed
- the level of fitness

TABLE 17.1 Prevalence of overweight and obesity in Australia

GROUP	BOYS AGED 7–15 YEARS (MEASURED)	GIRLS AGED 7–15 YEARS (MEASURED)	MEN (SELF-REPORTED DATA)	WOMEN (SELF-REPORTED DATA)
Overweight	17.3%	17.2%	40.5%	24.9%
Obese	7.7%	6.1%	17.8%	15.1%

Source: ABS National Health Survey, 2004–2005 (adult data) and NSW Schools Physical Activity and Nutrition Survey (SPANS), 2004.



Prevalence of overweight and obesity for various age groups

Source: ABS, Overweight and Obesity in Adults, 2004–05, 4719.0.

- nutritional status — that is, whether the diet is balanced or whether there are any nutrient deficiencies. If the obesity is due to a poor diet, often there is an excess of lipids, refined carbohydrates, sometimes protein and sometimes alcohol. The diet often lacks dietary fibre, and, quite commonly, particular vitamins and minerals. This means that, despite energy overnutrition, an obese person may be suffering from micronutrient undernutrition.

Obesity can cause significant health problems because of:

- the extra workload for the heart in pumping blood around a larger body
- considerable strain on the body's joints, particularly the knees, hips and ankles
- the reduced effectiveness of the body's temperature control mechanisms
- fatigue from simple physical tasks, because the body requires more energy to move.

Obesity also increases the risk of the following conditions:

- diabetes mellitus
- gall bladder disease
- cardiovascular disease
- hypertension, leading to stroke
- hiatus hernia
- respiratory disorders
- musculoskeletal disorders (such as arthritis)
- some cancers.

Many of these conditions can cause premature death.

REVIEW QUESTIONS

Remember

1. Explain in your own words what *good health* means.
2. Socioeconomic status can affect health. List some socioeconomic factors that might affect health and explain how each might have its effect.
3. What are the essential functions of adipose tissue?

Apply

4. Harold is 18 years old. He is 179 centimetres tall and weighs 80 kilograms. He has gained weight over the past three months after breaking his leg while playing football. His normal weight was 67 kilograms before his accident, when he was much more active with football games and regular training. He has noticed that his leg muscles have decreased in size since he stopped training, and his abdomen is larger. His waist circumference is now 85 centimetres and his hip circumference is 83 centimetres.
   - **a)** Calculate Harold's BMI, using his current weight and also his weight before the accident.
   - **b)** What weight range is 'acceptable' for Harold?
   - **c)** What would Harold's weight be if he was classified as 'severely underweight'?
   - **d)** What would Harold's weight be if he was classified as 'grade III obese'?
   - **e)** Work out Harold's waist-to-hip ratio. What does this indicate about Harold's weight gain?

Do an activity

5. Log in to **www.jacplus.com.au** and locate the *Thyroid* weblink for this chapter. Open this weblink to find out what role the thyroid plays in the body. How would it affect someone's weight if the thyroid was not working properly?
6. Design a simple pamphlet for parents about suitable rewards and treats for their children. In the pamphlet, explain why it is good to use non-food rewards, and suggest some ideas for alternatives to food.

eBook*plus*

Weblink

Conditions linked with overnutrition — hypertension

Hypertension (high blood pressure) is thought to contribute to nearly all Australian deaths caused by diseases of the heart and circulatory system. Too much sodium in the diet is a major contributing factor. Recall how sodium and potassium work together to keep the balance of fluid inside and outside cells (see page 116). When there is too much sodium, the body retains water and the heart has to

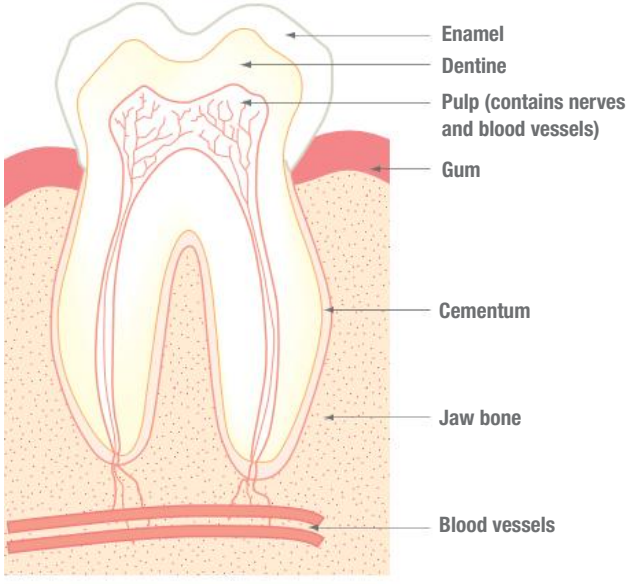
work harder to pump the blood under increased pressure. This means that blood circulation is less efficient, and the arteries become less elastic. Some problems that can result include:

- heart failure
- reduced blood flow to the brain, causing a stroke
- kidney disease
- aneurysm, a weakness in the blood vessel walls, which can burst, causing massive internal bleeding.

Blood pressure is measured using two different numbers. The pressure when the heart pumps the blood is called the **systolic pressure** and is about 120 mm Hg in healthy young adults. The pressure when the heart is at rest, in between pumps, is called the **diastolic pressure** and is about 80 mm Hg in young adults. So a normal blood pressure would be expressed as '120 over 80'. Someone has high blood pressure if their systolic pressure is above 140 mm Hg or their diastolic pressure is above 90 mm Hg.

High sodium intake is not the only cause of hypertension. Obesity itself can cause high blood pressure. Stress also increases blood pressure. As we age, our blood pressure increases, but it has been found that this occurs only when sodium intake is high. Human societies that do not use salt do not experience this age-related increase in blood pressure.

Conditions linked with overnutrition — dental caries



The tooth is a living part of the body with its own blood supply and nerves running through a mass of dentine, which is covered with a hard coating of enamel.

Dental caries are commonly called tooth decay. They occur when the enamel softens and then breaks down, allowing the **dentine** to decay. When a nerve is exposed, toothache occurs.

Tooth decay

Role of the diet in dental caries

Dental caries occur when carbohydrate is available to the bacteria that occur naturally in the mouth. The bacteria ferment the carbohydrate, producing acids, which dissolve the tooth enamel. The bacteria also produce an insoluble polysaccharide called **plaque**, which forms a film on the teeth, preventing the bacteria and acid from being rinsed away by the saliva. Acidic foods such as fruit juices and soft drinks (including diet soft drinks and soda water) can also contribute to dissolving the enamel. Saliva helps to protect against tooth decay by constantly rinsing your teeth. Saliva also contains minerals such as calcium that can help replace the dissolved enamel. Some dietary factors can interfere with this protection, such as foods that stick to your teeth, acidic foods and frequent snacking. Plaque also prevents the saliva from rinsing the teeth and needs to be removed regularly (by brushing and flossing) to prevent decay. Rinsing your mouth thoroughly after eating and drinking can also help to protect your teeth. If you need to eat between meals, foods containing calcium (such as milk and cheese) are much better choices than sticky or acidic foods.

Physical effects of dental caries

Dental caries cause significant problems. Apart from bad breath due to the bacteria and the pain of toothache, damaged or lost teeth can affect your nutrition. Missing or painful teeth make it difficult to chew tough or crunchy foods and this can lead to a diet that is low in fruit, vegetables and fibre. There are economic effects, too, with the associated costs including dental fillings, crowns and dentures.

REVIEW QUESTIONS

Remember

1. List four of the health problems that are more likely to occur in an obese person.
2. Explain in your own words what hypertension is and what causes it.
3. What is a normal blood pressure for a young healthy person?

Apply

4. Look at the following list of foods and fluids and identify which protect teeth and which increase the risk of decay.

Orange juice	protect / increase risk
Celery	protect / increase risk
Milk	protect / increase risk
Water	protect / increase risk
Diet lemonade	protect / increase risk
Cheese	protect / increase risk
Chewy caramels	protect / increase risk
Sugar-free gum	protect / increase risk
Sparkling mineral water	protect / increase risk
Salty crackers	protect / increase risk
Apple	protect / increase risk
Lollipop	protect / increase risk

Do an activity

5. Jacqueline is a 50-year-old woman who has a stressful management position in an advertising firm. The job requires her to work long hours and she often skips meals or eats takeaway food. Just recently, she was identified as having hypertension. Suggest five different ideas for her evening meal that would be quick and simple to prepare, and low in sodium.

Conditions linked with undernutrition — eating disorders

In a wealthy country like Australia, starvation due to poverty is rare, but psychological causes, such as eating disorders, are more common. Treatment of eating disorders requires a specialised team approach and sometimes hospitalisation. Long-term support and counselling are usually needed, sometimes for several years.

Anorexia nervosa

Anorexia nervosa is a psychological disorder that involves extreme self-induced weight loss by restricting food intake and often also exercising excessively. This disorder occurs most often in young women, aged from the late teens to the mid twenties. Fewer than one in twenty cases occur in young men. It is not fully understood what causes someone to develop an eating disorder. Anorexia nervosa typically occurs in people who set very high standards for themselves in all areas of their lives but who secretly fear failure or loss of control. Feeling in control of their body weight (as a result of a strict diet or exercise regimen) gives them a sudden sense of power at a time when physical and social changes can seem frightening and chaotic. Sometimes the dieting or exercise behaviour starts as a result of peer pressure or because of the perceived demands for a particular body shape in activities such as gymnastics and ballet.

Another unhelpful influence may be the 'ideal' body shape portrayed in the media, which is a very unrealistic image for both females and males. Some people do not have the time and resources to achieve and maintain such a body shape and may end up trying extreme methods such as over-exercising or starvation.

Although the specific causes of anorexia nervosa may be difficult to identify, the physical and behavioural characteristics of the disease are similar in all cases.

Physical effects of anorexia nervosa

In anorexia nervosa, inadequate energy intake leads to the breakdown of adipose tissue. Eventually the body starts to use muscle protein, resulting in an extremely wasted appearance.

During starvation, the body uses energy more efficiently to make fuels last as long as possible. Page 126 of chapter 7 lists some other changes that occur in the body to reduce energy expenditure during starvation.

The most obvious physical change in anorexia nervosa is muscle wasting. Additional changes seen in people with anorexia nervosa as they continue to lose weight include:

- *Lanugo.* Furry body and facial hair develop to help retain body heat. People with anorexia nervosa often feel cold

even in warm weather because the body reduces its temperature to conserve energy, and insulating adipose tissue has been lost.
- *Amenorrhoea.* Menstrual periods stop as normal body functions start to shut down.
- *Anaemia.* Normal blood cannot form due to protein and iron deficiencies.
- *Fainting.* Decreased blood pressure and a decrease in the oxygen that the blood can carry (because of anaemia) cause the person to feel weak and faint.

Abnormal food and exercise behaviour may include strange food rituals (cutting food into tiny pieces or perfect small shapes to make it last longer), chewing food and then spitting it out or vomiting, obsession with cooking and recipes despite not eating, exercising secretly (such as in the bathroom or in the middle of the night), and misuse of laxatives or diuretics.

Bulimia nervosa

Bulimia nervosa is a psychological disorder that is also known as binge eating. It is typical for someone with bulimia nervosa to report an uncontrollable urge to eat huge amounts of food over a short period of time. Self-induced vomiting, misuse of laxatives and diuretics, or extreme exercise behaviour are common following a binge-eating episode.

Diagnosis of bulimia nervosa is based on a history of two binge-eating episodes per week over the preceding three months. It may be difficult to identify someone with bulimia nervosa; they may be normal weight or slightly overweight, and they keep to fairly normal eating habits most of the time, effectively hiding both the binge eating and the vomiting behaviour.

Again, this disorder occurs most often in young women, but, in contrast with anorexia nervosa, bulimia nervosa is much more commonly associated with abuse, stress, depression or anxiety disorders. The binge eating episodes are often an extreme form of eating for comfort or stress relief, but the loss of control causes its own fears. The shame and guilt of the binge may then be purged by expelling the food (by vomiting, laxatives or extreme exercise) which is experienced as a relief.

Physical effects of bulimia nervosa

Frequent vomiting has harmful side effects. Stomach acid that is regurgitated with the stomach contents damages the gums, teeth (causing decay) and throat (causing bleeding and blistering, swelling of the salivary glands, and sometimes permanent voice changes). The pressure created during vomiting can cause bruising and swelling of the face. Both vomiting and laxatives can cause loss of potassium, which has led to heart failure and death in many cases. Like anorexia nervosa, bulimia is commonly associated with nutritional deficiencies.

CASE STUDY

The media and body image

Make-up and special effects (such as digital alteration) are frequently used to fake a better body shape in media photography. In fashion modelling and acting, it is regarded as normal for young women to be unnaturally underweight.

Gisele Bündchen, for example, appeared on the cover of *Vogue* magazine in 1999 with the title 'Return of the Curve', despite the fact that her BMI is only 18. Men who are models or actors are required to be unnaturally lean and muscular.

Brad Pitt reduced his body fat to 6 per cent of his weight, with months of special gym work and dieting, to appear fit in the movie *Fight Club*, and he took a whole year of preparation to build up for the movie *Troy*.

Most people do not have the money or resources to achieve such a body shape.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *media influences on body image* to complete the tasks ahead.

1. The article above has given some examples of unrealistic body shapes portrayed in the media. List two other examples you have seen.
2. Are such depictions of celebrities and sporting heroes harmful? Can the media have an effect on a young person's body image? Write a paragraph discussing these questions.

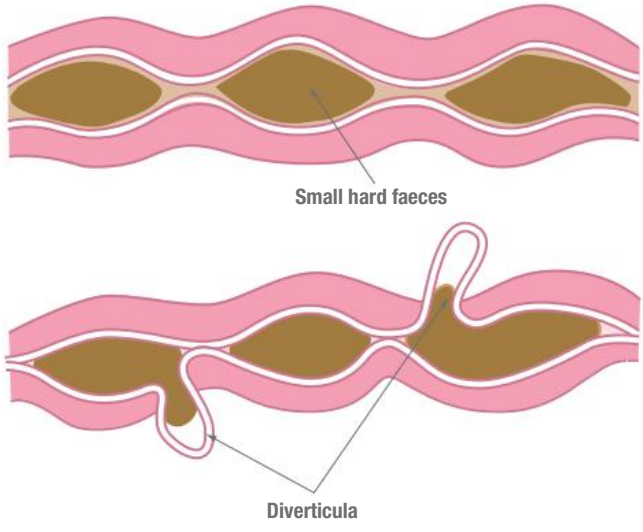
Conditions associated with undernutrition — nutritional deficiencies

Nutritional deficiencies were discussed in chapter 6 but some other conditions occur as a result of inadequate intake of particular nutrients.

Inadequate fibre

Defaecation (passing of **faeces**) normally occurs at regular intervals to clear waste from the body. Some people may have several bowel movements each day; for others, once every two to three days may be normal. This is considered acceptable as long as the faeces are soft and there is no discomfort in passing the stool. Dietary fibre helps to keep the bowel working normally, making the stool soft and stimulating the contraction of the muscles that help expel it from the body. Inadequate fibre can have the short-term effect of **constipation**, where the faeces are hard and dry, and difficult or uncomfortable to pass. In the long term, persistent constipation puts pressure on the muscles and lining of the bowel, causing some of the following health problems.

- ***Hiatus hernia***. High pressure in the abdomen causes part of the stomach to push upwards, forcing it through the small space where the oesophagus passes through the diaphragm. This means that the stomach cannot work normally and reflux is common.
- ***Varicose veins***. The increased pressure in the veins caused by constipation stretches the veins and stops the valves from closing properly. Varicose veins can then develop.
- ***Haemorrhoids***. Haemorrhoids are like varicose veins around the anus, again caused by the high pressure. These can sting, itch and bleed when damaged by later hard stools.
- ***Diverticulitis***. The high pressure in the bowel causes pockets to form at weak points in the bowel wall. Bacteria can cause inflammation and infection in these pockets, and this is diverticulitis (see the diagram below). Symptoms include abdominal pain, nausea, fever, a feeling of fullness and loss of appetite.
- ***Colon cancer***. Fibre *dilutes* the stool, helping to make it soft and bulky and speed up its passage out of the body. By doing this, fibre also dilutes any harmful substances in the stool and shortens the time that such substances are in contact with the cells that line the bowel. It is thought that this may reduce the risk of colon cancer.



Development of diverticulitis when constipation increases the pressure in the colon

Inadequate iron

Iron is the central part of the structure of haemoglobin, which is the oxygen-carrying protein in the blood. Iron deficiency **anaemia** can be caused by:

- blood loss. Although iron is saved for re-use by the body when haemoglobin is broken down, it is lost when blood is lost from the body, such as in an injury and during menstruation.
- inadequate dietary intake of iron, which means that the body cannot make enough normal blood cells.
- reduced absorption of iron due to:
  - diarrhoea, which speeds up the passage of nutrients through the gut, thus reducing the time available for absorption
  - malabsorption syndromes, which reduce the body's ability to absorb nutrients
  - inadequate copper, which is necessary for normal iron absorption
  - interference by substances such as phytic and oxalic acids and dietary fibre. When iron binds to these, it cannot be absorbed. This is of particular concern to people with a high intake of plant foods, such as vegetarians.

Physical effects of anaemia

Because iron enables the blood to carry oxygen to the muscles, which they need for producing energy, anaemia causes a feeling of weakness and faintness. A lack of energy is common. Persistent headaches and **palpitations** (rapid beating of the heart) may occur as the heart beats faster in an effort to carry enough oxygen to the muscles.

Inadequate calcium

The long-term effect of inadequate calcium is **osteoporosis**, which literally means 'porous bones'. Osteoporosis may be caused by one or more of the following factors.

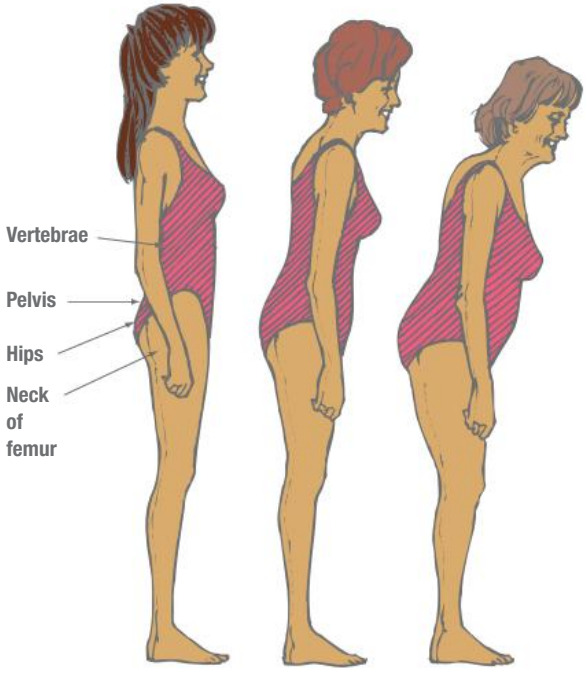
- *Insufficient calcium intake.* Nearly all of the body's calcium is found in the bones and teeth. The calcium in the bones acts like a bank account, where deposits of excess calcium can be added to the account, and withdrawals made whenever calcium is needed. After the age of about 30, further new deposits cannot be made to the account. The amounts withdrawn can be topped up, but the overall account balance cannot be significantly increased. If calcium intake is inadequate, the body's store is gradually depleted.

- *Physical inactivity.* Extended periods of inactivity, such as during a long illness, can lead to significant loss of calcium from the bones. Weight-bearing activities provide feedback within the body to increase bone strength.
- *Menopause.* Oestrogen, the female sex hormone, promotes calcium retention in the bones. After menopause, oestrogen production decreases and calcium may be lost more readily.
- *Abnormal bone structure.* This may occur as a result of a vitamin D or calcium deficiency during childhood or adolescence while the bones are still growing. The abnormal bone may not retain calcium in the normal way, leading to a more porous structure.

This bone is flexible enough to be tied in a knot because it has lost the calcium and phosphorus that normally keep our bones strong and stable to support our weight.

Physical effects of osteoporosis

Gradual loss of calcium from the skeleton results in bones that are weak, less dense and more prone to breaking, even with only slight trauma. Unable to support the weight of the body, the bones may deform or fracture. **Crush fractures** are caused by the weight of the body alone, in the absence of trauma.



Loss of bone strength in osteoporosis can lead to changes in spine shape and loss of mobility. Pressure on particular areas makes them more vulnerable to fractures and deformity.

REVIEW QUESTIONS

Remember

1. List three physical effects of anorexia nervosa and three physical effects of bulimia nervosa. What long-term health problems might develop in someone with an eating disorder?
2. Explain how fibre might protect against colon cancer.
3. List three factors that decrease iron absorption.

