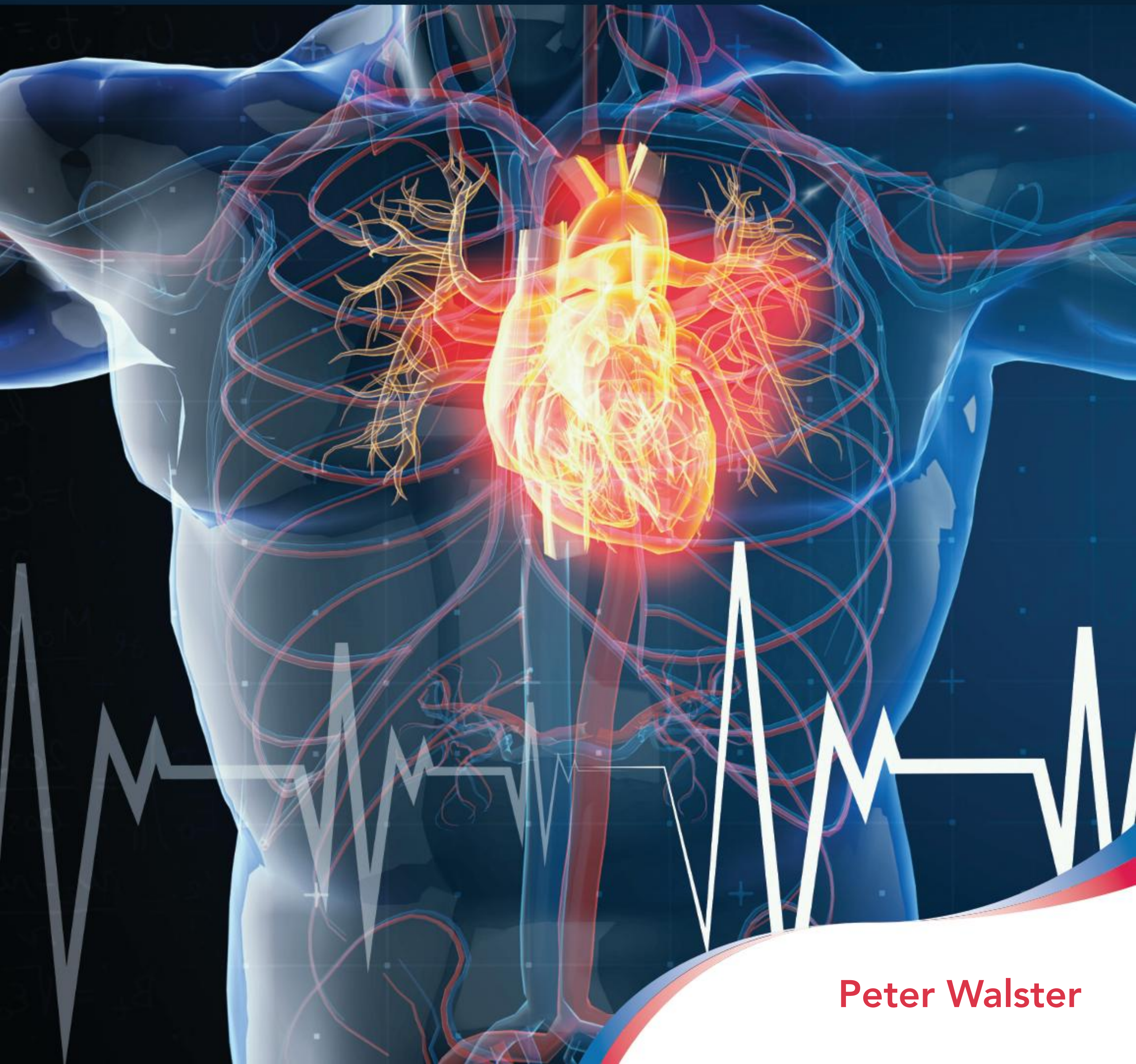
ACADEMIC ASSOCIATES

STUDY GUIDE

HUMAN BIOLOGY

YEAR 11 ATAR COURSE – UNITS 1 & 2

THIRD EDITION



Peter Walster

ACADEMIC ASSOCIATES

WACE STUDY GUIDE

HUMAN BIOLOGY

YEAR 11 ATAR COURSE

Peter Walster

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About the Author
Peter Walster was Head of Science in several WA government schools. With a science degree and Masters in Education, he has taught biology and human biology both in Western Australia and in the UK. Peter has been a WACE examiner whilst serving on a number of syllabus committees and reference groups.

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- Paul Appleton for his thorough editing.

TO THE STUDENT

This study guide has been written for the Year 11 Human Biology syllabus (ATAR course), Units 1 and 2. The order in which the sections have been presented is similar to that of the syllabus. However you may complete the study guide in which ever order is appropriate to you.

Review Questions and Answers

Each section starts with a list of terms that you are likely to be expected to know. The terms have been chosen because they are regarded as important. A feature of this subject is that it requires you to become familiar with many terms, many of which are likely to be new to you. Getting to know the terminology is part of the enjoyment of human biology and it is also an essential requirement.

Answers to all the questions in this guide are provided at the end of the book. Make sure to carefully check your answers against those that are given. You can learn to improve your answers in this way. Often the answers given are in greater detail than is actually required by the question. This is intentional, as students you will benefit by adding additional information to your own answers. By doing the review questions thoroughly you should improve your understanding of the course and should therefore improve your test performances.

Trial Tests and Answers

There are fifteen trial tests, one for each chapter. Each test has a multiple choice, a short answer and an extended answer section. This is intended to mirror the exams and school tests that you are likely to do. The answers given are also more detailed than is normally required. This is intended to expand your understanding. The time allocations are given as a guide only, but you should try to do the tests in the time allocated. Pay particular attention to the extended answer questions as this is an area that many students find most challenging. You may need more space than we have allowed for the extended answers — use some note paper if necessary. Study the answers given to determine the depth and the detail that is required in extended answers.

Glossary

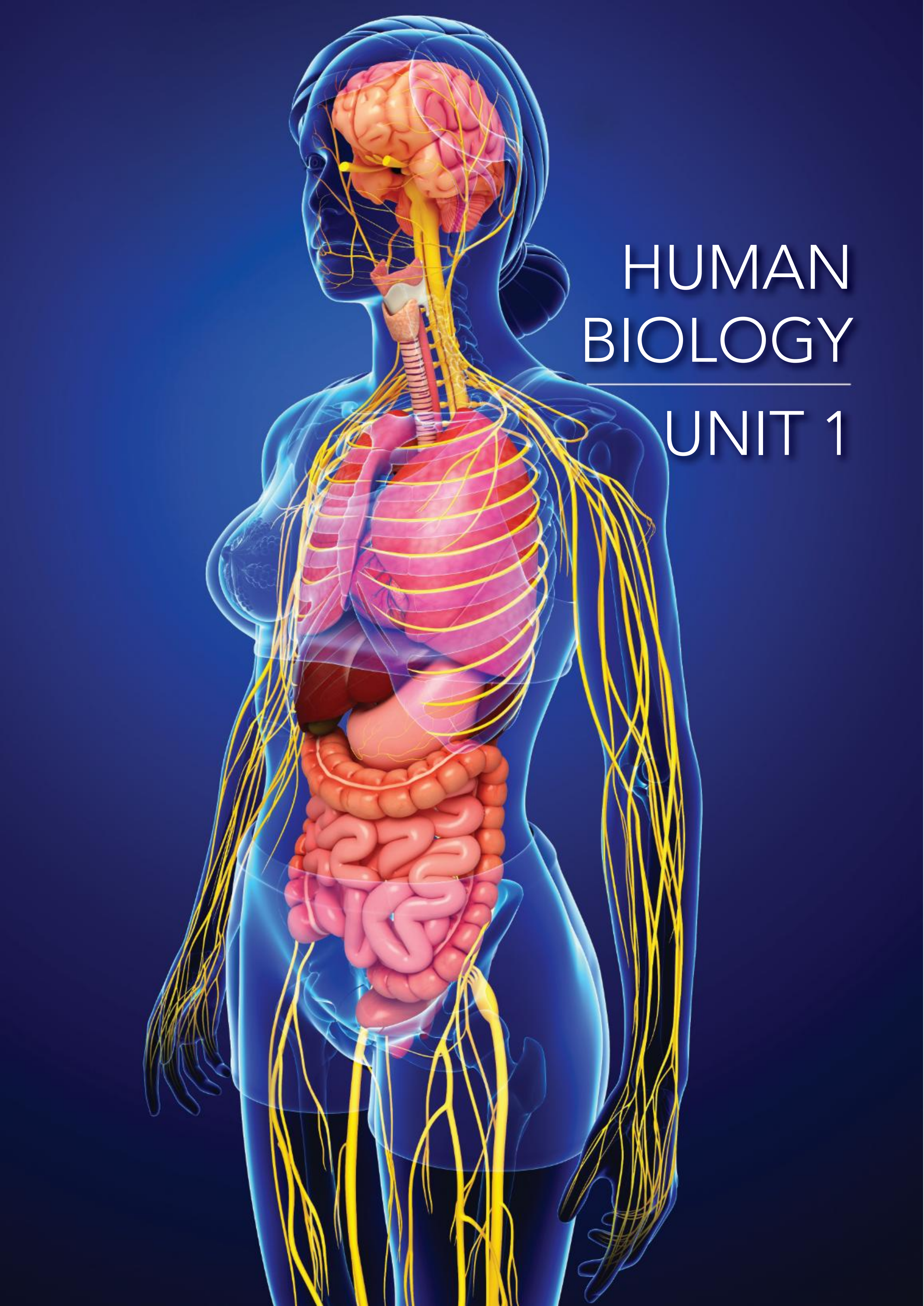
This is a comprehensive list of terms with their meanings. It represents a good proportion of the vocabulary that you need to be familiar with in the course. Consult the glossary frequently. Whenever you encounter a term that you are not quite sure about, use the glossary to check its meaning. In doing this you will become more familiar with the language used in this course and a more competent student of human biology.

Good luck in your studies!
Peter Walster

CONTENTS

HUMAN BIOLOGY

UNIT 1



SCIENCE INQUIRY SKILLS 1

1

SYLLABUS CHECKLIST

On completion of this chapter you should be able to:

- ☐ identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes.
- ☐ design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics.
- ☐ conduct investigations safely, competently and methodically for the collection of valid and reliable data.
- ☐ represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error and limitations in data; and select, synthesise and use evidence to make and justify conclusions.
- ☐ interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments.
- ☐ select, construct and use appropriate representations, including labelled diagrams and images of various cells, tissues and organ systems, to communicate conceptual understanding, solve problems and make predictions.
- ☐ communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports.

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) conclusion

(ii) dependent variable

(iii) hypothesis

(iv) generalisation

(v) independent variable

(vi) field of view

(vii) magnification

(viii) micrograph

(ix) monocular

(x) prediction

Review Questions

1. Give (i) an example of a hypothesis and (ii) a prediction based on that hypothesis.

(i) ____

____

____

____

(ii) ____

____

____

____

2. Write a prediction which could be made from each of the following hypotheses by completing the statements below it.

(i) Smoking does far less damage to the liver than excess alcohol.

If ____

then ____

(ii) Global warming is contributing to more mosquito borne diseases occurring in populations near the equator.

If ____

then ____

(iii) Australian indigenous people have a significantly shorter life expectancy than the non-indigenous population because of their lower educational opportunities.

If ____

then ____

3. Mark each of the following with an 'H' if it is an hypothesis or 'P' if it is a prediction.

(i) If a child has a balanced diet, she is likely to have better health. __________

(ii) People who have evolved in the artic circle do not loose heat as rapidly to the environment on a cold day as people who have evolved on the equator.

____

(iii) The man died because he was overfed. __________

(iv) Chidren who attend daycare centres on a regular basis as infants will find school easier to manage when they enter primary school.

____

(v) The man began to lose his hair as he was pining for his mate. __________

4. The data in the table below was collected from a large sample of the population.

(i) Graph this information in an appropriate form (use the grid provided).

CHOLESTEROL CATEGORY (weight per unit of blood volume)	HEALTH CATEGORY
120-159 mg/dl	Very Good
160-199 mg/dl	Good
200-239 mg/dl	Borderline
240-279 mg/dl	Poor
280-319 mg/dl	Very Poor

(ii) What general conclusions can you make from the data?

____

____

____

____

(iii) How might an individual's health category be determined?

____

____

____

____

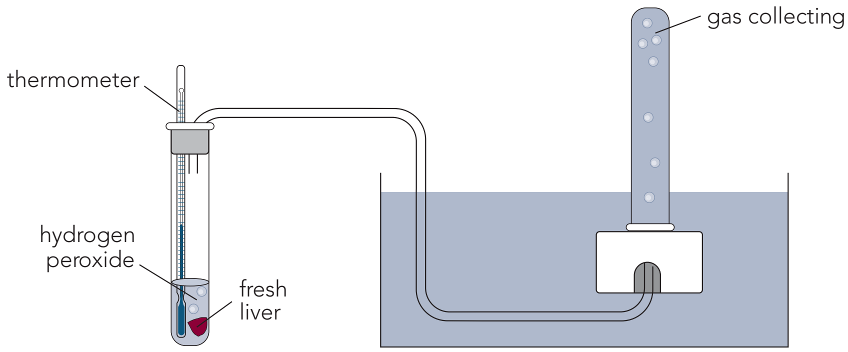
____

____

5. Catalase is an enzyme found in many living cells. It breaks down hydrogen peroxide (H_2O_2), a product of metabolism, which is harmful to cells. The general equation for this can be shown as:

$$2H_2O_2 \xrightarrow{\text{CATALASE}} 2H_2O + O_2$$

A student learned that catalase was present in large quantities in liver. To test the hypothesis that the effect of catalase on hydrogen peroxide is temperature dependent, she set up the equipment which is drawn below.



From the information given and using this equipment:

(i) How might the student measure the rate at which catalase breaks down hydrogen peroxide?

____

____

(ii) Name the gas which is collecting in the inverted test tube. ____________________

(iii) How could she vary the temperature of the substrate and the enzyme in the upright test tube?

____

____

(iv) In her experiment, what is:

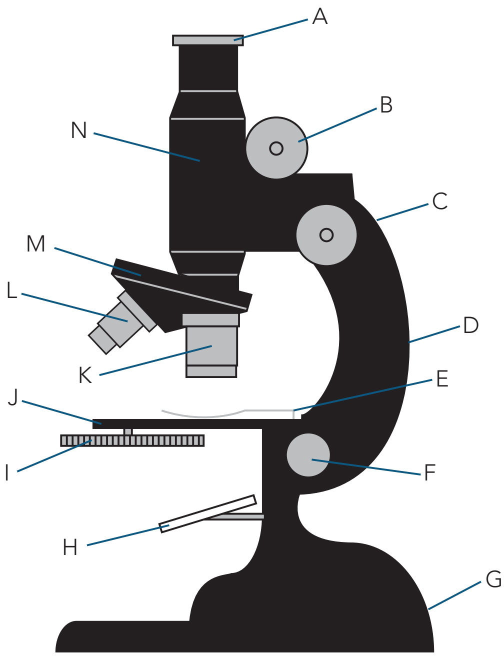
(a) the dependent variable. ______________________________

(b) the independent variable. ______________________________

(v) List other variables that would need to be controlled to make this experiment valid.

____

6. Label the monocular microscope shown below and indicate briefly each part's function.



A ______________________________

____

B ______________________________

____

C ______________________________

____

D ______________________________

____

E ______________________________

____

F ______________________________

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G ______________________________

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H ______________________________

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I ______________________________

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J ______________________________

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K ______________________________

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L ______________________________

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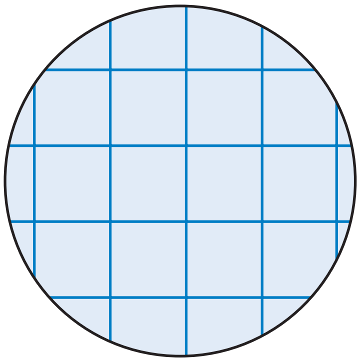
M ______________________________

____

N ______________________________

____

7. A student has made up a slide of a piece of 1 mm graph paper and observes this with her microscope. Using an ocular of 10x and an objective of 4x, she sees the image of the graph paper as shown below.



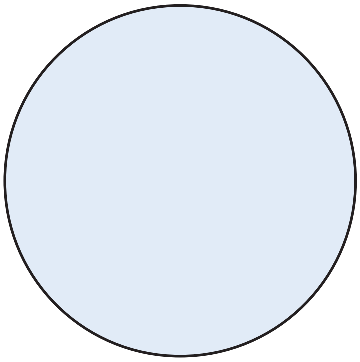
(i) What was the magnification used above? ________________________________

(ii) Estimate the diameter of the field of view at this magnification:

(a) in mm _______________ (b) in µm _______________

Using the same microscope, the student changed the objective to 10x.

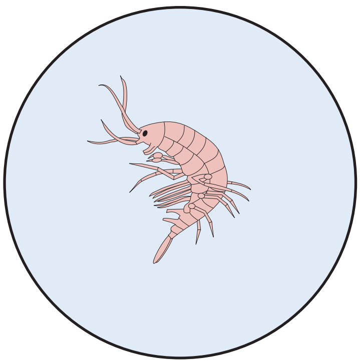
(iii) Draw lines on the circle below to indicate, approximately, the new image that she would observe.



(iv) Calculate the diameter of the field of view on this second magnification:

(a) in mm _______________ (b) in µm _______________

(v) Later that day, while using the second magnification, she observed an organism which she drew carefully as shown below.



Estimate the organism's:

(a) length _______________ mm or __________________ µm

(b) width _______________ mm or __________________ µm

8. (i) The micrograph below shows liver cells.

Name the parts a – d.

a ________________________________

b ________________________________

c ________________________________

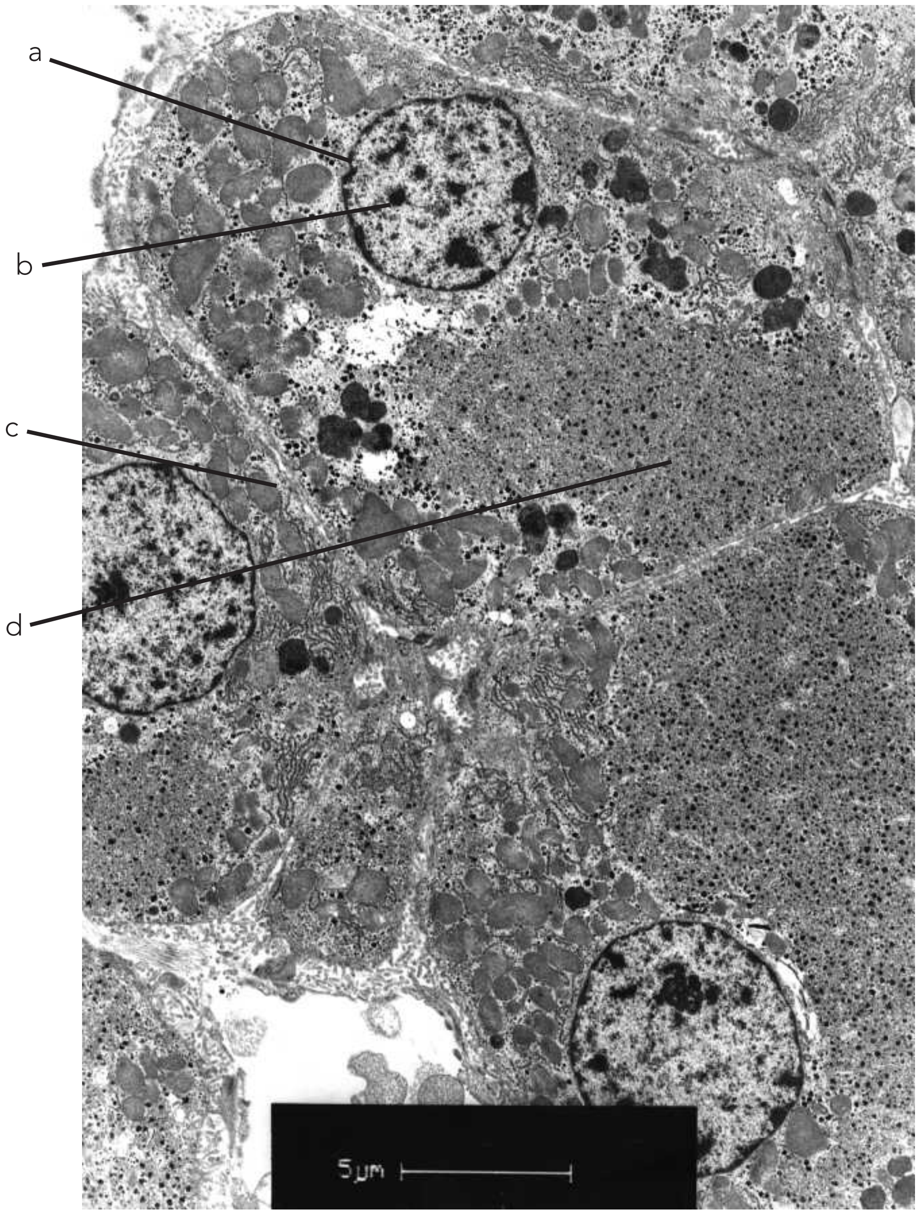
d ________________________________

(ii) Use the scale shown to estimate the dimensions of the cell which has been labelled. (Calculate the actual length and width at the widest points).

____

____

____



9. The micrograph below shows several white (X) and red (Y) blood cells.

(i) Which organelles do the white blood cells appear to have that are not present in the red blood cells?

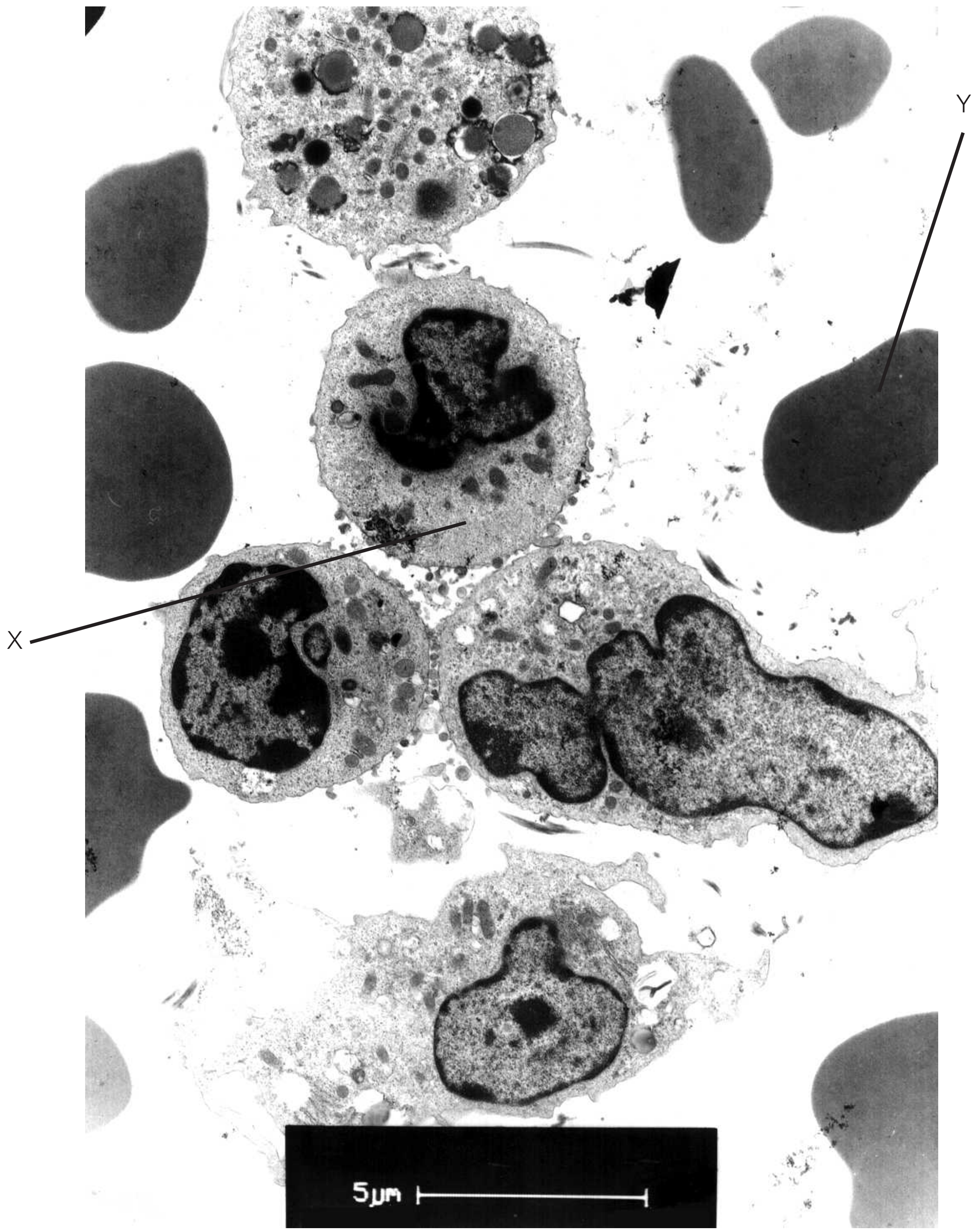
___

(ii) Estimate the size of the largest white blood cell using the scale shown. (Show your working.)

___

___

___

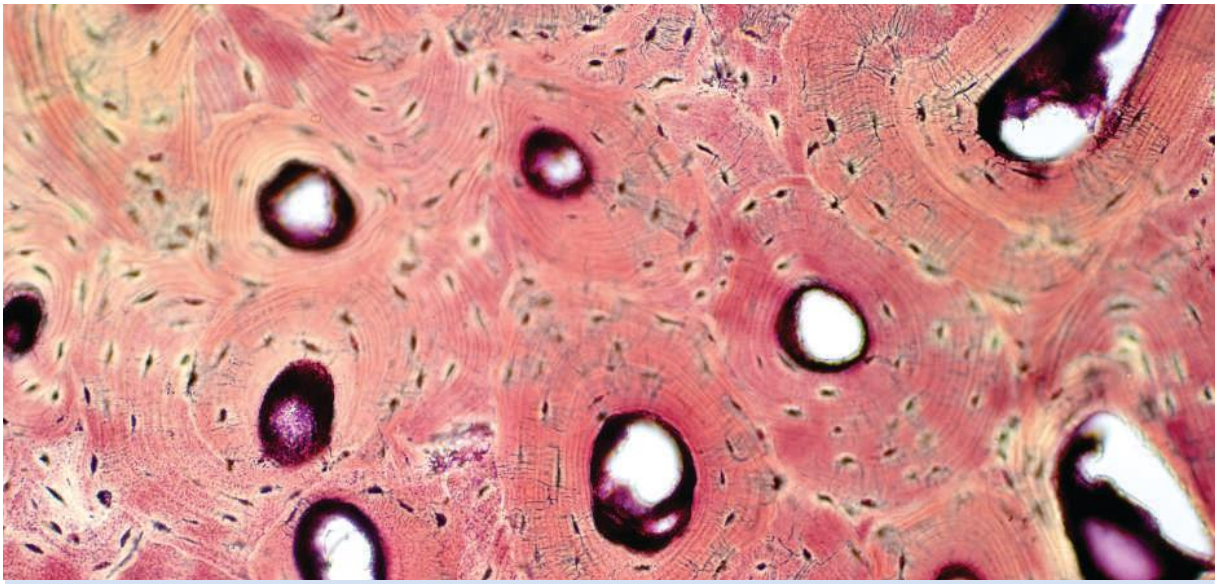


10. ‘Scientific Methodology’ refers to the process that scientists use to help solve a problem. Using any case study, give an example, in the boxes provided, of what is meant by the corresponding terms. (**Hint:** You may use the famous case study of Louis Pasteur’s investigation into the problem of wine souring.)

a) Problem recognition	a)
↓	
b) Information collected	b)
↓	
c) Hypothesis made	c)
↓	
d) Hypothesis tested	d)
↓	
e) Data recorded	e)
↓	
f) Conclusion made	f)

CELLS AND TISSUES

2



SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

2.1 THE HUMAN BODY

- ☐ the human body is comprised of cells, tissues and organs within complex systems that work together to maintain life.

2.2 CELL ORGANELLES

- ☐ cell organelles maintain life processes and require the input of materials and the removal of wastes to support efficient functioning of the cell.

2.3 THE CELL MEMBRANE

- ☐ the cell membrane separates the cell from its surroundings with a structure, described by the fluid mosaic model, which allows for the movement of materials into and out of the cell by osmosis, simple diffusion, facilitated diffusion, active transport and vesicular transport (endocytosis/exocytosis).
- ☐ factors affecting the exchange of materials across the cell membrane include surface area to volume ratio, concentration gradients, and the physical and chemical nature of the materials being exchanged.

2.4 TISSUE TYPES

- ☐ the various tissues of the human body perform specific functions and can be categorised into four basic tissue types: epithelial, connective, muscular and nervous.

2.1 THE HUMAN BODY

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) cell

(ii) organ

(iii) system

(iv) tissue

Review Questions

1. Place the followings terms in order of their increasing size and complexity:

   cell, organ, system, tissue.

2. What is meant by:

   (i) cell differentiation?

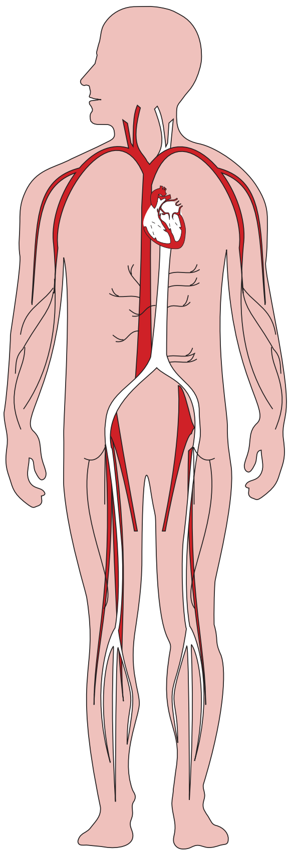
   (ii) cell specialisation?

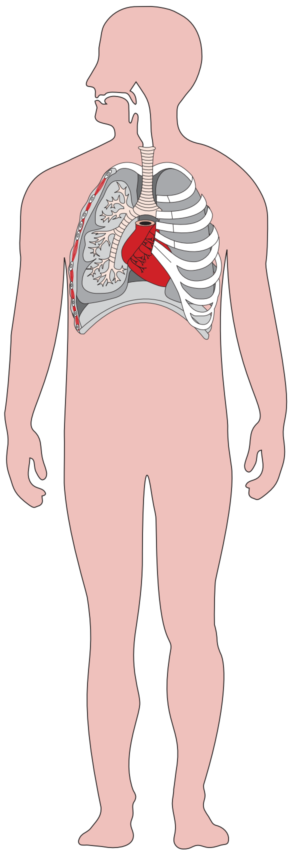
3. Why is tissue which lines the trachea or windpipe different to that which lines the small intestine?

4. Complete the table below.

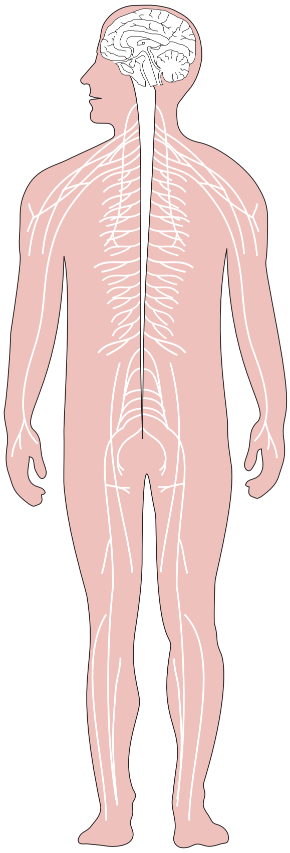
ORGAN SYSTEM	MAIN ORGANS	FUNCTION/S
(i) Circulatory	heart, arteries, veins, arterioles, venules , capillaries	
(ii)	lungs, nose , nasal cavity, pharynx, trachea, bronchi, bronchioles	
(iii) digestive		
(iv)	cardiac, smooth and striated muscle	
(v)		protects soft tissue, anchors muscle, site for blood cell synthesis, stores fat, supports body
(vi) excretory		
(vii)	lymph vessels, lymph nodes	

5. Name the system that is represented in each of the following diagrams:

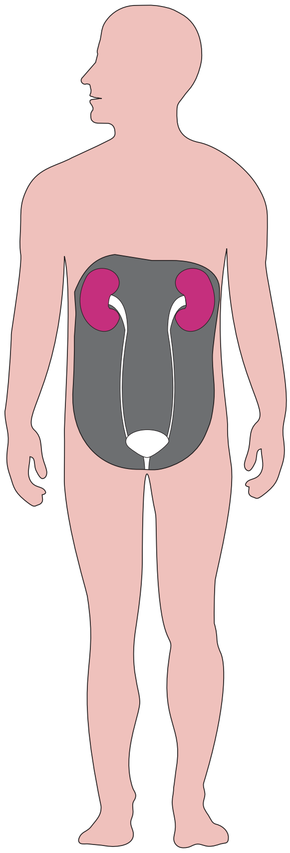




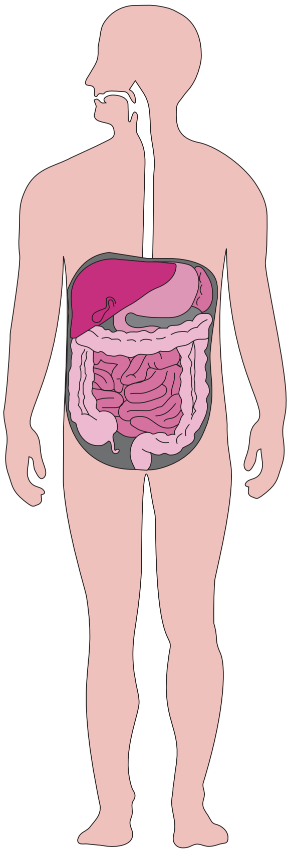
(i) ______________________________ (ii) ______________________________



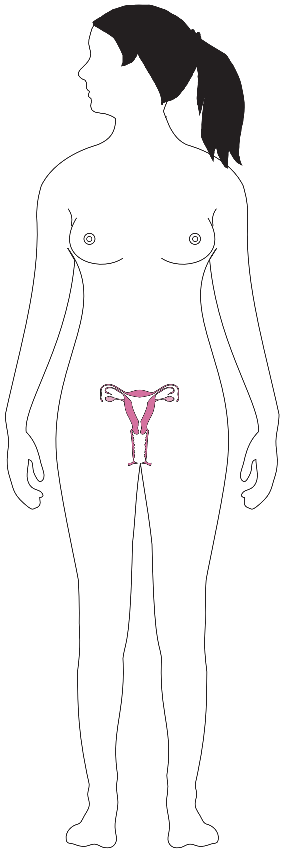
(iii) ____________________



(iv) ____________________



(v) ____________________



(vi) ____________________

6. Which two systems control and coordinate the other systems? ____________________

2.2 CELL ORGANELLES

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) cell waste

____

(ii) cytoplasm

____

(iii) life processes

____

(iv) organelle

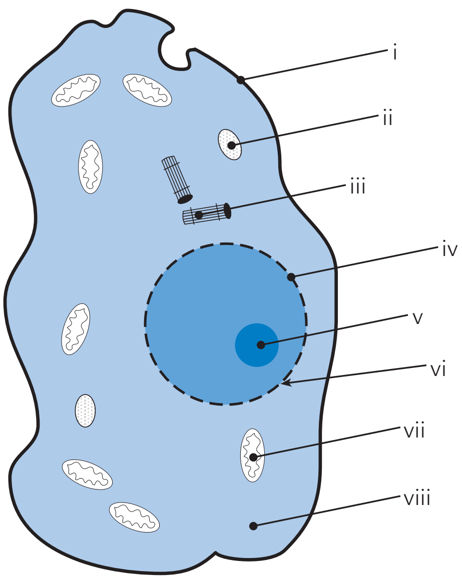
____

(v) ribosome

____

Review Questions

1. Label the diagram of the generalised cell below.



(i) ______________________________

(ii) ______________________________

(iii) ______________________________

(iv) ______________________________

(v) ______________________________

(vi) ______________________________

(vii) ______________________________

(viii) ______________________________

2. Draw and describe the location in the cell and the function of each organelle in the table below.

ORGANELLE	DIAGRAM	LOCATION	FUNCTION
nucleus			
nucleolus			
nuclear membrane			
mitochondrion			
lysosome			
Golgi apparatus			
rough endoplasmic reticulum			
smooth endoplasmic reticulum			
centriole			
cell membrane			

3. What is the importance of the cytoplasm?

4. What are main (i) inputs and (ii) wastes of a generalized human cell?

(i) Inputs

(ii) Wastes

5. Name the cellular process that requires oxygen and glucose and produces carbon dioxide and water as wastes.

2.3 THE CELL MEMBRANE

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) concentration

(ii) concentration gradient

(iii) glucose

(iv) lipid

(v) protein

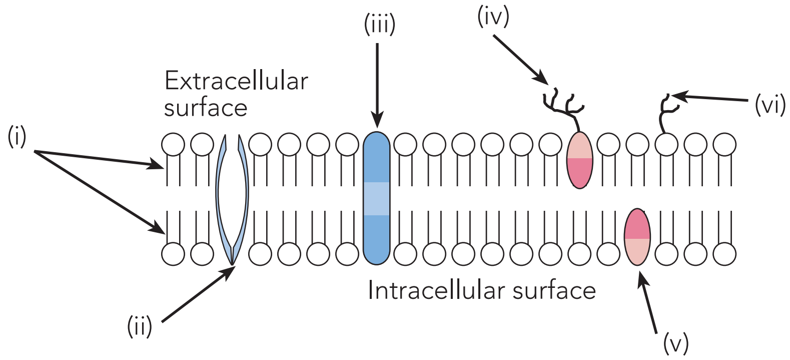
Review Questions

1. What are the two major chemical components which make up cell membranes?

(i)

(ii)

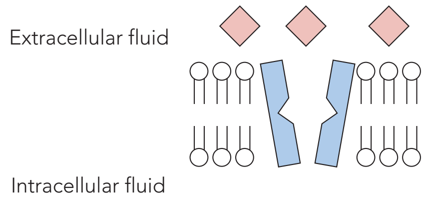
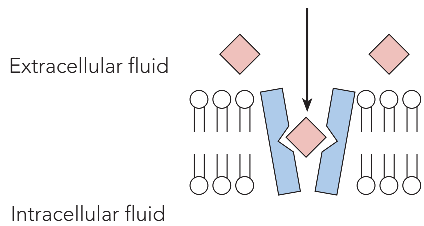
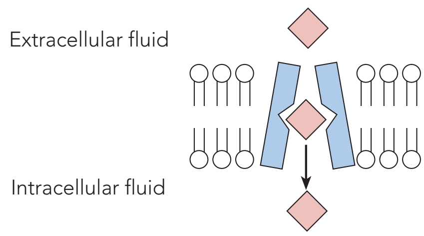
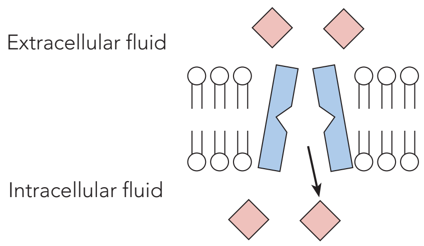
2. Using the diagram below, discuss the 'fluid mosaic' model of the cell membrane. You will need to add labels (i) to (vi) to the diagram first.



3. Describe the types of molecules that pass freely through the cell membrane because of its structure.

4. The diagrams below shows how a molecule like glucose, which is large and not soluble in lipids, is thought to move into a cell.

Complete the sentences.

(a)		This shows the glucose concentration is __________ on the outside than on the inside. Glucose molecules are too __________to pass into the cell by normal __________.
(b)		A glucose molecule fits on to a transport __________ like an enzyme fits its __________.
(c)		The transport protein changes __________ so that the __________ molecule can move __________ the cell membrane.
(d)		This process is called __________ diffusion. Another glucose molecule can now fit onto the __________ protein.

5.

(i) Which of the following processes are **active** means by which substances move across cell membranes:
diffusion, osmosis, active transport, pinocytosis, phagocytosis, exocytosis.

____

(ii) Explain why these are described as 'active'.

____

(iii) Which processes are passive?

____

(iv) Explain why these are described as 'passive'?

____

____

(v) Which two processes are examples of endocytosis?

6. Describe clearly what is meant by:

(i) diffusion

(ii) osmosis

(iii) active transport

(iv) pinocytosis

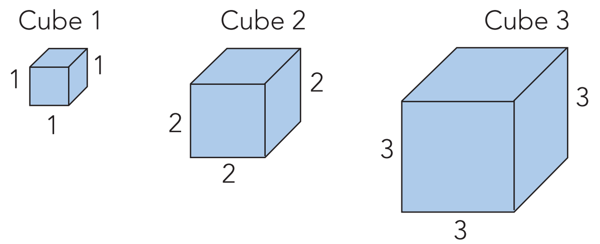
(v) phagocytosis

(vi) facilitated diffusion

7. As a cell grows its surface area compared to its volume decreases, that is SA:V becomes smaller. To appreciate this idea, complete the following activity.

(a) Calculate the surface area and the volume of each cube shown (their dimensions are in centimetres). Enter your answers in the table.

(b) Now calculate the surface area per cubic centimetre for each cube. Enter your answers in the last column.



CUBE	SURFACE AREA (cm^2)	VOLUME (cm^3)	S.A. : V (cm^2/ cm^3)
1			
2			
3			

Use the results in the table to answer the following questions:

(i) Which cube has the greatest surface area per cubic centimetre? _________

(ii) Which has the smallest surface area per cubic centimetre? _________

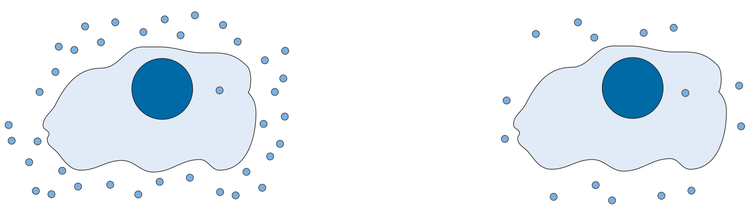
(iii) What generalisation could be made from these observations?

____

____

8. Look at the diagrams below. The dots around the cells represent small fat-soluble molecules.

(a) Cell A (b) Cell B



(i) Which cell would absorb the molecules most rapidly? ____________

Explain your answer.

____

____

(ii) If this fat molecule is used (e.g. respired) by the cells, describe what will happen in both cells A and B.

2.4 TISSUE TYPES

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) blood

(ii) bone

(iii) cartilage

(iv) duct

(v) gland

(vi) muscle

Review Questions

1. Complete the table.

TISSUE TYPE	GENERAL DESCRIPTION	EXAMPLES
epithelial		
connective		
muscular		
nervous		

2. In the spaces provided, draw and label:

(i) cuboidal epithelial cells lining a duct

(ii) cartilage

(iii) smooth muscle tissue

(iv) a nerve cell

3. For each tissue example in the table list its type, structure and function. The first example has been completed for you.

TISSUE EXAMPLE	TYPE	STRUCTURE	FUNCTION
non-striated	muscle	long fibres – tapering cells	contraction
cartilage			
squamous			
glandular			
areolar			
adipose			
cuboidal			
bone			
cardiac			
striated			
stratified			
blood			

METABOLISM

3

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

3.1 ENZYME SPECIFICITY

- [ ] biochemical processes, including anabolic and catabolic reactions in the cell, are controlled in the presence of specific enzymes.

3.2 CELLULAR RESPIRATION

- [ ] cellular respiration occurs, in different locations in the cytosol and mitochondria, to catabolise organic compounds, aerobically or anaerobically, to store energy in the form of adenosine triphosphate (ATP).

3.3 CELLS REQUIREMENTS

- [ ] for efficient metabolism, cells require oxygen and nutrients, including carbohydrates, proteins, lipids, vitamins and minerals.

3.4 FACTORS AFFECTING ENZYME FUNCTION

- [ ] enzyme function can be affected by factors including: pH, temperature, presence of inhibitors, co-enzymes and co-factors, and the concentration of reactants and products.

3.1 ENZYME SPECIFICITY

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) digestion

____

(ii) product

____

(iii) reactant

____

(iv) reaction rate

____

(v) synthesis

____

Review Questions

1. What is an anabolic reaction?

____

2. Does an anabolic reaction require an input of energy? Explain.

____

3. Give one example of an anabolic reaction which occurs in human cells and indicate where in the cell the reaction occurs.

____

____

4. What is a catabolic reaction?

____

____

5. Does a catabolic reaction require an input of energy? Explain.

____

____

6. Discuss one example of a catabolic reaction and describe where it occurs in human cells.

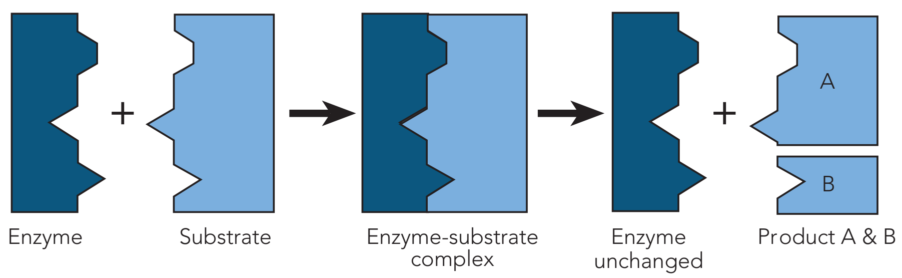
7. (i) What is an 'enzyme'?

(ii) Outline the 'lock and key' principle which has been proposed to explain how enzymes function.

(iii) Why are enzymes required only in small quantities?

(iv) What is the '**active site**' on the enzyme?

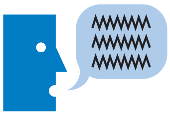
(v) Use the diagram below to explain how enzymes digest food – write in the spaces provided.



(vi) Explain why this is called “chemical digestion”?

(vii) Explain what is meant by “enzyme specificity”.

3.2 CELLULAR RESPIRATION



Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) aerobic respiration

(ii) anaerobic respiration

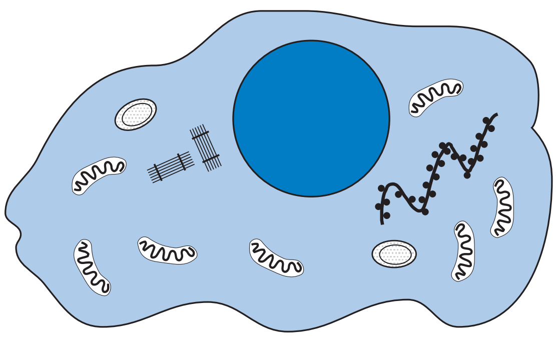
(iii) ATP

(iv) cytosol

(v) protein synthesis

Review Questions

1. On the diagram of the cell below, show clearly where protein synthesis (an anabolic reaction) and where aerobic respiration (a catabolic reaction) occur.



2. Why is respiration classified as catabolic?

3. Write a word equation for:

   (a) anaerobic respiration.

   (b) aerobic respiration.

4. Complete the table below to contrast the two processes of aerobic and anaerobic respiration.

	AEROBIC RESPIRATION	ANAEROBIC RESPIRATION
Site of occurrence		
Requirements for oxygen		
Products in animal (human) cells		
Amount of ATP produced from 1 molecule of glucose		

5. (i) How does ATP store the energy that is released by the breakdown of glucose in respiration?

   (ii) How is ATP formed?

   (iii) What are five cellular uses of the energy stored in ATP?

-
-
-
-
-

(iv) How does ATP release its stored energy?

Illustrate your answer.

(v) Each cell uses about 10 million molecules of ATP per second. Where does all the ATP come from?

3.3 CELLS REQUIREMENTS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) carbohydrate

(ii) metabolism

(iii) mineral

(iv) nutrient

(v) vitamin

Review Questions

1. The nutrients required by our cells are listed in the table below.
Complete this table. The first nutrient has been completed for you.

NUTRIENT	SOURCE	FUNCTION
amino acids	plant and animal proteins	used to synthesis the cell's structural proteins and enzymes
simple sugars		
fatty acids		
vitamins		
minerals		

2. Why do most cells need oxygen?

____

3.4 FACTORS AFFECTING ENZYME FUNCTION

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) active site

____

(ii) chemical concentration

____

(iii) denature

____

(iv) inhibit

____

(v) pathogen

____

Review Questions

1. (i) What do enzyme inhibitors do and how are they believed to work?

(ii) Describe how an inhibitor could be used to treat a disease caused by a pathogen.

2. (i) Describe how the concentration of a product in an enzyme controlled reaction can affect the reaction rate.

(ii) How does a cell deal with this problem?

3. (i) Describe the effect that temperature has on enzyme action.

(ii) Describe other factors that may change enzyme activity.

RESPIRATORY SYSTEM

4

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

4.1 STRUCTURE AND FUNCTION OF THE RESPIRATORY SYSTEM

- [ ] the exchange of gases between the internal and external environments of the body is facilitated by the structure and function of the respiratory system at the cell, tissue and organ levels.

4.2 GAS EXCHANGE

- [ ] the efficient exchange of gases in the lungs is maintained by the actions of breathing, blood flow and the structure of the alveoli.

4.1 STRUCTURE AND FUNCTION OF THE RESPIRATORY SYSTEM

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) alveolus

___

(ii) capillary

___

(iii) diffusion

___

(iv) haemoglobin

___

(v) external intercostal muscle

___

(vi) oxyhaemoglobin

___

(vii) pleural cavity

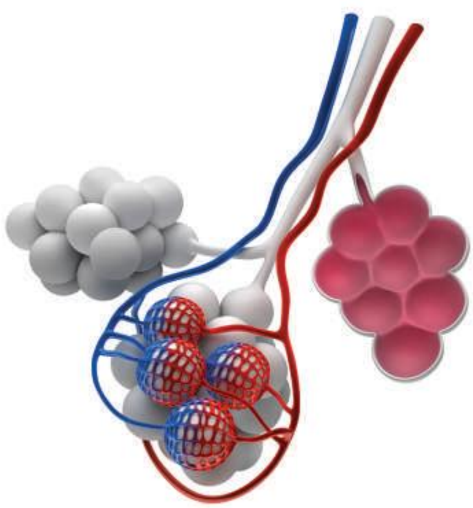
___

(viii) thoracic cavity

___

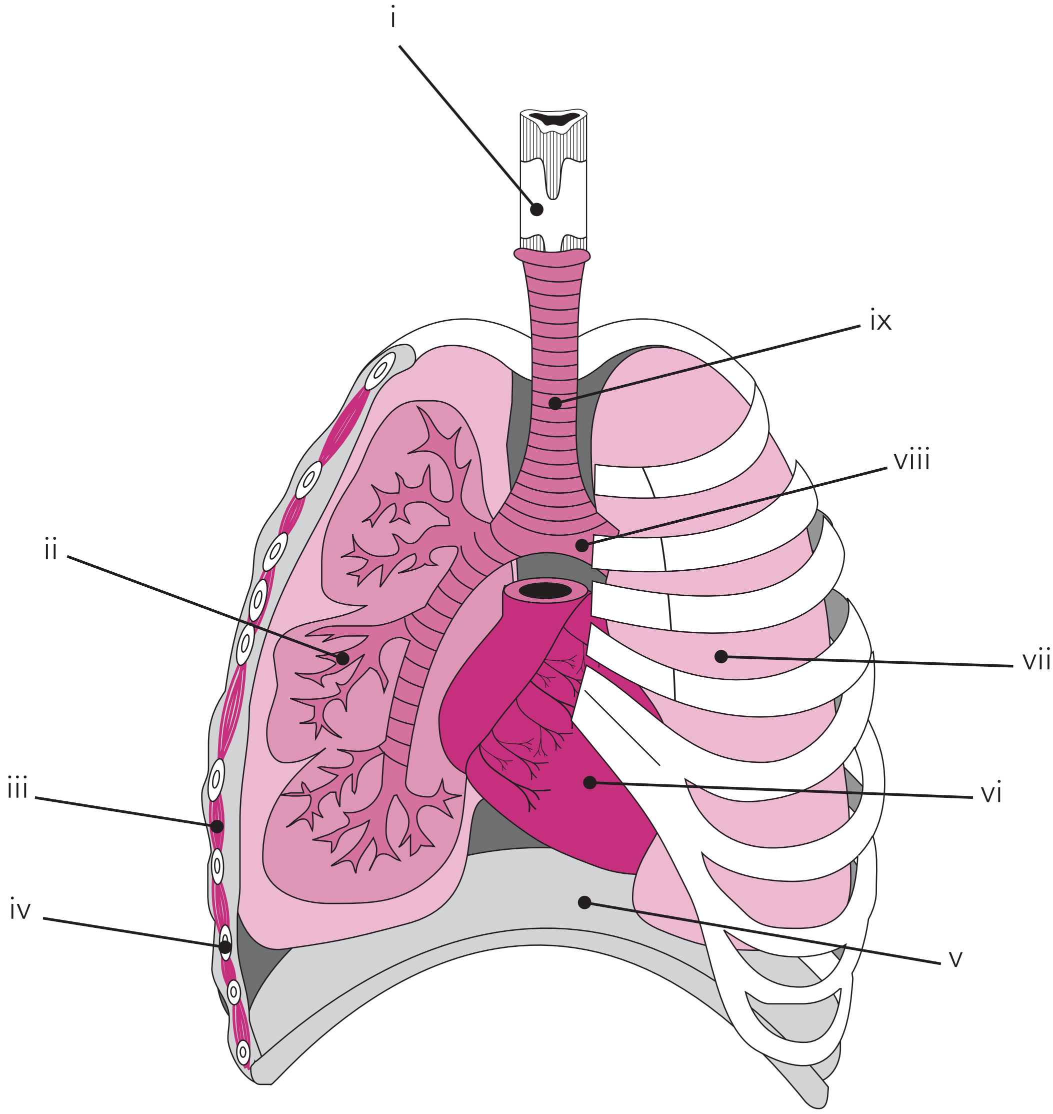
(ix) vocal cords

___



Review Questions

1. Label the diagram of the human respiratory system shown below.



i ______________________________

ii ______________________________

iii ______________________________

iv ______________________________

v ______________________________

vi ______________________________

vii ______________________________

viii ______________________________

ix ______________________________

2. In the table below describe the structure and functions of each part. The first example has been completed for you.

NAME	STRUCTURE	FUNCTIONS
nose	Part of face which protrudes. Holes, called nostrils, allow air to enter and leave nasal cavity.	Warms, filters and humidifies air, contains smell receptors (olfactory).
pharynx		
larynx		
trachea		
lungs		
bronchi		
bronchioles		
alveoli		
pleural membranes		
diaphragm		
intercostal muscles		
vocal cords		

4.2 GAS EXCHANGE

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) diaphragm

___

(ii) erythrocyte

___

(iii) intercostal muscles

___

(iv) tidal volume

___

Review Questions

1. (i) Describe, in steps, what causes air to be drawn into the lungs (i.e. inspiration)

___

___

___

___

___

(ii) Describe, in steps, what causes air to be forced out of the lungs (i.e. expiration)

___

___

___

___

___

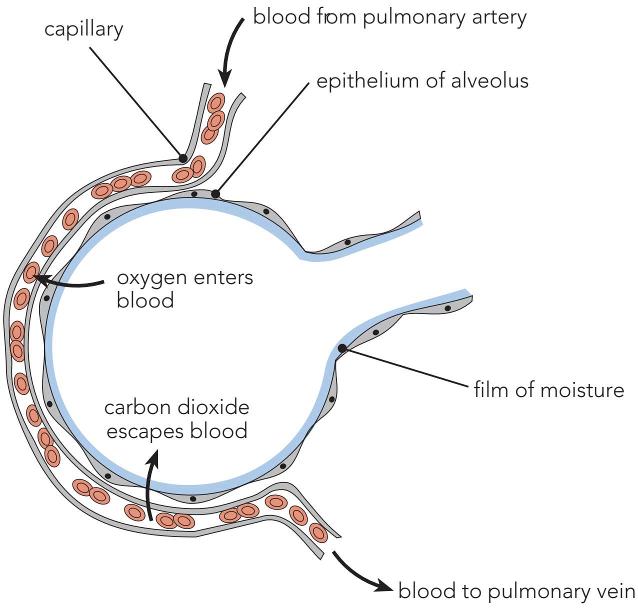
2. List, in order, the parts of the respiratory system that air passes over to reach the alveoli.

___

___

___

3. The diagram below shows a capillary vessel in close contact with an alveolus.



(i) Explain why oxygen moves from the alveolus into the erythrocytes?

____

____

(ii) Explain why carbon dioxide moves in the opposite direction?

____

____

4. List the special adaptations that an alveolus has to make it efficient in carrying out its function.

____

____

____

____

5. How is the oxygen concentration gradient between the alveoli and the blood in the capillaries maintained?

____

____

____

____

CIRCULATORY SYSTEM

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

5.1 STRUCTURE AND FUNCTION OF THE CIRCULATORY SYSTEM

- [ ] the transport of materials within the internal environment for exchange with cells is facilitated by the structure and function of the circulatory system at the cell, tissue and organ levels.

