food tech focus

stage 6

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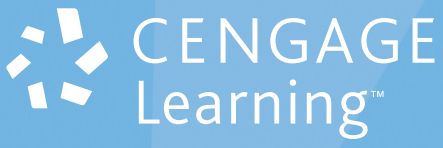

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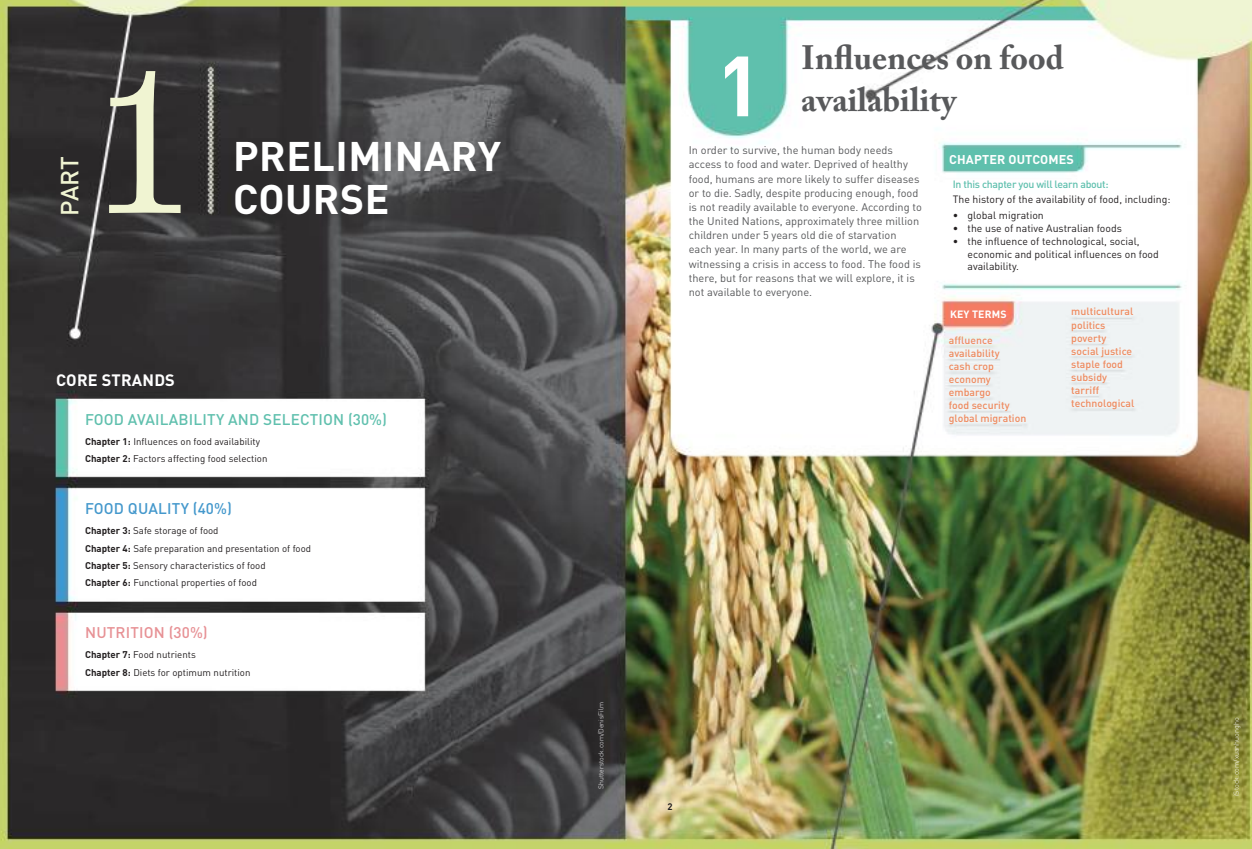
introduction

About this book

Food Tech Focus Stage 6 has been written to meet all the requirements of the New South Wales Stage 6 Food Technology Syllabus. The all-new text is complemented by the contemporary and visually appealing design, logical structure and features that you will recognise from its bestselling Stage 5 sister publication, enhanced to take students to the next level and support success in their HSC exams.

Core strands are colour-coded for both the Preliminary and HSC courses for easy navigation

Chapter openers introduce students to the content for each chapter



Key terms are defined in a detailed glossary at the front of the book

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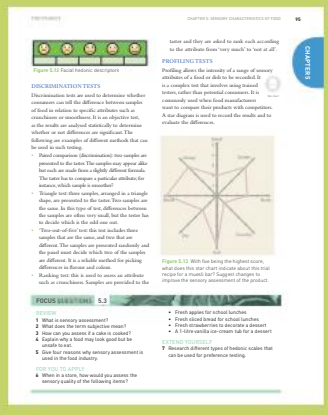
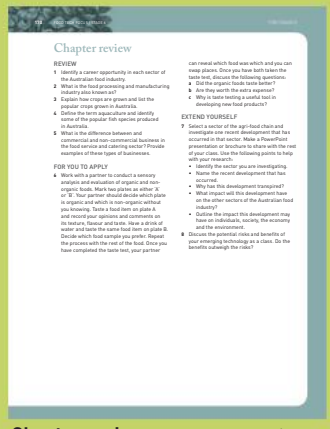


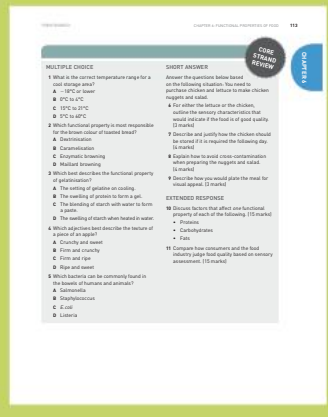
Focus questions provide regular opportunities for students to review, apply and extend their learning.

Food in focus provide industry links and real-world examples to address learning outcomes in a case-study approach. They contain questions to consolidate and extend students' knowledge.

Practical applications tasks are structured to deepen and broaden practical knowledge, preparing students for work and further study.



Chapter reviews appear once at the end of a chapter and provide an additional opportunity for students to review, apply and extend their learning across the entire preceding chapter.



Core strand reviews are HSC-style exams, with multiple-choice, short-answer and extended-response questions. There is one bank of questions for each core strand.

Bringing it all together provides an HSC-style exam with short-answer and extended-response questions from across all the core strands.

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Access to NelsonNet also provides students with additional web-based materials such as worksheets, bonus recipes, videos and study tips.

Weblinks

Students and teachers can link directly to external websites referred to in *Food Tech Focus Stage 6* via the free, unprotected weblinks site located at http://ftf6.nelsonnet.com.au.

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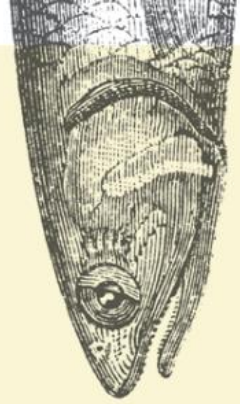
glossary



active non-nutrients substances that, while not necessary in our diet, have added health benefits to enhance optimum body functioning

active packaging packaging that moves beyond just containing a product. It may involve the ability to sense freshness or respond to environmental changes

adipose tissue the body tissue that contains fat; a combination of connective tissue and fat cells, where fat can be stored

adverse reactions unexpected reactions or responses to a particular substance after consumption; they can range from trivial to life-threatening

advisory groups bodies that provide strategic advice to corporations or other organisations

aeration the process of incorporating air into food products to increase the volume and create a light airy texture

affluence great wealth and abundance

agriculture all grown foods, including plants and animals

agri-food chain the process of producing and supplying food for the consumer

allergen a protein found in foods that the body may identify as foreign matter. The immune system responds to this foreign intrusion by attacking the allergen

amenorrhea an abnormal absence of menstruation, possibly caused by malnutrition

amines a group of chemicals produced when proteins are either aged, fermented or start to break down. Foods such as cured meats and cheeses have a high quantity of these chemicals

amino acids the building blocks for all proteins. Proteins consist of various types of these building blocks in different combinations to create a unique protein compound

amylase an enzyme produced in the human body to aid in the digestion of starches and other sugars

anabolism the manufacture of new molecules in the body. The simple components of digested food are used to build new molecules

anorexia nervosa a mental illness and eating disorder involving self-induced weight loss via controlled consumption of food, often little to no food, coupled with rigorous exercise

antibodies a group of proteins present in the blood that combat disease and other toxins

antioxidants chemicals found in plant foods that prevent oxidation; these chemicals prevent oxidative damage within the body as well as preventing fats and oils from turning rancid

aquaculture the production of plants and animals in the water environment

ascorbic acid the chemical name for vitamin C

aseptic sterile or free from contamination

atherogenic diet a diet that is not conducive to good heart health. Such a diet may consist of high-fat or highly processed foods, with too much salt and or sugar, which contributes to hardening of the arteries

atherosclerosis a disease characterised by plaque build-up on the inner walls of the arteries, restricting movement throughout the artery and placing added pressure on the heart muscle

Australian dietary guidelines a set of suggestions for Australians to follow in order to improve their diet and health. The guidelines are formulated from research done by the National Health Medical Research Council

Australian food industry the organised production, processing, storage and marketing of Australian food products

autoimmune disorder a condition where the body makes antibodies to fight its own synthesised proteins. For example, type 1 diabetes is a condition where the body fights the insulin produced by the pancreas, thus making the body insulin deficient

automated when a process or facility has been set up to primarily be operated by automatic equipment

available something that is easily obtainable

bacteria micro-organisms that you cannot see, often known as germs. Some bacteria don't harm humans, but others can make us sick if they multiply in the food we eat

beriberi a disease that causes inflammation of the nerves and heart failure caused by a deficiency of b-group vitamins, especially thiamine

bio-technology the use of biological processes for industrial and other purposes

blanching a cooking method where a food is plunged into boiling water and then refreshed in ice water

Body Mass Index (BMI) a simple index of weight for height that is commonly used to classify underweight, overweight and obesity. It is defined as the weight in kilograms divided by the square of the height in metres (kg/m^2)

bulimia nervosa a mental illness and eating disorder characterised by recurrent binge-eating episodes followed by self-induced vomiting, fasting, over-exercising and/or abuse of laxatives, designed to minimise weight gain that would be otherwise caused by the binge-eating episodes

caramelisation the process that sugars undergo when heated to high temperatures that make them develop a golden brown colour

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carbohydrates compounds made up of carbon, hydrogen and oxygen. They provide most of the energy in the human diet and they are the body's preferred energy source

cardiovascular disease (CVD) a collective term for diseases of the heart and blood vessels. The term commonly includes diseases such as coronary heart disease, heart failure and stroke

cash crop a crop grown to be sold not consumed; for example, coffee, tobacco and cotton

catabolism the process of breaking down complex compounds to more simple components. This is done to release energy or to synthesise other substances required by the body

cholesterol a lipid found in animal products. The human body can also synthesise its own cholesterol. It is linked to cardiovascular disease if high levels are found in the blood

chyme the mixture of partly digested food and digestive juices found in the stomach

coagulation a form of denaturation that occurs when there is a permanent change in the protein from a liquid into thick masses as a result of heat or the addition of acids

coeliac disease when the small intestine is hypersensitive to gluten (a protein), leading to difficulty in digesting foods containing this protein

commercialisation the process of introducing a new product to the market. It involves full-scale production and launch

complete proteins foods that contain all the essential amino acids required by the human body

consumer an individual who buys products or services for personal use

contamination when something that should not be there gets into food. It can make someone sick if they eat it

convergent thinking a systematic and logical way of thinking

coronary heart disease (CHD) a disease in which plaque builds up on the inside of the coronary arteries. These arteries supply oxygen-rich blood to your heart, which can be placed under stress because of plaque build-up

cross-contamination when germs that are in one place, such as on food, benches, hands or equipment, pass to another place, such as another food item

demographic statistical data based on population, such as age, income and level of education

denaturation the permanent structural change of the protein molecules in food

dental caries holes that form in the teeth because of bacterial breakdown of the hard tissues of the teeth (enamel, dentin and cementum), also known as tooth decay or cavities

design brief a written description of the essential characteristics required to develop a new product

dextrinisation the process that occurs when a starch is exposed to dry heat; the starch is broken down to dextrin, resulting in a change in colour to golden brown

dietary supplements products for consumption that contain ingredients intended to add further nutritional value to support the diet

digestion the process of converting food to simpler components in order for the body to absorb and thus use these nutrients

disaccharides the sugars that are made up of two monosaccharides joined together

distribution the spreading of a product to the marketplace ready for purchase

divergent thinking a spontaneous and free-flowing way of thinking

drivers resources, processes or conditions that influence the performance, success and growth of a business

dry-heat cooking a method of cookery whereby direct heat is applied to a food. Some methods include roasting, grilling, baking and frying

economics the study of the production, distribution and consumption of goods and services

economic forces factors that help to determine the competitiveness of the environment in which a business operates. These factors include employment, inflation and government policies

economy all activity related to production, distribution, consumption and trade of goods and services

elimination diet a diet used to identify foods that a person may be intolerant to. All suspected foods are excluded from the diet and then reintroduced one-by-one. Foods are slowly reintroduced to determine what and what cannot be tolerated

embargo when a country partially or completely stops trading with a particular country or group of countries

emulsion a mix of two or more liquids that don't normally combine evenly; for example, water and oil

enzymes protein molecules that help other organic molecules enter into chemical reactions with one another but are themselves unaffected by these reactions

essential amino acids the amino acids found in our food supply that our body cannot manufacture

expenditure the amount of money spent on something

family a fundamental social group typically consisting of one or two parents and their children

fatty acids carbon chains joined with glycerol, which forms lipids

feasibility a study carried out to assess the viability of a new concept in terms of estimated sales, costs and profits

FIFO (first in, first out) a process to make sure old supplies are used before new supplies

flow process chart a pictorial representation of the steps or tasks that make a process that takes a food or object from raw material through to the finished product

food additives substances added to food to improve flavour, appearance or shelf life

food allergy an adverse reaction to a food protein, whereby the body reacts by treating the protein as

foreign matter. The reaction causes various symptoms and can be fatal

food consumption the act of eating or drinking food and beverage products

food handler someone involved in any food activity; for example, preparing, cooking, serving or transporting food

food intolerance (non-allergic food hypersensitivity) an adverse reaction, often delayed, to chemical compounds found in foods, developing symptoms similar to those of a food allergy

food manufacturing equipment tools and machines used to transform raw ingredients into food products

food packaging a way of storing or containing food so that is safe, stable and looks appealing

food poisoning illness caused by eating contaminated food

food preservation the process of treating and handling food to slow down spoilage, loss of quality or nutritional value and to allow food to be stored for longer

food processing/manufacturing the process of turning raw food into different food products

food product development the process of developing a new food product for the market

food retail sector the food business where the consumer can buy processed food products

food safety ensuring that food is safe to eat

food service and catering sector the preparation of foods so they are ready to eat

food security when all people at all times have access to necessary safe, nourishing, culturally appropriate food to sustain a healthy active life

food service and catering sector the food businesses responsible for meals prepared outside the home such as restaurants, hotels, catering operations and many other formats

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 a code set by FSANZ. It lists requirements for foods such as additives, food safety, labelling and genetically modified foods. Enforcement and interpretation is the responsibility of state and territory departments and food agencies

food taboo a prohibition against consuming certain foods. The word 'taboo' refers to something that is sacred or forbidden and it is often linked to religious beliefs

forces the power to have an important effect or influence on someone or something

free trade agreement (FTA) a treaty between two or more countries to create a free trade area where they can trade goods and services without tariffs or other hindrances

freezer burn discoloured patches of grey/white on frozen food caused by water evaporating into the air of a package

functional foods foods that have a potentially positive effect on health beyond basic nutrition. For example, oats are considered a functional food because they contain soluble fibre that can help lower cholesterol levels

functional properties the physical and chemical properties of ingredients that affect food preparation and processing

gelatinisation the process that occurs when starch granules absorb liquid in the presence of heat and thicken the liquid, forming a gel

generic a product that is sold using 'no-name' or nondescript brand based on the type of good. It is generally sold at a lower price than the comparable branded products

genetic engineering a process that involves taking a gene with a desirable characteristic and transferring it to another living organism

global migration the international movement of people from one country to another with the intentions of settling permanently in the new location

globalisation the process of international integration and the breaking down of barriers to make a united global community

gluten a mixture of proteins found in wheat and related grains, including barley, rye and oats

glycerol a three carbon chain that is the backbone of triglyceride lipids

glycogen a polysaccharide that is the main source of energy stores found in the muscle tissue and liver

government a system by which a state or community is run

hazard something that is a risk or danger to people

hazard analysis critical control points (HACCP) a systematic method of identifying, monitoring and controlling hazards

health the state of being free from illness or injury. Complete health also encompasses psychological and spiritual stability

high-temperature/short-time processing (HTST) a method of pasteurising food using very high heat for a short time

hormones substances that act as messengers in the body. They are predominantly made of proteins

hygiene being and keeping clean

hypertension abnormally high blood pressure

incomplete proteins the protein foods in our diet that do not provide the correct ratio of the essential amino acids. In this case, the diet needs to consist of complementary proteins in order to supply all essential amino acids

inflation the rate at which the price level of products and services rises and the value of currency reduces

innovation the creation of something new or different. It may take the form of new processes, products or ideas

intelligent packaging packaging that can sense changes and inform the consumer or food manufacturer

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kilojoule a unit of energy measurement for food. One kilojoule is composed of 1000 joules, 4.2 kilojoules is equivalent to one calorie

kwashiorkor a form of malnutrition caused by protein deficiency in the diet, typically affecting young children in developing nations

labelling the process of attaching a label, which, for food, includes a number of requirements of what should and should not appear

lactation the production of breast milk in order to feed a newborn

lactose intolerance the inability of adults and children to digest lactose, a sugar found in milk and to a lesser extent dairy products, causing side effects

laxative a product taken to improve gut function. The role is to either promote the peristaltic movement of the muscles in the gut or to bulk or soften waste products to make them pass more comfortably. Helps alleviate symptoms caused by constipation

legislation the action or process of making laws, or those laws collectively

levels of operation the scale of food production and degree of mechanisation (automation and computerisation) of different food producers

line extensions the use of an established product brand name for a new item in the same product category. Line extensions occur when a company introduces additional items in the same product range under the same brand name such as new flavours, forms, colours, added ingredients and/or package sizes

lipid the general name given to the fats in our diet. Most of the lipids are not water soluble, and may carry any or all of the vitamins A, D, E and K

macro-environment the major external, uncontrollable factors that influence a business

macro-nutrient a nutrient required in large amounts by the body. These include protein, carbohydrates and lipids. They all supply the body with energy

Maillard reactions occur when a protein and sugar or starch are present in the same mixture and dry heat is applied during baking creating a golden brown

malnourishment a condition that results from eating a diet in which nutrients are either not enough or are too much. A diet, which offers malnourishment, may cause health problems

marasmus a severe under nutrition that causes a child's weight to be significantly low for their age (e.g., below 60 per cent of normal)

market share the percentage of a product's total sales earned by a particular company over a specified time period

marketing promoting a product from the moment of its inception to the point at which customers buy it

marketing mix the basis of a company's marketing plan. Everything they can do to get the customer to buy their product

marketplace a place where people can purchase products. It may be a physical location or an online platform

metabolism the chemical processes that occur in order to maintain life

me too a product designed to be similar to or imitate a product made by another company

micro-environment the major internal, controllable factors that influence a business

micro-nutrients a category of nutrients required in small amounts by our body; namely the vitamin and mineral groups

micro-organism a very small living thing that can only be seen with a microscope, such as bacteria

minerals inorganic elements found in plant and animal sources of food. They are essential to our health and required in small amounts

moist-heat cooking a method of cooking where moisture is used to heat and cook food. Methods include boiling, steaming, poaching and stewing

monosaccharides the simplest of all sugars. If they combine together they will make other sugars or starches. All simple sugars have the chemical formula of $C_6H_{12}O_6$

monounsaturated a fatty acid that has one double bond (mono means one)

mouthfeel the way the food feels against the skin on the inside of the mouth

multiculturalism the coexistence, acceptance, and/or promotion of diverse cultures within a single society

new to the world a completely new food product that has arisen as a result of innovation

niche market a section of a market that is usually quiet small and with specific needs

non-essential amino acids amino acids that can be supplied by food or synthesised by the human body

nutrient density a measure of the content of nutrients within a food in relation to the amount of energy in that food. Some foods are considered more nutrient dense than others

obesity an abnormal accumulation of body fat, usually 20 per cent or more over an individual›s ideal body weight, as measured by BMI. Obesity is associated with an increased risk of illness, disability and death

omega-3 fatty acids unsaturated fatty acids that have a chemical combination where the first double bond is located between the third and fourth carbon on the chain

organic farming farming with minimal use synthetic chemicals and with concern for the whole environment

overeating the over consumption of foods whereby too many kilojoules are consumed for energy expenditure requirements

overweight a condition of being above the desired weight for height ratio as measured by BMI

pathogenic something that causes disease

perishable foods foods that deteriorate quickly

peristalsis the wave-like movement of the muscles in the gastrointestinal tract. These muscle contractions move the substances along the tract

personal hygiene keeping yourself and your clothing clean

pesticides chemicals used to kill pests to minimise pests' impact on agriculture, health and human interest

physical contamination when an object is found in a food that should not be there; for example, glass, a Band-Aid or a stone

physical/physiological relating to the body and its systems

phytochemicals a variety of biologically active compounds found in plants

phyto-oestrogens oestrogens occurring naturally in legumes, considered beneficial in some diets for their role in simulating the hormone oestrogen

place the distribution of the new food product to the consumer at the right time and to the right location

policy a course of action adopted or proposed by an organisation (often government) or an individual

politics our system of public administration or government

polysaccharides carbohydrates that contain many different sugar molecules bonded together (poly meaning many and saccharides meaning sugar). It is a number of monosaccharides joined together

polyunsaturated the fatty acid chemical combination where there is more than one double bond in the chain

postmenopausal a woman who has experienced 12 consecutive months without menstruation

poverty the state or condition of basic needs for food, clothing and shelter not being met; it maybe absolute or relative

precursors chemicals that can be converted to an active form for a chemical reaction to occur

price in the marketing mix, the amount of money expected, required or given in payment for the purchase of a food product

primary packaging the first layer of packaging that is in contact with the product; where the product is contained

product an item offered for sale

product life cycle the stages a product goes through from introduction to withdrawal or decline

production systems manufacturing systems that include all the processes needed to design, produce, distribute and service a product.

profitability the ability of a business or a product to generate a profit and increase revenue

promotion in the marketing mix, the methods used by a business to inform, persuade and remind a target market about its products

protein a macro-nutrient needed by the body. Its main role is to build and or repair muscle tissue, produce enzymes and hormones and may be used as a source of energy. Amino acids are the building blocks of these food substances

prototype a first or preliminary version of a product from which improved versions are developed

psychological relating to the human mind, the mental and emotional state of a person

qualitative research descriptive research that uses words, perceptions and feelings

quality assurance a guarantee that manufacturing standards will be maintained so that the quality of the product remains consistent

quality control the operational techniques and activities used to produce products and services economically and consistently to meet or exceed customer requirements

quality management systems policies, processes and procedures used to plan and perform quality production, development and service for an organisation

quantitative research the use of numerical data and statistics

raw food food that is not cooked

raw materials basic substances that are in their natural or semi-processed state, used as an input to a production process to be transformed into a finished product.

ready-to-eat food food that is ready to eat without more any preparation other than perhaps heating

recommended dietary intake (RDI) a nutrient reference value indicating amounts of energy, nutrients and other dietary components to best support health

research active, diligent and systematic process of inquiry in order to discover or revise facts

research and development (R&D) the study, design and planning processes used to make new products. It can involve modifying or updating an existing product or creating something entirely new

resources useful or valuable possessions or qualities that can be drawn upon when needed, such as raw materials, energy, services, staff and knowledge

salicylates derivatives of salicylic acid that occur naturally in plants and serve as a natural immune hormone and preservative, protecting the plants against diseases, insects, fungi, and harmful bacteria

sanitise/sanitiser a method of killing germs by using a chemical or heat

saturated fatty acids a fatty acid that is carrying the maximum number of hydrogen atoms as possible. There are no double bonds in these fatty acids

saturated solution a solution in which a solvent (water) is able to dissolve in a solute (sugar)

scurvy a disease caused by a deficiency of vitamin C. It is characterised by swollen, bleeding gums and the opening of previously healed wounds, which particularly affected poorly nourished sailors until the end of the 18th century, because of a lack of fresh fruit during long journeys

secondary packaging the middle layer of packaging for a food product, such as a cardboard box with a number of identical products inside

sedentary a state of being inactive where little energy is burned

selection the act of choosing something (a food product) as being the best or most suitable

self-regulated when a person or group polices itself without outside assistance or input from the government

9780170400572

sensory assessment a subjective evaluation conducted by using the senses

sensory perception recognising and interpreting information gathered through the use of the senses

shelf life the length of time a product can be stored without becoming unsafe to eat

social justice the promotion of tolerance, freedom and equality for all people in their everyday lives, in every level of society

solutions in a business sense, a combination of ideas used to help a company achieve its objectives

sous vide a method of preserving food by partial cooking followed by vacuum-sealing and chilling

specifications a clear outline of the main features, properties and attributes of the food product and any other requirements that must be met in order for the product to be successful

sphincter a circular muscle found throughout the gastrointestinal tract that can open or close an opening. Sphincters regulate the flow of substances

staple food a food that makes up the main part of a population's standard diet contributing a significant portion of energy intake

starch a type of polysaccharide derived from plant sources and made of glucose. Starches are examples of soluble fibre

subsidy a payment made to producers to encourage local production, supplement income and assist their operations

supersaturated solutions solutions that contain more dissolved material than could normally be dissolved under normal circumstances; for example, heating then rapidly cooling water and sugar, so the water can dissolve more sugar than it could normally

sustainability the ability to continue a defined behaviour at a particular level, indefinitely. In an environmental sense, not harming the environment or depleting natural resources, ensuring long-term availability

syneresis the over coagulation of protein resulting in the tightening of the structure and weeping of liquid

taboo a social or religious custom prohibiting or restricting a particular practice because it is improper, sacred or unacceptable

tamper evident a kind of packaging designed to show any interference with the contents

tangible a physical or real product, capable of being touched

target market a particular group of consumers or market segment at which a product is directed

tariff a tax that adds to the cost of imported goods

technological something based in science and applied to everyday life to solve problems

tertiary packaging the final layer of packaging that the consumer usually does not see; it includes boxes, pallets and shrink wrap

trace elements the essential mineral micro-nutrients required by the body

trend the general development or change in a market, a product or consumer behaviour

umami a flavour usually described as a savoury, meaty or 'moreish'; it is often described as the fifth taste

unsafe (food) food that can cause harm if it is eaten

unsaturated fatty acids a fatty acid missing at least one hydrogen atom due to a double bond

unsaturated solution a solution in which a solvent (such as water) is able to dissolve more solute (such as sugar)

utensils tools used in the kitchen, such as knives, peelers, graters, mixers and serving spoons

vacuum something that has all air removed. In cooking, vacuum packing is a method of packaging that removes air from the product before it is sealed, which inhibits bacterial growth

value adding the processing of goods to increase their worth

vegan a diet where the person avoids all animal-based produce, solely eating plant-based foods, primarily fruit, vegetables, nuts, seeds, grains and cereals

virus an infective agent only able to multiply within the cells of a host

vitamins the class of organic micro-nutrients that are vital for our health. They are only required in small amounts. See RDIs for further information on daily intakes needed

weaning the stage of the life cycle when solid foods are introduced to a baby's diet. Breast or formula milk is gradually removed, while solid foods are gradually included

weight management a long-term approach to a healthy lifestyle. It includes a balance of healthy eating and physical exercise to equate energy expenditure and energy intake. Developing healthy eating habits while using tips that will keep us fuller longer can be useful tools in weight management

yeast a kind of fungus that ferments sugar to produce carbon dioxide. It is used in a variety of ways in the kitchen, primarily to make bread rise

PART 1 PRELIMINARY COURSE

CORE STRANDS

FOOD AVAILABILITY AND SELECTION (30%)

Chapter 1: Influences on food availability

Chapter 2: Factors affecting food selection

FOOD QUALITY (40%)

Chapter 3: Safe storage of food

Chapter 4: Safe preparation and presentation of food

Chapter 5: Sensory characteristics of food

Chapter 6: Functional properties of food

NUTRITION (30%)

Chapter 7: Food nutrients

Chapter 8: Diets for optimum nutrition

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1 Influences on food availability

In order to survive, the human body needs access to food and water. Deprived of healthy food, humans are more likely to suffer diseases or to die. Sadly, despite producing enough, food is not readily available to everyone. According to the United Nations, approximately three million children under 5 years old die of starvation each year. In many parts of the world, we are witnessing a crisis in access to food. The food is there, but for reasons that we will explore, it is not available to everyone.

CHAPTER OUTCOMES

In this chapter you will learn about:

The history of the availability of food, including:

- global migration
- the use of native Australian foods
- the influence of technological, social, economic and political influences on food availability.

KEY TERMS

affluence
availability
cash crop
economy
embargo
food security
global migration
multicultural
politics
poverty
social justice
staple food
subsidy
tarriff
technological

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Food security

Food security is a human right, and it exists when all people at all times have access to necessary, safe, nourishing, culturally appropriate food to sustain a healthy and active life. In many areas throughout Australia and around the world there are people who run out of food and the means to purchase food regularly. Daily, too many people face barriers, such as remoteness, low income or little education, to accessing enough healthy food, and the United Nations estimates one in nine people around the world (793 million) go hungry every day.

According to the Food and Agriculture Organisation (FAO), food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. It includes:

- adequacy of food supply and availability of sufficient quantities of appropriate, quality foods.
- stability of supply, without fluctuations or shortages from season to season or year to year
- accessibility to/affordability of food
- quality and safety of food, taking into consideration clean water, sanitation and health care.

From the definition above, it is clear that food security involves more than just the production of sufficient quantities of food. It also requires food to be accessible, affordable and of sufficient variety and quality to enable a healthy life.

In order to be assured of good food security now and into the future, there are several dimensions that must be addressed – physical availability of food, economic and physical access to food, food utilisation based on knowledge of basic nutrition and stability of the other three dimensions over time.

Not everyone in the world enjoys secure access to food. The factors that can cause food insecurity and affect food availability are often multiple and interrelated, including:

- the 'financialisation' of food – food is traded as a commodity rather than regarded as a right
- market dominance of multinational agribusinesses and exporters leaving small-scale farmers with limited avenues to market their produce

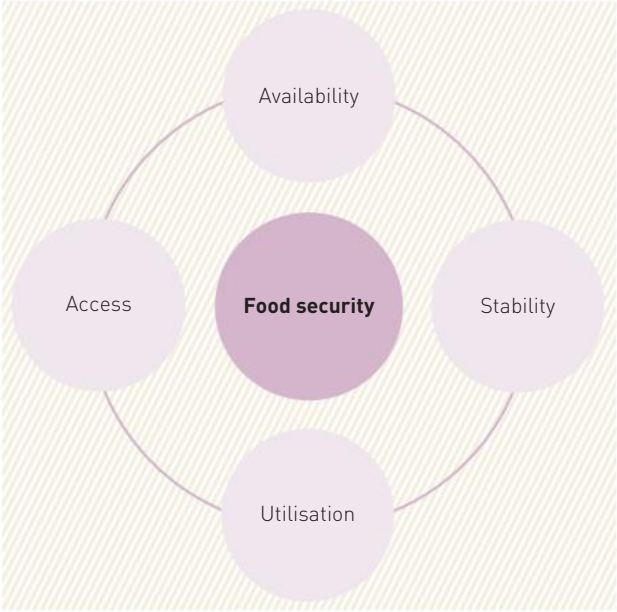


Figure 1.1 Dimensions of food security

- lack of access to farming land needed to produce food and generate income
- land 'grabbing' by large business who take over land that has been traditionally farmed by families, to grow food for export or extract natural resources. This deprives local communities of the basic resources they need to survive.
- Biofuels being produced from plants such as sugar cane or corn; as farmland is diverted to grow plants for biofuels, the amount available to grow food has decreased and deforestation has increased
- natural disasters such as drought, floods, typhoons and cyclones, which can wipe out an entire harvest, and climate change, which influences global weather patterns
- conflict and war leading to food shortages and triggering years of food crises
- unfair trade rules that can see small local food producers treated unfairly, many not being rewarded for the worth of their labour or produce
- food wastage, which occurs at all stages of the food chain is often preventable.

Physical availability and access to food are further influenced by a diverse range of factors.

WorldHunger.org

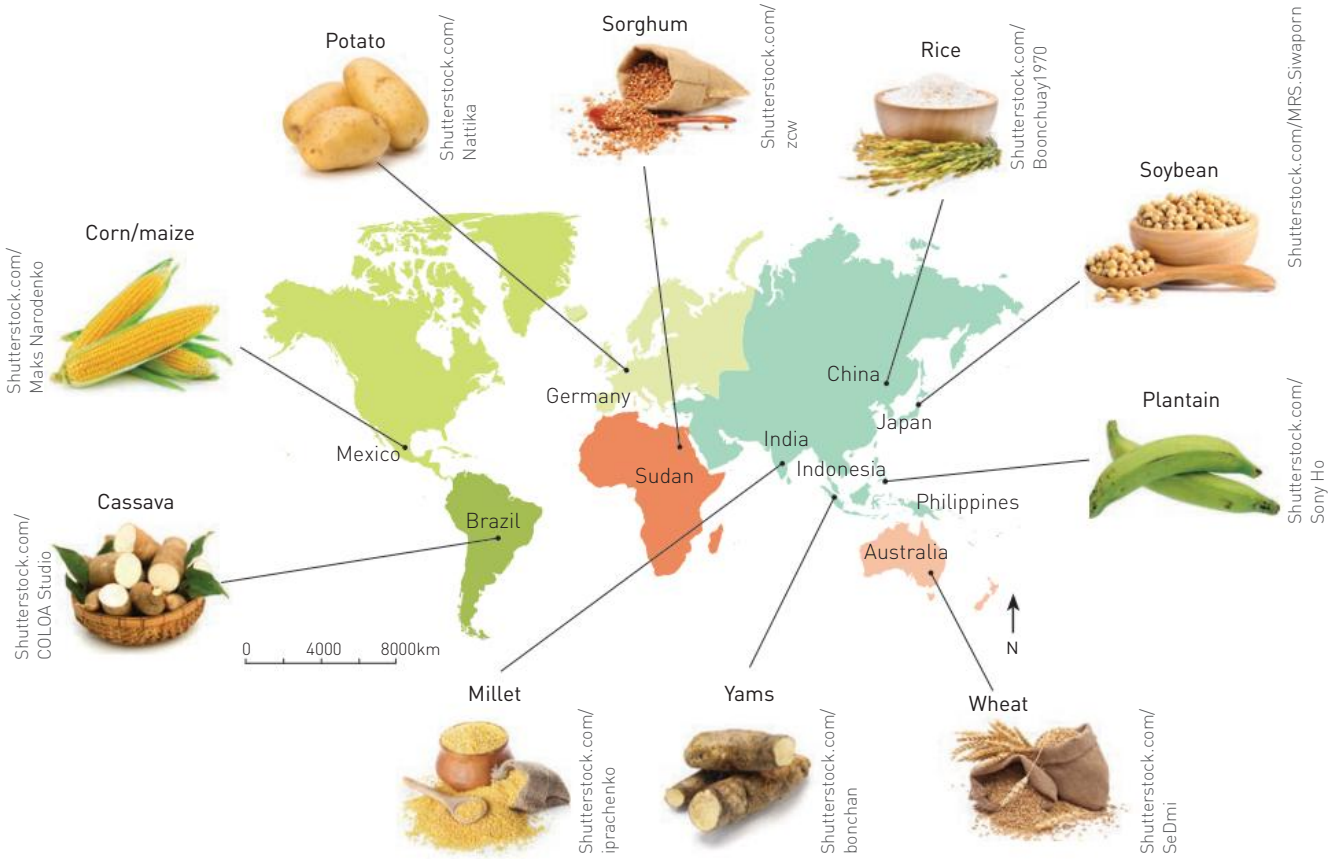


Figure 1.2 Staple food crops around the world

Historical changes to the availability of food

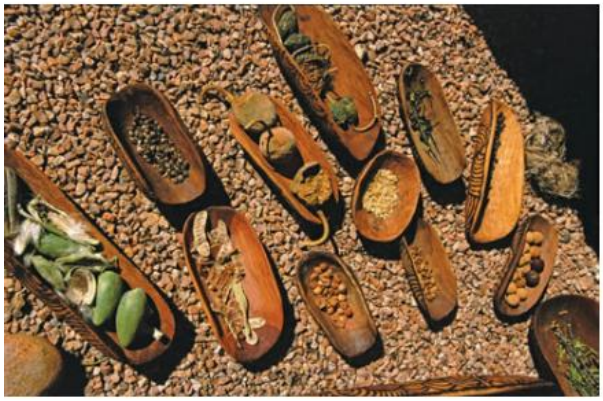
Global migration

When people move from one country to another or to another part of their own country, they bring with them the desire for and knowledge of the foods they already know. As a result of this migration, the new location may gradually introduce the newcomers' most preferred foods into the local diet. Over time some of these foods become part of the daily diet and are called staple foods. To be classed as a staple, the food must be readily available to most of the population, and provide a major source of energy in their diets. 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.

Throughout history as populations moved around the world so too did staple food crops – so that today we have access to a variety of staple foods. Where crops are currently grown around the world bears little association with where they were historically grown and produced. Countries like Australia, with solid economic growth and good trade markets have morphed from predominantly low-nutrient-density staple foods including potato chips, doughnuts, and biscuits, to higher-nutrient-density staple foods including increased consumption of meat.

Native Australian foods

Before European settlement in 1788, Indigenous Australians lived successfully off the land. There were more than 300 000 Aboriginal and Torres Strait Islander people living in 500–600 family groups, each consisting of between 100–1000 people. Each tribe had its own territory and language and, being a nomadic society, moved from place to place so did not build permanent houses and had very few possessions. Family groups usually moved in a regular cycle over a defined territory following seasonal food sources, and returned to the same places at the same time each year. They were governed by nature, not only in times of plenty, but also in times of flood and drought, frequently travelling great distances



Alamy Stock Photo/Davo Blair

Alamy Stock Photo/Christine Osbourne Pictures

Alamy Stock Photo/National Geographic Creative/Jason Edwards

Alamy Stock Photo/David Hancock

Figure 1.3 A huge selection of nutritious foods can be found in the Australian bush.

in search of the available food supply. When food supplies become scarce, a family would move to a new area where the supply was more plentiful. These areas were more commonly on the water, near rivers or where there was high rainfall, as animal and plant food sources were more accessible.

Aboriginal and Torres Strait Islander people were very successful at providing for their families through hunting and gathering activities. Usually, men were the hunters and went out each day to hunt, but often returned with very little. What they did bring back – larger animals such as kangaroos and emus, and other birds, mammals, reptiles or fish – was then shared among their tribe. The women and children supplied the more substantial part of the food requirements. They gathered plant foods, caught small animals and collected delicacies such as grasses, seeds, fruits and berries, witchetty grubs, honey ants, bogong moths and emu eggs. Aboriginal and Torres Strait Islander people consumed only enough food for their immediate needs and mostly enjoyed a nutritious, seasonally varied and sustainable diet that meant they were generally a very healthy race of people.

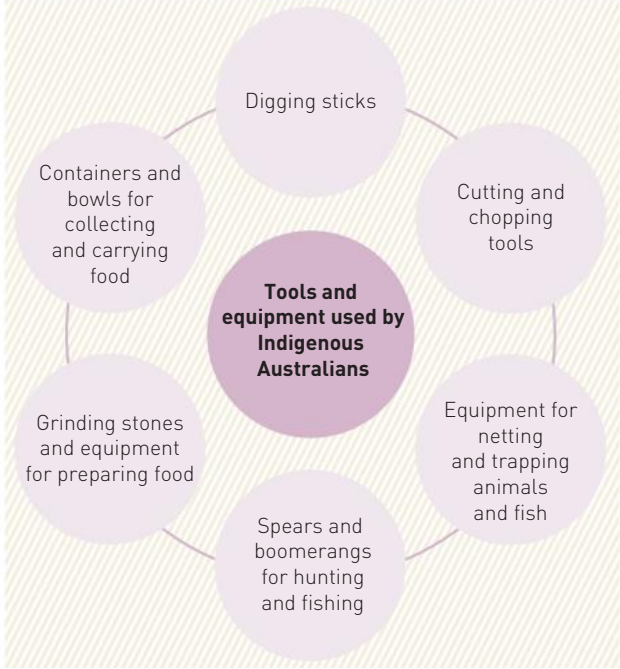


Figure 1.4 Tools and equipment used by Indigenous Australians.

Joseph Lycett, Aborigines using fire to hunt kangaroos, 1817, National Library of Australia, nla.obj-138501179

Figure 1.5 Bill Gammage's book *The Biggest Estate on Earth: How Aborigines Made Australia* examines the sustainable farming practices of Indigenous Australians.

Murumittigar

There were few recognised agricultural practices present at this time, although it is believed that people used a range of tools and equipment as well as various sustainable land management techniques, including 'firestick' practices to chase out animals and aid in hunting. Regular burning of limited areas increased the availability of new grass to feed the animals they hunted, ensuring resources were abundant, convenient and predictable upon their return to the area.

CONTEMPORARY USES OF AUSTRALIAN NATIVE FOODS

Many native ingredients are now being recognised for their subtle flavours and nutritional benefits and are being featured in the menus of modern contemporary restaurants around Australia. With the current trend of localism and transparency of ingredient origins, chefs are successfully incorporating the flavours of the Australian bush into more traditional European- and Asian-based cuisines and dishes.

It is estimated that there are up to 5000 native food species in Australia; that is, almost 20 per cent of our native flora and fauna. These comprise a hugely diverse range of flavours, colours and textures. The modern indigenous food industry uses native animals and plants in different ways to how they were traditionally eaten. Today, native plants, seeds and fruits are mainly used for flavour and texture rather than for nutrition. As these items are now being recognised as 'gourmet' they are becoming more available in specialty shops as well as in supermarkets and online. Traditional meats like kangaroo, crocodile and emu can be purchased from supermarkets and in specialty butcher shops.

FOOD IN FOCUS 1.1

NATIVE FLAVOURS ON AUSTRALIAN TABLES

The Robins Foods 'Outback Spirit' range offers a selection of indigenous food and products, widely available through Coles supermarkets. Outback Spirit sources bush foods to produce sausages, cooking sauces, dressings and condiments such as chutneys and preserves, which use distinctive bush ingredients and flavours. Ten cents from every Outback Spirit product and every bottle of Yaru Water sold is donated to the Coles Indigenous Food Fund, which supports Indigenous business development and promotes Australian native bush foods. From Central Australia to the Kimberleys, Cape York and the Tweed Valley, Coles is helping local community groups develop commercial planting and harvesting of key ingredients like bush tomatoes, Kakadu plums, wild limes, Davidson's plums and a range of native herbs that are used in these products. This assistance offers employment opportunities and modern farming skills to the Indigenous communities harvesting these native foods.

One of the big success stories is an investment in Acti-sol organic fertiliser for bush tomato growers who supply Outback Spirit. 'They improved their yield from half a kilogram per plant up to two to three kilograms,' Coles Indigenous Food Fund Chairman Chris Mara said. 'This means they've gone from growing hundreds of kilograms up to three to four tonnes of bush tomatoes. That is now a very healthy commercial harvest from what was a wild harvest.'

>

a

Wikimedia/Robert Ackerman Creative Commons Attribution-ShareAlike 3.0 License

b

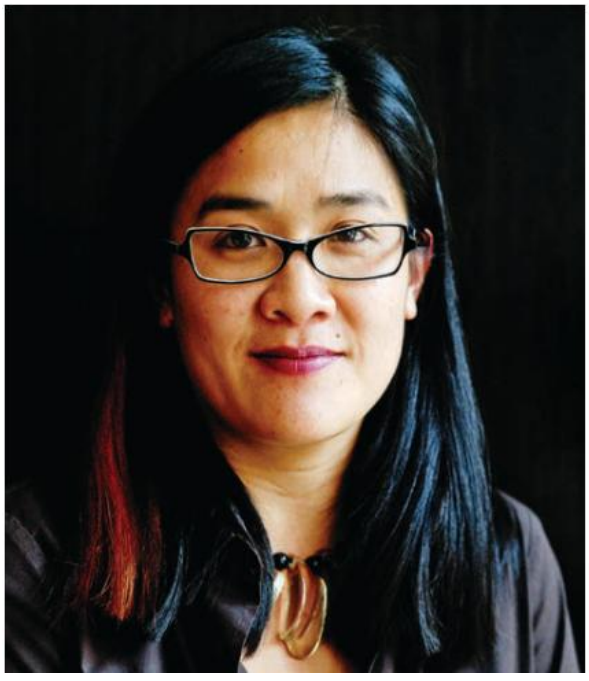
Outback Spirit

Figure 1.6 (a) Bush tomatoes are used in (b) Outback Spirit products.

RESPOND

1. Why are consumers today more accepting of local bush foods?
2. Describe the range of products that feature the flavours of the Australian bush that are available for purchase at Coles supermarkets.
3. Use an example to explain how the Coles Indigenous Food Fund has assisted in creating opportunities for community-based indigenous communities.
4. How could you incorporate these products into your everyday meals?
5. Design a food product based on an indigenous ingredient.

Famous Australian chef Kylie Kwong has said that discovering native foods completely revolutionised the way she cooks. Kylie has a great respect for indigenous ingredients and has incorporated items such as warrigal greens, rosella flowers, lemon aspens, desert fruits and finger limes into her contemporary Asian dishes.



Fairfax Syndication/SHD/Fiona-Lee Quimby

Figure 1.7 Australian chef Kylie Kwong is passionate about using indigenous ingredients.

'The way I cook is all about emphasising simplicity, fresh ingredients and clean flavours. My cooking style has also evolved from living in Australia, where we have access to some of the world's finest produce: organic and free-range poultry to meat; seafood from pristine waters; and a bountiful range of fruit, vegetables and herbs, including bush foods and foraged wild weeds.'

FOODS IN THE NEW COLONY

The arrival of Captain Arthur Phillip and the First Fleet in 1788 marked the beginning of the end of the traditional way of life for Indigenous Australians. Eleven ships carrying 1350 people arrived with instructions from Britain to establish the first British colony in Australia.

Food brought on the First Fleet consisted of flour, rice, salted meat, salt, alcohol, vinegar, seeds and vine cuttings; some from England and others gathered along the journey. Livestock such as goats, hogs and

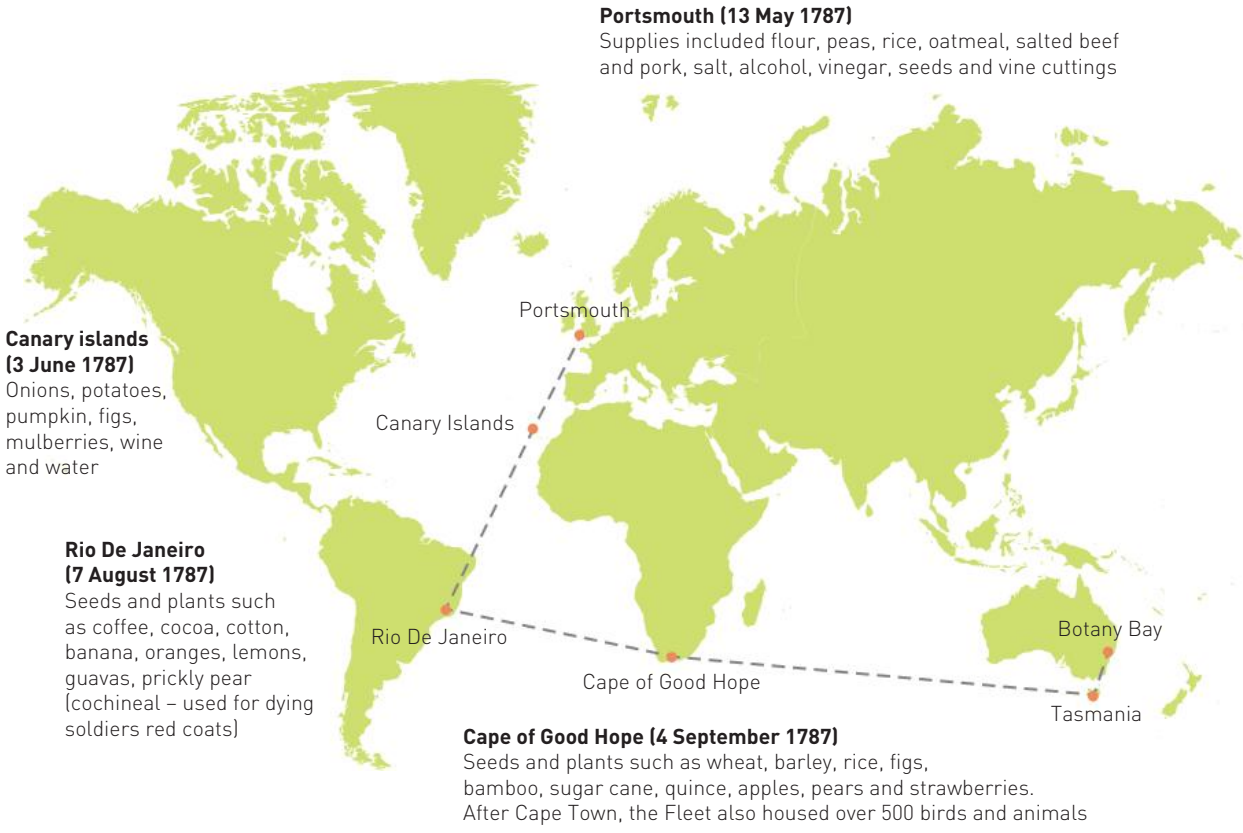


Figure 1.8 The First Fleet stopped at ports on their way to Australia, experiencing and collecting a variety of exotic foods.

chickens were brought as a source of fresh meat. Unfortunately, the settlers' crops did not grow well in Australian conditions and the livestock died or escaped.

The absence of farming experience, poor soils and the harsh climate created problems for the first European settlers. Unlike the local Indigenous people, the new arrivals were unaware of the abundant and nutritious food supply that surrounded them. They became dependent on food supplies delivered by ship. During the 1790s, the colony was challenged by continuous food shortages and, as a result, malnutrition and scurvy were common. Food rationing was necessary for the first few years of settlement and diets were nutritionally inadequate. Meals were monotonous and unappealing and settlers maintained the diet of their traditional British background. For adults, weekly rations included 7 pounds of flour, 7 pounds of pork or beef, 3 pints of peas, 6 ounces of butter and half a pound of rice. Women in the colony received two-thirds of the men's rations and children were entitled to even less.

Migrant groups in Australia

Once the colony was more established, other European migrants began to arrive. Each new migrant group introduced new foods and preparation techniques that over time became a part of the Australian lifestyle. Modern Australian cuisine is a reflection of our rich cultural diversity and our history.

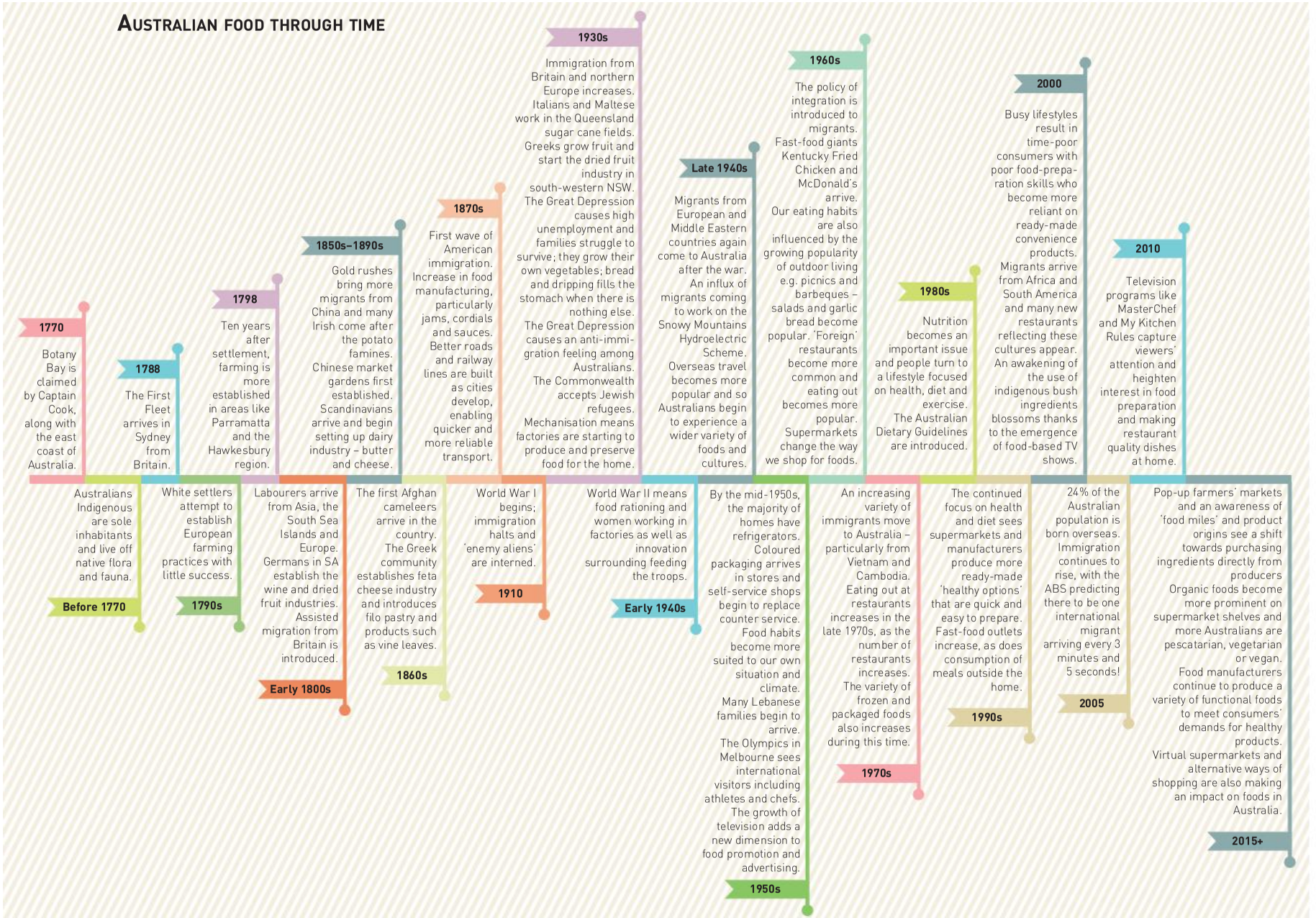


Figure 1.9 Australian food through time

CHAPTER 1

PRACTICAL APPLICATION

MULTICULTURAL TASTE TEST

AIM

To taste test a variety of multicultural foods you have probably never tried before.

METHOD

As a class, each student can bring in a food traditionally associated with their own cultural heritage. Add to the selection with a variety of foods from the local supermarket.

1.1

RESPOND

1 Complete a sensory analysis of the foods you try.
2 Give an overall evaluation of your experience.

AUSTRALIA TODAY

The Australian food supply today is diverse, safe, abundant, fresh and of high quality. Our diet has changed from a traditional and uninteresting one, to one that is among the most varied in the world. We now readily combine ingredients and cooking styles from wide-ranging sources to create new dishes and flavour combinations. It could be said that along with meat pies and roast lamb with vegetables, 'spag bog' (spaghetti bolognese) is now one of Australia's real national dishes, with Pad Thai and Malaysian laksa also high on the list of favourites.

FOCUS QUESTIONS 1.1

REVIEW

1 Define food security and explain how it influences food availability both in Australia and around the globe.
2 Outline how global migration has contributed to the movement of staple foods around the world. Use specific examples to support your answer.
3 Discuss how the traditional diets of Indigenous Australians were sustainable and nutritious.
4 Summarise the key migration points that have influenced Australian cuisine today.

FOR YOU TO APPLY

5 Develop a comprehensive timeline outlining the historical changes to food availability in Australia. Use the brief timeline on page 9 and the Australian food timeline weblink to help.

Australian food timeline

EXTEND YOURSELF

6 Design and make a 'national dish' for Australia that truly represents the modern contemporary food scene. Justify your choices

Technology's impact on food availability

An ever-increasing number of technological advances have changed the way food is produced, manufactured and distributed in Australia and around the world today. All aspects of our food supply chain have been affected by technology. Improvement in our knowledge of storing, packaging and preserving food, along with improved breeding and farming techniques, have all contributed to the availability, quality and safety of food. Transportation and information technology have meant that we are more able to purchase a wide selection of foods from our modern supermarkets in a variety of ways.

Food technology is inspiring people to change the way they think about the food they eat, where it comes from and how it is produced. Increasingly, technology influences the foods we eat. Technology affects many aspects of the food industry including:

- processing techniques, such as sous vide
- production and manufacturing, mass, batch and one-off production
- resources – energy, water, gas
- tools and machinery – both domestic and commercial
- storage and distribution systems, such as to supermarkets or local farmers' markets.

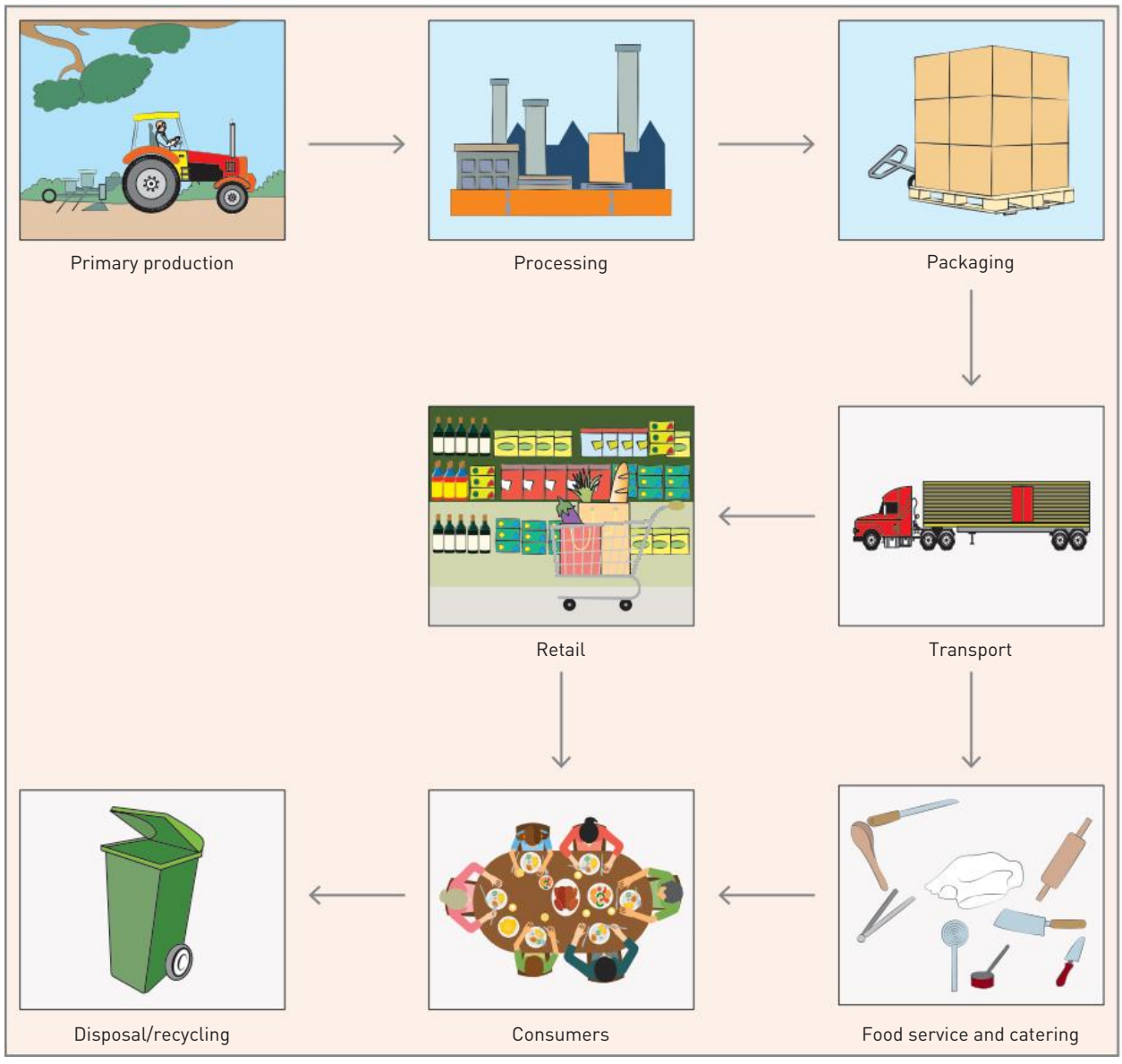


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Figure 1.10 Australia's food system and supply chain is complex and has many intersecting components.

Food production processes

Throughout history, human civilisation has developed around the establishment of farms and agriculture. Advancements in science and technology have contributed to better soil, nutrient, water and pest management and to more effective methods of planting, harvesting, storing, processing and transporting farm products. These enhancements have resulted in more and better quality food than ever before.

Initially, humans obtained food through hunting and gathering, we were food collectors. Once we realised we could cultivate plants and domesticate animals, we became food producers. This was the start of civilisation as we know it – the rise of an agricultural food system that allowed people to have surplus food and economic stability. Subsistence agriculture became prominent, with humans growing enough food for themselves and their families while still having some left over to trade and sell. Individual farms grew into villages some of which developed into cities. New jobs emerged and fewer people needed to be farmers. Over time, more and more people moved away from villages and settled in cities around the globe.

With the Industrial Revolution came new developments in science and technology and

Figure 1.11 The progress of food production systems

dramatic changes in social organisation. City people had neither the time nor the space to grow food, so industries developed to feed the people living in the cities. Thus the emergence of the current industrialised or global agricultural system where many crops are grown by large multinational companies.

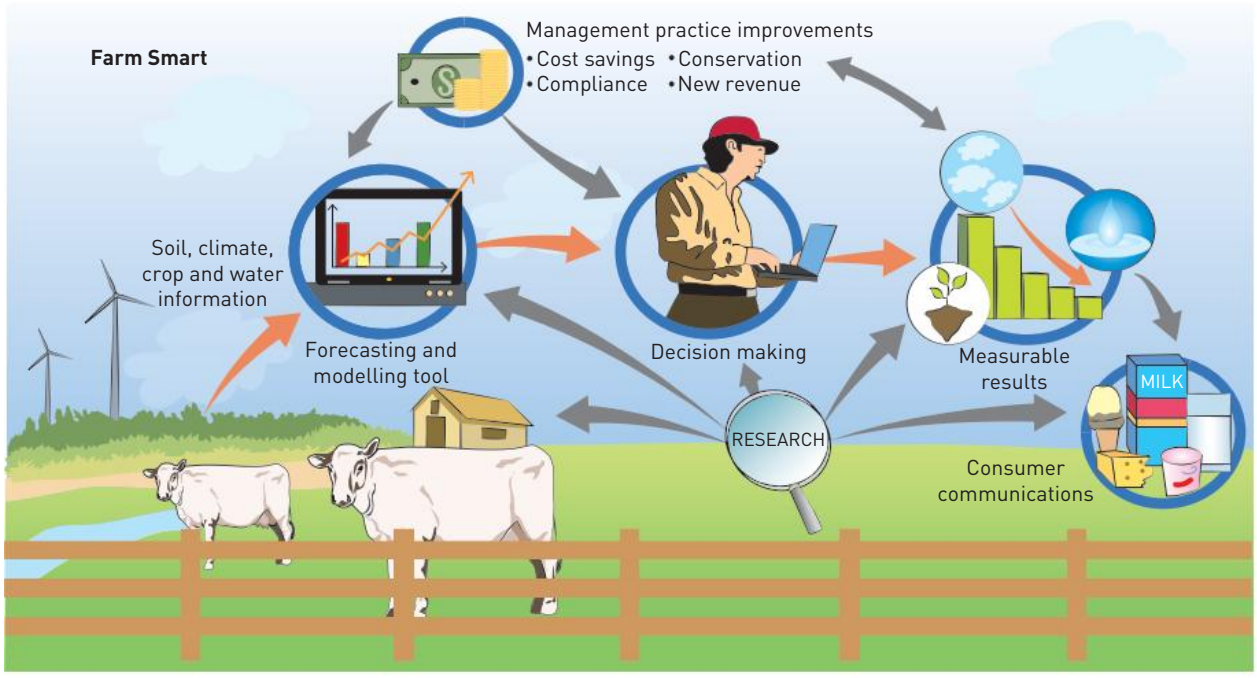
Humans have progressed through hunter-gatherer, agricultural and industrial stages to become providers of goods and services. In the world today, subsistence agriculture and industrialised agriculture are used to feed the population. Subsistence agriculture is used mainly in the developing world whereas industrialised agriculture is used by the developed nations.

SMART FARMS

To keep agriculture on the cutting edge, many farmers now implement a range of technologies, including precision agriculture, remote sensing, computers, the internet, specialised software, global positioning, drip irrigation and biotechnology. Precision agriculture is often called satellite farming, and refers to the use of Global Positioning System (GPS) tracking systems and satellite imagery to monitor crop yields, soil levels and weather patterns to increase farm efficiency. The information gathered by the GPS helps the farmer identify precisely where to plant, and when and where to apply pesticides and fertiliser.

Table 1.1 Comparison of food production systems.

	HUNTING AND GATHERING	SUBSISTENCE AGRICULTURE	INDUSTRIALISED AGRICULTURE
Production	• No production • Some firestick burning to promote growth	• Low, aimed to supply the farmer and family • Small surplus to barter and trade	• Large quantities • Sell products in national and international markets
Characteristics	• Labour intensive • Takes only what is needed for survival • Involves whole family • Good knowledge of land and natural resources • Dependent on seasons and weather conditions	• Outdated technology • Large labour force • Variety of crops and animals • Dependent on natural resources and weather conditions • Farmers have good knowledge of the land	• Technological, scientific and mechanical advancement • Often mono-cultivation • Use of irrigation and chemicals • Little consideration given to environmental effects
Location	• Traditional e.g. Indigenous Australian, Native American	• Underdeveloped regions e.g. Asia, Africa, Papua New Guinea	• Developed regions e.g. USA, Europe, Australia



Innovation Center for U.S. Dairy

Figure 1.12 In Smart Farms, advanced information technology, improved communications systems, robotics, drones and other new technologies have the potential to boost agricultural yields and reduce waste while tempering environmental degradation.

FUTURE PRODUCERS

Technological advances, new farming equipment and innovative cultivation techniques are allowing commercial farms to decrease labour needs while increasing the overall productivity of the land. However, as farmland becomes scarce or unproductive, producers are looking for innovative places to grow food. One example is underground; in London, a hydroponic farm has been built in abandoned underground tunnels that were once air raid shelters, so that local restaurants and stores can have a reliable local source of fresh produce and herbs.

Science Photo Library/Louise Murray

Figure 1.13 Pea shoots, radishes, mustard, coriander, celery, parsley and rocket are all being grown under London.

Hydroponic technology is continuing to grow in popularity because food can be grown using a nutrient-rich water solution instead of soil. Companies are also working on creating special LED bulbs that produce specific wavelengths to help grow plants indoors. Since LED bulbs do not get hot, they can sit closer to the plants and can produce lights suited to different species of crops, maximising growth and production. These new technologies are also being implemented in urban farms where vertical farming is being explored. These new-concept farms look more like a factory than a field, and reduce labour costs considerably by taking the farmer out of the loop in favour of automation. In these green hubs, food can be produced with less water (since it recirculates), less waste is created and the 'farm' takes up less space than it would traditionally. For large cities, these urban farms give city consumers greater access to fresh, nutritious food all year round, reducing the distance travelled to get to the fork.

Another technology that is pushing the limits on food production is 3D printing. Chocolate and candy were the first products to be developed using this technology but recently NASA produced a pizza with the aim of improving astronaut meals

iStock.com/LouisHiemstra

Figure 1.14 Vertical gardens: the modern urban farm

in space. The Foodini is a 3D printer designed for the home cook. It is described as a 'new generation kitchen appliance that combines technology, food, art and design'. The user prepares the ingredients with a food processor or blender, and the 3D printer can print shapes out of the mix. It is meant to avoid the time-consuming process of making things by hand.

FOODS OF TOMORROW

Many foods we will eat in the future do not yet exist. Researchers constantly experiment with plant and animal ingredients, processed foods and even packaging, to improve and change appearance, flavour and nutritional value.

From farm to table, much about food production will continue to change over the next few decades – for both farmers and consumers. Everyone eats; therefore, everyone relies on food systems, local and global, and like any other business, farmers will continue to adapt to a technologically changing world. The ability of this industry to adapt, innovate and form successful collaborations will continue to support a strong and prosperous Australia with sustainable food security.

Manufacturing and processing

Food processing has occurred since prehistoric times, changing dramatically throughout history. Processing food includes actions that change raw plant or animal materials into foodstuffs suitable for consumption, cooking and storage and usually requires technology. Commercial food manufacture uses scientific and technological principles to extend the shelf life of foods by slowing down the natural processes of deterioration. Without food processing and manufacturing, it would be difficult to meet the needs of urban populations, and the selection of foods would be restricted to seasonal availability.

Humans first used fire to assist with cooking, a form of food processing to improve the palatability, digestibility and safety of food. Meat and fish were salted, smoked or dried and fruit was preserved with sugar or fermented to make alcohol. Foods preserved this way were a common part of warriors' and sailors' diets. In more recent times, technological innovations in processing have transformed our modern food supply into the diverse range of goods available in the marketplace today.

Table 1.2 Development of food-processing techniques

TRADITIONAL PROCESSING	MORE MODERN PROCESSES	MOST MODERN TECHNIQUES
Canning	Extrusion cooking	Freeze drying
Fermentation	Freezing and chilling	Infra-red processing
Freezing	Pasteurisation	Irradiation
Oven drying	Sterilisation	Microwave processing
Pickling	Ultra-heat treated (UHT)	Spray drying
Salting		Modified atmosphere packaging
Smoking		Ultra-sonification
Sun drying		Ohmic heating

Value, consistency and convenience are the key benefits of the food manufacturing process. Food processing allows manufacturers to maintain or improve food quality, and enhance food safety. Food producers can preserve sensitive nutrients, add vitamins and minerals, remove toxins and design foods to enhance health and minimise the risk of disease. They can reduce product loss and wastage, and can distribute food locally and globally so it is continually available. Different levels of food processing can be used to create many products.

Minimally processed foods include fresh fruits and vegetables, fresh seafood, nuts and salads. They are found in the 'fresh' section of a supermarket and are basically still in their raw state. These products have been cleaned and sorted with the simple addition of approved waxes or coatings used to maintain their freshness and quality. Other products in this category include canned fish and beans, baby food that is pureed and jarred, and frozen fruits and vegetables.

Moderately processed foods have ingredients added to facilitate safety and preservation but are still recognisable in their true form. These foods should retain their visual and taste appeal. These are foods with ingredients added for flavour and texture such as sweeteners, spices, oils, colours and preservatives and include jarred pasta sauce, salad dressing, yoghurt and cake mixes.

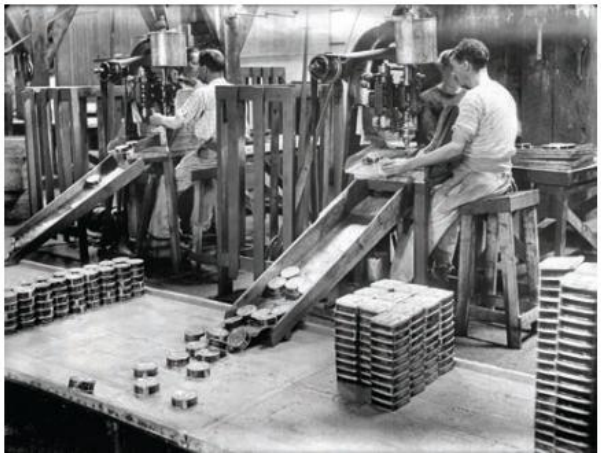
Heavily processed foods are often made of multiple ingredients, and there is no way to know where anything originally came from. Frozen or pre-made meals such as frozen pizza and microwave dinners have undergone many processes so they are ready-to-eat right out of the package. Breakfast cereals, muesli bars, deli meats, biscuits, frozen desserts, soft drinks and spreadable cheese are all examples of heavily processed foods.

Negative perceptions about processed foods exist, with some seeing them as detrimental to the general health and wellbeing of society. Controversy surrounds some aspects of modern processing technology such as areas of biotechnology and genetic engineering and there are many concerns about excess packaging and its effects on the environment, as well as the influence of labelling and advertising on our society.

Equipment and tools

There have been many changes to equipment and tools in all areas of the food industry. These developments have resulted in increasing efficiency through saving time, labour and energy. Computer-based control systems, sophisticated processing and packaging systems, and logistics and distribution advances have increased efficiencies, ensuring product quality, improving food safety and reducing cost in food production.

Since the Industrial Revolution, food production has been influenced by rapidly advancing technologies. Steam was the main power source and did not simply replace other sources of power – it transformed them, meaning we no longer relied solely on human and or animal resources.



Getty Images/Boyer/Roger Viollet

Figure 1.15 Factories began to use production line techniques to improve production and efficiency.

The development of electricity as a source of power led to the design of electric tools in the workplace, which could be smaller, more reliable, safer and quieter than their earlier steam-driven equivalents. In the home, electric power provided heat to make cooking easier, and over time electric appliances proved to be time savers throughout the house. Ovens, toasters, dishwashers and other appliances all used electricity to improve the domestic household by reducing physical labour, while electric refrigeration increased food safety and availability.

Long ago, snow and ice, cool streams, springs, caves and cellars were used to keep food cold. Refrigeration transformed the food industry. Commercially available in the mid-19th century, refrigeration saw huge changes to the way foods were stored and transported. Once refrigerated

train carriages, trucks and ships were available, perishable food could be transported across nations and beyond. By the end of the 19th century, many Australian households still stored their perishable food in an insulated 'icebox', usually made of wood and lined with tin or zinc, which used large blocks of ice delivered every few days to keep food cold. Electricity made refrigerators, and later freezers, an appliance that people could rely on for food preservation and storage. Diets and food habits evolved when people could purchase, store and eat fresher foods all year round. Local supermarket offerings diversified, making it possible for foods grown or produced locally and internationally to end up next to each other in the same fridge.

In the 19th century, modern food-processing technologies were largely developed to serve military needs; for example, canned foods. In the early 20th century, the space race, changes in food habits and environmental and quality consciousness of consumers furthered the development of food processing, with advancements such as spray drying, juice concentrates, freeze drying and the introduction of artificial sweeteners, colourants and preservatives. In the late 20th century, products including dried instant soups, reconstituted fruit juices and self-cooking meals, such as ready-to-eat food rations, were developed to meet the ever-growing consumer demand for convenience. All of these new products depended on the development of specialised tools and equipment to make these technological goals achievable.

Tomorrow's food

Food packaging is one example of technology's impact, as it has evolved from a container to hold food to something that plays an active role in food quality and production. Developing from leaves and animal skins into 'smart' environmentally friendly plastic films, packaging continues to change and develop. Products such as retort pouches and trays, stand-up flexible pouches, zipper closures on flexible pouches, multilayer barrier plastic cans, microwave subsectors, dispensing closures, and gas barrier bags for prime cuts of meat and fresh produce are examples of innovations in this area. Many packages are still simply containers, but they have properties that have been developed to protect the food. These include barriers to oxygen, moisture and flavours along with sensors for measuring these product traits. Active packaging, which plays an active role in food quality, includes some microwave packaging as well as packaging that has absorbers built in to remove oxygen from the atmosphere surrounding the product or to provide antimicrobials to the surface of the food. Packaging technology is a tool that has allowed increased access to quality food all year round that otherwise could not be preserved.

Food storage and distribution

Before reaching your plate, food undergoes a series of post-harvest activities such as food processing, transportation, storage, packaging and marketing.

For a food industry to be effective, it must be able to supply consumers with food products when they want and need them. Globally, enough food is produced to feed everyone in the world but the food does not always reach those who need it most. One of the reasons for this is problems with distribution and storage. This means that food suppliers must design and build facilities to protect foods from contamination and spoilage after harvest but before distribution or processing, and governments must build and maintain transport systems such as road networks to distribute food where it is needed.

Shutterstock.com/Richard Thornton

Figure 1.16 Oranges waiting to be transported and distributed around the world.

Appropriate food storage plays a critical role in preserving the nutritional value of food. It prevents food-borne illnesses caused by harmful bacteria and helps protect vital nutrients. Today,

new storage and distribution options provide increasing opportunities for food manufacturers to provide good quality products to the consumer with convenience. Technology has enabled the development of sophisticated storage systems such as those used for wheat and other grains.

Advancements in grain storage have seen technology contribute towards improvements in silo design – monitoring temperatures, moisture and ventilation, spoilage prevention using advanced digital technology, and automated monitoring controls to optimise the condition of grain stored in silos, flat storage warehouses and piles.

Source: ShockWatch Pty Ltd

Figure 1.17 Cold-storage sensors are disposable chemical indicators available for cold shipments. These indicators change colour if temperatures exceed safe levels. This allows the receiver to easily confirm that the foods have arrived in a safe condition.

Australian primary producers compete in international export markets and also supply domestic markets. They rely on efficient transport to ensure the delivery of fresh, high-quality produce to consumers. Within the developed world there are four basic transport modes for shipping large quantities of packaged products: water, rail, truck and air.

Each of these systems have seen advancements in technology that enhance the availability and quality of products. New technology is changing the way we transport foods both locally and globally. Advanced manufacturing technologies, new energy technologies, intelligent transport systems and driverless vehicles are transforming transportation.

Environmental concerns have forced the food industry to improve energy efficiency and reduce

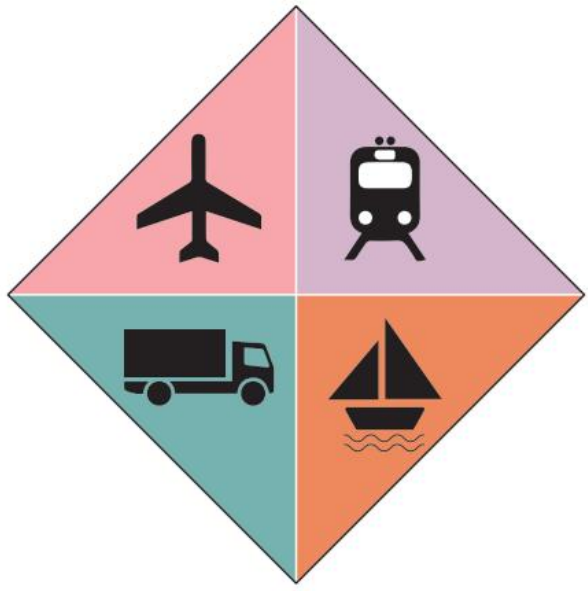


Figure 1.18 Basic transport modes for distributing food products: water, rail, truck and air.

emissions in all forms of transportation without compromising performance. This has seen the development of advanced materials such carbon fibre and plastics as well as the use of alternative fuels such as solar and wind energy. Following a successful trial of electric vehicles and electrification technology, many food companies are seeking to adopt electric technology in vehicles such as delivery vans.

Intelligent transport systems can raise system performance, reduce travel times, improve safety and enhance the customer experience. The Victorian Government is trialling high-capacity signalling on the Melbourne metropolitan rail network and the use of intelligent systems to manage roads and improve transport and logistics routes. Autonomous, or driverless, vehicles will also need to be considered as part of future intelligent transport systems.

Recent trends have seen consumers wanting to know where their food comes from and how far it has travelled. New technology allows products to be tracked by consumers and retailers, ensuring greater accountability along the production chain. Different tracking methods include barcodes, biometric scanning and infra-red scanning to determine a product's authenticity. Effective tracking means that every single pallet, case or item tells its story, anywhere, anytime. This facilitates better product recalls, allowing potentially dangerous food and drink products to be recalled quickly and without posing

a risk to consumers. Producers are also able to gain valuable information on how well their goods are surviving the export process.

With technology such as Quick Read (QR) codes and augmented reality apps, consumers have increased brand awareness as well as access to valuable product information, knowing that the product is safe and fresh as well as where it came from. Another example is the McDonald's mobile app, which combines augmented reality with GPS and time and date data to give customers a better idea of what goes into the food they are eating.

Changes in the marketplace

The marketplace is where consumers purchase goods and services they want and need. Goods were once sold locally in stores, which offered personal service. Before the supermarket, consumers purchased their food every day from door-to-door sellers like the milkman or at markets and specialist food shops, such as greengrocers, butchers and fishmongers. The food was mostly fresh, natural and unprocessed. Modern supermarkets provide fresh food options alongside a wide range of ready-to-eat and processed foods designed to save the consumer time and cater for a general decrease in food-preparation skills. Consumers now drive to the marketplace and make decisions based on what is available to them, while being bombarded with a vast array of goods packaged and displayed in ways to capture their attention.

Today, goods can also be purchased from smaller corner stores, specialty shops, niche retailers, farmers' markets and paddock-to-plate producers both locally and internationally. They can be obtained in person or over the internet with a variety of delivery methods including click and collect or door-to-door service.

CLICKS OR BRICKS?

Personal

When it comes to food and drink, customers enjoy the in-store experience and are keen to touch and feel products, be inspired by new things to buy and to hunt for the best prices. Retailers are now encouraging their customers to have greater connectivity while shopping. Using in-store touchscreens, QR codes, augmented reality apps or barcode scanners, there is now a multitude of ways for customers to buy, order or gather information online while they are doing their grocery shopping. Tablet-laden smart trolleys are currently being tested, where the shopping trolley itself provides recipe recommendations, lets you tick items off your shopping list and follows you through the store via body recognition sensors. Self-serve checkouts are another in-store technological change that consumers have embraced in the modern marketplace and have generally proven to be a time saver when shopping in-store.

Retailers also use technology to streamline internal operations, such as using cameras to monitor availability of stock and queue lengths, mobile signal monitoring to locate hot spots in-store and staff touchscreens to provide them with a better information about products.

Online

Websites and smartphone apps enable anytime and anywhere online purchasing. Ordering online for home delivery is the most commonly preferred flexible retailing option, using either the big supermarket chains or increasingly, smaller online grocery sellers like Aussie Farmers Direct.

A smaller number of consumers are also using 'click and collect' services, where they order groceries online for pickup at a store or other location. Virtual supermarkets are being introduced in train stations and at bus stops. In this marketplace, virtual displays of groceries allow customers to browse and make purchases by clicking on images of the products or scanning QR codes. These purchases are either picked up in-store or home delivered.

Fairfax Syndication/The Age/Michael Clayton-Jones

Figure 1.19 A virtual Woolworths store

FOOD IN FOCUS 1.2

AUSSIES WANTING TO BUY AUSTRALIAN

Aussie Farmers Direct is an independent online retailer supplying a broad range of all-Australian products including fruit and vegetables, dairy, bread, deli items, meat, chicken, seafood, pasta, juices and fresh gourmet meals, with free delivery to the consumer's door. The General Store also offers every day household goods and pantry items, giving consumers a real alternative to the traditional supermarket. It promises a 'full supermarket shop' that will match prices in Coles and Woolworths, beat prices in IGA and Aldi and support Aussie farmers in a way its competitors never have.

Aussie Farmers Direct provides an alternative way for consumers to buy what they need and want, when they want it, to make life easier. It supplies 100% Aussie food, produced ethically and sustainably. By offering only products that are Australian made and grown by farmers you can find out about on their website, Aussie Farmers Direct are supporting the local agricultural industry, the local and Australian economies and the future of farming and manufacturing in Australia. Aussie Farmers has presented itself since inception in 2005 as a supporter of Australian producers and promises to pay Australian farmers and producers fair prices.

According to market research firm IBISWorld, online orders will make up a tiny $2.4 billion of the $88 billion Australians spend on groceries each year – Coles has 30 per cent of the online market and Woolworths has 42 per cent. To date Aussie Farmers Direct has over 130 000 active customers and delivers more than 1.25 million products each week across major metropolitan areas in all states. They are hoping to challenge the major supermarket chains in the online marketplace.

RESPOND

1 Who or what is Aussie Farmers Direct?
2 What goods and services does this online company offer?
3 What are the benefits to the consumer of using an online marketplace?
4 Are there any disadvantages for this type of shopping?
5 Why do you think it is important for Australian consumers to purchase Australian produce?
6 How much do Australians spend on groceries each year?

EXTEND

7 Visit the Australian Farmers Direct website and investigate one of the farmers that supply fresh Australian produce.

FOCUS QUESTIONS 1.2

REVIEW

1 Discuss how the way we gather and process foods has changed from prehistoric times until now.
2 How did the invention of refrigeration contribute to the availability of food for consumers in the early 1950s and what difference does it make today?
3 Explain, using specific examples, how technology has made producers, manufacturers and retailers more accountable to the consumer.
4 Why do you think there has been a move towards simple, locally produced food in the Australian marketplace?

FOR YOU TO APPLY

5 Describe your vision of farms and marketplaces of the future. Justify your ideas.
6 Design an online campaign to encourage Australian consumers to purchase Australian made and manufactured food products.

EXTEND YOURSELF

7 Investigate the practice of 'cash cropping' by multinational companies. Examine how this practice may contribute to poor distribution of food in some countries.
8 Genetically modified foods are not widely used or accepted in Australia. Discuss reasons for and against this practice. Use the think/puzzle/explore template available online to help you organise your thoughts on this topic.

Economic, political and social factors affecting food availability

Type and state of the economy

The economy is the framework of production, distribution and consumption of goods and services. The government tries to encourage its growth to satisfy the needs of the population. Economic strength or weakness results from the style of economy, the commodities it has to trade and its past and present state. A strong economy gives its country political power, while a weak economy leaves its country less protected from the world market.

Within our economy, there are several major phases that occur and influence the way consumers spend as well as what products are being marketed and sold at what price. They are:

- high economic activity – growth or expansion/boom
- low economic activity – inflation, recession or decline
- recovery – moving from recession into prosperity.

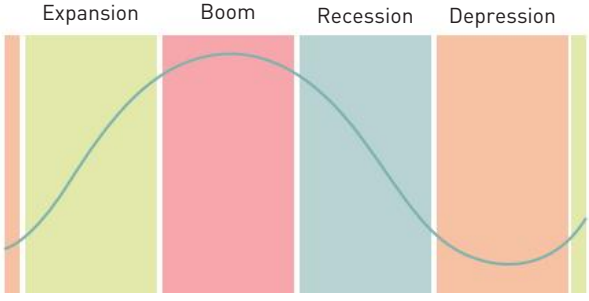


Figure 1.20 The phases of an economic cycle follow a wave-like pattern over time, with expansion leading to a peak, followed by recession leading to a drop.

TYPES OF ECONOMY

Different types of economy include the following:

- *Agricultural economy* – this relies on the production and export of agricultural products to maintain standard of living (developing countries with technology). There are very few remaining agricultural economies today – Sierra Leone, the Central African Republic and Chad are currently agriculture-based economies.
- *Subsistence economy* – does not produce a surplus of food and is dependent on the weather. Usually produces enough to feed the populace. Limited examples of these economies exist today. Aboriginal cultures of the Amazon Rain forest and remote tribes in Africa and Polynesia are still living in this way.
- *Industrial economy* – produces large amounts of food for trade. Uses recent technologies. India and China are considered to be growing industrial economies.
- *Market economy* – based on the use of resources for production and distribution. Where demand and supply determine what will be produced, how much and for whom. Australia and the USA could be classified as having market economies.
- *Mixed economy* – a combination of two or more of the above.

Australia is a mixed market industrial economy, meaning producers and consumers dictate production, distribution and price, government regulates the economy to ensure prosperity and avoid absolute poverty, where individuals and communities are unable to supply any basic needs for long periods of time. Alternatively, subsistence agriculture economies found in parts of Africa and Asia are reliant on agriculture; weather determines stability, hence foods are not often in surplus. These are commonly considered weak economies because of the scarcity of food, poor medical services, little technology, few manufacturing industries and unstable governments. This means large parts of the population are in absolute poverty and entrapment in the poverty cycle is common.

Effects of poverty and affluence

Economic differences between countries are reflected in the availability of food. While the world produces enough food to feed everyone, approximately one-quarter of the world's population is still inadequately fed. The United Nations says 'Poverty is more than the lack of income and resources to ensure a sustainable livelihood. Its manifestations include hunger and malnutrition, limited access to education and other basic services, social discrimination and exclusion as well as the lack of participation in decision making'.

In affluent countries like Australia, money can mean the difference between living comfortably and living in relative poverty. *Relative poverty* is when a person cannot afford to satisfy one or more of the basic human

needs (food, clothing, and shelter) and their standard of living falls below that of the rest of the community. In many developing countries, the lack of money results in absolute poverty. *Absolute poverty* is life threatening because of the inability to supply any of the basic human needs over a long period of time.

THE CYCLE OF POVERTY

Poverty can easily trap someone into a cycle of food insecurity and poor health. A very poor family may have little to eat and limited access to health care. The children can miss school because of health complications from malnourishment. As a result, they grow up with little education or skills and partake in limited work. Their parents could die young from preventable diseases and the children are left to look after themselves. As the children reach adulthood, they may have their own children who grow up in similar conditions, so the cycle continues.

This is not an issue that is isolated to developing nations. The Red Cross Australia estimates that 2.5 million people – nearly 14 per cent of all Australians – are unable to supply themselves and their families with life's basic needs and are living on or below the poverty line. Poverty affects people regardless of geographic location, ethnicity, background, religion or creed.

Figure 1.21 Absolute poverty is often a cycle that is difficult to escape.

Australian Red Cross

Figure 1.22 Information on Australians in poverty

FOOD IN FOCUS 1.3

BELLA'S STORY

Bella* grew up as a poor child and teenager in an Australian country town. She knew what it meant to go to bed hungry. But life wasn't always that way. For the first years of their lives life was often joyful for the little girl and her siblings, until their parents' marriage broke up. Bella grew to know the misery of exclusion; of being teased by classmates for being 'poor'. She missed out on several school excursions and camps. 'I was acutely aware that I was different; we just didn't have the money to send me on extra activities like camps,' says Bella. 'Mum did her best but they were hard times.' It was as a young teenager that Bella, her siblings and her mother came into contact with their local Salvation Army corps. Bella's mother gained some much-needed emotional

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and material support from caring people. Things really began to change for Bella and her family. The practical help from The Salvation Army was important, Bella says, but the main difference was 'that someone really cared about our future'. Discussing poverty can seem unreal to many members of Australia's wealthy consumerist society. It can be hard for middle class, 'well-off' Australians to relate to the shame and blame that Bella experienced as a 'poor' child. The Salvation Army is committed to fighting against poverty for children like Bella. *Name changed to protect privacy

Others, Issue 14, Oct 2010, The Salvation Army, Australia Southern Territory, Social Programme Department

RESPOND

1. What factors contributed towards Bella's initial poverty?
2. Discuss some of the consequences of growing up poor in Australia?
3. How did Bella and her family break the cycle of poverty?
4. Why is it important to discuss issues like poverty in Australia?
5. How can you help to make a difference to people who are living below the poverty line?

The factors that lead to poverty are complex. It is not possible just to fix one thing, and make the problem go away. To release people from this cycle of injustice, many organisations have programs for children, youth and adults in countries around the world. Organisations such as Oxfam, Caritas and smaller groups like CanHelp all act to break the cycle of poverty by empowering individuals and communities to make a difference. Caritas Australia says the best way to begin to eradicate poverty is by 'providing low-income earners with good health care and education; reducing military spending and promoting peace; creating employment for the poor; working towards a sustainable environment; reducing the gender gap; cancelling debt; increasing overseas aid; and promoting fair trade'.

UN ending poverty and hunger video

FOOD IN FOCUS 1.4

CanHelp

CanHelp is an Australian-based charity that exists to enhance the quality of life for members of poor communities in Nepal and Cambodia, with particular focus on the education of children and the empowerment of mothers. Through projects such as child and teacher sponsorship, bicycles for children and small business support, CanHelp is improving the socioeconomic circumstances and self-sufficiency of communities by socially empowering and assisting people to become economically independent. These programs significantly enhance feelings of self-worth, and importantly; through the rise in status and education of girls the potential to improve family planning resulting in reduced population pressures at the family, community and national levels.

Source: Adapted from CanHelp.org.au

RESPOND

1. Describe the main focus of CanHelp.
2. What types of projects does this charity offer?
3. How does CanHelp make a difference to communities in poverty, in the short and long-term?
4. Visit the CanHelp website. Examine the effects of three of the initiatives CanHelp has had on individuals and communities.

CanHelp

EXTEND

5. Investigate one other aid organisation and discuss the initiatives they are using to help communities break out of the poverty cycle.

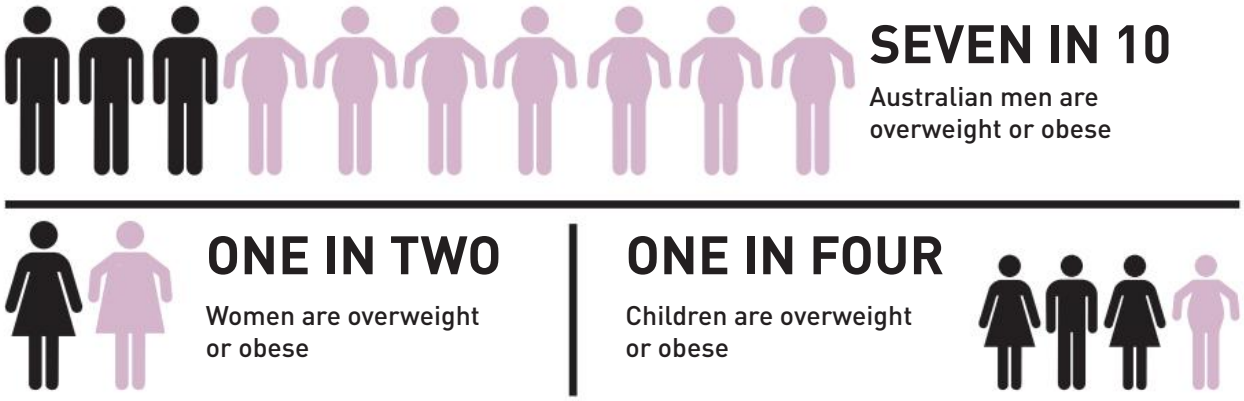


Figure 1.23 Affluence can also affect the availability of food – with many Australians making poor food choices.

AFFLUENCE

At the other end of the scale, lack of exercise, high incomes (affluence) and a taste for fast-food and sugary drinks have seen many Australians suffer from diseases associated with consuming too much of the wrong types of food. The general health of Australians is in decline and a large proportion of our population is overweight or obese, which has long-term effects on our general health status.

Health problems are not limited to the poor or rich; however, issues related to excess weight impose substantial economic burdens on individuals, families and communities. The direct cost of overweight and obesity in Australia is over $50 billion. Direct costs include general practitioners, allied health, hospital care, pharmaceuticals and weight-loss intervention, while the indirect costs include absenteeism, productivity and government subsidies. These issues will be examined further in later chapters of this book.

The politics of food

Politics refers to our system of public administration or government. The people in political power decide how tax revenue will be spent. They allocate money to address food or health problems, and regulate the food industry and its products to make sure food is healthy and is distributed safely.

Food is a vital commodity in the world and the availability is therefore greatly influenced by economic and political factors. On the world market, food is a major item of trade. Most countries are involved in the import and export of food. Imported food is used to feed the country's population and/or used by food processing companies to make their products. Exported food earns the country valuable export dollars which help pay for other commodities.

Shutterstock.com/Dan Breckwoldt

Figure 1.24 The Australian government operates on three levels – federal, state and local. Each of these can have some influence over food availability and distribution.

SOCIAL JUSTICE

The food systems in developing countries today face three major challenges:

1. the need to ensure food security, domestically and globally
2. that the production and consumption of food must be environmentally sustainable
3. that food policy must promote public health.

Only a socially just food system can meet these challenges, but considerations of fairness are largely peripheral to food policy debate, which instead tends to focus on economic and environmental issues.

Shutterstock.com/dworri

Figure 1.25 'Almost certainly, however, the first essential component of social justice is adequate food for all mankind.' – Norman Borlaug

The effect of government policy on food availability

Availability, pricing, variety and quality of the Australian food supply are all affected by government policies. Government decisions can change information available to consumers and ultimately affect the confidence consumers have in the food supply.

Policies can define regulations and either encourage or restrict trade and investment. The government can control how much money they will invest in things like food production. They make decisions about how much money will be spent to address food problems, what lands will be used for food production, what crops will be grown (for individual use or export) and how food will be distributed.

TAXATION

There are many forms of taxation in Australia. Individuals and companies are required to pay taxes or charges to local, state and federal governments. Taxes are collected to pay for public services like education, roads and hospitals and to help certain people in the community, such as people with a disability or the unemployed. One tax that all Australians must pay is the Goods and Services Tax (GST). GST is a broad-based tax charged on most goods, services and other items sold or consumed in Australia. Any processed or manufactured goods including food have this tax added to their final price. Fresh fruit and vegetables, meat, eggs, bread, some dairy products and other basic items are exempted from the tax.

A tariff is a tax that adds to the cost of imported goods and is one of several trade policies that countries like Australia can enact. Governments may impose tariffs to raise revenue or to protect domestic industries from foreign competition. Tariffs make imported goods more expensive, which gives consumers an incentive to buy domestically produced goods. With a free Trade Agreement in place, tariffs work both ways. Chinese tariffs placed on Australian-made dairy products will be phased out over the next decade, opening up new opportunities for Australian farmers into this market. Australian cheese producers are already reaping the benefits of tariff-free exports to South Korea.

EMBARGOES

Embargoes are the partial or complete prohibition of trade with a particular country or a group of countries as enforced by government and international communities. They are used in a variety of political situations such as a punishment for acts of terrorism and arms trading. In recent times, the Australian government placed a ban on exporting live cattle to Indonesia as many animals were enduring routine abuse and brutal slaughter. This ban devastated farmers and regional economies with the industry losing billions of export dollars. The issues were quickly rectified and since then new conditions have been written into export permits and new markets, such as Vietnam, have been established. The suspension and the resulting changes in Indonesian policy slowed the trade significantly, but in the past years it has recovered to levels greater than before the ban.

AAP Image/Xavier La Canna

Figure 1.26 Controversy surrounds live cattle exports to Indonesia

Another example is the ban on importing fresh bananas into Australia. Despite pressure from countries such as New Zealand, there are no fresh banana imports because of the disease threat they pose to local production. Russia has imposed a full embargo on food imports from Australia including beef, dairy, fruit and vegetables. This was retaliation from Russia against Australia who had acted with other members of the international community to impose sanctions against Russia over its conflict with Ukraine. This ban left Australian producers with excess produce and it contributed to dairy oversupply problems in the domestic market.

PRACTICAL APPLICATION 1.2

DEBATING POVERTY

Conduct a class debate using one or more of the following topics:

1. Poverty is only a problem of the developing world
2. Everyone in Australia has equal access to food
3. Enough food is produced in the world that hunger should not be an issue

Record your own opinions on each topic into the summary sheet.

SUBSIDIES

Subsidies are payments made to producers to encourage local production, supplement income and assist in operations. The USA provides subsidies for wheat farmers to enable them to put their product on the world market at a lower price, and India offers a subsidy to help sugar producers get their product to port.

This creates problems for local farmers who cannot compete with cheap imported foods. Australian farmers receive the lowest levels of subsidies of any nation's farmers, and the government supports them by enforcing tariffs or embargoes on imported produce. There are limited subsidies offered in the area of research and development to food manufacturers looking to export their products to emerging Asian markets.

EXPORT STRATEGIES

Trade is important part of the global food system. Very few countries are able to produce everything. Australia has a strong tradition of sending much of its primary produce to overseas markets. Currently we export approximately 60 per cent of the food we produce. China, Indonesia, Japan, South Korea and the USA are some of our major export partners. Australia's reputation as a producer of clean, green and safe food has created high global demand for Australian food products – particularly beef, wheat, canola, barley, sugar and dairy. Some other high-value products including truffles, saffron and vanilla make up a more niche export market.

The government has a significant role to play in facilitating market access for Australian producers globally. Australian trade representatives are vital in reducing barriers and developing free trade policies with agricultural trading partners, to assist farmers in reaching existing and emerging markets. The establishment of a national food brand that builds on the existing credentials of Australian produce in foreign markets – food safety and quality and innovation – will help to build a solid reputation to compete against strong global competition.

WAR

War and armed conflicts are often associated with poor food security, famine and death. There is a link between countries at war and poor food availability.

Most conflicts disrupt food production through physical destruction and plundering of crops and livestock, harvests and food reserves; they prevent and discourage farming; they interrupt transportation, which affects food distribution and they interfere with humanitarian relief. Wars destroy farm capital; conscripting or recruiting young and able-bodied men, taking them away from farm work and suppressing income earning occupations. The impact of conflicts on food security often lasts long after the violence has ended, because assets have been lost, people are killed or injured, populations are displaced, the environment damaged and health, education and social services devastated.

Using the starvation of civilians as a method of warfare is a well-known and recognised war crime.

Sadly, in recent times, countries like Syria and South Sudan have deprived people of their means of survival by blocking relief supplies sent in by aid agencies, such as food and medicines – a potent military tactic used as part of long-running conflicts. Innocent civilians died from starvation and those who survived were malnourished and traumatised.

Achieving food security for all, now and into the future, is a basic human right. Australia might be food secure, but not everyone has a place at the table. Food security in Australia means good conditions for farmers, sustainable food systems, fair food retailing and access to healthy food for all.

PRACTICAL APPLICATION 1.3

WAR AND FOOD

AIM

To investigate the effects of war on food supply.

METHOD

In small groups, research the effects of a recent war on the population's access to food. For example, you could look at the recent conflict in Syria. Share your findings with the rest of your class. Use the think/puzzle/explore template to help you develop your findings.

RESPOND

Display your results in the form of a fact sheet or infographic for display in your classroom or for publication in your school newsletter.

FOCUS QUESTIONS 1.3

REVIEW

1. Discuss, using examples, the state and type of economy we have in Australia.
2. Describe the difference between relative and absolute poverty.
3. Explain the difference between a subsidy, embargo and tariff. Explain how they contribute to the food availability of a country.
4. Australia has a reputation of having a 'clean and green' food supply. Examine what this means and evaluate how it can contribute to our national economy.
5. How and why is food used as a weapon in war?

FOR YOU TO APPLY

6. Investigate Australia's current obesity epidemic. How does it compare to other developed and/or developing nations?
7. Design a small 'pop up' notice that could be incorporated onto your school portal or newsletter promoting a healthy lifestyle choice.
8. Make a list of foods you have in your home that are exempt from the GST and those that have had the GST applied.

EXTEND YOURSELF

9. Investigate Australia's current export strategies. Discuss how these strategies contribute to our nation's food security.

Chapter review

REVIEW

1 What is food security and how will it affect future food supplies?
2 Outline the historical changes to food availability in Australia.
3 Describe the ways food retailers have used technology in their marketplace practices to make food easily available to consumers.
4 Australia is considered to be an affluent county. Outline the effects that result from the abundance of food. Consider both positive and negative effects.
5 Describe how, over time, technology has allowed food manufacturers to make more food available to consumers.
6 Identify ways that world food hunger may be reduced in the future.
7 Explain the reasons poverty may contribute to malnutrition in Australia.

FOR YOU TO APPLY

8 Use current examples to discuss:
– the contribution of the state of the economy to a country's food availability
– the influence of government on food availability
– the effects of war on food availability.
9 Use an example to show how global migration has affected food availability in Australia.
10 Interview an older Australian about how the food available in Australia has changed over the last 50 or more years.
11 Develop a campaign aimed at reducing household food waste in Australian homes.
12 Research some iconic Australian restaurants. Investigate what foods they include on their menus and identify the reasons for their inclusion.
13 Hold a fundraising event to help raise awareness of an organisation working to break poverty cycles in Australia or overseas.

EXTEND YOURSELF

14 Investigate Australia's current export strategies. Discuss how these strategies contribute to our nation's food security.
15 Assess how history and politics have influenced food availability in modern contemporary Australia. Use specific examples to support you answer.
16 Create an infographic based on one of the issues you have learnt about in this chapter.

CHAPTER

2

Factors affecting food selection

Food choice is never a simple process; so many factors go into determining what people choose to eat in different parts of the world. As the adage goes, you are what you eat. This is especially true when it comes to people's food choices, which are influenced by a wide variety of internal and external factors that may actually have little to do with the food itself. We make many choices regarding food each day, and factors you scarcely notice influence why individuals choose one particular food over another.

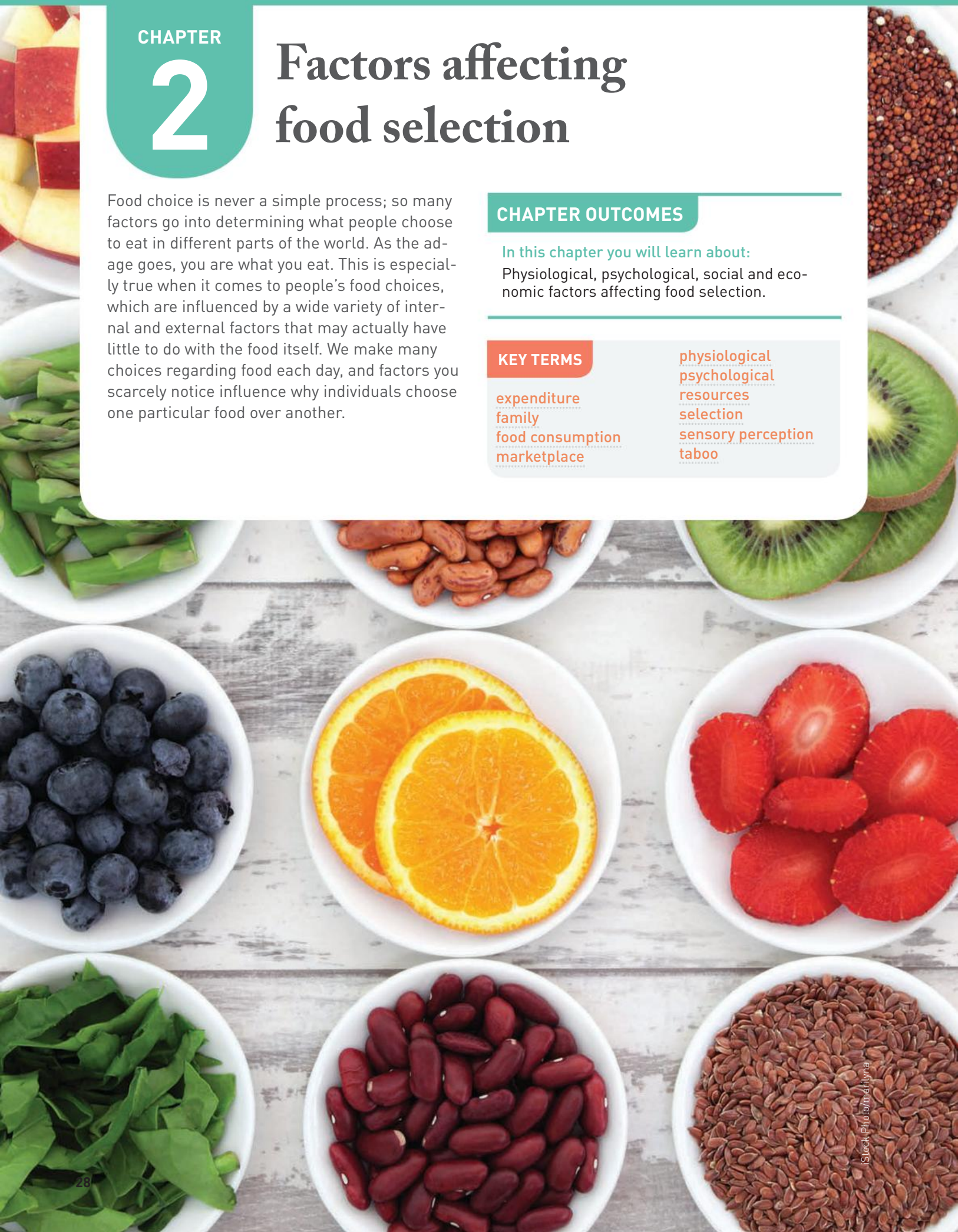
CHAPTER OUTCOMES

In this chapter you will learn about:

Physiological, psychological, social and economic factors affecting food selection.

KEY TERMS

expenditure
family
food consumption
marketplace
physiological
psychological
resources
selection
sensory perception
taboo



iStock Photo/marilyna

Physiological factors that affect food selection

Physiological factors affect the body's need and desire for food. Humans need energy and nutrients to survive and will respond to feelings of hunger and satiety. The central nervous system is involved in controlling the balance between hunger, appetite and food consumption.

PRACTICAL APPLICATION 2.1

FOOD SELECTION

AIM

To assess the reasons you select and eat the foods you do.

METHOD

Complete a 24-hour food diary. Record the foods you eat and the reason you are eating that food.

RESPOND

Account for the main factors affecting your food selection over the last 24 hours. Complete the following sentences in reference to your findings:

I used to think....

Now I think ...

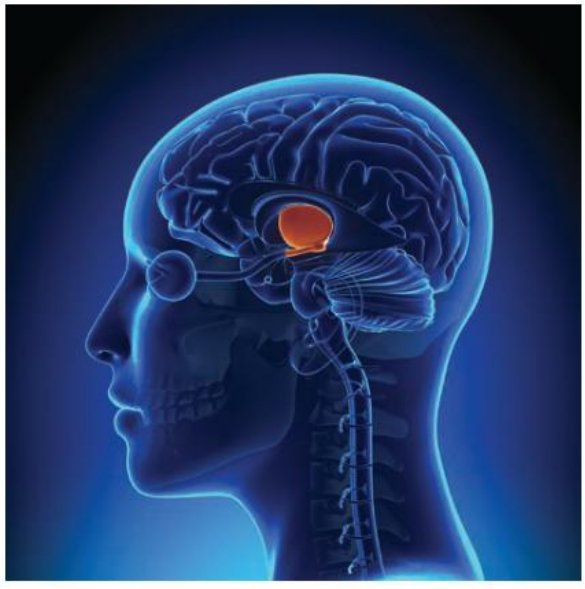
What makes us eat?

What, when and why we choose the foods we eat is a complex issue with many factors involved in this decision-making process.

HUNGER

Hunger represents the physiological need to eat food. It may be defined as a feeling of emptiness, weakness or pain caused by a lack of food. Numerous physiological cues tell us we are hungry, such as an empty or growling stomach, a decrease in blood glucose levels, light-headedness and changes in circulating hormones. This sensation makes it difficult for us to think of anything except food, making it the main focus of our lives until we eat something.

The gland that controls hunger is located at the base of the brain and is known as the hypothalamus. This small gland plays a key role in the body, working with the pituitary gland to regulate body temperature, control appetite, thirst and body fluids, prompt sleep and wakefulness and control the release of growth and sex hormones.



Shutterstock.com/decade3d - anatomy online

Figure 2.1 The hypothalamus is a small but important part of the brain.

APPETITE

Appetite is the desire or craving for food even when the body is not hungry. It is associated with sensory experiences or aspects of food such as the sight and smell of food, emotional cues, social situations and cultural conventions. 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 begins to water.

Hunger acts as the more basic drive, while appetite is more of a reflection of eating experiences. At times we are not hungry but have an appetite, such as when we see a tempting dessert after eating a full meal. Or we may be hungry but have no appetite, such as when we are sick or recovering from an illness. Other appetite stimulants or suppressants include stress, illness, emotional cues, culture, environmental influences, religion and social situations.

BMA Complete Home Medical Guide, 2010 © Dorling Kindersley Limited

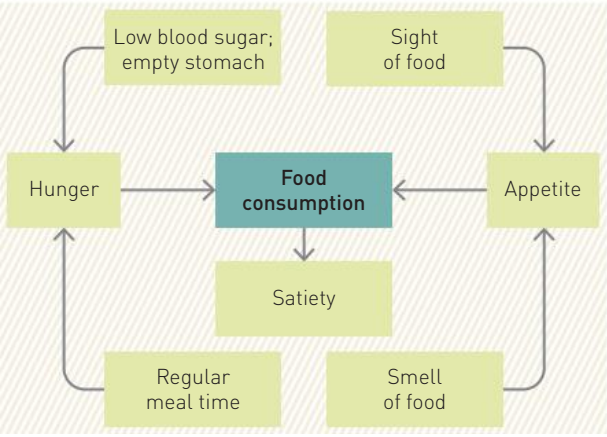


Figure 2.2 How much and how often we eat is determined by both hunger and appetite.

SATIETY

Satiety is the absence of hunger; it is the physiological and psychological experience of 'fullness' that comes when eating adequate amounts of food. Once you start eating and food enters your gastrointestinal tract, hunger will subside and satiation will start. Signals start in the stomach and travel to the brain then, as they increase, they promote the feeling of fullness and prompt you to stop eating. Once you stop eating, satiety continues to suppress hunger and appetite and stops you from wanting to eat again for a few hours.

Nutritional awareness

All humans have the same basic nutritional needs to enable growth and repair of body tissues, to regulate our basic life processes and to provide energy. The nutritional requirements of the human body vary from individual to individual and change as we move through different life stages. The factors that determine an individual's nutritional needs include age, gender, size and activity level.

AGE

Nutrition plays a critical role in every stage of our lives. Age is a biological factor affecting nutritional needs. From conception through pregnancy, birth, childhood and into older age, good nutrition supports health and wellness, improving quality of life.

iStock.com/RonTech2000

Figure 2.3 A healthy balanced diet is important at all stages of the life cycle.

A varied diet that includes plenty of nutrient-dense foods is recommended for everyone, regardless of age. However, at specific times in the life cycle particular nutrients are more important. At times of rapid growth such as childhood, during adolescence or pregnancy, people require more energy and protein for growth. Additional minerals such as calcium and iron are also favoured in these stages. Elderly people require less food because they are less active; however, they need to eat calcium-rich foods to maintain bone density.

GENDER

Both genders need the same essential nutrients. However, there are some significant gender differences in the quantities of specific nutrients needed to produce the optimal diet for health. One example of this is iron, where the recommended daily intake for an adult woman is about twice that for a man.

Muscle burns more kilojoules than fat, so people with more muscle require more kilojoules. Because women tend to be smaller and carry less muscle mass than men, their kilojoule needs are generally lower.

BODY SIZE

A larger person will use more energy than a smaller person doing the same task. Individuals who have larger builds require more nutrients to

maintain and operate their basic body processes. It takes more energy to move a larger mass than a smaller one.

ACTIVITY LEVEL

A person's activity level will affect their nutritional requirement. An athlete will need a different nutritional requirement than an office worker. Exercise improves metabolic efficiency in some people and increases nutrient requirement.

Sedentary activities
- sitting
- lying down

Light activities
- standing
- moving around home or school

Moderate activities
- walking briskly
- gentle swimming

Vigorous activities
- jogging
- aerobics

Food Solutions, Food Studies Units 3 & 4, fourth edition, Heath, McKenzie, Tully, Cengage Learning 2016.

Top to bottom: iStock.com/ImageDB; Shutterstock.com/antoniodiaz; Jacek Chabraszewski; Milkos

Figure 2.4 Examples of different activity levels

PHYSIOLOGICAL STATES

Physiological states, such as pregnancy and lactation, or varying states of health may lead people to consume more of certain types of food and/or less of other types of food. If, for example, a person has high high-density lipoprotein (HDL) cholesterol, they may opt to reduce the amount saturated fat in their diet. Those suffering from osteoporosis should consume additional calcium-rich foods. Food selection and consumption may also be affected by general health status. Those who are ill tend to eat less, and often prefer more simple, bland foods. The use of drugs may alter food consumption, as many drugs stimulate or suppress appetite.

PRACTICAL APPLICATION 2.2

NUTRITIONALLY BALANCED MEAL PLAN

AIM

Design a nutritionally balanced meal plan for yourself for one day.

METHOD

1. Include breakfast, lunch, dinner, snacks and beverages.
2. Justify your choices.

RESPOND

Show how this meal plan would change if you were over 70 years old.

Reactions to food

Individuals select or reject food based on their reaction to the food's physical appearance, its presentation, odour and taste. We use our senses to gauge the quality and appeal of food, and our judgements based on these reactions are called sensory perceptions. Each sense plays a role in this selection process including sight, smell, feel, sound and taste.

APPEARANCE

Your first reaction to food often comes from the appearance of the product. The size, shape, colour, temperature and surface texture all play an important role in this initial reaction. Food can be identified by sight alone—we don't have to eat a strawberry to know it is a strawberry. When we first look at food, we are in a sense already 'eating it' with our eyes: judging for shape and colour, ripeness or rottenness, smoothness or crunchiness, well-cooked or burned. Food that is displayed attractively looks more appetising – Our eyes have been conditioned to see certain foods in a particular way and while some colours stimulate the taste buds, others are capable of killing the appetite.

ODOUR

You judge a food by its smell. The aroma of a food can stimulate or suppress the appetite. Eighty per cent of what we perceive of the flavour of food is due to

Getty Images/Heinz

Figure 2.5 Kids preferences saw Heinz introduce 'fun' sauce colours but they didn't last long. Would you choose to use purple tomato sauce?

smell. The nose detects volatile smells released from food. Many people are especially alert to the smell of their favourite foods, such as cookies baking. Smell can also warn you away from foods; for example, many people recognise the smell of milk that has gone sour. Odour and taste work together to produce flavour. This is the reason why people with a blocked nose or poor sense of smell find it difficult to determine the flavours of foods.

Shutterstock.com/hartphotography

Figure 2.6 The sense of smell is one of the senses we can't turn off.

SOUND

The crunch of a chip, the snap of a celery stick, the popping of popcorn or the fizz of a freshly opened beverage influences how we think those foods will taste and how they will feel in our mouths. The sounds of food being prepared, cooked, served and eaten all influence our preferences and food choices.

FOOD IN FOCUS 2.1

HESTON BLUMENTHAL'S 'SOUND OF THE SEA'

Great food experiences are about so much more than just taste and in Heston's hands – on TV and in his restaurants – food becomes theatre, as he sets about engaging all of his diners' senses. He says our enjoyment of food depends on a range of sensory responses. Heston believes all the senses – taste, touch, sight, smell and sound – combine to contribute to our enjoyment when we eat and drink.

Katie Parla

Figure 2.7 Heston Blumenthal's 'Sound of the Sea'

>

One dish Heston serves at his Fat Duck restaurant uses sound to enhance the experience of the food. The ingredients for 'The Sound of the Sea' include seafood, kelp and seaweed, which are plated to resemble the seashore. Everything you see on the plate can be eaten, even the sand! When waiters serve the meal, they also bring each customer a small iPod in a conch shell, which plays sounds of seagulls and the ocean waves. Some diners are moved to tears by the experience.

Do particular sounds change our perceptions of taste? Scientists have been researching this subject and some early results show that listening to high pitches enhances sweet flavours while low tones emphasise bitterness. Additionally, the noise level has an effect too, with a 2011 study indicating that loud background noises can make it more difficult for us to taste sweet and salty flavours. This is some intriguing information to chew on!

RESPOND

1 Why do you think great food experiences are about so much more than just taste?
2 What senses does Heston believe play a role in our enjoyment of food?
3 How has the Fat Duck restaurant incorporated sound into the menu?
4 How does sound change our perception of taste?
5 What have scientists discovered about our reactions to food with changes in sounds?

TASTE

Taste is an incredible sense, sending information to the brain about whether you're eating sweet, salty, sour, bitter or umami.

Shutterstock.com/hilight

Figure 2.8 Umami, the enigmatic fifth taste, is a rich, meaty flavour and a catalyst that unlocks and defines the deliciousness in certain savoury foods.

The average adult person has approximately 10 000 taste buds that are able to detect the chemical constituents of food and beverages. These small sensors on the surface of the tongue, mouth and throat, work in conjunction with sight, smell and touch to tell us about the flavour of foods.

Taste may be described by association with a particular food, such as meaty, minty or fruity. The intensity can also be recorded; for example, mild or strong cheddar. Taste is a learnt sense. Sometimes, when you first try a new food, you do not really like it; but the more you eat it, the more you grow to like it.

TEXTURE

Texture can be assessed through touch – the sense we use for picking our foods because it allows us to pick up on texture, astringency, consistency and temperature. Generally with food, we start our touch evaluations with our fingers and then, as the food moves towards our lips, we experience the mouthfeel. Different sensations are felt as the food is chewed. It can tell us whether a steak is tender or chewy, dry or moist, if the soft drink is bubbly or flat, if fruits are crispy or rubbery. Viscosity is also a factor – if yoghurt is runny or thick. Touch inside the mouth also determines a food's temperature and spiciness. Heat and cold are detected by the taste buds. The sensation of spiciness, like the one caused by capsaicin in hot peppers, is caused by irritating nerves.

Supertaster test

PRACTICAL APPLICATION 2.3

SENSORY ASSESSMENT

AIM

To experience how our senses work together.

METHOD

1 Cut an orange into segments. Hold your nose and close your eyes. Taste the orange – describe the flavour and mouthfeel of this piece of fruit.

2 Now taste the orange with your eyes open, making sure you take a good smell of it before placing it in your mouth. How is this experience different to the first? Record your results in a table similar to below.

TEST	DESCRIPTION
1 – no sight or smell	
2 – all senses	

RESPOND

Consider and respond to the question: do our senses work together?

ADVERSE PHYSICAL REACTIONS TO FOOD

When people complain of symptoms such as headaches, bloating or mouth ulcers after eating, they are describing an adverse reaction to food.

Food allergy

A food allergy is an immune system response to a food protein causing distressing and often severe symptoms. The body mistakenly believes the food is harmful and releases histamine and other naturally occurring chemicals in the body, which subsequently cause inflammation. Symptoms are usually immediate and can be mild such as skin rashes, tummy pain and wheezing, or severe and even life threatening including swelling of the lips, tongue or face, throat constriction, breathing difficulties and rapid pulse and heart rate increase – leading to anaphylaxis. Immediate treatment with injected adrenaline can be lifesaving. People at risk of anaphylaxis should always carry an EpiPen with them for emergencies.

How to give an EpiPen

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Figure 2.9 The nine most common food allergens

Food allergy now affects one in 10 infants and about two in 100 adults in Australia. Some people may outgrow their allergy; however, some adults can develop a food allergy later in life after eating the food without a problem for many years.