Apply

4. Log in to **www.jacplus.com.au** and locate the *Food Composition Database* weblinks for this chapter. Use an online food composition database to make a list of foods that a 20-year-old vegan man might use to meet his recommended daily intake (RDI) of calcium. Take into account any factors that might increase or decrease calcium absorption.
5. Why might women be more susceptible to both iron and calcium deficiencies?

Do an activity

6. Imagine that you are a member of a product innovation team that has been approached by a leading company in the food industry. Working in pairs, your task is to develop a new food product, based on an existing product but with an increased fibre content.
   - **a)** Design and prepare the product.
   - **b)** Prepare a written report to be presented to the company to justify your selection.
   - **c)** Evaluate your product's taste, appearance, texture and aroma, and compare these with the existing product.

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Weblink

Diet-related disorders

Apart from the effects of over- and undernutrition, other health problems are closely related to food intake. Diet plays an important part in the management of such conditions.

Type 2 diabetes

Diabetes is a condition in which the body is unable to control the level of glucose in the blood. Normally this control is managed by the action of the hormone insulin, which is made in the pancreas. When glucose is released from the carbohydrates you eat, your pancreas produces insulin, which enables your body cells to take in glucose. While there is plenty of glucose available from the meal, insulin works to promote the use of glucose as a fuel and prevents your body from making new glucose or using fat or protein as a fuel. Between meals, when there is no food in your system, the level of insulin is low. This allows your body to use stored fat and to make new glucose as needed. This keeps the level of glucose in the blood fairly stable. As the blood glucose level gets low, more glucose is made. As the blood glucose level increases after eating, insulin acts to decrease it.

In **type 2 diabetes** (also called maturity-onset diabetes mellitus or non-insulin dependent diabetes mellitus, NIDDM), the pancreas does not produce enough insulin for normal control of the blood glucose level. This may be

because the body has become **insulin resistant**. Excess adipose tissue can interfere with the normal action of insulin, so obesity is a risk factor for type 2 diabetes. To manage the blood glucose level, medications can be used to stimulate pancreatic insulin production and to increase the body cells' sensitivity to insulin. Sometimes, people with type 2 diabetes need to inject insulin as well. The amounts of carbohydrate at each meal must be controlled to keep a balance between the amount of glucose taken in and the amount used by the body cells.

Type 1 diabetes is *not* a diet-related disorder. It is caused by a condition where the pancreas cells are damaged or destroyed and cannot make insulin. Artificial insulin has to be injected regularly to allow the body to use the glucose from food. Again, the amounts of carbohydrate at each meal are controlled to enable this to occur without the blood glucose level rising too high. The carbohydrate needs to be spread out over the day to prevent the blood glucose level going too low between meals.

Physical effects of diabetes

Diabetes causes health problems due to the loss of control of the blood glucose level. Low levels of blood glucose (**hypoglycaemia**) cause dizziness, shakiness and fainting. If the level is too low, the body's cells run out of energy and the person can die. High levels of blood glucose (**hyperglycaemia**) can also cause coma and death. In the long term, high blood glucose levels damage the small blood vessels in the body, such as those found in the kidneys, eyes and feet. The result is that kidney failure is common in people with diabetes.

Eye problems may also be experienced as a result of diabetes. Examples include glaucoma and cataracts, both of which can lead to blindness. Diabetes is the leading cause of blindness in adults. Other physical effects of diabetes include damaged blood vessels, which means that many parts of the body receive a poor supply of oxygen and nutrients, and healing may be impaired. For example, sores or blisters on the foot can turn into deep ulcers and become infected so that the foot eventually requires amputation. If blood pressure is high, there is a much greater risk of cardiovascular disease as well. These conditions can be prevented with good control of blood glucose levels. Kidney failure, blindness and amputations are all extreme effects that can occur after many years in someone with poorly controlled diabetes. People with diabetes need to monitor their blood glucose level every day for the rest of their lives to prevent these complications and stay healthy.

Diet and diabetes

Diet is a powerful tool in managing diabetes. In those who are overweight or obese, losing weight significantly improves their blood glucose control and can sometimes eliminate all signs of diabetes. As well, diet can help to control blood glucose levels and prevent long-term complications.

Traditionally, people with diabetes were advised to avoid all sugars. However, this is now recognised to be mistaken advice. It often resulted in a diet that was high in fat and sodium, as sweet foods were replaced with salty, high-fat alternatives. The increased risk of cardiovascular disease in people with diabetes means that reducing sodium and saturated fat intake is an important part of diabetes management.

Additionally, it is now recognised that some sugars can be consumed in line with a healthy diet. There has been a great deal of research on how carbohydrate foods affect the blood glucose level. This research has shown that some starches have a more dramatic effect on blood glucose than do some sugars, so it makes little sense to avoid only the sugars. Instead, the focus is on choosing foods that do not cause dramatic changes in blood glucose level. Foods with a low **glycaemic index (GI)** are those that release glucose slowly into the blood, while foods that release it quickly have a high GI (see table 17.2). Spreading the carbohydrate foods out over the day (as three equal-sized meals, or even as six small meals) also helps to control the blood glucose levels. Regular physical activity is recommended as it improves insulin sensitivity, blood circulation and body weight. The economic costs of diabetes are high because it is a condition requiring intensive monitoring and often large amounts of medication (subsidised by the health system) over the whole lifetime.

TABLE 17.2 Some examples of high and low glycaemic index foods

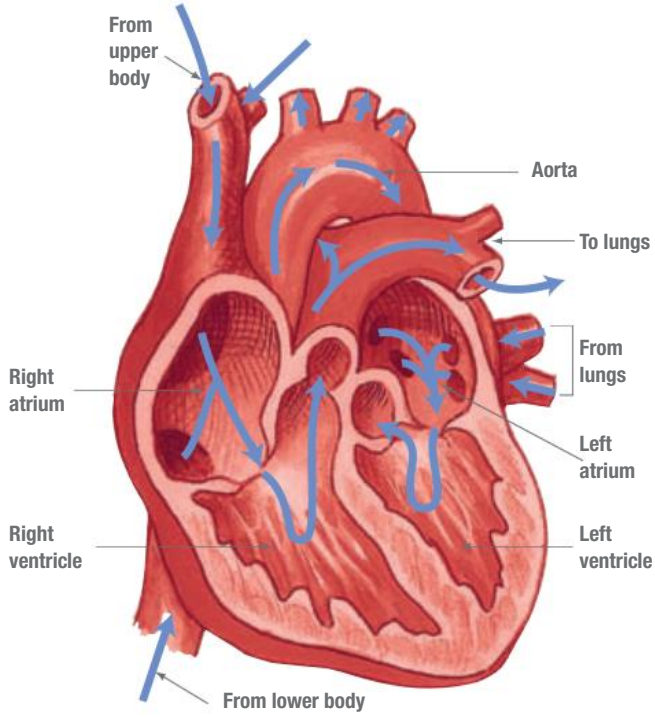
FOODS WITH A HIGHER GLYCAEMIC INDEX	FOODS WITH A LOWER GLYCAEMIC INDEX
• glucose, maltose	• fructose, lactose
• watermelon	• most fruits, most dairy foods
• potato	• legumes, most vegetables
• puffed, popped or flaked grains (such as popcorn and some breakfast cereals)	• whole grains (such as rolled oats and wholegrain bread)
• millet, most kinds of rice, highly processed starches	• barley, oats, rye, basmati rice, doongara rice
• white and brown bread	• bread with whole grains and seeds
• rice noodles, potato	• wheat pasta
• foods with a low fibre content, puffed or flaked foods. These have a high surface area, and are fast to digest and empty from the stomach.	• foods with a high fibre content, boiled foods, foods containing fat or protein. These contain resistant starches and/or are slow to digest or empty from the stomach.

Log in to **www.jacplus.com.au** and locate the *Glycaemic Index Database* weblink for this chapter. Open this weblink to find the glycaemic index values of other foods.

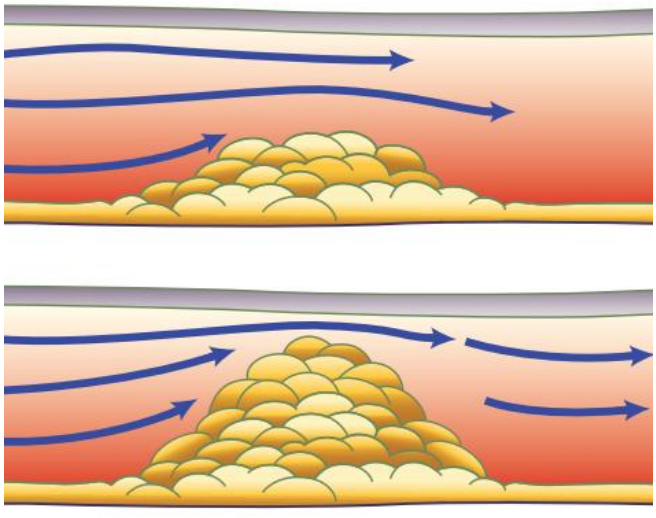
eBookplus Weblink

Diet and cardiovascular disease

The heart is a muscle that pumps blood to all the cells of your body. The blood carries the oxygen and nutrients that cells need to work properly, and this includes the cells of the heart itself, which receives blood via the coronary arteries (see diagram below).



Structure of the heart



Plaque is a fatty, fibrous material, containing cholesterol, that can collect on the walls of arteries, narrowing them and leading to hardening of the artery walls, or **atherosclerosis**. The coronary arteries are small and narrow so a build-up of plaque can constrict them (which causes severe chest pain or **angina pectoris**), or block them (causing a heart attack).

In chapter 6 (see page 109), we saw that cholesterol is an insoluble lipid. It is transported through the body by **lipoproteins** — either **high-density lipoproteins (HDL)** or **low-density lipoproteins (LDL)**. HDLs take cholesterol out of the body; LDLs are more likely to deposit the cholesterol along the walls of the blood vessels. This means that the ratio of HDL to LDL in the blood can affect the risk of plaque formation, with a lower ratio being associated with a higher risk. Factors that encourage a higher blood level of HDL include:

- physical activity
- the presence of oestrogen
- moderate alcohol intake (no more than one to two standard drinks per day)
- healthy weight (overweight and obese people tend to have a higher level of LDL).

Factors that affect the development of cardiovascular disease include:

- *age.* Cardiovascular risk increases with age. Middle-aged men and postmenopausal women are the most likely to be affected.
- *gender.* Although older men and women have similar cardiovascular risk, coronary heart disease is eight times more common in men than in premenopausal women.
- *heredity.* A history of coronary heart disease in the family usually indicates an increased risk of developing the condition.
- *smoking.* Smoking increases the risk of blood clots forming in blood vessels. It also affects the condition of the blood vessel walls so that cardiovascular risk is nearly three times greater in smokers than in nonsmokers.
- *stress.* An increased stress level has been associated with heart attack risk.
- *exercise.* An increased level of physical activity protects against cardiovascular disease.
- *obesity.* The heart has to work harder to pump blood around a heavier body. Cardiovascular risk is 30 times higher for those who are in the obese weight range, due to this increased work by the heart, changes in blood pressure and higher levels of LDL.
- *nutrition.* Diet can help modify cardiovascular risk, not just by controlling weight to prevent obesity, but also because it can help reduce LDL levels, blood pressure and the amount of fat in the blood.

The economic costs of cardiovascular disease are significant. Together, cardiovascular diseases (including heart disease, hypertension and stroke) are the most expensive disease conditions in the Australian health system, due to both the hospital costs and the expensive (subsidised) medications.

Nutritional considerations for specific groups

As we saw in chapter 7, factors such as age and physical condition affect an individual's nutritional needs. Such factors mean that some groups in our community

are nutritionally vulnerable. Groups that are most at risk are:

- adolescent girls
- pregnant and lactating women
- postmenopausal women
- middle-aged men who live alone
- the elderly
- people with health conditions (such as diabetes, hypertension and allergies) that are managed with diet, or those who have a restricted diet (such as vegetarians)
- athletes
- Aboriginal and Torres Strait Islander people.

Here we examine the specific nutritional needs of Aboriginal and Torres Strait Islander people.

Health status of the Aboriginal and Torres Strait Islander population

The Aboriginal and Torres Strait Islander population represents about 2 to 3 per cent of the population of Australia. About two-thirds of them live in regional and remote areas. Although most live in New South Wales, they make up only about 2 per cent of the population here, while they represent over 30 per cent of the population in the Northern Territory. Indigenous people have significant health disadvantages when compared with the non-Indigenous population.

- The life expectancy of Indigenous men is 59 years, which is 17 years less than that of non-Indigenous men (77 years).
- The life expectancy of Indigenous women is 65 years, which is 17 years less than that of non-Indigenous women (82 years).
- The leading causes of death, in order, of Indigenous people are:
  - diseases of the circulatory system, including heart disease and stroke
  - injuries
  - diseases of the respiratory system
  - cancers
  - endocrine diseases, particularly diabetes
  - digestive system disorders.

Obesity is also common among Indigenous adults. Children in remote communities are more likely to experience poor growth because their food supply is inadequate. All of these health problems have important interrelationships with diet and lifestyle, particularly cardiovascular disease and type 2 diabetes.

Cardiovascular disease

Cardiovascular disease includes all conditions related to the heart, veins and arteries. The conditions of heart disease and hypertension (which can lead to stroke) are of significant concern for the Aboriginal and Torres Strait population.

- The leading cause of death of both men and women in the Indigenous population is coronary heart disease.
- The rate of death due to coronary heart disease is 1.7 times higher in the Indigenous community than in the non-Indigenous community.
- The death rate for 25–34 year olds and 35–44 year olds in the Indigenous population is 13 to 18 times higher than that in the non-Indigenous population.
- The death rate due to stroke is three times higher in indigenous men, and 1.7 times higher in Indigenous women, than that in the total population.

Type 2 diabetes mellitus

Diabetes is much more common among Indigenous Australians (11 per cent incidence) than in Australians of European descent (3 per cent incidence). Also of concern is the fact that Indigenous people tend to develop type 2 diabetes at a younger age. This increases their chance of developing the complications of blindness, kidney disease, poor wound healing and gangrene.

Dietary management of diabetes and heart disease have been discussed earlier in this chapter, but other factors can influence the development of these conditions. The following factors are also important for indigenous people.

- Lower levels of education and literacy increase the chance that medication is used incorrectly and makes it more difficult to learn and maintain strategies to manage disease.
- Increased levels of poverty and unemployment often mean inadequate cooking facilities and inadequate money to buy healthy fresh foods.
- Inequitable access to health services means that Indigenous people are less likely to be monitored to prevent problems or to be given advice on how to manage a disease.
- Many Indigenous people are geographically isolated; living in remote communities. Healthy fresh foods are expensive and not always available, and health services may be intermittent or inconveniently located.

Strategies to promote optimum health of Indigenous people

Improving the health status of our Indigenous population requires an imaginative problem-solving approach by health care teams. Here are some of the projects that have been implemented to address the issues mentioned above.

- Involving the Indigenous community in developing, implementing and maintaining health, hygiene and nutrition education programs helps to ensure that these programs target the community's needs appropriately. For example, nutrition education can feature local food habits and bush foods, which have nutritional benefits, encourage physical activity and maintain cultural values.
- Aboriginal health service officers maintain good communication between health workers and the community to ensure that the health service is well used.

- Recognising that diabetes and heart disease develop at an earlier age in Indigenous people, early intervention programs identify health problems and enable preventive action.
- Improving the supply and affordability of healthy foods in rural and remote communities, subsidising particular foods and establishing a regional stores policy helps to increase the intake of a wide variety of foods.

CASE STUDY

FOOD SUBSTANDARD AND TOO DEAR

by PADRAIC MURPHY

Urgent government action was needed to ensure fresh fruit and vegetables were available at affordable prices in remote communities, a leading health professional said yesterday.

With remote communities forced to pay high prices for substandard fruit and vegetables, Australian Indigenous Doctors Association president Mark Wenitong said governments needed to look at freight subsidies.

Education programs were also needed to ensure outback children ate properly.

'In all of the talk about intervention in the Northern Territory, nobody has mentioned nutrition', said Dr Wenitong.

'We need a complete overhaul, nutritional programs introduced to children even before they start school.

'Any long-term health monitoring will show that poor nutrition is having profound effects in indigenous communities.'

A report published in the *Australian Medical Journal* last January found healthy food was almost 30 per cent more expensive in remote indigenous communities, while unhealthy food was less than 15 per cent dearer.

'There really needs to be subsidies to keep freight costs down', Mr Wenitong said. 'Children in these remote areas are more susceptible to ear and chest infections, and that is directly linked to the availability of good food in these communities.'

Source: The Australian, 3 July 2007.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *indigenous health* to complete the tasks ahead.

1. Why do people living in remote areas have difficulty in obtaining a healthy diet? Identify two of the contributing factors in this problem, and for each one describe a project that could be implemented in a remote area to address this.
2. What barriers might prevent the projects from being successful?

CASE STUDY

Helping overweight children

As many as 25 per cent of Australian children are overweight. Catherine Saxelby gives parents 20 tips to help their children fight fat.

1. Clean up your act
Set a good example by eating well yourself. Research shows the eating habits of parents are closely related to the weight of their children.

2. Rewards
Don't use food as a reward for good behaviour.

3. Meal sizes
Young kids need to eat small amounts of food and often, but that doesn't mean they should graze all day long. Stick to regular meals with a small snack in between.

4. Drink more water
Make water the main family drink with meals. Cordials, fruit juices and soft drinks are high in sugar and too easy to have too much of.

5. Respect your child's appetite
Your child's appetite will vary so allow them to determine how much they need to eat. By forcing them to eat more, they lose the ability to know how much is enough.

6. Limit junk food
Don't buy junk food. Keep it for special occasions.

7. Turn off the TV
The evidence is overwhelming — too much TV helps to make our kids overweight! Experts recommend TV viewing should be limited to a maximum of one hour per day.

8. Monitor school food
Find out what's available at school. If there aren't many healthy alternatives, limit tuckshop to once a week.

9. Think long term
Don't expect rapid weight loss. It often takes a year for your child to slim down.

10. Snack right
Much of the reason for kids' weight problems is that 'snack foods' are not suitable snacks — they're loaded with fat, sugar or salt.

11. Get active
Head outdoors to kick a ball in the backyard, go cycling or visit the park — anything to get kids moving. Have fun!

12. Go low fat
If your child is two or older, low-fat milk, yoghurt and cheese are suitable.

13. Don't skip brekkie
Overweight people tend to skip breakfast. Get your kids into the good habit of eating breakfast early on.

14. Breastfeed
Breastfeed your child if you can as this has been shown to protect against weight issues later in life.

15. Strike a balance
Don't ban any food completely. By forbidding foods, you only make them more desirable.

16. Bust a move
Make an effort to include physical activity in your child's life. Putting your child in charge of walking the dog every day is a good start.

17. Tread carefully
Don't make derogatory comments about your child's weight or shape or they may start to label themselves, thinking 'I'm a fat pig'. This will not do them any favours.

18. Slow down
If your schedule is so busy you often have to resort to high-fat takeaway dinners, you need to slow down. A home-cooked meal is better for everyone.

19. Be positive
There's lots of yummy foods your child CAN eat like fruit, breads, cereals, yoghurt, meat and eggs. Don't dwell on what they CAN'T eat.

20. Eating to cope
Look at when and why your child eats. Is he/she unhappy or stressed? Are they being teased at school? Kids, like adults, use food to cope with difficult times or to fill a void — it may be the reason they're too heavy.

Best snacks for kids

- Fruit and fruit-based snacks
- Yoghurt
- Bread, toast, toasted muffins or crumpets
- Breakfast cereal and milk
- Milkshake or smoothie with low-fat milk
- Baked beans or canned spaghetti
- Popcorn (pan-popped, not microwaved)
- Corn on the cob
- Noodles (low-fat, not instant)

Source: Foodwatch Nutrition Centre.

OUTCOME TASK **RESEARCH ASSIGNMENT**

Students learn to:

- explain the consequences of malnutrition
- independently investigate and report on the health of a group in Australia. Develop a strategy to promote optimum health through good nutrition for this group
- plan diets and prepare food/meals to address dietary requirements of special groups.

Contributes to the following outcomes:

- independently investigates contemporary nutrition issues
- develops, realises and evaluates solutions for a range of food situations.

Carefully consider the article on the previous page. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *promoting good nutrition* to complete the tasks ahead.

1. *Helping overweight children* is written in the form of 20 brief tips. Why is it important for such nutrition advice to be easy to read?
2. What are the specific nutrition recommendations made in this article? What other (non-nutritional) recommendations are made?
3. If a child usually ate high-fat and high-sugar snacks, but then started replacing these with items from the 'Best Snacks for Kids' list in the article, what effect would this have on his or her macronutrient, micronutrient and fibre intake?
4. In small groups, choose one of the 'groups who are nutritionally vulnerable' from the list on page 319.
   a) Investigate this group's current health status in Australia
   b) Research the special nutritional needs of this group.
   c) List the factors that influence this group's nutritional requirements.
   d) Suggest some simple strategies to promote the health of this group through good nutrition. (You might like to use the '20 tips' format as used in *Helping overweight children*.)
   e) Prepare a PowerPoint presentation that could be used in an education session for people in this group, and present it to the class.