5.2 THE COMPONENTS OF BLOOD

- [ ] the components of blood facilitate the transport of different materials around the body (plasma and erythrocytes), play a role in the clotting of blood (platelets) and the protection of the body (leucocytes).

5.3 THE LYMPHATIC SYSTEM

- [ ] the lymphatic system functions to return tissue fluid to the circulatory system and to assist in protecting the body from disease.

5.1 STRUCTURE AND FUNCTION OF THE CIRCULATORY SYSTEM

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) artery

(ii) atrioventricular valve

(iii) atrium

(iv) cardiac muscle

(v) diastole

(vi) double circulation system

(vii) inflammation

(viii) lumen

(ix) sinuatrial node

(x) systole

(xi) vein

(xii) ventricle

Review Questions

1. Explain why body cells require each of the following:

   (i) oxygen ______________________________

   ____

   (ii) glucose ______________________________

   ____

   (iii) minerals ______________________________

   ____

2. How are the substances in question 1 above delivered to the body cells?

   ____

   ____

   ____

3. Small organisms like jellyfish do not have a circulatory system. Why do humans and other complex multicellular organisms need one?

   ____

   ____

   ____

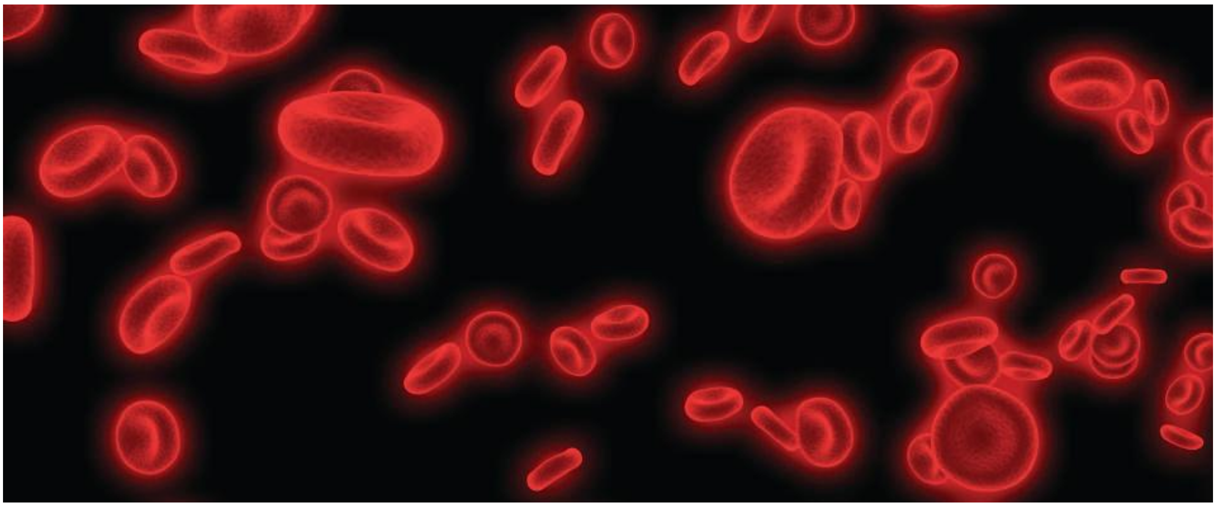
4. The circulatory system connects all the organs in the body. Explain how it is able to do this.

   ____

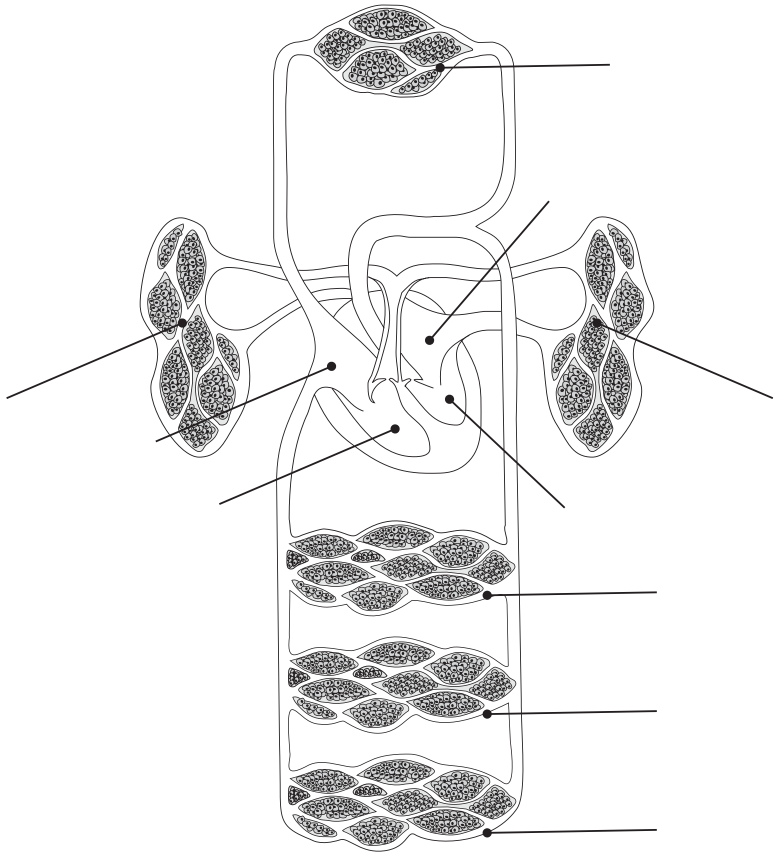
5. If a wound becomes inflamed, how does this help the body recover?

   ____

   ____



6. The diagram below represents the circulatory system. Label the diagram then complete the activity below.



(i) On the diagram:

(a) using a pencil, draw arrows to indicate the direction in which the blood flows through this system

(b) using a red pen, shade in the arteries and veins which carry oxygenated blood

(c) using a blue pen, shade in the arteries and veins which carry deoxygenated blood

(ii) In general terms, where does the blood become deoxygenated?

___

(iii) Specifically where does the blood become oxygenated?

___

(iv) Name the arteries that carry deoxygenated blood.

___

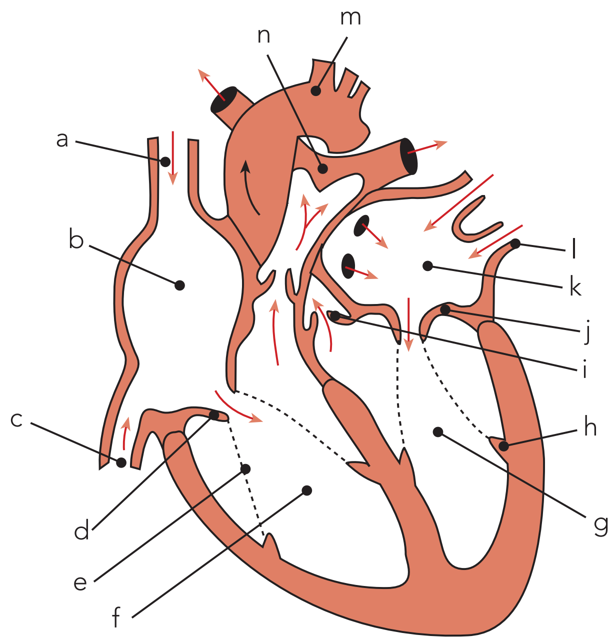
(v) Only two veins in the diagram carry oxygenated blood. Which veins?

___

(vi) What is carried by the hepatic portal vein?

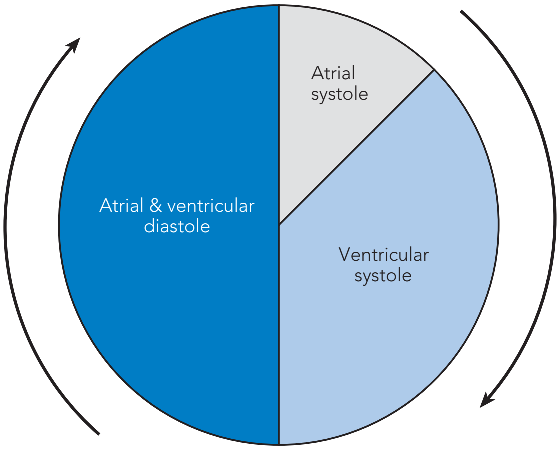
___

7. Annotate the diagram of the heart using the table below.



LABEL	NAME	FUNCTION
a		
b		
c		
d		
e		
f		
g		
h		
i		
j		
k		
l		
m		
n		

8. Study the diagram below:



One complete cardiac cycle (0.8 second)

(i) What is atrial systole? ______________________________

____

(ii) What is atrial diastole? ______________________________

____

(iii) What is ventricular systole? ______________________________

____

(iv) What is ventricular diastole? ______________________________

____

(v) How long does each phase last? (Use the diagram above to calculate each).

atrial systole ______________________________

atrial diastole ______________________________

ventricular systole ______________________________

ventricular diastole ______________________________

9. (i) During which of the phases above would blood pressure in the arteries be highest?

____

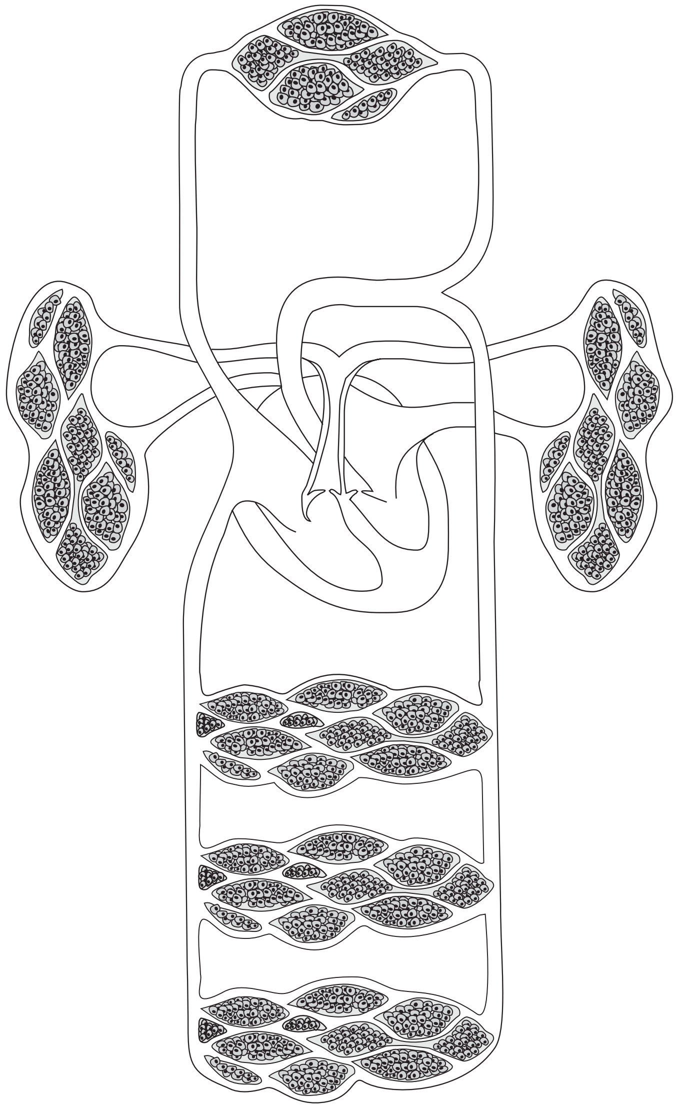
(ii) During which phase would it be at its lowest?

____

(iii) While the ventricles are in a state of diastole, why does the blood pressure remain high in the arteries?

____

10. (i) On the diagram below, shade the pulmonary system (e.g. use blue) and using a different colour (e.g. use green) show the systemic circulation.



(ii) Make a list of the arteries and veins that make up the:

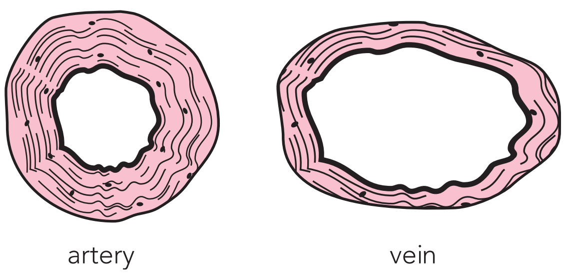
Pulmonary circulation ____

____

Systemic circulation ____

____

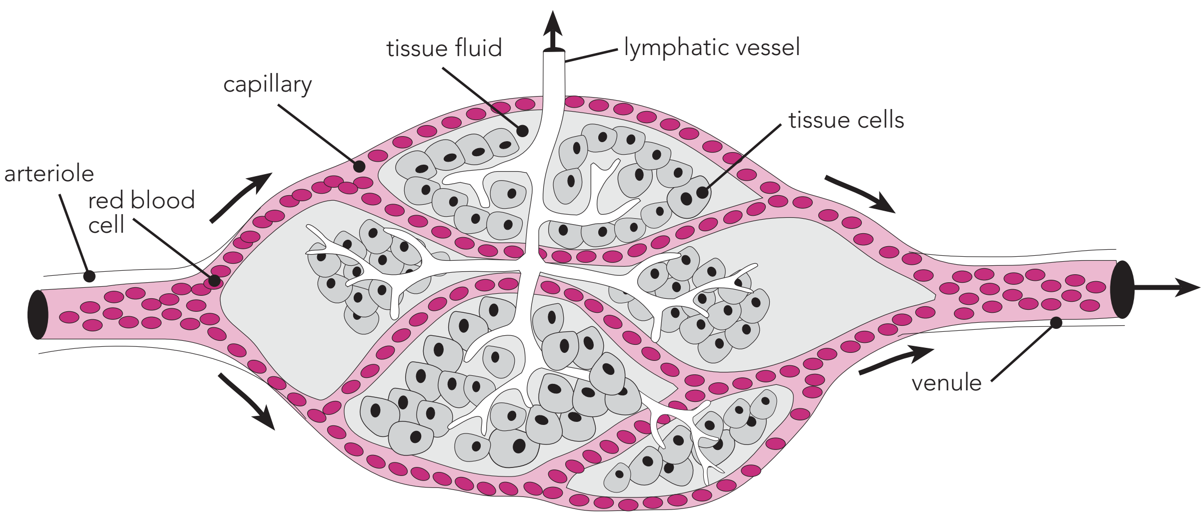
11. The diagram below shows some differences between arteries and veins.



Complete the table below to describe the main differences.

FEATURE	ARTERY	VEIN
comparative thickness of wall		
comparative diameter of lumen		
presence of valves		
elasticity		

12. The structure of the circulatory system enables it to deliver oxygen and nutrients to, and remove wastes from, every living cell in the body. Capillaries, the finest of the vessels that make up the system, are always very close to each cell. This arrangement, together with associated structures, is illustrated below:



Using the diagram and information above, complete the table below:

	STRUCTURE	FUNCTION
arteriole		
venule		
capillary		
lymphatic vessel		

5.2 THE COMPONENTS OF BLOOD

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) carbaminohaemoglobin

____

(ii) deoxygenated blood

____

(iii) fibrinogen

____

(iv) haemorrhage

____

(v) plasma

____

(vi) platelet (thrombocyte)

____

Review Questions

1. What type of tissue is blood? Explain why it is placed in this category.

____

____

2. Describe five functions of blood.

(i) ____

(ii) ____

(iii) ____

(iv) ____

(v) ____

3. (i) List the components of blood plasma.

____

____

(ii) What percentage of the blood is plasma? ________________________

(iii) The plasma is viscous. What does this mean?

____

4. How does carbon dioxide travel in the blood?

____

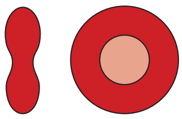
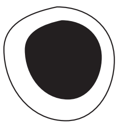
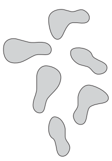
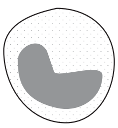
____

5. Describe two ways in which the blood is protective.

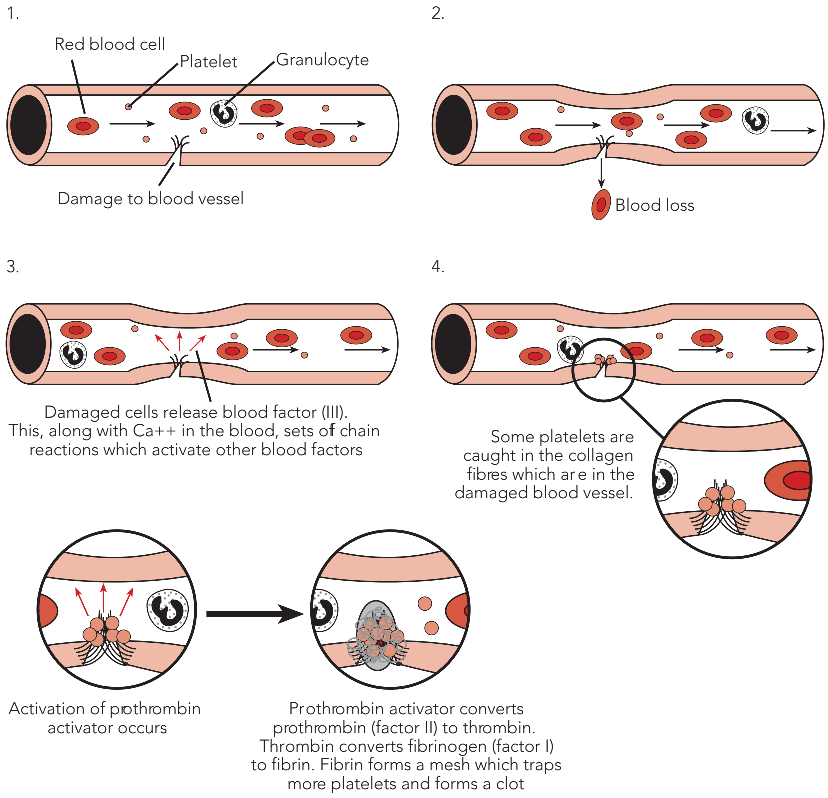
____

____

6. Forty-five per cent of the volume of blood is made up of formed elements (cells and cell fragments). The most important of these are illustrated in the table below. Complete the table to name each, indicate its origin (where it is synthesised), its function and any other significant points about it.

DIAGRAM (not to scale)	NAME	ORIGIN	FUNCTION	OTHER NOTES
 side view				
				
				
				
				

7. Blood clots at the site of the wound through a complex set of chemical reactions. This process can be represented as follows:



(i) Why is it necessary for a blood clot to form?

___

___

(ii) When a blood vessel is damaged, what do the platelets do?

___

___

(iii) What do the platelets do when at the site?

___

(iv) What role is played by the blood vessel's damaged cells?

___

___

(v) What does prothrombin activator do?

___

(vi) What does thrombin do?

___

___

8. How does the circulatory system contribute to the efficient exchange of gases in the lungs?

9. (i) Red blood cells contain a protein which is important in transporting oxygen around the body. What is the name of this protein?

(ii) Red blood cells have no nucleus. What advantage does this give?

(iii) What is the disadvantage of having no nucleus?

(iv) Where are old dysfunctional red blood cells broken down?

(v) Name the useful product formed from this breakdown process.

5.3 THE LYMPHATIC SYSTEM

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) lacteal

(ii) lymph

(iii) lymph node

(iv) lymph valve

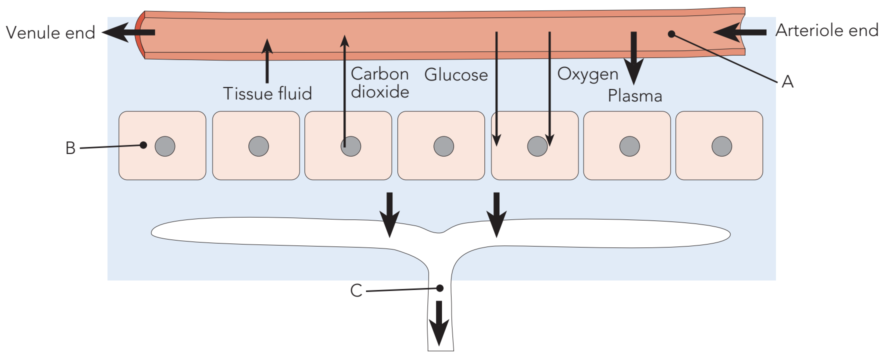
(v) lymphocyte

Review Questions

1. (i) Describe the two main functions of the lymphatic system.

(ii) Discuss briefly how it carries out each of these functions.

2. Some tissue fluid returns to the blood via the lymphatic system. Excess fluid drains into the lymphatic system as shown below:

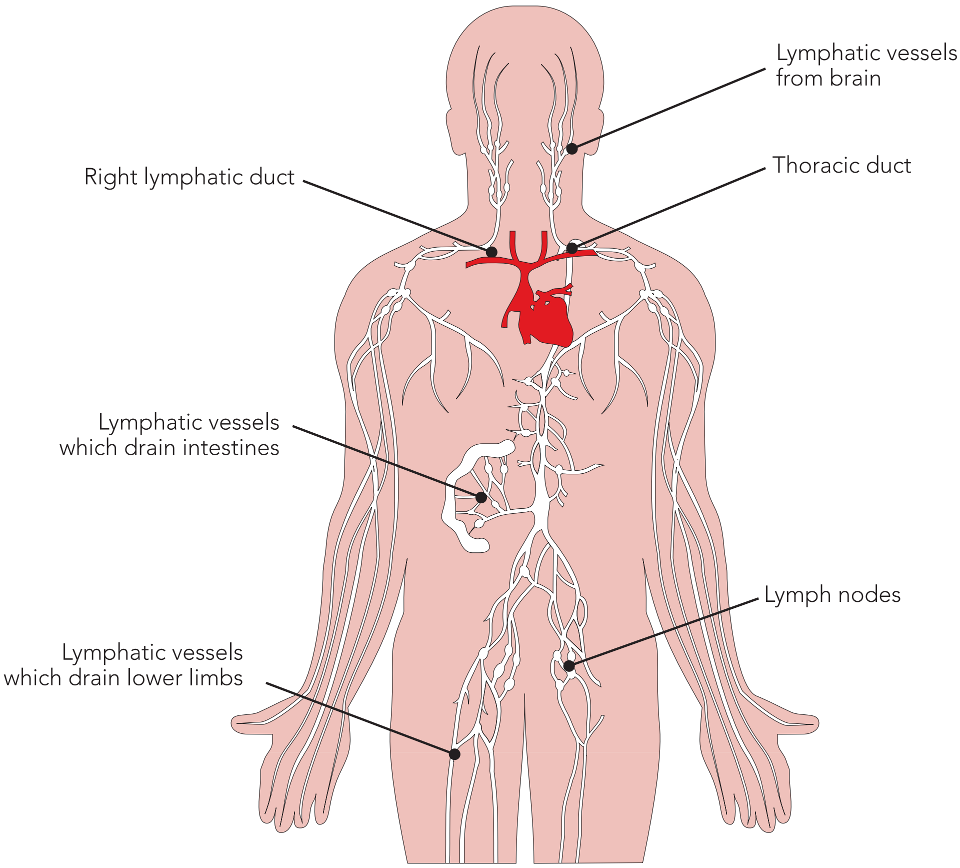


(i) Name the substances labelled A, B and C.

(ii) Explain why glucose moves out of the blood circulation and into the cells.

(iii) Explain what might happen if the lymphatic vessel were removed or blocked.

3. The diagram below shows the main drainage routes of the lymphatic system:



(i) Using arrows, show the direction in which the fluid (lymph) flows in the lymphatic system.

(ii) Where does the fluid return to the blood circulatory system?

____

4. (i) How does the lymph move in the lymphatic system?

____

(ii) Why does it move only in one direction?

____

5. Why is the lymph which flows from the small intestine often milky in appearance?

____

6. Discuss the main differences between blood and lymph.

____

____

DIGESTIVE SYSTEM

6

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

6.1 STRUCTURE AND FUNCTION OF THE DIGESTIVE SYSTEM

- ☐ the supply of nutrients in a form that can be used in cells is facilitated by the structure and function of the digestive system at the cell, tissue and organ levels.

6.2 DIGESTION

- ☐ digestion involves the breakdown of large molecules to smaller ones by mechanical digestion (teeth, peristalsis, churning and bile) and chemical digestion (by enzymes with distinctive operating conditions and functions that are located in different sections of the digestive system).
- ☐ the salivary glands, pancreas, liver and gall bladder produce or store secretions which aid the processes of digestion.

6.3 ABSORPTION

- ☐ absorption requires nutrients to be in a form that can cross cell membranes into the blood or lymph and occurs at different locations, including the small intestine and large intestine.

6.4 ELIMINATION

- ☐ elimination removes undigested materials and some metabolic wastes from the body.

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) alimentary canal

(ii) bolus

(iii) defaecation

(iv) ingestion

(v) microvilli

(vi) peristalsis

(vii) sphincter muscle

Review Questions

1. Why does the body need the following nutrients?

(i) Proteins

___

(ii) Carbohydrates

___

(iii) Lipids

___

(iv) Vitamins

___

(v) Minerals

___

2. Label the diagram of the alimentary canal and its associated organs.

i ___

ii ___

iii ___

iv ___

v ___

vi ___

vii ___

viii ___

ix ___

x ___

xi ___

xii ___

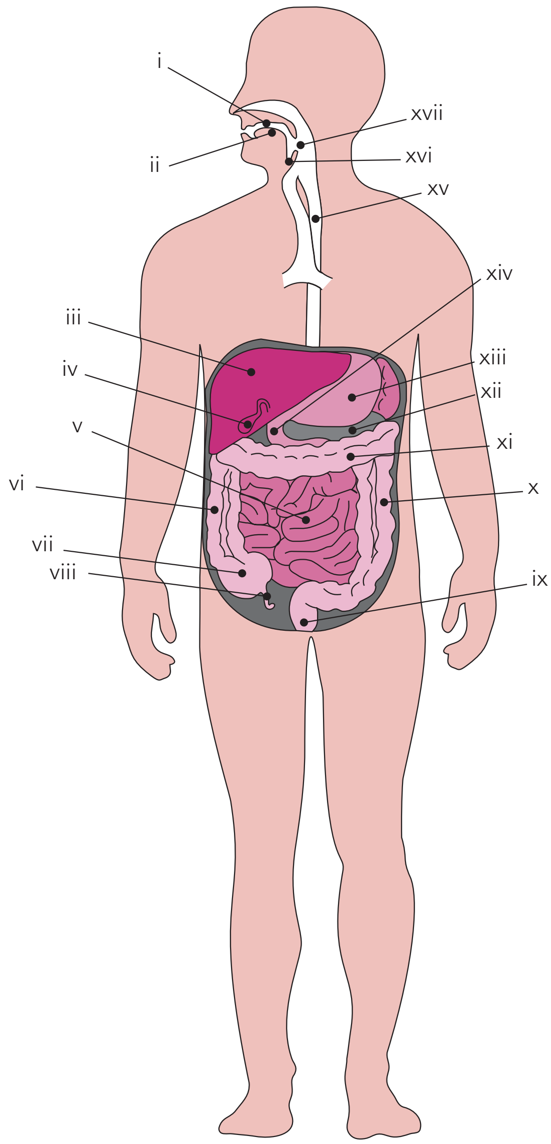
xiii ___

xiv ___

xv ___

xvi ___

xvii ___



3. Name the part/s of the alimentary canal that is/are involved in:

(i) Secretion of enzymes ______________________________

(ii) Absorption of nutrients ______________________________

(iii) Peristalsis ______________________________

(iv) Defaecation ______________________________

4. (i) Explain the role of the circulatory system in absorbing and transporting nutrients.

____

____

____

(ii) Explain the role of lymphatic system in absorbing and transporting nutrients.

____

____

____

5. There are several sphincter muscles along the length of the digestive tract.
Describe the position and function of each in the table below.

SPHINCTER	LOCATION	FUNCTION
lower oesophageal		
pyloric		
ileo-caecal		
anal		

6. What are the names of the three sections of the small intestine from the anterior to the posterior end?

____

6.2 DIGESTION

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) bile

____

(ii) chyme

____

(iii) emulsification

____

(iv) enzyme

____

(v) exocrine gland

____

(vi) mastication

____

(vii) pyloric sphincter

____

(viii) saliva

____

Review Questions

1. What are the chemical 'building blocks' of the following organic compounds?

(i) carbohydrates ______________________________

(ii) lipids ______________________________

(iii) proteins ______________________________

2. Draw simple diagrams to show how the 'building blocks' are arranged in these substances.

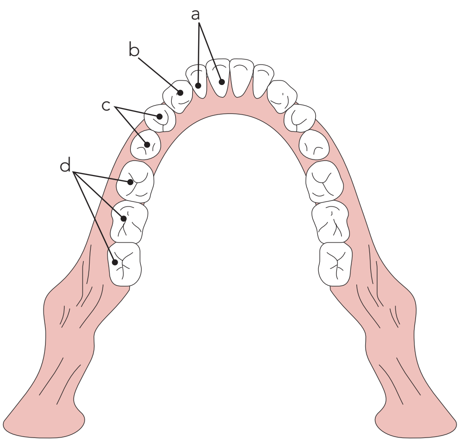
(i) carbohydrates

(ii) lipids

(iii) proteins

(iv) DNA (a nucleic acid)

3. (i) Label the four tooth types shown:



a ______________________

b ______________________

c ______________________

d ______________________

(ii) What type of digestion do the teeth carry out? ______________________

(iii) How is physical digestion different to chemical digestion?

____

____

____

____

____

____

(iv) What is the function of physical (or mechanical) digestion?

(v) Explain why the human dental formula is written as $\frac{2\ 1\ 2\ 3}{2\ 1\ 2\ 3}$

4. Describe the mechanical digestion that takes place in the:

(i) mouth

(ii) stomach

(iii) small intestine

5. Describe the chemical digestion that takes place in the:

(i) mouth

(ii) stomach

(iii) small intestine by pancreatic juice

(iv) small intestine by intestinal juice

6. (i) The gastric glands produce pepsinogen not pepsin. Explain.

(ii) How is pepsinogen converted to pepsin?

(iii) What prevents the hydrochloric acid produced in the gastric pits from damaging the intestinal lining?

7. (i) What is the role of bile in the digestive process?

(ii) Where is bile produced and stored?

6.3 ABSORPTION

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) catabolic reaction

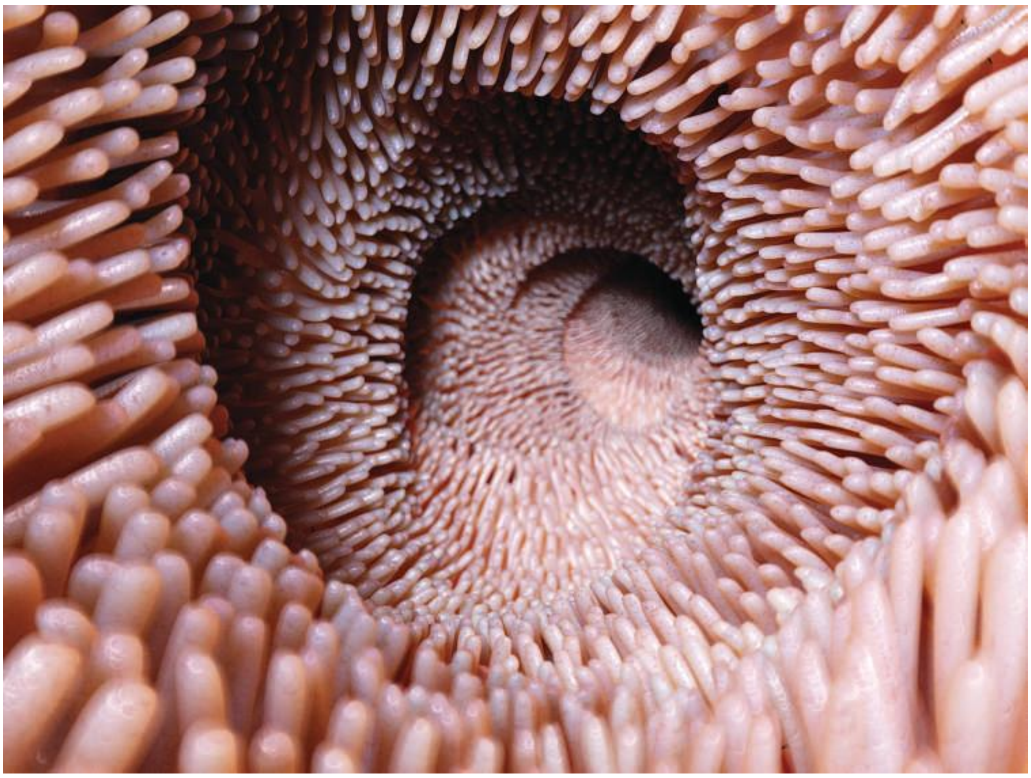
(ii) fatty acid

(iii) hepatic portal vein

(iv) ileum

(v) lacteal

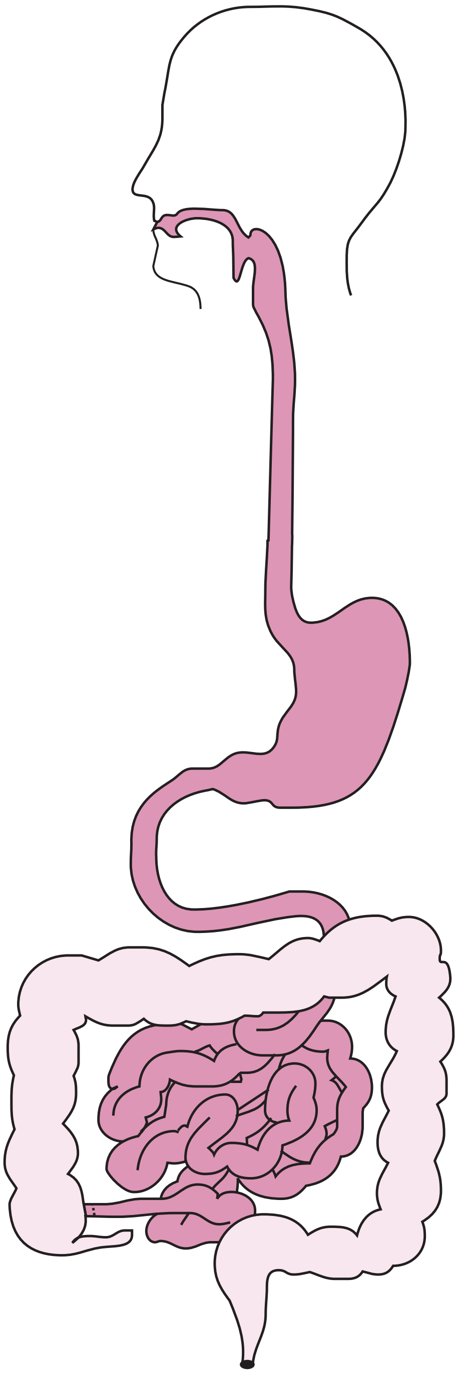
(vi) monosaccharide



Review Questions

1. (i) Add to the diagram below the **liver, gall bladder, pancreas and their associative ducts (bile and pancreatic ducts)** – label these with the letters **A, B, C, D, and E** respectively.

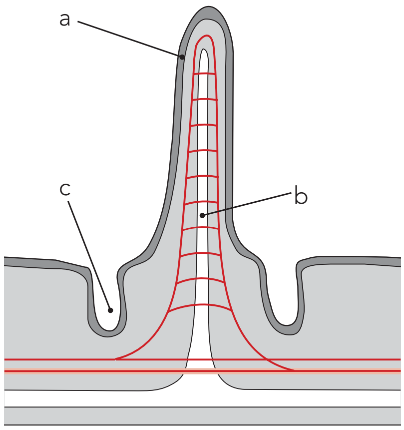
   (ii) Label the **anal sphincter, appendix and rectum** with the letters **F, G and H** respectively.



(iii) Complete the table.

	FUNCTIONS	ENZYMES	ENZYME SOURCE	SUBSTRATE	PRODUCT
Mouth					
Oesophagus					
Stomach					
Small intestine					
Large intestine					

2. (i) The diagram below shows a single villus. Label the parts shown.



a ______________________

b ______________________

c ______________________

(ii) Where are villi found in the digestive system?

____

____

____

(iii) Why are the villi so small and so numerous?

____

(iv) Name the nutrients that are absorbed by the capillaries in the villi.

____

(v) Name the nutrients that are absorbed by the lacteals in the villi.

____

3. Where does most absorption take place along the digestive tract?

____

4. Absorption may occur through any of the following processes. Briefly describe each process:

(i) Diffusion

____

(ii) Osmosis

____

(iii) Active transport

____

(iv) Endocytosis

____

6.4 ELIMINATION

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) bacteria

(ii) central nervous system

(iii) dietary fibre

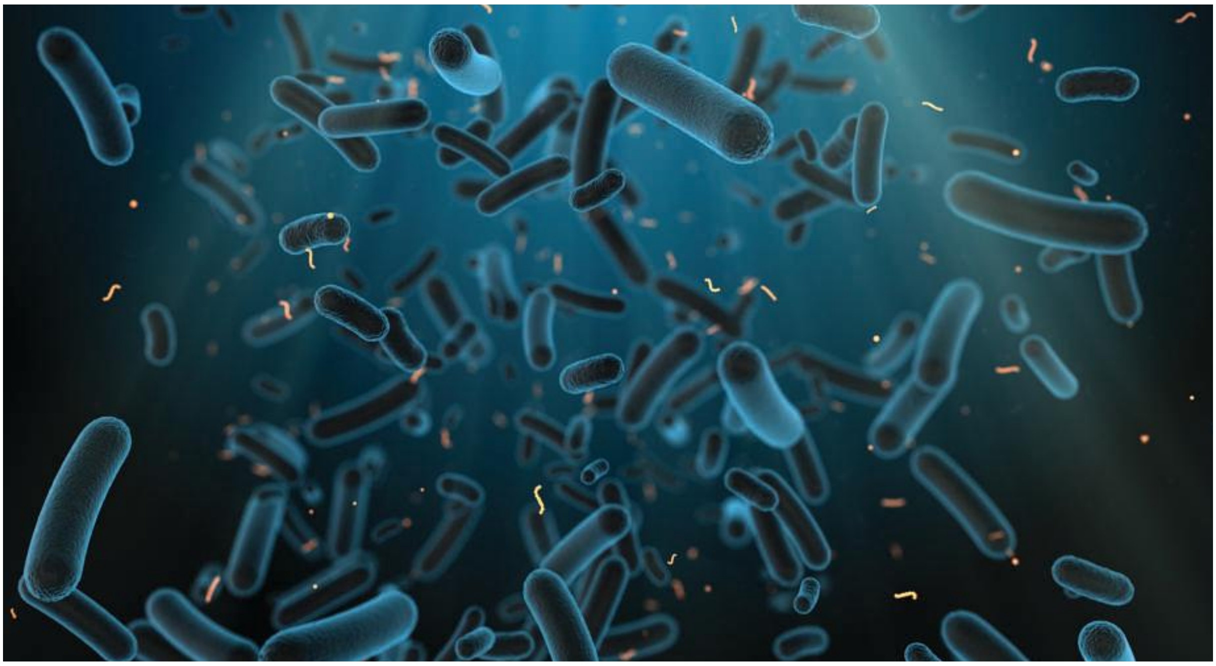
(iv) involuntary

(v) motor nerve

(vi) receptors

(vii) sensory nerve

(viii) stimulus



Review Questions

1. (i) The wastes that move down to the lower part of the colon or large intestine consist mainly of:

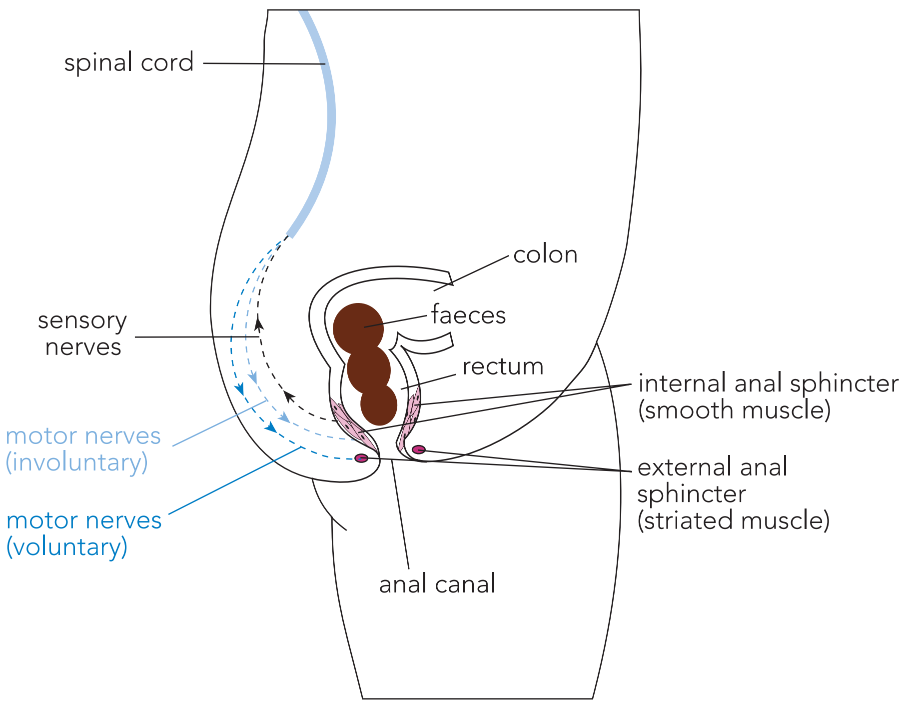
   (ii) Why does dietary fibre stimulate muscular movement of the colon?

   (iii) If faeces remain too long in the colon what might happen to its water content? Explain.

   (iv) How does this dehydration affect the consistency of the faeces? Name the condition that may result.

   (v) Explain the difference in meaning between the terms "excretion" and "defaecation".

2. Study the diagram below. The diagram will help you to answer the questions that follow.



   (i) What moves the faeces along the colon towards the rectum?

(ii) In which direction do the sensory nerves send impulses?

(iii) In which direction do motor nerves send their messages?

(iv) Describe the function of a sphincter muscle.

(v) What differences are there between the internal and the external anal sphincters?

3. Part of the flow chart below represents the "defaecation reflex" – refer to the diagram in question 2 in studying the chart.

1. A large mass of faeces is pushed into the rectum.

↓

2. The mass of faeces stretches the walls of the rectum. This stimulates stretch receptors connected to the sensory nerves.

↓

3. Sensory nerves carry messages back to the central nervous system

↓

4. Involuntary nerve messages are sent from the central nervous system to the smooth muscles of the rectum and lower colon causing them to contract and to the internal anal sphincter muscles causing them to relax.

↓

5. Faeces is forced into the anal canal — stimulating stretch receptors along the anal canal.

↓

6. Sensory nerves carry messages from the receptors of the anal canal to the conscious part of the central nervous system (cerebrum).

↓

7. A conscious decision may be made in the cerebrum to relax the external sphincter muscles and allow faeces to be eliminated.

(i) When the faeces is eliminated what will happen to the stretch receptors in the rectum?

____

(ii) As a result, what will the smooth muscles in the walls of the colon and rectum do?

____

(iii) What will the internal sphincter muscles do?

____

(iv) How will the removal of faeces from the anal canal affect the external sphincter muscles?

____

(v) A reflex is an involuntary response to a stimulus. What is the first stimulus in this flow chart?

____

(vi) Describe the part of the flow chart which is not part of a reflex.

____

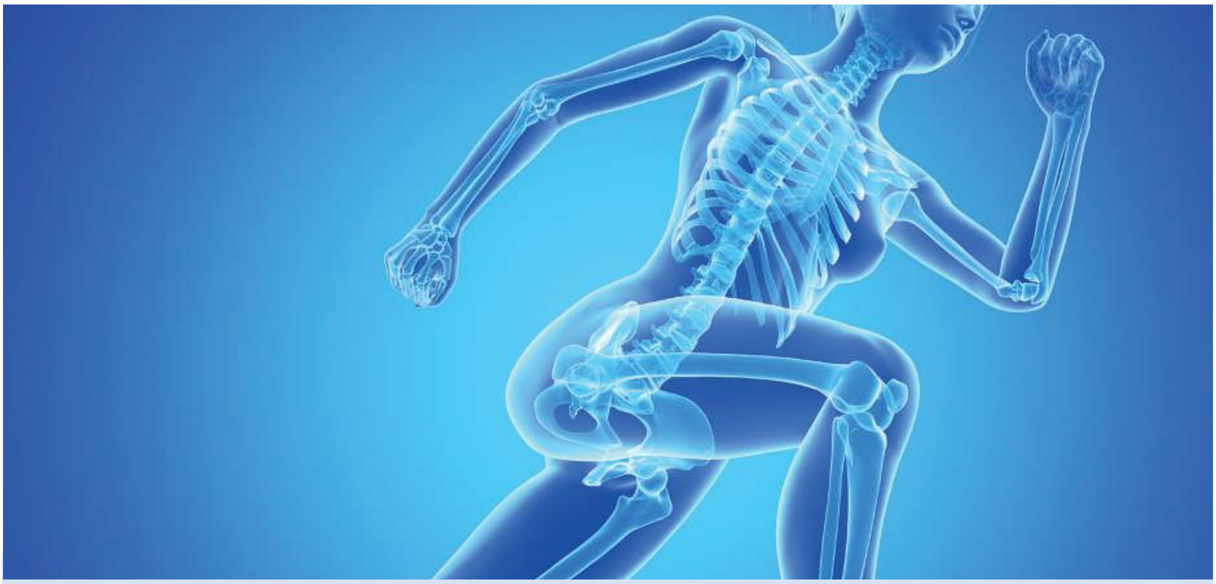
____

(vii) Name the muscles that an infant, who has not been "potty trained", cannot control.

____

MUSCULOSKELETAL SYSTEM

7



SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

7.1 STRUCTURE AND FUNCTION OF THE MUSCULAR SYSTEM

- ☐ the muscular system is organised to maintain posture and produce movement; muscle fibre contraction can be explained using the sliding filament theory.
- ☐ movement results from the actions of paired muscles, with others acting as stabilisers, to produce the required movement.

7.2 STRUCTURE AND FUNCTION OF THE SKELETAL SYSTEM

- ☐ the skeletal framework of the body consist of bone and cartilage which function to provide body support, protection and movement, and is facilitated by the structure and function at cell and tissue levels.
- ☐ articulations of joints of the skeleton are classified according to their structure or the range of movements permitted.

7.1 STRUCTURE AND FUNCTION OF THE MUSCULAR SYSTEM

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) agonist

(ii) antagonist

(iii) insertion (of a muscle)

(iv) ligament

(v) muscle

(vi) origin (of a muscle)

(vii) synergist

(viii) tendon

Review Questions

1. Complete the table below for the three muscle types.

TYPE OF MUSCLE	LOCATION	DIAGRAM	RESULT OF ITS CONTRACTION

2. What are the two main proteins that make up skeletal muscle?

____

3. Describe the SLIDING FILAMENT theory of muscle contraction. Use a diagram to illustrate your answer.

____

____

____

____

____

4. Muscles generally act in pairs that are described as antagonistic.

(i) What does antagonistic in this context mean?

____

____

(ii) In supporting the body and keeping it in an upright position the muscles shown below must be in a state of partial contraction. What is this partial contraction called?

____

Refer to the diagram below to answer these four questions:

(iii) Which muscles prevent buckling at the knee joint? (Use letters shown).

____

(iv) Which muscles hold the pelvis in position?

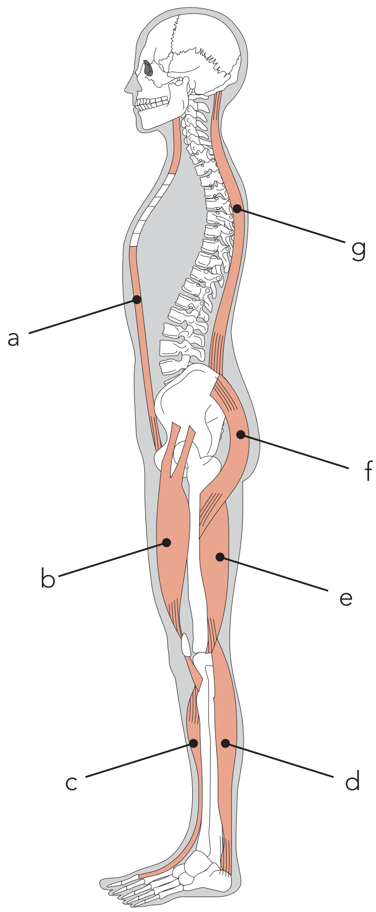
____

(v) Which muscles extend the spine?

____

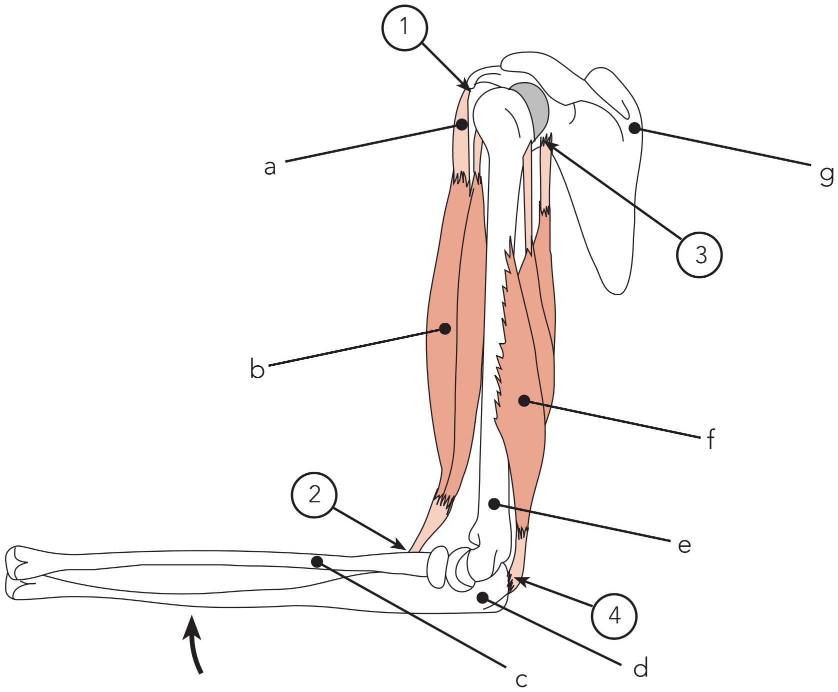
(vi) Which muscles flex the spine?

____



5. Study the diagram below, provide only the labels shown, then answer the questions that follow it.

(i)



a ______________________ e ______________________

b ______________________ f ______________________

c ______________________ g ______________________

d ______________________

(ii) Which numbered point is an **origin** of the triceps? ______________

(iii) Which numbered point is the **insertion** of the triceps? ______________

(iv) The biceps has two origins — hence the name **bi**ceps — describe where the origins are.

____

____

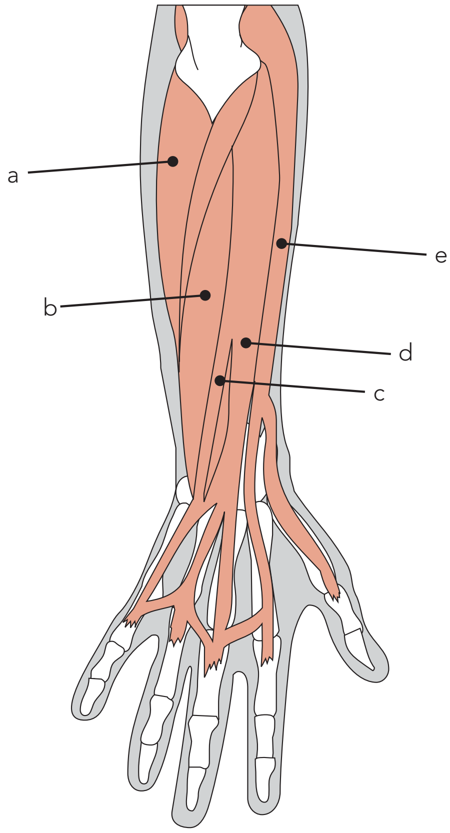
(v) How many origins do you think the triceps might have? ______________

(vi) When the hand is raised to the position shown above, which muscle contracts?

____

Which muscle relaxes? ______________________________

6. The drawing shown below shows a view of the hand and forearm with the palm facing downwards

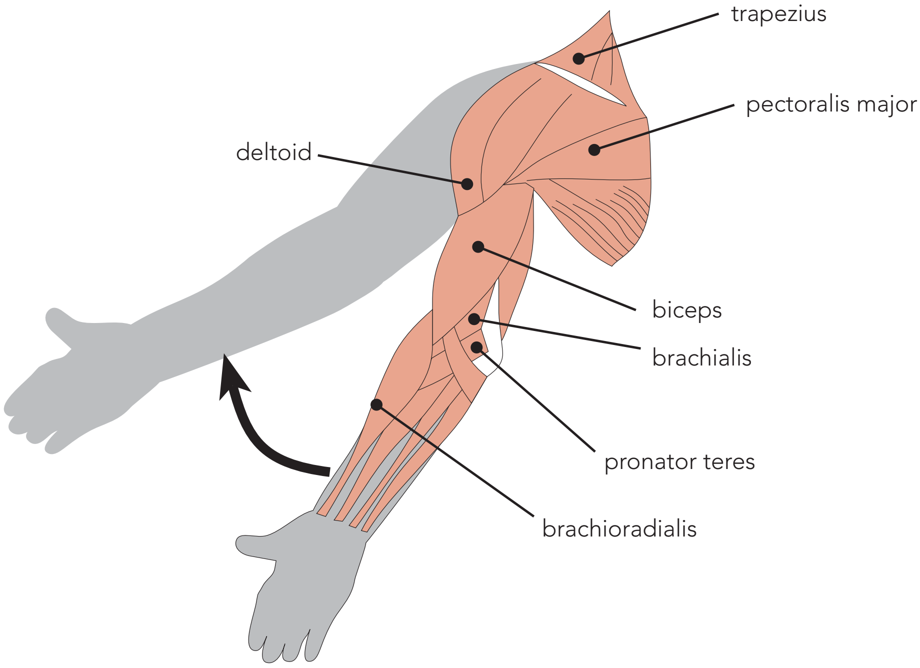


(i) If the middle finger was in a flexed position, which muscle would extend it?

(ii) In general terms, where are the muscles which control the extension and flexion of the fingers?

---

7. The diagram below show the main muscle groups associated with the upper limb.



(i) Which muscle would raise the humerus as shown by the arrow?

(ii) Which joint would be involved in this movement?

(iii) What type of joint is it?

(iv) Why do we have such great flexibility at this joint?

8. (i) When you bend down to pick up a small object (example a pencil) from the floor, which two fingers do you normally use?

(ii) When the object is held between these fingers, what type of grip is being applied?

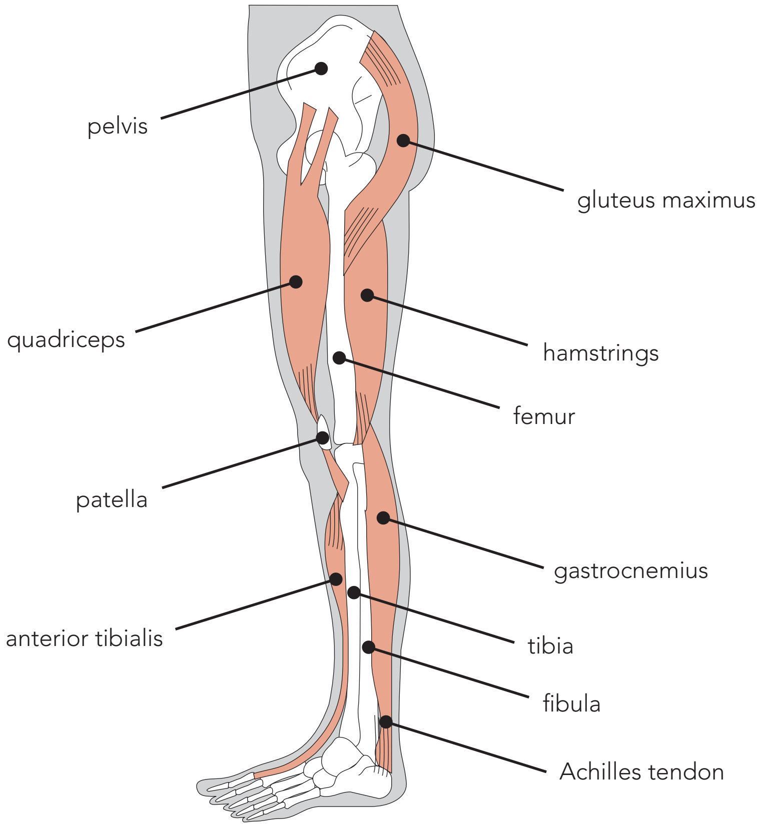
(iii) If you use a hammer to drive a nail into some wood, how many fingers are used (on the hammer)?

(iv) Describe their positions.

(v) Name the type of grip used.

(vi) How and when might an ape use each of the grips described above?

9. The diagram below shows the main muscle groups associated with the lower limbs.



(i) Describe the movement, which results from the contraction of the following muscles shown on the diagram above.

Gluteus maximus

___

Hamstrings

___

Gastrocnemius

___

Anterior tibialis

___

Quadriceps

___

(ii) Which muscles would contract if this leg were to be thrust forward as a step is taken?