Food intolerance

Food intolerance or food sensitivities are not so clear cut and it can take some time to diagnose the cause as reactions are delayed and symptoms may take several hours, or even several days to appear. The symptoms caused by these reactions do not involve antibodies and include migraines, bloating, diarrhoea, lethargy, joint pain and a general feeling of poor health. Food intolerance has been associated with asthma, chronic fatigue syndrome and irritable bowel syndrome (IBS). People can be intolerant to many different types of food but the most common include

1 IN 10

Babies born In Australia today will develop a food allergy

Figure 2.10 Allergies influence the food selection of many Australians.

milk and lactose (the sugar in milk), gluten, wheat, food preservatives and naturally occurring compounds in foods, such as caffeine.

Gluten-free muffins

Shutterstock.com/Alexander Raths

Figure 2.11 Skin prick tests determine the patient's reaction to specific foods.

FOCUS QUESTIONS 2.1

REVIEW

1. Explain the way the body operates to make us want to eat foods.
2. Use examples to illustrate how nutritional requirements change depending upon individual characteristics.
3. Discuss how our senses work together to help us fully experience the foods we consume.
4. Describe the differences between a food allergy and a food intolerance.

FOR YOU TO APPLY

5. Visit your local supermarket – outline at least five marketing tricks used in this store to make you spend more money while shopping. Use the connect/extend/challenge template to help you with your observations.

Psychological factors that affect food selection

Eating is an intensely personal act. What we eat communicates to others our beliefs, cultural and social backgrounds and experiences. Food choice is a complex process which depends on culture and is influenced by different factors such as values, beliefs, habits, attitudes, emotions, self-concept and experiences.

Values

Values are guiding principles in our lives that influence what we believe or do across a variety of situations. Values are generally a reflection of a person's upbringing and relate closely to culture and family. Values such as animal welfare, climate change or health and nutrition may guide many of our attitudes and actions when it comes to food selection. Consumers who have a deep passion about the environment tend to make more sustainable food choices – such as becoming vegetarian or eating less meat. Those who are concerned about health might follow a paleo diet or choose organic foods, while those who are concerned about human or animal welfare might choose fair-trade and free-range products. Our values are shaped by our experiences and can change throughout our lives. Growing concern for food origins is a value-based issue that has seen the emergence of local farmers markets in urban areas as well as 'grow your own gardens' programs emerge in schools around Australia.

Aquafaba meringues

Beliefs

One of the most significant factors influencing our food choice is what we learnt in childhood – our foundational beliefs. These are usually associated with culture and religion. Children who grow up learning to adhere to specially chosen or prepared foods for religious reasons may continue to be influenced by these experiences and beliefs into their adult life. For example, in the Buddhist religions consuming both pork and beef is frowned upon or considered taboo, as it is considered to be 'unclean' meat. For the same reason, followers of Islam and Judaism are prohibited from eating pork but can consume all other meats as long as have been halal or kosher certified. This means that special rituals are undertaken and prayers are performed to make eating these animals acceptable for followers of these religions.

Multicultural pizza

Sea creatures that do not have fins and scales, such as lobsters and oysters, are also taboo in

Judaism. In Hindu culture, cows can never be killed or eaten, as the animals are considered holy symbols. Most Christians consume meat without the need for any kind of repentance to God in the form of prayer; however, followers are encouraged to abstain from consuming meat on special days within the Christian calendar such as Good Friday, in honour of the Passion of Jesus. Other religions such as Jainism do not allow eating any meat or any vegetables grown beneath the soil.

Cultural food taboos vary across the world and to others food taboos seem to make no sense at all. What some people see as normal cuisine is deemed unacceptable or inedible in other cultures. Unwritten social beliefs dictating the acceptable consumption of food exist in nearly every society around the globe.

Although the origins are generally unclear, many food taboos are believed to have started as a way to protect populations from real or imagined health hazards, but in some cases they are a hindrance to good nutrition. A taboo may be followed by a whole national group or tribe, by part of a tribe or by certain groups in the society. In India, eggs are among foods that the Jain community and 'upper caste' Hindus are forbidden from eating. Many people in Western Africa believe that women shouldn't eat eggs or they will become sterile. In Papua New Guinea, menstruating women are believed to be weak and sickly, and therefore 'intense' foods such as bananas and meat are taboo during this time. They are also often not allowed to cook, as it is believed that food cooked by a menstruating woman will somehow 'contaminate' or spoil the food, making it poisonous. In Gambia, people from the Fulla tribe believe that if a pregnant woman eats beef, the baby will be born fat. Rat meat is a dietary staple for many communities around the world, including some in India, Vietnam and Ghana. In Laos however, it is taboo for pregnant women to consume rat meat. Some of these traditional food practices and taboos are believed to contribute towards malnutrition in some groups.

age fotostock/Tobias Titz

Figure 2.12 Some foods are spiritually significant to people, such as witchetty grubs to Indigenous Australians. These are often called totems. These animals and plants need to be protected and are either only eaten during ceremonies or not eaten at all.

Habits

Food habits are learnt behaviours that are a part of our daily routine. They shape why and how people eat, which foods they eat and with whom, as well as the ways people obtain, store, use and discard food. Over time, we develop patterns and routines to which we become accustomed. When it comes to eating, most people have strong habits; some are good, such as always eating breakfast, and some are not so good, like snacking while studying, watching television or listening to music. Acquiring tastes for highly salted foods or soft textured foods lacking in dietary fibre at an early age will continue into adulthood and are risk factors for diet-related diseases.

As a nation, food habits in Australia have changed over time. A recent report issued by the Australian Bureau of Statistics confirmed there is some good and bad news about our current eating habits. About 75 per cent of the population eat vegetables every day; however, most do not enough vegetables to meet the recommended daily intake. Just over half of all Australians meet the daily recommended intake of fruit and eating breakfast cereal is still an important part of our national food habits. Along with this, most of us consume at least one dairy product per day, but 90 per cent do not eat enough milk, cheese and yoghurt for

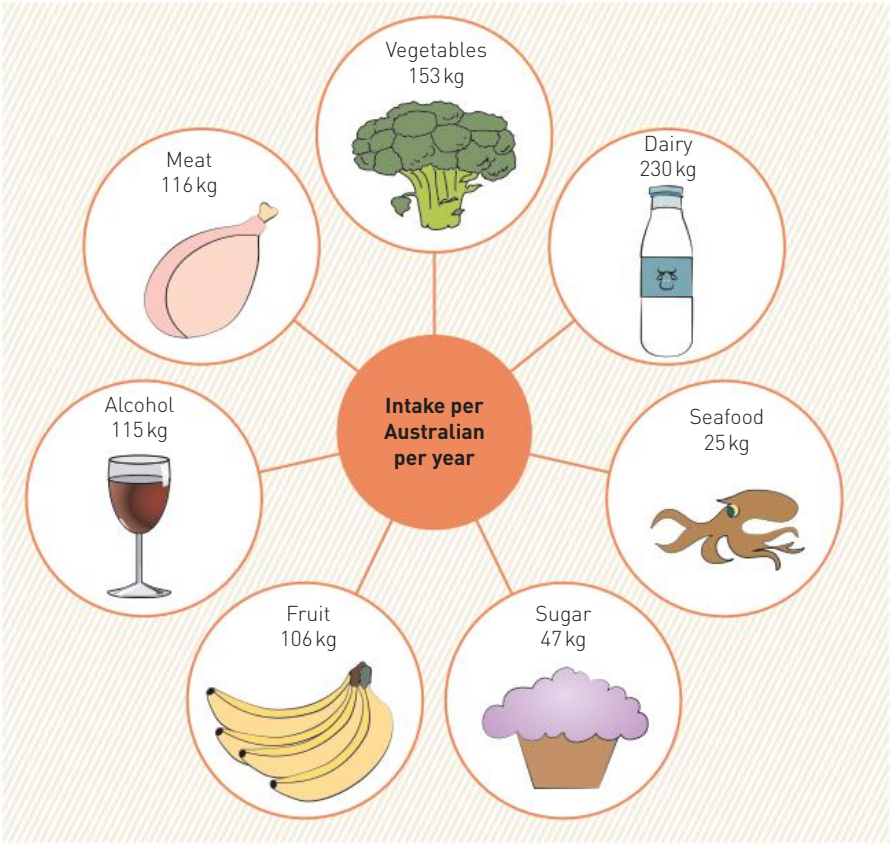


Figure 2.13 What do Australians eat?

optimal health. While we still enjoy carbohydrate-based products for our energy sources, 35 per cent of our average energy intake is coming from junk food or 'discretionary food'. It is no surprise that chicken has overtaken beef and lamb as our preferred source of protein, and fish is still popular. By promoting the increased consumption of fresh fruits and vegetables, as well as reducing our intake of discretionary foods, we could change our food habits to increase our overall health status as a nation.

Attitudes

Attitudes are an established way of thinking or feeling typically reflected in a person's behaviour. Attitudes vary by individual, within groups of a population and across countries. Our attitudes are shaped by our life experiences, our personal history and society in general.

We all have personal limits on what we do and don't eat and what we find acceptable. While most people would not want to eat a sheep's head or a rotting shark, this is an annual practice in Iceland when the population feasts to celebrate its Viking ancestry. Shellfish, for example, is loved in Australia and most parts of Europe, while some African and Asian communities find it revolting. Horsemeat is sometimes consumed in France, while Australians and Americans refuse to eat it. Residents in Asian countries like China and Korea have been known to consume dogs, and many are raised simply for human consumption. Cat meat is commonly found on menus in China, Vietnam and parts of South America. While some people might turn up their noses at succulent caterpillars or other insects, such delicacies make up an integral food source in several Asian, African and Latin American countries.

According to a survey by Newspoll, Australians today are worried about food safety and quality; believe what is added to food is harmful to our health; try to choose foods with no or fewer additives; believe food processing and pesticides are a major problem; and if the price was the same, would prefer to buy organic food.

1 There is too much sugar in packaged products.	2 Food from Australia is safer than food from other countries.	3 Farming/food production should be conducted in a manner not harmful to the environment.	4 I prefer to get nutrition from natural food sources rather than taking additional supplements and vitamins.	5 There is too much salt in our packaged products.
6 Food production should use our country's resources in a more environmentally sustainable way.	7 Eating less fat and sugar are equally important.	8 Artificially sweetened products are just as bad for you as the sugar they are replacing.	9 Food/drinks should be packaged in recyclable packaging.	10 There is too much fat in packaged products.

Ipsos Marketing Australia Food CHATs

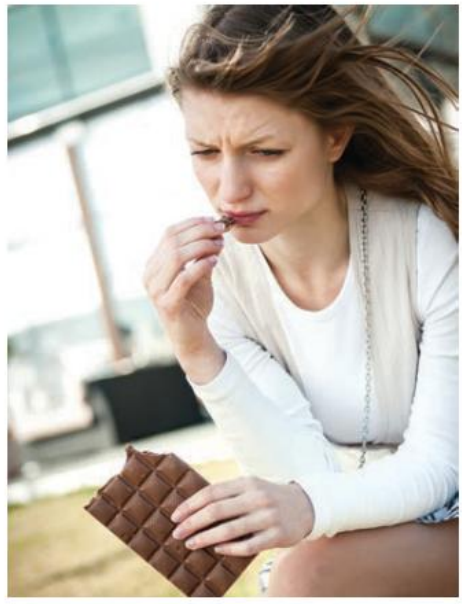
Figure 2.14 Australian attitudes towards food and health

Attitudes can and do change; as a nation our attitude to dietary fat has changed in the last 50 years. This is evident through a decrease in the amount and types of fat eaten in our diet today.

Emotions

The relationship between emotions and food is complex – from birth, we develop an emotional connection to feeding, eating and food. Food may be used to nurture, socialise, celebrate, calm, reward, relieve boredom or depression and to comfort in times of sadness and emotional distress. Positive and negative moods can lead to preferences for different kinds of foods. For example, if given the choice between grapes or chocolate, someone in a good mood may choose the former while someone in a bad mood may choose the latter.

Research suggests that low levels of vitamins, mineral deficiencies and low intake of fatty acids



iStock.com/Martinan

Figure 2.15 Studies have shown just how difficult it can be to eat healthily and resist so-called emotional eating in a stressful world.

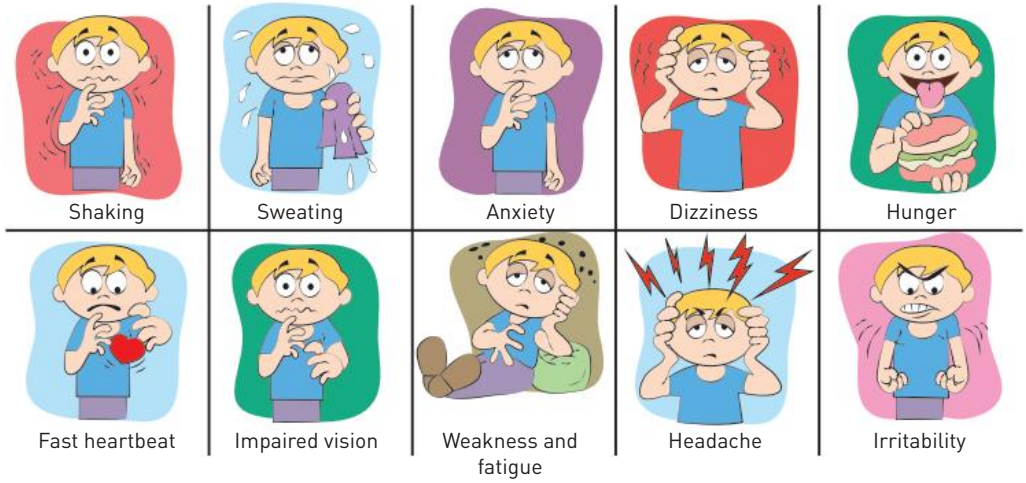


Figure 2.16 Symptoms of low blood sugar levels

and omega-3s can contribute to altered moods and emotions. Changes in blood sugar may also change your mood. High blood sugar can often lead to irritability, while low blood sugar can bring about feelings of anxiety, depression and lethargy.

FOOD IN FOCUS 2.2

WITH A CUP OF COFFEE ALL THINGS ARE POSSIBLE

When it comes to purchasing foods, emotions play a decisive role in buying decisions. Coffee consumption is an example of a product closely correlated to emotions. Coffee arouses a positive emotional charge among the people who drink it, and its consumption is linked to the emotions of pleasure, activity, energy and happiness. The start of the day is the time consumers prefer to enjoy a cup of this beverage and at this time it is linked to activity, energy and kindness. Coffee drunk socially is associated, depending on the atmosphere and the company in which it is drunk, with affection, yearning, friendship, satisfaction, good nature and pleasure. Coffee taken leisurely leads to sensations of calm, sweetness, peace, happiness and tranquillity. The reason this product is so appreciated worldwide can be found in the positive emotions it arouses.

RESPOND

1. Why is drinking coffee closely related to emotions?
2. What time of the day do most consumers enjoy a coffee? Why?
3. What are some of the social associations of drinking coffee?
4. Discuss how drinking coffee leisurely is good for a person's wellbeing?
5. Research the different types of coffees offered at most cafes. Describe the differences between them and think about the different emotions each might arouse.

PRACTICAL APPLICATION 2.4

CAFÉ VISIT

AIM

To observe and analyse your experience, and the experience of others, in a local coffee shop.

METHOD

1. Visit a local café on your own or with others.
2. Order a coffee or other beverage.
3. Sit at a table and observe.

RESPOND

4. Describe the setting of the café. Did this influence your emotions?
5. What sort of emotions do you think the other customers were feeling? Why?
6. Report on how the overall experience made you feel.

Self-concept

Self-concept encompasses all that you know about yourself. It includes certain personality traits, how you look, your personal values and life goals, and your place or role in life. The culture you are brought up in, your emotional development and even your education all affect your self-concept. Self-concept is ever-changing and continually developing as each person faces different situations, new information and fresh challenges. Attitudes and beliefs about yourself and what you eat determine the food selections you make and what you eat. If you see yourself in a positive and healthy light, your life experiences and food selections will be positive and healthy.

Experiences

Past experiences influence current food choices. Every individual has unique likes and dislikes concerning foods that influence their food selection. These preferences develop over time, and are influenced by personal experiences such as encouragement to eat, exposure to a food, family customs and rituals, advertising and personal values. The social group of an individual can further dictate what is popular or fashionable in food patterns or eating style and thus influence an individual's personal experiences with food.

How someone feels after eating a food can have a long-lasting effect on their food preferences. If eating a food is followed by negative effects such as nausea, then a person may develop a lifelong aversion to that food. Liking foods usually develops slowly and familiarity with particular foods leads to satisfaction and feelings of satiety. Early experiences with food and eating are vital in the developing eating patterns, which continue to develop and change throughout life. Neophobia is defined as an aversion to eating unfamiliar food. In infancy, when a child is mainly fed by adults, neophobia is rare, but it increases though early childhood as a toddler begins to explore their world and make choices of their own. Neophobia can be reduced with repeated opportunities to experience new food, helping children develop a taste for fresh nutritious foods such as fruits and vegetables.

Shutterstock.com/Elizabeth A. Cummings

Figure 2.17 Would you ever eat another apple if a worm crawled out of one you were about to bite into?

FOCUS QUESTIONS 2.2

REVIEW

1. Discuss the difference in values between a vegan, a lacto-ovo vegetarian and a pescatarian.
2. Identify some of your own good and bad food habits. Suggest reasons for why they occur.
3. Using specific examples explain what a food fallacy or taboo is and discuss how they may be detrimental to health.
4. Compile a list of foods that remind you of pleasant and unpleasant occasions. Do you know why you have these feelings about these foods?
5. Discuss how self-concept affects food selection.

FOR YOU TO APPLY

6. Write a response to the following question posted on an internet forum:
   'I think my best friend is out of control with her diet. She is way too skinny and exercises whenever she can. Do you think I am overreacting or maybe even jealous or could she really have a problem? What can I do?'

EXTEND YOURSELF

7. Plan a weekly menu for an active adolescent male who has decided to become vegan.

Social factors that affect food selection

Friends, school work, relationships, family and work combine to make food choices even more complex and challenging. Members of a social group depend on each other, share a common culture, and influence each other's behaviours and values. A person's membership in particular peer, work or community groups impacts food behaviours.

Often when you get together to enjoy food and beverages with your friends, the actual food is not as important as the social aspect. Usually when friends come to visit, they are offered food or beverages by the host to make them feel welcome.

Tradition and culture

People are connected to their ethnic or cultural group through similar food patterns – often using food as a social means to retain their cultural identity and to strengthen community bonds. The ingredients, methods of preparation, preservation techniques and types of foods eaten at different meals and during specific traditional celebrations vary among different cultures.

No matter where you are in the world, regardless of culture or religion, food is an

iStock.com/monkeybusinessimages

Figure 2.18 Eating out does not mean making unhealthy choices.

important part of any traditional celebration. Different countries use food in different ways to help celebrate special occasions such Christmas, New Year, weddings and birthdays.

World celebration foods

As food traditions vary widely throughout the world, sensitivity to food rules and customs is important. Culture plays a role in food-related etiquette, customs and rituals. In Australia as in most westernised countries, most people eat with knives, forks and spoons; other groups may use their fingers or chopsticks. Among some groups who primarily eat food with their fingers, diners in India and the Middle East use only the right hand to eat. Some people in parts of Africa use only three fingers of the right hand. Among other groups, use of both hands is acceptable. In some countries, licking the fingers is polite; in others such as Japan, licking the fingers is considered impolite.

Lifestyle

Your lifestyle has an important impact on the resources available to you. Sometimes people's lifestyles cause them to make choices they might not make otherwise. For most people, time largely determines what they eat. People experience increasing time pressures brought about by their jobs, school, family responsibilities, location and leisure activities. Time-saving behaviour related to food preparation and an increasing desire for convenience are significant aspects in daily food selection.

EMPLOYMENT

With the typical length of employment being 3.3 years and Australians today working an average of 17 jobs in their lifetime, we are seeing a shift from job stability to job flexibility. When and how often you work can influence your own food selection as well as your family's. Families with two working parents have little time for food preparation. Busy dual-income families may enjoy meals out of the home in restaurants. Conversely, poverty risks including inadequate food selection opportunities are highest in jobless families or low-income earners and lowest among dual-income families. Low-income groups have a greater tendency to consume unbalanced diets and, in particular, have low intakes of fresh fruit and vegetables. Access to more money increases the range of foods to select from but does not automatically equate to a better quality diet.

Shutterstock.com/Production Perig

Figure 2.19 Lunch on the run

What you choose to eat may depend on the physical demands of your type of employment. For example, construction workers require more energy than those working in an office. Active jobs require the worker to consume more energy through carbohydrate rich foods, while people who do sedentary work need to be careful not to overeat. Time-saving behaviour, such as eating on the run or having lunch at the desk, are habits that are associated with the business of working life. This is associated with a shift from the traditional three meals a day pattern, resulting in increased consumption of snacks and meal skipping.

EDUCATION

Most people value good health, but not everyone who is responsible for selecting food in the home has studied nutrition in detail. Preparing and cooking food is also important. Individuals require cooking skills or they are limited in their food choices and have little option but to purchase pre-prepared food. Some people gain knowledge and skills in food preparation by helping a more experienced cook to prepare food. Children helping parents with meal preparation or grandparents sharing their favourite recipes are two ways we learn about food. Participation in Food and Technology or Food Studies classes at secondary school is another way that young Australians can learn a wide range of skills in food preparation as well as gain knowledge about nutrition and making wise food choices.

More recently, television programs such as *MasterChef*, *My Kitchen Rules* and SBS's *Food Lover's Guide* have ignited a real interest in food, inspiring Australians to again discover the valuable skill of cooking. To meet these new demands, manufacturers and supermarkets have developed a range of strategies to assist such as point of sale or product recipe cards with step-by-step instructions to help inexperienced cooks and in-store magazines such as *Good Taste*, *Fresh*, *Super Food Ideas* and *Coles Magazine*. These are supported by various web pages that offer information about new products, how to prepare specific foods and suggested menu plans for the week – complete with a shopping list and details about how to store the ingredients. This valuable information empowers customers with limited food knowledge to evaluate food and make wise decisions about their nutritional intake.

FOOD IN FOCUS 2.3

MASTERCHEF

MasterChef's entrance into Australia has reinvigorated the food industry. The competitive TV show, based off the original British version was instantly popular in Australian households since its introduction in 2009 and continues be enjoyed by millions of viewers in Australia and around the world. The show has launched successful culinary careers for its contestants and inspired home cooks everywhere.

The reality TV show sees hand-picked 'home-grown' contestants participate in cooking challenges; their skills determining how far they proceed through the competition. Their dishes are critiqued by judges, and the show regularly sees celebrity chefs tutor the contestants, and even compete against them. *MasterChef* not only provides the contestants with greater food knowledge, but encourages the audience to cook.

The influence of the show upon the public and the food industry has been very significant with many viewers feeling encouraged to be more creative in their cooking habits. *MasterChef* has had a notable impact on the eating, cooking and shopping habits of Australians.

From Our Family Table by Julie Goodwin Copyright © Julie Goodwin 2010 Reproduced by permission of Penguin Random House Australia Pty Ltd

Figure 2.20 Many cookbooks have been published as a result of the MasterChef success.

Termed the '*MasterChef* effect', the revived interest of cooking gourmet food continues to be felt by food retailers with demand for unusual ingredients featured on the show growing. Other flow-on industries that have benefited from this phenomenon include cookbooks, magazines and cookware.

Source: FRDC/SCRC, Undergraduate unit for seafood marketing, Module 6 page 7, http://www.fishfiles.com.au/knowing/Pages/Undergraduate-unit-for-seafood-marketing.aspx.

RESPOND

1. What is *MasterChef* and how does it work?
2. Why do you think *MasterChef* has been so successful?
3. Discuss the influence this show and others like it have had on the Australian food industry.
4. Explain the concept of the '*MasterChef* effect'.
5. Make a list of other TV cooking shows that have also enjoyed success. Why do you think each of these shows has appealed to the Australian public?

PRACTICAL APPLICATION 2.5

MASTERCHEF MYSTERY BOX CHALLENGE

AIM

As a class, conduct your own *MasterChef* mystery box challenge.

METHOD

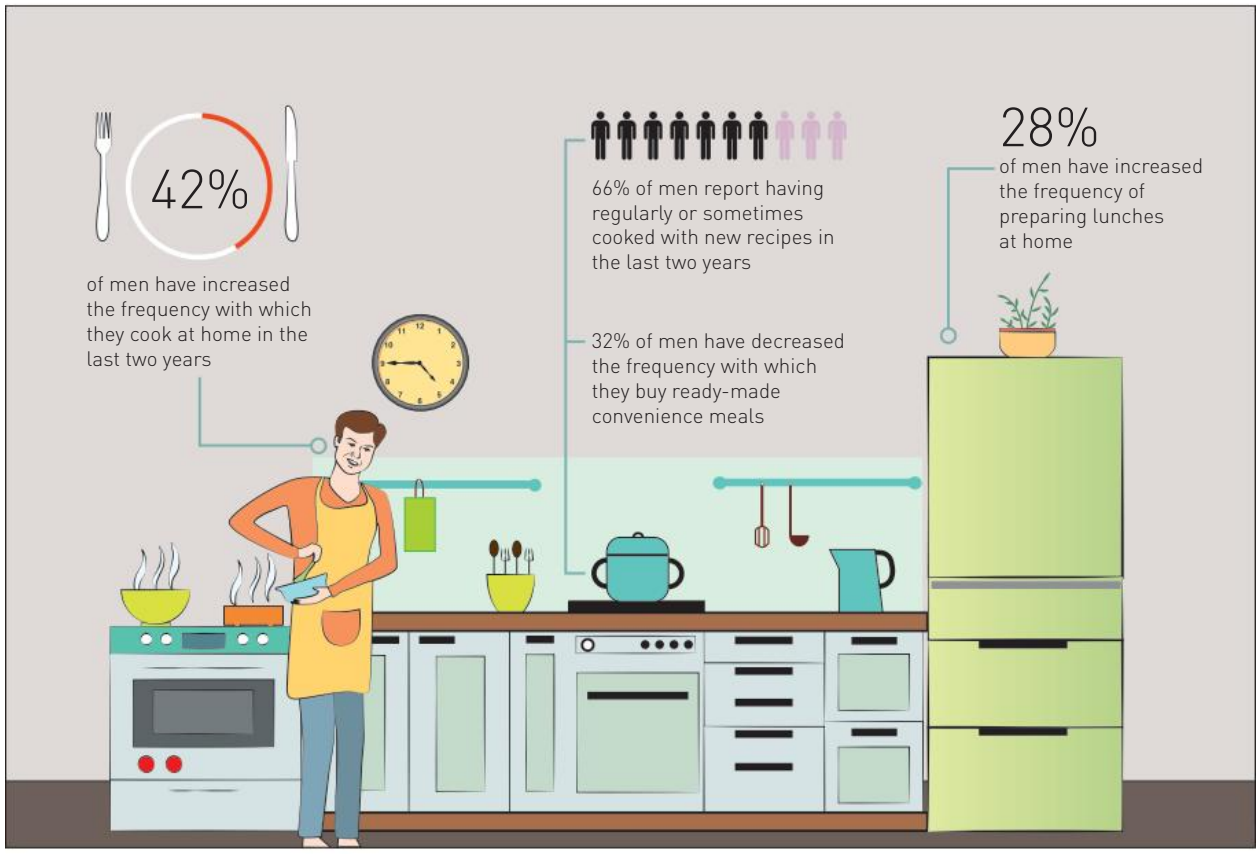
1. Your teacher will present you with a mystery box of ingredients. Use the ingredients from the mystery box to develop a meal within the time limit given by your teacher.
2. You could have a local chef visit your class to judge the winner of the event.

HOUSEHOLD ROLES AND STRUCTURES

The basic structure of Australian families is undergoing a substantial shift away from the traditional or 'nuclear' model of mum, dad, two children and the family pet. Today there is greater diversity in household structures with de facto couples, couples without children, multigenerational households, same-sex couples, step-families, single-parent households and blended families all being commonplace.

The roles that family members adopt within these various family structures might not be as traditional as they once were and can vary dramatically from one family to another. One of the most profound changes to the structure of Australian families is the increased presence of women in the workforce – not just as supplemental earners but as household breadwinners. In Australia, we tend to see dual-income situations where one partner works full-time while the other works part-time. Modern families are starting to see a greater proportion of households where the female partner is earning more than the male and traditional roles within the household have shifted.

The make up of the family unit as well as their employment status and activity schedules all determine the variety, quality and quantity of food consumed in a meal. Parents may be working different shifts and so cannot both be at home for meals with the family. Many teens may get home from school before their parents and so are responsible for preparing the evening meal for their families. Single-parent families where the parent is working see the children helping out more with food preparation and cleanup. After school activities can further complicate these issues with meals needing to be scheduled around the activities. This often means family members do not eat together but rather grab a snack whenever they can fit it in. People's busy lives have led to the growth of the fast-food industry, the development of drive-through restaurants, and innovations such as cup holders in vehicles. Many of these circumstances may see families purchasing ready-to-eat processed foods that can simply be heated and served; often not the best nutritional choice.



Mitsubishi Electric Australia Pty. Ltd.

Figure 2.21 Traditional gender roles are blurring thanks to men's increasing interest in preparing meals at home and entertaining guests. The result is greater equality in the kitchen than in previous generations.

GEOGRAPHIC LOCATION

Accessibility to shops and marketplaces is another important factor influencing food selection, which is dependent on resources such as transport and geographical location. Food affordability and quality may deter healthier food choices in geographically isolated communities. In remote locations, food supply is often limited to a 'general store' that is not always open, and is often expensive. Accessing fresh ingredients at a reasonable price is more difficult for people who live in these remote areas, such as communities in the Cape York Peninsula in Queensland, where the food truck only delivers once a week in the dry season and often not for months in the wet. This affects nutrition and has flow-on impacts to all areas of life: health, child welfare, education and mortality rates.

In larger towns or cities access to a wide range of supermarkets and fresh food markets is more reliable. Asian, Middle Eastern and Mediterranean supermarkets are now found in most large cities, increasing selection by making a variety of specialised, multicultural ingredients more available. Some suburbs have become centres for particular community groups; for example, Cabramatta in Sydney is home to many Vietnamese families so Asian greengrocers and butchers are a common sight. Norton Street in Leichhardt, also in Sydney, is well known for its authentic Italian flavours and supplies. Sydney Road, in the Melbourne suburbs of Brunswick and Coburg, is bustling with Middle Eastern bakeries, enticing shoppers to try the delicious Turkish pides, Lebanese flatbreads and wonderful pastries such as pistachio baklava or pine nut nightingale nests.

With food miles being a growing consideration for consumers we are now encouraged to buy locally and cut down on the distances our foods travel to reach us. Farmers' markets and local community gardens are examples of strategies developed to satisfy this growing consumer demand.

INTERESTS

A person's interests will influence their lifestyle and food choices. Many people a develop special interest around food and food experiences. A foodie is a person who has a particular interest in food, especially in eating or cooking. A foodie seeks new food

experiences as a hobby rather than simply eating out of convenience or hunger. They appreciate knowing the ingredients of food, the proper preparation of food, and find enjoyment in niche ingredients and exemplary preparation. They are concerned with where their food comes from, how it was raised and what's being added to it to make the end product.

With more disposable income and more leisure time to travel, consumers have become more interested in the various cuisines and cultures from countries all over the world, and are planning holidays specifically to incorporate culinary experiences. Food tourism tells the story of a destination's history, culture and people. Returning to familiar destinations to enjoy a tried and tested culinary experience, or travelling in search of new and unique cuisines, encountering unusual ingredients and enjoying local hospitality, gastronomy and food adventures have become a vital part of the tourism experience. Tourists not only want to taste the local food but also to learn its origins and the way it has been produced.

Exposure to a wide range of food experiences and cuisines has changed the basic expectations of consumers who now like to have access to a wide selection of multicultural food stuffs available on their return home.

With this ever-growing interest in food and the food industry, society has seen a rise in new food blogs and websites. Print magazines have expanded their online presence to cover a wider scope of food, recipes and travel and television cookery, and travel programs featuring food experiences dominate primetime viewing.

Social interactions

As discussed earlier, coming together to enjoy food can be as much about the social aspect of dining as about the meal. Social influences on food intake refer to the impact that one or more persons has on the eating behaviour of others, either direct or indirect, conscious or subconscious. Even when eating alone, food choice is influenced by social factors because attitudes and habits develop through interacting with others. Research has shown that we eat more with our friends and family than when alone and the quantity of food increases as the number of fellow diners grows. We also eat differently when we are with other people compared with when we are alone. Sharing a meal with friends, family or work colleagues is a common activity. Celebrating special occasions often involves food. Birthdays have cakes, weddings have special meals and many religious celebrations have their own food.

PEER GROUP

Peer pressure purchasing is about fitting in with others, so your decisions around food selection may correspond with a product or brand that your friends or family recommend or use. The type of foods, the time, place and style of eating and even what you wear to eat are all part of the patterns created. Every age group experiences foods that are peculiar to their group. Trends in food come and go in the food industry especially in those foods that market to a narrow age group such as breakfast cereals and ice-cream. Children starting school like to eat foods that are similar to what others in the group are eating to show they belong to this new social group. Peer influence is probably greatest in adolescence and can be active or passive. With the addition of social media pressures peer influence will continue to be a major contributing factor in our food selection process.

FAMILY HOSPITALITY

Food is associated with family, hospitality and expression of friendship. Sadly over the last 50 years for many reasons, the traditional family meal time has declined and with it went an interaction that was a precious part of family life. Meals were an opportunity to converse and to 'catch up' on the lives of family and friends. Today families tend to eat in shifts, fitting meals in around sport, hobbies, school activities and the hours of working parents. Meals are less formal than in earlier generations with many being consumed in front of television, at the kitchen bench or outdoors. Because of busy schedules, more meals are eaten out and takeaway foods are replacing home-cooked meals.

The average Australian household still entertains family and friends approximately eight times a year and entertainment that is done in the home has become more informal and often centres on the barbeque in the backyard or large easily shared dishes like tacos, pasta dishes, stir-fries and curries. Those who entertain in their homes find it saves them money, offers more flexibility and is more sociable.

Media

Today we live in a world full of information. When considering food selection, media is a powerful source of information and misinformation. Before the introduction of television, advertising food was via newspapers, radio, magazines and billboards. This impact was not as powerful as that now experienced through the use of television and social media.

Social media sources such as Instagram, Pinterest, Twitter and Facebook are redefining the ways people cook, plan their meals and eat. Food blogs, food forums and social networks centred on food are numerous. Social media changes food culture and selection by influencing how consumers think about, talk about and experience food.

Research has shown that advertising, no matter how it is carried out, plays an important role in promoting unhealthy eating habits, influencing the brands consumers choose and encouraging them to like and ultimately purchase salty, sugary or fatty foods rather than more nutritious choices such as fresh fruits and vegetables. Advertising aimed at specific audiences is very strong and effective. For example, family restaurants, confectionary and novel foods are aimed at children. The marketing messages created through the use of cartoon characters, jingles, celebrity endorsements, product placement in TV shows and films, smartphone 'advergames' with embedded brand messages and competitions strongly affect consumers.

Shutterstock.com/Golubovy

Figure 2.22 Australians share their food experiences, talk about them and often flaunt them through numerous online platforms.

PRACTICAL APPLICATION 2.6

SHARING FOOD PHOTOS

AIM

Design and make a meal or dish that can be photographed and published on a social media site.

RESPOND

1 Photograph your dish – did it turn out how you expected?
2 Evaluate the reasons for selecting your ingredients for this activity.
3 Why did you make the choices you made regarding how to present your dish?
4 Use the photos produced by the class as part of a see/think/wonder activity.

FOCUS QUESTIONS 2.3

REVIEW

1 Discuss the ways that tradition and culture can sometimes hinder food selection, using specific examples.
2 Why do many Australians often skip breakfast and/or lunch. What are the implications of this decision?
3 How have the changing roles and structures of the basic family unit in Australia changed our food selection patterns?
4 Evaluate how social media is affecting food decisions today.

FOR YOU TO APPLY

5 Compile a summary chart that illustrates common religious food practices. Include Buddhism, Hinduism, Judaism, Mormonism, Islam, Catholicism, Seventh-day Adventists, Pentecostal Christianity and any others you can think of.

EXTEND YOURSELF

6 Explore the following statement: Access to more money increases the range of foods to select from but does not automatically equate to a better-quality diet. Use the think/puzzle/explore template to help you with this task.

Economic factors that affect food selection

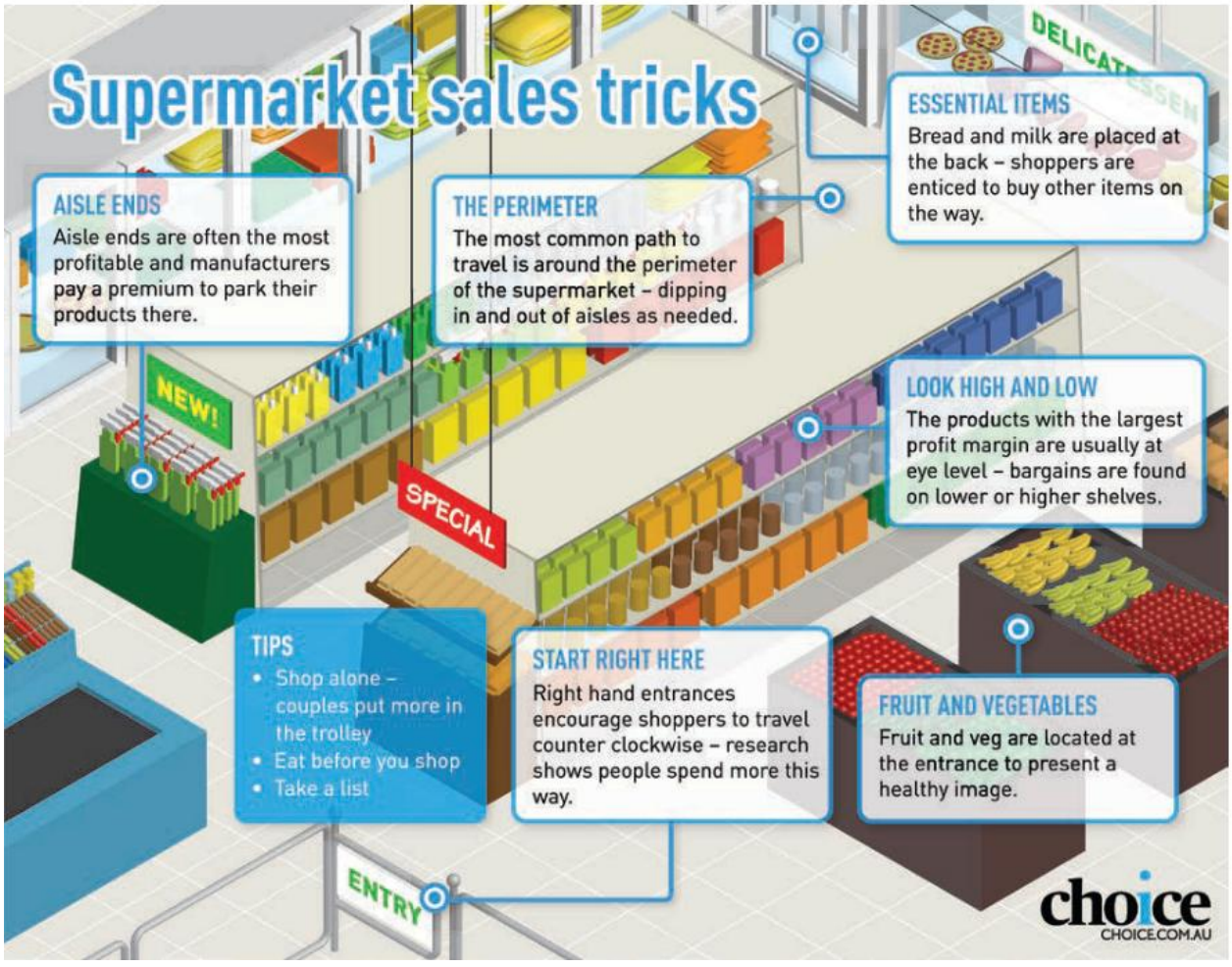
Economic decision factors such as food price and income influence people's food choices; however, other factors may also contribute.

MARKETPLACE

A market, or marketplace, is traditionally a location where people meet to buy and sell supplies. Retailers use a wide range of methods to encourage food purchases. Australia has a highly concentrated supermarket sector. Our two big players, Coles and Woolworths, control over 70 per cent of the market with smaller retailers like Aldi and IGA making some inroads. When you enter a big supermarket, fresh fruit and vegetables are often the first shopping zone you come across. This gives the consumer the impression that this marketplace is fresh and healthy. By setting up different 'marketplace' areas within one store, customers feel as though they have visited several different stores to make their purchases. In-store delis and bakeries further assure the shopper of the healthy, positive place they are in. The milk and bread are often at the rear of a store and more often than not at opposite ends – this encourages the shopper to walk right through the shop and be tempted to buy other products along the way. Private labels, specials, in-store advertising and shelf talkers (printed signs attached to a store shelf) further tempt consumers to make unplanned or impulse purchases.

Online retailers are also becoming a favoured point of purchase and tactics such as free delivery or saved favourite shopping lists entice online shoppers to make additional purchases.

Supermarket loyalty or reward cards are structured marketing strategies encouraging customer loyalty.



Graphic September 2014, reproduced with permission from www.choice.com.au

Figure 2.23 Do not be tricked into purchasing something you really do not need.

These cards are clever marketing tools and allow the retailer to build up a demographic profile of individual shoppers, and collect data about shopping habits by tracking how loyal they are, what they buy and how much they spend. Retailers can then use this information for targeted marketing bombarding customers with 'special' offers and 'preferred' advertisements from their marketing partners.

With all that to contend with, many food purchases made by consumers today, in particular staple purchases, tend be habitual. Habitual decisions are characterised by little or no conscious effort. These purchases are routine in nature, and sometimes we make them without even knowing. More often than not, consumers apply limited knowledge about price, brand and place of origin to food-selection decisions, such as which brand is on special or whether the product is Australian made. Raised consumer awareness of food trends have seen consumers apply more extensive decision-making processes to purchasing specialised foods such as organic or fair-trade products.

Available resources

With reference to economic factors, a resource is defined as a service or other asset used to produce goods and services that meet human needs and wants. In the case of food selection, this may include the factors money, time, available equipment and knowledge and skills.

MONEY

For many people, the cost of an item is the most important aspect of purchasing a product. Put simply, the amount of money you have determines what you can buy, and this is especially true for low-income households. When money is limited, the choice and variety of food is also limited. Price may also influence perception of a product as being superior or inferior, or the difference in deciding between products if more than one meets the consumer's requirements. The potential for food wastage leads to reluctance to try 'new' foods for fear the family may reject them and valuable resources will be wasted.

Evidence shows that across Australia, food is more costly in rural areas than metropolitan ones. Furthermore, limited availability, accessibility and high costs of nutritious food influence consumers who are socially or geographically disadvantaged and affect their ability to consume healthy food. Australians at particular risk of food insecurity include older people, those living in rural and remote areas, and those with a disability.

Some health experts have discussed applying a 'junk food tax' in Australia. Taxing unhealthy foods may provide an incentive for manufacturers to reduce the fat, salt or sugar content of their products to maintain market share. This, along with providing subsidies for transporting fresh foods in rural and remote areas, may change food selection for some groups in our community.

TIME

Time is frequently mentioned as a resource that is lacking in busy households. Families today tend to be busier, working and juggling many activities, and are quite prepared to compromise 'homemade' to save some time. This need has been met with a shift in the fruit and vegetables market from loose to pre-packaged, prepared and ready-to-cook products such as salad mixes. These products are more expensive than loose products but people are willing to pay the extra cost because of the convenience they provide. Other ready-to-eat meals or partially prepared meals such as pasta sauces and curry pastes are very popular choices for busy households. More time can be available for busy individuals and families if they plan their food shopping, buy, prepare and store foods when there is time so that less preparation time is required at busier times of the week.

Getty Images/Carla Gottgens/Bloomberg

Figure 2.24 Mixed lettuce and pre-prepared salad mixes are popular time savers in supermarkets.

Figure 2.25 The traditional family meal is becoming a thing of the past, with only half of Australians regularly eating meals at the table and more than one in three eating in front of the TV.

As mentioned earlier, lack of time has also lead to the loss of traditional family meal times. Where families once sat down and shared a meal together, family members are now often too busy to stop for a meal, instead grabbing a quick snack between activities or choosing to eat meals in front of the television. Enjoying family dinners at least four times a week has been linked to numerous benefits such as a lower risk of obesity, substance abuse and eating disorders, and an increased likelihood of graduating from high school.

KNOWLEDGE AND SKILLS

A lack of knowledge and the loss of cooking skills limit a consumer's food selections. The transition in cooking and food-preparation skills, involving the increased use of pre-prepared, packaged and convenience foods, which require fewer and/or different skills than what is often referred to as traditional or 'from scratch' cooking, has had some impact on the eating patterns of individuals and families. However, the creativity of cooking continues to fascinate many consumers and the numerous cooking shows, magazines, books and websites that offer a range of skills and knowledge in this area are a testament to cooking as a leisure pursuit. Ignorance and laziness may also be responsible for restricting choices. People living alone or cooking for one seek out convenience foods rather than cooking from basic ingredients. Low socioeconomic families may not have the nutrition and health knowledge to make the best food choices for the money they have available. In some suburban areas, councils and voluntary support groups provide programs to assist families to shop for food, helping them make wiser food selections.

EQUIPMENT

Many Australian households are now lucky enough to have a vast array of food preparation, processing and storage equipment and tools as well as cookware, bakeware and advanced appliances. Many homes now have devices such as a food processor, stand mixer, blender, electric kettle, steamer, electric toaster, microwave oven, refrigerator and freezer and a dishwasher. These labour-saving devices are designed to save time and money and to make daily food preparation more enjoyable. By the end of this century, the majority of kitchen devices will be interconnected, devices will share information between themselves, larger equipment such as the oven and fridge will be linked and information will be stored and shared across the internet.

PRACTICAL APPLICATION 2.7

FOOD-PROCESSING EQUIPMENT

AIM

To investigate modern electrical food-processing equipment and consider the manual tasks it has replaced.

METHOD

1. Make a list of all the food-processing equipment you have available to you at school and at home.
2. For each piece of equipment, describe the task it is used for.
3. Describe how this task would have been carried out before this equipment was available.

Occupation and finances

As discussed previously, work life and the type of occupation a consumer has can influence food selection. The physical demands and psychologically stressful working conditions of a job as well as its social expectations are reflected in food choices. The income received from employment also determines the quality and quantity of food chosen. For low- and moderate-wage earners, long hours, inflexible schedules, shift work and multiple jobs have an impact on the time and energy available for food purchase and preparation.

Individuals from higher status occupational groups tend to consume more healthy foods such as fruit, salad and vegetables, wholemeal bread and high-fibre breakfast cereals, while those at the other end of the financial scale consume energy-rich and nutrient-poor diets. In some cases, healthy foods such as fruit and vegetables cost more to purchase than a basket of junk foods, making choosing healthy more challenging for some groups. In recent years, research has shown that individuals with less education, working in manual occupations or with low incomes have less healthy diets as well as higher-risk factors for long-term diet-related chronic diseases than those with higher education, in professional occupations and with greater incomes.

FOCUS QUESTIONS 2.4

REVIEW

1. How has the retail and purchasing practices of Australians changed over time?
2. What are the advantages and disadvantages of using a supermarket rewards card?
3. Using examples, explain how good use of available resources can help an individual with food selection.
4. Outline how income may affect the food purchases of individuals and families.
5. Discuss how your occupation may affect your food selection.

FOR YOU TO APPLY

6. Design a healthy menu for entertaining a group of 10 friends in your home. You have a minimal budget to follow and your preparation time is limited. Justify your selections.

EXTEND YOURSELF

7. Investigate the current food consumption and expenditure patterns in Australia
   - i write a headline that captures what you already know about this topic.
   - ii investigate the topic further by following the 'What Australians are eating' weblink, above.
   - iii Write a new headline - How has your headline changed based on your learning?

Chapter review

REVIEW

1 Describe *three* social factors that have resulted in an increase in people dining out more regularly.
2 Discuss the role of media in food selection in Australia.
3 How would the household structure and different stages of the life cycle affect food selection in a family home?
4 Compare *two* types of tests used for sensory analysis.
5 Using examples, explain the sensory assessment considerations that consumers use in the marketplace when shopping for ingredients.

FOR YOU TO APPLY

6 Use the current food consumption tables or an online calculator (follow the Eat for health weblink) to identify your own specific nutritional needs.

7 Conduct a survey of your school canteen. Classify each of the menu items using a traffic light system (green = healthy, amber = okay, red = unhealthy).

8 Use the latest findings for the Household Expenditure Surveys from the Australian Bureau of Statistics to investigate the current consumption and food spending patterns of Australians. Summarise your findings into an article to publish in a food magazine.

EXTEND YOURSELF

9 Design and create a meal for an identified group. Justify why you have chosen the items in your menu and discuss any specific considerations you made while planning and preparing the meal.
10 Complete the extended response:
To what extent do various factors influence food selection for individuals and groups?

CORE STRAND REVIEW

MULTIPLE CHOICE

1 Global migration has influenced food availability in Australia by:

- **A** confusing consumers with too many choices.
- **B** creating acceptance and use of ingredients and preparation techniques from a variety of cultures.
- **C** promoting the use of Australian bush foods in restaurants around the world.
- **D** restricting the food choices available in the marketplace.

2 The hypothalamus is a part of the brain that controls:

- **A** body temperature, sleep, thirst, appetite.
- **B** hunger, thirst, breathing, appetite.
- **C** release of growth hormones, pain, body temperature, breathing.
- **D** release of sex hormones, heartbeat, hunger, sleep.

3 Relative poverty occurs when:

- **A** affluence is common.
- **B** basic needs can't be met.
- **C** limited resources are available.
- **D** there is low life expectancy.

4 Which of the following are psychological factors affecting food selection?

- **A** Aroma and values
- **B** Hunger and age
- **C** Lifestyle and beliefs
- **D** Self-concept and habits

5 The government regulates the movement of foreign products onto our supermarket shelves by enforcing:

- **A** embargoes.
- **B** subsidies.
- **C** tariffs.
- **D** taxation.

6 The most common resource in short supply is:

- **A** equipment.
- **B** money.
- **C** skills.
- **D** time .

7 A food intolerance is:

- **A** a chemical reaction to a particular food but is not a response of the immune system.
- **B** a response of the immune system to the consumption of a particular food.
- **C** much less common than a food allergy.
- **D** the cause of an anaphylactic reaction, which may be life threatening.

8 Lifestyle factors influencing the selection of food are:

- **A** attitudes and experiences.
- **B** household structure and roles.
- **C** occupation and finances.
- **D** self-concept and beliefs.

9 Australia is classified as a developed nation because of:

- **A** its isolation as an island nation.
- **B** over-cropping of soils.
- **C** the high levels of technology.
- **D** the largely subsistence economy.

10 Which of the following is a physiological factor that influences food selection?

- **A** Appetite
- **B** Beliefs
- **C** Lifestyle
- **D** Occupation

SHORT ANSWER

11 Describe how Australian bush foods are being incorporated into contemporary Australian cuisine. (3 marks)

>

12 Food producers are now relying on technology to help them produce quality raw materials. Outline three ways this is being achieved. (3 marks)

13 Explain how war disrupts food availability. (3 marks)

14 Identify the factors that may lead to unequal access to the world's food supply. (3 marks)

15 Discuss the reasons 'value-added' foods are popular in Australian households. (3 marks)

EXTENDED RESPONSE

16 a Describe current marketplace practices used in the Australian food industry. (7 marks)

b Assess how these may reflect the psychological and social factors that affect food choices. (8 marks)

17 Examine how the current food consumption trends and expenditure patterns in Australia reflect the historical changes to food availability. (15 marks)

CHAPTER

3

Safe storage of food

Appropriate food storage is important at every stage of production, from the paddock through manufacturing and to the plate. Safe storage makes food easier to use, helps maintain its quality so that it is appetising to eat and extends the amount of time it is safe to consume. It also means fewer resources, such as food, time and money, are wasted.

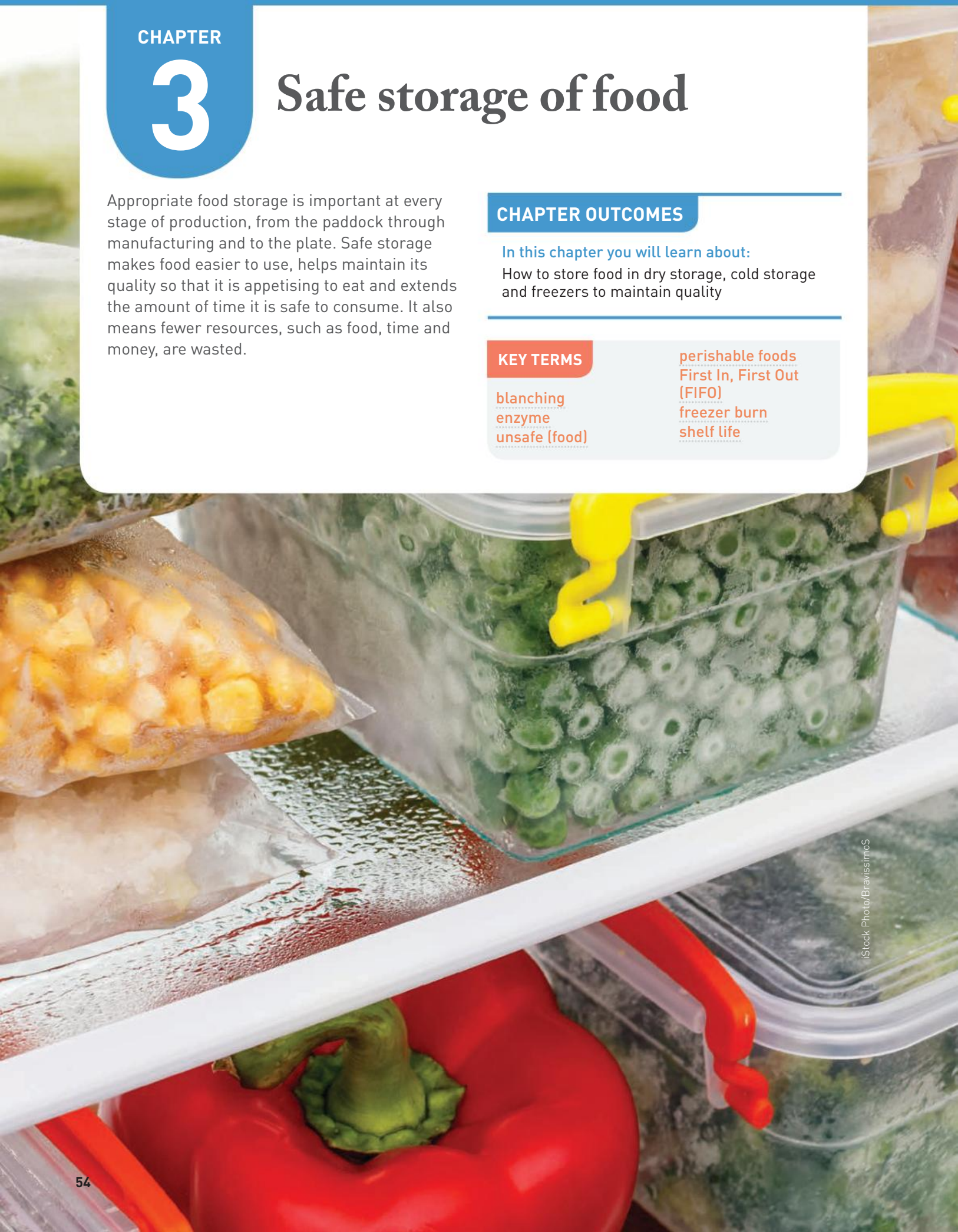
CHAPTER OUTCOMES

In this chapter you will learn about:

How to store food in dry storage, cold storage and freezers to maintain quality

KEY TERMS

blanching
enzyme
unsafe (food)
perishable foods
First In, First Out (FIFO)
freezer burn
shelf life



iStock Photo/BravissimoS

Methods of storing food

Vietnamese rice paper rolls

Food cannot be stored indefinitely, but if you employ appropriate storage methods you can maintain the quality of a food and extend its shelf life by:

- preserving the sensory properties of food such as colour, flavour and texture
- maintaining the nutritional value of a food
- delaying the action of enzymes in food that cause ripening and decomposition
- protecting food from spoilage caused by environmental factors such as air and moisture
- protecting food from contaminants such as microbes (yeasts, mould and bacteria) pests and chemicals.

Storage requirements of different types of food

WS Classifying perishable foods

All foods have a shelf life. Shelf life refers to the amount of time a food can retain its quality and be safe to eat. How you store a food depends on its shelf life or perishability. There are three types of foods based on their shelf life. Each has its own storage requirements.

Produce storage cheat sheet

PERISHABLE FOODS

Perishable food can go 'off' quickly if left at room temperature. When food is 'off', the food has been spoiled and is no longer is edible. It may have started to decompose, so that it no longer has desirable sensory characteristics – the taste, smell, texture or appearance is no longer appetising. It may also mean the food has become unsafe to eat because it is spoiled by microbes (yeasts, moulds and bacteria).

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Figure 3.1 Mould on bread is a clear sign it has gone 'off'.

All raw foods such as fruits, vegetable and meats contain enzymes. Room temperature (20–25°C) is ideal for the function enzymes play in speeding up chemical reactions in a food. Hence, enzymes help to ripen and age food until its eventual decomposition. Physical and chemical changes during decomposition often makes a food unpalatable because its texture, aroma or flavour changes.

The warmth of room temperature also encourages the growth of microbes. This may occur even before you can observe any changes brought about by enzymes. The presence of mould is detectable on some perishable foods, such as strawberries, and orange juice that has been fermented with yeasts has an unpleasant taste. Bacteria growth, however, – particularly food poisoning bacteria – is not as noticeable. Fresh chicken, for example, may become unsafe to eat if it is not stored at the correct temperature because of how quickly the bacteria multiplies over time.

Perishable foods usually last less than seven days, even when stored appropriately. For example, fresh meat lasts less than five days in cold storage. By law, most packaged perishable foods such as milk need to be labelled with a 'use-by' date, after which date the food becomes unsafe to eat.

Perishable food should be kept in cold storage such as a refrigerator or cool room between 0°C and 4°C to delay the action of enzymes and microbes. Many preserved packaged foods also need to be treated like perishable foods once opened, particularly those that contain animal ingredients such as long-life cream or chicken stock. This is because they are now exposed to external conditions that will spoil the food.

Perishable foods tend to be fresh, moist foods such as fruits, vegetables and many protein-rich foods.

Examples of perishable foods include:

- fresh fruit and vegetables
- fresh meat, poultry and seafood
- dairy products: milk, yoghurt, cream and butter, and soft cheese such as ricotta

- freshly cooked food
- sliced and shaved meats such as ham and devon
- fresh pasta
- bread
- opened long-life products such as milk, liquid stock and juice
- opened canned and bottled foods containing animal products or high water content foods
- frozen foods – ice-cream, pastries, fruits, vegetables, seafood and ready-to-eat meals.

Frozen foods are considered highly perishable foods. This is despite the fact that, depending on the food, a frozen food can last from a few weeks to a year under correct storage in a freezer. Food that is frozen is covered, and then placed into a freezer at a temperature below –18°C. Freezing converts the water in food to ice. With no water, no air and a very cold environment, the action of enzymes and the growth microbes are inhibited; the enzymes can no longer speed up chemical reactions in the food and microbes can no longer multiply. As a result, the food is preserved and will not spoil. The enzymes and microbes, however, are not destroyed; their actions are just slowed by the conditions.

Frozen foods need to be stored immediately after purchase or delivery and kept frozen at below –18°C until ready to use. Temperatures above –18°C will cause microbes in the food to multiply rapidly, which will affect its quality and may make it unsafe to eat. For instance, ice-cream that has been allowed to defrost before being placed into a freezer will no longer have a smooth creamy texture. After shopping, it is best to transport frozen and chilled perishable foods home in an insulated bag to maintain the quality and safety of the food.

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Figure 3.2 Stores use chilled displays to store perishable foods below 4°C.

SEMI-PERISHABLE FOODS

Semi-perishable foods last a week to several months, depending on the type of food and how it is stored. They last longer than perishable foods because their lower water content slows the action of enzymes and microbes or because they have been preserved, which controls microbial growth and enzymatic action, for instance with cured and smoked meats. Many also have a high sugar or fat content. Some require refrigeration of below 4°C, while others require dry cool storage.

Most packaged semi-perishable foods carry a 'best-before' date. At this date you can expect a food to retain its colour, taste, texture and flavour as long it has been stored correctly. After this date, the product may lose some of its quality but should still be safe to eat. Examples include:

- eggs
- cheeses
- unsliced small goods such as salami
- some vegetables, potatoes, onions, pumpkins
- nuts
- butter
- sauces
- dressings
- biscuits
- chocolate.

NON-PERISHABLE FOODS

Non-perishable foods do not spoil quickly, even when kept at room temperature. These foods are able to withstand months of unrefrigerated storage without spoiling or decaying. Most are dried foods with very low water content and many are processed packaged foods. However, once packaged foods are opened, they are susceptible to food spoilage.

Non-perishable foods are best stored in cool, dry, well ventilated cupboards, pantries or dry stock rooms. The food is best stored in its own package, but once opened it should be stored in sealed, waterproof and rust-proof food containers to protect it from air, dust and pests. Any leftover canned food should not be stored in the can as tin and iron can dissolve into the food, spoiling the flavour.

Some packaged non-perishable foods, particularly those from animal sources or that high in water content,

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Figure 3.3 Potatoes need to be kept away from light to stop them from sprouting. Storing potatoes in the refrigerator causes the starch to convert to sugar, producing a sweeter potato and discolouration when cooking.

need to be refrigerated after opening because they are prone to bacterial growth that could lead to food poisoning. These include jars of simmer sauces, cans of tuna or opened cartons of long-life milk.

Most non-perishable foods have a best-before date printed on their container, but if a food can last longer than two years, no date is required. This is why many canned foods do not carry any date marking. However, it is advisable that you do not keep unopened canned foods longer than 12 months because of the uncertainty of the true age of the product. Canned rhubarb, fruit juices, soft drinks and some baby foods have a maximum storage life of about six months because they are highly acidic.

It is important to follow the storage instructions on the food labels. Some food packages are labelled with specific instructions, such as 'refrigerate after opening' or 'consume within 3 days after opening'. These instructions must be followed to minimise the risk of food poisoning.

Examples of non-perishable foods include:

- flour
- sugar
- uncooked rice
- dried beans and lentils
- uncooked pasta and noodles
- pasta and simmer sauces
- tinned food
- breakfast cereals
- oats
- tea and coffee
- dried food, such as fruit, soups, powered milk
- packaged snack foods such as chips
- unopened long-life (UHT) products such as milk and juice.

PRACTICAL APPLICATION 3.1

PRODUCE A FOOD HAMPER

AIM

Make a food hamper using healthy non-perishable foods. Try to include foods that could be made into a meal. You could even establish a food drive and present hampers to a local charity.

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Figure 3.4 Food hampers make useful gifts. They are also a great way to help supply food to the needy.

MATERIALS

- Non-perishable foods such as pasta, rice, cereal, canned fruit, vegetables and soups, baby food and long-life juices
- Basket or container to hold food
- Cellophane, tape and ribbon for wrapping

METHOD

Gather your food items and arrange them in your basket or food container in a visually appealing manner.

RESPOND

1 Why are non-perishable foods suitable for this project?
2 What meals could be made from the ingredients in the basket?
3 Research and report on the activities of a local charity that collects food donations.

Alamy Stock Photo/Blend Images

Figure 3.5 Always read the storage instructions on food packages.

Food storage areas

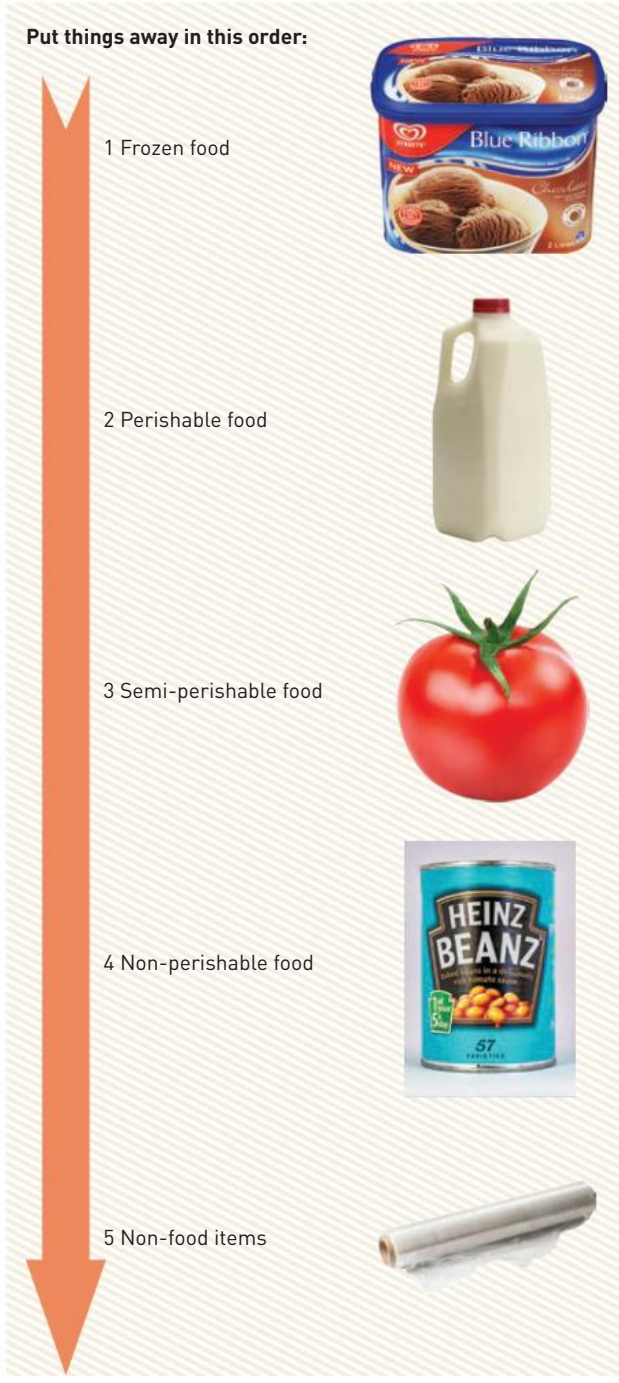
WS Storing foods

When food arrives home or at a place of business, it should be put into the correct storage areas quickly so that its sensory characteristics are maintained and it is not exposed to contaminants such as microbes, pests, dust, heat, dampness or humidity. The storage areas themselves also need to be kept clean and well maintained, and the temperature controlled.

DRY STORAGE

Dry storage is suitable for non-perishable foods. In the domestic kitchen, the pantry or cupboards are ideal for dry storage. In the food industry, open shelving or a dry stock room are preferred over cupboards, as they make it easier to store and access large quantities of foods. They commonly use stainless steel shelving as it is durable and does not rust or react with food.

To maintain food quality, dry storage temperatures should be between 10° and 21°C and at 50 to 60 per cent humidity. The storage area should not be exposed to direct sunlight as this could raise its temperature, causing some foods to dry out while others may sweat and become prone to growing mould. It should also be well ventilated to allow in fresh air and prevent dampness. Food should be stored off the floor in sealed containers or kept in their original packaging until opened, to avoid contact with air, dampness and pests.



Dlibrary.com.au
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Figure 3.6 The order to put away shopping or deliveries.

Many non-food supplies such as cling-wrap, foil and paper serviettes can be stored in a dry storage area, however, they should be stored separately to food. All chemicals, including sanitisers, detergents and fly sprays must always be kept in secure location where they cannot contaminate food or be easily

Table 3.1 Tips on storing different types of food.

TYPE	STORAGE
Dairy products	Fresh milk, cream and some soft cheeses have a short shelf life and must be refrigerated. Hard cheeses have a longer storage life but may develop surface mould if exposed to air and moisture. Reduced-salt cheeses may have a shorter shelf life than regular cheeses as salt is a preservative. Keep dairy products sealed to prevent them absorbing flavours from other foods.
Eggs	Eggs should be stored in the refrigerator for a longer shelf life and preferably left in their cartons with their pointed ends down. This will help to reduce moisture loss through the shell.
Raw meat, poultry to seafood	The term 'meat' includes beef, lamb, pork, etc. These items should be stored in the coldest part of your refrigerator at 0° to 4° C. Wrapped fresh meat can be kept safely for three days. The wrapping keeps the meat moist, but encourages the growth of micro-organisms, causing the meat to become slimy and unsafe to eat. Unwrapped meat lasts five days but the exposed surface dries out. This drying retards microbial growth but over-drying causes undesirable colour changes and loss of flavour. A compromise can be reached by storing meat in an adequately ventilated container or loosening the wrapping around the meat so air can circulate. The longest recommended storage time for uncooked minced meat, liver, kidneys, poultry and seafood is three days. They usually carry large numbers of micro-organisms that can grow even at refrigeration temperatures, so they should be stored as close to 0° C as possible. Pet food should not come into contact with meat for human consumption as it may have been produced under less hygienic conditions.
Delicatessen meats	Meat such as ham, corned beef, salami and other luncheon meats must be stored in the fridge. Sliced luncheon meats will keep 4–5 days after purchase. They need covering to prevent them drying out and should not be used if they develop a bad smell. Pre-packaged, vacuumed-packed delicatessen items can be stored until the 'best-before' date, but once opened, they need to be consumed within a few days. Some fermented salamis, bacon and whole hams will keep for 2–3 weeks.
Fresh fruit and vegetables	Fruit and vegetables should be handled carefully to avoid bruising and breaking the skin. Such damage will encourage deterioration and rotting. Most fresh produce is temperature sensitive and should be stored in the coolest part of the house or refrigerated. Different varieties of a fruit have different keeping qualities. For example, Granny Smith and Fuji apples have three times the storage life of other apples. Remove overripe, rotting or injured fruit, as these will trigger ripening and subsequent ageing in the remaining fruit. Rockmelon, pineapple, paw paw, bananas, mangoes, avocados, stone fruit, tomatoes and pears need to be ripened at room temperatures, but away from sunlight. Pineapple and bananas are chill sensitive and should not be stored in the refrigerator. To reduce mould growth, keep strawberries in perforated plastic containers. To reduce wilting due to water loss, keep leafy and root vegetables, such as silverbeet, broccoli, carrots and parsnips, in loose or perforated plastic bags in the refrigerator. You can extend the life of carrots, parsnips, turnips and beetroot by removing their leafy tops. Keep potatoes in a cool dark well ventilated place to avoid greening and sprouting; remove from plastic bags and store loose in a container. Sweet potatoes are cold sensitive and should not be kept in the fridge. To reduce mould growth in onions, whole pumpkin, marrows and squashes, store at room temperature under dry conditions, in a net or loose bag. Cut fruits and vegetables should be covered in cling-wrap to prevent moisture loss and any enzymatic browning as a result of exposure to oxygen. Foods that produce ethylene need to be separated from ethylene-sensitive foods. Ethylene is a plant hormone released in the form of a gas. It triggers cells to degrade, fruit to turn softer and sweeter, leaves to droop and seeds or buds to sprout. This why placing ripe bananas, apples or passionfruit with unripe fruit speeds up ripening. Most fruits produce ethylene while most vegetables are sensitive to it, which is why refrigerators separate fruits and vegetables into two crispers.

accessed by children. These chemicals should also be kept away from heat and stored in their original packaging, as the labels will provide data if there is an accident when using the product.

COLD STORAGE

Cold storage generally refers to refrigeration. It includes free-standing refrigerators, as well as walk-in cool rooms, refrigerated food display cabinets and refrigerated trucks. It is ideally suited to perishable and semi-perishable foods where, depending on its type, the food may last a few days or a few weeks in cold storage. As discussed, cold storage should range from 0–4°C. This temperature range retards the deterioration of food by enzymes and slows down the micro-organism growth.

Cold storage, however, does not kill micro-organisms or deactivate enzymes and if kept for too long in cold storage, foods will still decompose. For example, cheese can still go mouldy, fruit can become overripe and meat become slimy if kept for too long in cold storage. In addition, once a food returns to room temperature, microbes can thrive in the warmer temperature.

Tips for storing food in cold storage

- Do not open doors for too long, as warm air may enter, raising the temperature of the refrigerator.
- Cover food to avoid moisture loss and prevent the spread of food odours.
- Refrigerators usually have designated temperature zones for certain foods designed to maintain freshness, such as vegetable crispers.
- Separate cooked food and raw food.
- Cool hot food for 20–30 minutes before placing into cold storage to avoid raising the temperature of the cold storage.
- Label and date the food so you know what to use first.
- Keep food away from the cool room floor and walls to allow air to circulate.
- Store different types of meat separately.
- Store raw meat on bottom shelves and cooked meat on upper shelves to prevent the risk of cross-contamination from blood and juices dripping.
- Place meat and poultry in single layers with the fat side up; cover the trays.
- Store fish in the coolest part of the cool room or refrigerator.

Many new refrigerators have sensors that will alert you when doors have been left open and many commercial cool rooms have fans above the doors to ensure warm air does not enter.

Dreamstime.com/Sebastian Czapnik

Figure 3.7 Can you see any problems with this cool room?

FREEZING

Depending on the food, a freezer can store and maintain the quality of food for long periods, usually between three and twelve months. The process of freezing involves holding food at very cold temperatures of below –18°C, which converts the water in food to ice. At this temperature, the action of microbes and enzymes are inhibited, although they are not killed. Furthermore, with no access to water, and the packaging preventing exposure to air, microbes cannot grow. When the food begins to defrost, the microbes and enzymes are reactivated; hence defrosted foods should be treated like perishable foods.

Table 3.2 Recommended refrigeration storage temperatures for some foods.

FOOD STORAGE TEMPERATURE	°C	SHELF LIFE
Seafood	0–4	3 days
Crustaceans and molluscs	0–4	2 days
Meat	0–4	3–5 days
Minced meat and offal	0–4	2–3 days
Cured meat	0–4	2–3 weeks
Poultry	0–4	3 days
Fruit juices	0–4	7–14 days
Milk	0–4	5–7 days
Cream	0–4	5 days
Cheese	0–4	variable (1–3 months)
Butter	0–4	8 weeks
Margarine	0–4	variable (6 months)
Leftovers	0–4	3–5 days

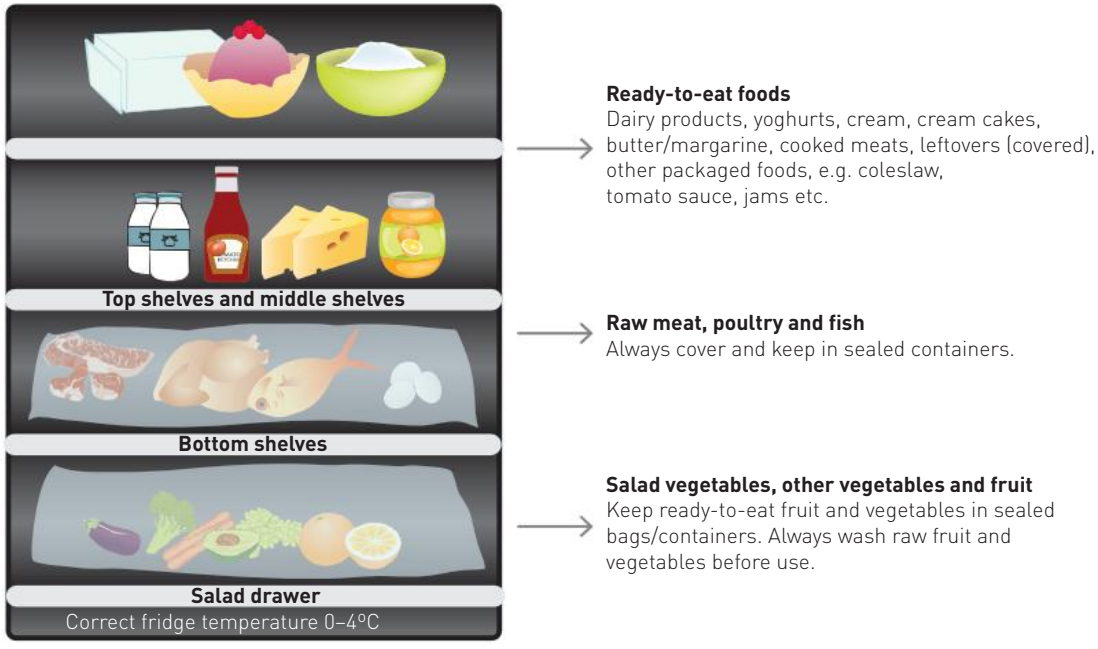

Figure 3.8 Appropriate storage of foods in a refrigerator helps maintain food quality and prevent cross-contamination.

Some frozen foods have a shorter storage life than others. For instance, mincemeat has a shorter storage life than larger pieces of meat as more of its surface area is exposed to air. Fresh foods with high water content such as fruits and vegetables do not freeze well, as the water forms large ice crystals that can break down the texture of a food. A tomato will go firm and keep its shape in the freezer but on defrosting its structure will collapse. Many vegetables also need blanching before freezing. This involves cooking the vegetables in boiling water until they return to boiling point and then stopping the cooking by placing the food into ice water. The heat destroys the enzymes in the food as well as any microbes present. Blanching helps to preserves the colour of the vegetable.

Frozen foods should never be thawed at room temperature as this places it in the food temperature danger zone for growing food poisoning bacteria while it is is left to defrost. This is particularly dangerous for high-risk foods such as meats and poultry. There are three acceptable methods for thawing food:

- Thaw food in the refrigerator at 4°C or below, but take care to avoid cross-contamination by preventing juices from the defrosted meat dripping onto other foods. It may take up to two days to defrost large cuts of meat.
- Thaw food under running water at 21°C or lower
- Thaw the product in the microwave if it will be cooked immediately

Thawed foods should not be refrozen as this increases microbe growth. Thawed food that will be cooked (such as raw meat), may be refrozen but its quality will be reduced. Smaller cuts of meat such as steaks and chops can be fried or grilled direct from frozen.

To allow cold air to circulate, it is important not to overload the freezer. It is also important not leave the freezer door open for long periods so the temperature does not rise above –18° C.

When packaging food, choose good quality packaging that is similar in size to the amount of food you wish to freeze, allowing a small amount of room for expansion. When wrapping food in cling-wrap, like meat, it is important to dispel air from the package. These processes prevent 'freezer burn', where ice crystals form on top of the food and the food becomes dry, tough and discoloured. Generally, the food is safe to eat once the burn has been removed.

When packaging food such as steaks, it is best to freeze them individually as stacking them will cause them to stick together and increases the time for the food to freeze. If freezing small foods such as homemade mini spring rolls, freeze them quickly on a tray and then pack to prevent them sticking together. Many food producers use a blast freezer for this purpose.

Hot food needs to be cooled before freezing so it will not increase the freezer temperature above –18°C. Remember to date and label food that you freeze so you can identify it and use the older stock first.

Getty Images/Jan Kruger

Figure 3.9 Freezer burn on meat

Shutterstock.com/humbak

Figure 3.10 Vacuum packaging helps to eliminate air and avoid freezer burn.

This table provides freezer storage times for many common frozen food items, so you know how long your frozen food can taste its best.

Table 3.3 Freezer storage guidelines

TYPE	TIME
Bread and desserts	
Baked bread and biscuits	3 months
Cakes, pastries, doughnuts, muffins	3 months
Produce	
Fruits	1 year
Juices	1 year
Vegetables	8 months
Nuts	3 months
Dairy and eggs	
Ice-cream	2 months
Butter	9 months
Cheese	3 months
Eggs (raw, not in shells)	1 year
Milk	1 month
Meats	
Mince meat	4 months
Beef (e.g. roasts, steaks)	1 year
Lamb and veal	9 months
Ham	2 months
Pork chops	4 months
Pork roast	8 months
Bacon and sausage	1 month
Poultry	
Chicken and turkey	1 year
Turkey and chicken mince	4 months
Seafood	
Fatty fish (e.g. salmon)	3 months
Lean fish (e.g. whiting)	6 months
Crab and lobster	10 months
Prawns and scallops (not crumbed or battered)	1 year
Miscellaneous	
Casseroles (cooked)	3 months
Pasta and rice (cooked)	3 months
Soups and stews	2 months

PRACTICAL APPLICATION 3.2

FREEZE FOOD

WS Freeze food practical application

AIM

Freezing is an excellent healthy method of preserving foods for future use. Practice freezing and packaging foods.

MATERIALS

2 small carrots
2 pieces of broccoli
1 piece of minute steak
1 small ripe banana
Freezer bags
Cling-wrap
Permanent marker

METHOD

DAY 1

1. Describe the appearance and texture of each food before processing.
2. Carrots and broccoli: slice one carrot. Blanch the carrots in boiling water until the water boils and then refresh in cold water. Drain the carrot and then package in freezer bag, removing as much air as possible. Finally, date and label the product as blanched carrots and then freeze. Repeat the process for the other carrot, but do not blanch. Label as non-blanched.

   Repeat the process for the broccoli.
3. Meat: cut the meat in half. Wrap one in piece cling-wrap, label and date. Place the other on freezer-proof plate. Freeze both pieces.
4. Banana: wrap in cling-wrap and freeze.

DAY 2

5. Unwrap food, then observe and describe the appearance and texture of the food before it is allowed to thaw.
6. Observe and describe the appearance and texture of the food, once thawed.

RESPOND

WS Freeze food

1. Outline reasons for blanching vegetables before freezing.
2. Why is packaging and labelling important for frozen food?
3. Why did the banana go mushy after thawing?
4. How could you use the thawed banana?
5. Are frozen foods healthy? Justify your response.

Stock rotation

For all storage areas it is important to apply the First In, First Out (FIFO) process so that older food stock is used first and therefore wastage is avoided.

This usually involves moving old stock forward and putting the new supplies behind it. It is important to read the use-by or best-before dates on stock to decide which items to place in front. It is also vital to inspect the sensory quality of a food in addition to the date marked. For instance, grated cheese may become mouldy before its best-before date if not stored well.

Dispose of damaged or stale stock wisely. Food infested with pests should be wrapped and placed in garbage bins. Consider composting for wilted fruit and vegetables.

Food storage legislation

The *Food Act 2003 (NSW)* requires all food businesses to make sure the food they serve is safe to eat. Under this legislation it is an offence for food businesses to:

- store potentially hazardous foods at unsafe temperatures
- have unclean food storage areas
- store foods in a manner that may cross-contaminate food or attract pests
- not keep records of food delivery times, food storage temperatures and cleaning schedules.

Environmental Health Officers who work for local councils to implement the Food Act check that storage areas are clean, well maintained, at the correct temperature, comply with design regulations and that the food is appropriately stored.

Under the Food Standards Code for Food Labelling, manufactured foods must provide storage instructions to maintain the quality and safety of food, as well as provide date markings for the safe consumption of foods.

Table 3.4 Maintaining storage areas

FOOD STORAGE AREAS NEED TO BE ...	HOW WILL IT BE DONE?
Clean	• Make sure no food is stored on the floor • Keep shelves tidy and orderly • Check for defects or damage, e.g. loose or rusty shelving or damaged containers • Clean up any spills promptly • Have cleaning schedules to regularly wash and clean the area
At the right temperature	• Regularly check temperature of storage areas • Keep seals around doors clean and undamaged • Keep shelves uncluttered so air can circulate well
Free from pests	• Check for cracks in walls, ceilings or floors where insects and pests might get in or breed • Look for signs of pests; for example, mouse droppings, cobwebs, grubs or chewed containers • Clean up any food spills promptly • Check lids on containers are tight

Chapter review

REVIEW

1 What is the role of enzymes found in food?
2 Name three types of microbes.
3 Distinguish between a perishable, semi-perishable and non-perishable food, providing examples.
4 Why should frozen foods be stored first?
5 What is the ideal temperature range for dry, cold and frozen storage areas?
6 Name the food safety legislation that protects consumers of foods in NSW.
7 What do environmental health officers examine when inspecting food storage areas in a premises?
8 Compare the use of 'use-by' dates and 'best-before' dates on a food package.
9 Outline strategies to prevent pests in dry food storage areas.
10 What is freezer burn and how can it be prevented?

FOR YOU TO APPLY

11 Three deliveries arrive at the same time from different suppliers.

DELIVERY 1	DELIVERY 2	DELIVERY 3
Tinned fruit Flour Sugar Rice Dried bread crumbs	Fresh cream Strawberries Yoghurt Fresh chicken Lettuce	Frozen meat balls Ice-cream Frozen beans

- List the order you would follow to put each delivery away. Justify your decisions.
- Identify where you would store each delivery. Justify your decisions.
- Select a food from each delivery and explain how the sensory characteristics of the foods might change if stored incorrectly.
- Explain the importance of stock rotation and outline a method you could implement to ensure stock rotation.
- Choose an ingredient from each delivery and investigate its expected shelf life.

EXTEND YOURSELF

12 Visit a food service provider or a food manufacturer and arrange a tour of the food production area of the establishment. Ensure the food storage areas are discussed. After your tour, report on the following:

- identify food storage areas used by the establishment
- name some foods they store in each storage area and discuss why they have been stored there
- describe how hygiene and temperature control are maintained in each storage area.

CHAPTER

4

Safe preparation and presentation of food

Knowing how to safely prepare and present food helps us to produce meals that look and taste good. It is vital to work safely when handling food and equipment. This minimises the risk of accidents and injuries and helps to protect food from becoming contaminated and making it unsafe to eat.

CHAPTER OUTCOMES

In this chapter you will learn about:

- which equipment and utensils to use to produce quality food products
- safe and hygienic practices when working with food
- how to prepare correctly to produce quality food products
- how to style food to be visually appealing and suitable for food photography and service.

KEY TERMS

bacteria
contaminate
cross-contamination
food handler
food poisoning
food safety
hazard
hygiene
micro-organism
personal hygiene
physical contamination
raw food
ready-to-eat food
sanitise
utensils
virus

iStock Photo/PhotographyFirm

Equipment and utensils to produce quality food products

A utensil is a small handheld tool that is designed for a particular task in preparing food such as a wooden spoon to stir a cake mixture. Equipment generally refers to larger tools and appliances designed to prepare and cook food, such as the cake tin and oven to cook the cake.

Both domestic and commercial kitchens use similar utensils. Equipment in commercial kitchens, however, is usually larger, stronger and more powerful than in a domestic kitchen, as larger amounts of food are prepared. Gas is preferred for cooking in commercial kitchens as it is faster and easier to control heat.

Most utensils, equipment, benches and shelves in commercial food preparation are made from stainless steel. This is because it is strong, rust proof, does not react with food easily and is easy to clean and sanitise.

Shutterstock.com/Anteromite

Figure 4.1 Kitchen utensils

Table 4.1 Kitchen utensils and equipment

UTENSILS		
Hand tools	**Measuring tools**	**Knives**
• Ladle	• Scales	• Chef's
• Peeler	• Jugs	• Turning
• Tongs	• Cups	• Cleaver
• Grater	• Spoons	• Boning
• Corer	• Thermometer	• Filleting
• Spatula	• Timer	• Paring
• Whisk		• Butcher's
• Wooden spoon		• Sharpening steel or stone
• Metal spoon		
• Zester		
• Palette knife		
• Sieve		
• Egg slice		
• Slotted spoon		
• Pastry brush		
• Potato masher		
• Piping bags and nozzles		
EQUIPMENT		
Food preparation	**Small electrical**	**Large appliances**
• Mixing bowls	• Mixer	• Oven
• Colander	• Blender	• Hot plate
• Chopping boards	• Toaster	• Barbeque
• Rolling pin	• Food processor	• Microwave
• Pastry board	• Kettle	• Refrigerator
• Pots and pans	• Rice cooker	• Freezer
• Baking trays	• Juicer	• Dishwasher
• Muffin tin		
• Cake tin		
• Moulds		

Shutterstock.com/atm2003

Figure 4.2 Equipment in commercial settings varies according to the food prepared.

Table 4.2 Commercial kitchen equipment

Meat grinder	Chicken rotisserie
Meat slicer	Grill
Hot plate	Crepe machine
Waffle iron	Pizza oven
Stock pot	Deep-fat fryer
Sandwich press	Bakery oven
Salamander	Sous vide machine
Steamer	Blast freezer

FOCUS QUESTIONS 4.1

REVIEW

1 Define a utensil.
2 Give five examples of utensils.
3 Name five types of equipment used in a domestic kitchen.
4 Name five types of equipment used in a commercial kitchen.
5 Discuss how equipment in a commercial kitchen differs to that in a domestic kitchen.

FOR YOU TO APPLY

6 Find a recipe for:
- scones
- chicken stir-fry
- homemade ice-cream.

After reading each recipe, assess the utensils and equipment required to produce the recipe. Explain how this might vary for a dish produced domestically and one produced commercially.

EXTEND YOURSELF

7 Research the function of the following commercial equipment:
- Salamander
- Blast freezer
- Sous vide machine

Safe and hygienic work practices when handling food

WS Safe work practices

Safe work practices

Handling food not only includes the physical actions of selecting, storing and preparing food, it also involves using heat, water, power, tools and machinery and other potential hazards that could affect people or property. Hence, it is vital to implement safe work practices when handling food. The main safe work practices you should follow are:

- Use correct manual-handling techniques such as bending knees or using a trolley when lifting heavy objects.
- Use safe posture and movements. Use ergonomically sound workstations designed to keep your body comfortable.
- Take breaks and rotate tasks to avoid becoming tired.
- Safely use hazardous equipment, such as sharp knives, hot appliances or electric cooking tools.
- Safely handle hazardous substances, such as cleaning chemicals.
- Pay attention to safety signs.
- Use personal protective equipment.
- Identify, remove or control hazards from your own work area.
- Have easy access to first aid.
- Know emergency and evacuation procedures.

FOOD IN FOCUS 4.1

LEGISLATION FOR SAFE WORK PRACTICES

The Work Health and Safety Act 2011 (NSW) aims to protect the health, safety and welfare of people at work. Failure of employers to provide safety for workers can result in heavy fines, business closure or imprisonment. Employers must also provide safety training to employees. The government organisation SafeWork NSW can inspect premises at any time to check on health and safety issues.

Read the safe work practices that staff at Old School House Café must follow and then answer the questions that follow.

Old School House Café
Health and safety procedures

- Identify and report hazards promptly
- Ring 000 in case of emergency
- Follow evacuation procedures in case of emergency
- Know where first aid kits and fire extinguishers are kept
- Attend compulsory safety training
- Follow all safety signs

Slips, trips, falls, sprains

- Keep your work area well maintained and tidy
- Clean spills immediately
- Wear enclosed shoes with non-slip soles
- Lift objects correctly, ask for help or use a trolley if the load is heavy
- Use a step stool if you need to reach high objects
- Do not run

Kitchen safety

- Wear long sleeves, rolled down
- Wear other protective clothing as specified
- Use dry thick cloths when touching hot utensils
- Turn off steam before opening steamers
- Be careful near deep fryers
- Keep floors dry and clean
- Keep knife blades sharp and handles clean
- Carefully carry, store and use knives
- Unplug machines and equipment before cleaning and at the end of the day

Electrical safety

- Inspect equipment and the power cord before use; do not use if faulty or damaged
- Only use electrical equipment that has a current inspection tag
- Be especially careful when working in wet areas
- Unplug equipment before cleaning

Personal safety

- If you feel uncomfortable or unsafe in a situation, call for help
- Call police if there is any violence
- Know the contact details of security and your supervisor
- If you feel you are being harassed or bullied, tell the person to stop. If you are uncomfortable with doing this or nothing changes after you ask them to stop, tell your supervisor.

Figure 4.3 Safe work practices

RESPOND

1 For each point under kitchen safety, assess the consequences of not following the safe work practice.
2 What rules do you need to follow when using an electrical appliance such as a toaster?
3 Give examples of emergencies that could occur at a café? How could they best be avoided?

Table 4.3 Possible food-handling hazards

POSSIBLE HAZARDS WHEN HANDLING FOOD	POSSIBLE INJURIES AND ACCIDENTS WHEN HANDLING FOOD
• Liquid spills on floor	• Sprains and strains
• Lifting heavy loads	• Muscle and tendon damage
• Working near hot objects and liquids	• Burns
• Working with knives or other sharp tools	• Fractures
• Poor lighting	• Cuts
• Heat	• Lacerations
• Exposure to hazardous substances	• Bruises
• Faulty machinery and appliances	• Crushing
• Faulty wiring in electrical appliances	• Dehydration
• Unsafe storage of stock or equipment	• Electrocution
• Electrical leads lying across high traffic areas	• Poisoning
• Blocked stairways and emergency exits	• Trips and falls
• Fatigue and stress	• Fires
	• Explosions
	• Damage to equipment

Alamy Stock Photo/Image Source; Shutterstock.com/Chantal de Bruijne; Shutterstock.com/Amnarj Tanongrattana; Shutterstock.com/Lester Balajadia

Figure 4.4 In Australia, safety signs are colour-coded.

Hygienic work practices

Being hygienic means being clean to ensure food is safe to eat. Not only does the food handler have to be clean but so too does the environment in which the food is prepared and stored. Using hygienic work practices minimises the risk of someone getting sick, injured or even dying from food poisoning. Food can be contaminated by physical, chemical or microbial means.

PHYSICAL

Physical contamination is caused by foreign objects such as hair, dirt, dust, chipped tiles, stone, pests,

jewellery, band aids or glass entering food during food preparation or service. It generally results in an injury such as chocking or damage to the gastrointestinal tract, but objects and pests also carry bacteria which can cause food poisoning. Pests such as insects and rodents can spoil food products by damaging the food itself or its package, and commonly leave behind their faeces.

Work practices to prevent physical contamination when handling food include:

- disposing of foods infected with pests
- undertaking regular pest control
- covering food
- covering hair
- removing jewellery
- wearing gloves over band aids on fingers
- avoiding using glass and other items which break easily
- washing fruits and vegetables before use.

CHEMICAL

Chemical contamination occurs when chemicals such as flyspray, detergent, herbicides or pesticides get onto food. Chemicals can be poisonous to the body. Work practices to prevent chemical contamination include:

- keeping chemicals away from food
- using safe chemicals to wash, sanitise and clean equipment
- washing fresh fruit and vegetables before use.

Some foods contain toxins which can be life threatening if eaten and hence should not be used in cooking. This includes some forms of wild mushrooms, puffer fish and rhubarb leaves.

MICROBIOLOGICAL

Microbes are single-celled organisms that multiple rapidly in the right conditions to spoil food. They include moulds, yeasts, bacteria and viruses.

Mould is often seen on food as blue or white furry spots. Some moulds are useful in making products like brie, camembert and blue vein cheeses. Some, however, like mould on bread, jam and hard cheeses can cause food poisoning. Mould, however, is often easily seen on foods and so the food is rejected for consumption.

Yeasts are also useful for making products such as bread, doughnuts, wine and vinegar. Yeasts found naturally in some foods, such as watermelon and other sweet fruits, can ferment, given the right conditions, causing the food to have an 'off' flavour and smell. As a result the food is often rejected for consumption. Both moulds and yeasts can be destroyed by heating to 60°C for 10 minutes.

Bacteria are not as visible, even in large numbers, and they cannot be easily smelled, tasted or seen. There are many different types of bacteria and they are everywhere in our environment, including in the air, in food, on equipment and even on animals and humans. Bacteria can be useful to make products such as cheese and yoghurt, and the human body uses good bacteria in the gut to help break down food during digestion; however, some forms of bacteria can cause food poisoning and even death.

Viruses are minute micro-organisms even smaller than bacteria. They don't grow in food but can easily be transferred to food and one particle may be enough to make you sick, which is why it is important that sick people do not prepare food. Some dangerous viruses that cause food-borne disease include hepatitis A, Norwalk virus, Norovirus and Rotavirus.

Figure 4.5 Symptoms of food poisoning

- Nausea
- Vomiting
- Diarrhoea
- Abdominal cramps
- Fever

Shutterstock.com/leungchopan

Hepatitis A is usually transferred from the faeces of an infected person and contaminates food, drinks or food-handling equipment through poor personal hygiene practices. It can also be spread through contact with contaminated water.

Some groups of people are more affected by food poisoning than others, including:

- the elderly
- pregnant women
- children
- people who are sick or have a condition that leads to low immunity
- people who are allergic to certain foods e.g. peanuts.

Figure 4.6 Conditions for the growth of bacteria.

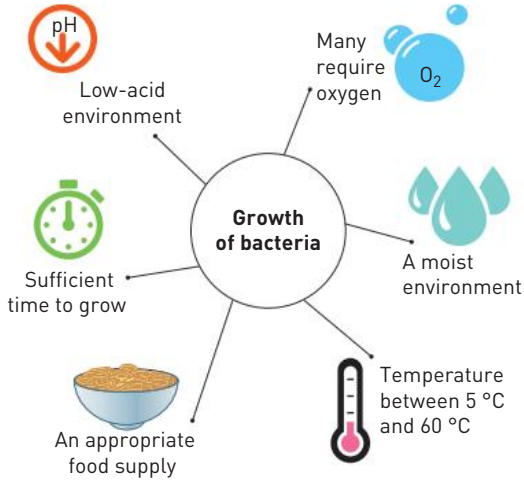

Table 4.4 Sources of food poisoning bacteria

FOOD POISONING BACTERIA	SOURCES
Salmonella	Found in the gut of animals, particularly chicken, as well as flies, mice, birds and pets
Clostridium perfringens	Found in raw meat and vegetables covered in soil or dirt
Staphylococcus	May be present in nasal passages, mouths, infected skin, wounds and pimples; coughing, sneezing and contact via hands spreads the bacteria
E. coli	*E. coli* lives in the bowels of humans and animals; many raw foods contain *E. coli*
Listeria	Main sources are dust, water, fish, shellfish, birds, insects, milk products, smallgoods and soft-serve ice-cream

In order to implement work practices to prevent microbial growth, particularly bacteria, it is important to understand the types, sources and growth conditions of food poisoning bacteria.

CROSS-CONTAMINATION

Cross-contamination is the transfer of food causing bacteria to spread from one source to another source. It is particularly dangerous when harmful bacteria from raw foods (usually animal foods) are transferred to cooked or ready-to-serve food. Bacteria cannot fly, but they can be transferred easily from place to place by means such as hands, a cloth, a utensil or a drop of blood.

Table 4.5 Conditions for the growth of bacteria.

CONDITIONS	EXAMPLES
Food supply	High-risk foods allow bacteria to grow rapidly. They are usually high in moisture and either protein or starch. Examples include milk and milk products, meat and smallgoods, fish and seafood, poultry, raw eggs, cooked pasta and rice, coconut, gelatine and ice-cream. Low-risk foods include margarine, butter, cooking oil, citrus fruit, vinegar, salted fish, jams and most vegetables. This is because bacteria does not easily grow in foods that are highly acidic or high in fat, sugar or salt.
pH (level of acidity)	Bacteria prefer a low-acid environment within the 4–6 pH range. This is the range for most protein-based foods.
Moisture	Bacteria thrive in conditions such as wet dishcloths, damp tea towels, as well as equipment and utensils that have not been dried properly.
Oxygen	Many bacteria need oxygen so it is important to appropriately package or cover food.
Temperatures between 5–60°C	Known as the danger zone for bacterial growth, it should be avoided. Bacteria growth is inhibited below 5°C and most bacteria are killed above 60°C. High temperatures are needed to clean cooking equipment to prevent bacterial growth. Chemical sanitisers kill bacteria without heat and are used in cleaning food-preparation areas.
Time	Bacteria reproduce every 10–30 minutes and given sufficient time, their numbers greatly increase to cause contamination. The total time a high-risk food can be at temperatures between 5°C and 60°C is 4 hours. After this time it must be discarded.

FOOD IN FOCUS 4.2

FOOD SAFETY AND THE LAW

The *Food Act 2003 (NSW)* requires food business owners to make sure that food they sell or prepare for sale is safe to eat. It sets minimum standards of cleanliness for food storage, preparation and service areas and hygienic food-handling practices. Food businesses must have a food safety program, which shows their food safety and hygiene practices and procedures. Environmental Health Officers undertake inspections to ensure food safety is implemented.

Examine the hygiene procedures for staff to implement at Old School House Café

Old School House Café
Food safety procedures

Personal cleanliness checklist

- Wear appropriate clothing – a clean uniform with sleeves and clean non-skid, close-toed work shoes.
- Do not wear your apron to and from work, and take it off before using the toilet.
- Change your apron if it becomes soiled or stained.
- Wear a hairnet or cap that completely covers all hair in any food production area.
- Never comb or brush your hair in a food-handling area.
- Keep beards and moustaches neat and trimmed.
- Do not wear jewellery in the food production area, only a plain wedding band is permitted.
- Maintain short, clean, and polish-free fingernails. No artificial nails are permitted in the food production area.
- Wash hands (including under fingernails) and up to forearms vigorously and thoroughly with soap and warm water for a period of 20 seconds. Do this before preparing food, after sneezing, coughing, eating, smoking or using the toilet and after handling raw food, money or rubbish.
- Wash hands only in hand sinks designated for that purpose.
- Dry hands with single-use towels. Turn off taps using a paper towel to prevent recontaminating clean hands.
- Change disposable gloves as often as hand washing is required.
- Do not smoke inside the building or anywhere near where food is handled.
- Do not sneeze, blow or cough over food or food-contact surfaces.
- Do not sit, lean or stand on bench tops, bars or tables.
- Bandage any cut, abrasion, or burn that has broken the skin. Cover bandages on hands with gloves.

Food preparation and food service checklist

- Wash fruit and vegetables before use.
- Keep chemicals away from food.
- Prepare raw and cooked foods separately using separate chopping boards and utensils.
- Keep hot foods above 60°C and cold foods below 5°C. Keep high-risk foods out of the danger zone for bacterial growth.
- Discard high-risk foods that have been in the danger zone of 5°C to 60°C for more than 4 hours.
- Ensure meat dishes are cooked adequately. Mince meat and poultry must be cooked to at least 75°C.
- Reheat foods to a temperature above 75°C and hold for two minutes. Reheat food only once.
- Don't store raw foods above cooked foods.
- Use a clean utensil each time you taste food.
- Never place fingers on the rim of a plate or the top half of a glass when serving.
- Cover foods.
- Do not use chipped crockery to serve food.
- When serving buffet food, have separate serving utensils for each dish.

Cleanliness and sanitation checklist

- Wipe up spills immediately.
- Regularly replace cleaning cloths.
- Wash, rinse, and sanitise equipment. Use hot water above 82°C.
- Air dry equipment.
- Empty bins regularly and ensure garbage containers have tight-fitting lids.
- Report any openings, cracks, broken seals or other opportunities for pest infestation to your supervisor.
- Regularly clean facilities such as storage areas, large equipment and walls.

Figure 4.7 How to avoid contamination of food.

RESPOND

1 Identify the procedures that would prevent physical contamination of food.
2 Identify the procedures that would prevent chemical contamination of food.
3 Give reasons why the organisation would provide employees with a list of hygienic work practices to implement.

Table 4.6 Cross-contamination of food

CROSS-CONTAMINATION PATHWAY	HOW CAN CROSS-CONTAMINATION HAPPEN?
Person → person	If you shake hands with someone who has not washed their hands after going to the toilet, or who has sneezed into their hand
Person → food	If you don't wash your hands after going to the toilet, then touch food
Food → food	If you allow raw meat to drip onto ready-to-eat food on a lower shelf in the fridge or you use the same chopping board and knife to cut raw and cooked food
Equipment → food	If you use tongs to take raw chicken to a pan, then use the same tongs to move cooked chicken onto a plate If you use a knife and chopping board to cut raw food like meat, then use the same knife and chopping board to cut cooked food
Linen → food	If you handle raw meat, wipe your hands on a tea towel, then use the tea towel to wipe a bench where food will be prepared
Crockery → food	If you use crockery with chips and cracks. Bacteria grow in the chips and can then get into the food

FOCUS QUESTIONS 4.2

REVIEW

1 Identify four potential hazards when handling food.
2 Identify four possible injuries when handling food.
3 Outline six safe work practices when working with food.
4 Outline four personal hygiene work practices when handling food.
5 Explain how physical contamination of food can occur.
6 Explain how chemical contamination of food can occur.
7 List three examples of bacteria that could cause food poisoning.
8 List five high-risk foods that are susceptible to food poisoning.
9 What is the danger zone temperature for harmful bacteria?
10 What are four symptoms of food positioning?
11 What are the six conditions required for bacterial growth.
12 Describe five ways to prevent cross-contamination of food.

FOR YOU TO APPLY

13 Undertake an audit for safety signage displayed at food-preparation areas at your school.
- **a** Assess what signs should be displayed in food-preparation areas. Give reasons.
- **b** Conduct the audit and record what signs are displayed.
- **c** Produce any necessary safety signage and display at the required food-preparation areas.

EXTEND YOURSELF

14 Using the internet, find a recent news article about a food poisoning outbreak in Australia and answer the following questions.
- Who got food poisoning?
- How serious was it?
- What was the cause of the poisoning?
- How could it have been prevented?
- What happened to the food venue?.

Preparation methods to produce food products across a range of settings

Whether food is prepared on a small scale in the home or on a larger scale in a childcare centre, nursing home, canteen, restaurant or factory production line, it is important to prepare foods safely and to a high quality. Some basic principles

to ensure you produce quality food products include:

- Choose the best quality ingredients.
- Know your recipe terminology and follow recipes carefully.
- Prep before you cook; for example, chop vegetables, preheat the oven and grease tins.
- Use the cooking technique that best suits the particular food and maintains its nutritive value.
- Be consistent with size of food, such as for chopped vegetables.
- Season food with care, don't use too much salt or pepper.
- Serve hot food hot and cold food cold.
- Consider the tastes and needs of the people the food is cooked for.
- Consider time management and work flow. You need to look at the recipes on a menu and work out the preparation steps logically. For instance, dessert may be last on a menu, but you may need to prepare it before the entrée or main meal.

PRACTICAL APPLICATION

4.1

PRACTICE PRECISION CUTTING TECHNIQUES

AIM

Ensuring ingredients like fruit and vegetables are cut into even and consistent shapes contributes to the visual appeal of the end product. It also helps you to cook ingredients evenly. The aim of this activity is to safely practise this essential skill.

MATERIALS

Chef's knife
Chopping board
1 onion
2 carrots
1/3 medium sweet potato or 1 potato
1 lettuce or cabbage leaf
1 celery stick
1/3 cucumber
1 tomato
A ruler

METHOD

Precision cutting technique

1. Watch the tutorial videos in the weblink or conduct an internet search to find your own.
2. Wash and peel vegetables.
3. Use the table below to produce the following precision cuts.
4. Use the ruler to evaluate your cutting skill.

RESPOND

1. Provide examples of recipes where each precision cut can be used.
2. How did you consider safety when cutting the ingredients?

Table 4.7 Precision cutting techniques

NAME	SUGGESTED INGREDIENT	SIZE	EXAMPLE
Brunoise (dice)	Peeled half onion	2 mm × 2 mm × 2 mm small dice cubes	Shutterstock.com/ Vladimir Volodin
Julienne	Carrot or celery	2 mm × 2 mm × 40 mm stick size (sometimes a longer, thinner cut is asked for)	123RF.com/ annunna1
Chiffonnade	Lettuce or cabbage	2 mm thin shreds	iStock.com/ kdhudak

>

4.1

NAME	SUGGESTED INGREDIENT	SIZE	EXAMPLE
Macedoine	Sweet potato or potato	10 mm × 10 mm × 10 mm cubes	Shutterstock.com/Hong Vo
Jardinière	Carrot or cucumber	4 mm × 4 mm × 20 mm sticks	Alamy Stock Photo/foodfolio
Mirepoix	Combination of carrot, onion and celery	Rough but even cut	Shutterstock.com/Moving Moment
Paysanne	Carrot , celery or cucumber	Thin slices about 2 mm thick matching the shape of the vegetable	Shutterstock.com/Shebeko
Concassé	Tomatoes	Peeled, seeded and roughly chopped	Alamy Stock Photo/Trevor Pearson

Methods of cooking

MOIST HEAT

Moist-heat cooking methods use relatively low temperatures combined with liquid to cook the food. The liquid medium may be water, steam, stock, milk, fruit juice or wine. Moist-heat methods include boiling, simmering, poaching, steaming, stewing and braising, sous vide, pressure cooking or slow cooking.

Foods suitable for moist-heat cooking include muscular (tougher) cuts of red meat, fish, poultry, most vegetables, fruits, eggs, pasta, rice, pulses, lentils, legumes and puddings.

Advantages

- Economical as cheaper, tougher cuts can be used as moist heat tenderises meat.
- Little attention is required while the food is cooking; less likely to burn food.
- Texture of food becomes softer and lighter and it is more easily digested.
- Suitable for cooking large quantities of food.
- Whole meals can be cooked in one pan; for example, soups or stews.

Disadvantages

- Moist-heat cooking can be time consuming
- Overcooking may disintegrate food.
- Water-soluble vitamins may be lost to cooking water.

DRY HEAT

Dry-heat cooking methods uses high temperatures to apply heat directly to the surface of the food. The method includes roasting, baking, grilling, barbecuing, smoking and toasting. It also includes frying (dry, stir, shallow, deep) and confit (poaching in oil) as heat is applied through the medium of fats or oils.

Foods suitable for dry-heat cooking include: tender cuts of meat, fish, poultry, sausages, eggs, bread, many vegetables, cakes and pastries.

Advantages

- Grilling, frying and barbecuing are quick.
- Food is quickly sealed, causing a crispy surface and maintaining the flavour.
- Heat causes water to evaporate from the food, concentrating its flavours.
- Besides frying, most methods are healthy as little fat is used.
- Roasting and baking need little attention and are suitable for large quantities of food.

Disadvantages

- Grilling, frying and barbecuing need constant attention to avoid burning.
- Grilling, frying or barbecuing food needs to be turned frequently and temperatures controlled to ensure even cooking.
- Grilling and frying is not suitable for food that is too thick.
- Food shrinks because it loses moisture.
- High heat toughens protein, causing foods like meat to become tough.
- Deep-fried foods require coating to prevent overcooking and to prevent the food breaking up and absorbing too much fat.

MICROWAVE

Microwave cooking involves the transfer of energy to the food in the form of electro-magnetic radiation. These microwaves penetrate the food and rapidly move the molecules of liquid it contains. This creates friction, which in turn creates heat to cook or reheat food. Materials such as paper and some plastics allow microwaves to pass through them but do not heat up; glass and ceramics can be used in microwaves but do get hot; while metals reflect microwaves and should not be used.

Advantages

- Food cooks quickly.
- Little loss of nutrients because of quick cooking and little use of water.
- Quickly defrosts food.
- Excellent for reheating.

Disadvantages

- Easy to overcook foods.
- Food does not brown.
- Pastries and cakes tend to go soggy in a microwave oven because of the steam created by microwaving.
- Not suitable for large quantities.
- Cannot use metal containers.

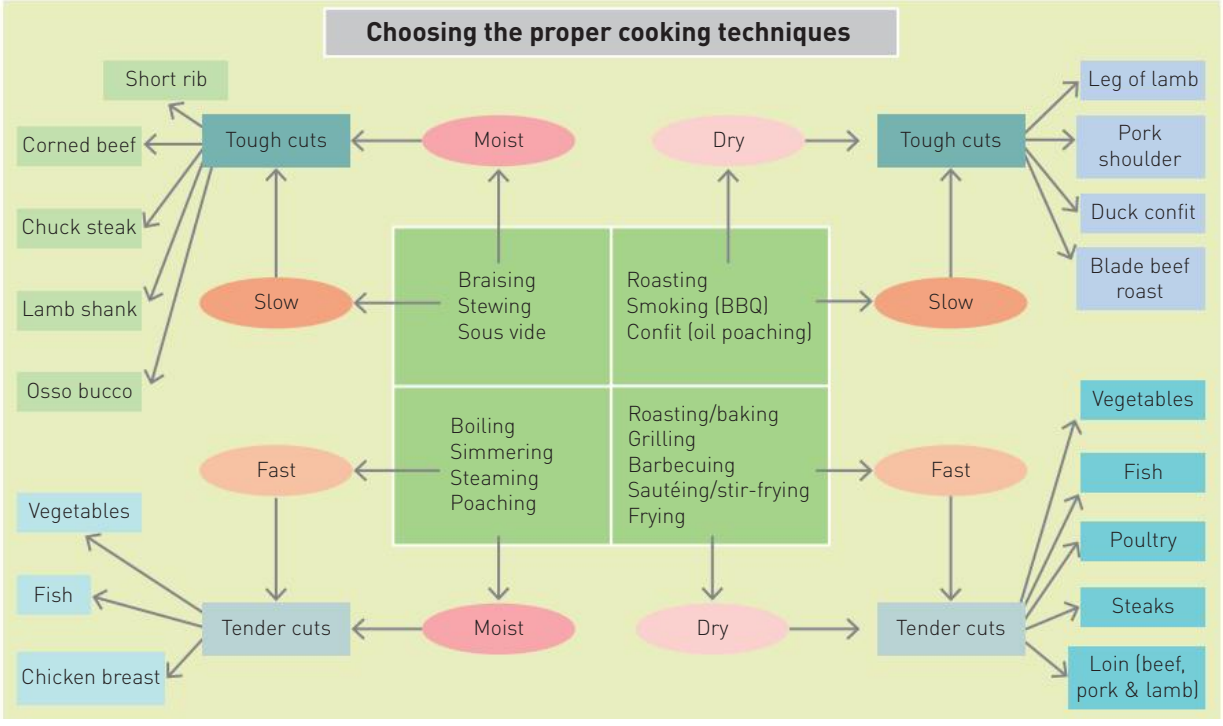

Figure 4.8 Choosing the proper cooking techniques

FOCUS QUESTIONS 4.3

REVIEW

1 Complete the following table.

CUT	DESCRIPTION	SUITABLE VEGETABLE	SUITABLE RECIPE/DISH
Brunoise (dice)			
Julienne			
Chiffonnade			
Concassé			
Paysanne			
Mirepoix			

WS Cuts

2 Name a moist-heat method of cooking and outline its advantages and disadvantages.
3 Name a dry-heat method of cooking and outline its advantages and disadvantages.
4 Explain the difference between simmering and boiling.
5 Discuss the advantages and disadvantages of microwave cooking.

FOR YOU TO APPLY

6 Name a method of cooking suitable for each of the following ingredients and suggest a dish you could make with each.
- Spaghetti
- Rice
- Eggs
- Potatoes
- Whole chicken
- Apples
- Sausages
- Bread dough
- Chuck steak

EXTEND YOURSELF

7 Research sous vide as a method of cooking and discuss its advantages and disadvantages. How is this method of cookery used both in the home and commercially?

Laying out food for visual appeal

If a food looks good, we are enticed to eat it. Various techniques can help make food visually appealing.

Plating food

Plating is an ever-evolving art form. Traditionally a meal consisting of a protein food like meat with vegetables was plated up according to a clock face. The meat was placed at the 6 o'clock position and the vegetables arranged from 10 o'clock through to 2 o'clock. Today, a more freeform plating styling is on trend. This involves treating a plate like abstract art. The food components are carefully positioned in a manner that appeals to the senses.

White plates are popular because they contrast foods well, but other materials such as stone plates and wooden boards have also been a recent trend in presenting food. Garnishes and decorations are edible ingredients; they are usually placed on a plate last to provide a finishing touch. Garnishes are used for savoury dishes and examples include chopped herbs, croutons and lemon wedges. Decorations for sweet dishes include strawberry fans, whipped cream and chocolate sauce. Garnishes and decorations should complement a dish by enhancing its flavour, texture and colour in addition to adding visual appeal.

The following design principles should be applied when plating food.

- Use contrasting colours. Colours should look natural and not clash or look too similar.

Garnishes and crockery can add colour when a dish looks bland.

- Use a variety of shapes, for example round, whole potatoes served with carrot sticks. However, like too many colours, too many shapes can be confusing.
- Use a range of textures, such as crispy chips served with soft, flaky fish.
- Ensure the main ingredient stands out. You should not be looking for the prawns in a prawn stir-fry.
- Have a focal point. This can be achieved by having one food sitting higher than another or by using a garnish or decorations.
- Keep balance and proportion. Food should not be overloaded or lost on a plate. The rim of the plate should be seen.
- Repeat an aspect of the design, such as a colour or shape. Garnishes often repeat an ingredient in a dish.
- Use clean, unchipped crockery and wipe off spills and drips before serving.
- Garnishes should be edible and enhance the dish.
- Place the best side of the food facing up.

Getty Images/Adam Gault

Shutterstock.com/Hvoenok

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iStock.com/serg78

Figure 4.9 Plating styles

PRACTICAL APPLICATION 4.2

FREEFORM SALAD PRESENTATION

AIM

Freeform presentation involves plating your dish in a random but interesting manner. Practice freeform plating to create a salad that reflects your creativity.

INGREDIENTS

Examples of ingredients for salad

- Cooked chat potatoes
- Greens such as baby spinach, coral lettuce or rocket
- Cucumber
- Carrots (traditional or heirloom style)
- Small tomatoes (traditional or heirloom style)
- Olives
- Figs
- Broad beans
- Capers
- Cooked chicken or eggs
- Avocado
- Cold meats such as prosciutto or smoked salmon
- Edible flowers e.g. lavender

Examples of dressing ingredients

- Olive oil
- Mustard
- Selection of vinegars
- Balsamic vinegar glaze
- Tomato relish
- Mayonnaise
- Seasoning (salt and pepper)

Example of tools

- Squeeze bottles
- Vegetable peelers
- Mandolin
- Tongs
- Chef's knife

METHOD

1. Research images of freeform plating styles.
2. Select ingredients for your salad.
3. Decide on a dressing for the salad.
4. Find a suitable plate to present the salad.
5. Plan your plating idea.
6. Produce your salad using available tools.

>

RESPOND

1 Name the salad.
2 Create a PMI chart of the process of making the salad.

PLUS	MINUS	INTERESTING

4.2

Styling for photography

Preparing a visual display of food is called food styling. A food stylist often works in conjunction with a photographer in order to get a perfect shot. You see examples of food styling and photography in recipe books, in the print media (magazines, brochures, leaflets, and billboards), on television advertisements and cooking shows, on webpages and social media, on menu boards and on food packaging.

A day in the life of a food stylist

When presenting foods, food stylists employ the basic design principles of variety in colour, texture and flavour. They also like to create themes with their props to suggest a situation where the foods could be consumed. In food advertisements, food stylists usually repeat the colours of the food package being promoted in the background to help reinforce the product.

Food styling – burgers

Taking the perfect shot when photographing food can be difficult. Lighting causes foods to dry out, shrink, sag and discolour, so food stylists employ some interesting techniques, using tools such as blow torches to cook the surface of foods; tapes, pins, toothpicks, elastic bands, fine wire and glue to hold food in place; scissors and scalpels to cut food; tweezers, eye droppers and syringes to carefully position ingredients; and ear buds to help wipe away mistakes. Additionally, stylists often spray or paint glycerine on food to create a shiny surface. Software, apps, lighting, props and digital tricks assist the photographer. Today, with the popularity of social media, many photographers are also filming and editing food shoots.

Food styling – ice-cream

iStock.com/Jack.Jelly

Figure 4.10 A food stylist at work.

FOOD IN FOCUS 4.3

FOOD BLOGGING

Many Australians have fused their love of the internet, photography and their passion for food into mouth-watering daily blogs and inspiring social media accounts that capture their food adventures and new creations. For instance Melanie Lionello is a qualified nutritionist who writes about healthy recipes as well as writing restaurant reviews and travel stories on her blog Naturally Nutritious. Emma Galloway is a chef whose blog My Darling Lemon Thyme is about gluten-free vegetarian food recipes and tips on organic gardening. Some bloggers do get paid by companies to promote their products but many are independent.

My darling lemon thyme

PHOTOGRAPHY AND STYLING

Souvlaki for the Soul is a blog by Peter Georgakopoulos who prepares, styles and photographs both traditional and unusual versions of Greek classic dishes. Some of his recipes include pork souvlaki with cucumber and pineapple, avocado tzatziki and kale and feta bread as well as his mother's spanakopita. He has been recognised as one of the best food bloggers in Australia for his food styling and photography skills. Peter provides the following advice when styling and photographing a dish:

Naturally nutritious

- Determine what scene/mood you are after – vintage, modern, rustic or just plain simple with no props – just a cooked dish.
- Step back and again ask yourself – do the colours work well, is there enough texture and how will lighting affect the final shot?
- Sprinkles of flour, sugar, cake crumbs, herbs and spices can create a homely, casual look.
- Sugar syrup sprayed from a pump bottle can add a little shine to food.
- Sometimes less is more but at other times adding bits and pieces as props helps tell a story. For instance adding some cream and a cup of coffee for a cake shoot, but make sure it does not distract from the actual food.
- Meats lack colour so add some vegetables and salads. Meats are best cooked to medium-rare and will look juicer when brushed with their cooking juices.
- Photograph cakes from an angle and cut a piece from a cake and even a bite from a biscuit or muffin as it adds drama and tantalises the taste buds.

Souvlaki for the soul

Adapted from: https://souvlakiforthesoul.com/2011/11/food-and-prop-styling-for-food-bloggers

Shutterstock.com/Rawpixel.com

Figure 4.11 Food blogs almost always feature mouth-watering photos of food.

FOCUS QUESTIONS 4.4

REVIEW

1 Define a decoration and give examples.
2 Define a garnish and give examples.
3 Describe the clock plating style.
4 Give three examples of where a food photographer can display their work.
5 Identity five tools you would find in a food stylist's toolbox.

FOR YOU TO APPLY

6 Produce a work of food art suitable to encourage children to eat their fruit and vegetables. Style and photograph your food display.
7 Find a photo image of an entrée, main or dessert dish that uses a modern plating style.
   a Identify the type of plating style used for the arrangement of the food.
   b Analyse the design principles employed in the plating of the food.
   c Find and prepare a suitable recipe and apply the same style and design principles to your dish.

EXTEND

8 Research a current Australian food blogger. Assess the techniques they have employed to photograph foods on their website.

Chapter review

1 Give an example of a recipe that would require the following utensils:
- Apple corer
- Palette knife
- Ladle
- Zester

2 What does hygienic mean?

3 Identify the legislation that protects the safety of workers.

4 Why should sick people not prepare food?

5 How long can a high-risk food be stored in the danger zone for harmful bacteria?

6 Describe three ways to precision cut carrots.

7 Define dry and moist-heat methods of cooking.

8 Describe five tips for plating food for visual appeal.

9 Referring to Food in Focus 4.3 on page 81, answer the following questions.
- **a** Who is Melanie Lionello and what does she do?
- **b** What is My Darling Lemon Thyme and what is its purpose?
- **c** Why is Peter Georgakopoulos considered one of Australia's best food bloggers?
- **d** Outline some tips for good food styling and photography.
- **e** Find a food blogger not listed in this article. Why does their work appeal to you?