REVIEW QUESTIONS

Remember

1. What is the difference between:
   a) type 1 and type 2 diabetes mellitus
   b) anorexia nervosa and bulimia nervosa?
2. What is atherosclerosis?
3. Link each of the following conditions with its cause.

Condition	*Cause*
anaemia	high blood cholesterol
osteoporosis	excess energy intake
dehydration	low-fibre diet
obesity	iron deficiency
atherosclerosis	calcium deficiency
hypertension	excess sodium intake
haemorrhoids	water deficiency

4. A number of conditions are linked to obesity. List three of these conditions and describe the effect that they have on the body.

Apply

5. The Aboriginal and Torres Strait Islander population is at an increased risk of some diet-related health problems. Choose two of these problems. For each, list six factors that increase the risk in indigenous people in particular.

Do an activity

6. Design a dessert that is appropriate for someone with diabetes. Analyse its nutritional value using computer software or food composition tables. Prepare the dessert, evaluate its acceptability and write a short report explaining what attributes make it suitable as part of a diabetic diet.

CHAPTER 17 SUMMARY

- Good health is a state of physical, mental and social wellbeing, which means that it is affected by a wide range of lifestyle factors.
- Malnutrition occurs when an inappropriate diet causes health problems and is usually classified as either overnutrition or undernutrition.
- Being overweight or obese are examples of overnutrition, usually caused by energy intake exceeding energy expenditure. Genetic and hormonal factors can also contribute to obesity. Obesity is increasingly common in Australia, in both children and adults.
- Obesity can be assessed using subjective methods, body composition measurements, waist-to-hip ratio and body mass index.
- Hypertension, or high blood pressure, may be caused by excess sodium intake. Obesity also contributes to hypertension.
- Dental caries occur when mouth bacteria decay the teeth using substances they make from carbohydrate foods. Excess intake of sugary or starchy foods that stick to the teeth can contribute to dental caries.
- Anorexia nervosa and bulimia nervosa are eating disorders: psychological conditions that are associated with life-threatening abnormal eating behaviours.
- Inadequate fibre intake can cause constipation and contribute to long-term health problems such as hiatus hernia, varicose veins, haemorrhoids and diverticulitis.
- Inadequate iron intake causes anaemia, which is associated with fatigue, headaches and palpitations.
- Inadequate calcium intake causes osteoporosis, which leads to a high risk of bone fractures and changes in bone shape.
- Diabetes and cardiovascular disease are both conditions that are associated with overnutrition. Both can lead to serious long-term health problems.
- Indigenous people have a shorter life expectancy than the rest of the population, and also have a higher risk of many diseases. Different factors contribute to this risk but many are being addressed by a variety of health programs.

KEY TERMS

adipose tissue
anaemia
angina pectoris
anorexia nervosa
atherosclerosis
bulimia nervosa
central obesity
colon cancer
constipation
crush fractures
defaecation
dental caries
dentine
diabetes
diastolic pressure
diverticulitis
faeces
glycaemic index (GI)
haemorrhoids
hiatus hernia
high-density lipoproteins (HDL)
hyperglycaemia
hypertension
hypoglycaemia
insulin resistant
lipoproteins
low-density lipoproteins (LDL)
malnutrition
nutrition
obese
osteoporosis
overnutrition
overweight
palpitations
plaque
systolic pressure
type 1 diabetes
type 2 diabetes
undernutrition
varicose veins

Chapter 18
Options for managing nutritional fitness

Chocolate that contains all your vitamins and minerals? Soft drinks with fibre? In the future, could what we now call a junk food diet actually be healthy? Nutritionally modified foods are a growing area of the food manufacturing industry, allowing new products to be created and old ones to be marketed as 'new and improved'. Whether such products are useful, or whether they are just another kind of marketing tool, depends on what modifications have been made and whether they meet the nutritional needs of the consumer.

In this chapter you will learn about:

- the production/manufacture and health benefits of nutritionally modified foods and functional foods
- the role of 'active non-nutrients' in the diet, e.g. phytochemicals, probiotics and fibre
- the role of supplements in the diet, e.g. vitamins, minerals, protein
- the role of the individual, community groups, the food industry, government organisations and private agencies in promoting health.

Soft drinks with added fibre or vitamins are popular in Japan, where functional foods are widely marketed. In this vending machine, the popular sports drink 'Pocari Sweat' is sold. It is intended that electrolytes lost when sweating can be replaced by this soft drink.

Improved nutrition through modified and functional foods

Chapter 6 looked at food nutrients which are essential for good health. These essential nutrients represent just a fraction of the beneficial substances that are found in food. Some of these beneficial substances are poorly understood and still being researched; others have well known health benefits and have been used in marketing new and modified food products, such as **functional foods**. Functional foods are foods that have health benefits beyond those provided by the basic nutrients (the macronutrients and micronutrients) in the food. These might be naturally occurring, or may be added during manufacture. **Nutritionally modified foods** are foods that have been altered in some way to improve their nutritional characteristics, by adding or removing particular components. There is a wide variety of nutritionally modified and functional foods, and these can be grouped into three categories.

1. Foods that *naturally* contain beneficial substances other than the essential food nutrients. Such substances include dietary fibre and **phytochemicals** (beneficial plant chemicals found in fruits, vegetables and other plant foods) such as anti-oxidants.
2. Foods with *added* **active non-nutrients** such as phytochemicals, modified starches, or probiotic organisms (beneficial bacteria normally found in a healthy gut, that can improve health when consumed in food).
3. Other modified processed foods, where essential nutrients (such as vitamins or minerals) have been added, or where something has been removed or reduced (such as fat, sugar or salt).

Active non-nutrient components of functional foods

Active non-nutrients are substances that are not essential for life but which can enhance the functioning of the body or contribute to the promotion of good health. For example, fibre can help keep the gut healthy by providing fuel for beneficial bacteria, and by stimulating the muscle contractions (**peristalsis**) that keep the gut contents moving effectively. Other active non-nutrients include phytochemicals, which are beneficial substances found naturally in plants. Examples of phytochemicals include anti-oxidants and phyto-oestrogens.

Anti-oxidants

There are at least 8000 different **anti-oxidants** that occur naturally in fruits, vegetables and other plant sources. The most significant anti-oxidants are the nutrients vitamin E, vitamin C, beta-carotene and the other carotenoids (the precursors of vitamin A), but there are many non-nutrient anti-oxidants that have significant benefits too.

Fruit and vegetables contain hundreds of non-nutrient anti-oxidants that may play a significant role in controlling blood cholesterol levels and neutralising the action of free radicals in the body, thus reducing the incidence of some cancers.

Flavonoids and carotenoids

Carotenoids and **flavonoids** are colour compounds found in fruit and vegetables. They act as anti-oxidants and also have mild phyto-oestrogen effects. Flavonoids can be divided into two subcategories: anthocyanins, which contribute most of the red, purple and blue colours of fruit and vegetables; and anthoxanthins, which are pale yellow. Carotenoids are the chemicals that contribute to yellow, orange and some red colours of fruit and vegetables. One of the most thoroughly researched carotenoids is lycopene, a dark red carotenoid found particularly in tomatoes. Lycopene is thought to be protective particularly against prostate and breast cancers.

Of all the anti-oxidants, vitamin E seems to be most involved in controlling blood cholesterol levels. Chapter 17 explained how lipoproteins transport cholesterol in the bloodstream. Vitamin E acts to stop **low-density lipoproteins (LDLs)** from breaking apart and depositing cholesterol along blood vessels. There is evidence to suggest that vitamin C assists vitamin E in this anti-oxidant role. The anti-oxidants in fruit and vegetables may also help reduce the risk of developing cancer of the prostate, bladder, oesophagus or stomach. Experimental studies have indicated that taking anti-oxidants in supplement form does not have the same beneficial effect as eating them in food. This may be due to the fact that the anti-oxidants work together in the body as a whole system, and foods provide multiple parts of the system in the right amounts, while supplements do not.

Phyto-oestrogens

Food products containing added phyto-oestrogen ingredients include soy and linseed breads, biscuits and cereals. The amount of phyto-oestrogen in these products is often quite low, however, and you would need to eat a large amount each day to obtain the claimed effects.

Phyto-oestrogens are another category of phytochemicals. They are substances that are converted, by bacteria in the gut, into hormone-like compounds which can imitate the hormone **oestrogen**. There is some evidence that these chemicals have benefits including:

- for women, a reduction of uncomfortable symptoms of menopause (such as hot flushes)
- for both men and women, improved cardiovascular health (because the chemicals can inhibit the oxidation of the low-density lipoproteins)
- most importantly, a reduction in the risk of cancers that are stimulated by the sex hormones (for example, breast cancer in women and prostate cancer in men).

The most significant sources of phyto-oestrogens are:

1. **isoflavonoids**, which are found in fruits, vegetables, seeds, nuts and legumes. The most powerful source is the soya bean, which contains the strongest oestrogen-like substances, genistein and daidzein.
2. **lignans**, which are found in grains and seeds. The single richest source of lignans is linseeds.

Dietary fibre

Fibre was discussed in chapter 6. It is not considered a nutrient, but does help to keep your gut working well, so it is still important as a beneficial substance found in food. Fibre is found only in plant foods, and includes a variety of gums, gels and indigestible carbohydrates that absorb moisture in your gut, swelling to create a larger and softer faecal mass. This makes the faeces easier to pass, stimulating the intestinal muscle contractions (called peristalsis) that keep your gut contents moving. This means that the gut contents move through the body more quickly, reducing the time that any toxins are in contact with gut cells. This may reduce cell damage and protect against some cancers. Fibre also acts as a fuel for the beneficial bacteria in the gut, encouraging them to multiply. These then benefit the body in return, protecting against infection and producing substances that the body can use, such as vitamins (vitamin K and some B-group vitamins) and **butyric acid**. Butyric acid is a short-chain fatty acid that the gut cells use for energy, keeping them healthy and well-nourished.

Fibre is often classified into two categories, **soluble fibre** and **insoluble fibre**. Soluble fibre is the type that dissolves into a gel in the gut, and is digested by bacteria in the colon. It helps increase the feeling of fullness after eating, slowing the rate that the stomach empties. It may also help to reduce cholesterol levels. Insoluble fibre is the type often called 'roughage' that remains mostly unchanged while passing through the gut. It is the main promoter of movement through the gut, protecting cells from damage.

Psyllium (also known as isphagula or fleawort) is a source of gel-like soluble fibre. The husks of the psyllium seed are used in fibre supplement products and to increase the fibre contents of some processed foods.

Although these two types can be distinguished by their effects, in reality most plant foods contain both types of fibre. Fruit, vegetables, nuts, seeds and legumes are all good sources of fibre, but you can also obtain dietary fibre from fibre supplements and from processed foods that have added fibre. Many breads and cereal products have high-fibre alternatives available where fibre, such as psyllium fibre, bran or modified starches, has been added to increase the fibre content.

Omega-3 fatty acids

The name **omega-3** refers to the chemical structure of the fatty acids, indicating they are unsaturated, with their first double bond occurring at the third carbon on the chain, (see chapter 6 to review the structure of fatty acids). **Omega-3 fatty acids** can be converted to hormone-like substances called **prostaglandins** that are directly involved with the correct functioning of the cardiovascular system. There are different types of prostaglandins, which have many different roles in increasing or decreasing blood flow, muscle contractions, inflammation, and the immune system. The prostaglandins that are associated with omega-3 fatty acids are **anti-inflammatory**, helping to reduce cardiovascular disease by:

- reducing the formation of clots in the bloodstream
- protecting against serious heart rhythm disorders
- helping to correct impaired blood vessel function.

Omega-3 fatty acids are also important for normal brain development in infants and children, and it has been claimed that they have other benefits to do with brain function, such as relieving depression and reducing memory loss associated with ageing.

Most of the evidence for benefits of omega-3 fatty acids relates specifically to DHA and EPA (docosahexaenoic acid and eicosapentaenoic acid). Fish and fish oils are the best sources of omega-3 fatty acids. Plant sources of omega-3 fatty acids provide mainly ALA. These sources include canola oil, flaxseed oil, soya beans and linseed. Omega-3 fatty acids are now added to a wide range of processed foods including margarines and breads, and in Japan are even used in some chewing gum products. The omega-3 content of primary produce can be increased if producers use stock feeds that are high in omega-3 fatty acids. Omega-3 enriched eggs are a widely available example. It is also possible to obtain omega-3 fatty acids in supplement form, for example as fish oil capsules.

CASE STUDY

Bread and superbread

Can bread really make you brainier?

Bread and superbread

In brief

- Claims that certain breads keep you regular, are good for your heart, or make your kids brainier are mainly marketing hype.
- The healthiest breads are those made from whole grains — plain old wholemeal and multigrain.
- Knowing if bread is, in fact, wholemeal is not as simple as reading the label.

Breaking the bread myth

It used to be that there was white bread and brown bread. Now there's high-fibre white bread, bread with low GI, bread with soy and linseed, bread with extra calcium, bread with omega-3s, to name a few. They make some big health claims and come with a price tag to match.

But are these superbreads really worth paying extra for? Are they as good for you as the labels and ads claim?

What we tested

We took a close look at their ingredients and the science (if any) behind the claims for:

- whole grains
- dietary fibre
- low glycaemic index
- omega-3s
- soy, linseed and phyto-oestrogens.

What we found

- The healthiest breads are still those made from whole grains, such as wholemeal and multigrain.
- However, some of the 'wholemeal' breads we found in the supermarkets were in fact made from a mixture of wholemeal and refined white flour, and the manufacturers don't tell you how much wholemeal flour you're getting.

  For most foods, manufacturers are now required under the Food Standards Code to state the percentage of any ingredient that's mentioned in the name. We're taking it up with the state and territory health and food agencies responsible for enforcing the code. Bread is a staple food and consumers are entitled to know what's in it.
- While the health claims of some of the other ingredients, such as omega-3, are backed up by science, you may have to eat a lot more than a few slices a day to get the claimed benefits.

Whole grains

The claims

- 'Whole grains … provide a whole range of benefits for our wellbeing, including the protective benefits of dietary fibre, phytochemicals and anti-oxidants.'
  – Country Life Bakery, Biomax
- 'Whole grains are less processed and contain a variety of beneficial nutrients.'
  – Bürgen®, Rye
- 'Contains whole grains to help maintain a healthy heart and digestive system.'
  – Tip Top, 9 Grain

The facts

- There's very good evidence that eating whole grains in bread and cereals helps protect you against heart disease, type 2 diabetes and some forms of cancer.
- 'Whole grains' doesn't just mean the little bits in multigrain bread that can get between your teeth. The whole grains can be milled into wholemeal flour or processed in other ways that retain the nutritious bran and germ.
- The vitamins, minerals, anti-oxidants and other phytochemicals that are concentrated in the outer layers of the grain are mostly lost when it's milled to make white bread flour.

The verdict

- Bread made from whole grains is the best you can eat, and the evidence matches the claims.
- However, some of the 'wholemeal' bread we found in supermarkets was made from a mixture of wholemeal and refined white flour.

Dietary fibre

The claims

- 'Fibre helps keep you regular and helps maintain a healthy digestive system.'
  – Tip Top, Up Calcium & Hyfibe
- '… to help maintain a healthy digestive system.'
  – Tip Top, 9 Grain
- 'Beneficial for maintaining good digestive health.'
  – Bürgen®, Rye

The facts

Experts recommend that we aim to eat at least 30 grams of fibre a day. Nearly all the special breads we looked at give you plenty of dietary fibre. But it doesn't all come from whole grains. We found breads with the most fibre have it boosted with various supplements. Some of these supplements don't contain insoluble fibre, the kind associated with keeping your digestive system healthy.

- *Psyllium husks* (Country Life Bakery — Performax; Moores — Rye and Wholegrain Low GI). Psyllium's rich in soluble fibre and there's strong evidence it can protect against heart disease. But you'd need about 10 grams a day to see a significant benefit, much more than you'd get in a few slices of these brands of bread. It would be cheaper to buy psyllium separately from the supermarket (about $4 for 200 grams).
- *Guar gum* (Bakers Delight — Hi-Fibre Lo-GI; Tip Top — Up Energi; Wonder White + Calcium, Wonder White Low GI and Wonder Gold + Iron). Also called 'vegetable gum (412)', it's a form of soluble fibre that's used a lot in processed food as a thickener. There's strong evidence that it can protect against heart disease (if you eat enough of it) and it lowers the glycaemic index when it's added to bread.
- *Inulin* (Country Life Bakery — Biomax) is extracted from chicory roots or made synthetically from ordinary sugar (sucrose). It counts as dietary fibre under the Food Standards Code but there's little evidence that it provides the same health benefits. It may reduce your risk of bowel cancer, but only if you eat a lot more of it than you'd get from regularly eating a few slices of bread. But it's a prebiotic (meaning that it can boost the numbers of useful bacteria in your gut).
- *Hi-maize* is a much-promoted ingredient of Wonder White breads. It's made from a special variety of maize that's rich in resistant starch — a form of starch that's not broken down by our digestive enzymes. It has some of the health attributes of dietary fibre and counts as dietary fibre under the Food Standards Code. So if your kids really won't eat wholemeal bread it's better for them than regular white bread.

The verdict

- Bread with these supplements is probably better for you than white bread with a lot less fibre of any sort,

although you don't get the other health benefits that come from whole grains.
- However, much of the evidence for the health-promoting properties of dietary fibre comes from studies in which the fibre was in the form of fruit, vegetables and whole grains — not supplements like the ones added to these breads.

Omega-3s

The claims
- 'Omega-3 DHA helps to promote healthy brain development and function . . . helps maintain heart health . . . helps to develop and maintain our eyesight.'
  – Tip Top, Up Omega-3
- '. . . includes soy and linseed which contain omega-3 ALA to help maintain a healthy heart.'
  – Tip Top, 9 Grain

The facts

There are two types of omega-3 fats: those derived from plants (mainly ALA) and those from fish (mainly EPA and DHA).
- There's very good evidence that the omega-3 fats from fish can reduce your risk of heart disease. Expert opinions differ a little, but typical recommendations are 300 to 500 mg per day of EPA/DHA.
- There's also evidence EPA and DHA are important for the development of the central nervous system in babies, before and after they're born, and suggesting that if women eat fish rich in EPA and DHA when they're pregnant and breastfeeding, it helps the baby's development.
- Other studies suggest you might increase your child's IQ by 0.8 to 1.8 points, but you'd need to increase your intake of DHA by 1 gram (1000 mg) per day. To get that much DHA from Tip Top Up Omega-3 bread you'd need to eat four whole loaves of it.
- Omega-3s may also assist in the development of good eyesight in babies, but there's no evidence that they help to maintain good eyesight for the rest of us.
- There's no evidence you get the same health benefits from ALA. This fat may help to prevent heart disease, but none of the other claimed benefits are proven and you need to eat even more of it (800 to 1100 mg per day).

The verdict
- Tip Top Up Omega-3 bread contains fish oil (using technology developed by CSIRO) but other breads that make omega-3 claims only contain the omega-3 fats from plant sources.
- Most people get plenty of ALA from cooking oils and spreads but on average we're not getting enough EPA and DHA. The Tip Top bread makes a real contribution, but a sandwich made with tinned salmon (40 grams) and ordinary bread would give you about 600 mg of EPA and DHA, more than a day's quota in one hit. And there's little evidence that even that much will make your child brainier.

Soy, linseed and phyto-oestrogens

The claims
- 'Soy and linseeds contain phyto-oestrogens, reported to be beneficial for women's wellbeing.' — Molenberg, Swiss Bake
- 'For women's wellbeing . . . including soy and linseed that are beneficial for women's health.'
  — Bürgen®, Soy-Lin

The facts
- Phyto-oestrogens are substances found in some plants, such as soy and linseed, which mimic the hormone oestrogen.
- The theory is that they relieve the symptoms associated with menopause, such as hot flushes, and protect against heart disease and some cancers, including breast cancer.

The verdict
- There's no consistent evidence that soy phyto-oestrogen extracts or soy products reduce the severity or frequency of hot flushes, and no evidence at all that linseed helps to relieve menopausal symptoms.
- There's also little evidence that phyto-oestrogens lower the risk of heart disease or breast cancer. So there's no point buying soy and linseed bread unless you just like the taste.

Source: www.choice.com au, September 2006.