___

7.2 STRUCTURE AND FUNCTION OF THE SKELETAL SYSTEM

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) articulation

(ii) cancellous bone

(iii) chondrocyte

(iv) collagen fibres

(v) compact bone

(vi) foramen

(vii) Haversian system

(viii) macroscopic

(ix) osteocyte

(x) periosteum

(xi) red marrow

(xii) synovial fluid

(xiii) yellow marrow

Review Questions

1. Describe briefly five functions of the skeleton.

(i)

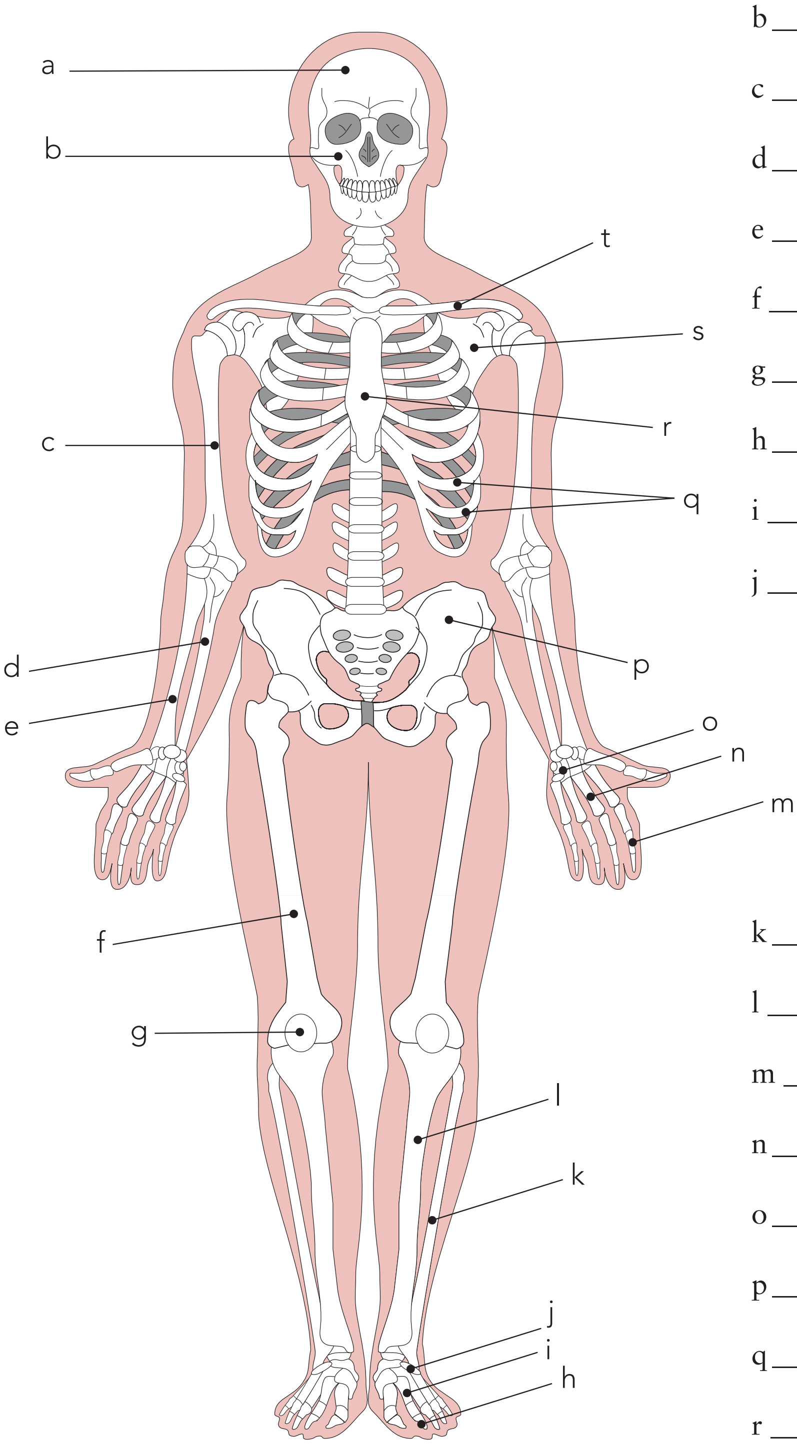
(ii)

(iii)

(iv)

(v)

2. (i) Label the following diagram.



a ______________________________

b ______________________________

c ______________________________

d ______________________________

e ______________________________

f ______________________________

g ______________________________

h ______________________________

i ______________________________

j ______________________________

k ______________________________

l ______________________________

m ______________________________

n ______________________________

o ______________________________

p ______________________________

q ______________________________

r ______________________________

s ______________________________

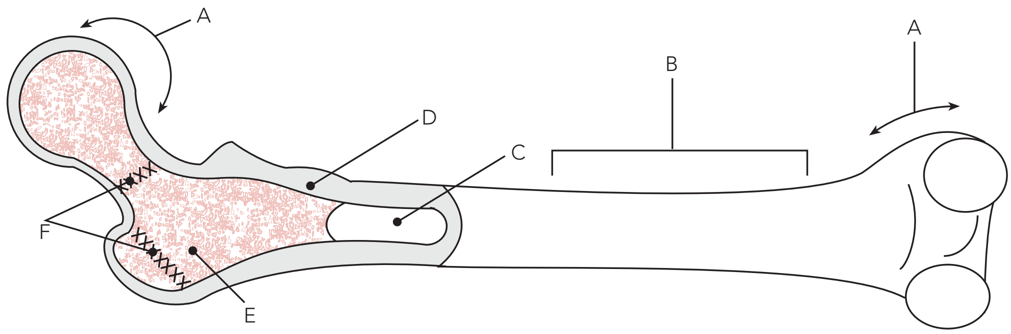
t ______________________________

(ii) Name the major bones that make up:

a) the shoulder girdle ______________________________

b) the pelvic girdle ______________________________

3. (i) Label the diagram of a bone (macroscopic view).



(ii) Sketch and label a microscopic view of bone.

4. (i) Where in the body would you expect to find cartilage?

____

(ii) What is the function of cartilage?

____

____

5. Complete the table below.

TYPE OF CARTILAGE	WHERE FOUND	FUNCTION
Hyaline		
Fibrocartilage		
Elastic cartilage		

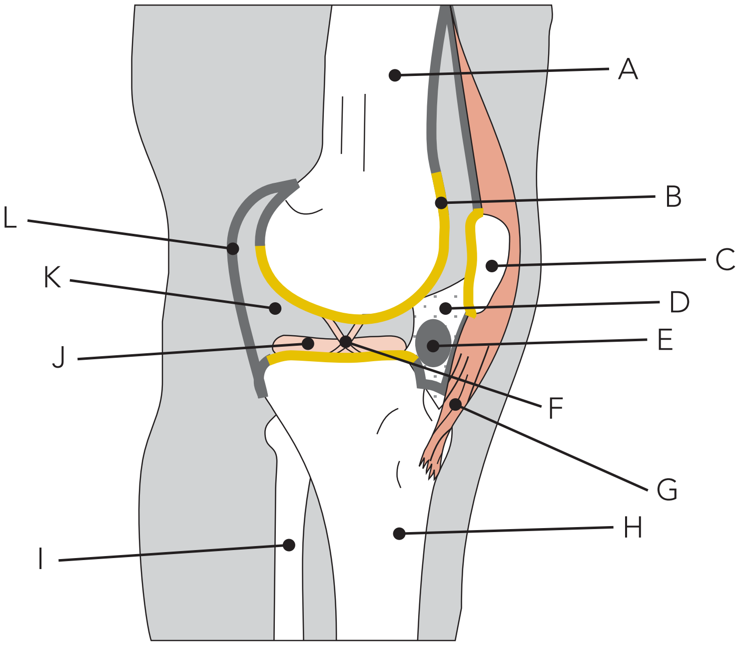
6. (a) Describe a synovial joint.

___

___

___

(b) Label the following diagram.



A ___

B ___

C ___

D ___

E ___

F ___

G ___

H ___

I ___

J ___

K ___

L ___

7. Complete the table below.

TYPE OF JOINT	DIAGRAM	WHERE FOUND IN THE BODY	POSSIBLE MOVEMENT IN THE JOINT
(i) IMMOVABLE			
(ii) CARTILAGINOUS			
(iii) SYNOVIAL			
Ball and socket			
Hinge			
Pivot			
Gliding			

EXCRETORY SYSTEM

8

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

8.1 STRUCTURE AND FUNCTION OF THE EXCRETORY SYSTEM

- [ ] the excretory system regulates the chemical composition of body fluids by removing metabolic wastes and regulating water, salts, and nutrients (regulatory processes not required).

8.2 DEAMINATION

- [ ] deamination of amino acids in the liver produces urea, which then is transported to the kidneys for removal.

8.3 THE NEPHRON

- [ ] the nephrons in the kidney facilitate three basic processes: filtration, reabsorption and secretion during urine formation to maintain the composition of body fluids (hormone control is not required).

8.1 STRUCTURE AND FUNCTION OF THE EXCRETORY SYSTEM

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) abdominal cavity

(ii) cortex

(iii) medulla

(iv) metabolic waste

(v) micturation

(vi) renal

(vii) sweat gland

(viii) toxic

(ix) ureter

(x) urethra

(xi) urinary bladder

(xii) urine

Review Questions

1. What is meant by the term 'excretion'?

2. Why is excretion necessary?

3. Describe the role played by each of the following structures in excretion:

   (i) Lungs

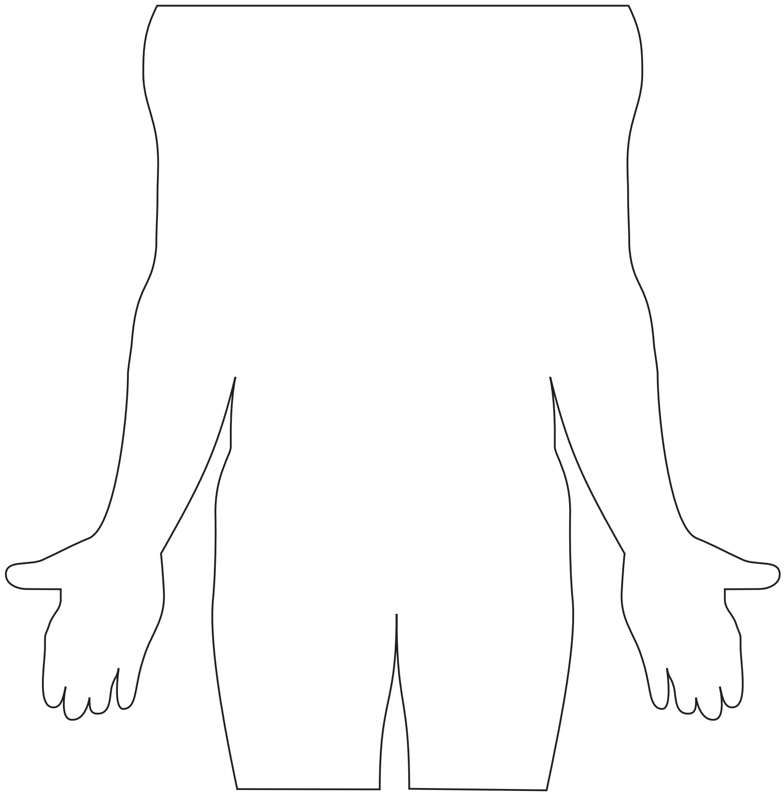
   (ii) Sweat glands

   (iii) Alimentary canal

   (iv) Kidneys

(v) Liver

4. On the outline of the body below, draw in the following: *kidneys, aorta, renal arteries, renal veins, ureters, bladder, urethra* (label each part clearly).



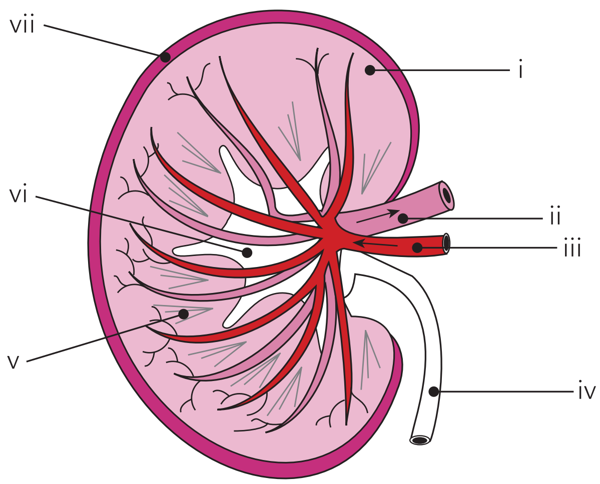
5. In general terms, compare the **contents of the fluids** in each of the following:

(i) renal arteries

(ii) renal veins

(iii) ureters

6. Label and annotate the diagram of the kidney.



(i)

(ii)

(iii)

(iv)

(v)

(vi)

(vii)

8.2 DEAMINATION

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) ammonia

(ii) glycogen

(iii) protein

(iv) respiration

(v) urea

Review Questions

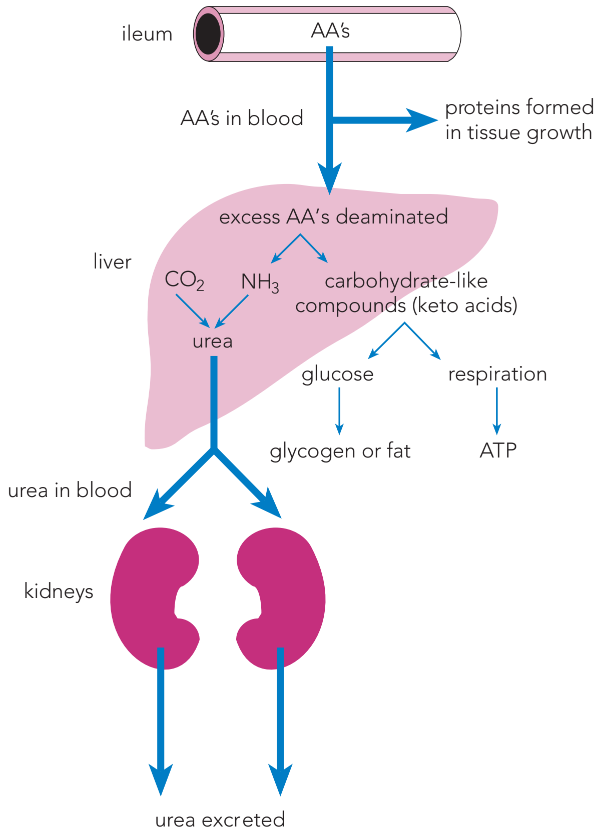
1. What is urine? What substances does it normally contain?

2. (i) What is urea? Where is it produced?

(ii) The chemical formula for urea is $CO(NH_2)_2$. Name the elements present in this compound.

(iii) Discuss the relative size of this compound compared to other organic compounds and its solubility in water. Explain why these properties are important.

3. The diagram below shows some of the pathways amino acids (AA's) may take following the digestion of dietary proteins. Answer the questions that follow.



(i) Explain what "deamination" means.

____

____

(ii) Why are excess proteins deaminated?

____

(iii) Why is ammonia converted to urea?

____

(iv) Why is the urea excreted?

____

(v) Excess amino acids are not entirely wasted. Explain this statement.

____

(vi) How is excess glucose stored?

____

(vii) The chemical formula of urea is $CO(NH_2)_2$. Where does the carbon come from in urea?

____

8.3 THE NEPHRON

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) active transport

(ii) afferent arteriole

(iii) collecting duct

(iv) convoluted tubule

(v) diffusion

(vi) efferent arteriole

(vii) filter

(viii) filtrate

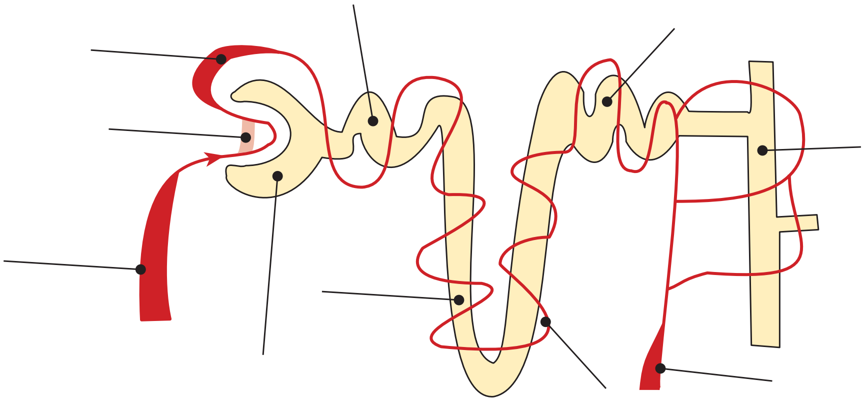
(ix) osmosis

(x) peritubular capillary network

(xi) tubular secretion

Review Questions

1. Each kidney contains approximately one million nephrons. One nephron is drawn below. Label this diagram, then answer the questions which follow it.



Describe the pathway taken by:

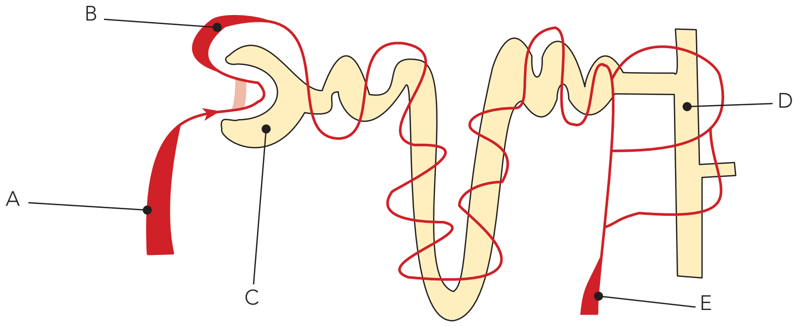
(i) a large protein from the time it enters the kidney to the time it leaves.

(ii) a glucose molecule from the time it enters the kidney to the time it leaves.

(iii) a nitrogenous waste (e.g. urea) from the time it enters the kidney to the time it leaves.

(iv) explain briefly why each of these pathways is different.

2. Study the diagram and the table below then answer the questions.



FLUID TESTED	CONCENTRATION OF SUBSTANCE IN FLUID TESTED (MG/100ML)		
	urea	**glucose**	**protein (large)**
plasma in A	20	100	7000
plasma in B	20	100	8000
fluid filtrate in C	20	100	0
urine in D	500	0	0
plasma in E	15	98	7500

(i) What happens to the concentration of large proteins in the blood as it flows through the glomerulus and on to point B in the diagram?

____

(ii) Explain how the increase in the protein concentration in the blood may have occurred.

____

(iii) Explain why large proteins do not move across the membranes separating the blood from the inside of the glomerular capsule.

____

(iv) What happens to the glucose in the fluid from the tubule to the right of the glomerular capsule C?

____

(v) Explain why glucose leaves the glomerulus and enters the glomerular capsule when proteins do not.

____

(vi) Why is there a slight drop in glucose concentration in the plasma in the venule E?

____

(vii) What is the process called in which glucose is absorbed against a concentration gradient?

____

(viii) Explain why there is the high concentration of urea at point D.

3. What is meant by the following terms:

(i) glomerular filtration

(ii) renal filtrate

(iii) reabsorption

(iv) obligatory reabsorption

(v) tubular secretion

4. If the nephrons in the kidneys were diseased or damaged, how might this affect body fluids?

5. Most of the glucose reabsorption takes place in the proximal convoluted tubule.

(i) Explain why both passive diffusion and active transport are necessary for the recovery of most of the glucose.

(ii) What explanations could be given if a significant concentration of sugar is found in the urine?

(iii) Why does the body tend to recover all the glucose from the filtrate?

(iv) Why does the body not recover all the water from the filtrate?

SCIENCE AS A HUMAN ENDEAVOUR 1

9

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

- ☐ blood transfusions rely on determining blood groups and can be used to treat many different diseases and conditions.
- ☐ treatment of conditions due to system or organ dysfunction has changed through improvements in early diagnosis and appropriate use of drugs, physical therapy and removal and/or replacement of affected parts.
- ☐ osteoporosis and osteoarthritis are diseases, primarily of ageing, that cause disability. Increased understanding of the causes of these conditions leads to improved practices for management and prevention.
- ☐ lifestyle choices, including being active or sedentary, the use of drugs and type of diet, can compromise body functioning in the short term and may have long-term consequences.

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) agglutination

____

(ii) antibody

____

(iii) antigens

____

(iv) diagnosis

____

(v) dysfunctional

____

(vi) erythrocyte

____

(vii) hygiene

____

(viii) hypertension

____

(ix) osteoarthritis

____

(x) osteoporosis

____

(xi) transfusion

____

(xii) therapy

____

Review Questions

1. When are blood transfusions used?

2. Explain why blood tests must be done on the recipient's blood before they are given a blood transfusion.

3. (i) Complete the ABO blood group table below.

BLOOD GROUP	ANTIGEN/S ON RBCS	ANTIBODIES IN PLASMA	CAN RECEIVE BLOOD TRANSFUSION FROM GROUP/S	CAN DONATE BLOOD TO GROUP/S
A				
B				
AB				
O				

(ii) Explain why blood group O is described as the "universal donor".

(iii) Explain why blood group AB is described as the "universal recipient".

4. (i) Blood is also classified as Rh negative (Rh^-) or Rh positive (Rh^+). Explain the differences between the two.

(ii) Why does the first transfusion of an Rh positive donor to an Rh negative recipient often cause no problems?

(iii) Complete the table below.

BLOOD GROUP	CAN RECEIVE BLOOD TRANSFUSION FROM GROUP/S	CAN DONATE BLOOD TO GROUP/S
A Rh^-		
A Rh^+		
B Rh^-		
B Rh^+		
AB Rh^-		
AB Rh^+		
O Rh^-		
O Rh^+		

5. Discuss the problem that occurs when pregnant Rh^- women are carrying Rh^+ babies?

6. Discuss one example of a disease in which each of the following treatments can impove the condition of the patient.

(i) early diagnosis and appropriate use of drugs.

(ii) physical therapy.

(iii) removal and/or replacement of affected parts.

7. Complete the table below.

	OSTEOPOROSIS	OSTEOARTHRITIS
possible causes		
resulting disabilities		
prevention		
management		

8. Explain why cardiovascular disease has increased in importance in the last fifty years.

9. What is the most common cause of cardiovascular disease?

10. (i) What factors may cause hypertension?

(ii) How can hypertension be controlled?

11. Distinguish between **arteriosclerosis** and **atherosclerosis**.

12. What physiological effects do the following risk factors have on the body? Show also the resultant cardiovascular disease each may cause.

RISK FACTOR	PHYSIOLOGICAL EFFECTS	RESULTANT CARDIOVASCULAR DISEASE
(i) smoking		
(ii) lack of exercise		
(iii) poor diet (e.g. high intake of fats)		
(iv) stress		

13. List the steps a person can take to adopt a health sustaining lifestyle.

____

____

____

____

____

____

14. (i) What is 'personal hygiene'?

____

____

____

(ii) Although avoiding all infections is not entirely possible, we can minimise the times we do become sick. What are some of the things we can do to prevent ourselves from becoming ill?

____

____

____

____

(iii) What special personal hygiene is recommended for women?

(iv) What special personal hygiene is recommended for men?

15. (i) What are anabolic steroids?

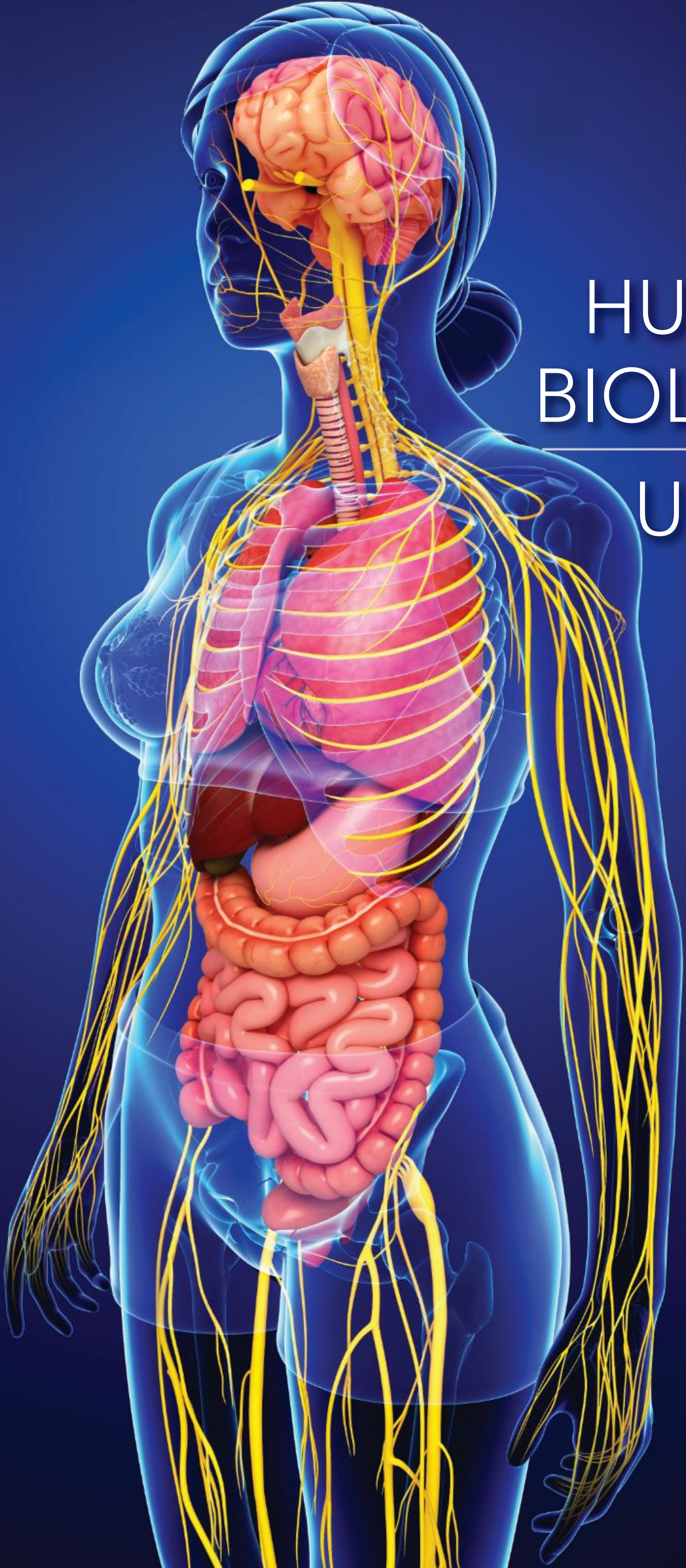
(ii) Can anabolic steroids be used for legitimate reasons?

(iii) For what purposes are anabolic steroids used illegally?

(iv) What other effects do they have on the body?

HUMAN BIOLOGY

UNIT 2



SCIENCE INQUIRY SKILLS 2

SYLLABUS CHECKLIST

On completion of this chapter you should be able to:

- ☐ identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes.
- ☐ design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics.
- ☐ conduct investigations, safely, competently and methodically for the collection of valid and reliable data.
- ☐ represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error and limitations in data; and select, synthesise and use evidence to make and justify conclusions.
- ☐ interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments.
- ☐ select, construct and use appropriate representations, including models of DNA replication, transcription and translation, Punnett squares, pedigrees and karyotypes, to communicate conceptual understanding, solve problems and make predictions.
- ☐ communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports.

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) antivivesection

(ii) ethics

(iii) experimental control

(iv) karyotype

(v) peer review

(vi) prediction

(vii) primary data

(viii) qualitative data

(ix) quantitative data

(x) reliable data

(xi) valid data

(xii) variable

Review Questions

1. How is scientific methodology unique?

2. (i) Distinguish between a hypothesis and a prediction.

   (ii) Give an example of a hypothesis.

   (iii) Write down a prediction based on your hypothesis.

   (iv) In your hypothesis, identify:

   (a) the dependent variable.

   (b) the independent variable.

3. Imagine that you are a scientist working about eighty years ago. After some years of casual observation you make the hypothesis that smoking causes lung cancer. At the time no one believes you, as it is a new and surprising idea!

   (i) How might you gather evidence to support your hypothesis?

   (ii) What evidence would support your hypothesis?

(iii) What evidence would refute it?

4. A scientific report may be written up under the following headings:

a) Title b) Aim c) Materials d) Procedure e) Results f) Conclusion g) References

Briefly describe what kind of information is generally given under each heading.

a)

b)

c)

d)

e)

f)

g)

5. (i) Explain briefly why the *sequence* of nitrogenous bases in DNA is important.

(ii) What is a section of the DNA, which codes for the synthesis of a particular polypeptide or protein, called?

(iii) Describe the structure of a chromosome.

____

____

____

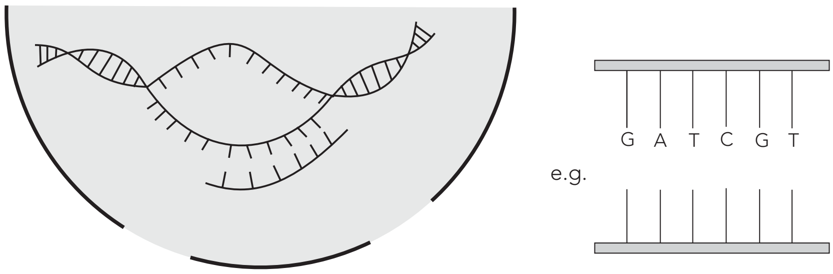
____

6. Draw simple well labelled diagrams to show how a DNA molecule is believed to replicate.

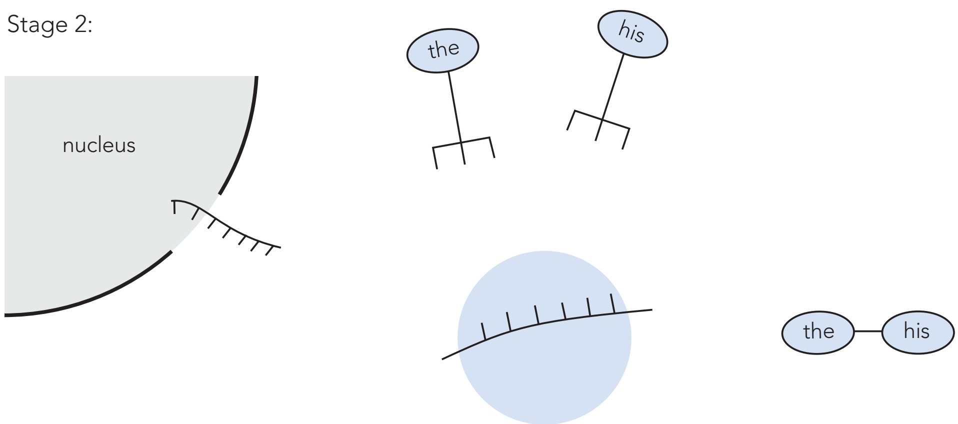
7. The diagram below shows the main sequences that take place during protein synthesis.

Protein synthesis has two stages

Stage 1:



Stage 2:



(i) Label the following:

DNA, mRNA , tRNA, nuclear pore, cytoplasm, ribosome, amino acid

a) Using the e.g. on the top right hand side of the diagram write in the letters of the nucleotides in their correct order on all mRNA molecules.
b) Show the anticodons by writing on to the tRNA the appropriate nucleotide letters.
c) Complete the diagram by showing where the tRNA molecules join the mRNA.
d) Circle and label the codons.
e) Circle and label the area where transcription is taking place.
f) Circle and label the area where translation is taking place.

(ii) The diagram shows only two amino acids – what is the name of the chemical bond that forms between them?

____

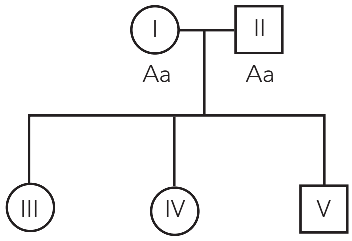
(iii) If a protein was formed what changes would be required to the diagram?

____

____

____

8. The diagram below shows a short pedigree.



(i) Use a punnet square to show the possible genotypes of individual IV.

(ii) Use the punnet square to determine the probability of each offspring's genotype.

____

____

____

(iii) If "A" represents the gene for normal skin pigmentation and "a" represents the gene for albinism, what is the probability of each possible phenotype in the offspring? Show how you arrived at your answer.

____

____

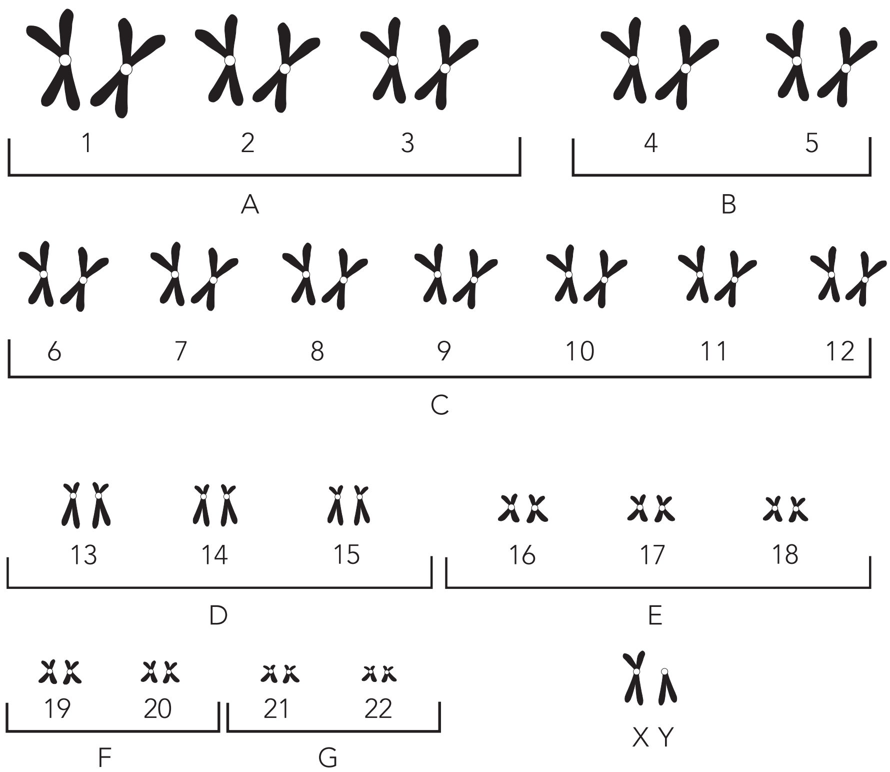
____

____

____

____

9. The diagram below shows a human **karyotype**.



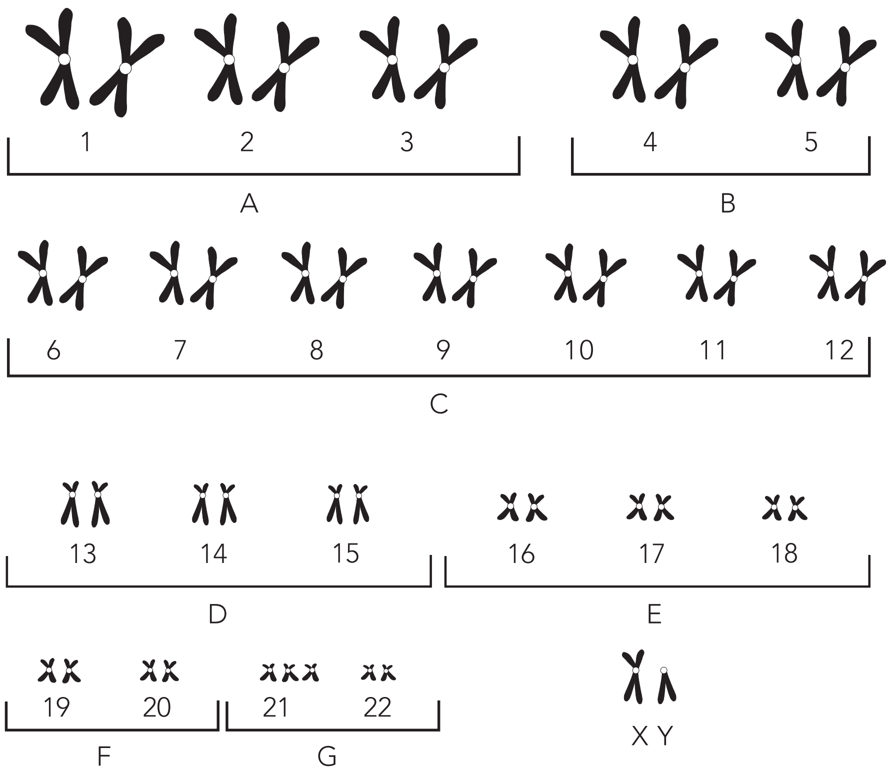
(i) What is a karyotype?

(ii) How are karyotypes made? List the steps.

(iii) Of what use are karyotypes?

(iv) List what you can interpret from the karyotype shown.

10. Carefully study the karyotype below. Then answer the questions that follow it.



(i) How is this karyotype:

(a) different to the karyotype in question 9?

(b) similar to the karyotype in question 9?

(ii) Explain how this difference may have come about. Use a labelled diagram to illustrate your answer.

(iii) During cell division, at what stage would this error have occurred?

(iv) Name the condition that this mutation causes.

DNA

11

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

11.1 DNA

- [ ] DNA occurs bound to proteins in chromosomes in the nucleus and as unbound DNA in the mitochondria.
- [ ] DNA stores the information for the production of proteins that determines the structure and function of cells.
- [ ] the structural properties of the helical DNA molecule, including double-stranded, nucleotide composition and weak bonds involved in base pairing between the complementary strands, allow for its replication.

11.2 PROTEIN SYNTHESIS

- [ ] protein synthesis involves the transcription of a gene on DNA into messenger RNA in the nucleus, and translation into an amino acid sequence at the ribosome with the aid of transfer RNA.

11.3 EPIGENETICS

- [ ] epigenetics is the study of phenotypic expression of genes, which depends on the factors controlling transcription and translation during protein synthesis, the products of other genes, and the environment.

11.1 DNA

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) base pair

(ii) chromosome

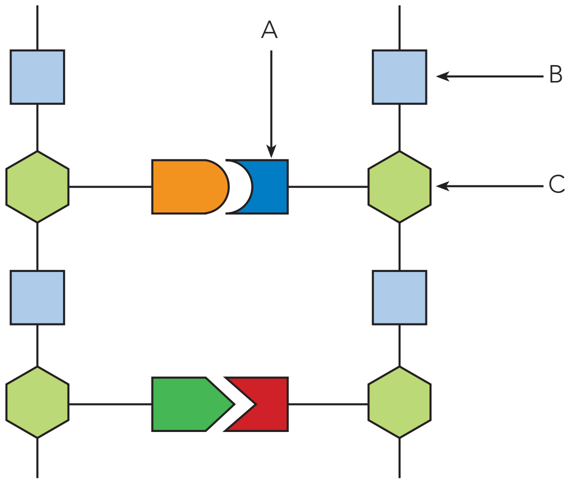
(iii) complimentary DNA strand

(iv) DNA replication

(v) histone

Review Questions

1. The following diagram represents a short segment of DNA.



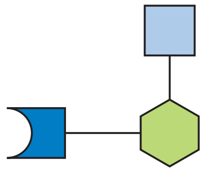
Name the substances labelled A, B and C.

A ______________________________

B ______________________________

C ______________________________

2. If a small part of the molecule is isolated, it could be represented by:



(i) What is this unit called ? ______________________________

and (ii) where might it be found in this separated form?

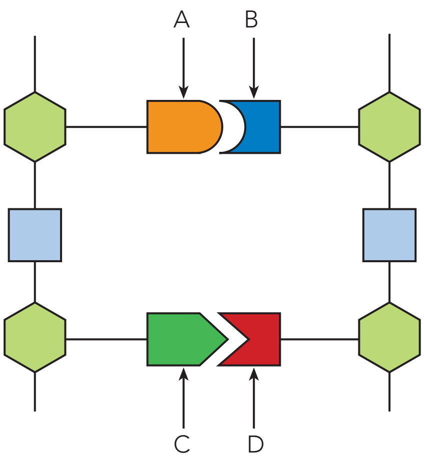
____

3. There are four different nitrogenous bases in DNA. What are they called?

____

____

4. In the following diagram:



If A is cytosine, then B is ______________________________

If C is thymine, then D is ______________________________

5. Explain briefly why the *sequence* of nitrogenous bases in DNA is important.

____

____

6. Name the **two** organelles where DNA is found in a normal cell.

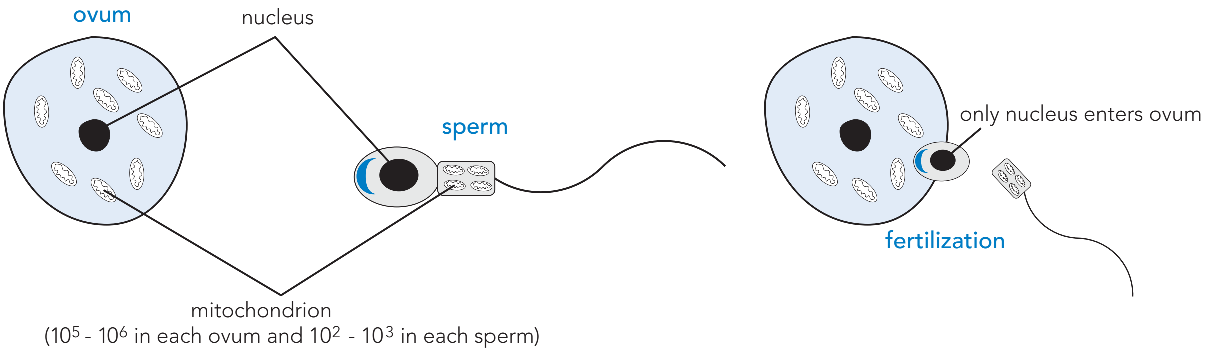
____

7. What is the importance of mitochondrial DNA?

____

____

8. Study the following diagrams carefully (cells not drawn to scale).

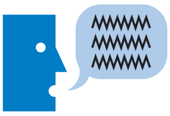


(i) Explain why one gamete type contributes most of the mitochondria to the new zygote. Which gamete type contributes the mitochondria?

(ii) Which organelles contain DNA?

(iii) Mitochondrial DNA is believed to control the production of proteins which are involved in respiration. Which parent always contributes this DNA to the offspring?

11.2 PROTEIN SYNTHESIS



Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) anticodon

(ii) codon

(iii) m RNA

(iv) ribosome

(v) t RNA

(vi) transcription

(vii) translation

Review Questions

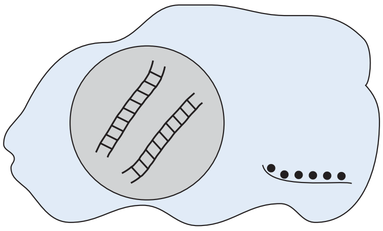
1. Proteins have important roles in the body. Name five of these roles.

2. (i) What do the letters in DNA and RNA stand for?

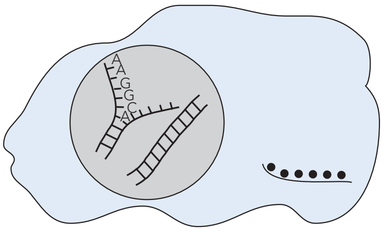
(ii) List four differences between these two molecules.

3. The series of diagrams below show how protein synthesis occurs in cells. Beside each diagram write down what is occurring in that stage.

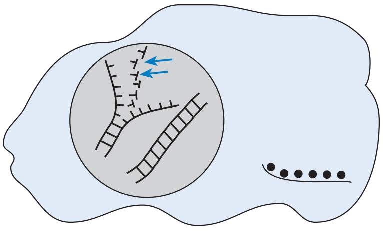
(a)



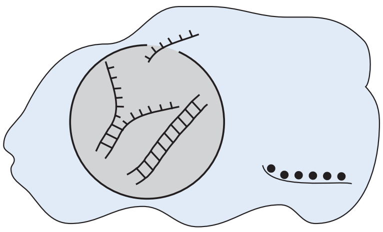
(b)



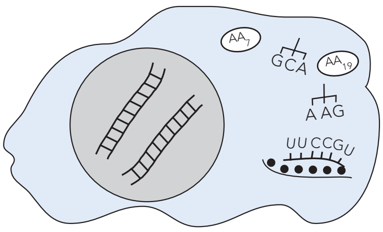
(c)



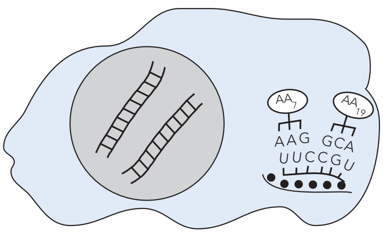
(d)



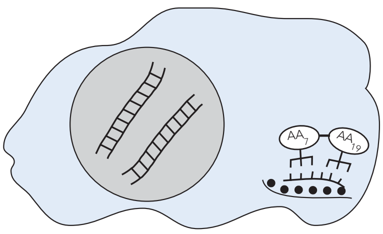
(e)



(f)



(g)



4. For a protein to be made or synthesised, information has to be taken off a DNA molecule and used to link amino acids together in a specific sequence. This involves two processes—transcription and translation. Distinguish between transcription and translation by completing each sentence in the table below.

TRANSCRIPTION	TRANSLATION
• occurs inside the ______________________. • is the process that copies the code on part of the _________________________ onto a strand of mRNA. • the ________________molecule unwinds and one strand of the helix is used as a template. • an enzyme (DNA __________________) joins ____________________ together to form a strand of messenger RNA. • the sequence of bases on mRNA is complimentary to the sequence of bases on the strand of ______________________.	• occurs in the _________________________. • is the process in which _________________ acids are assembled to form proteins. • ________________ leaves the nucleus and moves into the cytoplasm. • mRNA attaches onto a ________________. • the anticodon on _____________________ attaches to the ____________ on the mRNA. • the amino acids from tRNA are linked together to form the amino acid chain or _________________________.

5. The genetic code is described as a "triplet code" and "degenerate". Explain what is meant by these two terms.

____

____

____

____

6. Use the genetic code below to answer the questions that follow.

		SECOND BASE OF CODON					
		U	C	A	G		
FIRST BASE OF CODON	U	phe phe leu leu	ser ser ser ser	tyr tyr STOP STOP	cys cys STOP trp	U C A G	THIRD BASE OF CODON
	C	leu leu leu leu	pro pro pro pro	his his glu glu	arg arg arg arg	U C A G	
	A	ile ile ile met+start	thr thr thr thr	asp asp lys lys	ser ser arg arg	U C A G	
	G	val val val val	ala ala ala ala	asp asp glu glu	gly gly gly gly	U C A G	

(i) What would be the sequence of amino acids that the following strands of mRNA represent?

(a) AUGCAUGGCAAAAUCCUAGAUUAG

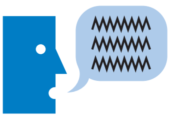
(b) GGGCAUAUCGUUAUAUGAUCUGGC

(ii) Complete this table

STRAND OF DNA THAT IS 'READ'	TRANSCRIBED mRNA STRAND	tRNA ANTICODONS
G	C	
	C	G
	C	
T	A	
A		A
G	C	
T	A	
	A	U
	U	

(iii) What amino acids does the strand of DNA code for?

11.3 EPIGENETICS



Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) epigenome

(ii) genome

(iii) inheritable

(iv) methyl group

(v) nucleosome

Review Questions

1. Explain what is meant by 'gene expression'.

2. Name two things that could permanently change the expression of the genes in a cell.

3. Explain why epigenetics is an expanding new area of research.

4. Gene expression can be modified by the environment. Two examples are:

   (i)

   (ii)

5. Explain how UV light affects melanin production.

6. Show how DNA and histones are bound together in a chromosome. Illustrate this with a simple labeled diagram below.

7. (i) Explain why histone modification in important in gene expression.

(ii) How does DNA methylation affect gene expression?

(iii) The methyl tags which attach to DNA can be passed on to offspring. What is the significance of this discovery?

(iv) Some scientists have described a person's genome as being like the hardware of a computer while the person's epigenome is like the computer's software. Briefly discuss what this analogy means.

(v) An individual's DNA may not change during his or her lifetime but his or her epigenome must change. What does this statement mean and what evidence is there to support it?

(vi) How can epigenetics explain the differences between identical twins?

(vii) How might epigenetics explain why identical twins appear to become more different as they become older?

CELL REPRODUCTION

12

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

12.1 MITOSIS

- ☐ mitosis forms part of the cell cycle producing new cells with the same genetic content.
- ☐ the sequence of DNA replication, chromosome duplication and chromosome separation are important processes in the production of identical daughter cells by mitosis for growth, repair and replacement of tissues within the body.
- ☐ stem cells have the ability to divide by mitosis and differentiate into many different tissues, depending on the level of cell potency.
- ☐ uncontrolled division of cells can result in the development of tumours/cancers.

12.2 MEIOSIS

- ☐ meiosis produces gametes for reproduction and involves DNA replication, chromosome pairing, and two successive nuclear divisions distributing haploid sets of chromosomes to each gamete.
- ☐ crossing over, non-disjunction and random assortment of chromosomes during meiosis will produce gametes with different genetic content.

12.3 DIFFERENCES BETWEEN MITOSIS AND MEIOSIS

- ☐ differences between mitosis and meiosis reflect their roles in the body.
- ☐ variations in the genotypes of offspring, including gender, arise as a result of the processes of meiosis and fertilisation.

12.1 MITOSIS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) carcinogenic agent

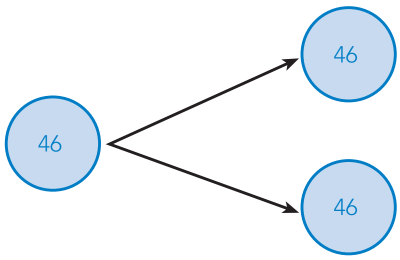
(ii) differentiation

(iii) neoplasm

(iv) tissue

Review Questions

1. When a cell with 46 chromosomes undergoes mitosis, it produces two daughter cells each with 46 chromosomes.



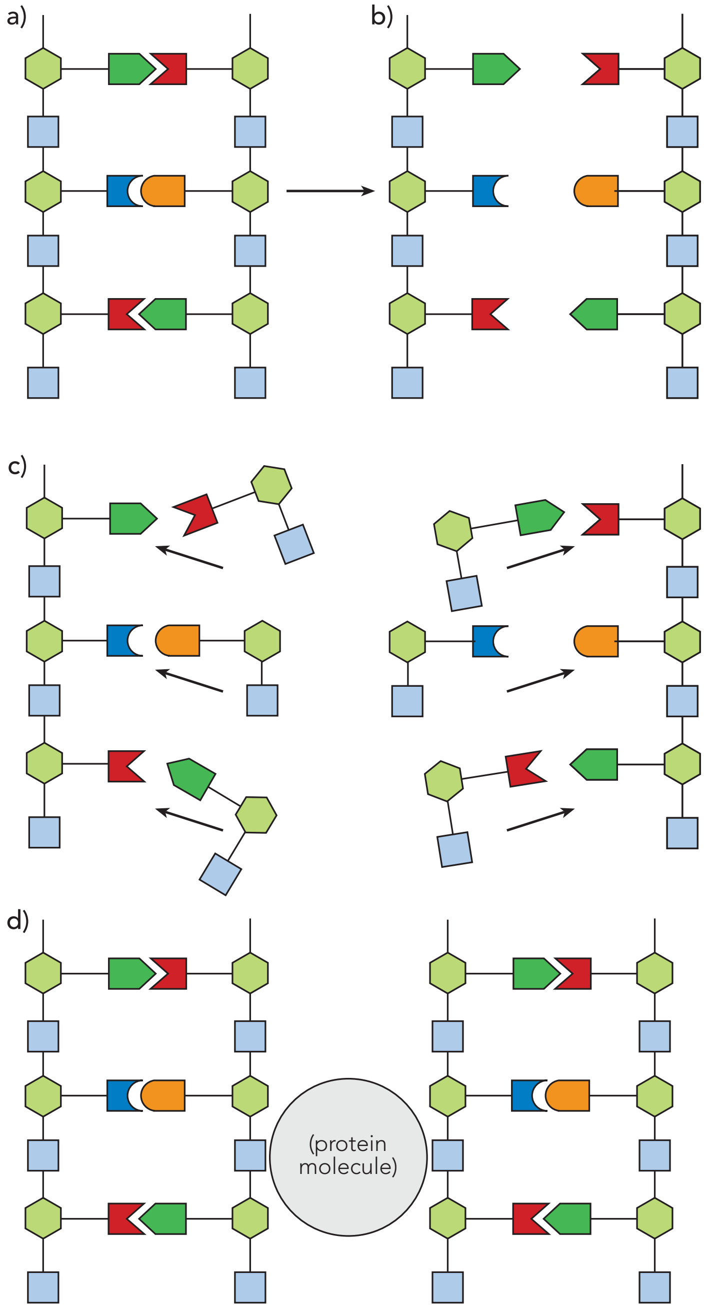
(i) How do the two daughter cells compare to the parent cell?

(ii) How do the chromosomes in each daughter cell compare to the parent cell's?

(iii) What is the **total** number of chromosomes in the two daughter cells?

(iv) Explain where the extra 46 chromosomes have come from.

2. Study the sequences of changes in a short DNA molecule shown below. Then answer the questions that follow them.



(i) Describe the changes to the DNA molecule which have occurred between stages (a) and (b).

(ii) What appears to be occurring in stage (c)?

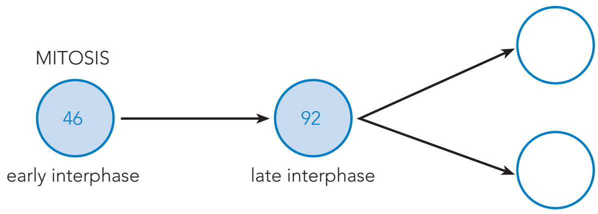
(iii) Describe the two new DNA molecules in stage (d).

(iv) What is this process called in which chromosomes are copied?

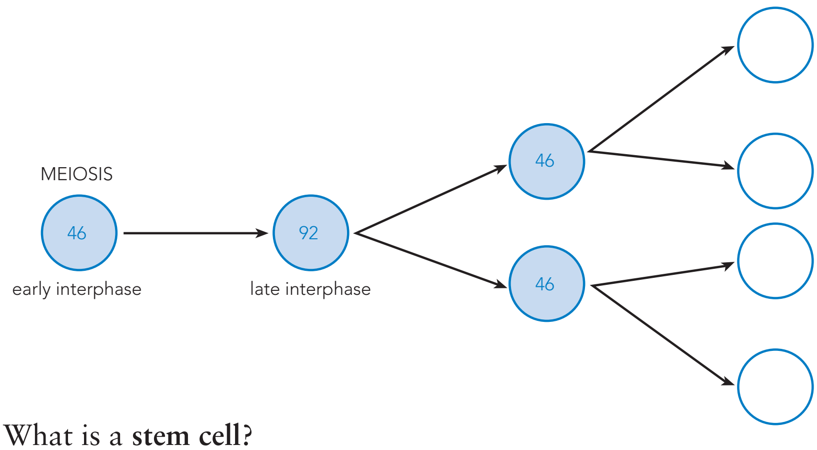
(v) When do DNA molecules replicate?

(vi) Complete the diagrams below which show the number of DNA molecules present during both mitosis and meiosis.

(a)



(b)



3. (i) What is a **stem cell**?

(ii) What is meant by the 'potency' of a stem cell?

What are the following cell types?

(iii) Embryonic Stem Cells

(iv) Adult Stem Cells

4. Why is mitosis necessary? Provide three reasons.

5. What is cancer?

6. Outline the differences between a malignant and a benign tumour.

7. Discuss the causes of cancer.

12.2 MEIOSIS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) cell division

(ii) chromatid

(iii) chromatin

(iv) cytokinesis

(v) daughter cell

(vi) homologous chromosomes

Review Questions

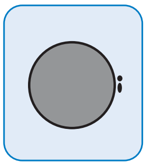
1. (i) Define **haploid.**

(ii) Which cells are haploid?

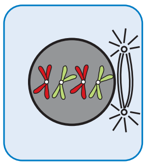
(iii) Define **diploid.**

(iv) Which cells are diploid?

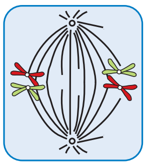
2. (i) The following sequence shows a cell undergoing **meiosis**. This is not a human cell. In the spaces provided, describe what is occurring in and to the cell.



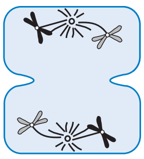
1. ______________________________



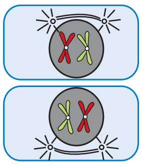
2. ______________________________



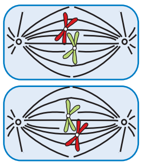
3. ______________________________



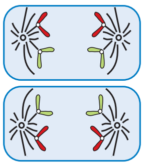
4. ______________________________



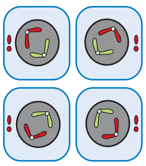
5. ______________________________



6. ______________________________



7. ______________________________



8. ______________________________

In the example above:

(ii) How many chromosomes did the parent cell contain? __________

(iii) How many chromosomes do each of the gametes contain? __________

(iv) What is the total number of chromosomes in the four daughter cells? __________

(v) How do you account for the apparent increase in the total number of chromosomes?