FOR YOU TO APPLY

10 Find a recipe for a cooked breakfast suitable for a special occasion. Assess:
- **a** What method(s) of cookery are involved?
- **b** What equipment and utensils are required to prepare the food?
- **c** What hygiene work practices will you implement?
- **d** What safety work practices will you implement?
- **e** How will you plate the food so that it is visually appealing?

EXTEND YOURSELF

11 Produce a short video showing the production of a biscuit or slice recipe that is suitable to place on social media.

12 Visit a food manufacturer or food service provider. Interview the manager regarding the hygiene and safe-work practices of their organisation.

CHAPTER

5

Sensory characteristics of food

In this chapter, we will examine how identifying and understanding the sensory properties of food will assist us to select, prepare and present quality food products. We will also provide examples of how food producers, manufacturers, retailers, marketers and service providers use the sensory properties of food to develop food products and displays that entice consumers to part with their money.

CHAPTER OUTCOMES

In this chapter you will learn about:

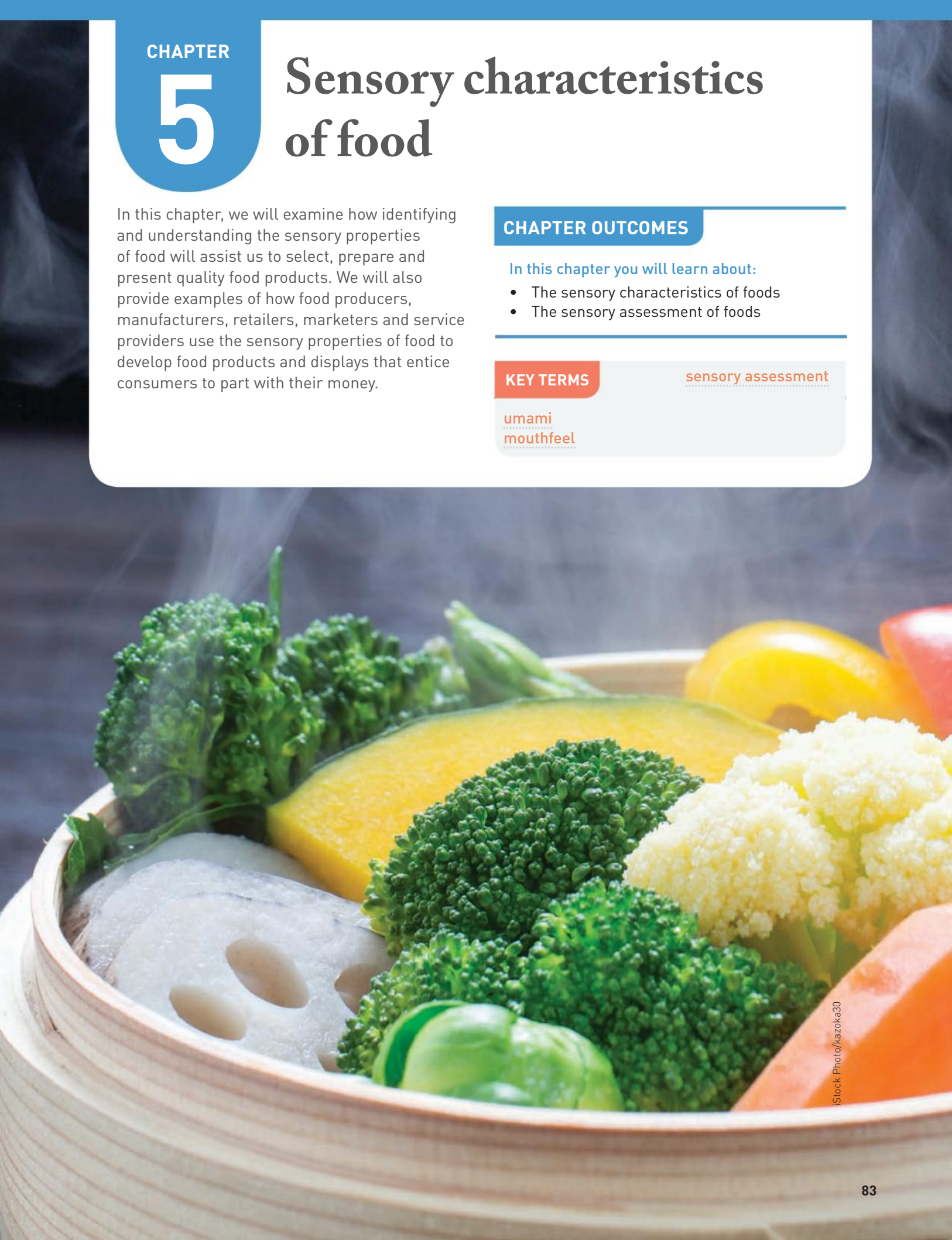
- The sensory characteristics of foods
- The sensory assessment of foods

KEY TERMS

sensory assessment

umami

mouthfeel



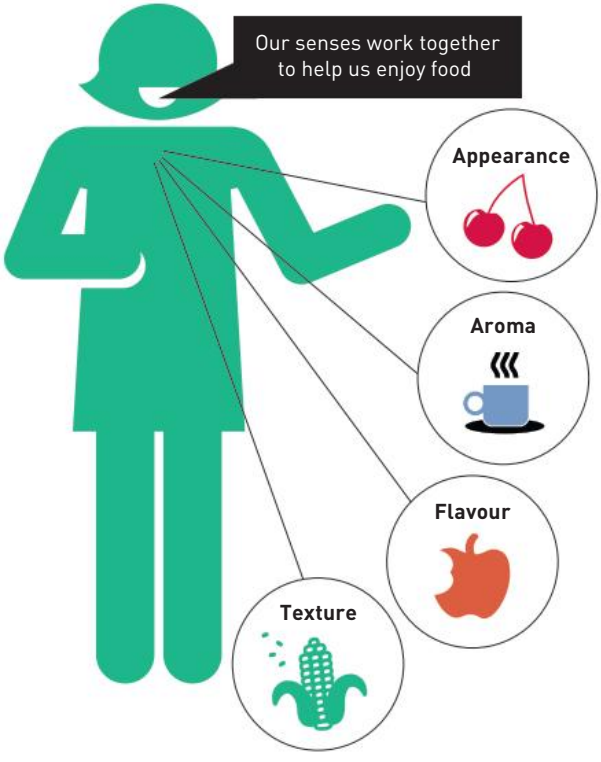
iStock Photo/kazoka30

Food and the five senses

Our choice of food is strongly influenced by our five senses – smell, sight, touch, hearing and taste. Have you ever selected a food based on how it looks, only to be disappointed with its taste or flavour? That is because humans usually choose foods with our eyes first and then with our ears and fingers, and lastly with our nose and tongue. Indeed, when we discuss our food with others we usually describe our sensory reactions to a food. For instance ice-cream is often described as rich, creamy, smooth and sweet.

Although the senses play an important role in determining our food preferences and helping us to evaluate food, other factors are also involved. These include previous experiences with food, allergies, level of hunger, beliefs, values and traditions about food.

Our senses react to the appearance, aroma, flavour and texture of food. As a result they are referred to as the sensory characteristics of food.



Food Solutions, Food Studies Units 3 & 4, fourth edition, Heath, McKenzie, Tully, Cengage Learning 2016.

Figure 5.1 The sensory characteristics of food

Appearance

Cupcake challenge

The appearance of food is usually the first way we assess a food. If a food is not visually appealing and recognisable, most people will be reluctant to eat it. The colour, shape, size and surface texture all contribute to the appearance of a food.

Shutterstock.com/gorillaimages

Figure 5.2 Hamburgers combine several flavours, colours and textures. The smell of meat grilling can stimulate the appetite and when we bite into a hamburger with fresh lettuce, we can hear the crunch.

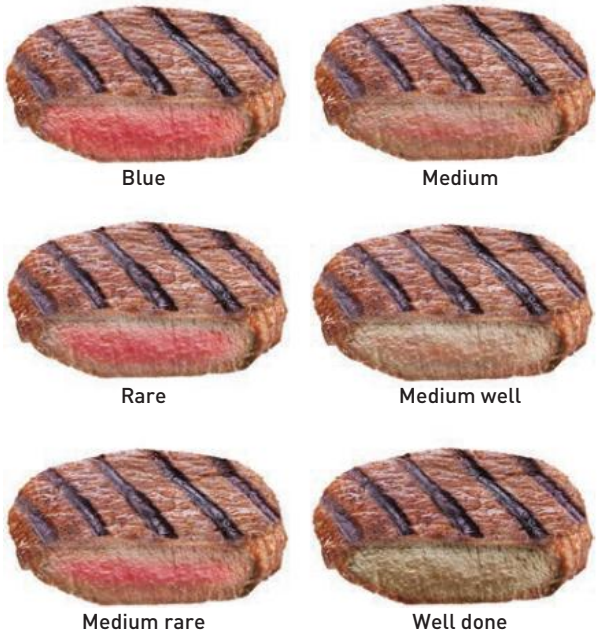
COLOUR

Colour enhances our enjoyment of food and plays a major part in how we perceive a meal. For example, we expect strawberry-flavoured foods to be pink or red in colour.

We also prefer meals that include a variety of colours. Stir-fries usually use different coloured vegetables and a chocolate cake is commonly decorated with strawberries, dusted icing sugar or cream to add colour for visual appeal.

Colour also helps us to judge food quality. For instance, the colour of a banana skin indicates its degree of ripeness. Green bananas are hard and have a sharp flavour, while brown spots on the skin may indicate a banana is soft and sickly sweet. We often assume that oranges with a green tinge on their skins will be less sweet than those with a bright orange skin, even though this is not necessarily the case.

Colour can assist us to judge if a food is cooked, such as the golden crust on fresh-baked bread. Lamb is often cooked so that it is brown on the outside but still pink inside to maintain its tenderness; however, we recognise that cooked chicken that is still pink is a food safety risk. When sautéing onions, we fry them until they are translucent before adding in other ingredients.



Shutterstock.com/Valentyn Volkov

Figure 5.3 Colour is used to indicate how well-cooked a steak is, such as for beef and lamb.

SHAPE AND SIZE

We also use sight to assess the shape and size of food. These elements also help us assess the quality of a food. For instance, fruits are often packaged and displayed not only based on their colour but also on their size and shape. Food producers also know that consumers prefer even-sized and shaped fruit and vegetables rather than those that are excessively large or small.

Again, a variety of shapes and sizes is preferred and utilised in food presentation and preparation. When preparing a salad, each separate ingredient is commonly cut into different shapes such as tomato wedges and julienne carrots. Consistent ingredient sizes are important not only for visual appeal but vital when cooking so that foods, such as potatoes for a salad, are cooked evenly.

Shutterstock.com/Aleksandar Mijatovic

Figure 5.4 Food is commonly displayed according to type, colour and size.

SURFACE TEXTURE

Sometimes we can judge the quality of a food simply by observing its surface texture. For instance, celery may look limp, scone dough may look wet and require more flour before shaping, we look for fish with clear eyes and we judge the leanness of meat by the amount of fat visible and connective tissue on the surface. Steam off the surface of food is a visual indication that our food is hot.

Odour

Odour or aroma refers to the smell of food. Pleasant smells can stimulate your appetite even before you see a food. Think about the aroma of a cake baking or the smell of a barbecue.

Odour is created when certain chemicals in food escape into the air. When the chemicals reach the olfactory cells in the nose they transmit signals to the brain where the odour is recognised.

When foods are heated, the aromas are often accentuated because the chemicals are more volatile. This explains why hot foods have a stronger aroma than cold foods. Some examples include the smell of barbecued sausages or the aroma of heated spices such as cinnamon and vanilla. Cooking sulphur-rich foods like cabbage strengthens the sulphur compounds in the food and some people may find the odour released unpleasant. On the other hand, the smell of many other fresh cut vegetables, such as fresh beans, is reduced with cooking, as the enzymatic reactions cease. Cutting foods like fresh herbs intensifies their aroma as the surface area becomes smaller and more volatile chemicals are released.

Our sense of smell can help us judge the quality of foods. For instance, we smell rockmelons to check for ripeness, while foods that are 'off' such as milk are often obvious to the nose. Aroma can also indicate if a food is cooked. For instance, a pasta sauce that has been simmering for a long time will produce a rich fragrant aroma from the cooked tomatoes, onion and herbs. And finally, of course, we can easily smell when a food has been burned.

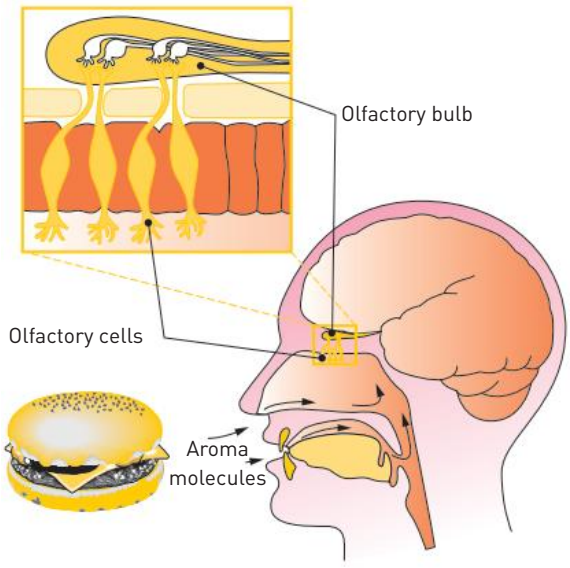


Figure 5.5 How we smell the aroma of food.

Shutterstock.com/Lopoloz

Figure 5.6 We often smell the aroma of a food before we see it and the smell can create an emotional response.

PRACTICAL APPLICATION 5.1

THE ODOUR CHALLENGE

AIM

Set an experiment to see if students in another class can identify ingredients used in food preparation.

MATERIALS

8 paper or plastic cups (do not use clear plastic)
8 pieces of kitchen towel
8 elastic bands
Marker pen
8 items selected from the following:

- vanilla essence
- chocolate chips
- coconut
- crushed garlic
- ground spice e.g. ginger or cinnamon
- fresh herb e.g. parsley or rosemary
- dried herb, such as oregano
- parmesan cheese
- orange or lemon peel
- soy sauce or tomato sauce
- tea leaves
- coffee beans
- rose petals or lavender

METHOD

1. Set up 8 plastic or paper cups, and place each of your 8 selected items in a cup.
2. Cover each cup with a piece of kitchen towel. Hold the kitchen towel in place with elastic bands.
3. Label each cup with a number from 1 to 8.
4. Have each tester smell the contents of the cups without lifting the covers. Record their guesses using the table below.

>

SAMPLE	TESTER'S GUESS	IDENTIFICATION OF SAMPLE
1		
2		
3		
4		
5		
6		
7		
8		

5 When everyone has smelled each sample, your teacher will identify the sample.

5.1

RESPOND

1 Why were the samples covered for the smell test?

2 Which samples did the majority of the class guess correctly?

3 In small groups, come up with a list of points accompanied by examples that could be used to plan an answer to the following extended-response exam question:
'Discuss why the sense of smell is important when selecting, preparing and cooking food?'

WS Odour challenge

Flavour

WS How things taste

While appearance is important in food selection, flavour is the most-remembered aspect of the experience of eating food. Flavour is a combination of the taste and aroma of food.

When a food is placed in the mouth, saliva helps to dissolve the chemicals that produce the flavour. Taste buds on the tongue react to these chemicals and send nerve impulses to the brain, which identifies the sweet, sour, salty and bitter flavours in a food. At the same time, the nose detects the aromas of the food. Indeed, it is difficult to identify the exact flavour of foods when you hold your nose or have a cold.

It was previously thought that the tongue had very specific zones for taste buds, but current research indicates that this is not entirely true. And, as discussed earlier, studies have also found the fifth taste, 'umami', a Japanese term for rich, meaty, protein flavours. It is also suggested the tongue can taste other flavour sensations such as fatty and metallic tastes.

The ability to detect and appreciate flavours varies between people. Some people enjoy the bitter taste of eggplants, while others do not. We are influenced greatly by our culture and our experiences with food. Young children tend have more taste buds and are therefore more sensitive to tastes. As you get older, your taste buds gradually die and are not replaced.

Flavour is important when preparing meals. The flavour of a dish is usually tested before serving to determine whether any flavours are too dominant or the food too bland. Salt is commonly used to enhance the flavour of foods. Cooking often contributes to the flavour of food. If you cook onions slowly, they develop a sweet flavour, but if you cook them too quickly and they burn, a bitter taste results.

Meals should also contain a balance of flavours. For instance, Thai curries commonly combine sweet palm sugar, salty fish sauce, sour lemongrass and bitter egg plant, with mild jasmine rice to balance the strong flavours. Menus of two or more courses often start with savoury foods and balance them with sweet foods for dessert.

Texture

Texture can be assessed through touch. When we touch foods with our hands, we can feel their physical structure. The ripeness of fruits such as peaches can be determined by squeezing them gently. Touch is used to judge how well something is 'done' when cooking steaks or when baking a cake.

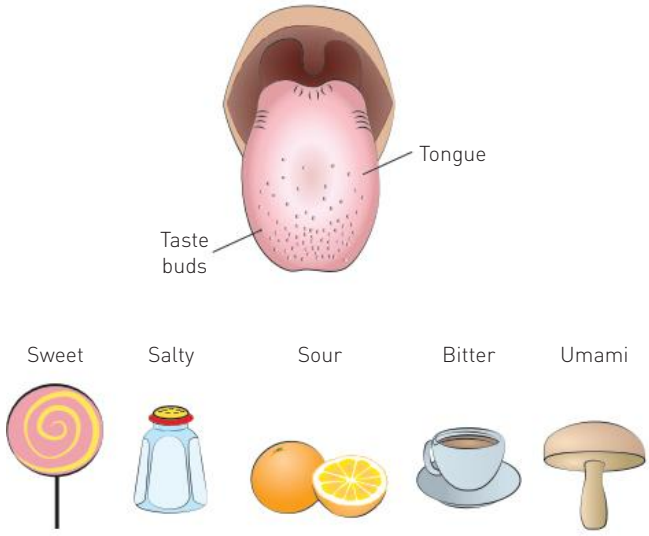


Figure 5.7 Taste buds can detect these basic flavours in foods.

Mouthfeel is the way food feels in the mouth – between the lips, against the teeth, on the tongue and on the roof of the mouth. By chewing, we can feel if a food is smooth, crunchy, firm, moist, lumpy or hard. Besides the texture, the amount of liquid, air and fat content in a food also contribute to mouthfeel. For instance, plain milk chocolate is commonly described as smooth and creamy.

The sense of hearing is often linked with texture, such as the crunching of a crispy apple or the fizzing of a carbonated drink.

Variety in texture is important in meal planning to appeal to the appetite. This is why crusty bread is often served with soup, crackers with dips and hot chips with grilled fish.

Shutterstock.com/minadezhda

Figure 5.8 The meatballs not only add protein to this dish but also texture. What other sensory properties are used in this soup?

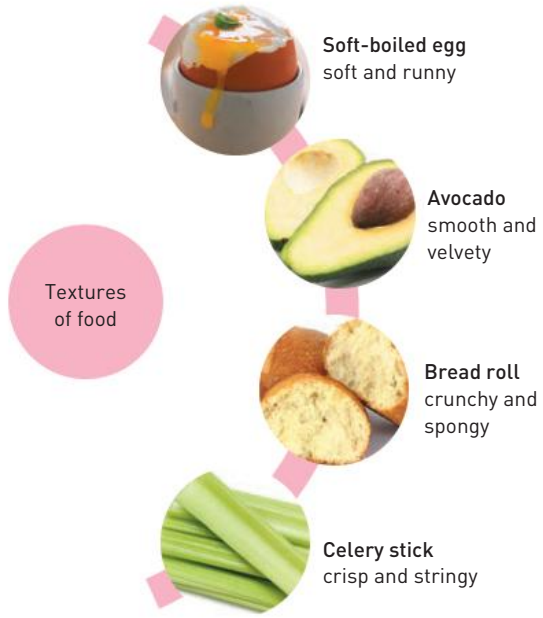


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Figure 5.9 Textures of food to indicate quality.

Food Solutions, Food Studies Units 3 & 4, fourth edition, Heath, McKenzie, Tully, Cengage Learning 2016.

PRACTICAL APPLICATION 5.2

TAKE THE MYSTERY BOX CHALLENGE

WS Mystery box challenge

AIM

Produce a two-course meal that appeals to the senses from the ingredients in the mystery box.

MATERIALS

Mystery box ingredients:

- 1 chicken breast
- 1 sheet of puff pastry
- 1 granny smith apple
- 1 egg
- 1 carrot

METHOD

1. In pairs, prepare and present a two-course meal, using all of the ingredients in the mystery box in 2 hours.
2. You will be allowed to research suitable recipes and supplement the mystery box with other ingredients such as butter, sugar or flour.
3. In addition to the time limit, consider other constraints such as equipment available and prohibited foods such as nuts.

RESPOND

Using the video function on a device, self-evaluate your progress during the activity.

FOOD IN FOCUS 5.1

Read the article below on the ways fast-food restaurants use our senses to part us from our money. When you have finished reading the article, answer the questions that follow.

THE TRICKS FAST-FOOD RESTAURANTS USE TO GET YOU TO EAT MORE

From using tempting smells, meal deals and super-sized portions, there are numerous ways the fast-food industry is indeed fuelling the obesity crisis by encouraging us to eat more. Here are some of tricks of the trade.

A scientific study by Brian Wansink at the University of Illinois investigated the ways people over-consume based on the way food is presented to them. Wansink found, aside from hunger, participants claimed they started eating at fast-food restaurants because 'I saw the food', or 'I wanted to be with other people', or because eating provided them with something to do.

Fast-food chains all play on these desires. By having restaurants on busy streets, shopping centres and motorway service stations, they can tempt people in to eat when they're shopping or driving somewhere – even when they're not hungry as they can see and smell the food. They also show pictures of the food on offer in window display posters and on large, bright boards above the tills.

They play on the 'wanting to be with people' aspect by providing a space for people to sit down around a table and eat together. This also means they are more likely to stay longer and eat more courses – returning for dessert or another fizzy drink.

The scent or smell of the restaurant can influence how much people eat too as 'odour can influence food consumption through taste enhancement. By piping pleasant scents into their restaurants, fast-food chains can encourage people to eat more. They can also do this by making people queue and order at the counter, rather than offering table service. This means the customer has to wait to see the person in front of them being served their food at the counter on a tray. The first customer will then walk back past the waiting customers who will see and smell the food on their tray – again enticing the waiting customer to order more when it's their turn.

The music fast-food restaurants play can also affect how much we eat. Hearing soft music that's not too up-tempo has been proven to encourage diners to stay at a restaurant longer and eat more.

Fast-food chains have made it easier than ever for people to eat there – from offering drive-through service so you don't even have to leave your car to be served, to meal deals where you can get a drink, main meal and dessert all in one go.

Meal deals are a further way to get people to eat more. They encourage people to think they are saving money when they could actually be buying more food than they need.

Portion size is another issue. When presented with one large bucket of chicken, many people would eat the lot. But if the same amount of chicken were given to them in three smaller boxes, they wouldn't eat it all. Wansink points out that although the physical effort to open the small component packages is minimal, a psychological barrier may prevent individuals from opening another.

RESPOND

1 What health issue may result from an over consuming fast-food?
2 How do fast-food restaurants use the following senses to get people to buy their food:
   a sight?
   b smell?
   c sound?
3 What other ways are consumers encouraged to purchase fast food?
4 Why is portion size a concern when consuming fast food?
5 Discuss the reasons why you choose or choose not to consume fast foods.

FOCUS QUESTIONS 5.1

REVIEW

1 Name the five senses that influence our choice of food.
2 Name four sensory characteristics of food.
3 What attributes contribute to the appearance of food?
4 Give an example of how odour can help you judge food quality.
5 Name five taste receptors that contribute to flavour.
6 Define the term 'mouthfeel'.
7 How is the sense of hearing related to the texture of food?

APPLY

8 Find an image of a savoury dish. Identify and describe its sensory characteristics.
9 Thai cooking can stimulate all tastes in one dish. Match the Thai ingredient with the taste sensation.

INGREDIENT	TASTE
Thai eggplant	Umami
Fish sauce	Sour
Palm sugar	Salty
Lime	Bitter
Chicken	Sweet

EXTEND

10 Imagine you have been employed to manage an Instagram account that provides information on the sensory characteristics of fresh fruit or vegetables. Select some fruit and vegetables to post. Include an image of the food and simple descriptions and hashtags to describe the appearance, texture and flavour of the food.

Sensory assessment

Sensory assessment is the process of using the five senses to analyse and evaluate a food. It can be both a subjective (personal opinions) and scientific method of measuring human responses to the composition of food and drink.

For example, you may notice some yellow bananas that feel soft, so you decide to make a banana cake. While mixing the batter, you add cinnamon for extra flavour and extra milk because the mixture looks dry. The odour from the oven indicates the cake may be ready so you look to see if the crust is golden colour and touch the cake to see if it has a firm crust and if the centre bounces back. To make sure, you insert a skewer into the centre of the cake to check it comes out clean. After eating the cake, you reflect that by adding chopped walnuts to the batter and by icing the cake with a lemon cream cheese frosting, the appearance, flavour and texture of the cake could be enhanced.

In general, both individuals and the food industry use sensory assessment to:

- evaluate a range of existing dishes and food products
- analyse food for improvements
- gauge responses to a dish or product; for example, acceptable versus unacceptable
- explore specific characteristics of an ingredient or dish
- check whether a final dish or food product meets its original specification.

Sensory characteristics and food quality

As individuals we constantly undertake sensory assessment when we purchase, prepare and present, eat and even discuss food.

The food industry also undertakes sensory assessments at different stages of product production.

Sensory assessment is essential to quality assurance programs to ensure consumers receive good quality food that is safe.

Remember, while some foods look, smell and taste good, they may still be dangerous to our health if they have been exposed to toxic levels of chemicals, microbes, pests or viruses that are not easily detected by our senses. This is why it is important to implement food safety procedures both in the home and within the food industry.

Shutterstock.com/theowl84

Figure 5.10 Sometimes our desire to eat foods that appeal to all our senses means otherwise safe and tasty foods are wasted. However, some food retailers have started selling imperfect-looking fruits and vegetables as they are still nutritious, have the same flavour and texture, and are cheaper.

Table 5.1 Sensory characteristics to indicate food quality

FOOD	SENSORY CHARACTERISTICS	EXAMPLE
Beef	• A bright red colour • Firm to the touch • Creamy/white fat • Does not smell strongly • Does not feel slimy	Shutterstock.com/ Cahaya Images
Lamb	• Rose pink flesh • Creamy/white and waxy fat • Does not feel slimy • Does not smell strongly	Shutterstock.com/ JIANG HONGYAN
Pork	• Light pink flesh • Creamy/white and soft fat • Does not feel slimy • Does not smell strongly	Shutterstock.com/ Kelvin Wong
Poultry (includes chicken and turkey)	Should not: • smell strongly • have slimy flesh, bones or skin • have any bruises or dark colours on the skin.	Shutterstock.com/ OH studio image gallery
Fish	• Round, bright, shiny eyes • Firm and springy flesh to the touch • Bright red gills • Shiny skin and scales intact • A fresh sea smell	Shutterstock.com/azure1

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Table 5.1 *(Continued)*

FOOD	SENSORY CHARACTERISTICS	EXAMPLE
Other seafood (prawns, oysters and crayfish etc.)	• Should have a fresh sea smell. • Shellfish such as mussels and clams should be closed, • Check for water around fish or seafood, it might have been frozen then thawed	Shutterstock.com/JIANG HONGYAN
Fruit, vegetables and herbs	• Firm texture, not wilted • Bright in colour • Right degree of ripeness for use • Free from visible mould, decay, cuts or bruises • Fresh in aroma • Uniform in size • Free of a green skins and sprouts on potatoes	Shutterstock.com/Viktor1
Fresh milk and dairy	• Pleasant smell • Check date marking • White liquid • No lumps • Below 4°C	Shutterstock.com/Alexeysun
Fresh bread	• Check date marking for packaged bread • No mould • Not dry • No torn packages	Shutterstock.com/MaraZe
Frozen food	• Should be at –18°C or lower • No ice-crystals on the package as this indicates the food has been allowed to defrost and then refreeze • Food should feel hard. Items such as peas should be loose, not clumped. Clumping is evidence of incorrect freezing or thawing. • Check that there are no juices or drips around the food. • Check for freezer burn. This shows as a change in colour. The food has not been correctly packaged and has dried out	Alamy Stock Photo/ Chloe Johnson
Packaged and tinned food	• Avoid damaged packages such as dented or rusted cans, or torn packages • Use unopened packages • Follow best-before dates	Shutterstock.com/de2marco

Evaluating the appeal of foods

The food industry is continually developing new products. They do this for many reasons including to:

- improve their products
- extend their product range
- meet consumer demands, such as for lactose-free milk
- compete against a competitor's product by producing something similar
- develop a completely new food product
- keep up with new food trends and changes in lifestyle and technology.

The food industry commonly use sensory assessments, such as taste tests, to determine consumers' desire for new food products. These tests can be carried out by a food producer, but usually they employ a specialised market research team to obtain independent results.

The taste-testing panel can be a group of experts in tasting a particular food or drink, and/or groups of consumers from the target market the new product is aimed at. The results of the tests provide the manufacturer with feedback and identify preferences and any changes that may be required. Importantly, these tests are conducted before a product is placed on the market, which helps to avoid wasting money, time and effort if the new product is not well received by the target market.

Neapolitan chicken salad

Table 5.2 Sensory properties

APPEARANCE – SIGHT	AROMA – SMELL	FLAVOUR – TASTE	TEXTURE – TOUCH AND MOUTH FEEL
• Appetising • Attractive • Clear • Cold • Colourful • Crumbly • Creamy • Dry • Firm • Fresh • Greasy • Hard • Healthy • Hot • Moist • Runny • Smooth • Soft	• Burnt • Fragrant • Fruity • Freshly baked • Garlicky • Sickly • Spicy • Stale • Yeasty	• Acid • Bitter • Bland • Cheesy • Creamy • Dry • Fruity • Herby • Meaty • Old • Salty • Sharp • Sickly • Sour • Spicy • Stale • Sweet • Tangy • Tasteless • Tasty • Undercooked • Watery	• Airy • Brittle • Chewy • Creamy • Crisp • Crumbly • Crunchy • Dry • Fatty • Firm • Fizzy • Flaky • Foamy • Gooey • Greasy • Gritty • Hard • Lumpy • Mushy • Powdery • Slimy • Smooth • Soggy • Sticky • Stringy • Tender • Watery

FOOD IN FOCUS 5.2

RED GALAH

Red Galah is a market research company that provides product feedback from consumers to food manufacturers about food products they are developing. They have a database of members and when a client requires a certain type of consumer, Red Galah invites members who fit the criteria to participate in evaluating the new food product. Testing may be conducted at a member's home, online or onsite at a sensory assessment laboratory. Consumers are then rewarded for their time.

At their Castle Hill location, they have a sensory assessment laboratory that consists of booths where consumers taste samples of products and then complete a survey based on the food product. Most of the surveys involve consumers rating products according to criteria such as their appearance. Often they have to rate the criteria on a scale from 1 to 10 on a continuum.

In the test kitchen, staff prepare the food before it goes to the booths and label samples so that consumers are not influenced in any way. A glass of water is also provided in the booths. Testers are instructed to drink water between samples to clear their palates. Collecting data from consumers helps food manufacturers to decide if the food will appeal to the target market and if any modifications need to be made.

When opinions from consumers from outside Sydney are required for a project, Red Galah conducts testing in other sensory laboratories around Australia or they set up testing booths in community facilities in regional areas.

Red Galah

Figure 5.11 A taste-testing booth at Red Galah

RESPOND

1. What type of company is Red Galah?
2. What service do they provide for food manufacturers?
3. Why do they supply taste testers with water?
4. Why are booths used when undertaking taste testing?
5. How do food manufacturers respond to the data collected from the taste tests?

Sensory tests

Usually one of three types of sensory testing is used when developing a new food product.

PREFERENCE TESTS

These types of tests supply information about people's likes and dislikes of a product. They are not intended to evaluate specific characteristics, such as crunchiness or smoothness. They are subjective (personal opinion) *and* include hedonic, paired comparison (preference) and scoring testing methods.

Hedonic descriptors describe the 'pleasure' a food gives them. Hedonic descriptors can be presented and recorded in a variety of ways. Tasters can:

- describe the food using terms such as delicious, tasty, yummy, luscious, appetising, nice, good, revolting, horrible, dreadful and foul.
- rate food on a nine-point scale between 1 and 9, with 5 being a neutral reaction, 9 being 'liked very much' and 1 being 'disliked very much'.
- use a facial hedonic descriptor to describe taste reaction using different facial expressions, such as a smiling face to indicate you are very happy with the flavour. Paired comparison (preference) testing asks tasters to decide which product they prefer from two samples, while scoring tests ask respondents to rank products on a scale.

Figure 5.12 Facial hedonic descriptors

DISCRIMINATION TESTS

Discrimination tests are used to determine whether consumers can tell the difference between samples of food in relation to specific attributes such as crunchiness or smoothness. It is an objective test, as the results are analysed statistically to determine whether or not differences are significant. The following are examples of different methods that can be used in such testing.

- Paired comparison (discrimination): two samples are presented to the taster. The samples may appear alike but each are made from a slightly different formula. The taster has to compare a particular attribute; for instance, which sample is smoother?
- Triangle test: three samples, arranged in a triangle shape, are presented to the taster. Two samples are the same. In this type of test, differences between the samples are often very small, but the tester has to decide which is the odd one out.
- 'Two-out-of-five' test: this test includes three samples that are the same, and two that are different. The samples are presented randomly and the panel must decide which two of the samples are different. It is a reliable method for picking differences in flavour and colour.
- Ranking test: this is used to assess an attribute such as crunchiness. Samples are provided to the taster and they are asked to rank each according to the attribute from 'very much' to 'not at all'.

PROFILING TESTS

Profiling allows the intensity of a range of sensory attributes of a food or dish to be recorded. It is a complex test that involves using trained testers, rather than potential consumers. It is commonly used when food manufacturers want to compare their products with competitors. A star diagram is used to record the results and to evaluate the differences.

WS Star chart

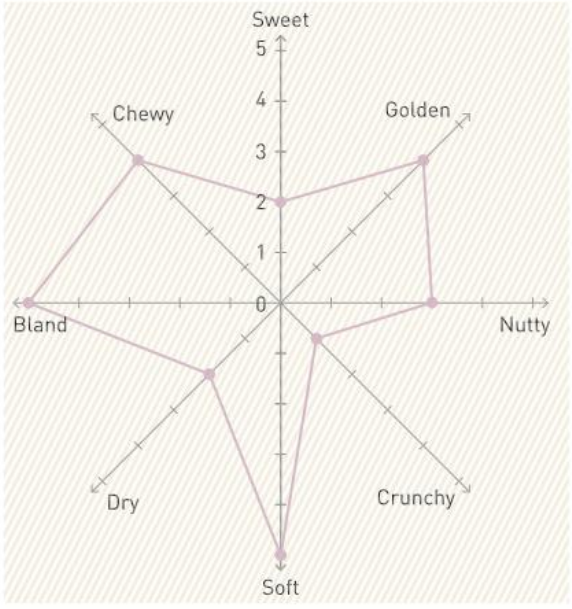


Figure 5.13 With five being the highest score, what does this star chart indicate about this trial recipe for a muesli bar? Suggest changes to improve the sensory assessment of the product.

FOCUS QUESTIONS 5.3

REVIEW

1 What is sensory assessment?
2 What does the term subjective mean?
3 How can you assess if a cake is cooked?
4 Explain why a food may look good but be unsafe to eat.
5 Give four reasons why sensory assessment is used in the food industry.

FOR YOU TO APPLY

6 When in a store, how would you assess the sensory quality of the following items?

- Fresh apples for school lunches
- Fresh sliced bread for school lunches
- Fresh strawberries to decorate a dessert
- A 1-litre vanilla ice-cream tub for a dessert

EXTEND YOURSELF

7 Research different types of hedonic scales that can be used for preference testing.

Chapter review

REVIEW

1 Name three words to describe aroma.
2 Give three examples of how the food industry uses sensory assessment to assess food quality at different stages of production.
3 What information does preference testing provide?
4 Why is discrimination testing used when developing new products?
5 What is profile testing of food and when is it used?

FOR YOU TO APPLY

6 Treat yourself to a biscuit. First, name the type of biscuit, then examine its appearance and aroma and, finally, taste it. Complete the following table.

SENSORY PROPERTY	DESCRIPTION OF PROPERTY USING ADJECTIVES FROM THE TEXT
Appearance	
Aroma	
Flavour	
Texture	
Noise	

EXTEND YOURSELF

7 Conduct a ranking taste test on students in another class at your school. Make sure to ask if any student has a food allergy.
- Choose a food that comes in different brands such as corn chips, vanilla yoghurt or milk chocolate. Choose 3 brands only.
- Design a ranking worksheet where students can rank the samples of food from most liked to least.
- Place samples of the food in appropriate containers, making sure that you label them with a letter or number that in no way indicates the brand.
- Set up tables so students cannot talk to or see each other.
- Ask students to taste each of the samples and then rank them after tasting all three samples.
- Ensure that students sip water in between their tasting to clear their palate.
- Collate the data and present your findings in an appropriate graph.

CHAPTER 6

Functional properties of food

Food provides nutrients that contribute to the health and functioning of our bodies. However, the nutrients in food also have functional properties that can change physically or chemically when subjected to factors such as oxygen, heat or agitation. For instance, when we fry an egg, we are not only cooking a food high in protein but also, when subjected to heat, the protein helps to the set the egg so that it is no longer runny. In this unit, you will examine the functional properties of protein, carbohydrates and fats in foods and the factors that may affect the success of the functional property. Understanding the functional properties is essential in producing food products that are flavoursome, have a pleasant aroma, appropriate texture and are visually appealing.

CHAPTER OUTCOMES

In this chapter you will learn about:

- the functional properties of food
- factors that affect the functional properties of food.

KEY TERMS

emulsion
functional properties
coagulation
denaturation
gelatinisation
aeration
caramelisation
dextrinisation
maillard reactions
saturated solutions
supersaturated solutions
unsaturated solutions
syneresis

iStock Photo/gizemmuresan

Factors that affect the functional properties of food

Several factors influence the functional properties of food.

Oxygen

Many of the changes that happen when oxygen reacts with components in food are undesirable, such as food drying or browning, so we use methods to prevent or reduce a food's exposure to oxygen. Covering food with plastic wrap is one way to reduce a food's exposure to oxygen. For some recipes, incorporating oxygen into a food makes the product lighter, increases its volume and helps it to rise. Think about how light and airy whipped cream is because of the air that is incorporated into the mixture via agitation during beating.

Temperature

All chemical and physical changes have an ideal range of temperatures at which they occur and temperature itself can bring about changes. Consider the changes that happen to a piece of meat as it cooks – going from red to light brown, to brown, to charcoal black if it is burned.

Acidity (level of pH)

The acidity and alkalinity of a food is measured by the pH scale of 0 to 14, with 7 being neutral. Values less than 7 are acidic, more than 7 are alkaline. The further the values move from 7, the more acidic or alkaline they are. Water has a pH of 7 and most foods have a pH of between 2 and 8. Many foods contain acids, such as citric acid in lemons and oranges, malic acid in apples, acetic acid in vinegar and lactic acid in milk. Even meat is slightly acidic. Changing the pH of a food can have significant effect on it. For instance, if you add vinegar to milk, the milk curdles/clots because the milk proteins denature. While this may not be desirable when serving milk as a drink, acids assist milk to clot to produce products such as buttermilk.

Alkalis do not commonly occur in foods; however, bicarbonate of soda is alkaline and when you combine it with an acid it produces carbon dioxide gas that, when heated, helps cakes and biscuits to rise. Baking powder and self-raising flour have acid and alkaline ingredients for this reason.

Agitation

Agitation such as beating, stirring, whisking or folding ingredients can affect a functional property. For instance, when making a pavlova, beating egg whites is required to stretch egg protein, which then traps air and sugar to form a firm foam structure with high peaks. Cornflour is then folded gently into the foam, as further beating may cause the egg proteins to over stretch and permanently deflate the structure.

Enzymes

Enzymes are in all living things and their primary function is to catalyse (speed up) chemical reactions. For each chemical reaction, there is a specific enzyme. They are responsible for ripening fruits and vegetables as well as foods decomposing. Some enzymes can also help to tenderise food. For instance, the papaya fruit contains an enzyme

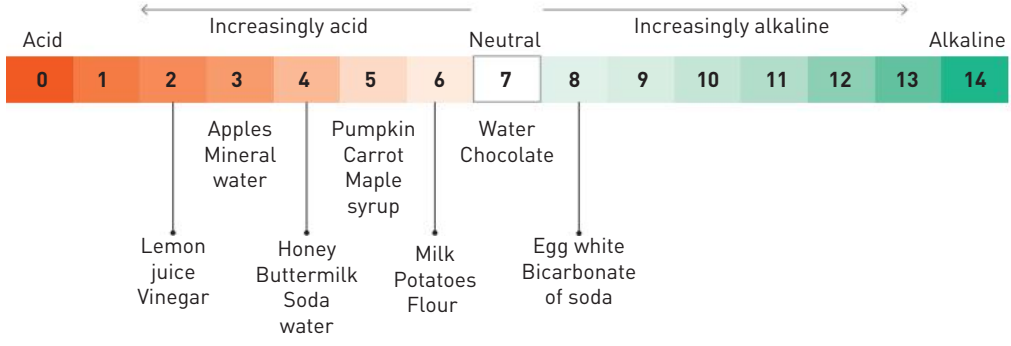


Figure 6.1 The pH scale

Shutterstock.com/Ph0neutria

Figure 6.2 Marinating fresh calamari with kiwi pulp can make cooked calamari less chewy, as the kiwi fruit contains an enzyme that can breakdown some proteins.

called papain, while pineapples contain bromelain which can breakdown protein to tenderise foods such as meats.

The activity of enzymes is affected by moisture, temperature and pH. Enzymes work best at body temperature (around 37°C). They are destroyed at high temperatures and work more slowly at low temperatures.

Adding other ingredients

Whenever you add something to food you change the end product. Sugar, salt and fat are examples of ingredients that are commonly added to foods to fulfil particular functions. Timing is very important to success when adding ingredients. For instance, when making pavlova, sugar is added slowly to the egg white foam to stabilise it, but if it is added too early when beating the egg whites, it will not make stiff foam and the pavlova will not have a stable structure.

PRACTICAL APPLICATION

6.1

CREATING BUTTERMILK

Buttermilk is added to many batters such as cakes and pancakes. Once the acids in the buttermilk come into contact with the baking soda or baking powder (an alkali) in the batter, the carbon dioxide produced makes the final product light, airy, tender and tasty. Buttermilk is also used when marinating chicken to help to tenderise it.

Buttermilk is traditionally the whey produced from churning cream to make butter. Today it is made from skim milk and cultures (lactic acid bacteria) that sour and thicken the milk because it changes the structure of the milk protein present.

AIM

To investigate how pH and agitation affects the functional properties of food.

MATERIALS

2 cups milk
1 tablespoon vinegar or lemon juice
1 ¾ teaspoon cream of tartar
1 cup plain yoghurt
¾ cup sour cream
300 mL cream
1 carton of store purchased buttermilk
spoon for stirring
electric beater

METHOD

You can make buttermilk using milk, yoghurt, sour cream or cream.

MILK

There are two ways to make buttermilk using milk:

1 **a** Combine 1 cup milk and lemon juice or vinegar, stir.
  b Let the mixture stand at room temperature for 5 to 10 minutes until slightly thickened and curdled.
2 **a** Mix 1 cup milk with 1 ¾ teaspoons cream of tartar.
  b Stir and let stand 5 to 10 minutes until slightly thickened and curdled.

YOGHURT

Mix ¾ cup plain yoghurt with ¼ cup water to thin the yoghurt.

SOUR CREAM

Mix ¾ cup sour cream with ¼ cup plain water to thin sour cream

CREAM

1 Overbeat 300 mL of fresh cream until the cream becomes yellow and separates into curds (clumps of fat globules) and whey (liquid).
2 Strain the whey into a container. This is butter milk.
3 Refrigerate in a jar for up to a week, where it should thicken as the lactic acid bacteria builds.
4 Collect the curds, strain further to remove as much whey as possible.
5 Add some salt and you have produced butter by agitation.

>

6.1

RESPOND

1 Identify the acid ingredients in the two milk, yoghurt and sour cream recipes.
2 What affect does the acid have in the two milk recipes?
3 What affect do acids have on milk proteins?
4 What role does agitation play when using cream?
5 Compare the sensory characteristics of each of the homemade buttermilks to a store-bought product.
6 Research and prepare a recipe that uses buttermilk.

FOCUS QUESTIONS 6.1

REVIEW

1 Give an example of how oxygen can have a negative reaction with food.
2 Give an example of how oxygen can have a positive reaction with food.
3 What is the primary function of enzymes?
4 How does temperature affect enzymes?
5 Name two foods that contain citric acid.
6 Name three common ingredients that can affect the functional properties of food.

FOR YOU TO APPLY

7 Produce a mind map that identifies the factors that affect the functional properties of food.

EXTEND YOURSELF

8 Find a recipe to trial making your own ricotta or cottage cheese.
- Why does the milk clot?
- Explain what factors are required for a successful end product.

Functional properties of proteins

Protein structure

Many foods contain protein, such as collagen in meat and gluten in wheat flour. Proteins form part of the structure of cells, as well as providing nutrition to the body when consumed. Proteins are made up of small units called amino acids. Amino acids are compounds of molecules of carbon, hydrogen, oxygen and nitrogen. A few also contain the elements sulphur and phosphorous.

There are 22 different types of amino acids. They can combine in many ways to form different proteins. The join between two amino acids is called a peptide bond. Proteins are referred to as polypeptides, as around 500 amino acids can join together to make a long chain.

As the proteins are so long, they coil like a spring and this results in protein molecules that are either globe shaped (round) or fibrous shaped (elongated). Cross-bonds hold the structure together. The shape of the molecule is important as it affects the functional properties of the protein, specifically its ability to denature, coagulate, gel, foam or brown.

Denaturation

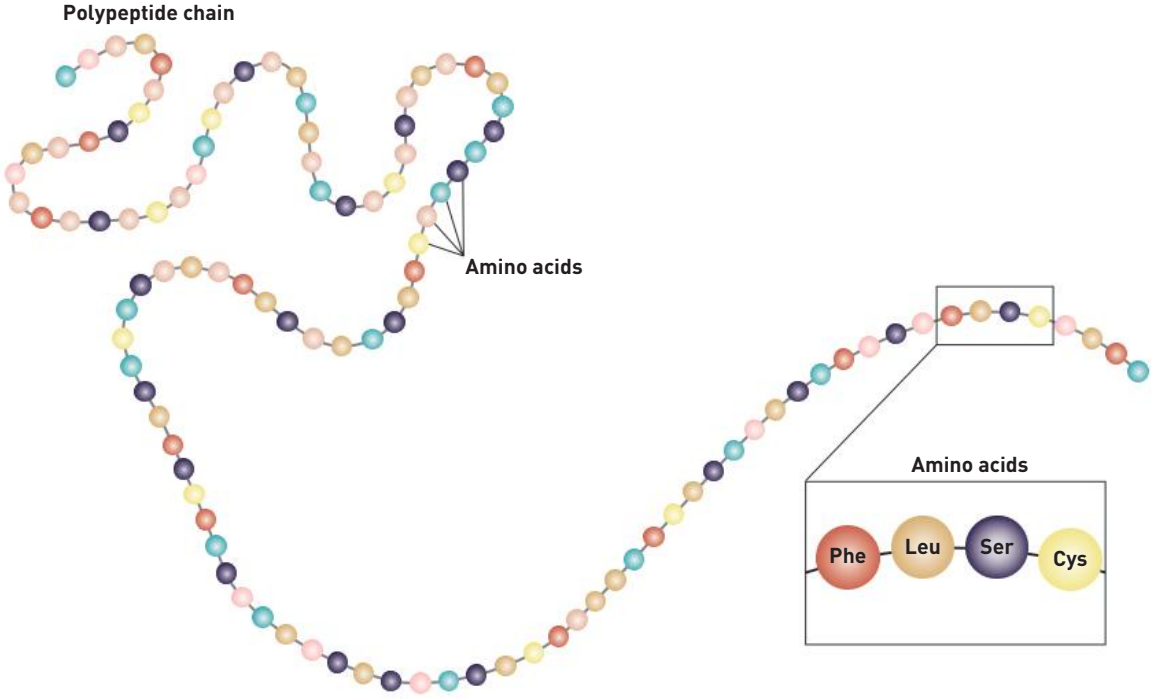
Denaturation is when the structure of the protein breaks apart. Hydrogen bonds are broken, causing the coiled strands to unwind. Heat (above 40°C), agitation (kneading, mixing, whipping and beating), acids, salts and enzymes can all denature proteins. However, denaturation is not easy to observe as it is a chemical change that occurs before the more obvious physical changes such as coagulation, gelation and foaming.

Marinating meat in an acid such as lemon juice or soy sauce causes the proteins to denature and results in meat that is more tender. Enzymes found in fresh pineapples and kiwifruit can also tenderise meats through denaturation. You should also rest meat after it is cooked, as denaturing helps the meat to reabsorb some of the juices that escaped from it during cooking.

Salts help denatured proteins to remain moist and this is one reason you may use salt as an ingredient in some sweet dishes. Obviously, the higher the temperature, the quicker the protein will denature.

Denaturation

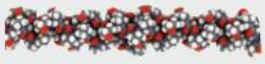
Figure 6.3 Proteins are like a long beaded chain with each coloured bead being a different amino acid.



Amino acids

Ala: Alanine	Gln: Glutamine	Leu: Leucine	Ser: Serine
Arg: Arginine	Glu: Glutamic acid	Lys: Lysine	Thr: Threonine
Asn: Asparagine	Gly: Glycine	Met: Methionine	Trp: Tryptophan
Asp: Aspartic acid	His: Histidine	Phe: Phenylalanine	Tyr: Tyrosine
Cys: Cysteine	Hyp: Hydroxyproline	Pro: Proline	Val: Valine
Cys2: Cystine	Ile: Isoleucine		

Table 6.1 Food sources of different proteins

STRUCTURE OF PROTEIN	PROTEIN NAME	FOOD SOURCE
Fibrous  Shutterstock.com/molekuul_be	Collagen	Connective tissue of meat, poultry, seafood
	Myosin	Muscle tissue of meat, poultry. seafood
	Elastin	Muscle tissue of meat, poultry. seafood
	Gluten	Wheat
	Globulin	Legumes, pulses and soy beans
Globular Shutterstock.com/ibreakstock	Caseinogen	Milk curd (solids)
	Lactalbumin	Milk whey (liquid)
	Lactoglobulin	Milk whey (liquid)
	Ovalbumin	Egg white
	Lipovitellin	Egg yolk
	Mucin	Egg white

Coagulation

Coagulation occurs after denaturation. Heat, acids and enzymes can cause the separated strands of amino acids in the denatured protein to regroup with new cross bonds. Liquid is then trapped between these coagulated proteins and a gel or elastic solid is formed. Hence, coagulation results in a physical change in food.

Eggs are a good foodstuff to demonstrate coagulation. When an egg is exposed to heat, the liquid albumen (egg white) gradually sets to form a white rubbery mass and the yolk becomes firm. Because of the different proteins in the egg, they coagulate at different temperatures, white at 62–65°C and egg yolk at 65–70°C.

Eggs are often used for crumbing food and in mixtures like hamburger patties. As the egg coagulates with heat, it binds the ingredients together. Many cakes also include eggs, as, when heated, the coagulate egg contributes to the fixed and firm shape of the finished product. This is also true when egg white foams (meringue) are set in an oven to make pavlova.

Many baked products, such as cakes and biscuits, are made from wheat flour. Wheat contains the protein gluten. Agitation, such as beating or kneading, denatures the protein causing it to stretch. Under heat, the stretched gluten coagulates and the set gluten helps to form the structure of the baked product. The more gluten in a flour, the stronger the structure will be. Hence, when making bread, we use high-gluten flour whereas when making cakes, we use low-gluten flour so they remain light and fluffy.

Coagulation also occurs when making cheese and yoghurt. To make cheese, the enzyme rennin (which comes from the digestive system of young mammals) is added to warm milk to coagulate the milk into curds (solid) and whey (liquid). To make yoghurt, good bacteria is added to warm milk and converts the lactose (milk sugar) to lactic acid, which thickens the milk by coagulating the protein and gives yoghurt its tangy taste.

Proteins in meats and fish also coagulate when they are cooked. And with milk, the skin which can form when it is heated consists of coagulated milk proteins of casein and lactalbumin.

If coagulation continues for too long, over-coagulation will occur, where the proteins shrink and toughen, forcing liquid out from inside the proteins. This is known as syneresis. It is irreversible and this is why when you overbeat egg whites they revert back to a runny mass and can no longer be beaten into a foam. Over-coagulation from high heat is the reason why meat shrinks and water escapes from scrambled eggs and baked egg custards. It is also the reason we use a water bath to bake creme caramel and a double boiler to make lemon curd.

The addition of other ingredients will affect the denaturation and coagulation process. Adding sugar increases the temperature at which proteins coagulate, while adding salt or an acid lowers the temperature at which the proteins coagulate. This why an acid such as vinegar is added to boiling water when poaching eggs.

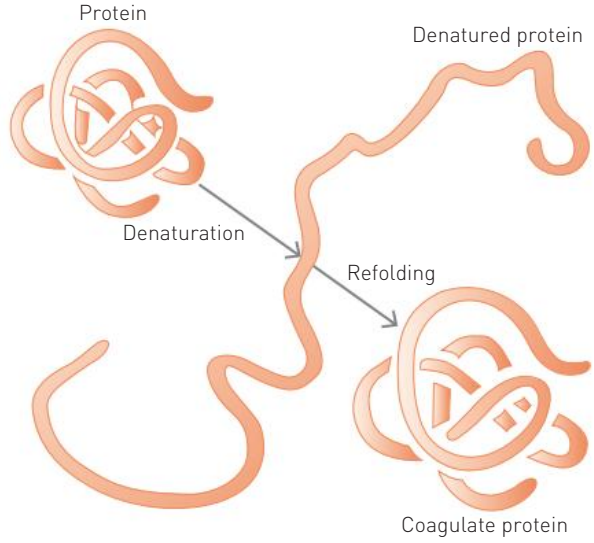


Figure 6.4 Liquid is trapped in coagulated proteins.

Shutterstock.com/Olga Miltsova

Figure 6.5 Proteins in the egg, bacon and bread have coagulated to set the foods.

Gelation

Gels can be described as elastic (wobbly) solids. Gelation of proteins occurs when tiny droplets of liquids become trapped within coagulated proteins. For instance, custards commonly use egg and milk as ingredients. When heated, the egg and milk proteins coagulate, thickening the mixture and on cooling a gel is formed.

Gelation

When you make a soup or stock with meat bones and cool it in the refrigerator, a clear gel layer often forms on top. This is because the meat bones and connective tissue of the meat surrounding the bones contain the protein collagen. On heating, the collagen is denatured into a protein called gelatin, which has the ability to gel large amounts of liquid. Gelatin is sold commercially as gelatine and is used to produce chilled desserts, jelly, confectionary, ice-cream and thickened cream as it produces a clear, stable and flavourless gel.

Packet jelly is made from sugar crystals, gelatine, flavouring and colours and dissolved in warm water. The heat helps to coagulate the protein and, on cooling, a gel is formed as droplets of liquids become trapped within coagulated proteins.

Slow cooling produces more stable gels. Enzymes found in raw pineapple, kiwifruit, paw paw and figs prevent gelatine from gelling, while the concentration of gelatine to liquid needs to be increased in a recipe if an acid ingredient such as lemon juice is used.

Other examples of gelation include making junket and soft cheeses. Both use the enzyme rennin to set the milk into gel.

Shutterstock.com/sarocha wangdee

Figure 6.6 Gelatine is used to gel warmed cream and milk in panacotta.

Foaming

Soufflé omelette

A foam results when a gas such as air is dispersed through a liquid. Proteins in egg whites have an excellent ability to foam when denatured by beating. The beaters create spaces for air to enter and then it becomes trapped within the stretched denatured proteins. The denatured proteins give stability to the foam.

Egg white foams are used to aerate many products such as meringues, pavlovas, sponges, omelettes, soufflés and mousses.

Table 6.2 Factors affecting egg white foams

FACTORS	EFFECT ON EGG WHITE FOAM
Temperature	Egg whites foam better if they are at room temperature. Gentle low heat will coagulate proteins to set foams.
Acidity	Acids such as cream of tartar and vinegar delay the formation of foam but increase its stability. They are usually added after the foam is formed.
Agitation	Faster beating and finer blades produce greater and finer foam. Over-beating past the hard peak stage over-stretches and over-coagulates the protein and the foam collapses permanently.
Adding other ingredients	Fat in egg yolk prevents foam formation. Water increases a foam's volume but decreases its stability. Adding sugar before soft peaks form delays foam formation. Adding sugar gradually after soft peaks form makes the foams shinier, finer and more stable. Fresher eggs have thicker whites, which increase the foam volume. Gelatine can be used to set foams such as in mousses.

Shutterstock.com/Elena Veselova

Figure 6.7 Meringues are light because of the air trapped in the foam.

Browning

There are several ways proteins contribute to browning foods.

ENZYMATIC BROWNING

Enzymes are proteins that speed up chemical reactions in living things. In food preparation, many light-coloured fruit and vegetables such as bananas, potatoes, avocado, peaches and apples go brown when their flesh is exposed to oxygen in air. This is because the enzymes cause oxygen to react with substances on the surface of the cut fruit or vegetable, causing them to go brown. Enzymatic browning can be reduced by:

- covering a cut food such as cut apples with cling wrap
- coating cut fruit with citric acid such as lemon juice
- submerging the food in cold water such as soaking peeled potatoes.

MYOGLOBIN BROWNING

When the blood protein myoglobin in meat is heated, it denatures, changing the colour from pink to brown. Because the outside of the meat experiences the heat first, the colour change happens from the outside to the inside.

When fresh meat is exposed to air or it ages, the oxygen causes the meat to brown as it changes the iron present on myoglobin. Covering the meat in cling wrap helps prevent the browning.

MAILLARD REACTION

The Maillard reaction occurs when the denatured proteins recombine with the sugars present under the presence of dry heat. It results in the development of a brown colour and also a change in flavour.

Maillard reactions

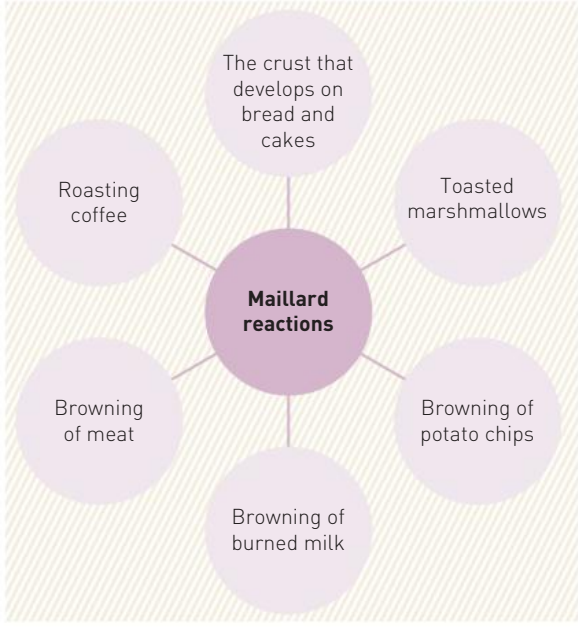


Figure 6.8 Examples of Maillard reactions

Shutterstock.com/SKUpics

Figure 6.9 Toasted marshmallows are an example of Maillard reactions.

FOCUS QUESTIONS 6.2

REVIEW

1 Answer true or false
- **a** There are 10 different amino acids.
- **b** Protein structures are long chains of amino acids that coil into globular or fibrous shapes.
- **c** Denaturation is the unwinding of protein structures.
- **d** Coagulation of proteins occurs before denaturation.
- **e** Low-gluten flour is best for making pizza.
- **f** Acids and enzymes can both coagulate proteins.
- **g** It is impossible to over-coagulate proteins.
- **h** Quick cooling produces more stable gels.

FOR YOU TO APPLY

2 With reference to the functional properties of food, reply to the reader's question on a food blog:
- **a** How do I stop the cut apples I give to my children as snacks from going brown?
- **b** Why are my egg whites not foaming to the stiff peak stage?

EXTEND YOURSELF

3
- **a** Research the production of gelatine.
- **b** Explain why some people may object to the use of gelatine in food.
- **c** What gelatine alternatives are available for use in food products?

Functional properties of carbohydrates

Apple and custard teacake

As carbohydrates are formed by the process of photosynthesis, all plant foods and some animal foods contain carbohydrates. In cookery, carbohydrates are classed as sugars, starches and fibres based on the length of their molecules. Sugar and starch contribute most to the functional properties of carbohydrates. However, fibres such as pectin are useful for gelling fruits when making jams.

Starches are found in grains, such as rice, corn, wheat, rye and oats, and in other cereal products such as flour, bread, pasta and breakfast cereals. They are also present in fruits, vegetables, legumes and pulses.

Sugars made from sugar cane include white, raw, brown, caster and icing as well as golden syrup; scientifically they are known as sucrose. Glucose and fructose are sugars found in fruits and honey, while lactose is a milk sugar and maltose is the sugar in malt.

Gelatinisation

Gelatinisation refers to the breakdown and swelling of starch granules that occurs when heat is applied in the presence of water or other liquid such as milk or stock. The swelling causes the mixture to thicken and if enough starch is used a gel will form on cooling. Examples of gelatinisation include:

- boiled rice and pasta
- porridge made from oats
- sauces thickened with wheat or corn flour such as gravy, white sauce and cheese sauce
- custards
- pie fillings
- flour to thicken stews or casseroles.

Gelatinisation

Table 6.3 Factors affecting gelatinisation

FACTOR	EFFECT ON GELATINISATION
Temperature	Starch is insoluble in cold liquids and heat is required to soften the starch to absorb liquids. Depending on ingredients in the mixture, gelatinisation occurs between 55–85°C. No thickening occurs past boiling point.
Acidity	Acids break down starch granules and should be added after thickening.
Agitation	Agitation such as stirring is essential for a smooth, gelatinised sauce. Lack of agitation causes starch granules to burst, resulting in lumps.
Adding other ingredients	Sugar competes with starch for water resulting in less thickening. Sugar raises the temperature at which the granules start gelatinising. Starch in cornflour and arrowroot produce clearer and lighter gels and sauces than starch in wheat flour.

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Figure 6.10 Both the cheese sauce and the macaroni use gelatinisation in macaroni and cheese.

Dextrinisation

Dextrinisation is the process in which a starch is exposed to dry heat, which causes the starch to break down to dextrin (a smaller molecule), resulting in a change in colour to golden brown.

Examples of dextrinisation include toasted bread, toasted muesli and the golden crust on bread, cakes, biscuits, pastries and even on starchy roasted potatoes. These use dry-heat methods of toasting or baking.

Dextrinisation only occurs on the surface of food products because the moisture inside stops the temperature from becoming hot enough to brown the starch. Compared to starch, dextrin is more flavoursome – and more digestible.

When making gravy, the flour is browned over dry heat to colour it. However, a larger quantity of

PRACTICAL APPLICATION 6.2

GELATINISATION OF STARCHES

AIM

To study the gelatinisation ability of different types of starch commonly used in cookery.

MATERIALS

1 tablespoon of each of the following starches: plain wheat flour, cornflour, tapioca flour (arrowroot). Chickpea, potato and rice flours can also be investigated

½ cup water for each starch

3 small bowls for blending starches

A wooden spoon

3 small wetted moulds

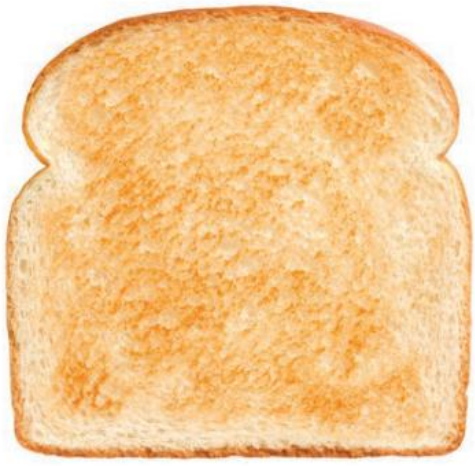
3 plates

METHOD

1. Wet the moulds by rinsing with water and draining quickly.
2. Place the wheat flour in a small saucepan and slowly blend in the water, mixing well so there are no lumps.
3. Place the saucepan over medium heat; stir continuously until the mixture comes to the boil. Continue stirring and cook for 1 minute.
4. Pour the thickened mixture into the wetted mould. Label and allow cooling and setting.
5. Repeat with the other starches.
6. Loosen the edges of each mould and turn onto a plate.

RESPOND

7. Emulate by ranking the starches in order of which starch:
   - was the easiest to blend
   - thickened the most on boiling
   - produced a clear gel
   - produced a glossy gel
   - produced a cream gel
   - best held its shape
   - had the most flavour.
8. Give a reason as to which starch would be best to:
   - prepare a clear glaze on a fruit flan/tart
   - thicken a stir fry or clear soup
   - thicken a casserole, stew, curry or vegetable soup
   - make a white/cheese sauce for dishes such as macar cheese or tuna mornay.
9. Investigate which flours are suitable for gluten-free cooking.
10. Investigate the difference between tapioca and sago. Prepare sago pudding to further observe the process of gelatinisation.



Shutterstock.com/Danny Smythe

Figure 6.11 Toast is an example of dextrinisation.

flour is needed compared with making other sauces as dextrin does not thicken as well as starch.

Dextrinisation

Caramelisation

When sugars, or foods with high sugar content, are heated above melting point they can undergo a physical change to produce a golden brown caramel. This happens more readily without water but syrups (sugar and water) will caramelise with rapid heating. Overheating will, however, cause the caramel to become bitter, dark and eventually burn.

Besides sugar, foods naturally containing sugars include honey, maple syrup, fruits, milk and even vegetables such as onions and carrots.

Caramelisation

Figure 6.12 Caramelised food products

Shutterstock.com/AS Food studio

Figure 6.13 Caramelisation

Crystallisation

Sugar (sucrose) from sugar cane is made of crystals that can dissolve in water. When a large concentration of sugar is dissolved in a liquid and the solution is heated, the liquid evaporates, further concentrating the sugar solution. As the solution cools, the sugar crystallises again. Hence, crystallisation is the ability of sugar to dissolve and reform crystals. This functional property is useful for making confectionary such as toffee, brittle, fudge and fondant.

FACTORS AFFECTING THE FUNCTIONAL PROPERTY OF CRYSTALLISATION

Concentration of sugar

A supersaturated sugar solution is required for crystallisation. At room temperature, saturated solutions have the maximum amount of sugar that can be dissolved in water, while unsaturated solutions can take more sugar to reach saturation. Supersaturated solutions have much more sugar than the water can dissolve, but on heating the sugar dissolves making it ideal for crystals to reform. The more sugar in a solution, the harder the end product.

Temperature

Heat is required to dissolve sugar. Low temperatures when heating solutions produce softer products such as fudge, while higher temperatures produce harder products such as brittle. Overheating will cause a bitter, darker product and burning. Crystallisation occurs as the solution cools,

usually between 40–50°C. Confectionary becomes harder at this stage. Placing a few drops of boiling solution into cold water can be used to test the stage of crystallisation.

Agitation

Agitation triggers crystallisation. Hence, sugar must be stirred and fully dissolved into a liquid before boiling starts. Stirring during or just after boiling point is reached encourages crystals to develop and the product can become grainy. It is important to brush away any sugar on the sides of the saucepan when boiling the sugar solution as these may trigger crystallisation too early. Beating needs to occur as the solution cools with different products requiring agitation at different points. It is avoided completely when making toffee so as to avoid large crystals forming.

Adding other ingredients

Some ingredients can interfere with the crystallisation by stopping the sucrose molecules from boding together. However, they are still used when making confectionary to create smaller crystals and softer and smoother products such as caramels and nougat. Too much of these ingredients, can result in runny, unset products. The following are interfering agents:

- simple sugars like glucose and fructose found in honey and corn syrup
- acids such as cream of tartar, lemon juice and vinegar
- fat such as butter or cream.

Bicarbonate of soda is used to add air bubbles to confectionary after it has reached the hard crack stage. The heat breaks down the bicarbonate to release carbon dioxide gas.

PRACTICAL APPLICATION 6.3

MAKING HONEYCOMB

AIM

To assess factors that affect crystallisation

MATERIALS

1 1/2 cups (335 g) white sugar
1/2 cup (125 mL) honey
1/3 cup (80 mL) water
2 tablespoons golden syrup
2 teaspoons bicarbonate of soda
oven tray
baking paper

METHOD

1. Grease and line an oven tray with baking paper.
2. Combine sugar, honey, water and golden syrup in a medium saucepan.
3. Place over low heat and cook, stirring, occasionally brushing down sides of the pan and spoon with a pastry brush dipped in water to remove any sugar crystals, for 5–7 minutes or until sugar dissolves.
4. Increase heat to high and bring to the boil. Cook, without stirring, for 5–7 minutes or until the syrup reaches crack stage (154°C on a sugar thermometer).
5. Remove from heat and set aside for bubbles to subside.
6. Add the bicarbonate of soda and quickly stir with a wooden spoon until combined (mixture will bubble and foam).
7. Pour onto the tray and set aside to cool completely.
8. Turn the honeycomb onto a clean surface. Break into large pieces.

RESPOND

1. What type of solution is created by the sugar and the water?
2. What affect does the honey have on the crystallisation process?
3. What is the role of the bicarbonate of soda in this recipe?
4. Why is stirring not permitted after boiling?

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Figure 6.14 Honeycomb

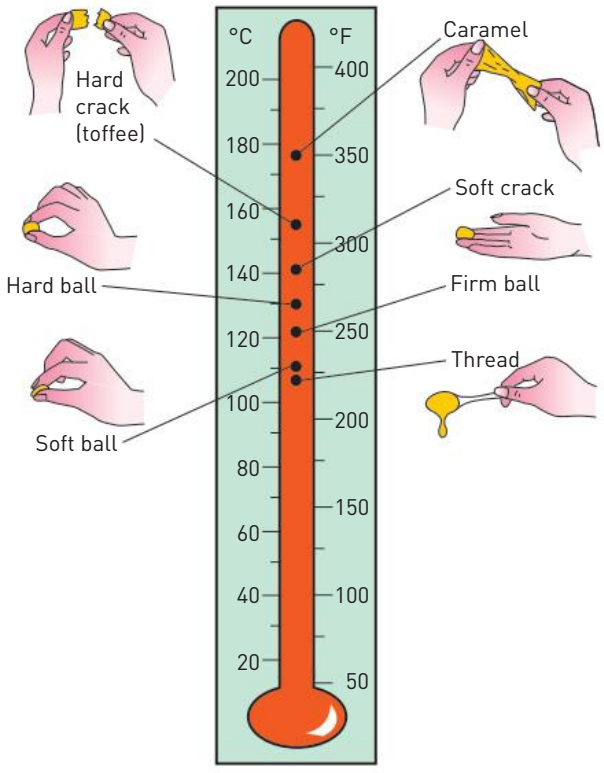

Figure 6.15 A sugar thermometer measures the different stages of crystallisation and caramelisation. You can also drop a small amount of the mixture in a glass of water to check its consistency.

FOCUS QUESTIONS 6.3

REVIEW

1 Answer true or false:

- **a** Carbohydrates are in all animal foods.
- **b** Glucose is found in fruits and honey.
- **c** Gelatinisation is the swelling of sugar granules.
- **d** Gelatinisation is completed before boiling point.
- **e** Dry heat is required for dextrinisation.
- **f** Meat browns because of caramelisation.
- **g** An unsaturated sugar solution is required for crystallisation
- **h** Agitation triggers crystallisation.

FOR YOU TO APPLY

2 With reference to the functional properties of food, reply to the following questions on a food blog:

- **a** Why does rice triple in size when cooked?
- **b** Why is my toffee not set and why is its texture grainy rather than smooth and clear?

EXTEND YOURSELF

3 **a** Find a recipe for each of the following:

- White sauce
- Cheese sauce
- Béchamel sauce

b Examine the similarities and differences of these sauces such as the ingredients used and the method of production.

c Identify the functional property that is used to make these sauces and the factors that would affect the success of the end product.

Functional properties of fats

Rich food sources of fats include cream, butter and margarine, oils (olive, canola, vegetable, coconut) and lard. Fats add flavour to foods but they also have other functional properties.

Emulsification

Oil and water may not mix, but with a little help, the two can join together in an emulsion. We can have an emulsion of fats in water, like milk, cream, salad dressings (oil and vinegar), or we can have an emulsion of water in fat, as we do in butter and peanut butter. There are two kinds of emulsions: temporary and permanent.

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Figure 6.16 The fact that olive oil and balsamic vinegar do not combine can make a tasty and visually appealing appetiser.

An example of a temporary emulsion is simple vinaigrette salad dressing. You combine the oil and vinegar in a jar, mix them up and they come together for a short time.

Mayonnaise is an example of a permanent emulsion, consisting of egg yolks, oil and vinegar. The egg yolks and oil would not naturally mix together, but by slowly whisking the oil into the egg yolks, the two liquids form a stable emulsion that won't separate. The vinegar is added slowly after the emulsion is formed and becomes part of the permanent emulsion. Lecithin, a fatty substance in egg yolk, is responsible for combining the two ingredients and is called an emulsifier. It is soluble in both fat and water and will combine with both to hold the liquids together, creating a thicker product. Many salad dressings also contain mustard and garlic, both of which contain gums to help to stabilise emulsions.

Homogenised milk is another example of a permanent emulsion. Homogenisation reduces the size of fat globules in milk so they are evenly distributed through the milk and the fat rises to the top to form a cream layer. Chocolate is another example, it is an emulsion of milk and cocoa butter.

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Figure 6.17 Hollandaise sauce is an emulsion of melted butter, vinegar and egg yolk. Over-beating the ingredients and using temperatures too low or too high may spilt the emulsion.

Aeration

Aeration is the process of incorporating air into food products to increase the volume and create a light, airy texture. Sifting flour and beating the mixture are examples of how air can be incorporated into a food product such as a cake. When heated, air expands, which makes the cake rise. Fats also play an important part in aeration. You can notice this when using low-fat products such as light cream, as these do not whip up successfully.

Table 6.4 The role of fat and agitation in aeration

METHOD OF INCORPORATING AIR	ROLE
Creaming	Used for cakes and biscuits where butter and sugar are beaten together, trapping air as the sugar is pressed into the fat to produce a fine crumb. They should be creamed until light and fluffy.
Rubbing in	Used for scones and pastries; air is incorporated as the fingertips lift and rub butter into the dry ingredients.
Folding and rolling	A technique used to make puff and flaky pastry used for pies. It involves spreading fat between layers of dough. The layers trap air and cause the pastry to rise and separate into flaky sheets. Spreading melted butter between layers of filo pastry also helps to make a light and flaky pastry product.
Whipping	Whipping cream causes fat globules to surround air bubbles to create foam. As air bubbles become finer, fat globules cling together increasing the stability of the foam. Over-beating will permanently collapse the foam and it is irreversible, with curds and whey resulting (which forms the basis of butter). Low-fat creams do not foam as they have less fat, while thickened creams include gelatine to help hold the foam.

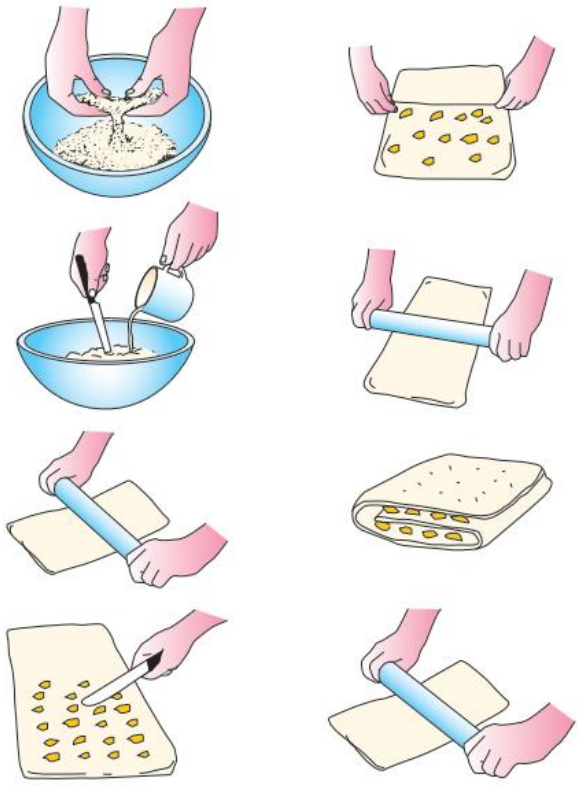

Figure 6.18 The stages of making flaky pastry.

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Figure 6.19 Ice-cream is made by whipping a custard of cream, milk and egg yolks.

FOCUS QUESTIONS 6.4

REVIEW

1 Name four types of fats used in cooking.
2 What is formed when oil and water mix?
3 What is a temporary emulsion? Give an example.
4 Give an example of a permanent emulsion.
5 What is the emulsifier naturally found in egg yolk?
6 Define aeration.
7 What is the name of the process of beating butter and sugar together until they are light and fluffy?
8 How does this affect the sensory properties of cakes and biscuits?
9 Describe the process of rubbing in?

FOR YOU TO APPLY

10 Research and prepare a recipe for making homemade French dressing and homemade mayonnaise.
11 Explain why the French dressing separates but mayonnaise does not.
12 Suggest food products where you can use mayonnaise and French dressing.
13 Compare the ingredients of your homemade product to commercially produced varieties. What differences are there in the ingredients used in both products and suggest why they might be different.

EXTEND YOURSELF

14 **a** Research and prepare a recipe for a meat pie with homemade flaky pastry.
b Analyse and compare your flaky pastry with that of a store-bought pie

Chapter review

REVIEW

1 With reference to functional properties of food, what does agitation mean?
2 List three ingredients that are classified as acidic.
3 Name food sources for the following proteins:
- Collagen
- Gluten
- Lactoglobulin
- Ovalbumin

4 Explain the relationship between denaturation and coagulation.
5 Define a gel.
6 Explain why meat browns when cooked by dry heat.
7 Name four ingredients that are rich in:
- Sugars
- Starches

FOR YOU TO APPLY

8 Use the table below to summarise the functional properties of food.

WS
Functional properties

FUNCTIONAL PROPERTY	DEFINITION	NUTRIENT INVOLVED	TWO FOOD EXAMPLES
Dextrinisation			
Gelatinisation			
Crystallisation			
Coagulation			
Aeration			
Caramelisation			
Emulsification			
Foaming			
Gelation			

EXTEND YOURSELF

9 Produce a summary note to help plan this extended-response question:

Most cake recipes use flour, eggs, butter, milk and sugar. With reference to the functional properties of proteins, carbohydrates and fats, explain the role each ingredient may have in producing a light, well risen and golden cake.

CORE STRAND REVIEW

CHAPTER 6

MULTIPLE CHOICE

1 What is the correct temperature range for a cool storage area?

A −18°C or lower

B 0°C to 4°C

C 15°C to 21°C

D 5°C to 60°C

2 Which functional property is most responsible for the brown colour of toasted bread?

A Dextrinisation

B Caramelisation

C Enzymatic browning

D Maillard browning

3 Which best describes the functional property of gelatinisation?

A The setting of gelatine on cooling.

B The swelling of protein to form a gel.

C The blending of starch with water to form a paste.

D The swelling of starch when heated in water.

4 Which adjectives best describe the texture of a piece of an apple?

A Crunchy and sweet

B Firm and crunchy

C Firm and ripe

D Ripe and sweet

5 Which bacteria can be commonly found in the bowels of humans and animals?

A Salmonella

B Staphylococcus

C *E.coli*

D Listeria

SHORT ANSWER

Answer the questions below based on the following situation: You need to purchase chicken and lettuce to make chicken nuggets and salad.

6 For either the lettuce or the chicken, outline the sensory characteristics that would indicate if the food is of good quality. (3 marks)

7 Describe and justify how the chicken should be stored if it is required the following day. (4 marks)

8 Explain how to avoid cross-contamination when preparing the nuggets and salad. (4 marks)

9 Describe how you would plate the meal for visual appeal. (3 marks)

EXTENDED RESPONSE

10 Discuss factors that affect *one* functional property of each of the following. (15 marks)

- Proteins
- Carbohydrates
- Fats

11 Compare how consumers and the food industry judge food quality based on sensory assessment. (15 marks)

CHAPTER

7 Food nutrients

One of the most significant contributors to the health of all Australians is diet and nutrition. The body requires nutrients in certain amounts in order to perform functions necessary to sustain life. Paying close attention to diet and exercise and developing good habits over many years should reward you with sound health. This chapter looks at the types of nutrients your body requires and the interrelationships between them. It will also help you understand how the digestive system works.

CHAPTER OUTCOMES

In this chapter you will learn about:

- Food nutrients: carbohydrates, proteins, lipids, vitamins, minerals, and water
- The structure of carbohydrates, proteins, and lipids
- Sources and functions of carbohydrates, proteins, lipids, vitamins, minerals and water
- Important interrelationships between nutrients
- Digestion, absorption and metabolism of food

KEY TERMS

adipose tissue
amino acids
amylase
anabolism
antioxidant
ascorbic acid
carbohydrates
catabolism
cholesterol
chyme
complete protein
digestion
disaccharides
essential amino acids
fatty acids
glycerol
glycogen
hormones
incomplete protein
lipid
macro-nutrients
metabolism
micro-nutrients
minerals
monosaccharides
monounsaturated
non-essential amino acids
omega-3 fatty acids
peristalsis
polysaccharides
polyunsaturated
precursor
protein
saturated fatty acids
sphincter
starch
trace elements
unsaturated fatty acids
vegan
vitamins

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CHAPTER 7

Food nutrients

Nutrition begins with food. Nutrition is the process by which the body nourishes itself – transforming food into energy to use in the body. The science of nutrition looks at everything the body does with food to carry out its functions. A nutrient is a substance found in food that provides nourishment for growth, energy, metabolism or reproduction.

Gnocchi with a creamy pesto sauce

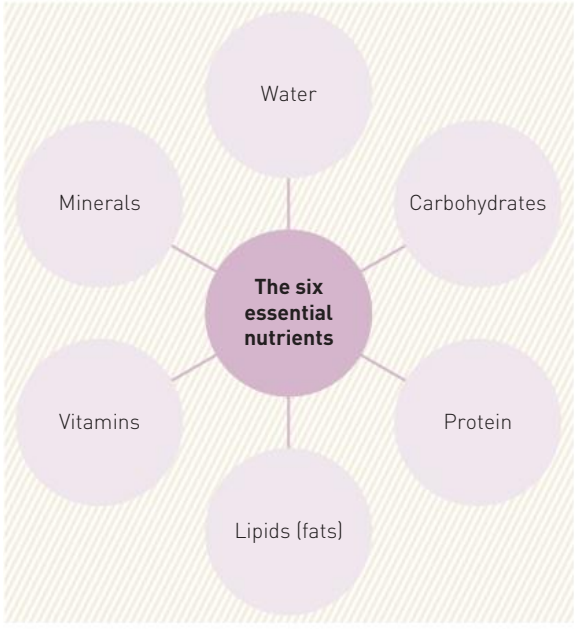

Figure 7.1 The six essential nutrients

Macro-nutrients are those required by the body in relatively large amounts, such as protein, lipids, and carbohydrates. Their two main functions are to supply energy and to help grow and maintain body tissue.

Micro-nutrients are those required in smaller amounts, such as vitamins and minerals. Their main role is to ensure the body has a strong immune system, but they perform many other functions, described later in the chapter.

Chorizo and rocket pasta salad

A balanced diet is the key to optimum health. It provides all the necessary food nutrients in the correct proportions and quantities to meet our nutritional requirements. One way to ensure your diet is balanced is to eat a variety of foods from a variety of sources, which will supply you with a range of nutrients. Some refer to the concept of 'eating the rainbow', which means choosing foods of various colours. Others say that 'variety is the spice of life'.

How well you nourish your body does not necessarily depend on you choosing any one food, but rather depends on you eating many different foods at meal times over a long period. Diet-planning principles and dietary guidelines are key concepts to consider when selecting foods during grocery shopping, dining out or cooking at home.

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Figure 7.2 To ensure your diet is adequate and balanced, eat a variety of foods every day.

Carbohydrates

Carbohydrates provide most of the energy in the human diet and they are the body's preferred energy source. Most plants manufacture carbohydrates through photosynthesis.

Structure of carbohydrates

Carbohydrates are compounds made up of carbon, hydrogen and oxygen to a ratio of 1:2:1. Carbohydrates are classified according to their structure as follows:

- monosaccharides
- disaccharides
- polysaccharides.

MONOSACCHARIDES

Monosaccharides are the simplest form of carbohydrates, consisting of single molecules. The main examples of dietary importance are glucose, galactose and fructose. These are the building blocks of other carbohydrates.

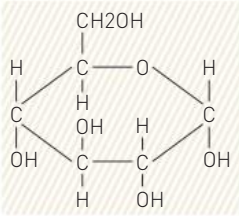

Figure 7.3 The simplest form of carbohydrate is a glucose molecule – $C_6 H_{12} 0_6$.

DISACCHARIDES

Disaccharides consist of two monosaccharides linked together, such as sucrose (glucose + fructose), lactose (glucose + galactose) and maltose (glucose + glucose).

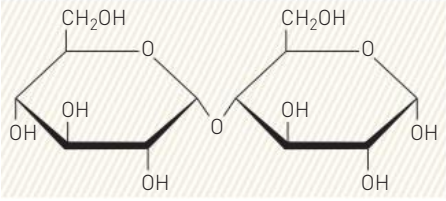

Figure 7.4 Maltose links two glucose molecules together – $C_{12} H_{22} 0_{11}$. The single carbon and hydrogen atoms are not shown.

POLYSACCHARIDES

Polysaccharides are built up from many molecules of monosaccharides. Simple polysaccharides occur in foods such as starch, dextrins (cooked starch) or glycogen (a substance stored in the liver and muscles, and converted to glucose for energy use). The indigestible part of plant foods, known as cellulose or dietary fibre, is another example of a simple polysaccharide. Some more complex polysaccharides include pectin and gum. Pectin can be found in fruits, such as apples and berries, and some vegetables; gums can be found in the sap and seeds of many trees and also in seaweed.

Sources of carbohydrates

Carbohydrates occur naturally in plants, such as fruits, vegetables and cereals, and in dairy products. They may also be added to processed foods for a variety of reasons, but usually to provide sweetness. Sugars are found in fruits, cane sugar, soft drinks, honey, confectionary, milk and other sweet food products.

Starches are found in cereals, vegetables, and many cereal products such as flour, pasta, rice, porridge, bread and noodles. Pectins are polysaccharides contained in the cell walls of plants. They are particularly found in the seeds, pith and peel of fruits and some vegetables. Pectin is an important source of dietary fibre, as well as being a functional ingredient in many processed foods such as jams.

Dietary fibre is found in the cell walls of all plants, and therefore it is found in those carbohydrate foods that are in their natural or less processed state. These include fruits and vegetables with their skins on, brown rice and wholemeal flour and pasta. Bread is an important source of dietary fibre.

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Figure 7.6 Carbohydrate-rich foods

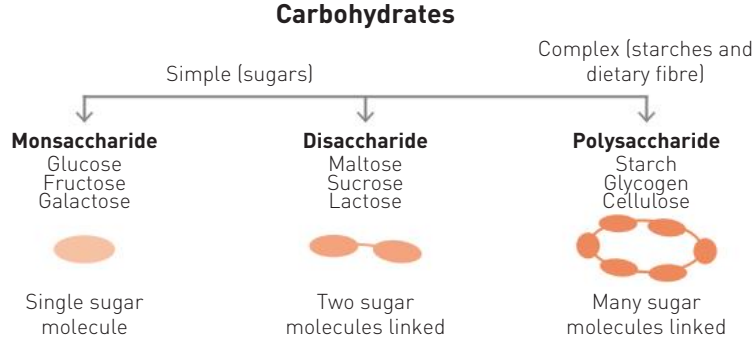

Figure 7.5 The three types of carbohydrates

Functions of carbohydrates

The main function of carbohydrates in our body is to provide energy. The body uses energy continuously to maintain its basic functions such as breathing, regulating body temperature, keeping the heart pumping and ensuring that all organs are functioning. When you undertake physical activity, your body needs even more energy, which it usually draws from carbohydrates. Carbohydrates are also responsible for many other roles in the body.

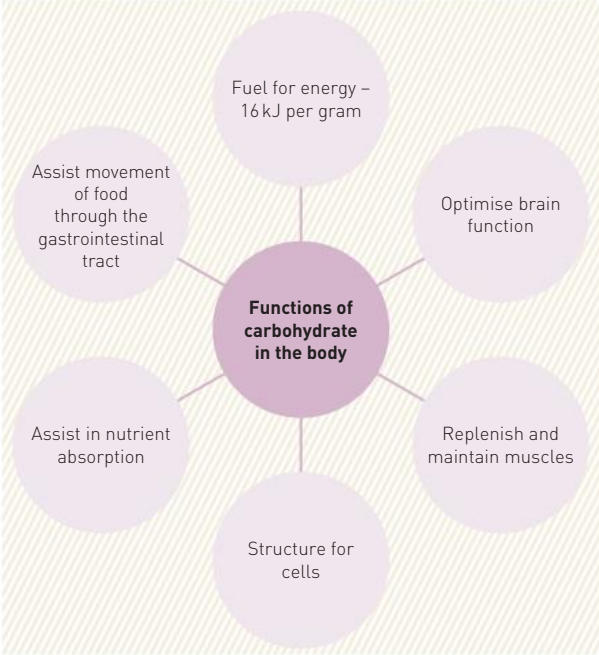

Figure 7.7 Functions of carbohydrates in the body

Protein

The word protein is derived from the Greek word protos, which means first. Proteins are a part of all cells, both plant and animal. Our body cells are constantly being replaced and repaired, and new cells are created – and these processes require protein. Thus, protein is essential to life.

FOOD IN FOCUS 7.1

WAYS AUSTRALIANS CAN IMPROVE THEIR HEALTH

The Australian Institute of Health and Welfare estimates that half of all Australians are living with a chronic disease and one in five suffers from multiple chronic diseases. These diseases, including cancer, mental illness, diabetes and heart disease, can have a hugely negative effect on people's quality of life and ultimately lead to premature death.

Chronic diseases often share the same risk factors, and obesity is one such risk factor. The over-consumption of sugary drinks is directly linked to weight gain and an increased risk of developing a chronic disease, such as type 2 diabetes. Young Australians are particularly at risk, as studies have indicated that nearly half of children and young Australians aged between 2 and 16 years old consume sugary drinks every day. Consuming 340 mL of sugary drink a day (which equates to less than one can) can increase the risk of type 2 diabetes by 22 per cent when compared to drinking one can a month or less.

Some health experts have suggested introducing a 20 per cent tax on sugary drinks, which could reduce chronic illness and help prevent the next generation of young Australians from suffering heart attacks, strokes and diabetes. It is estimated such a tax could generate $400 million a year, which could be put towards health and awareness programs.

RESPOND

1. What percentage of Australians suffer from a chronic disease?
2. Give some examples of chronic diseases.
3. What is the link between chronic disease and consuming too much sugar?
4. Which chronic diseases are directly associated with high sugar intake?
5. From you own knowledge, what other foods are high in sugar?
6. How could a tax on sugary drinks help save Australian lives?
7. How could you reduce sugar in your diet?

FOCUS QUESTIONS 7.1

REVIEW

1 Why is it important to include carbohydrates in our diet?
2 Explain how carbohydrates can be classified.
3 What are the benefits of consuming wholemeal and wholegrain cereal products as recommended by the Australian Dietary Guidelines?
4 Which carbohydrates should be considered as 'occasional foods'? Explain why.
5 Explain ways of increasing your fibre intake.

FOR YOU TO APPLY

6 Design a pre-event meal for an athlete who requires sustained energy.
7 Design a magazine advertisement showing the importance of including more fibre in your diet.

EXTEND YOURSELF

8 Investigate the effects of long-term low-carbohydrate diets.

Structure of proteins

Proteins are polymers that are made up of monomers called amino acids. Amino acids are made up of nitrogen (N), Hydrogen (H), Carbon (C) and Oxygen (O). Some amino acids, such as methionine and cysteine, also contain sulphur (S), but sulphur-containing amino acids are less common.

All amino acids share the same basic structure – a central carbon (C) atom that has a hydrogen atom (H), an amino group and a carboxyl group (COOH) attached to it. However, carbon atoms need to form four bonds, so it is the content of this fourth bond that makes each amino acid different. This fourth bond can be a distinct atom or a group of atoms, and it is known as the side or radical group, signified with an 'R'. The diversity of the radical groups makes proteins more complex than carbohydrates or lipids.

Of the 22 amino acids the body needs, humans can synthesise 14 as adults and 13 in infancy. This means that we have to obtain eight amino acids in our diets as adults and nine as children. The

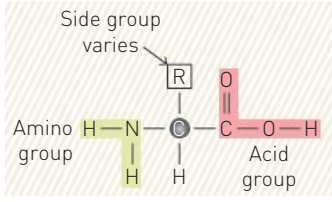

Figure 7.8 Amino acid structure

eight essential amino acids required by the body in adulthood are isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. These cannot be synthesised by the body. Histidine is essential in infancy only.

As discussed in Chapter 6, proteins are formed when amino acids link together. There are many potential sequences to link the available amino acids, so thousands of different proteins can be created. The links between amino acids are known as peptide bonds – two amino acids bonded together is a dipeptide, three amino acids joined is called a tripeptide and additional bonds create polypeptides. Most proteins are between a few dozen and several hundred amino acids long.

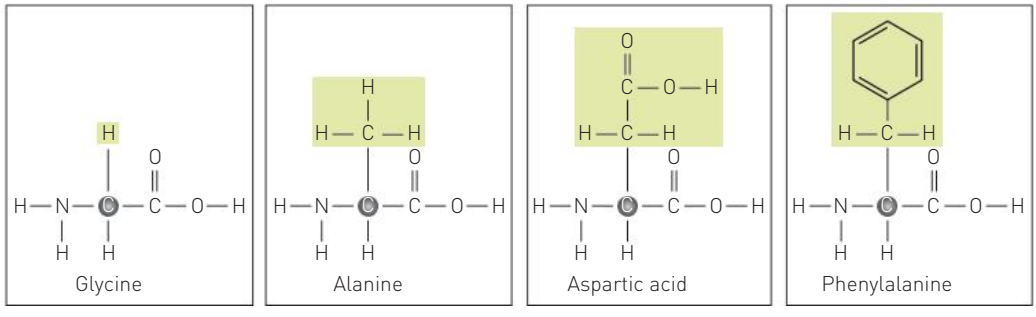

Figure 7.9 Examples of amino acids

Table 7.1 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 (in infancy)	Glycine
	Hydroxyproline
	Proline
	Serine
	Tyrosine
	Histidine (in adulthood)

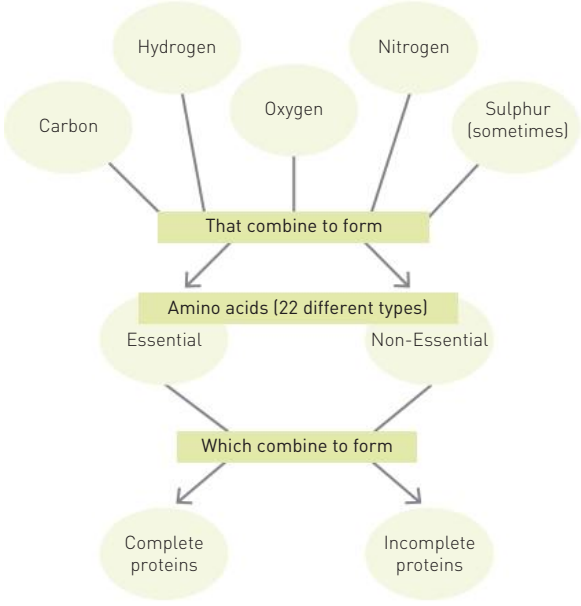

Figure 7.10 Complete and incomplete proteins

Proteins can also be classed as globular or fibrous. Globular proteins have a three-dimensional globe-like shape. Examples of globular proteins include albumin in eggs, caseinogen in milk and haemoglobin in meat.

Fibrous proteins have a linear and more elongated shape that can coil, like gluten in wheat, or remain straight, such as elastin in meat gristle. This is explained in more detail in Chapter 6.

Food sources of protein

Many foods contribute protein to the diet, although the quantity and quality vary depending on the source. The importance of a certain food as a source of protein differs according to the amount eaten and its protein quality.

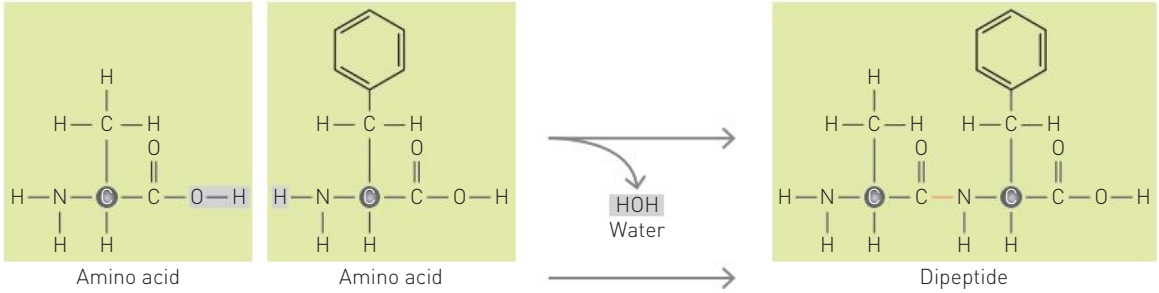

Figure 7.11 The formation of peptide bonds

As mentioned, the eight essential amino acids must be obtained from foods as they cannot be made by the body. Protein foods containing all eight essential amino acids are called high biological value (HBV) proteins or may be called complete proteins. Complete proteins are found mainly in animal foods such as red meat, fish, poultry, eggs, milk, cheese and other dairy products. Soy beans, buckwheat and quinoa are the only plant foods considered to be complete.

Those proteins that lack one or more of the essential amino acids are called low biological value (LBV) proteins or incomplete proteins. These are found in cereals, legumes, nuts and some vegetables. Plant protein sources, or incomplete proteins, can be combined to form complete proteins. Some examples are rice with dhal, hummus and pita bread, beans on toast, poached eggs on toast, spaghetti and meatballs or rice and fish. Non-essential amino acids can also be made from an excess of other amino acids in the diet.

Dreamstime.com/Robynmac

Figure 7.12 Food sources of protein include cheese, lentils, red and white meat, kidney beans, fish, tuna, nuts and eggs.

Roles and functions of proteins in the body

Protein has both structural and dietary roles in the body and can be found in many forms, because of the numerous potential combinations of amino acids. See figure 7.13 for more details.

FOCUS QUESTIONS 7.2

REVIEW

1. What are the chemical elements that make up proteins?
2. Discuss the role of a polypeptide chain.
3. What is the difference between a globular and fibrous protein? Give examples.
4. What are incomplete proteins?
5. List three sources of complete protein.
6. Discuss the main role of protein in the body.

FOR YOU TO APPLY

7. Design a meal high in protein. Justify your choices.
8. Design a weekly meal plan for an active adolescent male who has recently become a vegan.

EXTEND YOURSELF

9. What results from a deficiency of protein in the diet? What are the long-term consequences of such a diet?
10. What is the recommended dietary intake (RDI) of protein in Australia?

Lipids

Fats and oils are known as lipids. They have the same chemical structure, but their physical appearance differs. Fats are solid at room temperature and oils are liquid. They are described as organic substances, insoluble in water. Lipids are present in food either as 'visible' or 'invisible' fat.

Visible fat is easy to see in food; for example, fat on meat, butter, margarine, lard and cooking oil. Invisible fat is a part of a food and is difficult to see; for example, the fat in pastry, cakes and biscuits.

The structure of lipids

Lipids are made up of carbon, hydrogen and oxygen. Types of lipids include:

- fatty acids
- triglycerides
- phospholipids
- sterols.

Shutterstock.com/Volhah

Figure 7.13 Functions of proteins in the body

FATTY ACIDS

Fatty acids are chains of carbon atoms joined together with three H+ atoms at one end and two O_2 and a H+ at the other end. There are three types of fatty acids, saturated fatty acids and two kinds of unsaturated fatty acids, each differing chemically in the way the carbon atoms are linked.

Saturated fatty acids

Saturated fatty acids are straight molecules and make the fat firm, such as with beef dripping. They are saturated because they cannot accept any more H+ atoms in their structure, and there are no double bonds.

Saturated fatty acids occur in animal and vegetable foods (fatty meats, some dairy foods, palm and coconut oil, chocolate and certain biscuits, cakes, pastries, most fast foods and some types of confectionary). They are associated with risk factors

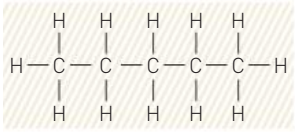

Figure 7.14 Saturated fatty acids cannot accept any more hydrogen atoms in their structure.

for heart disease, as they increase 'bad' low-density lipoprotein (LDL) cholesterol levels.

Monounsaturated fatty acids

Monounsaturated fatty acids are short-chained fatty acids that have one double bond in the chain so therefore can accept more H+ atoms. They tend to be soft fats or liquid oils such as oleic acid, which is found in many animal and plant fats such as olive oil. It can also be found in canola, peanut, hazelnut, macadamia, avocado and their oils, as well as in eggs, chicken and some fish. Monounsaturated fatty acids contain HDL, which is associated with a reducing the 'bad' LDL cholesterol. HDL helps to ferry cholesterol away from the arteries to the liver, where it is broken down into bile.

Polyunsaturated fatty acids

Polyunsaturated fatty acids have more than one double bond in the molecule and can accept H+ atoms. These are found mainly in vegetables, polyunsaturated margarine, nuts and seeds.

Shutterstock.com/Kateryna Sednieva

Figure 7.15 Populations which traditionally follow a diet rich in monounsaturated fats, such as the Greeks and Italians, have low incidences of heart disease and cancer.

Trans-fatty acids

Another type of polyunsaturated fat are trans-fatty acids. These fats are created by adding hydrogen to artificially harden them. However, they can increase the risk of heart disease and rheumatoid arthritis and may be linked to some cancers. Trans-fatty acids increase the levels of LDL cholesterol in the blood and may reduce levels of good HDL cholesterol. Unfortunately, ingredient panels often do not list trans-fatty acids, but they do list the terms hydrogenated or partially hydrogenated oils, and these contain trans-fatty acids.

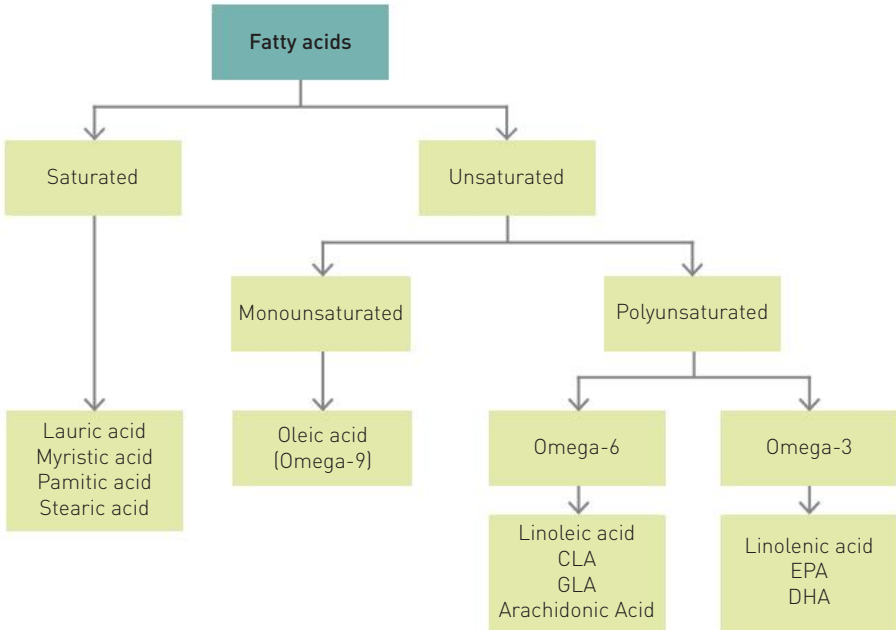

Figure 7.16 Fatty acids

TRIGLYCERIDES

Triglycerides comprise about 95 per cent of the fat in our diet. It is formed when three fatty acids combine with glycerol. The properties of triglycerides vary according to the fatty acids they contain.

STEROLS

Sterols make up 1 per cent of the total lipids in the diet and are created when many fatty acids combine with glycerol. The most common sterol is cholesterol, which is found only in animal cells, not in plants. Most cholesterol is made in the liver, but about 25 per cent of our cholesterol comes from food. If someone's supply of cholesterol from food increases, their body usually reduces its own production. However, if you consume a lot of saturated fats, this will raise your overall blood cholesterol levels, particularly the 'bad' LDL cholesterol. This is linked to heart disease and hardening of the arteries (arteriosclerosis). See Chapter 20 for more information.

PHOSPHOLIPIDS

Phospholipids are another essential element of your cells. How much you have can affect the integrity and fluidity of the cell. The most common example is lecithin; it is found widely in different foods as it can appear in both plant and animal cells.

Food sources of lipids

Lipids can come from both plants and animals and the different sources are made up of different kinds of fatty acids. Plant sources include olives, canola, sesame and sunflowers as well as nuts and some fruits such as avocado. Animal sources include fat on and in meat; lard; oily fish like tuna, salmon and mullet; eggs; and dairy fats such as cream. Processed foods, such as chocolates, fried foods, pastries, cakes and biscuits, contain high levels of lipids.

Cholesterol is found in animal products such as meat, eggs and dairy.

Lipids in the body

Lipids are the human body's most concentrated source of energy. However, any lipids not used for energy are stored as adipose (fat) tissue in the body, and can perform a range of important functions.

Figure 7.17 Functions of lipids in the body

ESSENTIAL FATTY ACIDS

There are specific polyunsaturated fats that are vital for health and cannot be made in the body. These are called essential fatty acids (EFAs) and must be obtained from food. The two main EFAs are Omega-3 (linolenic acid) and Omega-6 (linoleic acid).

Omega-3 reduces the risk of blood clots forming, thereby reducing heart attack risk. This fatty acid may also reduce the incidence of inflammatory diseases, such as rheumatoid arthritis.

Omega-6 fatty acids help to reduce LDL cholesterol, but eating too much may also reduce levels of 'good' HDL cholesterol. Both Omega-3 and 6 are needed for brain development in babies. Humans make special linolenic and linoleic acids in breastmilk, which is one of the reasons why human breastmilk is considered best for babies.

FOOD IN FOCUS 7.2

GOOD FATS VERSUS BAD FATS: EVERYTHING YOU NEED TO KNOW

'Don't eat fat, fat is bad.' 'Eat lots of fat, fat is good.' 'Only eat some fats, but stay away from bad fats.'

Either heavily promoted or criticised, fat has the reputation of being the good guy one month and the devil the next. And, quite frankly, we're just as confused as you are.

To help settle the confusion, cardiologist Dr Aseem Malhotra and Christine Cronau, a speaker, best-selling author and nutritionist, share their insights.

'Fat is full of nutrients and we need those nutrients for good organ function, including our heart,' Cronau told *The Huffington Post Australia*.

According to Cronau, the body needs fats for adequate hormone production.

'We need fat and cholesterol to produce adequate serotonin, which is our feel-good hormone. We also need fat and cholesterol for healthy cell function, and if our cells don't function well, we cannot produce adequate energy or stay well,' Cronau said.

'In addition, the cell membrane is made mostly of fats. And if we don't eat enough natural, quality fat, it is impossible to keep the cells hydrated. This then causes premature ageing and wrinkles.'

Healthy fats also help us to feel full and provide a number of essential nutrients, including vitamin E and omega-3 fatty acids.

'Omega-3 fat consumption is associated with the best health outcomes,' Malhotra told HuffPost Australia. 'Over-consumption of omega-6 fatty acids, which are pro-inflammatory, are potentially harmful, being linked to heart disease, cancer and dementia.

'Trans-fats should be avoided altogether and industrially processed vegetable oils are particularly bad in fast-food and packaged food,' Malhotra said.

To ensure we're eating good fats and not bad fats, Cronau suggests avoiding packaged foods, manufactured oils and spreads.

'Eat real food,' Cronau said. 'If we fill our shopping trolley with actual foods, such as grass-fed meat, free-range eggs, vegetables, butter, cheese, plain yoghurt, cream, coconut oil and cold-pressed olive oil, we can't really go wrong. We will be eating natural fats. Healthy, good fats.'

RESPOND

1. Why do we need fats in our diet?
2. What are the negative effects of Omega-6 fatty acids?
3. What are trans-fats and why should they be avoided?
4. Suggest ways we can ensure we are including the right fats in our diet.

FOCUS QUESTIONS 7.3

REVIEW

1 Why are lipids an essential component of our diet?
2 What is an essential fatty acid?
3 Describe the structure of fats.
4 What are the differences between 'good' fats and 'bad' fats? Give examples.
5 Explain the similarities and differences between fats and oils.

FOR YOU TO APPLY

6 Design a meal based on a Mediterranean 'good' fat diet.
7 Write a blog post to support the Australian Dietary Guidelines that advises: 'Limit intake of foods containing saturated fat, added salt, added sugars and alcohol'.

EXTEND YOURSELF

8 Fats used to be included as a part of the core food group. Find out why they were removed.
9 Trans-fatty acids have been labelled as 'evil'. Investigate why and suggest ways to reduce the use of these in the average Australian diet.

Vitamins

Vitamins are substances the body is unable to synthesise. They are necessary in our diet for the body to function well. Although vitamins are only required in small amounts, each is essential to general good health. Some vitamins are classified as 'essential non-nutrients', and others act as antioxidants.

Vitamins are classified according to whether they are soluble in fat or water.

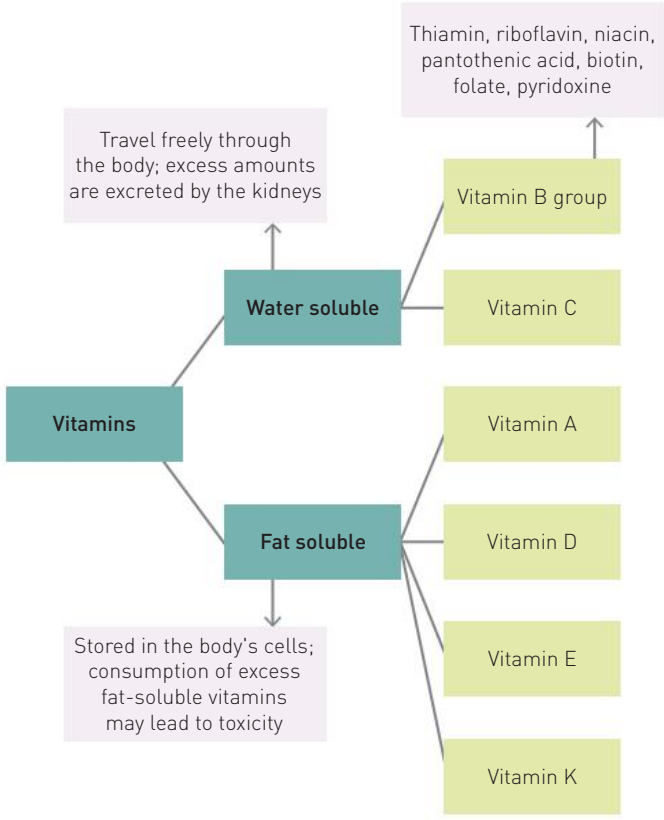

Figure 7.18 Vitamins can be separated into water-soluble and fat-soluble.

Vitamins – functions and sources

Tables 7.2 and 7.3 describe the functions and sources of water-soluble and fat-soluble vitamins.

Table 7.2 Water-soluble vitamins

NUTRIENT	FUNCTION	SOURCES
Thiamine (vitamin B1)	Part of an enzyme needed for releasing energy for metabolism; important for nerve function and maintaining muscle tone.	Found in all plants and animals, therefore in all foods in moderate amounts. Good sources include pork, wholegrain and enriched breads and cereals, legumes, nuts seeds, yeast and even Vegemite!
Riboflavin (vitamin B2)	Part of an enzyme needed for releasing energy for metabolism; important for normal vision and skin health.	Found in all plants and animals so wide variety of sources including milk and dairy products, leafy green vegetables, wholegrain or enriched breads and cereals, eggs and yeast.
Niacin (vitamin B3)	Part of an enzyme needed for energy metabolism; vital for nervous system, digestive system and skin health.	Meat, fish, poultry, wholegrain or enriched breads and cereals, vegetables (especially mushrooms, asparagus, and leafy green vegetables), peanut butter, dairy foods. Niacin can also be made in the body.

Table 7.2 *(Continued)*

NUTRIENT	FUNCTION	SOURCES
Pantothenic acid	Part of an enzyme needed for energy metabolism.	Widespread in all foods, particularly found in organ meats and wholegrain cereals. Pantothenic acid can also be synthesised by gut bacteria in the body.
Biotin	Part of an enzyme needed for energy metabolism.	Widespread in foods; can be produced by bacteria in the body's intestinal tract.
Pyridoxine (vitamin B6)	Part of an enzyme needed for protein metabolism; helps make red blood cells, hormones, antibodies and enzymes.	Excellent sources include meat, organ meats, eggs, fish and poultry. Vegetables and fruits contain small amounts.
Folate/folic acid/ folacin	Part of an enzyme needed for making DNA and new cells, especially red blood cells. Helps protect against neural tube defects such as spina bifida in unborn babies.	Found in all foods, good sources include leafy green vegetables, legumes, seeds, orange juice and liver; now added to most refined grains.
Cobalamin (vitamin B12)	Part of an enzyme needed for making new cells; important to nerve function and production of red blood cells.	Found in meat, poultry, fish, seafood, eggs, milk and milk products; not found in plant foods.
Ascorbic acid **(vitamin C)**	Antioxidant part of an enzyme needed for protein metabolism; involved in the formation of collagen important for immune system health; aids in iron absorption.	Found in fruits and vegetables, especially citrus fruits, vegetables in the cabbage family, rockmelon, strawberries, capsicum, tomato, potato, lettuce, paw paw, mango and kiwifruit.

Table 7.3 Fat-soluble vitamins

NUTRIENT	FUNCTION	SOURCES
Vitamin A (retinol) and its precursor***, beta-carotene** *A precursor is converted by the body to the vitamin.	Needed for vision, healthy skin and mucous membranes, bone and tooth growth and immunity.	Vitamin A from animal sources includes fortified milk, cheese, cream, butter, fortified margarine, eggs and liver. Beta-carotene from plant sources includes leafy, dark green vegetables; dark orange fruits (apricots, rockmelon) and vegetables (carrots, sweet potatoes, pumpkin).
Vitamin D	Promotes absorption of calcium (for bone strength) and phosphate.	When exposed to sunlight, the skin can make vitamin D. Other sources include egg yolks, liver, oily fish, dairy fats. Note: to become bioavailable, vitamin D must be converted to its active form in the body.
Vitamin E	Antioxidant: protects cell walls and other nutrients from oxidative damage and reduces effects of free radicals.	Polyunsaturated plant oils (soybean, corn, cottonseed, safflower); leafy green vegetables; wheat germ; wholegrain products; liver; egg yolks; nuts and seeds; margarine.
Vitamin K	Needed for blood clotting.	Leafy green vegetables and vegetables from the cabbage family, milk. Smaller amounts in cereals, grains, seeds and fruits. May be produced in the gut by bacteria.

ANTIOXIDANT VITAMINS

Antioxidant vitamins have an important effect on our health. Antioxidants ward off free radicals, which are random atoms resulting from the body's use of oxygen, such as for breathing and digestion. Left to their own devices, free radicals can form a chain reaction that may lead to serious damage to cells and/or contribute to heart disease and some cancers. Antioxidants form a defence system against these free radicals. Antioxidants occur naturally in a wide range of foods.

Table 7.4 Antioxidant vitamins and the foods that contain them.

VITAMIN	FOODS
Vitamin A	Red and orange fruit and vegetables, e.g. carrots, tomatoes, apricots and peaches.
Vitamin C	Citrus fruits, blackcurrants, kiwifruit, green leafy vegetables e.g. broccoli, etc.
Vitamin E	Vegetable oils, wholegrain cereals, green leafy vegetables.

The health benefits of antioxidants

Antioxidants safeguard long-term health by reducing the risk of chronic diseases; for example, heart disease, a variety of cancers, and disorders of the intestine caused by increased numbers of free radicals; they also reduce damage to body cells and tissues.

In addition, antioxidants maintain a healthy immune system by destroying free radicals that attack the body's natural defence system.

They reduce the harmful oxidation of fats in the body by preventing free radicals oxidising polyunsaturated fatty acids in cell membranes, preventing cell damage, and by slowing the rate at which LDL cholesterol is deposited on artery walls, thus reducing the risk of heart disease.

Fruit and vegetables are a source of antioxidants and also provide insoluble fibre. This provides additional health benefits such as reducing constipation to help prevent bowel cancer and obesity.

FOOD IN FOCUS 7.3

SCURVY: LACK OF VITAMIN C SEES HISTORICAL DISEASE RETURN AS WESTMEAD HOSPITAL RECORDS A NUMBER OF CASES

DOCTORS are battling a surprise resurgence in scurvy disease, which dropped off the radar in Australia more than a century ago.

The re-emergence of scurvy is another unhealthy side effect of the nation's obesity crisis, with people's vitamin C levels dropping dangerously low because their diets lack fresh fruit and vegetables.

Westmead Hospital has seen a recent spate of patients diagnosed with the historical disease that's associated with old-world sailors on long voyages.

Professor Jenny Gunton discovered the disease was re-emerging after a patient's wound would not heal for more than seven months until she queried the woman's diet and prescribed a simple vitamin C supplement.

A stream of diabetic patients with long-running unhealed wounds have now been treated with vitamin C after being diagnosed with scurvy.

'All of them who turned out to have low vitamin C ate vegetables pretty much every day but they cooked them a lot. There has been a whole series of them now and in each case the wounds have cleared up with taking vitamin C,' Prof Gunton said.

Overcooking vegetables eradicates the vitamin C.

'And most of these people are overweight so it just comes down to the quality of the diet.'

Prof Gunton said the reappearance of scurvy was 'very surprising' and she is now screening patients by quizzing them about their diets.

>

'(It was last seen in) Englishmen back in the days where people got on ships for long periods of times and it used to be fatal after several months of sailing because sailors would become vitamin C deficient and then die,' she said.

Prof Gunton heads the Centre for Diabetes, Obesity and Endocrinology research at The Westmead Institute and is expanding her scurvy research to patients with foot problems as she believes the issue is more widespread.

Latest figures show just six per cent of adults in NSW eat the recommended five serves of vegetables a day while just 48 per cent eat enough fruit.

'The message is more vegetables, more fruit but also don't cook your vegetables too much. People have been cooking broccoli in the vicinity of 20 minute and peas for 15 minutes,' Prof Gunton said.

Vitamin C is essential for wounds healing as well as dental health and bone strength.

'The issue would apply to anybody if your diet sets off alarm bells to your GP,' she said.

Prof Gunton's research on the issue has been published in the Diabetic Medicine journal.

Diabetic Penelope Jackson, 56, was diagnosed with scurvy by Prof Gunton after suffering ulcers for months that would not heal.

'It was very surprising ... I wasn't eating a great deal of fruit and vegetables but I was eating them a few times a week mostly.'

She was prescribed vitamin C supplements that she continues to take and it effectively treated the ulcers.

Foods high in vitamin C include oranges, strawberries, capsicum, broccoli, kiwifruit and grapefruit while overcooking any food destroys the vitamin C.

Source: Rose Brennan, *Daily Telegraph*

RESPOND

1. What has led to the re-emergence of scurvy in Australia?
2. Which vitamin is lacking in the diets of those suffering from scurvy?
3. What symptoms are patients showing that indicate they have this deficiency?
4. How are patients treated for scurvy?
5. What is the recommended number of serves of fruit and vegetables for Australian adults?
6. What percentage of adults eat the recommended serves of fruit and vegetables?
7. How can Australians increase their intake of vitamin C?

FOCUS QUESTIONS 7.4

REVIEW

1. How are vitamins classified?
2. Which vitamins can be toxic? Why?
3. What is a precursor? Give an example.
4. Why are folate supplements recommended for pregnant women?
5. How do vitamins act as an antioxidant?

FOR YOU TO APPLY

6. Create a strategy to promote eating two serves of fruit and five serves of vegetables.

EXTEND YOURSELF

7. Vitamin D is a vitamin without an official RDI in Australia. Find out why. Why has this recently been reviewed?

Minerals

Minerals are essential in the diet as they cannot be manufactured by the body. The body uses minerals for many different jobs, including keeping your bones, muscles, heart, and brain working properly. Minerals are also important for making enzymes and hormones. Some minerals are required in larger amounts (macro-minerals) including calcium, phosphorus, magnesium, sodium, potassium, chloride and sulphur. Others, known as trace elements (micro-minerals) are required in much smaller amounts. They include iron, manganese, copper, iodine, zinc, fluoride, selenium, nickel, silicon, vanadium and cobalt.

Minerals – functions and sources

Tables 7.5 and 7.6 describe the function and sources of the macro- and micro-minerals our bodies need.

Table 7.5 Macro-minerals

MINERAL	FUNCTION	SOURCES
Calcium	Important for healthy bones and teeth; helps muscles relax and contract; important in nerve functioning, blood clotting, blood pressure regulation and immune system health.	Found in dairy foods; canned fish with bones (salmon, sardines); tofu, soy milk and tahini; green vegetables (broccoli, mustard greens) and legumes.
Magnesium	Needed for making protein and bone, helps with muscle contraction, nerve transmission and immune system health.	Found in nuts and seeds, legumes, leafy green vegetables, seafood, chocolate and artichokes.
Phosphorus	Important for healthy bones and teeth; found in every cell; part of the system that maintains acid base balance connected to release of energy.	Meat, fish, poultry, eggs, dairy foods, milk, legumes, nuts, seeds.
Potassium	Needed for proper fluid balance, nerve transmission, muscle contraction and relaxation energy release.	Found in fresh fruits and vegetables, whole grains, legumes, meat, fish, cereals and chocolate.
Sodium	Required for fluid balance, nerve transmission and muscle contraction uptake of glucose.	Found in table salt, processed meat, fish and seafood, soy sauce and most processed foods; small amounts in milk, breads, spreads, vegetables and unprocessed meats.