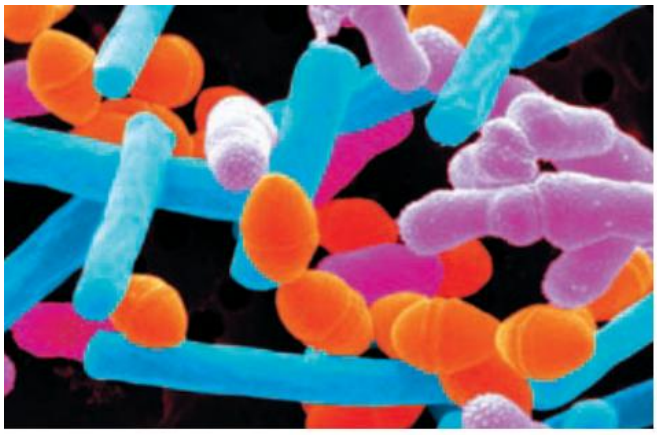
CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *functional foods* to complete the tasks ahead.

1. Why is bread so often chosen as a product for functional food modifications and additions?
2. What are the claimed benefits of eating whole grains?
3. Why do whole grains have these benefits? Name two beneficial components or qualities of whole grains that are not found in white flour.
4. Is fibre-supplemented bread a good source of fibre compared to other high-fibre foods? You will need to use food tables to answer this question.
5. Is omega-3-supplemented bread a good source of omega-3 compared to other sources?
6. Do you think that the claims made about food products should be more closely regulated? Give some examples from the article to illustrate your argument.
7. Log in to **www.jacplus.com.au** and locate the *Bürgen®* weblink for this chapter. Explain why George Weston Foods seized the opportunity to produce soy linseed bread.

eBookplus
Weblink

Probiotics



Yoghurt is said to contain beneficial or friendly bacteria.

The human gut contains billions of bacteria — in fact, if your gut is healthy, there may be more bacteria cells in your body than human cells! Some bacteria are harmful and can cause illness, but a healthy gut has a protective lining of 'good' bacteria to shield you from these. As seen above, these beneficial **gut flora** also help maintain good health by making vitamins and contributing to the nutrition of the gut cells. **Probiotics** are another name for these beneficial bacteria, when they are added to foods to promote health. Gut infections or surgery, a poor diet, or particular medications (such as antibiotics) can reduce the numbers of healthy gut flora, and probiotic foods are often used in these situations to increase them again. The health benefits of yoghurt have been known for hundreds of years, and many of these benefits are due to the effects of the lactic acid bacteria that are responsible for transforming milk to yoghurt and continue to be present in the food. More recently, other bacteria strains have been used in food products.

Although beneficial bacteria happily survive in the colon, they normally do not live in other parts of the gut. In fact, one of the functions of stomach acid is to kill bacteria eaten in food, and prevent them passing into your lower gut and causing infection. This means that many of the normal gut flora cannot be used as probiotics in food, as they would not survive the journey to the colon where they do their beneficial work. Researchers have been working to identify suitable bacteria that can survive during the shelf-life of the food product, and in the stomach acid, and during the process of digestion in the small intestine, to reach the colon safely. Some different bacteria that you might see on food labels include *Lactobacillus acidophilus* and *Bifidobacterium bifidum* (used together in many different yoghurt products), *Lactobacillus rhamnosus GG* (used in Vaalia yoghurt), and *Lactobacillus casei Shirota strain* (used in Yakult).

Modified processed foods

Food manufacturing is a competitive industry and one way to attract an increasing share of the market is by appealing to consumers' concerns about health and nutrition. There has been an increase in consumer interest in health, and an increasing demand for foods that meet their nutritional needs. Meeting this demand may be as simple as altering the marketing of an existing product to make it seem more natural and healthy. Another way that manufacturers have met consumer demands is by creating line extensions of many products. The most common modifications result in reduced energy, reduced fat and reduced salt foods. Reducing saturated fat (particularly trans fatty acids) and increasing fibre, vitamins or minerals (such as folate, or iodine) are other modifications that you may be able to find in products at the supermarket.

REVIEW QUESTIONS

Remember

1. Explain in your own words what is meant by *probiotics*.
2. Read the following phrases and identify whether they refer to soluble or insoluble fibre, or both:
   - **a)** dissolves in water — soluble / insoluble / both
   - **b)** does not change during passage through the gut — soluble / insoluble / both
   - **c)** is also called roughage — soluble / insoluble / both
   - **d)** comes from plants — soluble / insoluble / both
   - **e)** helps keep the gut healthy — soluble / insoluble / both
   - **f)** speeds the passage of the gut contents — soluble / insoluble / both
   - **g)** helps to soften the stool by forming a gel — soluble / insoluble / both
   - **h)** is fermented by bacteria in the colon — soluble / insoluble / both
   - **i)** is used as an additive in food products — soluble / insoluble / both

Apply

3. 'A colourful diet is a healthier diet.' Explain why this might be true.
4. Think of three different examples of modified processed foods that are available in the supermarket. For each, identify one main reason why consumers might choose the modified version of the product, and one main reason why they might prefer the unmodified version.

Do an activity

5. Go to the supermarket and choose a product that is available in both a modified and an unmodified version. Compare the nutritional compositions of the two. What are the significant differences? Choose one nutrient that is different between the products and check the RDI for that nutrient. How does the difference between the products compare to a whole day's intake of that nutrient?
6. Log in to **www.jacplus.com.au** and locate the *Functional foods* weblink for this chapter.
   - **a)** What health claims are made about this food product?
   - **b)** How might consumers misinterpret the message of this marketing?
   - **c)** Find another example of health-related marketing of a common food — for example, in a magazine or website. What health benefits are claimed? Is the claim believable?

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Weblink

Fortified foods

Refining food can destroy its vitamins and minerals, decreasing its nutritional value. In these products, the vitamins and minerals need to be restored by the manufacturers. These are referred to as enriched foods. Some foods can go through the refining process and retain all their original nutritional content. When manufacturers add more of the same vitamins and minerals to these foods, they become **fortified foods**. Some common fortified foods are breads, cereals and milk, which may contain, for example, added folic acid, calcium, iron or fibre.

Fortifying foods is a good way to introduce into a person's diet valuable nutrients they may otherwise lack. Poverty and limited education or knowledge of nutrition may help explain poor nutritional choices in food selection. Supplementing everyday items like bread and milk with these vitamins and minerals allows people to benefit from them without making conscious nutritional decisions.

Debate on the pros and cons of food fortification continues. There are obvious benefits, but there is also an argument against fortification. It has been suggested that escalated levels of particular vitamins and minerals can have a negative effect on a person's health, causing illness or masking already existing conditions. In Australia, laws regulate the voluntary and mandatory fortification of foods. Voluntary fortification means manufacturers can decide to fortify their products with any vitamin or mineral, providing they follow rules set out in the Australia New Zealand Food Standards code. You will have seen examples of these products in your local supermarket, such as high-fibre breads or fish with omega 3. In the case of mandatory fortification, certain products have been identified by the government as foods that should always be fortified in a certain way. So every manufacturer of these items must, by law, fortify that food to a specific level. One example of these foods is margarine. Because a public health need for vitamin D has been identified, all margarines must be fortified with vitamin D. Similarly, all wheat flours used for bread making must be fortified with thiamine and folic acid. All consumers of foods such as margarine and bread will therefore receive an increased intake of specific nutrients. It is this lack of consumer choice that prompts some people to disagree with fortification.

Role of supplements in the diet

Most people know that we need a balanced diet to provide the necessary nutrients for good health. It seems to be a common belief, however, that a balanced diet is not enough. Health food stores, pharmacies and supermarkets sell a wide range of supplement products providing individual vitamins, multivitamin combinations, minerals, fibre and protein, in the form of a variety of tablets, capsules, liquids and powders. Many supplements are also available for mail order via the internet. It is rare for a medical practitioner to be involved in the selection of these products: more often, consumers decide on their own to purchase and consume them, based on fears about the nutritional value of their diets. Sometimes the marketing used to sell supplements plays on these fears, sometimes even making false claims that the modern food supply has been stripped of nutrients. It is important to look critically at such claims.

Questions to ask about supplements include:

- Can a healthy diet supply all the essential nutrients?
- Can supplements be dangerous? Are there any side effects from excessive use of supplements?
- Are there any particular groups that need supplements?

These questions will be answered separately for vitamins and minerals.

Vitamin supplements

The food supply in Australia is wide and varied. Most people have access to the right foods for a healthy and balanced diet, which should provide all the vitamins required by the body. For this reason, vitamin deficiencies are rare in Australia.

Vitamins taken in excess can have side effects. As we saw in chapter 6, vitamins can be categorised as either water soluble (B-group and C) or fat soluble (A, D, E and K). Excessive doses of most water-soluble vitamins are excreted in the urine with little effect; however, fat-soluble vitamins are different because any excess is stored in body fat and can build up to toxic levels. Even water-soluble vitamins can cause problems: a high dose of vitamin C, if taken for a prolonged period, may have no side effects, but if the supplement is stopped suddenly then the symptoms of scurvy may occur! (This is called 'rebound scurvy'.) There may be other disadvantages to consuming supplements. (Refer to the *Vitamins* weblink on page 333.)

Some groups in the community do have particular vitamin requirements, the most obvious group being pregnant women. A pregnant woman needs to increase her intake of vitamins, particularly folate. Quite a high dose of folate is recommended for prevention of neural tube defects in the unborn baby, and many women find this difficult to achieve with food alone, particularly early in pregnancy when nausea and tiredness can result in a reduced food intake. Foods that are fortified with folate, or folate supplements, are both useful alternatives that ensure adequate folate intake at this time.

There may be some health benefits associated with higher intakes of anti-oxidant vitamins, above the basic requirements (see chapter 7 to review the Nutrient Reference Values). Anti-oxidants are readily available in supplement form, but the advertising may encourage consumers to disregard the fact that plant foods are also a good source which provides other benefits that supplements do not — such as

other vitamins and minerals, fibre, and the feeling of satiety. Compared by weight, fresh fruit, vegetables and other plant foods are a much cheaper alternative to supplements. Additionally, scientific evidence increasingly suggests that there is no health benefit to taking supplements of vitamin E, beta-carotene or vitamin C.

Mineral supplements

A balanced diet should be able to provide all the minerals required for good health. However, there is some evidence of mineral deficiencies in Australia, particularly of calcium, iron and iodine. Even so, paying attention to dietary intake of these minerals would provide sufficient amounts in most cases. The Australian Dietary Guidelines, in particular, emphasise the importance of foods containing iron and calcium.

Mineral supplements can be dangerous, because the body stores most minerals and requires only very small amounts for day-to-day processes. Even normal amounts of supplements can cause side effects: some minerals cause diarrhoea and others, such as iron, may cause constipation. It is important to obtain appropriate medical advice before taking mineral supplements. Iron supplementation may be needed in people who are unable to consume enough iron in their diet to meet increased needs. Teenage girls, women, vegetarians and athletes are most at risk of developing **anaemia** as a result of iron deficiency. (This can be diagnosed accurately only with a blood test.)

Some people take calcium supplements, but it is usually easy to obtain in sufficient amounts from dairy foods. Most people who are lactose intolerant can still consume certain dairy foods that are lactose-reduced, but those with a dairy allergy may find it difficult to obtain adequate calcium as other dietary sources of calcium must often be consumed in large amounts — foods fortified with calcium, and calcium supplements may therefore be required.

Most parts of Australia have a low level of iodine in the soil, and this has resulted in a low level in foods. Lack of iodine may lead to thyroid problems, mental problems, hearing loss, and goitre. Some brands of salt are fortified with iodine and the use of this salt in food processing and cooking may help to prevent iodine deficiency.

Don't count on meeting your iodine needs by eating salty processed food, because the sodium used is probably not iodised. In future, food regulations may require food manufacturers to use iodised salt as a way to prevent deficiency in the Australian population.

Who is responsible for the promotion of good health?

An individual's good health is strongly influenced by his or her food and exercise behaviours, and food choice is one part of this. While individuals do need to take responsibility for appropriate food choices, there are other external factors that influence food behaviour and, therefore, affect nutritional health:

- government policies and initiatives
- the food industry
- non-government organisations and community groups.

Role of the government in promoting good health

When individuals make unhealthy food choices, ultimately there is a cost not just to themselves but to the health system that we all share. The government recognises that it is more cost-effective to promote healthy behaviours and prevent problems before they develop, rather than to treat the long-term results of unhealthy behaviours.

The Australian Bureau of Statistics makes available a large amount of data on the health patterns of different groups — for example, the main causes of death in groups defined by age, gender, ethnic background or geographic location. Such data enable the government to assess the health status of various groups, and identify priorities for action. This action may include:

- writing official government policies and strategic plans, which state what the health priorities are. These are used as a guide for health organisations in their planning and funding. Examples of these government documents include the National Public Health Partnership's Nutrition Strategy and Action plan — 'Eat Well Australia, 2000–2010' (see chapter 9) and the Australian Dietary Guidelines (see chapter 7).
- running health promotion campaigns, such as the Australian Guide to Healthy Eating
- developing and funding preventive programs, such as the projects addressing the high cost of healthy food in remote communities
- drafting new **legislation**, which guarantees safe food supply (by controlling chemicals and additives allowed, the specific processing techniques used, and hygiene in food preparation — see chapter 9, pages 173–7) and helps to support other health initiatives (such as by ensuring that the consumer has access to appropriate nutrition information on food labels)

- liaising with other government organisations, such as **Food Standards Australia New Zealand (FSANZ)**, the National Health and Medical Research Council (NHMRC), and the Australian Institute of Health and Welfare.

Role of the food industry in promoting good health

The range of foods available in Australia is constantly expanding. A growing market, with increasing competition for the consumer dollar, means that food manufacturers will usually produce healthy foods only if there is consumer demand for them. Food regulations also play a part in controlling practices such as labelling, food safety and use of particular processes or ingredients, which affect health. Food retailers may also be involved in marketing that can inform consumers about healthy eating. The '7-a-day' program (Go For 2 Fruit + 5 Veg), designed by the partnership of Coles supermarkets and the Dietitians' Association of Australia, is an example of retailers being involved in the promotion of healthy food choices.

Woolworths is now behind the campaign to get children to eat healthier food by providing a website devoted to recipes and games with healthy food.

Role of community groups and private agencies in promoting good health

Organisations outside the food industry also play a part in the promotion of health. The National Heart Foundation, the Dietitians' Association of Australia and the Australian Consumers' Association are examples of non-government organisations that have some involvement in providing information on food and nutrition, shaping consumer perception and guiding the food industry. The National Heart Foundation promotes healthy food choices with their 'tick' denoting their endorsement of foods that meet certain criteria for fat and sodium content. This encourages food manufacturers to modify food products to meet the guidelines. The Australian Consumers' Association investigates food labelling claims and conducts product comparisons, publishing its findings online and in its *Choice* magazine to alert consumers when products are presented in a deceptive or misleading way.

Community groups may also be involved in public discussion of issues that have an impact on consumers, such as **genetically modified** foods, environmental concerns, and the relationship between food choices and long-term health. Other associations focus on helping groups with specific dietary needs, such as people with food allergies, diabetes, or cancer.

Role of the individual in promoting good health

The final responsibility for good health, including food and exercise behaviours, rests with the individual consumer. In the end it is the consumer who makes the decision to buy a particular food, to prepare it in a certain way, and to eat it. But there are many factors that can affect these decisions, such as the variety and affordability of products available to the individual, their education level, and the nutrition information available to them. Whether someone can be an informed consumer depends on their knowledge of nutritional requirements and the general nutritional value of different foods. Product information (such as on food labels) may be misleading, and consumers need to learn to interpret it with care, in order to choose the right components of a balanced diet.

REVIEW QUESTIONS

Remember

1. Classify these vitamins as water-soluble or fat-soluble: vitamin C, vitamin D, thiamine, vitamin K, beta-carotene, riboflavin, pyridoxine, vitamin A, vitamin E.

WATER-SOLUBLE	FAT-SOLUBLE

2. Complete the following table.

ACTIVE NON-NUTRIENT	NATURAL FOOD SOURCES	ADDITIVE IN	HEALTH BENEFITS
Anti-oxidants			
Dietary fibre			
Omega-3 fatty acids			
Probiotics			
Phyto-oestrogens			

Apply

3. When are supplements appropriate? Match each person with the right supplement.

a)	An elderly man who is allergic to dairy foods	vitamin B_{12}
b)	A woman who is planning to start a family and dislikes vegetables	fibre
c)	A nun who wears a full-face veil and long habit (gown)	calcium
d)	A teenage boy who follows a vegan diet	folate
e)	A young vegetarian woman with heavy menstruation	iron
f)	A man who is on a liquid diet after breaking his jaw	vitamin D

4. Vitamins may be harmful in excessive doses. Why is this more likely with fat-soluble vitamins than with water-soluble vitamins?

5. Would it be possible to live on vitamin and mineral supplements alone? Why or why not?

Do an activity

6. Imagine that you are the author of a 'Dear Doctor' column in a health magazine. In 150 words, advise your readers on whether or not they should use dietary supplements.

7. Look through your fridge and pantry at home.
- **a)** What fortified foods are you consuming day to day?
- **b)** Which vitamins and minerals do they contain?
- **c)** What are the health benefits of these supplements?

8. Investigate the way in which one community group or private organisation contributes to the promotion of good nutritional health in the community.

9. Visit a health food store in your area.
- **a)** List five products containing substances that you do not recognise, and investigate the claimed benefits of each of these substances.
- **b)** Choose two of the following: vitamin C, vitamin E, iron, calcium.
  - **i.** For each, check how much the supplement costs, how many tablets/capsules it contains, and calculate the cost of each tablet/capsule.
  - **ii.** Work out how many tablets/capsules you would need to meet your RDI for that nutrient.
  - **iii.** List five good food sources of that nutrient.
  - **iv.** Compare the cost of food versus tablets/capsules for meeting your RDI for that nutrient.

10. Choose a position for or against mandatory fortification of foods. Write a five-minute speech putting forward your views on the issue.

11. Log in to **www.jacplus.com.au** and locate the *Vitamins* weblink for this chapter.
- **a)** What damage is caused by free radicals and what are some of the diseases that might be associated with the action of free radicals?
- **b)** Why might supplements not always have the desired effect?

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Weblink

CASE STUDY

FOOD THAT OBEYS ORDERS

by DANIELLE TEUTSCH

'Smart' foods are already on our supermarket shelves but they're becoming even smarter — and not everyone is in favour.

Remember those space-age futurists of the 1960s who predicted we would be popping pills for dinner instead of sitting down to meat and three veg?

It seems they were half right after all. But instead of tucking into food in a vitamin pill, we're eating vitamin pills disguised as food.

Already supermarket shelves are full of foods with labels that might have been prescribed by a doctor. There are margarines that lower cholesterol, soy-enriched breads that help with menopause, juices fortified with iron and calcium and chewing gum with xylitol to help reduce tooth decay. In the pipeline are intelligent eggs with omega-3s; breads with an appetite suppressant and juices containing blood-pressure medication and other drugs.

Australia's first National Centre of Excellence in Functional Foods (NCEFF) at the University of Wollongong opened last year, a sign that the food industry is taking these so-called 'smart foods' seriously. Nestlé is on the board, along with Murray Goulburn (owner of Devondale) and Meat & Livestock Australia.

They are not the only companies sniffing out the potential of selling functional foods to a health-obsessed public looking for short cuts.

The global food giant Unilever now makes 20 per cent of its overall margarine sales in Australia from plant sterol enriched spreads, and is looking at developing the heart-health market further. And the Australian company So Natural has signed a deal with swimmer Ian Thorpe as part of its push to become a national leader in functional foods, focusing on soy and fish products.

The message is clear: we will be seeing more 'smart' foods on supermarket shelves.

The centre's director, Professor Linda Tapsell, said functional foods were broadly defined as health enhanced, enriched by a bioactive compound. 'It's this century's version of vitamin pills,' Tapsell said.

She points out that enriched spreads, milks, juices and breads are already accepted by Australian consumers. So why not a breakfast muffin that gives a feeling of satiety? Or a super muesli bar that prevents tooth decay while giving energy?

'The centre is looking at special pre-prepared meals that are designed for various activities — for example, a breakfast that gives a slow release of energy for an all-day golf game, or a low-calorie meal with an appetite suppressant for a sedentary worker', she said.

There are plenty of parents who would welcome the idea of a drink that delivers all the proteins, carbohydrates, vitamins and minerals required by a child who otherwise refuses to eat anything healthy.

As science advances so do the possibilities, like cows being genetically engineered to produce those heart-healthy omega-3s normally found in fish. It's called having your steak and eating it too.

The CSIRO's senior research dietitan Dr Manny Noakes sees functional foods as a natural evolution of eating habits. Just as we no longer need to hunt animals whenever we feel hungry, we may no longer bother to eat foods that don't optimise our health.