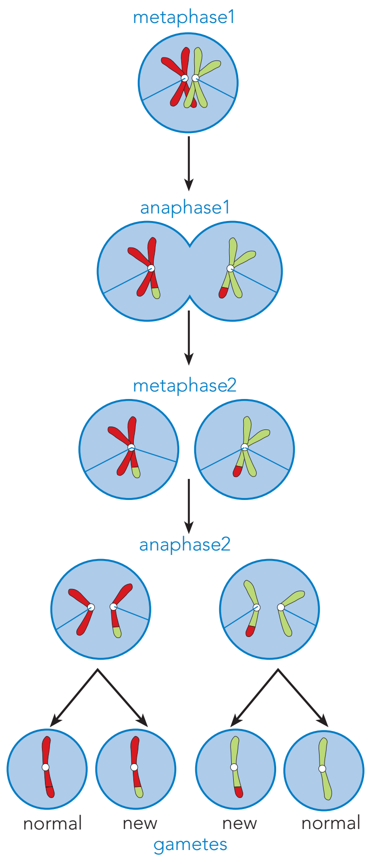
(vi) Why must the gametes contain less chromosomes than the parent cell?

3. Why does meiosis occur?

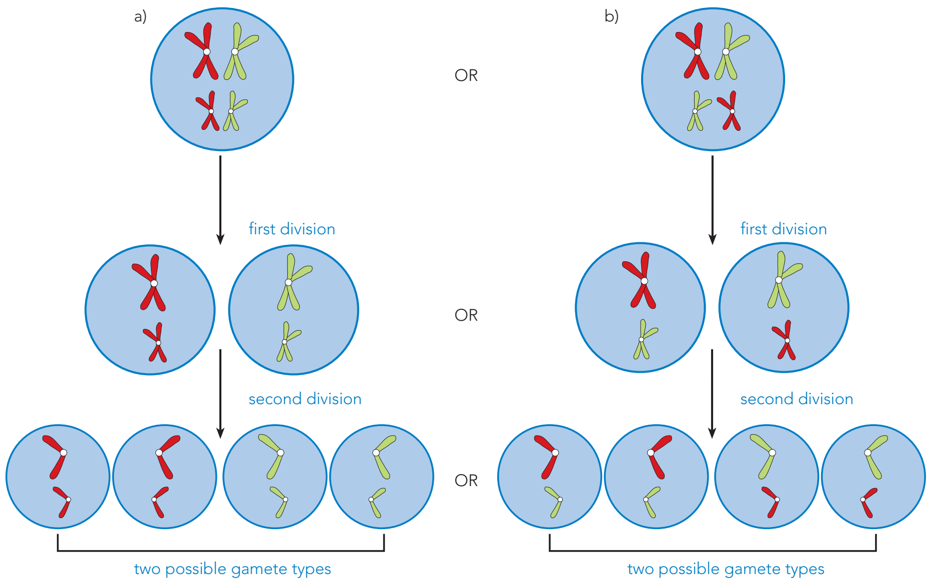
4. In the study of inheritance what is meant by "variation"?

5. Use the diagrams to **explain** the causes of variation in the gametes and therefore the causes of variation in offspring.

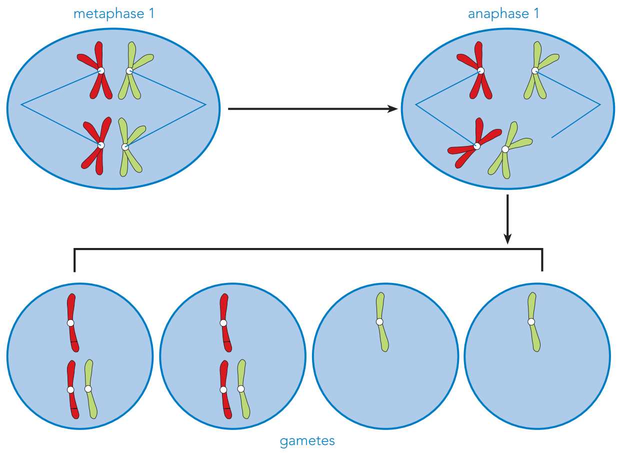
(i) Crossing over (during meiosis)



(ii) Random assortment during meiosis



(iii) Non disjunction during meiosis



(iv) What do the previous three examples have in common?

12.3 DIFFERENCES BETWEEN MITOSIS AND MEIOSIS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) gamete

(ii) gonad

(iii) ovary

(iv) parent cell

(v) random assortment

(vi) reduction division

(vii) sex chromosome

(viii) testis

(xi) zygote

Review Questions

1. Complete the table to compare mitosis and meiosis in humans.

	MITOSIS	**MEIOSIS**
Function		
Location		
Chromosome number in parent cell		
Chromosome number in daughter cells		
Number of daughter cells		
Number of divisions		

2. (i) When meiosis occurs in human testes what proportion of the gametes formed contain an X chromosome?

____

(ii) In the testes what proportion of gametes formed contain a Y chromosome?

____

(iii) When meiosis occurs in human ovaries what proportion of the gametes contain an X chromosome?

____

(iv) How does this affect the proportion of males and females in the population?

____

3. (i) What is fertilisation?

____

____

(ii) What is the relationship between meiosis and fertilisation?

____

____

(iii) How does fertilisation contribute to variation?

____

____

____

____

4. Complete the following:

Variation in offspring results from the fact that when fertilisation occurs, each sperm type that is produced has an ___________________ likelihood of fertilisation and each _____________ type that is produced also has an _______________ likelihood of fertilisation.

The way in which couples meet and form sexual relationships is also a _____________ process which therefore creates variation. If blondes were only attracted to blondes, there would be less variation in hair colour.

HUMAN REPRODUCTION

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

13.1 STRUCTURE AND FUNCTION OF THE MALE AND FEMALE REPRODUCTIVE SYSTEMS

- [ ] the production of offspring is facilitated by the structure and function of the male and female reproductive systems in producing and delivering gametes for fertilisation and providing for the developing embryo and foetus.
- [ ] both male and female reproductive systems are regulated by hormones, including the regulation of the menstrual and ovarian cycles.

13.2 SPERMATOGENESIS AND OOGENESIS

- [ ] human gametes are produced through spermatogenesis and oogenesis, which are specific forms of meiosis, but varying significantly in process and products.

13.3 DEVELOPMENT

- [ ] for the establishment of a pregnancy, conception requires the union of viable sperm and ovum at the optimal time in the ovarian cycle.
- [ ] the development of the embryo after implantation involves the differentiation of cells into three different germ layers that will eventually produce specific systems in the body and the placenta.
- [ ] the stages of labour include birth, during which there are circulatory system changes in the child.

13.4 CONTRACEPTION, STI'S, ASSISTED REPRODUCTIVE TECHNOLOGIES, SCREENING EMBRYOS AND FOETUSES

- [ ] contraception methods that reduce the probability of the union of gametes or implantation all have limitations, risks and benefits, and include methods that:
  - use fertility awareness
  - use steroid hormones
  - use physical barriers between gametes
  - use chemical spermicides
  - use sterilisation (tubal ligation, vasectomy)
  - function after coitus (emergency contraceptive pill and intrauterine devices [IUDs]).

- ☐ sexually transmitted infections (STIs), diseases transmitted through unprotected sex or genital contact, can be prevented through safe sex methods; early detection and treatment of infection are important and, if left untreated, STIs can lead to serious health consequences
- ☐ there are a variety of assisted reproductive technologies to help overcome infertility problems, but each has its limitations, risks and benefits
- ☐ there are a range of techniques available to screen embryos before implantation or during early development, including blood tests, ultrasound, amniocentesis and chorionic villi sampling

13.1 STRUCTURE AND FUNCTION OF THE MALE AND FEMALE REPRODUCTIVE SYSTEMS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) bulbourethral gland

____

(ii) endocrine gland

____

(iii) exocrine gland

____

(iv) fertilisation

____

(v) hormone

____

(vi) menstrual cycle

____

(vii) ovarian cycle

____

(viii) ovulation

____

(ix) prostate gland

____

(x) seminal vesicle

____

(xi) target organ

____

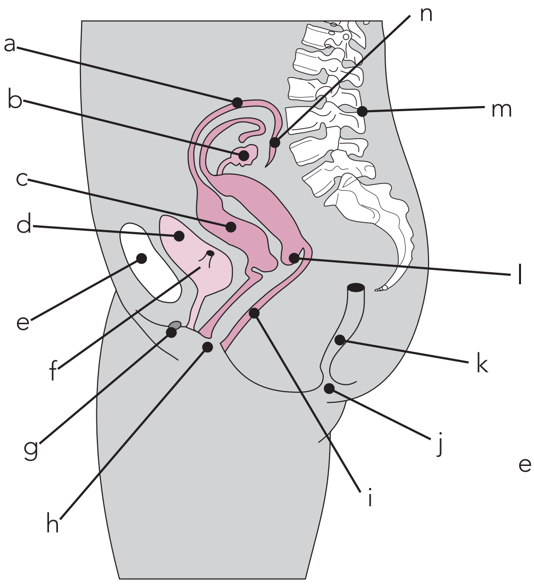
(xii) testosterone

____

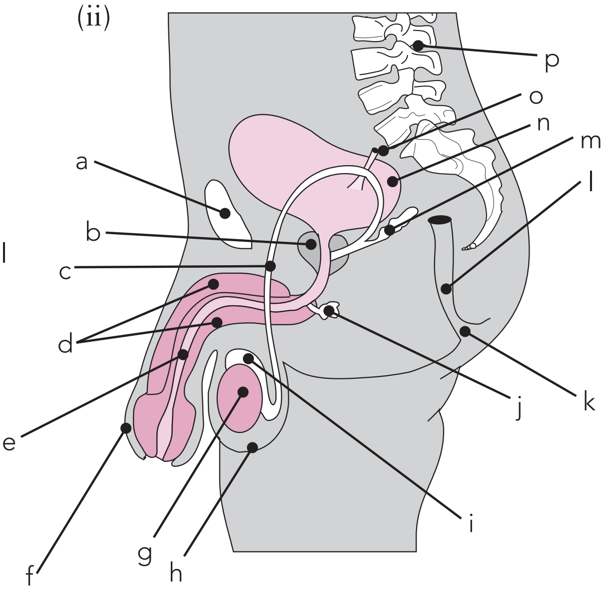
Review Questions

1. Label the following diagrams:

(i)



(ii)



(i)

a) ______________________ h) ______________________

b) ______________________ i) ______________________

c) ______________________ j) ______________________

d) ______________________ k) ______________________

e) ______________________ l) ______________________

f) ______________________ m) ______________________

g) ______________________ n) ______________________

(ii)

a) ______________________ i) ______________________

b) ______________________ j) ______________________

c) ______________________ k) ______________________

d) ______________________ l) ______________________

e) ______________________ m) ______________________

f) ______________________ n) ______________________

g) ______________________ o) ______________________

h) ______________________ p) ______________________

2. (i) Describe the function of these female organs:

(a) the ovaries

(b) the uterine (Fallopian) tube

(c) the uterus

(d) the vagina

(ii) Describe the function of these male reproductory organs:

(a) the testes

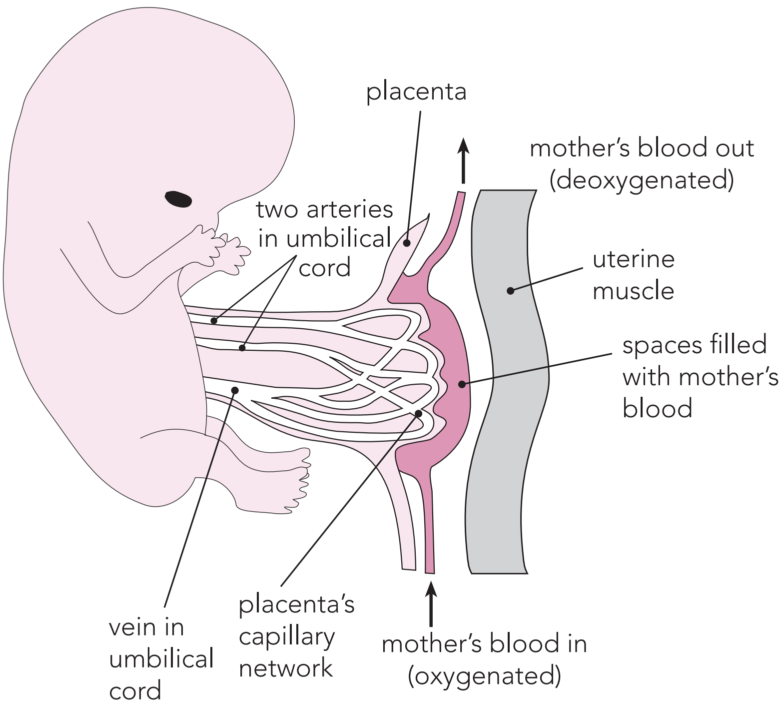
(b) the epididymis

(c) the vas deferens

(d) the urethra

3. Explain why the mother's blood and the foetal blood do not come in contact under normal circumstances.

4. On the diagram below, shade in the areas of the blood vessels which carry oxygenated blood (use red) and those that carry deoxygenated blood (use blue).



5. (i) List the changes which occur to the expectant mother's breasts early in her pregnancy.

____

____

(ii) Which hormones bring about these changes?

____

(iii) When is the hormone prolactin produced?

____

____

____

(iv) Where is the hormone prolactin released?

____

____

(v) What does prolactin do?

____

6. **Label** and **annotate** the diagram below.

i) ______________________________

____

ii) ______________________________

____

iii) ______________________________

____

iv) ______________________________

____

v) ______________________________

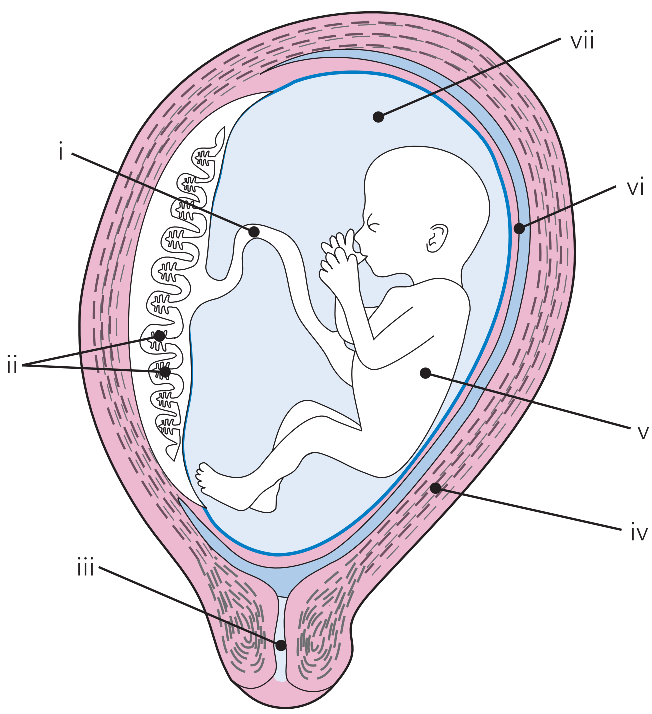
____

vi) ______________________________

____

vii) ______________________________

____



7. Discuss the importance of each of the following:

(i) amniotic fluid

(ii) yolk sac

(iii) chorion

8. (i) Why is there a 40% increase in the volume of blood in a pregnant woman?

(ii) Why must she be particularly careful about what she eats and drinks?

(iii) Why is her intake most critical in the first 12 weeks of her pregnancy?

9. (i) What is a hormone?

(ii) Name and describe the type of gland that produces and releases a hormone.

(iii) How does a hormone reach its target?

10. Complete the table on hormonal regulation.

HORMONE	WHERE HORMONE IS RELEASED	TARGET ORGAN/S	EFFECT OF HORMONE
FSH (follicle stimulating hormone)			
LH (luteinising hormone)			
Oestrogen			
Progesterone			
HCG (human chorionic gonadotrophin)			
Oxytocin			
Prolactin			
Testosterone			

11. Why is the corpus luteum important in the maintenance of an early pregnancy?

____

____

13.2 SPERMATOGENESIS AND OOGENESIS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) diploid

(ii) dormant

(iii) epididymis

(iv) flagellum

(v) follicle

(vi) gametogenesis

(vii) haploid

(viii) meiosis

(xi) menarche

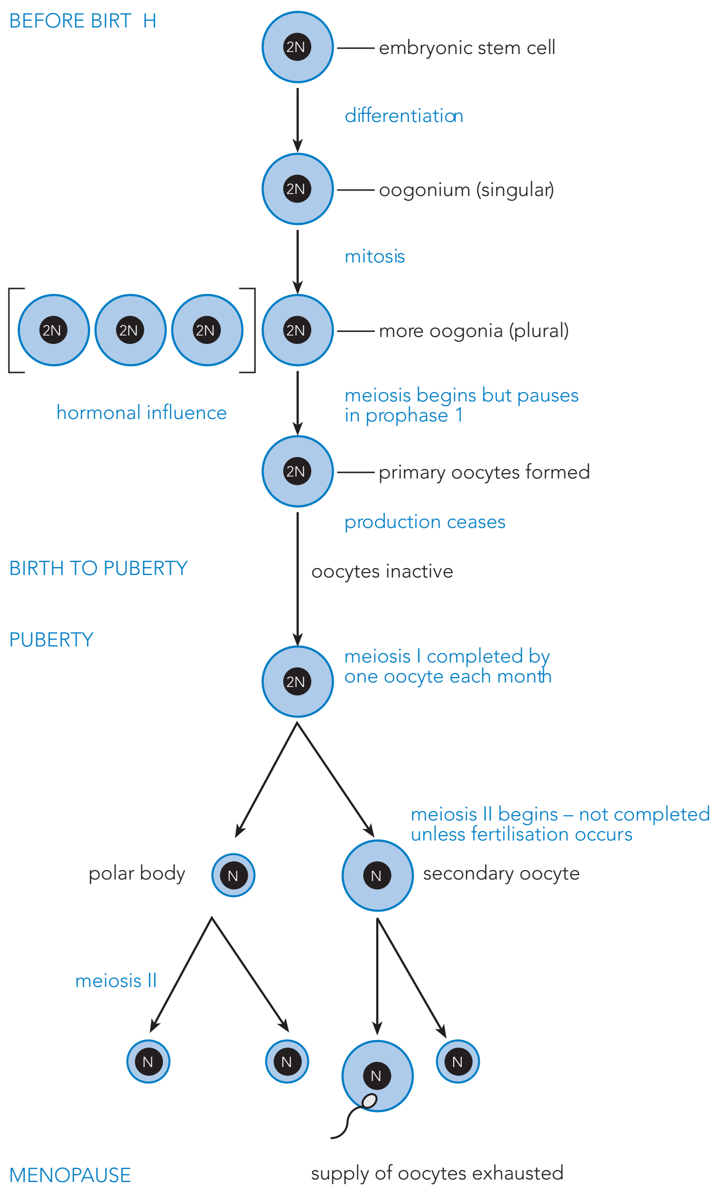
(x) menopause

(xi) mitosis

(xii) spermatid

Review Questions

1. Study the diagram of human oogenesis below then use it to answer the questions which follow.



(i) What is an oogonium?

____

(ii) How do the oogonia increase in numbers?

____

(iii) How many chromosomes does an oogonium have in its nucleus?

____

(iv) Before birth, the oogonia begin to undergo meiosis, but meiosis is not completed.

At what meiotic stage does it pause? ________________________________

(v) What is the cell called at this stage? ________________________________

(vi) After birth, the cells remain dormant until what age?

(vii) What happens when puberty is reached?

(viii) When is meiosis completed?

(ix) What are ‘polar bodies’?

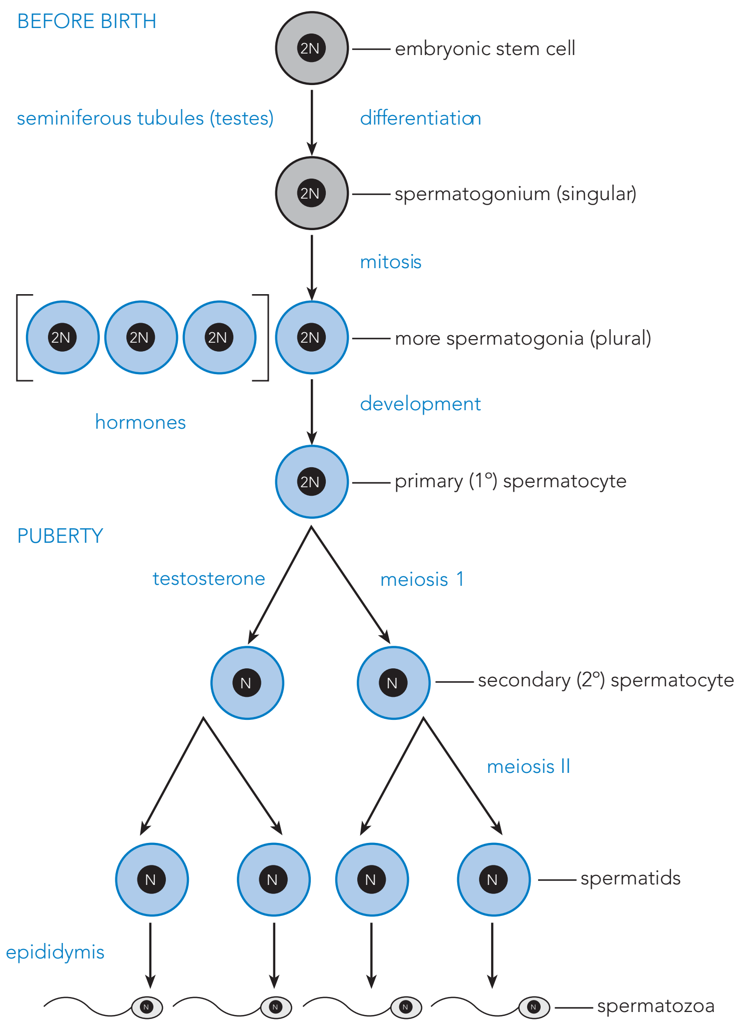
(x) What is the advantage of producing one viable ovum and three polar bodies?

(xi) How does the ovum move from the ovary to the uterus?

(xii) How might this mode of locomotion advantage the ovum?

(xiii) Where does fertilisation normally occur?

2. Study the diagram of human spermatogenesis below then use it to answer the questions which follow.



(i) In which part of the body do the embryonic stems cells differentiate into spermatogonia?

(ii) How do the spermatogonia increase in number?

(iii) Spermatogonia develop continuously through childhood into primary spermatocytes. When do they begin to undergo meiosis?

(iv) What hormone causes meiosis to begin?

(v) Where do the spermatids mature?

(vi) At the completion of their maturation, what are they called?

____

(vii) Each spermatozoon possesses a whip-like tail. What is it called?

____

(viii) How does a spermatozoon move?

____

(ix) How does a spermatozoon obtain energy for movement?

____

____

(x) Draw a simple diagram of a spermatozoon showing its three main parts. Clearly label your diagram.

3. Summarise the similarities and differences between human spermatogenesis and oogenesis in the table below.

SIMILARITIES	DIFFERENCES

13.3 DEVELOPMENT

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) blastocyst

(ii) cervical dilation

(iii) conception

(iv) embryo

(v) foetus

(vi) foramen ovale

(vii) implantation

(viii) optimum

(ix) pituitary gland

(x) placenta

(xi) umbilicus

(xii) viable gamete

Review Questions

1. Draw and label a series of simple diagrams, above the time line below, to show what changes occur to a primary follicle during the ovarian cycle.

2. (i) Place the stages in the menstrual cycle in their correct order. Begin with menstruation in the table below and describe the important events which occur at each stage.

Menstruation, Postovulation, Preovulation

STAGE	IMPORTANT EVENTS
menstruation	

(ii) On the timeline below mark in when each stage occurs and when ovulation is most likely to occur.

3. (i) How long will an ovum live in the reproductory tract after it is released from the ovary?

(ii) How long can sperm live in the reproductive tract of a female?

(iii) Therefore how long **before** ovulation could sexual intercourse result in fertilisation?

(iv) How long **after** ovulation could sexual intercourse result in fertilisation?

(v) If an ovum meets a number of sperm, usually in the uterine tube, fertilisation may occur. Why are a number of sperm required and not just one?

(vi) What is conception?

(vii) When the single haploid sperm nucleus enters the haploid ovum, describe what happens to their nuclei?

4. Explain how an understanding of the menstrual and ovarian cycles may be used in natural forms of contraception.

5. (i) Although the blastocyst consists of many more cells than the zygote, it is **not** very much larger. Explain why this is so.

____

____

(ii) Describe how the cells are produced.

____

(iii) Are these cells haploid or diploid? Explain your answer.

____

____

6. (i) How many days after fertilisation does implantation normally occur?________

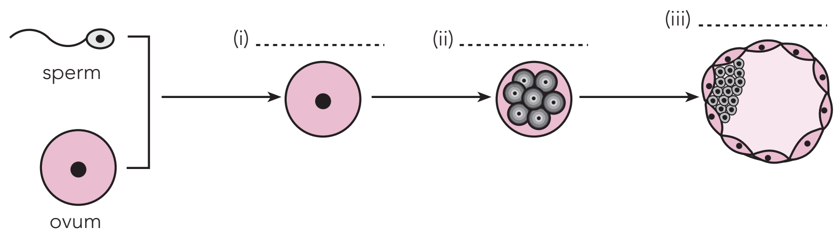
(ii) Briefly describe the process of implantation.

____

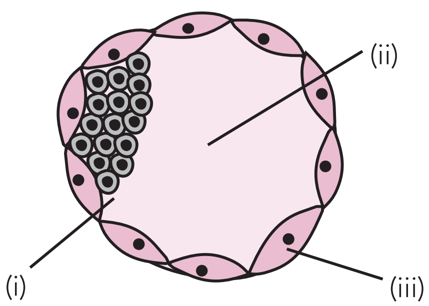
____

____

7. Add the three missing labels to the diagram below:



8. Label the blastocyst using the following labels: *inner cell mass, trophoblast cells* and *fluid filled cavity*.



(i) ______________________________

(ii) ______________________________

(iii) ______________________________

9. Complete the following sentences:

(i) After implanation, the inner cell mass forms three 'germ' layers. These are called the

_______________, ______________ and _________________.

(ii) These three layers later become the __________________.

10. The three 'germ layers' give rise to different tissues and organs in the body. Make a list of these in the spaces below:

(i) endoderm

____

____

(ii) mesoderm

____

____

(iii) ectoderm

____

____

11. When cells begin to specialize i.e. the germ cells develop into either nerve cells, muscle cells, skin cells, etc. they are said to have

____

12. (i) The original cells, the zygote and the morula cells, have the potential to develop into embryonic or placental cells.

What is the name given to such cells? ________________________________

(ii) The inner cell mass consists of cells, all of which can form either endoderm, mesoderm or ectoderm cells.

These cells are called ________________________________

(iii) Some cells can differentiate into a more limited number of different cell types. For example, germ cells in the bone marrow can differentiate into only leucocytes, erythrocytes or thrombocytes.

This type of stem cell is called ________________________________

(iv) A cell which can only form one type of cell when it divides by mitosis is called

____

(v) Which of the cells above are true stem cells?

____

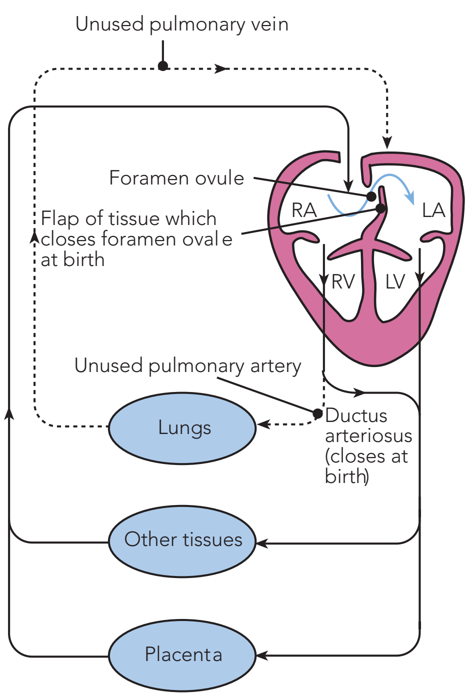
13. Describe briefly each of the three stages of labour.

(i) First stage

(ii) Second stage

(iii) Third stage

14. The diagram below shows some of the blood flow in the foetal circulation.



(i) How is the foetal blood diverted away from the foetal lungs?

(ii) Why is the foetal blood diverted away from the foetal lungs?

(iii) Describe what happens to these diversions at birth.

(iv) In addition to the foramen ovale and the ductus arteriosis, one other diversion is present in the foetal circulation (this is not shown in the diagram).

(a) What is it called?

(b) Where is it?

(c) What is its function?

13.4 CONTRACEPTION, STI'S, ASSISTED REPRODUCTIVE TECHNOLOGIES, SCREENING EMBRYOS AND FOETUSES

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) abortion

(ii) chorionic villi

(iii) contraception

(iv) incubation period

(v) infectious

(vi) in situ

(vii) intrauterine

(viii) lesion

(ix) oxytocin

(x) progesterone

(xi) spermicide

(xii) symptom

(xiii) urethritis

Review Questions

1. Describe two mechanical barriers that can be used to prevent conception.

   (i)

   (ii)

2. Why are chemical barriers considered only useful if mechanical barriers are used simultaneously for contraception?

3. In general terms, briefly discuss how hormonal contraceptives prevent conception:

4. What is an IUD (intrauterine device) and how is it used to prevent pregnancy?

5. Discuss how each of the following medical procedures are carried out:

(i) Vasectomy

(ii) Tubal ligation

6. In the table below outline the advantages and disadvantages of the above procedures:

PROCEDURE	ADVANTAGES	DISADVANTAGES
vasectomy		
tubal ligation		

7. Complete the table below.

CONTRACEPTIVE METHOD	LIMITATIONS	RISKS	BENEFITS
oestrogen and progesterone pill			
progesterone only pill			
condom			
diaphragm			
chemical spermicides			
intrauterine devices			
morning-after pill			

8. What is a sexually transmitted infection (STI)?

____

____

9. Complete the table below to summarise five significant STIs in our community.

INFECTION	CAUSATIVE AGENT	EFFECT ON THE BODY	TREATMENT	CONTROL
Syphilis				
Gonorrhoea				
Chlamydia				
Genital herpes				
HIV				

10. (i) Name three STI's caused by viruses.

____

(ii) Name three STI's caused by bacteria.

____

(iii) Name two organisms other than bacteria and viruses that can cause STIs.

____

11. (i) How could a mother's STI affect her unborn child?

____

____

____

____

(ii) What precautions could the pregnant mother take to reduce the possibility of her foetus becoming infected?

12. (i) If a person tests positive for HIV he/she is likely to require tests for other STIs? Explain why this may be necessary.

(ii) How can the risks of contracting a STI be minimized?

13. (i) What is meant by 'infertility'?

(ii) What are the main causes of infertility?

(iii) What is meant by IVF?

(iv) Outline the procedure used in IVF.

(v) Explain how an understanding of the menstrual cycle and implantation assist in the success of this procedure.

14. (i) About what proportion of pregnancies are thought to result in miscarriage or spontaneous abortion?

(ii) Which hormones are involved in the maintenance of the early pregnancy? Explain why these are important.

15. (i) Pregnancies are quite frequently monitored using ultrasound scans. Explain briefly how this technology is used.

(ii) What aspects of the foetal development can be observed?

____

____

____

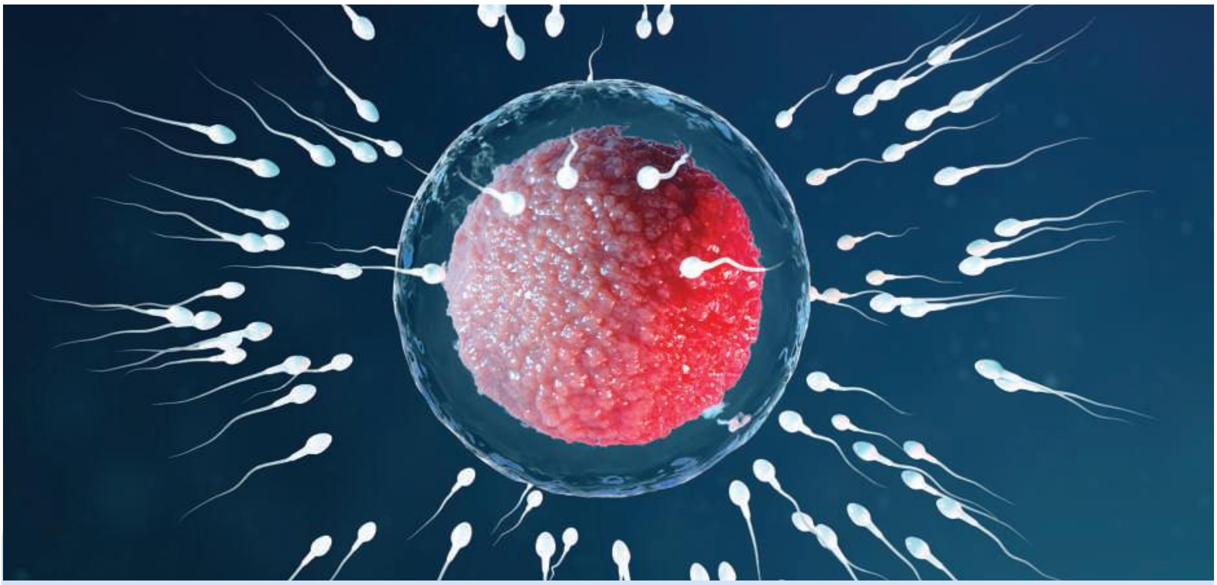
____

____

16. Briefly describe how the techniques in the table below are used to screen embryos during early development.

TECHNIQUE	DESCRIPTION
blood tests	
amniocentesis	
chorionic villi sampling	

14 TYPES OF INHERITANCE



SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

14.1 PREDICTING GENOTYPES AND PHENOTYPES

- [ ] probable frequencies of genotype and phenotype of offspring can be predicted using Punnett squares and by taking into consideration patterns of inheritance, including the effects of dominance, co-dominance, autosomal or sex-linked alleles, and multiple alleles: Huntington's disease, phenylketonuria (PKU), ABO blood groups, red–green colour blindness/haemophilia show different inheritance patterns.

14.2 PEDIGREE CHARTS

- [ ] pedigree charts can be constructed for families with a particular genetic disorder and can be used to reveal patterns of inheritance and assist in determining the probability of inheriting the condition in future generations.

14.1 PREDICTING GENOTYPES AND PHENOTYPES

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) co-dominance (or incomplete dominance)

(ii) dominant

(iii) frequency

(iv) genetics

(v) genotype

(vi) haemophilia

(vii) hereditary

(viii) heterozygous

(ix) homozygous

(x) phenotype

(xi) red green colour blindness

(xii) sex-linked trait

Review Questions

1. Explain what is meant by each of the following terms:

   (a) autosomal inheritance

   ____

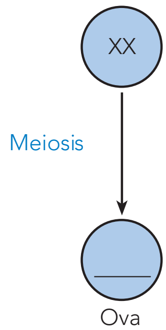
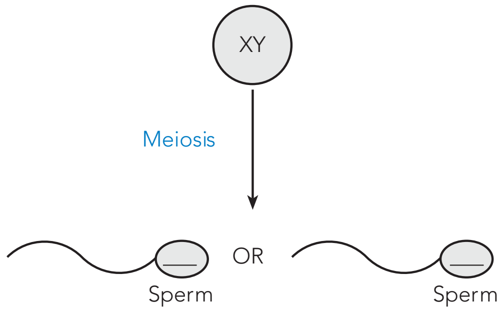
   (b) sex-linked inheritance / x-linked inheritance

   ____

2. Complete the table below.

	TOTAL NUMBER OF AUTOSOMAL CHROMOSOMES IN EACH SOMATIC CELL	TYPE OF SEX CHROMOSOMES IN EACH SOMATIC CELL	TOTAL NUMBER OF CHROMOSOMES IN EACH SOMATIC CELL
Female			
Male			

3. Complete the diagrams to show what types of gametes may be produced in females and males.

FEMALE'S PARENT CELL	MALE'S PARENT CELL
	
All ova contain an ____ chromosome	Sperm may contain an ___ or a ___ chromosome

4. How is the sex of a person determined at conception?

____

____

____

____

____

____

5. Right handedness is due to a dominant allele (R) and left handedness to its recessive allele (r). A right handed woman with a left handed husband has one left handed child and three right handed children.

(i) Write the genotypes of the parents.

Woman ________________

Man ________________

(ii) Using a punnet square, show what the genotypes of their children could be.

Man

Woman		

(iii) What is the phenotypic ratio expected in their children?

____

(iv) If this couple had four children, how many would be expected to be right handed and how many left handed?

____

(v) Why did their children not show these proportions?

____

____

6. (i) Complete the table using the symbols I^A, I^B and i.

BLOOD GROUP	POSSIBLE GENOTYPES
A	
B	
AB	
O	

(ii) How many different **phenotypes** are present here? __________

(iii) How many different **genotypes** are present here? __________

(iv) Which genotype/s illustrate **dominance**? ____________

(v) Which genotype/s illustrates **co-dominance**? ____________

7. Use punnet squares to answer the following questions.

(i) A man with blood group O marries a woman with blood group O. What is the probability of them having a child with group B?

Man

Woman

(ii) A woman with blood group O marries a man with blood group B. What is the probability of them producing a child with blood group A?

Man

Woman

Man

Woman

(iii) A man with blood group AB marries a woman with blood group B. What is the probability of them producing a child with group A?

Man

Woman

Man

Woman

(iv) A man with blood group B had a mother with group O. He marries a woman who is I^AI^A. Show the ratio of the genotypes and phenotypes they could expect in their children.

Man

Woman

8. Haemophilia is a sex-linked disease. The gene for haemophilia is on the X chromosome which can be represented as X^h. The normal gene can be represented as X^H.

(i) If a man who has haemophilia marries a normal woman who has no history of haemophilia in her family, what would be the expected genotypic and phenotypic ratios in their offspring?

___

___

___

Man

Woman

(ii) If a woman who is a 'carrier' marries a normal male, what is the probability that they will have a son who has haemophilia?

___

___

___

Man

Woman

9. (i) For each of the conditions in the table below indicate whether it is sex-linked or autosomal and whether it is dominant, recessive or codominant.

CONDITION	AUTOSOMAL /SEX LINKED	DOMINANT/RECESSIVE/ CODOMINANT
Huntington's disease		
red-green colour blindness		
PKU		
sickle-cell anaemia		
haemophilia		

(ii) Choose appropriate symbols and use these to indicate the genotype of each of the following phenotypes. The first example has been done as a guide.

PHENOTYPE	APPROPRIATE SYMBOLS	GENOTYPE
Male with red-green colour blindness	X^C, X^c, Y	X^cY
Female with Huntington's disease		
Female with red-green colour-blindness		
Male with normal colour vision		
Male with PKU		
Male with haemophilia		
Female with sickle-cell anaemia		
Male with sickle-cell trait		
Female normal for blood clotting		
Female without PKU		

14.2 PEDIGREE CHARTS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) disease

____

(ii) dizygotic twins

____

(iii) mode of inheritance

____

(iv) monozygotic twins

____

(v) probability

____

(vi) recessive trait

____

Review Questions

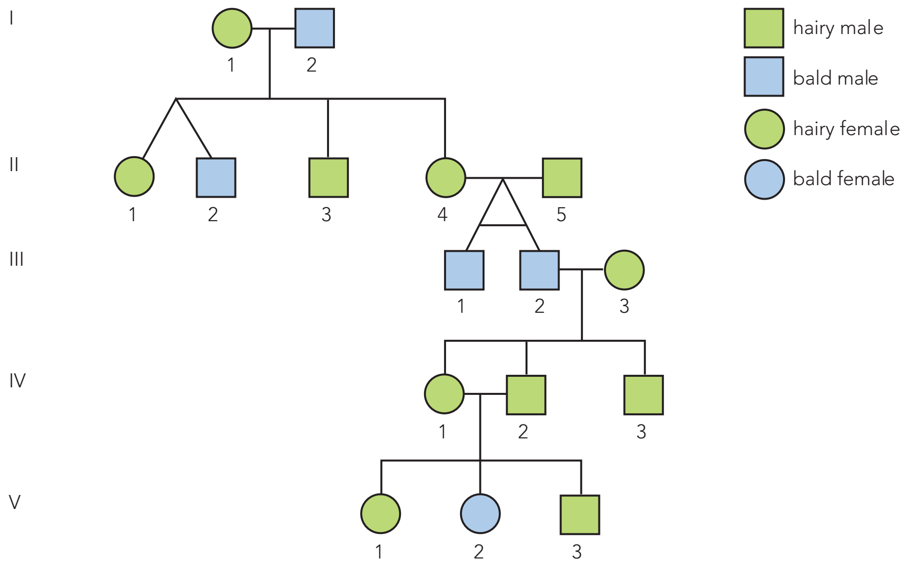
1. Draw the following pedigree in the space provided.

   (i) Bill marries Sue. They have four children, Bob, Sally, Rosie and Tom. Bob marries Cathy and Rosie marries Jim. The other two children do not marry. Bob and Cathy have five children, Bert, Ernie, Harry, Charlie and Pete. Rosie and Jim have only one child whom they name Jane.

   (ii) Jane marries Edmund and they have identical twins (girls). Draw a diagram to illustrate this.

   (iii) Bernard marries Debra and they have non-identical twins, show all the possibilities (given that we are not told the sex of these twins).

2. The pedigree below shows the incidence (in rats) of a disease which causes total baldness.



(i) (a) How is this disease inherited, ie. what is its mode of inheritance?

____

(b) Explain how you arrived at your answer.

____

____

____

(ii) Write down the possible genotypes of each individual in the pedigree. Use a key.

I 1 ________	I 2 ________			
II 1 ________	II 2 ________	II 3 ________	II 4 ________	II 5 ________
III 1 ________	III 2 ________	III 3 ________		
IV 1 ________	IV 2 ________	IV 3 ________		
V 1 ________	V 2 ________	V 3 ________		

(iii) Which individuals are twins in this pedigree?

____

(iv) Which twins are monozygotic and which are dizygotic?

____

____

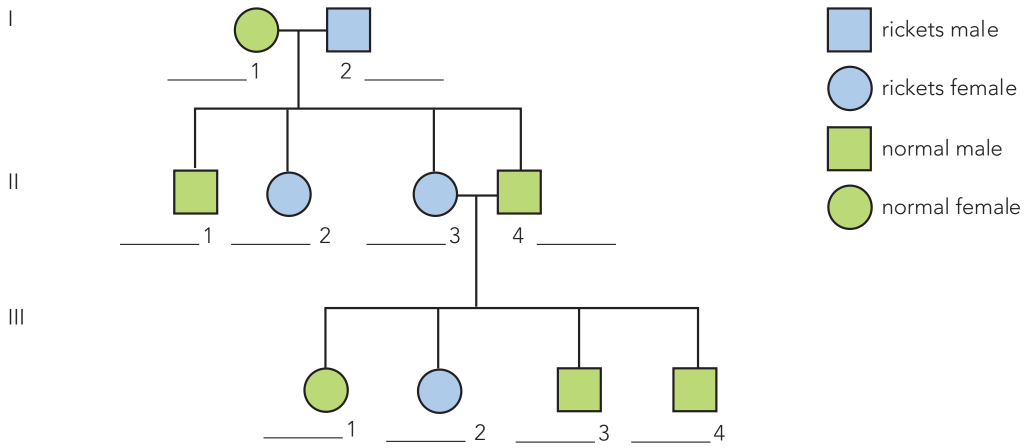
____

(v) Where did the genes which gave rise to V 2's baldness come from?

____

____

3. A rare inherited form of rickets is shown on the pedigree below.



This disease is unusual because it is caused by a gene carried on the X chromosome (sex linked).

(i) How is this defective gene different from the usual sex-linked defective gene?

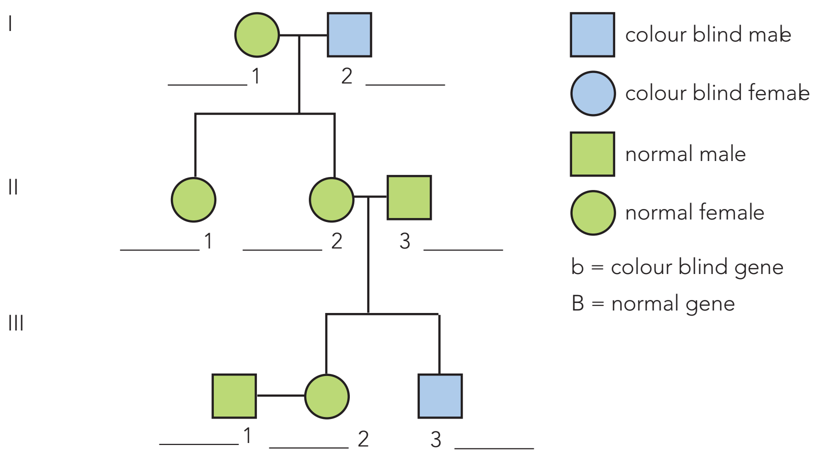
(ii) From which parent did individual II 2 inherit the defective gene?

(iii) Under each individual in the spaces provided, write possible genotypes. (Use a key to indicate what your letters stand for.)

(iv) Would you expect more males or more females to inherit this disease? Explain.

---

4. (i) A family with a history of colour blindness (an x-linked recessive trait) has the pedigree shown below.



Write the possible genotypes for each individual in the spaces provided.

(ii) If individuals 1 and 2 in generation III have children, what is the probability of each of the following genotypes in their offspring? (Use punnet squares to work out your answers).

X^bY ______________________________

____

X^BY ______________________________

____

X^BX^B ______________________________

____

X^BX^b ______________________________

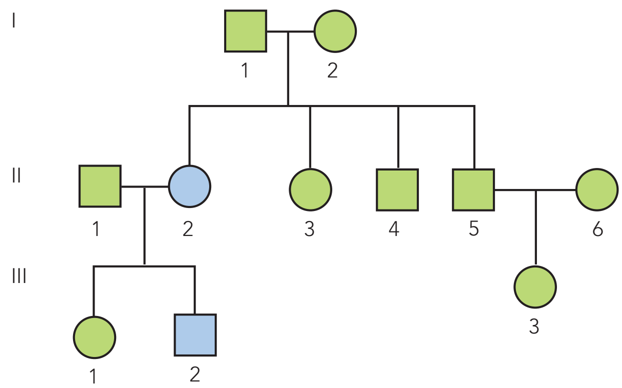
____

X^bX^b ______________________________

____

5. For each of these pedigrees, determine the most likely mode of inheritance (ie. whether sex linked or autosomal **and** whether dominant or recessive). Explain how you arrived at your answer in each.

(i)

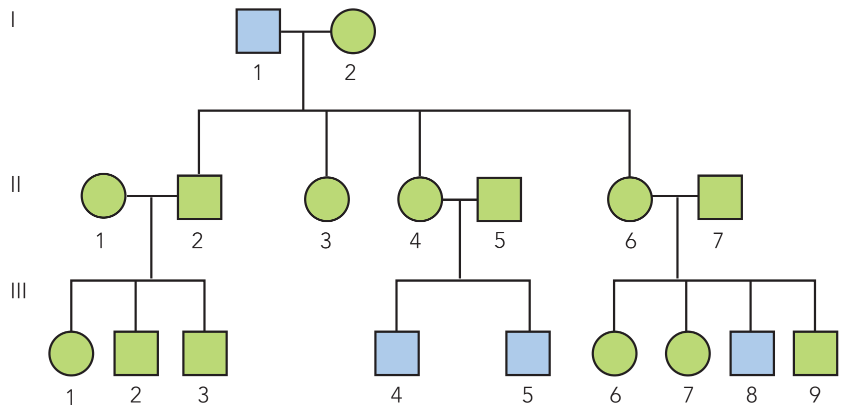


____

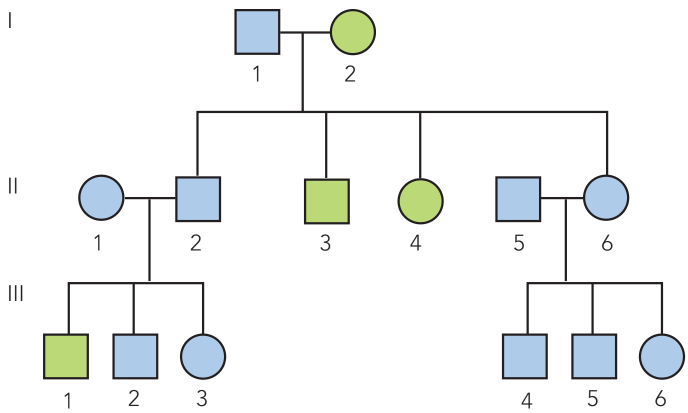
____

____

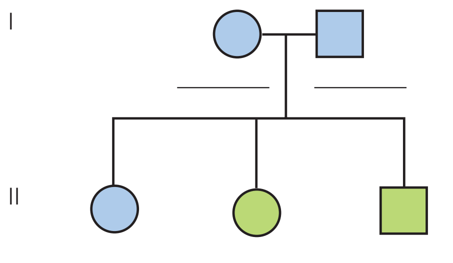
(ii)



(iii)



6. In the pedigree below, an autosomal dominant condition represented by R is shown.



(i) Write the possible genotypes in the spaces below each individual.

(ii) If this couple has another child, what is the probability that it will have the condition?

Man

Woman

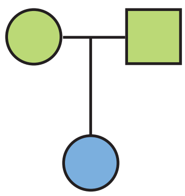
(iii) What is the probability that the child is homozygous (RR or rr)?

(iv) If the child has the condition, what is the probability that he or she is homozygous?

(v) If the child does not have the condition, what is the probability that he or she is homozygous?

(vi) What is the probability that a child both inherits the condition and is heterozygous?

7. (i) Given that a baby girl tests positive for PKU, show on the diagram below what genotypes her parents must have, given that neither parent has the disease.



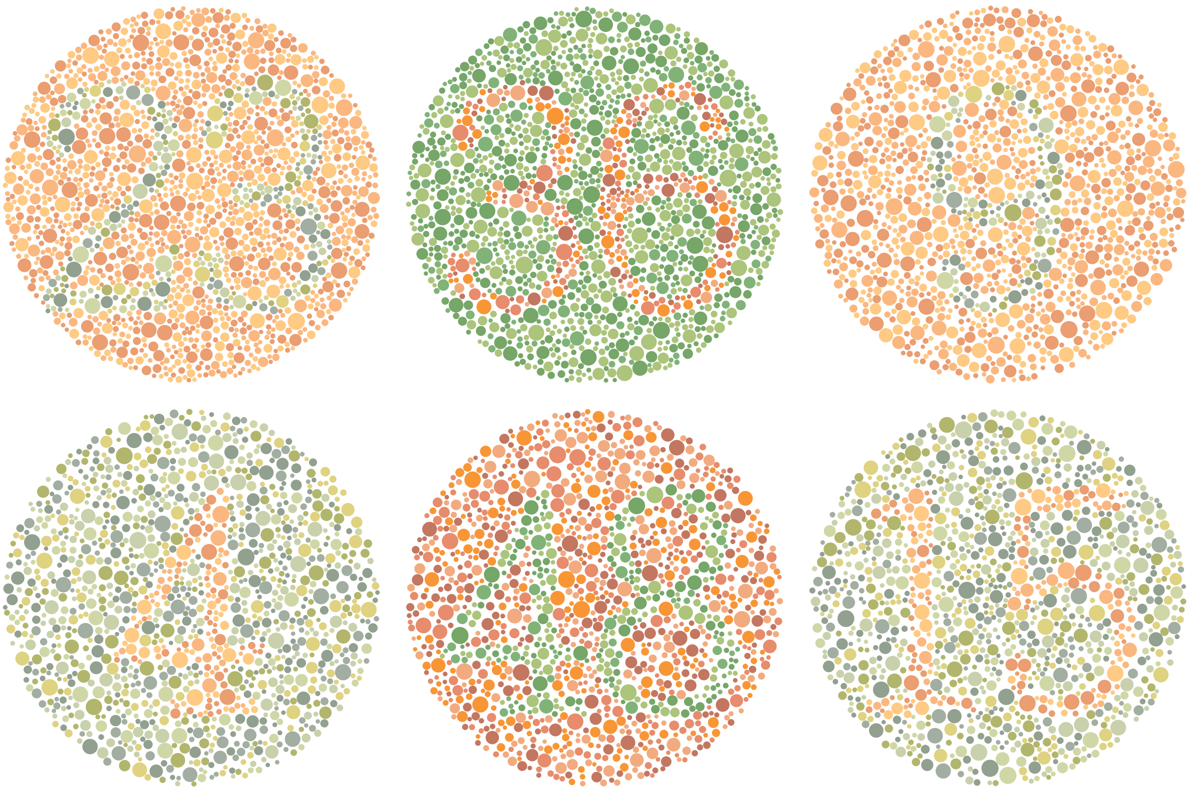
(ii) Using a punnet square show all the possible genotypes for the children these parents could have together.

(iii) When the girl matures into an adult, how could genetic counsellors determine the likelihood of her having children with PKU?

(iv) How are children tested for PKU?

(v) If a child does test positive, how is the disease treated?

(vi) How would the disease affect the child if it were to go untreated?



15 SCIENCE AS A HUMAN ENDEAVOUR 2

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

- ☐ the use of genetic screening to assess the risk of inherited disorders has implicit ethical considerations.
- ☐ discoveries made through the use of modern biotechnological techniques have increased understanding of DNA and gene expression.
- ☐ greater understanding of the menstrual cycle, conception and implantation has produced improved methods of the establishment of a pregnancy, along with advancements in contraceptive methods; both have ethical considerations.
- ☐ new technologies, including the cervical screening test, breast screening and blood tests for prostate cancer, have made early detection of cancers possible.
- ☐ lifestyle choices, including diet, illicit drugs, alcohol and nicotine, may affect foetal development.

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) foetal development

(ii) gene expression

(iii) genetic screening

(iv) genetic tags

(v) human papillomavirus (HPV)

(vi) prenatal diagnosis

(vii) spina bifida

(viii) syndrome

(ix) vaccine

Review Questions

1. List what information is provided through the following procedures.

(i) genetic screening of adults

(ii) genetic screening of embryos

2. Discuss the advantages and disadvantages of obtaining this information for:

(i) adults

(ii) embryos

3. (i) Why might parents wish to select the sex of the child?

(ii) How might a baby's sex be selected?

4. (i) How can a genetic disease be prevented?

(ii) What is meant by 'prenatal diagnosis' of genetic disease?

(iii) How is prenatal diagnosis carried out?

5. The study of epigenics has revealed that what a person does during their lifetime may affect their children and grandchildren.

(i) Explain how this is thought to happen.

(ii) What are the implications of this finding for lifestyle choices? Give an example.

6. (i) Vaccines are being developed to temporarily cause infertility in both men and women. What do the vaccines target?

(ii) Describe another method used to temporarily reduce a male's fertility by chemical means.

7. Explain how each of the following make the early detection of cancer possible?

(i) cervical screening test

(ii) breast screening

(iii) blood tests for prostate cancer

8. (i) Explain why folate (a B group vitamin) is recommended for women of child-bearing age.

(ii) Which foods contain listeria and why are these foods a risk to pregnant women?

(iii) Why do some fish present more of a risk to the unborn child than do others?

9. (i) How might smoking by a women who is pregnant affect her unborn child?

(ii) What is the condition known as foetal alcohol syndrome and how can it be avoided?

TRIAL TEST 1: SCIENCE INQUIRY SKILLS 1

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. A scientist, while watching the movement of a protozoa on a wet mount under the microscope, noticed that when these organisms moved near the edge of the water on the slide, they stopped and moved back towards the centre of the water. The scientist guessed that their behaviour was due to oxygen in the water near the air.

   The process of making the educated guess is described as:
   (a) making an observation
   (b) analysing the data
   (c) forming a hypothesis
   (d) reaching an inference.

2. If you predicted that an experiment would produce a certain result and the result was different from what you expected, which of the following would be your most appropriate scientific response?
   (a) "I should have carried out the experiment before making my prediction."
   (b) "The school's equipment is obviously inadequate to get reliable results."
   (c) "I need to improve the experiment so that the results more closely fit my prediction."
   (d) "My prediction, experiment or observations were at fault."

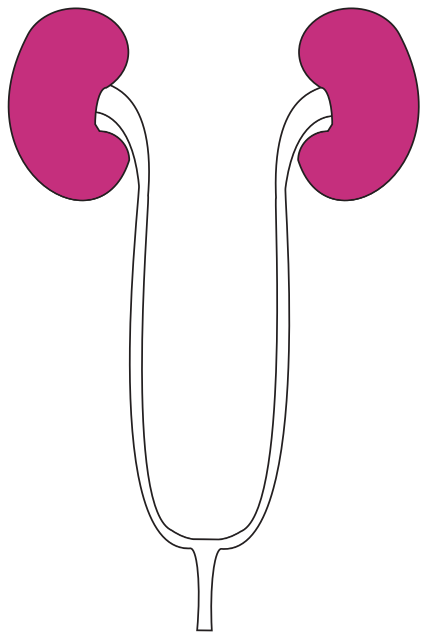
3. Which of the following statements describes a scientific theory?
   (a) An hypothesis that has a large amount of evidence obtained which supports it.
   (b) An educated guess which is testable.
   (c) A prediction about what may happen in the future.
   (d) A statement that has little supporting evidence.