Table 7.6 Micro-minerals

MINERAL	FUNCTION	SOURCES
Iron (Iron is considered a trace mineral, although the body needs more of it than other micro-minerals)	Part of a molecule (haemoglobin) found in red blood cells that carries oxygen in the body; helps with formation of collagen and needed to metabolise energy.	Red meats and organ meats, fish, poultry, shellfish (especially clams), egg yolks, legumes, nuts and seeds, dried fruits, dark green leafy vegetables and wholegrain cereal foods.
Iodine	Found in thyroid hormone, which helps regulate growth, development, and metabolism.	Seafood and seaweed, foods grown in iodine-rich soil, iodised salt, bread and dairy products.
Zinc	Part of many enzymes; needed for making protein and genetic material; has a function in taste perception, wound healing, normal foetal development, production of sperm, normal growth and sexual maturation, immune system health and release of energy.	Meats, fish, seafood and shellfish, poultry, leavened whole grains, liver, nuts, vegetables and cheese.
Fluoride	Involved in formation of bones and teeth; helps prevent tooth decay.	Drinking water (either fluoridated or naturally containing fluoride), fish and most teas.

FOCUS QUESTIONS 7.5

REVIEW

1 Why are minerals essential in the diet?
2 What are the classifications of minerals?
3 What is a trace mineral? Give some examples.
4 Which minerals work together to promote bone health?
5 Which minerals are important for releasing energy in our bodies?

FOR YOU TO APPLY

6 Design a menu that is suitable for an elderly person suffering from osteoporosis and anaemia.
7 Examine the effects of a high-sodium diet and suggest a strategy to avoid this.

EXTEND YOURSELF

8 Choose three minerals necessary in our diet. Examine the effects on the body if a person were deficient in these minerals. What are the symptoms?
9 Investigate the debate surrounding adding fluoride to water supplies.

Water

Water is essential to life – approximately 70 per cent of the body is made up of water. Water has many valued roles in the body's functioning and can therefore be classified as a nutrient. Water does not have kilojoule content but does contain valuable trace elements. As a general recommendation you should 'drink to your thirst' and choose water over other beverages wherever possible. This prevents dehydration and replenishes liquid lost via perspiration and excretion of wastes.

Table 7.7 Water-rich foods

FOOD	WATER CONTENT PERCENTAGE
Cucumber	96%
Watermelon	96%
Lettuce	96%
Celery	95%
Tomatoes	94%
Spinach	92%
Broccoli	92%
Grapefruit	90%
Carrots	90%

Structure of water

Water has a simple molecular structure. The water molecule is composed of hydrogen and oxygen, in a ratio of 2:1, with the molecular formula being H_2O.

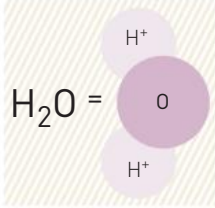

Figure 7.19 The molecular structure of water

Sources of water in our diet

Fruits, vegetables and drinks (especially plain water) are all good sources of water in our diet. Additionally, our body manufactures its own water as a by-product of many metabolic activities.

PRACTICAL APPLICATION 7.1

SELLING THE 'DRINK MORE WATER' MESSAGE

AIM

Design a public relations campaign to promote drinking more water in your school community.

METHOD

Include the following information in your campaign:

1 Why is water counted as a nutrient?
2 Why does the body need water?
3 Besides drinking water what are some good sources of water in our diet?

Functions of water in the body

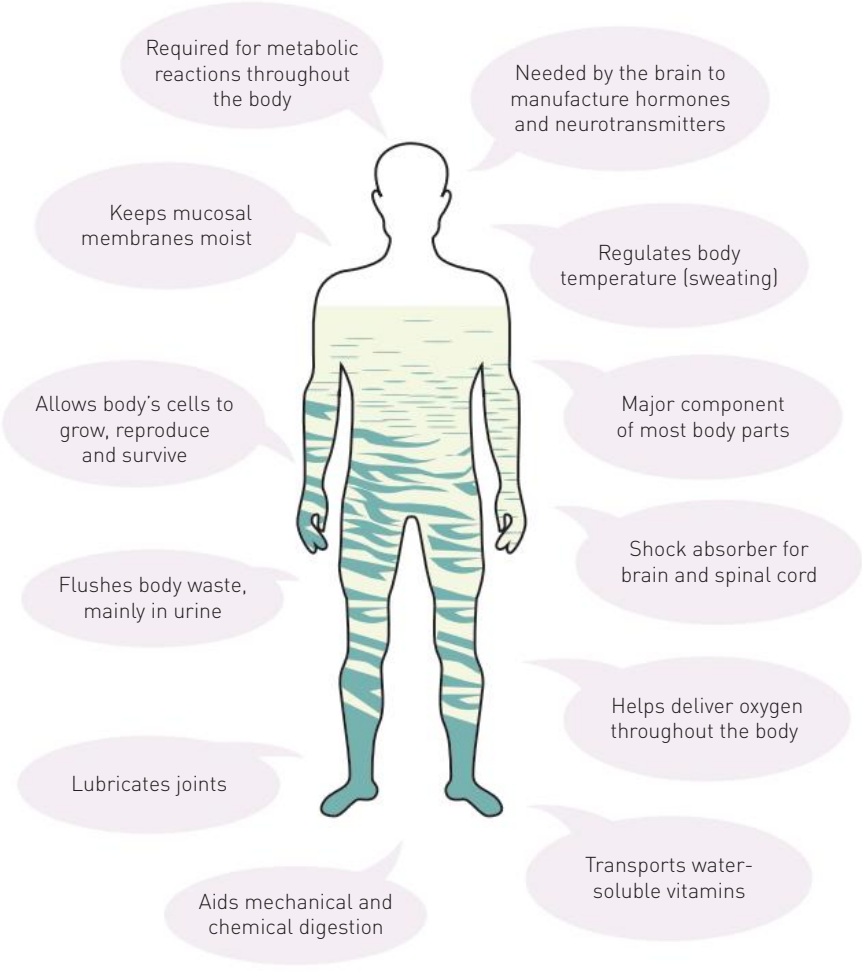

Figure 7.20 Functions of water in the body

FOCUS QUESTIONS 7.6

REVIEW

1 Explain the chemical structure of water.
2 Why is the water in Sydney fluoridated?
3 Why do you think not all water supplies around Australia have this mineral added to them?
4 Besides drinking water, what are good sources of water in the average diet?
5 What are the benefits of a diet high in water?

FOR YOU TO APPLY

6 How much water do you drink in a day? How could you increase this amount?

EXTEND YOURSELF

7 Investigate how the hypothalamus and kidneys help control how much water is kept in the body.
8 What percentage of the world's population have a safe water supply? Investigate reasons for this statistic.

Interrelationships between nutrients

Turkish pide

Combinations of various foods will either enhance or inhibit the absorption of particular nutrients. In some cases, one nutrient depends on another for it to be absorbed or to perform a task. So a balanced diet, including a variety of foods from many sources, is essential to overall good health. Here are some examples of how certain nutrients work when consumed together in a meal.

Iron and vitamin C

You can increase your body's iron absorption by eating vitamin C (also known as ascorbic acid) at the same time. Iron and vitamin C work together in the synthesis of red blood cells, as iron is a vital part of haemoglobin, found in red blood cells, and vitamin C is essential for the integrity of the blood vessels. So, when eating iron-rich foods it is best to consume foods that are rich in vitamin C, like citrus fruits or greens, at the same time.

While vitamin C greatly increases iron absorption, this is true only when consuming iron-rich foods, such as red meat, green leafy vegetables or wholegrains. There are no proven benefits to taking multivitamin or mineral supplements. Another option is to take pure, pharmaceutical-grade ascorbic acid, which comes in a powder, with a meal containing iron-rich foods.

Be aware that high-fibre and dairy foods, and foods high in tannins (tea, dates) can block iron absorption. For example, you should avoid eating a breakfast cereal high in fibre along with an iron-rich food, as absorption is hindered by the fibre in the cereal grains. Furthermore, avoid eating iron-rich foods alongside dairy foods high in calcium as this also blocks absorption.

Iron and fibre

Too much fibre in foods such as green leafy vegetables and fresh fruit can bind with iron and hence not allow it to be absorbed into the blood. Phytates found in food containing non-soluble fibre will remove iron from the body. Phytates form insoluble complexes with iron in the small intestine

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Figure 7.21 When eating a beef burger with a tomato, the presence of vitamin C in the tomato will increase absorption of the iron in the beef by approximately 30 per cent.

which then inhibits iron absorption. Phytic acid in wholegrain cereals binds with iron to prevent absorption. So, for example, if you consume fibrous grains or seeds at the same time as red meat, your body does not absorb iron as effectively.

Calcium and phosphorus

Calcium and phosphorus are both required for the formation and maintenance of calcium phosphate, which gives bones and teeth their strength. If blood levels of calcium and phosphorus fall too low, then the hormone produced by the parathyroid gland removes these nutrients from the bones and teeth and sends them back into the blood. Calcium and phosphorous levels are closely related – if calcium levels rise, phosphorous levels fall and vice versa. Dairy foods are the best source of calcium, and the added benefit of these foods is the phosphorus and lactose content as well. These two nutrients increase and promote the absorption of calcium, so the dairy food group is invaluable to us. Eaten on their own, many nutrients are supplied and absorbed, and this group makes for an ideal snack in between meals, provided they are not consumed with high-fibre foods that could inhibit absorption.

Table 7.8 Foods rich in phosphorus and calcium

PHOSPHOROUS (RDI 700 MG)	CALCIUM (RDI 1000 MG)
Cheese	Cheese
Milk	Milk
Yoghurt	Yoghurt
Chicken	Spinach
Beef	Broccoli
Pumpkin seeds	Orange juice

Calcium and vitamin D

Vitamin D promotes the absorption of calcium. Without vitamin D we cannot make use of the calcium in food, resulting in weak bones and teeth. Vitamin D can be synthesised in the skin when exposed to ultraviolet (UV) light from the sun, or can be supplied in the diet from foods such as fish liver oils. Consuming fish and dairy foods at the same time would help your body absorb the optimum amount of these micro-nutrients.

Calcium and fibre

Insoluble fibre cannot be processed in the human digestive system; therefore, much of the calcium in fibrous foods is unavailable to the body. So it is best to eat dairy foods separate from fibrous foods. Fibre as a macro-nutrient has many health benefits, as it helps with supporting the digestive system and gut flora. However, it does affect the absorption of some micro-nutrients and this must be taken into consideration when planning meals.

Calcium and lactose

Lactose is a disaccharide found in dairy produce. It increases calcium absorption during digestion. Therefore it is a healthy decision to snack on a small quantity of dairy foods in order to allow the body to absorb quality calcium supplies. For those who suffer lactose intolerance, calcium absorption can be supported by both phosphorus and vitamin D.

Folate and Vitamin B12 (cobalamin)

Folate helps prevent certain forms of anaemia (pernicious anaemia) and is necessary to metabolise amino acids (protein). Folate can protect the nervous system and it is essential for the formation of blood cells. Women who are pregnant or are trying to become pregnant must ensure their diet is rich in this B-group vitamin to help protect the foetus against neural tube defects such as spina bifida.

Folate is required for the release of energy from food, especially protein. Both folate and B12 are essential for normal growth. Folate is found in most foods, but is especially rich in foods such as green leafy vegetables, organ meats and yeast. Vitamin B12, in its active form, is only found in animal sources such as meat, fish, poultry, eggs and dairy produce. Some plant foods such as spirulina, seaweed and fermented soy foods may have traces of it. If a person follows a vegan diet, they should consume fortified foods (such as soy milk) or take supplements.

Folic acid, vitamin B12 and iron all undergo complicated interactions inside the body. Having an insufficient amount of any one of these nutrients may prevent the others from doing their jobs properly. For example, the formation of healthy red blood cells requires both folate and B12. This is one of the reasons that supplements for vitamin B12 often contain folic acid as well. It just ensures that the two vitamins are in balance and can work together properly.

Sodium and potassium

These two minerals work closely together and are dependent upon one another to perform crucial roles within the body. Water balance is one role – this is where salts are required by cell walls so that nutrients in the blood can flow into body cells and waste products can flow out. Another role is helping correct muscle and nerve activity – too low an intake of sodium can result in muscle cramps, yet too much may lead to hypertension. The relationship between potassium and the sodium in salt influences your overall cardiovascular wellbeing. If the diet contains too much sodium compared to the amount of potassium, the imbalance can increase the risk of developing high blood pressure and/or heart disease.

FOCUS QUESTIONS 7.7

REVIEW

1 Why is considering the interrelationships of nutrients vital to studying nutrition?
2 How might a lactose-intolerant person support the absorption of calcium?
3 Explain why foods high in iron and foods high in dietary fibre are best not consumed together.

FOR YOU TO APPLY

4 Make a list of dishes that demonstrate the nutritional benefits of the following interrelationships.
- Iron and vitamin C
- Calcium and phosphorus
- Folate and vitamin B12

EXTEND YOURSELF

5 For an identified at-risk group, such as sufferers of anaemia or osteoporosis, design a two-course meal that promotes the digestion, absorption and metabolism of the desired vitamins and minerals.

Digestion, metabolism and absorption of food

Digestion is the complex process of breaking down the food eaten into nutrients, which the body absorbs for fuel in order to survive. The digestion process also involves creating and eliminating waste.

Digestion involves both the mechanical and chemical breakdown of food:

- Mechanical breakdown occurs through chewing and peristalsis.
- Chemical breakdown occurs as secretions and enzymes react with the food.

Absorption takes place when these components move from the gut into the blood and lymphatic systems of the body. This is the delivery system for the nutrients. The cells receive the nutrient components, which are then used by the body for their intended job.

Metabolism is referred to as all the chemical processes that use nutrients to make other substances required by the body. There are two categories of metabolism:

- Catabolism is the breaking down of nutrients to their components, usually in the form of energy.
- Anabolism is when new substances are made from the components derived from catabolism. For example, anabolism is involved in the making of new proteins required when the body is repairing muscle tissue.

The digestive system

The digestive system

The gastrointestinal tract is a long twisting tube that starts at the mouth and ends at the anus. It is made up of a series of muscles that coordinate the movement of food and other cells that produce enzymes and hormones to aid in the breakdown of food. Along the way are three other organs that are needed for digestion: the liver, gall bladder, and pancreas, which have their role to play in the digestion of food.

PARTS OF THE DIGESTIVE SYSTEM

The table on pages 135–6 looks at each organ that is involved in the digestive process, outlining its role and digestive function.

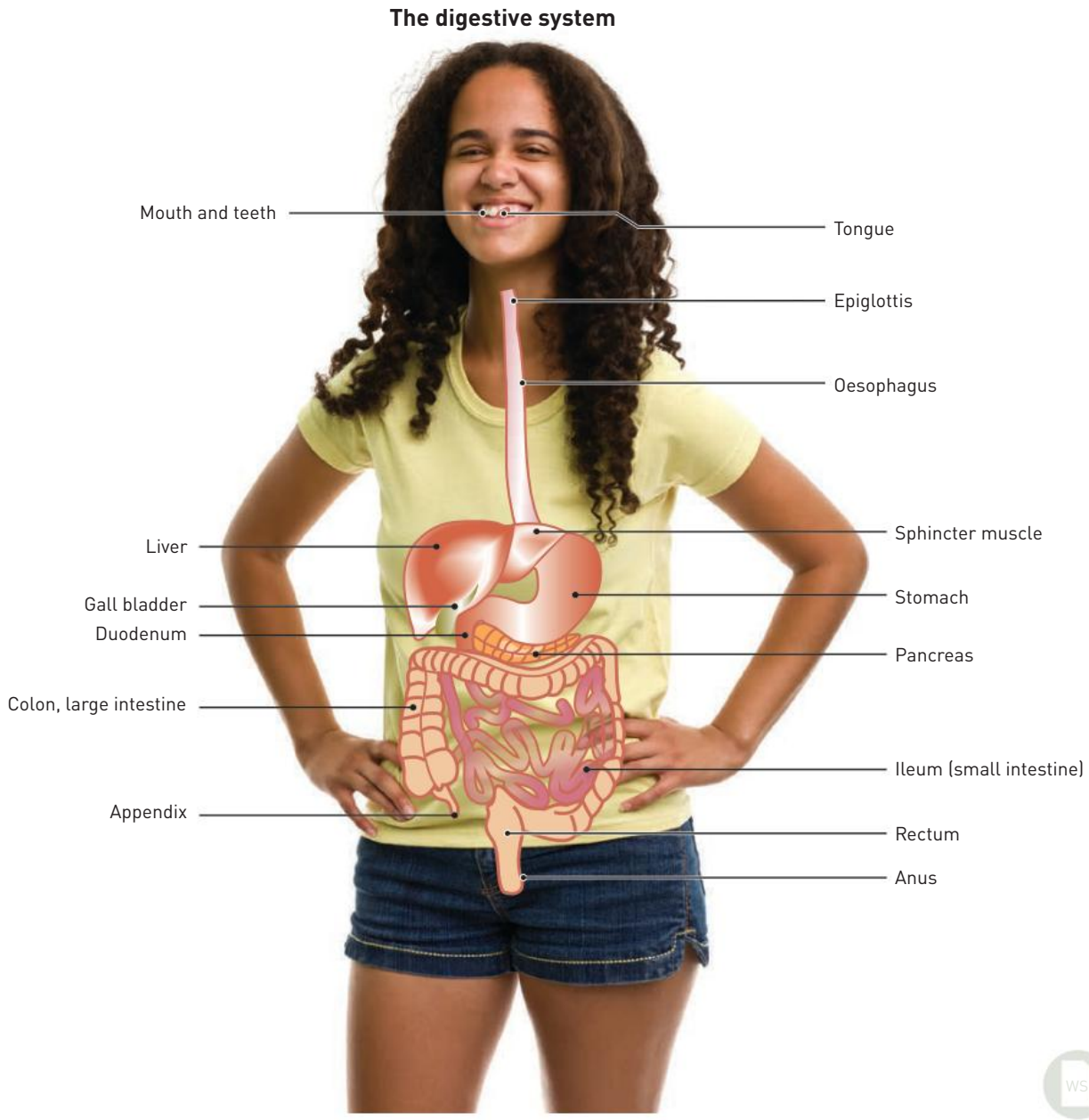

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Figure 7.22 The digestive system

The digestive system

Table 7.9 Organs

ORGAN	ROLE	DIGESTIVE FUNCTION
Mouth, teeth, salivary glands	Mechanical (chewing or masticating) and chemical (saliva) breakdown of food.	Tongue and teeth grind food and mix it with the saliva containing amylase and mucin. Food is broken into smaller pieces and mixed with saliva, and digestion begins. Amylase is an enzyme that starts to work on the digestion of starches.
Oesophagus	Links the mouth to the stomach. Peristaltic movements push food down this tube and into the stomach.	No actual breakdown of food in the oesophagus. Its main role is to ensure no acidic mixture in the stomach splashes back up into the mouth. The oesophageal sphincter should do this.

Table 7.9 *(Continued)*

ORGAN	ROLE	DIGESTIVE FUNCTION
Stomach	This large, bag-like organ has muscles lining the walls that work to further grind the food.	Chyme is formed where gastric juices are mixed with the food in the stomach. These gastric juices are a combination of hydrochloric acid and enzymes, which work on proteins and further digest carbohydrates. This chyme is then released slowly in to the small intestine, controlled by the pyloric sphincter.
Small intestine	Divided into three distinct areas: duodenum, jejunum, and ileum. This section of the digestive system is 6 metres in length on average and is where the majority of digestion and absorption occurs	Chyme enters the duodenum, coming into contact with insulin released via the pancreas, bile released via the gall bladder and gastric juices secreted by the walls of the intestine as well. An alkaline environment in this section of the digestive tract neutralises the acidity from the stomach's hydrochloric acid.
Large intestine	The colon and rectum make up the last 1.5 metres of the gastrointestinal tract. It is thicker than the small intestine and its main role is to remove residue from food and any other waste products. Waste matter enters as a liquid form where the majority of water is absorbed, leaving a semi-solid mass.	Bacteria or gut flora are present here and are responsible for processing fibrous matter and other undigested food stuffs, producing a small amount of energy as well as vitamin K and some B-group vitamins, which are then absorbed into the bloodstream. Remaining wastes are excreted via the anus in the form of faeces.

The digestion, absorption and metabolism of individual nutrients

Chorizo and rocket pasta salad

There are differences between how each nutrient is treated by the gastrointestinal tract.

LIPIDS

Digestion

Fat digestion starts off slowly in the mouth, with lipase from saliva starting the process. In the stomach, a lot of churning takes place that helps to break fat down into smaller components. This readies fat for further digestion. The stomach also releases lipase to continue with fat digestion. However, the majority of fat digestion occurs in the small intestine. Here, the bile (which is made by the liver and stored in the gall bladder) emulsifies fat molecules allowing the lipase enzymes to completely break fats down to monoglycerides.

Absorption and metabolism

Small molecules of digested triglycerides can diffuse into the intestinal cells and are absorbed directly into the bloodstream. The blood carries these fats to the rest of the body for immediate use or for storage. Lipoproteins are the vehicle for transporting lipids.

PROTEINS

Digestion

Proteins are crushed and churned in the mouth but most of the digestion takes place in the stomach. Protein is denatured by the stomach acids in order for pepsin to digest proteins down to their simplest amino acid form. Within the small intestine, proteases and peptidases further break proteins down to their simplest forms.

Absorption and metabolism

Specific carriers transport amino acids into the intestinal cells, where the amino acids are used for energy or used to synthesise necessary proteins. Unused amino acids are transported to the liver. From here, amino acids are used to synthesise hormones, enzymes and muscle tissue for the body to use.

CARBOHYDRATES

Digestion

Amylase found in saliva starts to act on breaking down carbohydrates in the mouth. The small

intestine performs most of the digestion of carbohydrates. Pancreatic amylase enters the intestine via the pancreatic duct and is responsible for breaking all polysaccharides and disaccharides down to monosaccharides (mostly glucose molecules). Within 1–4 hours after consuming food, all the sugars and available starches have been digested.

Absorption and metabolism

To some extent, glucose can be absorbed through the lining of the mouth. However, most nutrient absorption takes place in the small intestine. The blood from the intestines circulates through the liver, and cells there take up the simple sugars and convert them to other compounds.

VITAMINS

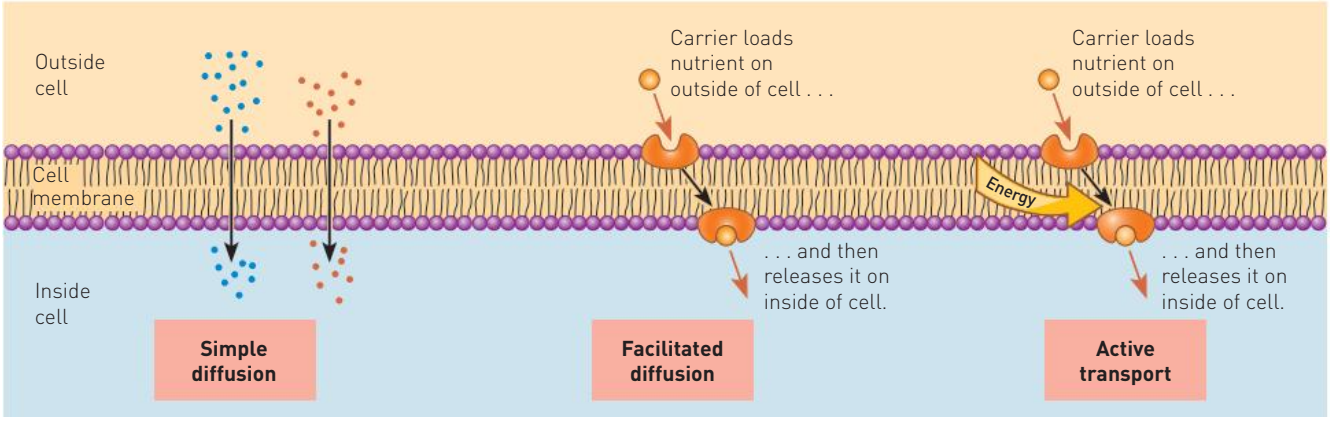
Digestion

The availability of vitamins depends upon the food eaten, which releases the vitamins in the small and large intestines. Fat-soluble vitamins (A, D, E and K) require fats to carry them via the bloodstream to the liver and other fatty tissues. Water-soluble vitamins (B and C) are digested and carried into the blood through the intestine. The small intestine serves as the primary site of vitamin digestion and absorption.

Absorption and metabolism

The small intestine is where vitamin absorption takes place. Water-soluble vitamins, such as vitamin C, are picked up in the small intestine. The vitamin molecules are carried through the intestine's cell walls to where they can enter the bloodstream. Because they dissolve in water, vitamin C does not require stomach acids to be absorbed, but this means that each day it leaves the body in your urine. Therefore, you need to consume vitamin C daily to stay healthy. B-group vitamins are also water-soluble and need to be consumed daily, although they are absorbed differently. B-vitamins are bound to proteins and need to be broken down by stomach acids.

Fat-soluble vitamins need to be dissolved in fat before they can enter the body. Fat-digesting bile acids from the liver and small intestine break down the fat and the vitamins move with the fat through the intestinal wall, into the body, and are stored in the liver and in body fat, where they can be accessed as required. Therefore, fat-soluble vitamins do not need to be eaten every day, as the body can store them.



Some nutrients (such as water and small lipids) are absorbed by simple diffusion. They cross into intestinal cells freely.

Some nutrients (such as the water-soluble vitamins) are absorbed by facilitated diffusion. They need a specific carrier to transport them from one side of the cell membrane to the other. (Alternatively, facilitated diffusion may occur when the carrier changes the cell membrane in such a way that the nutrients can pass through.)

Some nutrients (such as glucose and amino acids) must be absorbed actively. These nutrients move against a concentration gradient, which requires energy.

Figure 7.23 How nutrients are absorbed.

MINERALS

Digestion

Minerals are digested in a similar fashion to that of vitamins. These trace elements are not affected by the digestive system themselves; however, the digestive tract releases minerals so they are made available for absorption.

Absorption and metabolism

Absorption of minerals predominantly takes place in the small intestine. Once absorbed they are sent to required areas of the body for the particular roles they play. Certain components of food may inhibit their absorption, and it is also essential to be aware that over consuming minerals can be toxic.

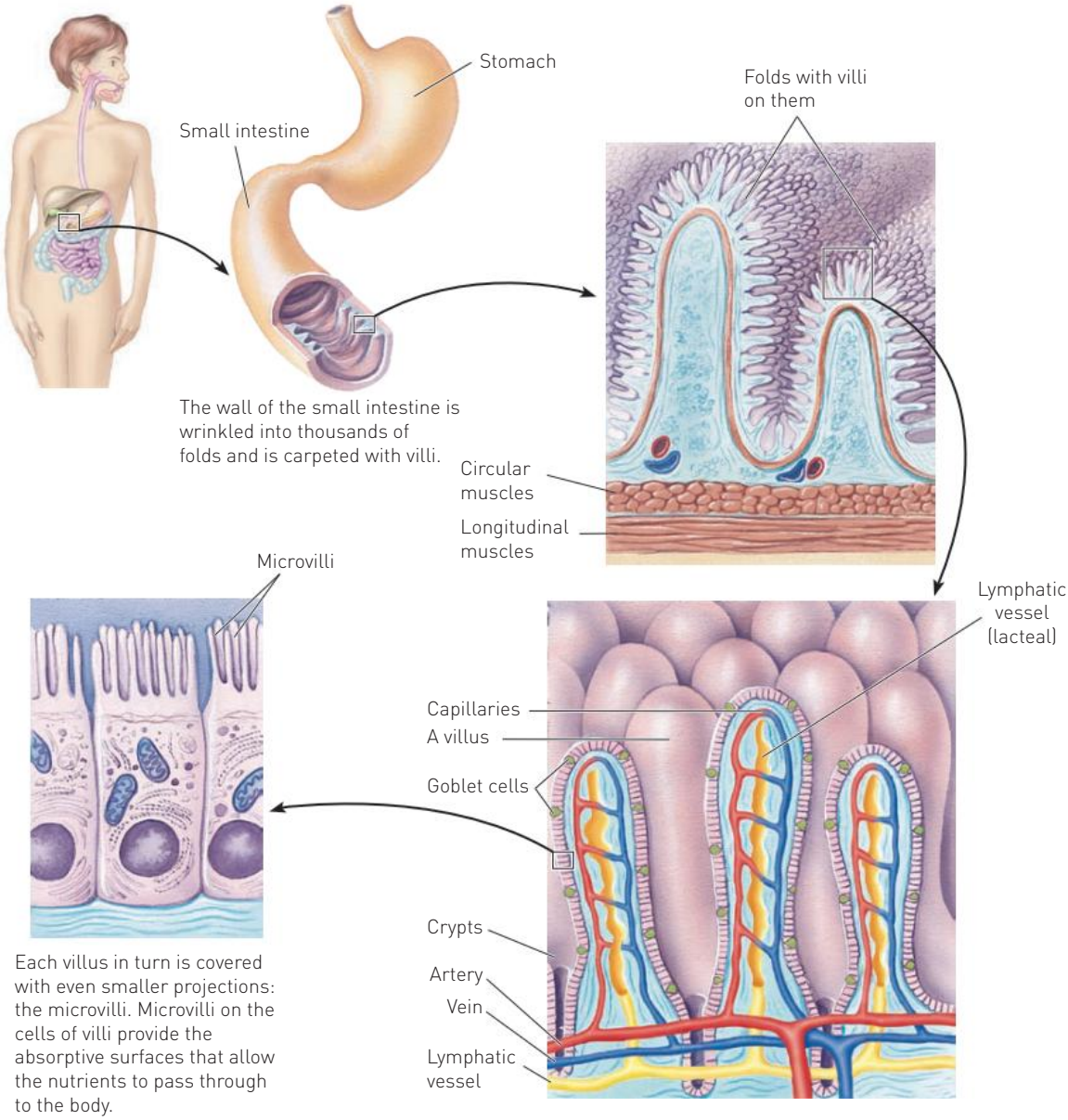
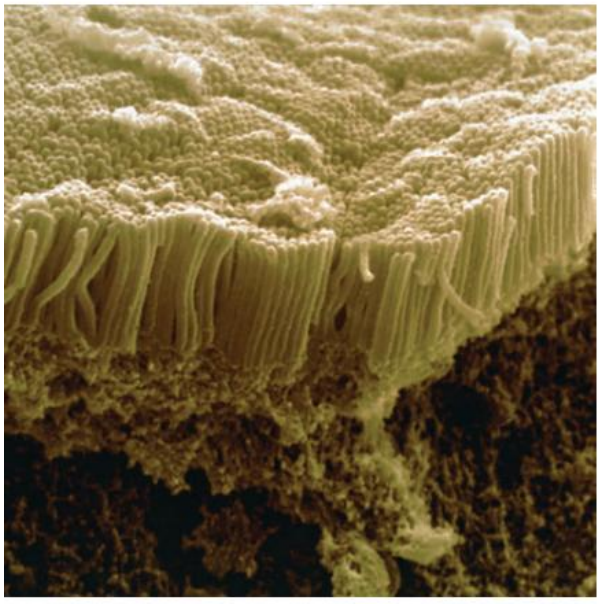


Figure 7.24 The surface area of the length of the small intestine is enhanced considerably by thousands of microscopic finger-like projections called villi. These villi recognise the nutrients required by the body and regulate their absorption.



Getty Images/Eye of Science/SPL

Figure 7.25 A microscopic image of microvilli covering the intestinal wall.

DIETARY FIBRE

Digestion

Dietary fibre is a form of polysaccharide that cannot be broken down by our digestive system. In the mouth, fibre is mixed with saliva to moisten it for swallowing. In the stomach, the fibre delays gastric emptying, which aids in satiety. Delays in absorption occur in the small intestine because of the presence of fibre. Once in the large intestine, insoluble fibre aids the formation of excrement, binding unwanted wastes to excrete from the body. No absorption of insoluble dietary fibre exists in the human body.

FOCUS QUESTIONS 7.8

REVIEW

1 What is digestion and why is it important?
2 Define absorption and metabolism.
3 What is the difference between chemical and mechanical digestion?
4 What is chyme?
5 What are villi and what role do they play in digestion?
6 Identify each of the key stages of digestion.

FOR YOU TO APPLY

7 Coeliacs have difficulty absorbing nutrients. What is a coeliac and what is the cause of this food intolerance? Design a meal suitable for this group of people.
8 What is the only substance absorbed through the stomach? Why is this important to know?

EXTEND YOURSELF

9 Using a specific food item, such as a hamburger, describe the process of digestion, absorption and metabolism of this food.

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Chapter review

1 Identify the food nutrients, their sources and their functions in the body. Classify these nutrients as either a macro-or micro-nutrients.
2 Identify various carbohydrates and classify them accordingly.
3 Identify the groups of proteins available in our diet. Give examples.
4 What are amino acids? How many are classified as essential amino acids?
5 What are lipids? How are they classified?
6 The two major groups of vitamins are either water-soluble or fat-soluble. Identify which vitamins are classified into which groups, along with a brief explanation of their role in the diet.
7 Make a list of foods you enjoy eating. Identify the nutrient content of this list. In your opinion, does this list meet your basic nutritional needs?
8 Analyse the following diet and determine how suitable it is for an adolescent. Use Nutrient Reference Values (NRVs) to help you determine the quality of this diet.
   - Breakfast: 1 cup milk, 3 weetbix, 1 piece of fruit
   - Lunch: 1 salad and chicken sandwich (on wholegrain bread) with 1 teaspoon butter, 1 tub low-fat yoghurt
   - Dinner: steamed fish served with broccoli, pumpkin, corn and peas
   - Snacks: 10 almonds, piece of fruit, 25 g chocolate
   - Beverages: 6 glasses water throughout the day.

NRVs

9 Create a mind map showing the interrelationship of certain nutrients in the body during their digestion and absorption.
10 Explain why the body is able to digest starch but not cellulose. What is the difference between soluble and insoluble fibre?
11 Why is folate supplementation routinely recommended for pregnant women? What food is fortified with folate?
12 Do further research on minerals such as iodine and other trace elements by visiting the Nutrition Australia website. Make notes and share with your classmates.

Nutrition Australia

EXTEND YOURSELF

13 Create a recipe that combines foods for nutritional benefits and interrelationships. Prepare and present this recipe in class. Evaluate its success.

CHAPTER 8

Diets for optimum nutrition

Abundant information is available to help us make wise food choices to meet our nutritional needs throughout the life cycle. Optimum nutrition is affected not only by making the right food choices, but also by the quantities, sources and combinations of foods, and the preparation techniques, all of which will be addressed in this chapter.

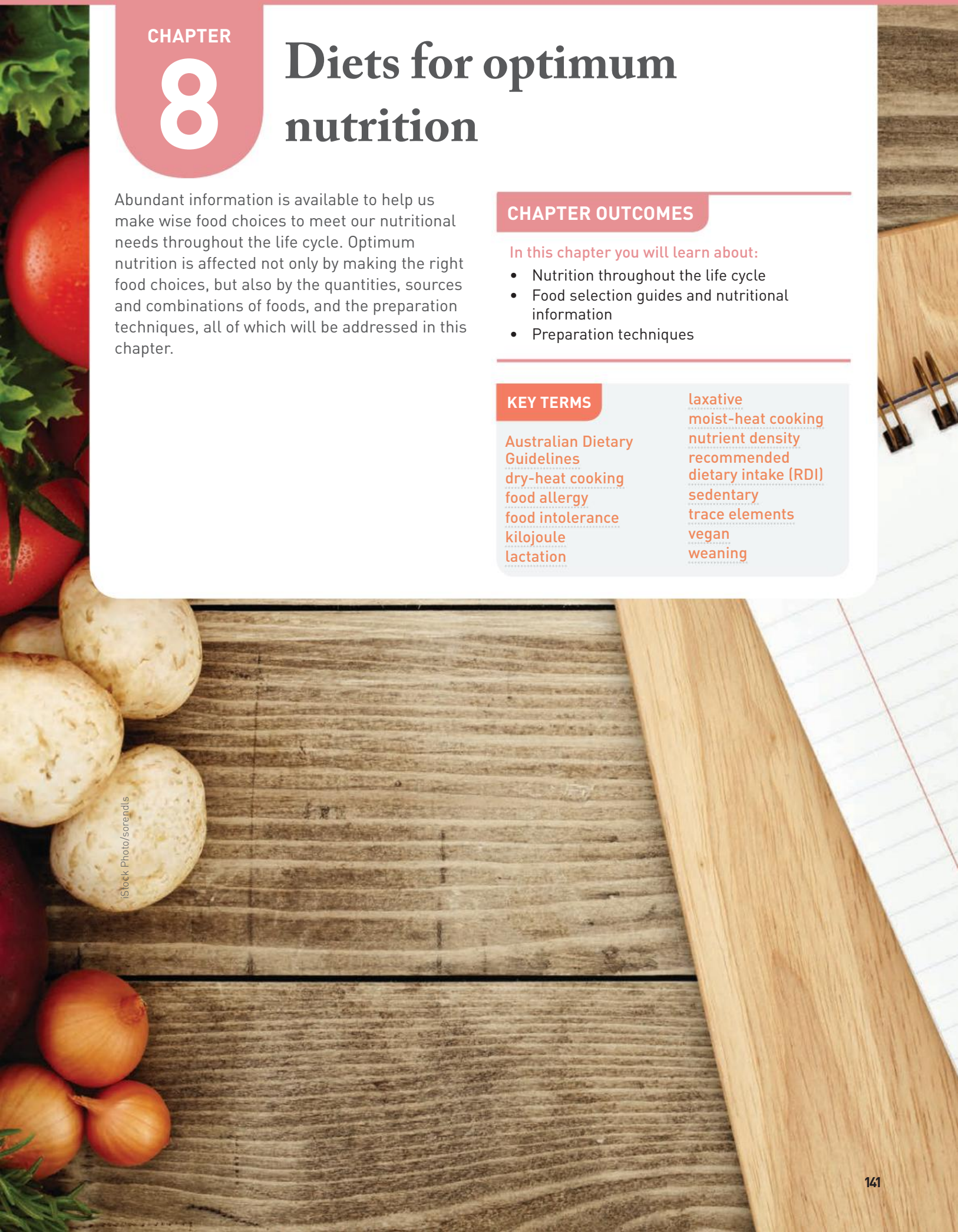
CHAPTER OUTCOMES

In this chapter you will learn about:

- Nutrition throughout the life cycle
- Food selection guides and nutritional information
- Preparation techniques

KEY TERMS

Australian Dietary Guidelines
dry-heat cooking
food allergy
food intolerance
kilojoule
lactation
laxative
moist-heat cooking
nutrient density
recommended dietary intake (RDI)
sedentary
trace elements
vegan
weaning



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Nutritional requirements throughout the life cycle

The term life cycle refers to the continuum of life from birth to death. Each individual goes through various stages and with those stages come various dietary considerations and needs. Our nutritional requirements not only vary throughout our life, but are affected by factors such as gender, body size and composition, health status, levels of activity, or, in the case of a woman, whether she is pregnant or lactating. To plan our diets to meet our nutritional needs throughout the life cycle, we can use tools such as the Australian Dietary Guidelines. Principles such as nutritional adequacy, balance, variety, and moderation of substances that can be detrimental are considered. To appreciate each stage of the life cycle, look at the breakdown of each stage below.

Pregnancy

Pregnancy involves the development of a zygote, followed by an embryo and finally a foetus before the birth of a child. During this stage of the life cycle, it is necessary for women to consume more carbohydrates for energy, more protein for the growing foetus and placenta, more vitamins (especially folate), more minerals for bone and teeth development and more lipids to supply essential fatty acids.

Infancy

Infancy is the initial part of childhood. It is the period of time from birth to one year. This is a period of rapid growth, as the infant will approximately triple their weight. Breast milk contains the exact quantities and types of nutrients the infant requires. However, formula milks can also be used to feed an infant, if required. By 6 months of age, the infant's diet can be supplemented by introducing semi-solid foods such as pureed vegetables. Common sense when selecting infant foods as well as a nurturing environment will support the infant's overall health and wellbeing. Infants require twice as much energy as an adult, because of their rapid growth and development. Trace elements are required in much larger amounts for the same reason. Proteins are necessary for developing muscles and other body tissue, as well as to build the infant's immune system.

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Figure 8.2 Women are encouraged to breastfeed their infant; however, an infant can thrive on formula as well. Love, affection and a nurturing environment all contribute to the infant's development.

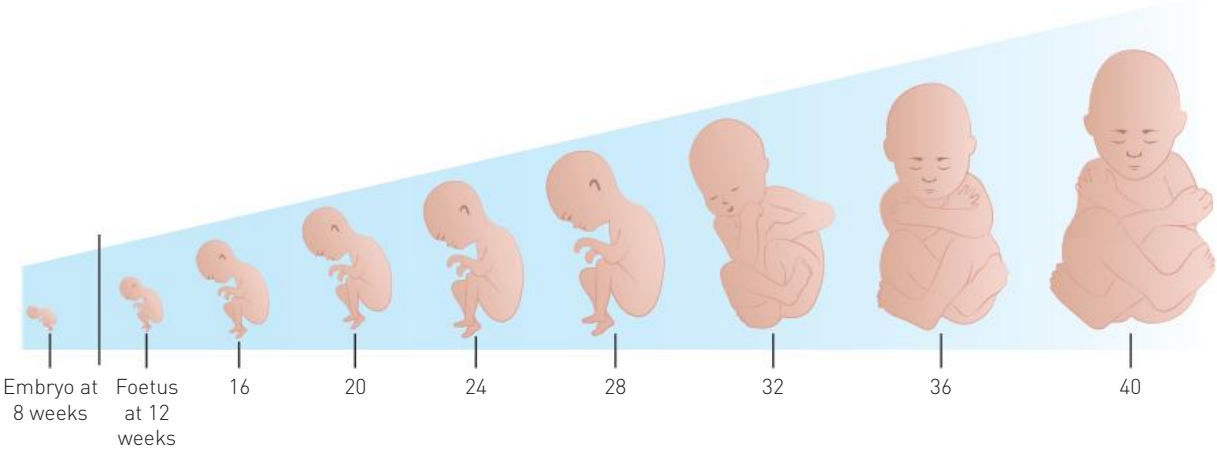

Figure 8.1 Foetal growth from 8 to 40 weeks

Toddler years

The toddler years are from ages one to three and are also part of early childhood. The rate of growth slows after the age of one until adolescence. During the toddler years, children can stand alone and are beginning to toddle, climb, jump, run and be more active. This requires the lengthening of bones and development of muscles. The risk of under nutrition at this stage of the life cycle increases with weaning as toddlers can become fussy and certain foods may not be liked or tolerated. Parents need to be very careful about choosing a vegan diet for their toddler, as malnutrition and deficiencies of vitamin B12, iron, and calcium may occur. Ideally a toddler should be able to sit at the dining table and enjoy a variety of healthy food options with the rest of the family.

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Figure 8.3 Weaning from the primary source of milk to solid foods occurs at the toddler stage. By one year, the toddler should be drinking from a cup, and enjoying most foods at mealtimes with the family.

Childhood

Childhood takes place from ages four to eight. The body is on its continual growth path, where macro-nutrients are necessary to support growth, and micro-nutrients are required for muscle development, maintenance and energy. Childhood obesity is a concern, so it is important for parents and carers to be aware of health at this stage and provide the correct amounts of quality produce to avoid malnutrition. The number of overweight children has increased dramatically over the past 30 years; these children are more likely to become obese in adulthood, and the health complications associated with this are enormous.

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Figure 8.4 Health and wellbeing are still crucial for the childhood phase of the life cycle.

Puberty

Puberty is the period from ages 9 to 13, which is the beginning of *adolescence*. At this stage there is an abrupt change in growth patterns whereby the body rapidly matures. On average, males grow 20 centimetres, females 15 centimetres, with males gaining 20 kilograms and females 16 kilograms. Energy needs to dramatically increase in order for the body to cope with this intense period of growth. Good quality proteins are necessary for hormonal production, as well muscle growth and

Dreamstime.com/Verkoka

Figure 8.5 As they grow, teenagers need to continue eating healthy nutritious food. Some teens choose foods that lack vital nutrients.

maintenance. A balanced diet with plenty of variety is conducive to good physical health and growth during this phase. During adolescence, external factors, such as the influence of peer groups and the media, may begin to have more influence over food choices.

Older adolescence

Older adolescence is the stage that takes place between ages 14 and 18. Teenagers are now making their own choices when it comes to diet. The issue here is the influence of peers, media and the like on their dietary habits. Growth at this stage tends to slow down and eventually stop as the person progresses to adulthood. At this stage, energy requirements are a little less, especially if the adolescent life style is relatively sedentary.

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Figure 8.6 As a teen becomes and adult, food choices still need to consider the dietary planning principles. Poor habits, such as consuming alcohol or recreational use of drugs, eating junk foods and avoiding fresh produce, need to be limited.

Adulthood

The period from adolescence to the end of life begins at age 19. Maintenance is the key to optimum nutrition from here. Consuming unprocessed, good quality foods from a variety of sources should fuel the body effectively and allow the adult to continue through life without dietary-related disorders. Avoiding malnutrition is imperative to good health. Energy intake should not exceed energy expenditure; protein is needed for maintaining muscle tissue and synthesising hormones and digestive enzymes. Minerals are needed to strengthen and maintain bones, teeth, hair and fingernails.

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Figure 8.7 Regular physical activity coupled with a well-balanced diet is the key to optimal health during adulthood.

Middle age

Middle age goes spans 31 to 60. An adult's life style may slow down at this stage so they may require less energy; however, the supply of good quality foods from a wide variety of sources is still important.

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Figure 8.8 Around middle age we tend to lose bone and muscle yet gain body fat. Maintaining muscle strength and mass can be achieved through a balanced diet and exercise.

Senior years

The senior years extend from age 60 onwards until the end of life. People may have to make special dietary considerations at this stage of the life cycle; for example, they may need to follow a low-salt diet

to avoid complications from hypertension. This time of the life cycle usually encompasses retirement – people need less energy and their lives may become more sedentary. As we age, our needs start to become more varied. The older we are, the more impact our life style choices may have on our wellbeing. Physical stressors (such as drug and alcohol abuse or injury) as well as psychological stressors (such as work stress or the death of a loved one) can drain the body of its reserves, leaving it weakened and vulnerable. Oxidative stresses and cellular damage also come with age, and may reduce the body's ability to fight disease or convalesce from illness. Antioxidants, found in fresh fruits and vegetables, may help slow the ageing process.

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Figure 8.9 Healthy ageing involves mindful eating, a balance of nutrient-dense foods and a combination of both physical and mental activities.

FOCUS QUESTIONS 8.1

REVIEW

1. List the nine stages of the life cycle.
2. What are trace elements?
3. What is lactation?
4. How does the diet of an adult vary from that of a toddler?
5. Explain the term mindful eating.
6. Why is breast milk recommended as the best food for an infant? List the advantages of breast feeding.
7. Introducing infants to solid food requires a sensible approach. What factors must be taken into consideration when starting to feed a baby solids?

FOR YOU TO APPLY

8. Create a fact sheet for adolescents to follow when planning a weekly menu. Ensure your fact sheet:
   - **a** explains the nutritional requirements
   - **b** offers suggestions on how to plan healthy meals
   - **c** describes where to go to get reliable information.

EXTEND YOURSELF

9. Design a two-course celebration meal suitable to meet the specific nutritional needs of an individual or group. Justify your choices with reference to appropriate data. Prepare and present your meal in a practical lesson.

Current food selection guides and nutritional information

Dieticians and nutritionists keep in mind six basic principles of planning a diet.

1 Adequacy

Adequacy is concerned with ensuring enough energy and essential nutrients are consumed. Adequate consumption is about finding the balance between too much and too little food. Following guidelines underpinned by detailed scientific research, such as the Australian Dietary Guidelines, the Australian Guide to Healthy Eating and the NRVs for Australia and New Zealand will help maintain an adequate supply of required foods.

2 Balance

Developing a balance in the diet involves developing an understanding of the foods and what nutrients they provide. Some combinations of foods work well together, as discussed in Chapter 7. For example, the combination of lentils or white meat providing protein, eaten together with some dairy foods supplying calcium would ensure a sound supply of both protein and calcium. The absorption of the nutrients would work well in the gastrointestinal tract as well. Yet the diet would also need foods from the remaining food groups to ensure other nutrients are supplied.

3 Energy control

Energy (kilojoules) is needed by the body for basic metabolic reactions and physical activity. Consuming enough kilojoules is important for the body to have sufficient energy to meet its needs. However, you need to ensure you do not have energy left over, as it ends up being stored as adipose (fat) tissue. This does not mean you should count kilojoules, but it is worth knowing how much energy is in a food and how many nutrients it contains as well. For example, a piece of chocolate may have the same kilojoule content as a piece of avocado, but which food offers other valuable nutrients as well as the energy content? Yes, the avocado!

Table 8.1 Average daily kilojoules

AGE	MALE	FEMALE
12–15	10 900 kJ	9550 kJ
16–18	12 900 kJ	10 200 kJ
19–50	11 550 kJ	9300 kJ
51–70	10 450 kJ	8800 kJ
Adults over 70	9450 kJ	8300 kJ

Source: National Health and Medical Research Council

4 Nutrient density

In order to eat well, foods that have a high dose of nutrients with lower amounts of kilojoules are considered to be nutrient dense. This is where wise food choices and correct portion size helps the individual maintain a healthy weight and ensures all nutrients needed are supplied in the diet. Take cheese and yoghurt as an example, both are good sources of calcium, yet one is much higher in kilojoules than the other.

One key to success with diet planning is choosing foods that are nutrient dense. It makes sense to consume foods with a high amount on nutrients in them rather than consume 'empty kilojoule' foods. These empty kilojoule foods (such as lollies, chips and soft drinks) offer little other than energy and should be avoided or only eaten in small amounts.

5 Moderation

To practise moderation in a diet involves consuming all food groups, while limiting empty kilojoule foods. Foods high in fat and sugar do taste good, but they also provide a gateway to poor health if eaten too much. Therefore moderation and variety in the diet is imperative to good health. If we consume a wide variety of foods from all food groups, then our diet is varied, which allows for the supply of all necessary nutrients.

6 Variety

A variety of foods in the diet improves nutritional adequacy. Eating a variety of foods adds to satiety and enjoyment of meals. To 'eat the rainbow' is to eat an arrangement of colourful foods. For example, fruits are

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Figure 8.10 45 grams of cheese contains 765 kilojoules whereas 45 grams of yoghurt contains 85 kilojoules.

an amazing group of nutrient-dense foods. However, just eating apples all the time could become boring. There are seasonal fruits, berries, stone fruits and so on that covers a variety from just one group of foods available to us. Remember, variety is the spice of life!

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Figure 8.11 It is important to eat a variety of different foods and colours.

The Australian Dietary Guidelines

Australian Dietary Guidelines

The Australian Dietary Guidelines give advice on eating for health and wellbeing. They are based on the latest scientific evidence, and describe how to eat to maintain good health and minimise dietary-related diseases.

There are five principal recommendations featured in the Australian Dietary Guidelines. Each guideline is considered to be equally important in terms of public health outcomes.

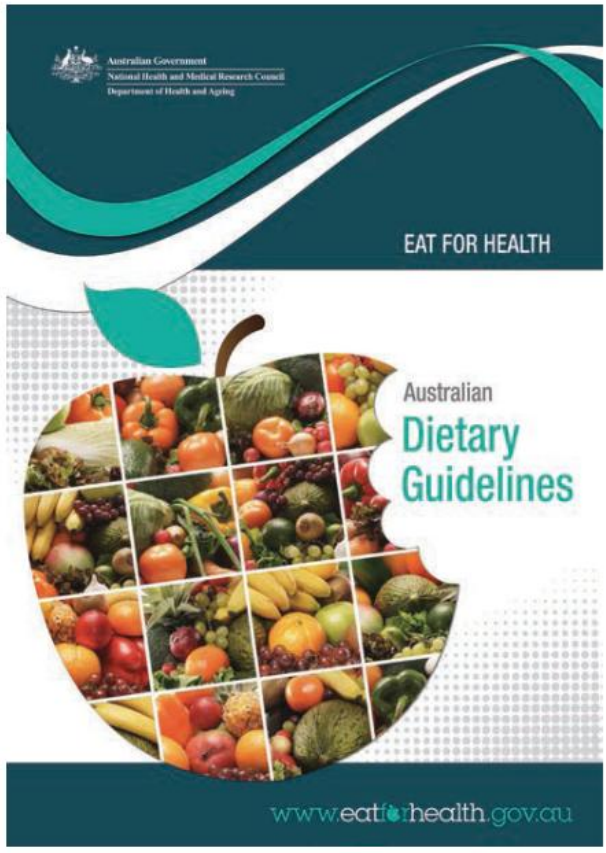

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Figure 8.12 The Australian Dietary Guidelines

Guideline 1

To achieve and maintain a healthy weight, be physically active and choose amounts of nutritious food and drinks to meet your energy needs

- Children and adolescents should eat sufficient nutritious foods to grow and develop normally. They should be physically active every day and their growth should be checked regularly.
- Older people should eat nutritious foods and keep physically active to help maintain muscle strength and a healthy weight.

Guideline 2

Enjoy a wide variety of nutritious foods from these five groups every day:

- Plenty of vegetables, including different types and colours, and legumes/beans
- Fruit
- Grain (cereal) foods, mostly wholegrain and/or high cereal fibre varieties, such as breads, cereals, rice, pasta, noodles, polenta, couscous, oats, quinoa and barley
- Lean meats and poultry, fish, eggs, tofu, nuts and seeds, and legumes/beans
- Milk, yoghurt, cheese and/or their alternatives, mostly reduced fat (reduced-fat milks are not suitable for children under the age of 2 years)

And drink plenty of water.

Guideline 3

Limit intake of foods containing saturated fat, added salt, added sugars and alcohol

a Limit intake of foods high in saturated fat such as many biscuits, cakes, pastries, pies, processed meats, commercial burgers, pizza, fried foods, potato chips, crisps and other savoury snacks.

- Replace high fat foods which contain predominantly saturated fats such as butter,

>

cream, cooking margarine, coconut and palm oil with foods which contain predominantly polyunsaturated and monounsaturated fats such as oils, spreads, nut butters/pastes and avocado.
- Low-fat diets are not suitable for children under the age of 2 years.

b Limit intake of foods and drinks containing added salt.
- Read labels to choose lower sodium options among similar foods.
- Do not add salt to foods in cooking or at the table.

c Limit intake of foods and drinks containing added sugars such as confectionary, sugar-sweetened soft drinks and cordials, fruit drinks, vitamin waters, energy and sports drinks.

d If you choose to drink alcohol, limit intake. For women who are pregnant, planning a pregnancy or breastfeeding, not drinking alcohol is the safest option.

Guideline 4

Encourage, support and promote breastfeeding.

Guideline 5

Care for your food; prepare and store it safely.

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Table 8.2 Recommended average daily number of serves from each of the five food groups* Additional serves for more active, taller or older children and adolescents.

AGE/STAGE	VEGETABLES AND LEGUMES/ BEANS	FRUIT	GRAIN (CEREAL) FOODS, MOSTLY WHOLEGRAIN	LEAN MEAT AND POULTRY, FISH, EGGS, NUTS AND SEEDS, AND LEGUMES/ BEANS	MILK, YOGHURT, CHEESE AND/OR ALTERNATIVES (MOSTLY REDUCED FAT)	APPROX. NUMBER OF ADDITIONAL SERVES FROM THE FIVE FOOD GROUPS OR DISCRETIONARY CHOICES
Toddlers **						
1–2	2–3	½	4	1	1–1½	
Boys						
2–3	2 ½	1	4	1	1 ½	0–1
4–8	4 ½	1 ½	4	1 ½	2	0–2 ½
9–11	5	2	5	2 ½	2 ½	0–3
12–13	5 ½	2	6	2 ½	3 ½	0–3
14–18	5 ½	2	7	2 ½	3 ½	0–5
Girls						
2–3	2 ½	1	4	1	1 ½	0–1
4–8	4 ½	1 ½	4	1 ½	1 ½	0–1
9–11	5	2	4	2 ½	3	0–3
12–13	5	2	5	2 ½	3 ½	0–2 ½
14–18	5	2	7	2 ½	3 ½	0–2 ½
Pregnant	5	2	8	3 ½	3 ½	0–3
Breastfeeding	5 ½	2	9	2 ½	4	0–3

*Includes an allowance for unsaturated spreads or oils, nuts or seeds (½ serve [4.5 g] per day for children 2–3 years of age, one serve [7–10 g] per day for children 3–12 years of age; 1 ½ serves [11–15 g] per day for children 12–13 years, and two serves [14–20 g] per day for adolescents 14–18 years of age and for pregnant and breastfeeding girls).

** An allowance for unsaturated spreads or oils or nut/seed paste of one serve (7–10 g) per day is included. Whole nuts and seeds are not recommended for children of this age because of the potential choking risk.

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Table 8.3 Recommended average daily number of serves from each of the five food groups* Additional serves for taller or more active men and women.

AGE/ STAGE	VEGETABLES & LEGUMES/ BEANS	FRUIT	GRAIN (CEREAL) FOODS, MOSTLY WHOLEGRAIN	LEAN MEAT AND POULTRY, FISH, EGGS, NUTS AND SEEDS, AND LEGUMES/ BEANS	MILK, YOGHURT, CHEESE AND/OR ALTERNATIVES (MOSTLY REDUCED FAT)	APPROX. NUMBER OF ADDITIONAL SERVES FROM THE FIVE FOOD GROUPS OR DISCRETIONARY CHOICES
Men						
19–50	6	2	6	3	2 ½	0–3
51–70	5 ½	2	6	2 ½	2 ½	0–2 ½
70+	5	2	4 ½	2 ½	3 ½	0–2 ½
Women						
19–50	5	2	6	2 ½	2 ½	0–2 ½
51–70	5	2	4	2	4	0–2 ½
70+	5	2	3	2	4	0–2
Pregnant	5	2	8 ½	3 ½	2 ½	0–2 ½
Lactating	7 ½	2	9	2 ½	2 ½	0–2 ½

* Includes an allowance for unsaturated spreads or oils, nuts or seeds (4 serves [28–40 g] per day for men less than 70 years of age; two serves [14–20 g] per day for women and older men).

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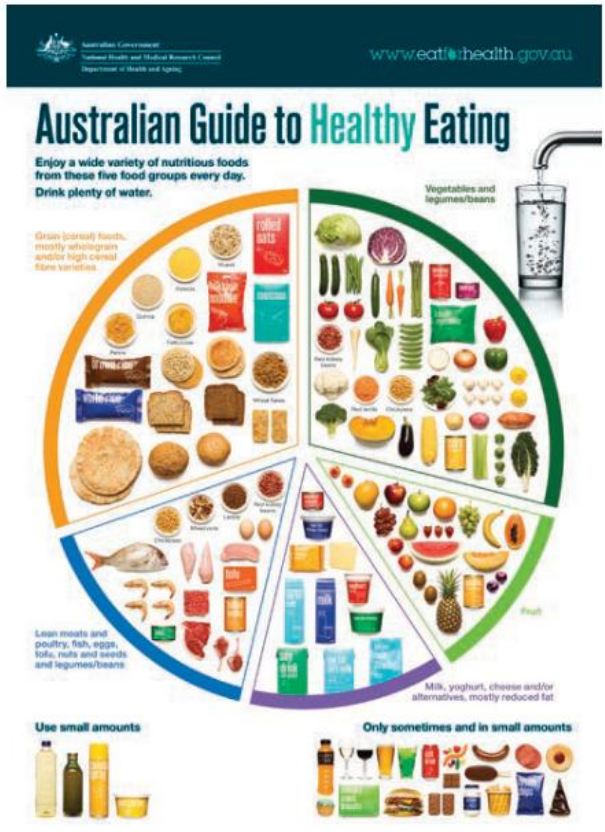
The Australian Guide to Healthy Eating

The Australian Guide to Healthy Eating is a visual food selection guide that clearly shows the portions of food from each of the five major food groups that should be consumed daily. It has been created through extensive research funded by the Department of Health and follows the Australian Dietary Guidelines.

The Australian Guide to Healthy Eating



Australian Guide to Healthy Eating, National Health and Medical Research Council © Commonwealth of Australia

Figure 8.13 The Australian Guide to Healthy Eating

Nutrient reference values for Australia & New Zealand

The nutrient reference values (NRV) for Australia and New Zealand include two sets of values to guide nutrient intake – RDI and Adequate Intake (AI). In order to set an RDI there must be sufficient evidence that the figure provides the average daily amount of a nutrient to sustain most healthy people; if there is insufficient evidence to determine an RDI, an AI is set. Both are useful to guide a balanced intake of nutrients.

PRACTICAL APPLICATION

CALCULATING NRVs FOR VARIOUS STAGES OF THE LIFE CYCLE

8.1

AIM

Assess the nutrient requirement values for the following people:

- an active teenage male
- a sedentary adult female
- a toddler.

METHOD

Research nutrient reference value tables to find the information necessary for the above scenarios.

RESPOND

1 Calculate the nutritional requirements for each person.
2 Suggest three meals that could help each person meet these requirements. Justify your choices.

Nutrition Australia Healthy Eating Pyramid

The Healthy Eating Pyramid © 2015

Figure 8.14 The Nutrition Australia Healthy Eating Pyramid

The Healthy Eating Pyramid is a simple visual guide to the types and proportion of foods that we should eat every day for good health. It contains the five core food groups, plus healthy fats, according to how much they contribute to a balanced diet based on the Australian Dietary Guidelines (2013). The layers of the pyramid are based on the recommended food intake for 19–50 year olds according to the Australian Dietary Guidelines (2013). However, the proportions and placement of each food group are generally applicable to all age groups from 1–70 years. The Healthy Eating Pyramid provides similar information to the Australian Guide to Healthy Eating with the main difference being the presentation of the information. It is produced independently by Nutrition Australia, a not-for-profit community group.

Go for 2 & 5

Go for 2 & 5

This state government initiative is a campaign aimed at promoting the Australian Dietary Guideline that recommends adults eat at least two serves of fruit and five serves of vegetables each day. These amounts will vary for children, depending on their age. In NSW in 2005, 51 per cent of adults consumed the recommended 2 serves of fruit each day, while only 7.4 per cent of adults ate the recommended 5 serves of vegetables.

PRACTICAL APPLICATION

ANALYSING THE FIVE BASIC FOOD GROUPS

8.2

AIM

Analyse the five food groups by visiting the Eat for Health website.

METHOD

Follow the links for each of the five groups of foods on the website.

Eat for Health

RESPOND

Make notes on the examples of foods, the requirements of this group of foods in the diet, and any other points of interest.

National Health and Medical Research Council © Commonwealth of Australia

Australian Government
National Health and Medical Research Council
Department of Health and Ageing

www.eatforhealth.gov.au

EATFORHEALTH

FOLLOWING THE RECOMMENDATIONS IN THE AUSTRALIAN DIETARY GUIDELINES

The sample meal plan outlined below provides the nutritional and energy requirements for a CHILD aged 9-11 years of average height, healthy weight and light activity

BREAKFAST

Wheat biscuit with milk and yoghurt

(1 wheat biscuit, ½ cup reduced fat milk, 100g yoghurt)

AFTERNOON BREAK

Crumpet

(1 crumpet with a light spread of margarine)

Glass of milk

(1 cup/250ml reduced fat milk)

MORNING BREAK

Banana

(1 medium banana)

Crispbreads with peanut butter spread

(3 crispbreads, 1T of peanut butter spread)

EVENING MEAL

Lamb kebab with vegetables

(65g cooked lamb kebab, 1 small boiled potato, ½ cup cooked carrot, ½ cup cooked beans)

EVENING SNACK

Fruit salad (tinned or fresh) and reduced fat yoghurt

(1 cup mixed fruit plus small tub/100g yoghurt)

LUNCH

Egg, cheese and salad sandwich

(2 x slices of wholemeal bread, 1 boiled egg, 20g/1 slice reduced fat cheese, 1 cup mixed salad)

Drink plenty of water throughout the day

Figure 8.15 With all this information on what we should eat, how much we should eat, what specific needs we have at certain stages of the life cycle, and thinking of the principles of planning a diet, putting the plan into action is the next step. Here is an example of a diet that has been planned for a child of 9–11 years, following the Australian Guide to Healthy Eating. How would this plan differ if it were for an adolescent?

Preparation techniques to produce nutritious foods

Preparing nutritious meals requires an understanding of what foods to choose, what amounts or portions to prepare, safely storing ingredients for meals, and ultimately the ability to cook these foods with the aim of retaining as many of the nutrients as possible.

Food selection guides can allow us to develop an understanding of what foods to choose, along with a guide as to how much of that particular food should be consumed within the day. The ability to prepare these foods without compromising their nutritional value is equally as important. As a general guide, you should consider the following information:

- Fruits and vegetables should be fresh, in good condition, and stored appropriately. Raw rather than cooked can be of benefit (with a few exceptions, such as carrots), and the skin should be left intact because of the valuable vitamins, minerals and fibre located on or under the skin layer.
- Be careful when boiling plant foods, as overcooking leaches essential nutrients. Using larger pieces helps to reduce the surface area and therefore leaching.
- Try to choose the leaner cuts of meat, and consider using the visible fat and skins of animals sparingly as this part of the food is kilojoule dense.
- Choose wholegrain cereals and breads, as the fibre content encourages a healthy gut.
- Fresh herbs, spices, garlic, lemon and other flavours will liven up a dish, and reduce the need to add too much salt. Salt naturally occurs in many of our foods and is not needed in extra amounts.
- Avoid deep frying foods as this increases the quantity of fat in the meal and some fat-soluble vitamins may leach into the cooking fat and be lost.
- Create sauces that are vegetable based, not cream based. Making your own sauces reduces the amount of additives and preservatives in the diet. The water used to boil vegetables can be the base of a sauce and therefore any leached nutrients will be incorporated into the meal via this sauce.
- If you are preparing meals for those requiring a lower fat diet, consider low-fat dairy produce such as low-fat milk, cheese and yoghurt.

Microwaving

Microwaving is considered one of the healthiest way to cook because of its short cooking times, which results in minimal nutrient destruction. Microwaves cook food by heating it from the inside out. They emit radio waves that 'excite' the molecules in food and make them move around, which generates heat, thus cooking the food. While microwave cooking can sometimes cause food to dry out, this can easily be avoided by splashing the item with a bit of water before heating, or placing a wet paper towel over the top of your dish. The best part is you can microwave just about anything, from veggies and rice to meat and eggs.

Boiling

Boiling is quick, easy, and needs nothing but water. However, in addition to the high temperatures, the large volume of water dissolves and washes away water-soluble vitamins and 60 to 70 per cent of minerals. However, while this method leaches out vitamins and minerals, it is still considered more healthy than deep frying.

Steaming

Steaming anything from fresh veggies to fish fillets allows them to cook in their own juices and retain their natural goodness. It helps to add a little seasoning first, whether a sprinkle of herbs and spices or a squeeze of lemon juice. The carcinogen-fighting glucosinolates in broccoli are preserved during steaming and it is considered to be the best way to cook them. In the body, glucosinolates become compounds called isothiocyanates, which have the potential to inhibit the growth of cancer cells.

Poaching

Poaching is cooking the given food in a small amount of hot water (just below boiling point). It takes slightly longer, which may decrease nutrient retention, but is a great way to gently cook delicate foods like fish, eggs or fruit.

Broiling

Broiling entails cooking food under high, direct heat for a short period of time. Broiling is a great way to cook tender cuts of meat (remember to trim excess fat before cooking), but may not be ideal for cooking veggies, as they can dry out easily.

Grilling

In terms of getting maximum nutrition without sacrificing flavour, grilling is a great cooking method. It requires minimal added fats and imparts a smoky flavour, while keeping meats and vegetables juicy and tender. However, it has been suggested that regularly consuming charred, well-done meat may increase risk of pancreatic cancer and breast cancer. Cooking at high heat can also produce a chemical reaction between the fat and protein in meat, creating toxins that are linked to the imbalance of antioxidants in the body and inflammation, which can lead to an increased risk of diabetes and cardiovascular disease. So with this in mind, cooking meat to a rare to medium-rare consistency is a better option.

While grilling does require some oil in the pan, it should only be a moderate amount – just enough to get a nice sear on your meat and veggies. The choice of oil is also important, as coconut oil or olive oils work well and are more nutritionally sound.

Stir-frying

Stir-frying is effective for bite-sized pieces of meat, grains like rice and quinoa, and thin-cut veggies like capsicum, julienned carrots, and snow peas. It retains nutrients while using only a little oil at high heat.

Raw foods

There are benefits of incorporating more raw foods into the diet, and it has been said that 'eating the rainbow' consistently reduces the risk of cancer. Considering these foods are mostly plant-based, more vitamins, minerals, and fibre are consumed overall, with no added sugars or fats from cooking. Blending and juicing foods is a convenient way to prepare fruit and vegetables raw.

Baking

This dry-heat method of cookery is done in an oven, whereby the food is left in one position and does not need attending during the cooking process. Unnecessary fats are sometimes used in this preparation method. Heat-sensitive vitamins such as vitamin C are destroyed via baking.

Frying

Both shallow and deep frying are considered dry-heat methods of cookery because of the high temperatures used. Damage to some nutrients occurs because of the high heat, and fat-soluble vitamins may leach into cooking medium. Unnecessary fats are consumed when foods are prepared via this method.

FOOD IN FOCUS 8.1

PREPARATION TECHNIQUES FOR A CAFÉ MENU

Harry and Mario (HAM) Café is a vibrant, bustling eatery located in the heart of Cronulla, just south of Sydney. The owners pride themselves on serving quality dishes, made with locally sourced ingredients. The methods of food preparation provide high-quality nutritional meals, as can be seen in their menu on their website.

RESPOND

1 Outline the preparation techniques involved in making the dishes on offer for breakfast.
2 Which allergies or intolerances does the menu cater for?
3 From reading the menu, identify dishes incorporating the following food preparation techniques:
   a poaching
   b slow roasting
   c boiling
   d baking
   e grilling.
4 Why have HAM used those methods of preparation?
5 Suggest an extra dish for each part of their menu. Justify your choice.

9780170400572

Chapter review

REVIEW

1 List the various NRVs available to Australians in order to know how much of a particular nutrient is required by the body at the various stages of the life cycle.
2 Compare and contrast the nutrient needs of adolescent males and females. Why are there differences?
3 Explain the six basic principles to diet planning.
4 Visit the Nutrition Australia website and make notes on the strategies suggested regarding diet and meal planning.

FOR YOU TO APPLY

5 Create a recipe to be used by an elderly man as a main meal option. Justify your choices by referencing the Australian Guide to Healthy Eating, Australian Dietary Guidelines and NRVs.
6 Analyse some diets of your family and/or friends. Ask them to keep a tally of a week's food consumption, then determine how they may improve their diet or congratulate them on consuming all the correct foods in the correct portions if they do so! This could also be done as a class activity where you can analyse each other's diets.
7 Research a hospital cyclic menu of your choice. Determine the nutritive value of the options available. Discuss the menu's worth in relation to providing sound nutrition for those in hospital.
8 Plan a day's menu for an adolescent. Justify your choices and analyse its nutritive value by reflecting on the RDI tables in this chapter.

EXTEND YOURSELF

9 Visit the Nutrition Australia website and click on the 'A brief history of the Pyramid' link. Certain changes have been made to both the content and design of the pyramid. Suggest why the organisation made these changes.

CORE STRAND REVIEW

MULTIPLE CHOICE

1 Which of the following are examples of 'trace elements'?

- **A** protein, carbohydrates, vitamin C
- **B** iron, zinc, magnesium
- **C** vitamins, minerals, fats
- **D** potassium, sodium, omega 3 fatty acids

2 What is the main role of protein in the body?

- **A** As a source of energy
- **B** To prevent diabetes
- **C** To grow and repair body cells
- **D** As a carrier of vitamins A, D, E and K

3 Which identifies three examples of disaccharides?

- **A** pectin, sucrose and maltose
- **B** glycerol, dextrin and sucrose
- **C** pectin, glycerol and starch
- **D** lactose, sucrose and maltose

4 The concentrations of which vitamins are reduced when vegetables are boiled?

- **A** Vitamins A and C
- **B** Vitamins A and D
- **C** Vitamins B and D
- **D** Vitamins B and C

5 Catabolism would be best defined as:

- **A** the combination of food and gastric juices.
- **B** the chemical process of using nutrients.
- **C** the grinding and mastication of food.
- **D** the breaking down of nutrients to their simpler components.

SHORT ANSWER

6 **A** Assess the role of protein in an adolescent diet. (4 marks)

B Explain the role of water in the diet. (4 marks)

7 Discuss, with examples, government campaigns aimed at improving the health of Australians. (7 marks)

EXTENDED RESPONSE

8 'Nutritional needs vary throughout the life cycle.' Discuss this statement, justifying these variations. (15 marks)

9 An Australian food company has just put a single serve, organic kale based smoothie on the market for retail.

A What are the nutritional benefits of smoothies in general. What is the benefit of adding kale? (3 marks)

B Explain the drivers for this product. Which target market would this product be nutritionally beneficial for? (5 marks)

C Discuss the importance of nutritional composition of fast foods and convenience foods, linking your answer to common dietary related diseases faced by Australians. (7 marks)

(Total 15 marks)

PART 2

HSC COURSE

CORE STRANDS

THE AUSTRALIAN FOOD INDUSTRY (25%)

Chapter 9: Sectors of the Australian food industry

Chapter 10: Aspects of the Australian food industry

Chapter 11: Policy and legislation

FOOD MANUFACTURE (25%)

Chapter 12: Production and processing of food

Chapter 13: Food preservation

Chapter 14: Packaging, storage and distribution

FOOD PRODUCT DEVELOPMENT (25%)

Chapter 15: Factors that impact on food product development

Chapter 16: Reasons for and types of food product development

Chapter 17: Steps in food product development

Chapter 18: Marketing plans

CONTEMPORARY NUTRITION ISSUES (25%)

Chapter 19: Diet and health in Australia

Chapter 20: Influences on nutritional status

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CHAPTER 9

Sectors of the Australian food industry

The Australian food industry comprises the growing, producing, manufacture, processing, packaging, storage and distribution of food, along with the marketing and sale of food products. 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! In addition, many people work in the food industry, including supermarket staff, chefs, waiters, farmers and factory workers. The Australian food industry is a major employer and contributes to Australia's gross domestic product. In this chapter we will examine the sectors of the Australian food industry and how it addresses issues such as quality assurance, the environment and the impact of food production on society.

CHAPTER OUTCOMES

In this chapter you will learn about:

- The sectors of the agri-food chain in Australia: agriculture and fisheries, food processing and manufacturing, food service and catering, and food retail
- Emerging technologies the Australian food industry

KEY TERMS

agriculture
agri-food chain
aquaculture
Australian food industry
bio-technology
economy
food processing/ manufacturing
food retail sector
food service and catering sector
genetic engineering
organic farming
quality control
pesticides
value adding

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The Australian food industry

Australia is well positioned to produce a variety of food. This is due to the geographic position and diversity within our country; warm and humid conditions in the north are ideal for growing tropical fruit, and cool temperate conditions in the south are suited to cereal crops and vegetables. As a result, farmers are able to produce a wide variety of foods for us to enjoy all year round.

Advances in technologies, such as bio-technologies and genetic engineering, mean that we are able to prolong the shelf life of raw materials through correct storage methods and various processing and manufacturing techniques. These developments have led to a safe and reliable food supply for domestic and international consumers.

The food industry is essential to Australia's economic and social success. It accounts for around 20 per cent of domestic manufacturing sales and service income. Australia also has an international reputation as a modern, safe, reliable and sustainable food producer.

The food industry is of incredible importance to the Australian economy. Australian Food Statistics found that 1.68 million people work in the food industry – from farm and fisheries production through to food and beverage manufacturers – representing 15 per cent of Australia's workforce.

Thai chicken, vegetables and noodles

The agri-food chain

The Australian food industry is broken into four sectors known as the agri-food chain. The agri-food chain is the production and supply of food to the consumer.

The agri-food chain relies on the success of each sector and each is dependent on the other. A break in the agri-food chain or a problem in one sector of the agri-food chain can have a substantial influence on and repercussions for the other sectors, affecting supply, production, manufacturing and eventually sales and income.

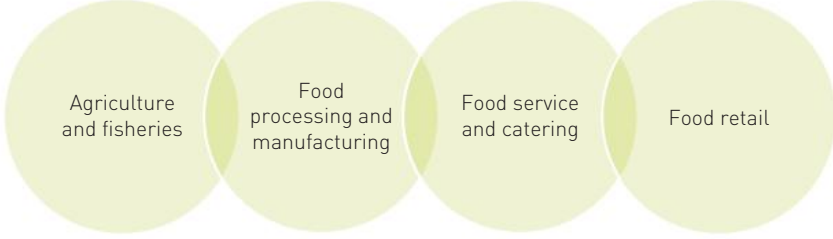


Figure 9.1 The agri-food chain

FOOD IN FOCUS 9.1

A BREAK IN THE AGRI-FOOD CHAIN

In February 2016, a salmonella outbreak was traced back to pre-packaged lettuce and salad mixes grown and sold to major supermarkets and other food industry organisations. Companies in the food processing and manufacturing sector purchased the lettuce to produce food such as Lite n' Easy meals and to make value-added products such as pre-packaged salad mixes.

The salmonella outbreak also affected the food service and catering sectors, as they had to change menus to cope with the decreased availability of lettuces and other leaf greens. The food retail sector also had less product available for consumers to purchase.

>

LETTUCE RECALL AT COLES, WOOLWORTHS: WHY WE SHOULD AVOID PRE-PACKAGED GREENS

The salmonella outbreak has spread, with Lite n' Easy warning customers not to eat its salad and 7-Eleven recalling some sandwiches.

Lite n' Easy uses the same lettuce supplier – Victorian company Tripod Farmers – linked with a salmonella outbreak that has so far infected 28 people, including at least one child.

It warned customers that the lettuce recall would affect some lunches in its menu delivered this week. It has dumped the lettuce supplier following the recall.

'While we have had no related reports of illness to date, we recommend that, if you have already consumed the lunch and have any concerns regarding your health, you should consult with your doctor or medical practitioner,' the Lite n' Easy notice reads.

There are also reports that sandwiches sold at 7-Eleven have been recalled, and that the affected lettuce was used in souvlaki and burgers made at a Victorian school canteen.

It may look clean, packaged and pristine, but prewashed bags of lettuce or vegetables can carry their own hidden danger.

While it is rare for salmonella to occur in fruit and vegetables, Lydia Buchtmann from the Australian Food Safety Information Council told news.com.au there could be three reasons behind the outbreak.

Last night the supermarket giants were forced to issue a recall over Coles 4 Leaf Mix, Woolworths salad mix, SupaSalad Supamix and Wash N Toss salad mix.

'For salad to have the bacteria, the water used during growing might've been contaminated,' she said. 'Another reason is the water in the washing process could be contaminated. There is also the possibility that someone who has handled the food could have had salmonella.'

She also said there wasn't much point in rewashing pre-packaged salads.

'Washing the salad with your own water isn't enough to get rid of the bacteria,' she said. 'Although it might get rid of some traces – it's not worth it.

'Salmonella is an unusual bacteria, as it can take 72 hours or even longer to come out through symptoms.'

The lettuce in question was grown and distributed by the Victorian company Tripod Farmers who are currently working with health authorities to determine how the outbreak occurred ...

... Food safety Australia and New Zealand spokeswoman Lorraine Haase told news.com.au a salmonella outbreak of this kind was almost unheard of in Australia, which had excellent quality assurance and distribution practices when it came to food handling.

Ms Haase said people were just as likely to get salmonella from a normal head of lettuce as they were from pre-packaged leaves.

However, she did say pre-packaged food was handled more during the package and washing process although stressed it was too early to say if this was how the infection was spread.

'This is an extremely rare occurrence,' she said, adding she hadn't heard of such a case in recent years. 'Even with the best quality controls and assurances, this can happen.'

Another food poisoning expert warned against buying prewashed or pre-cut fruit and vegetables as the more a food is handled and processed, the more it's likely to attract bacteria.

'I avoid these like the plague,' said Bill Marler, a managing partner of Marler Clark, known as the 'Food Safety Law Firm'.

'We've gotten so used to the convenience of mass-produced food – bagged salad and boxed salads and pre-cut this and pre-cut that. Convenience is great but sometimes I think it isn't worth the risk.'

Mr Marler told the Food Poisoning Journal that he buys unwashed, uncut produce in small amounts and eats it within three to four days to reduce the risk for listeria, a deadly bug that grows at refrigerator temps. Ms Buchtmann said salmonella was more common in meat, poultry to eggs, but it had occurred in fruit and vegetables in the past.

'It has been linked to melons in the past during the irrigation process, and it's often hard to tell exactly what has caused it,' she said...

Source: News.com.au, February 5, 2016

RESPOND

1. Outline the importance of Lite n' Easy and 7-Eleven recalling products.
2. Discuss the impact that the salmonella outbreak has had on the sectors of the agri-food chain.
3. Identify the three main reasons why the salmonella outbreak may have occurred.
4. Discuss why it is uncommon for salmonella to be present in fruits and vegetables.
5. Outline the benefits of purchasing only unwashed, uncut produce in small amounts that are consumed within 48 hours or being purchased.
6. Make a PMI chart to analyse the Plus/Minus/Interesting implications to the salmonella outbreak and food recall procedures.
7. Drawing on your knowledge from Chapter 4, outline the conditions for microbial growth. Investigate foods commonly associated with salmonella and quality control measures to assist in reducing contamination. Discuss the signs and symptoms of infection and treatment methods.
8. 'The more a food is handled and processed, the more it's likely to attract bacteria.' Discuss this statement and justify your answer.

Agriculture and fisheries sector

Agriculture is a term used to describe the activity of cultivating the land to grow food and includes farming both plants and animals. Fisheries refers to the production and cultivation of plants and animals in an aquatic environment. Commercial fishing is the largest component of the fisheries sector, with aquaculture gaining popularity. Aquaculture is the controlled farming of fish and shellfish such as barramundi, trout, yabbies, oysters and salmon as well as the harvesting of plant species such as bull kelp and marine algae.

A vast majority of food sold in Australia is grown and supplied by Australian farmers. As a nation, we are able to export more than half of our agricultural produce, while more than 90 per cent of the fresh fruit and vegetables, meat, milk and eggs sold in supermarkets are domestically produced. Cereals, dairy and meat are the most significant products produced in this sector of the agri-food chain.

Over the past 200 years, there have been many changes in farming methods and Australian farmers have had to adapt to different conditions. During this time, farmers have faced harsh weather conditions such as drought and flood, limited access to water, overgrazing problems, high transport costs, pests and diseases, feral animals, and long distances between farms, to the manufacturers and to the marketplace. These challenges have meant that agricultural practices have had to become more mechanised and dependent on new technologies and farming methods as the industry seeks to remain viable and become more sustainable into the future. Technological developments in the Australian food industry include irrigation systems, genetic engineering, breeding programs and sophisticated farming equipment. Approximately two-thirds of Australian land is used for agricultural purposes.

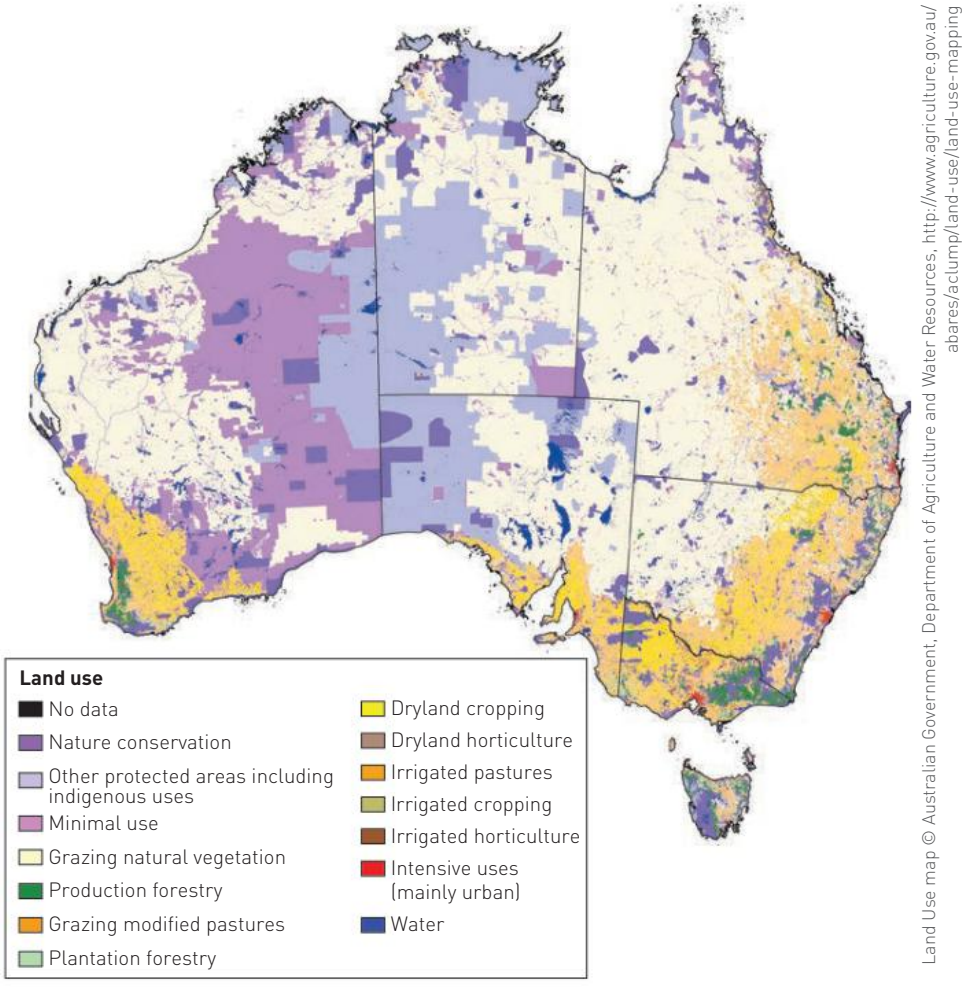
Grazing, the feeding of cattle, continues to be the highest value sector in farm production. Recent data suggests the highest value of production in order, is cattle, wheat, dairy, vegetables and fruit and nuts, followed by lamb meat and wool. At the same time, most of Australia's agricultural businesses are involved in a 'two-legged' economy – combining the growing of wheat and sheep on the same property.

DAIRY FARMING

Dairy farming in Australia is a $13 billion farming, manufacturing and export industry, with its main markets being into Asia, specifically China. It is estimated to have a farm-gate value of around $4 billion and is a vital contributor to the Australian economy while enriching the lives of those living in regional Australia. There are over 6000 dairy farmers in Australia who produce around 9.7 billion litres of milk each year. The Australian dairy industry directly employs about 40 000 Australians who work on farms and in factories. More than 100 000 Australians are indirectly employed in related service industries. Much of the processing or value adding to milk occurs close to farming areas, thereby generating economic activity in regional areas. Value-added products include milk products, butter, yoghurt, custard and cheese. A vast majority of Australian milk is exported as manufactured cheese, milk powder, evaporated milk, casein and whey powder to Asian markets.

EXPORTS AND MEAT

Australia is the world leader in exporting beef and dairy cattle, sheep and goats to many countries around the world. In 2014 Australia exported



Land Use map © Australian Government, Department of Agriculture and Water Resources, http://www.agriculture.gov.au/abares/aclump/land-use/land-use-mapping

Figure 9.2 Land use in Australia

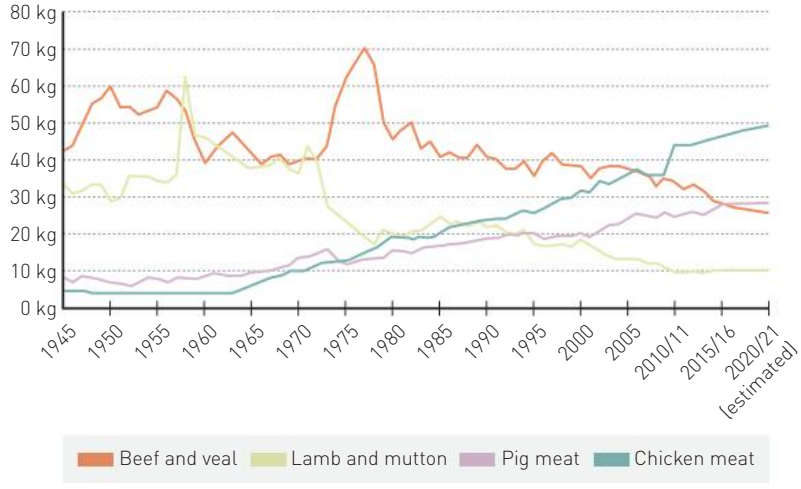


Figure 9.3 Consumption of meats in Australia

approximately 3.68 million livestock worth around A$1.475 billion. Statistics show that in 2015–16, Australians consumed about 46.2 kg of chicken meat per person, making us one of the largest consumers of chicken meat in the world!

CROP INDUSTRIES

Cropping, the growing of plants for harvest and processing, produces a wide assortment of grains, such as wheat, oats and barley, and other crops such as corn and legumes. Smaller agricultural practices, such

Figure 9.4 The stages of meat production

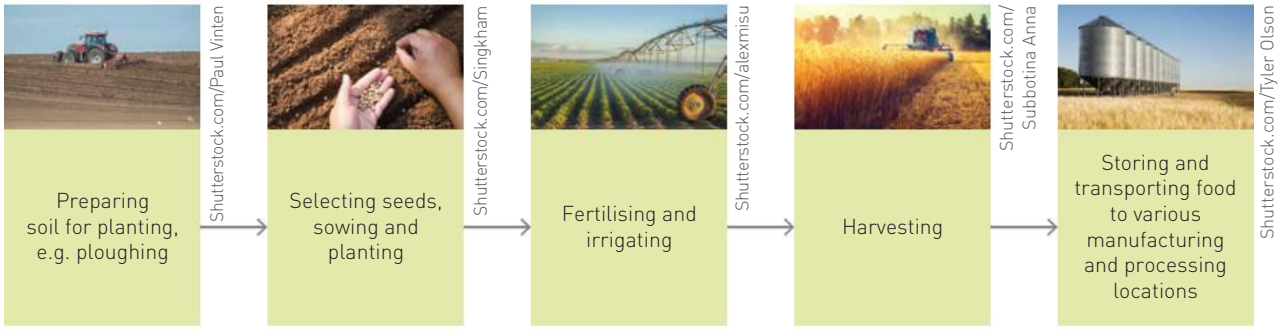


Figure 9.5 The stages of plant food production

as fruit and nut trees, grape growing, sugar cane and other crop businesses represent about half the number of the total grain, beef, cattle and sheep businesses. New producers are constantly developing in niche industries such as organic farming and native bush foods. The main cereal crops produced in Australia are canola, wheat, oats, barley, rice, maize and sorghum.

FISHING AND AQUACULTURE

Australian's consumption of fish and seafood has led to increasing production of fish and other aquatic species. Fisheries or aquaculture is the commercial growing, farming and catching of fresh and saltwater fish and seafood, and the industry is worth about $3 billion to the Australian economy. More than 600 varieties of fresh and saltwater species are grown in Australia and they are consumed locally and exported to countries such as Japan. Popular species include Atlantic salmon, prawns, albacore tuna, barramundi, blue grenadier, oysters and snapper. Wild-caught fish still account for the majority of the seafood produced in Australia, meaning the fish come from seas, rivers and other natural bodies of water. Farm-raised fish (aquaculture) are grown in tanks, irrigation ditches and ponds, and aquaculture production in Australia is a growing industry.

Figure 9.6 Commercial aquaculture and fishing

Food processing and manufacturing sector

The majority of plants and animals produced in the agriculture and fisheries sector of the Australian food industry undergo some form of 'value adding' or alteration in some way before they reach the consumer. Value adding is the processing or enhancement of a product to increase its shelf life and/or selling price. The original food product may undergo significant changes such as the pasteurisation and heat treatment of milk, snap freezing of berries, or the grinding and milling of wheat to make flour that is baked into bread.

Other value-adding steps may not be as involved and may be as simple as providing convenient pre-packaged bags of fruit or vegetables for consumers.

The food processing and manufacturing sector of the Australian food industry is the largest sector of the agri-food chain and employs many people. This sector must compete with cheaper overseas labour markets and imported goods. The cost of labour in Australia has led to an increase in highly computerised and mechanised processing systems to ensure economic viability and a safe and constant food supply. A large proportion of processing and manufacturing organisations are multinational, meaning they have operations spread across the world. More information on food processing and manufacturing in Australia can be found in Chapter 12.

Dreamstime.com/Nilsversemann

Figure 9.7 An industrial food processing plant

Food service and catering sector

Often referred to as the hospitality industry, the food service and catering sector includes all aspects of commercial food preparation, production and service. This sector of the Australian food industry is made up of commercial and non-commercial organisations.

Food service and meal catering are available in organisations such as hospitals, nursing homes, prisons and the armed services. These are referred to as non-profit or non-commercial as they are a feature of the service provided.

Commercial or profit-making ventures such as restaurants, cafes, clubs, pubs and fast-food establishments aim to make a profit from the food they sell.

Caterers prepare and cook food, while food service staff such as waiters deliver the food to patrons. Many multinational fast-food chains operate in this sector of the Australian food industry, including McDonalds, KFC and Subway.

Shutterstock.com/Jacob Lund

Figure 9.8 There are many employment opportunities in the food service and catering industries.

Food retail sector

This sector of the Australian food industry involves selling food to consumers (the marketplace). The types of organisations that sell food vary both in terms of size and the types of products they sell. Large national food retailers include Woolworths, Coles, IGA and Aldi. These supermarkets will generally stock a large and diverse range of products suited to a large demographic. Smaller retail outlets may include operations such as milk bars, convenience stores, petrol stations, fruit and vegetable stores, delicatessens, butchers and bakeries. They offer a more limited range of food items.

Shutterstock.com/TK Kurikawa

Dreamstime.com/Lucidwaters

Figure 9.9 The food retail sector includes large national companies and small independent retailers.

FOCUS QUESTIONS 9.1

REVIEW

1 Rapid growth in the food service and catering sector is due to:
   - **a** consumers not having the skills required to prepare fresh food.
   - **b** Australians leading busy lifestyles.
   - **c** an unreliable fresh food supply.
   - **d** people having surplus income to spend on takeaway food.

2 Which sector of the Australian food industry would be most affected by a drought?
   - **a** Food retail
   - **b** Agriculture and fisheries
   - **c** Food service and catering
   - **d** Food processing and manufacturing

FOR YOU TO APPLY

3 Each sector of the agri-food chain is important for providing a safe and reliable food supply for consumers. List examples of events or contributing factors of a break in the supply chain.

EXTEND YOURSELF

4 We have seen that the Australian food industry is a valuable contributor to the economy. Reseach the dollar value that each of the different comodities listed below contributes to our economy.
   - Vegetables
   - Fruits
   - Nuts
   - Cereals
   - Meat
   - Dairy
   - Seafood

Emerging technologies in food production

There are several factors that influence developments in the Australian food industry. New technologies and practices are constantly emerging in areas relating to farming practices and food production, manufacturing and processing, packaging, the environment and global competition. Consumer

Table 9.1 Recent developments in the food industry

DEVELOPMENT	SECTOR	EXAMPLE
Online shopping	Food retail	Supermarkets and other stores offering online shopping and home delivery services.
Bio-technology in genetic engineering	Agriculture and fisheries	Involves the transfer of genes with desirable characteristics into another plant or animal. This may lead to pest- and disease-resistant plants.
Organic farming	Agriculture and fisheries	Foods grown without the use of artificial fertilisers, pesticides, herbicides, antibiotics or growth hormones or regulators.
Packaging	Food processing and manufacture	Light-weight glass, smart labels, biodegradable plastics
Home delivery	Food retail and food service and catering	UberEATS, Deliveroo, foodora, Woolworths home delivery
Production of low-fat products	Food processing and manufacture	Low-fat mayonnaise, butter, milk, yoghurt and cheese
Nutritionally fortified foods	Food processing and manufacture	Bread with added iron and fibre
Pre-prepared food items	Food processing and manufacturing and food retail	Marinated kebabs and pre-packaged salads

Shutterstock.com/Rawpixel.com

Figure 9.10 Online food shopping

demand is also an import factor when considering recent developments in the industry.

Many of the recent developments in the food industry make use of new and emerging technologies. These emerging technologies each come with potential risks, such as lower yields in organic farming and decreased employment opportunities due to online shopping, and benefits that food manufacturers must take into account when considering whether to make use of them.

Biotechnology in genetically modified food

Genetic modification is the process of modifying the genetic material of plants or animals. This is done by specially trained biologists who may duplicate, remove or insert one or more new genes into a specific plant or animal in order to improve its characteristics. This level of biotechnology allows the desirable characteristics of certain plants or animals to be transferred or transplanted from one organism to another. However, genetically engineered food is controversial, as consumers are concerned about scientists interfering with nature. Genetic modification of plants and animals may be advantageous as it has the potential to increase the world's food supply and food security.

GENOMICS

Genomics is the science of gene mapping and study of genes and their functions. The technology behind this scientific process has developed rapidly over the years. Producers anticipate that genomics will

Getty Images/Pallava Bagla

Figure 9.11 The same species of eggplant; the one at the bottom has been genetically modified to be resistant to insect attack

be of significant benefit to breeding programs as it is possible to select certain breeding patterns based on gene mapping; for example, 'built-in' protection against a specific insect or plant disease or tolerance to a specific herbicide or weed killer, or to improve the nutritional composition of a crop.

TRANSGENIC ORGANISMS

Some forms of genetic modification may involve the DNA from a particular plant or animal being transferred to another plant or animal even though they may not be directly related. These are called transgenic organisms. As an example, an 'antisense' gene has been inserted into a tomato plant that stops the function of the gene that produces ethylene. Ethylene is the usual signal for ripening in tomatoes. Transgenic tomatoes that cannot produce ethylene are unable to ripen until they are exposed to external ethylene. Therefore, tomato ripening can be controlled to extend produce shelf life. It may also relate to growth hormones being injected into embryos to produce animals with lean flesh that are ready for sale or slaughter at a faster rate.

Ecologically sustainable production methods

ECOLOGICAL FARMING

Ecologically sustainable farming methods that are less harmful to the environment are increasingly popular with farmers and consumers alike. Ecological farming refers to all methods put in place to grow plants and animals. It includes the prevention of soil erosion, organic farming practices, water infiltration and retention, reduced carbon emissions, use of biofuels

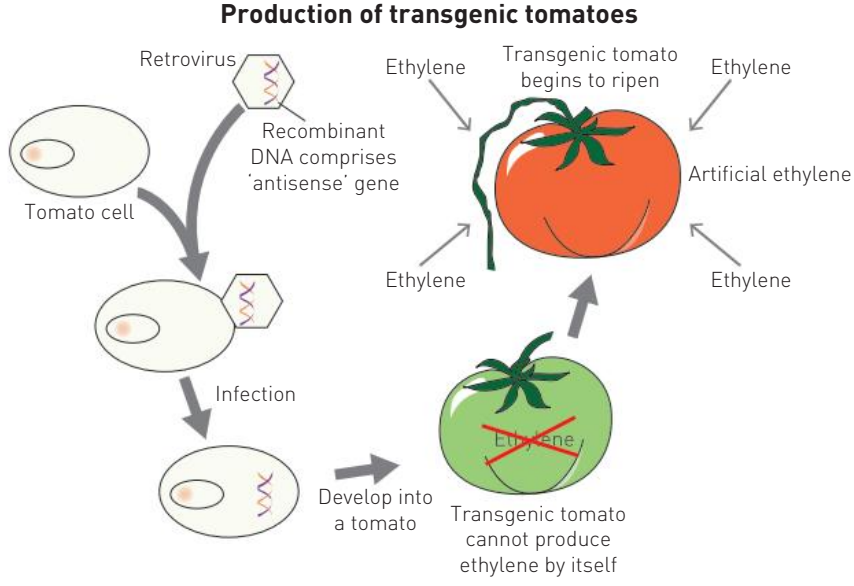


Figure 9.12 Producing transgenic tomatoes

and increased biodiversity. Farming techniques that are used include no till, multispecies cover crops, strip cropping, terrace cultivation and crop rotation.

ORGANIC FARMING

Organic farming practices produce food without the use of harmful chemicals that can damage the environment. Foods produced organically are done so in a natural way. This means that they are grown, processed and manufactured without the use of pesticides, herbicides, fertilisers or growth hormones. Crop rotation is an important feature of organic farming practices, as it give the soil the chance to rejuvenate and replenish its nutrients. During processing foods are not treated with synthetic chemicals and they cannot be genetically modified in any way. As a result, their yield may be lower and the produce more expensive.

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Figure 9.13 Organic farming practices produce food without the use of harmful chemicals that can damage the environment.

FOOD IN FOCUS 9.2

IMPROVING AUSTRALIANS' HEALTH WITH BARLEYMAX

Chronic diseases are a heavy burden on Australia's economy and wellbeing. Obesity, heart disease, stroke, type 2 diabetes and cancer are the leading causes of preventable death. Obesity alone cost Australian society and governments over $58 billion in 2008.

Australia needs practical, effective diet and lifestyle solutions that can help reduce the burden of these chronic diseases. Increased wholegrain intake has been shown to reduce the risk of certain cancers, heart disease, diabetes, stroke and even help with weight control.

CSIRO scientists have seen the potential to enhance the nutritional value of wholegrains, like barley, to help combat these health problems.

OUR RESPONSE:

BARLEYmax™: the grain that is better for you.

CSIRO has long been interested in barley as a grain with human health benefits. One particular barley grain emerged from research as having higher fibre content and enhanced nutritional benefits compared with regular barley. A program of conventional plant breeding led to the development of BARLEYmax, a high-fibre wholegrain with high levels of resistant starch.

An extensive program of experimental studies, including a number of human trials, showed that a range of foods produced with BARLEYmax as their key ingredient had a low glycemic index and also produced positive changes in a range of biomarkers of bowel health.

In a joint venture with Australian Capital Ventures Ltd, CSIRO bred the new BARLEYmax grain, then worked with food manufacturers to create products containing BARLEYmax, including breakfast cereals, food wraps, rice mixes and bread. Consumers have been able to enjoy the benefits of foods containing BARLEYmax since August 2009.

BARLEYmax is now licensed to a CSIRO spin-off company, The Healthy Grain.

THE RESULTS:

Better health for Australians, greater benefits for farmers

The potential value of improved health outcomes for Australians from widespread, regular consumption of BARLEYmax is estimated to be worth approximately $305 million per year due to its potential for lowering rates of type 2 diabetes, cardiovascular disease and colorectal cancer.

>

In addition, the total savings in health system costs from increased dietary fibre intake are forecast at up to $17 million per year. BARLEYmax also benefits grain growers, through additional earnings from guaranteed prices for barley and diversification of farm business models.

'Improving Australians' health with BARLEYmax™, CSIRO Agriculture and Food, http://www.csiro.au/en/About/Our-impact/Our-impact-in-action/Health/BARLEYmax

csiro.au

RESPOND

1. Research the nutritional qualities of barley in human health.
2. Visit the Foodwatch website and read the review of BARLEYmax by nutritionist, Catherine Saxelby. Nutritionally speaking, how does BARLEYmax max compare with the standard variety of barley?
3. Considering the information above, outline the impact that the development of this product has had on society and the economy.
4. Discuss the benefits of consuming foods that have a lower glycaemic index.
5. Conduct your own product review of a breakfast cereal containing BARLEYmax.

foodwatch.com.au

Emerging agriculture technologies

There are four key areas of emerging technologies relating to agricultural and food production.

1 SENSORS

Sensors help agriculture by enabling real-time traceability and diagnostics of crop, livestock and farm machinery.

Table 9.2 Sensors

Air and soil sensors	Important additions to the automated farm, these sensors allow for real-time understanding of current farm, forest or body of water conditions.
Livestock biometrics	Collars with GPS, RFID (Radio Frequency Identification) and biometrics (a form of identification control) have the capacity to automatically identify livestock and relay vital information about them in real time.
Crop sensors	Instead of prescribing fertilisation before application, high-resolution crop sensors inform application equipment of correct amounts needed. Optical sensors or drones are able to identify crop health across the field (for example, by using infra-red light).

2 FOODS

The availability of certain foods may be increased from genetic modification and even producing meat directly in a lab.

Table 9.3 Technological foods

Genetically designed food	The formation of completely new strains of food derived from plants and animals in order to better address biological and physiological needs. A departure from genetically modified food, genetically designed food would be engineered from the ground up.
In-vitro meat	Also known as cultured meat or 'tubesteak', this is a flesh product that has never been part of a complete, living animal. Several experimental research projects are currently growing in-vitro meat. No product has been produced in Australia for public sale or consumption.

3 AUTOMATION

Automation will help agriculture using large-scale robots and micro-robots to observe and maintain crops at the plant level.

Table 9.4 Automation

Agricultural robots	Also referred to as 'agbots', these are used to automate agricultural processes, such as harvesting, fruit picking, ploughing, soil maintenance, weeding, planting, irrigation, etc.
Precision agriculture	Farming management based on observing (and responding to) intra-field variations. With satellite imagery and advanced sensors, farmers can optimise returns on inputs while preserving resources at ever larger scales. Further understanding of crop variability, geolocated weather data and precise sensors should allow improved automated decision-making and complementary planting techniques.

4 ENGINEERING

Engineering involves technologies that extend the reach of agriculture to new means, new places and new areas of the economy. Of particular interest will be synthetic biology, which allows for efficient reprogramming of unicellular life to make fuels and by-products accessible from organic chemistry to smart devices.

Table 9.5 Engineering

Vertical farming	A natural extension of urban agriculture, vertical farms would cultivate plant or animal life within dedicated or mixed-use skyscrapers in urban settings. Using techniques similar to glass houses, vertical farms augment natural light using energy-efficient lighting. The advantages are numerous, including year-round crop production, protection from weather, support of urban food autonomy and reduced transport costs. See pages 13–14 in Chapter 1 for an example.
Closed ecological systems	Ecosystems that do not rely on matter exchange outside the system. Such closed ecosystems would theoretically transform waste products into oxygen, food and water in order to support life-forms inhabiting the system. Such systems already exist at smaller scales, but existing technological limitations prevent them from scaling up.

FOCUS QUESTIONS 9.2

REVIEW

1 Crops that have been genetically modified for human consumption are an example of the use of what recent technological development?
   - **A** Nutritionally modified foods
   - **B** Biotechnology
   - **C** Nanotechnology
   - **D** Organic farming

2 Discuss the meaning of the term 'ecologically sustainable food production'.

3 Explain how organic food is produced. Outline the advantages and disadvantages for farmers and consumers.

FOR YOU TO APPLY

4 Research a home delivery food company such as UberEATS, foodora or Deliveroo. Justify the introduction into society of these food delivery companies.

EXTEND YOURSELF

5 'Genetically modified crops are important to feed our nation.' Discuss this topic in relation to genetically modified crops in food production.

Chapter review

REVIEW

1 Identify a career opportunity in each sector of the Australian food industry.
2 What is the food processing and manufacturing industry also known as?
3 Explain how crops are grown and list the popular crops grown in Australia.
4 Define the term aquaculture and identify some of the popular fish species produced in Australia.
5 What is the difference between and commercial and non-commercial business in the food service and catering sector? Provide examples of these types of businesses.

FOR YOU TO APPLY

6 Work with a partner to conduct a sensory analysis and evaluation of organic and non-organic foods. Mark two plates as either 'A' or 'B'. Your partner should decide which plate is organic and which is non-organic without you knowing. Taste a food item on plate A and record your opinions and comments on its texture, flavour and taste. Have a drink of water and taste the same food item on plate B. Decide which food sample you prefer. Repeat the process with the rest of the food. Once you have completed the taste test, your partner can reveal which food was which and you can swap places. Once you have both taken the taste test, discuss the following questions:
   a Did the organic foods taste better?
   b Are they worth the extra expense?
   c Why is taste testing a useful tool in developing new food products?

EXTEND YOURSELF

7 Select a sector of the agri-food chain and investigate one recent development that has occurred in that sector. Make a PowerPoint presentation or brochure to share with the rest of your class. Use the following points to help with your research:
   - Identify the sector you are investigating.
   - Name the recent development that has occurred.
   - Why has this development transpired?
   - What impact will this development have on the other sectors of the Australian food industry?
   - Outline the impact this development may have on individuals, society, the economy and the environment.
8 Discuss the potential risks and benefits of your emerging technology as a class. Do the benefits outweigh the risks?

CHAPTER 10

Aspects of the Australian food industry

The successful operation of organisations with in the Australian food industry varies depending on a number of factors, as do the activities carried out by these businesses.

The level of operation, research and development, quality assurance procedures, consumer influences, career opportunities and working conditions along with the impact an organisation has on the environment, the economy and society, all influence the running of organisations and vary from sector to sector.

The size of a business may also affect its ability to influence government policies and legislations that regulate the food industry. Larger business will tend to have greater input and influence over decision-making processes. It is in the best interest of all organisations, regardless of size, to be members of organisations that can offer support and help relay their views to the government and to consumers. Advisory groups play an important role in guiding the government when developing legislation, to facilitate the smooth running of all aspects of the Australian food industry.

CHAPTER OUTCOMES

In this chapter you will learn about:

Organisations within the Australian food industry, particularly:

- levels of operation and mechanisation
- research and development
- quality assurance
- consumer influences
- impact on the environment, economy and society
- career opportunities and working conditions.

KEY TERMS

automated
Food Standards Australia New Zealand (FSANZ)
Hazard Analysis Critical Control Points (HACCP)
landfill
levels of operation
niche market
non-renewable resources
organic farming
quality assurance
research and development (R&D)
sustainability

iStock Photo/snvv

Levels of operation and mechanisation

The 'level of operation' of an organisation refers to a measure of food production, as well as the extent and complexity of the technology used. In general terms, the level of technology (automation, computerisation and mechanisation) used by an organisation will increase in sophistication as the size of the business increases.

Household

At this level, food production is very simple and the quantities are small. An example might be making cakes or biscuits to sell at a street stall, fete or farmers' market. Households make limited use of tools and equipment and these are generally small, domestic items such as hand beaters, mixing bowls and measuring spoons.

iStock.com/RBOZUK

Figure 10.1 Household food production

Small business

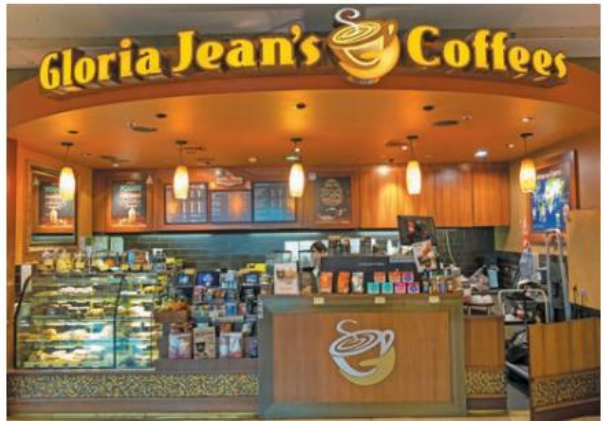
Food prepared and sold by small business is commonly produced on a small scale. Examples include bakeries, butcher shops and cafés. These businesses employ less than 20 staff (as defined by the Australian Bureau of Statistics) and may be family run or operate as a partnership. The equipment in small businesses is not usually industrial, but may be semi-automated such as bread slicers or sausage mincing machinery.

Shutterstock.com/FiledIMAGE

Figure 10.2 A small food business

Large company

A large company or business (generally, more than 50 employees) may operate multiple stores or processing plants across a state or country. The quantity of food manufactured or sold is on a large scale. The majority of the duties carried out by these organisations are processes that involve automated equipment and machinery, which requires less manual labour. An example is nudie, which produces premium beverage products on a large scale that are distributed to retail outlets such as Coles and Woolworths across Australia.



Alamy Stock Photo/RosalreneBetancourt 5

Figure 10.3 Gloria Jean's Coffees have stores throughout Australia

Multinational

Multinational food organisations operate in several countries or all over the world. These organisations use sophisticated technologies and are highly productive. In general terms, the larger an organisation or

operation, the more people the business will employ. As the production volume increases, so too does the sophistication of equipment and the level of automation. The computerised and automated machinery and equipment decreases the need for human labour.

Examples of multinational organisations that operate and produce food products in Australia include Unilever, Simplot, Nestlé, Fonterra, Heinz, Coca-Cola, Kraft, Arnott's, Cadbury Schweppes and Kellogg's. During the 1990s many large companies were bought out and taken over by multinationals, which led to ownership of food business becoming more concentrated. Now, 85 per cent of our food products are made by foreign-owned companies. Large, high-profile multinational companies have many advantages due to economies of scale.

A decrease in human labour can ensure that procedures, such as filing cans, bottles and glass jars to a specified weight, are consistent and carried out with maximum efficiency and safety. Despite the operation having many streamlined processes in place, there is also a greater risk of problems developing that could have significant repercussions for the business. Problems such as metal or plastic fragments contaminating products or pieces of broken glass from packaging material, could easily fall into the manufactured goods during processing. To help avoid these potential risks to public health, special quality management systems (such as HACCP, discussed on page 178) and quality control machinery (x-ray machines and metal detectors) have been developed to help identify such problems and allow the organisation to rectify situations before the food product reaches the consumer. Machinery breakdowns can also be an issue, causing the production line to stop until the problem is fixed. A halt in production is very costly for the organisation as they not only have to pay for the machinery to be repaired, but more importantly they lose valuable time and money while they are unable to continue to produce their goods.

The capacity and size of commercial equipment means processing and manufacturing organisations can produce large quantities food (production runs), and they can operate 24 hours a day, seven days a week (continuous production). Sourcing and storage of raw materials and ingredients is not a problem as multinational organisations have access to global suppliers and plenty of space and equipment to store raw materials.

Figure 10.4 The 10 largest food and drink brand owners in Australia.

Research and development in the Australian food industry

Consumer demand for new, healthy, convenient and safe food products is rising and, in particular, market growth in the Asian region is booming.

Research and development (R&D) is the process used to create new food products, improve existing products and explore the market in which food organisations operate. R&D is costly for businesses, yet necessary, as competition in the food industry is fierce. In Australia, the marketplace is constantly changing and expanding and the wants and needs of consumer groups are diverse. Food manufacturers are constantly trying to create new and/or improved products to increase their market share. Any increase in market share may lead to greater profits for the company and increased popularity with consumers.

As R&D is important to stay competitive, organisations spend large amounts of money and time on it. Organisations dedicate entire teams and departments to ensure the continuing success of food products to satisfy consumer demand. At all levels of operation in the Australian food industry, R&D is necessary to remain up to date and competitive with the rest of the world.

Government organisations that assist the Australian food industry with R&D include the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Australia's Rural Research and Development Corporations (RDC). RDCs are a conglomerate between the Australian government and different food-related industries generated to share the funding and strategic direction for primary industry research and development. RDCs are the main way the Australian government and primary producers co-invest in R&D for the food industry. Investment in innovation is essential for ongoing growth and prosperity in the Australian food industry, which will help maintain its productivity, profitability, competitiveness and long-term sustainability.

CSIRO research relates to all sectors of the food industry. Their diverse food and farming research varies from studying the makeup of plant crops and animals to the methods and food-processing systems used to produce more safe and healthy, sustainable food for Australians.

The benefits of R&D within the Australian food industry include:

- the ability to respond to changing markets and consumer demands
- developing new technologies to assist in growing, processing and manufacturing food products
- improved profitability within all sectors of the Australian food industry
- increased export opportunities
- gaining a competitive edge in the global market
- ensuring a safer, more consistent and more nutritious food supply.

As a result of an increasing global population, Australia has the potential to be able to supply a great variety of high-quality food.

CSIRO

Table 10.1 CSIRO research areas

RESEARCH
Animal science
Working with livestock farmers and allied industries to improve productivity, profitability and sustainability through improved livestock breeds and agricultural management practices while also developing premium feed for animals, improving gene technologies and protecting animals from harmful pests and disease that could threaten the industry.
Aquaculture
Research in aquaculture aims to boost the value, competitiveness and sustainability of Australia's aquaculture industry. Research is undertaken to improve quality and is focused on farmed finfish, crustaceans and molluscs. The research aims to improve food production from aquaculture species through combined studies of genetics, physiology, health, aquafeeds, environments and food science.

Table 10.1 *(Continued)*

RESEARCH
Plant science
Assisting cropping farmers to clothe and feed Australia in the international market in a more sustainable manner while ensuring a profitable return. To do this, the CSIRO helps to enhance plant breeds and improve management practices of scarce resources such as water, while considering ways to manage threatening pests and diseases. Sugar cane is a major export crop for Australia and is grown from New South Wales to far north Queensland. Through research, the CSIRO aims to develop new methods to produce sugar cane varieties with higher yields, resulting in improved profitability and sustainability of the Australian sugar industry.
Sustainable farm management
The CSIRO has assisted in developing new tools and equipment to better manage farming practices. This leads to increased profitability and productivity and a reduction in natural resource use that in turn preserves ecosystem health.
Digital agriculture
'Digital agriculture' includes developing, testing and deploying information and communication technologies for agricultural research, development and delivery. The CSIRO wants to help farmers, agribusiness, policy-makers and researchers improve decision making by using digital innovation. In the future, agriculture will be digitally integrated at all stages of production, from understanding genetics to transport logistics.
Nutrition and health
Partnering with Australia's food, health and wellness industries, the CSIRO is involved in developing innovative ways to ensure health and economic benefits for all Australians. An example of this work is the *CSIRO Total Wellbeing Diet* books and online community.
Bio-based products
The CSIRO is developing new bio-based or bioproducts – energy, chemicals or other materials made from renewable biological resources. The development of new bio-based technologies will support the move of the Australian industrial economy to a more sustainable resource base for foods and industry. The CSIRO are developing novel seed, leaf and algal-based materials for more rigorous and effective manufacture of plant oils for both industrial and nutritional uses.
Food science
• The expertise of CSIRO scientists assists the Australian food industry to be competitive by ensuring that food products for consumers are safe, sustainable and taste great. • Research into food-borne bacteria, fungi and chemicals is conducted to ensure Australians can be confident that foods purchased are safe to eat. • Research is conducted into how the quality, structure and makeup of food may be affected when food is processed. The work carried out helps the food industry develop an innovative and healthier food supply.
Producing healthier, safer and more sustainable food
Working with industry, the CSIRO aim to develop a range of methods and technology to assist food processing and manufacturing to be more sustainable. Water recycling research aims to reduce the reliance on drinking water by food manufacturing and processing plants while addressing concerns about the use of recycled water.

Government organisations such as Food Standards Australia New Zealand (FSANZ) also conduct consumer and industry research. Research was conducted by FSANZ in order to evaluate the best options for nutrition content claims on food labels. Research was also undertaken relating to consumers' understanding of percentage daily intake values (%DI) listed in the nutrition information panel, and on 'no added sugar' claims on packaging.

FOCUS QUESTIONS 10.1

REVIEW

1 Copy and complete the table below by filling in the description and features of the different levels of operation.

LEVEL	CHARACTERISTICS AND DESCRIPTION	FEATURES
Household		
Small business		
Large business		
Multinational		

FOR YOU TO APPLY

2 Explain why research and development are an important part of the success of the Australian food industry.

EXTEND YOURSELF

3 Choose an organisation that operates in the Australian food industry and identify the sector or sectors to which it belongs. Outline the level of operation and what the organisation is responsible for.

FOOD IN FOCUS 10.1

PRECISION LIVESTOCK MANAGEMENT – LOCATING CATTLE AND MEASURING BODY CONDITION

LOCATING CATTLE WITH UNMANNED AERIAL VEHICLES

The CSIRO is working towards developing, testing and demonstrating the latest thermal remote sensing technology on an unmanned aerial vehicle (UAV). This will be able to identify the location of livestock in extensive rangelands. By using UAVs, livestock can be located across broad areas which will assist farmers to become more efficient by reducing the cost of mustering, which is often done by helicopter.

THE CHALLENGE

Locating cattle can be costly and dangerous.

The gross value of Australian cattle and calf production was estimated at $9 billion for 2013. The state of Queensland has Australia's largest beef cattle herd and is the nation's largest producer and exporter of beef.

The cost of mustering alone can be high (estimated to be average around $5–6/head per year for two musterings) and includes machinery, fuel, labour and maintenance costs. It can also have serious safety risks. In remote areas, some animals are not mustered due to their location being unknown or too difficult to access.

OUR RESPONSE

UAVs provide new opportunities.

We are currently leading research and development of applications for a range of precision livestock technologies. The use of UAVs as a platform for remote sensing applications is becoming a feasible option to add to this suite of technology solutions.

The first phase of the project was run at the Lansdown Research Station near Townsville and brought together the latest remote sensing technology and domain know-how.

CSIRO Agriculture and Food

Figure 10.5 Livestock management aided by thermal imaging drone.

We have been able to evaluate the latest thermal imaging on a UAV platform as well as cutting-edge data processing techniques and bring them together with knowledge on how they might be applied in livestock management.

THE RESULTS

Promising initial tests of thermal imaging.

A team of researchers has tested a thermal imaging instrument on a UAV platform to see how accurately they can identify the location of livestock in rangeland conditions.

The FLIR Tau 2 thermal camera is capable of 640 × 512 pixel resolution at 30 frames per second and is sensitive to the 7.5-13.5 µm spectral band. The team used an Eagle quad-rotor helicopter UAV platform, with in-house automation software providing mission control.

The imagery was processed to create a panoramic composite image of the entire flight area, and targets were then identified and compared to actual GPS location of the cattle.

Different test flights were undertaken to compare different landscapes (grasslands vs treed) and pre- and post- dawn to look at the effect of interference from direct solar infra-red reflections, as well as changing temperature differentials between living animals and the background.

A reliable and cost-effective system is required to detect animals across broad areas of differing landscapes. That way, mustering can be better planned to optimise how resources are organised and cattle are gathered.

The next step is a larger-scale assessment capturing more variation in environment, vegetation and cattle type, as well as testing the range of technology settings and different flight conditions such as altitude.