'There is evidence we need a lot more than we realise of things like folate, B6, B12 that are involved in DNA stability,' she said. 'And some people need more than others.'

She believes functional foods will eventually decrease our expenditure on pharmaceuticals. 'Quite likely, there will be disease-specific foods, to prevent or treat arthritis or heart disease,' she said. 'It's taking a few short cuts to optimise nutrition.'

Food critic and founder of the Sydney Slow Food convivium Matthew Evans is, not surprisingly, horrified by Noakes's vision. For him it conjures up nightmare images of the not-too-distant past when processing ruled and consumers were lumbered with such abominations as tinned pineapple, plastic cheese and Spam.

'For the average person, getting a balanced diet is a no-brainer. We all know we need to eat fruit and veg, a bit of fish and wholegrains,' he said.

Noakes agrees that good health is easily achievable in Australia, with its abundance of food and decades of public education about nutrition.

Even so, many people still can't manage to achieve a good diet. Blame laziness, apathy, lack of time, the surfeit of tempting fast food outlets or bum-on-seat office jobs: Australians are still most likely to die of a lifestyle-related disease such as diabetes or heart disease.

'Yes, food by itself is perfectly adequate,' Noakes agreed. 'But what's not adequate are our choices. Rather than beating our heads against the wall, we are finding a solution.'

Nutritionist Rosemary Stanton said the quest to develop functional foods was not just about making the population healthier, but about making profits healthier for food industry giants.

'If food companies really cared about our health, they would stop bulking up foods with a range of additives,' Stanton said. She points to the danger of relying on functional foods as a magic solution.

For example, if a manufacturer produces a calcium-enriched soft drink, does that mean kids no longer need milk?

'We need to look at the total picture,' she said. 'Milk doesn't just have calcium. It has riboflavin, proteins and phosphorus. Food is complex.'

But, despite Stanton's fears about health-enhanced doughnuts and cheeseburgers, Food Standards Australia and New Zealand is adamant we won't be seeing them soon. While it allows margarine, dairy products, flour, juices and cereals to be fortified, it won't allow the same for fatty or sugary foods such as sausages, sweet biscuits and fish fingers.

Those who dream of a multivitamin jellybean may have to wait.

Source: The Sun Herald, 16 May 2004.

OUTCOME TASK **DEBATE**

Students learn to:

- discuss the relationship between nutritionally modified foods and health
- discuss the role of 'active non-nutrients' in the diet
- debate the role of dietary supplements in a balanced diet.

Contributes to the following outcomes:

- evaluates the relationship between food, its production, consumption, promotion and health
- independently investigates contemporary food issues
- develops, realises and evaluates solutions for a range of food situations.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *functional foods* to complete the tasks ahead.

1. List two types of new foods that the National Centre of Excellence in Functional Foods is considering as possibilities. Choose one and list the advantages and disadvantages of such a food. Could the same goals be achieved using ordinary foods? Give examples to explain your answer.
2. Fill in the following table. The first line has been completed for you.

EXPERT	ROLE	ATTITUDE TO FUNCTIONAL FOODS: FOR/AGAINST	SUPPORTING ARGUMENT(S) FOR OR AGAINST FUNCTIONAL FOODS
Professor Linda Tapsell	Director of the National Centre of Excellence in Functional Foods	for	• likely to be well-accepted by consumers • would achieve goals that normal foods are unable to meet
Dr Manny Noakes			
Matthew Evans			
Dr Rosemary Stanton			

3. Conduct a class debate on the topic: 'Nutritional supplements and functional foods are necessary to ensure good health'.

CHAPTER 18 SUMMARY

- Active non-nutrients are beneficial substances in food other than the essential food nutrients. These include:
  - anti-oxidants
  - phyto-oestrogens
  - fibre
  - omega-3 fatty acids
  - probiotic organisms.
- Functional foods are those with health benefits additional to their nutritional value, such as foods containing a high level of active non-nutrients.
- Nutritionally modified foods are those that have been changed in some way during manufacturing, either to add or remove some component(s) to improve the nutritional value of the product.
- Many vitamins and minerals, as well as fibre and protein, are available in supplement form.
- Supplements are widely used, but often this may be unnecessary or inappropriate.
- Excessive intakes of vitamins and minerals may have undesirable or dangerous side effects.
- There are some groups in the population who might benefit from the use of particular vitamin or mineral supplements. The most common of these supplements are folate, iron, calcium and iodine.
- The government, the food industry, community groups and the individual all have a role in promoting good nutritional health.

KEY TERMS

active non-nutrients
anaemia
anti-inflammatory
anti-oxidants
butyric acid
carotenoids
flavonoids
Food Standards Australia New Zealand (FSANZ)
fortified foods
functional foods
genetically modified
gut flora
insoluble fibre
isoflavonoids
legislation
lignans
low-density lipoproteins (LDLs)
nutritionally modified foods
oestrogen
omega-3
omega-3 fatty acids
peristalsis
phytochemicals
phyto-oestrogens
probiotics
prostaglandins
soluble fibre

Chapter 19
Influences on nutritional status

If you are well-nourished, how did you get that way? Would you be as healthy if your family's income was halved? Would your eating habits be different if you had never seen any advertisements for fast foods or chocolate? There are many different influences on your nutritional status — not just the foods you choose to eat, but also heredity, environment, and the lifestyle and food habits of your family, your friends and your community.

In this chapter you will learn about:

- health and the effect of heredity and role of diet in the development of conditions including diabetes, cardiovascular disease, food sensitivity/intolerance/allergies
- media and the impact of advertising practices on food consumption such as the promotion of 'health' foods and 'fast' foods
- lifestyle and the effect of cultural and social practices.

What's on TV — hamburgers, chips, confectionery and maybe obesity? Children are specifically targeted in the promotion of snack foods.

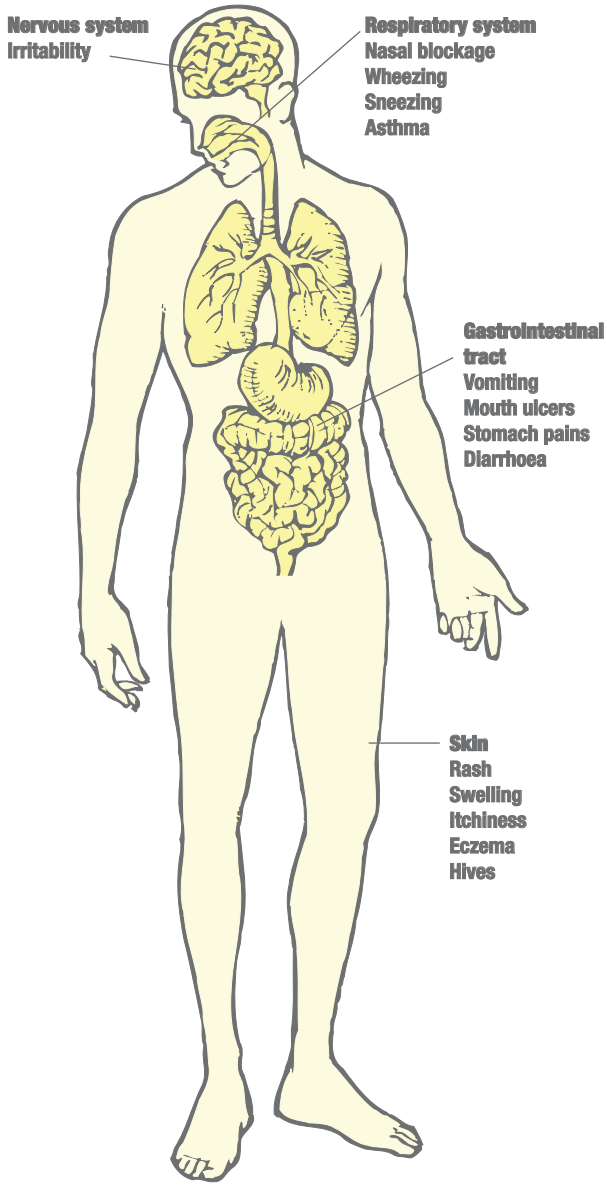
The foods you choose have a major role in influencing your nutritional status. If you have a balanced diet, you should have adequate amounts of the essential nutrients for good health. But other factors can also make a difference. Many nutrition-related conditions have a strong genetic component. For example, your risk of developing diabetes or cardiovascular disease is much higher if other members of your family have these conditions. Food allergies and intolerances also seem to run in families. However, even a very strong family history of a condition does not mean that you will definitely develop it, but you may have to be more careful than other people, paying closer attention to other risk factors such as diet.

Food sensitivities

Over thousands of years, humans have developed the food supply to eliminate harmful foods. Foods that caused unpleasant effects such as skin irritations, restricted breathing, or even death, were processed to make them safer, or were excluded from the diet and regarded as poisonous. But some people still experience physical reactions to a particular food or group of foods that the majority of people easily tolerate. We call these **adverse reactions**, which may be either a food allergy or a food intolerance. Although some of the symptoms may be similar, these two conditions are very different.

Food allergies

A **food allergy** occurs when the body's immune system responds to a specific food protein (an **allergen**) and incorrectly identifies the allergen as a dangerous foreign protein. **Antibodies** are then produced in order to destroy the food protein. This reaction between the allergen and the antibodies causes the symptoms of the allergy, which can be dramatic and life-threatening, even with only very tiny amounts of the allergen present. Allergy symptoms can affect different systems of the body, not just the gastrointestinal tract, as the diagram above right shows.



Different parts of the body can show the symptoms of an allergic reaction.

Identifying and managing food allergies

Food allergy reactions often occur immediately after the allergen-containing food is consumed, and this enables the possible causes to be identified. Skinprick testing is then used to confirm whether the suspected foods are the cause. This test shows whether the individual has specific antibodies to a particular food protein, by pricking the surface of the skin (usually on their forearm) with a solution of the suspected food. Multiple suspected allergens may be tested at the same time. If antibodies are present for a particular allergen, a wheal (a raised lump like a mosquito bite) forms where the skin was pricked. If the skinprick test cannot be done, then a RAST blood test can be used to measure antibody levels. If the result of the skinprick test is unclear, a supervised **food challenge** can be done to observe the individual's physical reaction to specific food allergens eaten in a strictly controlled environment such as an allergy clinic.

CASE STUDY

WHEN FOOD CAN BE FATAL: UPDATE

by HELEN DALLEY

Despite growing community awareness about the dangers of severe food allergies, Australian children continue to die from preventable acute allergic reactions known as anaphylaxis. This week *Sunday* reveals for the first time the tragic story of four-year-old Alex Baptist who died a year ago from anaphylactic shock in a Melbourne pre-school, even though he was carrying life-saving medication. Earlier this year, *Sunday* spoke exclusively to the parents of Hamidur Rahman — a 13-year-old who also died from an allergic reaction to peanut butter while attending a school camp three years ago. The family were bewildered how this tragedy could have happened when they say they informed the school that their teenaged son couldn't eat peanuts. Following an inquest into Hamidur Rahman's death last week, NSW Deputy State Coroner Jacqueline Milledge recommended there must be proper training of all staff and students in the state's schools and childcare centres about the risks of food allergies and correct emergency treatment of acute reactions. All this is cold comfort to Alex Baptist's parents who believe their son would still be alive today if proper training of childcare staff had been widely available in Victoria at the time of his death . . .

This week marks one year since young Alex Baptist died after an anaphylactic — or severely allergic — reaction, while attending his local kindergarten. It's suspected the vibrant four-and-a-half-year old inadvertently came into contact with the merest trace of peanuts . . . a food that's harmless to most of us, but enough to send his nut-allergic little body into a rapid spiral towards death.

When Alex was a toddler he had been properly diagnosed by an allergy clinic as potentially anaphylactic to peanuts. He was prescribed an Epi-pen — containing a life-saving adrenaline dose — that was to be administered immediately if he showed any symptoms of an allergic reaction.

During an acute anaphylactic reaction, the victim's blood pressure drops and their tongue and throat swell, blocking the airways and leading to death by suffocation and heart failure. Quickly administering adrenalin in the early stages of a reaction can reverse these deadly symptoms.

. . . To ensure such preventable tragedies never happen again, last week the Coronial findings recommended:

- Anaphylaxis awareness training immediately be undertaken by childcare centres and school staff and students, including proper training using Epi-pens.
- All schools and childcare facilities must undertake 'risk assessment' for all educational and recreational activities involving children.
- Identify all children in schools and childcare facilities who suffer from allergies and put this information on a central register accessible by all staff.
- All children at risk of anaphylaxis be subject to a uniform management plan.
- That parents be required to tell schools if their child is at risk of an allergic reaction.
- The NSW government should fund the employment of nurse-educators to provide proper training in all schools and childcare facilities.
- The NSW Attorney General enact legislation similar to Canada's 'Sabrina's Law', to protect children at risk, and to safeguard staff from prosecution, if they come to a child's assistance. This law followed the death of Ontario schoolgirl Sabrina Shannon, who died after inadvertently eating a trace of allergen in the school canteen. The intention of this law would be to protect pupils at risk of anaphylaxis and safeguard teachers and staff from prosecution if an act done to manage or save a child was undertaken 'in good faith' . . .

Source: http://sunday.ninemsn.com.au, 18 September 2005.

CASE STUDY QUESTIONS

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food allergies* to complete the tasks ahead.

1. Why is anaphylaxis life-threatening?
2. How is anaphylaxis normally managed in an emergency situation?
3. What steps should be taken in a food service setting to prevent someone from being exposed to an allergen that affects them?

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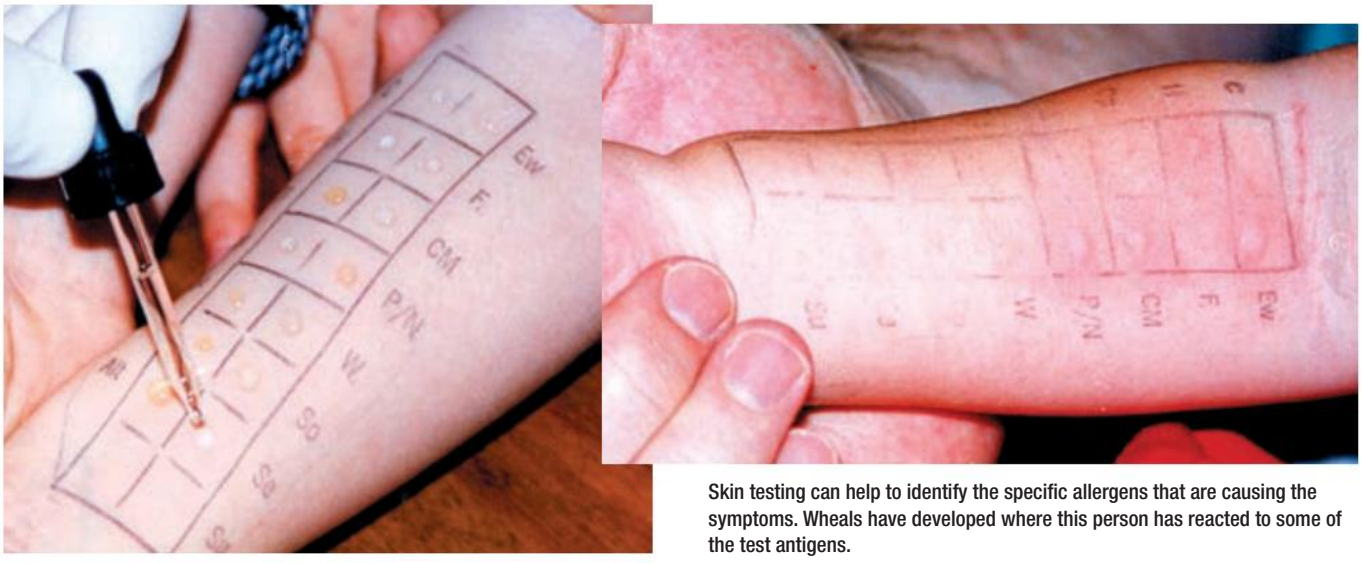
Additional case study



Skin testing can help to identify the specific allergens that are causing the symptoms. Wheals have developed where this person has reacted to some of the test antigens.

Once a particular allergen has been identified as the cause of the symptoms, a long-term management plan is needed to prevent a life-threatening reaction. Someone with an allergy will need to ensure complete avoidance of all foods that contain even small amounts of the allergen. The **Food Standards Code** requires food companies to list all the ingredients in a food product or used in processing, and there is mandatory labelling of the most common allergens.

Common food allergens

Peanut
Other nuts ('tree nuts')
Egg
Milk
Seafood
Sesame
Wheat
Soy

If you look at food labels, you will notice that many of them go beyond this, stating if the food manufacturing equipment may previously have come into contact with other ingredients not in the food, or simply saying 'This product may contain traces of …'. This enables people with allergies to avoid foods that might have tiny traces of allergen in them, even when they are not included as an ingredient.

The most common allergies are to eggs, cow's milk, fish and peanuts. Many people who are highly allergic will often have allergies to several different things. Children's response to allergens such as egg and milk can lessen with age, as the body becomes desensitised to the allergen over time. This means that almost all children with egg or milk allergies may eventually be able to reintroduce these allergens to their diets very gradually in small amounts. Nut (including peanut) and fish allergies may persist into adulthood.

Coeliac disease (immune reaction to gluten)

Coeliac disease is the condition in which the presence of gluten damages the lining of the small intestine. **Gluten** is a protein found naturally in wheat, barley and rye. The damage caused to the intestinal lining means that the gut cannot absorb nutrients properly, leading to nutritional deficiencies. Continuing exposure to gluten increases the risk of developing a type of gut cancer. Although coeliac disease is not uncommon, affecting one person in every one to three hundred, an individual has a greater chance of developing the condition if there is a family history. The symptoms of coeliac disease can include:

- gut symptoms, such as abdominal cramping, nausea
- signs of malabsorption, such as diarrhoea or flatulence
- signs of malnutrition, such as weight loss, anaemia, osteoporosis. Children may experience a failure to thrive, or delayed development.

As with all other food allergies, diagnosis requires proper medical investigation. A blood test can indicate whether someone possibly has an immune reaction to gluten, but the only definite way to confirm coeliac disease is by sampling part of the intestinal lining in a biopsy. Once diagnosed, coeliac disease must be managed with a strict diet that avoids all foods containing gluten, both naturally occurring or as an additive. Table 19.1 shows foods that can and cannot be included in the diet of a person suffering from coeliac disease.

TABLE 19.1 **Foods that coeliacs should avoid and include**

TYPE OF FOOD	FOODS TO AVOID	FOODS TO INCLUDE
Meat	Prepared products such as processed meats, meat pies and frozen dinners; sausages	Fresh, canned, smoked or frozen meats that do not contain sauces or crumbs; bacon, ham
Dairy products	Ice-cream in cones; processed cheese, pastes and spreads; milk products with malt (e.g. malted milk)	Fresh, UHT, condensed, evaporated, powdered or dried milk; some ice-creams, cream, cheese, cottage cheese
Takeaways	Pizzas, battered or crumbed food, hamburgers, souvlaki	Grilled fish, steak and chicken; steamed rice and vegetables
Bread	All bread including rye bread; breadcrumbs, croissants, bagels	Gluten-free bread, rice cakes
Flours	Wheat, rye, barley and triticale flours	Lentil, potato, rice, tapioca and soya flours, pure maize cornflour, cornmeal, gluten-free baking powder
Cereals	Most commercially prepared breakfast cereals; porridge, muesli	Homemade muesli made using gluten-free products; rice and corn cereals
Pasta and rice	Most pastas	Gluten-free pasta; rice; rice vermicelli; rice noodles; cornmeal; pure corn taco shells and tortillas; pure corn and rice cereals
Fruit	Prepared pie fillings	Fresh, frozen, dried and canned fruit; 100 per cent fruit juices
Vegetables	Vegetables in crumbs and/or sauces; creamed vegetables; commercially prepared potato salad	Fresh, frozen, dehydrated and canned vegetables that do not have sauces; 100 per cent vegetable juices

(continued)

TABLE 19.1 *(continued)*

TYPE OF FOOD	FOODS TO AVOID	FOODS TO INCLUDE
Legumes and nuts	TVP (textured vegetable protein); processed legumes that have been thickened	Gluten-free baked beans; peanut butter, dried peas, beans, nuts and seeds
Snacks and flavourings	Cakes and cake mixes, biscuits and biscuit mixes, buns, muffins, pikelets, crumpets, licorice, filled chocolates, white pepper, mustard, sauces, chutneys, pickles, curry powder, stock cubes, soy sauce containing wheat, Marmite, Promite, salad dressings and mayonnaise that contain flour, most savoury snacks	Popcorn, gluten-free corn chips, rice cakes and crackers, plain chocolate, fresh herbs, spices, vinegar, honey, jam, marmalade, peanut butter, golden syrup, pure cocoa, gelatine
Beverages	Coffee substitutes, malt, drinking chocolate, Milo, Ovaltine, milk flavourings	Coffee, tea, milk, water, mineral water, soft drink, fruit and vegetable juices, cordials
Desserts and confectionery	Most frozen desserts, custard powder, instant puddings; confectionery containing glucose syrup or dextrose unless specifically gluten free	Jelly, meringue, some ice-creams, pavlova

REVIEW QUESTIONS

Remember

1. How is a food allergy diagnosed?
2. Name five of the most common food allergens.

Apply

3. Describe, in your own words, what is happening in the body when an allergic reaction occurs.

Do an activity

4. Select one product from the following list. Modify a recipe for that product so it is suitable for a person suffering from coeliac disease, and then prepare the food.
   - crumbed chicken fillet
   - hamburger
   - muffins

   If possible, compare the taste, appearance and texture of the product to the gluten-containing version.
5. Log in to **www.jacplus.com.au** and locate the *Diabetes* weblink for this chapter.
   a) Look at the risk factors for developing type 2 diabetes and identify whether they could be changed by improving lifestyle behaviours (modifiable risk factors) or whether they are outside an individual's control (unmodifiable risk factors).