4. The statement that "life exists on planets in distant galaxies" is:
   (a) an observation
   (b) an hypothesis
   (c) a theory
   (d) none of the above.

5. The results of an experiment may be made more reliable by:
   (a) Repeating the same experiment a number of times in order to average results.
   (b) Getting a second opinion on the hypothesis being tested.
   (c) Making sure to only record results which support the hypothesis being tested.
   (d) Approaching the experiment with a completely open mind.

6. Which of these procedures would help to make an experiment valid?
   (a) Repeat the same procedure many times.
   (b) Use a control group.
   (c) Use a small sample size.
   (d) Choose only healthy individuals for tests.

7. Which organ is missing from the system that is illustrated below?



(a) kidney
(b) liver
(c) bladder
(d) urethra.

8. A good definition of a scientific sample is:
(a) a small number of individuals which are carefully selected to represent a typical group.
(b) a small number of individuals which are randomly selected to represent a population.
(c) a large group that approximates the total population.
(d) a large group that is not likely to contain any atypical individuals.

9. The validity of an experimental procedure can be confirmed by determining if:
(a) sufficient trials have been conducted that always produce the same results.
(b) the hypothesis is correctly written and not controversial.
(c) the independent variable is the only variable that can affect the dependent variable.
(d) the experiment is conducted in a modern, well equipped laboratory.

10. One advantage of scientific experimentation over other human endeavours is that:
(a) it can provide reliable evidence on which to make sound judgements
(b) it will develop all the answers to what is not understood at present
(c) it can determine the decisions for the wider community
(d) it can provide unquestionable facts which become fixed laws.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. (i) Which of the following statements is a hypothesis? ______________

   (A) Smoking is a cause of emphysema.

   (B) A vaccine for the AIDS virus is likely to be produced in five years.

   (C) The population in Australia is approaching twenty two million.

   (D) Does exposure to UV radiation result in skin cancer?

   (E) The average heart rate for a resting adult is 72 beats/minute.

   [1 mark]

   (ii) Give a reason for your choice.

   ___

   ___

   [1 mark]

   (iii) For each of the other statements, indicate why it is not a hypothesis.

   ___

   ___

   [2 marks]

2. (i) Design an experiment to test the hypothesis that:
   Eating excess salt causes hypertension (high blood pressure).

   ___

   ___

   ___

   ___

   ___

   [5 marks]

   (ii) Name four variables that need to be controlled in your experiment.

   ___

   ___

   [2 marks]

   (iii) What is the independent variable? ______________________________

   [1 mark]

   (iv) What results would support the hypothesis?

   ___

   ___

   [1 mark]

(v) What results would refute the hypothesis?

____

____

____

[1 mark]

(vi) What could you do to be more confident of your results?

____

[1 mark]

(vii) How would you sample to obtain valid results?

____

[1 mark]

3. A medical scientist measured the pulse rate of a person while the subject was immersed in a bath of water. The temperature of the water was gradually changed as indicated in the table below. Study the data and answer the questions that follow it.

WATER TEMPERATURE IN BATH (°C)	SUBJECT'S PULSE RATE (bpm)
10	95
15	83
20	78
25	72
30	71
35	78
40	83
45	115

(i) What hypothesis was the scientist testing?

____

____

[1 mark]

(ii) Name the:

a) independent variable ______________________

b) dependent variable ______________________

[2 marks]

(iii) Use the grid below to plot the data in the table.

[4 marks]

(iv) Give one conclusion that can be made from these results.

[1 mark]

(v) How could this experiment be improved so that the data become reliable?

[1 mark]

4. (i) What is a "control" in a scientific experiment?

[1 mark]

(ii) Why is a control necessary?

____

____

____

____

____

[1 mark]

(iii) Why are each of the following important in an experiment?

(a) Sample size

____

____

____

[1 mark]

(b) Randomly selected samples

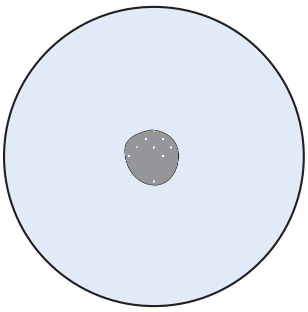
____

____

____

[1 mark]

5. A white blood cell appears in the field of view of a microscope as shown in Figure 1.



2000x

(i) If the diameter of field of view is 125μm, what is the actual size of this cell?

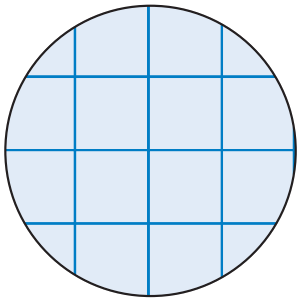
______________________ [1 mark]

(ii) What would the diameter of the field of view of this microscope be at a magnification of:

(a) 200 x ______ μm (b) 100 x ______ μm (c)40 x ______ μm

[3 marks]

6. Using another microscope with a magnification of 40 x a scientist observed a piece of mm graph paper as below:



40x

(i) What is the diameter of the field of view of this microscope at the following magnifications?

(a) 40 x ______ µm

(b) 60 x ______ µm

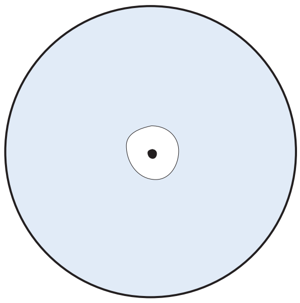
(c) 100 x ______ µm

(d) 400 x ______ µm

(e) 600 x ______ µm

[5 marks]

When using this microscope to observe a human egg cell, at a magnification of 400 x, it appeared in the field of view as shown below.



400x

(ii) Estimate the size of the human egg cell (ovum).

____

[1 mark]

7. (i) What arguments can be made in support of the use of animals in medical research? (List three)

____

____

____

[3 marks]

(ii) What arguments can be made against the use of animals in medical research? (List three)

[3 marks]

8. The use of hormone replacement therapy (HRT) to reduce the effects of menopause in women has recently been criticised by researchers in America as dangerous to the health of the women using this therapy. This was reported in the local newspapers. How should a person react to such newspaper reports?

[1 mark]

9. Define each of the following terms:

(i) primary data

(ii) scientific error

(iii) system

(iv) risk assessment

[4 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

1. People with normal vision use special cells called rods in their eyes to observe objects in dim light. Imagine that you are given the task to test the hypothesis that the rods will only function well if people have an adequate amount of vitamin A in their diet. Without sufficient vitamin A, a person's night vision will be impaired.

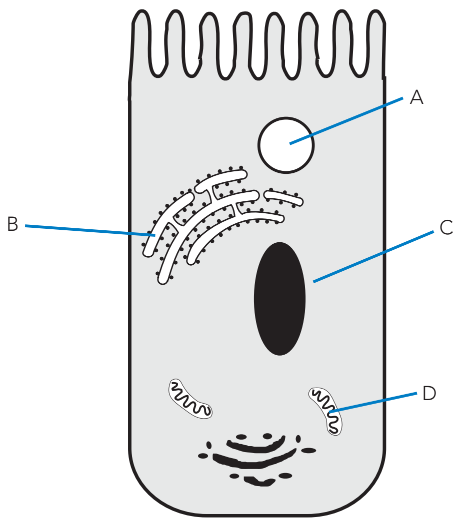
   Design an experiment to test the hypothesis. Indicate clearly what results would support and what results would refute the hypothesis and describe two hypotheses that could be derived from this experiment.

TRIAL TEST 2: CELLS AND TISSUES

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. Which labeled structure in the cell below is the site of aerobic respiration?



(a) A
(b) B
(c) C
(d) D

2. The function of the cell's microvilli is to:
(a) increase the surface area of the cell for absorption
(b) enable extra storage within the cell cytoplasm
(c) provide a surface to join to other similar cells
(d) increase the volume of the cell for efficiency.

3. Which of the following lists contains only organelles?
(a) nucleus, cytoplasm, mitochondrion, cilium
(b) nuclearplasm, nucleolus, plasma membrane, Golgi body
(c) cilium, ribosome, endoplasmic reticulum, nucleus
(d) cytosol, mitochondrion, plasma membrane, ribosome.

4. Which cell type is likely to contain an abundance of mitochondria?
(a) bone
(b) cartilage
(c) hair
(d) sperm.

5. Which list contains organs from only one system?
(a) heart, artery, vein, kidney
(b) lung, trachea, artery, alveolus
(c) ileum, rectum, stomach, oesophagus
(d) femur, cranium, sternum, biceps.

6. The concentration of some molecules inside a cell may be different from the concentration of those molecules outside the cell. The structure that directly controls this concentration gradient is the
   (a) nucleus
   (b) mitochondrion
   (c) Golgi body
   (d) plasma membrane.

7. Which of the following organelles is most closely connected to the cell function shown?
   (a) the nucleus and aerobic respiration
   (b) the Golgi body and DNA synthesis
   (c) lysosomes and intracellular digestion
   (d) ribosome and cell movement.

8. The following are connective tissue:
   (a) bone, blood, nervous
   (b) blood, cartilage, adipose
   (c) adipose, smooth muscle, bone
   (d) smooth muscle, cardiac muscle, striated muscle.

9. Epithelial tissue may be found in:
   (a) the lining of the blood vessels
   (b) in a semi-fluid matrix
   (c) flowing along blood vessels
   (d) attaching bone to muscle.

10. A description of cartilage would include:
   (a) containing many branching capillaries
   (b) can repair easily
   (c) can contract
   (d) firm but flexible.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. Explain briefly how the respiratory and circulatory systems work together to maintain life.

____

____

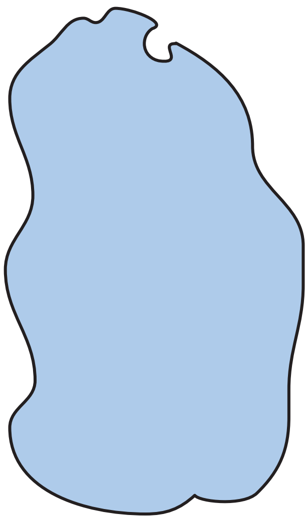
____

____

[4 marks]

2. (i) Use the outline of a cell below to sketch in and label the following structures.

nucleus, nucleolus, nuclear membrane, chromosomes, endoplasmic reticulum, ribosomes, Golgi apparatus, mitochondria, lysosomes, centrioles, cell membrane, cytoplasm.



[6 marks]

(ii) Describe the function of:

endoplasmic reticulum

____

____

ribosomes

____

____

Golgi apparatus

____

____

mitochondria

____

____

lysosome

____

____

centrioles

____

____

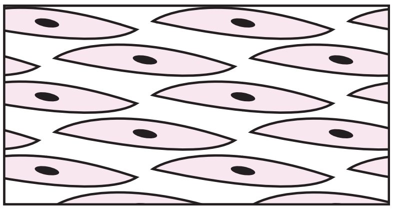
[6 marks]

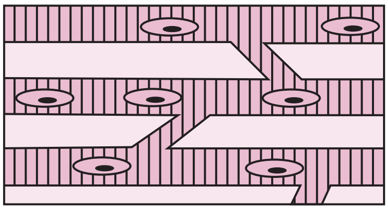
3. (i) In the table below, describe the important features of each of the four basic types of tissue and give two examples of each type.

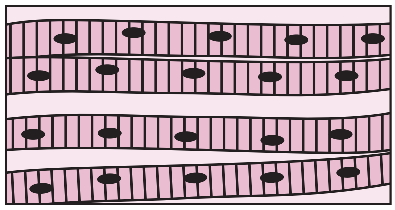
TISSUE TYPE	IMPORTANT STRUCTURAL AND FUNCTIONAL FEATURES	EXAMPLES
Epithelial		
Connective		
Muscular		
Nervous		

[8 marks]

(ii) Name the type of muscle tissue shown in each diagram below.



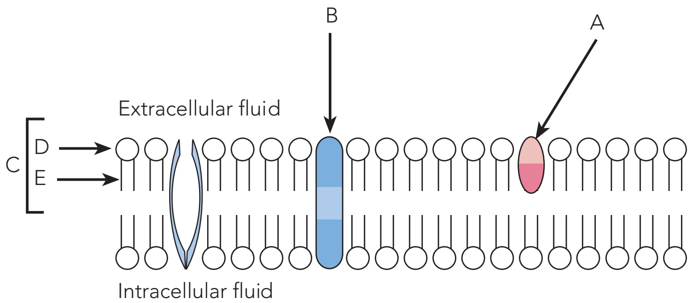




(a) ____________________ (b) ____________________ (c) ____________________

[3 marks]

4. The diagram below shows the fluid mosaic model of membrane structure.



(i) If A and B are proteins, besides their shape, in what way are they apparently different?

____

[1 mark]

(ii) C represents one of the two lipid layers. Explain why on the outer layer, part D faces outwards and part E inwards but this is reversed on the inner layer.

____

____

____

[2 marks]

(iii) What are the two major chemical components in the cell membrane?

____

[2 marks]

(iv) Explain what is meant by the 'fluid mosaic' model of the cell membrane

____

____

____

[3 marks]

(v) This model explains why some substances pass through the membrane while others do not. Use it to explain briefly why each of the following categories of substance passes through the membrane.

(a) fat-soluble molecules

____

(b) small uncharged atoms and molecules

____

(c) water

____

[3 marks]

(vi) Explain why not all proteins are likely to pass through a membrane easily.

____

[1 mark]

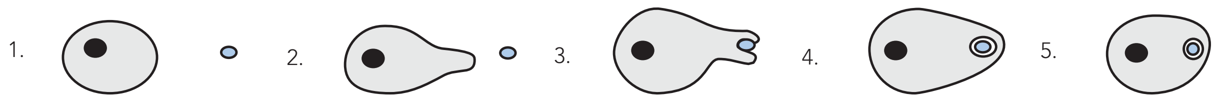
(vii) Why do alcohol and detergent destroy cell membranes?

____

____

[2 marks]

5. In the sequence of events shown below, a single cell is seen to engulf a food particle.



(i) What is the process called? ______________________________

[1 mark]

(ii) Is this an active or a passive process? Explain.

____

____

____

[2 marks]

(iii) Is the food particle likely to be solid or liquid? ____________________

[1 mark]

(iv) Is this process an example of exocytosis or endocytosis? Explain.

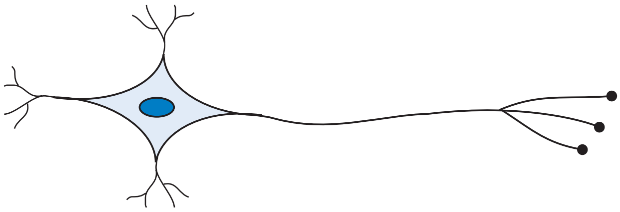
____

____

____

[2 marks]

6. Cells vary in shape and size. Explain why the following cells have their particular shape.



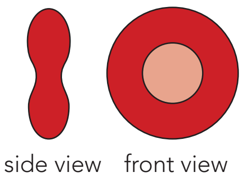
(i) A nerve cell

____

____

____

[1 mark]



(ii) A red blood cell

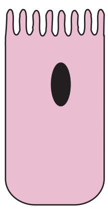
____

____

____

[1 mark]

(iii) An intestinal cell



____

____

____

[1 mark]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

Describe the following mechanisms by which substances cross the plasma membrane of a cell.

(a)	passive transport and facilitated diffusion	[5 marks]
(b)	osmosis	[3 marks]
(c)	active transport	[3 marks]
(d)	endocytosis	[5 marks]
(e)	exocytosis	[2 marks]
For presentation, grammar and clarity		[2 marks]

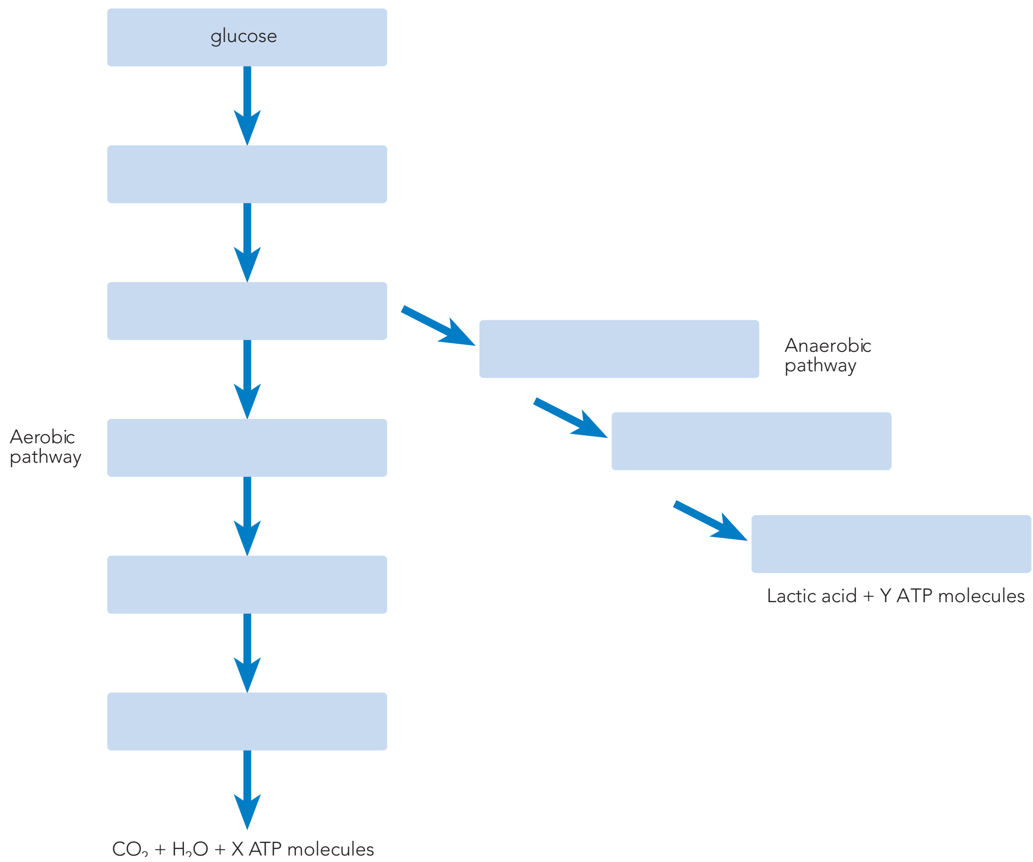
TRIAL TEST 3: METABOLISM

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. The **specificity** of an enzyme refers to its:
   (a) capacity to speed up a chemical reaction
   (b) potential to be recycled
   (c) sensitivity to temperature and pH
   (d) restriction in fitting only one substrate.

The diagram below represents the series of chemical changes that occur in aerobic and anaerobic respiration:



Use these diagrams to answer the following two questions (2 and 3).

2. If **one** molecule of glucose was respired, the values for X and Y respectively could be:
   (a) 1 and 36
   (b) 36 and 1
   (c) 36 and 2
   (d) 2 and 36.

3. The processes in both pathways are controlled by enzymes. Therefore the rates at which both occur depend on:
   (a) the temperature in the cells
   (b) both the temperature and the pH in the cells
   (c) only the pH in the cells
   (d) the available oxygen.

When glucose is respired aerobically and ATP is formed, the energy relationship between the two reactions can be shown as:

$$\text{glucose} + \text{oxygen} \longrightarrow \text{carbon dioxide} + \text{water}$$

$$\text{ATP} \longleftarrow \text{ADP} + \text{P}$$

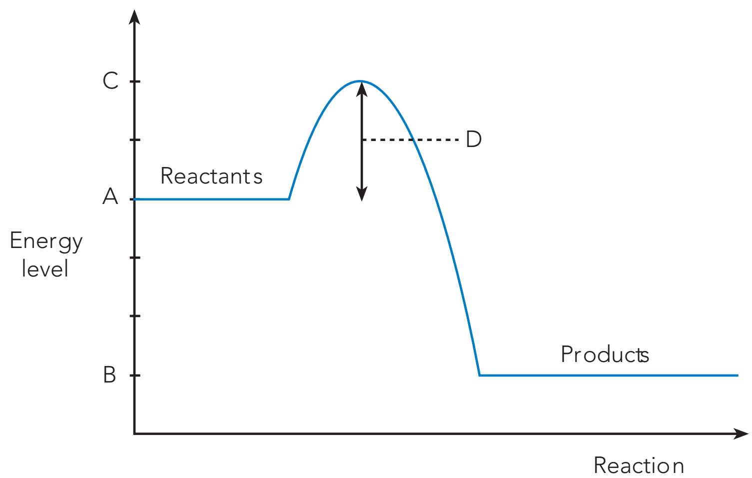
Use this to answer questions 4–6.

4. The diagram indicates that as chemical energy is released from the glucose molecule:
   (a) ADP + P are formed
   (b) ATP absorbs the energy
   (c) ADP + P release ATP
   (d) ADP + P absorb the energy.

5. Not all the energy in the glucose is transferred. Some of the energy:
   (a) remains in the products and some is lost as heat
   (b) forms heat and light
   (c) is absorbed by the mitochondria
   (d) is actively transported from the cell.

6. The ATP that is formed is used as an energy store and can be used by the cell in many processes. Which of the following lists contains only processes which use ATP as a source of energy?
   (a) cell division, protein synthesis and diffusion
   (b) cell division, osmosis and photosynthesis
   (c) protein synthesis and respiration
   (d) protein synthesis and active transport.

7. The graph below illustrates the energy levels of the reactants and the products in an enzyme controlled chemical reaction.



The activation energy is illustrated by:

(a) A
(b) B
(c) C
(d) D

8. The reaction in the graph in question 7 could represent only one of the following reactions. Which one?

(a) diffusion
(b) digestion
(c) protein synthesis
(d) osmosis.

9. Thousands of proteins are found in living cells. Their main role/roles in cells is/are to:

(a) provide energy
(b) provide structure and catalyse chemical reactions
(c) assist other chemicals to break down
(d) provide the physical structural components of membranes.

10. The organelle which is associated with aerobic respiration is the:

(a) ribosome
(b) lysosome
(c) endoplasmic reticulum
(d) mitochondrion.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. (i) Write the word equation for anaerobic respiration.

____

[1 mark]

(ii) Why is the product of human anaerobic respiration a problem for cells?

____

[1 mark]

(iii) Where in the cell does anaerobic respiration occur?

____

[1 mark]

(iv) Compare the amount of energy released in anaerobic respiration with the amount released in aerobic.

____

____

[2 marks]

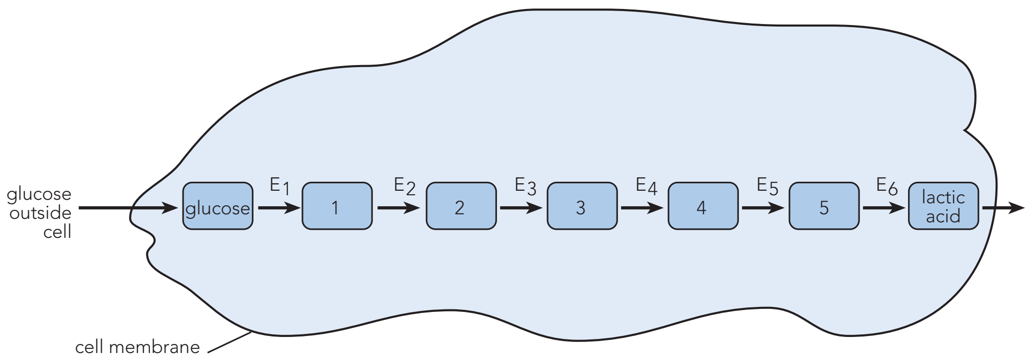
(v) Is the transfer of energy from glucose to ATP efficient? Explain your answer.

____

____

[2 marks]

2. The following diagram illustrates the action of enzymes in a human cell converting glucose into lactic acid. This occurs when the cell is 'fed' glucose in the absence of oxygen.



The breakdown of glucose involves the intermediate compounds represented by the numbers 1 to 5 and each stage of the reaction is controlled by a different enzyme represented by the letters E_1 to E_6.

(i) What would happen if the enzyme E_6 was not present in the cell?

[1 mark]

(ii) Normally lactic acid moves out of the cell into the extracellular fluid. What might happen if lactic acid accumulated in the cell?

[1 mark]

(iii) Suppose the cell was slowly heated to a temperature which well exceeded the normal temperature of the cell. How might this affect the process?

[1 mark]

(iv) Explain your answer in terms of the 'lock and key' hypothesis.

[2 marks]

3. (i) Write the word equation for aerobic respiration.

[1 mark]

(ii) Show how the energy produced by the above reaction is stored in ATP (adenosine triphosphate).

[1 mark]

(iii) When the energy is needed show how ATP breaks down to release the energy required.

[1 mark]

(iv) What is the energy used for?

[2 marks]

4. Explain why a cell requires each of the following:

(i) proteins

(ii) lipids

(iii) carbohydrates

(iv) vitamins

(v) oxygen

(vi) water

(vii) mineral ions

[7 marks]

5. Discuss how enzyme function is affected by each of the following:

(i) pH

(ii) temperature

(iii) presence of inhibitors

(iv) co-enzymes and co-factors

(v) the concentration of reactants and products

[10 marks]

6. (i) What are two properties of catabolic reactions?

(a)

(b)

[2 marks]

(ii) Give an example of a catabolic reaction that occurs in a cell.

[1 mark]

(iii) Where does this catabolic reaction occur in the cell?

[1 mark]

(iv) What are two properties of anabolic reactions?

(a) ______________________________

(b) ______________________________

[2 marks]

(v) Give an example of an anabolic reaction that occurs in a cell.

____

[1 mark]

(vi) Where does this anabolic reaction occur in the cell?

____

[1 mark]

(vii) Explain what is meant by 'metabolism'.

____

____

[2 marks]

(viii) Why does metabolism in living cells produce heat?

____

____

[2 marks]

(ix) The heat that is produced is important and necessary for the living cells. Why?

____

____

[2 marks]

7. Distinguish between a competitive enzyme inhibitor and a non-competitive enzyme inhibitor.

____

____

____

____

____

[2 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

(i) Discuss the "lock and key" model of enzyme action. Use diagrams to illustrate your answer. [10 marks]

(ii) Use the model to explain why the activity of enzymes is affected by temperature. [4 marks]

(iii) What is meant by the "activation energy" of a chemical reaction and how do enzymes affect activation energy. Sketch simple graphs to help explain your answer. [6 marks]

TRIAL TEST 4:
RESPIRATORY SYSTEM

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. Which one of the following has walls one cell in thickness and is well supplied with blood?
   (a) bronchioles
   (b) bronchi
   (c) alveoli
   (d) trachea.

2. The main function of the nasal cavity is to:
   (a) warm and filter air
   (b) act as a resonating chamber for sound
   (c) provide a surface to detect odours
   (d) supply mucus.

3. The area of ciliated tissue in nasal cavities is increased by projections called:
   (a) septa
   (b) sinuses
   (c) villi
   (d) conchae.

4. Which of the following allows the lungs to move freely and with reduced friction between the inner walls of the thorax?
   (a) moisture in inhaled air
   (b) mucus within the bronchioles
   (c) fluid within the pleura
   (d) pulmonary blood supply.

5. Air enters the lungs during inspiration because:
   (a) there is a vacuum in the alveoli
   (b) air pressure outside the body is greater than in the lungs
   (c) the intercostal muscles push outwards and stretch the lungs
   (d) the lungs are attached to the diaphragm which is raised.

6. During expiration, the:
   (a) diaphragm lowers
   (b) ribs move upward and outward
   (c) pressure inside the thoracic cavity increases
   (d) size of thoracic cavity increases.

7. Which of the following is true of gaseous exchange through the wall of the alveolus?
   (a) Nett diffusion of oxygen is from alveoli to the blood capillaries
   (b) Diffusion of carbon dioxide occurs at the same rate in both directions
   (c) Nett diffusion of carbon dioxide is from alveoli to the blood capillaries
   (d) Diffusion of oxygen occurs at the same rate in both directions.

8. Oxygen passes from the alveoli to the blood in capillaries by:
   (a) osmosis
   (b) diffusion
   (c) active transport
   (d) all of these.

9. The volume of air that moves into and out of the lungs with each breath is called:
   (a) residual volume
   (b) reserve volume
   (c) vital capacity
   (d) tidal volume.

10. The substance to which oxygen becomes chemically bonded within the red blood cell is:
   (a) oxyhaemoglobin
   (b) haemoglobulin
   (c) haemoglobin
   (d) carboxyhaemoglobin.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. Write the appropriate term or words for each of the phrases below:

   (i) Nerve endings which are sensitive to substances in the air and enable us to distinguish between smells.

   ____

   (ii) Two folds of membrane in the larynx. ______________________________

   (iii) The trachea is prevented from collapsing by rings of

   ____

   (iv) The two-layered membrane covering each lung. ______________________

   (v) The dome-shaped muscle that separates the abdominal cavity from the thoracic cavity.

   ____

   (vi) The muscles between ribs which assist in inhalation and exhalation.

   ____

   (vii) Carbon dioxide attaches to this compound which is found in the red blood cells.

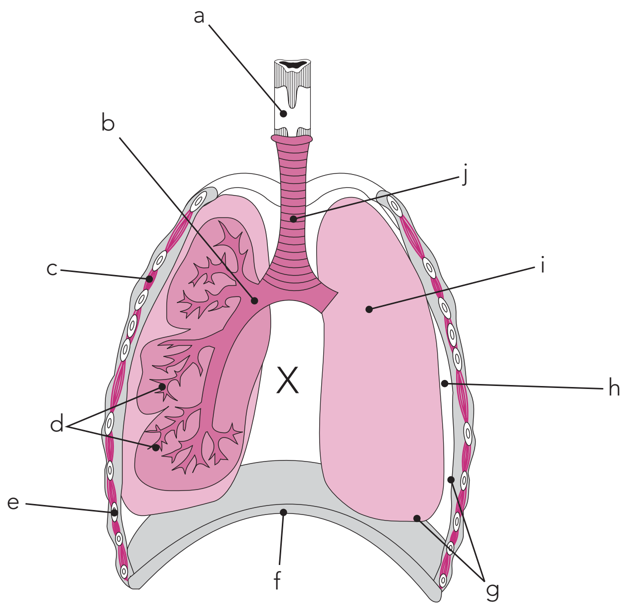
   ____

   (viii) Most of the carbon dioxide which travels in the blood plasma does so in the form of:

   ____

[8 marks]

2. (i) Label the diagram of the respiratory system in the spaces provided.



a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

f) ______________________________

g) ______________________________

h) ______________________________

i) ______________________________

j) ______________________________

[5 marks]

(ii) Which organ is found in the space marked **X**?

____

[1 mark]

(iii) The cells which line the trachea and bronchi are ciliated. Explain why this lining is necessary.

____

____

[2 marks]

(iv) List the organs and tissues through which oxygen travels from its entry to the body at the nose until it moves into the blood plasma in the capillaries of the lungs.

____

____

[2 marks]

3. What are three functions of the nasal cavity?

(i) ____

(ii) ____

(iii) ____

[3 marks]

4. (i) Describe how air is drawn into the lungs during inhalation.

[2 marks]

(ii) Describe how air is forced out of the lungs during exhalation.

[2 marks]

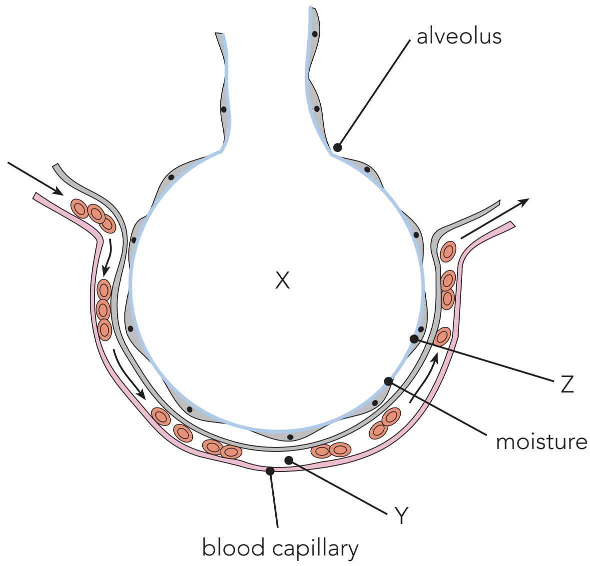
(iii) At rest a person breathes between 16 and 18 times per minute, using only the diaphragm. Which muscles increase the volume of each breath when exercising?

[1 mark]

5. Describe how the air changes as it is breathed in and out of the respiratory system.

[2 marks]

6. The diagram below shows the structural relationship between an alveolus and a blood capillary.



(i) After inhalation explain why oxygen moves from X to Y and carbon dioxide from Y to X.

[2 marks]

(ii) As the oxygen moves into the blood plasma, how does it travel in the blood?

[2 marks]

(iii) Why must the lining of the alveolus Z remain moist?

[1 mark]

(iv) What special features enable the alveoli to absorb sufficient oxygen for an adult's needs?

[2 marks]

7. The table below shows the approximate % of the gases in inhaled air and air that is exhaled when resting and when exercising.

	Inhaled Air	Exhaled air when resting	Exhaled air when exercising
Nitrogen	78%	78%	78%
Inert gases	1%	1%	1%
Oxygen	21%	16%	11%
Carbon dioxide	0.03%	4.5%	9.5%
Water vapour	variable	saturated	saturated

NOTE: *The level of CO_2 indicated for inhaled air is lower than would be expected in metropolitan areas (ie. 0.04%)*

(i) Which gases are not involved in respiration?

[1 mark]

(ii) By how much does the percentage of CO_2 in exhaled air increase when a person who is resting begins to exercise?

[1 mark]

(iii) By approximately how much does the percentage of oxygen used increase when an adult, who has been resting, begins to exercise?

[1 mark]

(iv) Explain why these percentages change when a person is exercising.

[2 marks]

(v) How does breathing affect the level of water in our blood plasma?

[1 mark]

8. Emphysema is a disease which affects the alveoli and may be caused by long-term exposure to tobacco smoke. The lung tissue loses its elasticity and many of the capillaries which service the alveoli are destroyed.

(i) How do you think these changes to the lungs would affect its efficiency? Why?

[2 marks]

(ii) What would be the likely symptoms of a person suffering from this disease?

[2 marks]

(iii) Emphysema is irreversible. How do you think the disease's progress could be slowed?

[2 marks]

9. Asthma is a common condition in which a narrowing of the bronchioles accompanied by an accumulation of mucus in these passageways occurs. These are temporary symptoms often caused by allergies which may cause the muscles of the bronchioles to contract and reduce their diameter.

(i) Why might a person suffering from this condition find breathing difficult?

[1 mark]

(ii) How might inhalants (puffers etc) assist a person suffering an asthma attack?

[2 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

The human lung is a very good example of a surface which enables aerobic respiration to occur efficiently in body cells. Discuss how it is structured to carry out this important function.

TRIAL TEST 5: CIRCULATORY SYSTEM

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. Blood which is returning to the heart from the brain will enter the:
   (a) left atrium
   (b) left ventricle
   (c) right ventricle
   (d) right atrium.

2. Which artery carries de-oxygenated blood?
   (a) aorta
   (b) hepatic portal
   (c) pulmonary
   (d) carotid.

3. Although the heart beats rhythmically, the blood pressure in the arteries does not drop to zero between heart beats and the blood is kept in continuous motion. Which of the following best helps to explain these observations?
   (a) The left and right ventricles contract alternately
   (b) The lymph that is draining into the lymphatic vessels is released steadily into veins
   (c) The blood expands and contracts with the pressure changes
   (d) The walls of the arteries are elastic.

4. Which of the following blood components have the power of amoeboid movement?
   (a) Erythrocytes
   (b) Macrophages
   (c) Platelets
   (d) All of the above.

5. Exchange of nutrients and waste material between the blood and the cells occurs through:
   (a) Lymph
   (b) Lymphatic vessels
   (c) Intercellular fluid
   (d) Intracellular fluid.

6. A person suffering from a deficiency of red blood cells is unable to carry out prolonged vigorous physical exercise. The main reason for this is that:
   (a) Waste products cannot be removed rapidly enough.
   (b) The amount of blood sugar being carried to the body cells would not be sufficient for the energy required.
   (c) The concentration of carbon dioxide in the extracellular fluid would become too high.
   (d) Insufficient oxygen can be carried by the blood.

7. Which of the following blood proteins is concerned with blood clotting?
   (a) Calcium
   (b) Globulin
   (c) Fibrinogen
   (d) Haemoglobin.

8. Which of the following is found in the blood plasma but not in the lymph?
   (a) amino acids
   (b) red blood cells
   (c) glucose
   (d) white blood cells.

9. Which of the following are **most** important in the formation of a blood clot when a blood vessel is damaged?
   (a) red blood cells, platelets and macrophages
   (b) damaged cells, platelets and prothrombin
   (c) damaged cells, platelets, red blood cells
   (d) damaged cells, thrombin, red blood cells.

10. Inflammation in the area of a wound, like a tear in the skin, is a useful reaction to the damage because:
   (a) It results in more blood flow to the area
   (b) It allows more seepage of plasma from the capillaries into the surrounding tissue
   (c) It may enable a blood clot to form more readily in the area
   (d) All of the above.

SECTION 2 – SHORT ANSWER (50 MARKS)

1. Write the appropriate term or words for each of the phrases below:

   (i) The membrane which completely encloses and protects the heart is called the

   ____

   (ii) When heart muscles contract. ______________________________

   (iii) The approximate time for one complete cardiac cycle is

   ____

   (iv) Blood flow from the heart to the lungs and then from the lungs back to the heart is the

   ____

   (v) The instrument which is used to measure blood pressure is called a

   ____

   (vi) Erythrocytes have a relatively short life span because they lack a

   ____

   (vii) Tissue fluid and blood plasma both exist outside cells, therefore they are said to be

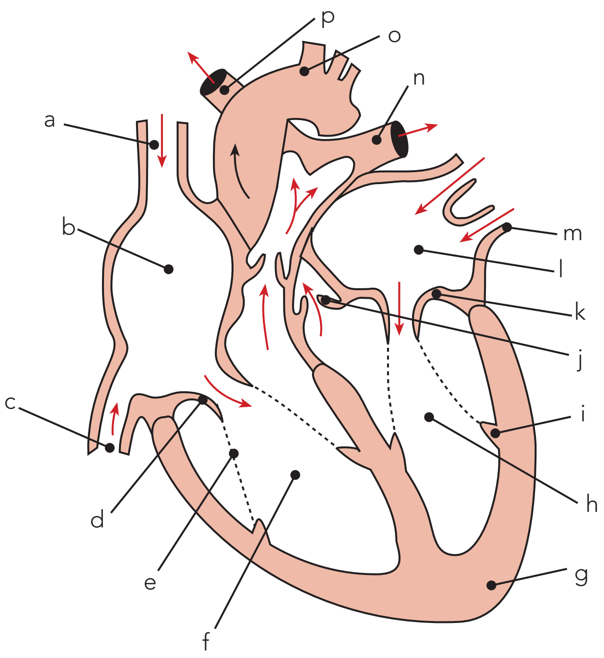
   ____

(viii) The percentage of plasma in blood is approximately

____

[8 marks]

2. (i) Label the diagram of the heart.



c) ______________________________

d) ______________________________

e) ______________________________

f) ______________________________

g) ______________________________

h) ______________________________

i) ______________________________

j) ______________________________

k) ______________________________

l) ______________________________

m) ______________________________

n) ______________________________

a) ______________________________

o) ______________________________

b) ______________________________

p) ______________________________

[8 marks]

(ii) What is the function of the tricuspid and bicuspid valves (atrioventricular valves)?

____

____

[2 marks]

(iii) What is the function of the semi-lunar valves?

____

____

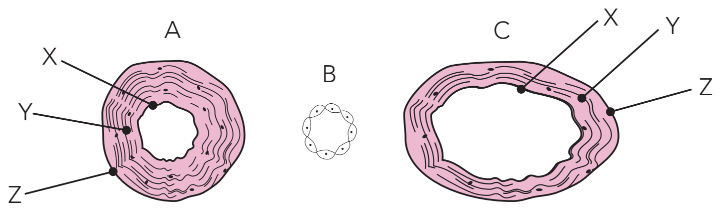
[2 marks]

(iv) During a cardiac cycle the heart makes two distinct sounds which are about 0.3 seconds apart. What are these two sounds?

____

[1 mark]

3. The diagrams below show a vein, an artery and a capillary.



Which is the: (i) vein _____ (ii) artery _____ (iii) capillary _____

[3 marks]

(iv) Name the tissues shown at

X ____

Y ____

Z ____

[3 marks]

(v) Explain why each of the following has a different structure.

artery ____

vein ____

capillary ____

[3 marks]

(vi) Why do veins have valves along their lengths?

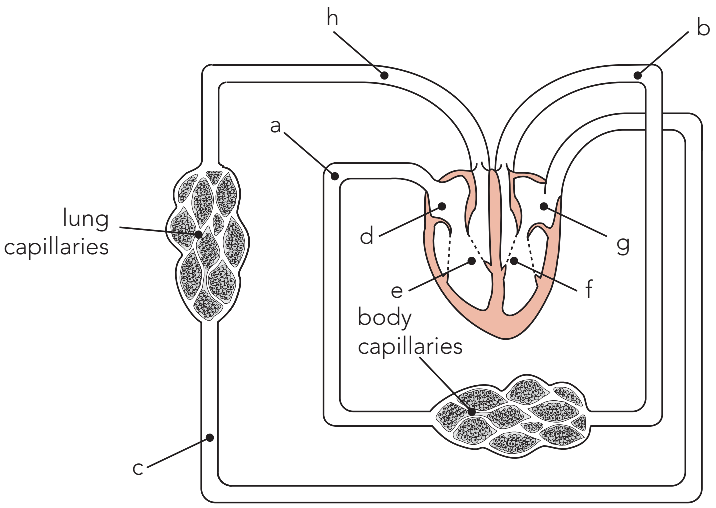
____

[1 mark]

(vii) Draw labelled diagrams to show how blood is forced along a vein when nearby skeletal muscles contract.

[4 marks]

4. (i) Label the blood vessels and chambers of the heart shown in the diagram below.



a) ______________________

b) ______________________

c) ______________________

d) ______________________

e) ______________________

f) ______________________

g) ______________________

h) ______________________

[4 marks]

(ii) Using arrows show the direction of blood flow through the circulatory system.

[2 marks]

(iii) On the diagram, which blood vessels make up the:

a) pulmonary circulation

____

[1 mark]

b) systemic circulation

____

[1 mark]

5. What are the general functions of:

(i) erythrocytes

____

[1 mark]

(ii) leucocytes

____

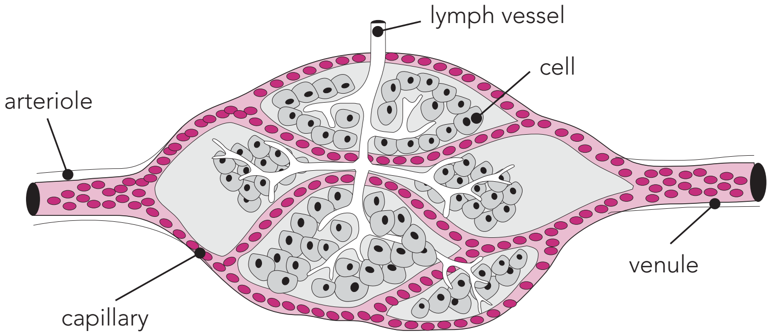
[1 mark]

(iii) platelets

____

[1 mark]

6. The diagram below shows a tissue bed.



Describe the function of the lymph vessel in the tissue.

____

____

[2 marks]

7. Circle the term that does not belong in each of the following lists:

(i) atrio-ventricular valves open, atrial systole, semi-lunar valves closed, ventricular systole.

(ii) plasma, intercellular fluid, lymph, intracellular fluid.

[2 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

A single celled animal like an amoeba does not require a circulatory system however large multicellular animals do. Explain (a) why this is so; and (b) how our circulatory system delivers oxygen and nutrients to and removes wastes from the cells of the human body.

TRIAL TEST 6:
DIGESTIVE SYSTEM

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. Which of the following equations represents the conversion of starch to a substance which can be used for cellular respiration?
   (a) peptide $\xrightarrow{\text{peptidase}}$ amino acids

   (b) nucleic acid $\xrightarrow{\text{nuclease}}$ nucleotides

   (c) polysaccharide $\xrightarrow{\text{amylase}}$ monosaccharide

   (d) lipid $\xrightarrow{\text{lipase}}$ fatty acids

2. The organic nutrient with the highest energy content is:
   (a) lipids
   (b) proteins
   (c) carbohydrates
   (d) sugars.

3. The best source of protein in the list below is:
   (a) milk
   (b) oranges
   (c) fish
   (d) potatoes.

4. The molecules that result from the digestion of proteins and carbohydrate share some characteristics. These include:
   (a) they are short chains of monosaccharides
   (b) they are amino acids
   (c) they are small enough to pass through cell membranes
   (d) they contain carbon, hydrogen and nitrogen.

5. The lungs and intestines have similar structures related to all of the following except:
   (a) a large surface area enabling rapid diffusion of molecules into the blood
   (b) a thin surface lining separating the internal and external environments
   (c) a rich supply of blood
   (d) a large number of air spaces between the cells to reduce the weight of the organs.

6. Study the table below. Which represents the human adult's dental formula?

(a)	$\frac{2123}{2123}$
(b)	$\frac{2132}{2132}$
(c)	$\frac{2122}{2122}$
(d)	$\frac{2033}{2033}$

7. After digestion and absorption in the villi of the small intestine, which one of the following nutrients would enter the blood stream via the lymphatic system at the thoracic duct?
   (a) sugar
   (b) amino acids
   (c) lipids
   (d) vitamins.

8. Which of the following organs is primarily involved in the absorption of water and the formation of faeces:
   (a) ileum
   (b) stomach
   (c) duodenum
   (d) colon.

9. Bile is secreted into the duodenum. Its function in digestion is to:
   (a) chemically digest lipids
   (b) neutralise the acids of the stomach
   (c) emulsify fats
   (d) complete the digestion of proteins.

10. Pepsin is produced by gastric glands as inactive pepsinogen. In the stomach it mixes with hydrochloric acid which activates it. This occurs so that:
   (a) the cells that produce the acid do not self destruct
   (b) the cells that produce the pepsinogen are themselves not attacked by pepsin
   (c) mucus is better able to protect the lining of the stomach from digestive enzymes
   (d) the hydrochloric acid is neutralised by the pepsinogen.

SECTION 2 – SHORT ANSWER (50 MARKS)

1. Write the appropriate term or words for each of the phrases below:

   (i) A chemical process in which nutrients are broken down into small molecules so that they can be absorbed by the body.

   ____

   (ii) The term used to describe the sum total of all the chemical processes which occur in the body.

   ____

   (iii) A protein which acts as a catalyst either inside or outside cells.

   ____

   (iv) The organ which produces bile using the haemoglobin in worn out red blood cells.

   ____

   (v) The acid which is secreted into the gastric pits in the stomach.

   ____

   (vi) Any enzyme that catalyses the breakdown of lipids.

   ____

(vii) Proteins are long chains of smaller sub-units called

____

(viii) The mucosa of the small intestine has small finger-like projections called

____

(ix) Food moves along the digestive tract due to the contraction of muscles along its length. The contractions are called

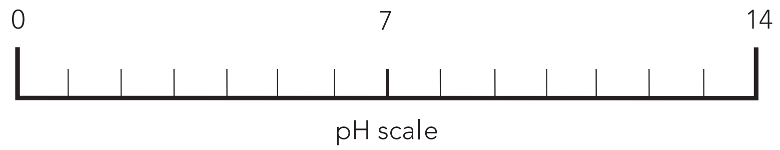
____

(x) The tooth type most responsible for crushing and grinding food.

____

[10 marks]

2. (i) On the pH scale below using arrows mark in the range of increasing acidity and increasing alkalinity (or basicity).



[1 mark]

(ii) Explain why the contents of the stomach need to be at pH of about 2 for it to carry out its function.

____

[1 mark]

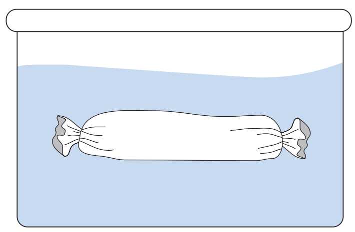
(iii) What is the optimum pH for most other enzymes in the human body?

____

____

[2 marks]

3. A semi-permeable bag containing starch solution, when placed in distilled water, as shown below, begins to expand and become turgid.



(i) Why does the bag expand?

____

[2 marks]

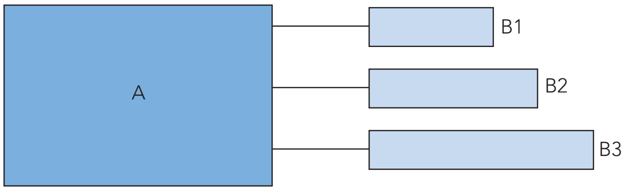
(ii) A similar bag containing sugar (glucose) solution treated in a similar way expands in the first few hours but then begins to collapse and become soft again. Explain.

____

____

[2 marks]

4. Triglycerides are an important type of fat which make up the fat stored in the body. All triglycerides have a similar structure illustrated below.



(i) (a) What is the chemical name of part A? ____________________

(b) What is the general chemical name for molecules marked B1, B2, B3?

__________________________ [2 marks]

(ii) In what form is glucose stored in the body's muscles and liver?

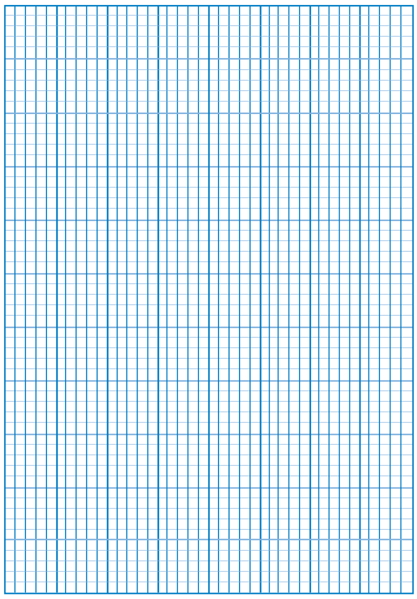
__________________________ [1 mark]

(iii) Glucose is described as a monosaccharide. When large numbers of glucose molecules are bonded together, they form a

__________________________ [1 mark]

5. Study the data in the table below.

TEMPERATURE (°C)	ENZYME ACTIVITY (ARBITRARY UNITS)
10	5
15	8
20	12
25	43
30	61
35	98
40	98
45	53
50	40
55	15
60	7
65	4
70	0



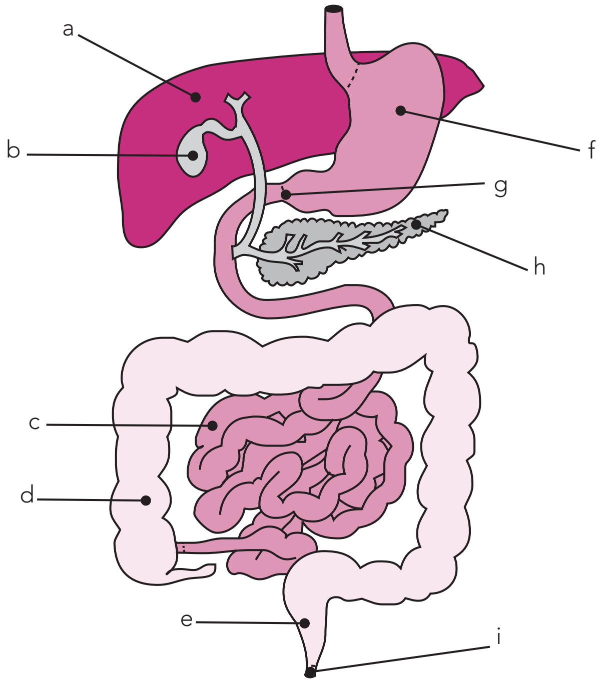
(i) Graph this data using the grid.

[5 marks]

(ii) What temperature is optimum for the activity of this enzyme?

__________________________ [1 mark]

6. (i) Using the diagram below name and write the function of each part shown.



Name of:

a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

f) ______________________________

g) ______________________________

h) ______________________________

i) ______________________________

Function of:

a) ____

b) ____

c) ____

d) ____

e) ____

f) ____

g) ____

h) ____

i) ____

[9 marks]

(ii) Mark with the letter "S" two sphincter muscles which have not been labelled.

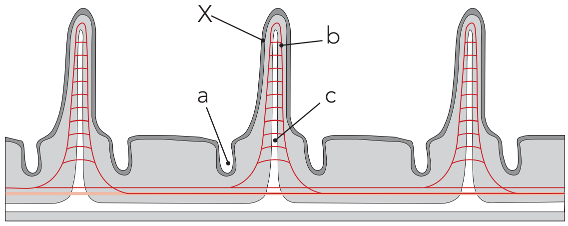
[1 mark]

(iii) Mark with the letter "X" an organ which does not have a function in humans.

[1 mark]

7. (i) The diagram below shows several intestinal villi.

Name and write the function of the three parts.



a) ______________________________

____

____

____

b) ______________________________

____

c) ______________________________

____

[3 marks]

(ii) The cells marked "X" are either absorptive or secretory. What special adaptation do the absorption cells have to assist them to absorb nutrients?

____

[1 mark]

8. Complete the table below.

ORGAN	ENZYME	ACTS UPON	PRODUCTS
Salivary glands	(i) ____________	Starch	Disaccharide (maltose)
Stomach	Pepsin	(ii) ____________	Peptides
Pancreas	Pancreatic - amylase - lipase - protease - nucleases	 starch (iv) ____________ protein (v) ____________	 (iii) ____________ fatty acids + glycerol peptides sugar + nitrogen bases
Small Intestine	Maltase Sucrase nuclease lactase peptidase	(vi) ____________ disaccharide nucleic acids disaccharide peptides	monosaccharide monosaccharide sugar + nitrogen bases (vii) ____________ amino acids

[7 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

Activities associated with the digestive tract include ingestion, mechanical digestion, chemical digestion, propulsion, absorption and elimination. Discuss each of these processes; indicate where enzymes are produced and secreted and what organs and tissues are involved in each process.

TRIAL TEST 7: MUSCULOSKELETAL SYSTEM

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. A muscle which steadies a joint during its movement is called:
   (a) an agonist
   (b) an antagonist
   (c) a prime mover
   (d) a synergist.

2. Myofilaments are made of actin and myosin. These two structures are types of:
   (a) protein
   (b) carbohydrate
   (c) nucleic acid
   (d) lipid.

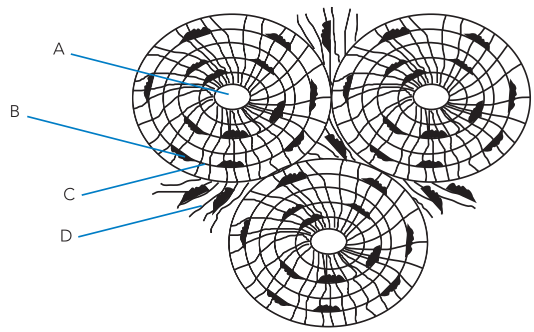
3. Which of the following statements is correct:
   (a) skeletal muscle and cardiac muscle are under involuntary control
   (b) cardiac muscle and smooth muscle are under voluntary control
   (c) smooth muscle and skeletal muscle are under voluntary control
   (d) smooth muscle and cardiac muscle are under involuntary control.

4. Smooth muscle tissue is found:
   (a) attached to bones
   (b) in the walls of the heart
   (c) in the tongue
   (d) in the iris of the eye.

5. The red marrow of long bones is responsible for the:
   (a) production of blood cells
   (b) storage of fat
   (c) secretion of synovial fluid
   (d) storage of proteins.

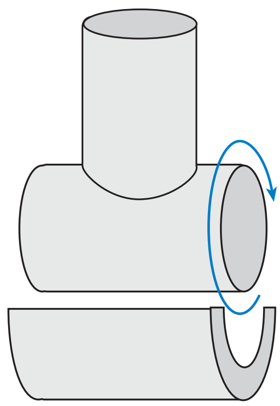
6. A bursa is:
   (a) part of a bone
   (b) a sac of fluid often found between tendons and bones
   (c) part of the pelvis
   (d) connective tissue found in muscles.

7. The diagram below shows the microscopic structure of compact bone:



(a) A is the osteocyte, B is the canalculi, C is the lamella and D is the Haversian canal
(b) A is the osteocyte, B is the matrix, C is the Haversian canal and D is the lacuna
(c) A is the Haversian canal, B is the lacuna, C is the lamella and D is the canalculi
(d) A is the Haversian canal, B is the matrix, C is the lamella, D is the osteocyte.

8.



This joint is a typical example of:
(a) a fibrous joint
(b) a cartilaginous joint
(c) an ankle joint
(d) a vertebral joint.

9. Which list has the joints in order of least movement to most movement?
(a) immoveable, gliding, pivot , hinge, ball and socket.
(b) ball and socket, hinge, pivot, gliding, immoveable
(c) immoveable, hinge, gliding, pivot, ball and socket
(d) immoveable, gliding, hinge, pivot, ball and socket.