'Locating cattle with unmanned aerial vehicles', CSIRO Agriculture and Food, http://www.csiro.au/en/Research/AF/Areas/Animal-Science/Precision-livestock-management/Locating-cattle

RESPOND

1. Explain how UAVs operate and what they are useful for.
2. Why are UAVs an important tool for farmers in rural and remote areas?
3. Develop a PMI chart for the use of UAVs in the agricultural sector of the Australian food industry.

Quality assurance

Quality assurance is the responsibility of everyone involved in producing and manufacturing food products and it requires many diverse analytical skills. Quality assurance is best described as a process of ensuring that certain standards relating to the quality of the product are met at all stages of the production or manufacturing process. In the food industry, quality assurance is needed to ensure consistency in products, which leads to consumer satisfaction and a positive company image.

Quality assurance personnel continually monitor incoming raw materials and products to ensure they comply with set quality standards such as microbiological standards and physical standards like correct shape and size. Quality assurance staff can stop production, refuse acceptance of raw materials, or halt the delivery of products if specifications for a certain item or process are not met, as discussed in Chapter 12. For an organisation to set a standard for a finished product, a prototype or benchmark product is often created to which all other products of the same type are compared. This allows the organisation to ensure that food produce is optimal.

To guarantee the high standards are met, Quality Management Standards (QMT) such as Hazard Analysis Critical Control Point (HACCP) are implemented. HACCP is all about risk management. The aim of HACCP is to detect potential problem areas in the food production process that could affect product safety, and identify ways to control or minimise these hazards and associated risks. The systematic technique or process is designed to follow the steps in Figure 10.6.

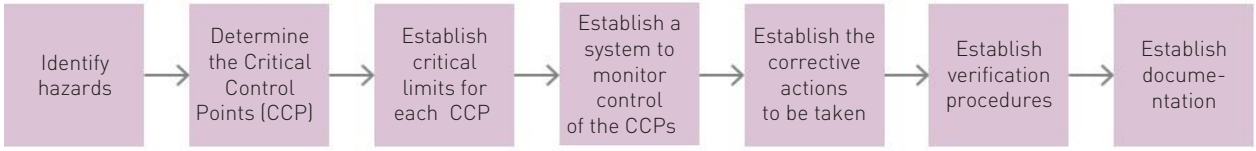


Figure 10.6 The seven steps of HACCP

Hazards in the food industry may be biological, chemical, or physical. Each hazard has the potential to impact on the safety of the product and could negatively affect the health of consumers.

Table 10.2 Potential hazards

HAZARD	EXAMPLE
Biological	Microbiological – bacteria, yeasts, moulds, viruses, microscopic parasites or algae. Pathogens common to all foods that originate in the gut of mammals and are carried on food and by people and animals.
Chemical	Mycotoxins (e.g. aflatoxins – toxins produced by fungi found on some agricultural crops), agricultural sprays, heavy metals
Physical	Glass, wood, stones, sticks, insects, plastic, metal

One of the main reasons to implement a documented food safety system is to demonstrate to consumers that a business is committed to delivering a safe supply of quality food at all times. Major food processing and manufacturing organisations, along with supermarket chains, are now using quality assurance methods such as HACCP as a promotional tool to attract the attention and ultimately the money of consumers.

As this is also a legal requirement linked to legislation for the production of some food products, another reason to use such systems is to avoid litigation. If a business supplies food that turns out to have been contaminated during production or processing, the business involved may be liable for prosecution.

In Australia, consumers are supported by organisations such as New South Wales Fair Trading, which aim to help consumers make informed choices and decisions relating to purchasing goods and services and understand their rights should they need to make a consumer complaint. Many Australian food-processing organisations offer a money-back guarantee and have complaint policies in place to deal with any quality issues. Food Standards Australia New Zealand (FSANZ) also provide current information about food recalls.

Australia's leading consumer advocacy group, CHOICE, fights to ensure consumers have the correct and current information about products, so that companies can't get away with dishonest claims.

A typical quality assurance department may have a chemistry and/or microbiology laboratory, along with a raw materials inspection laboratory and a place to conduct sensory analysis and evaluate food products. These investigations assure consumers that the food we eat is of the highest quality and safe to consume. After all, it is quality that will bring a customer back again and again.

Table 10.3 Major features of a quality assurance department

FEATURE	EXAMPLES
Compliance with specifications	Legal requirements, industry standards, internal company standards, shelf life tests, customers' specifications.
Test procedures	Testing of raw materials and finished products, and in-process tests.
Sampling schedules	Use a sampling schedule to maximise the probability of detection while minimising workload.
Records and reporting	Maintain all QA records so that customer complaints and legal problems can be followed up.
Troubleshooting	Solve various problems caused by poor quality raw materials, erratic supplies and malfunctioning process equipment, and investigate reasons for poor quality product to avoid repetition.
Special problems	Deal with customer complaints and production problems, ensure personnel training and so on.

Consumer influences on food industry organisations

The wants and needs of Australian consumers and available export opportunities are ultimately what drive the Australian food industry. Because of Australia's constantly changing demographics and the geographical locations of Australians, there is an increasing demand for different types of foods to be produced. To stay competitive, the food industry must ensure they meet consumer demand through the products they produce, as discussed in Chapter 16.

Growth in demand for healthy foods, organic foods, wholefoods and biodegradable packaging are just some of the trends and reasons consumer influence impacts the food industry. R&D teams work together to develop and create new food products to cater to the ever-changing purchasing and consumption patterns across the nation.

Customers may be inclined to pay more for safer food with a longer shelf life or for food that is certified organic or bio-dynamic. Consumers are becoming increasingly aware and informed about the nutritional value of the food they consume and want 'functional foods' that have increased nutritional value and provide additional health benefit to individuals beyond that of the basic nutrients. Improved taste, texture, freshness and visual appeal are all qualities consumers are looking for in the foods they purchase.

With Australians leading busy lives, people are increasingly consuming foods outside the home and buying foods that have been partially prepared. Our multicultural society has led to an increase in consumers' willingness to try different cuisines, resulting in an increase in the range of culturally diverse foods available.

Where people live will also influence the food they purchase and consume. For people in cities, access to food for people is rarely a problem with major supermarket chains and many specialty food shops within easy reach. Prices in larger towns and cities are generally competitive as there is usually more than one supermarket or fresh food market in the same vicinity, which helps to keep prices reasonable for consumers.

People living in remote or rural areas may have greater difficulty accessing fresh food at reasonable prices. The range of products available may be more limited and the nearest shops could be many kilometres away – in some cases, even hundreds of kilometres away. Families may shop on a monthly basis and require large freezers to store fresh produce.

Our ageing population and smaller family sizes have also had an influence on the types of foods produced. Smaller serving sizes, easy to open packets, single portion serves and 'meals for one' are all examples of items produced to respond to consumer demand.

Table 10.4 Responding to consumer demands

THE TREND	DEMAND ON INDUSTRY	EXAMPLE OF PRODUCT
Development of healthier foods	Individuals are gaining a better understanding of diet-related health issues such as heart disease, type 2 diabetes and hypertension. This has led to an increase in production and availability of nutritionally modified products being promoted as healthy.	Low- and reduced-fat products – yoghurt and milk High-fibre products such as breads Reduced-salt products Alamy Stock Photo/ studiomode

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Table 10.4 *(Continued)*

THE TREND	DEMAND ON INDUSTRY	EXAMPLE OF PRODUCT
Development of functional foods	Functional foods provide additional health benefit to individuals beyond that of basic nutrition. Food products which have a positive impact on our health are constantly being created by the food industry.	Omega-3 in foods like eggs to improve brain health and function Probiotic yoghurts for improved gut health and digestion Shutterstock.com/ morisfoto
Production of superfoods	There is no clear definition of the word 'superfood'; however, they may be defined as a food item that has a high concentration of nutrients. They may be rich in phytochemicals and antioxidants and their consumption may be promoted in magazines and on social media.	Chia and chia pods, kale and kale chips, acai berries, ancient grains, quinoa Shutterstock.com/ Valentina Razumova
Consumers' busier lifestyles	Foods that are already prepared or that are quick and easy to prepare at the end of a busy day.	Pre-prepared salad or vegetable packs, cut and ready to stir-fry or sold in microwavable steaming bags Frozen meals such as Lean Cuisine Ready-made, heat and eat meals such as lasagnes, pies, and soups. Mark Fergus
Demand for healthier snack foods	Consumer demand for healthy snack foods to eat between meals is increasing. The 'school lunch box' category is also expanding at a rapid rate.	Dip and crackers together in a sealed container Small boxes of dried fruit and nuts Protein bars and muesli bars Dreamstime.com/ Felinda
Demand for 'on-the-go' foods	Consumers are increasingly eating breakfast outside the home. Food companies are meeting consumer demands by producing breakfast foods to consume 'on the go'. These products involve no preparation and are easy to take to school or to work.	Up and go 'liquid breakfasts' Mark Fergus

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Table 10.4 *(Continued)*

THE TREND	DEMAND ON INDUSTRY	EXAMPLE OF PRODUCT
Single-parent families and those living in a tight budget who want value for money	The demand for low-cost nutritious foods has increased.	Generic food brands such as home-brand and black and gold. Fairfax Syndication/The Age/Craig Sillitoe
Demand for functional or nutritionally modified products	'Free from' (lactose, gluten) products are readily available in major supermarkets. These types of products were once only available at specialty health food stores and were expensive. At first, these products were generally purchased by consumers with specific allergies or intolerances in food. But with the increase in awareness and interest in health this sector has grown rapidly in the past five years.	Gluten free, lactose free, yeast free, refined sugar free Pangkarra Pty Ltd
Environmental & ethical concerns and a connection to the land	With concerns for the environment and long-term sustainability, consumers want to be informed about where their food is from and how it has been grown and processed. 'Country-of-origin' labelling has been introduced to help customers make informed choices. Consumers are also concerned about 'food miles' – how far food has travelled and the impact this has on the environment. Animal welfare is also an important factor – the increased popularity of free rage and grass or pasture-fed animals is another trend.	Grass-fed beef Free-range chickens Cage-free eggs Dreamstime.com/ Carbonbrain
Demand for organic foods	Over the past 10 years, consumer demand for food products free from synthetic sprays, chemicals and growth regulators, as well as concerns for the environment, has led to a dramatic increase in the amount of organic food products available in the major supermarket chains.	Organic fruits and vegetables, organic dairy products, organic juices and organic meat and poultry Shutterstock.com/ ValeStock
Environmental concerns relating to over packaging	Customers are interested in reducing and recycling food packaging. Buying in bulk is another way they reduce packaging.	Bulk buying Shutterstock.com/AwayIGl

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Table 10.4 *(Continued)*

THE TREND	DEMAND ON INDUSTRY	EXAMPLE OF PRODUCT
Meal replacement	Calorie and portion-controlled food that is quick and easy to prepare and eat for the consumer.	Protein bars, diet shakes and soups Getty Images/ Thomas_EyeDesign
All-in-one appliances	Advances in technologies relating to domestic and home appliances.	Home espresso or coffee pod machines, the thermomix Shutterstock.com /Kitch Bain

PRACTICAL APPLICATION 10.1

COMPARING CURRY PASTES

AIM

To conduct an evaluation and sensory analysis of a commercially prepared curry paste compared with one made using household equipment and appliances.

INGREDIENTS

½ teaspoon cumin seeds
1 teaspoon coriander seeds
¼ teaspoon black peppercorns
¼ teaspoon salt
4 large dried chillies, soaked in warm water for 25 minutes, then finely chopped
½ teaspoon grated fresh ginger
1 stalk lemongrass, white part only, finely chopped
3 coriander roots, washed, finely chopped
1 shallot, finely chopped
2 cloves garlic, crushed
1 teaspoon shrimp paste
4 red bird's eye chillies, seeded
A jar of commercially manufactured curry paste (ensure the purchased product has a suggested recipe on the packaging)

METHOD

1 Place cumin, coriander and peppercorns in a small frying pan and dry roast over medium heat for 2 minutes or until fragrant.
2 Remove from heat and cool to room temperature.
3 Using a mortar and pestle, grind the roasted spices until a fine powder forms.
4 Add the remaining ingredients and continue to pound until they form a smooth paste. Ensure that the paste is as smooth as possible. You can share this task among the class.
   a Half of the class are to prepare the recipe as per the label on the purchased product.
   b The other half of the class are to make the same recipe substituting the purchased curry paste with the home-made paste.

This will provide you with two versions of the same recipe with which to conduct an evaluation and comparison.

RESPOND

1 Compare the texture and consistency of each of the curry pastes.
2 Identify the positive and negative aspects relating to the production of each of the curry pastes.
3 Compare the level of operation and mechanisation used to create each type of curry paste.
4 Complete a sensory evaluation of the two dishes and write a critical review of each dish.

FOCUS QUESTIONS 10.2

REVIEW

1 Outline the seven principles of HACCP.
2 Why is it important to identify Critical Control Points?
3 How has the changing nature of Australian society resulted in the demand for new food products?

FOR YOU TO APPLY

4 Discuss the statement 'Quality control of food products from paddock to plate is important to ensure a safe and reliable food supply'. Justify your answer and provide examples.

EXTEND YOURSELF

5 Conduct a product evaluation of four current food trends that have recently appeared in the marketplace. Discuss their characteristics and why they are 'on trend'.

PMI Chart

Impact of the food industry on the environment

Environmentally sustainable production and processing methods are of great importance and concern for growers, food manufacturers and food retailers in the Australian food industry. As our food moves through the agri-food chain, it affects the environment. The processing or production of any food item, irrespective of the type, uses energy and water that contributes to the carbon emissions released into the atmosphere. The majority of food purchased by consumers is also packaged and must be transported and distributed from the producer to the point of sale. Another challenging environmental issue is food waste, which is created at nearly every point along the agri-food chain. In response to these environmental issues, farmers, food manufacturers and processors, the food service and catering sector and food retailers all look for strategies to minimise the environmental impact of the Australian food industry, to ensure the long-term sustainability of food supply and the environment.

Traditional farming methods

Traditional farming methods use chemical products such as insecticides, pesticides and herbicides to control weeds, pests and diseases. Growth hormones and fertilisers are used to help control and facilitate the growth of crops and animals. Over time, severe damage can be done to the land and surrounding environment, rendering it unsuitable for further use. Industrialised agricultural methods of food production (those that rely substantially upon machinery and large-scale chemical use) have contributed to land degradation, climate change, water scarcity or pollution and a lack of nutrients in the soil. Across the entire food industry, natural resources are used, greenhouse gases are emitted and a large amount of food is wasted.

Australia is a significant producer of greenhouse gases. In a report from the Public Health Association of Australia – Food System and Environmental Impact document, it is estimated that Australians produce more emissions per capita than any other country in the developed world. Recent studies suggest agriculture is responsible for approximately 15.2 per cent of Australia's total greenhouse gas (GHG) emissions, 65.1 per cent of which are attributable to methane emissions from livestock. Nitrous oxide emissions from fertiliser used on agricultural soils are the second largest contributor, contributing 17.8 per cent of total GHG emissions from agriculture. Other estimates suggest that the agricultural sector (when emissions from energy, transport and waste are included) produces 23 per cent of national GHG emissions.

The Australian food industry is heavily dependent on fossil fuels for its existence. Large amounts of oil are required to power farm equipment and to produce artificial fertilisers. Petrol is also used in trucks to transport food to supermarkets. In addition, cities in Australia are expanding and competition for land between primary producers and developers is extensive. It has been estimated that in the last 70 years, over a million hectares of rural land has given way to urban sprawl.

Land clearing resulting from the expansion of agricultural businesses and larger farming practices

has contributed to a considerable loss of native vegetation, while cattle grazing is a major burden on biodiversity. Chemicals such as pesticides and fertilisers used in intensive agriculture are polluting the marine environment, and aquaculture is disrupting marine ecosystems, through contaminating and polluting water systems. This also has a negative impact on marine biodiversity and many species have been overfished.

As a result of the damage done, it is estimated that over half of Australia's farmland requires some form of intervention, such as chemical use or crop rotation, to treat infertility, salinity and acidification of the soil along with methods of repairing soil and waterways suffering damage from erosion. Run-off from chemicals such as pesticides may be present in waterways, poisoning aquatic wildlife and plants because of algal blooms.

However, industrial agriculture is important and without it a large proportion our food supply would not exist.

Organic farming methods

Organic farming practices are an alternative to industrial farming. This production method has increased in popularity among farmers and consumers alike over the past 10 years and is rapidly becoming an important player in the global agricultural production market.

In the Australian Organic Market Report released in 2012, the total farm-gate value of the organic industry in Australia was estimated to be $300.6 million with a total farm turnover of $432.2 million.

It is estimated that the annual growth of the organic food industry is approximately 20 per cent per year. No longer just a niche market, the organic industry is moving towards mainstream agriculture. The New South Wales Department of Primary Industries fully supports the growth of organic producers with ongoing advice and support.

The organic industry in New South Wales has over 1000 accredited producers, and a farm-gate value of over $108 million. Popular organic products are fruit, vegetables, dairy, wheat and other cereals, soybeans, rice, wool, lamb, beef, wine and herbs. In order to be certified as 'organic', specific requirements must be met.

'Conversion' to organic farming methods refers to the physical and biological processes the farmer and the farming system must undergo to comply with organic standards. 'Certification' refers to a formal process to assess and then accredit that the farming system complies with organic standards. There are several organisations in Australia that certify producers and products as organic. These include AUS-QUAL, NASSA Certified Organics and Australian Certified Organic.

Organic farming involves the use of farming practices to produce food without the use of synthetic chemicals and instead uses natural products and techniques such as crop rotation. Organic farming methods have a wide range of benefits and advantages to producers, society, consumers and the environment. These environmentally friendly methods aim to improve soil fertility by using techniques such crop rotation and organic fertiliser to assist in plant growth. Natural methods are used to reduce insect infestation and for weed control. It is imperative that organic farmers consider all aspects of the environment in their production processes to conserve water, soil and energy. While organic farming is advantageous to the environment, there are some disadvantages for farmers and consumers. Organic produce often costs more to purchase because of the labour-intensive production methods used. Produce may also be smaller and yields are often less than those produced by conventional farming methods.

Australian Organic Ltd

Figure 10.7 Australian Certified Organic is one of several organisations that certifies organic farmers.

Waste management

There is a large amount of food wastage in Australia. In a report from Food Alliance, it is estimated that between 35 and 40 per cent of public waste is typically food, and on top of that, 21.5 per cent of commercial and industrial waste is also food. In New South Wales, households discard an average of about $1036 worth of food a year. Nationally, it is estimated

that $8 billion worth of food is wasted. Food waste that goes to landfill further contributes to greenhouse gas emissions as methane is produced as the food breaks down.

Australians throw out roughly one-third of all food produced, which equates to about 1.3 billion tonnes per year. Any food item grown, produced or manufactured uses natural resources such as gas, water and energy, which add to the increased carbon emissions being released into the atmosphere, damaging the surrounding environment. Most of the foods purchased for consumption are also packaged and have been transported safely from the producer or manufacturer to a distribution centre and finally to the retailer for sale or consumption. When food is wasted, these valuable resources are wasted too.

The food processing and manufacturing, food service and catering and food retail sectors of the Australian food industry may also have a detrimental impact on the environment through poor waste-handling methods, excessive packaging material, energy and water use in production and manufacture and through transporting food products.

FOOD IN FOCUS 10.2

KFIBRE

One way of reducing waste is to value add to the raw product instead of sending it to landfill. KFSU LTD, based in far north Queensland, has come up with an innovative way to use sugarcane mulch.

Kfibre is derived from sugarcane. Fresh sugarcane is washed and roughly chopped, and the sugary juice (sucrose) is removed by the process of diffusion. The pulp then has the excess moisture removed by using centrifugal force before being dried at a low temperature. After the waste component of the plant is dried, it is then ground into a fibre powder. The powder is a 100% natural whole plant dietary fibre used to aid and maintain digestive health. During the process, the sugarcane retains its natural plant micro-nutrients, giving Kfibre many additional health benefits compared with other fibre products on the market.

The product uses the part of the sugarcane that is traditionally a waste product of sugar production. So this is a sustainable way to create a use for the cane stalk fibre. Kfibre is promoted to consumers as being '100% natural whole plant dietary fibre for the maintenance of digestive health'. It is found to provide the following health benefits:

- It is high in fibre.
- It is low in kilojoules.
- It has a low glycaemic index.
- It is gluten and allergen free.

Kfibre could be used as a wheat flour substitute for sufferers of coeliac disease, or as a substitute for flour in baked goods. By using Kfibre, the GI and overall kilojoules are lowered while increasing the fibre content. Kfibre is currently only available online; however, it is being exported to Japan, where it is a key ingredient in the burgers of a Japanese fast-food chain, is used by Japanese health food companies when making low-sugar snacks and is also added to the school lunches of children to increase their daily fibre intake.

KFSU Ltd

Figure 10.9 Kfibre

RESPOND

1. Outline the nutritional benefits Kfibre claims to have on human health.
2. Drawing on your knowledge of nutrition, what are the benefits associated with having a high-fibre diet?
3. Discuss the impact that this innovation has on individuals, society and the environment.
4. What do KFSU recycle? How is this process reducing waste?

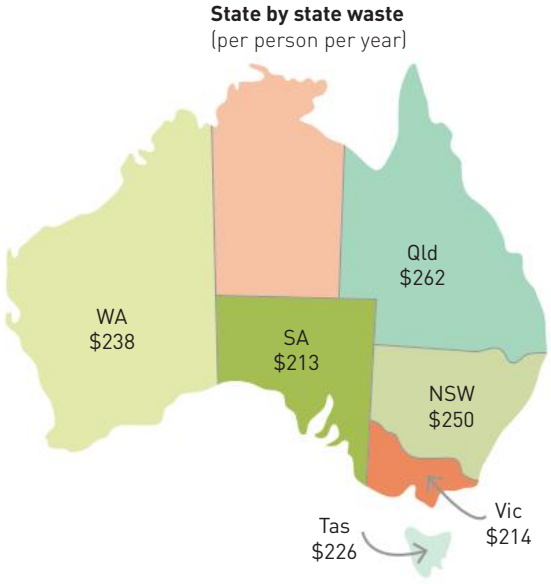


Figure 10.8 The dollar value of waste produced by Australians each year. Figures are not available for the ACT or Northern Territory.

Food manufacturers and retailers are conscious of the need to work towards establishing more environmentally sustainable food production and processing systems. As food moves through the agri-food chain – from paddock to plate – it has an impact on the environment.

The generation of food waste is also a concern for all sectors of the food industry as waste and by-products are created at almost every point along the food supply chain. As a result, food processors, food retailers and consumers must all look for strategies to minimise the environmental impact of food processing, retailing and consumption to ensure the long-term sustainability of our food supply.

Foodwise

BIOGAS

Reducing waste and waste by-products caused by food processing can reduce the impact on the environment as well as reducing costs. One example of this is the production of biogas from solid waste materials.

In Tasmania, Simplot have introduced an anaerobic digester that converts potato waste into biogas. This enables the company to use this green energy source in the plant's boiler, producing steam to heat water for vegetable processing. The Moses Lake facility has also partnered with a neighbour to utilise their industrial waste as a fuel source. This is one of the only boilers in Australia to burn a unique blend of bio, hydrogen, and natural gases. The manufacturing plant also has a water treatment plant that is used to irrigate crops, saving growers $800 000 a year. Potato starch from process water is recovered and used in a polymerisation processed for paper manufacturing. Simplot have received many awards for the environmentally sensitive practices that have been incorporated into their operation.

OzHarvest

In the food retail sector, Woolworths and OzHarvest have combined forces with the aim of eliminating food waste sent to landfill by 2020. This partnership will see OzHarvest become the principal partner for Woolworths collecting and distributing edible food to people in need across Australia. Woolworths will involve their network of farmers, producers, manufacturers, employees and customers to help reduce food waste, along with supporting OzHarvest's educational campaigns on food-waste reduction.

This partnership with OzHarvest is part of a much larger commitment from the company to eliminate food waste and to instead use it for purposes such as animal feed, commercial compost and power generation. This partnership will allow OzHarvest to divert even more surplus food from landfill and further help Australians in need, while addressing the extensive issues of food waste, sustainability and food security.

THE ODD BUNCH

Another initiative set up by Woolworths is the introduction of the 'Odd Bunch' range of misshapen or imperfect fruits and vegetables. It is estimated that almost 25 per cent of fresh produce is rejected because of imperfections or surface damage. Through the introduction of this product line, Woolworths wants to show its customers that even though the food is imperfect, it is still delicious and healthy. The sale of these fruits and vegetables is also helping farmers sell more of their crops.

Packaging practices

Packaging is an important factor in the food supply chain. Packaging protects and preserves food items from spoilage and damage during transportation, along with providing the consumer with information about the product. Manufacturers can use packaging as a promotional tool and, in certain cases, packaging can make the food more convenient for the consumer,

such as with microwavable or resealable packaging. While packaging is essential for a safe and reliable food supply, if it is not recycled or re-used in some way, it creates environmental waste that is sent to landfill.

Food manufacturers use a variety of packaging materials, systems and approaches to minimise the impact packaging has on the environment. Materials minimisation is one strategy implemented by manufacturers to reduce packaging waste and cost, by reducing the weight of materials used while not compromising on packaging strength. Food packaging generates a variety of complex problems that impact upon the environment. Many types of packaging materials are made from non-renewable resources, including petroleum in the production of plastics. The manufacture of packaging materials also uses substantial amounts of natural resources such as water, coal and natural gas. According to the 'Waste Less, Recycle More' report published by the New South Wales government, nearly 1.6 million tonnes of paper, cardboard, timber and plastics went to landfill in 2010–11. Plastic packaging is of particular concern because, while it is economical to produce, it can take hundreds of years to break down. During the degradation process, plastic packaging produces greenhouse gases, particularly methane, damaging the environment further.

Shutterstock.com/Sokolenko

Figure 10.10 Much of the food packaging produced in Australia ends up in landfill.

Energy use and production techniques

All sectors of food production, supply and consumption generate greenhouse gases – most of these greenhouse gas emissions are a consequence of energy use or the release of gases such as methane and nitrous oxide during stages of the production system.

Food processing and manufacturing organisations use energy for a variety of reasons. These include:

- refrigerating and freezing commodities
- storing ingredients and finished products
- heating cooking equipment to process ingredients
- powering assembly lines and conveyer belts
- lighting
- heating and cooling of premises
- transporting products
- running computer systems, for example to monitor stock control.

The food service and catering sector, along with the food retailers, use large amounts of energy in order to keep food safe for human consumption. This involves keeping fresh food out of the temperature danger zone (i.e. keeping food below 4°C or above 60°C), cool in refrigerators and freezers or warm in bain-maries.

Energy is used in the food service and catering and food retail sectors for the following reasons:

- running large refrigerator and freezer storage for fresh and frozen products
- running stoves, ovens, bain-maries and dishwashers
- heating and cooling for the comfort of staff and customers
- lighting to ensure adequate visibility for staff and customers
- computer systems essential to run retail and food outlets.

STRATEGIES TO IMPROVE ENERGY USE IN FOOD PROCESSING AND RETAILING

To address the large amount of energy used in these sectors, energy-efficient strategies are being developed and implemented to help food manufacturers, the food service and catering sector and retailers reduce their environmental impact. Woolworths is making choices to run its business sustainably. Woolworths' Sustainability Strategy 2007–15 set a range of targets for the business to improve its sustainability and decrease its environmental impact. By 2015, the strategy achieved 40 per cent reduction in carbon emissions along with reducing food waste sent to landfill by 20 per cent.

Strategies used by food processors and food retailers include:

- Reduce air conditioner power use by using acceptable temperature settings, especially during non-production and non-occupied periods. A temperature band of 19–26°C is acceptable.

- Managing the use of equipment more efficiently by installing controllers to automatically switch off equipment when not in use.
- Ensuring seals around doors, windows, refrigerators, freezers and cool rooms are tight and well maintained.
- Training staff to close doors and windows after use.
- Installing automatic door closers.
- Upgrading equipment to the most energy efficient.
- Installing solar panels where feasible.
- Installing sensor lighting.

In addition, supermarkets are installing more energy-efficient lighting systems such as LED lights, along with sensors that turn lights off when no movement is detected. Inefficient open-chest freezers are being replaced with self-closing vertical-door freezers.

Sustainable water use

A safe and secure water supply is crucial for the ongoing availability of fresh foods in Australia and is an important natural resource for all sectors of the Australian food industry. The processing of food uses more water than any other Australian industry. Water is used both directly and indirectly in food production, including being used as an ingredient, used to wash of raw materials and employed as a heating and cooling source. The majority of water used in this sector is actually used to clean and sterilise processing equipment along the entire processing plant. All sectors of the Australian food industry are investigating different approaches to develop more sustainable water use. In their Sustainability Report released in 2014, Simplot has stated that through their 'Simplot Water Wise Program' manufacturing sites throughout the nation are focused on improving their water use and have committed resources to achieve a 10 per cent decrease in water use. This poses a great challenge for the organisation; however, they have achieved improvements and reductions in water use at several manufacturing plants. Another example of sustainable water use is in the agriculture and fisheries sector. The development of genetically modified crops has led to some crops requiring less water and irrigation for their growth and productivity.

Food transport and the environment

Transportation of food goods has a significant impact on the environment. This is because petroleum and diesel power is generally used to transport items. These fossil fuels create air pollution such as carbon monoxide, which is a contributing factor to global warming. As the majority of our food supply is transported by trucks, this form of road transport poses a major environmental problem.

Transportation, whether by road, rail or air, is a necessity because of Australia's geographical location and size. The most densely populated areas of the country are within 50 kilometres of the Australian coastline. There is a particularly high population density on the south-east and east coasts of Australia between Adelaide and Cairns as well as on the west coast south of Perth. This expansive population spread, coupled with the fact that much of the country's agriculture and food production, processing and manufacturing organisations are in rural and remote locations, lies behind Australia's heavy reliance on food transport.

The majority of Australia's fuel used for transport is from non-renewable sources. This is cause for concern, as our transport system's reliance on greenhouse gas-producing fuels is unsustainable because of the detrimental effect on the environment. It is important that the use of fuels be managed in order to minimise transport's impact on the environment.

Noise from the different modes of transport can also be an environmental concern, along with other issues such as traffic congestion and oil spills in marine waterways.

Impact of the food industry on the economy

Food and beverage processing is the largest manufacturing industry in Australia. As we know, food companies range from multinationals that produce large volumes of fast-moving consumer goods through to smaller businesses that have greater flexibility to meet the unique needs of consumers. Food and beverage processing is a major industry sector for the Australian economy, in terms of both its financial contribution and level of employment.

The industry is very dynamic and is focused on meeting consumer demand while providing diversity, quality and value in the products they produce. The cultural diversity of Australia is evident in the food ranges available, with many specialty products having European, Asian and Middle Eastern influences. Foods with specific characteristics such as kosher, halal and organic are also catered for by food growers and manufacturers in accordance with specific certification systems and to set standards. The Australian food industry is internationally focused with exports to over 200 international markets.

The Department of Agriculture reported that Australian food exports in 2012–13 totalled approximately $31.8 billion. Our high-quality food products are increasingly being sought by countries in the AsiaPacific region and throughout the rest of the world. The Australian government supports the export industry through strategies such as the 'Korea-Australia Free Trade Agreement', and the 'Japan-Australia Economic Partnership Agreement'.

Australia has a reputation for providing safe, clean and natural products and being a reputable supplier. Quality and safety are very important and as high standards are set and enforced along the supply chain this has contributed to the growth of our export industry.

Australia has well established education and training facilities that caters to the food industry. The high standard of training delivered has created a very able and flexible workforce with many specialised skills. It is estimated that 1.6 million people are employed throughout the food sector. This has a significant impact on communities in both rural and regional areas.

Impact of the food industry on society

We are fortunate in our society that most of us can easily access safe and reliable food sources. The Australian food industry provides consumers with a large variety of food to purchase and consume. Many Australians do not grow, prepare or cook their own foods and so rely on the food industry to supply them with the essential items and avoid many hours preparing foods.

Over the past decade, the food consumption patterns and way of life for Australian consumers has changed dramatically. Today, our society is made up of many different cultures, all bringing with them their own unique ingredients, cooking styles and cuisine, to make Australia a truly diverse place to live. Migration and the opportunities we have for travel coupled with the strong desire to try new foods is reflected in the enormous variety of foods available in the marketplace. Entire aisles in supermarkets and small speciality retailers, such as Asian grocers and European – style delicatessens, are dedicated to supplying our society with foods from different cultures.

The large multinationals that exist in the Australian food industry dictate, to an extent, the types of foods that appear on supermarket shelves. They work in conjunction with the major supermarket chains to develop and formulate the wide variety of foods we have to choose from. Often

Figure 10.11 Three different brands and products made by the same company, Simplot.

one multinational may be responsible for producing a variety of different brands all within the same product. For example, Simplot Australia produces pasta sauces for Leggo's and Aldi. Similarly, Nestlé, Fontera and Unilever produce a range of food products to sell under their own and other labels.

The large variety of foods available to purchase and consume makes choice a significant concern and may also have a negative impact upon the health of individuals – it is harder to make healthy choices if there are many unhealthy options as well. While the decision to make healthy food choices is ultimately the responsibility of the individual, the food industry can help individuals make informed decisions and wise choices. Information on food labels and nutritional information panels are one way the food industry can support our decision making – advertising and marketing is another. The food industry has a social responsibility to consumers and must not make false or misleading claims about their products.

LIFESTYLE CHANGES

The busy and varied lifestyle of individuals and families also affects the types of food products created. Convenience foods such as breakfast bars and meal-replacement drinks, frozen meals and heat-and-serve dinners are designed to help time-poor members of society. However, while access to convenience foods may save time, it raises the question, at what cost? The majority of processed foods are high in fat, sugar and salt. A diet that consists mostly of processed convenience foods may lead to health problems – obesity, hypertension, cardiovascular disease, diabetes and dental caries. The food processing and manufacturing sector have responded to dietary concerns raised by society by producing nutritionally modified foods that are lower in fat, salt and sugar. However, taking out fat can take away the flavour, making the food products less palatable. So fat is often replaced with sweeteners. So while a product may be labelled low-fat, its sugar content may in fact be quiet high.

Alamy Stock Photo/david a eastley

Figure 10.12 Convenience foods are popular with consumers.

We are now seeing a lot of growers, food manufacturing companies, restaurants and food retailers producing foods to please health-conscious consumers. These consumers are demanding greater access to functional foods and superfoods, while wanting the use of preservatives and artificial colours and flavours to be reduced.

Supermarket chains are continually vying for the consumer's dollar. Coles and Woolworths, the two largest chains, are in constant battle to offer the best price for shoppers and compete for consumers' attention. Catchy advertising slogans and jingles, loyalty programs, longer opening hours, express retail outlets, price wars and exclusive product lines are just some of the strategies used to entice members of society. Woolworths have moved into a non-traditional market for the retailer and have started opening cafés in some of their stores as a service to consumers while they shop. This is in response to the sophisticated demands of some consumers as Woolworths become increasingly aware of food trends and societal changes that have evolved recently such as café culture and time-poor shoppers.

Career opportunities and working conditions

The Australian food industry offers a wide variety of employment opportunities across all its sectors. There are many jobs available for all skill levels; however, as all sectors of the industry become more computerised and automated, the need for unskilled and unqualified workers may slowly decline.

Table 10.5 Possible career opportunities in the food industry

AGRICULTURE AND FISHERIES	FOOD PROCESSING AND MANUFACTURING	FOOD SERVICE AND CATERING	FOOD RETAIL
Farmer	Forklift driver	Chef	Butcher
Fisher	Fitter and turner	Wait staff	Baker
Grain buyer	Food technologist	Barista	Cashier
Wool classer	Food product developer	Cleaner	Sales assistant
Stock agent	Market researcher	Kitchen hand	Visual merchandiser
Mechanic	Production line workers	Breakfast cook	Fishmonger
Vet	Engineer	Functions manager	Managers
Horticulturalist	Factory manager	Events coordinator	Warehouse personnel
Viticulturist	Graphic designer	Cashier	Sandwich hand
Agronomist	Abattoir worker	Bar staff	Product demonstrator
Fruit and vegetable pickers		Food stylist	
Plant and animal geneticist		Food photographer and blogger	

TYPES OF EMPLOYMENT

Many of the large manufacturing companies and multinationals operating in Australia are open 24 hours a day, 7 days a week. This continuous production means they can meet consumer demand, but means shift work and long hours are very common. Shift work and long working days are also commonplace in the food service and catering sector and food retail sectors. The type of employment options available include casual, part-time, full-time and contracts for people with specific skill sets. Employees in the agriculture and fisheries sectors may only have limited work due to the seasonal nature of this sector.

As would be the case with any employment, wages in the food industry will vary depending on the skill level required, qualifications and the nature of the work. All four sectors of the Australian food industry offer a large and diverse range of career opportunities and jobs. Some vocations require the employee to have university or TAFE qualifications, while others have no prerequisites.

WORKING CONDITIONS

Working conditions in the food industry are largely dependent on the type of organisation but the following characteristics are common.

- Pay rates will depends on skill level, qualifications and specific requirements.
- Many employees belong to unions.
- Enterprise bargaining is popular as it enables employees to negotiate conditions with the employer.
- Career advancement and salary increases are often dependent on performance reviews and company profits.
- Workers may be required to wear personal protective equipment while performing their jobs, this must be supplied by the employer.

GENDER ISSUES WITHIN THE FOOD INDUSTRY

Different segments of the Australian food industry are affected by a gender imbalance when looking at specific sectors and jobs.

The traditional masculine occupation of a farmer is echoed in the fact that according to a recent report from the Australian Bureau of Statistics (ABS), men make up the majority (72 per cent) of farmers in Australia. Only 28 per cent of people working in this 'non-traditional' profession were women, which means the proportion of female farmers has fallen slightly from 30 per cent in 1981. However, the proportion of women in other occupations has increased from 37 per cent in 1981 to over 47 per cent today. The low percentage of female farmers could be attributed to the fact that much of the work involves manual labour and can be dangerous. The days are long and for part-time and casual employees, the work is often seasonal and the pay may be lower than other sectors. On average, 49.3 hours are spent working by those employed in the agriculture and fisheries sector, which is approximately 10 hours more than people employed in other occupations.

Workers in the agriculture and fisheries sector tend to be significantly older than employees in other sectors. In 2011 the ABS reported that the median age of farmers was 53 years, compared with 40 years of age for workers in other occupations. This may be attributed to the fact that that farmers are more likely to continue working past the age at which most other workers retire. In 2011, 23 per cent of farmers were aged 65 years or over. This is a stark contrast to other occupations where just 3 per cent of employees were above 65 years of age. The inclination of farmers to work beyond the traditional retirement age may be the reason that there has been a steady decline in younger generations taking over family farms and working the land.

Australia's food processing and manufacturing industry provides a variety of employment opportunities to support the economic growth of Australia. In 2013–14, the food, beverage and grocery processing industry directly employed approximately 300 000 people; 45 per cent of those jobs were located in rural and regional areas across the nation. The Food and Grocery Council of Australia estimates that one out of every three jobs in manufacturing in Australia is in the food and grocery sector. Approximately 220 500 people are employed in food and beverage processing; 30 295 are employed in grocery manufacturing and 48 936 people are employed in the fresh produce retail sector.

Traditionally, more women are employed in the retail sector as this area provides greater flexibility for those wishing to work part-time or casually to fit in family needs. More men tend to work in processing and manufacturing because of the physically demanding nature of the industry, long hours and shift work.

Despite all sectors of the Australian food industry providing equal employment opportunities and exciting career paths, it is still failing to attract an equal balance of male and female employees in the food service and catering sector. Decisions to move into the food industry for a career are often affected by employment entitlements, working conditions, image and future career prospects. For these reasons, some job opportunities continue to attract a particular gender.

FOCUS QUESTIONS 10.3

REVIEW

1 Using Table 10.5 on page 192, list the career opportunities that exist in the food industry for skilled and unskilled workers.
2 Outline the advantages and disadvantages of organic farming practices.
3 Discuss why shift work is common in the Australian food industry.

FOR YOU TO APPLY

4 Consumers easily become bored with food products and are always looking for something new and exciting. Discuss how consumer demands influence an organisation's development of value-added foods.
5 A small company that supplies prepared calorie-controlled meals for busy people has just opened a production plant in a rural area in New South Wales. Identity the environmental, social and economic factors to for this business to consider

EXTEND YOURSELF

6 Food producers are concerned about their environmental footprint. Explain how Australian food producers and manufacturers attempt to minimise their impact on the environment.
7 Discuss the impact the food industry has on the health of our society. Use the summary from the PMI chart below to construct an extended response to this question.

PLUS	MINUS	INTERESTING
Nutrition labels – lets consumers make more informed choices e.g. assessing the fat content for a low-fat diet, assessing the sugar content for diabetes Healthy convenience foods: 1. meals e.g. lean cuisine, salad packs, gluten-free options for allergies and intolerances; 2. snacks e.g. snacks/ wraps, high-fibre/low-GI snack bars Organic food production – greater choice of organic foods available which means less damage to the environment and potential health benefits	Food waste – due to large quantity available in our food supply More automation for manufacturing food, therefore less jobs Food product range of unhealthy snacks high in fat and sugar has led to more diet-related illnesses, e.g. heart disease, diabetes	Variety of food choices – fresh, packaged and convenient Both healthy and less healthy options, e.g. low-fat, low-salt, sugar free and high-fibre, as well as foods that are processed with high amounts of fat, sugar, salt and additives GM Foods – although controversial, there are some benefits, e.g. the development of Golden rice for developing countries – is a cheap staple and can increase the Vitamin A content and may reduce vision problems Exports positive is that there is a greater worldwide market share, e.g. meat and vegetable exports; however, less control of animal welfare – cruel slaughter of animals in overseas countries and less regulation of safe food production

Chapter review

REVIEW

1 Define the term 'level of operation'.
2 Identify the levels of operation in the Australian food industry and provide an example of a business that fits into each of the four categories.
3 Outline the role of the CSIRO in the Australian food industry.
4 Why is research and development necessary?
5 In recent times, what influence have consumers had on the retail sector of the Australian food industry?

FOR YOU TO APPLY

6 Using the internet, research the following careers in the Australian food industry: food technologist, food stylist, baker, human resource manager, work health and safety supervisor, quality control manager, stock controller and agronomist.
What qualifications are necessary? What does each job involve? What are potential places of employment? What skills and attributes are required for each position?
7 Identify four different food-related organisations in your area. These may include a café, supermarket, bakery, butcher, restaurant, manufacturer or small-scale producer. Provide a brief description of the organisation and details of the activities they carry out.
Identify their level of operation and the sector of the Australian Food Industry to which they belong.

EXTEND YOURSELF

8 Explain the following statement: 'The Australian food industry is a significant contributor to the Australian economy'. Provide examples to support your answer.

CHAPTER 11

Policy and legislation

Policies and legislation in the Australian food industry are crucial for a safe and reliable food supply. It is essential to recognise the difference between policy and legislation and understand the importance of why they exist and who is responsible for making and enforcing our laws.

CHAPTER OUTCOMES

In this chapter you will learn about:

- Advisory groups that help form and implement policy and legislation
- Government policies and legislation at local, state and federal levels that affect the Australian food industry

KEY TERMS

advisory groups
free trade agreement (FTA)
globalisation
legislation
policy
Recommended Dietary Intake (RDI)
self-regulated
Australia New Zealand Food Standards Code

iStock Photo/shironosov

Policy and legislation in the Australian food industry

A food policy is a strategy put in place by the government that provides national leadership on the regulation of the food supply. A policy might address a particular concern or aim to improve standards. Policies relating to the food industry may cover areas such as the use of genetically modified food in food production, food-labelling laws or policies relating to the import or export of certain food items.

The policies put in place by the government are reflected by the development of parliamentary acts, which become the law. Legislation is a law that is passed by government that states or describes what can and cannot be done in certain situations. Food legislations exist at the local, state and federal levels of government. Laws can be rewritten, modified, changed or revoked at any time. However, this is a lengthy process and legislation must go before parliament before any changes are made.

All businesses in the food industry must obey these laws. If the legislation is not followed, they can be fined, put out of business or in extreme circumstances, the people concerned may be jailed.

Some food producers and businesses are self-regulated, meaning they have their own codes of practice (rules and operating requirements for particular activities) that control their operation. Areas such as food safety, product-recall procedures and promotions are overseen by specific industry bodies. All producers of a particular product must adhere to guidelines if they are in a self-regulated industry.

Advisory groups

Advisory groups are independent organisations responsible for guiding and providing advice to the government when it is developing policies and legislation.

Advisory groups are experts in their field with in-depth knowledge of their particular industry and its associated products and links to other industries. An advisory group may be defined as a business group that belongs to a particular sector of the food industry, who provide support and promotion of their products. Pork Limited Australia is an example of an advisory group in the agriculture and fisheries sector. Advisory groups may also be involved in providing specific information and advice on health-related issues such as Diabetes Australia and the National Heart Foundation. They can also be independent legislative bodies that are able to create and amend laws pertaining to food. Food Standards Australia New Zealand (FSANZ) is one such advisory group.

Advisory groups may also lobby the different levels of government to encourage and support policies and legislation that may benefit their particular industry or organisation and/or the consumer.

AUSTRALIAN FOOD AND GROCERY COUNCIL

The Australian Food and Grocery Council (AFGC) is the leading national advisory body representing Australia's food, drink and grocery manufacturing industry. The AFGC helps shape a business environment that encourages the food manufacturing sector to grow and remain profitable and provides input into policy formulation that impacts the profitability, viability and sustainability of the industry both nationally and internationally.

NUTRITION AUSTRALIA

Nutrition Australia is an independent, non-government, non-profit, community-based organisation that promotes the health and wellbeing of all Australians. Nutrition Australia is Australia's main community nutrition education body, providing scientifically based nutrition information to encourage all Australians to become healthier by eating a variety of foods and by being physically active.

AUSTRALIAN BEVERAGES COUNCIL

The Australian Beverages Council is the peak organisation representing the non-alcoholic beverages industry. They try to advance the industry as a whole, along with representing the range of beverages produced by their members. The range produced

includes carbonated soft drinks (both regular and diet), sport and energy drinks, bottled waters, fruit juices, iced teas, cordials and ready-to-drink coffees. The Australian Beverages Council represents the industry by advocating for fairness on standards, regulations and policies that apply to non-alcoholic beverages.

PRACTICAL APPLICATIONS 11.1

ADVISORY GROUPS

AIM

To discover industry advisory groups

METHOD

1. The Australian Beverages Council is just one specific advisory group. See if you can think of three more.
2. Visit the websites of at least five advisory groups – while there are prominent examples such as the Australian Beverages Council try to find some your classmates might not know about.
3. Share your findings with your class.

Food Standards Australia New Zealand

The agency that sets the standards (regulations) that must be met before food is sold is Food Standards Australia New Zealand (FSANZ). This is an independent statutory agency, which means it has the power to make laws relating to food. FSANZ was established by the *Food Standards Australia New Zealand Act 1991* (Commonwealth). FSANZ works with the governments of Australia and New Zealand to develop and implement uniform standards relating to what is in our food and its labelling requirements. FSANZ is also responsible for setting nationwide standards to maintain food safety. Health ministers from all states and territories work with FSANZ to ensure consumers are well educated in relation to food and food products.

The key goal of FSANZ is to ensure a safe food supply. To do this, they perform a number of functions:

- Preventing organisations from making misleading claims or engaging in deceptive conduct.
- Providing information to consumers about food-labelling laws, food safety, food contamination, nutritional issues, food allergies and intolerance health claims, country-of-origin labelling, food additives and product recalls.
- Researching, developing and reviewing the Food Standards Code.
- Coordinating product recalls.
- Developing food-labelling laws.
- Coordinating national food surveillance.
- Developing risk-assessment policies for imported foods.
- Monitoring and controlling food safety.
- Providing food-handling advice to consumers.
- Providing support to the Department of Agriculture and Water Resources in the control of imported goods.

Food Standards Code

One of the main roles of FSANZ is to develop and administer the Australia New Zealand Food Standards Code. The Food Standards Code (the Code) ensures a manufacturer is not able to produce a new food product and make it available to consumers without first abiding by the rigorous standards set. The Code is made up of a collection of individual food standards that are divided into four chapters. The Code was first published in December 2000 and a revised Food Standards Code came into effect on 1 March 2016.

Chapter 1 covers the general standards that apply to all foods such as labelling requirements, use-by dates, food additives like vitamins, minerals, flavours and colours, nutritional information and the acceptable levels of contaminants and residues that are permitted in food. Chapter 2 contains standards for particular classes of foods, including cereals, meat, eggs, fish, fruits and vegetables, dairy products, edible oils, sugars, honey, alcoholic beverages, non-alcoholic beverages and special purpose foods such as infant formulas and meal replacements. The standard for each of these classes of foods dictates exactly what the food must or may contain and by law, nothing else is allowed to be in that product. The standard includes information on identity of particular foods; composition of foods, which describes the make up of the food by listing what ingredients and additives are permitted; and the minimum nutritional content and maximum amounts of contaminants and residues. Microbiological, analytical standards and additional labelling requirements are also covered in Chapter 2.

Chapter 3 covers the food safety standards to ensure only safe and suitable food is sold for human

consumption. The standards in this chapter relate only to Australia. Information about food safety programs such as HACCP, food safety practices, food premises and equipment and food services to vulnerable people (children, the elderly and those that are sick or immune suppressed) in society are also covered.

Chapter 4 includes standards for dealing with the primary production and processing of food in Australia. It includes standards for seafood, poultry, meat, dairy products including specific cheeses, eggs and egg products along with standards for seed sprouts and wine production requirements.

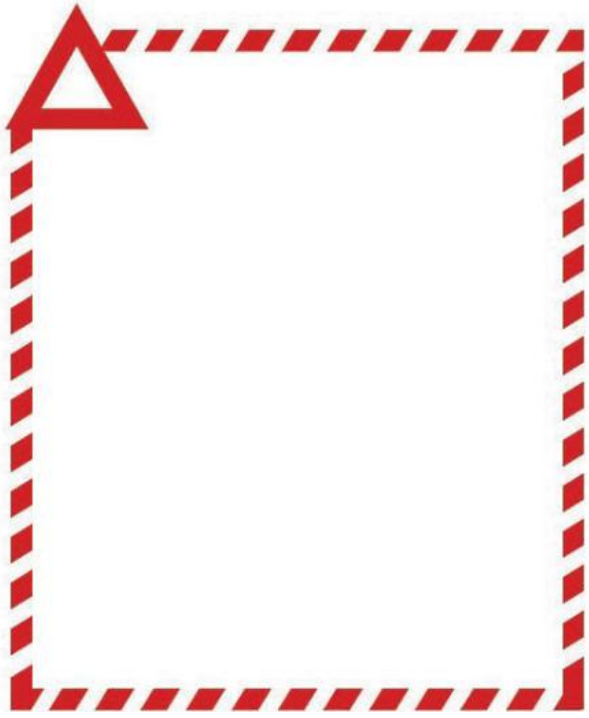
The Code includes guidelines to help businesses interpret and apply them. These guidelines combine extensive explanations and compliance guidance for primary producers, manufacturers and retailers, and details on how they can be used and applied to specific products.

FSANZ have also developed codes of practice. These are non-binding agreements that businesses and industries within a particular sector are encouraged to follow. These codes of practice help provide additional information aiming to cover areas that may not appear in the Food Standards Code. For example, FSANZ has developed a code of practice about what nutritional claims can be made in food labels and in advertisements. It is hoped that this will help further explain the legal requirements of the Code in plain English and help those in the industry to understand how to comply with it.

The Code is continually undergoing change. Applications to change or modify the Code may be made by any individual or organisations. FSANZ may also change the Code by initiating a proposal or change. Any application and proposal made to FSANZ needs to go through a rigorous assessment and review process after which it is put to the public for consultation. Suggestions for changes to the Code may come from the food industry or from consumers.

PRODUCT RECALLS

FSANZ coordinates and monitors food recalls in Australia. A food recall removes food that may pose a health or safety risk from distribution, sale and consumption. A food recall may occur because of a complaint or a report from a manufacturer, wholesaler, retailer, importer or consumer. A food recall may also occur after a food business has conducted an internal test has identified a threat the public.



Food Standards Australia New Zealand

Figure 11.2 Food recall notices must be distributed in a template provided by FSANZ.

Food product recalls occur for two main reasons:

1 A defect in the quality of a food item which does not present a risk to public health and safety.
2 A defect in the quality of a food item that could pose a safety threat to consumers due to a production fault or tampering.

Food recalls occur after consultation between state and territory governments and the food manufacturer or importer.

Businesses can also conduct a food withdrawal, which is different to a food recall. A food withdrawal may occur if the manufacture has identified a problem that does not pose a threat to public health, but breaches other specifications or laws such as being the incorrect weight stated on the label.

A food product may be recalled for many reasons. A recall could be due to the presence of harmful microorganisms, toxic chemicals, undeclared allergens, tampering, packaging faults or harmful foreign bodies that could cause ill-health or death.

When a food safety issue has been identified, food businesses must act quickly to eliminate unsafe food from the marketplace to ensure the health and safety of consumers. FSANZ assists food businesses to recall unsafe food by alerting state and territory government agencies and industry groups. Food businesses are responsible for notifying the public of a recall.

Food Standards Australia New Zealand

Figure 11.3 Who does what in a food recall?

Between 1 January 2007 and 31 December 2016, FSANZ was notified of 608 recalls. The average number of recalls per year for the last ten years is 61 recalls per year. While FSANZ has the overall responsibility for food recalls, each business in the food industry must have an up-to-date food recall plan.

Some examples of reasons for recalling food products include:

- A foreign body such as glass or plastic has been detected in a batch of food.
- Foods such as processed meat products show signs of micro-organism growth.
- Chemical contamination of food from pesticides or insecticides has been detected.
- A food item has been incorrectly labelled such as the company failing to inform consumers that the product contains an allergen like peanuts, gluten, eggs or shellfish.
- During processing a problem may have occurred such as milk not reaching the appropriate temperature during the heat treatment process of producing UHT milk.

If quality assurance procedures fail during the processing or manufacture of a product, food products containing harmful micro-organisms, toxic chemicals or harmful foreign bodies could potentially reach the consumer. Safety procedures are the responsibility of the producer, manufacturer or food service organisation. If a food product is recalled, it may be removed from the marketplace on a permanent or temporary basis and can only return to the market once the problem or issue has been resolved.

Department of Agriculture and Water Resources

The Australian Government Department of Agriculture and Water Resources (formerly the Department of Agriculture, Fisheries and Forestry) develops and implements policies and programs to ensure Australia's agricultural, fisheries, food and forestry industries remain competitive, profitable and sustainable. It also supports the sustainable and productive use of rivers and water resources. This department is responsible for managing quarantine controls at borders to minimise the risk of exotic pests and diseases entering Australia, along with certifying imports to help preserve the health of Australia's people, plants and animals. This is referred to as preserving our biosecurity.

As a nation, we are fortunate to be relatively free from a number of biological threats, such as Foot and Mouth disease that can affect cattle and sheep. Australia has strict policies and protocols in place to keep the country free from unwanted pests and disease that if allowed into the country could have a devastating effect. A significant role of this government department is to ensure a disease-free environment and this is achieved by having strict verification and certification activities for all agriculture and food products. Australia's location has played an important role in maintaining a pest and disease-free environment. However, this is changing as the obstacles of time and distance become less significant as international travel and imports increase.

Our coastline spans more than 60 000 kilometres and this offers a variety of entry points for exotic pests and diseases. The Department of Agriculture and Water Resources monitors, inspects and declares 'fit for entry' the millions of people, mail parcels, baggage, ships, animals, plants and cargo containers that enter Australia every year. This is achieved by using X-ray machines, surveillance and detector dogs.

Getty Images/Ramin Talaie/Corbis

Figure 11.4 Detector dogs are used to prevent products that may contain unwanted pests or diseases from entering Australia.

To protect Australian agriculture from potential contamination, the following activities are carried out:

- Inspecting imported animals, plants and their products.
- Monitoring and inspecting international travellers to ensure they do not bring restricted plants, animals and other prohibited products into the country.
- Certification of all agricultural exports for the global market.

To ensure biosecurity, the following safety programs have been implemented:

- Airport screening programs that involve X-ray machines, baggage inspection and the use of detector dogs to detect forbidden foods and products.
- An international mail program has also been implemented that again uses detector dogs and X-rays to scan mail as it enters the country.
- A seaport program is also in place to that requires trained personal to board visiting sea vessels and inspect consignments.
- A ballast water program which involves checking where visiting ships have taken on ballast water. Ballast water (water that is carried by empty ships to help provide stability) may be problematic if it is contaminated and dumped into our waterways.
- A plant and animal isolation station where imported plants and animals are quarantined and kept for inspection.

Biosecurity controls at Australia's borders minimise the risk of exotic pests and diseases entering Australia and protect our $32 billion agriculture export industries as well as our unique environment, native flora and fauna, our tourism industries and lifestyle.

FOCUS QUESTIONS 11.1

REVIEW

1 What is the difference between policy and legislation?
2 Explain the role advisory groups play in the Australian food industry and discuss the impact they have on the food industry. Provide examples.
3 Outline the types of advice that may be offered by the Australian Food and Grocery Council.

FOR YOU TO APPLY

4 Go to the FSANZ website and search for current food recalls. Select a current food recall and consider why it is in place and what impact it may have on the manufacturer of the product.

EXTEND YOURSELF

5 Research an advisory group and create a brochure for your class mates that outlines their role and what they are responsible for. How do they support their members?

Government policies and legislation and the food industry

As we have already established, the Australian government is responsible for formulating policies in many areas. Many of these policies have a direct impact on the Australian food industry. The two main policy areas that are of significant importance are policies relating to nutrition and trade.

Food and nutrition policy

During the 1990s, the Australian government developed and assessed the implementation of its Food and Nutrition Policy. The National Public Health Partnership through the Strategic Inter-Governmental Nutrition Alliance (SIGNAL) developed 'Eat Well Australia, 2000–2010', which became the National Public Health Partnership's Nutrition Strategy and Action Plan, aiming to address the rising prevalence of lifestyle-related chronic disease.

The strategy focused on four key nutrition priority areas:

1 preventing people becoming overweight and obese
2 increasing the consumption of vegetables and fruit
3 promoting optimal nutrition for women, infants and children
4 improving nutrition for vulnerable groups.

(Note: while both the Eat Well Australia policy and the Indigenous policy detailed below spanned 2000–2010, they have not been replaced so their goals still apply.)

A separate action plan was also developed by SIGNAL that was designed specifically for Aboriginal and Torres Strait Islander people. The National Aboriginal and Torres Strait Islander Nutrition Strategy and Action Plan 2000–2010 was

created to provide a framework and guidelines to improve the overall health and wellbeing of Aboriginal and Torres Strait Islander Peoples.

Its seven key areas for action were:

- food supply in remote and rural communities
- food security and socioeconomic status
- family-focused nutrition promotion
- nutrition issues in urban areas
- the environment and household infrastructure
- Aboriginal and Torres Strait nutrition workforce
- national food and nutrition information systems.

During the past two decades, there have been numerous government initiatives established to target the health and nutrition levels of individuals. These include the target on healthy eating, the five food groups, the 12345+ Food and Nutrition Plan, the Recommended Dietary Intake (RDI) scheme, the National Health and Medical Research Council's (NHMRC) Dietary Guidelines for Australians and most recently in 2013, the Australian Guide to Healthy Eating. These health and nutrition educational programs are intended to raise awareness, promote health and wellbeing and make Australians more accountable for their eating and physical activity patterns and food choices. You will learn more about these in Chapter 20.

Australian Trade and Investment Commission – Austrade

Australia has solid trade ties with the rest of the world. Australia's location has allowed it to become a major supplier to markets in the Asia Pacific region. Importing and exporting food products is commonplace in Australia as we supply and receive goods from all around the world.

The Australian government has a number of policies to develop and assist Australian businesses involved in international trade. Regulation also exists to protect domestic industries, consumers and the environment from harmful and dangerous goods imported from overseas.

Austrade contributes to Australia's food industry by assisting Australian businesses in a variety of ways. Austrade is responsible for developing international markets and promoting productive foreign investment. This is achieved by producing market information and insights and promoting Australia's capabilities worldwide. They are also responsible for developing policies and making connections through an extensive global network of contacts while providing quality advice and services.

Free trade agreements (FTAs) are international treaties that reduce barriers to trade and investment and that open up opportunities for the Australian food industry to export its goods into overseas markets. FTAs have also increased the quantities of imported goods brought into the marketplace. FTAs provide the Australian food industry with better access to important markets along with an improved competitive position for Australian exports. They also provide greater prospects for increased two-way investment, and reduced import costs for Australian businesses and consumers alike. An up-to-date list of FTAs currently in force, to which Australia is a signatory, can be found on the Department of Foreign Affairs and Trade website.

Globalisation and free trade are major considerations for the Australian food industry. Globalisation can have a positive effect on the food industry as it means we as consumers have greater access to a variety of foods, imported from around the world. It also means the Australian Food Industry can export our food products to other countries for financial gain. Globalisation and international export markets provide exciting opportunities for the Australian food industry, offering the chance to further develop our reputation and revenue to allow the industry and the Australian economy to prosper further.

Food legislation: who creates it?

The regulation of food production, processing and manufacture happens globally. As a nation, we have established strong relationships with regulatory bodies worldwide so that food-related issues in Australia reflect world's best practice. Australia is an active participant 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).

International food trade has been around for thousands of years. During the past 100 years, the

quantity of food traded internationally has grown significantly. All types of fresh and processed foods now travel around the world every day.

Codex is about the supply of safe, good quality food for everybody, everywhere. Codex has developed international food standards, guidelines and codes of practice to ensure safety, quality and fairness relating to international food trade. These international standards have been established so consumers and importers can feel safe knowing that food products will meet certain specifications relating to safety and quality.

Codex was established by the FAO and WHO, and has become a global reference point for consumers, producers and processors, national food control agencies and international food traders. Codex members cover 99 per cent of the world's population. It has input from over 160 countries who have helped to create and endorse the international food code.

We have established that FSANZ is in charge of reviewing standards and for the development of codes of conduct for food-related business in Australia and New Zealand. Despite FSANZ being under a Commonwealth Act, each state is responsible for enforcing their own Food Acts. As an example, New South Wales has the *Food Act 2003* (NSW) and the New South Wales Food Authority (NSWFA) is the state government organisation responsible for food safety across the NSW food industry. The NSWFA works with local government, supporting their role in food regulation.

Federal food laws

COMPETITION AND CONSUMER ACT 2010

Before 1 January 2011, the *Competition and Consumer Act 2010* (CCA) was known as *The Trade Practices Act 1974*. However, the change of name did not change its content. The aim of the Act is to enhance the welfare of all Australians by promoting competition and fair trading as well as protecting consumers. This Act commonly relates to the business activities of most companies, as well as sole traders and partnerships. The CCA covers most areas of the market: the relationships between suppliers, wholesalers, retailers, and consumers. Broadly, it covers product safety and labelling, unfair market practices, price monitoring, industry codes, industry regulation, electricity, gas, telecommunications, and mergers and acquisitions.

State government legislation

The New South Wales state government also passes legislation that has a direct impact on the food industry. Legislation varies from those designed to protect the environment to those aimed at ensuring food is handled and prepared correctly and those protecting the health and safety of employees and consumers.

The *Food Act 2003* is a significant piece of legislation for the food industry, consumers and the general public. The aims of this Act are to:

- ensure food for sale is both safe and suitable for human consumption

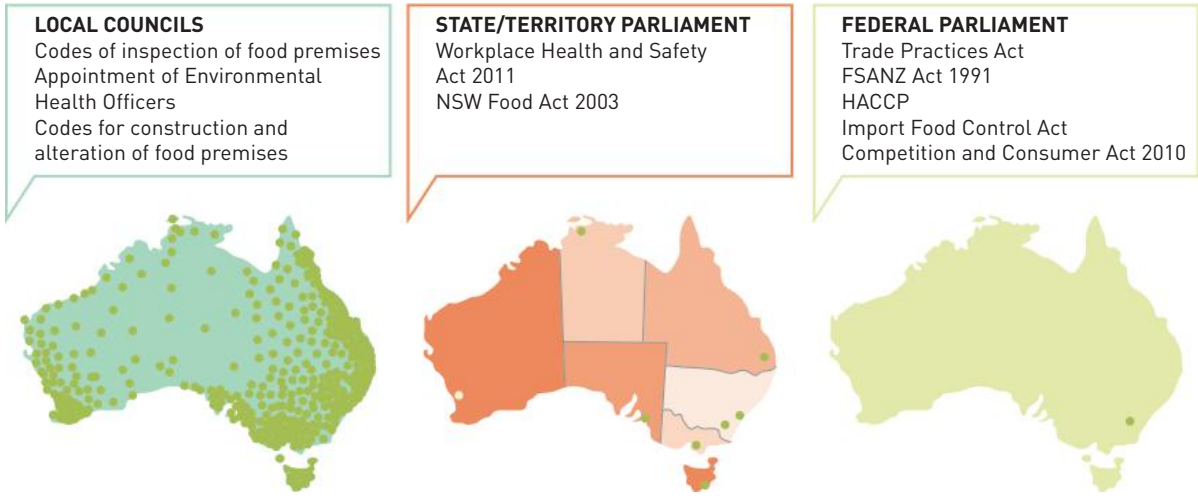


Figure 11.5 Local, state and federal food legislation in Australia

- prevent misleading conduct in connection with the sale of food
- provide for the application in NSW of the Food Standards Code.

The NSWFA ensures that businesses follow food safety policies and legislation by conducting inspections and audits of food-related businesses. These inspections are carried out under the *Food Act 2003* to ensure compliance with the *Food Regulation Act 2015* (NSW). The *Food Regulation Act 2015* underpins the Food Authority's food regulatory work, which aims to reduce the incidence of food-borne illness.

Any food-related business that is accredited to handle or process food will be audited according to the food safety risk profiling framework. This framework classifies licenced premises according to their associated food products and potential consumers. High-risk industries, or those that are a 'priority 1' business, are inspected regularly, while those that are a 'priority 4' pose little risk to public health and safety are known as 'notifiable'. During an audit, trained personnel ensure that there is a food safety program in place and that the organisation has trained food safety supervisors to oversee and monitor processes and food production. An auditor will also check to make certain that the organisation keeps detailed records of all food products it handles and that all processes are documented, should a problem arise. Systems are also put in place to ensure that staff are trained correctly and that there are systems in place for hygiene, chemical storage, pest control, training, product recall, internal reviews and customer complaint handling.

The Food Act 2003

Other state government legislation that affects the food industry is in Table 11.1.

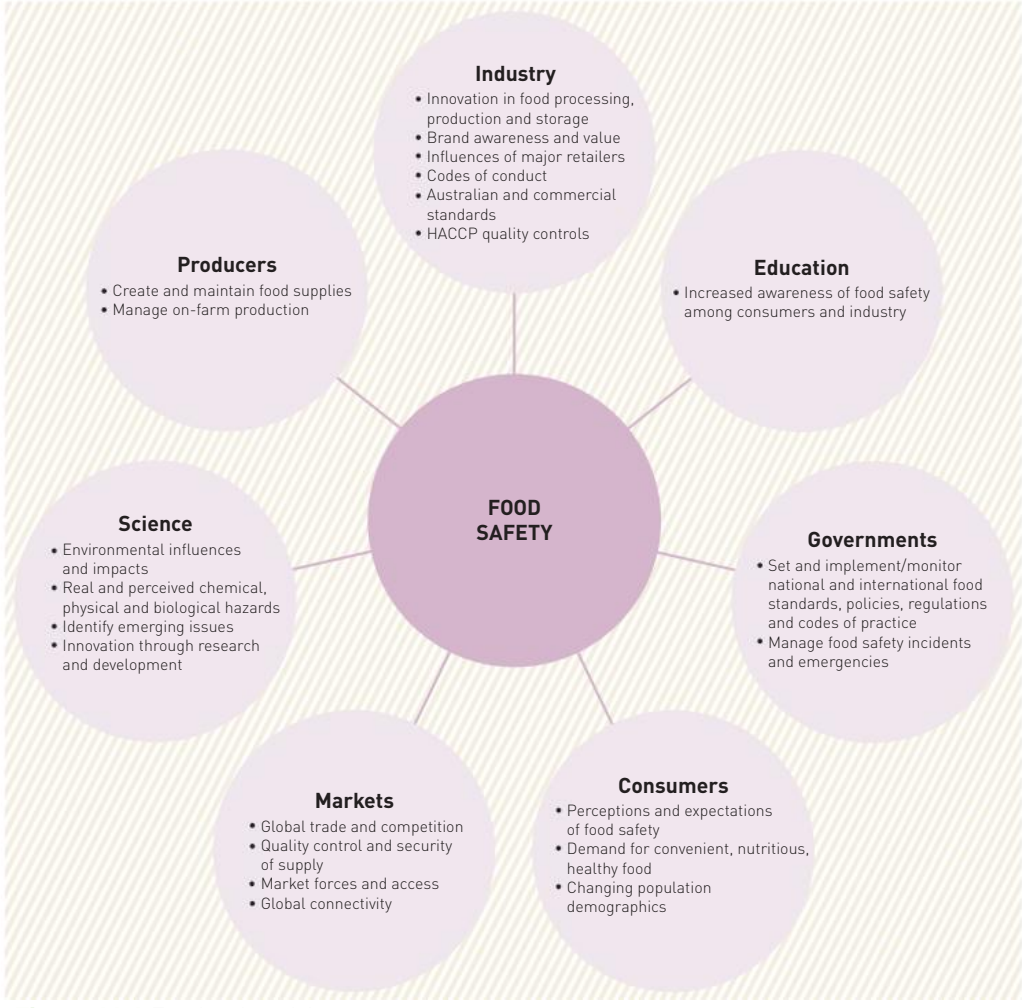


Figure 11.6 Food safety drivers

Table 11.1 NSW government legislation that impacts on the Australian food industry

ACT	DESCRIPTION AND OBJECTIVE
Work Health and Safety Act 2011 (NSW)	The main objective of this Act is to provide a consistent framework to protect the health and safety of workers and workplaces. This is achieved by aiming to protect individuals from harm to their health, safety and welfare. It helps individuals through the elimination or minimisation of risks arising from work or from specified types of substances or plants. If also provides fair and effective support and advice in relation to work health and safety by encouraging all parties to take a constructive role in promoting improvements in work health and safety practices. It also assist businesses and workers to achieve a healthier and safer working environment by provide advice, training, education and information in relation to work health and safety.
Protection of the Environment Act 1997 (NSW)	The aim of this Act is to protect, restore and enhance the quality of the environment in New South Wales, while ensuring ecologically sustainable development is maintained. It also aims to reduce risks to human health and prevent the degradation of the environment through pollution prevention, cleaner production and the elimination of harmful wastes.
Biosecurity Act 2015 (NSW)	The primary object of this Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers.
Marine Safety Act 1998	The objective of this Act is to ensure the safe operation of vessels in sea ports and other waterways.

NSWFA and the local government's role in food safety

The NSW Food Authority was established in 2004 to provide the state with an integrated food regulation system. Many organisations work with the NSWFA to ensure a safe and hygienic food supply, and they are the single point of contact relating to food safety and regulation for industry, local government and consumers. As stated on their website, their aims and objectives are to 'ensure the safety and integrity of the food industry in NSW (from paddock to plate) by regulating and monitoring food safety, managing food-related incidents such as food-borne illness outbreaks and participating in safe food-handling promotions – in conjunction with other government agencies, industry to local councils'.

NSWFA also help develop and implement trans-Tasman food policies and are involved in proposals to amend the Food Standards Code. They establish food safety schemes for higher-risk foods and businesses through risk analysis, along with educating consumers by providing information on good food-handling practices and assistance in understanding food labels. They have led the way on national policy initiatives such as requiring fast-food outlets to disclose nutrition information.

LOCAL COUNCILS

At the local government level, each suburb, district and council is responsible for appointing an environmental health officer (EHO) whose role is to specialise in food surveillance. They are responsible for inspecting food and food premises and advising on building requirements, such as the construction and alteration of food premises.

Working for the local government, EHOs have the authority under the *Food Act 2003* to do routine inspections of all food premises in their local area without notifying the business beforehand. Their role may vary according to the council they work for; however, their responsibilities generally include investigating complaints about food premises and ensuring that food preparation is safe and hygienic.

EHOs will also ensure all food is stored and served according to the set guidelines and standards. If a problem arises, they may take food samples for chemical and microbial analysis. They are also responsible for educating food industry workers about food safety, hygiene and checking food suppliers. After inspections, they compile reports relating to the premises and if required, recommend any improvements needed. If, upon further inspection, the business still fails to fix the problems, the EHO can issue fines and close down the premises. EHOs also work closely with the NSW Food Authority to ensure that all foods sold meet labelling and other legal requirements. The NSWFA publishes lists of businesses that have breached or are alleged to have breached NSW food

safety laws. Publishing these lists gives consumers more information to make decisions about where they eat or buy food. EHO's play an important role in maintaining food safety standards at the local government level to ensure a safe and reliable food supply for consumers.

FOCUS QUESTIONS 11.2

REVIEW

1 What are the main aims of the *Competition and Consumer Act 2010*?
2 Which organisations are responsible for setting up Codex?
3 What is the difference between a priority 1 and priority 4 business under the *NSW Food Act 2003*?

FOR YOU TO APPLY

4 Discuss why the implementation of the *Workplace Health and Safety Act 2011* is important for employees and employers.
5 Create three mind maps relating to legislation that governs the Australian food industry at a federal, state and local level.

EXTEND YOURSELF

6 Debate the topic 'Free trade agreements are to the detriment of the Australian food industry'.
7 Go to the NSW Food Authority website and locate the register of penalty notices. Browse the notices and take notes about the penalties that have been issued. Consider their impact upon the food businesses involved.

NSW register of penalty notices

FOOD IN FOCUS 11.1

RAW PRAWN IMPORTS BANNED OVER WHITE SPOT DISEASE

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Figure 11.7 The import of raw green prawns into Australia was suspended in January 2017.

The import of all raw green prawns into Australia has been suspended following an outbreak of deadly white spot disease at five prawn farms south of Brisbane.

Agriculture and Water Resources Minister Barnaby Joyce yesterday announced the temporary ban, designed to protect the $358 million local prawn industry from the highly contagious virus not previously found in Australia. About one-third of overseas prawns are imported raw, but the temporary ban is not expected to affect consumer prices.

Vietnam, China and Thailand are the major sources of the 48,000 tonnes of prawns worth $620m that were imported last year. The white spot disease is endemic in all three countries.

The ban will remain until the cause of the Logan River farms contamination can be identified. Other prawn products are imported cooked, marinated or crumbed and cannot carry the active white spot virus.

While the source and cause of the Logan River outbreak remains a mystery, one major Chinese prawn importer, Sino, yesterday had its import licence revoked and will face serious criminal charges for breaching Australian quarantine laws.

The federal government is also set to revoke the import licences of four other foreign importers it has been investigating, accusing them of deliberately breaching biosecurity rules.

It is alleged Sino and the other four companies deliberately provided samples of non-infected green prawns for biosecurity testing by the federal Agriculture Department when their imported consignments were known to be contaminated with the disease.

White spot might have contaminated the Logan River prawn farms from an infected imported raw prawn being used as fishing bait and then passing into the local food chain.

>

Alternatively, an infected raw prawn or shell could have been thrown deliberately into the farms. Mr Joyce said the priority was to protect the local prawn industry, which catches 20 000 tonnes of wild prawns annually and farms another 5200 tonnes, worth $86m, mostly in large prawn farms in north Queensland, which remain free of the white spot disease. 'We will not be taking any chances; Australia's prawn industry must be protected and not put at risk by the selfish actions of a few,' Mr Joyce said. He appealed to holidaying Australians not to use imported green prawns that might carry the deadly disease as bait. Infected prawns die quickly from the white spot disease, with the infected Logan River farms all now emptied of prawns and decontaminated. Two other nearby coastal prawn farms have been quarantined as precautionary measure, although they remain free of white spot. Mr Joyce stressed yesterday that the temporary suspension of green prawn imports was on quarantine grounds and not because the prawns were a risk to public safety.

Eating a white spot-infected prawn — most imported green prawns are sold in Coles and Woolworths or used by the food services industry as a low-cost alternative to more expensive Australian prawns — cannot make people sick.

RESPOND

1. Why has the importation of raw prawns into Australia been banned?
2. Identify the countries that Australia imports the most prawns from.
3. How might the white spot disease have been introduced into Australian waters?
4. What consequences might there be for the Australian prawn industry from white spot disease if the importation ban had not been enacted?
5. What is the purpose of quarantining some prawn producers despite their products not being affected?
6. Discuss how the importation ban will protect the local prawn industry and preserve our biosecurity. How has this ban affected consumers?

Chapter review

REVIEW

1 Why are policies and legislation important for the Australian food industry?
2 What is the role of advisory groups relating to policy and legislation?
3 Outline the role of an environmental health officer.
4 What are the main aims of the *Food Act NSW 2003*?
5 Identify the four key nutrition priority areas.
6 Discuss the role of the Department of Agriculture and Water Resources in relation to biosecurity.

FOR YOU TO APPLY

7 Research the countries that Australia has trade agreements with. What commodities do we export to these countries? What do we import? What are the advantages and disadvantages of having FTAs?

EXTEND YOURSELF

8 Using examples, discuss which policies and legislation have the most significant impact on Australia's food supply.

CORE STRAND REVIEW

MULTIPLE-CHOICE

1 What are the main benefits of organic farming to the consumer?

- **A** Cheaper food products
- **B** Increased shelf life of fresh products
- **C** Foods free from chemical residues
- **D** Larger foods that are free of insect damage and blemishes

2 Which level of operation dominates the food manufacturing industry in Australia?

- **A** Household
- **B** Multinational
- **C** Small business
- **D** Large company

3 A food manufacturer has identified a source of contamination in a food product they sell nationally. Which advisory group should be consulted to assist with the food recall?

- **A** CSIRO
- **B** FSANZ
- **C** Australian Food and Grocery Council
- **D** NSW Food Authority

4 A bakery has an untrained worker operating the bread slicing machine. What legislation is being breached?

- **A** *Food Act 2003* (NSW)
- **B** *Work Health and Safety Act 2011* (NSW)
- **C** *Competition and Consumer Act 2010* (Commonwealth)
- **D** *Food Standards Australia New Zealand Act 1991* (Commonwealth)

5 Which of the following best describes the activities carried out in the agriculture and fisheries sector?

- **A** Processing of raw materials
- **B** Purchasing of food from outlets
- **C** Production of plants and animals
- **D** Preparation of food for customers

SHORT ANSWER

6 Identify in which sector of the food industry each of the following recent developments have occurred:

- **a** Technological applications helping to overcome harsh climatic conditions
- **b** Busy lifestyles and greater disposable income
- **c** Growth and development of multinationals
- **d** Expanding aquaculture markets
- **e** Self-serve check outs, online shopping and home delivery services (5 marks)

7 Identify a recent situation where the activities of one sector of the Australian food industry have had a negative impact on other sectors. (2 marks)

8 What benefits does research and development offer a food business? (2 marks)

9 Describe the role of the CSIRO in the Australian food industry. (2 marks)

10 Explain the term quality assurance. Why is it important to a food business? (4 marks)

11 Outline the importance of the Australian food industry to society and the Australian economy. (4 marks)

12 What are the differences between policy and legislation? (2 marks)

13 Discuss the importance of biosecurity in the Australian food industry. (5 marks)

14 What is the role of FSANZ? Why are they important to the Australian food industry? (5 marks)

15 Summarise the contents of the four chapters of the Food Standards Code. (8 marks)

>

EXTENDED RESPONSE

16 Identify and describe the activities carried out by one organisation that operates in the Australian food industry. Explain the activities carried out by this organisation in relation to the following points:

- Level of operation
- Impact on the individual, society and the environment
- Quality assurance techniques used
- How they respond to consumer demand
- Career opportunities and working conditions
- What policies and legislation do they comply with? (15 marks)

17 Choose one sector of the Australian food industry.

a Outline three ways in which this sector has had a positive impact on Australian society.

b Using two examples, explain how this sector contributes to the Australian economy.

c Discuss two recent developments that have occurred in this sector and their impact on society. (15 marks)

CHAPTER 12

Production and processing of food

The aim of a food manufacturing organisation is to add value or transform a product that is then sold for human consumption. For this to be achieved successfully, a company must be able to source a sufficient *quantity* of good *quality* raw materials, then process the product using suitable equipment and best practice systems to ensure a safe and viable product for consumers in the marketplace.

CHAPTER OUTCOMES

In this chapter you will learn about:

- Quality and quantity control
- How food additives are used in the manufacturing process
- The equipment used in food production
- Production systems used in food manufacture – from small-scale manual operations to large computerised operations
- Quality management considerations

KEY TERMS

food additives
food manufacturing equipment
flow process chart
quality management systems
production systems
raw materials

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Quality and quantity of raw materials

Raw materials may be defined as any product that is used in the manufacture or production of a processed good.

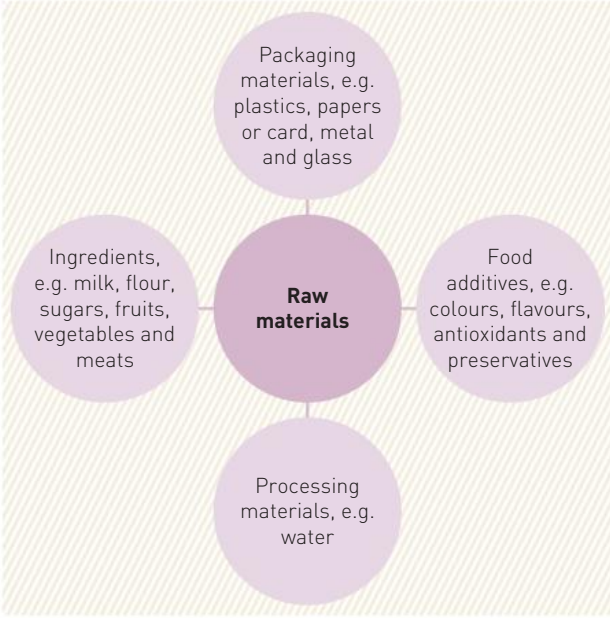

Figure 12.1 Raw materials used in food processing and manufacturing can be classified into four main areas.

Raw materials entering a food processing plant have usually been subjected to some form of processing. Herbs may have been dried, ground and packaged; flour has been ground from wheat; fruits and vegetables may have been peeled and cooked. Because of their prior processing, the quality control of raw materials entering the manufacturing plant is very important. All incoming raw materials must undergo testing to ensure they are the right quality before being used.

QUALITY CONTROL OF RAW MATERIALS

In manufacturing, quality control and quality assurance is everyone's responsibility. Food manufacturing organisations spend significant time and money sourcing and procuring quality raw materials in order to produce their products to the highest standard possible.

Suppliers are investigated to make certain they are able to provide a sufficient quantity of quality raw materials that meet the standards stipulated by the manufacturing organisation. Raw materials supplied must be free of impurities, pollutants and contaminants and meet the standards, called raw materials specifications, required by the manufacturer.

By law, all raw materials must be purchased from reputable suppliers. Raw materials must not enter a manufacturing plant unless they have been verified and established as having met the company's specifications, as detailed in the check sheet.

Testing of raw materials is referred to as quality control and is generally carried out by specialised quality control technicians. Some organisations may arrange for quality testing to be done by the supplier prior to delivery. The goal of the quality control testing is to establish the quality of raw materials and to detect any problems and prevent contamination of other raw materials. Contaminated raw materials can result in an inferior end product that may need to be discarded, resulting in financial losses for the organisation.

Raw materials that fail to meet the strict guidelines in the raw materials specifications are rejected and returned to the supplier or disposed of with no payment.

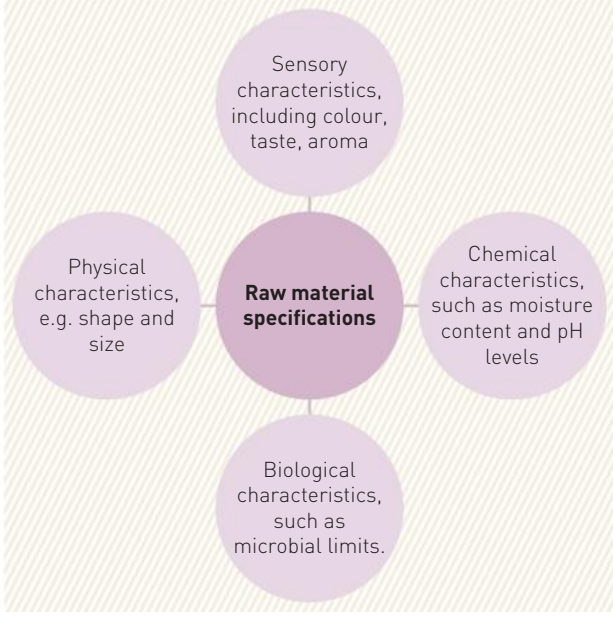

Figure 12.2 Raw materials specifications

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Figure 12.3 Raw materials, such as strawberries for a juice company, are rejected if they do not meet specifications.

CREATING RAW MATERIAL SPECIFICATIONS

Traditionally, the R&D team were responsible for selecting raw materials. In today's manufacturing world, a comprehensive team of experts is required to source and set up raw material specifications. This is due to increased access to unique and complex raw materials, international sourcing, handling methods, geographic locations, and strict regulations. The team is responsible for assessing the material and determining if there are any limitations such as the product being too costly to handle, or if additional safety measures are necessary to prevent potential issues for staff or the product.

The team responsible for selecting and setting up specifications for raw materials may be made up of specialists from the following areas: R&D, quality assurance and production (from receiving to shipping and sales).

Once the team is assembled, they discuss and agree upon the key characteristics for the raw materials. Then the next step is to document these expectations. The complexity of raw material specification sheets will differ depending upon the size of the organisation and the types of products made. As a minimum, the following information relating to technical and food safety information should be included:

- the name and a description of the product, including the components or composition of the material
- the presence of regulated or customer-recognised food allergens
- organoleptic information (appearance, flavour, and aroma)
- pertinent physical, chemical, and microbiological information
- shipping and storage information
- shelf life
- handling directions.

These requirements are designed to provide accurate descriptions of the raw material along with certain tolerances and standards relating to physical characteristics such as size and shape, and sensory characteristics such as colour and aroma. The chemical characteristics such as moisture content, pH level and tolerances for microbiological limits should also be noted. There is no value to the manufacturer in specifying a characteristic unless it can be tested. A clear understanding of the materials being obtained is essential for suppliers and customers alike. Materials that do not meet the manufacturers expectations or specifications may significantly reduce productivity, increase costs and may place the product, company and consumers at risk. Should a raw material not meet the specifications, action needs to be taken to rectify the problem. The manufacturer may do the following once results have been obtained from the tests.

1. Accept the raw material if it complies with the set standards.
2. Reject the raw material if it does not comply with set standards.
3. Start procedures to control the problem if the raw material is not outside the set standards but has the potential to deteriorate further.

Similar types of specifications are used to explain and outline the quality features of a final product once processed.

Food additives

Food additives are substances added to food that are not normally consumed by themselves. They are an important part of our food supply, ensuring our food is nutritious, safe to eat, convenient, and meets the needs of the consumer. Food additives may include food colourings (such as tartrazine-yellow or cochineal-red), flavour enhancers (such as monosodium glutamate) or a range of preservatives. They are mostly used in processed foods and in relatively small amounts. Without the use of additives, food processing, manufacture and distribution would be almost impossible. It is common for people to mistakenly believe that processed foods automatically contain food additives. Foods such as long-life milk and frozen foods are all processed, yet contain no food additives. It is wise to check food labels if you are uncertain whether or not a product contains an additive. Be aware that some ingredients in 'value added' products listed may contain food additives without this being mentioned on the label. For instance, 'margarine' might be listed as an ingredient and margarine contains food additives.

Getty Images/ROBYN BECK/AFP

Figure 12.4 Food additives are listed on food packaging but sometimes they can be present within other ingredients.

Uses for food additives during processing and manufacture

Food additives can be used to improve the taste or appearance of a processed food. For example, beeswax, a glazing agent (901), may be used to coat apples to improve their appearance and make them shiny under the lights in retail outlets. Additives can also improve the keeping quality and stability of a food. For example, sorbitol, a humectant (420), may be added to mixed dried fruit to maintain the moisture level and softness of the fruit. They are used to preserve food by extending its storage life; for example, sulfur dioxide, a preservative (220), is added to some meat products such as sausage meat to limit microbial growth. Some additives may also be used

PRACTICAL APPLICATION 12.1

SENSORY ANALYSIS OF FOODS WITH AND WITHOUT ADDITIVES

AIM

To investigate the difference between a frozen, pre-prepared lemon tart, packet mix lemon tart and a lemon tart made from scratch.

METHOD

Lemon meringue tart

1. Find and prepare a recipe for a traditional lemon meringue tart. You may use the recipe on the website accompanying this book.
2. Purchase and thaw a frozen pre-prepared lemon meringue tart
3. Purchase and prepare a packet mix lemon meringue tart.

RESPOND

Additives

1. Conduct a sensory analysis and evaluation of the three products.
2. Was there any textual differences between the three products?
3. Outline the role of the additives in the frozen and packet mix.
4. As a group, debate the following statement: 'The use of additives is essential to ensure a safe and reliable food supply for the domestic and internal market'.

to supplement special dietary needs, such as the use of artificial sweeteners in products that are sugar free.

Some common food additives can be purchased at the supermarket and are common additions to many recipes. Food colouring, flavouring essence, food acids and artificial sweeteners are all examples of food additives. Food additives can be placed in classes or functional groups.

Many substances used as additives occur naturally. Additives such as vitamin C or ascorbic acid (300) is found in fruit, and lecithin (322), which is present in egg yolks, soya beans, peanuts and corn. The human body cannot distinguish between a chemical naturally present in a food and that same chemical present as an additive. However, some people are allergic or intolerant to certain types of additives. For most of the population, additives do not pose a problem in the short term. However, scientific testing has found that approximately 50 of the 400 approved additives in Australia have been linked to adverse reactions in some consumers. Some food additives, often the ones used to give a food a particular sought-after quality such as colour, are more likely to cause reactions than others. Some of these reactions include:

- Digestive disorders – diarrhoea and colicky pains
- Nervous disorders – hyperactivity, insomnia and irritability
- Respiratory problems – asthma, rhinitis and sinusitis
- Skin problems – hives, itching, rashes and swelling

Some specific food additives that may cause problems for consumers include:

- flavour enhancers – monosodium glutamate (MSG) 621
- food colourings – tartrazine 102; yellow 2G107; sunset yellow FCF110; and cochineal 120
- preservatives – benzoates 210, 211, 212, 213; nitrates 249, 250, 251, 252; and sulphites 220, 221, 222, 223, 224, 225, 228
- artificial sweetener – aspartame 951.

It is important to note that many of the symptoms experienced as a result of food sensitivities may actually be caused by other disorders. Therefore, seek the assistance of a medical practitioner for confirmation.

Regulating food additives

For foods that are processed and manufactured in Australia, FSANZ has overall control over the use of additives. The FSANZ website provides a comprehensive list of additives approved for use in foods sold in Australia. This list applies to locally produced products as well as those that have been imported.

Should a manufacturer choose to use an alternative or additional substance to those listed,

FOOD IN FOCUS 12.1

FOOD ADDITIVES

Ben is a six-year-old boy who has an assortment of food intolerances. As a younger child, Ben was always active, on the go and found it hard to sit still and concentrate for long periods. His mother noticed that certain foods made his behaviour worse. After much distress for his family, it was found that Ben's was intolerant to many different substances. Ben's family discovered what triggered his poor behaviour through trial and error and eliminating certain products from his diet.

In due course, it was established that Ben reacted to most food colourings and preservatives along with lactose and gluten. However, there is a wide variety of foods that Ben is able to consume and enjoy.

If Ben is invited to attend special events such birthday parties or sleepovers, his mother contacts the child's parents to discuss his food intolerances. Sometimes it is necessary for his mother to pack his own meal and snacks for him to avoid consuming the types of food that may trigger a reaction. Ben is allowed to consume sweets and treats, providing they are free from the ingredients he is intolerant to.

Ben's parents have started encouraging him to make his own food choices when it comes to selecting food to eat when they are out and also when doing the grocery shopping with his parents. Occasionally, Ben makes a poor food choice which leads to a decline in his behaviour, but more often than not he chooses the correct foods.

Since controlling his diet, the family have found that he does not display any signs or symptoms of his previous hyperactivity.

RESPOND

1. Do you think Ben's case is an isolated problem? Why?
2. Do you believe Ben's parents should give him the responsibility of choosing his own foods when shopping and eating out? Discuss your reasons.
3. Discuss the physical and emotional feelings that Ben would experience when having a severe hyperactive reaction to foods?
4. Plan a selection of recess and lunch items that Ben could eat at school. You will need to keep in mind the types of additives and food substances Ben is intolerant to.

they must apply to FSANZ for approval. This application process was established to ensure consumer safety by regulating what can and cannot be used in food processing and manufacture. If an organisation is applying to use a new additive, they must provide proof to FSANZ of its safety, as well as the technological reasons for its use as a food additive. The role of FSANZ is to review the evidence supplied before making a decision about an additive's use.

As previously mentioned, if additives are used they must be included on the product label in the nutrition information panel. Because the names of some additives are very long, a code numbering system for food additives was developed and implemented. Since 1986, additives used in food production and manufacture in Australia have been identified by their class name along with an individual name or code number. This system is based on an international system used to identify all food additives. It also enables someone intolerant to a particular additive to easily identify whether a food product contains it.

Alamy Stock Photo/DWImages

Figure 12.5 Food additives are often identified by a code number.

Table 12.1 Functional groups of food additives

ADDITIVE	FUNCTION	EXAMPLE	FOUND IN
Acids/acidity regulators/ alkalis	Help maintain a constant acid level in food. Important for taste, as well as to influence how other substances in the food function; e.g.an acidic food can retard the growth of some micro-organisms.	Tartaric acid 334	Fruit juice drinks Pasta sauces
Anti-caking agents	Reduce the tendency of individual food particles to stick together and improve flowing characteristics; e.g. seasoning with an added anti-caking agent flows freely and doesn't clump together.	Calcium carbonate 170	Salt
Antioxidants	Retard or prevent the oxidative deterioration of foods; e.g. in fats and oils, rancid flavours can develop when they are exposed to oxygen. Antioxidants prevent this from happening.	BHA – butylated hydroxyanisole 320	Margarine and spreads Salad dressings Walnuts Instant mashed potato

Table 12.1 *(Continued)*

ADDITIVE	FUNCTION	EXAMPLE	FOUND IN
Artificial sweeteners	Replace the sweetness normally provided by sugars in foods without contributing significantly to their available energy.	Sacharines 954	Diet soft drinks Diet yoghurts
Bulking agents	Increase the volume of food; e.g. sugar often contributes to the volume of lollies, while some low-joule foods need bulking agents added to them to replace the bulk normally provided by sugar.	Sorbitol 420	Chewing gum
Colours	Add or restore colour to foods; e.g. icing mixture is coloured to make it more attractive on cakes.	Tartrazine 102	Jellies Jams Confectionary
Emulsifiers	Stop oil and water from separating into layers; may be used in margarine to prevent oil forming a layer on top.	Lecithin 322	Ice-cream Margarine
Firming agents	Maintain even dispersion of substances in solid and semi-solid foods.	Calcium chloride 509	Tofu Cheese making
Flavour enhancers	Enhance the existing taste and/or odour of a food.	Monosodium glutamate 621	Stock powder Instant noodles
Humectants	Reduce moisture loss in foods; e.g. glycerine may be added to icing to prevent it from drying out.	Sorbitol 420	Pastries Dried fruits
Preservatives	Retard or prevent the deterioration of food by micro-organisms, and thus prevent spoilage of foods.	Sulfur dioxide 220	Wine Dry cereal with semi-moist raisins
Thickeners	Increase the viscosity of a food; e.g. a sauce might contain a thickener to give it the desired consistency.	Dextrins 1400	Packet sauces Gravy mix

Shutterstock.com/nito (corn chips), Nastya22 (cordial), Hong Vo (fruit loops), BW Folsom (canned fruit), Gossip (fairy bread), D Pimborough (licorice sweets), Joe Gough (red cheddar)

Figure 12.6 Which additives might be found in these snack foods?

PRACTICAL APPLICATION 12.2

ADDITIVES IN SNACK FOODS

AIM

To determine the common additives in popular snack and convenience foods

METHOD

1 As a group, collect a variety of packaging from popular snack and convenience foods.
2 Using the list of ingredients found on the packaging, identify the additives in each product and outline the class of additive they fit into.

RESPOND

1 Are there any additives that are common in all products?
2 Discuss the role of additives in food manufacturing. Outline the advantages and disadvantages of using food additives in manufactured products.
3 Why was the code numbering system for food additives introduced?

Characteristics of equipment used in production

The size, shape, type and level of complexity of food manufacturing equipment will vary depending on the quantity of food being produced. Food manufacturing equipment is created and designed to perform the tasks in a similar way to domestic kitchen appliances and utensils, albeit on a much larger scale. Because of the nature of food processing and manufacturing, it is important that machines and equipment are able to withstand long operating hours, produce large volumes and be easy to clean to avoid cross-contamination that may pose a risk to public health. Safety of staff within the processing plant is also taken into consideration when designing and manufacturing such equipment. Important attributes for food manufacturing equipment are described as follows.

Efficient, durable and sturdy

Processing equipment may need to operate continuously and process large quantities of food. A consistent end product is also an important factor when considering equipment. The reliability of the equipment is also considered as it is costly for the organisation if production is halted due to breakdowns. Industrial equipment may run 24 hours a day, 7 days a week; therefore, energy efficiency is essential. Gas is generally used as a heating source as it is cost effective and efficient.

Safe and hygienic

It is vital that processing equipment is easy to clean. The cleaning of manufacturing equipment is often carried out by a cleaning in place (CIP) process. This process is commonly used in hygiene-critical processing industries such as the food and beverage manufacturing industries. It uses a mix of chemicals, heat and water to clean and sanitise machinery, fittings and pipes without having to dismantle equipment. This is an integral part of automated processing plants as it is fast and less labour intensive than conventional cleaning methods.

Processing equipment must also be fitted with safety guards to prevent staff being injured. The equipment must also be constructed from non-reactive and non-corrosive materials, such as stainless steel, which is strong, scratch-resistant and impervious.

iStock.com/leezsnow

Figure 12.7 Equipment used in food production is highly varied.

Production systems

Food is produced in a variety of different ways, from costly manual labour through to highly automated and computerised production systems.

The type of production system used by a food manufacturer will depend on certain factors. These include the type of product being made, the amount of product being produced along with the cost and time involved to set up new production systems.

Table 12.2 Production systems are classified into five main categories

PRODUCTION SYSTEM	DESCRIPTION AND MAIN FEATURES
Small scale	Small-scale production is used at the household (domestic) level of production. They are much less complex to operate; e.g. a piping bag to pipe cream into éclairs, or a domestic food processor or KitchenAid mixer to make dough.
Manual	This involves an employee physically adding ingredients or performing certain operations by hand. Usually found in small-scale operations, the organisation relies heavily on the skill and judgement of its staff. The costs associated with this operation are usually high and efficiency and consistency is often reduced. As its name suggests, this level of production is labour intensive; e.g. hand dipping chocolate truffles.
Large scale	Used in large production operations where there may be production lines, large-scale production has the advantage of producing large volumes of product over short periods. This production level could include Arnott's biscuits.
Automated	Automation refers to when machines handle and control the processing of food from the receipt of raw materials through to the finished product. Automated systems have preset and predetermined specifications for operation, mixing times and speed, temperature control, cooking or cooling times, cleaning and sterilisation; e.g. an automated production line to process fresh milk.
Computerised	In highly sophisticated manufacturing organisations, the automated equipment and machinery are operated by computerised sensors that are capable of keeping complex operations running 24/7. These computerised systems have the ability to store complex data, keep records of batch numbers, pH levels, production conditions, dates and times. Cheese making is an example of a production system that uses computerisation.

Unit operations

Food processing and manufacturing equipment is designed or modified to complete certain processes depending on the foodstuff being produced. Each step of the production process is referred to as a unit operation. A variety of different employees will work in the manufacturing plant to operate and oversee production.

Unit operations

Food processing plants use many different types of equipment that vary from plant to plant depending on the foods being processed or produced. The term unit operations refers to the detailed processes food is subjected to during production to obtain a product that is safe for human consumption. Examples of unit processes include heating, mixing and transportation. A processing plant will use a variety of raw materials and may require many different types of processing equipment to perform certain unit operations. The use of separate unit operations is required as many manufacturers produce a large assortment of products. There are many different unit operations; we will look in detail at the most common used by the food processing and manufacturing industry.

Separation processes

The food processing and manufacturing industry uses several techniques to transform food ingredients into different forms for consumers. Separation of food can be done in two ways. It can occur as physical separation of the components of food, such as removing the skins from fruit and vegetables, or as chemical separation of components in foods, such as adding chemicals to milk to separate the whey from the fat and protein when making cheese.

Table 12.3 Methods of separating food components commonly used in food manufacturing

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Separation	To isolate or remove certain components of food	Sieving Removing the peel from fruit and vegetables	Potato rumbler	Sifting flour to remove lumps or husks
Filtration	Passing liquid through a filter	Sieving	Filtration system	Removing pulp and fibre form orange juice Removing curd from whey
Centrifugation	Separation of food particles that have different densities	Spinning salad to remove water from leaves after washing	Centrifuge	Separating cream from whole milk

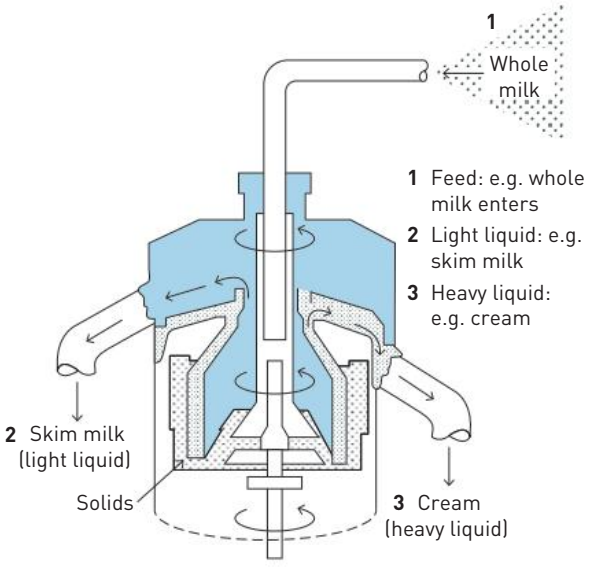

Figure 12.8 The separation of cream from whole milk in a centrifuge

Physically separating food components is most commonly used in food manufacturing. Methods include sieving, filtration and centrifuging.

Reducing the size of raw food components

Slicing, dicing, chopping, grinding and milling of food components is designed to reduce the size of the ingredient so it can be processed as required. Food sizes may be reduced for many reasons, including to make the ingredient easier to handle or to make it better able to be incorporated into a final product. Size reduction may also be necessary to make a completely new product, such as milling wheat to make flour or grinding whole coffee beans to put into coffee pods.

courtesy of Treif

Figure 12.9 Industrial dicing machines make dicing vegetables easy.

Table 12.4 Size reduction in industrial food processing

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Grinding and milling	To make food smaller or into a paste	Salt or pepper mill Spice grinders Mortar and pestle	Computerised grinding and milling machines Grinders and processers	Milled spices for curry pastes
Cutting, slicing, dicing and grating	To make food smaller	Using a knife to cut vegetables into small pieces	Dicing, strip-cutting and grating machines	Pre-cut stir-fry vegetables Bags of grated cheese

Mixing

Mixing is the process used to ensure all ingredients are thoroughly incorporated and dispersed throughout a batch of product. Equipment used to mix ingredients will vary from highly computerised systems used by food manufacturers, to manually operated mixers in small businesses and industries. The type of machine used also depends on the size of the batch and the food ingredients being mixed.

Getty Images/Gary Ombler

Figure 12.10 Industrial mixing machines are crucial to creating quality products.

Table 12.5 Mixing in industrial food processing

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Mixing	To incorporate food ingredients into each other	Using a wooden spoon, electric beater or whisk.	High-pressure mixers Industrial mixers Bread-kneading machines	Whisking egg whites to make a pavlova Mixing bread dough

Heating processes and equipment

The three most common methods of transferring heat to cook food include conduction, convection and radiation.

Conduction occurs when food is heated by having direct contact with a hot surface, such as frying an egg. Convection is the processing of heating or cooking food by the movement of liquids or gases around the food, such as steaming or boiling vegetables. Radiation refers to having a heat source directly above or beside the food, which cooks or heats the food without touching it, such as a toaster.

The heating and subsequent cooking of food using steam is probably the process used most often in food manufacturing. The type of heating equipment used depends on the type and composition of the food being processed.

It is common for food manufacturers to heat food using tubular heat exchangers or plate heat exchangers. A tubular heat exchanger operates by having hot water or steam flowing through an outer surrounding case while the food products flow through an inside tube, heating the product as it flows. A plate heat exchanger works by having the food product flow between several heated surfaces in a very thin stream. This system allows the product to be heated evenly and at a rapid rate.

In the food manufacturing industry, heating or cooking food can be done using blanching, canning, baking, heat exchangers and evaporation, as shown in the table below.

Table 12.6 Heating processes used in industrial food manufacturing

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Blanching (a processing method, not used to fully cook food)	Low-intensity heat-transfer method used to destroy enzymes that may cause food spoilage	Plunging food into boiling water on a stove	Blanching tanks and steam blasters	Used when processing freshly picked vegetables prior to freezing
High temperature short time (HTST)	To destroy pathogenic micro-organisms	n/a	Tubular heat exchangers and plate heat exchangers	Plate heat exchangers to pasteurise milk and fruit juices Tubular heat exchangers to make pasta sauces

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Table 12.6 *(Continued)*

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Canning and bottling	To preserve food in metal or glass containers and extend its shelf life	Fowlers Vacola home bottling and preservation systems	Canning, aseptic canning and glass production lines Retort machines	Tinned fruits Glass jars of pickled onions or gherkins
Baking	To cook food, and in some cases such as biscuit making, to remove moisture	Oven and microwave	Industrial ovens Tunnel ovens	Bread, cakes and biscuits

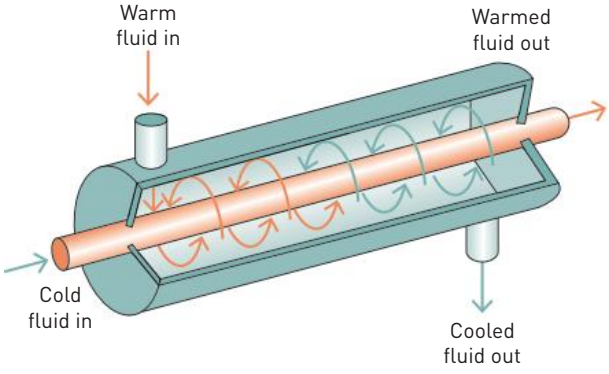

Figure 12.11 A tubular heat exchanger

Figure 12.12 An industrial tunnel oven

Cooling processes and equipment

The chilling or cooling of food is used to slow down or halt the activity of micro-organisms and enzymes that contribute to food spoilage. Food products can be cooled by using cooling exchangers or plate chillers along with commonly used cooling equipment such as refrigerators and blast chillers. Refrigerators lower the temperature of foods or manufactured products during processing and storage. Cooling systems such as plate chillers and exchangers are used in confectionary manufacture and in fruit and vegetable cold-storage warehouses. Cooling exchangers and plate coolers operate in the same way as tubular heat and plate heat exchangers, except the gas is replaced with chilled water. Blast chillers are used to rapidly reduce the temperature of products before refrigeration or freezing.

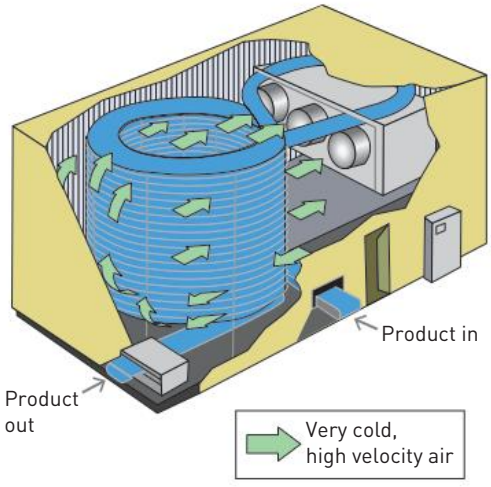

Figure 12.13 A spiral blast chiller

Table 12.7 Cooling processes used in industrial food manufacturing

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Cooling	To reduce the temperature of food and slow down the activity of micro-organisms that cause food spoilage	Refrigerator	Industrial refrigerators Blast chillers Plate coolers Chilled water exchangers	Chilling dairy products Chilling fruits and vegetables

Freezing processes and equipment

The time it takes to freeze the liquid component of a food product will determine the size of the ice crystals formed. If freezing occurs slowly and at a relatively high temperature (0 to −5°C) larger ice crystals will form. Quick freezing at low temperatures (−15 to −30°C) will produce very small ice crystals. Therefore, the most rapid rate of freezing is desirable, so that product quality is not compromised.

There are four categories of freezing equipment used in food processing and manufacturing, these are:

- air blast freezers
- plate freezers
- tunnel freezers
- immersion freezers.

Air blast freezers blow very cold air (−240 to −210°C) at high speeds around the food product and are popular in most food manufacturing plants, especially in the meat processing industry.

Plate freezing is where the food product is in direct contact and packed between plates that are kept at the desired freezing temperature. Plate freezers are used to freeze fish, meat products and vegetables. Tunnel freezing is used on continuously operating production lines and is designed to quickly freeze items during production. Food items are placed on a mesh conveyer belt or into a fluidised bed that moves through a tunnel. Cold air is passed over the food as it moves along. Food is agitated on the belt which prevents it from sticking together during the freezing process. This process is commonly used for fruit and vegetables. Immersion freezing involves the food product being in direct contact with a low-temperature refrigerant, such as brine or liquid nitrogen. The freezing temperature for liquid nitrogen is very low and this process is known as snap freezing. Soft fleshed foods such as berries are commonly processed this way.

Table 12.8 Freezing processes used in industrial food manufacturing

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Freezing	Used to change liquid into a solid so it becomes inaccessible for micro-organisms	Freezer	Air blast freezers Plate freezers Blast freezers Immersion freezers	Fruit and vegetables Meat and poultry Fish and seafood Ice-cream

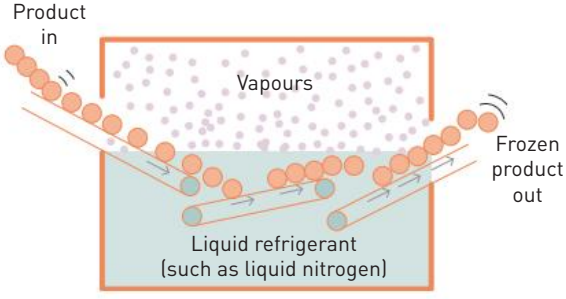

Figure 12.14 Immersion freezing using liquid nitrogen

Evaporation

Evaporation is a method used to concentrate or increase the solids concentration of a liquid food product. The temperature of a food product is raised to boiling point where it is held at 100°C until the correct concentration is achieved. The evaporation process is used to produce fruit juice concentrates and evaporated milk. The milk is reduced by 60 per cent, resulting in a thicker liquid with a concentrated flavour and colour.

Table 12.9 Evaporation processes used in industrial food manufacturing

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Evaporation	To concentrate the flavour of liquids by removing moisture	Reduction process by boiling stock on a stove top	Evaporators Spray dryers	Milk, fruit juices, tomato paste

Dehydration

Dehydration means removing moisture from a food, which affects its final volume. The aim of dehydration is to reduce a food's moisture content to between 5 and 25 per cent. At this level, there is minimal moisture left to support microbiological growth or other reactions. Moisture is removed from the food product by heating it or drying it in the atmosphere and this can be done in a number of ways. The dehydration method used will depend greatly on the characteristics of the product being processed along with the size of the batch and the desirable end characteristics.

Table 12.10 Dehydration processes used in industrial food manufacturing

PROCESS USED	PURPOSE	DOMESTIC COMPARISON	INDUSTRIAL EQUIPMENT	FOOD EXAMPLE
Dehydration	To remove moisture from food	Domestic food dehydrator	Industrial dehydrators	Fruits, herbs, vegetables
Cabinet drying	Placing food on trays in an enclosed space where hot air is circulated	n/a	Cabinet dryers	Fruits, vegetables
Tunnel drying	Used in automated production – food moves through a heated tunnel	n/a	Tunnel drying conveyer belts	Meat, vegetables and fruits
Sun drying	Using the heat from the sun to try out food	Laying food out in the sun	Large mesh trays placed outside in direct sunlight	Tomatoes, grapes
Spray drying	Liquidised food is forced through a spray nozzle into hot air; the liquid dries instantly to a powder	n/a	Spray drying cabinets Spray dryers	Instant coffee, powdered milk and dried soup powders

FOCUS QUESTIONS 12.1

REVIEW

1. Identify ways that food can be separated during the manufacturing process.
2. Outline the advantages and disadvantages of automated processing in food manufacturing?
3. Explain how centrifuging differs from filtration.
4. Define the term 'process'. Is a frozen chicken processed? Research the processes it has undergone.

FOR YOU TO APPLY

5. Research and identify the unit operations that can be performed on:
   - **a** solid foods
   - **b** liquid foods.

   Provide examples to support your research.
6. Identify three ways heat can be transferred to food. Give examples of food products heated by each method.
7. What are the advantages of fast-freezing methods over slow-freezing methods?

EXTEND YOURSELF

8. Research and identify two products that use heat exchangers as part of their processing. Discuss the process involved from the receipt of raw materials to the when the product is packaged.
9. For what type of food is evaporation used? Explain the evaporation process that is applied to the food you have identified.
10. Outline the types of cooling systems commonly used by food manufacturers. What is the purpose of cooling a product?

Flow process charts

A flow process chart is a graphic representation of a production process relating to the production and manufacture of a specific product. In the food industry, it generally represents all the steps that the raw materials go through to become a finished product. Process flowcharts are closely linked and aligned

to the quality assurance and hazard analysis critical control points (HACCP) plans of an organisation. Steps in a process chart can include receiving raw materials, storing ingredients, preparing, cooking, cooling, packaging, labelling, storing and distributing the food product. Process flowcharts are constructed using five symbols. Each symbol describes a particular process that occurs during each stage of production. The symbols can be used independently or in combination with one another. Process flowcharts must run vertically down the page of a process chart. Appropriate symbols are placed on the left-hand side of the page, with relevant details regarding that particular symbol placed to the right. All symbols must be joined by vertical lines to indicate a continuous flow. The degree of complexity of any flow process chart will be determined by the purpose of each specific chart and the product being manufactured.

Process flowcharts are an important tool for food processing and manufacturing organisations as they act as a guide and overview of the entire process the food goes through. This allows new staff to quickly become aware of each step in the production process and measure the importance of that step to the overall production line. Each individual step of the process flowchart can be analysed to decide how effective it is, relating to product standards such as quality and quantity. Process flowcharts can also be used to identify critical control points that could pose a risk to public health or loss of revenue.

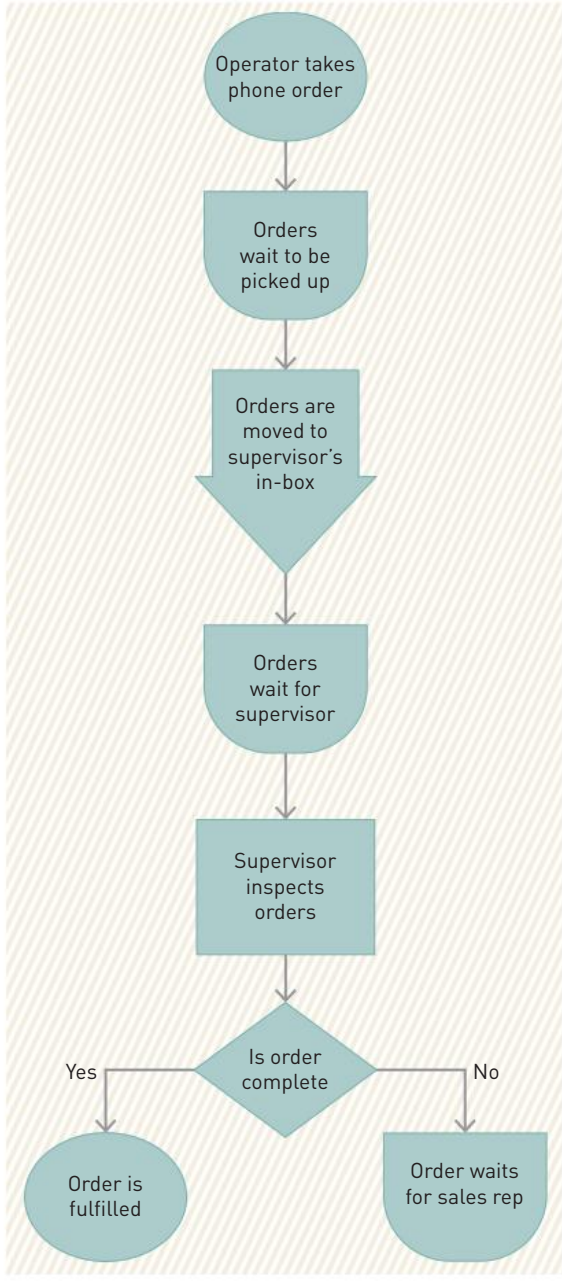

Figure 12.15 A sample flowchart

Operation

A unit operation takes place when a raw material is purposely changed in any way, shape or form. This could be either a chemical or microbiological change or a step in processing where an item is put together or separated from other raw materials. It may also relate to the process of preparing raw materials to undergo another operation or inspection, transportation, storage or distribution. An operation generally requires some form of labour along with the use of equipment. Examples of an operation in food processing are cutting, grinding, milling, peeling, mixing, cooking, chilling and freezing.

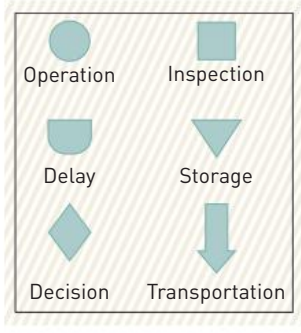

Figure 12.16 Sample flowchart symbols

Inspection

An inspection happens when raw materials or the final product are examined, tested, sampled and compared to set standards. These standards measure quantity, quality and other characteristics set by the

manufacturer. Again, inspection requires some form of human labour along with the use of sophisticated equipment and machines designed to determine if the product meet the specifications determined by the process. Inspections are designed to ensure that the process is being performed correctly and they can also measure quality or quantity of foods produced. Examples of inspection would be recording the temperature of ingredients that are being cooked and canned, or inspecting eggs for cracks in shells before use.

Transportation

Transportation occurs when human labour and equipment such as conveyer belts, forklifts, robots and laser-guided vehicles are used to transport a product from one place to another. This may be from the production line to the warehouse or to another part of the processing plant in order for another operation to be performed. It is important that this type of transportation occurs without altering the product or packaging material. Examples of transportation in food processing would be pumping tomato paste from a holding tank to the production line, moving beetroot from the cool room to be peeled and sliced before being cooked and canned or shifting pallets of drinks to the warehouse for distribution.

Delay

A delay may be a momentary halt in the production and processing of a product and often occurs when internal systems do not allow the next step of the process to take place. Delays rarely occur as they are costly for the organisation in terms of time and money.

Storage

Storage occurs when a raw material or finished product is held in a controlled environment. This may be in temporary storage where a finished product may be held in a warehouse or when raw materials and ingredients are stored prior to use. Examples include keeping perishable items in refrigeration, keeping frozen foods in freezers, keeping canned products in specialised laboratory storage conditions to ensure the product remains shelf stable and for record keeping processes in case of future consumer complaints or product recalls.

Two procedures at once

If two procedures or operations occur at the same time, such as an operation and an inspection, then the corresponding symbols are used together. This is represented on a flow diagram a by placing one symbol inside the other. This may occur when adding raw materials into a mixing bowl that are added or mixed into other ingredients.

PRACTICAL APPLICATION

12.3

BUTTERMILK PROCESS

AIM

Create a process flowchart for the simple buttermilk pancake recipe below

Buttermilk pancakes

Buttermilk pancakes

Preparation time 10 minutes **Cooking time** 15 minutes **Serves** 2

INGREDIENTS

- 1 cup self-raising flour, sifted
- 1 tablespoon caster sugar
- 1 egg, separated
- 15 grams butter, melted
- ½ teaspoon vanilla extract
- 1 cup buttermilk
- Toppings to serve (your choice)

METHOD

1. Combine flour and sugar in a bowl
2. Combine egg yolk, melted butter, vanilla and buttermilk in another bowl
3. Whisk buttermilk mixture into the flour mixture
4. Beat egg white in a small bowl until soft peaks form
5. Fold egg white gently into the batter
6. Pour a quarter of the batter into a small greased fry pan. Cook over medium heat until browned lightly and flip over and cook
7. If you would like toppings, add your choice of toppings and serve

FOCUS QUESTIONS 12.2

REVIEW

1 Explain why process flow charts are used by food manufacturers.
2 Outline the meaning of each symbol used in a process flow chart.
3 What are the advantages of food manufacturers using process flow charts when training new staff?

FOR YOU TO APPLY

4 Create a flow chart for a manufactured food item, using the production methods listed below.
- Inspection of raw materials
- Washing
- Peeling
- Size reduction
- Blanching
- Inspection
- Chilling
- Inspection
- Snap freezing
- Packaging
- Freezer storage
- Distribution

EXTEND YOURSELF

5 Create a process flow chart for the production of a recipe of your choice. Use the appropriate symbols and describe what process occurs at each step.

Quality management considerations and systems

Quality management systems can be defined as a set of policies, processes and procedures required to plan and execute a safe and reliable food supply for consumers. Manufacturers integrate various quality management systems in their internal processes, which enables them to be proactive in identifying and controlling potential quality issues. Quality control procedures are essential for good manufacturing practices and will ultimately lead to improved business performance and better end products.

Food producers and manufacturers have set quality standard for their products. They organise their processes, from 'paddock to plate', with the focus of achieving the high-quality standards set. The phrase given to the management of these quality systems and processes is quality assurance. In order for high-quality standards to be achieved, everyone who is involved in the 'paddock-to-plate' process must work together and take responsibility for achieving quality standards.