MODIFIABLE RISK FACTORS FOR TYPE 2 DIABETES	UNMODIFIABLE RISK FACTORS FOR TYPE 2 DIABETES

   b) What difference does family history make to your risk of developing type 2 diabetes?
   c) Which risk factors would also increase your risk of cardiovascular disease?

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Weblink

Food intolerances

A food intolerance is different from a food allergy in two ways:

1. The response does not usually involve the immune system.
2. The body is not responding to an individual protein, but to other chemicals found widely in a variety of foods, and sometimes requiring large amounts to cause a reaction.

Foods are complex combinations of chemicals. Both processed and unprocessed foods contain large numbers of different chemical substances, either found naturally in food or added during manufacturing or preparation. People who are sensitive to particular chemicals will react to either source, whether natural or artificial.

Food intolerances are an individual's response to a specific chemical or combination of chemicals. Symptoms may appear shortly after eating the food or some time later. In some people the chemicals build up in the body over time and produce constant or recurring symptoms only once they reach a certain level. Sensitivity varies widely between individuals, with some reacting to very small amounts of particular chemicals while others will have a reaction only to large amounts.

A wide variety of symptoms have been reported as resulting from a food intolerance, including the following:

- skin symptoms such as hives, eczema or skin rashes, mouth ulcers
- respiratory symptoms such as blocked nose, sinus pain, asthma
- gastrointestinal symptoms such as abdominal pain, nausea, diarrhoea, flatulence, constipation
- neurological symptoms such as headaches (even migraine), lack of energy, dizziness, ringing or buzzing sound in the ears (tinnitus), impaired memory and concentration
- behaviour and mood symptoms such as depression, irritability, aggressive behaviour.

Some of these symptoms may be very similar to those of a food allergy — only the cause is different.

Asthma is a disease characterised by severe difficulty in breathing and is potentially life-threatening. Up to 20 per cent of adults with asthma find that they experience attacks in association with an intolerance to particular food chemicals.

Flavour in food comes from food chemicals, and these are many of the same ones that cause common food intolerances. These include:

1. **Salicylates** are a group of chemicals found in all plant foods. High levels are found in many fruits and fruit juices, vegetables, herbs, spices and nuts, as well as coffee, tea, beer and wine. They are also used as additives in foods (as preservatives, including benzoates, and in peppermint and eucalyptus flavourings) and are found in other products like toothpaste and aspirin.
2. **Amines** are a group of chemicals that are produced when protein foods are aged, fermented or start to break down. High levels are found in cheeses, processed meats, beer and wines. Concentrated protein products like meat and fish pastes, paté and yeast extracts, contain high levels of amines. They are also found in some fruit and vegetables like bananas, tomatoes and avocadoes. Chocolate is also a source of amines.
3. **Glutamate** is one of the amino acids, as you will recall from chapter 6. Because of this, it is found naturally in all plants and animals. When it is 'free', that is not bound into a protein molecule, it provides part of the savoury flavour in foods such as mushrooms, tomatoes and tomato products, cheeses, soy sauce, and meat extracts. Glutamate is also available as a salt of pure monosodium glutamate (MSG), which is used as a flavour enhancer in many snack foods and in some Asian cooking. Once MSG is consumed, it breaks down into sodium and glutamate, so it is no more harmful than a dish that contains salt and the natural glutamates from mushrooms or tomatoes. Despite this, many people believe that MSG is dangerous, and avoid it without realising that they are still consuming equivalent substances regularly in their diet.

Identifying and managing food intolerances

The identification of a food intolerance is far more complicated than the identification of a food allergy because it involves chemicals that are present in a much wider range of foods. In the case of a food intolerance, the specific chemicals need to be isolated. To do this, the individual is placed on a strict **elimination diet**. The elimination diet allows only a narrow selection of foods to be consumed — that is, those foods that do not contain high levels of any substances likely to cause reactions. These are very bland foods because they are low in the flavourful food chemicals that are associated with intolerances. The following foods are included in the elimination diet prescribed at the Royal Prince Alfred Hospital Allergy Unit in Sydney:

- meats — only lamb, veal and skinless poultry
- eggs
- fats — only safflower or sunflower oils
- vegetables — only lettuce, parsley, and thickly peeled old potatoes
- fruits — only thickly peeled fresh ripe pears, or pears canned in syrup (not juice)
- cereals — only white rice and rice products, wheaten cornflour, arrowroot flour and potato flour
- white sugar
- beverages — only instant coffee, pear juice, mineral water and soda water.

It takes between two and six weeks for the intolerance symptoms to subside, and some people may suffer withdrawal symptoms during this period, where symptoms temporarily worsen. Once all of the possible chemicals have been eliminated from the body, chemicals suspected to be responsible for the symptoms are re-introduced into the diet one by one as a food challenge. If no effect is identified after two days, the next challenge is introduced. The whole process must be performed under close supervision with support from a specialist allergy clinic.

Long-term management of a food intolerance does not require complete avoidance of the chemicals that cause the problem, since the reactions usually depend on how much is consumed. Reducing the offending foods, and establishing how much is safe, is important. This can be more complicated than managing a food allergy, because a much wider range of foods will contain the particular chemical or chemical group that causes the symptoms, and the chemicals occur both naturally in foods, and as additives. Because food additives are often shown as just a code number on food labels, people with food intolerances need to read food labels carefully so that they can keep track of their intake of the foods that cause their problems. Dietitians or doctors

specialising in allergies and intolerances can help in identifying the food sources of particular chemicals. Booklets containing the list of food additive code numbers are available from a variety of sources, including the National Health and Medical Research Council, Food Standards Australia and New Zealand, and the Australian Consumers' Association.

An example of a food intolerance: lactose intolerance

A lactose intolerance is not to be confused with a **milk allergy**. A milk allergy is an immune system response to milk protein, whereas a **lactose intolerance** results when an individual has difficulty in digesting lactose. Lactose is the main carbohydrate in milk. As we saw in chapter 6, it is a disaccharide which is broken down in the gut to monosaccharides, glucose and galactose. This process requires an enzyme, lactase. If the body produces insufficient lactase, some lactose is not broken down and cannot be absorbed. Unabsorbed lactose reaches the colon, causing a watery stool. Colon bacteria may digest some of the lactose, producing gas. The gas can cause abdominal cramping and pain, as well as flatulence.

Approximately one million Australians have some degree of lactose intolerance, suffering from discomfort, diarrhoea or flatulence if they have too much lactose. There are genetic factors linked to lactose intolerance (the majority of sufferers are of Asian, Aboriginal or Mediterranean background) but lactase levels will also naturally decrease if an individual does not consume any lactose. Lactose intolerance can also occur temporarily after a gastrointestinal infection, which reduces lactase levels for a few days.

Lactose is found naturally in dairy foods, in different amounts, and may also be used as an additive in many processed foods. Here are some common dairy foods, and their lactose contents per 100 grams:

Regular cow's milk	5–6 g	Yoghurt	2–8 g
Goat's milk	5–6 g	Most cheeses	2–3 g
Reduced-fat cow's milk	6–7 g	Ricotta cheese	1–6 g
Evaporated milk	12–14 g	Ice-cream	2–6 g
Lactose-reduced milk	1–2 g		

Lactose intolerance should be managed under medical supervision, but fortunately it is not usually necessary to eliminate dairy foods from the diet altogether. Since they are a valuable source of calcium, it is preferable to:

- choose dairy foods that are lower in lactose, such as lactose-reduced milk, cheeses that are naturally low in lactose, and yoghurt (which contains lactase produced by the yoghurt bacteria)
- limit the amount of dairy food consumed at any one time, so that the amount of lactose is limited
- spread dairy food intake out over the day so that the gut receives only small amounts of lactose at a time
- consume dairy foods with meals, rather than on an empty stomach, so that the lactose is gradually released, with the other foods, from the stomach into the gut.

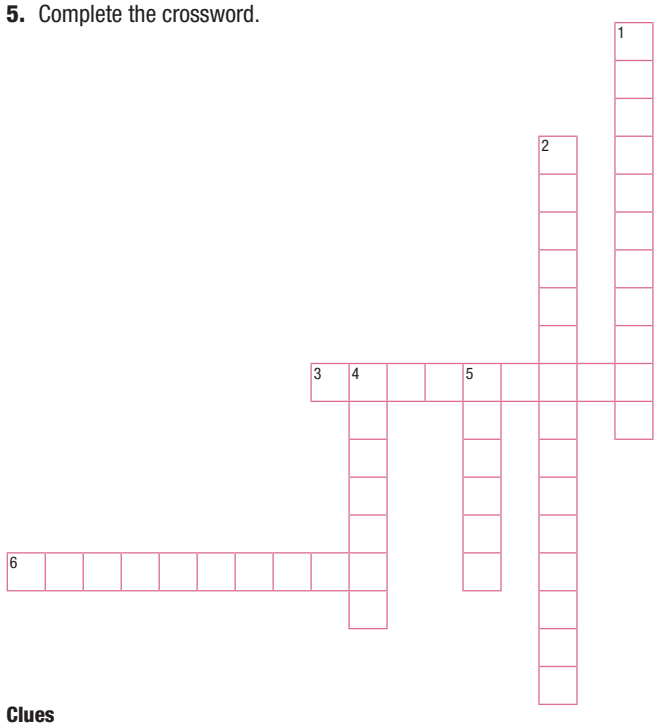
REVIEW QUESTIONS

Remember

1. Describe in your own words the difference between an allergy and an intolerance. Explain how the causes, symptoms and diagnosis differ for milk protein allergy and lactose intolerance.
2. What is meant by *food challenge*?
3. List three foods that naturally contain glutamate.

Apply

4. Why is it more difficult to diagnose food intolerance than a food allergy?
5. Complete the crossword.



Clues

Across

3. Food chemical that gives a savoury flavour
6. Produced as part of the body's immune system to fight foreign proteins

Down

1. Food chemical used as a preservative and found in toothpaste
2. A bland diet with lots of pears and rice, used to reduce the body's level of food chemicals
4. The sugar found in milk
5. Food chemical produced by fermenting protein foods

Do an activity

6. People who have lactose intolerance need to pay attention to their calcium intake. Prepare a two-day meal plan for a sixteen-year-old boy with lactose intolerance that meets his RDI for calcium without needing to take a supplement.
7. Plan a day's meals using only those foods that are included in the elimination diet. Prepare the main meal of the day and assess its visual and taste appeal.

Media impact on food consumption

The food industry uses the media for several purposes:

- to increase awareness of a brand or individual food product
- to shape the consumer's perception of his or her own needs and desires
- to guide the consumer's product choices and buying patterns.

Ethical issues and responsible advertising

The issue of junk food advertising is a hot topic. There is regular public debate over its impact on childhood and adult obesity. The greatest concern, however, is for the effect it has on children, as children are less prepared and equipped to make wise individual food choices. Children are more susceptible to the messages being delivered to them through advertising, which now surrounds us every day on television, radio and billboards, in films and at sporting events. Of course advertising is not solely responsible for obesity and other health issues; there are many contributing factors. But heavy advertising of unhealthy food products is cause for concern.

Advertisers make use of fun characters, bright colours and short story plots, all of which appeal to children. The association of fun, happiness and play fuels a desire for the product. The focus is not on the issue of health at that level, as the child is most likely unaware of the value of nutrition or of the food's nutritional content. These advertisements are usually run during children's programs to maximise the number of children they will reach. Messages are also embedded for the parents' benefit. The catch-phrase 'high in calcium' is used in an advertisement for ice-cream, which also happens to be high in sugars and fats. McDonald's promotes healthy eating by offering an apple with Happy Meals, while purposely not highlighting the fact that the meal contains the standard burger, which is high in fats, sugars and salt.

The Advertising Standards Board (ASB) is an Australian organisation in place to monitor and respond to inappropriate advertising. On 1 August 2009 they launched a new initiative that established stricter rules for fast-food advertising. Fast-food companies could no longer advertise free toy offers or use their licensed characters unless the meal they were advertising met specific nutrition criteria. With so much force and attention behind responsible food advertising, and initiatives like this, there has been a notable drop in junk food advertising in recent years. This has meant that fast-food and junk-food companies have had to become more creative. A common trend now is to use other advertising techniques such as cross-promotions and product placement.

In a cross-promotion a company will advertise a product through association with another non-food-related product — for example, another popular television show or film, a sports team or event, toys or games. These connections spark the interest of a large number of consumers, seducing them into purchasing the associated item. Product placement is a similar but less obvious ploy. Food advertising can be strategically placed in television shows and films, promoting the product simply by its presence and association with the show. A character might be drinking a clearly branded soft drink or eating chocolate from a familiar purple Cadbury wrapper. The brand or product name might even be directly mentioned in the course of the show. All of these visual and auditory references are absorbed by viewers on some level and prompt the desire or craving to purchase.

Ultimately it is up to the individual — or, in the case of a young child, their parent or guardian — to make sensible choices concerning their food and diet. But the advertisers of unhealthy foods do have a responsibility to inform the public and so assist them in making the correct choices for themselves. They have a responsibility to be honest about the product, and to be clear about the nutritional advantages and disadvantages of a product. It is unethical for advertisers to lie, which is why advertisements will often highlight the positive points about a product and avoid addressing the negatives.

Promotion of health foods

Fortifying foods with vitamins and minerals has been common practice for decades. In one way this could be seen as a service to consumers, helping them to meet their nutritional needs easily. But of course food companies can also use this as a way of making their products more competitive. In the 1970s, the Australian Dietary Guidelines encouraged consumers to seek out foods with reduced levels of fat, sugar and salt, and with increased levels of fibre. Many companies created **line extensions** to meet these demands. Today, many companies are producing **functional foods** (see chapter 18) to appeal to consumers' desire for improved health and wellbeing.

Defining 'health food' is difficult because there are no legal requirements on the use of the word 'health', 'healthy' or 'natural' in food labelling. Such products do not need to meet any particular standards, so the consumer is left to interpret these terms in his or her own way.

Food companies can also link their products with health by the use of nutrition information on the label of the food product. This is regulated by the Australian Food Standards. Food labels are permitted to include statements about their nutritional value ('x serves per day will provide your daily requirement of nutrient y') and about the role of nutrients in health ('nutrient y does z in the body'), but generally may not make any reference to how the food product can cure or prevent disease. It is possible to imply such messages, however, and leave it up to the consumer to make the link. For

example, marketing material sponsored by dairy food producers may promote the importance of calcium intake for healthy bones and preventing osteoporosis, but milk advertising mentions only the calcium content. Similarly, advertising for beef might compare the iron content of beef with that of other foods, but without ever mentioning anaemia. These advertising messages have influenced consumer purchasing behaviours, resulting in improved sales of the products they are promoting.

Promotion of fast foods

Australians eat, on average, four meals per week that have been prepared outside the home. Many of these meals consist of fast foods. The major multinational fast food companies devote a large part of their huge annual promotional budget to advertising in the mass media.

Impact of lifestyle on nutritional health

Lifestyle choices play a significant role in determining the health status of individuals. Some of the factors that affect health have been discussed in chapter 2. In addition to these, exercise behaviour and alcohol consumption also contribute to the health status of the individual.

Exercise and nutritional status

As we saw in chapter 7, the energy intake obtained from the diet must be balanced with energy expenditure. An excessive energy intake, or inadequate activity, will result in the body storing the excess energy and gaining weight. If this continues, an individual could become overweight or even obese. But exercise is not just for weight control: it helps to maintain wellbeing in other ways too. Keeping fit, keeping muscles firm and strong, and feeling positive and alert are all benefits of exercise that can be enjoyed at any weight.

Over the last century, Australians' activity level has decreased dramatically. One hundred years ago, it was quite common for school students to help chop all the firewood for the day's needs before walking for an hour to school! Many of the jobs available were high-intensity physical jobs with long work hours, and many of the chores around the house took much more physical effort than is needed today. To clean our clothes we no longer need to light a fire to heat the washing water, or stir the clothes in the tub by hand. Machines perform many of the manual jobs both in the home and at work. Improvements in technology mean that leisure activities are more passive too, with television and computers providing after-school activities to replace bike-riding and tree-climbing. All of these changes mean that Australians now have a sedentary lifestyle and many people do no exercise at all, missing out on the health benefits and increasing their risk of weight gain and lifestyle-related diseases.

While exercise is good for us, too much exercise can be harmful. Extreme levels of exercise can damage skeletal joints, deplete iron stores, and may increase cancer risk due to the increase in oxidative damage to body cells. Some elite athletes may feel pressure to keep their body weight unrealistically low, which can make nutritional deficiencies much more likely, given their increased requirements for some nutrients. For women, being underweight can also affect hormone levels so that menstruation ceases and the risk of osteoporosis is significantly increased.

Alcohol consumption and nutritional status

Alcohol is toxic to body tissues, damaging the liver, pancreas and brain, but regularly consuming a very small amount of alcohol appears to have some health benefits in adults. (These benefits do not occur if the alcohol is consumed in a larger amount, even if less frequently!) Over-consumption of alcohol contributes to weight gain due to its high energy content, and metabolising the alcohol depletes the body of important nutrients. Heavy drinkers experience a wide variety of serious health problems that can be life-threatening as well as costly to the health care system. There is also a cost to the community, as alcohol can cause a loss of inhibitions which normally maintain acceptable social behaviour, and heavy drinking can be associated with aggression, violent crime, and relationship problems.

Impact of culture and religion on nutritional health

Why do you eat what you eat? Your attitudes to food were established in early childhood, and you carry them with you into adult life. Your food habits reflect your environmental, family and cultural background (discussed in chapter 2). These influences might include:

- your family's food preferences
- food preparation methods used in your home
- the disposable income that your family allocates to food
- historical influences on food practices in your family — for example, making something the way your great-great-grandmother used to make it, or the way it was made in the country your ancestors came from, or the way that your religion specifies it should be done.

Australia is a culturally diverse country, so a wide variety of cultural and religious influences affect our food habits. Food taboos mean that certain foods may be excluded from the diet altogether, not for any nutritional reason but as part of religious tradition. Here are some food taboos that affect the diets of different groups in Australia:

- At Easter, many Christian people avoid eating red meat on Good Friday and may avoid certain foods during the period of Lent leading up to Easter.

- People from Catholic or Orthodox backgrounds may avoid eating red meat on Fridays throughout the year.
- Muslims abstain from food and drink during the daylight hours in the holy month of Ramadan, then celebrate the end of Ramadan with a feast.
- Christmas is celebrated with a feast in countries with a significant Christian background; in some traditions this may occur on Christmas Eve instead.
- Seventh Day Adventists and many Buddhists follow a vegetarian diet.
- Hindus may avoid beef and beef products.
- Jewish and Muslim people avoid pork and pig products, and will eat animal products only when the animals have been killed in a special way.
- Jewish people avoid shellfish.
- Some Jewish people avoid eating dairy foods at the same meal as meat products.
- Muslims, Seventh Day Adventists, and many Buddhists and Hindus avoid alcohol.

Social practices affecting nutritional status

People are social beings, and many of our social gatherings revolve around food. Sharing a meal can symbolise harmony and friendliness, and is a way of expressing hospitality and caring. Particular foods are often viewed as appropriate for certain types of social occasion, and the choice of foods and beverages will reflect the cultural practices of the group. Examples include:

- a children's birthday party
- an adults' dinner party
- after-work drinks
- dinner at a restaurant
- a casual meeting for coffee in a café
- a family celebration.

There may be nutritional benefits from recent changes in what is considered appropriate foods for a barbecue. Beer, steak and sausages are part of the stereotypical Aussie barbecue, but there is an increasing trend towards fish and seafood, chicken, vegetables, and a variety of different accompaniments.