10. In the table below match the type of cartilage to where it is found.

TYPE OF CARTILAGE	WHERE IT IS FOUND
A Hyaline	(i) Eustachian tubes
B Fibro	(ii) Between vertebrae
C Elastic	(iii) At the ends of long bones

The correct matches are:
(a) A (i), B (ii), C (iii)
(b) A (ii), B (iii), C (i)
(c) A(iii), B(ii), C (i)
(d) A(i), B (iii), C (ii)

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. Write the appropriate term or words for each of the phrases below:

   (i) Where bones meet and move relative to one another this is called

   ____

   (ii) The cavity in the shaft of a long bone is generally filled with

   ____

   (iii) Immovable joints, like those between the bony plates which make up the skull are called

   ____

   (iv) The four fused vertebrae which make up the human tail are called the

   ____

   (v) The socket into which the head of the femur fits is called the

   ____

   (vi) The heel bone is properly called the ______________________

   (vii) A dense fibrous tissue that covers the outside of the bone

   ____

   (viii) The large hole at the base of the skull through which the spinal cord passes is called

   ____

   (ix) All muscles have the ability to ______________________

   (x) Muscles which act to move a bone in opposite directions are called

   ____

[10 marks]

2. (i) When muscles contract to decrease the angle between two bones, this is called

   ____

[1 mark]

   (ii) When muscles contract to increase the angle between two bones, this is called

   ____

[1 mark]

(iii) What is a tendon?

____

____

[1 mark]

(iv) What is a ligament?

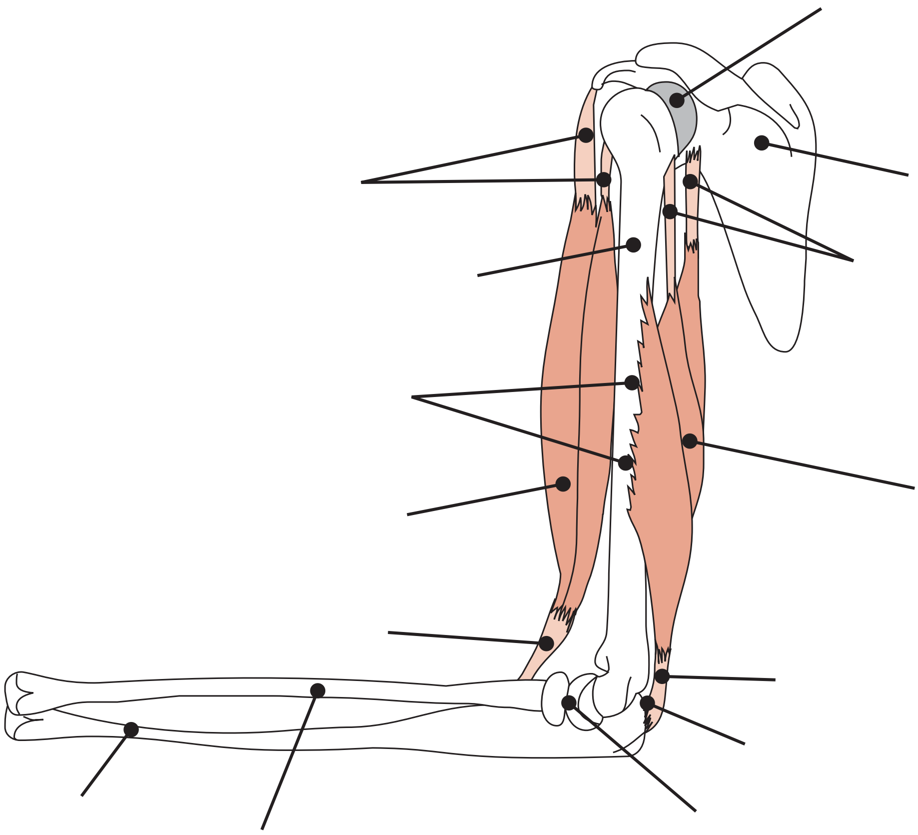
____

____

[1 mark]

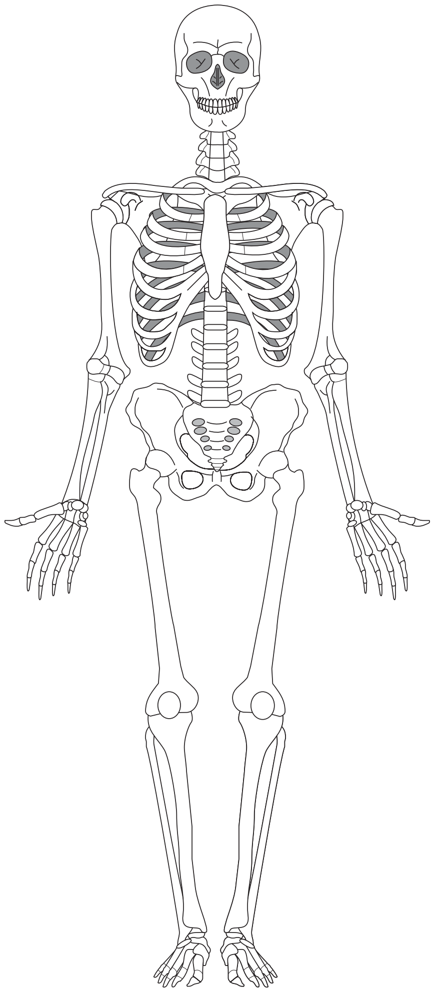
3. (i) Use the following letters to label the diagram below.

a tendons (origin of biceps)
b humerus
c radius
d tendon (insert of the triceps)
e ulna
f tendons (origin of triceps on humerus)
g scapula
h biceps
i triceps
j tendon (origin of triceps on scapula)
k tendons (insertion of biceps)
l pivot joint
m ball and socket joint
n hinge joint



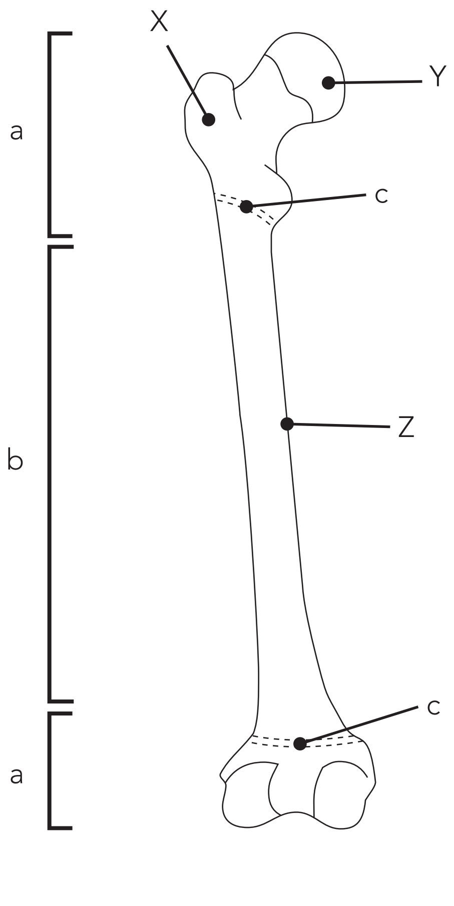
[7 marks]

4. On the diagram below, shade the axial skeleton in blue and the appendicular skeleton in red.



[2 marks]

5. (i) On the diagram of the femur below, label the parts shown in the spaces.



a) ______________________________

b) ______________________________

c) ______________________________

[3 marks]

(ii) Name the membrane which covers the region **b.** ______________________________

[1 mark]

Of what importance is this membrane?

____

[1 mark]

(iii) What type of bone tissue is found at:

Z ______________________________

X ______________________________

[2 marks]

(iv) The area **Y** is covered by a smooth tough tissue called ______________________

[1 mark]

The function of this tissue is to

____

[1 mark]

6. (i) Serious injury sometimes occurs when the ligaments in the central part of the knee joint are snapped.

Name the ligaments involved.

______________________________ [1 mark]

(ii) Name the fluid that fills the cavity of the knee joint.

______________________________ [1 mark]

(iii) Describe the function of this fluid.

____

____

[1 mark]

(iv) On the top of the tibia a layer of articular cartilage is curved upwards around its edges. Name this cartilage.

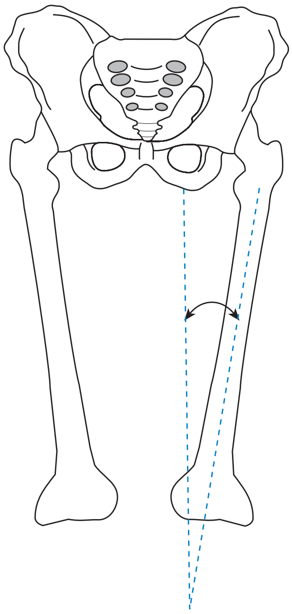
____

[1 mark]

(v) Why is this cartilage curved in this way?

[1 mark]

7. (i) Because of the wide human pelvis, the femurs form an angle to the vertical as they converge towards the knee (see diagram below).



What is this angle called?

[1 mark]

(ii) The angle enables humans to walk with a smooth striding gait. How does it help to achieve this?

[1 mark]

(iii) The head of the femur forms a joint with the pelvis. The ball of the femur's head fits into a depression in the pelvis. What is the depression called?

[1 mark]

(iv) Why is this a large joint in humans but much smaller in a quadrupedal animal of the same weight?

[1 mark]

8. (i) Humans have a broad, shallow pelvis which is tilted back. Why is the pelvis shaped and positioned in this way?

____

____

[1 mark]

(ii) The joints between the sacrum and the pelvis are fused, immovable joints in humans. Explain why they are not freely movable.

____

____

[1 mark]

9. What are four functions of the skeleton?

____

____

____

____

[4 marks]

10. List three structural features of the human vertebral column which enable humans to stand upright and walk bipedally.

____

____

____

____

____

____

[3 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

(i) Explain the sliding filament model of muscle contraction. [5 marks]

(ii) Discuss the three types of joints and the movements each provides. [6 marks]

(iii) Describe the three types of muscle, where each is found and what each type does. [9 marks]

TRIAL TEST 8: EXCRETORY SYSTEM

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. The substance that gives urine its yellow colour is:
   (a) urea
   (b) bile
   (c) potassium
   (d) amino acid.

2. Which of the following nutrients cannot be stored in the body.
   (a) carbohydrates
   (b) vitamins
   (c) lipids
   (d) proteins.

3. Large proteins are not normally found in the urine because they:
   (a) are broken down by the kidneys
   (b) are too large to be filtered by the kidneys
   (c) are needed by the body for growth and repair
   (d) do not exist in the blood, only amino acids are present in blood.

4. Which of the following organs are generally considered to be excretory:
   (a) kidneys and lungs
   (b) kidney, lungs and large intestine
   (c) kidney, skin and lungs
   (d) lungs, large intestine and skin.

5. Following the metabolic breakdown of amino acids in the liver, which substance is formed:
   (a) bile
   (b) urea
   (c) carbon dioxide
   (d) lactic acid.

6. The bladder's main function is to:
   (a) absorb some vitamins
   (b) reabsorb water from urine
   (c) reabsorb mineral ions from urine
   (d) store urine before it is voided.

7. The order in which urea may pass out of the body is:
   (a) artery → kidney → ureter → bladder → urethra
   (b) artery → kidney → urethra → bladder → ureter
   (c) vein → kidney → ureter → bladder → urethra
   (d) vein → kidney → urethra → bladder → ureter.

8. Which is the best description of excretion:
   (a) excreta is eliminated from the digestive tract
   (b) metabolic wastes from cells are removed from the body
   (c) urea is produced in the liver
   (d) deamination occurs in the liver.

9. In a normal healthy person, glucose is not usually found in the urine. Why is this?
   (a) because glucose is not filtered by the kidney, it is too large a molecule
   (b) glucose is used in respiration to produce energy for movement
   (c) glucose is reabsorbed after the filtration process in the kidneys and passed back into the blood
   (d) excess glucose is converted to glycogens and stored in the liver and muscles.

10. Blood in the glomerulus is under strong pressure due to:
   (a) contractions in nearby muscles
   (b) concentration gradients
   (c) reabsorption in the nephron
   (d) blood pressure in the renal artery

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. Write the appropriate term or terms for each of the phrases below.

   (i) the breakdown of amino acids in the liver ______________________________

   (ii) the main excretory waste found in urine ______________________________

   (iii) a disease in which glucose frequently appears in the urine__________________

   (iv) the name of the microscopic unit which filters the blood in the kidneys

   ____

   (v) the blood is delivered to each kidney by a branch of the aorta which is called a

   ____

   (vi) if a person's kidneys fail due to damage or disease, they may need to have their blood cleared of wastes at a hospital using this machine

   ____

   (vii) the compound which is of greatest percentage in the urine is ________________

   (viii) urine is released from the bladder under the voluntary control of this muscle type

   ____

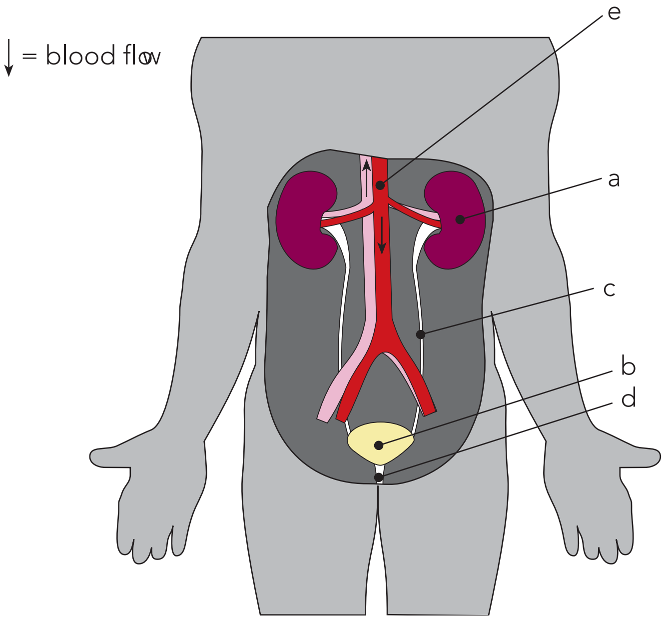
   (ix) a nitrogenous waste which is far more toxic than urea ______________________

   (x) that part of the excretory system that removes carbon dioxide from the body

   ____

[10 marks]

2.

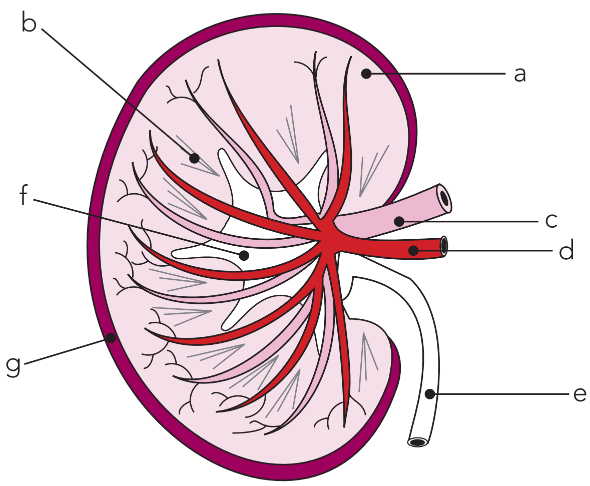


Complete the table shown below.

STRUCTURE	NAME	FUNCTION
a		
b		
c		
d		
e		

[10 marks]

3. (i) Label the following diagram of the kidney.



a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

f) ______________________________

g) ______________________________

[7 marks]

(ii) Using a red biro, mark the direction in which blood flows into and out of the kidney.

[2 marks]

(iii) What process occurs in the cortex? ______________________________

[1 mark]

(iv) Where does urine accumulate in the kidney? ______________________________

[1 mark]

(v) What is the function of the renal capsule?

____

[1 mark]

(vi) Why is the renal artery thicker than the renal vein?

____

[1 mark]

(vii) Why is the blood which is entering the kidneys under strong pressure?

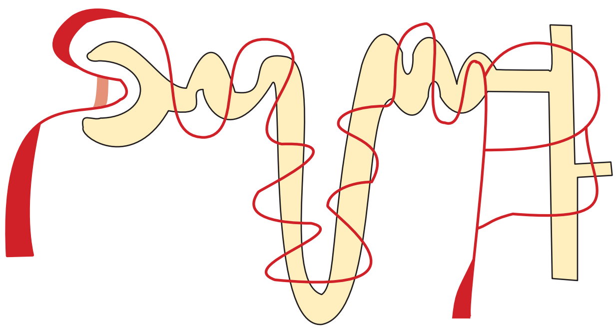
____

____

[2 marks]

4. Using the key below mark each location on the diagram of the nephron.

A Where the blood enters the nephron
B Where glucose is reabsorbed
C Where the urine leaves the nephron
D Where filtration occurs
E Where the blood leaves the nephron



[5 marks]

5. The word equations below shows two stages of a process that occurs in the liver.

First Stage: amino acid + oxygen → carbohydrate + ammonia

Second Stage: carbon dioxide + ammonia → urea + water

(i) What is the name for this process? ______________________________ [1 mark]

(ii) Why must the ammonia be converted to urea?

____

[1 mark]

(iii) The carbohydrate formed in the first stage can be used. What might it be used for?

____

[1 mark]

(iv) Where does the urea (which is an end product) go to immediately from the liver?

____

[1 mark]

(v) Where might the carbon dioxide which is required in the second stage come from?

____

[1 mark]

(vi) The second reaction is anabolic and therefore it requires energy. How can you tell that it is anabolic?

____

____

[1 mark]

(vii) Since producing urea from ammonia uses some of the body's metabolic energy, why does the body carry out this process?

____

____

[2 marks]

(viii) Why is concentrated urine more harmful than diluted urine?

____

[1 mark]

(ix) If your urine is concentrated, it looks more yellow. When would your urine most likely become more concentrated?

____

[1 mark]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

Discuss the role of the kidneys, liver, lungs and skin in excretion.

TRIAL TEST 9:
SCIENCE AS A HUMAN ENDEAVOUR 1

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**100**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. In which of the following situations would a transfusion of blood be necessary?
   (a) a snake bite
   (b) excessive loss of blood
   (c) a blood test
   (d) extreme dehydration.

2. Which of the following blood groups can be used in an emergency as a donor to all the other three groups?
   (a) group A
   (b) group B
   (c) group AB
   (d) group O.

3. The early diagnosis of a disease can be most advantageous to the patient because this:
   (a) is more cost effective for the patient and the health services
   (b) enables early intervention to limit the damage the disease may do
   (c) always results in a cure for the disease
   (d) is most convenient for the medical profession.

4. One important achievement in modern surgery has been to:
   (a) reduce post operative infections
   (b) reduce the patients' time spent in hospitals
   (c) limit the spread of infectious diseases
   (d) develop vaccines to prevent diseases.

5. Laproscopic surgery or keyhole surgery has several advantages over traditional surgery. Generally one such advantage is that it:
   (a) takes less time for the surgeon to perform
   (b) involves the use of simple equipment
   (c) requires less medical training for the surgeon
   (d) results in a shorter recovery time for the patient.

6. Bones are likely to break due to minor injuries in a person with:
   (a) Osteoarthritis
   (b) Rheumatoid Arthritis
   (c) Osteoporosis
   (d) Malnutrition

7. Which type of tissue is osteoporosis likely to affect most:
   (a) cancellous bone
   (b) compact bone
   (c) osteocytes
   (d) ligaments.

8. To prevent osteoarthritis developing as you become older, medical advice is likely to include:
   (a) try to avoid the use of those joints which are susceptible to the condition
   (b) if you are overweight try to reduce your weight
   (c) do not exercise regularly
   (d) reduce your dietary calcium intake.

9. The immediate effects of alcohol on the body include it:
   (a) depresses the brain and nervous system
   (b) raises awareness of a person's surroundings
   (c) decreases the heart rate
   (d) raises the glucose level in the blood and the level of fat stored in body cells.

10. Long term effects of excessive alcohol intake include:
   (a) high blood pressure
   (b) damage to the liver
   (c) coronary heart disease
   (d) all of the above.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. Write the appropriate term or words for each of the phrases below:

   (i) An artery which delivers blood directly to the heart

   ____

   (ii) A condition in which part of the brain has an interrupted blood supply

   ____

   (iii) A total interruption of blood delivery to part of the heart muscles

   ____

   (iv) A chest pain caused by a temporary deficiency of blood delivery to the heart muscle

   ____

   (v) Loss of elasticity of the alveoli, the formation of fibrous material in the lungs and the breakdown of alveoli which reduced the efficiency of the lungs

   ____

   (vi) A disease of the liver where normal tissue is replaced by fibrous tissue. It may result from alcohol abuse, nutritional deprivation or hepatitis virus

   ____

(vii) High blood pressure

____

(viii) A cancer which may spread, invade other organs and may form secondary tumours

____

(ix) Indigestible matter, e.g. cellulose fibres, in the diet which gives the contents of the digestive system bulk, promoting peristalsis and regular bowel 'motions'

____

(x) Keeping the body clean, taking care not to infect others with diseases we may have and taking precautions not to contract infections wherever possible.

____

[10 marks]

2. The Federal Office of Road Safety has issued instructions as to how a person can calculate roughly what his/her blood alcohol concentration (BAC) is likely to be. It has given the following steps:

Step 1: Calculate the number of 'standard' drinks you have consumed and multiply by 10. (This tells you how many grams of alcohol consumed).

Step 2: Multiply the number of hours you have been drinking by 7.5 grams. (This is the average rate the liver takes to break down alcohol).

Step 3: Subtract Step 2 from Step 1.

Step 4: Multiply your weight in kg by 6.8 (male) or 5.5 (female).

Step 5: Divide Step 3 by Step 4 to give your approximate BAC.

(i) Use these steps to calculate Peter's BAC. Peter is a 77 kg male and has had three cans of full strength beer (each contains 1.5 'standard drinks') over two hours.

____

____

____

____

____

[5 marks]

(ii) It is not safe for Peter to drive a motor car. Why?

____

____

[2 marks]

(iii) What should Peter do before he drives?

____

____

[2 marks]

3. (i) Name the deficient **mineral** that could cause each of the following dietary diseases:

(a) rickets ____________________

(b) osteoporosis ____________________

(c) anaemia ____________________

(ii) Name the **vitamin** which may be deficient in the following dietary diseases:

(a) scurvy ____________________

(b) rickets ____________________

(c) night blindness ____________________

[6 marks]

(iii) What lifestyle factors are associated with hypertension?

____

____

[2 marks]

(iv) List the factors that contribute to cardiovascular disease that could be avoided by adopting a healthy lifestyle.

____

____

____

____

[4 marks]

(v) Explain the importance of water in the human diet.

____

____

[2 marks]

4. (i) Discuss the immediate effects of alcohol in the human body.

[5 marks]

(ii) One effect of excessive alcohol intake may at least prevent the person who is abusing the drug from poisoning themselves. What is that effect?

[2 marks]

5. Discuss the effects of excessive long-term consumption of alcohol on the:

(i) Nervous System

[2 marks]

(ii) Cardiovascular System

[2 marks]

(iii) Digestive System

[2 marks]

(iv) Liver

[2 marks]

6. The physical effect on a person of any drug depends on several aspects of that person. What are some of these aspects?

[2 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

Discuss (i) the causes and risk factors of osteoarthritis and osteoporosis. [6 marks]

(ii) how these diseases may be prevented and [8 marks]

(iii) modern practices for their management. [6 marks]

TRIAL TEST 10: SCIENCE INQUIRY SKILLS 2

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. The statement that "life exists on planets in distant galaxies" is:
   (a) an observation
   (b) an hypothesis
   (c) a theory
   (d) none of the above.

2. A "possible explanation of a problem" is properly called:
   (a) an hypothesis
   (b) a theory
   (c) a prediction
   (d) an observation.

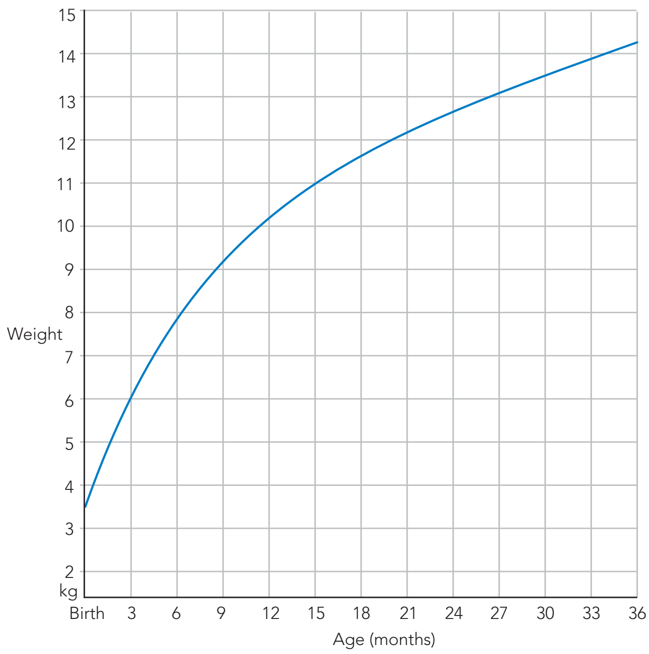
3. Which of the following could be considered a scientific hypothesis?
   (a) the school's cricket team is better than its football team
   (b) brand 'x' pens last longer than brand 'y'
   (c) there is water on the driveway
   (d) oranges taste better than apples.

4. Which of the following indicates the normal order for a scientific study?
   (a) data recorded, hypothesis made, problem recognised, conclusion made
   (b) problem recognised, data recorded, hypothesis made, conclusion made
   (c) problem recognised, hypothesis made, data recorded, conclusion made
   (d) data recorded, hypothesis made, conclusion made.

5. If an experiment is carefully conducted a number of times, which aspect of the experiment is likely to improve? Its:
   (a) reliability
   (b) validity
   (c) accuracy
   (d) precision.

6. If a scientist were to propose the hypothesis that UV radiation increases the level of vitamin D in the blood, a relevant prediction that could be made from this hypothesis is that:
   (a) a person who lives in a cave and only emerges at night is likely to have high levels of vitamin D in her blood
   (b) if a person has excess exposure to UV radiation, then she may develop skin cancer
   (c) if a dark skinned person lives in a northern European country e.g. Denmark, she may have a vitamin D deficiency
   (d) if a fair skinned person lives near the equator, she is likely to have high levels of vitamin D in her blood but may develop skin cancer.

Use the following information to answer questions 7–10. The graph below shows the weight of a boy from birth to three years of age.



Use the key below to answer the questions (7–10):

(a) if the graph supports the statement
(b) if the graph disproves the statement
(c) if the graph neither supports or disproves the statement
(d) if the graph is related to the statement but does not provide support for it

7. The boy's weight over the three years increased most rapidly between the ages of 12 and 21 months.

8. The period of most rapid growth in weight over the three years occurs between the ages of 0 and 6 months.

9. The boy's height increased more slowly between 12 and 36 months, than between 0 and 6 months.

10. The boy's height increased more rapidly in the summer than the winter.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. (i) Before you begin a new experiment in the science laboratory it likely that you will need to make a risk assessment of the experiment. What does this mean?

____

____

____

[3 marks]

(ii) Why is it necessary to do a risk assessment?

____

____

[2 marks]

2. The data below show the change in resting temperature of an adult female over a thirty one day period.

DAY	0	1	2	3	4	5	6	7	8	9	10
Temp (°C)	36.5	36.5	36.7	36.8	36.7	36.8	36.8	36.7	36.6	36.8	36.7

DAY	11	12	13	14	15	16	17	18	19	20	21
Temp (°C)	36.7	36.6	36.4	36.3	36.7	37.1	37.2	37.0	37.1	37.2	37.2

DAY	22	23	24	25	26	27	28	29	30	31
Temp (°C)	37.0	37.0	37.1	37.2	37.0	36.8	35.9	35.8	35.9	36.6

(i) Graph these readings on the grid below. [4 marks]

(ii) What interpretations can you make from these results?

____

____

[2 marks]

(iii) How could you check to verify that the changes in resting body temperature for the female were normal?

____

[1 mark]

(iv) If the same pattern of change was discovered in most adult females tested, what hypothesis could be made from this observation?

____

[1 mark]

(v) If your hypothesis was supported by other observations, what prediction could you make regarding the resting temperature changes of an adult **male**?

____

[1 mark]

(vi) How would you test your prediction?

____

____

____

[1 mark]

3. Explain the difference between primary and secondary data. Give one example of each.

____

____

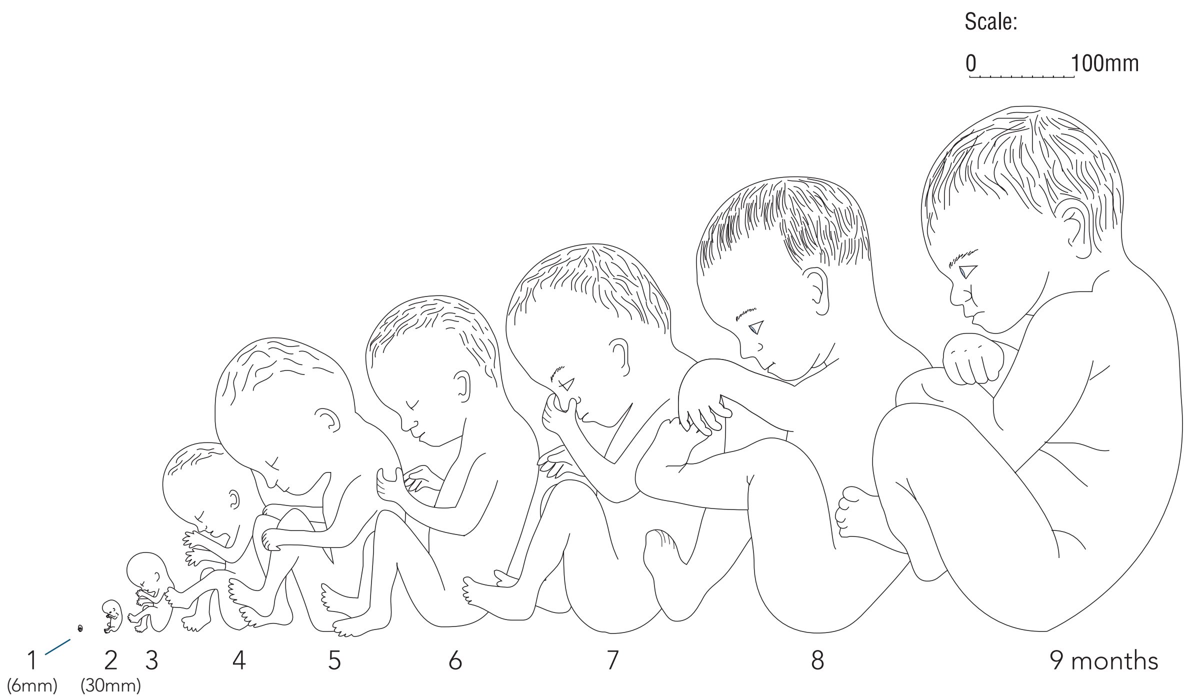
____

____

____

[4 marks]

4. The following diagrams show the average size of a foetus as it develops in the uterus over a number of months. The actual size of the embryo is shown at 1 and 2 months.



(i) Construct a table to record the average length, from the crown of the head to the buttocks over the period of the diagram. **Use the scale to show actual sizes.**

[4 marks]

(ii) Graph the results on the grid below.

[4 marks]

5. Define each of the following terms.

(a) observation

(b) hypothesis

(c) prediction

(d) data

(e) random

(f) placebo

(g) variable

(h) sample

(i) replicate

(j) procedure

[10 marks]

6. (i) Design an experiment to test the following hypothesis:

"If peas are frozen immediately after picking they retain more vitamin C than peas that are kept at room temperature."

[5 marks]

(ii) Name four variables which need to be controlled in your experiment.

[2 marks]

(iii) a) What is the independent variable?

[1 mark]

b) What is the dependent variable?

[1 mark]

(iv) a) What results would support the hypothesis?

[1 mark]

b) What results would refute the hypothesis?

[2 marks]

(v) What would make you more confident of your results?

[1 mark]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

(i) Describe the structure of a DNA molecule using labeled diagrams to illustrate your answer. How might changes to this structure cause a change in protein production? In your answer include reference to transcription and translation.

[15 marks]

(ii) What effects might such a change have on cell activity? Could the change have an effect on the health of the person? Explain.

[5 marks]

TRIAL TEST 11: DNA

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. Which of the following nitrogen bases pairs with adenine in a DNA molecule?
   (a) cytosine
   (b) guanine
   (c) uracil
   (d) thymine.

2. Which of the following statements is correct? DNA has:
   (a) a molecular shape that creates an 'active site'
   (b) nitrogen bases bonded to phosphate molecules
   (c) equal amounts of cytosine and guanine
   (d) paired bases of guanine and thymine.

3. The basic building blocks which make up a DNA molecule are called:
   (a) nucleotides
   (b) amino acids
   (c) nitrogenous bases
   (d) monosaccharides.

4. The importance of mitochondrial DNA is that it codes for enzymes which are directly involved in the process of:
   (a) protein synthesis
   (b) endocytosis
   (c) nuclear division
   (d) respiration.

5. DNA in the cell nucleus is important because it carries codes for:
   (a) chromosomes replication
   (b) new mitochondria
   (c) protein synthesis
   (d) carbohydrate synthesis.

6. The molecule which transfers information to the ribosomes where protein synthesis occurs is called:
   (a) Messenger RNA (mRNA)
   (b) Transfer RNA (tRNA)
   (c) Carrier RNA (cRNA)
   (d) Messenger DNA (mDNA).

7. Which of the following nucleotides is found in DNA but not in RNA molecules?
   (a) adenine
   (b) cytosine
   (c) guanine
   (d) thymine.

8. When protein synthesis occurs, the type of protein produced is determined by:
   (a) the order of nucleotides that is copied by mRNA
   (b) the temperature of the cell
   (c) the tRNA available to carry amino acids
   (d) enzymes present in the nucleoplasm and cytoplasm.

9. Proteins that are closely associated with gene expression and together with DNA form chromosomes are called:
   (a) centrioles
   (b) nucleosomes
   (c) histones
   (d) lysines.

10. Small differences in the appearance of "identical twins" are likely to be due to
   (a) mistakes made during meiosis resulting in slightly different genotypes
   (b) differences in their phenotypes
   (c) slight mutations in their DNA since birth
   (d) different methylation of their chromosomes.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. (i) A nucleic acid which transfers free amino acids in the cytoplasm to the ribosomes where amino acids are linked to form proteins

   ____

   (ii) The copying of DNA which occurs in cells during the interphase

   ____

   (iii) Mitochondria and mitochondrial DNA are inherited from this parent

   ____

   (iv) The order of these determines the message carried from the nucleus to the ribosomes

   ____

   (v) The fluid in which free nucleotides are available for DNA copying

   ____

   (vi) The word for D in DNA

   ____

   (vii) The formation of a complimentary strand of mRNA from a section of DNA in the nucleus

   ____

(viii) Weak bonds involved in base pairing between the complementary strands of a DNA molecule

____

(ix) The phenotypic expression of genes due to something other than the sequence of bases on the DNA

____

(x) The process in which methyl groups are transferred to histone proteins of chromosomes

____

[10 marks]

2. (i) A human cell normally has 46 chromosomes (diploid number). When a human cell undergoes mitosis, each of the two cells formed has 46 chromosomes. Explain how the number of chromosomes in each cell is maintained.

____

____

____

[3 marks]

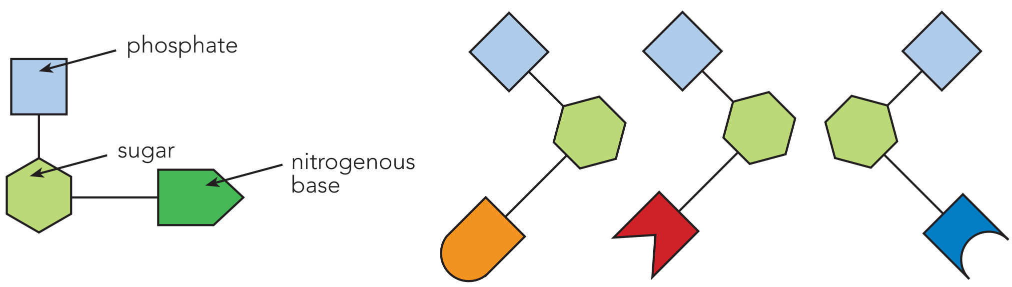
(ii) Where do the extra nucleotides come from to create the extra 46 DNA molecules?

____

____

[1 mark]

3. The diagrams below show four different nucleotides.



(i) In what way is each nucleotide shown different?

____

[1 mark]

(ii) Draw a diagram below to show how these four nucleotides could be linked to form part of a DNA molecule.

[2 marks]

(iii) A molecule of DNA normally contains thousands of nucleotides, not just four. In which part of the DNA molecule is the cell's genetic information stored?

____

[1 mark]

(iv) Explain briefly **how** this information is stored and **how** it is translated.

____

____

____

____

____

____

____

____

____

[8 marks]

4. A freshwater amoeba may have as many as 600 chromosomes whereas a cat cell has only 38. Does this imply that the amoeba is a more complex animal than the cat?

____

Explain:

____

____

____

[2 marks]

5. (i) When DNA replicates, it unzips along its entire length. How does this compare to the changes it undergoes when protein synthesis occurs?

____

____

[2 marks]

(ii) Name the four nucleotides which move to the unzipped section of DNA for protein synthesis.

____

[4 marks]

(iii) Name the smaller nucleic acid which is formed on the exposed nitrogenous bases of the DNA molecule

____

[1 mark]

(iv) Describe what happens to this smaller nucleic acid from when it is formed until when it reaches a ribosome

____

____

[2 marks]

(v) Amino acids are assembled at the ribosome according to the code on the nucleic acids. How are the correct amino acids brought to the appropriate codon on the nucleic acid?

____

____

____

[3 marks]

(vi) How are amino acids held together or bonded? ______________________

[1 mark]

(vii) Proteins which form at the ribosomes may have several uses in the cell. Name two of these uses:

____

____

[2 marks]

(viii) Place the five molecules below into an increasing order of size and complexity DNA, tRNA, amino acid, mRNA, protein

[2 marks]

6. (i) What is epigenetics?

[2 marks]

(ii) What is the significance of this area of study?

[3 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

(i) Describe how DNA molecules replicate before cell division occurs. Use diagrams to illustrate your answer.

[10 marks]

(ii) Transcription and translation are the two main stages in protein synthesis. Describe the steps in each stage in their correct order. [10 marks]

TRIAL TEST 12:
CELL REPRODUCTION

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. During which stage of mitosis does DNA replication occur?
   (a) interphase
   (b) prophase
   (c) metaphase
   (d) anaphase.

2. Which of the following is the correct name for the process in which a cell splits into two smaller cells?
   (a) karyokinesis
   (b) metakinesis
   (c) cytokinesis
   (d) prokinesis.

3. Mitosis occurs in a number of locations in an adult organism's body. It may occur where:
   (a) haploid cells are required for reproduction
   (b) diploid cells are needed as gametes
   (c) either haploid or diploid cells are needed for growth and repair
   (d) only diploid cells are required.

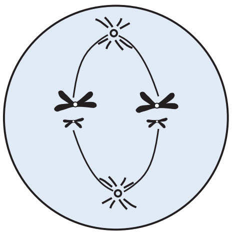
4. When bacteria reproduce, their single dough-nut shaped DNA molecule replicates and the cell then divides into two, each receiving one copy of the DNA molecule. This is an example of:
   (a) binary fission enabling asexual reproduction
   (b) meiosis enabling asexual reproduction
   (c) mitosis enabling sexual reproduction
   (d) mitosis enabling asexual reproduction.

5. When germ cells undergo meiosis, the daughter cells they produce contain:
   (a) the haploid number of chromosomes
   (b) the diploid number of chromosomes
   (c) a replicate number of chromosomes
   (d) the same number of chromosomes as the parent cells.

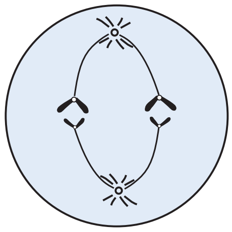
6. Following meiosis, a germ cell may have produced four sperm cells. The total number of chromosomes in the sperm cells will be:
   (a) four times that of the germ cell
   (b) half that of the germ cell
   (c) twice the number in the original germ cell
   (d) the same as in the original germ cell.

7. Which of the following diagrams represent a stage in meiosis?

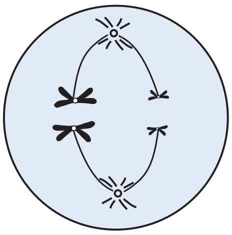
(a)



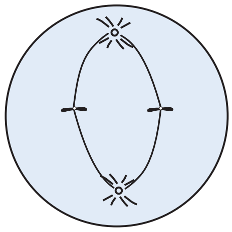
(c)



(b)



(d)



8. The random assortment of chromosomes during meiosis results in germ cells producing many various combinations of chromosomes in gametes. Because of this, how many variations would result from a germ cell which contained three pairs of chromosomes?
(a) 2
(b) 4
(c) 6
(d) 8.

9. There is less likelihood of mistakes being made during mitosis than meiosis because:
(a) mitosis begins with fewer chromosomes
(b) mitosis does not occur in the gonads
(c) meiosis is a longer process which involves more divisions and opportunity for error
(d) meiosis occurs in more mature cells.

10. Which of the following correctly compares mitosis and meiosis in humans?
(a) mitosis involves the production of two identical cells, meiosis produces four different cells
(b) mitosis requires two divisions, meiosis requires four divisions
(c) mitosis is only for growth, meiosis is for reproduction
(d) mitosis stops at adulthood, meiosis begins during puberty.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. (i) Explain how the growth of the human takes place at the cellular level.

____

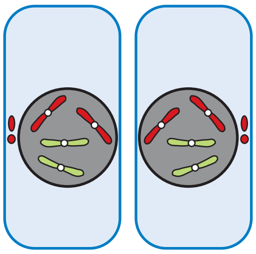
____

____

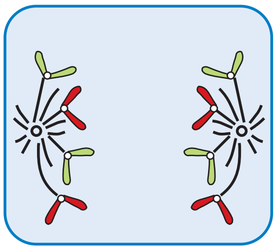
____

[2 marks]

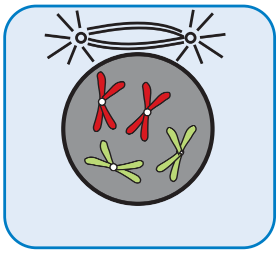
(ii) The diagrams below show some stages of mitosis in a jumbled order. Write the name of each stage underneath it.



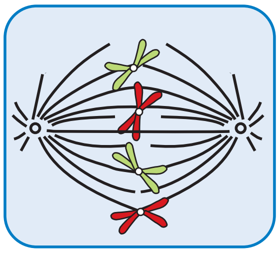
(a) ______________________________



(b) ______________________________



(c) ______________________________



(d) ______________________________

[2 marks]

(iii) Write the order in which these phases would occur.

____

[1 mark]

2. Cells which are undergoing mitosis can be 'fixed' and stained so that their chromosomes can be viewed with the aid of a microscope. Describe how you would distinguish between the following:

(i) cells in interphase and cells in prophase;

____

____

____

____

[2 marks]

(ii) cells in metaphase and cells in anaphase;

____

____

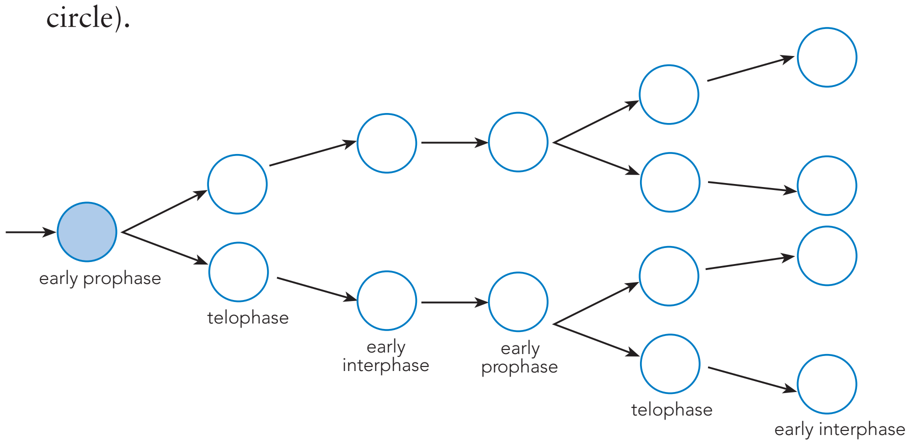
____

____

[2 marks]

3. The first circle below represents a human cell which in the early prophase of mitotic division has 92 DNA units.

(i) A number of mitotic divisions occur. Complete the diagram to illustrate how many DNA units are present at each stage shown (write the numbers in each circle).



[3 marks]

(ii) How many mitotic divisions are represented in this diagram? ____________

[1 mark]

(iii) What is the total number of chromosomes in the final cells that have been formed?

________________________________ [1 mark]

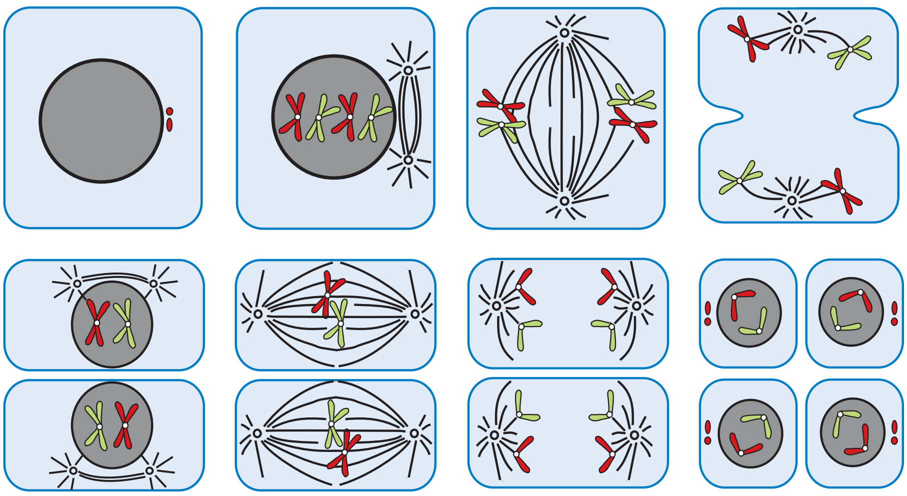
(iv) Where have the extra DNA molecules come from?

____

____

[1 mark]

4. The following sequence shows a cell undergoing **meiosis**.



In the example above:

(i) how many chromosomes did the parent cell contain?

________________________________ [1 mark]

(ii) how many chromosomes do each of the gametes contain?

______________________________ [1 mark]

(iii) what is the total number of chromosomes in the four daughter cells?

______________________________ [1 mark]

(iv) how do you account for the apparent increase in the total number of chromosomes?

____

____

[1 mark]

(v) why must the gametes contain less chromosomes than the parent cell?

____

____

[1 mark]

5. (i) Stem cells have a level of potency. Explain what this means.

____

____

____

____

[2 marks]

(ii) Distinguish between totipotency, pluripotency and multipotency.

____

____

____

____

____

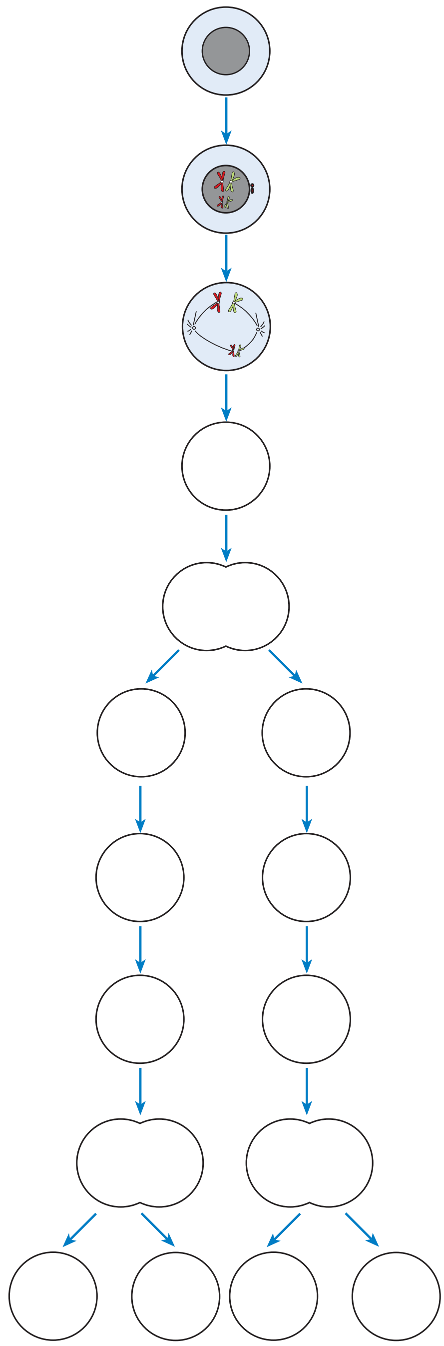
____

____

____

[3 marks]

6. (i) Beginning with the diagram shown below, complete the changes which occur to it while it undergoes meiosis. (Draw in the chromosomes, nuclear membranes and the spindle fires where appropriate.)



Interphase

Prophase I (early)

Prophase I (late)

Metaphase I [1 mark]

Anaphase I [1 mark]

Telophase I [1 mark]

Phophase II [1 mark]

Metaphase II [1 mark]

Anaphase II [1 mark]

Telophase II [1 mark]

(ii) In which phase/s could ‘crossing over’ occur?

____

[2 marks]

(iii) In which phase/s could non-disjunction occur?

____

[2 marks]

7. Each of the following statements refers to the processes which take place during human cell division. Use the following key in the answer:

MITOSIS = (MI) MEIOSIS = (ME) BOTH = (B) NEITHER = (N)

(i)	Each daughter cell has 23 chromosomes	________
(ii)	Each daughter cell has 46 chromosomes	________
(iii)	Two daughter cells each with 23 chromosomes	________
(iv)	Four daughter cells each with 23 chromosomes	________
(v)	Four daughter cells each with 46 chromosomes	________
(vi)	Chromosomes replicate during the interphase	________
(vii)	Process takes place in the lining of the digestive system	________
(viii)	Process occurs only in gonads	________
(ix)	Process occurs in the gonads and elsewhere in body	________
(x)	In females, the process is suspended until fertilisation occurs	________
(xi)	Process occurs in sexually producing organisms	________
(xii)	Process is required for growth and repair	________

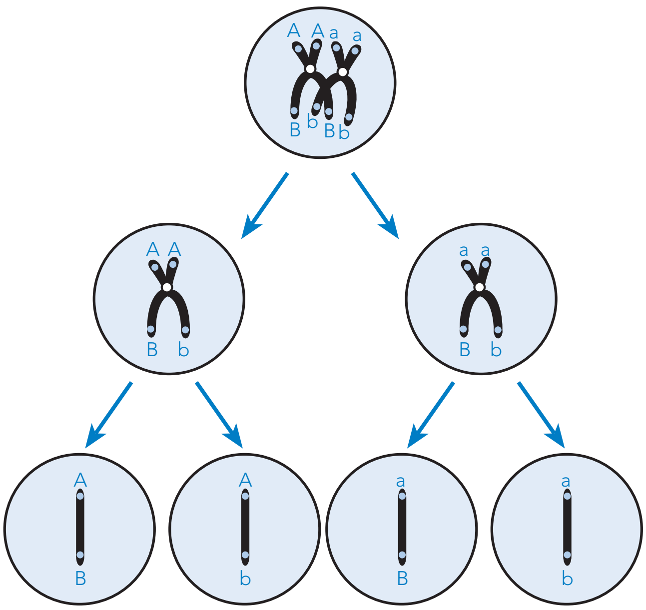
[6 marks]

8. The drawing below illustrates how two pairs of genes which are normally linked become separated during meiosis. Write down what is occurring in the process and the phase which is represented on the next page. (Note: most of the stages are not shown.)

(i)

(ii)

(iii)



(i)

[3 marks]

(ii)

[2 marks]

(iii)

[3 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

Explain how new genetic combinations are made as a result of meiosis and fertilisation which give rise to unexpected variations in offspring.

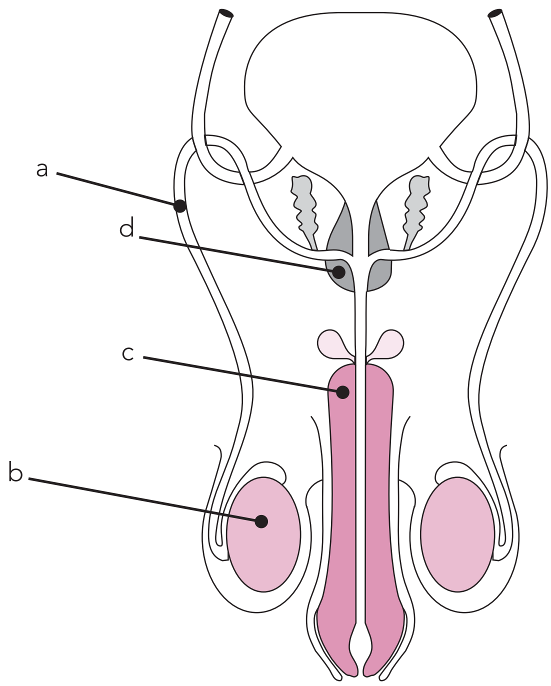
TRIAL TEST 13: HUMAN REPRODUCTION

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

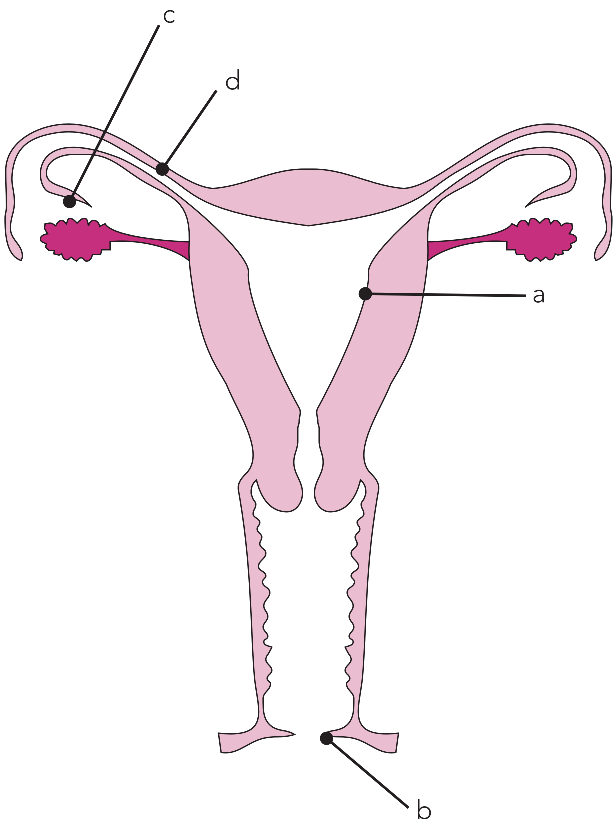
1. The production of male sperm occurs best at:
   (a) normal body temperature, 37°C
   (b) above normal body temperature
   (c) below normal body temperature
   (d) temperatures a few degrees above or below 37°C.

2. Use the following diagram to answer the next question:



Which of the structures above is necessary to bring about normal internal fertilisation (without reproductive technologies)?
(a) a
(b) b
(c) c
(d) d.

3. Use the following diagram to answer the next question:



Fertilisation usually occurs in:

(a) a
(b) b
(c) c
(d) d.

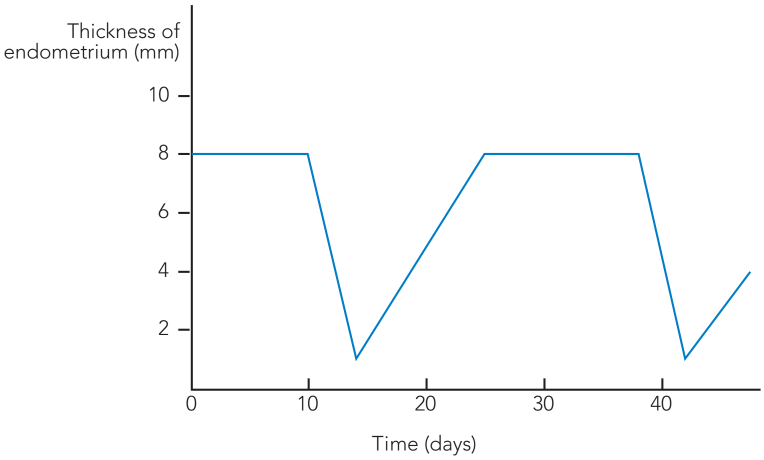
4. If a couple who had been trying unsuccessfully to have a baby wished to try IVF using the woman's own ovum and the man's sperm, which infertility problem is it most likely that they have?

(a) failure of the sperm to mature
(b) reduced levels of progesterone causing the endometrium to break down
(c) insufficient room for the foetus in the uterus
(d) blocked uterine tubes (Fallopian tubes) due to an earlier infection.

5. The ovarian follicle secretes the hormone:

(a) luteinising hormone, LH, to cause ovulation
(b) follicle stimulating hormone, FSH, to promote the development of a follicle
(c) progesterone to assist in the breakdown of the endometrium
(d) oestrogen to help increase the thickness and blood supply to the endometrium.