Food safety is a significant quality assurance issue. Therefore, quality management systems such as HACCP and quality management strategies such as workplace health and safety practices are used by manufacturers to ensure safe food for consumers and a safe working environment for staff.

Setting up a quality management system

The Australian food manufacturing industry uses a number of quality assurance systems to ensure consumers receive a safe and nutritious food supply. Systems such as Good Manufacturing Practices (GMP), HACCP and International Organisation for Standardisation (ISO) are examples of quality management systems used by industry to ensure best practice. These systems are often used in combination to guarantee food quality and safety. It is important to have an understanding of how such programs work in food manufacture.

Procedures for quality assurance programs include the following:

- A clear and concise final product specification. This outlines the level of quality that is expected and ways this can be achieved.
- Procedures for assessing and evaluating the quality of the products against set specifications. Any raw materials (ingredients, packaging materials) that do not meet the specifications may be rejected.
- Specifications for the processing and manufacturing environment are also set. The

manufacturing plant must be free from physical, chemical and microbiological contaminants.

- Finally, food sampling and testing of the finished product is undertaken. This involves quality assurance personnel testing packaging and food labels to ensure these meet the standards set, and sampling and testing the food against benchmarks. Quality assurance technicians and trained staff regularly perform checks on the production lines to ensure all products meet required specifications.

Quality assurance is the responsibility of everyone and all staff must be aware of the importance of quality control to produce high-quality products. For this reason, staff are trained to accurately monitor and record any relevant information on the production line, and to quickly react and respond to problems that arise during the production process. One method used to do this is HACCP.

HACCP

As discussed in Chapter 10, HACCP is a quality assurance and food safety system that identifies potential food hazards and their control points at all stages in the production of food. HACCP has become the basis for ensuring that all food is prepared, manufactured and handled safely. Employees using the HACCP system are trained in the seven steps and are responsible for its implementation and monitoring when working on production lines.

Steps in a HACCP system

1. Conduct an assessment of the hazard. Personal and environmental hygiene and food production hazards are identified. These hazards may include ingredients such as eggs or chicken, cooking or holding temperatures for the food or the use of chemical cleaning agents in the production process.
2. Identification of critical control points (CCPs) during each stage of manufacturing. CCPs are the stages at which problems may arise. This could be related to temperature control, cross-contamination, safety or sanitation issues.
3. Establish 'critical limits' for each CCP – critical limits will vary depending upon the nature of the business, but include minimum and maximum limits, such as the acceptable temperature in which foods should be cooked or chilled.
4. Establish a monitoring system for the CCPs – the business must establish a method to check that critical limits are not exceeded. Observations and recording of data must happen at regular intervals.
5. Establish corrective actions – the organisation must identify the actions to be taken if a problem occurs. These actions are intended as a precaution and may require more than one corrective task; for example, food being discarded and/or staff retrained.
6. Verify that the HACCP system is working efficiently – the HACCP system must be re-viewed regularly. Systems must be amended and updated if required.
7. Set up records – detailed records of results must be kept for auditing purposes and ideas for improvements.

GOOD MANUFACTURING PRACTICE

Good manufacturing practice (GMP) is a system for ensuring that products are consistently produced and controlled according to quality standards. The GMP process is designed to reduce the risks involved in food production and processing that cannot be eliminated through testing of the final product.

GMP covers all aspects of production from selecting and receiving raw materials, premises and equipment to staff training and personal safety and hygiene for workers. Comprehensive, written procedures are vital for each process where the quality of the end product may be affected. There must be systems in place to provide documented proof that the correct procedures have been followed consistently at each step in the manufacturing process, every time a product is made.

INTERNATIONAL ORGANISATION FOR STANDARDIZATION

The International Organisation for Standardization (ISO) is another quality management system that specifies requirements for a food safety management system. ISO 22000 is the specific set of guidelines for food safety management. These guidelines are suitable for organisations in the food chain who need to demonstrate their ability to control food safety hazards in order to ensure that food is safe at the time of human consumption.

ISO 22000 is relevant to all organisations involved in any aspect of the agri-food chain, regardless of size, who want to implement systems that consistently provide safe products.

ISO 22000:2005 specifies requirements to enable businesses in the food industry to plan, implement, operate, maintain and update a food safety management system aimed at providing products for consumers

Here is just one example of how the ISO helps make food supply and consumption safe around the world. In 2008, a number of children died and many became seriously ill after drinking milk contaminated by melamine. In response to this crisis, ISO and the International Dairy Federation prepared technical specification ISO/TS 15495, which provides a robust internationally recognised means for regulatory authorities, manufacturers and producers to determine the presence of melamine, in order to ensure the integrity and safety of milk products and prevent future incidents.

WORKPLACE HEALTH AND SAFETY

The food processing and manufacturing industry can be a dangerous place to work because of the types of machinery and equipment being used. It is important that businesses are aware of potential accidents and put policies and procedures in place to ensure a safe working environment.

The incidents and seriousness of accidents in food manufacturing is quite high when compared to other types of employment. There are general laws that help ensure the health, safety and wellbeing of workers and others while in a workplace. It is also important to consult staff about workplace health and safety issues and where a business has more than 20 staff, a work health and safety (WHS) committee must be formed. Employers must ensure that:

- the work environment, systems of work, machinery and equipment are safe and properly maintained
- chemicals are used, handled and stored safely
- adequate workplace facilities are available, such as personal protective equipment (PPE)
- information, training, instruction and supervision are provided
- workers' health and workplace conditions are monitored
- any accommodation provided to workers is safe.

WHS rules also stipulate certain responsibilities of employees. These include using PPE that is supplied, undertaking training in correct equipment use and reporting WHS issues. It is essential they provide and share information with anyone likely to be directly affected by a WHS matter. When this information is shared, employees must have the opportunity to express their views and contribute to any decisions relating to the matter. Employers must take their views into account and let them know the outcome of consultation in a timely manner. If a WHS committee is established it is important the committee and management consult when:

- identifying hazards and assessing risks
- making decisions about ways to eliminate or control risks
- proposing changes that may affect the health and safety of workers
- making decisions about consulting procedures, resolving safety issues, monitoring workers' health and conditions, and providing information and training.

Workers are responsible for:

- taking care of themselves and others
- wearing appropriate personal protective equipment (PPE) such as gloves, hairnets, masks, earplugs and glasses
- using equipment safely and only in the way it is intended to be used
- notifying and reporting to management any accidents or faulty equipment.

A safe, hygienic and secure working environment will help to ensure happy productive staff and this leads to a safe and reliable food supply, delivered to consumers at the highest quality possible.

FOCUS QUESTIONS 12.3

REVIEW

1 Explain the term 'quality management systems'.
2 Outline the benefits of using quality management systems when manufacturing food products.

FOR YOU TO APPLY

3 Create a table with the following quality management system headings, for food manufacturers. Use the table to summarise the key features of each of the systems.

HACCP	GMP	ISO	WHS

4 Conduct a WHS inspection of your Food Technology classroom.

EXTEND YOURSELF

5 Thinking about an organisation in the Australian food industry that you have studied, research the quality control procedures it employs to ensure a safe and reliable food supply for consumers. Provide examples to support your research.

Chapter review

REVIEW

1 When raw materials enter a factory, what quality checks are performed?
2 Why is it essential that manufacturers purchase goods from a reputable supplier?
3 List the information that should appear on a raw materials specification check list.
4 Why was the code numbering system implemented for food additives?
5 Outline the key attributes of processing equipment used in food manufacturing.
6 Identify a separation and size reduction process that is used in the food processing and manufacturing industry. Provide a domestic comparison.
7 Identify a quality management system used in food manufacture and outline the key features.
8 List some ways that cross-contamination can be avoided when preparing food.

FOR YOU TO APPLY

9 **a** Collect a variety of food packaging and bring it to class. Ensure the list of ingredients is intact.
b Draw up a table and list the food additives that appear in each package. What is the role of the additives identified in the food products?

EXTEND YOURSELF

10 Identify a manufactured food product you have studied.
11 List the major ingredients used to make this product.
12 Thinking about the product, identify the CCPs and describe quality control procedures at each control point in the production process.
13 Evaluate the importance of the quality control procedures described above for producing quality foods that are safe for human consumption.

CHAPTER 13

Food preservation

Food preservation is best defined as the processing of food to reduce conditions or factors that may cause food to spoil. By preserving food, we are able to keep it in an acceptable state for a longer period and extend the time it is safe for human consumption. Preservation techniques may help maintain the nutritive value of food and reduce waste.

CHAPTER OUTCOMES

In this chapter you will learn about:

- Reasons for preserving foods
- Causes of food deterioration and spoilage
- The principles of food preservation techniques
- Preservation processes

KEY TERMS

aseptic
bacteria
food preservation
high temperature/short-time processing (HTST)
micro-organisms
moulds
pathogenic
perishable
sous vide
vacuum
yeasts

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Reasons for preserving foods

Today, consumers demand seasonal foods be available all year round and, because of high-density living in major cities and towns, there is little space available for people to grow and harvest their own food. This has led to the need to preserve and process food, which allows for easier methods of distribution and transport to deliver quality products to consumers. Food preservation is one of the oldest technologies used by human beings and has a long history associated with survival. Basically, food preservation refers to any one of a number of techniques used to prevent food from spoiling, thus extending its shelf life. Food preservation has become an increasingly important component of the food industry, as consumers demand better quality and variety of goods from all around the world.

- To put the above into context, let us think about the seasonal availability of blueberries. If blueberries were only available to purchase when in season, they would only be available for consumers to buy in the warmer summer months. This would mean that for the rest of the year, we would not be able to make blueberry yoghurt or smoothies. However, preservation methods such as canning, dehydrating and freezing mean that they are now available all year round. When in season, there are plenty available and they are sold as a fresh product. However, without preservation, there might be an oversupply and some blueberries would go to waste. Preserving blueberries extends their shelf life, retains their nutrient value and keep them safe and free from spoilage micro-organisms (mould, yeast and bacteria).

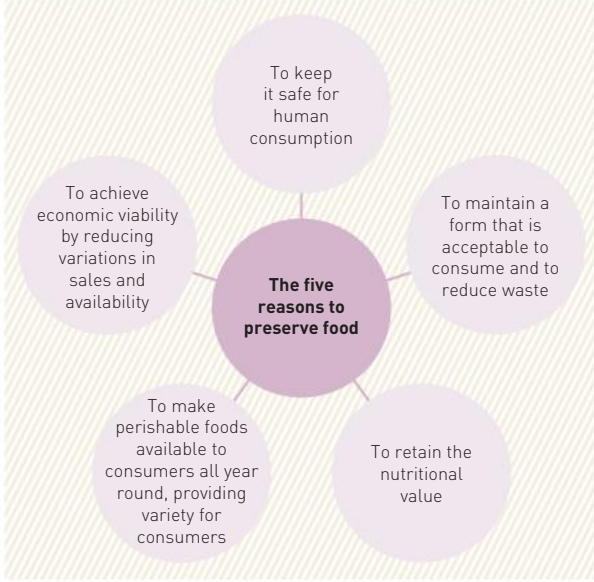


Figure 13.1 The five reasons to preserve food

Causes of food deterioration and spoilage

The deterioration and spoilage of food products can be caused by a number of factors. These include chemical, physical and enzymatic changes, microbial activity or environmental factors such as rodents and insects.

Table 13.1 Causes of food deterioration and spoilage

CAUSE	EXPLANATION	EXAMPLES
Chemical	Caused by a chemical breakdown of the food or when food may be chemically contaminated by another substance	Cheese and nuts becoming rancid Residue pesticides and insecticides on fruits and vegetables
Physical	Physical changes caused by exposure to oxygen, light and water alter the structure of food and acceptability of food in some way. This may include surface damage or colour change.	Surface damage may be bruising that has occurred during transportation of fruit, and colour change may result from freezer burn.
Infestation	Rodents and other pests such as cockroaches, insects and mealworms can cause food spoilage through infestation.	Mice and rats gnawing at packaging and foods and leaving droppings pantry moths that infest dry cereal products and nuts; insects such as fruit fly that cause damage to fruit

>

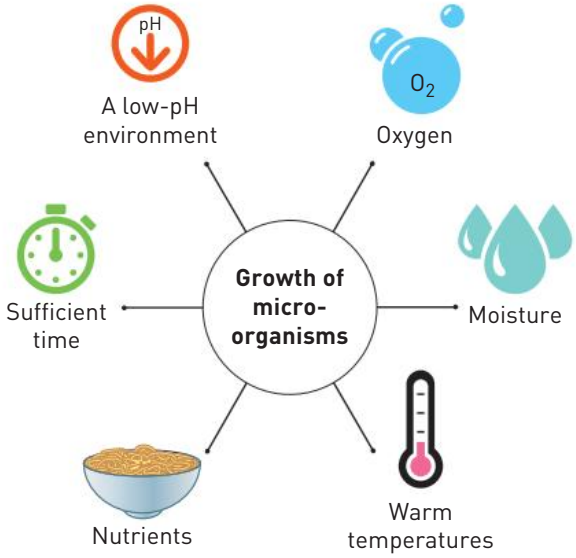
Table 13.1 (*Continued*)

CAUSE	EXPLANATION	EXAMPLES
Microbial contamination	Yeast, moulds, bacteria and viruses cause food to spoil. When conditions are favourable, micro-organisms grow and multiply quickly, causing food spoilage and poisoning.	Mould on bread or fruit Slimy meat caused by action of micro-organisms Mould on jams or tomato paste Fermented juice Sour milk
Enzymatic	Enzymes are chemical substances that act as catalysts to speed up chemical reactions in food, e.g. meat, poultry, fruit and vegetables. After harvesting, food continues to ripen and enzymes continue to cause deterioration and break down fresh food products.	Over ripening of fruits and vegetables and the decomposition of protein foods such as meat.

It is important to understand the difference between food spoilage and food poisoning. Food spoilage occurs when the quality of a food product deteriorates. This is generally due to the activity of yeasts, moulds and enzymes and results in the physical and sensory properties of the food becoming unacceptable. This means you can 'see it, taste it and smell it'.

Food poisoning, on the other hand, is an illness caused by consuming contaminated food that has been affected by bacteria, chemicals or biological contaminants. If food is poisoned you can't 'see it, taste it or smell it'. If you could, you wouldn't eat it and therefore, would avoid any associated illness.

To ensure a safe and reliable food supply we must control the growth of micro-organisms that lead to the eventual spoilage or poisoning of food. We must also keep in mind that not all micro-organisms are pathogenic (harmful) as some are very beneficial and are essential to the way in which food is produced; for example, the production of yoghurt and cheese.



Food Solutions, Food Studies Units 3 & 4, fourth edition, Heath, McKenzie, Tully, Cengage Learning 2016.

Figure 13.2 Growth of micro-organisms

How do micro-organisms grow?

When conditions are favourable, micro-organisms grow and multiply very quickly. The growth and reproduction of these pathogenic micro-organisms needs to be controlled during food manufacturing processes.

As micro-organisms grow, they pass through different phases. These are the lag phase, the logarithmic growth phase, the stationary phase and the death phase. The lag phase is an adjustment period, where the microbes need to adapt to their new environment. At first there may be a decrease in numbers as some become 'stressed' but there will still be some growth and multiplication occurring. Cooler conditions will extend the lag phase.

Bacteria grow and multiply by the process of binary fission (splitting into two) and when conditions are favourable, they can divide every 20 minutes. The number of bacteria present and environmental issues such as temperature, moisture and nutrients have a direct impact on the logarithmic

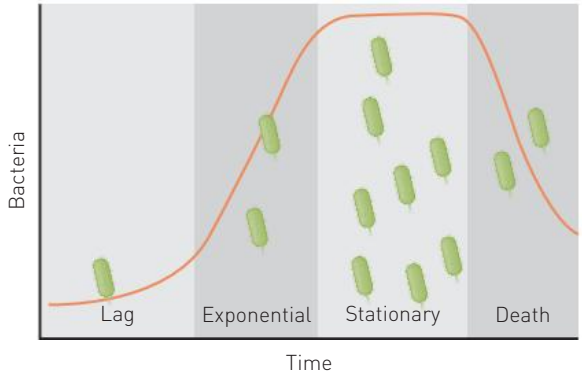


Figure 13.3 The growth phases of micro-organisms

or exponential growth phase. Because of this rapid growth and multiplication, one single bacterium can become more than one million in the space of 3 hours.

The stationary phase sees the number of bacteria remain relatively constant, which means the number of cells being formed equals the number of cells that die. A lack of nutrients, a build-up of toxic waste products along with competition from other microbes leads to the rapid death rate of microbes.

PRACTICAL APPLICATION 13.1

GROWTH OF MICRO-ORGANISMS

AIM

To conduct an experiment to observe the growth of micro-organisms.

MATERIALS

yeast (packets of yeast are available in the baking section at your local supermarket)
a small, clean, clear plastic drink bottle
1 teaspoon sugar
warm water
a small balloon

METHOD

1. Fill the bottle with approximately 2 cm of warm water.
2. Add the yeast and gently move the bottle in a circular motion for a few seconds.
3. Add the sugar and gently swirl the mixture around again.
4. Inflate a balloon to stretch it out. Place the balloon over the neck of the bottle.
5. Leave the bottle to sit in a warm place for approximately twenty minutes.
6. Observe as the balloon slowly inflates.

RESPOND

What phase is the yeast in when it is in the packet. Why?

What phase does the inflation of the balloon indicate?

When preserving food, it is important to make the lag phase as long as possible to restrict the growth of microbes. You can achieve this by maintaining hygienic work practices, equipment, tools and utensils. If the environment is clean and sanitised, micro-organisms will take longer to begin multiplying, thus extending the lag phase. Environmental changes such as reducing or restricting access to moisture, warm temperatures and low pH levels can also increase the lag phase time, extending the shelf life of the food item.

FOCUS QUESTIONS 13.1

REVIEW

1. Define the term micro-organism and list the four main groups of micro-organisms associated with the food industry.
2. What is a pathogen?
3. List the six main requirements for microbial growth.

FOR YOU TO APPLY

4. Explain why dry foods such as flour, raw pasta and rice are unlikely to support the growth of food-poisoning bacteria.
5. What does the term pH refer to? Identify some low-acid (between 4.5 and 7.0) foods and some high-acid foods (below 4.5) and explain how they support or hinder microbial growth.

EXTEND YOURSELF

6. For each of the ways in which food can deteriorate or spoil, identify some guidelines workers can follow to prevent food spoilage from happening.

Preserving food safely

Most processed ingredients have a natural protective outer layer that is generally removed before processing. Think about the skins, husks and shells on fruits and vegetables, an egg shell, and the skin and fat on meat, fish and poultry. Often, these outer protective layers harbour most of the micro-organisms that could cause food spoilage or poisoning to occur. For this reason, separation processes are used to remove the unwanted protective outer layer. When the protective outer layer becomes damaged, decomposes or is removed, micro-organisms can spread from the outer surface to the inner tissue, and enzymatic browning occurs. Therefore, hygienic handling, appropriate storage and sturdy packaging are vital to minimise spoilage through cross-contamination and physical damage.

Washing, trimming and preparing raw material in a safe and hygienic manner can remove soil, spores, residues and insects that may cause spoilage; however, even this can be hazardous if the water is contaminated. If food spends too much time in contact with water, or is not dried quickly, micro-organisms will grow and multiply, as moisture helps them to grow. Removing any bruises, spots, blemishes or spoiled portions of food can extend the shelf life and quality of food. Citrus fruits are a classic example. If a mouldy orange is left in a fruit bowl, the mould spores will quickly become airborne and spread to other fruit, causing them to become mouldy and deteriorate quickly too.

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Figure 13.4 Mould spores quickly become airborne and cause other fruit to deteriorate quickly.

Principles of preservation

As previously mentioned, we need to control certain conditions that support and encourage microbial growth. Controlling moisture levels, nutrients, oxygen, time, temperature and pH levels will help to ensure a safe and reliable food supply that will remain shelf stable for a long time. There are four main principles required to preserve food, described below.

Principles of preservation

1 Temperature control

Micro-organisms like warm conditions, especially room temperature, and pathogens grow best when temperatures are between 5 and 60°C (the food temperature danger zone). The best way to preserve food and stop microbial growth is by controlling temperature.

Subjecting food to heat and cooking it is probably the most common method of food preservation. Cooking food usually involves three specific stages.

1 Heating and warming the food
2 Holding the food at the desired temperature for a time
3 Cooling the food, unless it is to be consumed while still hot

When food is warmed, enzymatic reaction rates increase and then reduce as the optimum temperature for growth and reproduction is exceeded. The reaction will stop when the enzyme, a protein, is denatured.

Micro-organisms also become active during the warming process and this activity increases as the temperature increases. Once past the optimum temperature for growth and reproduction, their metabolisms slow until eventually all activity ceases as they are destroyed by the heat. Enzymes and microbes are impaired by temperatures over 60°C. Holding food at 100°C for a few minutes is enough to destroy all enzymes and kill most forms of bacteria. However, some spore-forming micro-organisms, such as *Clostridium perfringens*, can survive temperatures of 100°C for up to 5 hours.

Tomato and eggplant chutney

Foods with high acidity generally require less time and lower temperatures to destroy any bacteria that may be present. It is important that all parts of the food receive a sufficient and even exposure to heat to prevent food spoilage and kill food poisoning organisms. For this reason, it is critical that the middle section of large joints of meat or large pots of foods have their core temperature tested to ensure a safe temperature has been reached. Once food has reached the preferred temperature and been held there for an adequate period, it should not be allowed to stay in the 'danger zone' – rapid cooling of food to below 5°C is also vital for preventing microbial growth. If food is not eaten hot and allowed to cool to room temperature, this could present a serious food poisoning hazard.

2 Restricting moisture

All living things require moisture to grow. Bacteria generally need more moisture than yeasts or moulds. Controlling water levels is a preservation method that

Table 13.2 Susceptibility of foods to food poisoning

FOOD ITEM	WATER ACTIVITY	RISK LEVEL
Meat, poultry, fish	0.98 or higher	High
Bread, tomato paste	0.98–0.93	Medium
Parmesan cheese or condensed milk	0.93–0.85	Low
Dried apricots, sultanas, flour, jam	0.85–0.60	Low risk, but may support food spoilage micro-organisms
Chocolate, noodles, pasta,	0.60 and lower	No risk

aims to remove or decrease the amount of moisture in food (water activity level – a_w). By applying this method in food manufacture, microbes no longer have access to water, which reduces their ability to grow and multiply. Foods that have a high moisture content tend to be highly perishable and their quality deteriorates quite quickly. Preservation methods such as dehydration (drying) and evaporation are effective ways to prevent enzyme and microbial activity. This is because both require water to be active. Microbes grow best in clean pure liquid water. If water turns to solid (ice), this once again reduces the microbes' capacity to grow and multiply. Enzymes may still be active when frozen; however, their activity transpires very slowly, which explains why foods cannot be stored in the freezer indefinitely. Foods or liquids that have been subjected to evaporation techniques may still support the growth of some micro-organisms as they still contain a high percentage of moisture.

The table above outlines the water activity level of various foods and their susceptibility to food poisoning.

When substances such as salt (brine solutions for cured meats or soft cheeses), sugar (sugar syrups for canned fruit or adding sugar to fruit to make jam) and acids (vinegar and lemon juice for preserved bottled vegetables) are added to water, they change the way water acts, making it unsuitable for microbes to grow and reproduce. The water activity level (a_w) is chemically altered and microbes cannot thrive.

3 Exclusion of air

Like all living things, most microbes require oxygen to be active and survive, these microbes are referred to as 'aerobes'. Aerobes grow on exposed surfaces of foods and liquids. By eliminating the air and oxygen that surrounds the food source, these microbes become dormant or inactive.

For bacteria that are anaerobic (survive without oxygen) it is important that processing and packaging techniques are suitable as foods may be very susceptible to supporting the growth of these types of food-poisoning bacteria. The most common anaerobe is Clostridia and this micro-organism can grow inside meats, gravies and stews as well as in canned foods that have not been properly processed.

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Figure 13.5 Canning fruit in sugar syrup extends the life of fruit further.

Some micro-organisms such as salmonella and *Staphylococcus aureus* can be facultative, meaning they can grow and survive with or without oxygen. These may grow on the surfaces of foods or deep in cuts and crevices.

Air may be excluded from food and packaging in a variety of ways such as canning and bottling by using a 'hot-fill' process. This is where the lid or seal of the package forces air from the package, creating a vacuum when the product cools. Vacuum packing or cryovacing is another method used to exclude air, and is a popular method for meats. However, the meat will still support the growth of anaerobes, so must be refrigerated to prevent food poisoning.

Shutterstock.com/Marietjie

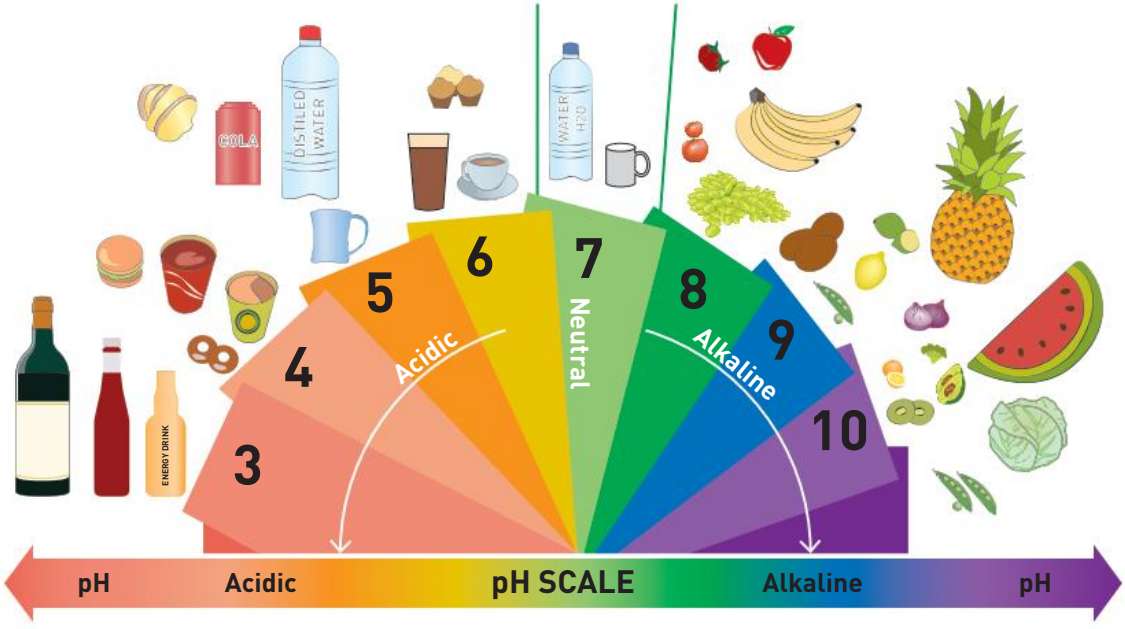
Figure 13.6 Vacuum packaging excludes air and delays food spoilage.

Gas flushing (inserting gases other than oxygen into packaging) is another popular method manufacturers use to exclude air from packages.

4 Control of pH levels

A pH scale is used to measure the level of acidity or alkalinity of a product. As discussed, the pH scale ranges from 0–14 with 7 being neutral. Any pH value greater than 7 is alkaline and any pH level below 7 is acidic. This means that the lower the pH reading, the more acidic the food product, and therefore the safer the product is from food poisoning bacteria. Most food poisoning bacteria grow and multiply best when foods have a pH value higher than 4.6, meaning they are closer to being pH neutral.

Adding acids such as vinegar or lemon juice to foods can minimise food spoilage by denaturing enzymes and destroying micro-organisms. The presence of acids also decreases the time and



3	Carbonated water, energy drinks	**Neutral ph** 7	Water
4	Popcorn, cream cheese, buttermilk, prunes, pastries, pasta, cheese, pork, beer, wine, black tea, pickles, chocolate, roasted nuts, vinegar, artificial sweeteners	8	Apples, almonds, tomatoes, grapefruit, corn, mushrooms, turnips, olives, soybeans, peaches, capsicum, radish, pineapple, cherries, wild rice, apricot, strawberries, bananas
5	Most purified water, distilled water, coffee, sweetened fruit juice, pistachios, beef, white bread, peanuts, nuts, wheat	9	Avocados, green tea, lettuce, celery, peas, sweet potatoes, eggplant, green beans, beets, blueberries, pears, grapes, kiwi, melons, tangerines, figs, dates, mangoes, papayas
6	Fruit juices, most grains, eggs, fish, cooked beans, cooked spinach, soy milk, coconut, plums, brown rice, barley, cocoa, oats, liver, oysters	10	Spinach, broccoli, artichoke, Brussels sprouts, cabbage, cauliflower, carrots, cucumbers, lemons, limes, seaweed, asparagus, kale, onion

Figure 13.7 Foods on the pH scale

temperature of heat processing needed to preserve food. Low-acid foods between 4.5 and 7 on the pH scale generally spoil very easily as they have so little acid to protect them. Other additives such as chemical preservatives, food acids and smoke may also be used to help retard or destroy micro-organisms, depending on the amount of the additive used. Bacon, jams, corned beef and pickled onions are examples of foods that use other chemical substances such as salt, sugar, acids and smoke, to inhibit microbe growth.

Preservation processes

Food can be preserved by removing one or more of the factors that bacteria and fungi need to survive such as oxygen or moisture. A variety of preservation methods can be used to either totally prevent, delay, or reduce food spoilage, while still maintaining the nutritional value, texture, and flavour of the food. The most effective processes designed to preserve food involve a number of different food preservation methods.

Pasteurisation

Pasteurisation is a particular method of heat treating foods and is used to significantly reduce the number of micro-organisms present in raw products. Pasteurisation is used for processing milk, specifically to destroy disease-causing micro-organisms or at least to reduce the number present to an acceptable level. It must be noted that this process does not completely sterilise the food.

The simplest form of pasteurising fresh milk is known as the 'holder-process method'. Other products such as fruit juices, beer, wine and dried fruits are also pasteurised this way. In the 'holder-process method', milk is quickly heated to a temperature of 65°C and held there for 30 minutes, before being quickly cooled.

Today, HTST, or 'high temperature, short time', is the most commonly used method for pasteurising milk. This process involves using plate or tubular heat exchangers, in which the milk is heated rapidly to a temperature of 72°C and held at this temperature for 15 seconds. The milk is then cooled rapidly to below 5°C.

UHT (ultra-heat treated) milk is heated to about 140°C and held at that temperature for a few seconds as a means of sterilising the milk. Because of the way this milk is preserved, you can occasionally detect a 'cooked' flavour. UHT (long-life) milk does not need to be refrigerated and can be kept at room temperature. However, once opened, the product must be kept in the fridge.

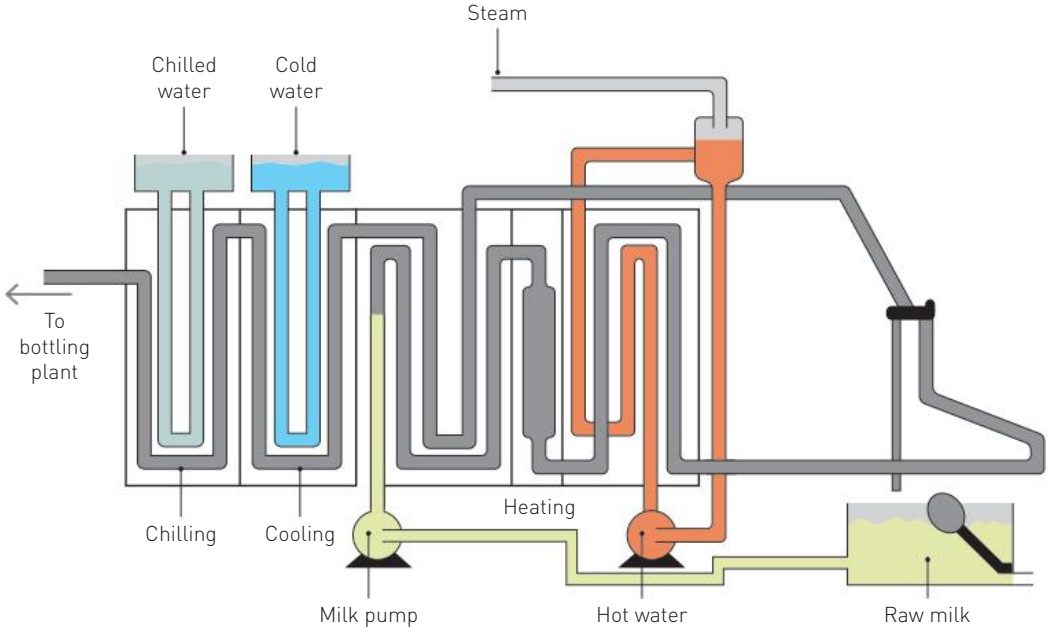


Figure 13.8 HTST pasteurisation of milk using a heat exchanger

Table 13.3 Pasteurisation

ADVANTAGES	DISADVANTAGES	SUITABLE FOOD SOURCES
Kills specific pathogenic micro-organisms such as listeria, salmonella and tuberculosis	Flavour change Some enzymes required to achieve desirable changes in foods such as soft cheeses may be destroyed	Milk and cream Juices Cheese Yoghurt

Canning

Canning food combines both the principles of cooking (applying heat) and vacuum packing (exclusion of air) so that micro-organisms and enzymes are destroyed by heat in vacuum-sealed packaging. This process excludes all air from the can, meaning food is safe and shelf stable for a prolonged period of time.

Traditional canning methods involve the cans being filled with a food product and then a liquid, such as syrup or juice for fruit or brine or oil for fish, is added to top up the can and forces air out of the container. The air above the food is removed using either steam or a vacuum chamber. The lid, which forms the end of the can, is placed on the can and sealed. The filled cans are then heated in a large pressure cookers called retorts for long enough to kill any micro-organisms that may be present. The can is then quickly cooled, before being labelled and packed. For some products, the cooking times may be longer to ensure that the heat has reached the centre of the food. Some foods are not suitable for canning, as their quality suffers because of the canning process.

Aseptic canning is another method used by the food industry. This method involves heating the food to the correct temperature then putting it in a sterile can. This method is much faster because the food is already sterile and the filled can does not need further heat treatment. This popular method also ensures that the food has been evenly heated and the contents of the can are sterile.

When purchasing cans, consumers should ensure that the ends of the cans are slightly concave, which is a result of the vacuum created during processing. If the end of a can bulges, one of three problems may have occurred.

1. Bacteria may have entered the can after processing because of poor can-closing procedures, or because the food was under-cooked, meaning the bacteria were not destroyed. Microbial action produces acid and gas in the can, which places pressure on the can, causing it to bulge.
2. Over-filling of a can at a low temperature may also cause permanent bulging of the can after heating; this is referred to as physical induced swelling.
3. Chemical swelling of cans may occur if foods react with the can and start corroding the container. This causes a chemical reaction that produces hydrogen gas. Cans used for high-acid food are lacquered on the inside to prevent this reaction.

Getty Images/Noppawat Tom Charoensinphon

Figure 13.9 Canning combines the preservation techniques of heating and excluding air.

Chilling

Chilling food (lowering its temperature to 0–5°C) slows down microbial growth and enzyme activity. It is useful for slowing down spoilage micro-organisms and suitable for storing most foods on a short-term basis. Chilling is the method of preservation most often used for storing perishable food.

Table 13.4 Advantages and disadvantages of canning

ADVANTAGES	DISADVANTAGES	SUITABLE FOOD SOURCES
Long storage life Easy to store Easy to transport Products' availability	Heavy Expensive equipment Unable to view contents Some nutrients are destroyed	Fruits and vegetables Meats, poultry and fish

Foods require different temperatures to help maintain their quality. The lower the temperature, the slower the chemical changes occur in the food and the slower the microbial growth happens. Fruits and vegetables are still living, so the low storage temperature helps to retard the ripening process. Some moulds and bacteria that can withstand cold conditions often cause food spoilage even under refrigerated conditions. Chilling foods does not destroy micro-organisms and when foods are returned to room temperature, the micro-organisms will warm up and become active again, contributing to food spoilage.

FREEZING

Freezing is the process of retarding the activity of micro-organisms and enzymes by storing food at temperatures less than –18°C. These low temperatures turn moisture or liquids into solids, which prevents microbial and enzymatic growth. Micro-organisms that survive the freezing process will recover rapidly after thawing and begin multiplying when conditions are favourable. Foods should be defrosted slowly in the refrigerator or in a microwave, not left in the danger zone at room temperature. It is important that high-protein foods are completely thawed before cooking and they should be cooked as soon as possible.

The steps for commercial freezing of food products are as follows:

- Use high-quality raw materials and ingredients.
- Pre-treat raw ingredients by washing, peeling, trimming, blanching, and in some cases adding food additives. Blanching is particularly important as this destroys enzymes and micro-organisms, protects vitamins and enhances the colour of foods prior to freezing.
- Freeze using either air or contact plates.
- Package the food carefully – suitable packaging must be used to protect food from drying out or developing freezer burn.
- Store at –18°C to –25°C.

In order to maintain quality, food should be frozen quickly. Quick freezing occurs when the temperature of food reduces as quickly as possible below the critical temperature zone. The critical temperature zone is the temperature at which the majority of the moisture in the food changes to ice.

Table 13.5 Freezing

ADVANTAGES	DISADVANTAGES	SUITABLE FOOD SOURCES
Keeps food longer Contains little to no preservatives Seasonal foods available all year round Helps reduce waste	Texture of the food may alter when defrosted Slow freezing can do damage to cell structure Does not destroy micro-organisms	Fruit and vegetables Meat, poultry and seafood Cooked foods

PRACTICAL APPLICATION

13.2

CREATE A FROZEN MEAL

AIM

To demonstrate the process of freezing and discover how reducing temperatures can prolong the shelf life of food.

INGREDIENTS

200 grams beef mince
1 egg
1 teaspoon mixed herbs
1 teaspoon barbecue sauce
1 clove of garlic
vegetable oil
100 grams French beans
1 corn cob
2 carrots
1 tomato
2 brown onions
1 gravy packet mix

METHOD

MEAT PATTY

- Finely chop the onion, crush the garlic and combine in a bowl with the beef mince, egg, mixed herbs and BBQ sauce.
- Divide into four equal portions and form into patties.
- Fry in a pan with oil until golden brown.

FRENCH BEANS

- Wash the beans, remove the top and tail, cut diagonally into 2 cm lengths.

>

- Blanch in boiling water for 1 minute, remove and place into iced water. Drain when cooled.

CORN ON THE COB

- Trim the stalks and tips, cut the cob into four pieces.
- Blanch in boiling water for 3 minutes, remove and cool.

CARROTS

- Top and tail the carrots and cut into 2–3 equal sections. For each section, cut into ½ cm julienne strips.
- Blanch in boiling water for 1 minute. Remove and cool.

13.2

TOMATO AND ONION GRAVY

- Finely chop 1 small onion and fry in 2 teaspoons of oil.
- Blanch and refresh 1 medium tomato place the tomato in boiling water for 1 minute and place into iced water for 30 seconds.
- Remove core and peel off skin, roughly chop and add to fried onion. Add ¼ cup cold water with 1 teaspoon packaged gravy mix and cook for 2 minutes.

ASSEMBLING THE FROZEN MEAL

- Neatly arrange all elements of the meal into containers, place gravy over the meat patties or into separate containers.
- Cover with the lid and place in the freezer. Alternatively, arrange the meals into vacuum pack bags, seal air tight and freeze.

RESPOND

1. Explain why you blanch and refresh the vegetables.
2. What additive was added to the meal? What was its role?
3. Explain *two* principles of preservation used in this recipe: control of temperature and removal of oxygen.
4. Identify the unit operations the raw materials have undertaken.

Drying

Today, many cultures still sun-dry food as a way of preserving it for later use. Dehydration, or the removal of moisture, is one of the oldest methods of food preservation. Dehydration methods allow food to be kept for a long time if storage conditions are favourable. Most dehydrated foods still contain enough moisture to allow some enzymatic and microbial activity, which may result in food spoilage. Salt and sugar may also be used to help preserve dried foods.

Modern drying methods that are used extensively in industry include air drying, freeze drying, drum dryers, kiln dryers, spray dryers, sun drying, cabinet drying and tunnel drying.

Dreamstime.com/Sabinoparente

Figure 13.10 Drying food in the sun is an age-old food preservation technique, still used today.

AIR DRYING

Air drying means food is subjected to temperatures between 40°C and 100 °C. The water inside the food evaporates, increasing the solute concentration within the food product. This may cause physical damage to the food in a similar way to freezing, or the food could be damaged by the heat. During the drying process, the food will suffer a loss of structure and the proteins present in the food will denature. Most plant and animal tissue will shrink. Once reconstituted (having water put back), most foods will not regain their original shape, volume or structure.

DRUM DRYERS

Drum dryers are made from stainless steel and are one to two metres in diameter. They are heated with steam, while the food products form a thin layer on the drum surface and are dried as the drum rotates. The dried product is scraped off the drum and the process is repeated. The dried foods may then be ground into a powder.

KILN DRYERS

Kiln dryers are normally a two-storey construction. The floor of the upper level is lined with narrow slats

to support food items that are laid in thin layers. Hot air rises from below, drying the food.

SPRAY DRIERS

This process is used to dry liquid products. The food is sprayed in small droplets from the top of very tall structures, and is suspended by hot air rising from below. It settles as it dries and is packaged as a dry powder.

TUNNEL DRYING

This method is used extensively for fruits and vegetables. Foods move slowly through a long (10–15 metre) tunnel as hot air is blasted down the tunnel to dry the food. It is common practice for some sun-dried foods to be 'finished off' in tunnel driers.

FREEZE DRYING

Freeze drying is a complex process where food is frozen and the moisture in the food product removed by allowing the ice to sublime under a vacuum. The complex process of subliming is the direct conversion of ice to water vapour, without going through the liquid water stage. This is beneficial to foods being processed as they avoid heat damage caused by conventional driers. However, food can still be damaged by the freezing process involved. Foods retain their volume and have a porous texture, which allows food to rehydrate more easily than conventionally dried products. Instant coffee is an example of a food that is processed using the freeze-drying method.

Moulds and bacteria will continue to grow in foods when as little as 13 to 20 per cent moisture is present. To combat this potential growth, manufacturers aim to dry products to the point where only 5 to 6 per cent moisture is present.

Fermentation

Fermentation has become a very popular method of food preservation in recent years because it can create desirable changes to the food. Fermentation can affect the flavour, texture and nutritional value of food products. The fermentation of food is caused by the activities of micro-organisms. This process involves the biochemical breakdown of particular food components, causing a change to the food's chemical composition. Fermentation also causes the physical nature of food to alter.

Fermentation of food and beverage products occurs when carbohydrates are converted to acids or alcohol through the action of micro-organisms. The most commonly known use of the fermentation process is in the production of alcoholic beverages. Alcoholic beverages are produced when yeasts act upon the sugars in honey, grapes, grains or fruits and convert them to alcohol. Carbon dioxide gas is produced as a by-product of this process. Yeast fermentation is important for producing bread and bakery products where the gas is needed to make the bread rise. Alcohol is created during the bread-making process, but the amount is negligible and is destroyed during baking. Sourdough breads use the fermentation processes to create their distinctive flavour. They are made using lactic acid-producing bacteria and special types of yeasts able to withstand the acidic conditions.

Fermentation can take a few hours such as when making yoghurt, or a few months such as when producing salami. Other fermented food products include:

- sauerkraut: a traditional German dish of fermented cabbage
- tempeh: an Indonesian mix of fermented soya beans and grain

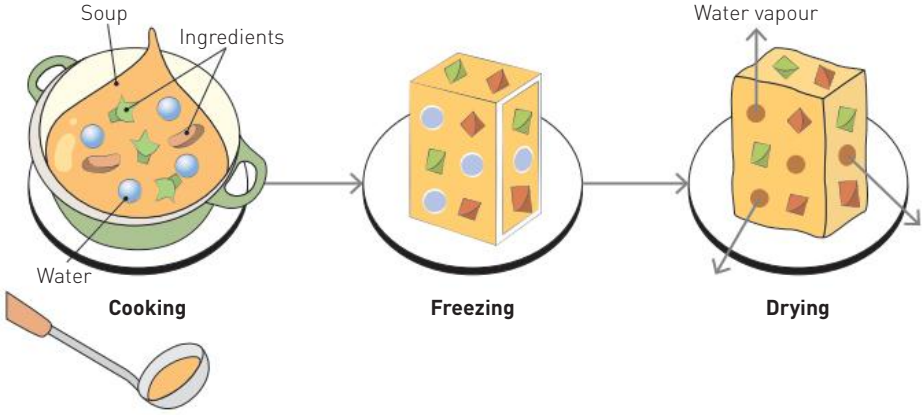


Figure 13.11 The freeze-drying process

Shutterstock.com/Kongsak

Figure 13.12 A bowl of kimchi; fermented foods are popular in many cultures.

- kefir: a fermented drink made using cow's milk or goat's milk
- kimchi: a fermented spiced cabbage dish of Korean origin
- kombucha: a fermented tea beverage that has [?] naturally bubbly effervescence and is full of probiotics, antioxidants and B-group vitamins.

Table 13.6 Fermented foods

FOOD	ORGANISMS RESPONSIBLE FOR FERMENTATION
Cheese and yoghurt	Moulds and bacteria
Cabbage sauerkraut	Bacteria
Salami	Bacteria
Breads, doughnuts	Yeast
Soy sauce and fish sauce	Mould
Alcoholic beverages	Yeast

FOCUS QUESTIONS 13.2

REVIEW

1 What are the five main reasons for preserving food?
2 What causes food deterioration and spoilage? Provide an example for each.
3 Describe the difference between pasteurisation and ultra-heat treated (UHT) treatment.
4 Why does unpasteurised milk require refrigeration but pasteurised UHT milk can be stored on the shelf before opening?

FOR YOU TO APPLY

5 Use the table below to make a summary of the different preservation methods used to prolong the shelf life of food. The first row has been completed for you.

Table 13.7 Preserving foods

PRESERVATION METHOD	FOOD EXAMPLES	WHY DOES THIS PRESERVATION METHOD WORK?	ANY ADDITIONAL INFORMATION
Freezing	Meat Fruit	Slows enzyme action Makes water unavailable for microbial growth	Freezing kills up to 80 per cent of microbes. Blanching is used in vegetables to reduce enzyme action.
Dehydration			
Canning			
Pasteurisation			
Fermentation			
Chilling			

WS Preservation methods

EXTEND YOURSELF

6 **a** Find a recipe for kimchi, sauerkraut or kombucha. You may use the recipe for kimchi on the website accompanying this textbook.
b Prepare the recipe following the instructions.
c Conduct a sensory evaluation of the product once the fermentation process has occurred.
d Purchase a commercially prepared version of your chosen recipe and compare its sensory properties with the homemade product.

Kimchi

Chapter review

REVIEW

1 Identify the main causes of food spoilage.
2 What conditions are favourable to microbial growth?
3 Identify ways to minimise cross-contamination during food preparation and storage.
4 Describe the four principles of preservation.
5 Outline the preservation principles used in canning.
6 What are the benefits of blanching foods?
7 Explain what happens to micro-organisms when food is frozen.
8 Why is it not advisable to refreeze thawed foods?
9 How does dehydration help preserve foods?

FOR YOU TO APPLY

10 Copy the table below, then fill in the information relating to pasteurised milk and UHT milk.
11 Draw a process flowchart for making tomato relish.

EXTEND YOURSELF

12 Discuss the following statement: 'All pathogens are destroyed during the cooking process, so it is OK to leave cooked food at room temperature'.
13 Describe the processing techniques, equipment used and types of packaging that could be applied to peas. Use diagrams to show the 'paddock to plate' or 'fork to freezer' process. Keep in mind that peas can be purchased fresh, frozen, canned and dehydrated.

	PASTEURISATION	UHT
Time and temperature		
Identify the micro-organisms that are destroyed		
Storage conditions required before opening		
Storage conditions required after opening		

CHAPTER 14

Packaging, storage and distribution

A visit to any supermarket will show just how far the packaging industry has come in recent years. There are many packaging innovations and designs that may assist the food preparation process. Lots of research, thought and scientific investigation goes into selecting the correct package for particular foods. For manufacturers, the type of packaging used is a strategic decision, as it also becomes a marketing and advertising tool that informs the consumer while protecting the product.

CHAPTER OUTCOMES

In this chapter you will learn about:

- Functions of packaging and the types of materials they are made from
- Current developments in packaging
- Storage conditions and distribution systems used in food manufacture.

KEY TERMS

active packaging
food packaging
intelligent packaging
labelling
primary packaging
secondary packaging
sous vide
tamper evident
tertiary packaging

iStock Photo/DutchScenery

Functions of packaging

Food packaging is a means of providing the correct environmental conditions for food while it is stored and distributed to the consumer. Packaging is designed to enhance the product's appeal by promoting and informing consumers of its contents, while also being convenient and user friendly. Packaging materials can be made using many materials and substances, including plastic, aluminium, glass, paper and cardboard. By law, all food packages must contain labels and important consumer information, which helps consumers make informed choices when selecting products. There are five main reasons to package food.

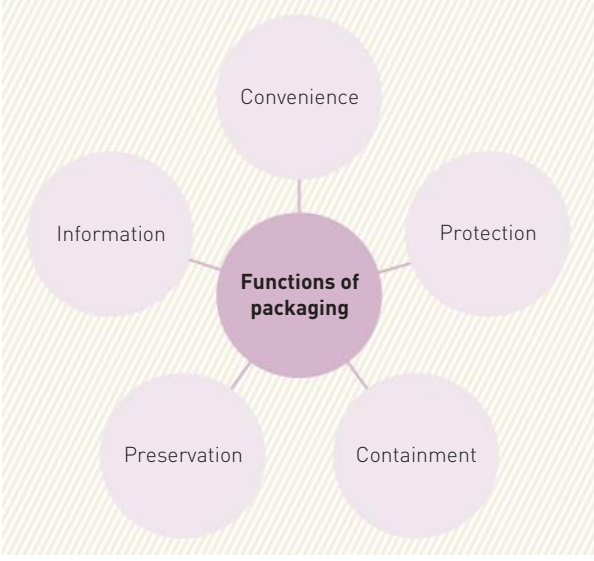


Figure 14.1 Functions of packaging

Packaging provides a container for food products

At its most basic level, packaging is simply a way to contain food products to allow for easy storage and distribution. For example, it is very difficult to effectively transport grains of rice unless they are contained together in some way.

Packaging needs to protect the products

It is essential that all food packaging protect food products from physical, chemical, microbial and mechanical damage. When packaged foods are stored prior to transport and distribution, they are usually stacked on top of one another or side by side. For this reason, packaging must also protect food from being damaged while stored. Packaging should also protect contents from environmental elements such as moisture, heat and sunlight, which may cause irreversible damage to a product; therefore, the packaging must be designed to withstand these elements if they are to be exposed to such conditions. Food products that reach the marketplace or consumer in an unacceptable manner, such as being broken, crushed, dented, bruised or damaged, will be rejected.

When food products leave the processing and manufacturing plant, they are usually placed inside large robust packing boxes designed to protect the product and for ease of storage and distribution.

The product must be protected against being dropped or crushed, and from the vibration and movement it suffers during transport. To use space efficiently during transport, boxes are stacked on top of each other, resulting in a huge amount of weight and pressure placed on the boxes at the bottom of the stack. Packaging must be durable enough to withstand and support these heavy loads against vertical impact. Delicate products such as fruits and vegetables are placed inside rigid plastic trays and then inside boxes to protect them while being stored and transported.

The safety and security of food products once they have left the production plant are also a major concern for manufacturers. As a result, tamper-evident packaging designs and devices are used to show consumers that the product is in its original form, unopened and safe to consume. Product tampering occurs when a person interferes or damages a product, such as opening a packet while having no intention to purchase the product. Tampering may occur at any stage of the production, manufacturing, storage, distribution or retail process and specialised packaging plays an important role in ensuring consumer safety and satisfaction is not compromised.

In recent years, there has been much publicity about foods that have been intentionally damaged or tampered to cause harm to consumers. These

safety threats are taken very seriously and usually result in products being withdrawn from sale. This action can have serious repercussions for any business involved. Some common examples of tamper-evident devices are:

- plastic shrink-wrapped seals around the lid and neck of a bottle or jar such as jars of curry paste and bottles of water
- screw-top jars that have a 'pop top', which when released or opened for the first time make a distinct popping sound
- a layer of foil that acts as a seal under the lid of some bottles, tins and jars, such as in Milo tins, juice bottles and jars of Nutella
- plastic screw-top lids that leave a plastic ring or collar around the container when opened, such as on jars of peanut butter and vegemite
- paper or plastic strips that extend from the lid and down each side of a jar which tear when the seal is broken
- cellophane or plastic wrapping that surround products such as chewing gum.

Shutterstock.com/vincent noel

Figure 14.2 Tamper-proof packaging has become more common in recent years following publicity regarding intentional tampering to harm consumers.

Packaging preserves foods

Packaging is important to prevent contamination, food spoilage or food poisoning caused by micro-organisms. A wide range of foods require packaging, so the type used must be suitable for the product. Some food products, such as fruits and vegetables, can be better preserved by having packaging materials that allow them to 'breathe' or respire. Other dry food products are preserved by packaging that prevents moisture from entering. Conversely, it is sometimes necessary for packaging material to prevent loss of moisture from products that contain high percentages of water. Products that have a high fat content such as butters, oils and potato chips must be protected from light and oxygen to prevent rancidity. Often, no single form of packaging can perform all functions needed to maximise the shelf life of food. That is why so many different forms of packaging material are used to protect, contain and preserve our food.

Packaging provides convenience

Many food packages allow the consumer to use or consume the product directly from the package, such as yoghurt and baby food that are sold in squeezable pouches. Packaging may also be integrated into the food product's preparation, such as with microwavable meals. Packaging may save time for the consumer, such as tubes of fresh-chopped herbs. Glass jars are convenient as they are easily resealed and stored for future use. The glass may also be recycled or repurposed. Food packaging may also have built-in handles to make it convenient to carry and use, such as milk and juice bottles.

Packaging informs the consumer and promotes and markets the product

Food packaging acts as an advertising and information vehicle from the manufacturer to the consumer. Packaging is generally the only connection the consumer has with the place the product was manufactured or imported from. Therefore, the packaging acts as an information, marketing and advertising system to inform the consumer not only about the package's contents but also about the company. For this reason, packaging a product is important for image and branding and needs to catch the eye of the consumer. Packaging used by a company will identify their business, product and brand generally through the use of their logo and trademark. By law, packaging must also display the list of ingredients, the quantity, and provide a brief description of the product. It must also provide directions for use, use-by dates, nutritional information panels, health warnings, declaration of allergens and provide the name and address of the manufacturer and country of origin.

WS
Food labelling

FOOD LABELLING

As discussed in Chapter 11, the Food Standards Code includes labelling rules and regulations applicable to food sold in Australia and New Zealand. Labelling on food packages provides consumers with valuable information about the nutritional content of the food and also provides them with instructions for use. The control of food labelling in Australia focuses on three main areas:

- Information or words that must appear on the label.
- Information or words that may appear on the label under certain circumstances.
- Information or words that must not appear on the label.

Information that must appear on a label

Any food products that are not weighed and packaged in front of the consumer must include the information in the table below, written in English and clearly visible to the consumer.

Information that may appear on a label

Barcodes often appear on our food packages as they are a useful feature for the both food manufacturers and food retailers. When scanned, they provide retailers with information about the price, date of manufacture and batch number of the product.

However, barcodes are not compulsory. Serving suggestions, preparation techniques and different cooking methods help consumers with ideas and ways to serves the product. These may sometimes appear on food labels, but are not mandatory.

Information that must not appear on a label

Food manufacturers must ensure that packaging does not have any false, misleading or deceptive information such as a picture of a fresh banana on confectionary that only contains banana flavouring and not the real product. Food packaging must not have any claims that state a particular food is able to cure a specific illness or disease. They cannot make claims such as 'vitamin enriched' or 'vitamin fortified' or a comparison of

Table 14.1 Information that must appear on food labels in Australia

LABELLING REQUIREMENTS	PURPOSE OF THE REQUIREMENT
Name and description of the food	Identification of the product and allows it to be easily recognised. The label must not be misleading; e.g. fruit yoghurt must contain real fruit (as opposed to fruit-flavoured yoghurt).
Identification of packaging premises, batch lot and job lot	Coded in numbers and/or letters, which identifies the product in the case of a food recall.
Name and address of the manufacturer	Address must be shown in sufficient detail to ensure the purchaser can contact the manufacturer directly.
Information for allergy sufferers – mandatory warning statements and declaration of any allergens present in the food	Enables consumers who have a food allergy or intolerance to avoid these products, e.g. nuts, egg, gluten.
Ingredient list	All ingredients listed in descending order by weight. Food additives must be shown in the ingredients list by category and number.
Date marking – use-by or best-before	Applies to foods with a shelf life of less than two years. This enables consumers to eat food while it is in its best condition.
Nutrition and health-related claims	A nutrition content claim or health claim can only be included on a label if it is approved by FSANZ or is supported by scientific evidence.
Nutrition information panel	Must show the amount of nutrients per serve and per 100 grams.
Characterising ingredient or percentage labelling	The proportion of characterising ingredients must be shown in percentages.
Directions for use and storage	Provides information about the storage and use of the product necessary to protect the health of consumers, e.g. 'refrigerate after opening'.
Country of origin	Identifies where the food was made and/or produced or packaged.
Weight and measure of contents	The weight must be stated in metric units of measurement and the word 'Net' must be included.

Food Standards Australia New Zealand [Creative Commons licence]

Figure 14.3 Requirements of food labelling in Australia.

the vitamin or mineral content with any other food. Packaging cannot use the word 'health' if used in conjunction with the name of the food. Statements or claims that the food is slimming or has weight-reducing properties must not appear on food packaging.

From 1 July 2016 the Australian Government introduced new guidelines for country-of-origin labelling to be introduced by food manufacturers by July 2018. The country in which food is grown, produced, made or packed and the percentage of Australian ingredients present is now stated more clearly to help consumers make informed decisions.

Choosing the best packaging

Food processors and manufacturers must choose packaging that not only provides the specific functions mentioned above, but are also suited to the food being packaged. Materials used and the packaging design are selected according to specific factors. These include the characteristics of the food and the likelihood of spoilage or loss of quality that may result from physical damage, microbial growth and enzyme activity. The desired shelf life of the food is another factor that determines what packaging is used. Most non-perishable items, such as herbs, spices, sauces and canned foods, require more durable packaging. Foods with a relatively short shelf life, such as meat, bread and bakery products, require packaging that is suitable for short-term protection rather than preservation. Manufacturers also consider how consumers will use the product. Packaging must be an appropriate shape and size and allow for ease of handling and storage. Some foods may be packaged in specifically designed containers that value add to the product and provide added convenience to the consumer. Examples include rock salt and pepper corns that are packaged in jars with grinding devices.

Some manufacturers like their packaging to have a point of difference that sets them apart from other similar products in the marketplace. An example is the Leggo's range of pasta sauces that are sold in square jars rather than the traditional round jar. Consumers learn to recognise the packaging and logos of individual brands, which is important to gain acceptance in the marketplace to help win market share.

Packaging is expensive and adds significantly to the cost of the end product. Manufacturers must

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Figure 14.4 Gourmet salt and pepper products are now packaged in jars with built-in grinding devices.

Simplot Australia

Figure 14.5 Leggo's branded pasta sauces come in a distinctive square jar that sets them apart from the competition.

consider this when deciding on what packaging to use for their food product. If the cost of the packaging is more expensive than the actual ingredients, the manufacturer must consider if this is a viable option for them as these costs must then be passed onto the consumer. Standard packaging that is mass produced by packaging companies, such as round glass jars and aluminium cans, are far less expensive for a company to purchase and use than customised packaging.

As packaging comes in all different shapes and sizes, it is essential that the type of packaging material suits the production facilities. It can be a costly exercise if a company has to replace its machinery and equipment just to suit the packaging. Packaging that is suitable for a variety of purposes and products achieves economies of scale as less raw materials are required and production time spent from changing over lines to accommodate new forms of packaging.

Some packaging materials may have a detrimental impact on the environment. Packaging suppliers and food manufacturers must take this into consideration when making and choosing food packaging. Food packaging made from recyclable materials (for example, PET, glass and paperboard) or that can be repurposed are better for the environment and are more popular with consumers.

Finally, some high-acid foods may react with their packaging so manufacturers must ensure the packaging they choose keeps the product safe to eat; for example, laminated cans prevent syrups reacting with the package.

FOCUS QUESTIONS 14.1

REVIEW

1 Identify and describe the functions of packaging.
2 Why is it important for packaging to protect food?
3 How do manufacturers determine the suitability of packaging for their food products?

FOR YOU TO APPLY

4 For the following types of food products, research the different types of packaging materials that could be suitable for the product. Discuss how the functions of packaging apply to each type of packaging.

Jam, olive oil, dried fruit, fruit juice, butter, rice crackers, chocolate

EXTEND YOURSELF

5 Food manufacturers spend a large amount of time and money on designing packaging. Design a food package for a new range of chilled breakfast drinks. Justify how the package contains, informs, preserves, protects and is convenient for the consumer.

Types of packaging

Often it is necessary for a manufacturer to use a combination of packaging materials and types of packaging to contain and protect their products. This is referred to as combination packaging. Where producers use combination packaging, a consumer may see two or more separate packaging materials performing particular functions independent of each other.

Combination packaging

Primary packaging refers to the layer of packaging that comes into direct contact with the food product, such as the wrapper on a muesli bar or a jar for jam. The main aim of primary packaging is to protect the food product from damage caused by handling or during storage and to ensure the product is not exposed to the outside air. Secondary packaging is the layer surrounding a group of primary-packaged food products, such as the box holding six muesli bars. Secondary packaging is the external, visible face of the product – it is designed to protect the primary packaging and for ease of handling. This layer keeps the primary packaging safe and helps to retain its original shape and structure during transport and distribution.

Tertiary packaging is used to secure multiples of secondary packaging for bulk handling and distribution, for example, large cardboard boxes used to hold many boxes of a particular product.

Shutterstock.com/monticello

Figure 14.6 Many products are packaged in primary, secondary and tertiary layers.

Packaging material

While there are many different types of material available for food packaging, most manufacturers use one of four main substances, described in Table 14.2.

Table 14.2 Four main materials for food packaging

PACKAGING MATERIAL	EXAMPLE OF PACKAGING USED
Glass	Bottles and jars used for jams or pasta sauces
Plastics	Plastic films to package fresh meat Flexible plastic for bags and pouches used for oats or rice Rigid plastics used for bottles and moulded tubs
Paper and board	Paper bags used for sugar or flour Paperboard to package tea bags and egg cartons Laminates such as multi-ply board boxes used for long-life products such as milk, custard or juice
Metals	Aluminium foils used for chocolate bars Aluminium and steel cans used for canned fruits and vegetables Metalised plastics used for bags of potato chips

GLASS

Glass bottles and jars are a popular choice with manufacturers. Glass is chemically inert, meaning it does not react with food so does not taint it or change its flavour. Glass is also impervious and non-porous, meaning there is no interaction between the outside environment and the food product. Another benefit of using glass for packaging is that is odourless, hygienic and easy to sterilise. For these reasons, glass is a suitable packaging material for a broad range of liquid, semi-liquid and solid foods.

Glass is 100 per cent recyclable and can be recycled without loss in quality or purity. Almost 80 per cent of all glass packaging recovered is made into new glass products. With advances in technology, a glass container can go from a recycling bin to the marketplace in as little as 30 days. Glass is usually transparent, and if consumers can see the contents it may help them to choose a product. Conversely, some glass packaging is coloured, such as oil bottles, and this can help prevent light from affecting the contents. Glass can be made into a wide variety of shapes and sizes.

Provided it is not dropped, glass packaging is strong and durable. However, through R&D, packagers are working to make glass even stronger and more durable, while weighing less and having thinner walls. Glass containers are favoured by manufacturers and consumers as they are easy to open and easy to reseal if the contents have not been used. They may

also be repurposed and used domestically; for example, to bottle home-made preserves such as jams, bottled fruits, pickles, sauces and relishes.

Some common procedures are followed when using glass packaging. To avoid the risk of glass fragments inside containers, when glass containers arrive at a manufacturing plant, it is standard practice to prepare them by air blowing, rinsing with warm water and/or washing containers with a detergent solution. This is a critical control point (CCP) for manufacturers that use glass, to ensure product quality and consumer safety. As part of this process, manufacturers will invert the bottles or jars, to remove any foreign bodies that may be present prior to filling. This makes the container aseptic.

Using glass packaging enables the manufacturer to use different processing methods. As mentioned, glass packages are usually aseptically sterilised and hot-filled, allowing for vacuum sealing to occur without the need for the product to be further cooked or heated in a retort machine. After glass containers have been filled, closures or lids are applied to seal in the contents. The jars and product are then cooled before having the label applied.

At all stages of the manufacturing process, workers must be careful when using glass, as jars and bottles can easily be damaged or break. Production lines that use glass have electronic sensors that automatically stop the line or conveyer belt if a broken glass container is detected, which is another example of quality control procedures.

PLASTICS

Using plastics to package foods has many advantages. It is lightweight while remaining strong, it is tough and durable and is resistant to breakage if dropped. Plastic packaging is available in a large variety of colours and can be moulded into many shapes and sizes. This gives the food manufacturer lots of choice, while providing an aesthetically pleasing product for the consumer. In addition, plastics are comparatively less expensive to produce when compared with other packaging materials in the food industry. Plastics are also lighter to transport, which saves on fuel costs and reduces the environmental impact.

Rigid plastic packaging

When using rigid plastic bottles to package food, they are treated the same way as glass bottles and jars. While plastic bottles do not shatter when dropped, they can become misshapen if exposed to high temperatures or excessive heat, which causes significant problems for the manufacturer. There are several types of plastic packaging available for use in food processing and manufacturing, but the two most commonly used are polyethylene terephthalate (PET) and high-density polyethylene (HDPE). These can be used to produce both rigid and flexible plastic packaging.

- PET is the plastic most often used for packaging that needs be transparent, such as water bottles. Adding a colouring pigment to PET can compromise its strength, so HDPE is the preferred material for coloured plastic packaging as it remains strong and durable when coloured. PET packaging has a better shelf life in terms of its strength and durability and its ability to protect its contents.
- HDPE is suitable for products with a shorter shelf life, such as milk, yoghurt and juice.
- Another type of rigid plastic packaging is polypropylene (PP). PP has the ability to withstand high temperatures so is a popular choice for manufacturers using a 'hot-fill' system such as for sauces. Polypropylene is the rigid plastic used to make moulded containers such as for heat-and-serve meals.
- Polystyrene (PS) is used to make foam trays, cups and boxes used by manufacturers. Polystyrene is also designed to protect food from physical damage as well as providing insulation. By law, all plastic packaging must display a recycling symbol and number that corresponds to the type of packaging material used.

Table 14.3 Different plastics for packaging

SYMBOL	CHARACTERISTICS AND FEATURES	EXAMPLES
Shutterstock.com/ Viktorija Reuta	Clear and tough, used for soft drink and water bottles	Shutterstock.com/ Scisetti Alfio

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Table 14.3 *(Continued)*

SYMBOL	CHARACTERISTICS AND FEATURES	EXAMPLES
Shutterstock.com/ Viktorija Reuta	Common white or coloured plastic, used for milk bottles	Shutterstock.com/addkm
Shutterstock.com/ Viktorija Reuta	Hard rigid clear plastic, such as cordial bottles	Shutterstock.com/ GraphicsRF
Shutterstock.com/ Viktorija Reuta	Soft flexible plastic, used in squeezable sauce bottles	Shutterstock.com/ AlenKadr
Shutterstock.com/ Viktorija Reuta	Hard but flexible plastic used in microwave containers, takeaway containers, yoghurt and ice-cream containers	Shutterstock.com/Eivaisla
Shutterstock.com/ Viktorija Reuta	Rigid, brittle plastic used in small tubs, such as those used for margarine and butter	Dibrary
Shutterstock.com/ Viktorija Reuta	All other plastics, including acrylic and nylon – large water cooler bottles	Shutterstock.com/Alexey Fursov

Flexible plastic packaging

Flexible plastic packaging is another popular choice with food manufacturers as it is a safe and convenient way to package and protect food and beverage products. Despite being thin and flexible, plastic is strong and durable enough to preserve food for long periods and is easier to transport, which saves energy. Most flexible plastic packaging comes in sheets or reels with thicknesses as low as 0.375 millimetres. These thin plastic sheets can be manufactured into a number of styles or types of food packaging. The most common type of flexible plastic packaging that most of us use of a daily basis is polyethylene (PET), used to make cling wrap. High-density polyethylene (HDPE) is more robust and is a suitable choice for tougher packaging such as the bags inside breakfast cereal boxes.

Low-density polyethylene (LDPE) is commonly used in applications such as liners, overwraps, consumer food storage bags, shrink and collation films for holding products together in cartons and laminating as well as for caps and closures. Polypropylene (PP) is also used as a flexible packaging and is suitable for packing lollies, chips and biscuits.

PAPER AND CARDBOARD

Paper and board packaging is versatile and cost effective and can be used for a variety of different food products. Paper and paperboard packaging comes in different shapes, styles and forms and can be made different textures and thicknesses depending upon the product it will be used to package. Some food products may need to be packaged in paper that has been coated or treated to provide a barrier against undesirable odours and moisture that may taint food. Carton-board is commonly used for liquid stocks and juices, dry foods, frozen foods and fast-food products. Corrugated board packaging has a variety of uses and applications and is often used when food comes into direct contact with packaging, such as with pizza boxes. Corrugated board is also used as secondary packaging as it is thick, sturdy and durable.

Pulped fibreboard is often more rigid and can be moulded into particular shapes that provide protection for delicate foods such as eggs, fruits and vegetables.

Table 14.4 Paper and cardboard packaging

TYPE OF PACKAGING	CHARACTERISTICS AND FEATURES
Paper bags Shutterstock.com/M. Unal Ozmen	Inexpensive and used for a variety of food products. When sealed, it keeps food safe and protected from dust and natural light. This type of packaging can be easily damaged.
Paper sacks Alamy Stock Photo/Darryl Webb	Similar to paper bags, but paper sacks are bigger and are made from thicker paper, which allows them to hold heavier contents. They may have a plastic lining.

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Table 14.4 *(Continued)*

TYPE OF PACKAGING	CHARACTERISTICS AND FEATURES
Moulded cardboard Shutterstock.com/sripfoto	Paper is pulped then spread into moulds and allowed to dry. This produces a thick end product that has a variety of uses depending upon the mould used.
Board-based packages Shutterstock.com/George W. Bailey	This packaging is made from cardboard that is between 0.5 and 1.0 millimetres thick. This product has a solid structure and is easily stacked on shelves in the marketplace. Board-based packages used for frozen items will have a plastic laminate coating for protection.
Composite containers Shutterstock.com/Paul Daniels	These packages comprise more than one type of packaging material. They may be a board-based canister with a metal or moulded plastic lid, or a board-based product with a foil laminate.

METAL

Metal cans made from steel and aluminium are one of the most popular and widely used packaging materials. Steel cans are commonly used to package solid and semi-solid foods such as canned fruits and vegetables, while aluminium is used for soft drinks and other beverages. Steel cans are generally coated with a thin layer of protective coating, which acts as a barrier (to stop any reactions taking place) between the packaging material and the food. Foods with a low protein and high-acid content require cans with special lacquer or plastic coating to ensure the package is inert and non-reactive. This will help the food to remain shelf stable for extended periods.

Metal cans are inexpensive, readily available, easy to use, safe and hygienic and cost effective for the manufacturer and consumer alike. Other advantages are that they are stackable and strong, which allows for ease of transport and distribution. Cans provide good protection for the products they contain as they are designed to prevent unwanted moisture loss or gain, which can damage the food inside. Using cans to package food is generally an easy process for manufacturers. They are easy to source, fill, seal, heat, cool and package. Cans are usually sourced as a standard shape and size, making them easy to stack and display on shelves in the marketplace. They are also reasonably easy to recycle. South Australia even offers money to consumers who recycle aluminium at designated recycle centres.

The disadvantages of cans are that they can be heavy and if they are dented or damaged or have bulging tops, the food inside could be damaged and unsafe to consume. It is not advisable to use the contents of these

Shutterstock.com/saiko3p

Figure 14.7 The benefits of canning

WS Packaging materials

cans as holes may be present that have allowed air to enter, enabling microbes to grow and multiply inside the can. The protective coating in the lines of the cans may also be damaged, causing food to react with the metal.

LAMINATIONS

Laminating is the process through which two or more flexible packaging products are joined together using a bonding agent, such as heat, adhesive or wax. The flexible packaging that make up the laminations consist of films, paperboards or aluminium foils.

Plastic pouches that are used to hold pre-prepared gravy and sauces are an example of packaging that is made by the lamination process. The plastic shrink wrap packaging used for vacuum packing salmon, cheese and meat is another example.

Foil is often used as a secondary material in the laminating process. Most of the foils used for food packaging are made from aluminium because it is lightweight, malleable, sturdy and ability to withstand variations in temperature. Aluminium laminates are used to make packaging for products including pouches of yoghurt and baby food, foil wrappers for butter and sachets of tomato paste. Foils are thin and fragile and are usually laminated with other materials

dlibrary

Figure 14.8 Flexible plastic packaging laminated with foil.

such as plastic and paper to add strength and structure. An example of this is materials used to create Tetra Paks. These are multilayered laminations made from layers of paper, metal and plastic, suitable for packaging long-life milk, juice and breakfast drinks.

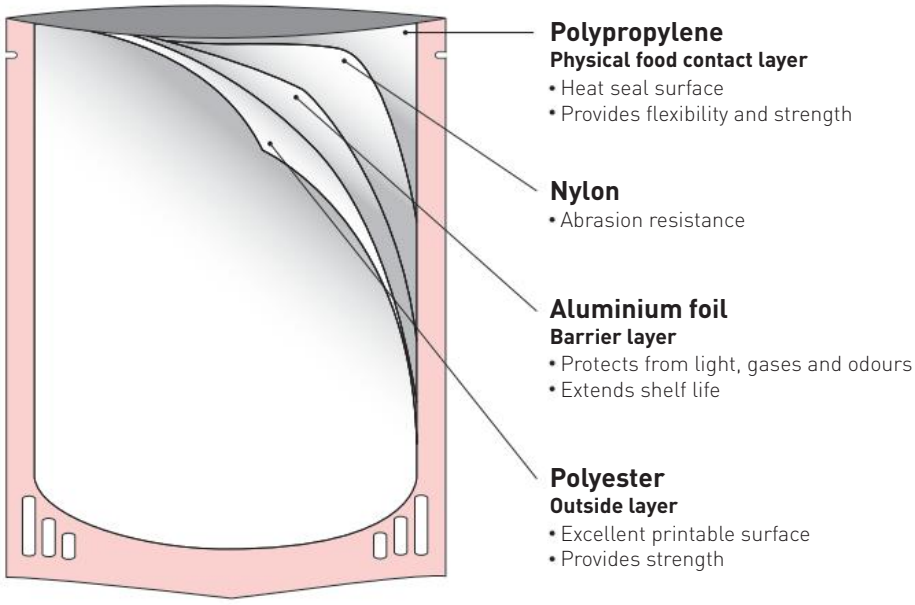

Figure 14.9 The construction of a Tetra Pak

FOCUS QUESTIONS 14.2

REVIEW

1 Why should dented cans be discarded?
2 Some cans are coated with a thin layer of lacquer on the inside. Why is this important? Identify the types of food that may be packaged in this style of can.
3 Glass is a popular packaging material. Outline the advantages and disadvantages of using glass to package food and identify a CCP that manufacturers must consider.

FOR YOU TO APPLY

4 Prepare one serve of chocolate-chip biscuits. As a group, design and create a suitable primary package and secondary package. Research and justify a suitable tertiary package that could be used to safely transport the product.
5 As a class, collect a variety of recyclable packaging material generated as waste in your homes. Bring the packaging into class and sort it according to the recycling codes. What observations can you make about the types of packaging materials and the foods they contain?

EXTEND YOURSELF

6 Research the history of canning. What are the major advances in canning that have occurred in the past 30 years. What were some of the problems faced by manufacturers in the early years of canning?

Current developments in packaging

The food packaging industry is constantly changing and highly competitive because of the technological advances that allow new forms of packaging to be developed and created. Food manufacturers are constantly looking for ways packaging can provide consumers with increased convenience while providing a longer shelf life and at a lower cost. The food manufacturing industry is conscious of the fact that consumers are looking for packaging that is innovative, novel, aesthetically pleasing and convenient to use. The food packaging industry must strive to modernise and revolutionise packaging to meet consumer demand as well as to make packaging more sustainable and environmentally friendly. The overview below covers some of the major trends and innovations that have occurred.

Modified atmosphere packaging

Modified atmosphere packaging (MAP) is a method of packaging used to extend the shelf life of fresh food products. MAP techniques substitute the atmospheric air or gas inside a package with a protective gas mix. This gas helps ensure that the product stays fresh for as long as possible and retards the growth of micro-organisms that may cause food to spoil.

By using a MAP system, the ideal mixture of gases such as oxygen, nitrogen or carbon dioxide can be added to the inside of a package to ensure that the food reaches consumers in optimum condition. For MAP to be effective, the packaging material used must not allow gases to pass through it once it is sealed. Modifying the atmosphere that surrounds food can be achieved using a variety of methods where the ratio of gases and packaging material are matched to particular foods. These methods include:

- barrier-specific packaging
- vacuum packaging
- gas packaging
- active packaging.

BARRIER-SPECIFIC PACKAGING

The barrier properties of this packaging material is designed to allow some gases into the packaging at different rates and exclude others. The respiration of fresh food produces moisture, which can cause changes to the gases inside the food packaging. To enhance the MAP systems, special packaging materials are used for specific food items. The packaging material used must be transparent and have anti-fogging properties to prevent condensation on the inside of the packaging. Barrier-specific packaging is used to package fresh pre-cut fruits and vegetables such as salad mix, as it allows them to respire without spoiling.

VACUUM PACKAGING

Vacuum packaging, or cryovacing as it is sometimes called, involves removing the air from inside the package to create a vacuum, so that the packaging seals the food. This is a cost-effective method of packing used for cheeses, meats such as salami, bacon and ham, fresh noodles, coffee and shelf stable olives and sun-dried tomatoes.

GAS PACKAGING

For this method of packaging, the gases within the package are specially designed to maximise the shelf life and meet the requirements of the food it contains. Manufacturers replace the air or 'head space' in the package with gases before the package is sealed. The packaging material used must not be permeable or porous, to maintain the correct gas balance. This method is used to package fresh pasta and snack foods such as chips, pretzels and popcorn. When products such as chips are packaged, nitrogen replaces oxygen in the package, which helps keep the package inflated, thus protecting the contents.

ACTIVE PACKAGING

Active packaging is a packaging system used to modify the environment within the package as it changes during storage. Active packaging films are used to hold food and provide a barrier to outside influences. Small reactive pouches are placed inside the packaging to control the internal environment of the package. These pouches or sachets (also known as 'scavengers') remove or add gases inside the packaging or remove odours that may be produced by the food. These pouches can be seen inside packets of naan bread, tortillas and nori sheets.

Sachets or pads of absorbent materials are also used when packaging fresh meat and poultry to absorb excess moisture that may escape during storage. This helps to maintain the appearance and sensory properties of the food when on display.

FOCUS QUESTIONS 14.3

REVIEW

1 Outline the information that must appear on a food label.
2 Define the term 'MAP'.
3 What are the benefits of using the MAP system of packaging?
4 Identify three types of MAP systems and give one example of a food packaged using each system.

FOR YOU TO APPLY

5 Purchase your favourite chocolate bar. Carefully unwrap the chocolate so the package remains intact. Open out the package and lay it flat. Refer to the labelling requirements table on page 250 and locate where the information appears on the wrapper.

EXTEND YOURSELF

6 Explain the statement: 'Food labels have both advantages and disadvantages for consumers and manufacturers'.

FOOD IN FOCUS 14.1

PICKLED VEGETABLE RANGE WITH 'LIFT AND DRAIN' PACKAGING

Adelaide food producer Spring Gully Foods has launched a range of pickled vegetables packaged in innovative 'lift and drain' baskets.

The range, which is available nationally through Coles, includes Australian grown and processed cucumbers, pickled onions, olives and capsicums.

Spring Gully Foods

Figure 14.10 Spring Gully Foods 'lift & drain' basket

The lift and drain packaging, in which the products sits in a basket within a container, is an Australian first for this category. The basket can be lifted from the liquid to allow easy use.

'We last processed Australian gherkins about 25 years ago when they were grown by commercial grape growers in the Adelaide Hills and Barossa Valley as a secondary crop,' said Spring Gully's Managing Director Kevin Webb.

'Since then we have been sourcing them from overseas. However, we recently signed a multi-year agreement with a large commercial market gardener at Virginia, north of Adelaide and will receive around 300 tonnes of fresh cucumbers this year. This volume is anticipated to increase year on year.'

Coles General Manager Grocery, Neil Lake said the supermarket is passionate about innovation and supporting Australian businesses to innovate and grow.

'We are proud to work with Spring Gully Foods to grow their business and develop new products for our customers to try. Their focus on innovation has led to these new products being the only items packaged in plastic containers in the category, making it easier and more convenient than ever for Australians to enjoy some of their favourites,' he said.

Source: Reprinted with permission of Spring Gully Foods and Food Magazine

RESPOND

1. Visit the Spring Gully website and outline the products they produce.
2. What are the advantages to the consumer of having the lift and drain feature?
3. Are there any disadvantages relating to this new packaging innovation?
4. Spring Gully is now able to source locally grown produce to prepare their products. Discuss the impact this will have on society, the economy and the environment.

Spring Gully Foods

SOUS VIDE

The sous vide process, often referred to as the cook–chill process, was originally developed in Europe to produce high-quality goods while retaining nutritive value. In Australia, it is used extensively in hospitals, nursing homes and restaurant chains as it allows food to be cooked ahead of time, cooled or frozen quickly and then reheated when needed. This method is used to extend the shelf life of food for several days or have the meals frozen until needed. To reheat, the bag or item is placed in boiling water or a specially designed steam oven. The packaging used is a polyester film that is able to withstand freezing as well as the high temperatures needed for reheating. Cooked foods are vacuum packed then blast chilled to 3°C, which enables the product to be shelf stable for up to six weeks.

The advantages of sous vide to consumers are that they are lightweight, inexpensive, easy to use and store, and the colour, flavour and texture are retained during cooking.

Innovations in packaging design

Research and development of new and innovative packaging technologies takes time and money. So that new packaging is cost effective for the developer and the food manufacturer, it must be able to be used for a range of food products. Associated costs to develop the packaging are passed onto consumers, which increases the overall cost of the product.

EDIBLE PACKAGING

As we know, most foods such as meats, breads, fruits, vegetable, cheeses and snacks come wrapped in some form of plastic packaging. This packaging creates a lot of non-recyclable and non-biodegradable waste that is harmful to the environment. Sometimes these thin plastic films do not prevent food spoilage and may even leach potentially harmful compounds into foods. To solve these problems, scientists are now developing packaging films that are made of edible milk proteins. The protein-based films are said to be 'powerful oxygen blockers' that can help prevent food spoilage.

Studies have indicated that when used as packaging, the film has the potential to reduce or prevent food waste that occurs during storage and distribution. The casein-based films are reported to be up to 500 times better than plastics at keeping oxygen away from food and because they are derived from milk, they are biodegradable, sustainable and edible. Apart from producing plastic pouches and wraps, scientists believe the casein coating could be sprayed onto food, such as cereal flakes to keep them crunchy when milk is added. At present, cereals retain their crunch in milk due to a sugar coating, so using a casein film would make them much healthier. Research also indicates that the spray could be used to line pizza boxes or other food boxes to keep the grease from staining the packaging. Along with this innovation, commercially available edible packaging varieties made from starch are already part of the marketplace.

INTELLIGENT AND SMART PACKAGING

The term intelligent packaging is very broad and may be defined in a number of different ways; in principle it can be defined as packaging that informs the consumer about some of the aspects of the packaged food product such as quality, nature of production or the history of the food.

Intelligent packaging may be used to indicate to the consumer whether its contents are warm enough or cold enough to maximise flavour. It may also be used to let the consumer know whether the food product is still safe to eat. Intelligent packaging can also inform the consumer of the conditions to which the food has been subject to during its time spent in storage and distribution. This packaging innovation can also help with information relating to traceability, tracking and record keeping from paddock to plate.

Insignia Technologies

Figure 14.11 Innovative packaging – this package has a chart showing the freshness of the meat.

Innovations in new polymers or coatings and the discovery of new nanomaterials will continue to see further advances in barrier materials used in the food industry. These materials help to impede the interaction of harmful elements, such as light and moisture, with food. One example of this is aqueous barrier coatings, which are ideal for cardboard food containers and disposable dishware as they are water and oil resistant. Innovations using nanoparticles, additives, emitters, and absorbers will continue to contribute to the rise of 'active' packaging. For example, the use of device indicators provides product information about conditions such as freshness, humidity, leakage and temperature.

Moulded fibre packaging has been used to hold delicate food items such as eggs for many years. However, new printing technology now makes it possible to print high-resolution coloured graphics directly on the packaging, improving sustainability by making additional labels and secondary packaging redundant.

Intelligent packaging has built-in capabilities able to respond in some way to the changing conditions within the package. For example, a food packaging company has developed a sensor that detects ethanol levels in the head space of a food package. The sensor is

designed to monitor ethanol levels emitted from foods as they age. The information obtained by the sensor is then transmitted from the package to the retailer or customer by using a reader. The data is saved digitally in a remote server that can be accessed by a smart device. The sensor and the RFID tag can be developed using printing techniques or be manufactured directly into a label. It could also be included as a sticker that could be easily attached to food package. The use of the sensor may make it possible to control the food quality throughout the distribution chain and to prevent waste caused by spoilage.

Thinfilm

QR CODE READERS

Quick Read (QR) codes are two-dimensional computer-generated images that can be scanned by smartphones or tablets to generate information or perform an action; they are now a very popular way for manufacturers to communicate with consumers. They work simply by aiming the camera of your smart device at the QR code: the software deciphers the code and then connects you to a webpage. The greatest benefit of QR codes is the ability to provide extra and additional information to the consumer without taking up valuable space on food packaging. Apart from providing valuable information, they may also be used to interact with consumers such as getting them to enter competitions, provide feedback or invite them to follow social media pages. An example of how QR codes are used as packaging can be seen by the Coca-Cola US promotion to raise money for the World Wildlife Fund to help conserve polar bears' Arctic habitat. Coca-Cola teamed with 7-Eleven stores to sell their beverage in white cups that had a QR code. When scanned, the two-dimensional barcodes took consumers to a site where they could download a 'Snowball Effect by Coca-Cola' app for iPhone and iPad. The app turns into a Facebook-based snowball throwing game. Participants who scored the most points where able to win prizes, including iPads and a trip for two to the Arctic. The app also takes scanners to a site where they can donate to the cause.

Alamy Stock Photo/ UniversalPhotography

Figure 14.12 QR codes can provide extra information or help companies engage with consumers.

FOOD IN FOCUS 14.2

SHAZAM MAKES KIT KAT PACKAGING INTERACTIVE

Music-identification app Shazam has partnered with Nestlé in an effort to enhance the way marketers engage with consumers and consumers engage with brands. The partnership will see millions of Shazam-enabled KITKAT bars distributed as part of their latest consumer promotion.

NESTLÉ and KIT KAT registered trade marks reproduced with the kind permission of Société des Produits Nestlé S.A., Vevey, Switzerland

Figure 14.13 KitKat and Shazam

To be in with a chance to win, consumers are invited to purchase any promotional KITKAT, Shazam the packaging, go to the website and follow the prompts. 'Shazaming' is easy – consumers simply need to open the Shazam app on their smartphone, hold the phone over the front of the KITKAT and then tap the camera icon to visually Shazam the packaging.

Visual recognition launched in June last year as part of Shazam's broader Shazam Connect for Brands product offering. When coupled with the app's existing audio recognition capabilities it allows marketers, for the first time, to make all consumer facing touch points clickable; including traditional media, POS and packaging – effectively building a bridge from physical to digital.

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Shazam's VP Asia Pacific, Steve Sos, said: 'We have launched over 40 visual campaigns since mid-last year but this is certainly our most ambitious undertaking to date. It is great to be working so closely with such a progressive marketer on one of the world's truly iconic brands, KITKAT. Our one touch audio and visual recognition, coupled with the scale our waterfront property on millions of smartphones brings, should add an exciting layer of interactivity and engagement to the KITKAT campaign.'

Chris O'Donnell, Head of Marketing at Nestlé, said: 'The partnership between KITKAT and Shazam shows how we can bring innovative and easy-to-use technology to consumers to enhance their break and delight them in new ways. We are excited to be the first confectionary brand in Australia to offer this technology on packaging and in doing so truly integrate through the line. There will be over 4.7 million Shazam-enabled KITKAT bars in the Australian market'.

The promotion is being rolled out via Shazam-enabled packaging, TVCs, digital marketing and social media, as part of a fully integrated campaign.

Source: Foodmag.com.au, May 10, 2016

RESPOND

1. What age group do you think this type of packaging is aimed at? Justify your answer.
2. Discuss the benefits to the consumer and the manufacturer for using this type of technology on packaging.
3. Investigate other forms of cross-promotion that food manufacturers use on or inside their packaging.

BIODEGRADABLE AND PLANT-BASED PACKAGING

In recent years, scientists have been developing bioplastic trays and films from corn and wheat starch.

Plantic Technologies

Plantic Technologies, an Australian-based company, has developed an environmentally friendly bioplastic suitable to use for food packaging. Plantic bioplastic packaging has several environmental benefits. Cornstarch is the main material used in manufacturing this product, which is derived from renewable and sustainable resources. Every stage of production is organic, from the growing and harvesting of the corn to the final product, which means no harsh chemicals are used. The Plantic bioplastic can be used to make both rigid and flexible packaging, making it a versatile food packaging product. Several major food manufacturers have chosen Plantic packaging for their food products, including Haigh's Chocolates and Cadbury Schweppes, who are both using this innovative packaging for their chocolate products. Plantic bioplastic may also be used to package fresh food products, including meat, fish, fresh salads and fresh pasta.

Bio-pac

Bio-pac is another Australian company that manufactures plant-based packaging solutions. Their aim is to replace all packaging made from non-renewable fossil-based resources. This company provides packaging for the food service and catering and food retail sectors.

Plant-sterol PET bottle

Coca-Cola has also begun using the world's first PET bottle made entirely from plant materials. The 'Plant Bottle' is a sustainable innovation developed by using emerging technologies to create a bottle that is fully recyclable and made from renewable plant materials. This product has been successfully launched internationally.

Alamy Stock Photo/Kevin Britland

Figure 14.14 Coca-cola has recently launched a PET bottle made entirely from plant materials.

Micro-fibrillated cellulose (MFC)

Micro-fibrillated cellulose (MFC) is a sustainable material that makes packaging stronger while creating an oxygen and moisture barrier. Extracted from plant waste this improved technological innovation produces packaging that is stiffer yet lighter than carbon fibre or glass and offers manufacturers the opportunity to reduce the amounts of raw materials used in packaging products.

PRACTICAL APPLICATION 14.1

PACKAGING

AIM

To research packaging that makes uses of emerging technologies

METHOD

1. As a class collect some examples of packages that make use of new and emerging technologies.
2. Consider tamper-proof openings and environmentally friendly features.

RESPOND

Analyse your findings – consider why this emerging technology has been introduced and to whom is it targeted?

Storage and distribution during food manufacture

Storage

Materials may be stored in a food manufacturing plant at several points during processing. Perishable and non-perishable raw materials need to be stored when they initially arrive at the processing plant. These commodities require controlled-atmosphere storage such as refrigerators, freezers and dry storage to ensure they are in optimal condition when required.

Products that have undergone some form of processing may also require storage before further operations take place, such as the hot holding of product prior to canning, or dough needing to rise before being baked into bread. This may be referred to as the delay stage. Storing the finished product is also required before it is distributed. Most food manufacturing plants have onsite warehouses to hold their products before being transported (JIT– just in time – production does not require products to spend significant time in warehouse storage.)

As discussed, cold storage should be at temperatures of 0–5°C; freezer storage must be kept between −18 to −30°C. Dry storage areas must be well ventilated, have controlled humidity levels and the temperature should not exceed 24°C. Exposure to sunlight should also be avoided.

Distribution

Distribution refers to the method used to take raw materials from the farm or processing plant to the food service and catering industry, food retailer or consumer. Distribution might involve transporting foods only once, such as transporting produce from a farm to a farmers' market where it is then purchased by the consumer. Or, distribution of food products may involve several stages.

The manufacturer must carefully consider what packaging to use so that it is compatible with the product's distribution method. Therefore, the size and shape of the finished food product is important. During the warehousing, transport and distribution process, empty space is costly for the manufacturer,

Figure 14.15 Distribution flowchart for canned beetroot

so they try to fit as much product in a storage facility as possible. Secondary and tertiary packaging are important to prevent damage to a product's primary package and contents. It also makes handling of the product easier during distribution. Supermarkets prefer tertiary packaging to be shelf ready, meaning the packaging should have perforations to allow for easy opening and be of the correct dimension to be placed directly onto the supermarket shelf.

Contamination (or risks to food safety due to incorrect storage temperatures) and loss of quality can still occur during storage, transport and distribution, so it is vital that quality management procedures are also used during this phase. Contamination or loss of quality may occur if refrigerated food is left on a loading dock for an extended period in warm weather. This could mean that the food product reaches temperatures that allow bacteria to grow. Fresh produce may become contaminated if it is loaded into a truck that was not cleaned after transporting animals or animal products. Food may also be at risk if the temperatures of refrigerated or freezer transports are not maintained at adequate levels. Manufacturers need to be particularly careful with storage and distribution of items packaged in glass. If a glass jar breaks, the contents could contaminate nearby foods, posing a risk to consumers.

Transport and distribution after manufacture

Once the food product has been through all stages of the production process, the packaged product will be stored in the manufacturing plant's warehouse until transport and distribution is required. Transport and distribution is often referred to as logistics. Transportation of product can occur in a number of different ways. This can be done by road, rail, air or sea. Manufacturers will send their food products to wholesalers, supermarket chains, retailers or direct to consumers using these methods. Food may also travel interstate or overseas, requiring specialised logistic companies to be used. There are three main distribution channels, as shown in Figure 14.16.

Food wholesalers and retailers need to be able to handle goods efficiently, so require packaging and handling methods that suits their needs. Manufacturing plants use laser guided vehicles and RORO (roll on, roll off) machines to quickly and efficiently load food items onto trucks to be transported. These automated systems reduce the need for human labour and are easy to use, eliminating the need for forklifts and double handling of products. They have a fast turnaround of vehicles, meaning loading or unloading can be completed efficiently.

Products can be damaged during transit if they are not packaged well or if they can move around

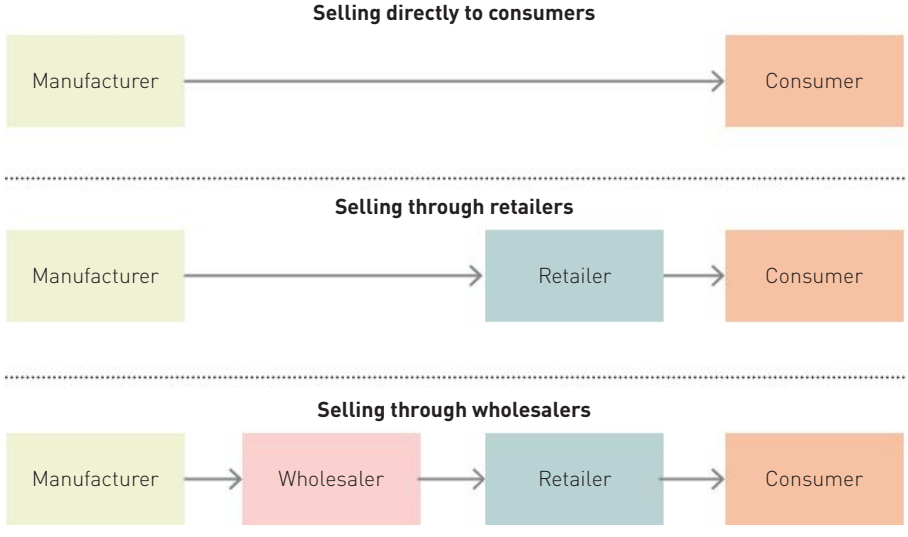

Figure 14.16 The three main distribution channels

too much, such as being bounced around in a truck. Packaging must be durable enough to withstand handling and movement, while still being lightweight.

When products arrive in distribution centres or warehouses, the cartons are removed from their pallets and arranged into large aisles or sections. There, the products are stored ready to make up orders to be transported to individual stores. These orders will contain many different brands and types of products, depending upon what is required by each retail outlet. Once delivered to the retailer, the items are removed from the transport and checked off against orders. The products are then placed onto the shelves ready to be purchased. Distribution centres are strategically located on major highways throughout Australia. One of Woolworths' major warehouse and distribution centres is located in Wodonga, Victoria, 290 kilometres north of Melbourne and 580 kilometres south of Sydney. The $90 million Woolworths Regional Distribution Centre employs more than 400 people and turns over $2 billion of stock every year.

FOCUS QUESTIONS 14.4

REVIEW

1 Outline the different points in the processing and manufacturing of food at which storage of food may be necessary.
2 Why is temperature control important during storage and distribution of food?
3 List the appropriate storage temperatures and conditions for the following food items:
- Chicken breast fillets
- Frozen corn on the cob
- Potatoes
- Milk
- Bananas
- Rockmelon
- Flour
- Canned tomatoes
- Prawns
- Ice-cream

4 Why is it necessary to keep foods with a high fat content away from direct sunlight?
5 When purchasing foods from a supermarket, outline the distribution channel the food has gone through.
6 Discuss the ways in which food items may become damaged during transport and distribution.

FOR YOU TO APPLY

7 As a class, research the use of laser guided vehicles and RORO (roll on, roll off) machines used in manufacturing plants. What are the advantages and disadvantages of using these types of sophisticated equipment?

EXTEND YOURSELF

8 Damage to food products can be very costly for food manufacturers. Design a type of packaging that protects a product of your choice from the inherent risks of damage that may occur in transportation by road. Explain and justify your design choices for your food item.

Chapter review

REVIEW

1 Why is packaging necessary for manufactured food products?
2 Outline the factors a manufacturer must consider before deciding on what type of packing to use for their products.
3 Evaluate the strengths and weaknesses of the following types of packaging materials: glass, board and rigid plastics.
4 Outline the differences between primary, secondary and tertiary packaging.
5 Summarise the principles of MAP packaging.
6 Describe the sous vide process.

FOR YOU TO APPLY

7 Research a current development in packaging material. What type of food products can be packaged using this material? Outline the benefits of using this type of packaging.
8 Compare the use of glass and rigid plastic as packaging material used for a soft drink.

EXTEND YOURSELF

9 Critically assess the suitability of cardboard as a packaging material.
10 Explain the importance of packaging and food labelling in relation to consumer health and safety.

CORE STRAND REVIEW

MULTIPLE CHOICE

1 Why is stainless steel often used when constructing food-processing equipment?

A It is magnetic.

B It is cost effective

C It does not react with foods.

D It is manufactured in Australia.

2 Which of the following has the most influence on the selection of raw materials for food processing?

A The level of physical damage.

B The cost of end-product distribution.

C The consistency of shape, size and colour.

D The seasonal availability.

3 Which of the following is a major advantage of using Hazard Analysis and Critical Control Point (HACCP)?

A It has a low cost of implementation.

B It increases profits and reduces waste.

C It does not require all staff to be trained.

D It creates more nutritious foods for consumers.

4 In which of the following groups of food are all foods produced using the process of fermentation?

A Jam, sourdough bread, yoghurt

B Cheese, jams, pickles

C Honey, salami, pickles

D Cheese, yoghurt, salami

5 Why is it necessary to pasteurise milk?

A To ensure consumer safety.

B To improve its flavour and colour.

C To simplify packaging.

D To increase its nutritive value.

SHORT ANSWER

6 What are raw materials? How can these be classified? Why is the quality of raw materials important? (5 marks)

7 Identify the requirements for microbial growth and outline how these can be controlled to extend the shelf life of perishable food. (8 marks)

8 Define the term food additive. Justify their use in manufactured food products. (5 marks)

9 Outline two features of HACCP and describe the benefits of using HACCP. (5 marks)

10 What are the causes of food deterioration and food spoilage? (5 marks)

11 Identify a food product you have produced in class. Identify and describe two unit operations that were applied in the making this product. Discuss two critical control points that you identified when making the product. (8 marks)

12 Compare the processes used when packaging food items using the following techniques:

- MAP
- Active
- Sous vide (6 marks)

13 Explain a preservation method that uses restriction of water to extend the shelf life of a food product. (2 marks)

14 Explain a preservation method that uses application of heat to extend the shelf life of a food product. (2 marks)

15 Why is quick freezing for preservation preferred to slow freezing? (4 marks)

EXTENDED RESPONSE

16 Explain the reasons for preserving foods. Select three preservation processes and discuss the principles of food preservation used in each. Use relevant examples to support your answer. (15 marks)

17 Discuss the advantages and disadvantages of using a fully automated and computerised production system. Explain the characteristics of processing equipment used in fully automated plants when compared to equipment used domestically. (15 marks)

CHAPTER 15

Factors that impact on food product development

Food product development is a term used to describe the process of bringing a new or improved food product or process to the marketplace – from conception through design and finally to market. Product developments can be original products, product improvements, product modifications or completely new brands that a company develops to compete with other products on the market. Food product development is an exciting and dynamic aspect of the food industry involving creativity, innovation, research and development, planning and marketing. Developing new products is a complex process requiring knowledge of ingredients, processing techniques, packaging materials, legislation and consumer demands and preferences.

CHAPTER OUTCOMES

In this chapter you will learn about:

- External factors in food product development (the macro-environment)
- Internal factors in food product development (the micro-environment)

KEY TERMS

demographic
economic forces
food product development
forces
government
inflation
macro-environment
micro-environment
sustainability
trend

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Food product development

New products are essential to the survival and long-term growth of any food company; however, throughout this process various challenges and opportunities can affect the development of the products. There are a number of factors that influence the decisions related to new food product development in an organisation. These can be broadly categorised into:

- external or market factors (macro-environment)
- internal or organisational factors (micro-environment).

The macro-environment

Every player in the food industry operates in a macro-environment of forces and trends. This includes all factors that can influence an organisation but that are out of its direct control. These external factors can increase or decrease the need for a product, or create entirely new product needs. Raw material costs might be driven up or down; new target markets might be created or old ones changed. These forces and trends shape opportunities and present challenges, and companies must react and adapt to these changes or face serious survival problems.

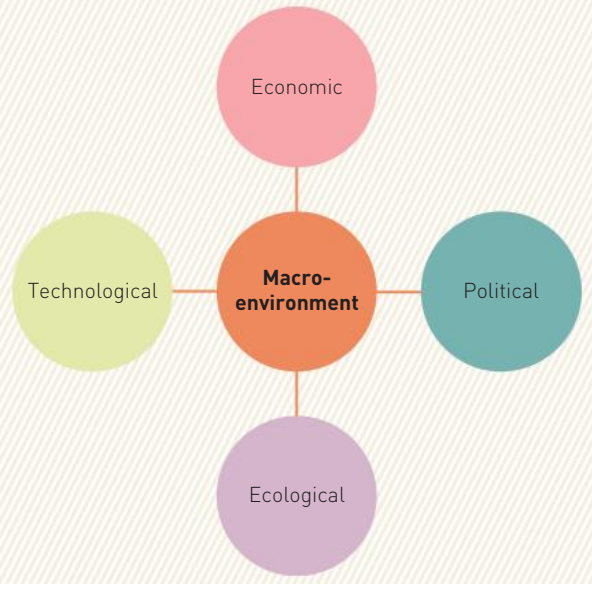


Figure 15.1 External factors that impact on food product development

Economic factors

Economic forces relate to factors that affect consumer purchasing power and spending patterns as well as an organisation's production abilities. Economic growth, currency exchange rates, inflation and interest rates, economic stability, credit availability, business cycles, anticipated shifts in commodity and resource costs and employment policies are all key factors in the economic environment. These factors influence an organisation's ability to compete in the marketplace and consumers' willingness and ability to purchase goods and services.

Food is an essential part of everyday life, although trends affecting purchasing power can have a strong impact on non-essential food products that may be perceived as luxury items. As discussed in Chapter 1, the state of the economy can influence a consumer's food decisions. In a recession, people may lose their job or worry about their employment stability. This makes consumers less willing to spend their disposable income on new or unknown food products. Conversely in an economic expansion or boom, job security makes people more willing to spend their disposable income on something different.

The same applies to food product development. Companies are more inclined to launch a new product in boom times when stakeholder confidence is high, but are hesitant to try when economic times are tough.

Level of employment is one of the main factors influencing demand for new food products. The more people receiving a steady income and expecting to continue receiving one, the more consumers there are in a position to make discretionary spending purchases, ensuring a market for a new food product.

Consumer spending is further influenced by the level of wages. If the economy is stable and wages are rising steadily, consumers generally have more discretionary income to spend (discretionary or disposable income is the portion of an individual's income available to invest, save or spend on

non-essential items, after paying taxes and buying personal necessities such as food, shelter and clothing). If wages are stagnant or falling, demand for unnecessary goods or new products is likely to fall.

Higher inflation and interest rates erode purchasing power of both food companies and consumers. For consumers, these added expenses make it less likely for them to have extra income to spend after covering basic expenses such as food and housing. For companies, the cost of raw materials, wages and processing costs can all be affected by these rates. Manufacturers are less likely to spend money on new equipment and processes and fewer new products are developed. To cover higher production and manufacturing costs, the end price of a food product may increase. Higher prices on goods will deter consumer spending.

Consumer confidence is another important factor affecting the demand for new food products. Regardless of their current financial situation, consumers are more likely to purchase new products when they feel confident about both the overall condition of the economy and about their personal financial future. High levels of consumer confidence can encourage food companies to launch or re-launch a food product.

The economic policy of the government can have a profound impact on food product development. Some categories of companies will be favourably affected by changes in government policy, while some are adversely affected.

Political factors

Every business is limited by the political environment in which it operates. This involves legislation, government agencies and pressure groups, all of which can influence organisations, individuals and food products. They may be influenced by organisational operations, tax policies and the national and international laws that affect demand and supply chains. Federal, state and local governments all have laws and regulations that affect the business operations of food companies.

These rules and regulations cover diverse areas such as product safety; product claims; trademarks, copyrights and patents; employee health and safety; the environment; corporate governance; listing and disclosure; employment; and taxes, and have been established to protect and support both consumers and industry. Changes in the government policy can be unpredictable and may have economic, legal or social implications or a mix of all of these factors.

What you eat is the most political thing you do every day – Jeanette Winterson.

Political factors can create advantages and opportunities for food companies and/or place obligations and duties upon them. Political factors that may affect food product development may include:

- Type of government regime – in Australia a democratic government; in some other parts of the world communist or dictatorship.
- War and conflict
- Legislation such as the minimum wage or anti-discrimination laws.
- Voluntary codes and practices as promoted by the Australian Competition & Consumer Commission (ACCC)

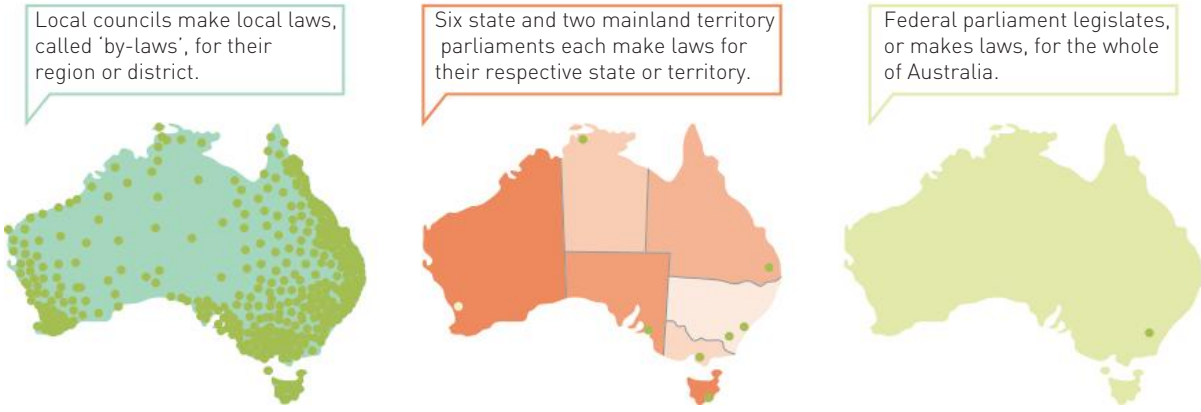


Figure 15.2 Australia has three levels of government: federal, state and local.

- Market regulations such as certification and labelling for organic or bioorganic foods.
- Trade agreements, tariffs or restrictions; for example, on genetically modified foods
- Tax levies and tax breaks
- Funding, grants and initiatives such as the 'Waste Less, Recycle More' initiative
- Advisory and research assistance from government organisations such as the CSIRO.

PRACTICAL APPLICATION 15.1

POLITICAL FACTORS

AIM

Investigate one or more political factors that may affect food product development in Australia.

METHOD

1. Select one or more of the political factors listed above. Identify how this factor creates advantages, opportunities or restrictions upon food companies looking to develop new food products.
2. Outline current issues surrounding this political factor.
3. How have food companies responded to this political factor?

The legal environment facing organisations is becoming more complex and is affecting food companies more directly. It has become increasingly difficult for businesses to be innovative without encountering a regulatory or legal problem. Failure to comply with these legislative obligations can lead to sanctions such as fines, adverse publicity and imprisonment. Ineffective voluntary codes and practices will often lead to governments introducing legislation to regulate the activities covered by the codes and practices, which affects current and future food product development projects.

Political changes are closely tied up with economic ones and relate to changing governmental influence. For example, in Australia a change from a Labor to a Coalition government may affect taxation policies, which would impact the overall cost of food production and manufacturing.

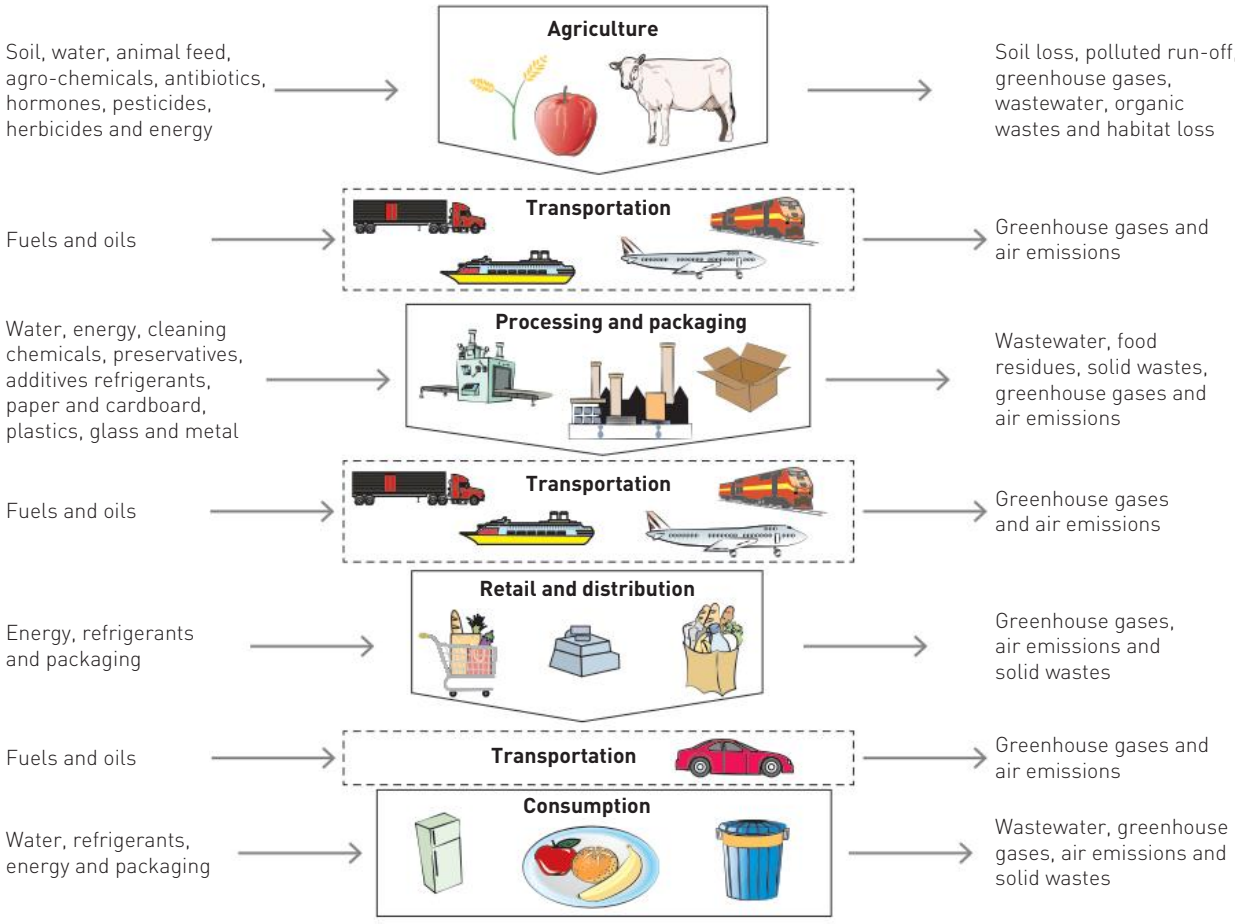
Ecological factors

Environmental concerns have grown strongly in recent years, which makes the ecological force a crucial factor to consider when developing a new food product. In Australia the production and consumption of food is intricately linked to the environment. The whole food system, which involves agricultural production, food processing and packaging, distribution, retail and consumption, uses environmental inputs such as land, air, water and energy.

These processes not only produce food but also other outputs that are returned to the natural environment, such as greenhouse gases, pesticides and fertilisers, wastewater, packaging and food waste. Consumers today have major concerns about these effects and are increasingly aware of the origins of food products, ensuring that companies consider and implement environmental sustainability into their products.

Significant natural forces and trends that are current in the global macro-environment include:

- Sustainability: many farming practices are unsustainable, such as the deforestation of rainforests, the use of non-renewable water resources for irrigation and the production of low-value water-intensive crops on irrigated land. The emergence of sustainably produced, 'rainforest friendly' products like coffee and chocolate are testament to consumers being concerned by this trend.
- Organic food: a major emerging trend that attempts to reduce the environmental impact of food production systems, and greatly impacts natural, economic and cultural forces. The rise in popularity of organically grown foods, meaning they are readily available in supermarkets, shows consumers' awareness of the environment.
- Water security: there is growing pressure on world water resources, largely due to the increasing demand for food. In Australia, long periods of drought have serious consequences for our food producers, with Australian farmers constantly challenged by water restrictions. Innovations such as improved plant breeds with reduced water needs are one way to counteract this growing issue.



Bradbear C and Friel S (2011). Food systems and environmental sustainability: A review of the Australian evidence. NCEPH Working Paper. Canberra: Australian National University, Figure 1: The environmental impact along the food supply chain, page 4

Figure 15.3 We don't often realise that the food that is so readily available in supermarkets is often there at a cost to the environment.

- Biodiversity: a significant issue in Australia has been the broad-scale clearing of land for agricultural production, threatening our native biodiversity in both plant and animal species. Waste from food and food packaging and waste water can also have implications for the health of ecosystems. The movement of the food industry towards minimising the use of unnecessary packaging, utilising environmentally friendly packaging options and using re-useable/recyclable packaging is in response to consumer demand for sustainable, environmentally friendly food products.

The growing shortage of raw materials and the preference for renewable resources are also important trends in the ecological environment that may impact on the development of new food products. In addition, increased pollution control, more attention to natural resource management and improved waste disposal also need consideration.

Asian noodle soup

Technological factors

The technological environment is a driving force of innovation and food product development, challenging companies to modernise and re-imagine how they stay relevant in today's society. Throughout time, developments in food technology have contributed greatly to our food supply and in some cases have changed our world. Inventions and innovations result in new products, innovative ingredients, new industries and new market opportunities. Natural sweeteners, high-pressure pasteurisation, resistant starch and drones are modern marvels changing the way food is grown, processed, distributed and sold.

Technology is used in all aspects of food innovation and may include areas such as biotechnology, nanotechnology or information and communications technology (ICT). Technological advances include computer-based information and control systems, as well as sophisticated processing and packaging methods that enhance product quality, improve food safety and reduce costs.

Alamy Stock Photo/Carolyn Jenkins

Figure 15.4 Mars sources 100 per cent of the cocoa used in its Galaxy chocolate bars from Rainforest Alliance certified farms — that's 160 million bars of chocolate each year!

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Figure 15.5 New country-of-origin food-labelling laws were applied to Australian products from 1 July 2016.

The highly connected nature of today's world means increased levels of accountability for the modern food company. Social media and smartphones have connected consumers to information about the harmful effects of certain ingredients, the source of products, and how things are made. The Nutella chocolate spread was recently attacked on social media for containing 'harmful' ingredients. Their sales were temporarily affected and a counter campaign was launched to overcome dropping sales. Will they be forced to change their ingredients? Recent food label reforms are an example of consumer demand for more information about the origin of foods. The legislation requires food suppliers to label their items with a kangaroo logo to indicate the product was made in Australia. The new labels will also include bar charts to indicate how much of the product includes Australia-based ingredients, as a percentage of weight. This along with the voluntary health star rating is enabling transparency for consumers and providing new opportunities for product development in the Australian food industry.

Technology is enabling researchers to make new discoveries that are changing our understanding of nutrition. This, along with greater consumer awareness of nutrition, diet and health, has led to many developments in areas of food manufacture and the formulation of food products with modified nutritional composition, such as the ever-evolving development of low-fat spreads, low-fat dairy products and low-kilojoule drinks. Another example of this is the FSANZ approval of omega-3 rich hemp as a food suitable for consumption in Australia. Hemp can be used as a form of flour, oil and protein powder and has created new opportunities in this area. Genetic modification or

PRACTICAL APPLICATION

15.2

MAKING CUPCAKES

AIM

To make a range of cup cakes during a practical lesson at school.

MATERIALS

cupcake recipe
ingredients and equipment listed in your recipe
cupcake packet mix
commercially produced cupcakes

METHOD

1 Make one batch of cupcakes completely by hand from scratch. You may use your own recipe or use the recipe from the website for this book.

Cupcakes

2 Make another batch using the same recipe, with the help of an electric handheld beater or a stand mixer.
3 Purchase a packet mix from the supermarket and follow the instructions to make another batch of cupcakes.
4 Buy one batch of commercially produced cupcakes – note down the ingredients.
5 Taste test the cupcakes as a class.

RESPOND

1 Discuss the advantages and disadvantages of the different methods of production.
2 How has technology helped with this simple household recipe?
3 How do you think technology contributes to a commercially produced range of cup cakes?

Alamy Stock Photo/67photo

Figure 15.6 Automated product inspection

bioengineering of ingredients in some countries has also been increasing new ingredients and opportunities. As discussed in Chapter 1, tracking devices and sensors used in transporting goods are reducing the waste associated with spoiled food; 3D printers are 'printing' nutrient specific foods; and robots are being used as a part of 'smart farming' practices. By emphasising the use of technology in agriculture, manufacturing, nutrition and health, new innovations continue to emerge and evolve and are making our food safer, more nutritious, more accessible, more affordable, convenient, and better-tasting.

Other external factors

Demographic forces relate to people – the size, density, age, gender, occupation and other relevant statistics or characteristics about the consumer. Consumer needs are one of the main reasons a company may develop a new food product. Large and diverse demographics offer opportunities but also challenges for food companies. Demographic changes such as the ageing population, an increase in female workers and a decline in homemade meals mean that many new food products in Australia are focused on value-added products that are quick and easy to prepare and serve. A changing demographic will lead to a shift in needs, which ultimately results in new target markets.

The types of goods and services demanded by consumers are a function of their social conditioning and their consequent attitudes and beliefs. Sociocultural forces link to factors that affect society's basic values, preferences and behaviours. Consumers are becoming more aware of health issues, and their attitudes towards food are constantly changing. This affects how we behave and what we buy; for example, the increase in 'gourmet' packaged popcorn reflects consumer demands for healthier snack foods. The influence of culture on buying behaviour varies between countries, so marketers have to be careful in analysing the culture of different groups, regions or even countries.

Flourless chocolate cake

FOCUS QUESTIONS 15.1

REVIEW

1. What is food product development and why is it important?
2. Use an example to explain how economic factors may affect the development of a new food product.
3. The author Jeanette Winterson said, 'What you eat is the most political thing you do every day'. Explain what is meant by this quote.
4. Discuss the effects of food production and manufacture on the environment.

FOR YOU TO APPLY

5. Investigate how the *Competition and Consumer Act 2010* can promote or deter the development of new food products in Australia.
6. Look at three emerging technologies currently used in the food industry to explain how they may influence the development of new food products both now and in the future.

Some recent innovations for you to consider include:

- new microwave heating technologies enabling better pasteurisation and sterilisation of food products
- new packaging technologies to extend the shelf life of meat products: advancements in barrier packaging, anti-microbial packaging, active packaging and smart packaging
- a revolutionary energy-saving technology for drying pasta
- methods to reduce the fat and salt content of meat products
- advanced nanotechnology and micro-technology solutions to aid with processes such as filtration.

EXTEND YOURSELF

7. For each of the external factors discussed on pages 271–6, outline how food companies could minimise the negative effects that may arise from changes to their macro-environment.

The micro-environment

Micro-environmental factors are those internal forces that a company has some control over and which have a direct and measurable impact upon the company's success. Some of these factors can be easily changed or altered while others are achievable but may come at a financial cost. All of these factors further contribute to a company's decision to introduce new foods to the market.