The choice of menu will affect the nutritional value of the meal. Gradual changes in cultural practices can have positive effects. For example, a trend towards the use of seafood or vegetables at barbecues may result in decreased consumption of saturated fat. Celebrating Christmas with cold seafood dishes instead of the traditional heavy roast meal is another example. Adopting food practices from other cultures may also be beneficial. The popularity of the 'Mediterranean Diet' idea in Australia is an example of one tradition having a nutritionally positive influence on another.

REVIEW QUESTIONS

Remember

1. List two harmful effects of extreme exercising.
2. What sorts of claims are food products permitted to include on their labels?

Apply

3. How does advertising shape the food attitudes of teenagers? Give some examples from your own experience.
4. Compare and contrast some typical ingredients and cooking methods used by people from two of the following backgrounds:
   - **a)** Indonesian
   - **b)** Greek
   - **c)** Indian
   - **d)** Chilean.

Do an activity

5. Find five foods that carry a nutritional claim on their packaging. Write down the name of each food and the claim made.
   - **a)** Describe the likely nutritional benefits of each product.
   - **b)** Why do you think the food manufacturer selected that particular claim to use on the label?
   - **c)** Select one of the claims and survey ten different people about their interpretation of what the claim means. Is there significant variation in how consumers interpret a claim? What does this mean for the food manufacturer?

6. Conduct a survey to determine which of the following are viewed as being a 'health food'. As a class, suggest possible explanations for the survey respondents' perceptions.
   - **a)** tofu
   - **b)** wholemeal bread
   - **c)** sugar-free lollies
   - **d)** carob bars
   - **e)** soy and linseed bread
   - **f)** a fresh apple
   - **g)** cholesterol-reduced potato chips
   - **h)** baked beans
   - **i)** reduced-salt crispbread
   - **j)** skim milk

CASE STUDY

McDonald's

McDonald's is a highly successful company, both in Australia and internationally, and many of its advertising practices are also used by other large fast food chains. McDonald's promotional activities target children and their parents using different strategies, sometimes within the same advertisement. Young children have been successfully targeted through the use of bait advertising — that is, the association of McDonald's with the release of merchandise from popular children's films. A range of toys may be released, usually with a different one becoming available each week, with the message 'collect them all!' This practice encourages repeat visits, and promotes product and company loyalty. Cheap family meal deals and children's birthday parties are consistent promotions which are attractive to both parents and children.

McDonald's television advertising is run during children's television programs, and features fun characters in bright settings, almost indistinguishable from those used in some of the programs themselves. By targeting children at a young age, McDonald's is attempting to develop a lifelong company loyalty.

McDonald's television advertising targets other age groups, by featuring busy parents able to relax at McDonald's, young workers buying a quick breakfast at the drive-through, teenagers enjoying it as a fun place to eat with friends, and even older people enjoying an inexpensive treat. The food is presented as fresh, appealing and even healthy; and the restaurants look clean and bright.

Fast foods rarely look as they do in the advertising, which aims to convey a healthy, fresh image.

McDonald's has saturated the marketplace with images of its products and its company logo. Its marketing tools include:

- distinctive product names (especially those using the 'Mc' prefix)
- product placement in popular films
- sponsorship of children's activities and charity events
- McDonald's outlets within children's hospitals and near schools
- sponsorship of sport — so that the company name or logo appears on signage around the sports ground or on uniforms or balls
- advertising during television coverage of major sports events like football finals
- roadside billboards, and signs on street seating and waste bins, indicating the distance and direction to the next McDonald's restaurant
- the large M logo outside each restaurant, placed high enough to be visible from a distance
- Ronald McDonald clown appearing in person at shopping centres and children's events.

A key element of McDonald's approach has been the attempt to respond to changing consumer demand as mentioned in chapter 16 (see the newspaper article on page 296). Despite these changes, it is consistency and familiarity that form the core of McDonald's efforts to encourage company loyalty. Customers are assured of familiar surroundings and good hygiene standards, and a Big Mac will generally look and taste the same whether it is purchased in Alice Springs, Bondi Beach or Lithgow.

OUTCOME TASK | **REPORT**

Students learn to:

- describe the relationship between nutrient intake and dietary disorders
- explain how advertising may influence attitudes towards foods and body image.

Contributes to the following outcomes:

- evaluates the relationship between food, its production, consumption, promotion and health
- independently investigates contemporary nutrition issues
- develops, realises and evaluates solutions for a range of food situations.

Carefully consider the article above. Remember that this is not just a comprehension task; use the stimulus material along with your knowledge of *food marketing and its effects on eating habits* to complete the tasks ahead.

1. Is it possible to obtain a healthy diet by eating only fast food?
2. Can fast food companies be held responsible for the recent increase in obesity and nutrition-related diseases? Does fast food marketing encourage over-consumption of unhealthy food?
3. Using the internet, prepare a report on the ways in which another major fast food company promotes its products. How are its marketing strategies similar to and different from the McDonald's strategies?
4. Describe the media campaign for a food product aimed at children — for example, Milky Way chocolate bars advertised on afternoon television. Identify the two main messages of the campaign. In a one-page essay, use your knowledge of nutrition to discuss the ethics of these messages.

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Additional case study

Weblink

CHAPTER 19 SUMMARY

- Nutritional status is affected by many different factors.
- Heredity plays a part in an individual's risk of different nutrition-related conditions.
- Food allergies and intolerances are closely related to both heredity and food intake.
- A food allergy is an immune system reaction to a food protein, even in a tiny trace amount.
- A food intolerance is a reaction to one or more food chemicals, when the amount in the body reaches a certain level that exceeds an individual's tolerance.
- Food allergies and intolerances may sometimes have similar symptoms, but their diagnosis and management are very different.
- Another influence on nutrition is the way in which food products are promoted in the media.
- Lifestyle behaviours also have an impact on nutritional status.
- An individual's family, community and religious traditions influence food and lifestyle behaviours.

KEY TERMS

adverse reactions
allergen
amines
antibodies
coeliac disease
elimination diet
food allergy
food challenge
food intolerance
Food Standards Code
functional foods
glutamates
gluten
lactose intolerance
line extensions
milk allergy
salicylates

HSC PRACTICE EXAM QUESTIONS

Multiple choice questions

1. Which of the following groups of foods have a low pH level?
   - **a)** Lemons, oranges, apples and cherries
   - **b)** Carrot, sweet corn, peppers and pickled vegetables
   - **c)** Mangos, tomatoes, bananas and seafood
   - **d)** Lemons, mushrooms, garlic and pears
2. Why does the issue of mandatory food fortification provoke debate?
   - **a)** Because public health cannot be improved through fortification.
   - **b)** The process of fortification is very expensive.
   - **c)** Mandatory fortification takes away the individual's choice.
   - **d)** Food fortification of any kind alters the taste of the food.
3. Organic farming
   - **a)** produces food more cheaply and profitably
   - **b)** produces food that has a low demand in today's market
   - **c)** has a negative effect on the environment
   - **d)** has lower yields than conventional farming.
4. What is food inequality?
   - **a)** Unevenly balanced pH levels
   - **b)** An unbalanced diet
   - **c)** The difference in food availability between developing and developed nations
   - **d)** The inability to access education and information on nutrition in developing nations

Short structured items

1. **a)** Explain the difference between overweight and obesity, describing the effects of each.
   b) Choose a group within the Australian population that has particular nutritional needs. Describe three nutrition strategies that could help to improve the health status of this group.
2. Heart disease is the leading nutrition-related cause of death in Australia.
   - **a)** What are the physical effects of this condition?
   - **b)** How does heart disease increase economic costs?
   - **c)** What are the nutritional factors that lead to the high incidence of heart disease in Australia? Describe each factor.
3. **a)** Explain the difference between functional foods and nutritionally modified foods, giving examples of each.
   b) What are the three categories of functional foods? Describe each category.
4. **a)** What are anti-oxidants and how do they assist in reducing cardiovascular disease?
   b) Name four vitamins and minerals commonly used in food fortification. Which foods would be suitable for fortification for each of them?
5. The Australian population is very diverse.
   - **a)** What are two social practices that negatively influence the nutritional status of Australians? Describe each practice.
   - **b)** For each of these two social practices, suggest a strategy that might help to promote better nutritional health. What barriers might prevent the successful implementation of your idea?

Extended response items

1. Discuss how diet and lifestyle choices contribute to the development of malnutrition conditions.
2. Discuss the role of dietary supplements in the Australian diet.
3. Discuss how an individual's food selection can be influenced by the food industry, the government and community groups.
4. Evaluate the impact of media and advertising on consumer perceptions of 'health' foods and 'fast' foods.
5. Discuss the impact of increased food availability on the incidence of conditions of overnutrition.

GLOSSARY

absolute poverty occurs when individuals are unable to afford the basic needs of food, clothing and shelter

active non-nutrients substances that are not necessarily essential in the diet, but can enhance the functioning of the body or contribute to the promotion of good health

active packaging food packaging designed to modify the atmosphere within the package in order to increase the product's shelf-life

adipose tissue the body tissue that contains fat. It consists of connective tissue filled with large numbers of fat cells. If the body gains or loses fat, the number of fat cells stays the same, but the amount of fat in each cell changes.

adverse reactions an unexpected response or effect as a result of consuming a substance. The consequences may be trivial, but sometimes they can be extremely serious, even life-threatening.

advisory group group responsible for advising and guiding governments in the development of policy and legislation

aeration the process of adding air to a substance

ageing process allows natural enzymes to break down the tough connective tissue in meats and for water to evaporate, leading to a more concentrated flavour

agriculture the cultivation of land to produce food and fibre

agri-food chain the production and supply of food for the consumer

allergen a protein that the body identifies as foreign, promoting an immune system response

amines a group of chemicals produced when protein foods are aged, fermented or start to break down. High levels are found in cheeses, processed meats, beer and wines, meat and fish pastes, yeast extracts, chocolate, and some fruits (bananas, tomatoes, avocadoes).

amino acids the molecules that form the basic building blocks of protein

amino group the NH_2 part of an amino acid

amylase the enzyme that triggers digestion of starch

anabolism the process by which new molecules are built up in the body. An example is when new body tissues are formed during recovery from injury, which involves anabolism as new proteins are built to repair and replace the damaged body tissues.

anaemia a diet-related deficiency disorder resulting either from a diet that is low in iron, or from iron loss (for example, due to blood loss or heavy menstruation)

angina pectoris pain in the centre of the chest, occurring during physical activity and ceasing at rest; caused by the narrowing of coronary arteries, which prevent the heart receiving enough blood when exercise increases demand

anorexia nervosa a psychological disorder characterised by self-induced starvation and life-threatening weight loss

antibodies proteins that circulate in the blood to combat bacteria, viruses and other toxins

anti-inflammatory anything that tends to reduce inflammation (swelling, redness, heat and pain in body tissues). Inflammation is normally part of a controlled process that fights infection and helps damaged tissue heal. When this control is lost, it can contribute to processes that are harmful to the body, such as cardiovascular disease. Anti-inflammatory processes may help to restore this control.

antioxidant a chemical that stops oxidation, preventing oxidative damage in the body or, in food, preventing fats and oils from becoming rancid

appetite the desire for food, even when the body does not feel hunger

aquaculture the production of plants or animals in water

aroma odour given off by food

ascorbic acid the chemical name given to vitamin C

aseptic sterile

astringency the characteristic that produces a puckered sensation in the mouth

atherosclerosis a condition that results from the deposition of fats and fibrous materials along the walls of blood vessels

athlete food food and drinks specially designed for nutrient needs of specific athletic events

atomiser processing equipment that reduces a liquid product to a fine spray

ATP (adenosine triphosphate) a molecule that all living organisms have. This molecule is the main source of usable energy for the activities of the cells.

audit a review and examination of records and activities by an independent party to assess whether set procedures have been adhered to

Australian Quarantine and Inspection Service (AQIS) a government body whose main role is to protect Australia's agriculture and environment from exotic pests and diseases

automated tasks that are done by machines instead of manual labour

automation a method of production that relies on mechanical or electronic technologies as a replacement for human labour

bacteria small single-celled micro-organisms

bacterial culture in cheese making this refers to the lactic acid bacteria that change the milk sugar to lactic acid. The acid inhibits undesirable types of bacteria from forming and assists in the removal of water from the curd.

bait advertising advertising a product at a price to attract a customer while intending to supply a more expensive product instead

ballast water water that is carried on board a ship to stabilise it. There is concern about marine organisms in the water that could harm the environment when pumped out.

basal metabolic rate (BMR) the minimum amount of energy that your body needs to maintain normal body processes. BMR is measured when you are lying awake (but totally relaxed and still), in a comfortably warm room, having not eaten for 10 to 12 hours. BMR is your lowest energy expenditure while awake.

bile a digestive liquid produced in the liver that aids in digestion by acting as a detergent to emulsify lipids

biochemical natural changes that occur in food

biodegradable able to be broken down by the action of living organisms such as bacteria

blanching process of immersing in boiling water

boom occurs in the economic cycle when consumers have more money to spend, can eat at better restaurants and try new products

break-even point the sale price of a product that covers all expenses related to its development, production, promotion, storage and transport, and the amount of product that needs to be sold in order to reach this point

bulimia nervosa a psychological disorder characterised by binge eating. Self-induced vomiting, laxative misuse or extreme

exercising are often used to compensate for the foods eaten during the binge eating episode.

bush food parts of plants and animals native to Australia that can be eaten

butyric acid a short-chain fatty acid that can be used as fuel by the cells lining the intestine; can be produced from fibre, by the action of bacteria found in the gut

carbohydrate one of the main nutrients needed by the body, providing energy and fibre

carboxyl group the acid part of the amino acid molecule, written as COOH

carotenoids chemicals that contribute to the yellow, orange and some red colours of fruit and vegetables

cash crops crops grown for money as opposed to being grown to feed the grower

catabolism the process by which complex molecules in the body are broken down to their components, usually for energy or to make other substances. Starvation is an example of catabolism, where muscles are broken down to produce energy. Food nutrients are also catabolised after we eat them, to release the substances that your body needs.

catalyst a substance that helps a chemical reaction to occur

cellulose a polysaccharide of glucose that cannot be digested by the human body. It forms part of the structure of plants.

central obesity a condition of obesity where the excess adipose tissue is predominantly distributed around the abdomen. This is associated with a higher risk of health problems as fat tends also to be deposited around the organs.

centrifuge equipment in which a product is separated into particles of different weights by the use of a spinning bowl

cereals edible grain from grasses; for example, wheat, oats, rye, rice

cholesterol a lipid of the sterol family that is produced only by animals. High levels of cholesterol in the blood have been linked to heart disease.

chyle a bodily fluid (looks milky) formed in the small intestine during digestion

chyme the mixture of partly digested food and digestive juices that is produced in the stomach

coagulation when a protein separates from other nutrients and turns from a liquid to a solid

code of practice a set of written operating requirements for specified activities

Codex Alimentarius (Latin for 'food code' or 'food book') an internationally recognised standard that includes codes of practice, guidelines and other recommendations relating to foods, food production and food safety

coeliac disease an allergy to gluten

colon cancer cancer of the lining of the colon

colostrum the first fluid that is produced by the breast for feeding a newborn infant. It is a sticky, yellow liquid, high in protein, minerals and antibodies.

Commonwealth Scientific Research and Industrial Organisation (CSIRO) a government group that undertakes significant research in several areas, including the food industry

competitive pricing a marketing approach in which the price a manufacturer charges for a food product is set below that of competitor products in order to facilitate entry into a market for the new product

complementary protein incomplete protein sources that can be combined to ensure that all essential amino acids are present in the correct proportions

complete protein protein that provides the essential amino acids in a ratio that meets human requirements

composite packages packaging made from two or more different packaging material types which are fused together in a single unit and cannot be separated by the consumer

conduction the food or its cooking container comes into direct contact with a hot surface

constipation the condition in which the faeces are hard, dry and difficult to pass

continuous flow a production process whereby one item at a time is produced (or a small batch of items) using processing steps that are non-stop

contraction occurs in the economic cycle with similar but less severe effects to those during periods of recession

convection food is heated by the hot air or liquid moving around the food

core temperature the internal temperature of a food item

corporate nutrition policy sets out the nutritional strategies the company will use when developing food products, conducting research and development and marketing to the consumer

cross-contamination the process in which micro-organisms pass from one food to another, usually from raw food to cooked food

crush fractures fractures that occur when the bones lose the ability to support the weight of the body as a result of weakened bone structure

crustacean class of anthropods that have hard-shelled bodies such as lobsters, shrimps and crabs

crystallisation formation of solid crystals that occurs when a very concentrated (supersaturated) sugar solution cools

death phase the point at which bacteria start to die due to lack of food

defaecation the process of expelling faeces

dehydration removal of water from the tissues of an organism

denaturation occurs when the helix structure of the protein breaks apart

dental caries tooth decay

dentine the hard body tissue that forms the main body of the tooth, through which run the nerves and blood vessels of the tooth

descriptive test a test based on words that are selected by the tester to best describe or explain various attributes of food

descriptive words group of words describing the range of a particular characteristic

design brief a simple statement of the task to be done which indicates the constraints under which the product designer must work; that is, what consumers want and how much they are willing to pay for it

dextrin the half-way stage in the breakdown of starch to glucose

dextrinisation the process in which starch breaks down into dextrins

diabetes a condition in which the body is unable to control the level of glucose in the blood. See also type 1 or type 2 diabetes.

diastolic pressure the blood pressure when the heart is at rest between pumps

difference testing sensory testing to determine differences between products
digestion process where food is converted to substances that can be absorbed by the body
disaccharides sugars (sucrose, lactose and maltose) that are composed of two monosaccharides joined together
distribution involves transport, handling and storage of food products from the manufacturer's facility to the point of sale
diverticulitis a disease of the colon where small pockets develop in the bowel wall due to high pressure (for example, when fibre intake is inadequate)
dry-heat cooking cooking by applying heat directly to a food
duo-trio test a test where two samples are assessed against a known sample that acts as a control

economies of scale the efficiencies that can be gained from operating on a large rather than small scale; for example, buying products in bulk may be cheaper
elimination diet a specific food pattern that is used to determine food intolerances. It contains a narrow selection of foods that are unlikely to cause reactions. Challenges are introduced one by one.
embargo a ban placed on the importation of a particular product
emulsifier a substance that has an attraction for both lipids and water. Emulsifiers cause stable mixtures to form.
emulsify to form a stable mixture of water and fat
emulsion a stable lipid and water combination
environmental health officer (EHO) a person usually employed by local government or state health authority to advise on and enforce public health
enzyme chemical substance that acts as a catalyst
enzymic browning takes place when the enzymes in fruit and vegetables react with oxygen, producing a brown colour on the surface of the food
essential amino acids proteins are made up of chemicals called amino acids of which there are 20 that the body requires to function properly. There are eight amino acids (called essential amino acids) that cannot be made by the body and must be obtained from foods.
ethylene gas gas that promotes the ripening of fruit
exclusive distribution occurs when a product is sold at only a few retail outlets. Such products may be expensive, specialty or luxury items.
expansion occurs when the economy grows in terms of production, employment opportunities and introduction of new products. Levels of prosperity increase and more items, including higher value foods, become accessible to consumers.
external factors include economic, political, ecological and technological issues that affect food product development. They are also referred to as the macro-environment and are often beyond the manufacturer's control.
extortion illegal use of force or threats to receive property or money
extrusion a method of processing where a viscous liquid is forced through a narrow opening and becomes a solid in the shape of the opening

faeces the wastes of digestion that are excreted via the anus
fatty acids carbon chains that join with glycerol to form lipids
feasibility study undertaken to establish whether an idea will be profitable; includes financial and technical feasibility
fermentation process by which alcohol or acid is produced through the action of micro-organisms
fibrous proteins proteins that have a long, string-like shape
filtration the process of passing a liquid through a filter to remove any solid particles
fisheries the cultivation of various aquatic species for commercial or scientific purposes
flavonoids two groups of chemicals (anthocyanins and anthoxanthins) that contribute to the colours of fruits and vegetables
flavour sensory message resulting from the taste and aroma of food in the mouth
foam formed when air is beaten into a liquid
food additive any substance added to a food, not normally consumed as a food by itself and not normally used as a typical ingredient of food
food allergy an immune reaction to a protein in food that the body identifies as foreign
food-borne illness disease/condition transmitted through ingestion of food that is contaminated with harmful micro-organisms or chemicals
food challenge after following an elimination diet, the reintroduction into the diet of substances suspected of causing a food allergy or intolerance
food intolerance a personal response to a specific chemical or group of chemicals found in food, such as salicylates, amines or glutamates. The response may be similar to that of a food allergy but does not involve the immune system.
food miles distance that food travels from when it is produced till it meets the consumer
food processing/manufacturing turning raw food into different food products
food profile combination of the ranking of groups of descriptive words
food safety program a written document that identifies all food safety hazards in a food business, the arrangements to control each hazard and the monitoring and supervision of the controls
food spoilage food that has deteriorated
Food Standards Australia New Zealand (FSANZ) an independent statutory agency that works with the government to achieve a safe food supply by developing food standards and codes of practice, and standardising food law
Food Standards Code (also referred to as 'the Code') sets out conditions that must be met before food is sold. The Code was developed and is maintained by FSANZ in partnership with the governments of Australia and New Zealand.
food stylist a person who styles food artfully for display
fortified foods foods whose nutritional content has been increased by the addition of more of the vitamins and minerals they already contain
free radicals very reactive substances that can promote a chemical reaction on their own. Free radicals inside the body can cause oxidative damage.
free range eggs eggs from hens that are allowed to remain in the open some of the time rather than being kept constantly in battery cages
free trade agreement an agreement between countries to trade without the use of trade barriers such as tariffs, subsidies and embargoes
freezer burn discoloured patches of grey/white on frozen food caused by water evaporating into the package's air spaces