The following graph shows the development of a particular adult woman's endometrium over the time shown. Use this graph to answer questions 7 and 8.



6. On which days shown on the graph did menstruation begin:
   (a) day 14 and day 32
   (b) day 0 and 28
   (c) day 10 and day 38
   (d) day 12 and day 40.

7. Ovulation from either one of her ovaries would probably have occurred around:
   (a) day 24
   (b) day 14
   (c) day 0
   (d) day 10 and day 38.

8. The developing child just a few days before birth is properly called:
   (a) an embryo
   (b) a foetus
   (c) an infant
   (d) a baby.

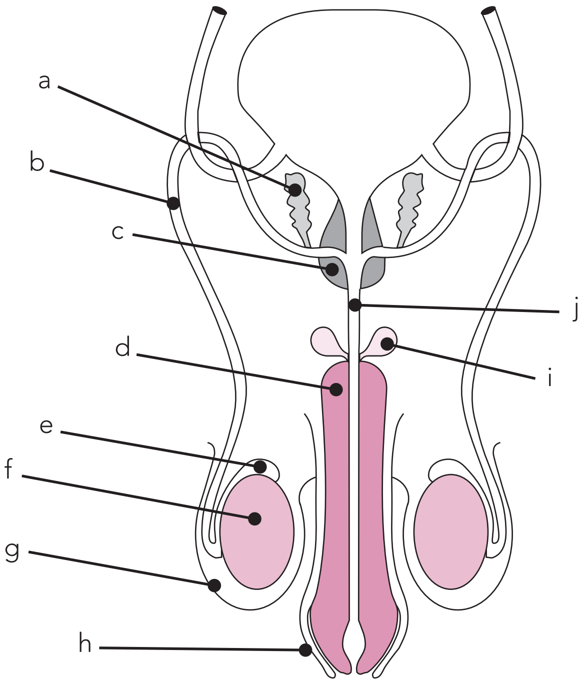
9. The foetal foramen ovale:
   (a) diverts blood from the right atrium to the left atrium
   (b) allows blood to flow more freely to the foetal lungs
   (c) is a problem which is rectified soon after birth
   (d) allows deoxygenated blood in the right atrium to mix with oxygenated blood in the left atrium.

10. During parturition, the cervix will be fully dilated by the:
    (a) end of the first stage of labour
    (b) middle of the second stage of labour
    (c) end of the third stage of labour
    (d) end of the second stage.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. Label the diagram of the male reproductory system below.



a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

f) ______________________________

g) ______________________________

h) ______________________________

i) ______________________________

j) ______________________________

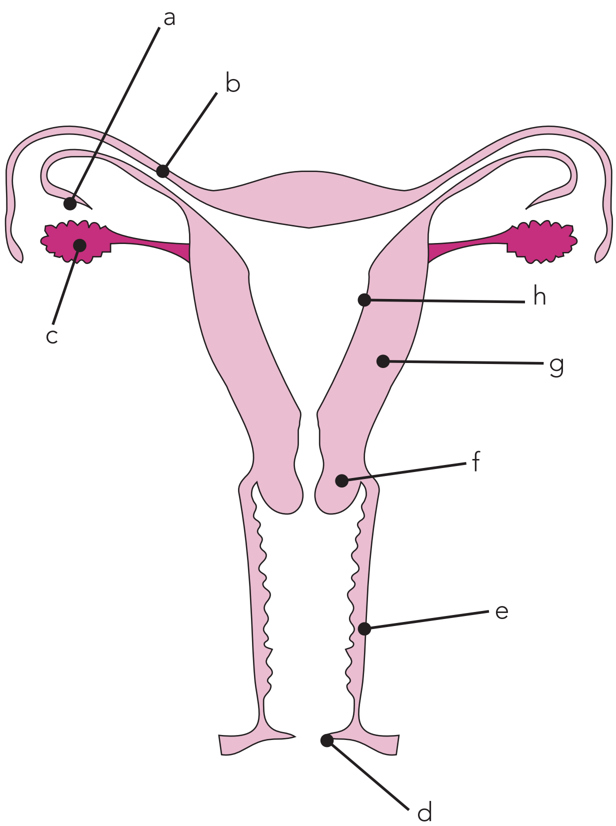
[5 marks]

2. Describe the functions of the male 'accessory glands'.

____

[1 mark]

3. Label the diagram of the female reproductory system below:



a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

f) ______________________________

g) ______________________________

h) ______________________________

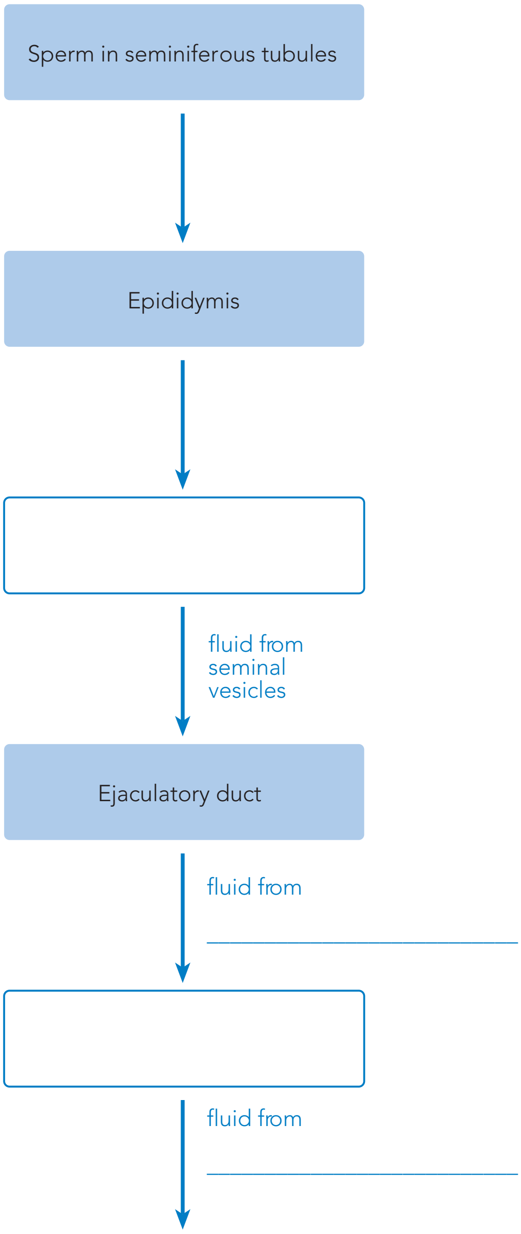
[4 marks]

4. Complete the table below:

HORMONE	WHERE PRODUCED	ORGANS TARGETED	EFFECT
FSH			
LH			
Oestrogen			
Progesterone			

[12 marks]

5. Complete the following diagram by writing the appropriate terms in the blank boxes and spaces.



[4 marks]

6. Describe the contents of the blood found in the:

(i) umbilical arteries

____

[1 mark]

(ii) umbilical vein

____

[1 mark]

7. (i) Explain the function of the placenta.

____

____

[2 marks]

(ii) Which organ pumps blood through the placenta? ____________

[1 mark]

8. In addition to the foramen ovale and the ductus arteriosis, one other diversion is present in the foetal circulation.

(i) What is it called? ______________________________

(ii) Where is it? ______________________________

(iii) What is its function? ______________________________

[3 marks]

9. Indicate in the table below which primary germ layer gives rise to the organs and tissues shown.

PRIMARY GERM LAYER	ORGANS AND TISSUES
i) ______________________	muscles, cartilage, bone
ii) ______________________	nerve system, epidermis of skin
iii) ______________________	epithelium of lungs and alimentary canal

[3 marks]

10. (i) What is meant by 'cervical dilation' and how does it occur?

____

____

[2 marks]

(ii) About how long does the first stage of labour last on average?

____

[1 mark]

11. During the second stage the baby is actually born.

(i) How long does this stage take on average?

____

[1 mark]

(ii) Which part of the baby is normally delivered first?

____

[1 mark]

(iii) What hormone is involved in the contractions that occur during parturition?

____

[1 mark]

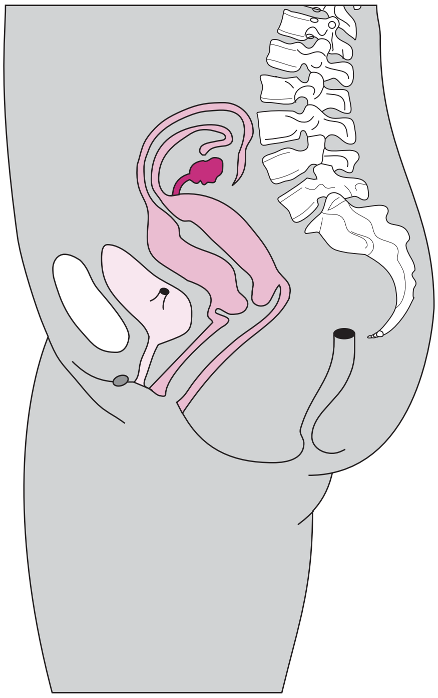
(iv) Where is this hormone released?

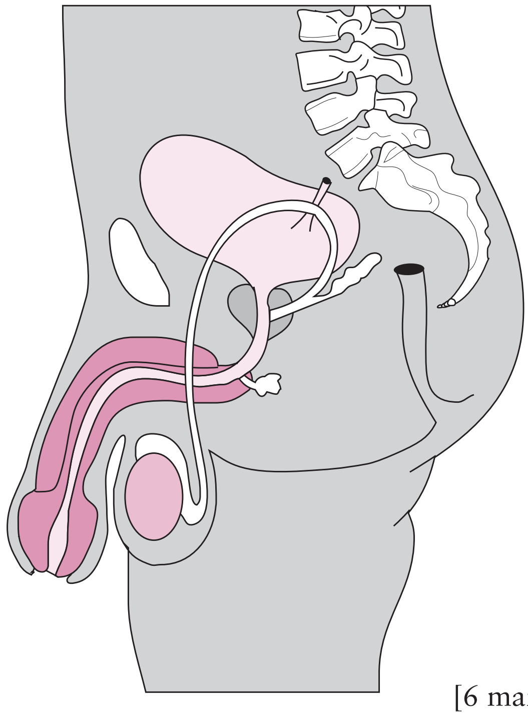
____

[1 mark]

12. On the diagrams below, label the parts of the body using the appropriate letters shown, where the method of birth control is applied or is targeted.

A. vasectomy
B. condom (male)
C. cervical diaphragm
D. tubal ligation
E. progesterone and oestrogen pill
F. morning after pill





[6 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

Spermatogenesis and oogenesis take place in very similar tissue, the testes and the ovaries. In what ways are these processes similar and in what ways do they differ. Describe how and why the gamete types are different.

TRIAL TEST 14:
TYPES OF INHERITANCE

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. The best description of a person in terms of his/her observable features is called his/her:
   (a) profile
   (b) genotype
   (c) phenotype
   (d) genome.

2. A person who has two identical genes for a particular trait, for this trait, is called a:
   (a) hybrid
   (b) homozygote
   (c) heterozygote
   (d) hemizygote.

3. A couple have a family of four daughters. Which of the following statements about the sex chromosomes of the family are true?
   1. All the sex chromosomes of the parents are X
   2. All the sex chromosomes of the husband are X
   3. All the sex chromosomes of the wife are X
   4. All the sex chromosomes of the daughters are X
   5. Half the sex chromosomes of the husband are Y and half are X
   6. Half the sex chromosomes of the wife are X and half are Y.
   (a) 1, 2 and 3
   (b) 2, 3 and 4
   (c) 3, 4 and 5
   (d) 4, 5 and 6.

Use the following information to answer questions 4 and 5.

Tongue rolling is inherited as a dominant autosomal trait. Non-tongue rolling is recessive.

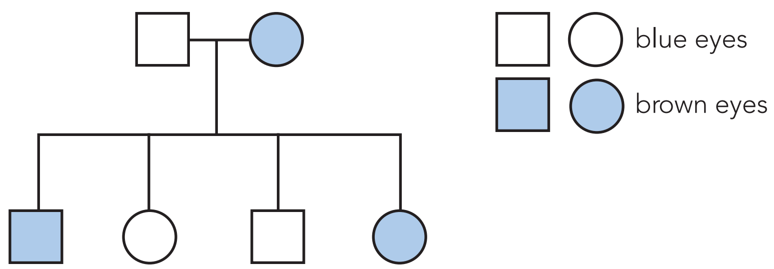
4. If two people, one of whom is a heterozygote for tongue rolling and the other who is a non-tongue roller have children, what is the probability that their first child will be a non-tongue roller?
   (a) 0.25
   (b) 0.50
   (c) 0.75
   (d) 0

5. What is the probability of a couple, one of whom is a homozygote for tongue rolling, the other who is a non-tongue roller, having a child who is a non-tongue roller?
   (a) 0.25
   (b) 0.50
   (c) 0.75
   (d) 0.00

6. Colour blindness is an X-linked recessive condition. What is the probability that a man who is colour blind who is married to a woman who is a carrier, have a child who is colour blind?
(a) 0.25
(b) 0.50
(c) 0.75
(d) 1.00

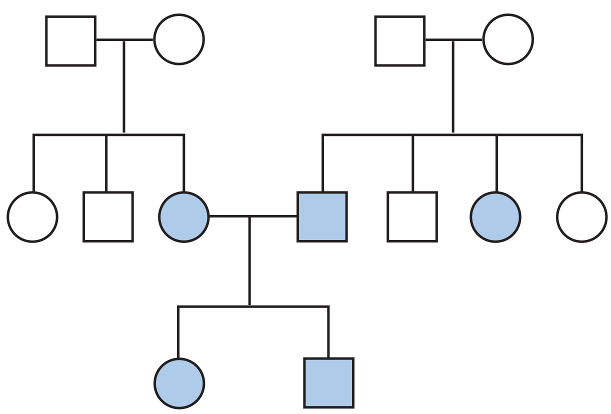
7. A good example of co-dominance occurs in the ABO blood grouping system. This occurs between the following alleles:
(a) I^A and I^B
(b) I^A and i
(c) I^B and i
(d) I^A, I^B and i.

8. Study the information below the pedigree to answer the next question.



Given the brown allele is dominant and the ratio of brown-eyed to blue-eyed offspring matches the theoretical ratio determined by Mendelian inheritance in this family pedigree, which of the following is true?
(a) the mother is homozygous and the father heterozygous for eye colour
(b) the father is homozygous and the mother is heterozygous for eye colour
(c) the father and mother are both homozygous for eye colour
(d) the father and mother are both heterozygous for eye colour.

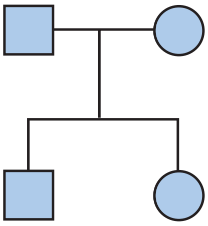
9. In the pedigree below, individuals who have a genetic disease are shaded.



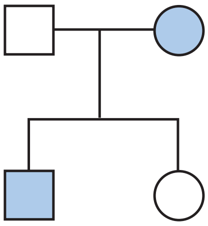
From this pedigree it appears that the grandparents:
(a) each carries a gene for the disease
(b) at least one of each grandparent couple carries a gene for the disease
(c) are all homozygous
(d) only one couple is homozygous.

10. Some people can taste a substance called phenyl thiocarbamide (PTC), others cannot. Non-tasters are shaded in the pedigrees shown. Which pedigree **proves** that the non-tasting gene is recessive?

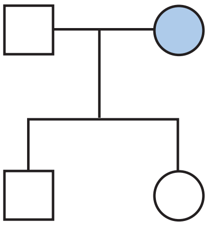
(a)



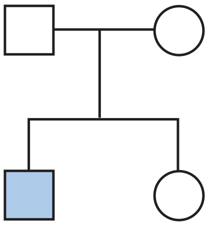
(c)



(b)



(d)



SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. Assume that the gene for brown eyes is dominant, B and the gene for blue is recessive, b. A brown-eyed woman whose mother had blue eyes marries a man with brown eyes. They produce four children all of whom are brown-eyed.

(i) What is the genotype of the mother? ______________________ [1 mark]

(ii) What are the possible genotypes of her husband? Explain.

____

____

[2 marks]

(iii) If their fifth child is blue-eyed, what is the husband's genotype? Explain your answer.

____

____

____

[3 marks]

(iv) Use a Punnet square to show the possible genotypes of their children.

	Man	
Woman		

[2 marks]

2. Sickle-cell anaemia is a genetic disease in which the homozygote ss causes the red blood cells to become sickle shaped and lose their oxygen carrying capacity. In the heterozygote Ss, both types of red blood cells are formed, i.e. both normal and sickling. The person is said to have sickle-cell trait (not anaemia). People who have Ss are quite healthy but they can suffer a shortage of oxygen at high altitudes or under extreme physical exertion. A person who is a homozygote SS is normal.

(i) What is this disease's mode of inheritance?

____

____

____

[2 marks]

(ii) If a couple who both have the sickle-cell trait have children, what is the probability that their first child will have sickle cell trait?

____

____

____

[3 marks]

Man

Woman		

(iii) If a person who has sickle-cell trait marries a normal homozygote, what is the probability that any of their children will have sickle-cell anaemia?

____

____

____

[3 marks]

Man

Woman		

3. Red-green colour blindness is an X-linked recessive condition. Alison has normal vision as do her parents, Dick and Dora, but Alison's brother Bob has colour blindness.

What are the genotypes of Alison, her parents Dick and Dora and her brother Bob. Use X^B and X^b to represent the alleles.

(i) Alison ______________________________

(ii) Dick ______________________________

(iii) Dora ______________________________

(iv) Bob ______________________________

[4 marks]

(v) How could you be sure of Alison's genotype?

____

____

____

____

[2 marks]

4. (i) Use the ABO system of blood grouping to explain what is meant by multiple alleles.

____

____

[3 marks]

(ii) What are the possible genotypes for this trait in the population?

____

____

[3 marks]

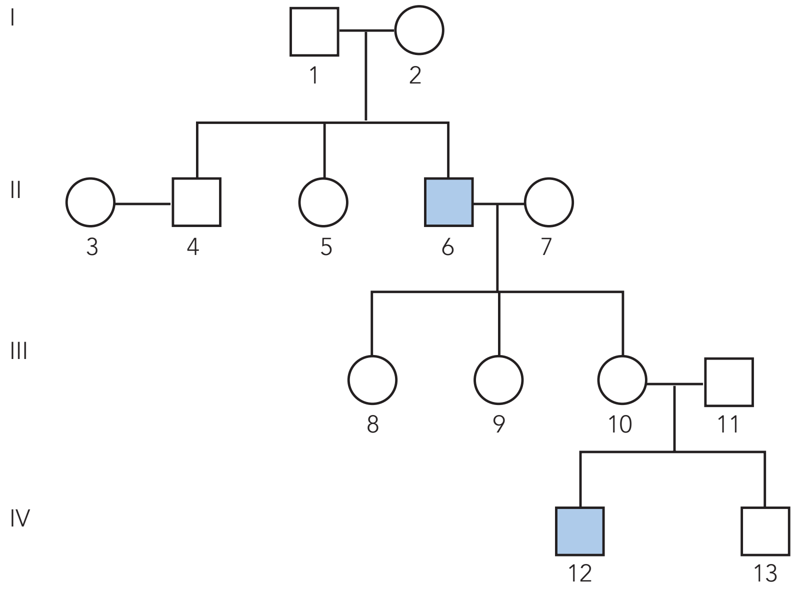
(iii) What evidence is there to suggest that other traits may be controlled by multiple alleles?

____

____

[2 marks]

5. The pedigree below shows the incidence of haemophilia (shaded individuals), which is a rare blood disease.



(i) What is the "mode of inheritance" of haemophilia? ________________________

[2 marks]

(ii) What is the chance of 10 and 11's next child having haemophilia? __________

[1 mark]

(iii) What is the chance of 10 and 11 having a daughter who is a haemophiliac?

__________ [1 mark]

(iv) The chance that 3 and 4's next son being a haemophilic is low. Why?

____

[1 mark]

(v) Write the genotypes of the following in the blank spaces:

1 ______________ 2 ______________ 4 ______________ 6 ______________

10 ______________ 11 ______________ 12 ______________ 13 ______________

[4 marks]

(vi) One hundred years ago very few haemophiliacs reached maturity. As a result, haemophilia was unheard of in females. Explain why females rarely inherited the disease.

____

____

____

[2 marks]

6. Write a word or phrase for each of the following descriptions:

(i) The genetic makeup in an organism for a particular trait.

____

(ii) The expression of a particular genotype.

____

(iii) A trait expressed by a heterozygote, which hides or masks another trait.

____

(iv) A chromosome which is not a sex chromosome.

____

(v) When a population's gene pool has more than two genes, any of which may occupy the same locus on a chromosome.

____

(vi) When two different alleles are present in an organism's genotype, neither is dominant and both are expressed in its phenotype.

____

(vii) An alternate form of a gene that can occur at the same locus on homologous chromosomes.

____

(viii) Paired chromosomes which are similar and carry the same type of genes although they are not necessarily identical.

____

(ix) A trait that is capable of being passed on through gametes from parents to offspring.

____

[9 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

(i) How do genetic counsellors use pedigrees and genetic testing to provide advice to couples who are planning to have children? [10 marks]

(ii) Why is it not uncommon for a couple to have four boys and no girls? However, in state primary schools, it is highly unlikely that all the children will be boys; such co-educational schools probably have about equal numbers of boys and girls. [5 marks]

(iii) If a man is colour blind and his wife is a 'carrier' for colour blindness, what is the probability that if they have four children all four are colour blind boys? [5 marks]

TRIAL TEST 15:
SCIENCE AS A HUMAN ENDEAVOUR 2

Time allowed:	**60 minutes**	**Section 1 –** Multiple Choice	10 marks
Total marks:	**80**	**Section 2 –** Short Answer	50 marks
		Section 3 – Short Answer	20 marks

SECTION 1 – MULTIPLE CHOICE (10 MARKS)

1. The most acceptable reason why parents may wish to select the sex of their child is:
   (a) to avoid sex linked diseases
   (b) to balance the family's gender
   (c) to provide the appropriate gender for possible future employment opportunities
   (d) to assist with the requirements of the family's future income.

2. Vaccines which are being developed to cause temporary infertility in both males and females. These vaccines are injections of chemicals which are designed to:
   (a) suppress the maturation of ova or sperm
   (b) stimulate the immune system to attack gametes
   (c) stimulate the immune system to remove particular sex hormones
   (d) suppress the production of particular hormonal glands which control spermatogenesis or oogenesis.

3. Prenatal diagnosis of a genetic disease means:
   (a) estimating the probability that a particular foetus will have a genetic disease
   (b) terminating a pregnancy because of the risk of the foetus having a particular genetic disease
   (c) choosing a particular embryo to avoid a genetic disease
   (d) determining the presence of a particular genetic disease at the embryonic or foetal stage.

4. A good example of a genetic disease that can be treated successfully if diagnosed immediately at birth is:
   (a) Huntington's disease
   (b) PKU
   (c) sickle-cell anaemia
   (d) diptheria.

5. By increasing her folic acid (or folate) intake before or during her pregnancy, a mother minimises the risk of her child developing:
   (a) spina bifida
   (b) cleft palate
   (c) Down syndrome
   (d) foetal alcohol syndrome.

6. The incidence of this condition increases significantly in infants of older mothers:
   (a) Down Syndrome
   (b) cleft palate
   (c) spina bifida
   (d) Huntington's disease.

7. Because the incidence of this disease increases with the age of the mother:
   (a) today women are choosing to start families earlier
   (b) older expectant mothers should be encouraged to seek genetic screening
   (c) older women should not have children
   (d) women must make an ethical decision as to what action to take.

8. Recent developments in our understanding of epigenetics has made us more aware of the importance of lifestyle choices as these choices are
   (a) likely to limit our life expectancy
   (b) likely to affect not just our children but also our grandchildren
   (c) likely to affect our mental health as well as our partner's and friends'
   (d) less significant than our genetic inheritance.

9. A developing child needs greater quantities of vitamin D, calcium and phosphorous
   (a) because it has a greater energy need
   (b) for increased metabolism
   (c) for the development of nerve tissue
   (d) because the skeletal system needs more at this time.

10. The developing child is most susceptible to alcohol during which stage of the pregnancy?
   (a) just before parturition
   (b) in the first three months
   (c) in the second three months
   (d) in the last three months.

SECTION 2 – SHORT ANSWER (50 MARKS)

Answer each question in the space provided.

1. (i) Why must a pregnant woman be very careful about what she takes into her body?

____

[1 mark]

(ii) Explain why an increased intake of each of the following is necessary during pregnancy.

(a) protein

____

(b) calcium

____

(c) iron

____

(d) folate

____

[4 marks]

2. (i) Are there any reasonable circumstances in which parents might want to select the sex of their child?

[2 marks]

(ii) Name two X-linked diseases that might cause parents to want to select the sex of their child.

[2 marks]

(iii) Name two X-linked diseases that should not cause parents great concern.

[2 marks]

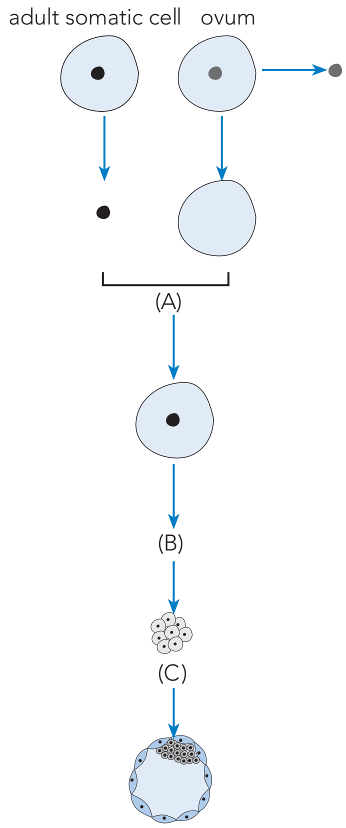
3. (i) How could the sex of a child be selected?

[4 marks]

(ii) If a child has been conceived and is developing in the uterus, what methods can be used to determine its sex and to detect genetic diseases?

[4 marks]

4. Study the diagram below then answer the questions which follow it.



(i) Using the following choices: "differentiation", "fertilisation" and "cleavage", name the processes in the blank spaces below:

A ______________________________

B ______________________________

C ______________________________

[3 marks]

(ii) The diagram shows an ovum nucleus being removed and substituted by a nucleus from a somatic cell. Are these nuclei both haploid? Explain.

____

____

[2 marks]

(iii) The embryo that may form from this replacement procedure would be called:

______________________________ [1 mark]

(iv) Who would this embryo grow to resemble if it was to mature?

____

____

[1 mark]

(v) Whose DNA would the new person inherit?

[1 mark]

(vi)

(a) At which stage would the cells be totipotent?

[1 mark]

(b) At which stage would the cells be pluripotent?

[1 mark]

(vii) What is the general name for cells with these potencies?

[1 mark]

5. How can an infection of the uterine tubes lead to infertility?

[2 marks]

6. Clearly explain what is meant by each of the following terms:
(i) conception:

(ii) implantation:

(iii) pregnancy;

(iv) contraception:

7. (i) What is one ethical consideration in using the "morning after" pill to avoid pregnancy?

[2 marks]

(ii) What early signs might a woman detect that indicate she could be pregnant?

[1 mark]

(iii) What medical test can be carried out to confirm a pregnancy?

[1 mark]

8. Complete the summary table below. Discuss each technology and how each makes early detection of cancers possible.

TECHNOLOGY	EXPLANATION OF THE TECHNOLOGY	HOW THE TECHNOLOGY MAKES EARLY DETECTION OF CANCERS POSSIBLE
Cervical screening test		
Breast screening		
Blood tests for prostate cancer		

[6 marks]

9. (i) If a prospective female parent develops a recessive disorder, but her partner does not, why is it important that her partner is screened for this condition (if screening is possible)?

[2 marks]

(ii) Use an example to show why this is important and the possible outcomes in terms of their children, if this screening is not carried out

[2 marks]

SECTION 3 – EXTENDED ANSWER (20 MARKS)

(i) Discuss the various birth control methods that are currently available in our society and new medical advances that are being developed in this field.

[15 marks]

(ii) Some methods are difficult to reverse. How might a male or female overcome infertility achieved through surgery?

[5 marks]

ANSWERS TO TERMINOLOGY AND REVIEW QUESTIONS

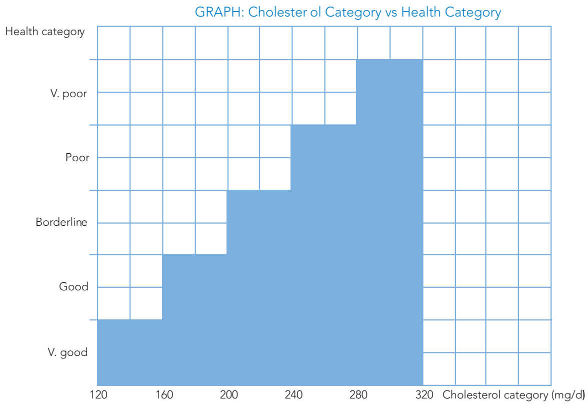
1: SCIENCE INQUIRY SKILLS 1

Terminology

(i) conclusion – is a final statement that says whether or not the hypothesis was supported or disproved.
(ii) dependent variable – also called the 'responding variable' as it is the one that responds to the changes to the independent variable. What is measured.
(iii) hypothesis – a statement that forms the basis of the experiment. It is an educated explanation of an observation that is also testable.
(iv) generalisation – a statement which applies to many cases, e.g. "Living things are made up of cells".
(v) independent variable – the variable in an experiment that is manipulated or changed in order to determine the effect that it may have on the dependent variable.
(vi) field of view – the circular area that is seen when looking into the ocular of a microscope.
(vii) magnification – the extent to which an object is enlarged by a microscope. It is expressed as the ratio of the image size to the actual size.
(viii) micrograph – a photograph taken with the aid of a microscope.
(ix) monocular – an instrument (microscope) in which only one eye is used to view the image
(x) prediction – a statement made about a future event. (In science a prediction is normally based on a hypothesis).

Review Questions

1.
(i) H: That smoking tobacco is the main cause of oral cancer in human populations
(ii) P: If a person smokes tobacco, then he/she is likely to develop oral cancer.
2.
(i) If a person smokes tobacco, then she will do less harm to her liver than if she drank excess alcohol.
(ii) If global warming is reversed, then the incidence of mosquito borne diseases will decrease.
(iii) If the Australian indigenous people are provided with better educational opportunities, then their average life expectancy will approach that of the non-indigenous population.
3. (i) P (ii) H (iii) H (iv) P (v) H
4.
(i)

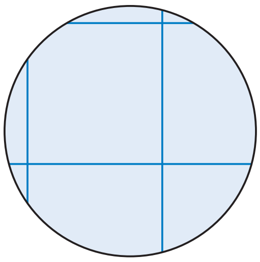


(ii) The lower the cholesterol category or the less cholesterol a person has in his/her blood the healthier they are likely to be.
(iii) The incidence of cardiovascular disease in each of these cholesterol ranges has been determined by research in the population. By measuring a person's blood cholesterol level his or her risk of cardiovascular disease can be determined and therefore their health category.
5.
(i) She could measure the rate at which the gas collected in the test tube.
(ii) Oxygen.
(iii) She could place the test tube in a water bath and raise or lower the temperature of the test tube by warming or cooling the water in the water bath.
(iv) a) the dependent variable: rate at which oxygen is collected in test tube.
b) the independent variable: temperature of the mixture in the test tube.
(v)
- *weight of liver*
- *volume of hydrogen peroxide*
- *concentration of hydrogen peroxide*
- *freshness of liver*

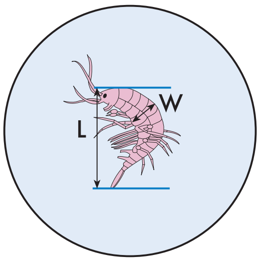
6. (A) Ocular (lens through which magnified image is viewed).
(B) Coarse adjustment (for large movements of body tube in rough focusing).
(C) Fine adjustment (for final focusing).
(D) Arm (used for carrying microscope).
(E) Clip (holds slide in place).
(F) Inclination joint (for tilting body tube).
(G) Base (provides stable support).

(H) Mirror (reflects light through aperture in wheel diaphragm).
(I) Wheel diaphragm (controls the amount of light passing through object).
(J) Stage (supports slide).
(K) High power objective (increases magnification).
(L) Low power objective (lesser magnification).
(M) Revolving nosepiece (moves objectives to change magnification).
(N) Body tube (allows light to pass up to ocular).

7.
(i) 40 ×
(ii) a) 4.5 b) 4500
(iii)



(iv) a) 1.8 b) 1800
(v) a) length 0.8 mm or 800μm
b) width 0.16 mm or 160μm



8.
(i) a) Nuclear membrane.
b) Nucleus/nuclear plasm.
c) Cell membrane.
d) Cytoplasm.
(ii) Length:
Length of the cell on page = 107 mm
Length of 5μm on page = 22 mm
∴ number of 5μm lengths = 107 ÷ 22 = 4.9
∴ actual cell length = 4.9 × 5μm = 24.5μm
Width:
Width of the cell on page = 70 mm
Length of 5μm on page = 22 mm
∴ number of 5μm lengths = 70 ÷ 22 = 3.2
∴ actual cell length = 3.2 × 5μm = 16μm.

9.
(i) Nuclei.
(ii) Length of white blood cell on page = 81 mm
Length of 5μm on page = 35 mm
∴ number of 5μm units in white blood cell's length = 81 ÷ 35
∴ actual cell length of white blood cell = 81 ÷ 35 × 5μm = 11.6μm

10. This is one example. You may choose any other suitable case study.
a) Louis Pasteur (1822 – 1895) recognised that often wine became sour while fermenting, whereas at other times the grapes fermented as required and produced drinkable wine. He recognised a problem.
b) The conditions in which the wines were crushed, bottled and cooked were examined. Other related food spoilings were assessed. Pasteur studied the microorganisms found in both sour and good wine. He observed that the wines had different micro-organisms.
c) Pasteur proposed the hypothesis that the souring of the wine was caused by different types of micro-organisms from the types that produced good wine.
d) Pasteur developed techniques to exclude bacteria from the crushed wine. He developed a method of killing all the microbes in wine that had fermented correctly. Pasteur carried out controlled experiments, e.g., his 'swan necked' flask, designed to prevent microbes from entering wine in an experimental flask.
e) Pasteur examined the condition of wine that had microbe contamination with wine that had none. He collected data from wine treated by heating it for a few minutes at between 50° and 60° (pasteurisation).
f) Pasteur's results supported his hypothesis that microbes of a particular type caused the souring. He also found that good wine could be preserved by pasteurisation.

2: CELLS AND TISSUES

2.1 The Human Body

Terminology

(i) cell – the basic 'building block' of living things (except viruses). Consists of membrane-bounded protoplasm.
(ii) organ – a collection of tissues which together carry out one or more major functions in an organism, e.g. kidney, heart.
(iii) system – a group of organs which together carry out a major function (or functions) within the body, e.g. circulatory, respiratory
(iv) tissue – a group of similar cells which together perform a particular function. Organs are composed of various tissues, e.g. muscle, nervous, connective.

Review Questions

1. Cell – tissue – organ – system
2.
(i) Cell differentiation: The development of specialised cells in multicellular organisms from unspecialised cells in the early stages of the organism's growth.

(ii) Cell specialisation: Mature cells usually become specialised; their shape and contents change so that they only carry out a narrow range of functions, e.g. red blood cells can only carry oxygen and carbon dioxide and because of their shape, a biconcave disc, they can bend so that they can pass through the narrowest of capillaries.

3. These tissues have different functions. Tissue that lines the trachea produces mucus and is ciliated. It helps remove dust and bacterial spores from the respiratory system. Tissue that lines the small intestine is secretory and absorptive. It produces digestive enzymes and absorbs digested food.

4.

ORGAN SYSTEM	MAIN ORGANS	MAIN FUNCTION/S
(i) circulatory	heart, arteries, veins, arterioles, venules, capillaries	transports nutrients and wastes, distributes heat, carries hormones and supports the role of the immune system
(ii) respiratory	lungs, nose, nasal cavity, pharynx, trachea, bronchi, bronchioles	delivers oxygen to and removes carbon dioxide from the circulatory system.
(iii) digestive	mouth, oesophagus, stomach, small and large intestine, rectum and anus	breaks down large organic molecules into molecules small enough to be absorbed through its lining.
(iv) muscular	cardiac, smooth and striated muscle	moves bones and other substances e.g. blood and the contents of the digestive system.
(v) skeletal	bones	protects soft tissue, anchors muscle, site for blood cell synthesis, stores fat, supports body
(vi) excretory	kidneys, ureters, bladder, urethra	removes metabolic waste from the body and regulates water balance in the blood
(vii) lymphatic system	lymph vessels, lymph nodes	drains excess tissue fluid returning it to the circulatory system, provides immunity to disease and absorbs the products of fat digestion

5. (i) circulatory (ii) respiratory (iii) nervous (iv) excretory (urinary) (v) digestive (vi) female reproductive.

6. Nervous and endocrine systems.

2.2 Cell Organelles

Terminology

(i) cell waste – substances which are not useful (but could be harmful) to the cell which are produced by its metabolic processes

(ii) cytoplasm – all the organelles (excluding the nucleus), cytosol (fluid) and inclusions in a cell

(iii) life processes – movement, reproduction, sensitivity, nutrition, excretion, respiration and growth

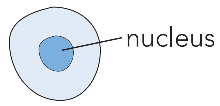
(iv) organelle – a small permanent structure within the cytoplasm of a cell which carries out a particular function, e.g. mitochondrion

(v) ribosome – an organelle, which is either attached to endoplasmic reticulum or free in the cytoplasm, on which protein synthesis occurs.

Review Questions

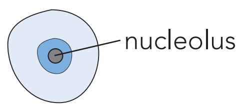
1. (i) cell membrane
(ii) lysosome
(iii) centriole
(iv) nuclear membrane
(v) nucleolus
(vi) nuclear pore
(vii) mitochondrion
(viii) cytoplasm

2. **Organelle – Nucleus**
Diagram –



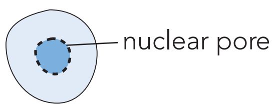
Location – near the middle of cell.
Function – contains the DNA of the cell and controls the activities of other parts of the cell.

Organelle – Nucleolus
Diagram –



Location – in the nucleus.
Function – synthesises and stores RNA.

Organelle – Nuclear membrane
Diagram –



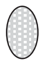
Location – around the perimeter of the nucleus

Function – allows molecules (mRNA) to move out of the nucleus through the pores to the ribosomes, while DNA is prevented from leaving nucleus.

Organelle – Mitochondrion
Diagram –

Location – in the cell's cytoplasm, outside the nucleus.
Function – site for aerobic respiration where ATP is formed which stores chemical energy.

Organelle – Lysosome
Diagram –

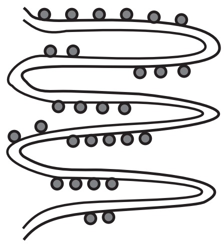


Location – in the cell's cytoplasm, outside the nucleus.
Function – a membrane bounded vesicle which contains powerful enzymes.

Organelle – Golgi apparatus
Diagram –

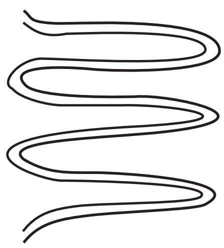
Location – close to the nucleus and near the rough endoplasmic reticulum
Function – a structure consisting of 4 to 6 flat sacs, which packages enzymes (making lysosomes) or waste into vesicles.

Organelle – Rough endoplasmic reticulum
Diagram –



Location – near the nucleus
Function – transports substances within the cytoplasm, protein synthesis occurs on the ribosomes.

Organelle – Smooth endoplasmic reticulum
Diagram –

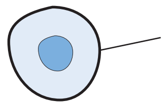


Location – close to the cell membrane
Function – transports substances within the cytoplasm.

Organelle – Centriole
Diagram –

Location – near the nucleus
Function – contains microtubules which form the spindles during cell division (mitosis and meiosis).

Organelle – Cell membrane
Diagram –



Location – around the periphery of the cell.
Function – semi-permeable membrane which controls the movement of substances into and out of the cell.

3. *The cytoplasm – contains all the cell's organelles except the nucleus and all the functions required for growth and replication take place in the cytoplasm. It provides a medium for the transport of materials the cell uses and produces. It provides support for the organelles and inclusions of the cell as the cytosol suspends them. It helps to maintain the shape of the cell. The cytoplasm acts as a site for essential metabolic reactions.*

4.
(i) Inputs – oxygen, nutrients including glucose, vitamins and mineral ions.
(ii) Wastes – carbon dioxide, lactic acid and water.

5. *Aerobic respiration.*

2.3 Cell membrane

Terminology

(i) concentration – amount of a substance divided by the total volume of the mixture of which that substance is part. This is a measure of the strength of a solution.
(ii) concentration gradient – the change in the concentration of a solute that may occur from one part of a solution to another part of that same solution.
(iii) glucose – simple sugar $C_6H_{12}O_6$. Glucose is a monosaccharide which is the main source of energy in the blood and cells.
(iv) lipid – an organic compound containing C, H and O. Lipids include natural oils, waxes and steroids. They are fats (solid) and oils (liquid) and are made up of glycerol and fatty acids.

(v) *protein – an organic compound containing C, H, O, N and sometimes S. Proteins are made of long chains of amino acids joined by peptide bonds. They make up many structures and enzymes in all cells.*

Review Questions

1. *(i) lipids (ii) proteins*
2. *Labels:*

(i) *bilipid layer (with lipids showing both hydrophobic and hydrophilic regions).*
(ii) *protein (with a central hydrophilic region which allows ions and some molecules to pass through).*
(iii) *protein (with shaded hydrophobic and hydrophilic regions) – passes through entire membrane.*
(iv) *branching carbohydrate attached to protein (forming a glycoprotein).*
(v) *small protein not spanning entire membrane.*
(vi) *glycolipid.*

The "fluid mosaic" model proposes that the cell membrane is made up of two layers of lipid. Proteins "float" in the lipids, some extend right across the membrane (and may form channels through which substances pass) and some proteins do not extend right though the membrane but float on either the external or internal surface of the membrane.

3. *Molecules which are non-polar (i.e. have no positive or negatively charged ends) and fat-soluble pass through the membrane easily.*
4.

(a) *This shows the* ***glucose*** *concentration is* ***higher*** *on the outside than on the inside. Glucose molecules are too* ***large*** *to pass into the cell by normal* ***diffusion****.*
(b) *A glucose molecule fits on to a transport* ***molecule*** *like an enzyme fits its* ***substrate****.*
(c) *The transport protein changes* ***shape*** *so that the* ***glucose*** *molecule can move* ***through*** *the cell membrane.*
(d) *This process is called* ***facilitated*** *diffusion. Another glucose molecule can now fit onto the* ***transport*** *protein.*

5.

(i) *Active transport, pinocytosis, phagocytosis, exocytosis.*
(ii) *These are called "active" processes because they require energy provided by the cell.*
(iii) *Diffusion and osmosis.*
(iv) *These are passive because no energy needs to be supplied by the cell. The particles move because they have kinetic energy and move 'down a concentration gradient'.*
(v) *Pinocytosis and phagocytosis.*

6.

(i) *Diffusion: movement of particles in a liquid or a gas from an area in which they are more concentrated to an area in which they are less concentrated.*
(ii) *Osmosis: movement of solvent (water) through a membrane from an area where the solvent (water) is in greater concentration (or solutes are in lesser concentration) to an area where the solvent is less concentrated (or solutes are in greater concentration).*
(iii) *Active transport: movement of substances by the cell membrane against a concentration gradient. This process requires carrier molecules and energy which is supplied by ATP.*
(iv) *Pinocytosis: this is the ingestion of fluid by a cell which occurs when an invagination (or infold) of the membrane envelopes the fluid, enclosing it in a vacuole within the cytoplasm.*
(v) *Phagocytosis: similar to pinocytosis but a pseudopod forms, engulfing solid particles which are enclosed within cytoplasmic vacuoles until digested by lysosomes.*
(vi) *Facilitated diffusion: molecules too large to diffuse into a cell passively are picked up by a transport (protein) molecule and moved quickly across the membrane when the transport molecule changes shape.*

7.

Cube	Surface Area (cm^2)	Volume (cm^3)	S.A. : V (cm^2/cm^3)
1	6	1	6
2	24	8	3
3	54	27	2

(i) *Cube 1 (it has 6 cm^2/cm^3)*
(ii) *Cube 3 (it has 2 cm^2/cm^3)*
(iii) *Provided the shape remains constant, the S.A. per unit volume becomes smaller as the cube increases in size.*
Note: As the cell increases in size, the rate of diffusion per cubic centimetre of its volume, would decrease. Its ability to absorb nutrients and eliminate wastes would become less rapid and therefore less efficient.

8.

(i) *Cell A. The concentration gradient is greater in cell A i.e. there is a higher concentration outside cell A and a low concentration inside cell A. Therefore the molecules will move rapidly into cell A.*
(ii) *The molecules will continue to be absorbed while there is a concentration gradient. If the cell is using up the molecules as they are absorbed, they will continue to enter the cell by diffusion until none remain in the extracellular fluid.*

2.4 Tissue types

Terminology

(i) blood – a mixture of cells or cell fragments (erythrocytes, leucocytes and thrombocytes) – 45% and plasma -55%, a fluid which contains mostly water, nutrients (e.g. glucose, amino acids, vitamins), proteins, antibodies , lipids , urea, carbon dioxide. Blood delivers the necessary substances to the cells and transports metabolic waste products away from cells.

(ii) bone – connective tissue which is dense, light and very strong. It has a number of functions including body support, providing a framework for muscle attachment, manufacture of blood cells, storage of minerals and fat.

(iii) cartilage – a tough flexible tissue which makes up part of the skeletal system.

(iv) duct – a tube or channel down which substances like sweat or bile can pass, from where they have been produced to where they will be used.

(v) gland – an organ or tissue which secretes a substance used somewhere else in the body. See exocrine and endocrine glands.

(vi) muscle – a body tissue capable of contraction (shortening) and relaxing.

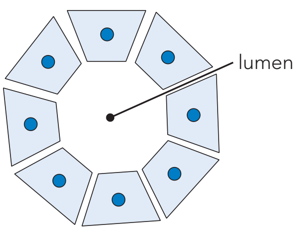
Review Questions

1.

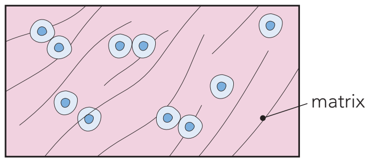
TISSUE TYPE	GENERAL DESCRIPTION	EXAMPLES
epithelial	Tissue which lines glands, hollow organs, blood vessels and the passages which lead from the body.	Stratified, cuboidal, squamous.
connective	Made up of cells and intercellular substances called the matrix, often fibres are found between the cells.	Areolar, dense connective, bone, blood.
muscular	Elongated cells capable of contraction.	Smooth, striated, cardiac
nervous	Made up of cells called neurons which have long extensions of the cytoplasm which carry nerve impulses.	Nervous tissue is not classified into subgroups.

2.

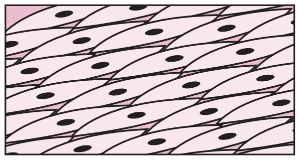
(i) cuboidal epithelial cells lining a duct



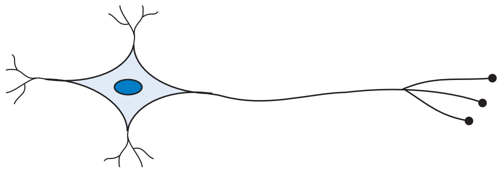
(ii) cartilage



(iii) smooth muscle tissue



(iv) a nerve cell



3. ***Example – Non-striated***
Type – Muscle
Structure – Long fibres (tapering cells)
Function – Contraction.

Example – Cartilage
Type – Connective
Structure – Cells in a matrix
Function – Support, reduces friction.

Example – Squamous
Type – Epithelial
Structure – Flat
Function – Lines digestive tract, arteries.

Example – Glandular
Type – Epithelial
Structure – Clusters of cells
Function – Secrete.

Example – Areolar
Type – Connective
Structure – Loose network of fibres, with scattered cells
Function – Forms a tough membrane which protects organs and holds organs in place.

Example – Adipose
Type – Connective
Structure – Fat filled cell with nucleus and cytoplasm forced to edge.
Function – Stores energy, insulates, absorbs shock.

Example – Cuboidal
Type – Epithelial
Structure – Cube shaped

Function – Forms tubules in kidneys - reabsorption and secretion.

Example – Bone
Type – Connective
Structure – Living cells in a hard matrix
Function – Support muscle attachment, mineral store.

Example – Cardiac
Type – Muscle
Structure – Striated muscle with cross connections
Function – Rhythmic contractions force blood to flow in circulatory system.

Example - Striated
Type – Muscle
Structure – Striated muscle with no interconnections between fibres. Multinucleate.
Function – Move bones of the skeletal system.

Example – Stratified
Type – Epithelial
Structure – Layers of cells of different shapes
Function – Forms the skin.

Example – Blood
Type – Connective
Structure – Formed elements (cells) in a fluid matrix (plasma)
Function – Transports nutrients, oxygen and wastes around the body.

3: METABOLISM

3.1 Enzyme specificity

Terminology

(i) digestion – the breakdown of larger more complex organic matter into simpler smaller compounds so that they can be absorbed.
(ii) product – substance formed in a chemical reaction.
(iii) reactant – a substance which is chemically changed during a chemical reaction.
(iv) reaction rate – the speed at which a reactant is used or a product formed in a chemical reaction.
(v) synthesis – the making of new substances from absorbed nutrients, e.g. a protein is synthesised using many amino acid molecules.

Review Questions

1. *A reaction in which smaller molecules or atoms are combined to form a larger molecule.*
2. *Yes. When smaller molecules or atoms form chemical bonds, energy is required to create the chemical bonds.*
3. *One example is protein synthesis where amino acids are joined together to form a large protein molecule. This occurs at the ribosomes. (Another example is the synthesis of ATP from ADP and P which occurs in the mitochondria.)*
4. *A reaction in which larger molecules are broken down into smaller molecules or atoms.*
5. *No net input. Catabolic reactions release energy, as the chemical bonds between combined molecules are broken and the energy in those bonds is released.*
6. *Respiration is a catabolic reaction in which glucose is broken down to carbon dioxide and water (aerobic)or lactic acid (anaerobic). Aerobic respiration occurs in the cytoplasm and mitochondria, anaerobic respiration occurs in the cytoplasm. (Other examples of catabolic reactions include the various forms of digestion where larger molecules are broken down to smaller molecules so that they can be absorbed through membranes as in the extracellular digestion which occurs along he digestive tract especially in the small intestine.)*
7.

(i) An enzyme is an organic catalyst, a protein which speeds up (or in some cases slows down) a particular chemical reaction.
(ii) Every enzyme has a unique three dimensional shape. On the surface of the enzyme is a particular part of that shape onto which another molecule (the substrate) can be held. The enzyme holds the substrate while the chemical reaction occurs. The changed molecule (the product) is released, leaving the enzyme unchanged. The enzyme can therefore be compared to a key and the substrate a lock (the key remains unchanged).
(iii) Because they are not changed by the reaction and are reused in the cell's metabolism many times before they denature.
(iv) The 'active site' or 'catalytic site' is the place on the enzyme onto which the substrate fits.
(v)

Enzyme and substrate (a large molecule in this case) have complimentary shapes	Enzyme and substrate fit together temporarily forming the enzyme - substrate complex	The substrate is broken apart. Each part moves away from the enzyme, leaving the enzyme unchanged and free to break apart another substrate molecule

(vi) It is called chemical digestion because a larger more complex molecule is broken down into simpler less complex molecules.

(vii) "Enzyme specificity" refers to the fact that because of the shape of its active site an enzyme will only accept a particular substrate molecule. Each enzyme therefore generally catalyses only one reaction.

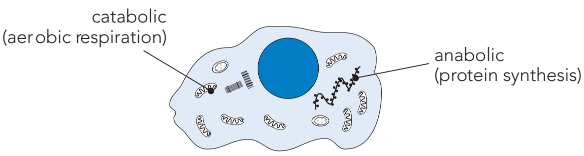
3.2 Cellular respiration

Terminology

(i) aerobic respiration – the chemical breakdown of organic matter (usually glucose) in cells using oxygen to release energy.
(ii) anaerobic respiration – the chemical breakdown of organic matter (usually glucose) in cells in the absence of oxygen to release energy.
(iii) ATP (Adenosine Triphosphate) – an important chemical which is source of energy in many cells. It releases energy when it breaks down to ADP and P (Adenosine diphosphate and inorganic phosphate).
(iv) cytosol – the liquid inside cells
(v) protein synthesis – the making of proteins which occurs on ribosomes by joining amino acids together to form a long chain.

Review Questions

1.



2. Respiration is classified as catabolic because the products of the reaction are simpler than the reactants (it is a breakdown reaction) and there is a net amount of energy released.

3.
(a) glucose → lactic acid + energy.
(b) glucose + oxygen → carbon dioxide + water + energy.

4.

	AEROBIC RESPIRATION	ANAEROBIC RESPIRATION
Site of occurrence	first part in cytoplasm then in mitochondrion	in cytoplasm
Requirements for oxygen	oxygen required	no oxygen required
Products in animal (human) cells	carbon dioxide + water (+ energy)	lactic acid (+ energy)
Amount of ATP produced from 1 molecule of glucose	large amount (36-38 ATP molecules produced)	small amount (2 ATP molecules produced)

5.
(i) ATP stores the energy in the bond between the second and third phosphate groups in the ATP molecule. The energy is captured when ATP and P combine.
(ii) ADP + P + Energy → ATP
ADP and P combine to form ATP
(iii)
- protein synthesis
- active transport
- endocytosis
- cell movement
- cell division

(iv) ATP breaks down to ADP and P, releasing the energy for cell activities

ATP → ADP + P + Energy

(v) ADP and P are recycled mainly in the mitochondria using energy released from the respiration of glucose. Some ATP is recycled in the cytoplasm using energy released through anaerobic respiration.

3.3 Cells Requirements

Terminology

(i) carbohydrate – an organic compound containing C, H and O, with the general formula $(CH_2O)_n$. Important carbohydrates include glucose and glycogen.
(ii) metabolism – the chemical processes which occur within the body. These include both anabolic and catabolic processes.
(iii) mineral – an inorganic substance which may be essential to life, e.g. iron, calcium.
(iv) nutrient – a chemical substance which is ingested to provide energy, contribute to growth or assist in the metabolism of the body
(v) vitamin – small organic molecule needed to promote health. Plants produce all their vitamins. Animals must eat vitamins produced by plants.

Review Questions

1.

NUTRIENT	SOURCE	FUNCTION
Amino acids	Animal and plant protein.	Structural proteins and enzymes.
Simple sugars	Starch and other carbohydrates.	Source of energy.
Fatty acids	Fats and oils	Structural lipids (e.g. cell membranes and hormones). Food store.
Vitamins	Plant and animal food.	Assist enzymes in metabolic processes.
Minerals	Plant and animal food.	Some are cofactors assisting enzymes and some are essential for development, e.g. bone growth (calcium), red blood cell synthesis (iron).

2. *Oxygen is needed for most cells to function and produce sufficient energy in the form of ATP to survive. This is needed for many cell activities including protein synthesis, active transport, endocytosis, cell movement and cell division.*

3.4 Factors affecting enzyme function

Terminology

(i) *active site – the part of an enzyme into which the substrate fits.*
(ii) *chemical concentration – refers to the amount of a substance in a solution.*
(iii) *denature – to change the tertiary shape of an enzyme by heat so that it no longer fits its substrate/s. This is usually irreversible. Also used to describe the process of heating DNA, splitting the molecule along its length.*
(iv) *inhibit – reduce, prevent or stop a process within the body.*
(v) *pathogen – a disease causing organism.*

Review Questions

1.
(i) *An enzyme inhibitor stops an enzyme from catalyzing a particular reaction. The inhibitor binds to the enzyme and prevents the substrate from attaching to its active site.*
(ii) *Enzymes in pathogens can be targeted by inhibitors preventing the pathogen from multiplying within the body or producing toxins that are harmful to it. Reverse transcriptase an enzyme necessary for HIV reproduction can be blocked in this way.*

2.
(i) *As the product's concentration increases and builds up in the cell, the reaction rate will slow.*
(ii) *The cell deals with this by exporting the product away from where it is produced. This can be done in a number of ways either by packaging it in a membrane as in the Golgi apparatus, channeling it through endoplasmic reticular, through active transport or by chemically modifying the product slightly.*

3.
(i) *Temperature alters the three dimensional shape of the enzyme molecule – it therefore alters the shape of the active site and affects the enzyme's efficiency (like a melting key). If the enzyme is heated too strongly its shape is changed irreversibly – it is denatured.*
(ii) *Enzymes are sensitive to pH and their activity is also affected by the concentration of both the reactants and the products.*

4: RESPIRATORY SYSTEM

4.1 The structure and function of the respiratory system

Terminology

(i) *alveolus – a microscopic air sac in lungs. (plural – alveoli)*
(ii) *capillary – a very thin-walled blood vessel which connects arteries to veins.*
(iii) *diffusion – the passive movement of particles from an area of high concentration to an area of low concentration.*
(iv) *haemoglobin – a compound made of protein and iron which carries oxygen and carbon dioxide in red blood cells.*
(v) *external intercostal muscles – assist with inhalation by lifting the ribs up and out, increasing the volume of the thoracic cavity.*
(vi) *oxyhaemoglobin – a chemical compound formed when oxygen combines with haemoglobin in red blood cells.*
(vii) *pleural cavity – the fluid filled space between two pleurae.*
(viii) *thoracic cavity – the chest cavity, containing lungs and heart. Enclosed between rib cage and diaphragm.*
(ix) *vocal cords – two folds of mucous membrane stretched across the larynx. They vibrate, to produce the sounds made in speaking.*

Review Questions

1. *(i) larynx*
(ii) bronchioles
(iii) intercostal muscle
(iv) rib
(v) diaphragm
(vi) heart
(vii) left lung
(viii) bronchus (left)
(ix) trachea (with rings of cartilage)

2. ***Name: Nose***
Structure: Part of face which protrudes. Holes (nostrils) allow air to enter and leave nasal cavity.
Functions: Warms, filters and humidifies air, contains smell receptors (olfactory).