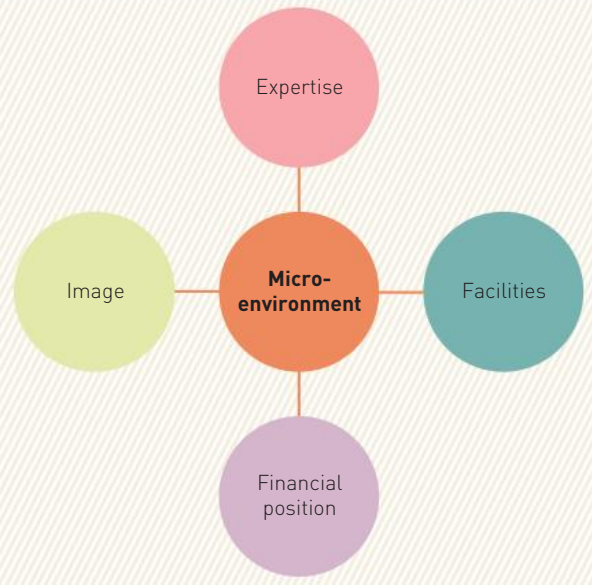

Figure 15.7 Internal factors that impact on food product development

Expertise

The success of any new product development is highly dependent on the personnel expertise of the whole organisation. Many personnel bring different skills and knowledge to the process, each contributing to the end product in their own way. The team may include the following:

- Marketing personnel
- Food technologists/scientists
- Technical managers
- Nutritional experts
- Microbiologists
- Engineers and maintenance workers
- Production staff
- Quality assurance staff
- Packaging (graphic) designers
- Commercial directors
- Financial advisors
- Distribution experts
- Lawyers (legality of products)

All of these team members work together to ensure that products developed are successful, attractive, profitable, safe and meet food standards. If skills in a particular area are lacking, then the success of the new food product could be jeopardised. In small companies one or two employees may be responsible for numerous roles in the product development process.

The management team play a key role, providing guidelines to staff by assessing and considering the factors from the macro- and micro-environment that could shape the development or redesign of food products. Technical personnel carry out research trials, observe the development process, create the new products and check the quality standards. Sales and marketing staff conduct surveys to collect consumer feedback and introduce the new product into the market. Some personnel will require specialised skills and training in particular responsibilities throughout the product development process. It is vital that all staff know and understand the role they play in the success of the end product.

Lack of skills can limit any potential solutions a team can create. Good communication, education and training can help overcome these barriers. Flexibility is another important consideration when working in a team environment as it enables worker to build on their experiences and level of expertise. Being multi-skilled with a willingness to work collaboratively offers an advantage to both an employer and employee as it allows for greater movement within the company's operations.

With rapid changes in consumer demands, technology, ingredients and government regulations it is important for personnel to continually build upon and improve their skills and knowledge within the industry. Many employers provide on-the-job training programs and encourage their staff to undertake ongoing training through a range of institutions

such as universities or TAFE. Alternatively employers may choose to recruit new team members with the required experience and qualifications needed to meet the demands of the ever-changing industry.

Facilities

To introduce a new product, a company must consider whether its current production facilities can adequately manufacture the proposed item. Production facilities may include machinery and equipment, power supply, water supply, storage and warehousing facilities. The level of operation and volume of production (as discussed in Chapter 10) will influence the facilities and equipment needed.

During the research phase of product development where only a small volume of one-off product is being produced, limited facilities would be needed and home-cooking style equipment may suffice. Once the product reaches the pilot stage and a batch of product needs to be produced, more specialised equipment may be required. If the product reaches the final stage of development, then to be successfully mass produced more automated and computerised facilities will be necessary to meet the desired volume of production and quality assurance standards. Equipment in these kinds of situations is often single purpose and in operation continually.

The company must identify all the necessary equipment required for the development of the new product before the plan is implemented. If the product can be produced in existing facilities without much disruption to regular production and minimal cost, then the new product will have a higher chance of being introduced.

Innovative products usually require more advanced techniques, so new equipment and plant facilities need to be purchased, thus increasing the capital expenditure of the company. The time taken to obtain new machines and to train staff in their use must also be considered.

Financial position

New food product development is a big investment for a company. By developing new food products, a company can reach new customers, enter new markets and eventually increase profits. A company's financial position is defined by its assets such as property, income and equipment, and liabilities like loans, wages and production costs.

A company must clearly evaluate their financial situation before any plan is put into action. Early in the project, an organisation must establish the budget required for the product development process, including funds available for R&D, and an estimated timeframe for the whole process. Without planning and monitoring, costs can spiral out of control. Failure to sell a new food product could be a great risk to a

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Figure 15.8 Mass production means fewer staff and quality maintained by automation.

PRACTICAL APPLICATION 15.3

MASS PRODUCTION

AIM

To replicate the work of a mass production line in your classroom.

METHOD

1. Find a recipe that includes multiple stages in the production process and can be easily replicated to feed your entire class – or you may use the recipe on the website accompanying this book.
2. Assign each class member to a single stage in the production process, ensuring consistency and quality of the end products.
3. Begin the production process in the time given by your teacher. Plate and present the dishes in identical ways.

Mass production

RESPOND

Are there any inconsistencies in your end product? How could these be resolved?

FOOD IN FOCUS 15.1

JOB PROFILE: FOOD SCIENTIST

NAME: Yuan Listiohadi

AGE: 30

Yuan's grandmothers Alat and Lin were good cooks and Yuan loved food so she thought she'd train as a chef. It turned out cooking wasn't Yuan's calling but food was.

She was determined to create gourmet foods that anybody could make regardless of the level of their cooking skills.

Yuan read about food scientists and food technology in magazines in her homeland of Indonesia. After completing an undergraduate degree in science, she got a job at CSIRO-Food Science Australia. While there, she completed both a Masters degree and PhD in food and pharmaceutical science in collaboration with the University of Western Sydney, majoring in lactose crystallisation.

TRAINING:

BSc, MSc and PhD, University of Western Sydney

JOB PROSPECTS:

There's a well-supported industry in food science in Australia with positions at leading science organisations.

JOB DESCRIPTION

GREAT BITS:

'I love research. I love science and I think this job is the best combination for someone who loves science and food.'

SUCKY PART:

'As a food scientist we are fortunate to be able to taste different foods from different parts of the world in order to deliver what a consumer wants – sometimes the food can be very challenging!'

WHAT IT INVOLVES:

Food scientists use laboratory techniques to produce food that is more palatable, nutritious, safe and has a longer shelf life. Yuan's work involves taking samples of flavours, vitamins or minerals from the warehouse to the lab. She then tests the sample using scientific techniques such as gas chromatography to analyse whether it is a pure compound or if it has been degraded.

Yuan also tests new foods on groups of consumers and analyses the results to find out what consumers prefer.

WANT THE JOB?

SUGGESTIONS:

Food scientists need to have a general knowledge of science, particularly in chemistry, biochemistry and microbiology. You also need to have a passion for food and good people skills, as you need to deal with people from the general public as well as managers and manufacturers.

WHO CAN HELP:

Food companies: such as Protech Research Pty Ltd, Food Australia, etc.

Food Science Australia

CSIRO

WHERE TO STUDY:

You can study science at most Australian universities. You can find more information about studying at university at the Australian Government's Going to Uni site.

IN THE MEANTIME:

Indulge your passion for knowledge and find out what sorts of improvements are made to food as part of food science. If this turns you on, look into getting some work experience and hit the microbiology, chemistry and biochemistry books.

'Food Scientist' Reproduced by permission of the Australian Broadcasting Corporation – Library Sales © 2017 ABC

RESPOND

1. Why did Yuan become a food scientist?
2. What does Yuan love about her job?
3. Is there anything Yuan dislikes about her job?
4. Describe the role of a food scientist.
5. How can you become a food scientist?

company, so it is very important to set appropriate cost targets and estimate the level of risk they can bear based on their current financial situation.

If finances are lacking, companies may raise funds in a variety of ways. Traditionally a company would borrow money from a bank or large financial institution and pay the loan back over time. Depending on the nature of the product or concept several alternative funding options can be considered. Government grants and assistance may be available and 'business angels' or crowd funding might be an option, as described below.

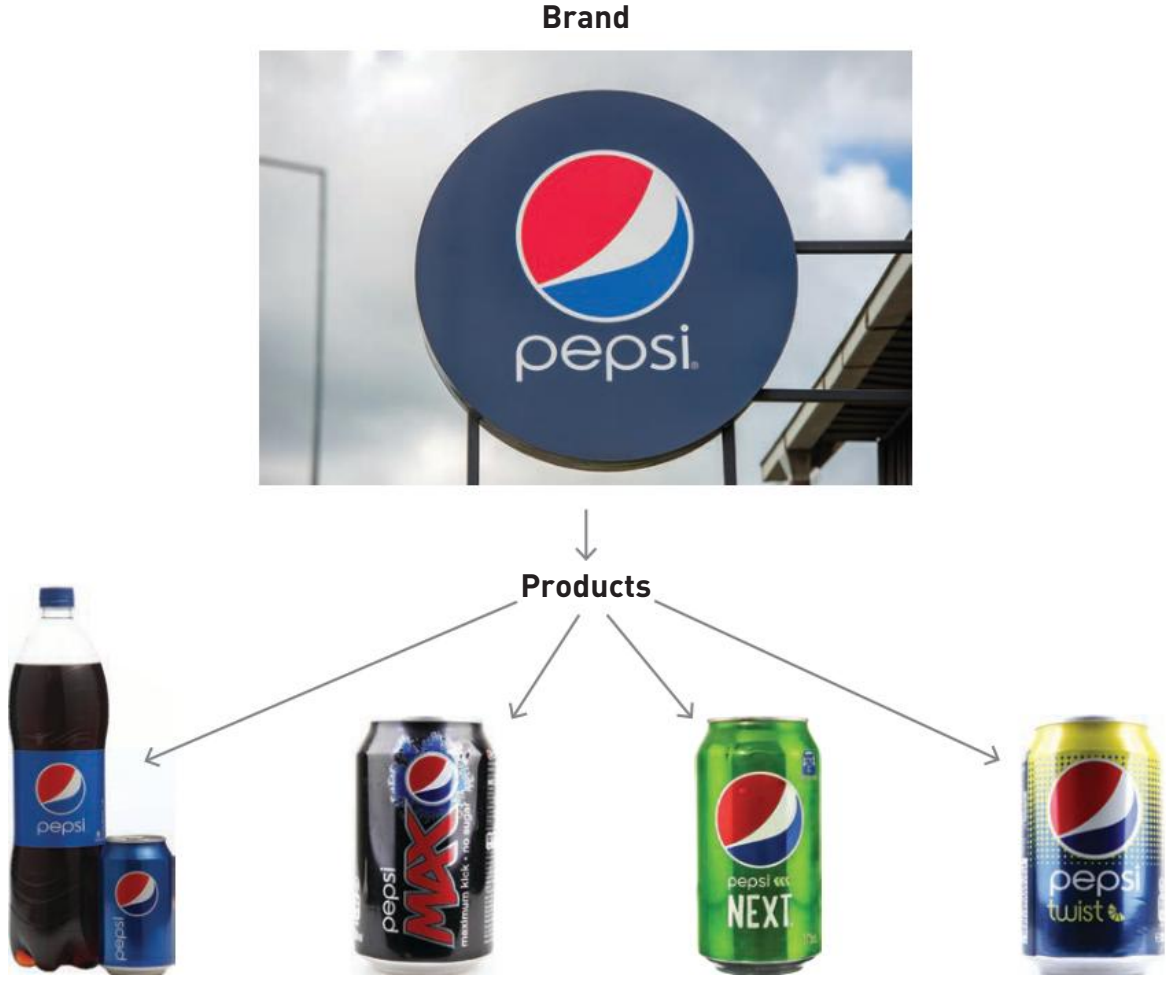
- Business angels invest in new or expanding businesses. They are usually involved in the business, either directly or as a mentor. Business angels can provide development capital, and they can also contribute their business skills and contacts to benefit a new business.
- Crowd funding raises funds by using online and social media networks to get a large number of people to contribute money towards a project in exchange for a good, service or equity.

Ultimately a company wants to ensure that the new food product will be able to compete in the marketplace, gaining good market share and making an ongoing profit for the business.

Company image

A company's image is what makes it stick in the minds of potential customers. It is the way others perceive a company, its activities and its products. A business can generate a specific image of itself by establishing a mission, vision and values. Marketing communications, organisational design and culture may also contribute towards an overall company image and reputation.

While considered to be an intangible asset, maintaining a positive reputation is fundamental to



Shutterstock.com/JuliusKielaitis, Shutterstock.com/focal point, Shutterstock.com/Nenov Brothers Images, Shutterstock.com/Sathit, Shutterstock.com/Nenov Brothers Images

Figure 15.9 Brands outlive products. A product is something that is made in a factory from natural or man-made ingredients; a brand is something that is bought by a customer. A company can have many different brands and brands can have many different products.

the profitability, relevance and existence of a business, reflecting its credibility and integrity. Company image builds brand confidence, loyalty and trust, building stronger customer relationships. Products have life cycles but a company's image and brand remain constant.

A good company image is an effective promotional and marketing tool' enhancing the opportunities for new product development within the company. For existing customers, any new product launched already has an 'image'. For example, if the company image is perceived as maintaining a high quality, then the new product will be assumed to be of the same standard.

SWOT ANALYSIS

Once an organisation has identified the internal and external factors that may affect a new food product's development, it is important they analyse their findings. A SWOT analysis is particularly useful to help a company decide if they should introduce a new food product to the marketplace. A SWOT analysis is a simple planning tool to help businesses audit their situation and strategically plan for the future, aiming to turn weaknesses into strengths, and threats into opportunities. A SWOT analysis:

- builds on strengths (S)
- minimises weaknesses (W)
- seizes opportunities (O)
- counteracts threats (T).

A SWOT analysis will give businesses options to match internal strengths with external opportunities. The overall outcome is to add value to new products so that a business can recruit new customers, retain loyal customers, and extend the life cycle of the proposed new product.

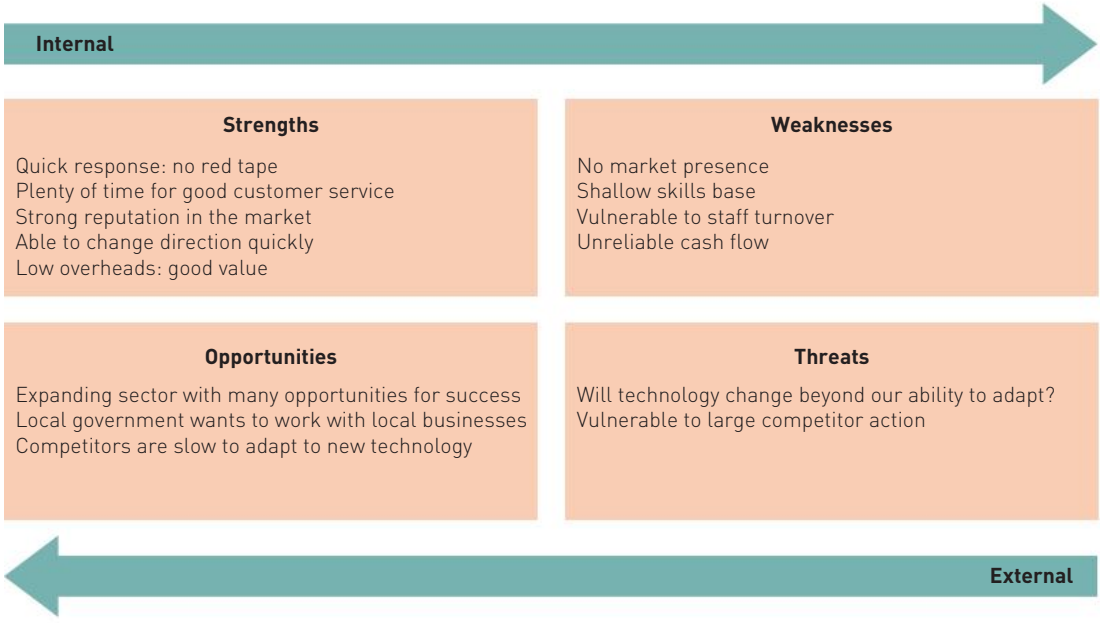


Figure 15.10 A SWOT analysis

FOOD IN FOCUS 15.2

HERBS IN A TUBE BUSINESS SELLS TO US COMPANY McCORMICK FOR $150 MILLION

One of Queensland's fastest growing high-tech agribusiness companies has been sold to a US buyer for $150 million ($US114 million).

McCormick & Company acquired 100 per cent of the privately owned Botanical Food Company, that manufactures and sells the Gourmet Garden brand of packaged herbs in a tube. The $150 million encountered no opposition from the Foreign Investment Review Board.

The Sunshine Coast-based company was launched in 1998 and employs 150 people at its processing headquarters, sourcing herbs from Central Queensland and Victorian farmers.

The Australian-based company had grown

>

Botanical Food Company

Figure 15.11 Gourmet garden

from being a small market leader in chilled, convenient herbs and spices to a very successful international leader. They export to 15 different countries with export making up to 60 per cent of current sales.

McCormick are the global market leader in the herbs, spices and seasonings space. The sale will enable the company to further strengthen export sales to the US and European markets

There are no plans to send jobs or manufacturing offshore as the company operates out of a dedicated environmentally friendly purpose-built facility and have a team of committed and skilled employees. One key element of their operation is the growing and harvesting practices. The herbs are cared for, fed and grown organically by a dedicated group of farmers using sustainable practices.

McCormick is basically purchasing a chilled capability technology which they previously have not had access to. The plan is to drive sales of the Gourmet Garden brand by expanding global distribution and building awareness with increased brand investment.

Adapted from 'Herbs in a tube business sells to US company McCormick for $150 million', Jennifer Nichols, ABC Rural, 29 April 2016, Reproduced by permission of the Australian Broadcasting Corporation – Library Sales © 2017 ABC

RESPOND

1 What products are the Botanical Food Company known for?
2 Why do you think this iconic Australian company has sold to McCormick's?
3 Analyse the macro-environmental issues that may have led to the sale of the Botanical Food Company.
4 Analyse the micro-environmental issues that may have led to the sale of the Botanical Food Company.
5 Conduct a SWOT analysis of the Botanical Food Company.

Gourmet Garden

FOCUS QUESTIONS 15.2

REVIEW

1 Outline the implication for a proposed new food product if the company do not have the personnel with the skills to produce the end product.
2 Discuss the differences between one-off production of a new product, a batch production run and a mass-produced product.
3 What advantages would a company with a strong financial position have over its competitors?
4 Explain the issues a company may have launching a new food product if they have a negative company image.

FOR YOU TO APPLY

5 Conduct a SWOT analysis of a product that already exists today. Use the analysis to make a list of suggested strategies this company might use to promote this product in the future.
6 Consider yourself as a brand. What sort of image do you portray to your family and friends?

EXTEND YOURSELF

7 Select one new food product currently available in the marketplace.
8 Research the brand behind the product. Who owns this company? What are the origins of the company? What is its reputation? What other products are produced by this brand?

Chapter review

REVIEW

1 New food products are introduced because:
   - **A** food companies recognise a need that may help them increase their profit.
   - **B** the Australian food supply chain is not meeting current consumer expectations.
   - **C** there are abundant food choices already available on the market.
   - **D** there is too much unemployment in the community.

2 For a food company, which of the following is most likely to occur during an economic recession?
   - **A** An increase in personnel numbers
   - **B** A decrease in quality assurance procedures
   - **C** A decline in new food products being released
   - **D** An expansion in the range of products available

3 A company discovers they are the only company in the market producing rainforest alliance chocolate snacks. This is considered a:
   - **A** strength.
   - **B** weakness.
   - **C** opportunity.
   - **D** threat.

4 Internal factors that influence the development of new food products include:
   - **A** income, market share, working conditions.
   - **B** production facilities, taxation, technology.
   - **C** skills of the workforce, company image, financial backing.
   - **D** taxation, company image, employment rates.

5 A food manufacturer has identified a contaminant in one of their food products. The advisory group that should be consulted to assist with food product recall would be:
   - **A** Australian Consumers' Association.
   - **B** Australian Food and Grocery Council.
   - **C** CSIRO.
   - **D** FSANZ.

6 Explain how food product development can be affected by government policy.

7 How does the food industry adjust its pricing structures in response to changes in the economy?

8 Outline an internal factor that would have an impact on the development of a new product.

9 Discuss the reasons a company would conduct a SWOT analysis.

10 Identify the political factors that can affect the development of new food products.

FOR YOU TO APPLY

11 Investigate a food company that promotes itself as 'environmentally friendly'.
   - Why do they make this claim?
   - How do they currently reduce their ecological footprint?
   - How could this be improved?

12 Genetically modified foods have limited use in Australia. Find out why. Do you think this will change in the future? Justify your answer.

13 Complete a case study of a food company that prides itself on its image. Find out how it uses its image to sell its products. How was this image first established and is it sustainable for the future?

EXTEND YOURSELF

14 Use a specific example to evaluate how food companies need to respond to both their macro- and micro-environments when developing new food products.

15 Identify a recently introduced food product.
   - Outline the internal and external factors that may have influenced its development.
   - Conduct a SWOT analysis on the product to predict its future success.

CHAPTER 16

Reasons for and types of food product development

Cook and connect, extreme indulgences, paddock to plate, whole food nutrition and meal solutions that require less cooking are some of the future trends driving the food industry. As environments, technologies and populations shift and evolve, the food supply chain in Australia is undergoing continuous change on all levels, presenting considerable challenges and significant opportunities for the development of new food products.

CHAPTER OUTCOMES

In this chapter you will learn about:

- Drivers of food product development
- Types of food product development

KEY TERMS

consumer drivers
generic
innovation
line extension
market share
me too
new to the world
profitability

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Reasons for food product development

With supermarket shelves overflowing and online markets stocked with a never-ending selection of food products from around the world, why do we need more? Companies grow by developing new food products. To stay viable in the competitive food market they need to be innovative. Few businesses can continue to offer the same unchanged product and maintain good market share or make a profit.

The resistance of the average Australian consumer to change makes this particularly challenging for the developers of new food products in Australia.

A Nielsen survey into innovation recently found globally consumers are generally happy to try new products, with 57 per cent of them having purchased a new product in their last grocery shop. Australian consumers, by comparison, appear more sceptical with an average of 37 per cent of consumers happy to try something new. Only a quarter (26 per cent) of Australian consumers said they were early purchasers of new product innovation, with more than half (52 per cent) saying they would wait until an innovation had proven itself before purchase.

Nielsen

Figure 16.1 For Australian consumers, trust in established or known brands is extremely important.

Changing lifestyles, higher incomes, health and environmental concerns and consumer awareness are creating consumer demand for a year-round supply of high-quality, diverse and innovative food products. Australians today want quality food products that taste real. With careful consideration of these changing needs and with the help of evolving technologies, companies can successfully design and market a 'breakthrough' innovation in the food sector.

Market drivers

Before a food company can start developing a new food product they need an understanding of the forces that will drive consumers to purchase the final product. These forces are known as market drivers, and can be defined as trends that cause markets to develop and grow. Consideration of these drivers will help a manufacturer to understand what is causing the market to change and identify new opportunities that may develop.

PRACTICAL APPLICATION 16.1

DRIVERS OF FOOD PRODUCT DEVELOPMENT

AIM

To consider reasons to develop new food products.

METHOD

1. 'Drivers' are the reasons that new food products appear on our supermarket shelves. Brainstorm some drivers for food companies to create new food products.
2. *Generate* a list of ideas and thoughts that come to mind when you think about this particular topic.
3. *Sort* your ideas according to how central they are to product development. Place central ideas near the centre of your map and less important ideas toward the outside of the page.
4. *Connect* your ideas by drawing lines between ideas that have something in common. Explain and write in a short sentence how the ideas are connected.
5. *Elaborate* on any of the ideas you have generated so far by adding new ideas that expand, extend or add to your initial concepts.

RESPOND

Continue until you have a good visual map of the drivers of new food products.

Market concerns

Food manufacturers need to consider consumer attitudes, values and concerns. If they discover a market niche related to a particular concern that can be met by developing a new food product, they may

decide to research this further. Products based on halal, kosher, vegetarian, organic, fair trade and non-GMO are examples of this. Manufacturers also have concerns and responsibilities of their own that may motivate them to change or improve products they already produce. These may include environmental and social responsibilities, changing legislations or new and emerging technologies.

HEALTH

Healthy eating is a critically important consumer driver and a trend that should be of concern to food manufacturers. Because of the increasing awareness of health and general wellbeing, along with the perceived risks of particular foods, consumers have become more conscious about what they eat. Consumers who are concerned about their health will read labels and have a willingness to pay premium prices for these healthier foods. Hoping to improve their brand image, food manufacturing companies continuously develop healthier food products, such as PepsiCo's Sunbites Snack Crackers with quinoa are an example. Health-conscious consumers prefer foods that are grown locally, are free of artificial ingredients and are organic. They are progressively becoming aware of and basing purchasing decisions on the presence of pesticides and are concerned about the long-term effects of genetically modified food products. Nutritionally modified and functional foods are being developed to meet this market concern.

AAP Image/Paul Miller

Figure 16.2 An Australian favourite made organic.

Food safety

Closely related to health concerns are food safety concerns. Food poisoning outbreaks such as for packaged lettuce and frozen berries sold in supermarkets have triggered greater calls for increased transparency and the ability to trace food purchased. As discussed in earlier, new labelling laws will help with this concern and many food companies have made changes to their packaging to facilitate various ways of tracing the origins of their produce through web pages, QR codes and GPS-based apps.

DIETARY CONSIDERATIONS

For some consumers, eating certain foods can be a debilitating, possibly even life-threatening, experience. Individuals with various forms of food allergies and sensitivities need to avoid certain foods or food ingredients in their diets such as peanuts, gluten or dairy. With the incidence of food allergy doubling in the last decade, this target market has become a growing reason behind the development of new food products. Food manufacturers have a significant obligation to not only ensure allergen warnings are clearly evident on packaging, but that their food products are not exposed to inadvertent contamination from potential allergens while they are being manufactured, moved, transported or stored. Products are constantly being developed and improved to ensure they are free from common allergens. A consumer with dietary considerations who feels understood and who has been adequately catered for will become a loyal customer.

Getty Images/Peter Dazeley

Figure 16.3 FSANZ enforces mandatory labelling of all possible allergens in food products.

FOOD IN FOCUS 16.1

GREEN BANANA FLOUR ENTERING THE EVER-GROWING GLUTEN-FREE MARKET

The California-based Edward and Sons Trading Company has recently launched organic green banana flour.

Aimed at people who follow Paleo and gluten-free diets, the flour has a slightly sweet and fresh taste.

Green banana flour can be used to make bread, pancakes, pastries and pasta.

SOURCES AND PROPERTIES

Varieties of green bananas are regularly eaten in areas where they grow such as the Caribbean.

Green bananas are starchier and less sweet than yellow varieties and are high in fibre, potassium and vitamin B6.

SELLING POINTS

Due to its high levels of resistant starch, green banana flour helps consumers feel satisfied faster.

Because most consumers are familiar with bananas, the company expects that people who want to try gluten-free flour but are uncertain about the taste of sorghum, for example, will readily embrace this new product.

OTHER BANANA PRODUCTS

Australian Food News has previously reported on banana flour and banana milk.

Source: http://www.ausfoodnews.com.au/2016/11/02/green-banana-flour-entering-the-ever-growing-gluten-free-market.html

Edward & Sons Trading Co.

Figure 16.4 Green banana flour

RESPOND

1. Which target market is this product innovation aimed at?
2. Why is this product suitable for this target market?
3. Describe the sources and properties of green bananas.
4. What are the main selling points of green banana flour?
5. Research some of the other banana products available on the Australian market.

THE ENVIRONMENT

Consumers and manufacturers today are aware that production, distribution, use and disposal of food products have environmental costs. Environmental stewardship encompassing concepts such as climate change, forest sustainability, preserving resources and food miles are high on the list of market concerns. These concerns have resulted in the rising popularity of products that are perceived to be 'environmentally friendly'. Examples include products that are grown organically, grass-fed, free-range or vegan and packaging that is biodegradable or recyclable. The trend to buy local as well as an effort to reduce food waste by promoting 'ugly' foods at supermarkets or mobile applications for donating foods are being incorporated into concepts for new food products. Increasingly, the story behind a food product is becoming important and a personal connection between food and the consumer will be a key focus for food manufacturers in the future.

Producers may need to modify their products, processes, production techniques or packaging in order to counteract consumer concerns about resource sustainability or the environment.

Woolworths Supermarkets, Australia

Figure 16.5 'The Odd Bunch' concept is to take all the 'ugly' fruit and vegetables, the odd-shaped carrot, the knobbly apple and the lumpy tomato and sell it at discounted prices in Woolworths Stores.

Corporate social responsibility

Major food companies want to build brand awareness by being seen to be giving something back to the community. They are focusing on implementing good corporate citizenship by taking meaningful action to improve their environmental policies, provide healthy options and ensure they are not exploiting workers or animals in order to retain their market share. This focus includes contributing time and money to a variety of ethically responsible projects, a duty to provide environmentally friendly products and services, and a desire to improve the lives of others whether they are in direct contact with the company or not. The influence of the internet in general and social media in particular is the driving force behind this demand, with companies being held more accountable for their actions. Consumers will react to issues they feel are not socially responsible and food companies may suffer the consequences.

Consumer demand

Most food product development today is said to be *consumer driven*. This means it is designed to satisfy consumer demand. Ultimately a company produces a new food product in the hope of increasing profits and staying in business; however, the needs, wants, trends, values and spending priorities of consumers are all major considerations in the process. Before initiating a new food product, the producer needs to know what the consumers want. The perceived consumer needs are assessed by extensive market research and consumer feedback. According to Nielsen, convenience (24 per cent) and affordability (23 per cent) top Australian consumers' list of reasons for purchasing a new product.

CONVENIENCE

When considering food product development, convenience should be looked at in terms of the reduction in time and effort spent buying, storing, preparing and consuming food. Time scarcity, stresses and work-life balance problems, meal fragmentation (where family members eat the same meal but at different times), speed shopping, the erosion of cooking skills and the desire for increased leisure time are stimulating the demand for more convenient food options.

Studies have shown that the majority of consumers spend no more than 30 minutes cooking dinner each night. Fully and partially prepared meals that assist people to simplify their lives add to the attractiveness of convenience foods.

Consumers demand convenience, but they are not willing to compromise on quality. They still want fresh, high-quality products. To assist with this they are increasingly ordering meal start-up kits such as meal plans offered by Hello Fresh and Aussie Farmers Direct. These provide convenient and easy food options with healthy, ethical and comforting choices. Although not strictly product development, there is a clear trend showing consumers flocking to pop-up markets and food truck events that feature new and interesting food options.

COST

All consumers love a bargain and search for value-added products that offer them more for their money. At the other end of the scale, consumers are willing to spend more on high-quality products that offer specific features such as health benefits or environmental sustainability.

Globally as we move into the future food prices will continue to rise. Higher food prices will mean consumers will become more selective in what they buy. They will be offered incentives to eat at

home and buy cheaper local products and seasonal produce. Consumers can be expected to adopt a more modest purchasing pattern, buying just the right amount of food, reducing waste and seeking foods that provide more value and functionality. For producers of new food products this will mean smaller package sizes, more functional foods, and better labelling and marketing to emphasise the value of individual products.

Desire for information

Food companies can build trust and loyalty with their target markets by offering them opportunities to become more educated about products and answering questions about their concerns honestly. Consumers have a thirst for information about products and want more transparency in the supply chain of food products. They want to know exactly where their food has come from and what is in it. Food manufacturers are being asked to provide more information including their production practices and food contents in detail, covering what has been fed to their livestock, poultry or seafood, often encouraging them to reformulate existing product recipes. Consumers also want reassurance around issues such as animal welfare, sustainable practices and fair labour practices. Further scrutiny surrounding labelling and health claims is occurring with consumers expecting more extensive product information.

Changing society

Because of advances in medicine, health care and birth control Australia's population is ageing, and its growth is slowing down. These trends, together with increasing family and cultural diversity, such as professional couples with no children, create important challenges when developing new products.

AGEING POPULATION

The fastest growing demographic in the food industry in Australia are consumers over the age of 65. This group wants products that offer general health benefits and that could help reduce disability and dependency, prolonging the quality of an independent life. As life expectancy and disposable income increase in this group, issues such as heart health; salt, sugar and fibre consumption; vitamin deficiency; diabetes; bone health; immune system health and hydration are high priorities. This generation are becoming more technologically savvy and informed, are more active and experimental than previous generations and want to enjoy life to the full. They have a growing demand for products that are simple and convenient, are easy to handle and prepare and that come in smaller portion sizes and packages.

Alamy Stock Photo/Ian Dagnall

Figure 16.6 Functional food products such as yoghurt with added fibre, probiotics, vitamins and minerals are marketed towards older Australians.

SINGLE-PERSON HOUSEHOLDS

Single young professionals and middle-aged divorcees who can afford their own place are contributing to the rise of single-person households in Australia. Currently one in four Australian households is a lone-person household. This demographic generally have more discretionary dollars to spend on food than any other sector in the market. They want to purchase products in single-portion sizes and are willing to experiment and try a wider variety of flavours. Single households have a high demand for frozen or ready meals that are portable and convenient. Many single young professionals in this group are global consumers who are often technology natives influenced by online marketing and social media. The growth of 'ready meals' in Australian supermarkets is recognition of this changing consumer demand.

Dlibrary

Figure 16.7 Ready-made meals are a booming industry in Australia.

PRACTICAL APPLICATION

16.2

READY-MADE MEALS

AIM

Design a ready-made meal suitable for a single active person with limited cooking skills.

METHOD

1. Describe the meal. Justify your selection.
2. Design the package, including easy-to-follow preparation steps and instructions.
3. Prepare your meal in class. Package and store your meal in the refrigerator or freezer until the following lesson.
4. Swap meals with a partner and follow the directions for use provided on the package to cook and serve the meal.

RESPOND

Evaluate the success of your partner's meal.

CHANGING WORKING HOURS

Changes in the Australian workplace such as job sharing, part-time work and more flexible work hours are a reflection of the 24/7 economy we now enjoy. The 'standard model' of working nine to five, Monday to Friday, is no longer considered standard. Extended working hours are now commonplace, with many industries working around the clock. For some, greater flexibility allows a greater work-life balance but for others it creates substantial work-life stress. Consumers are demanding more flexible food options to help meet these changes.

Multicultural Australia

People born overseas, or with one or more parents born overseas, make up a significant group in the Australian population. The ethnic and cultural diversity of Australia is reflected in the foodstuffs available. Australian supermarkets, markets, delicatessens, cafés, restaurants and takeaway stores offer an enormous variety of foods from around the world. Many specialty products have European, Asian and Middle Eastern influences. Foods with specific attributes including kosher, halal and organic are catered for by food certification systems and standards. Cultural diversity is a driver for food product development in Australia, requiring both the adaptation of existing products as well as the development of new ones.

Developments in technology

New and emerging technologies in the area of food product development are widespread. Technological advancement in all areas of the food system results in the production of higher quality food products, improved safety and reduced use of chemical preservatives. Technology allows consumers and manufacturers to track, analyse and understand the food production, manufacturing and marketing processes, making food more accessible, sustainable and transparent than ever before.

Food product developers are using food science and technology to meet changing demands from both consumers and retailers as well as improving their overall efficiency and profitability. These demands are particularly evident in the areas of processing and packaging.

PROCESSING EQUIPMENT

Consumer demand for high-quality, minimally processed, fresh food has led to the development of new food-processing techniques. Some of the latest food processing and preservation technologies being used as drivers behind new food product development include high-pressure processing technology (HPP) encompassing a range of fruit, vegetable and herb products now available;

microwaves and radio frequency used commercially for blanching, tempering, pasteurisation, sterilisation and drying; ohmic heating, applied to sensitive products such as egg products, sauces and cream; cold plasma (CP) and high-voltage pulsed electric fields (PEF), applied to fruit juices; ultrasound, irradiation, applied to herbs and spices; vacuum deep-fat frying; and infra-red energy.

FOOD IN FOCUS 16.2

EMERGING PROCESSING TRENDS – HIGH-PRESSURE PROCESSING

The global High-Pressure Processing market is projected to reach AUD 1.5 billion by the end of 2021. High-pressure processing (HPP) is a technology which is used as a natural option for processing an extensive range of food products. It is a freezing pasteurisation technique in which the final packed products are introduced into a container and then the container is subjected to the maximum level of isostatic pressure put by water.

The high pressure removes the bacteria, yeasts, moulds, parasites and viruses present in food, extending the life of the product and guaranteeing the safety of food. It eliminates the need for thermal degradation.

HPP is a natural and environmentally friendly process that helps in maintaining the characteristics of the ingredient such as nutrients and the flavour. This technology meets the demands related to thermal methods, which removes the vitamins and changes the flavour of the food while HPP maintains the taste as well as the vitamins, which are very essential for the consumer. HPP technology is put into practice by seafood and meat processors to satisfy the desired softness and extract the meat from crustaceans.

Source: Global High Pressure Processing Market - Trends Analysis & Forecasts to 2021 - Key Vendors Are Beskyd Frycovice, Kobe Steel & Thyssenkrupp - Research and Markets, Oct 28, 2016 (Press Release), http://www.businesswire.com/news/home/20161028005311/en/Global-High-Pressure-Processing-Market—Trends

RESPOND

1. What is HPP?
2. How is it used in the food processing industry?
3. Briefly explain how HPP works to preserve foods.
4. How is it different from the more traditional processing methods that require heat?
5. Outline the advantages of using HPP for the food industry and for the consumer.
6. Can you think of any disadvantage to using this type of processing technology?
7. Make a list of products currently available on supermarket shelves in Australia that use this type of technology.
8. How do you think foods will be processed in the future?

PACKAGING MATERIALS

As discussed in Chapter 14, packaging is constantly evolving with companies continuously on the hunt for materials and technology to improve convenience and lengthen shelf life. When it comes to packaging for new food products, consumers demand value, novelty and innovation. They expect packaging to be flawlessly functional, safe, green, compact, light and sustainable, but also highly visible and stylish.

Improved product experience is a key driver influencing technology when developing contemporary packaging. Consumers increasingly require packages that are easy to open and close, variable pack sizes such as single-serve or family packs, microwaveable or bakeable packs, and self-heating/cooling containers. Interactivity, transparency and information also continue to dominate this consumer drive.

With continuous advancement in technological processes and materials, as well as more regulatory requirements, food companies are forced to consistently develop and update their packaging solutions to ensure consumers are motivated to purchase or remain loyal to their product.

FOOD IN FOCUS 16.3

EATING YOUR PRODUCT AND PACKAGING TOO!

Edible packaging could cut down on food-related waste. But will consumers be open to trying it?

Loliware

LOLIWARE

Frustrated by the amount of disposable packaging discarded at events and the amount of time it takes for disposable cups to degrade, product designers who are working on biodegradable products have created a 'biodegredible' – biodegradable and edible – cup.

LOLIWARE

Figure 16.8 Loliware – edible disposable cups – functional, tasty and environmentally friendly.

The cups are made with organic cane sugar, organic tapioca syrup, vegan gelatine derived from seaweed, and flavouring and colouring that 'strives to be natural,' as well as a confectionary sugar coating. The single-use cups are designed to serve room temperature, chilled, or frozen drinks and desserts. Considered the 'Cup of the Future,' these premium disposable cups are the first product in what will be an expanded line of 100 per cent biodegr(edible) tableware and packaging.

Source: Adapted from sustainablebrands.com

WIKI-CELLS

Protective ultra-thin membrane technologies which encase various foods and liquids in edible membranes that function like the skin of a grape are another move towards sustainable packaging. This innovative new packaging inspired by nature's natural packaging can hold gazpacho soup, hot chocolate, ice-cream, yoghurt – almost anything. These natural packages keep the inner contents safe from contaminants, and keep food in. Each pod is individually portioned and the need for additional cutlery is eliminated.

While this solution may dispense with the wasteful primary packaging that actually touches the food, consumers are still demanding a box or wrapper to contain the products.

Beyond the novelty of these concepts is the idea that food waste and landfill will be reduced and packages for foods of the future will be all a part of the product itself. This technology is now available to purchase in products under the Perfectly Free brand.

Perfectly Free edible packaging

Figure 16.9 The wrapper that does not need to be binned.

RESPOND

1 Where did the idea for the edible cups first come from?
2 What does the term 'biodegredible' mean?
3 Outline what the cups are made of and why they are useful.
4 What other types of edible products will be available in the future?
5 Describe the uses of protective ultra-thin membrane technologies.
6 Evaluate some of the benefits of using this new packaging technology.
7 Why do you think consumers are reluctant to use these types of packages?
8 What is the main driver behind the development of edible packaging?

New home appliances

The latest home kitchen appliances are smarter, faster and more energy efficient than ever before. They are designed to make food preparation and cooking easier and to meet the demands of time-poor households. Modern designs and stainless steel appliances have completely transformed the home kitchen and created a driving force for product innovation. Products such as slow-cooker easy meals, bread mixes to use in domestic bread makers and ready-made yoghurt mixes have all been developed to keep up with the changes in domestic appliances.

PRACTICAL APPLICATION 16.3

APPLIANCE-SPECIFIC PRODUCTS

AIM

To research products developed with specific new home electrical appliances in mind.

METHOD

1 Conduct a survey of your classmates to compile a list of the latest cooking appliances being used in homes.
2 Brainstorm a list of products available from the supermarket that have been designed specifically for use with each of the appliances in your list.

Profitability

New product success is not simply about developing new products that sell; it's about getting them to market quickly with the lowest cost and the highest return. Food product development is fundamentally about making money for the business. This is a primary driver behind a company's desire to develop and promote a new product.

A profit margin is the amount that is left once a company has deducted costs from income generated by selling the product.

- *Gross profit:* is calculated by deducting direct costs – those directly attributable to the product or service such as raw materials, labour and staff costs, transport and so on.
- *Net profit:* is arrived at by deducting all additional overheads, such as administration staff costs, electricity, insurance and so on from the gross profit.

For new products to be profitable, companies must produce better products, faster than their competitors. Profit drives further investment in future food products and research into new technological development.

In order to remain profitable, a company introducing a new food product onto the market should:

- provide products that meet consumer needs
- operate efficiently and sustainably
- source reasonably priced, reliable supplies
- utilise clearly structured promotional strategies.

INCREASING MARKET SHARE

The food product development scene is fiercely competitive, with an ever-increasing number of companies competing for market share across a myriad of food types. Market share represents the percentage of a product's total sales earned by a particular company over a specified time period. Market share is calculated by taking the company's sales over the period and dividing them by the total sales of the industry over the same period. The more customers purchasing a product, the higher the market share is for that product.

FOOD IN FOCUS 16.4

PACKAGED FRUIT JUICE BRANDS' DOWNWARD SHIFT IN MATURE MARKET

Consumption of packaged fruit juice in Australia has been in freefall since 2012 according to the latest data from Roy Morgan Research.

Roy Morgan's data shows that in June 2012, 6.6 million Australians aged 14 and older were drinking at least some small amount of packaged fruit juice once a week, with the average person drinking 4.6 glasses each.

By June 2016, only 5.3 million Australians were drinking juice weekly, with an average intake of 4.3 glasses per week.

From the table below it can be seen that only one brand, Nudie, has managed to increase its sales while Bickford's has maintained its volume.

MEN MORE LIKELY THAN WOMEN TO DRINK JUICE

Australian men are slightly more likely than women to drink packaged juice, with 27.6 per cent of males saying they are juice drinkers compared to 26.3 per cent of women.

Supermarkets are the most common place for Australians to purchase packaged fruit juices.

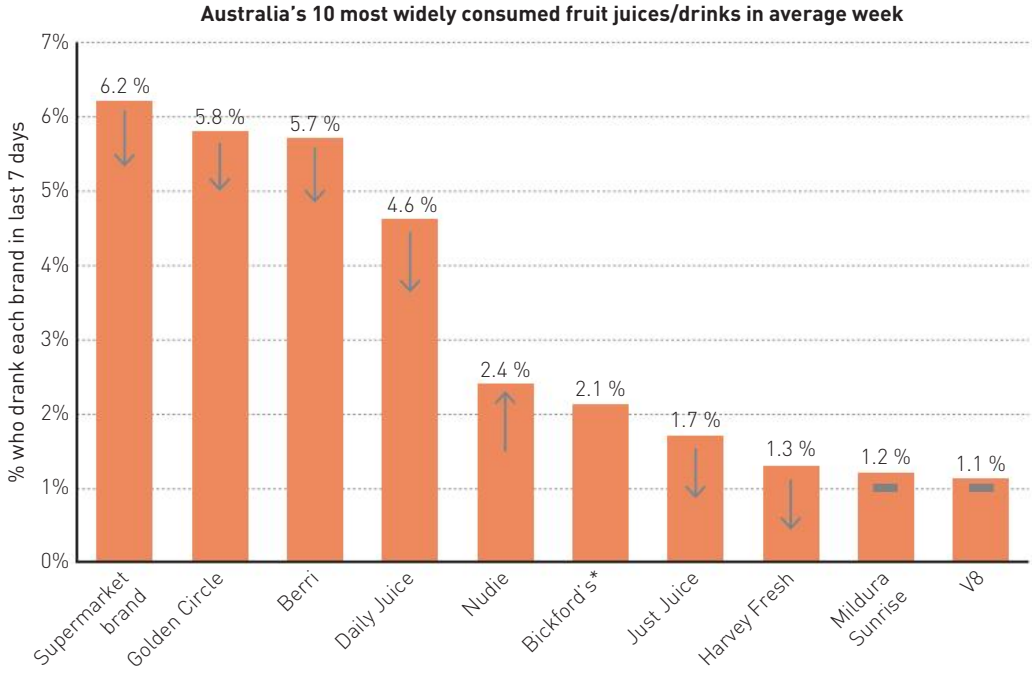
FRESH JUICE BARS STILL GROWING IN NUMBERS

While consumption of packaged juice is down, more Australians are drinking unpackaged fresh juice from juice bars.

According to market surveys, more than 1.8 million Australians agreed in 2016 that they often buy drinks from juice bars. This is a significant growth since 2012 when fewer than 1.6 million agreed.

Compared with the population average, juice-bar customers are:

- 119 per cent more likely to 'look for drinks with added ingredients that are good for my body'
- 104 per cent more likely to agree that 'the food I eat is all, or almost all, vegetarian'
- 96 per cent more likely to 'buy drinks that boost my energy'
- 91 per cent more likely to 'avoid dairy foods whenever possible'
- 54 per cent more likely to 'try to avoid drinks that contain caffeine'



* from Jan 2016. All other data from June 2015.

Figure 16.10 Juice consumption in Australia. Source: Ausfoodnews.com.au

- 33 per cent more likely to 'favour natural medicines and health products'
- 21 per cent more likely to agree 'I'm constantly watching my weight'
- 20 per cent more likely to 'always think of the number of calories in the food I'm eating'.

Source: Ausfoodnews.com.au

RESPOND

1 Explain the current changes in market share for the packaged fruit juice market.
2 Which brand has increased its market share over the last few years and which brand has maintained its share?
3 Which target market is most likely to consume juice in Australia?
4 How many Australians purchased juice from fresh fruit bars in 2016?
5 What special dietary considerations do juice-bar customers generally have?
6 In your opinion why has the packaged juice market share fallen and the fresh juice-bar market share increased?

FOCUS QUESTIONS 16.1

REVIEW

1 Define 'driver' in terms of food product development.
2 Why is it important that a company looking to develop a new food product considers a range of drivers before they start the process?
3 Using examples, discuss how consumer market concerns may influence the development of a new food product.
4 What do consumers demand from current food products?
5 Explain how societal changes may lead to the development of new food products.
6 Examine some of the technological developments that have occurred in the food industry to evaluate their contribution towards new food products.

FOR YOU TO APPLY

7 **a** Identify a selection of new food products that have recently emerged in the food marketplace because of:
- changes in packaging
- processing techniques
- new domestic appliances.

b Describe the products and the drivers behind each concept.

EXTEND YOURSELF

8 Identify a range of other drivers for or reasons that food product development may occur. Give specific examples. The Nestlé Health Science website is a good starting point.

Nestlé Health Science

Types of food product development

The ability of a company to produce new food products is often a factor that may determine whether they are able to remain competitive and keep up with market trends and changes. New food products can be classified in several ways; by the type of market the product is entering or the level of product innovation involved. Development of new food products may occur to establish a new market, to compete with a particular existing product or to improve an already established product.

Line extensions

Lemonade scones

Line extensions refers to expanding the range of an existing product. These account for more than half of product innovation each year and play a critical role in the life cycle of any brand. Under this development category, the marketer attempts to improve its current position in the market by either improving or upgrading existing products or by extending a product line by adding new products in the same category by

changing the recipe formula or packaging. New flavours, package sizes, labels, nutritional content or products containing special additives are included in this type of food product development. It may also include products being repositioned to appeal to new target markets or a new market niche and cost reductions.

These products are introduced to supplement established product lines and are often based on existing products that are modified in order to better meet customer needs or for improved performance. Line extensions add variety to existing products and are used to reach a more diverse customer base and entice existing customers with new options. A line extension can reinvigorate a product line that has reached market saturation and can bring it back into public awareness, drawing new customers, earning higher profits and extending its life cycle.

Line extensions are a low-risk form of product development as they are based on the existing success of a current product. Consumers will have an established brand loyalty and be more likely to try the new product line, which will expand the company's shelf space presence. There is greater marketing and production efficiency around this type of development as the company can use existing infrastructure such as processing equipment, production lines and marketing campaigns. The threats associated with this type of food product development are minimal; however, if the new line extension does not meet the needs and expectations of the consumer then there is a potential for the primary product's reputation to be tarnished. If the line extension is a success then a threat may develop as a result of competition created between the new and the original products.

Getty Images/robtek

Figure 16.11 What line extensions of these products can you think of?

The Australian Food News website has the latest news on product innovations.

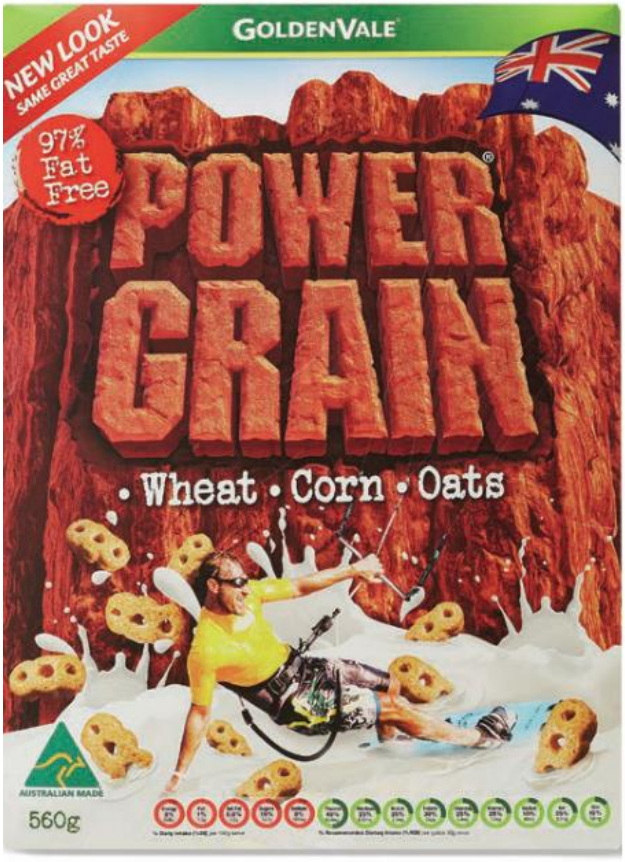
Me toos

When an innovative new food product appears and proves to be a success, other manufacturers compete for market share of the newly established market segment by developing their own version of the product. In this case, when a company enters the established market with their own version of a food product that is new to the company but not to the marketplace, it is said to be a 'me too' or 'copycat' product.

While 'me too' products give consumers greater choice and create competition in the marketplace, this type of development may be considered risky for food product developers. The company copying the original product may lack the knowledge, processing equipment, suppliers or expertise necessary to create a successful, competitive product. Entering a known and established market is, however, far less risky and more economical than developing a product from scratch.

The multi-billion-dollar category of supermarket own-label products are based on this type of product development. Once simply considered budget options, generic products, such as Woolworths Home Brand, Coles Smart Buy or IGA's Black and Gold, they were perceived to be of a lower quality and used simple mono-coloured packaging indicating their supermarket origin. They are now highly sophisticated competitors that offer a variety of options, from budget through to premium selections, that look, taste and feel almost identical to the leading market brand, but carrying a significant price reduction. Some supermarkets even produce 'phantom brands' which are simply home brands in disguise. These products are priced slightly higher than the supermarket own brands but less than the branded versions; with the store name omitted the shoppers perceive this new 'private label' brand as having better quality and providing more value for their money. Phantom brands sold by Aldi include Choceur Finest European Chocolate, Belmont Biscuits and Mamia Baby.

ALDI



Shutterstock.com/urbanbuzz

Figure 16.12 Two brands of cereal: one phantom brand, one name brand.

NEW TO THE WORLD

Completely new food products that have arisen as a result of innovation and not existed previously are classified as 'new to the world'. Typically this group is represented by breakthrough products that are so revolutionary they can create an entirely new market or they can segment an existing market. They may feature new technologies, processes, packaging or ingredients never seen or used in this way before.

This type of development makes up a very small proportion of overall new food products and is the most costly, time-consuming and risky process companies can undertake. Innovative new products require extensive testing, modification and trialling. New equipment may need to be purchased and staff trained to meet new demand. Establishing a new market can also be mean higher promotion costs and organisations may even need to apply for modifications to the Food Standards Code.

However, once developed and on the market, new to the world products are usually very successful and have the benefit of gaining customer loyalty prior to the introduction of any competitor's products.

NASA food product development

DeeBee's Organics

Figure 16.13 DeeBee's TeaPops are said to be the first certified 100 per cent organic, tea-based frozen novelty in the world.

FOOD IN FOCUS 16.5

INSECTS: FOOD OF THE FUTURE?

We need to eat more bugs. The Food and Agriculture Organization of the United Nations has suggested that entomophagy, or insect eating, is the key to our future food security.

Insects: Food of the future?

It may seem unpalatable to some, but insects such as crickets, locusts, grasshoppers, caterpillars and silkworm contain lots of nutrients, including protein, good fats, calcium, iron and zinc. Eighty per cent of nations, from Southeast Asia to Latin America, already consume more than 1900 different insect species, which are easier and less energy-intensive to farm than traditional livestock such as cows.

Students in the USA have introduced a new food ingredient called 'C-fu' to the food market. They developed a technique to isolate the protein from mealworms and restructure it, to make more appetising 'C-fu cubes', which resemble blocks of tofu. The creators of C-fu claim the product has more protein than tofu, is more protein rich than an egg and is high in omega-3 and omega-6 fatty acids, which are associated with lowering the risk of heart disease. They say the new ingredient is nutrient dense and will help alleviate global hunger and nutrient deficiencies.

Getty Images/Steve Russell/Toronto Star

Figure 16.14 C-fu adds a great crunch to salads! And it's loaded with protein, omega-3 and essential nutrients.

The development team hopes that its insect-sourced food will be acceptable to consumers because of its bland appearance and will be easily incorporated into future manufactured food products.

As an emerging new market for food product developers, perhaps in the future consumers will see an insect aisle at the supermarket featuring packages of 'beautiful, clean' shrink-wrapped mealworms and fast-food restaurants that serve bug burgers. With the latest culinary trend in many Australian restaurants being the use of insects like crickets, grasshoppers and mealworms and consumers being increasingly aware of the potential of insects as a nutritious, sustainable source of food, could traditional sources of protein be on the way out?

RESPOND

1. Define entomophagy.
2. Why does the Food and Agriculture Organization suggest we need to eat more insects?
3. Where are the majority of insects already consumed in the world?
4. How many known varieties of edible insects are there?
5. Why would the production of insects be more environmentally beneficial than traditional farming methods?
6. What is C-fu and how is it made?
7. Why do the developers of this new ingredient think it will be successful?
8. Do you think the use of insects as a new food ingredient will develop further?
9. Visit the C-fu website and make a list of ways this product can be used in food production.

C-fu

WS

Supermarket survey

Other drivers of food product development

Many foods are developed with specific end uses in mind. Often these foods are not for sale in supermarkets but used in particular industries or workplaces.

Table 16.1 Foods developed for specific end uses

PRODUCT	DRIVER
Nestlé Thicken Up Hydration – ready-to-drink thickened beverages	Consumers with special medical conditions such as dysphagia – suffered by people with difficulty swallowing.
Power Bar Gels	For athletes to quickly and easily consume nutrients while competing
Wise Food Storage emergency food supply buckets	Long-life foods designed for use in emergency situations like earthquakes, cyclones or floods.
Expedition Foods ration packs	Lightweight and compact foods for expeditions and adventures.

FOCUS QUESTIONS 16.2

REVIEW

1. Outline the three main types of food product developments.
2. Which type of development carries the greatest risk? Why?
3. Which type is the least expensive to develop? Why?
4. What is a 'phantom brand' and how and why are they used?
5. Brainstorm some examples of possible 'new to the world' food concepts.

FOR YOU TO APPLY

6. Select a commercial food product that has been recently released to the market. Analyse the type of food product development it represents.

EXTEND YOURSELF

7. Choose a popular recipe or product and modify it to produce two line extensions. Suggest possible target groups or niche markets that the new product lines may appeal to.

Chapter review

REVIEW

1 What is innovation and why is it important in the food industry?
2 A food manufacturer has developed a high-fibre, calcium-enriched, instant breakfast cereal biscuit with several different flavours.
   a Identify and explain the type of food product development that relates to this new breakfast biscuit.
   b Describe a target market for this product, and justify your answer.
   c Identify the macro- and micro-environmental factors that may affect the development of this product.
3 Choose a food product and identify three drivers for the development of this specific food product.
4 Describe the advantages and disadvantages of developing a me too food product.
5 Discuss how company profitability and market share are drivers for food product development.

FOR YOU TO APPLY

6 Make a collage or poster showing the different types of food product developments. Annotate the collage with reasons why each food fits into each category.
7 Create a Kahoot! quiz revising one of the drivers behind food product development. Play the quiz with the rest of your class.

8 Talk to an older person about some food innovations they can remember. Are the products still available? How have they changed since launch? Or why do you think they are no longer available?

EXTEND YOURSELF

9 Choose a line of processed food products marketed under a particular brand name. Draw a mind map to identify the original product and the products that have been developed as line extensions and/or 'me toos'.
10 Extended response:
   a Explain the reasons for the development of food products.
   b Using examples of line extensions, analyse how food manufacturers have responded to the reasons for the development of food products.

CHAPTER 17

Steps in food product development

Food product development is one of the riskiest yet most important endeavours of the modern food company. Many new food products are launched into the market every year, and food manufacturers invest time, effort and money into making sure their new products will be a success.

Competitiveness in the food marketplace is determined by the ability of companies to differentiate products and adapt them to specific identified needs. Once the internal and external operating environments have been audited and new opportunities and drivers have been identified, the process of food product development is initiated. Managing a new food product development successfully requires a commonly applied, multi-disciplined approach that may involve many facets of a business. In larger organisations, teams of food scientists and technologists, raw material suppliers, nutritionists, sensory analysts, analytical chemists, microbiologists, packaging specialists, food engineers and marketing experts all work together to ensure the success of the new product. Product development takes place in stages where innovation and the principles of food science are simultaneously applied – the physical, chemical, and microbiological composition of food, food quality, food safety, food processing and marketing are all factors that need to be carefully considered throughout this complex and dynamic process.

CHAPTER OUTCOMES

In this chapter you will learn about:

Design briefs based on project aims and development criteria:

- ideas generation and screening
- market research
- product specifications
- feasibility studies
- production process development
- developing a prototype
- testing a product prototype.

KEY TERMS

commercialisation
convergent thinking
design brief
divergent thinking
feasibility
prototype
qualitative research
quantitative research
specifications

iStock Photo/JGalione

Product development

Product development is an ever-evolving and fluid process. Planning and developing a new food product does not always follow the same steps in the same order. The process will vary from company to company and perhaps even from product to product. Most organisations follow a sequential design process that they can adapt to their own capabilities and customise to meet specific needs. Each step in the process requires research, reflection, planning and testing and is aimed at using resources effectively and efficiently.

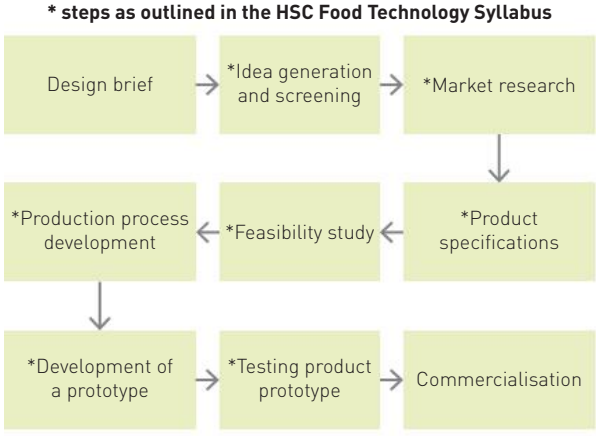


Figure 17.1 The steps of the product development process.

These steps can be grouped into three phases:

- Phase one: product definition
- Phase two: product implementation
- Phase three: product introduction

Phase one – product definition

Creating innovative new food products to meet changing market demand is a challenge for food manufacturers. To determine what products are already available in the marketplace and where there may be room for new products, a food company will conduct a market opportunity assessment. Concept testing is one process used to determine which products have real merit with consumers. Analysing real data at this early stage sets up a new food product with a strong market foundation leading to more successful products and greater end profits. Once a company has identified these opportunities, they may decide to develop a new product to meet the perceived demand.

THE PRODUCT DESIGN BRIEF

The design brief is the focal point of a new food product development project. It provides a scaffold to help generate and explore ideas, and a point of reference for ongoing reflection and evaluation. The design brief should define the essential characteristics of the product in terms of the situation that requires a solution.

A good brief will include information about the who, what, where, when and why of the proposed product.

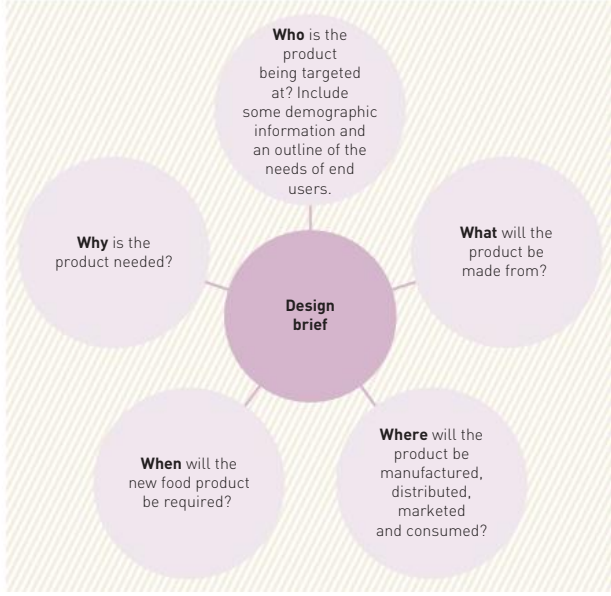


Figure 17.2 Design brief

At this early stage, the attributes of the product should be broad. In addition, the brief may include a price range, the potential new market, current industry trends, the use of a new technology or particular commodity, food legislation requirements, and could mention a rival or competitor in the same market space. The brief should give clear precise direction and help everyone working on the project develop an understanding of what is to be accomplished, establishing clear expectations and goals. A design brief is an integral step when creating a strategic approach to project coordination across departments and teams.

Aims, objectives and constraints may also be incorporated into a brief. The *aim* provides direction

for ideas about the project. The *objectives* establish identifiable goals for production and planning that will ultimately help achieve the aim. *Constraints* are any factors that may limit or define the scope of the project.

These characteristics will be used throughout the process as a way of measuring progress. The criteria established at this stage must be clearly defined and measurable.

An example of this is as follows.

Ready-made vegetarian meals

A small food manufacturer has been producing a successful line of frozen meals to sell at local produce markets and selected health food outlets. It is hoping to extend its range to include vegan options.

The company are looking to target the growing market of vegan consumers and need to extend their product range to stabilise and extend their business. They also anticipate a change in the distribution and sales of their product range and expect to be in full production within the next six months.

The company wishes to use its existing production facilities but is willing to fund research in this new area. The raw materials used for the products need to be sourced locally and preferably represent limited 'food miles'.

PRACTICAL APPLICATION 17.1

DESIGN BRIEF

AIM

To write a design brief for the development of a new food product

METHOD

1. Write a design brief for a possible new food product development.
2. Outline the who, what, where, when and why of the proposed product.
3. Include the aims, objectives and constraints for the proposed idea.

Design brief

RESPOND

Justify the type of food product development you think will best meet the needs of this brief?

GENERATING IDEAS

Every product starts from an idea. Ideas can be generated by trends in the marketplace, by studying external and internal factors or social and technological changes. New product ideas may be generated internally through R&D or by general employees, or externally by competitors and customers. Other sources of ideas may include trade journals and industry shows, wholesalers, suppliers, government and commercial agencies. Recent

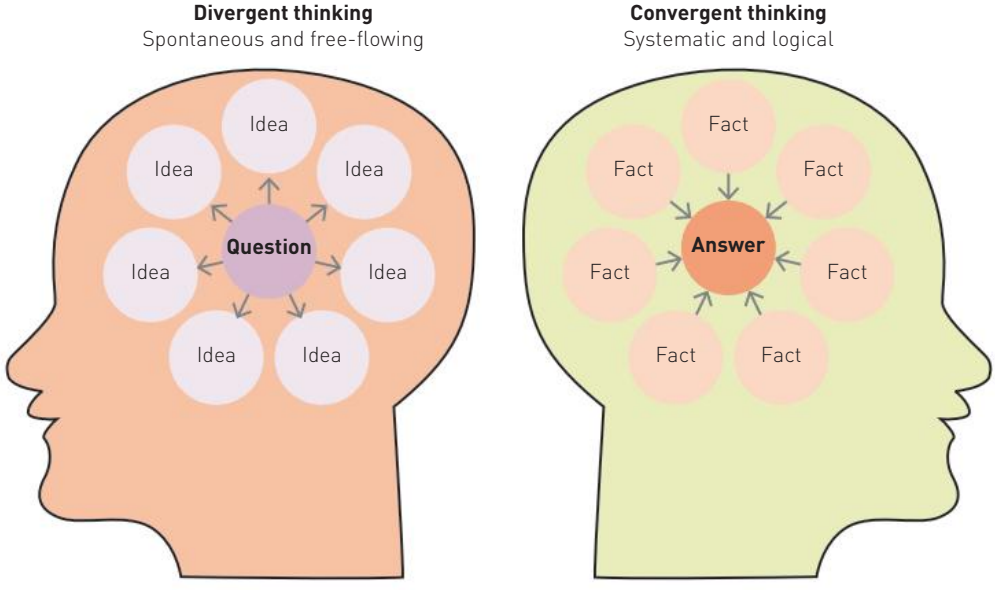


Figure 17.3 Both modes of thinking can be used to generate new ideas for food products.

studies have shown that almost 55 per cent of all new product ideas come from internal sources, such as company employees, while customers inspire a further 30 per cent of ideas. A business may need to generate many ideas to find one that is worth pursuing. One example of consumer-generated ideas was seen in the 'do us a flavour' competition run by Smith's to inspire the potato chip flavours. More recently, consumer demand to bring back limited-run flavours has also seen consumer preferences inspiring product ideas.

Several methods can be used to generate an idea. Focused or convergent thinking and free or divergent thinking are two commonly used models. They can be used in isolation; however, both may be useful depending on the company's product strategy.

With constant pressure to develop and launch new food products, the food industry tends to focus more on convergent, systematic types of idea generation where solutions are accountable and guaranteed. However, successful innovative products evolve from those companies where spontaneous ideas are encouraged and crazy new concepts are openly accepted and trialled.

SCREENING IDEAS

While the aim of idea generation is to come up with as many new innovative ideas and concepts as possible, these ideas need to be screened to target only those with real potential. At this point all ideas are reviewed. Those with potential pass through to the next stage while others are rejected. Screening helps maximise resources and avoids wasting time and money on unachievable concepts.

During this stage a systematic approach is taken to reduce the number of ideas quickly. Representatives from a variety of departments with a diversity of skills and knowledge are usually involved in this process and consumer preferences and opinions may also be considered. Ideas may be excluded for legal reasons; manufacturing restrictions; lack of resources, technology or personnel; marketing and distribution concerns. The overall aims and goals of the company will also influence the screening process.

This phase can be a simple one-step process or may be more involved with ideas moving through

Figure 17.4 Many ideas need to be generated in order to find one that is worth pursuing.

multiple screening stages. As the number of ideas is reduced, more accurate consideration can be given to technical, marketing and financial information as related to each individual concept.

Remaining ideas can be re-evaluated and refined to form a clear product concept. By the end of this stage the product has become more defined, with clarified specifications and criteria aimed at maximising market potential. For example, a food company wants to develop a range of 'crazy' ice-cream flavours to capture a new target market. What is meant by crazy? Who is the target market? Will the ice-cream be a premium or day-to-day variety? Who are the competitors for this product? Will 'health conscious' or 'allergy aware' consumers object to the concept?

The initial ideas may be broad but as they answer the key questions, the specifications for the new product narrow. One product idea description for the ice-cream might be, 'a line of ice-creams with a combination of 'crazy' ingredients, aimed as a gift to be taken to dinner parties, sold as a premium supermarket line'.

PRACTICAL APPLICATION

IDEA GENERATION

AIM

To apply convergent and divergent thinking to provide solutions to a design brief

METHOD

1 Brainstorm some possible solutions for the design brief you created for Practical Application activity 17.1. Use convergent and divergent strategies to formulate your ideas.
2 Screen your ideas and generate a refined list of options.

WS Idea generation

17.2

RESPOND

Describe in detail the best ideas you have for your new food product?

MARKET RESEARCH

The new product concept is now ready for further market research. This is where a company collects and analyses information about prospective consumer needs, gauging people's acceptance of the proposed new food product. Information can be collected using focus groups, surveys, experimental auctions, at-home trials and novel interview methods to understand how consumers think and feel about food and beverage products. This stage helps the company to further develop its business plan and to find out if the new product will appeal to customers.

At this point in the process, research is based around concept screening, where a target market group are shown a new concept to gather feedback and assess the attributes and benefits of the product. This type of research guides product design, price, packaging design, promotions and service. This is *primary market research* and organisations often hire independent market research firms to conduct these tests. Primary research gives a company control over the type of questions asked and the information gathered. This type of research is valuable; however, it can be costly and time consuming.

New product research requires a mixture of qualitative and quantitative research. *Qualitative research* is descriptive research that uses words, perceptions and feelings. It can be used to gain an understanding of consumer needs, trends, thoughts, opinions, and motivations. Qualitative data collection methods vary, often using unstructured or semi-structured techniques. The main research tools of qualitative research are focus groups, individual interviews and observations.

The use of *consumer focus groups* is invaluable for further developing the product concept and/or screening ideas. Small groups of consumers are presented with simple descriptions of the product concepts and they then discuss each idea. They can convey their own attitudes and behaviour towards the products as well as comment on predicted purchasing patterns. They are encouraged to identify product characteristics and strengths. Manufacturers can then assess the consumer's thoughts on basic product benefits – overall product, use, value and psychological benefits. The physical and psychological profile of the new product can be built from this valuable market research.

PRACTICAL APPLICATION

MARKET RESEARCH

AIM

To conduct basic market research to establish if an idea from Practical Application activity 17.2 is worth pursuing

METHOD

1 Make a list of possible ways you could conduct market research for one idea. Include suggestions for both quantitative and qualitative research.
2 Select one qualitative and one quantitative market research activity that you can conduct to establish if your ideas are worth pursuing.

17.3

WS Market research

RESPOND

Analyse the results from your market research. Is your idea worth pursuing?

Quantitative research generates numerical data and statistics. Through this type of research, manufacturers can gauge the demand for the new product, usage habits of the target market, attitudes towards the proposed new product, and the likelihood of sales. Quantitative research uses more structured methods such as online, paper, mobile and kiosk surveys; face-to-face and telephone interviews; longitudinal studies involving repeated observations of the same variables; and systematic observations. These methods provide robust and statistically valid results.

Manufacturers may also use *secondary market research*. This method uses existing credible and reliable sources to obtain information about consumers and customers at a more general level. It is often used to gain an initial understanding of the target market and market place. An example is

industry and demographic information drawn from the Australian census by the ABS. This research is known as secondary research because it is research done by others. A lot of this information is freely available online or accessible through trade journals and government studies. More detailed and sophisticated market analysis and industry information can be purchased from research companies.

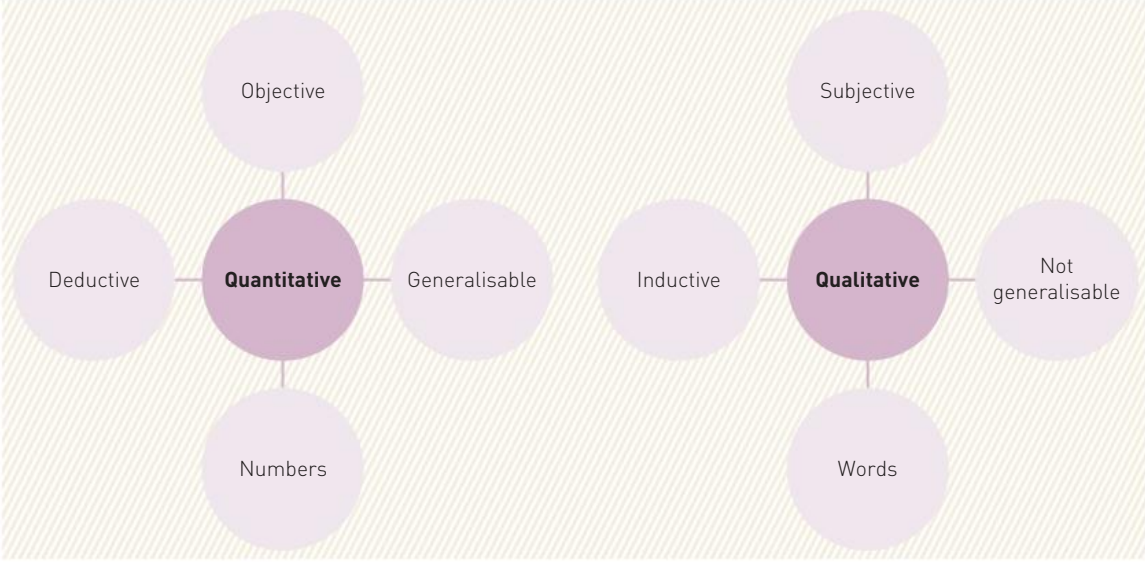


Figure 17.5 Aspects of quantitative and qualitative research

FOOD IN FOCUS 17.1

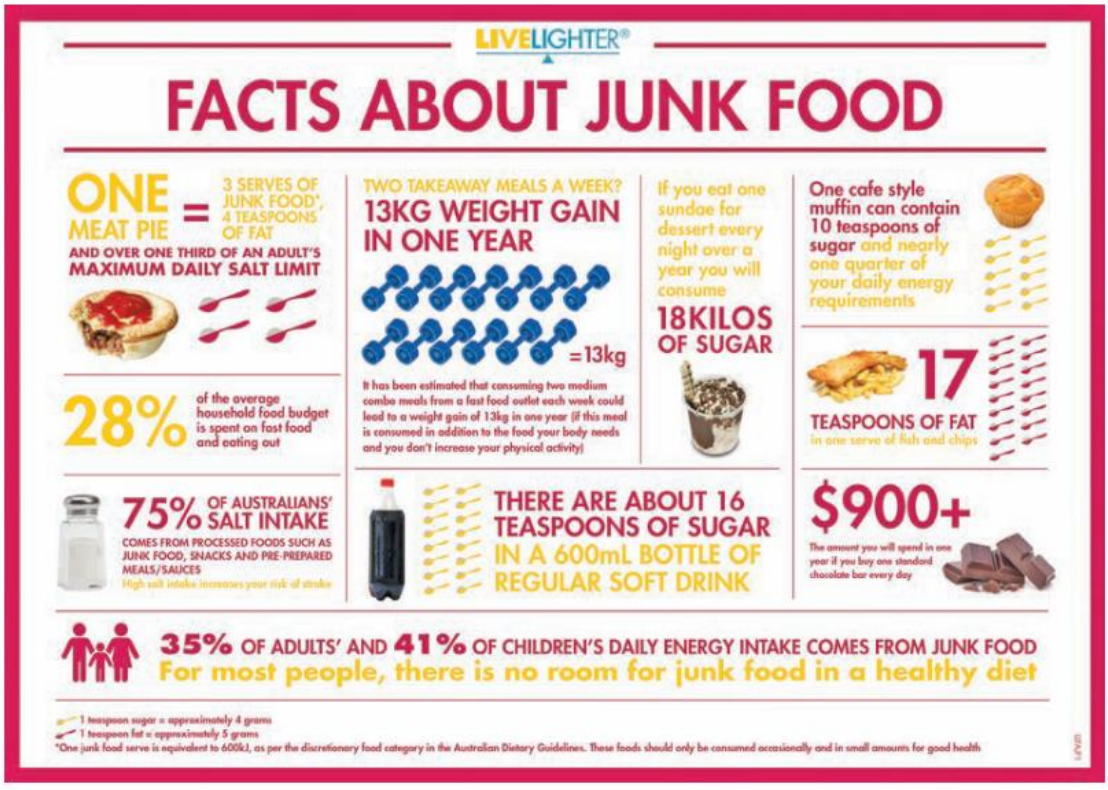


Figure 17.6 Junk food infographic

> **RESPOND**

The infographic above illustrates quantitative data about Australian eating habits.

1. Would this be classified as primary or secondary research?
2. What percentage of daily energy intake comes from junk food in the diet of an average Australian?
3. What percentage of the average household budget is spent on junk food?
4. How much money would you spend on average per year if you purchased one standard chocolate bar per day?
5. How might manufacturers of a new food product use this data as a part of their market research?

PRODUCT SPECIFICATIONS

The product specifications draw on the information collected and presented during the market research phase of the process based on feedback gathered from consumers. Information about the product qualities such as appearance, texture and flavour; raw materials; processing and production variables such as new production facilities, access to water and temperatures; storage variables such as time, temperature and humidity; pricing, packaging and marketing are also considered.

The product specification clearly defines the main features, properties and attributes of the food product and any other requirements that must be met for the product to be successful. A product design specification should include the information shown in Table 17.1.

Early attempts at the product design specification may be limited, as not all the required information may be available. After designers have generated preliminary product concepts, the target specifications are refined to account for technical, manufacturing and economic realities.

FEASIBILITY STUDY

A new product idea that survives the screening stage of the product development process needs a more refined and detailed business analysis or feasibility study. A feasibility study is carried out to assess the viability of the concept in terms of estimated sales, costs and profits. The objective of such a study is to ensure a project is legally and technically feasible and

Table 17.1 Product specifications

INFORMATION	DETAILS
General information	• Product concept: general statement on the product – name, form, function, perishable, frozen, shelf stable etc. • Product type – sweet snack, frozen dessert, flavoured pasta • Product image – convenient, healthy, economical • Product qualities – rich, tangy, creamy, smooth, crunchy (these should be tangible) • Target market – teenagers, elderly, families
Product design specifications	• Raw materials/ingredients – potatoes, butter, water, sugar • Processing/formulation • Packaging materials – sous vide, polyurethane, laminated paperboard, sizes • Storage, transport – time, temperature • Shelf stability – shelf life • Australian made
Marketing design specifications	• Packaging materials – label, graphics • Promotion – 4Ps (see Chapter 18) • Marketing/distribution channel • Price setting – wholesale price/unit • Competition
Consumer services and benefits	• Nutritional benefits, convenience, reusable packaging etc. • Product differentiation – what are the unique qualities of the product?
Environment	• Social – rainforest friendly, fair trade • Cultural – made in Australia, kosher, halal • Legal – labelling requirements • Physical – recyclable packaging
Costs	• Production • Marketing
Future directions	• Opportunities for further development, such as additional products to be added as line extensions

economically justifiable. This phase involves a more formal evaluation and planning process that ensures the proposed new food product is technically feasible, will be a sustainable product and will eventually be profitable. The feasibility study helps to narrow the scope of the project to identify the best way forward.

Areas that should be considered in this type of study include the following:

- *Operational feasibility* – if the product is developed, will it be purchased? Will customers make a change? Considerations include human and social issues, internal factors such as labour force and external factors such as government policies and legislation.
- *Technical feasibility* – is the product feasible within the limits of current technology, equipment, processing lines and trained staff? Does the technology exist at all? Can it be purchased within budgetary constraints? This involves checking all inputs for the product are available: technology, machines and equipment, site location and size.
- *Financial feasibility* – cost-benefit or break-even analysis. Is the product possible given current resources? Includes: cost of project, means of financing, estimates of sales and production, cost of production, marketing costs and projected cash flow.
- *Scheduling feasibility* – is it possible to develop the solution in the required timeframe? How long will it take the company to gain the technical expertise and skills required? What are the constraints and can they be met? Are the deadlines reasonable?

Applying a feasibility assessment to a new food product idea will help to determine the prospect of getting the product through the development process in an efficient and cost-effective way.

Phase two – product implementation

Up to this stage, the product development process very much a written exercise, but if the analysis for each of the steps to this point indicate to proceed, the next two phases move the project to a more hands-on, practical stage. The concept is developed into a tangible product, transforming the design ideas into a working prototype.

PRACTICAL APPLICATION 17.4

DETAILED PRODUCT SPECIFICATION AND FEASIBILITY STUDY

AIM

To write a detailed product specification and undertake a feasibility study

METHOD

If your research from Practical Application activity 17.3 showed your idea is worth pursuing, use it to complete the following task. If your research showed you do not have a viable idea, use a product you like that already exists.

1. Write a full, detailed product specification for your product.
2. Conduct a technical and economic feasibility study for your product.

RESPOND

1. Analyse the information you have learnt from your studies and make recommendations for how to continue with this project.
2. Investigate the impact of government legislation on further development of your product. Consider food standards, codes of practice, labelling and packaging laws and so on.
3. Based on your feasibility studies, how do you attend to proceed with the development of your new product?

PRODUCTION PROCESS DEVELOPMENT

After the concept has been clearly defined and narrowed down, a product development scientist or technical specialist, a chef, food technologist, and/or a home economist will work cooperatively in the research and development laboratory or test kitchen to develop one or more prototypes of the new food product. This stage of the product development process encompasses creating a prototype, testing the prototype, revising the formulation, retesting and so on, until a marketable food product emerges.

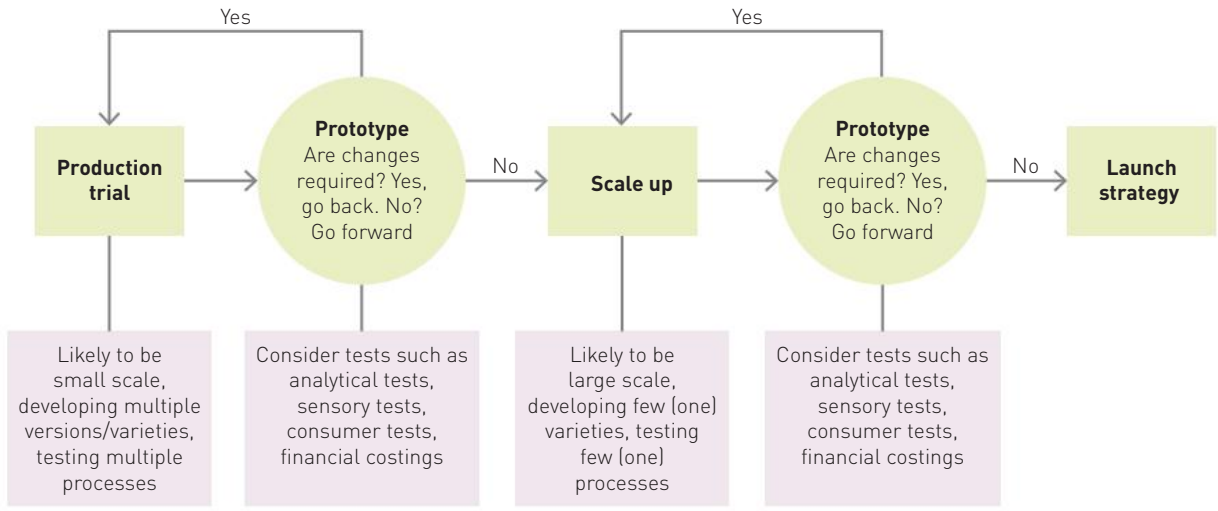


Figure 17.7 Key steps in the production process for developing a new food product

Some small batches of sample products may have been created earlier in the process and used for consumer screening. Feedback from these earlier models may lead to modifications of the original recipe formulations. An experimental design will be established to act as a *benchmark* for comparison during consumer sensory testing. Ingredients will be varied at defined intervals to test their effect on overall flavour, texture and colour. Each recipe will be evaluated, refined and modified to ensure the final prototype has all the attributes of the product's concept description and specifications. Further changes may need to be made to the product to transpose the original recipe into a manufacturing formulation suitable for 'scaled-up' commercial production. Depending on the degree of the change, the prototype may again need to be tested by consumers.

During this stage of the product development process, the recipe formula will transform from the bench-top, where small-batch process is used to produce a few servings, to the pilot plant, where large-batch process operations manufacture thousands of servings. Once the company is confident that the product is likely to succeed, it is ready for large-scale manufacture to begin in the production plant.

DEVELOPMENT OF A PROTOTYPE

Prototypes are tools that allow a business to extend their knowledge, gain clear visualisation and make improvements in their new food product. They are used as part of the product design process to allow food technologists, engineers and designers the ability to explore further design alternatives, test theories and confirm performance prior to starting full-scale production. Prototyping is simply taking the design from the virtual, imaginary realm into the physical world.

Throughout this stage of the process, a series of prototypes will be designed and tested. Following each of these trials, which usually involve consumer

PRACTICAL APPLICATION 17.5

PRODUCT DEVELOPMENT RECIPE

AIM

To perfect the recipe for your new food product development

WS Prototype development

METHOD

1. Conduct a series of prototype or product mock-up experiments to perfect the recipe for the proposed food product you have developed up to this point. Try different flavours, shapes, quantities and so on to get the recipe ready for development.
2. Evaluate the strengths and weaknesses of each prototype and make suggestions to improve them.
3. 'Scale-up' your recipe, re-test and re-evaluate your product.
4. Use consumer testing (such as testing your product with classmates, family or friends) to assist with your product evaluation.

Keep some of your prototypes to use in the packaging and storage trials in Practical Application activity 17.6.

and technical testing, the prototype may be redefined before evolving into the final product. Manufacturers often simulate full-scale production in smaller pilot production plants for this purpose.

A prototype is used as a way to gather further data about a viable product and verify its ability to perform as originally expected. A company can confirm if the new food product will be a commercial success. They will reassess consumer demand for the product, check whether it can be recreated on a larger scale, confirm the materials and components list (including product ingredients and packaging materials), authenticate safety, regulatory and environmental factors and finalise how the product will be packaged, distributed and delivered. Cost and feasibility are also factors that are further considered through the product prototype stage.

FOOD IN FOCUS 17.2

PULSE PASTA A NEW FOOD IN THE MAKING

Charles Sturt University

Figure 17.8 Neeta Karve and her PhD supervisor, Associate Professor Chris Blanchard, with a sample of the pulse pasta.

A RESEARCH student has created a new food product from pulses. Taking inspiration from the International Year of Pulses and her passion for the often forgotten food source, Charles Sturt University (CSU) PhD student Neeta Karve has developed a pasta from germinated yellow peas.

Ms Karve, who is doing her PhD through the School of Biomedical Sciences at CSU in Wagga Wagga, developed the new pasta with CSU graduate Dr Saira Hussain. The pair created the pasta to enter into the Australian Institute of Food Science and Technology student product development competition. A finalist in the competition, Ms Karve said the judges found the yellow pea pasta a 'great concept'.

To develop the pasta, Ms Karve said they used the germination process of yellow peas to create a yellow pea flour. 'The germination process of the yellow peas makes the end product more nutritious and the protein is more digestible,' Ms Karve said. She said her research had found yellow peas were grown in large amounts as break crop in Australia, but were usually used for stock feed or exported.

'Yellow peas are a great source of protein and I want to try to use the pulses we have here in Australia,' she said.

'I would like to see pulses become a staple product like rice.'

While the yellow pea pasta was just a prototype, Ms Karve said she hoped to develop the product further once she had completed her PhD in December next year. Director of the ARC Industrial Transformation Training Centre for Functional Grains at CSU in Wagga Wagga and PhD supervisor Professor Chris Blanchard said the product was a good example of how science was being translated into a functional food product, with health and economic benefits.

Source: Nicola Bell, *The Weekly Times*, July 18, 2016

RESPOND

1. What was the inspiration for developing the pulse pasta?
2. Describe the process Ms Karve used to develop the pasta.
3. Outline some of the benefits of the new product?
4. What is the usual use of yellow peas?
5. This product is just a prototype. Explain what that means.
6. What do you think the professor meant when he said 'science was being translated into a functional food product'?

TESTING THE PRODUCT PROTOTYPE

Thoroughly testing a new food product *before* investing significant time, energy and financial resources into it is vitally important for the long-term success of a business. As well as additional market testing carried out to check the acceptability of the product in the defined market and customer group, a product prototype will be continuously tested for performance, cost and process specifications. A product must satisfy the Australian Food Standards Code requirements by adhering to numerous food codes and regulations. This is discussed more in Chapter 11.

Technical testing

This type of testing can differ depending on the form and classification of the food being tested, the available testing facilities, safety requirements, processing needs and legal regulations. Quality tests of the prototype may be chemical, physical and/or microbiological and are used to ensure that total quality management (TQM) has occurred from the start of the production process, with the selection of raw materials through to the finished product. Technical testing is also used to verify food regulations are being met, ensure consumer safety and confirm any specific labelling requirements such as nutritional value and country of origin. This type of testing, which may include microbial, packaging and shelf life testing, serves to monitor food product specifications for quality and market acceptability.

Storage trials

Shelf life of a product is the predicted length of time a product retains quality under prescribed storage conditions. Storage trials test the shelf life of new food products to gauge their quality and safety. This process is also used to determine a use-by or best-before date for products. The responsibility of determining the shelf life of a food lies with the manufacturer and so is a component of the product development process.

As discussed, variables that affect shelf life include:

- microbial growth – the rate of growth of spoilage micro-organisms
- chemical or biological changes such as oxidation, non-enzymatic browning, enzymatic browning and, in some cases, food and packaging interaction
- rancidity of fats and oils caused by oxidation
- moisture and water vapour uptake or loss
- vulnerability to temperature, light, air and humidity

According to the CSIRO, the most direct way of determining a product's shelf life is to conduct properly constructed storage trials under realistic, defined conditions. During these types of trials, prototypes are stored over time and assessed for changes. The testing should take into account the storage and distribution conditions to which the food will be subjected along its supply chain. Shelf life testing takes time and needs to be started as soon as possible in the prototype development stage of the process. There is no single test that will determine shelf life; however, the testing of a specific product should include food safety, food spoilage and food quality parameters.

Storage trials in the food industry can be very complex and are assisted by many forms of technology. The results require careful statistical analysis and consideration. At the conclusion of the trial, a food manufacturer should be able to determine:

- the optimum storage conditions for the proposed new food product; for example, storage temperatures
- the safety parameters and limits for storing the product throughout the supply chain; for example, transportation times and temperatures
- the ideal storage conditions and recommended storage life to be printed on the product's label
- any modifications required to the processing procedures that may extend the shelf life of the end product, such as a change in the recipe formulation or cooking time.

Accurate and reliable storage trials help to identify factors that affect shelf life, improve food products, reduce the risk of product recalls and ultimately improve profitability.

Alamy Stock Photo/ Wavebreakmedia Ltd FUS1606-2

Figure 17.9 Stale or acceptable? Testing bread for freshness using a texture analyser.

Packaging tests

Storage trials of prototypes are also used as a way to investigate a range of packaging options that may be suitable for use on an end product. Packaging tests at this point are used to apprise:

- the overall effectiveness of the package and the packaging materials
- any adverse interactions that may occur between the selected package and the food product.

These trials may include tests to assess the effects of stacking, impact, dropping and tensile moisture levels. If the packaging has additional functional properties to fulfil, these characteristics are also tested. For example, resealable bags, microwavable packages, pouring convenience and easy-open devices are all tested, evaluated and modified if required.

PRACTICAL APPLICATION

PACKAGING AND STORAGE TRIALS

AIM

To test suitable packaging for your product

METHOD

1. Using some samples created through your prototype testing, conduct a series of packaging and storage trials.
2. Use your findings to decide on a suitable package for your new product.
3. Design a label for your new food product.

17.6

Packaging and storage trials

Sensory evaluation

Sensory evaluation is a simple analytical tool used in product evaluation aimed at quality assurance. It is a scientific discipline used to evoke, measure, analyse and interpret results of characteristics of foods and materials as they are perceived by the senses of sight, smell, taste, touch and hearing. Sensory tests can be used to determine differences in products as well as consumers' acceptance and/or preferences for the foods being evaluated.

Evaluating the sensory aspects of a new food product can be used at various points of food production. Sensory evaluation can be used to:

- maintain quality control
- determine shelf life

MATTEIS/LOOK AT SCIENCES/SCIENCE PHOTO LIBRARY

Figure 17.10 For accurate analysis, testers are often asked to focus on one sense at a time.

- judge whether a new product is marketable
- identify the sensory attributes in terms of flavour, texture, colour and appearance
- understand drivers of consumer preferences
- identify any tainting and check if a product is affected by storage or packaging.

To conduct a sensory evaluation, the company may use ordinary consumers, members of the production team or a panel of experts, such as scientists, who are trained to use their senses as an instrument to objectively analyse food products. This concept is looked at in more detail in Chapter 4, where the types of tests and how to conduct them are outlined.

Consumer testing

As discussed earlier in this chapter, consumer testing can be done throughout the process of food product development and in a variety of different ways. The opinions and attitudes of consumers will be collected from a group of representatives chosen from the identified target market for the food.

The design of consumer tests varies according to the type of the new product and the amount of market research carried out in previous stages. The size of the consumer testing panels typically increases at this point, as the importance of making the right decision becomes critical and the consequences of a wrong decision become larger. As the product is now in its final stages of development, the more consumers included in these final trials, the more reliable the tests. Product samples are often distributed to potential customers door-to-door, in shopping centres, at railway stations, at sporting venues or via internet sign-up sites. Consumers take the products

FOOD IN FOCUS 17.3

DON'T MESS WITH WHAT'S NOT BROKE

Lifehacker Australia

Figure 17.11 Arnott's Shapes

They have been a lunch box favourite for more than 40 years, but customers turned their backs on Arnott's Shapes, labelling the new recipe as 'revolting'.

In March 2016, Arnott's tampered with the original recipe for its Shapes range to make them healthier. The change was not well received by customers.

At the time, many independent consumer groups did taste tests to compare the old and new Shapes. Suffice to say the 'New and Improved' recipe left a lot to be desired. Consumers questioned why the manufacturer would change a recipe that worked.

Many Shapes consumers felt Arnott's had taken one of their happiest childhood food memories and ruined it. The resulting explosion of disgust and outright hatred made Shapes a trending topic on social media for weeks.

Arnott's said the new Shapes biscuits had been 'tested and trialled extensively' and the new flavour means the biscuits have an improved health star rating.

Arnott's relented and decided to bring back the original BBQ and Pizza Shapes flavours, which are now sold alongside the 'New and Improved' range. Look for the black 'original flavour' strip on-pack to distinguish between the original and new flavours.

RESPOND

1. Why did customers turn their backs on Arnott's Shapes?
2. What did the independent taste tests on the product indicate?
3. Why did consumers feel betrayed?
4. What was Arnott's response to the initial reaction to the new range of Shapes?
5. What effect do you think this issue may have had on the sale of this snack?
6. How did social media help fuel the campaign to bring back the original recipe?
7. What have Arnott's since done to rectify the problem?

home, use them under the normal conditions and complete questionnaires to provide feedback. At this stage, consumers are being asked to assess whether the product lives up to expectations. Consumers consider the product as a whole – packaging, marketing and, of course, sensory characteristics such as taste. If one element of the product is determined to be lacking or weak then this component may once again be reformulated and the testing will be redone.

Before being able to commercialise the new food product, several other activities, outside the scope of this chapter, need to take place. They include:

- the creation of compliant labels
- the calculation of nutrition panel information
- the product meeting regulatory approval
- the new formula added to the plant production schedule
- training for employees to use any new equipment required.

Phase three: product introduction

Finally, when a product has made it all the way through the new product development process, the only thing left to do is introduce it to the market – it is ready to be launched! Commercialisation is about how the new product is presented to the world. This is the final test phase for a product – it

tests the real market value of the initial product concept. Will it be accepted and enjoyed by the target market?

Launching a new product or service involves stepping up to full-scale production. This may be done gradually as the development team oversees the first few production runs, ensuring everything goes as planned and developing confidence in the consistency and success of the new product. Commercialisation also involves coordinating the supply chain and rolling out marketing plans, as discussed in Chapter 18. Product support needs to be in place to receive feedback from the manufacturing plant about how the product is running and from consumers to know if they are satisfied.

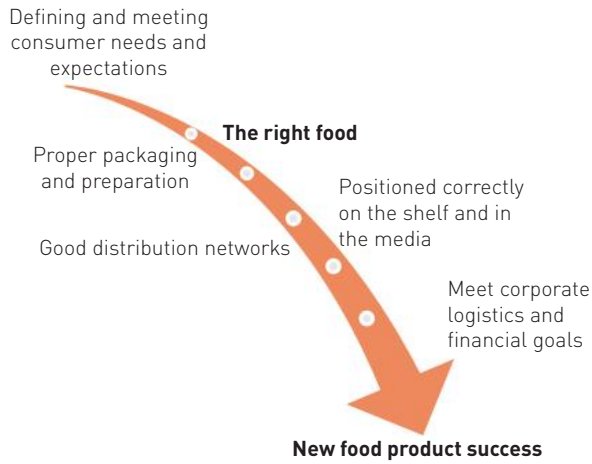


Figure 17.12 New food product development is all about an integrated approach.

FOCUS QUESTIONS 17.1

REVIEW

1. Outline the activities undertaken at each stage of the product development process.
2. Identify the different ways a company might develop a new food concept.
3. Discuss the difference between qualitative and quantitative research.
4. Outline the various aspects involved in a feasibility study.
5. Describe the product specifications for an identified product.
6. Explain the importance of producing a prototype when developing a new food product.
7. Assess the role of the consumer in the product development process. Use the following prompts to help you: I used to think ... Now I think ...

FOR YOU TO APPLY

8. Use an example to develop a product development flowchart that traces an existing product through each stage of the product development process.

EXTEND YOURSELF

9. Using the steps of the product development process, develop your own food product that meets an identified need.

Chapter review

REVIEW

1 Discuss how sensory evaluation can be used throughout the food product development process.
2 Outline the legal requirements that must be satisfied before a new food product can be launched onto the market.
3 Using an industry-specific example, identify one quality assurance procedure in the food product development process.
4 Explain how each of the following would influence the development of a new food product:
   a Idea generation and screening
   b Testing of product prototype
   c Australian Food Standards Code
5 Discuss the importance of thorough research in the early stages of food product development.

FOR YOU TO APPLY

6 How would you develop a new food product to meet an identified consumer need?
7 Draw an infographic depicting the main steps in the product development process. Use a recently launched food product to help you illustrate the process.
8 Investigate a consumer testing company. Find out about the types of products they test and how they conduct the tests.

EXTEND YOURSELF

9 Become a consumer tester for a new food product. Write a record of your experiences. Share with the class.
10 Visit the Australian Food News website and investigate what's new in the Australian food industry.

Australian food news – what's new

CHAPTER

18 Marketing plans

To many people, marketing just means selling, but it is far more than that. Marketing is about putting the right product in the right place, at the right price, at the right time. Marketing is everything a company does to promote their business and a new food product, from the moment they have an idea to the point at which customers buy it. It involves researching, selling, distributing, and promoting a product.

CHAPTER OUTCOMES

In this chapter, students will learn about:

- Product planning
- Price structure
- Place and distribution system
- Promotional program

KEY TERMS

distribution
marketing
marketing mix
place
price
product
product life cycle
promotion
target market
tangible

iStock Photo/scyther5

Planning a new product

Making a new food product is relatively straightforward – the hard part is ensuring that potential customers are aware of the new product and want to buy it. It is essential, therefore, that companies prepare a detailed marketing plan – a plan of action for the new food product.

A marketing plan includes everything from understanding the target market and a company's competitive position in that market, to how they intend to reach that market and how to differentiate themselves from competitors. A marketing plan generally includes analysis of the current market situation (opportunities and trends) and detailed action programs, budgets, sales forecasts, strategies and projected financial statements. It is important to devise a plan that balances profit, client satisfaction, brand recognition and product availability.

The marketing mix

When preparing a plan, it is essential to ensure the right marketing mix is clear from the start. The marketing mix is characterised by four different but equally important variables – the 4 Ps. These variables are never constant and may be changed over time. Each of the variables are interrelated and affect each other – a change in one of the variables may cause a change in all the others.

Figure 18.1 The 4 Ps of marketing

A marketing mix forms the basis of a company's marketing plan and is more or less everything they can do to get the customer to buy their product. A popular approach to the marketing mix is to use the 4 Ps of marketing – product, price, place and promotion. Food companies modify each element in the mix to establish an overall brand image and *unique selling point* to make their products stand out from the competition.

The marketing mix can be described in terms of the 'five Ps, to include people. Alternatively, the 'seven Ps' also includes physical environment and process, but this version is used mainly in the service industries.

Product

To maximise sales revenue and profits, a company must continually adapt its food products to the changing needs of consumers and the market. In broad terms, for a larger organisation, product planning is the process of searching for ideas for new products, identifying target markets, screening them systematically, converting them into tangible products and introducing the new product into the market. Product planning also entails managing individual food products throughout their product life cycle using various marketing strategies, including product line extensions, revisions or improvements, increased distribution, price changes and promotions.

In marketing terms, a simple definition of a product is anything that meets a consumer's needs and provides value that can be obtained by a customer through a marketing exchange. In the case of food product development, the actual food item would be considered the tangible product. However, a product is more than a tangible *thing*. A product

meets the needs of a consumer, and in addition to its tangible value a product also has other less obvious values.

When considering a new food product in marketing terms, it is useful for a company to split the product into levels. By analysing a new food product at different levels, the marketing team can have a better understanding of the product's competition, how the new food meets the needs of the consumers, and how it can be supported and clearly differentiated in the marketplace. Three levels of product can be identified. Each level adds more customer value.

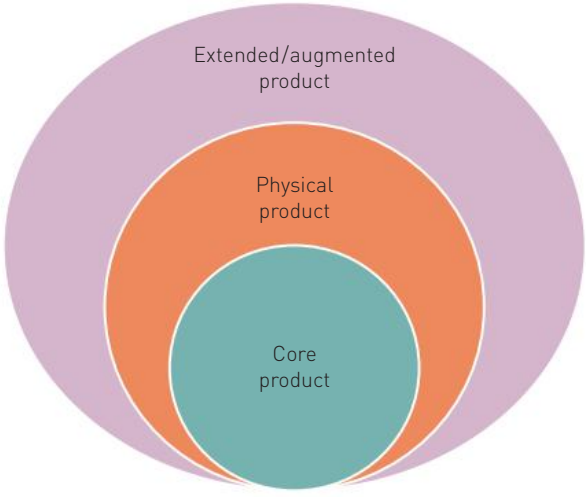


Figure 18.2 Levels of a product

Core product

At the centre of this concept is the core need that the new food product is trying to meet. This aspect of the product is not tangible; it is the benefit of the product that makes it valuable to the consumer. This helps the company to consider the product from a consumer's perspective – why is the customer buying this new food product?

A simple example of this might be to think about why a consumer would purchase a snack bar. Most customers would say something like, 'because they are quick and convenient and I was hungry'. Clearly the consumer has a need that the snack bar can fulfil.

Physical product

The actual product is the tangible, physical food product and features of the product. When describing a snack bar, you would identify some or all of the product features in Figure 18.3. The aim of the marketing team is to make sure the product design meets the core need or benefits identified by the target market.

Shutterstock.com/Stuart Fuidge

Figure 18.3 A snack bar

The extended/augmented product

The augmented product is the non-physical part of the product; it is about extending the offerings and set of benefits to the consumer without altering the product itself. To add extra value and benefits to a food product such as a snack bar, a company may consider:

- using a recyclable package
- having ingredients sourced sustainably and ethically
- providing a free replacement of the snack bar (if it is unsatisfactory)
- having serving suggestions on the packaging
- having a QR code on the packaging (linking to a website, competition or special offer)
- providing a discount voucher for a future purchase
- having interesting information on the packaging, such as fun facts about oats
- featuring celebrity endorsements
- donating a percentage of the sale to a charity; for example, 'Sales of this product contribute to the research of Batten Disease'.

Companies undertaking product planning need to remember that a consumer will purchase a new

food product not only because of how they will benefit or feel, but also because of the status, quality or reputation of the brand associated with the product. This means that products include tangible objects, like snack bars, as well as intangible ideas like health and sustainability.

Product life cycle

The product life cycle includes the stages a product goes through after development, from introduction, through periods of growth and maturity to its eventual decline. In response to changes in customers' interest and requirements for the product, changes in

PRACTICAL APPLICATION 18.1

ANALYSING FOOD PRODUCTS

AIM

To analyse the branding used by different brands and products

METHOD

1 Select five different food products available in your local supermarket. Include one fresh food item, such as an apple or banana.
2 Think about the colours and style of lettering. Look for slogans, claims or special features used to differentiate the product from its competitors. Record the following information:
   a Product name
   b Physical product attributes
   c Augmented features
   d Brand name/brand mark
   e Brand strategies
   f Packaging and labelling
3 Compare your findings to the rest of the class. What similarities and differences can you observe between different food brands and products?
4 As a class develop a game based around brand recognition. You could create a Kahoot! game.
5 Complete the following sentences in reference to food branding:
   I used to think ...
   Now I think ...

Kahoot!

FOCUS QUESTIONS 18.1

REVIEW

1 Explain the importance of a good marketing plan for a new food product.
2 What should be included in a marketing plan?
3 Discuss using specific examples the concept of 'product' in terms of a marketing plan.

FOR YOU TO APPLY

4 Look at the image of the snack bar packaging. Briefly describe:
   a the core product
   b the actual product
   c the augmented product.

EXTEND YOURSELF

5 Think of a product that has recently been 'reinvented' or removed from the market place. Trace its life cycle describing each of the stages it would have moved through.

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Figure 18.4 Crunchola bars

market conditions or new competitors, the marketing strategy for a product will be reformulated several times throughout its life cycle.

STAGES OF THE PRODUCT LIFE CYCLE

The four stages of a product's life cycle are introduction, growth, maturity, and decline. Each stage is marked by specific characteristics. A company will track the sales of all its products at each stage of the life cycle to determine the profitability of the product and to evaluate whether it will need to be recreated or replaced by a new product.

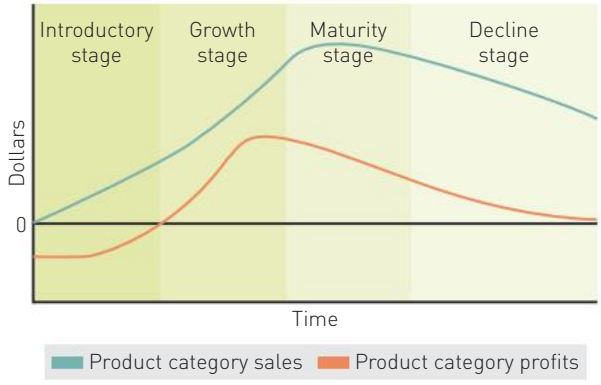

Figure 18.5 Stages of a product life cycle can be mapped using a graph.

Introduction

Launching a new food product is often the most expensive life-cycle stage for a company, because of the heavy costs of production and promotion. New-product sales are sometimes slow and profits are minimal. Production runs are usually small, product modifications may be needed and consumer and market testing is ongoing. The focus is on getting potential customers to try the product and the failure rate at this stage can be high.

Growth

The growth stage is typically characterised by a strong growth in sales and profits as rapid market acceptance of the product occurs. The size of production runs increase and distribution widens. Threats from copycat products are diverted by strong promotional activities aimed at brand preferencing.

Maturity

During the maturity stage, the product is established and the aim for the manufacturer is now to maintain the market share they have built up. Sales flatten out and profits stabilise and then decrease. Popular food products that have been available in the market place for an extended period of time may reach a point where sales cannot be improved. This is known as market saturation. As the market becomes saturated, this is the most competitive time for most products. Marketing efforts will now focus on new target markets and taking market share from competitors by price cutting or relaunching with line extensions or product revisions. Modifications or improvements to the production process that might create a competitive advantage are often considered at this stage.

Decline

The decline stage of a product is indicated by falling sales and often rapidly shrinking profits. While the decline may be inevitable, decisions need to be made on ways to revive sales by investing in further development, switching to less-expensive production methods and aggressive marketing or to quietly admit defeat and exit the market.

Getty Images/Mehmet Hilmi Barcin

Figure 18.6 Think about the life cycle of classic products such as Coca-Cola. How do they avoid decline?

FOOD IN FOCUS 18.1

THE LIFE CYCLE OF CADBURY DAIRY MILK CHOCOLATE

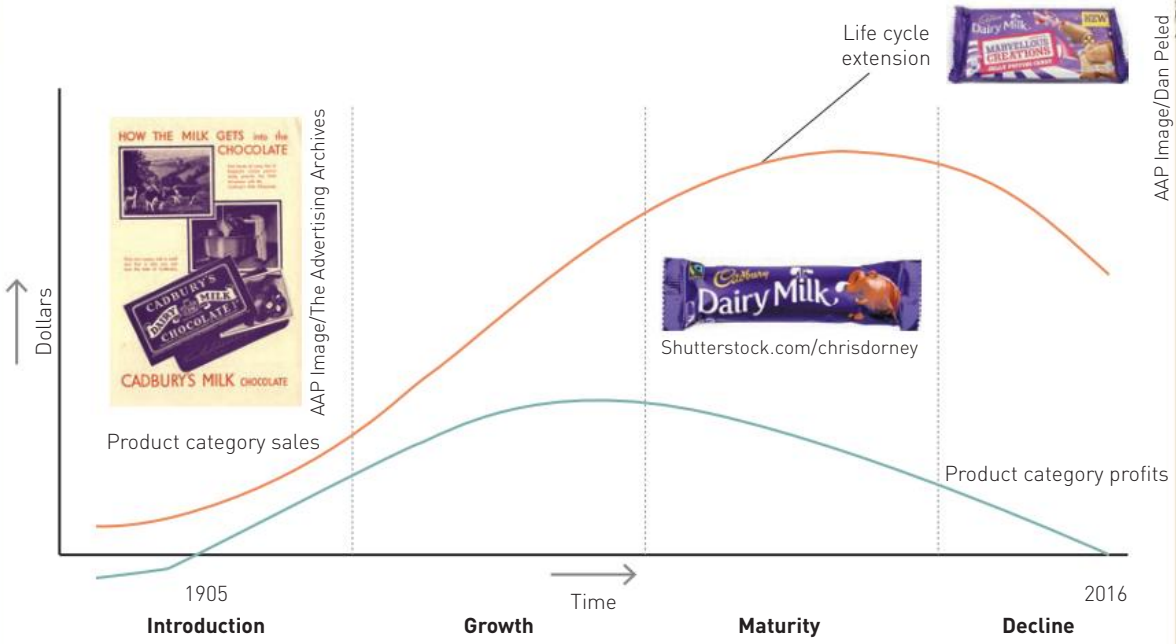

Figure 18.7 The Cadbury life cycle

RESPOND

Look at the growth cycle chart for Cadbury Dairy Milk chocolate and answer the following questions.

1. In 1905 when the dairy milk chocolate was first introduced, the major rivals of the brand were Swiss companies. Describe some of the strategies that may have been used to introduce this new product to the market – remember there was no internet and limited transportation at this time.
2. In the 1920s, Cadbury first introduced their iconic purple colour and the Cadbury script logo. How would have this helped with the growth of the product and brand?
3. Over the years, Cadbury developed many other chocolate bars but Dairy Milk remained a strong favourite. How did the maturity of this product help launch other products?
4. With consumers focusing on health, Cadbury Dairy Milk began to lose sales and needed to reinvigorate their brand. Discuss some of the strategies they have used to remain competitive.
5. Visit the Cadbury Australia web site. Make a list of the variety of different products Cadbury offers today. How do you believe these products will perform in the future? Justify your answer.
6. Chose one other product from the Cadbury range and draw a life cycle chart for that product.
7. Investigate the current strategies Cadbury are using to promote their products.

Cadbury Australia

Price

Price is a critical part of the marketing mix, and determining the right price for a product is critical to its success in the marketplace. Correct pricing strategies will help maximise profits and build strong relationships with consumers. By pricing effectively, a company will avoid the serious financial consequences that can occur if the new product is priced too low (not enough profit) or too high (not enough sales).

Pricing directly affects both performance and profitability of a new food product. Price structure is an extremely powerful and responsive marketing tool, capable of attracting or deterring consumers as well as contributing to a product's competitive strategies.

Pricing is one of the most dynamic of the marketing tools and in the food sector it can be constantly changing. The pricing strategy of a new food product should differentiate it from its competitors and be regularly reviewed by the company based on what is happening in the marketplace and at what stage of the life cycle the product is in.

Alamy Stock Photo/RosaIreneBetancourt 8

Figure 18.8 The price of fresh produce fluctuates seasonally; banana supply is affected by climatic conditions – especially cyclones!

Pricing considerations

Companies are aiming for a price that will attract customers and deliver the best profit margin. Formulating the right price involves considering a number of elements.

Figure 18.9 The key elements of pricing

- *Competitors*: pricing is viewed in comparison to competitors and existing market prices. As such, the strategies a company chooses to use must be competitive and accountable.
- *Consumer demand*: ongoing research will help determine the needs of the end users/target market of the product and how much they are willing to pay for what they are getting.
- *Flexibility*: as a pricing strategy is a long-term projection, a level of flexibility should be factored in. Price changes could incite customer reactions so they need to be planned decisions. The price margin should be able to accommodate short-term cost increases, such as the rising costs of raw material or energy.
- *Forecast volume*: overall profitability is affected by the amount of product sold both short and long-term. Variable costs including raw materials, machinery and labour will generally decrease as production volumes increase. Frequent review of the new product's sales forecasts should form a part of the pricing structure.
- *Product costs and profitability*: profits are not just based on consumer purchases. All the costs attached to a new food product such as ingredients, packaging, marketing, distribution and labour need to be factored into the selling price of goods.
- *Promotion*: a business may include particular promotional considerations within their pricing strategy, such as launching the product at a reduced price for a trial period to encourage initial purchasing, which should still deliver the long-term target profitability if customers buy the product again.

PRICING STRATEGIES

When considering a price structure, there are many pricing strategies a company might use to maximise their potential sales and profits.

- *Bundle pricing*: a group of products may be bundled together and sold at a reduced price. Supermarkets often use this method through their 'buy one get one free' offers. This is a good way of moving slow-selling products.
- *Captive pricing*: captive products are used strategically to maximise profit. Low prices are offered for the main product such as a coffee machine, but high prices are placed on supporting products such as the capsules to put in it.

Figure 18.10 Pricing strategies

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Figure 18.11 A bundled product

- *Competitive pricing*: here the price of a product is set to match what a competitor is offering, it may also be referred to as status quo pricing. This type of pricing is commonly used when a company introduces a copycat product. A company may decide to set their price:
  - higher to create a higher-quality perception or to target a niche market
  - the same to show more benefits for the same price
  - lower to try to gain a wider customer base.
- *Geographical pricing*: geographical pricing sees variations in price in different parts of the world or even within the same country or state. Prices may be affected by availability or distribution costs.
- *Optional pricing*: a company may add an 'optional extra' item within the price to increase a product's attractiveness and encourage customers to increase the amount they spend once they start to buy. For example, a customer who purchases two types of a particular brand of herb may be eligible to receive a free cookbook.
- *Penetration pricing*: a price set artificially low in order to build up sales and gain market share. Once a position is created, the prices are gradually increased.
- *Premium pricing*: a high price is set to establish the product as exclusive and of high quality. This approach is used where a substantial competitive advantage exists and the marketer is safe in the knowledge that they can charge a relatively higher price. Such high prices are charged for luxuries such as premium ice-creams or chocolates.

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Figure 18.12 The Connoisseur range of ice-cream adopts a premium pricing strategy.

- *Product line pricing*: when there is more than one product in a line, product quality, real or perceived, is a way to differentiate the features and benefits of the different products. Separating them into

various cost categories creates different quality levels in the minds of consumers, promoting purchase of line extensions using 'premium' products thus increasing overall company profits.

- *Psychological pricing*: This approach is used when the marketer wants the consumer to respond on an emotional, rather than rational basis. Often a company will make small changes to prices to make a customer think the item is priced lower than it is. This is often seen in prices ending in 99c. For example, an item market $1.99 will be perceived as closer in price to $1.00 than $2.00. In this respect, price may also be an indication of quality or benefits in unfamiliar markets, with consumers avoiding low-priced products for fear of inferior quality.
- *Skimming pricing*: The initial price is set high as the company holds a substantial competitive advantage with the introduction of a unique product. However, in a competitive market like food product development the advantage tends not to be sustainable. The high price attracts new competitors into the market, and the price inevitably falls.
- *Value pricing*: This approach is used where external factors such as recession or increased competition force companies to provide value products and services to retain sales; for example, value meals at McDonalds and other fast-food restaurants. The perception is that the customer is getting better value for what they are spending.

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Figure 18.13 Value pricing

No matter what pricing structure a business chooses to use, overall they need to arrive at a price that covers costs and delivers a reasonable profit margin, while also assessing what customers are willing to pay for the value they believe they receive from the new food product. Pricing needs to match the image of the company and the needs and nature of the customers, while delivering the profits necessary for the business to survive.

PRACTICAL APPLICATION 18.2

PRICE SURVEY

AIM

To research differences in price at various food outlets

METHOD

1. Make a list of 5–10 well known branded food products, such as milk, bread, coffee, chocolate or ice-cream.
2. Visit at least three food outlets and note the price of the identical products in each location. This could be done individually or as a group, with each member of your group visiting a different food outlet. Alternatively you could view different online food retailers to complete this task.
3. Create a table with the individual and total prices for each food outlet.

RESPOND

Analyse your results. Consider any differences in the prices for these items. Why would you pay more for an identical item?

FOCUS QUESTIONS 18.2

REVIEW

1. Why is price such a vital part of the marketing mix?
2. Explain why the pricing structure of a food product needs to be reviewed regularly.
3. Discuss some of the considerations a company should make when developing a pricing structure.
4. How is price determined?
5. Examine the different pricing structures a company may use. Give examples to show when and how they should be used.

FOR YOU TO APPLY

6. Use an existing food product and identify its pricing strategies. Why do you think this is the approach taken? Has it changed over time? Explain how you might price this item in different ways – justify your ideas.

Place and distribution

In the marketing mix, place refers to the distribution of the new food product to the consumer at the right time and to the right place. The distribution system is the combination of decisions relating to marketing channels, storage facility, inventory control, location, transportation and warehousing. Getting 'place' or a product's retail outlet right means greater chances of sales over a longer period. This translates into greater market share, more profits and better ability to track the changes in the marketplace in thinking, styles, trends and needs.

Distribution channels

The distribution process is about allowing the customers access to the food product when they want it. The distribution channel is a chain that links the point of manufacturing to the final customer. Companies need to decide how they will distribute their products. Products can be sold *directly* to customers (from the factory or over the internet) or *indirectly* through an intermediary – a wholesaler or retailer who helps move products from their original source to the end user. Sometimes food products are passed to consumers through multiple channels. Apart from the retailer, the other intermediaries are often 'invisible' with the consumer having little knowledge of their role and operation.

A recent Nielsen survey reported that ¼ of respondents order grocery products online and 55 per cent are willing to do so in the future.

Market coverage

Channels can be further divided by the intensity of the distribution network and refers to the number of outlets selling the product.

Figure 18.14 Food distribution from paddock to plate

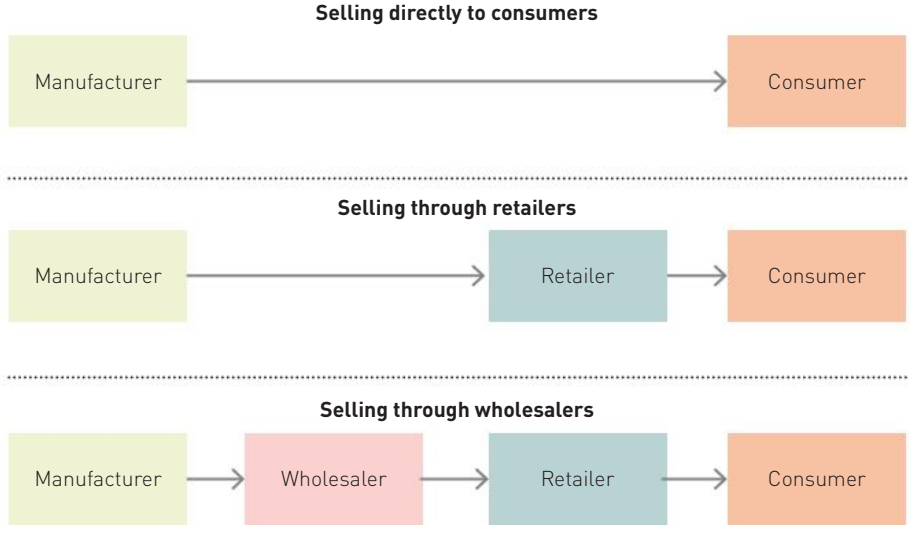


Figure 18.15 Distribution channels available to companies to sell their new food products.

Table 18.1 Where products are sold

STORE TYPE	DESCRIPTION
Supermarkets	Large retail stores with all kinds of goods, particularly daily needs and foods.
Department stores	Usually in the centre of a town or suburb and sells a wide range of goods from many producers.
Chain stores	Two or more stores with the same name and characteristics.
Discount stores	Offers a wide range of products, including branded products, at discount prices. Often all the products are similar.
Superstores	Very large out-of-town stores.
Direct sales	Goods are sold directly to the consumer, often at a farmers' market or from the manufacturer.
Mail order	Customers order via post by looking at the catalogue.
Internet/e-commerce	Customers order via the internet by looking at the website or using an app.

Can you think of specific examples of each of these types of stores? What types of food products do they distribute?

INTENSIVE DISTRIBUTION

An intensive distribution channel is chosen when the manufacturer wants to saturate the market with its product. Many convenience goods, such as milk, lollies and newspapers are distributed this way. Coca-Cola is an example. They use supermarkets, convenience stores, service stations and vending machines to ensure the distribution is as intensive as possible.