functional foods various definitions exist but, broadly, it is taken to mean foods that surpass the basic nutrients found in foods that have proven health benefits

garnishing an addition to food to improve its aesthetic appearance
gel an elastic solid that can be formed when protein, starch or pectin surrounds small droplets of water
gelatinisation the process that starch goes through as it absorbs water in the presence of heat, resulting in the thickening of the liquid
gelation the process of forming a gel
generic brands a basic product sold under the label of a large retailer e.g. Home Brand is Woolworth's generic brand
genetic engineering involves incorporation of genetic material from one organism into another to develop living organisms with more desirable characteristics
genetically modified describes a food that contains material derived from an organism that has had its genetic material altered in some way other than by conventional breeding
globalisation the interdependence of people throughout the world; the breaking down of barriers to create a unified global community
globular proteins proteins that have a three-dimensional shape. They often appear round, like a globe.
glutamates chemicals involving the amino acid glutamate, found naturally in all plants and animals. Free glutamate gives foods a savoury flavour and is found naturally in mushrooms, tomatoes, cheeses, soy sauce and meat extracts. Also available as a salt, monosodium glutamate (MSG) is used in many processed foods and some cuisines as a flavour enhancer.
gluten a type of protein found in grains that will stretch and form the structure of a flour product
glycaemic index (GI) an index of foods given a GI value according to their effect on the blood glucose level. High GI foods release a large amount of glucose quickly, causing a large fluctuation in the blood glucose level. Low GI foods have a slower release, causing less disturbance.
glycerol a three-carbon chain that forms the backbone of triglyceride fats
glycogen a polysaccharide of glucose, found in the liver and muscles. It is the main store of glucose in the body.
gross domestic product the value of all goods and services produced within a nation in a given year
gut flora the bacteria that live in the gut

haem iron the kind of iron found in the blood and in animal foods. It is easily absorbed in the gut.
haemorrhoids protruding varicose-like veins in the anus that can result from constipation
Hazard Analysis Critical Control Point (HACCP) systematic method for identifying, monitoring, and controlling hazards
head space the small amount of space left in all cans and other containers to allow for expansion of the product during heating
heat exchanger a device that transfers heat efficiently from one medium to another
hedonic scale pleasure scale for rating food characteristics
helix a shape similar to a spiral
hiatus hernia a condition that occurs when part of the stomach is forced up through the small space in the diaphragm where the oesophagus passes through
high-density lipoproteins (HDLs) lipoproteins that bind to cholesterol and help to remove them from the body, reducing deposition in the blood vessels
home meal replacements (HMR) food products not prepared in the home
homogenisation the process in which the size of the fat globules is reduced to small, uniform particles, which are then distributed evenly throughout the liquid
hopper cylindrical-shaped container with a funnel at its base
hormones protein messengers produced by the body
hunger a feeling of emptiness, weakness or pain caused by a lack of food
hydrogenation the treatment of unsaturated fatty acids that breaks double bonds between adjoining carbon atoms in a carbon chain. This results in a saturated fatty acid.
hydroponics a method for growing plants in nutrient solutions rather than in the ground with irrigation
hyperglycaemia abnormally high blood glucose level
hypertension high blood pressure
hypoglycaemia inadequate blood-glucose levels
hypothalamus a small gland at the base of the brain that regulates hunger, thirst, sleep and the release of some hormones

incomplete protein protein that does not provide the essential amino acids in a ratio that meets human requirements
inert chemically inactive material
insoluble fibre fibre that remains mostly unchanged as it passes through the gut. It helps to increase the bulk of the stool and speed up its passage through the body, reducing the chance of cell damage occurring from harmful substances in the stool.
insulin resistant the condition in which body cells do not respond to insulin even though adequate amounts of insulin are present; may result in even higher levels of insulin being released, high blood glucose, and abnormal metabolism of body fuels
intensive distribution for products which are sold at every possible retail outlet
internal factors include personnel expertise, production facilities, financial position and company image which impact on food product development. They are also referred to as the micro-environment and are within the manufacturer's control.
isoflavonoids chemical substances that have phyto-oestrogen qualities. They are found in fruits, vegetables, and legumes.

lactation production of breast milk for feeding an infant
lacto-ovo-vegetarian a person who eats a diet based on plant foods but which also contains dairy products and eggs
lactose intolerance a condition that results when an individual has some degree of difficulty in digesting lactose
lacto-vegetarian a person who eats a diet based on plant foods but which also contains dairy products
lag phase the time required for bacteria in contaminated food to become adjusted to their new environment
laminated process of combining two or more layers of material to form packaging. The layers are held together by an adhesive or heat bonding.
laxative a substance that promotes gut function, either by stimulating the gut muscles to contract, or by bulking or softening the gut contents to help the stool pass more easily and quickly through the gut
legislation a law passed by government that describes what is legal in specific situations

legumes seeds (peas, beans, lentils) that provide the best sources of plant protein

lignans chemical substances that have phyto-oestrogen qualities. They are found in nuts and seeds.

limiting amino acid the amino acid found in shortest supply in a particular incomplete protein food

line extensions involve relatively minor changes to a company's existing products by incorporation of such features as new flavours, packaging and serving sizes

lipids the general name given to a range of substances that include fats, oils, fatty acids, phospholipids, sterols, glycolipids and waxes. Most of these are not water soluble.

lipoproteins molecules composed of both protein and lipid. They are responsible for carrying lipids through the bloodstream.

logarithmic phase the time during which microbes grow in the ideal conditions on a contaminated food

low-density lipoproteins (LDLs) lipoproteins that deposit cholesterol along the walls of blood vessels

macro-environment broad external environment that influences a company and is largely out of the company's control, such as the level of interest rates

macronutrients the nutrients we need in large amounts, which are sources of energy. These are the proteins, lipids and carbohydrates.

Maillard reaction the browning that occurs when a protein and sugar are heated

malnutrition a condition that occurs when one or more nutrients are not present in the correct amounts in the diet

marbling deposit of fat within muscle fibres

market economy an economic system in which the producer decides what and how much to produce, as well as how much to charge based on consumer demand. The supply of products is based on the demand for them. Government involvement is limited to fair trading rather than tight control.

market segments categorise Australian consumers into different groups by criteria including age, economic status and cultural tradition

marketing mix refers to the four 'Ps'. It is the overall plan to market a new food product. It consists of product planning, price structure, placement for distribution and promotion.

marketing plan expresses a company's objectives in marketing terms; that is, how to maximise sales, improve customer satisfaction and quality aspects of a food product

marketing process relates to marketing strategies used to facilitate the market launch of new food products

marketplace the location where goods are presented to consumers for sale

mastication the mechanical breakdown of food using the teeth (chewing)

menopause the stage in a woman's life when she ceases to be fertile, most commonly between the ages of 45 and 55 years. The balance of hormones changes, the ovaries no longer produce eggs and menstruation ceases.

metabolise process of changing energy sources (e.g. food) into energy

metabolism refers to all the different chemical processes in your body where substances are broken down or built up or when energy is consumed or released. Metabolism is involved every time nutrients are released, used or stored.

me-too products direct copies, or minor modifications, of existing products

microbial a tiny life form

micro-environment the internal environment that influences a company and its ability to meet customer needs. The micro-environment is made up of forces that are within the company's control such as the level of staff training or the sophistication of production facilities.

micronutrients the nutrients we need in only small amounts. These are the vitamins and minerals.

military food specially designed to be carried by soldiers in their ration packs for consumption during active service

milk allergy an adverse response by the immune system to milk protein in the diet

mission statement the broad, long-term business goals of a company

modified atmosphere packaging (MAP) occurs when either the starting atmosphere surrounding food is controlled and the packaging is inert or the packaging material itself controls the movement of gases from inside and outside of the package

moist-heat cooking cooking by using liquid to apply heat to a food

monosaccharides the simplest of all sugars (glucose, galactose, and fructose), which combine to make other sugars and starches. All have the chemical formula $C_6H_{12}O_6$.

monounsaturated a fatty acid that has one double bond

mouth feel texture perceived in the mouth

multinationals large companies whose businesses and operations are spread around the world

multi-skilled refers to the provision of training and experience which will allow employees to perform a range of different tasks

mycotoxins toxic chemicals produced by certain mould species

natural toxins found in various foods such as potatoes and some types of beans. Some seafood may contain natural toxins at an unsafe level.

new-to-the-world products completely new and different products that have not been on the market before

niche market a section of a market that is usually quite small and with specific needs

non-essential amino acid an amino acid that the body can make itself

non-haem iron the kind of iron found in plant foods. It is not absorbed as easily as haem iron.

non-perishable foods that can be expected to last over a year, if stored appropriately

nutrition the scientific study of food consumption and the use of nutrients in the body

nutrition panel a table appearing on a label outlining the nutritive value of the food per serving and per 100 grams. Nutrition panels must list numerical values for energy, protein, fat, carbohydrates (total and sugars), sodium, potassium and any other nutrient that is mentioned in a nutrition claim.

nutritionally modified foods foods that have been changed to improve their nutritional qualities, either by adding some component (such as vitamins, minerals, fibre, active non-nutrients) or by removing or reducing some component (such as fat, sugar, sodium)

obese when an individual's weight is excessive, sufficient to cause significant health problems; usually defined as 20 per cent above a healthy weight range

occupational health and safety (OH&S) legislation and committees set up in the workplace to ensure that the working environment is safe
oestrogen a female sex hormone
offal organ meats from animals that are eaten; for example, beef liver
omega-3 see omega-3 fatty acids definition
omega-3 fatty acids unsaturated fatty acids that have their first double bond between the third and fourth carbon on the chain
omega-6 name for a family of polyunsaturated fatty acids
opportunities indicate whether there is a market for the new product
organic farming agricultural production system with limited or no use of synthetic pesticides and fertilisers
osteomalacia a sign of vitamin D deficiency in adults, in which bones soften, resulting in bone pain and increased risk of fracture
osteoporosis literally means 'porous bones'. This disease occurs when calcium is lost from bones, resulting in a weak bone structure.
outbreak two or more cases of a similar illness as a result of consuming a contaminated common food
overnutrition a condition which occurs when an individual's diet contains an excess of one or more nutrients
overweight when an individual's weight is greater than ideal for good health; usually defined as 10 to 20 per cent above a healthy weight range

paired test a comparison test where two samples are assessed for a given characteristic; the sample with the higher perceived level of the characteristic is selected
palpitations when the heart beats abnormally quickly
pasteurisation process by which milk is sterilised by holding it at a high temperature for a period of time
pathogenic bacteria micro-organisms capable of causing disease and illness
pectin a polysaccharide found in fruit and some vegetables. It is also used to make jams set.
peers people of a similar age, with similar interests and social status
penetration pricing when a product is priced below that charged for a similar product made by a competitor
peptide bond a bond that holds amino acids together in a polypeptide chain
peptones small chains of amino acids that are formed during digestion in the stomach
perishable foods with a shelf-life of only a few days
peristalsis the rhythmical wave-like motion of the muscles lining the digestive system that moves food through the gut
pH the acidity or alkalinity of a substance, which is measured on a scale from 0–14
phytochemicals non-nutrient plant chemicals that have beneficial effects in the body
phyto-oestrogens a particular group of phytochemicals that are converted by gut bacteria into hormone-like compounds which imitate the hormone oestrogen
plaque a deposit of an undesirable substance. Dental plaque is an insoluble substance secreted by bacteria onto teeth, which is used as a shield while causing tooth decay. Arterial plaque is a fatty, fibrous deposit in the walls of blood vessels, which causes blood vessels to narrow and become blocked, preventing normal blood flow.
policy a strategy developed to address a particular area of concern
polysaccharides a number of monosaccharides joined together
polyunsaturated describes a fatty acid that has more than one double bond
poverty cycle as countries with a subsistence economy struggle to produce enough food, the life expectancy of the population falls because of sickness. Sick people cannot work to produce food, so the cycle of poverty continues.
precursor chemicals that are converted to an active form of a substance
preservatives chemicals added to food to prevent spoiling. These chemicals may change the colour and taste of the food.
price skimming occurs when the price of a new food item is set at a level in excess of that indicated by list price or production and distribution costs
primary market research gathering original data through research methods such as experimentation, consumer surveys, store audits, observations and trade surveys
primary packaging the immediate container or wrapping the product is protected in
private company a company whose shares are not traded publicly
probiotics types of bacteria that are normally found in a healthy human gut, and which are incorporated into foods to provide health benefits
product life cycle traces the growth, stationary and decline phases of a product's sales revenue history
product recall request to return to the maker a batch or an entire production run of a product, usually due to the discovery of safety issues
product specification an accurate and detailed description of what the product will be
production process development the manufacturing processes that will need to change in order for a new product to be manufactured
production run quantity of product manufactured in a certain time period
profiling combining the ranking of groups of descriptive words
prostaglandins hormone-like substances that are involved in many processes in the body, including muscle contraction, blood flow, inflammation, and the immune system
protein one of the main nutrients needed by the body to repair and build cells, produce enzymes and hormones, and which can be used as a source of energy
protocol formal set of rules and descriptions of information
prototype model of a product that can be tested to see if it meets the needs of users of the product
public company a company that is listed on the Australian Stock Exchange. It means that the general public can buy and sell shares in that company.
public relations a means of communicating a favourable company image to the public
publicity providing information about a particular subject (a product for example) in order to make that information known to the general public. Methods of publicity may include issuing media releases, conducting product launches, and creating billboards or posters to increase public exposure.

quality assurance putting processes in place within an organisation to guarantee the standards achieved during processing; part of the total quality management plan of an organisation

quality control conducting tests to check the standards of raw materials or products before, during or after production
quality management a system to ensure that standards of quality are met
quality of life the level of wellbeing an individual experiences
quarantine activities directed at preventing, or controlling, the introduction and spread of quarantine pests and diseases

radiation food is cooked by heat waves which bounce off the sides and top of the heating chamber
rancid food that has the unpleasant smell or taste of decomposing oils or fats
ranking arranging samples in order of intensity of a characteristic
raw material any product that goes into the manufacture of another processed good
recession occurs when the economy of a country declines, resulting in less disposable income, lower capacity to pay for goods and services, and decreased employment
referral selling is the practice whereby a consumer is persuaded to buy goods or services on the understanding that they will receive a benefit for referring others to that business or for assisting in the supply of goods or services
relative poverty an inability to afford a standard of living similar to the rest of the community
resource something that is used to achieve a goal
rickets a sign of vitamin D deficiency in children, in which the bones do not harden normally and can become malformed
roux a combination of butter and flour, cooked until it bubbles

salicylates a group of chemicals found in all plant foods, particularly fruit and fruit juices, herbs, spices, nuts and many beverages, as well as being used as preservatives and flavouring additives in food products. Found in toothpaste and aspirin. Also known as benzoates.
sanitary landfill putting non-hazardous waste from the home and industry in natural depressions and quarries with successive layers of waste and soil
satiety a feeling of fullness experienced after eating
saturated fatty acid a fatty acid that has no double bonds
secondary market research investigating what others have done in a certain area
secondary packaging the shrink wrap, carton or bag holding several similar primary packaged items together; also refers to the bulk cartons used by retailers that hold many single items
sedentary describes a low level of physical activity, not involving much movement of the body
selective distribution when a product is sold widely, but not in all retail outlets
self-regulated a business or group of businesses that establish a code of practice that controls their operation
semi-perishable foods that are expected to last for several weeks to a few months
sensory analysis subjective evaluation conducted by using the senses
sensory perception reaction to food based on how the food looks, smells, tastes, feels and sounds when eaten
shelf-life the expected length of time a food will maintain its best quality
shrink wrapping wrapping material that is wrapped around a full load of goods to prevent the goods from slipping or moving
sieving a process which involves shaking powders/loose solids through mesh to separate out larger particles
soluble fibre the type of fibre that dissolves into a gel in water, and can be digested by bacteria in the colon to produce fuel for gut cells
***sous vide* process** a process in which food is cooked, vacuum packed and chilled for later use
space food specifically developed food for consumption by astronauts during space missions
specialised applications refer to situations that require food and beverages with properties different to those required for regular consumers
sphincter a ring-shaped muscle that may be tightened to slow or stop flow through part of the body. For example, the lower oesophageal sphincter prevents upward reflux of stomach contents.
spirulina algae-like bacteria that are high in protein and used to make health-food supplements
spore a structure that is capable of growing into a new organism. For example, bacteria can multiply because of spores that can survive even the harshest of conditions.
staple food food item that is eaten frequently, usually daily, and provides significant amounts of energy in the diet
starch a polysaccharide of glucose that forms the energy stored in plants
stationary phase when the number of microbes on a contaminated food remains constant
status-quo pricing sets the price of a food product at one similar to those of comparable products already on the market
sterilisation process of destroying all living micro-organisms on and in an object
strengths the advantages that a company, or a new product concept, has over its competitors
subjective evaluation assessment of a characteristic based on personal opinion
sublimation to change, when heated, from a solid state to a vapour without going through the liquid stage
subsidy direct aid given to food producers
subsistence agriculture when no surplus food is produced. The food that is produced is shared among the people in the local community.
sustainability in an environmental sense, the ability of ecological systems, including agriculture, industry, forestry and fisheries, to be preserved for future generations
SWOT an acronym of its components: strengths, weaknesses, opportunities and threats
systolic pressure the blood pressure when the heart is pumping the blood

tariff a tax imposed on imported goods
temperature danger zone the temperature range in which pathogens can grow is between 5 °C and 60 °C. Temperatures below the lower limit slow or stop cell growth but the micro-organisms may not die. Temperatures above 60 °C result in rapid cell death.
thermic effect of food (TEF) the energy expended as a result of eating. Energy is used to digest and absorb nutrients from food and convert them for use or storage, generating heat.
threats factors that will disadvantage the success of a company in its new product development and marketplace launch activities
tocopherols the chemical name for vitamin E
trace elements minerals required by the body in tiny amounts
triangular test a test where two of three samples are identical and the other one is to be identified

tuber underground root of a plant such as a potato

turgor refers to the pressure placed on cell walls or membranes by fluids within the cell. For example, crisp vegetables have high turgor and wilted vegetables have lost turgor.

two-out-of-five test a test where two of five samples are identical and these two are to be identified

type 1 diabetes a diabetic condition where the pancreas produces no insulin. Most commonly diagnosed during childhood or adolescence.

type 2 diabetes a diabetic condition where the pancreas produces insufficient insulin, or the cells lack sensitivity to insulin. Often associated with obesity and usually develops in later life.

umami taste sensation that enhances savoury qualities of flavour but does not have a distinct taste itself

undernutrition a condition that occurs when an individual's diet is lacking in one or more nutrients

unit operation a process involved in the transformation of raw materials into manufactured goods; for example, peeling, heating, freezing

unsaturated fatty acids fatty acids that have one or more double bonds

vacuum packing process used in the canning or bottling of foods, in which the air in the head space is removed and a vacuum is put in its place

value added the processing of products so that their selling price is higher than that of the raw materials from which they were made

value adding the processing of goods to increase their selling price

varicose veins a condition in which the valves in the vein have difficulty in closing. The veins stretch and swell with blood.

vegan a person who eats a diet based wholly on plant foods

vegetarian a person who does not eat meat, poultry or fish

viruses micro-organisms that are smaller than bacteria. Unlike bacteria, yeasts and moulds, viruses can only reproduce inside a living host cell and so cannot grow in food or live for very long outside their host.

viscosity the ease with which a liquid pours

vitamins chemical compounds required by the body in small amounts to carry out important activities

water activity (A_w) a relative measure of the amount of water that is not bound in food and is available for micro-organisms to use

weaknesses disadvantages associated with a new product idea for a company considering its introduction to the marketplace

weaning the process of reducing or ceasing breast milk or formula intake as it is replaced by solid foods in the diet

World Trade Organization (WTO) international organisation dealing with the rules of international trade between nations

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