SELECTIVE DISTRIBUTION

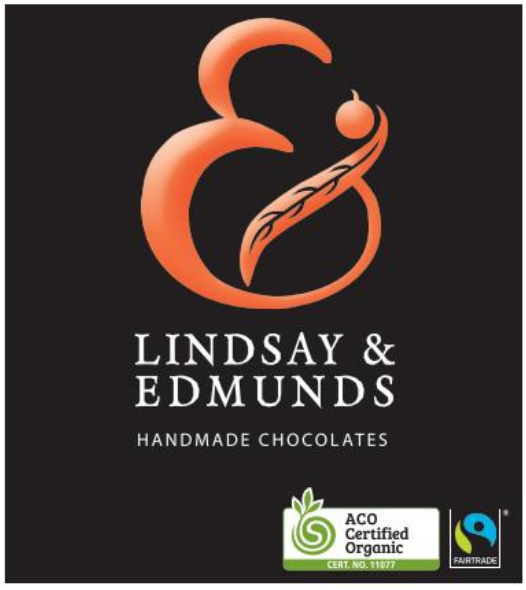
This involves using only a moderate proportion of all possible outlets. The consumer is prepared to travel and seek out a specific retail outlet that stocks a certain food product. For example, some specialty salamis and cheeses are only available from a local deli rather than a regular supermarket.

EXCLUSIVE DISTRIBUTION

This channel choice is often made for products positioned at the top of the market. It is generally favoured by producers selling high-quality or unique products, and distribution is intentionally limited. The price reflects the niche market where marketing efforts are directed towards one well-defined segment of the population, and the promotion and distribution also supports exclusivity.

FOOD IN FOCUS 18.2

HIDDEN CHOCOLATE HEAVEN



Lindsay & Edmunds Handmade Chocolates

Figure 18.16 Lindsay & Edmunds chocolate

Lindsay & Edmunds is a boutique Australian chocolatier created by former chef Peter Edmunds from his passion for the superior taste and environmental benefit of quality organic food, combined with his love of the French chocolatier. Located in Warriewood in Sydney's Northern Beaches this hidden gem is full of surprises.

The boutique business specialises in organic fair-trade chocolate and sells products such as salty caramel tarts, fancy versions of wagon wheels, biscuits, brownies and blondies. Lindsay & Edmunds' signature range can be bought individually or as white, milk and dark chocolate slabs. The establishment takes chocolate lovers to the next level with chocolate-making courses, an onsite café and a viewing platform where customers can see the chocolates being made.

The use of organic ingredients is a key point of difference for Lindsay & Edmunds chocolate. 'Part of our philosophy is that we use no artificial flavourings, oils, essences, colours or anything

>

like that,' Peter says. 'We want a product that is certified organic to be as natural as possible.'

This includes the ingredients that they use to create their flavoured chocolates. To come up with original handmade products, 'It depends on what organic products are available,' Peter says. 'So we see what we can find, and then think about how it could be combined with other ingredients and chocolate. For example, we might source some wakame (seaweed), and try mixing it with macadamias and dark chocolate. Or we might get some wasabi and try making a wasabi ganache chocolate. Coming up with an idea and then turning it into something that we can present to our customers is one of the things I enjoy most about being a chocolatier.'

These special treats were once only available from the store but are now selectively distributed through places such as Harris Farm and online via their website.

Peter Edmunds has more than realised his dream of becoming a chocolatier, and establishing not only a handmade chocolate business, but one of exceptional quality that prides itself on its organic and fair-trade certification.

Lindsay & Edmunds Handmade Chocolates

Figure 18.17 Divine organic Belgian chocolate slabs featuring sweet tooth honey-almond praline; tropical treat dried pineapple and papaya with pepitas and cape gooseberries soaked in Cointreau in white chocolate; raisins soaked in brandy with roast almonds in milk chocolate; caramelised chilli in dark chocolate.

RESPOND

1. Why is Lindsay & Edmunds chocolate different to other, mass-produced chocolates?
2. What kinds of products does this boutique business supply?
3. Besides chocolate what can you expect to find when you visit the establishment?
4. How does Peter go about developing new products for his range?
5. Describe the type of distribution used by this company.
6. Visit the web page and describe five varieties of chocolates available for purchase.

Lindsay & Edmunds

Logistics and distribution systems

Place also includes logistics. Logistics historically was largely about the physical distribution of goods from manufacturer to consumer; however, it now entails several interrelated activities.

WAREHOUSING ACTIVITIES

Warehousing occurs in either a storage warehouse or a distribution centre and is a set of activities which involves receiving, storing, and dispatching goods. A warehouse acts a central organising point for the efficient delivery of products and undertakes a number of specific tasks. Recent technological advances in warehousing have led to significant cost reductions and most are totally automated and run by computers.

As Australia's largest supermarket chain, Woolworths has several large distribution centres. The $90 million semi-automated Woolworths Distribution Centre in Wodonga employs more than 400 people and turns over $2 billion of stock annually. The 60 000 sqm warehouse (equivalent to nine football fields) operates 24 hours a day and generates up to 450 truck deliveries daily. The centre supplies more than 58 outlets across northern Victoria and southern NSW.

Figure 18.18 Warehousing activities

PHYSICAL DISTRIBUTION

Physical distribution is the 'behind the scenes' activities concerned with efficiently transporting products from the business to the consumer. It includes activities such as materials handling and inventory control.

Products needs to be physically moved from the warehouse to the retail outlets. This is often automated but also refers to the use of forklifts, conveyor belts, storage pallets and crates used to load goods onto vehicles for transportation. This stage requires filling orders and a quality assurance guarantee to ensure stock is logistically moved to where it needs to be as quickly, efficiently and safely as possible. With modern technology this stock movement is closely traced and monitored which has helped to reduce costs and waste. An intricate network of transportation is needed to deliver a wide range of products to where they need to be, such as on supermarket shelves. Developments in packaging and transportation have made the movement of food products faster, more efficient and cost effective.

Transportation

The method of transportation a business uses will largely depend on the type of product and the degree of service the business wishes to provide. Transportation costs can be expensive and therefore marketers need to choose carefully. The four most common methods of transportation are rail, road, sea and air. More information on the transportation and distribution of food products can be found in Chapter 14 of this book.

FOCUS QUESTIONS 18.3

REVIEW

1. Discuss the following statement: 'Promoting a product is all about advertising'.
2. Explain the difference between products sold directly to a consumer and products sold indirectly.
3. What is an intermediary and what is its role in the food supply chain?
4. Under what circumstances would a marketer *not* wish for market saturation?
5. Explain the factors of physical distribution of foods.

FOR YOU TO APPLY

6. Investigate the technology involved in the distribution warehouses of Coles and Woolworths. Explain how they work and why they are successful.

EXTEND YOURSELF

7. Investigate further the food shopping habits of Australians. Where do we like to shop and why? Do you think this will change in the future?

Promotion

Promotion describes the methods used by a business to inform, persuade and remind a target market about its products. For a new food product, promotion is the marketing strategy that includes advertising, sponsorship, selling, public relations, tradeshows, direct mail and other communication techniques. These are all tools for promoting the new food product and its features and benefits, and persuading potential customers to buy it. Promotion is often the most obvious element of the marketing mix.

The main goals of a well-structured promotional program are to:

- attract new customers by heightening their awareness of a particular product
- increase brand loyalty by reinforcing the image of the product
- provide information so customers can make informed decisions
- encourage new and existing customers to purchase new products

- change individuals' behaviour through information or persuasion
- increase sales and profits.

Developing a promotional program

An effective promotional program will enable a food manufacturer to attract customers while introducing and building the brand. To realise these goals, promotional programs must be carefully planned, taking into consideration the audience, budget and, of course, the ultimate result – how to get the consumer to actually buy the product. By delivering the message in many different ways, a food company can increase their chances of reaching their target market. Consumers are bombarded by hundreds of messages, but only a select few penetrate their consciousnesses. Of those, an even smaller percentage eventually lead them to take action. All the elements of a promotional program need to be integrated to form a coherent approach and create maximum awareness.

ADVERTISING

Australian lamb

Advertising usually involves paying to get a message to potential customers. It is used to change attitudes, build awareness and transmit information to the target market. There are many advertising media such as newspapers, radio, magazines and journals, television, cinema, outdoor advertising, digital and internet opportunities. Advertising is a one-way communication, which does not require an immediate response from the audience. A classic advertising strategy used to promote a new food product includes demonstrating a need or a problem to potential customers and showing them how this product will help fulfil that need or solve their problem. Coca-cola are masters of this type of promotion. Their ongoing campaign 'Share a Coke' with personalised cans and more recently their 'selfie bottles' are testament to a great marketing team.

Selfie bottles

PUBLIC RELATIONS

Public relations (PR) is about the company's public image. Public relations is a way to build awareness about a new food product, grow the brand, communicate to a target audience and turn consumers into customers. Companies usually do not pay for PR features such as media interviews or news stories about the business or product. The aim is to create favourable publicity through the media and also involves minimising the impact of any negative circumstances.

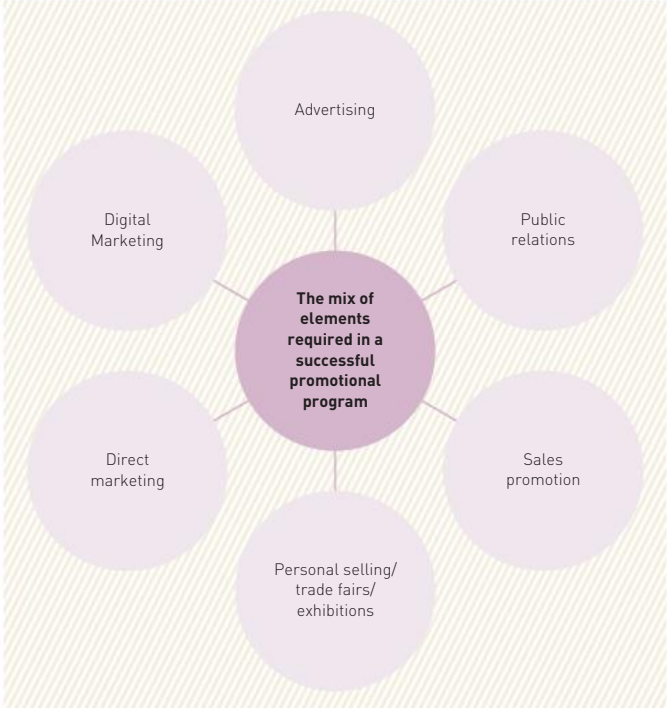


Figure 18.19 The mix of elements required in a successful promotional program

SPONSORSHIP

Sponsorship is another example of public relations. A company may sponsor an event, team or individual in order to build brand awareness and emphasise social or ethical credentials. Coca-Cola often uses this type of promotional strategy.

SALES PROMOTION

Sales promotion is an incentive tool used to entice consumers to purchase new food products. They include sales events, activities and contests to grab the attention of new customers and reward existing customers. Examples of sales promotion include introductory offers, vouchers, discount codes, loyalty card offers, 'flash sales', free samples or competitions. Promotions may be trade- or consumer-based, and are geared towards the demographic a new food product is targeted towards. This approach may also be used at point of sale with promotional material being displayed where the product is sold. It includes display racks, displays, stands, shelf talkers and posters.

Getty Images/Carla Gottgens/Bloomberg

Figure 18.20 Display racks on supermarket shelves are an example of sales promotion.

PERSONAL SELLING

This is the process of communicating with a potential customer face-to-face with the purpose of selling a new food product. It is a high cost form of promotion; however, it provides a two-way flow of information, allowing companies to discover the strengths and weaknesses of new products directly from the customers. This is a dynamic element allowing the seller the greatest freedom to adjust a message to satisfy individual customer characteristics and needs. Effective personal selling relies on well-developed interpersonal and communication skills, thorough product knowledge and the ability to sell product benefits to identified customers. New food products are often introduced through trade fairs and exhibitions that use personal selling strategies.

DIRECT MARKETING (POST AND E-MAIL)

This element specifically targets a person or company to generate new business, raise the profile of an organisation or product, or make a sale. It includes direct mail, telemarketing, and marketing via e-mail or text, which can all be individually personalised to specific customers. By directly targeting consumers, marketers are able to develop personal relationships and promote new food products directly to the customers who most need them. Direct marketing may be interactive, enabling the message to be tailored based on the recipient's response. Food companies are able to buy lists of names, e-mails and postal addresses corresponding with their target market for this purpose. Careful consideration of privacy laws and ethical issues must be taken into account when using direct marketing.

This kind of marketing is practiced by Coles with their Flybuys loyalty card, and Woolworths' Rewards card, which aim to build long-lasting relationships with customers through personalised targeted marketing practices. Every time your scan your loyalty card at the register, you provide data about your age, gender, address, household size and buying habits. This information is often used to personalise promotional material for specific products and may also be passed back to manufacturers to use as data for future product development projects.

DIGITAL MARKETING

The internet is the element most closely associated with digital marketing but others include the use of social media, wireless text messaging, mobile instant messaging, mobile apps, QR codes, podcasts, electronic billboards and digital television and radio channels. This form of marketing means consumers have access to information at any time and in any place they want it, giving them a more connected experience.

Digital marketing can also reach people in the off-line world using digital means. This type of marketing is multi-directional and instant. Pull digital marketing occurs when consumers actively seek information about a product through platforms such as search engines. They can sign up to have messages sent

via e-mail, text message or web feeds. Push digital marketing involves messages sent without the consent of the receivers, these include advertising banners or pop-ups notices that appear on websites and blogs.

As technology develops, more devices will become capable of being a part of digital marketing strategies and more consumers will have access to these devices.

The marketing of a new food product must be carefully planned and managed. New technology, changes in consumer tastes and trends, fluctuations in the level of economic activity and evolving consumer habits mean that the market is constantly changing and so must a marketing plan. Marketing strategies need to be evaluated and varied depending on the stage a product is at within its life cycle. By using a mix of promotional tools at different stages, a company can entice new customers and encourage these customers to remain loyal, therefore ensuring the success of a new product throughout its lifespan.

FOOD IN FOCUS 18.3

SOCIAL MEDIA

There's a reason food is such a popular subject for Instagram posts, and good food photos can make or break a new food product or menu item.

The fight to get noticed in the social media battlefield means the pressure is on brands to make their marketing campaigns more innovative, creative and engaging than ever before. Recent research indicates 57 per cent of Australians on social media access it every day and for most of those surveyed this occurs five or more times throughout the day. Fifty-two per cent of consumers indicated they are more likely to trust a brand if it interacted positively with its customers on social media. They enjoyed interacting with engaging, relevant and current content.

Today's consumers expect new food products to be featured on visual platforms such as Instagram and Facebook. They look for a business to offer recipe ideas, announce events and promotions, and showcase all there is to offer from their brand. Bad promotion through these social media platforms can have devastating consequences and long-lasting effects.

Companies, such as Kellogg's, are using digital marketing to overhaul old favourites. As part of breakfast cereal Nutri-Grain's strategic move away from 'iron man food' to a more belief-based message around individuals who live 'unstoppable lives', the brand launched a series of content-based YouTube campaigns with the aim of showing that there are no limits.

Businesses are using social media as a way to reach new customers. If it is done well they can in turn gain insights into who their customers are, where they come from and what they want.

RESPOND

1. Why do you think food is such a popular subject for Instagram posts?
2. Describe an instance when you may have taken a photo of food and posted it on social media.
3. What percentage of Australians access social media every day? Why is this figure relevant to a company launching a new food product?
4. Why do consumers trust brands that feature on social media?
5. What sort of expectations do consumers hold for the promotion of new food products on social media?
6. Describe another way social media is being used by food companies.
7. Discuss some of the positive and negative consequences of using social media as a promotional tool for a new food product.

FOCUS QUESTIONS 18.4

REVIEW: MULTIPLE CHOICE

1 To be successful, marketing plans should consider what consumers:
- **A** want.
- **B** say.
- **C** feel.
- **D** like.

2 Everything marketers do to place their product or service in the hands of potential customers is called:
- **A** selling.
- **B** marketing.
- **C** promotion.
- **D** placement.

3 The promotion tool that may include competitions, premiums, vouchers and other means of attracting consumer attention is best described as:
- **A** advertising.
- **B** public relations.
- **C** sales promotion.
- **D** personal selling.

4 Businesses such as Nudie Juice and Krispy Kreme Doughnuts promote their products by giving away free samples. Which of the following promotional mix strategies describes the promotional activities of these businesses?
- **A** Advertising
- **B** Public relations
- **C** Personal selling
- **D** Below-the-line promotions

5 Which of the following is not one of the primary advertising objectives?
- **A** To inform
- **B** To pursuade
- **C** To remind
- **D** To make a profit

FOR YOU TO APPLY

6 Discuss how branding and packaging add to a product being marketed. In your answer, consider the choices available in a drink-vending machine and the advantages Coca-Cola has over its competitors.

7 Discuss the increasing importance of social media in the promotion of food products.

EXTEND YOURSELF

8 Debate each of the following statements:
- 'Packaging is not just functional, but plays an important marketing role.'
- 'Pricing is an integral part of the marketing mix.'
- 'Place is simply where a consumer can purchase a product.'
- 'Promotion is all about advertising.'

9 Select a food product (you may use the product you developed in Chapter 17) and plan suitable strategies for marketing it to your customers.

Chapter review

REVIEW

1 What are the main goals of a well-structured promotional campaign?
2 A promotional plan should be an integrated approach. Discuss this statement using specific examples.
3 Discuss when and why a food business is most likely to adjust the marketing mix of a product?
4 Explain the strategies a food manufacturer may use to help increase sales of a premium branded product.
5 Evaluate the importance of a brand name when launching a new food product onto the market.

FOR YOU TO APPLY

6 Use 10 current food advertisements to complete the following table.
7 Design a series of advertising briefs for three different products, using three different target markets; for example, briefs to sell corn chips to families, older Australians and children.
8 Develop a flowchart showing how each element of the marketing mix is applied to a particular product.

EXTEND YOURSELF

9 You have decided to open and operate a food truck business in your local area. Describe the promotional strategies you could use to help promote sales in your new business.
10 Critically evaluate the importance of the 4Ps in the process of food product development.

NAME/PICTURE OF THE PRODUCT	TARGET MARKET	MAIN PRODUCT ATTRIBUTES	STYLE OF ADVERTISEMENT (E.G. INFORMATIVE, ENTERTAINING ETC.)

CORE STRAND REVIEW

MULTIPLE CHOICE

1 A food company has made a product that is a copy of an existing product. This type of product development is known as:

A feasibility.

B line extension.

C me too.

D new to the world.

2 A company discovers they have the only Australian grown organic tea currently available on the market. This is known as a:

A strength.

B weakness.

C opportunity.

D threat.

3 A prototype is a:

A copy of food that already exists.

B discarded idea.

C test sample of a new food product.

D successfully advertised food product.

4 Increased consumer demand for convenience foods has occurred because:

A convenience foods are cheaper than meals cooked from scratch.

B families are being influenced by cooking programs on TV.

C it is healthier to eat processed foods.

D more women are working and have less time to prepare and cook.

5 Manufacturers aim their products at particular groups of consumers. These groups are known as the:

A consumer testing panel.

B market segment.

C social media audience.

D target market.

6 A feasibility study for a new food product usually considers:

A ingredients and packaging.

B finances and trial products.

C technical and safety data.

D financial and technical information.

7 Which of the following is a major advantage of developing a new to the world food product?

A Expensive as companies may need to purchase new equipment.

B Gain large amounts of profit if successful.

C Meet consumer demands.

D Consumers are familiar with the product.

8 Marketing plans for new food products focus on the four Ps. The four Ps of marketing are:

A product, price, place and publicity.

B product, price, place and promotion.

C produce, price, place and promotion.

D produce, price, position and promotion.

9 The driving forces in food product development are:

A consumer demands, new manufacturing and packaging techniques, environmental considerations and me too products.

B consumer demands, technological developments, environmental considerations and marketing strategies.

C social pressures, consumer demands, technological developments and environmental considerations.

D social pressures, consumer demands, line extensions and environmental considerations.

10 Which one of the following is an example of food product development that uses genetic modification?

A Using membrane technology to produce whey protein powder from milk.

B Using high-pressure processing to kill unwanted genes in orange juice.

C Changing the DNA in tomatoes so that they ripen more slowly.

D Adding omega-3 fats to bread by microencapsulation.

>

SHORT ANSWER

11 Identify a range of techniques used to generate ideas for new food products. (2 marks)

12 Discuss why product specifications are an essential component of a design brief. (2 marks)

13 Assess the importance of consumer testing throughout the stages of food product development. (3 marks)

14 Outline the driving forces that have led to the increase of ready-made meals in supermarkets. (4 marks)

15 Use specific examples to discuss the importance of product place and distribution in a marketing plan. (4 marks)

EXTENDED RESPONSE

16 The original recipe for commercial salad dressing has been adapted to include varieties such as fat-reduced dressing, dressing with added herbs, Omega-3 dressing and dressing in individual serves or multi-portion packages.

- **a** Identify this type of food product development. (2 marks)
- **b** Identify the drivers that have influenced this product range. (5 marks)
- **c** Describe the benefits of this type of food product development to the consumer and the manufacturer. (8 marks)

17 For a specified food product, critically evaluate the steps in the food product development process. (15 marks)

CHAPTER 19

Diet and health in Australia

Good health has been defined by the World Health Organization (WHO) as 'a state of complete physical, mental and social wellbeing, and not merely the absence of disease and infirmity'. Our diet is one major factor that contributes to our health and wellbeing. Malnourishment can have an impact on the health status of an individual. In this chapter, you will examine the issues linked to dietary-related illnesses, the consequences of malnutrition, and appreciate ways to prevent some of these dietary related disorders.

CHAPTER OUTCOMES

In this chapter you will learn about:

- the consequences of malnutrition and diet-related disorders for the individual and society
- nutritional considerations
- the promotion of health in Australia
- the production of nutritionally modified foods
- the role of active non-nutrients in the diet
- the role of supplements in the diet.

KEY TERMS

active non-nutrients
amenorrhea
beriberi
body mass index (BMI)
dental caries
dietary supplements
functional foods
health
hypertension
kwashiorkor
malnutrition
marasmus
nutritionally modified foods
phyto-oestrogens
phytochemicals
postmenopausal
scurvy

iStock Photo/Yulia_Davidovich

Malnutrition

The majority of Australians have the option to eat a balanced and nutritious diet and enjoy good health. However, we are beginning to encounter people suffering from malnutrition. Malnutrition occurs when nutrients are not supplied to the body in the correct amounts; it can take the form of either over nutrition or under nutrition.

Over nutrition

Over nutrition occurs when the diet has an oversupply of one or more nutrients. It can lead to obesity and a host of associated negative physical effects.

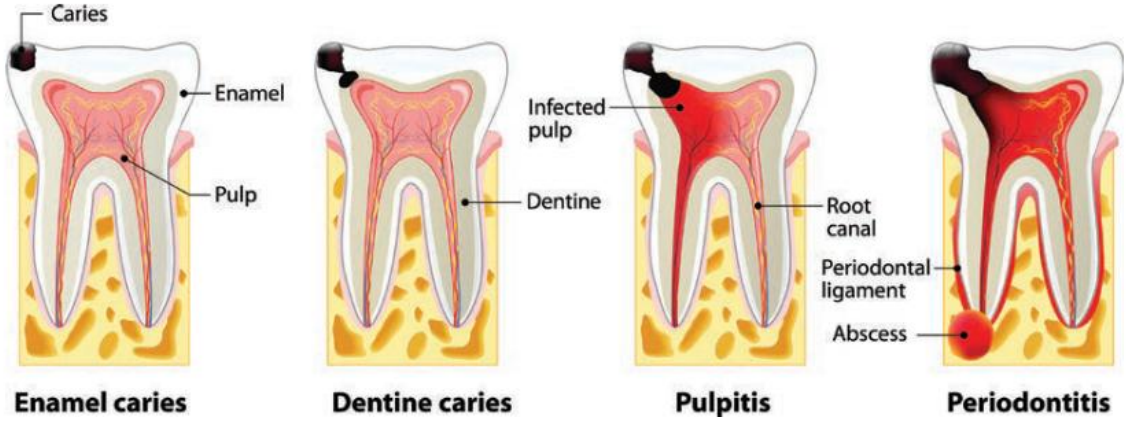
OVERWEIGHT AND OBESITY

Overweight and obesity is one of the most prominent dietary-related disorders facing Australians. The definition of being overweight is 10 to 19 per cent above the ideal weight; 'obese' is a body weighing 20 per cent or more above ideal weight. Being overweight or obese increases a person's risk of developing long-term health conditions including cardiovascular disease, hypertension (long-term high blood pressure), type 2 diabetes and some cancers. The Australian Diabetes, Obesity and Lifestyle study estimated that the total direct cost to Australian society of overweight and obesity was $21 billion per year with indirect costs estimated to be $35.6 billion per year. Obesity and its associated conditions are discussed in more detail in Chapter 20.

DENTAL CARIES

Dental caries is a scientific term used to describe tooth decay or cavities. Damage occurs when tooth enamel softens and breaks down, leaving the underlying dentine susceptible to decay. If a nerve is exposed, this can become a painful toothache. As well as the pain associated with this decay, bad breath from the action of bacteria is another physical effect of dental caries. Eventually there may be issues associated with lost or painful teeth, which could affect food choices and therefore nutrition.

In a recent study conducted by the University of Adelaide, with funding from the National Health and Medical Research Council, over 40 per cent of children aged 5–10 years had decay in their baby teeth and more than one-third of children aged 9–14 years had decay in their permanent teeth. Other studies conducted by the University of Adelaide indicated that approximately 19 per cent of adults aged 65 and over had no natural teeth. Of those aged 65 and over with some natural teeth, nearly half wore dentures. The costs associated with dental care including fillings, crowns, and dentures places a significant financial burden on society and financial strain on the individual. In 2012–13 total spending on



Shutterstock.com/Alila Medical Media, Designua

Figure 19.1 Teeth are a living part of the body, having their own supply of blood and containing nerves. Dentine covers this area of nerves and blood, and a hard coating of enamel protects the dentine. If left untreated, dental caries can penetrate the dentine and cause infection.

dental services (except those in hospitals) was $8706 million. The direct, out-of-pocket cost for individuals undergoing treatment was 58 per cent of this number.

A balanced diet can support the strength and maintenance of both teeth and bones to prevent damage to teeth. Dental caries develop when carbohydrate is available to the bacteria that naturally exist in the mouth. By cleaning our teeth and flossing, we wash away unwanted sugars that these bacteria feed on. Acid formed by bacterial action is what dissolves tooth enamel, and plaque develops as well. Frequent snacking, eating acidic foods, and consuming sugary foods will all contribute to dental caries. It is important to eat dairy produce or foods that supply both calcium and phosphorus to strengthen teeth. Rinsing the mouth and drinking plenty of water will also protect teeth from decay.

Under nutrition

Under nutrition results when insufficient nutrients are supplied to the body, which leads to weight loss or nutrient deficiencies such as anaemia (iron, vitamin B12 or folate) or scurvy (vitamin C). These can result in weakened immune function, poor wound healing and loss of muscle mass, strength and function. Certain vulnerable groups within our society may be subjected to under nutrition, such as Indigenous groups in remote areas who have limited access to fresh produce, or people suffering from diseases such as alcoholism, where diet and nutrient absorption is poor. Serious conditions resulting from prolonged under nutrition include kwashiorkor, marasmus, beriberi and scurvy. These conditions are very rare in Australia but can be common in developing countries at times of famine.

INADEQUATE FIBRE

Dietary fibre is required by the body to keep the digestive system healthy. It is found in plant foods such as cereals, vegetables, legumes, fruit, nuts and seeds. Eating at least three serves of vegetables, two serves of fruit and some cereal every day should provide adequate fibre in the diet.

Fibre, also known as roughage, is made up of the indigestible part of plant foods. Fibre passes relatively unchanged through our stomach and intestines, although bacteria in the large intestine can partly digest fibre by fermenting it. Fibre also helps by stabilising glucose and cholesterol levels. A diet high in fibre is vital to maintain the health of the digestive system. The digestive system is lined with muscles that massage food along the tract – since fibre is relatively indigestible, it adds bulk to aid digestion and help pass waste from the bowel. The physical effects of a lack of fibre in the diet include:

- *Constipation* – constipation can be a significant problem if fibre intake is low, but is virtually unknown in people who eat high-fibre diets. However, be aware that you must drink plenty of water in addition to eating a high-fibre diet to fix constipation.
- *Haemorrhoids* – haemorrhoids are common, but while they can happen to anyone, there is a direct association between them and a highly refined low-fibre diet. This diet causes constipation, which leads to straining when you go to the toilet. Eating a high-fibre diet will prevent constipation and relieve the symptoms of haemorrhoids
- *Irritable bowel syndrome* – increasing dietary fibre and using a bulking agent can help to treat irritable bowel syndrome.
- *Diverticular disease* – diverticular disease is where small pouches form in the intestine and can become inflamed. It is common in Western societies where many people have a low-fibre intake. It is much less common in vegetarians.

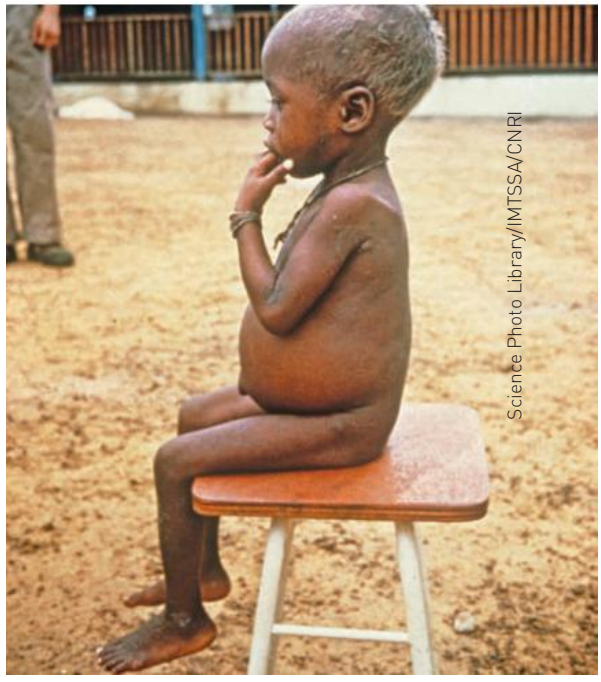


Figure 19.2 Kwashiorkor is caused by a lack of protein in the diet. The ankles, feet and stomach of sufferers swell with fluid. It is common in sub-Saharan Africa in times of famine.

- *Bowel cancer* – while the cause of bowel cancer is unknown, there is evidence that low-fibre diets can promote it, at least in susceptible individuals
- *Diabetes* – people with type 2 diabetes benefit from an increase in dietary fibre. A high-fibre diet is also likely to be low in fat and this is a further advantage.
- *Raised blood cholesterol* – some soluble fibre found in oats, psyllium and barley, as well as pectin, can reduce LDL cholesterol. Following a diet high in soluble fibre and low in saturated fat well help manage high levels of cholesterol.

As for other chronic diseases, the economic burden on society caused by symptoms relating to poor diet is cumbersome. Doctor's appointments, surgery, hospitalisation and time away from employment leading to lack of productivity all create a financial burden on our health system and on our economy.

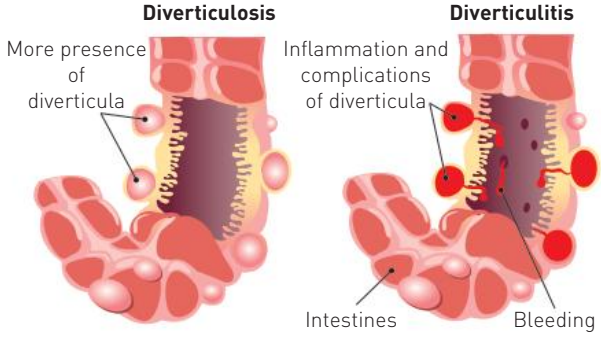


Figure 19.3 Diverticulosis and diverticulitis are linked to a low-fibre diet.

INADEQUATE IRON

Anaemia is a deficiency of red blood cells or haemoglobin. Red blood cells carry oxygen around the body, using a particular protein called haemoglobin. The formation of haemoglobin relies on the supply of iron in the diet. When a person is anaemic, their heart has to work harder to pump the quantity of blood needed to get adequate oxygen around their body. During heavy exercise, the cells may not be able to carry enough oxygen to meet the body's needs and the person can become exhausted. Eating iron-rich foods, such as red meat, usually provides enough iron, but some people may need to source a higher intake, particularly those who consume a specific diet and some women when menstruating.

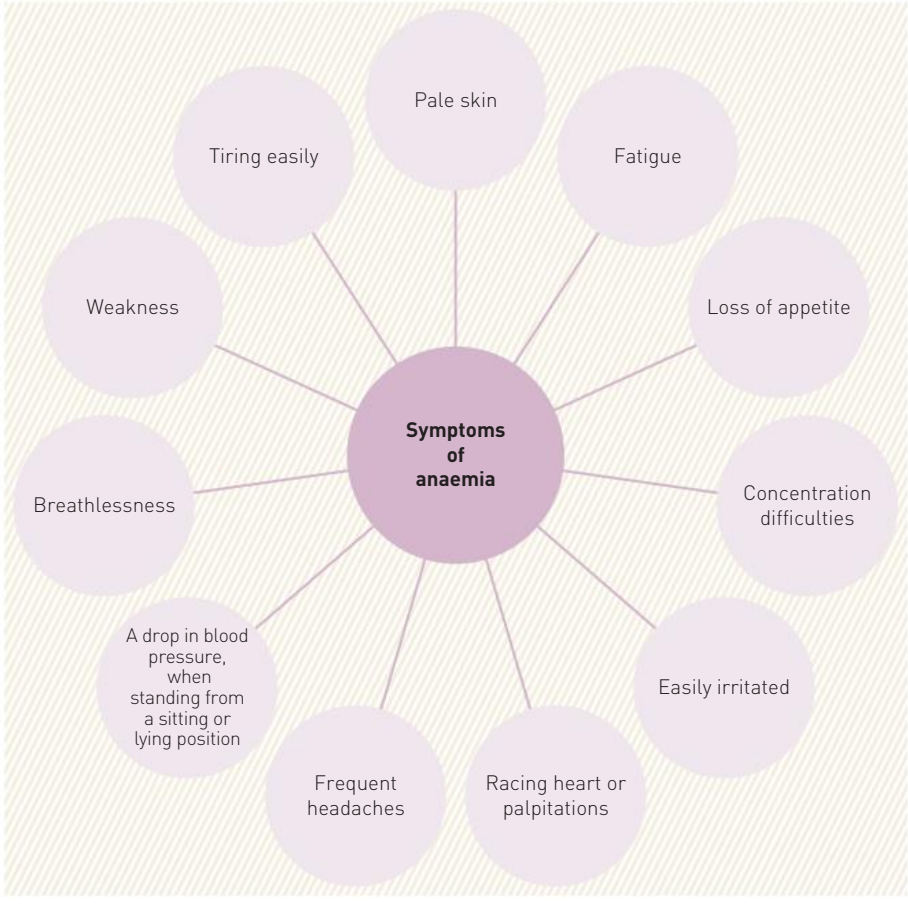


Figure 19.4 Symptoms of anaemia

INADEQUATE CALCIUM

The most common disorder associated with a lack of calcium in the diet is osteoporosis. This is where the bones have lost calcium and other minerals, which makes them more fragile and increases their chance of fracturing. In Australia, osteoporosis affects one in two women and one in three men over the age of 60. During childhood and the teen years, particularly just before puberty, the body is very efficient at storing calcium and building strong bones. By our early twenties, peak bone mass (maximum bone density) is achieved – this is when our bones are at their strongest. Building a higher peak bone mass early in life helps prevent osteoporosis later in life. It is essential to eat enough calcium-rich foods and do regular physical activity (high impact or weight bearing) during the first twenty years of life to help achieve a healthy maximum bone density.

After peak bone mass, a woman's bones gradually lose minerals and strength. For the 5 to 10 years following menopause, there is a sharp decline in the amount of the hormone oestrogen in a woman's body. During this time, women may lose 2–4 per cent of their bone per year. In men, bone loss generally occurs after the age of 50, but does not occur at the same rate as in women. By age 65, both men and women lose bone at the same rate.

Eating enough calcium-rich foods is therefore essential throughout life to maintain strong bones and to help slow down the bone loss that occurs naturally with age. The economic costs of osteoporosis are worth considering. As Australia's population ages, the incidence of osteoporosis will increase, especially if our society ignores the preventable measures that should be followed in relation to diet and exercise. In 2012, the total cost of poor bone health in Australia in people over 50 years of age was $2.75 billion. By 2022, the total costs are predicted to be $3.84 billion. So, over the next 10 years, poor bone health could cost Australians around $1 billion.

Diet-related disorders

Of the many diet-related disorders that exist in Australia, we will focus on type 2 diabetes and cardiovascular disease here. Chapter 20 gives more details about these disorders and others, but it is important to consider the physical effects of these two health problems and appreciate the economic costs they have on our society.

Figure 19.5 Osteoporosis risk factors

TYPE 2 DIABETES

Physical effects

When the cells in the body stop responding to insulin, the insulin does not work properly or the body gradually stops producing enough insulin in the pancreas, type 2 diabetes develops. This process can take many years – the insulin-producing cells in the pancreas slowly wear out and by the time someone finds out they have type 2 diabetes they could have lost 50–70 per cent of their insulin cells.

Often, type 2 diabetes shows no symptoms. The first sign of any physical effects may be a complication such as blurred vision or a foot ulcer. Other symptoms may be excessive thirst or hunger, leg cramps, cuts that heal slowly or feeling dizzy or lethargic.

Type 2 diabetes usually develops in older adults, or in specific groups such as Aboriginal and Torres Strait Islander people, but it is increasingly occurring in younger age groups.

Type 2 diabetes is a lifestyle disease – it is brought on by eating the wrong foods and a lack of exercise, but these factors can be modified. Unfortunately, it also has strong genetic risk factors that cannot be changed, so if you have a family member with type 2 diabetes you should be vigilant about having your blood sugar levels checked.

Managing type 2 diabetes involves combining regular physical activity with healthy eating and reducing excess weight. Over time, most sufferers will need medication or insulin injections as well as to maintain their lifestyle changes.

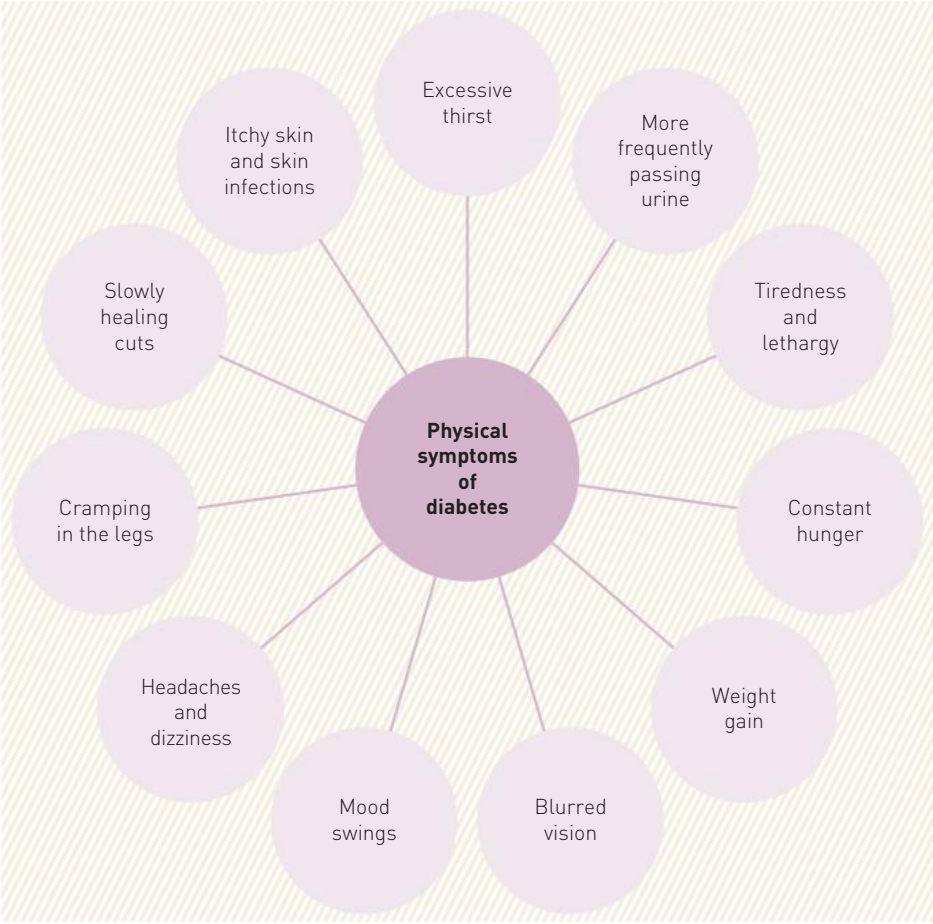


Figure 19.6 Physical symptoms of diabetes

Economic costs

The total annual cost for Australians with type 2 diabetes is up to $6 billion, including healthcare costs, the cost of carers and Commonwealth government subsidies. For an individual sufferer, the annual cost could be thousands of dollars each year. Other costs involve the impact illness has on productivity for the individual sufferer and the family and support network who help to care for those suffering with the sometimes severe complications associated with the disease. Diabetes is considered an epidemic of the 21st century and the biggest challenge confronting Australia's health system.

- 280 Australians develop diabetes every day. That's one person every five minutes.
- Around 1.7 million Australians have diabetes. This includes all types of diagnosed diabetes (1.2 million known) as well as silent, undiagnosed type 2 diabetes (up to 500 000 estimated).
- More than 100 000 Australians have developed diabetes in the past year.
- For every person diagnosed with diabetes there is usually a family member or carer who also 'lives with diabetes' every day in a support role. This means that an estimated 2.4 million Australians are affected by diabetes every day.
- Total annual cost impact of diabetes in Australia estimated at $14.6 billion.

CARDIOVASCULAR DISEASE

Economic costs

Cardiovascular disease (CVD) has the highest expenditure of any disease group in Australia with an estimated cost of $7 billion per year – 12 per cent of all health care expenditure in Australia. Among the elderly, CVD is both more common and more expensive to treat, which puts more economic pressure on expenditure, because of the ageing Australian population. Quite often the elderly person is no longer employed, and may not have the disposable income needed to cope with the financial burden of this disorder. Hospitalisation, medications and other costs associated with CVD can cost thousands of dollars per year.

Physical effects

CVD is a general term for all diseases of the heart and blood vessels. The physical effects can be varied,

Brain
Preoccupation with food/calories, fear of gaining weight, headaches, fainting, dizziness, mood swings, anxiety and depression

Hair/skin
Dry skin and lips, brittle nails, thin hair, bruising easily, yellow complexion, growth of thin white hair over body (lanugo) and intolerance to cold

Heart
Poor circulation, irregular or slow heartbeat, very low blood pressure, cardiac arrest, heart failure

Blood
Low iron levels (anaemia)

Intestines
Constipation, diarrhoea, bloating, abdominal pain

Hormones
Irregular or absent periods, loss of libido and infertility

Kidneys
Dehydration and kidney failure

Bones
Loss of bone calcium (osteopenia), osteoporosis

Muscles
Muscle loss, weakness, fatigue

Eating Disorders Victoria

Figure 19.7 Symptoms of anorexia

depending on the disorder. In general terms, the most common symptoms include angina, which is a chronic condition where short episodes of chest pain occur periodically, atherosclerosis, which is a build-up of plaque on the inner walls of arteries, high blood pressure, shortness of breath, lethargy, formation of blood clots, stroke and possible heart failure.

PSYCHOLOGICAL CAUSES OF UNDER NUTRITION

Anorexia nervosa

Some forms of under nutrition come from psychological causes, such as the eating disorders anorexia nervosa and bulimia nervosa. Anorexia nervosa is a mental illness and eating disorder involving self-induced weight loss by controlling the consumption of little to no food, coupled with rigorous exercise. This extreme reduction of nutrients supplied to the body has many physical effects.

- Abnormally slow heart rate and low blood pressure, which signify a change in the heart muscle; the risk of heart failure is increased
- Reduction of bone density (osteoporosis), which results in dry, brittle bones
- Muscle wastage and weakness
- Severe dehydration, which can result in kidney failure
- Fainting, fatigue and overall weakness
- Dry hair and skin; hair loss is common
- Growth of a downy layer of hair called lanugo all over the body, including the face, in an effort to keep the body warm
- Ongoing social isolation and impairment to performance causes disability, medical complications and increases risk of death
- For women, menstruation may cease (amenorrhea) and cause infertility

The economic costs of an eating disorder is not only felt by the individual, but by that person's entire family and circle of support. The impact may include caregiver stress, loss of family income, and disruption to family relationships and therefore family functioning. There is evidence that eating disorders, disordered eating and body image issues have increased worldwide over the last 30 years. Anorexia nervosa can affect anyone, regardless of age or sex, but it is more common among young women, especially those who are high achievers, set high standards and goals for themselves, yet secretly have a fear of failure.

Bulimia nervosa

Bulimia nervosa is a mental illness and eating disorder characterised by recurrent binge-eating episodes (the consumption of abnormally large amounts of food

in a relatively short time). Binge eating is associated with a feeling of losing control and is often followed by shame. This, in turn, leads to behaviours such as self-induced vomiting, fasting, overexercising or misusing laxatives. A person with bulimia nervosa usually maintains an average weight, which can make it less recognisable than anorexia nervosa. Many people, including some health professionals, assume that a person must be very underweight to have an eating disorder. Therefore, bulimia nervosa can remain undetected for a long period.

Bulimia often starts with weight-loss dieting. By depriving themselves of food, the person can trigger their body's starvation reaction – and experience an uncontrollable urge to eat. Once the person starts to eat, they can no longer hold back so they binge uncontrollably on junk food. Then, feeling guilty, they repeat the deprivation, leading to a binge/purge cycle that becomes more compulsive and uncontrollable over time. The physical effects of bulimia nervosa include:

- difficulties with activities that involve food
- loneliness caused by isolation and a reluctance to develop personal relationships
- deceptive behaviours around food
- fear of disapproval if the illness becomes known
- mood swings, changes in personality, emotional outbursts or depression
- self-harm, substance abuse or suicide attempts
- sensitivity to references about weight or appearance
- guilt, self disgust, self loathing and poor self-esteem
- anxiety
- frequent trips to the toilet, especially after eating
- food avoidance, dieting behaviour; this may be to avoid gaining weight or to avoid purging afterwards
- fluctuations in weight.

Health care costs to treat eating disorders are significant. According to government research, eating disorders are one of the highest causes of mental health hospitalisation within Australia. In the private hospital sector, the cost of treating anorexia nervosa comes second only to the cost of cardiac artery bypass surgery. In Australia, bulimia nervosa and anorexia nervosa are the eighth and tenth leading causes, respectively, of disease and injury in women and girls aged 15 to 24.

FOCUS QUESTIONS 19.1

REVIEW

1 Define 'malnutrition'.
2 Distinguish between over nutrition and under nutrition.
3 Match the terms on the left with the definitions on the right.

TERM	DEFINITION
CVD	Occurs when the body weighs more than 20% of ideal weight for height ratio
Anorexia	Tooth decay or cavities, potentially caused by simple sugars in the diet
Bulimia	Psychological disorder characterised by recurrent binge eating episodes
Diabetes	Formation of pouches in intestinal walls
Osteoporosis	Deficiency of haemoglobin or red blood cells
Anaemia	Fragile bones through calcium and other mineral losses
Diverticulitis	High blood glucose concentration linked with insufficient insulin
Obesity	Diseases of the heart and blood vessels
Dental caries	Psychological disorder involving self-induced weight loss

FOR YOU TO APPLY

4 Develop a comprehensive list of conditions faced by Australians that are linked to malnutrition. You may want to categorise your list into over nutrition issues and under nutrition issues. Include the groups of Australians most likely to develop these conditions.

EXTEND YOURSELF

5 Adolescent girls are considered a nutritionally vulnerable group within Australian society. Investigate this idea and devise a report on their vulnerabilities. Suggest ways to improve the health of adolescent Australian girls.
6 Identify other groups of Australians that are considered to be nutritionally vulnerable. Justify your choices.

Nutritional considerations for specific groups in Australia

Individual nutritional needs are affected by certain influences and situations such as age, gender, body composition and size, health status and lifestyle. With this in mind, some groups within the community are considered nutritionally vulnerable.

Adolescent girls

The nutritional vulnerability of adolescent girls lies in the need for extra nutrients caused by growth and menstruation.

ENERGY

Adolescent girls require a greater amount of energy than adult females as they are in a period of growth. The recommended kilojoule intake for female adolescents is 8100–13 500 depending on activity level.

IRON

Adolescents who have low intakes of iron are often tired, lack concentration and suffer more from infection. The estimated average requirement for adolescent girls aged 14–18 years is 8 mg/day but because of individual variation, some girls will require 15 mg/day or more of iron. Adolescent girls need extra iron because of losses in menstruation. As discussed in Chapter 7, an increase in vitamin C is also required to aid absorption of iron.

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

Adolescent girls require higher intakes of some minerals, particularly calcium and phosphorus. Calcium and phosphorus are required for bones to grow longer and thicker; inadequate intake at this time may affect future bone strength.

FOOD IN FOCUS 19.1

A DAY'S FOOD FOR AN ADOLESCENT GIRL

Table 19.1 A sample meal plan for 12- to 18-year-old girls

TIME	FOOD
Breakfast	1 bowl oat flake-based cereal with milk and bananaWater
Recess or morning tea	200 g tub yoghurt and 1 cup air-popped popcorn, water
Lunch	Ham, cheese and tomato sandwich and 1 cup fruit salad Water
After-school snack or afternoon tea	¼ cup hommus dip and 3 crispbreads and 40 g dried fruit and nuts
Dinner	Chicken and vegetable stir-fry with rice, water
Supper (if hungry)	1–2 slices fruit bread with ricotta and 1 glass milk

Source: The Royal Women's Hospital

RESPOND

1. Discuss if this meal plan looks similar to what you would eat in a day?
2. Write down what you would eat in a day and compare it with the meal plan above. Do you consider your daily diet to be nutritionally balanced? Justify your response.
3. What could you add to your regular food intake to ensure you are getting enough nutrients every day?

Pregnant and lactating women

The nutritional vulnerability of pregnant and lactating women lies in the need for extra nutrients to support a developing foetus or for the metabolic processes that occur to produce and sustain a milk supply. The energy and protein needs of lactating and pregnant women increase, much as they do in adolescence, but other nutrients are also required.

FOLATE

Women who plan on a pregnancy or are pregnant are recommended to increase the intake of folate in order to prevent neural tube defects in the infant. For this reason, all women planning a pregnancy should consume an additional 0.4 milligrams of folate per day above the normal RDI of 0.4 mg per day, normally in the form of a folic acid (the synthetic form of folate) supplement. By law, bread flour in Australia must be fortified with folic acid with the aim of ensuring adequate intake. Approximately half of all pregnancies each year are unplanned and therefore the incidence of neural defects can increase, so this is considered a preventative method.

MINERALS

During this phase of the life cycle, women require higher intakes of some minerals, particularly calcium and phosphorus. These two minerals are required for bones to grow and develop. Planning a diet for this group would focus on including dairy produce, as well as ensuring balance, variety and plenty of water.

POSTMENOPAUSAL WOMEN

Although postmenopausal women need less protein and energy, they are a nutritionally vulnerable group because of the effects of changes in the menstrual cycle and general ageing.

Calcium

Far less oestrogen is produced during the menopausal phase for women. The lack of oestrogen subsequently increases the risk of osteoporosis – a condition in which the bones are more prone to breaking due to thinning and becoming weaker. During menopause it is important to keep calcium levels up in order to help protect against the condition. Calcium can also help keep blood, muscles and nerves to work at optimum levels.

Vitamin D

Vitamin D and calcium are vital for bone health. Vitamin D is a suggested remedy for menopause as the body needs it to absorb calcium. Most adults need 600 IU (international units) per day, while those older than 71 need 800 IU per day. During the menopause onset it is beneficial to get vitamin D from the sun to promote calcium absorption.

Reducing intake of saturated fats

It is important for postmenopausal women to keep their intake of saturated fats low, to protect against heart disease, and it is suggested to choose low-fat options of dairy produce. However, it is important to still consume some fats, such as oily fish, which can contribute to a reduced risk of both heart disease and diabetes.

Active non-nutrients

Plants hold a particular chemical called phytoestrogen that has a similar structure to oestrogen. Experts believe the chemical tricks the body into thinking it is producing more oestrogen than it really is. This misunderstanding of the body is believed to ease the discomfort and other symptoms caused by low oestrogen levels. Planning a diet for this group would focus on a reduced fat, lower kilojoule diet, with an abundance of fresh fruit and vegetables, plenty of water for hydration, and minimal processed foods.

Table 19.2 Servings for a woman at each stage of life

STAGE OF LIFE – WOMEN	CEREALS (BREADS, RICE, PASTA, NOODLES)	VEGETABLES, LEGUMES	FRUIT	MILK, YOGHURT, CHEESE	LEAN MEAT, FISH, POULTRY, NUTS, LEGUMES	DISCRETIONARY FOODS (CAKES, PIES, LOLLIES)
19–50 years	6	5	2	2.5	2.5	0–2.5
51–70 years	4	5	2	4	2	0–2.5
70+ years	3	5	2	4	2	0–2
Pregnant	8.5	5	2	2.5	3.5	0–2.5
Breastfeeding	9	7.5	2	2.5	2.5	0–2.5

MIDDLE-AGED MEN WHO LIVE ALONE

As we get older, it is important to continue choosing healthy foods and enjoying eating as a social activity. However, our lifestyles and appetite can change and this can affect the types and amounts of foods we eat. A decreasing appetite or reduced ability to buy and prepare healthy foods can mean that many older people don't get enough essential vitamins, minerals and fibre, and this can contribute to general poor health or exacerbate some chronic illnesses. These issues are particularly pronounced for men who start living alone after age 30. It is important to use every meal and snack as an opportunity for maximum nutrition and find ways to improve our diet to fit with our personal tastes, ability and lifestyle, even if this means asking for help from friends, family or other community services. Planning a diet for this group would focus on convenience, ease of preparation and balance. Variety in food options should keep up interest and motivation at meal times.

THE ELDERLY

Shopping can become more difficult for the elderly, perhaps due to mobility issues or a lack of transport. The elderly need to maintain a good supply of calcium and phosphorus for bone and teeth health, while reducing the supply of energy dense foods due to a more sedentary lifestyle. So it is a good idea to have cupboards well-stocked with healthy foods that can keep for a long time. This makes it easier to prepare a nutritious meal. A diet for an older person should have little room for highly processed foods or alcohol; the Australian Guide to Healthy Eating offers a good dietary framework for the elderly to follow.

PEOPLE WITH HEALTH CONDITIONS

Various health conditions will dictate the specific dietary requirements for this group. Each diet needs to be suited to each person's condition, whether it be allergies and intolerances, genetics, heredity, or through dietary-related disorders. For example, if a person suffers from coeliac disease, their diet would have to include fibre from sources other than wheat. Similarly, someone who is lactose intolerant would need ensure they eat other foods high in calcium and phosphorus.

ATHLETES

Athletes are considered a vulnerable group because of their specific nutritional needs to prepare for and perform in their chosen sport. Drinking water is important, as is the correct balance of energy-dense foods, along with the protein to build and maintain muscle mass. Pre- and post-game meal planning is essential for the elite athlete and is sometimes done by a nutritionist or dietician.

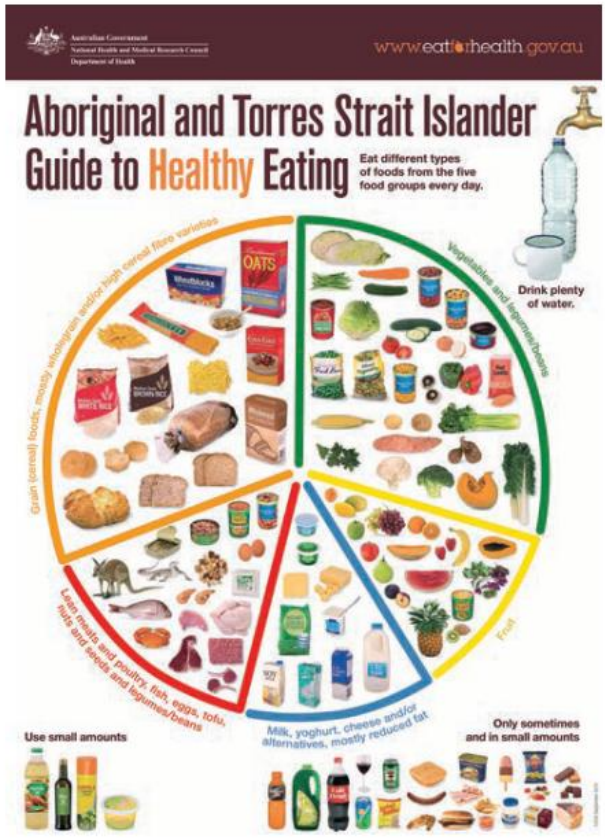
Planning a diet for this group focuses on refuelling the body, which is a key priority for recovering from physical activity. Muscle glycogen storage occurs at a slow rate and it takes about 24 hours for muscles to restore depleted fuel stocks back to their resting levels. Dehydration occurs gradually and must be taken into consideration. For every increment of fluid loss, there is a small rise in body temperature and heart rate, and an increase in the perception of how hard you are working. Water is the best option to rehydrate – sport drinks are not necessary for hydration. The pre-competition meal provides a final opportunity to top up the muscle and liver fuel stores. A high-carbohydrate, low-fat meal is the best choice. Larger meals should be consumed 2-4 hours before an event while lighter snacks can be consumed 1–2 hours beforehand.

ABORIGINAL AND TORRES STRAIT ISLANDER PEOPLE

Many Aboriginal and Torres Strait Islander people are vulnerable to dietary disorders because of their geographical location, higher mortality rates, and a predisposition to cardiovascular disease, diabetes, obesity and hypertension. Lack of education coupled with increased levels of poverty and unemployment in this sector of our community also contributes to their vulnerability.

Nutrition issues of particular concern for Indigenous people include overweight and obesity, under nutrition, poor growth in early childhood and foetal alcohol syndrome. The traditional diet

of Aboriginal and Torres Strait Islander people comprised mainly low-energy, high-nutrient density foods and this was combined with high-energy expenditure. With Western settlement, this changed to a diet high in fat and added sugars and low in fibre with reduced energy expenditure. As a result, Indigenous people suffer many diet-related diseases, including cardiovascular disease, type 2 diabetes and some cancers. Health professionals and government-funded strategies need to support accessible and affordable healthy foods, as well as furthering education on nutrition and food selection. The National Health and Medical Research Council has developed the Aboriginal and Torres Strait Islander Guide to Healthy Eating specifically to support this vulnerable group.



Aboriginal and Torres Strait Islander Guide to Health Eating, National Health and Medical Research Council © Commonwealth of Australia

Figure 19.8 Aboriginal and Torres Strait Islander Guide to Healthy Eating

FOCUS QUESTIONS 19.2

REVIEW

1 Complete the table below to summarise the nutritional needs of specific groups in Australia.

Nutritional needs

SPECIFIC GROUP	NUTRITIONAL NEEDS	EXPLANATION FOR THESE NEEDS
Adolescent girls	Energy Protein Iron _____	Rapid period of growth _____ _____
Pregnant and lactating women	Protein Folate _____	Folate to prevent neural tube defects in developing foetus. _____ _____ _____
Post-menopausal women	_____ Calcium Reduced fats _____	_____ Vitamin D for the promotion of calcium absorption to keep strength in the bones. Reduced fats _____

> 19.2

SPECIFIC GROUP	NUTRITIONAL NEEDS	EXPLANATION FOR THESE NEEDS
Middle-aged Men	Vitamins Fibre	Variety and balance is still necessary in the diet, despite the situations faced by this group.
People with health conditions	Depending on the specific health condition, nutritional needs will vary.	Coeliacs require fibre from food sources not containing gluten Lactose intolerant people require calcium and phosphorus from food sources not containing cow's milk
	Energy-dense foods Protein	Water is necessary to keep hydration levels up due to loss of fluid during competition
Aboriginal & Torres Strait Islander people	Same requirements of all essential nutrients, yet with a focus on foods with low GI, good quality fats, portion control, and fresh produce	Low GI foods to focus on overcoming the incidence of diabetes Better access to fresh produce for those living in remote areas
	Calcium and phosphorus	Ease and convenience of preparation of nutritionally balanced meals

FOR YOU TO APPLY

2 Research the Australian Guide to Healthy Eating. Make notes on the suggestions made to help the elderly plan and follow a healthy eating regime.

3 Devise a list of active non-nutrients considered to be beneficial for post-menopausal women. Give reasons for the inclusion of these active non-nutrients in their diet.

EXTEND YOURSELF

4 Investigate the NHMRC. What suggestions have been put in place for Aboriginal and Torres Strait Islander people? Devise a week's menu based on these suggestions. Justify your food choices.

The promotion of good health

Various community groups, the food industry, government organisations and private agencies can all contribute to supporting and educating society on food choices that promote sound health. Ultimately, though, it is the individual's choices that determine their nutritional status and, therefore, state of health.

Community groups

There are many community groups that exist to promote good health in our society. Some community groups focus solely on one health issue, such as Diabetes Australia, which aims to 'provide a collective voice

Diabetes Australia

for people living with diabetes, their families and carers'. Other community groups, such as Meals on Wheels, provide a service. Meals on Wheels provides nutritious meals while monitoring the physical and psychological wellbeing of people who are frail, recovering from illness or have a disability. Advocacy groups, such as CHOICE, provide information and advice for consumers, free from commercial bias.

Meals on Wheels

CHOICE

Government organisations

Diet-related diseases are largely preventable, but represent a high proportion of government health care expenditure, reducing the money available for other health care services, or for other areas such as education and welfare. Industry is less productive and less competitive when the workforce is not in good health, and this too becomes a financial burden on the government. The government's agenda on promotion of health is one of 'prevention rather than cure'. It is more cost effective to promote good health strategies rather than treat the long-term results of unhealthy practices. Data obtained by the ABS shows results indicating the health patterns of various groups within the community. The government can assess the health status of these groups and identify priorities for strategies to improve the status of vulnerable groups. Strategies can include drafting legislation, writing official policies, running health promotion campaigns and liaising with advisory groups and other government organisations to promote good health.

Department of Health

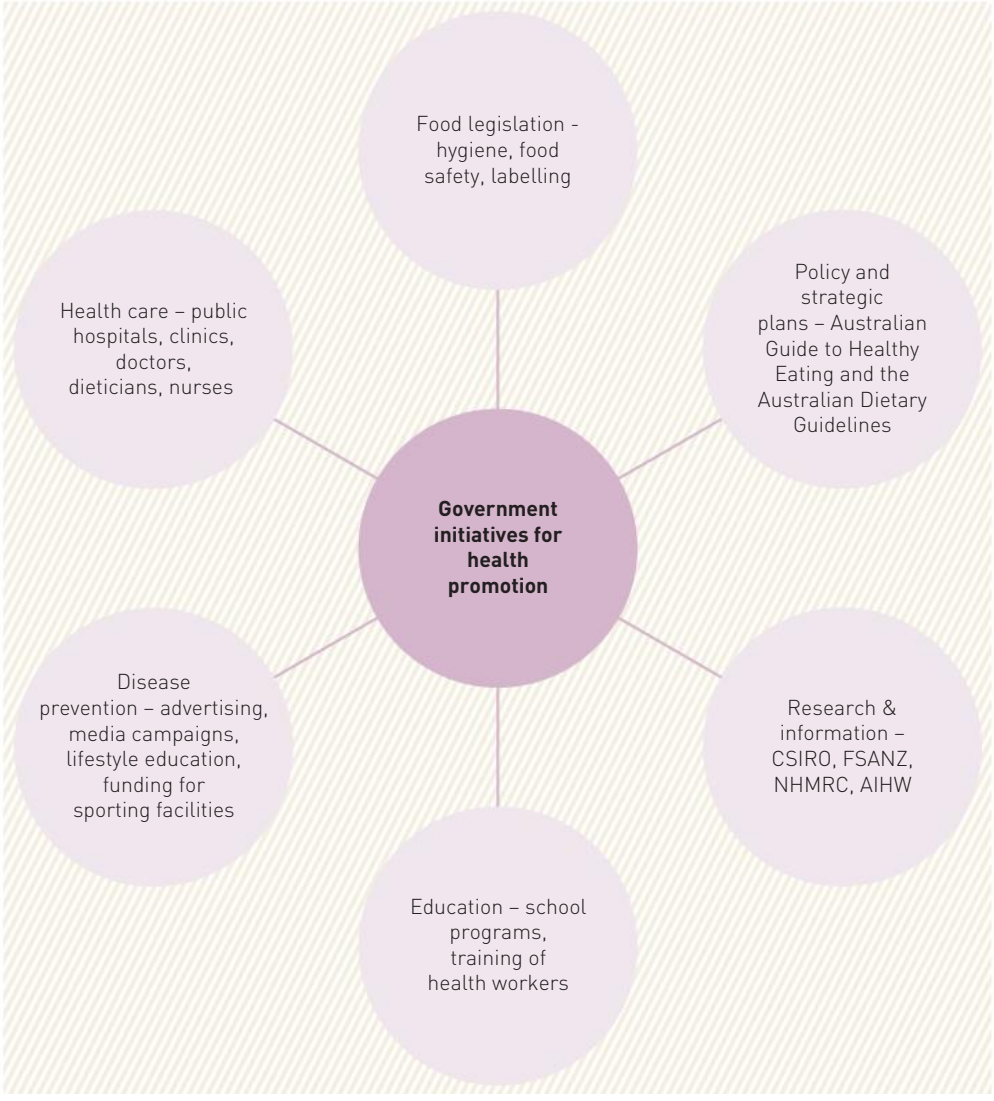


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Figure 19.9 Government initiatives promoting health in Australia.

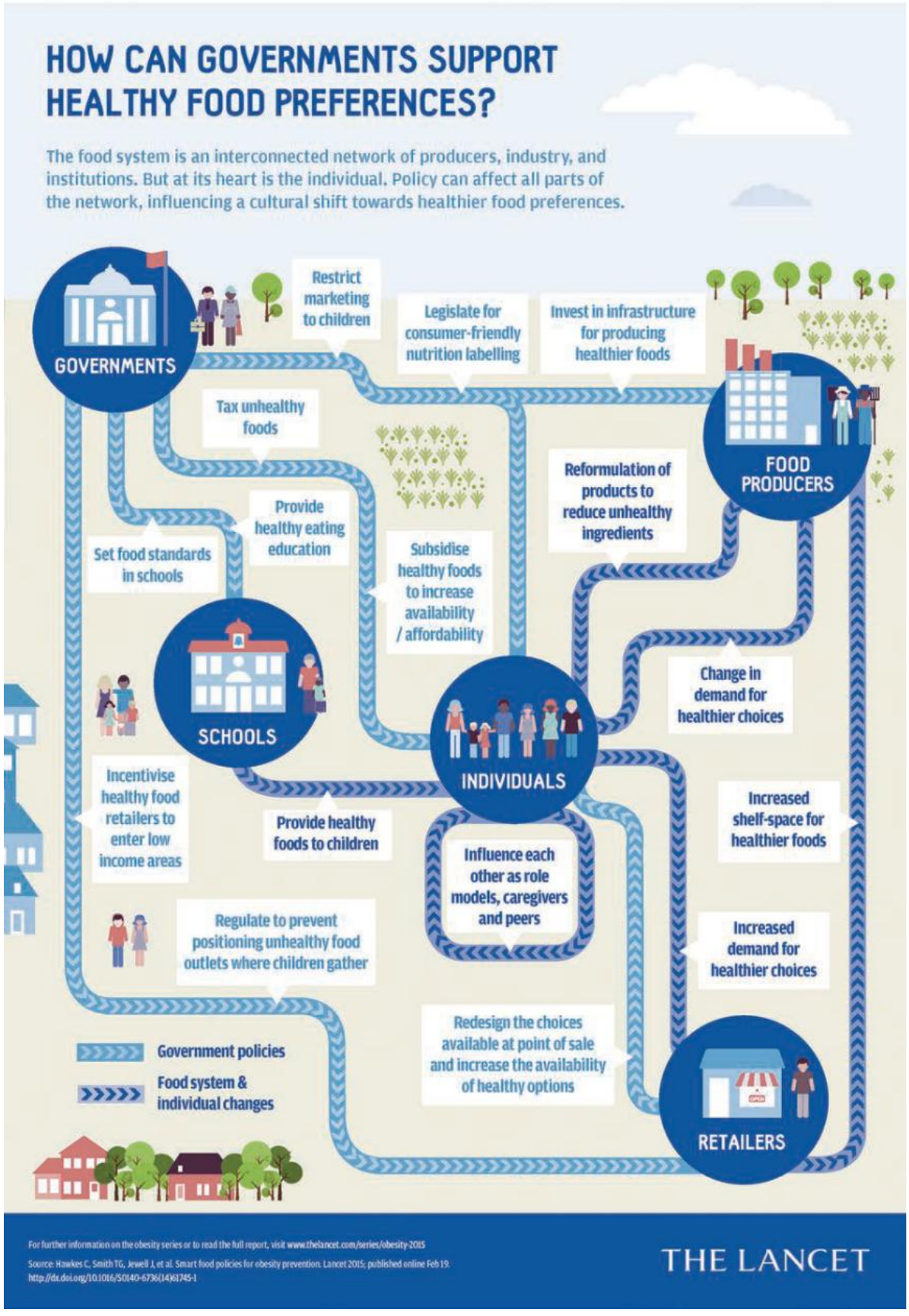

Figure 19.10 Public health strategies

Food industry

The range and availability of food in Australia is constantly evolving and food producers and manufacturers will make foods available that consumers want. The Australian food industry is currently responding to consumer demand for healthier food choices. The food industry is primarily interested in making a profit and it will promote good health if it makes sound commercial sense, but some companies, such as Sanitarium, have built their entire brands around promoting good health. Quinoa, an increasingly popular gluten-free and highly nutritious cereal from the Andes region of South America, has recently been grown successfully in Tasmania and Western Australia, retailers are stocking increasing varieties of healthy foods and the food service and catering sector are offering more healthy options on their menus. Sometimes government legislation is required to get the food industry to act in the best interests of the consumer, such as recent legislation to implement mandatory kilojoule labelling in fast-food outlets.

Private agencies

Private doctors, dental practices, weight-loss clinics, dieticians, gyms, sporting groups, alternative medicine groups and many other agencies fall under the umbrella of private agencies. Their main role is to offer support to society to help promote better health and generate a profit in doing so.

Individual

An individual lifestyle approach to health promotion is based on the premise that the major causes of illnesses and poor health are complications resulting from poor behaviour choices. The individual can access health services and health personnel to achieve higher levels of health. Evidence has shown the majority of premature deaths from lifestyle-related diseases can be attributed to lifestyle factors such as smoking, poor diet, physical inactivity and stress.

Nutritionally modified foods and functional foods

Food manufacturers have responded to consumer demand for healthier food choices. Functional foods are one of these choices – they contain extra health benefits along with essential macro- and micro-nutrients. These health benefits may be added during manufacture or exist naturally. For example, fruit and vegetables contain hundreds of antioxidants considered to help control blood cholesterol levels and neutralise the action of free radicals in the body, which may prevent the incidence of some cancers. Functional foods are categorised into three main groups:

1. Foods that contain natural preventative or curative substances: fruits, vegetables, fermented foods, high-fibre cereals and grains, oily fish, and dairy produce with the addition of certain bacteria.
2. Modified processed foods such as fat-reduced, or calcium enriched. Nutritionally modified foods are manufactured by altering the original food to incorporate more nutrients or remove some unwanted nutrients. Fortified foods have had nutrients added to the food to increase the levels that were originally there such as salt that has been fortified with iodine or bread being fortified with fibre. Nutritionally enriched foods are those that have had nutrients replaced that may have been lost during the manufacturing process. For example, refining wheat to make white flour removes several B-complex vitamins and iron that are contained in the part of the grain that is removed. Flour becomes enriched when those nutrients are added back in before it is packaged. This is a mandatory practice in Australia.
3. Foods containing active non-nutrients such as phytochemicals. These foods are considered to enhance the functioning of the body. Phytochemicals are either flavonoids or bioflavonoids, and are an example of one of at least eight thousand known antioxidants.

Food manufacturers have developed these functional foods to impart improved physical effects beyond those associated with the already existing nutrients in the original food.

PRACTICAL APPLICATION

19.1

ANALYSING FORTIFIED BREAD

AIM

To analyse a range of fortified breads available in the marketplace and discuss their relationship to health

METHOD

1 Visit a supermarket or look online to identify the range of pre-packaged breads available in the marketplace.
2 Read the labels or product information online and then identify which of the breads have been nutritionally fortified.
3 Write a list of the varieties of pre-packaged breads you have identified and what substances the makers have used to fortify them.

RESPOND

1 Research the benefits of each of the fortifications you have identified.
2 Discuss with your class the role of these products in promoting health for Australians.

Active non-nutrients

Active non-nutrients are not necessarily required or essential to life; however, they can improve overall health and contribute to the smooth functioning of the digestive system. The following table outlines some examples of active non-nutrients and their role in the diet.

Table 19.3 Active non-nutrients

ACTIVE NON-NUTRIENT	ROLE IN THE DIET
Antioxidants: • vitamin E • vitamin C • vitamin A **Phytochemicals (such as carotenoids)** Phyto-oestrogens	• Vitamin E helps control blood cholesterol levels as it acts to stop LDLs from breaking apart. • Vitamin C assists in this function. • Vitamin A and its precursors, carotenoids, can help combat some cancers. • One carotenoid is lycopene – it is found in tomatoes and is thought to protect against prostate and breast cancers. • These non-nutrients are chemicals found in plant foods that have beneficial roles in the body. • Bacteria can convert phyto-oestrogens into hormone-like compounds that imitate oestrogen. This can help treat menopausal symptoms and fight prostate and breast cancers. • Isoflavonoids (found in soy) and lignans (found in grains and seeds) are a great combination of phyto-oestrogens hence the manufacture of breads containing soy and linseed
Dietary fibre	• Only found in plant foods. Has known benefits for the gut. • Acts as a fuel for gut flora to protect against infection. Bacteria in the gut also produce vitamin K and some B-group vitamins as well as butyric acid (a short chain fatty acid used for energy by the gut cells). • Soluble fibre is digested by bacteria in the colon and aids satiety and may reduce cholesterol levels. • Insoluble fibre remains unchanged as it is not digested by the human digestive system, and has the main role of promoting movement throughout the gut, protecting cells from damage.
Omega-3 fatty acids	• Found in foods containing lipids. These fatty acids can be converted to a hormone-like substance that aids the cardiovascular system. • Prostaglandins can be anti-inflammatory and may reduce formation of blood clots or other blood vessel issues. • Omega-3 fatty acids can be found naturally in oily fish, in fortified foods such as margarine, or in enriched foods such as eggs where the chickens are fed a diet rich in omega-3.
Probiotics	• Known as the 'good bacteria' in our gut, these are the beneficial bacteria that help with the synthesis of some vitamins and nourish the gut cells. • Gut flora contains billions of bacteria and our diet can include added probiotics to promote health. Probiotics may help during illness, infection, after surgery, if diet is poor or if antibiotics have been taken. • Some probiotic foods or supplements contain lactobacillus acidophilus (yoghurt) or lactobacillus shirota (Yakult). These strains of bacteria can survive digestion to arrive at the colon, where they may multiply to improve gut flora.

Dietary supplements

Dietary supplements are widely promoted for their health benefits, but you need only limited amounts of the vitamins, minerals and other substances that supplements provide, and excessive amounts of some vitamins can be harmful. It is advised to always consult a doctor before taking a new dietary supplement, especially if you have any health conditions or take medications. Dietary supplementation is a multi-million dollar industry. Some people want to ensure they support their diet by consuming manufactured supplements, which are cleverly marketed by methods such as celebrity endorsements and sponsorship of major sporting events. Supplements are meant to improve your diet by providing vitamins, minerals, herbs, amino acids, fibre, enzymes and other beneficial substances. They come in a variety of forms, including capsules, soft gels, gel caps and tablets.

Getty Images/Recep Sakar/Anadolu Agency

Figure 19.11 Dietary supplements, such as Blackmores, often sponsor major sporting events.

Some questions to ask are, 'Are these supplements necessary in our diet?' 'Does a well-balanced diet supply enough nutrients to support a healthy existence?' With health food stores, pharmacies, online ordering and supermarkets selling such a vast range of supplements to suit every niche market, it can be confusing for the consumer. Here is a look at some advantages and disadvantages of dietary supplementation.

Advantages

Supplements can contribute to improved muscular strength, endurance and overall physical performance. For this reason, athletes commonly take them to improve their performance. Food supplements can also prevent a variety of diseases and health conditions. For example, pregnant women are advised to take folic acid to prevent birth defects. Other supplements are used in combination with drugs as a method of complementary or alternative treatment for health conditions. For Aboriginal and Torres Strait Islander people, supplements could prevent certain nutrient deficiencies leading to diseases such as pellagra, scurvy, and beriberi. Doctors can prescribe a supplement in a therapeutic dose to help overcome these issues. Dietary supplementation can give support to vulnerable groups to maintain good health. For example, people taking medications that interfere with the use of specific nutrients may rely on supplementation to fortify their diet.

Disadvantages

Because dietary supplements are not as strictly regulated as drugs, their effectiveness may not be as dependable. Furthermore, when taken in dosages that exceed the recommended dietary intake, some supplements may be toxic and cause serious side effects. Foods rarely cause nutrient imbalances or toxicities, yet supplementation can. Vitamin A toxicity, for example, can cause liver damage, blurred vision, headaches, bone pain and swelling, drowsiness and nausea. Another problem arises when people are either misinformed or uneducated, believing high doses of supplements can be therapeutic. Taking supplements instead of medication does not protect against the progression of certain diseases, and may even be harmful. This may also lead to a false sense of security, where a person relies solely on dietary supplements rather than consuming a nutritious and well-balanced diet.

Supplementation is available for most nutrients required by the body. See Table 19.4 for some examples of various dietary supplements. The perceived roles these supplements perform are also listed, yet some lack enough evidence to prove they do what is claimed by manufacturers.

Table 19.4 Supplements

SUPPLEMENT	ROLE
Protein/amino acid	To build muscle tissue, or repair and maintain muscle tissue Release of energy during athletic performance
Vitamins and minerals	Energy synthesis Replacement in vulnerable circumstances Combat deficiency diseases Bone, nail, hair and teeth strengthening
Pre/Probiotics	To promote gut flora health – promoting a healthy digestive tract and a healthy immune system are their most widely studied benefits. These are also commonly known as healthy bacteria.
Fibre	Alleviate symptoms from constipation Preventative strategy to protect digestive system
Fats/Oils	Omega-3 fatty acids from fish oil can lower blood pressure and triglyceride levels. Some evidence diets high in omega-3 fatty acids help with osteo- and rheumatoid arthritis. Omega-3 fatty acids have been linked to combating symptoms of asthma, cancer, depression, psoriasis, and inflammatory bowel diseases such as Crohn's disease and ulcerative colitis. While some of these studies have been promising, they are still inconclusive.

Chapter review

REVIEW

1 Explain the role of active non-nutrients in the diet.
2 Explain the relationship between nutritionally modified foods and health.
3 What is estimated to be the annual cost of obesity to Australian society?
4 Provide three strategies to prevent dental caries from forming.
5 What are the physical symptoms of inadequate amounts of iron in the blood?
6 Is the following statement true or false? 'Active non-nutrients are essential to life.'

FOR YOU TO APPLY

7 Ask family members or friends whether they take any form of supplements in their diet. Seek their opinion on why, how much and the cost. From your findings, share the information with the class and together come up with a discussion on the role of supplements and their effectiveness in the diet.

EXTEND YOURSELF

8 Choose a nutritionally vulnerable group within our society, and do some further research. Develop a strategy to promote optimum health through good nutrition for this group.

CHAPTER 20

Influences on nutritional status

Our genes can make us pre-disposed to conditions such as cardiovascular disease, diabetes and food sensitivities, intolerances or allergies, but it is also evident that our food and lifestyle choices play a major role in influencing our nutritional status. It can be difficult to make informed decisions because food products are not always advertised in a responsible manner, which raises many ethical issues in today's society.

CHAPTER OUTCOMES

In this chapter you will learn about:

- How our diet can affect health, particularly in relation to obesity, diabetes, cardiovascular disease and food sensitivity, intolerance or allergies
- The impact of our lifestyle, including cultural and social practices, on our nutritional status
- Ethical issues in relation to the media and the advertising and promotion of health and fast foods

KEY TERMS

adverse reactions
allergen
amines
antibodies
atherogenic diet
atherosclerosis
autoimmune disorder
cardiovascular disease (CVD)
coeliac disease
coronary heart disease
elimination diet
food allergy
food intolerance (non-allergic food hypersensitivity)
Food Standards Code
food taboo
functional foods
gluten
lactose intolerance
obesity
overeating
overweight
salicylates
sedentary
weight management

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Health and the role of diet

Research provides much evidence showing that diet affects the development of conditions such as obesity, type 2 diabetes and cardiovascular disease (CVD). There are other contributing factors, some of which may be out of our control (such as genetics), but a good diet is one way we have to stay as healthy as possible. Results from the 2014–15 ABS Australian Health Survey show that:

- almost two-thirds (63.4 per cent) of the population aged 18 and over are overweight or obese and 27.4 per cent of children aged 5–17 are overweight or obese
- 45 392 (29 per cent) of deaths were attributed to CVD in Australia in 2015
- An estimated 1 million people in Australia (4.4 per cent of the population) are living with type 2 diabetes, up from 840 000 in 2011–12.

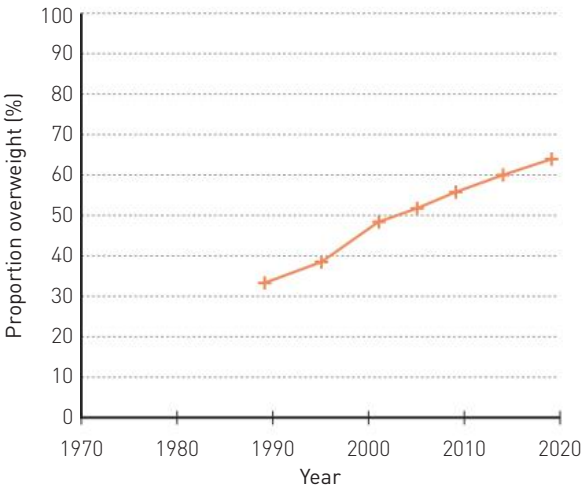
With these statistics in mind, it is evident that Australians need to be more conscious of their food choices to improve their overall health and prevent these disorders.

Obesity

Generally speaking, body weight is ideal if the amount of energy expenditure equals that of energy intake. A person may gain weight if their energy intake is greater than what they use, and, similarly, they may lose weight if they use more than they consume. Weight management is conducive to optimum health, and while it seems simple enough, nearly half our population struggles with weight issues. Therefore, many fad diets, pills, programs and so on are continually on offer to help us achieve this desirable and ideal weight. The graph on the next page shows the alarming rate of the prevalence of overweight and obesity over the past 20 years in Australia and how it is expected to continue to rise.

Table 20.1 The link between nutrient intake and dietary disorders

NUTRIENT	DIETARY DISORDER OVER NUTRITION	UNDER NUTRITION
Carbohydrate	Obesity Dental caries Diabetes CVD	Fatigue Muscle wastage Poor brain function
Protein	Obesity	Protein energy malnutrition
Fats	Obesity CVD Stroke Hypertension	Poor functioning due to lack of vitamins A, D, E and K
Vitamins	Toxicity from oversupply of fat-soluble vitamins	Scurvy from lack of vitamin C Beriberi or pellagra from lack of vitamin B Poor functioning from lack of vitamins in diet
Minerals	Possible link to toxicity and extra work for the kidneys to filter minerals Hypertension (Sodium)	Osteoporosis (Calcium) Anaemia (Iron) Dental caries (Phosphorus) Muscle cramping (Magnesium)
Fibre	Possibly linked to obesity	Constipation Bowel cancers Diverticulitis Poor gut health



C. Wang and coauthors, Health and Economic burden of the Projected Obesity Trends in the USA and the UK (2011), The Lancet, vol. 378, iss. 9793, p. 342. Copyright Elsevier Ltd

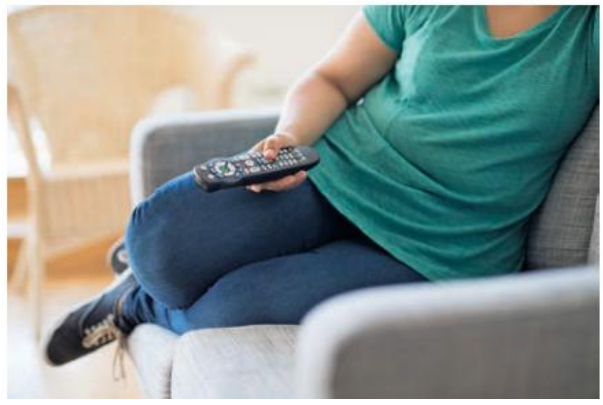
Figure 20.1 Obesity rates in Australia

A major concern is the amount of people suffering from long-term illness as a result of obesity. Obesity is linked to many other issues that negatively impact one's overall health. For example, diabetes, depression, cardiovascular disease and some cancers have been attributed to obesity.

The causes of obesity are varied: is it genetic, environmental, cultural, behavioural, physicality, or a combination of reasons? Why is it that some people accumulate excess body fat? While some will argue it is simply over-consumption in relation to the energy expended, studies have shown that some people gain more weight than others on comparable energy intake diets. Despite the confusion and lack of answers, one thing is very clear: we do live in an environment where overeating is the norm. We have an abundance of high-kilojoule, high-fat foods at our disposal, which are cheap, tasty and heavily advertised. Food is everywhere and is conveniently available morning, noon or night, and is often served in large portions. This is where eating too much is all too easy for the average Australian.

Mindful eating (attentive eating) is one method that aims to reduce this over-consumption. Mindful eating can be described as learning to pay attention to the present moment and to let thoughts and feelings come and go without providing judgement. Some studies have shown that attentive eating helps to change food consumption patterns. Eating when distracted was seen to increase food intake, whereas watching and thinking about consumption reduced poor habits.

Physical inactivity can also contribute to obesity. Sedentary habits contribute to weight gain as they reduce a person's energy expenditure. For example, watching television does not require much energy, and watching food advertisements will more than likely whet the appetite and some mindless eating may occur!



Getty Images/Tetra Images

Figure 20.2 Lack of physical activity coupled with over eating fosters obesity.

Diabetes

Over the past decade, the incidence of diabetes in Australia has risen dramatically for both adults and children. Diabetes mellitus describes a group of metabolic disorders characterised by high blood glucose concentrations and disordered insulin metabolism. Sufferers of diabetes may have ineffective insulin, or a lack of insulin, or a combination of both. The elevation of blood glucose (hyperglycaemia) can cause damage to nerves, blood vessels, and tissues. Type 1 diabetes is less common in Australia and is classified as an autoimmune disorder. It is a condition where the pancreas does not produce enough insulin for the body to metabolise its sugars effectively. An injection of insulin is necessary for sufferers of type 1 diabetes. Without insulin, the body's metabolism changes and these changes can be fatal. Type 2 diabetes is more prevalent, and as discussed in Chapter 19, is caused by the body becoming resistant to insulin; therefore, the pancreas releases more to cope with the demand. Over time, the pancreas wears out and cannot synthesise the required levels. This is where diet is important, as there is a correlation between obesity and the development of type 2 diabetes. Sugar and foods containing sugar need to be monitored to prevent high blood sugar levels, obesity and/or high blood pressure.

Although the actual cause of type 2 diabetes is unknown, the risk is substantially increased by obesity, ageing and a sedentary life style. To maintain near normal blood glucose levels, people with diabetes should follow these recommendations:

Table 20.2 Recommendations for people with diabetes

NUTRIENT	RECOMMENDATION
Total carbohydrate intake	Consistent and well-spaced throughout the day to avoid 'spiking' sugar levels. Hypoglycaemia (low blood glucose) is to be avoided as well.
Carbohydrate sources	Consider the GI of the carbohydrates being consumed. Low-GI foods are best as they release the energy slowly.
Dietary fat	CVD is a risk for those who suffer diabetes. Saturated fat intake should be monitored.
Protein	Intake should be monitored and not over consumed due to the pressure placed on the kidneys. Opt for lower fat foods that contain protein.
Alcohol consumption	Adult sufferers should monitor their intake. Alcohol is high in refined sugars, and kidneys are over worked if alcohol is over consumed.

Cardiovascular disease

Diseases of the heart and blood vessels (known as CVD) are the major causes of death around the world. Coronary heart disease is the most common form of cardiovascular disease and is usually caused by atherosclerosis. This hardening of the arteries usually begins with the accumulation of soft fatty streaks along the inner arterial walls. Eventually plaque build-up occurs and narrows the artery. A diet high in saturated fats is a major contributor to developing plaque and the progression of atherosclerosis. Narrowing of the arteries may lead to high blood pressure, among other health concerns. When arteries are narrowed, blood flow is restricted and the heart must then generate more pressure to deliver blood to the tissues. Arterial damage is caused by this pressure and blood clots may develop. Issues such as heart attack and stroke arise when atherosclerosis becomes severe. A diet high in Omega-3 fatty acids will help regulate blood pressure, alleviate the development of blood clots and is favourable for heart health.

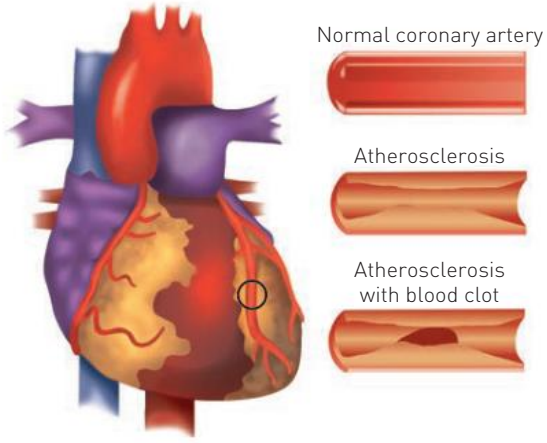


Figure 20.3 The formation of plaque in atherosclerosis.

RISK FACTORS

Risk factors linked to CVD can be reduced by eating a healthy balanced diet and exercise.

High LDL cholesterol

Cholesterol is carried by several lipoproteins. Low-density lipoproteins (LDL) are more likely to deposit cholesterol along the walls of the blood vessels. A diet high in alcohol consumption, a sedentary life style and/or obesity will contribute to the amount of LDL present. High-density lipoproteins (HDL) tend to transport cholesterol out of the body. Exercise and a balanced diet including vegetable oils, beans and legumes, whole grains, nuts and high-fibre fruit, such as apples, pears and prunes, can increase levels of HDL in the blood.

High blood pressure

Chronic hypertension is a condition in which your blood pressure is higher than the normal range for a long period of time. Chronic hypertension frequently accompanies atherosclerosis, diabetes and obesity. The higher the pressure, the greater the risk of heart disease, as the pressure injures the artery walls and accelerates plaque formation.

Diabetes

Blood vessels often become blocked and circulation is reduced for the sufferer of diabetes. This increases the development of atherosclerosis.

Atherogenic diet

An atherogenic diet that is high in saturated fats, trans-fat and cholesterol and low in fruits and vegetables increases the level of LDL in the blood and helps form atherosclerosis-causing atheromas. In turn, this increases deposits of cholesterol in the arterial walls. A diet that is varied, portion controlled and consists of nutrient-dense, rather than energy-dense, foods will contribute to optimal heart health.

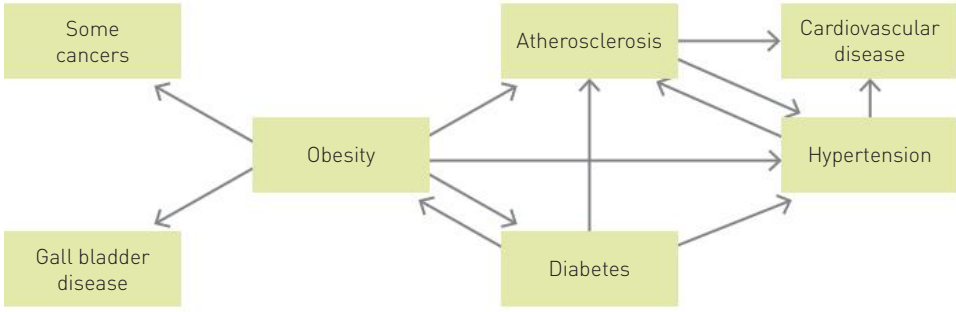


Figure 20.4 The relationship between obesity, diabetes and cardiovascular disease

Food sensitivities

Food sensitivities are classified as being either an allergy or intolerance.

ALLERGIES

Food allergies occur when the body reacts to an allergen protein found in food. The body's immune system targets these proteins in food, developing antibodies to fight what the body deems to be a foreign matter. The reaction between the allergen and antibodies is what causes the symptoms, which can be life threatening.

Someone who has an allergy needs a long-term management plan to prevent any life-threatening reactions. Part of the plan would be to read ingredient lists on manufactured foods to avoid allergens. The Food Standards Code requests food companies indicate all ingredients present on their product labels. Mandatory food labelling is required of the following common allergens: peanuts, tree nuts, milk, eggs, seafood, sesame seeds, wheat, and soy. More information on food labelling requirements can be found in Chapter 11.

Coeliac disease

Coeliac disease is an example of a condition linked to allergies. The protein gluten, found in wheat, barley, oats, and rye, reacts with the lining of the small intestine. Symptoms include stomach cramps,

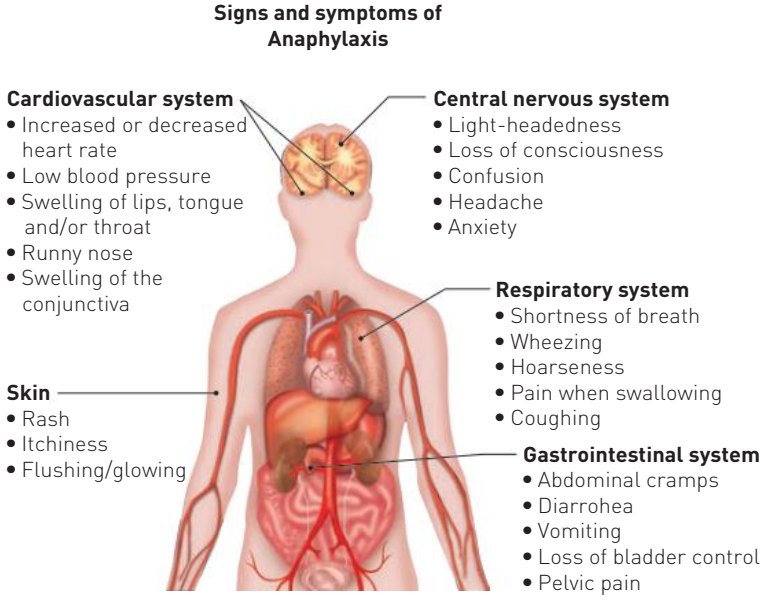


Figure 20.5 Symptoms of an allergic reaction

Getty Images/sisu

Figure 20.6 The welts on this person's arm indicate an allergic reaction to the chemicals tested.

malabsorption and, as a result, malnutrition. To find out if someone has coeliac disease, a doctor will conduct a blood test that can indicate an intolerance. A further biopsy on the small intestine can confirm the diagnosis. If someone is diagnosed with coeliac disease, it is necessary to follow a strict management plan, avoiding all foods with gluten. Many foods contain wheat, barley, oats and rye and some are not obvious – processed lunch meats, pies, sauces and gravies all may contain gluten. Coeliac Australia is a national not-for-profit association, comprising five state organisations, which provides information and support for people living with coeliac disease.

Coeliac Australia

PRACTICAL APPLICATIONS

20.1

AIM

To compare gluten-free products with their non-gluten-free counterparts.

METHOD

Gather a range of products available on the supermarket shelf that are labelled 'gluten-free'. Breads, cereals or pasta are good choices. Rate these products in relations to taste, mouth feel, eye appeal and cost. Compare them to non-gluten-free options.

RESPOND

1. Which products are more expensive? Why do you think this is so?
2. Identify the differences between the gluten-free option and the regular option.
3. Design a recipe for a person suffering from coeliac disease. Follow the weblink for some inspiration.

Coeliac NSW and ACT

FOOD INTOLERANCES

Food intolerances differ to allergies despite the symptoms being similar. An intolerance is the body's reaction to a chemical or a combination of chemicals within the food supply, whether that food is naturally occurring or manufactured. These symptoms may occur directly after consumption of food or may build up over time. Although these symptoms compare to allergy symptoms, the cause is different and intolerances are not generally considered to be life threatening. Some common causes of triggering an intolerance are: salicylates, a group of chemicals found in plant foods; amines, a group of chemicals found in protein-based foods such as cheese; and glutamates, a protein found in plant and animal foods. The majority of these chemicals are what gives food their flavour, and are therefore used as additives during manufacture to incorporate flavour in manufactured foods.

Identifying an intolerance can be quite difficult, as it involves chemicals that are present in a much wider range of foods. An example of a food intolerance is lactose intolerance, where an individual has difficulty digesting the sugar in dairy produce. This difficulty derives from the body not producing enough of the digestive enzyme lactase to break down this disaccharide. Unabsorbed lactose arrives at the colon, creating a watery stool. Gases that develop as a by-product from partial digestion here will cause stomach cramps, flatulence, and diarrhoea. Therefore, the person should choose dairy produce with low amounts of lactose, and monitor their consumption of dairy in general. They should not give up dairy altogether, however, as calcium is still important for bone health. They could also source calcium from leafy greens such as broccoli and spinach and soy products such as tofu.

Elimination diets

The best way to identify a food intolerance is through an elimination diet. This only allows consumption of bland or flavourless foods, as they are low in food chemicals. Foods identified as low intolerance foods are: some meats (skinless chicken), pears, lettuce, peeled potatoes, white rice, white sugar and sunflower oil. While on an elimination diet, the body is rid of all possible chemicals, which may take between two to six weeks to complete. Then the suspected chemicals are re-introduced to the diet, one at a time, with the aim of identifying the chemical responsible for the intolerance. Long-term management of intolerances

does not require complete avoidance, as with allergies, but a sufferer should reduce their consumption of the offending foods and be mindful of additives in manufactured foods. FSANZ offers information to assist sufferers in identifying additives in foods.

FSANZ

FOCUS QUESTIONS 20.1

REVIEW

1 What is obesity? Give reasons why people develop this diet-related disease.
2 Distinguish between type 1 and type 2 diabetes.
3 What conditions fall under the term CVD?
4 What is anaphylaxis? List some signs and symptoms of this condition.
5 Differentiate between a food sensitivity and a food allergy. Give examples.

FOR YOU TO APPLY

6 Justify why the Australian Dietary Guidelines are necessary.

EXTEND YOURSELF

7 Using specific examples, describe the relationship between nutrient intake and dietary disorders.

Lifestyle and nutritional status

Lifestyle refers to the way we choose to live our life. Choices can be either beneficial or detrimental to 'good' health. Our nutritional status refers to the condition of the body in respect to our diet; the levels of nutrients in the body and the ability of those levels to maintain normal metabolic integrity. For adults, general adequacy is assessed by measuring weight and height; the result is commonly expressed as the body mass index (BMI), the ratio of weight (kg) to height squared (m^2). Body fat may also be estimated by measuring skinfold thickness, and muscle diameter is also measured. For children, weight and height for age are compared with standard data for adequately nourished children. A health worker may also measure the circumference of the head and the development of bones. The levels of individual vitamins and minerals are normally determined by laboratory tests, measuring the blood or urine concentrations of the nutrients and their metabolites.

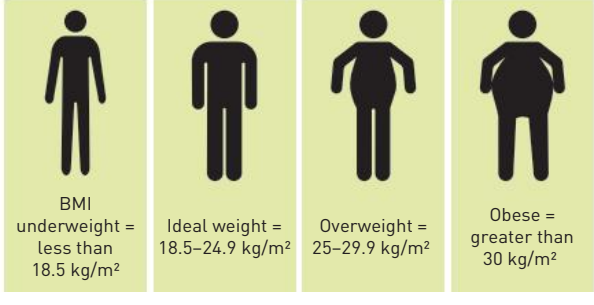


Figure 20.7 BMIs for under, ideal and overweight

Exercise

Exercise is seen as an important component to a healthy lifestyle, as it not only helps with controlling weight, but can help combat lifestyle diseases because being active boosts HDL ('good,' cholesterol) and decreases unhealthy triglycerides. This keeps blood flowing smoothly, decreasing the risk of CVD. In fact, regular physical activity can help prevent or manage a wide range of health problems and concerns,

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Figure 20.8 Exercise is conducive to heart and overall health.

including stroke, type 2 diabetes, depression, certain types of cancer, arthritis and falls. Exercise can improve your mood because physical activity stimulates various brain chemicals, such as serotonin, that may leave you feeling happier and more relaxed. You may also feel better about yourself with regular exercise, which can boost confidence and improve self-esteem.

Alcohol consumption

Many Australians try alcohol at some time in their lives. People drink alcohol for many reasons and in different social and cultural contexts. It is important to keep in mind that any level of drinking can increase the risk of ill-health and injury. Cirrhosis of the liver is one dietary-related disorder linked to consuming too much alcohol. This condition develops over a long period, but other negative consequences of drinking too much alcohol are more immediate – in Australia, an average of one teenager (14–17 years) dies each week from an alcohol-related incident.

Alcohol is a major factor in premature death, causing significant social harm and costing the health care system many millions of dollars. The National Health and Medical Research Council (NHMRC) has produced the Australian Dietary Guidelines, which state 'If you choose to drink alcohol, limit intake. For women who are pregnant, planning a pregnancy or breastfeeding, not drinking alcohol is the safest option'. In addition to the Australian Dietary Guidelines, the NHMRC has produced the 'Australian Guidelines to Reduce Health Risks from Drinking Alcohol', which state:

Guideline 1: Reducing the risk of alcohol-related harm over a lifetime

The lifetime risk of harm from drinking alcohol increases with the amount consumed.

For healthy men and women, drinking no more than two standard drinks on any day reduces the lifetime risk of harm from alcohol-related disease or injury.

Guideline 2: Reducing the risk of injury on a single occasion of drinking

On a single occasion of drinking, the risk of alcohol-related injury increases with the amount consumed.

For healthy men and women, drinking no more than four standard drinks on a single occasion reduces the risk of alcohol-related injury arising from that occasion.

Guideline 3: Children and young people under 18 years of age

For children and young people under 18 years of age, not drinking alcohol is the safest option.

A Parents and carers should be advised that children under 15 years of age are at the greatest risk of harm from drinking and that for this age group, not drinking alcohol is especially important.

B For young people aged 15–17 years, the safest option is to delay the initiation of drinking for as long as possible.

Guideline 4: Pregnancy and breastfeeding

Maternal alcohol consumption can harm the developing foetus or breastfeeding baby.

A For women who are pregnant or planning a pregnancy, not drinking is the safest option.

B For women who are breastfeeding, not drinking is the safest option.

National Health and Medical Research Council, Creative Commons (CC) BY Attribution 3.0 Australia licence

If a person chooses to drink alcohol it can directly affect their overall health. Alcohol contains empty kilojoules that may be converted to fat, and this can contribute to obesity. If someone drinks heavily, they may become malnourished, as they may neglect their diet. Inadequate food intake coupled with drinking too much alcohol leads to B-group vitamin depletion.

If someone develops alcoholism, this vitamin B loss may develop into Wernicke-Korsakoff syndrome. This syndrome is characterised by paralysis of the eye muscles, impaired memory and damaged nerves. For someone with alcoholism, overall nutrient deficiencies are almost inevitable. Even if the person eats a balanced diet, their body

does not metabolise the nutrients correctly. No diet can compensate for the damage caused by heavy alcohol use.

Tobacco and other drugs

As with alcohol, if a person chooses to use drugs this will affect their overall health. Smoking and illicit drug use is detrimental to your health; it can lead to the development of many preventable diseases and other health problems. Drug users may engage in other negative health behaviours. Generally speaking, people who use drugs are more likely to practice the following:

- Eating too few fruits and vegetables
- Eating high-fat foods
- Consuming alcohol and caffeine
- Not getting sufficient sleep
- Being physically inactive (not getting enough exercise)

Drug use not only increases the risk for serious health problems like cancer and cardiovascular disease, but it can also create unhealthy patterns in your daily routine. Smoking has a negative impact on the way our bodies use nutrients. Nicotine and the toxic substances in cigarettes drain the body of vitamins and minerals and block absorption. Consider these facts:

- Smoking just one cigarette robs the body of 25 mg of vitamin C (the amount of vitamin C in an orange).
- Smoking accelerates the production of free radicals; excess production can cause tissue and organ damage. The body fights back with antioxidants like vitamin C but, because vitamin C levels are lower in smokers, the body may be unable to fight these free radicals.
- Smoking affects the absorption of vitamin D, which aids in and improves the absorption of calcium. This contributes to smokers' higher risk of osteoporosis.

Cultural practices and nutritional status

Attitudes to food, our food habits, and what we choose to eat are reflective of influences from our family and environment. Our cultural background and religious beliefs play an important role in the choices we make in relation to food. Factors such as food preferences, preparation methods, sourcing produce, who you eat with and when all contribute to one's overall eating patterns. Australia is a culturally diverse country, so a wide variety of cultural influences affect our food habits. With diversity comes choice, and many Australians enjoy the choice of various cultural cuisines, and we as a society have embraced the many varied cuisines available to us.

As discussed in Chapter 2, traditions, commonly linked to religious beliefs, have introduced many food taboos in cultures and certain foods may be excluded from the diet altogether. Christians avoid red meat on a Friday (especially Good Friday) and may avoid certain foods during Lent. Muslims avoid eating any food and beverages during daylight hours throughout the period of Ramadan. This holy month is a period of fasting and ends with a feast to celebrate. Feasting is also common practice for most religions during times of celebration, such as Christmas. Hindus avoid beef and beef products, while Jewish and Muslim people abstain from pork and pork products in their diet. Other meats consumed must be slaughtered in a special way to meet their religious beliefs.

Fairfax Syndication/The Age/Justin McManus

Figure 20.9 Muslims may only eat meat that has been slaughtered to Halal certifications. Many products carry this symbol to identify a product meeting this religious requirement.

In addition, Jewish people avoid consuming shellfish as this religion believes in only eating fish that have both fins and scales. Seventh-day Adventists and many Buddhists follow a vegetarian diet. Muslims, Hindus, Seventh Day Adventists, and many Buddhists avoid consuming alcohol.

Any person following a limited diet needs to ensure they have a clear knowledge of their body's protein requirements and how to combine foods to complement and develop a complete protein diet.

Social practices and nutritional status

Socialising generally includes food, as sharing a meal is deemed to symbolise harmony and hospitality. Certain foods are linked to celebrations, and we will consume them as it is an expected behaviour such as when sharing a cake at a birthday party. Most Australians enjoy socialising, and our culture involves sharing food and, in many cases, enjoying alcohol. When dining out, enjoying work functions, celebrating special occasions and the like, the choice of menu and/or venue will affect the nutritional value of the meal. Recent trends in dining are focussing on the paddock-to-plate concept, where produce is fresh, locally sourced and often nutritionally sound. Certain cuisines such as the Mediterranean diet have been adopted and are often nutritionally beneficial. Furthermore, many casual dining outfits offer organic produce with a focus on high-quality food.

Shutterstock.com/Pressmaster

Figure 20.10 Celebratory foods such as birthday cakes are often not the most nutritious.

FOCUS QUESTIONS 20.2

REVIEW

1 What are food habits? How are they developed?
2 What factors contribute to eating patterns?
3 Make a list of common celebrations in our lifestyle. What foods can you associate with these celebrations?

FOR YOU TO APPLY

4 Conduct some research on three different cultures. Find the following information on your chosen cultures:
   a food taboos
   b religious beliefs in relation to food consumption
   c prohibited foods

EXTEND YOURSELF

5 **a** Select one culture from question 4, above. Complete a PMI (Plus, Minus, Interesting) chart on the effect the practices of that culture may have on a person's nutritional status.

WS
PMI chart

   b Investigate how people from your selected culture have attempted to address a negative consequence of following their cultural practices.

Media and ethical issues in advertising and promoting food

The Australian food industry uses the media to increase awareness of its products. Through the media, we, as consumers, are given information on products available to us, whether it be the promotion of health foods, fast foods, brands or companies who manufacture our foods. Obviously the main role of advertising is to sell a product. This is where the issue of ethics comes in. Ethics are the moral principles that govern a person's behaviour or how they conduct an activity. Advertising companies are successful if their campaigns are successful. They will get repeat business from the food industry if the campaign leads to increased sales.

The Advertising Standards Bureau is an Australian organisation responsible for overseeing the ethics related to advertising. For example, Australia has a stringent, self-regulatory system for food and beverage advertising to children. The codes and initiatives have been negotiated with government, industry and advertisers to ensure advertisements are appropriate for children. The rationale behind this initiative is to ensure children are not coerced or misled by advertising, as they are considered to be more susceptible to advertising messages. Advertisement can appear on various mediums such as television, radio, social media, sponsorship, billboards, and product placement of products in retail outlets and television shows and films. Strategies used by advertising companies can deliberately appeal to children's senses, through bright colours, fun characters and celebrity endorsements.

Advertising Standards Bureau

Australian Food & Grocery Council

AANA code for advertising & marketing communications to children

Because of the guidelines set, fast-food companies have developed a strategy of marketing through cross-promotions and product placement. Fast-foods are commonplace in the Australian household, and the companies who make them spend a large portion of their budget on promoting their products through

Dlibrary.com.au

Figure 20.11 Food manufacturers often use bright colours to appeal to children.

mass media. The skill of cross-promotion involves identifying another non-food product and linking their product through association. For example, a sporting team may be associated with a food product, such as KFC's sponsorship of Cricket Australia.

Getty Images/Chris Hyde for KFC

Figure 20.12 KFC's sponsorship of Cricket Australia is an example of cross-promotion.

The advertising sparks consumers' interest, and they may be seduced into purchasing the product. Visual and audio references to foods can be done through product placement as well. For example, a popular television show may have a character we can identify with consuming a food product and we, as viewers, absorb this, perhaps unconsciously, then

find ourselves buying that product. Similarly, product endorsements by celebrities may also influence our decision to purchase the product they have put their name behind.

Ultimately it is the individual's responsibility to learn what they should and should not eat to be healthy. For children, their parent or guardian should make sensible choices on their behalf. However, food manufacturers and advertisers have a responsibility to inform the public and assist consumers to make healthy choices. Honesty should be a right for the consumer and advertisers should be clear about the nutritional advantages and disadvantages of a product. It is unethical (and usually illegal) to lie when promoting a product. However, marketers will often focus on any positive aspects, while not mentioning the negative aspects. The promotion of health foods lies in the hands of the media as well. They need to make consumers aware of functional foods, fortified foods and other healthy food products.

The Australian Dietary Guidelines have made suggestions to maintain optimum health. The media's role is to inform consumers of these available products. Defining 'health food' can be difficult as there are no legal requirements on the use of the word 'health'. Therefore, advertising can use words such as 'natural', 'healthy', and 'lite' on the label to help promote the product. These products don't need to meet any particular standard, so the consumer is left to make their own interpretation of the information on the label. For example, the marketing of dairy produce will focus on the goodness of calcium and the necessity of it in our diet to help prevent osteoporosis and healthy bone formation, yet will not mention the high fat content of some of these products. Reading labels is one skill that is definitely needed in order to have a clear comprehension of what the product truly contains. More information on food labelling can be found in Chapter 11.

Chapter review

REVIEW

1 Make a list of lifestyle choices that are not conducive to 'good health'
2 What suggestions would you make to someone who is seeking a healthier diet?
3 Explain the symptoms and causes of diabetes, CVD and obesity.

FOR YOU TO APPLY

4 Research the website for Diabetes Australia. Identify the foods considered to be low-GI and give reasons for their inclusion in the diet for a diabetic.
5 In your opinion, does the media promote healthy food choices and provide an honest guide to food selections? Discuss.
6 Research various apps that monitor our overall health. What do you think is the purpose of wearing fitness tracking devices such as a Fitbit?

EXTEND YOURSELF

7 Discuss the correlation of diabetes, obesity and CVD.
8 Describe the relationship between diet, nutrient intake and dietary-related disorders.
9 Debate the ethical issues surrounding media promotion and advertising of junk and fast foods. Pay particular attention to the marketing strategies aimed towards children.
10 Go to the Healthy Food Guide awards website and read about the awards. Discuss whether the information is reliable and valuable.

CORE STRAND REVIEW

MULTIPLE CHOICE

1 Functional foods have been developed to:
- **A** address environmental concerns.
- **B** utilise technological developments.
- **C** meet market concerns about health.
- **D** provide convenience for consumers.

2 Which of the following is the primary benefit of consuming food products rich in probiotics?
- **A** Reduced fatigue
- **B** Improved memory
- **C** Increased gut flora
- **D** Improved cardiovascular health

3 A person who cannot consume wheat-based food products may be suffering from which condition?
- **A** Anaemia
- **B** Osteoporosis
- **C** Coeliac disease
- **D** Lactose intolerance

4 What is the major health concern regarding the misuse of vitamin C supplements?
- **A** Overload on kidneys
- **B** Poor absorption
- **C** Weight gain
- **D** Toxicity

5 Which of the following is an example of an active non-nutrient?
- **A** Refined carbohydrates
- **B** Fibre
- **C** Protein
- **D** Sugar

SHORT ANSWER

6 Investigate the health of a specific group in Australia.
- **A** Identify a significant health concern for this group and explain why it is a concern. (2 marks)
- **B** Explain the changes to dietary intake that would address the nutritional needs of this group. (4 marks)
- **C** Propose and justify a strategy to promote optimum health through good nutrition for this group. (4 marks)

7 Explain how levels of physical activity and nutrient intake contribute to young people being overweight or obese. (5 marks)

EXTENDED RESPONSE

8 Discuss the impact of nutritionally modified foods, active non-nutrients and dietary supplements on the dietary health of Australians. (15 marks)

9 Discuss the effects of food product development on the health of Australians. Use specific examples to support your answer. (15 marks)

The following questions are a guide only and should be used to help with your revision for the HSC exam.

SECTION I – MULTIPLE CHOICE (20 MARKS)

There will be objective response questions to the value of 20 marks.

You will be asked to use a specific multiple-choice answer sheet to record your answers for this section.

1 Sous vide is a method of

- **A** cooking food in a vacuum package.
- **B** freezing food after dehydration.
- **C** French food preparation.
- **D** sterilising food in a liquid form.

2 A process flowchart is used to show the

- **A** amount of raw material required in food production.
- **B** size, shape and quality of the equipment.
- **C** steps in manufacturing a food product.
- **D** temperature at which the raw materials should be stored.

3 The correct temperature range for a commercial cold room is between

- **A** 0°C and 4°C.
- **B** 5°C and 10°C.
- **C** –3°C and 4°C.
- **D** –18°C and –3°C.

4 Supermarkets are selling some fruit and vegetables which are up to 12 months old. The factor that has made this possible would be

- **A** developments in storage.
- **B** improvements in distribution.
- **C** increased use of local suppliers.
- **D** advances in genetic modification.

5 Company production facilities impact on product development activities as they

- **A** allow manufacture of completely new products.
- **B** determine the production level of the company.
- **C** enable all consumer demands to be met.
- **D** reflect the current ecological environment.

6 Foods produced using fermentation include

- **A** cheese, jams and pickles.
- **B** cheese, yogurt and salami.
- **C** honey, salami and pickles.
- **D** jam, honey and milk.

7 The organisation responsible for food product recalls in Australia is

- **A** Austrade.
- **B** CSIRO.
- **C** Department of Agriculture and Water Resources.
- **D** FSANZ.

8 The main role of an Environmental Health Officer (EHO) is to

- **A** audit financial records of food establishments.
- **B** guard against unfair trade within the Australian food industry.
- **C** inspect premises and equipment where food is prepared or sold.
- **D** monitor food imports and exports.

9 Functional foods are

- **A** foods that contain one main functional ingredient beneficial for health.
- **B** only available from farm animal food sources.
- **C** rich sources of vitamins, therefore very functional.
- **D** those that provide health benefits beyond those supplied by the traditional nutrients.

10 A multinational beverage company has just moved to Australia; producing a variety of nutritional carbonated juices. Which of the following characteristics would best define the organisation?

- **A** Highly automated using sophisticated machinery and equipment for large scale production and yield.
- **B** Large-scale production using automated equipment.
- **C** Large-scale production using seasonal workers and produce.
- **D** Small-scale production using domestic tools and equipment.

11 Food manufacturers have responded to concerns about environmental issues by increasing the use of which of the following?

- **A** Food additives
- **B** Fresh ingredients
- **C** Organic fertilisers
- **D** Biodegradable packaging

12 The overall role of government legislation in the Australian food industry is to

- **A** ensure consumer health and safety.
- **B** ensure the use of local raw materials.
- **C** increase food exports.
- **D** increase government revenue.

13 Anaphylaxis is associated with which of the following conditions?

- **A** Obesity
- **B** Diabetes
- **C** Food allergies
- **D** Cardiovascular disease

14 The use of a marketing plan in food product development would include

- **A** determinating use-by dates.
- **B** establishing storage conditions.
- **C** generating new ideas.
- **D** identifying a price structure.

15 A local supermarket is selling individual serves of fruit salad. This is an example of a

- **A** functional food.
- **B** value-added food.
- **C** new-to-the-world product.
- **D** home meal replacement.

16 An example of a quality-management system that is also a legal requirement within an Australian food company is

- **A** GMP.
- **B** HACCP.
- **C** ISO.
- **D** WHS.

17 Emulsifiers are used during the manufacturing process of a healthy salad dressing to

- **A** enhance the colour of manufactured foods.
- **B** prevent oxidation and deterioration of food.
- **C** stop dry ingredients sticking together.
- **D** stop liquids from separating.

18 Which of the following food products uses reduced water activity as a method of preservation?

- **A** Sauerkraut
- **B** Canned tuna
- **C** Condensed milk
- **D** Fruit juice

19 Which of the following would be considered an example of a government initiative designed to promote nutritional health?

- **A** Australian bananas – 'make your body sing' campaign
- **B** Funding of workplace dieticians
- **C** Subsidies for personal trainers
- **D** The Australian Dietary Guidelines

20 Which legislation must all food establishments in NSW comply with to ensure food is safe for human consumption?

- **A** *Food Act 2003* (NSW)
- **B** *National Measurement Amendment Act 2013* (Cth)
- **C** *Food Standards Australia New Zealand Act 1991* (Cth)
- **D** *Protection of the Environment Operations Act 1997* (NSW)

SECTION II – SHORT ANSWER (50 MARKS)

- There will be approximately 6 short-answer questions that may contain multiple parts.
- There will be approximately 14 items in total.
- At least four items will be worth 4–6 marks.

(In this section – generally allow 2 lines per mark)

21 The Australian food industry consists of the following sectors. (8 marks)

- Agriculture and fisheries
- Food processing/manufacturing
- Food service and catering
- Food retail

Choose *one* sector and discuss each of the following:

A levels of mechanisation (2 marks)

B quality management (2 marks)

C impact on society (2 marks)

D career opportunities. (2 marks)

22 Explain using examples one piece of legislation that impacts the Australian food industry. (3 marks)

23 A previously unknown disease has been detected and is having a significant impact upon the citrus industry, especially oranges.

A Predict the effect this disease could have on the other sectors of the Australian food industry. (3 marks)

B What role would the CSIRO and Department of Agriculture and Water Resources play in the above scenario? (3 marks)

24 Identify a food product you made in class.

A Thinking about the food product you have identified, list the raw materials used to produce this product. (3 marks)

B Identify and describe the quality control factors that need to be checked for each of the raw materials identified above. (3 marks)

C Outline **two** processes used in the transformation of the raw ingredients used in this product. (4 marks)

D Propose different ways this food could be nutritionally modified to meet the needs of a specific group. (5 marks)

25 Discuss the consequences of malnutrition in Australia. (6 marks)

26 **A** Why is it necessary to package manufactured food products? (3 marks)

B Identify and explain the requirements that must appear on Australian food labels. (5 marks)

SECTION III – STRUCTURED EXTENDED RESPONSE (15 MARKS)

- There will be *one* structured extended response question.
- The question will have two or three parts, with one part worth at least 8 marks.
- The question will have an expected length of response of around four pages of an examination writing booklet (approximately 600 words) in total.

27 A snack food company has been approached to develop a new range of savoury snacks based on the nutritional benefits of active non-nutrients.

A Demonstrate the sectors of the AFI that this type of product development may impact. (3 marks)

B Outline the main steps that will be involved in the development of the food product. (4 marks)

C Critically evaluate the types of quality control measures the food company will need to consider during the development of the product prototype. (8 marks)

ANOTHER EXAMPLE OF A QUESTION FOR THIS SECTION MIGHT BE:

28 Many people believe that food manufacturers should have some responsibility for the diet and health of their customers. Discuss this statement in relation to the diet and health of Australians with reference to:

- **A** reasons for preserving foods (3 marks)
- **B** foods available in the marketplace today (5 marks)
- **C** marketing techniques used to promote food products. (7 marks)

ANOTHER EXAMPLE OF A QUESTION FOR THIS SECTION MIGHT BE:

29 Advisory groups play a key role in formulating and implementing policy and legislation which effects the Australian food industry. Consider this statement in relation to:

- **a** the macro-environment that impacts on food product development (4 marks)
- **B** safe work practices and quality assurance in the food industry (5 marks)
- **C** promotion of health foods and fast foods. (6 marks)

SECTION IV – EXTENDED RESPONSE (15 MARKS)

- There will be *one* extended response question.
- The question will have an expected length of response of around four pages of an examination writing booklet (approximately 600 words).

30 Explain how diet, media and social practices influence the development of new food products and the nutritional status of the Australian community.

ANOTHER EXAMPLE OF A QUESTION FOR THIS SECTION MIGHT BE:

31 Current developments in food manufacturing have led to an extended shelf life and overall quality of manufactured products and has had a positive impact on the environment but a negative impact on the nutritional status of Australians. Examine this statement, using examples to support your answer.

ANOTHER EXAMPLE OF A QUESTION FOR THIS SECTION MIGHT BE:

32 Explore the relationship between specific marketplace trends, technology and developments in the Australian food industry.

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OVERVIEW

- Written for the Stage 6 NSW Food Technology Syllabus, building upon and following the same highly structured format as the hugely popular *Food Tech Focus* (Stage 5) text
- 'Food in Focus' boxes contextualise student learning and highlight food industry career paths
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