Name: Pharynx
Structure: Muscular tubular structure.
Functions: Carries air from the nasal cavity to the larynx (also food to oesophagus).

Name: Larynx
Structure: A short tubular structure reinforced with cartilage, which contains vocal cords.
Functions: Air forced over the vocal cords causes them to vibrate and produce sounds.

Name: Trachea
Structure: Windpipe, supported by horse-shoe shaped cartilage rings.
Functions: Carries air to the lungs, cilia filter the air.

Name: Lungs
Structure: Two large spongy organs which contain millions of highly vasculated alveoli.
Functions: Provides the large surface necessary for the blood to exchange carbon dioxide for oxygen.

Name: Bronchi
Structure: Two tubes at end of trachea which branch into left and right lungs.
Functions: Carry air to the lungs from trachea, filters air (mucus laden cilia trap dust and other foreign particles).

Name: Bronchioles
Structure: Very fine branches of the bronchi.
Functions: Carry air from bronchi into lungs.

Name: Alveoli
Structure: Tiny air sacs which are enclosed in blood capillaries.
Functions: Oxygen passes from alveoli into the blood and carbon dioxide moves from the blood into the alveoli. Site for gaseous exchange between internal and external environments.

Name: Pleural membranes
Structure: Two membranes which surround the lungs and line the thoracic cavity.
Functions: Assist diaphragm and intercostal muscles to draw the lungs into a large volume when inhaling.

Name: Diaphragm
Structure: Dome shaped muscle separating the abdominal and thoracic cavities.
Functions: When this muscle contracts it flattens and pulls lungs downwards, increasing their volume.

Name: Intercostal muscles
Structure: Muscles between the ribs (external and internal).
Functions: External intercostals pull the ribs up and out helping to increase the volume of the lung. Internal intercostals pull the ribs down and in helping to decrease the volume of the lungs (these muscles are therefore antagonistic muscles).

Name: Vocal cords
Structure: Two folds of elastic tissue on either side of the larynx.
Functions: Vibrate as air is forced out of the lungs over the cords producing a range of sounds depending largely on the force of the air and the tension on the cords.

4.2 Gas exchange

Terminology

(i) diaphragm – the dome-shaped muscle which separates the abdominal cavity from the thoracic cavity, used for breathing normally.
(ii) erythrocyte – red blood cell. Carries oxygen in blood.
(iii) intercostal muscles – the muscles found between the ribs, which move them.
(iv) tidal volume – the volume of air inhaled and exhaled in a normal resting condition.

Review Questions

1.
(i)
- *The diaphragm and external intercostal muscles contract, pulling the lungs down and out.*
- *The lungs' volume increases and the pressure inside each therefore decreases.*
- *Air moves from outside the nose where the pressure is higher into the lungs where the pressure is lower.*

(ii)
- *The diaphragm and external intercostals relax and the internal intercostal muscles contract.*
- *The lungs are therefore forced up and in.*
- *The lungs' volume decreases and the pressure inside each therefore increases.*
- *Air moves from the lungs where the pressure is greater through the nose to the outside where the pressure is lower.*

2. Nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveoli.

3.
(i) There is a higher concentration of oxygen in the air in the alveolus than in the plasma and the erythrocytes. Oxygen therefore diffuses into the erythrocytes.
(ii) There is a greater concentration of carbon dioxide in the plasma and erythrocytes than in the alveoli. Carbon dioxide therefore diffuses into the alveoli.

4. The alveolus is thin walled, its inner surface is kept moist, it has a rich supply of blood and it has a large surface area for gaseous exchange.

5. The constant aeration of the lungs ensures that a high level of oxygen is maintained in the alveoli and the constant flow of blood in the capillaries which surround the alveoli, removing oxygen, ensures that the concentration gradients remain steep. There is a large difference maintained between the *concentration of oxygen in the alveoli and the concentration of oxygen in the blood. The same is true for the carbon dioxide but in reverse. A higher level of carbon dioxide is maintained in the blood than in the alveoli.*

5: CIRCULATORY SYSTEM

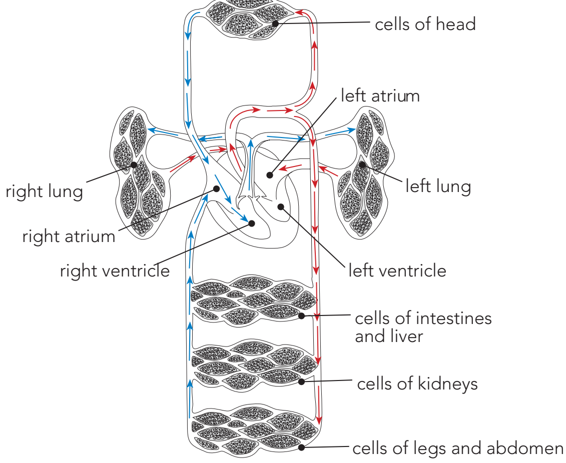
5.1 The structure and function of the circulatory system

Terminology

(i) *artery – a blood vessel that carries blood away from the heart.*
(ii) *atrioventricular valve – a valve which prevents blood flow from a ventricle back into an atrium (e.g. bicuspid and tricuspid valves).*
(iii) *atrium – one of two thin walled muscular chambers in the heart that receives blood from the pulmonary or systemic circulation*
(iv) *cardiac muscle – involuntary muscle tissue which is striated, has cross connections and forms the walls of the heart in the atria and ventricles.*
(v) *diastole – the phase when heart muscle is relaxed during the cardiac cycle.*
(vi) *double circulation system – circulation system in which blood flows from the heart to the lungs and back to the heart (pulmonary circulation), then from the heart to the other body tissues and back to the heart (systemic circulation).*
(vii) *inflammation – a red, swelling region which occurs in the vicinity of damaged tissue. It is caused by the dilation of blood vessels in the area, the delivery of more white blood cells and plasma to the tissue bed and a subsequent increase in the temperature in the area.*
(viii) *lumen – the space within a tube, e.g. inside of an artery.*
(ix) *sinuatrial node – the heart's pacemaker, tissue located in the right atrium that sends impulses to the cardiac muscle, in all four chambers, that controls the heart rate.*
(x) *systole – the phase of the cardiac cycle in which contraction of atria and/or ventricles occurs.*
(xi) *vein – a major blood vessel which carries blood from body tissue to the heart.*
(xii) *ventricle – one of two large thick walled chambers that collect blood received from the atria and pump it into either the systemic or pulmonary circulation.*

Review Questions

1. *(i) Oxygen – Required to release energy from food (glucose) in aerobic respiration.*
(ii) Glucose - Provides the chemical energy which is released in respiration.
(iii) Minerals – Used in metabolic processes to synthesise substances needed by cells, e.g. red bone marrow cells require iron to produce haemoglobin.
2. *They are carried to the body cells in the blood plasma of the circulatory system. They leave the capillaries and diffuse into the tissue fluid and then into the cells.*
3. *Larger organisms cannot obtain oxygen and nutrients or dispose of wastes simply by diffusion to the external environment. This would be too slow.*
4. *No living cell is more than 130μm from a capillary. Therefore the circulatory system permeates throughout the body and joins all the organs in this way.*
5. *Inflammation is a defence response to cell damage caused by foreign substances or microorganisms. The site of injury/invasion becomes red, indicating vasodilation has occured. Temperature rises as more heat is produced. White blood cells leave the circulation at the injury site to engulf foreign material and remove it.*
6.
(i) *a, b, c*



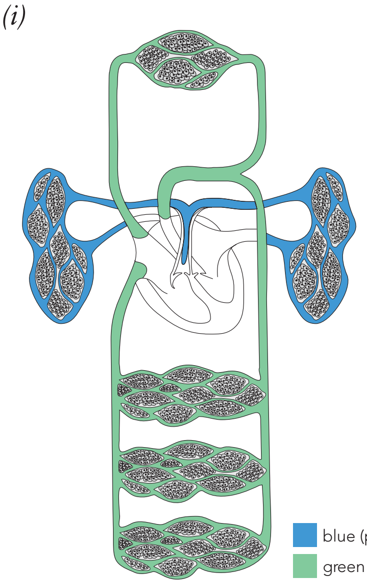
(ii) *Blood becomes deoxygenated near the body cells (liver, kidneys, legs).*
(iii) *Around the alveoli of the lungs.*
(iv) *Pulmonary arteries.*
(v) *Pulmonary veins.*
(vi) *Food (amino acids, glucose, etc.) that has been absorbed from the small intestine.*
7. *a) superior vena cava – returns deoxygenated blood from the head and arms*
b) right atrium – pushes deoxygenated blood into right ventricle
c) inferior vena cava – returns deoxygenated blood from legs, abdomen, liver, kidneys
d) tricuspid/right atrioventricular valve – prevents backflow of blood from right ventricle into right atrium during ventricular systole
e) chordae tendineae – prevents atrioventricular valves from inverting (turning inside out) during ventricular systole

f) right ventricle – pushes deoxygenated blood into the pulmonary artery towards the lungs
g) left ventricle – pushes oxygenated blood into aorta towards all body tissue (except lung tissue)
h) papillary muscle – contract to pull chordae tendineae and open atrioventricular valves during atrial systole
i) semilunar valve – prevents backflow of blood from an artery into the ventricle during ventricular diastole
j) bicuspid/left atrioventricular valve – prevents backflow of blood from left ventricle into left atrium during ventricular systole
k) left atrium – receives oxygenated blood from lungs and pushes this blood into the left ventricle
l) pulmonary vein – carries oxygenated blood from lung to left atrium
m) aorta – carries oxygenated blood from left ventricle to the body tissues (except lungs)
n) pulmonary artery – carries deoxygenated blood from right ventricle to lungs.

8.
(i) The period of time during which both atria contract.
(ii) The period of time during which both atria relax.
(iii) The period of time during which both ventricles contract.
(iv) The period of time during which both ventricles relax.
(v) Atrial systole - 0.1 sec
Atrial diastole - 0.7 sec
Ventricular systole - 0.3 sec
Ventricular diastole - 0.5 sec

9.
(i) Ventricular systole.
(ii) Ventricular diastole.
(iii) Because during ventricular systole the arteries are stretched, during ventricular diastole being elastic they push down on the blood.

10. (i)



(ii) Pulmonary circulation – pulmonary arteries, pulmonary veins.
Systemic circulation – aorta, carotid arteries, mesenteric arteries, renal arteries, inferior and superior vena cavae (these are some of the more important).

11.

FEATURE	ARTERY	VEIN
Comparative thickness of wall	Thicker	Thinner
Comparative diameter of lumen	Smaller	Larger
Presence of valves	Along length no valves (only semilunar)	Valves prevent back flow
Elasticity	Very elastic	Less elastic

12.

	STRUCTURE	FUNCTION
arteriole	Fine artery	Delivers blood to the tissues
venule	Fine vein	Removes blood from the tissues
capillary	Fine thin branches from arterioles (one cell thick)	Allows smaller molecules to move out of circulatory system into intercellular fluid
lymphatic vessel	Fine permeable tube	Drains excess fluid away from tissue bed

5.2 The components of blood

Terminology

(i) carbaminohaemoglobin – a compound formed when carbon dioxide combines with haemoglobin in the red blood cells.
(ii) deoxygenated blood – blood which has lost most of its oxygen to the body tissue.
(iii) fibrinogen – blood clotting factor I – a soluble protein which occurs in blood plasma. When converted to fibrin, by thrombin, it plays a major role in forming a blood clot.
(iv) haemorrhage – the loss of blood from a damaged blood vessel.
(v) plasma – the fluid part of blood (55% by volume).
(vi) platelet (thrombocyte) – a small volume of cytoplasm bounded by a cell membrane, but lacking a nucleus.

Review Questions

1. Blood is classified as connective tissue, because it consists of living cells surrounded by a non-living matrix of fluid, the plasma.

2. *Blood:*
- *delivers O_2 from the lungs to the body cells*
- *absorbs nutrients from the digestive system and delivers nutrients to cells*
- *carries metabolic wastes to the kidneys*
- *transports hormones from endocrine glands to their target tissue*
- *distributes heat evenly to all the organs and to the skin when heat loss is needed*
- *carries antibodies and white blood cells which provide protection*

3.
(i) *Plasma contains water (90%), nutrients, gases, wastes, hormones, proteins and ions.*
(ii) *Plasma makes up 55% of the blood's volume.*
(iii) *It is fairly thick and does not flow as readily as water.*

4. *Carbon dioxide travels in the blood*
- *linked to haemoglobin (in the rbc's) as carbaminohaemoglobin (22%),*
- *as hydrogen carbonate ions HCO_3- (70%) and*
- *dissolved in the plasma's water (8%).*

5. *The blood is protective in two ways:*
- *when a blood vessel is damaged, blood will form a clot to help prevent excess bleeding*
- *its antibodies and white blood cells attack pathogens such as bacteria, viruses and fungi which invade the body.*

6.
Name – erythrocyte
Origin – red bone marrow
Function – carries oxygen and carbon dioxide
Other Notes – is biconcave disk with no nucleus and average life span of 120 days
Name – lymphocyte
Origin – red bone marrow
Function – fights disease, may produce antibodies or chemicals which attract other white blood cells to an area of infection
Other Notes – two types: B cells and T cells. B cells mature in the bone, T mature in the thymus
Name – granulocyte
Origin – red bone marrow
Function – some phagocytose foreign chemicals and organisms, remove waste materials
Other Notes – three types (neutrophils, eosinophils and basophils)
Name – platelets/thrombocytes
Origin – red bone marrow
Function – help form blood clots, stop bleeding
Other Notes – very small cell fragments, no nucleus
Name – monocyte
Origin – red bone marrow
Function – become macrophages which phagocytose invading microorganisms
Other Notes – largest white blood cell, kidney shaped nucleus.

7.
(i) *Without the clot, blood would continue to leak from the wound, until the person's blood pressure becomes so low that insufficient oxygen and nutrients would be delivered to the cells which need them.*
(ii) *Platelets stick to the damaged site.*
(iii) *Platelets form a platelet plug.*
(iv) *The damaged cells release factors (chemicals) which together with calcium ions in the blood cause the production of prothrombin activator.*
(v) *Prothrombin activator converts prothrombin to thrombin.*
(vi) *Thrombin converts fibrinogen to fibrin. Fibrin forms fibres which help form and hold together a clump of platelets at the damaged site. This clump of coagulated blood is called a blood clot.*

8. *The circulatory system provides a rich supply of blood to each alveolus through a network of capillaries. It delivers deoxygenated blood to the lungs and moves oxygenated blood away in a constant, rapid flow; thereby maintaining a concentration gradient for the gaseous exchange between the alveoli and the blood.*

9.
(i) *Haemoglobin.*
(ii) *Having no nucleus means there is more room in the cell for haemoglobin and each cell therefore has a greater oxygen carrying capacity.*
(iii) *Having no nucleus means the cell has no nuclear DNA; it is unable to synthesise proteins and therefore unable to repair itself or replace denatured enzymes.*
(iv) *Worn out RBCs are broken down in the liver.*
(v) *A useful byproduct is bile, which contains bile salts that are useful in the emulsification of lipids during digestion.*

5.3 The lymphatic system

Terminology

(i) *lacteal – lymphatic vessel that absorbs the products of fat digestion. Lacteals are found in the small intestinal villi*
(ii) *lymph – the colourless fluid (similar to plasma) in the lymphatic system*
(iii) *lymph node – an oval shaped structure into which several lymph vessels drain. One lymph vessel drains the node.*
(iv) *lymph valve – a semi-lunar structure which prevents the backflow of lymph in lymph vessels. It is similar to valves in a vein.*

(v) *lymphocyte – a white blood cell that resides in the lymphatic tissue. Can be either of two types; T-lymphocyte or B-lymphocyte.*

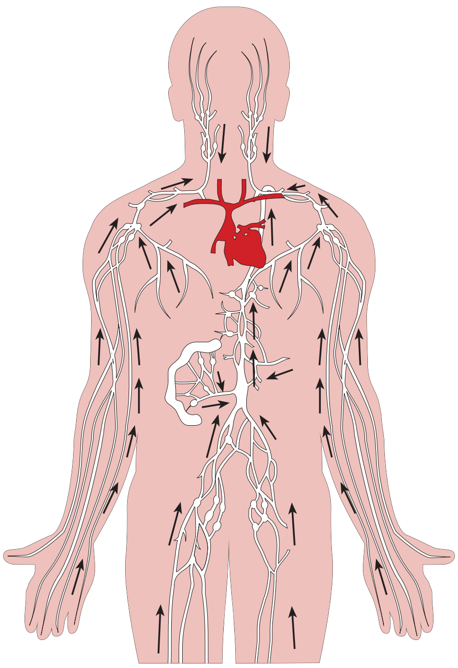
Review Questions

1.
(i) *Two main functions of the lymphatic system are:*
- *to remove excess interstial fluid from tissue beds around the body and*
- *to provide defence against disease pathogens through the lymphocytes and macrophages that reside in the system.*

(ii)
- *Lymph vessels drain excess tissue fluid from the tissue beds around most parts of the body and return the fluid (lymph) to the circulatory system via the subclavian veins.*
- *The lymphocytes either produce antibodies (B lymphocytes) which attack pathogens and their toxins or may produce chemicals (T lymphocytes) which attract other white blood cells to the area. Some T lymphocytes attack invading pathogens directly. Macrophages also found in the lymphatic system phagocytose some infectious microorganisms.*

2.
(i) *A = blood/plasma B = intracellular fluid C = lymph*
(ii) *Glucose moves by diffusion from where it is more concentrated to where it is less concentrated. Fluid pressure also carries fluid out of the arteriole.*
(iii) *There would be a build up of fluid in the tissue and it would begin to swell.*

3.
(i)



(ii) *Right and left subclavian veins (through the right lymphatic duct and the thoracic duct respectively).*

4.
(i) *Lymph moves in a similar way to blood in veins although it is under less pressure and moves more slowly. Muscle contractions squeeze the lymph vessels and force the lymph forward towards the circulatory system.*
(ii) *There are similar valves in the lymph vessels to those in the veins which allow the lymph to flow only in one direction.*

5. *The lacteals in the intestinal villi absorb the products of lipid digestion giving the lymph in that area the milky appearance of fat.*

6.
- *blood contains RBC's (it is red), high protein levels, many nutrients and many wastes.*
- *lymph contains no RBC's (it is mainly colourless), low protein levels, few nutrients and few wastes.*

6: DIGESTIVE SYSTEM

6.1 Structure and function of the digestive system

Terminology

(i) *alimentary canal – a tube beginning at the mouth and terminating at the anus. It is also called gastro-intestinal tract or digestive tract.*
(ii) *bolus – a rounded mass of food that is swallowed.*
(iii) *defaecation – the expulsion of faeces from the rectum.*
(iv) *ingestion – the taking in of food and water.*
(v) *microvilli – very small projections of cytoplasm from some cells, which increases the cells' total surface area for absorption, e.g. epithelial cells of the small intestine (singular is microvillus).*
(vi) *peristalsis – muscular contractions which move along tubes e.g. the digestive tract and the oviduct, to move the contents, e.g. food and ova.*
(vii) *sphincter muscle – a ring of muscle which closes an opening in the body, e.g. anal sphincter, pyloric sphincter.*

Review Questions

1.
(i) *Proteins are needed because they contain amino acids. Nine amino acids are described as "essential" because the body cannot synthesise them. They are needed so that the body can use them to assemble its own proteins.*
(ii) *Carbohydrates are the body's main source of energy. Starch in food is broken down to glucose .This is respired to produce ATP and heat. Cellulose, another carbohydrate, makes up a large proportion of roughage*

in the large intestine – necessary for peristalsis.

(iii) Lipids have twice the energy per gram compared to carbohydrates. They are a useful store of energy. Some fatty acids are also essential. Fat-soluble vitamins are also absorbed with lipid absorption.

(iv) Vitamins are small organic compounds that are essential for the body's metabolism. They are necessary in the production of energy as they assist enzymes. They cannot be synthesised in the body and therefore must be part of the diet.

(v) Minerals are needed in a variety of different ways in different cells. Iron is needed for haemoglobin in RBCs. Calcium for bones and muscle contractions. Potassium and sodium for nerve impulses. Some are co-factors that assist enzymes and are therefore necessary for metabolism.

2. i) mouth
ii) tongue
iii) liver
iv) gall bladder
v) small intestine
vi) ascending colon
vii) caecum
viii) appendix
ix) rectum
x) descending colon
xi) transverse colon
xii) pancreas
xiii) stomach
xiv) duodenum
xv) oesophagus
xvi) epiglottis
xvii) pharynx

3.

(i) Mouth (amylase), stomach (pepsin), small intestine (mainly from duodenum and jejunum – amylases, proteases, lipases).

(ii) Small intestine (mainly in ileum), large intestine (vitamins and water).

(iii) Oesophagus, stomach, small intestine, large intestine.

(iv) Lower colon (sigmoid), rectum and anal sphincter.

4.

(i) The stomach, small intestine and large intestine have a supply of blood, but the small intestine is most richly supplied with blood as it contains a higher density of capillaries and absorbs most of the nutrients. These nutrients are transported in the hepatic portal vein to the liver for processing.

(ii) Each villus has a lacteal which is part of the lymphatic system. The products of fat digestion i.e. fatty acids and glycerol are absorbed into the lacteals and transported via the lymphatic system to the subclavian veins.

5.

SPHINCTER	LOCATION	FUNCTION
lower oesophageal	between oesophagus and stomach	prevents food which is in stomach being regurgitated
pyloric	between stomach and duodenum	prevents food leaving the stomach and moving into intestine before it is ready
ileo-caecal	between small intestine and large intestine	prevents wastes moving into the large intestine before nutrients have been absorbed
anal	between rectum and exterior	prevents wastes from being eliminated until water is reabsorbed in large intestine

6. Duodenum → jejunum → ileum

6.2 Digestion

Terminology

(i) bile – a fluid secreted by the liver containing pigments and salts produced as breakdown products of the haemoglobin from used erythrocytes. It has a yellow-brown colour because of the iron compounds it contains.

(ii) chyme – partly digested food in the stomach which passes into the small intestine as a semi-fluid mixture.

(iii) emulsification – physical digestion of lipids into small globules that increases their surface area to volume ratio and makes them easier to chemically digest. Bile emulsifies lipids in the small intestine.

(iv) enzyme – a protein molecule which acts as an organic catalyst by lowering the activation energy of a reaction.

(v) exocrine gland – a gland which empties its product into a duct, e.g. salivary gland, gastric glands (cf. endocrine glands).

(vi) mastication – the grinding mechanical digestion of food.

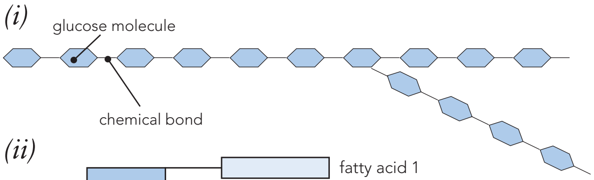
(vii) pyloric sphincter – the circular muscle between the stomach and the duodenum which prevents food from leaving the stomach until it has been processed.

(viii) saliva – a fluid secreted by the salivary glands. Saliva is mainly water, with small amounts of enzymes, mucus and antibacterial compounds. It contains the enzymes amylase that begins the chemical digestion of starch and lipase that breaks down fat.

Review Questions

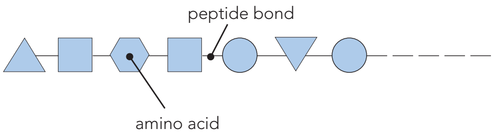
1. (i) Monosaccharides or simple sugars.
   (ii) Fatty acids and glycerol.
   (iii) Amino acids.

2.
(i)

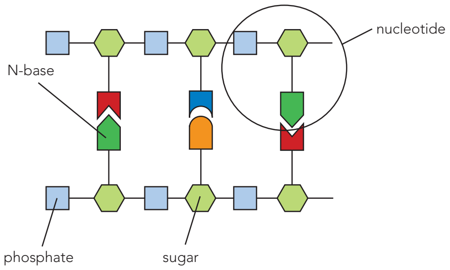


(ii)

(iii)



(iv)



3.
(i) a) incisor b) canine c) premolars d) molars
(ii) Mechanical digestion/physical digestion.
(iii) Physical digestion involves breaking the food into smaller pieces. The food is not chemically changed. Chemical digestion breaks large molecules into smaller molecules so that they can be absorbed through cell membranes more easily.
(iv) Physical digestion breaks food particles into smaller pieces so that it is easier to swallow and its surface area to volume ratio is increased. The increased surface area to volume ratio increases the efficiency and the rate of chemical digestion, as it exposes more of the chemically undigested food to the enzymes which break it down.
(v) The numbers on the top line refer to teeth on one half of the upper jaw (maxilla): 2 incisors, 1 canine, 2 premolars and 3 molars lower jaw.
The numbers on the lower line refer to teeth on one half of the lower jaw (mandible): 2 incisors, 1 canine, 2 premolars and 2 molars.

4.
(i) Mouth – the teeth masticate (chew) the food breaking it up into small pieces before the mouth and tongue roll it into a ball shaped bolus.
(ii) Stomach – churns the food through muscular contractions that further divides it into smaller pieces.
(iii) Small intestine – muscular contractions move the food backwards and forwards along the length (8 m) of the tube mixing bile and enzymes and forming segments in the food mass. Bile released by the gall bladder into the duodenum emulsifies the fats and oils.

5.
(i) Mouth – salivary amylase chemically digests some starch breaking it down to maltose.
(ii) Stomach – pepsin breaks down long chained proteins into polypeptides
(iii) Small intestine by pancreatic juice –
- pancreatic amylase breaks down starch into disaccharides
- trypsin break down proteins and polypeptides into peptides
- lipases breaks down lipids into glycerol and fatty acids
- nucleases breaks down DNA and RNA into nucleotides

(iv) Small intestine by intestinal juice –
- amylases break down disaccharides to monosaccharides
- peptidases break down peptides into amino acids
- lipases break down lipids into fatty acids and glycerol

6.
(i) Pepsinogen is inactive. It will therefore not digest (and destroy) the proteins of the gastric glands that produce it.
(ii) When pepsinogen enters the acidic environment of the stomach it is changed into pepsin, which then actively digests protein. (Similarly trypsin is produced as inactive trypsinogen.)
(iii) The intestinal lining is protected by a layer of mucus, which is also produced by the gastric pits.

7.
(i) Bile salts (byproducts of the breakdown of haemoglobin from old RBC's in the liver) mechanically digest fat, emulsifying it turning it into smaller droplets and therefore increasing its surface area to volume ratio. This makes the fats' chemical digestion by lipases more efficient.
(ii) Bile is produced in the liver and stored and concentrated in the gall bladder before it is released into the duodenum.

6.3 Absorption

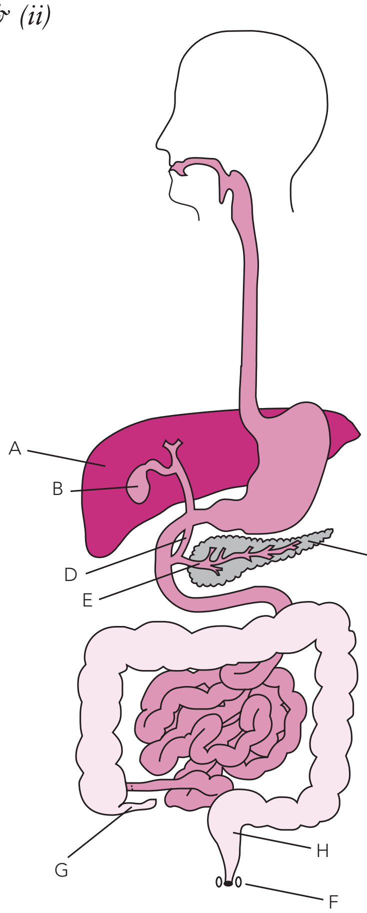
Terminology

(i) catabolic reaction – a chemical breakdown of complex molecules into simpler substances. This type of process gives out energy (cf. anabolic reaction).

(ii) *fatty acid – an organic compound consisting of C, H and O which may make up part of a lipid molecule.*
(iii) *hepatic portal vein – vein which transports blood carrying nutrients from the small intestine to the liver.*
(iv) *ileum – the last part of the small intestine.*
(v) *lacteal – lymphatic vessel that absorbs the products of fat digestion. Lacteals are found in the small intestinal villi.*
(vi) *monosaccharide – the basic building block of a carbohydrate; a simple sugar with only five or six carbon atoms in each molecule, e.g. glucose, fructose, galactose.*

Review Questions

1. *(i) & (ii)*



(iii) See next page.

2.
(i) *a) absorptive and secretory cells*
b) lacteal
c) intestinal gland
(ii) *In the small intestine from the duodenum to the last portion of the ileum.*
(iii) *They are about 1 mm long and being small and numerous increase the total surface area for the absorption of digested nutrients.*
(iv) *The capillaries absorb glucose, galactose, fructose and amino acids. The products of nucleic acid digestion – pentose sugars, nitrogen bases and phosphate ions are also absorbed by the capillaries.*
(v) *The lacteals absorb fatty acids and glycerol.*

3. *Most absorption takes place in the first half of the small intestine.*

4.
(i) *Diffusion is the passive movement of a substance from an area containing a high concentration of that substance to an area containing a low concentration of that substance.*
(ii) *Osmosis is the movement of a solvent (usually water) by diffusion through a differentially permeable membrane.*
(iii) *Active transport is the movement of a substance (e.g. glucose) across a cell membrane from a region of lower concentration to a region of higher concentration. This process requires energy normally provided by ATP.*
(iv) *Endocytosis is the process whereby a cell's membrane either folds inwards to absorb a fluid (pinocytosis) or protrudes outwards and engulfs a larger solid particle (phagocytosis).*

6.4 Elimination

Terminology

(i) *bacteria – microscopic organisms which have no membrane bounded organelles. Bacteria are classified as prokaryotes. Most bacteria are useful, many however are pathogens. (Singular is bacterium)*
(ii) *central nervous system – the brain and spinal cord*
(iii) *dietary fibre – nondigestible carbohydrates (e.g. cellulose) and lignin which are found in plants. Important as roughage to help avoid constipation.*
(iv) *involuntary – a muscle action or response that cannot be controlled by the will (or by conscious messages from the cerebrum).*
(v) *motor nerve – a nerve that carries impulses from the central nervous system to a muscle or gland.*
(vi) *receptors – special cells, tissues or organs which are sensitive to specific changes in the environment and react to that change, e.g. some nerve endings are sensitive to changes in temperature and when stimulated send impulses via sensory neurones to the central nervous system.*
(vii) *sensory nerve – a nerve which transmits impulses from receptors to the central nervous system.*
(viii) *stimulus – a change in the internal or external environment of the body which can be detected by it and induces a response.*

Review Questions

1.
(i) *Undigested plant fibre, cellulose, bacteria, water, intestinal secretions, cells that have sheared away from the lining of the intestine and bile pigments.*

1. *(iii)*

	FUNCTIONS	ENZYMES	ENZYME SOURCE	SUBSTRATE	PRODUCT
Mouth	• mastication – physical digestion • salivary glands secrete saliva – mixes with food – begins chemical digestion of starch	salivary amylase & lipase	three pairs of salivary glands	starch	maltose
Oesophagus	moves food (as bolus) from mouth to stomach by peristalsis				
Stomach	• mechanical digestion by muscular contractions of longitudinal, oblique and circular muscles produces chyme • beginning of protein digestion	• pepsin • rennin (infants)	gastric glands	• pepsin digests proteins • rennin coagulates milk	• polypeptides • coagulated milk
Small intestine	• muscular contractions of circular muscles mix enzymes and food • bile emulsifies lipids • enzymes complete the digestion of large organic molecule • absorption of small molecules (amino acids, fatty acids, monosaccharides, vitamins, minerals and water) occurs by diffusion and active transport	• pancreas releases amylase, trypsin, ribonuclease and deoxyribonuclease, lipases • intestinal glands release maltase, sucrase, lactase, peptidases and lipases and other enzymes	• pancreas • intestinal glands	• starch proteins RNA DNA lipids • maltose, sucrose, lactose, peptides, lipids	• maltose, peptides, nucleotides, fatty acids and glycerol • monosaccharides (e.g. glucose), amino acids, fatty acids and glycerol
Large intestine	• faeces collect here • salts, water and some vitamins (B complex and K) are absorbed or reabsorbed				

(ii) It stretches the wall of the colon and stimulates contractions.
(iii) More water is absorbed by the colon walls
(iv) The faeces become more solid in consistency. This results in constipation.
(v) Excretion is the removal of metabolic wastes from the body, which is the role of the kidneys and lungs mainly. Defaecation is the elimination of faeces, which is the role of the rectum.

2.
(i) Peristaltic contractions of muscles in the colon wall.
(ii) Sensory nerves send nerve impulses to the central nervous system.
(iii) Motor nerves send impulses from the central nervous system to muscles (and glands).
(iv) A sphincter muscle is a ring of circular muscle which contracts to close an opening. A good example is the pyloric sphincter which prevents chyme from leaving the stomach until it has been processed.
(v) The internal anal sphincters are under involuntary control, whereas the external anal sphincters are under voluntary (conscious) control.

3.
(i) They will no longer be stimulated and will stop sending impulses to the central nervous system.
(ii) These smooth muscles will no longer receive impulses via the involuntary motor nerves and will therefore relax.
(iii) The internal sphincter muscles will contract.
(iv) The external sphincter muscles will also contract.
(v) The walls of the rectum are stretched. This stimulus is detected by stretch receptors in the walls of the rectum.
(vi) Stage 7. The cerebrum makes a voluntary conscious decision to relax the external anal sphincter muscle.
(vii) The external anal sphincter muscle.

7: MUSCULOSKELETAL SYSTEM

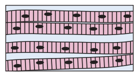
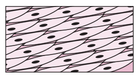
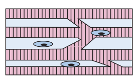
7.1 Structure and function of the muscular system

Terminology

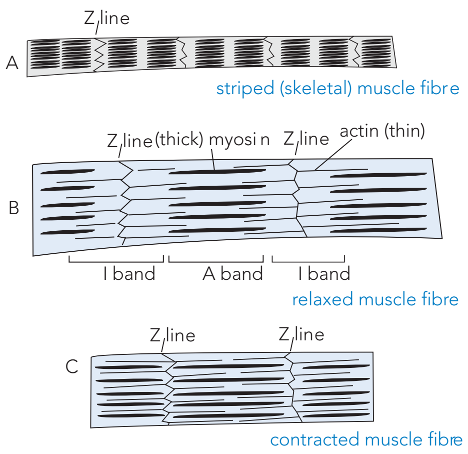
(i) agonist – a muscle which causes movement.
(ii) antagonist – term used to describe the opposite action of some muscles e.g. biceps and triceps.
(iii) insertion (of a muscle) – structure, often bone, which a muscle attaches to and moves.
(iv) ligament – an elastic tissue that joins bone to bone. It allows bending at joints.
(v) muscle – a body tissue capable of contraction (shortening) and relaxing.
(vi) origin (of a muscle) – structure, often bone, which a muscle attaches to but is fixed and stable. Usually this is at the proximal end of the muscle.
(vii) synergist – a muscle that helps another muscle to move a bone often by steadying a joint.
(viii) tendon – a connective tissue that joins muscles onto bones. It is inelastic. Shortening of a muscle pulls on the tendon resulting in the movement of bone.

Review Questions

1.

TYPE OF MUSCLE	LOCATION	DIAGRAM	RESULT OF ITS CONTRACTION
Skeletal (striated, voluntary)	Face, neck, arms, legs, trunk	Diagram of voluntary muscle 	Parts of the body move closer together e.g. the arm bends or further apart (as in extension)
Smooth (involuntary, unstriated)	Iris of the eye, stomach, gall bladder, intestines, bladder, uterus, arteries and veins	Diagram of Smooth muscle 	The space inside the structures it surrounds gets smaller e.g. pupil constricts; peristalsis occurs and food is moved down the digestive tract; the bladder empties
Cardiac	Heart	Diagram of cardiac muscle 	The spaces between the cells get smaller, the walls of the heart chambers move closer together and the heart empties blood into blood vessels.

2. actin and myosin.
3. The sliding filament theory refers to the movement of filaments past one another so that the overall muscle shortens in length. This requires energy (ATP). Finger-like projections on the thick myosin filaments form cross bridges with the thin actin filaments and pulls them over one another. This results in the I bands getting narrower and the A bands getting closer together. While the lengths of the actin and myosin filaments do not get shorter, the sarcomeres do. As all the sarcomeres shorten, the overall length of the muscle shortens too. This is muscle contraction in skeletal muscles.



4.
(i) muscles which have opposite effects (e.g. biceps and triceps)
(ii) tonus
(iii) b, c, d, e
(iv) a, b, e, f
(v) g
(vi) a

5.
(i) a) tendon
b) biceps
c) radius
d) ulna
e) humerus
f) triceps
g) scapula
(ii) 3
(iii) 4
(iv) Origins on the scapula, one near shoulder joint, other further towards central axis of body.
(v) three
(vi) biceps contract, triceps relax

6.
(i) d
(ii) in the forearm, along the radius and ulna

7.
(i) deltoid
(ii) shoulder (between humerus, scapula and clavicle)
(iii) ball and socket
(iv) because of the shape of the bones and the muscles which move this joint. The joint is also quite shallow.

8.
(i) Thumb and index finger
(ii) Precision
(iii) All
(iv) Four fingers (index, middle, ring and little) are wrapped around the object in one direction, the thumb is wrapped around it in the other direction.
(v) Power
(vi) Precision grip may be used to pick small berries or fruit from a tree or to remove a flea in grooming.
Power grip may be used for grasping a branch as in brachiating or a stick in defence.

9.
(i) Gluteus maximus – extends and rotates femur laterally (straightens hip and rotates femur sideways).
Hamstrings – flex leg at knee and extend the thigh backwards.
Gastrocnemius – extends foot at the ankle so toes point downwards.
Anterior tibialis – flex foot at the ankle so toes point up.
Quadriceps – extends knee and flexes thigh.
(ii) Quadriceps and anterior tibialis

7.2 Structure and function of the skeletal system

Terminology

(i) articulation – a joint , where bones (or skeletal cartilages) move in relation to one another.
(ii) cancellous bone – spongy less dense bone which is made up of many spaces often filled with red bone marrow and trabeculae (small needle-like rods of bone).
(iii) chondrocyte – a cartilage maintaining cell.
(iv) collagen fibres – a protein found in connective tissue that is relatively inelastic. It is found in the skin, tendons, bone and cartilage.
(v) compact bone – dense bone which is made up of Haversian systems or osteons.
(vi) foramen – an opening in bone through which blood vessels and nerves may pass.
(vii) Haversian system – the microscopic building block of compact bone. Each system contains a tube (called the Haversian canal) which contains blood vessels, lymph vessels and nerves. Each canal is surrounded by concentric layers of bone called lamellae. In spaces, called lacunae, found between the lamellae are osteocytes, the bone cells.
(viii) macroscopic – refers to the size of an object and means it can be seen with the naked eye.
(ix) osteocyte – a mature bone cell located in the small cavities called lacunae in bone.
(x) periosteum – membrane which covers the outer surface of the shaft or diaphysis of a long bone.
(xi) red marrow – located in the cancellous bone at the proximal ends of long bones and in the cavities of flat bones (e.g. sternum) and irregular bones (e.g. hip). These are the sites of blood cell formation.
(xii) synovial fluid – a clear fluid secreted by membranes in synovial joints. The fluid is, a lubricant.
(xiii) yellow marrow – found in the medullary cavity of long bones consists largely of fat storage tissue. It replaces much of the red marrow in an adult.

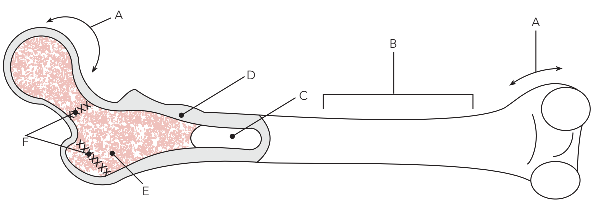
Review Questions

1. (i) *Reserve of minerals, e.g. calcium, phosphorous.*
   (ii) *Produces blood cells.*
   (iii) *Protects vital, soft organs.*
   (iv) *Muscle attachment enables movement.*
   (v) *Supports the body.*

2.
(i) a) *cranium*
b) *face*
c) *humerus*
d) *ulna*
e) *radius*
f) *femur*
g) *patella*
h) *phalanges*
i) *metatarsals*
j) *tarsals*
k) *fibula*
l) *tibia*
m) *phalanges*
n) *metacarpals*
o) *carpals*
p) *pelvis*
q) *ribs*
r) *sternum*
s) *scapula*
t) *clavicle*

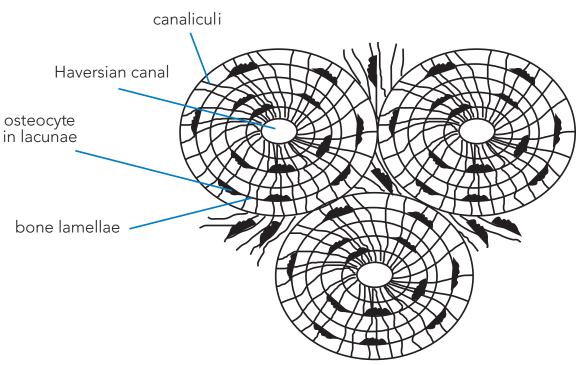
(ii) a) *The shoulder girdle – scapulas and clavicles.*
b) *The pelvic girdle – ilium, ischium and pubis (these are fused).*

3. (i) *(macroscopic view)*



A = epiphysis, B = diaphysis, C = yellow bone marrow, D = dense compact bone, E = spongy bone, F = epiphyseal (growth) line.

(ii) *(microscopic view)*

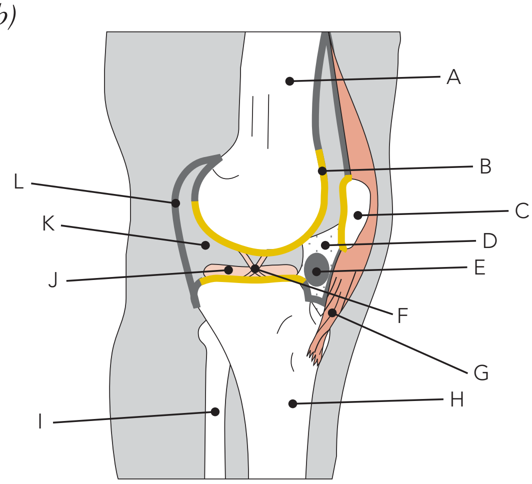


4.
(i) *At the ends of bones where they meet another bone, lining sockets of joints, the tip of the nose, the external ear, ribs and sternum.*
(ii) *To enable bones to move smoothly past one another, to cushion joints, e.g. between the vertebrae.*

5.

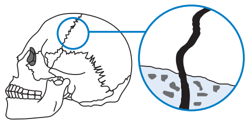
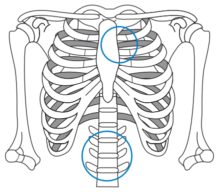
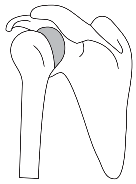
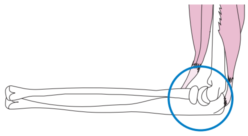
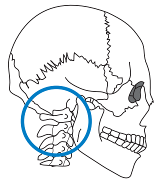
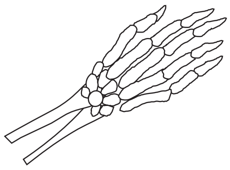
TYPE OF CARTILAGE	WHERE FOUND	FUNCTION
Hyaline	Ends of ribs and long bones, trachea, bronchi, nose, embryonic skeleton	Allows bones to move smoothly over one another by reducing friction, absorbs shock, support
Fibrocartilage	Between the vertebrae (intervertebral discs), knee, pelvis (pubic symphysis)	Support, rigidity
Elastic cartilage	Eustachian tubes, external ear	Support, shape

6.
(a) *These are freely moveable joints that have ligaments holding the bones together surrounded by a joint capsule lined with a synovial membrane and lubricated with synovial fluid.*
(b)



A	*Femur*	H	*Tibia*
B	*Articular cartilage*	I	*Fibula*
C	*Patella*	J	*Fibro cartilage (meniscus)*
D	*Bursa*	K	*Synovial fluid*
E	*Fat*	L	*Synovial (joint) capsule*
F	*Ligaments*		
G	*Patella ligament*		

7.

TYPE OF JOINT	DIAGRAM	WHERE FOUND IN THE BODY	POSSIBLE MOVEMENT IN THE JOINT
Immoveable		Skull (cranial and facial bones)	None once fused after birth. Immoveable
Cartilaginous		Between the vertebrae in the back bone, between first rib and the sternum, between the pubic bones – the pubic symphysis	Some flexibility
Synovial Ball and socket		Shoulder, hip	Freely moveable
Hinge		Elbow, knee, ankle	In one plane only
Pivot		Head on vertebrae; between radius and ulna of arm	One bone rotates on another
Gliding		Between carpel bones of wrist, or tarsal bones in the ankle	One flat, smooth surface moves over another

8: EXCRETORY SYSTEM

8.1 Structure and function of the excretory system

Terminology

(i) *abdominal cavity – space below the diaphragm and bounded on other sides by the abdominal wall and the vertebrae. It is filled with the liver, stomach, intestines, kidneys, bladder, ovaries, uterus and several other organs.*

(ii) *cortex – the outer part of an organ, e.g. kidney cortex*

(iii) *medulla – the inner part of an organ, e.g. adrenal medulla*

(iv) *metabolic waste – the products of metabolic activity which are not useful to the cells, e.g. urea, CO_2. They must be excreted as they may become toxic if allowed to accumulate in the body.*

(v) *micturation – the voiding of urine from the bladder via the urethra.*

(vi) *renal – associated with the urinary system, e.g. renal artery*

(vii) *sweat gland – exocrine gland that produces a combination of water, urea and organic salts which is secreted onto the skin. Sweat is produced in order to lose heat. Often called perspiration.*

(viii) *toxic – a chemical acting as a poison.*

(ix) *urethra – the tube that runs from the bladder to outside the body.*

(x) *ureter – the tube that carries urine from the kidney to the bladder.*

(xi) *urinary bladder – the internal storage organ for the retention of urine until it is released during micturation.*

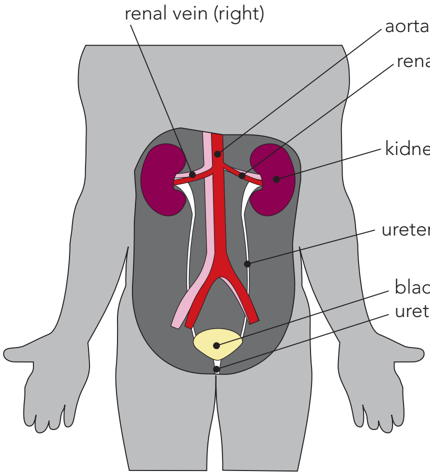
(xii) *urine – the liquid waste produced by the kidneys. Urine generally contains water, urea, uric acid, excess minerals, salts and hormones.*

Review Questions

1. *Excretion means the removal of metabolic wastes from the body.*
2. *Wastes, if allowed to accumulate in the cells and blood, become toxic, interfering with normal metabolic processes and therefore may cause illness and death.*

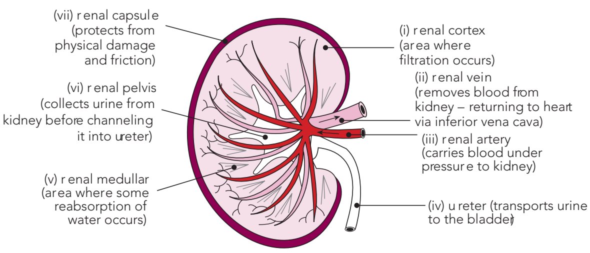
3.
(i) Provide a surface for the excretion of carbon dioxide which is a major metabolic waste.
(ii) Secrete water with some traces of urea, uric acid, salts, amino acids and ammonia. These glands have a minor excretory role.
(iii) Except for the excretion of bile salts, the alimentary canal has no role in excretion. It does have a major role in defaecation.
(iv) Filter many metabolic wastes and excrete large amounts of urea.
(v) Breaks down excess amino acids in a process called deamination. The amino acids, which cannot be stored in the body, are combined with oxygen to form a carbohydrate and ammonia. The ammonia, which is highly toxic, is then combined with carbon dioxide to form urea and water. These two processes occur in the liver.

4.



5.
(i) Contains larger concentration of urea, glucose, oxygen, water, amino acids, proteins, hormones, minerals and antibodies.
(ii) Much smaller concentrations of urea, less oxygen, water, amino acids, smaller proteins, hormones, some minerals, antibodies and glucose.
(iii) High concentration of urea (and other nitrogenous wastes), water, small molecule hormones, some minerals, some amino acids.

6.



8.2 Deamination

Terminology

(i) ammonia – a very toxic substance produced as a waste product of the deamination of amino acids in the liver.
(ii) glycogen – a polysaccharide consisting of a long chain of glucose molecules. Humans store glucose as glycogen in liver and muscle cells.
(iii) protein – an organic compound containing C, H, O, N and sometimes S. Proteins are made of long chains of amino acids joined by peptide bonds. They make up many structures and enzymes in all cells.
(iv) respiration – the breakdown of organic matter (usually glucose) in cells to release energy.
(v) urea – a nitrogenous waste formed in the liver.

Review Questions

1. Urine is the fluid produced by the kidneys. It contains excess water and other substances such as urea, creatinine, uric acid and inorganic ions such as sodium, potassium, chloride, sulphates, phosphates, ammonium, magnesium and calcium (approximately 96% water, 2% urea and 2% salts).

2.
(i) Urea is a nitrogenous waste formed in the liver. Deamination of amino acids produces the highly toxic substance ammonia. Carbon dioxide combines with ammonia to form the much less poisonous urea. This is a soluble salt of small molecular size which is easily transported in the blood.
(ii) Carbon, oxygen , nitrogen and hydrogen.
(iii) Urea is a relatively small organic compound that is soluble in water. Being small and soluble in water enables urea to be carried readily, dissolved in the blood plasma and filtered in the nephron's glomerulus so that it is easily removed.

3.
(i) Deamination is the breakdown of excess amino acids in the liver. This involves the removal of the amino group of atoms (NH_2) from the amino acid. Ammonia (NH_3) is formed. It is converted to urea $CO(NH_2)_2$, for excretion.
(ii) Proteins and amino acids cannot be stored in the body.
(iii) Ammonia is highly toxic, urea is less toxic.
(iv) As the concentration of urea increases it becomes more toxic; because it is alkaline this negatively affects the function of enzymes. It must therefore be excreted.
(v) Part of the amino acid molecule can be used to form glucose or fat and become a source of energy.
(vi) Excess glucose is converted to glycogen; this may be stored in the liver (or muscles).
(vii) The carbon is derived from CO_2 which combines with ammonia to form urea.

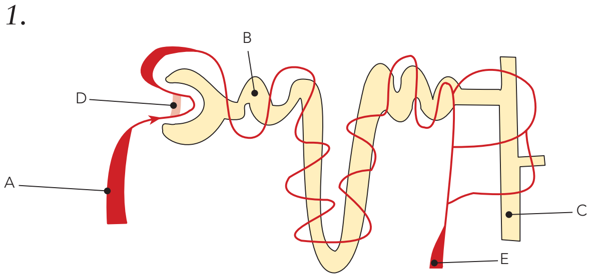
8.3 The nephron

Terminology

(i) *active transport – the movement of a substance (e.g. glucose) across a cell membrane from a region of low concentration to a region of high concentration. This process requires energy.*
(ii) *afferent arteriole – a small artery which directly services the glomerulus of the nephron.*
(iii) *collecting duct – a small tube in the kidney into which urine drains from several nephrons.*
(iv) *convoluted tubule – a tube with many bends which add internal and external surface area to it length.*
(v) *diffusion – the passive movement of particles from an area of high concentration to an area of low concentration.*
(vi) *efferent arteriole – a small artery which carries blood from the glomerulus of the nephron to the peritubular capillary network.*
(vii) *filter – a layer which functions to separate smaller molecules and ions from larger ones.*
(viii) *filtrate – the liquid with dissolved molecules and smaller suspended particles that passes through a filter.*
(ix) *osmosis – the movement of a solvent (usually water) by diffusion through a semi-permeable membrane.*
(x) *peritubular capillary network – capillaries that encircle the proximal convoluted tubule, loop of Henle, distal convoluted tubule and collecting duct of a nephron.*
(xi) *tubular secretion – the active secretion of ions from the peritubular capillaries into the tubules of the nephron. This occurs when certain excess ions, natural poisons and drugs are in the plasma ; includes H^+, which therefore reduces the acidity of the plasma.*

Review Questions

1.



(i) *Renal artery → afferent arteriole → glomerulus → efferent arteriole → peritubular capillary network → venule → renal vein.*
(ii) *Renal artery → afferent arteriole → glomerulus → glomerular capsule → proximal convoluted tubule → peritubular capillary network → venule → renal vein.*
(iii) *Renal artery → afferent arteriole → glomerulus → glomerular capsule → proximal convoluted tubule → loop of Henle → distal convoluted tubule → collecting duct → renal ureter.*
(iv) *Each pathway is different because of the size of the molecule, whether it moves through membranes easily and whether or not it is required by the body.*

2.
(i) *The concentration increases.*
(ii) *As a large amount of water is pushed into the glomerular capsule, the concentration of substances left behind (like large proteins) is therefore increased.*
(iii) *Large proteins are molecules which cannot physically fit through the pores or between the lipids in the membranes.*
(iv) *It is reabsorbed back into the blood plasma in the peritubular capillaries.*
(v) *Glucose is a much smaller molecule.*
(vi) *Some glucose is used by the tubular cells (for example in active transport).*
(vii) *Active transport.*
(viii) *Concentration of urea at point D is high because little urea is reabsorbed into the blood. Most of the water is reabsorbed so the concentration of urea is increased (proportionately).*

3.
(i) *The process whereby smaller molecules move from the blood plasma in the glomerulus into the glomerular capsule.*
(ii) *The fluid that collects in the glomerular capsule.*
(iii) *When molecules return from the filtrate back into the blood plasma in the peritubular capillary. This occurs by diffusion or active transport.*
(iv) *Water absorption which occurs passively in the proximal convoluted tubule and the loop of Henle.*
(v) *Where molecules and ions are secreted by the tubular cells into the filtrate as a way of actively eliminating excess or toxic substances.*

4. *If the nephrons were diseased or damaged the kidneys may no longer be able to remove wastes like urea from the blood. The wastes may accumulate and case serious ill health. The regulation of water levels in the blood (osmotic pressure) may also be affected and adversely change the body's metabolism.*

5.
(i) *At the end nearest the glomerular or Bowman's capsule, where the glucose concentration in the tubule is higher than its concentration in the peritubular capillary, glucose moves out of the tubule and into the blood by passive diffusion. The glucose concentration decreases as it moves along*

the tubule until it will no longer diffuse back into the blood where the concentration has reached a similar level. Further reabsorption, against a concentration gradient, requires active transport.

(ii) Either the person has been eating excessive amounts of glucose or food containing sugar or they have developed a disease such as diabetes.

(iii) Glucose is an essential nutrient. The brain's only source of energy is glucose. If there is an excessive amount of glucose in the blood, the body will store it first as glycogen in the liver and muscles then, when those areas are filled, as fat in adipose tissue.

(iv) If all the water was reabsorbed the urea would become solid. It would be more toxic to the tubular cells in this concentrated form and would not move through the tubules.

9: SCIENCE AS A HUMAN ENDEAVOUR 1

Terminology

(i) agglutination – the clumping together of cells in an antigen – antibody reaction.

(ii) antibody – a protein (immunoglobulin) produced by lymphocytes in response to the presence of an antigen. It is released into the blood stream.

(iii) antigen – a foreign substance, often a protein, which is not produced by the body. Its presence stimulates the production of antibodies.

(iv) diagnosis – a medical procedure used to determine the presence of a disease.

(v) dysfunctional – describes a part that does not work.

(vi) erythrocyte – red blood cell. A small biconcave disc shape cell, lacking a nucleus and therefore with a limited "life span". Carries oxygen in blood.

(vii) hygiene – activities that promote the preservation of good health.

(viii) hypertension – high blood pressure.

(ix) osteoarthritis – the breakdown of cartilage, usually due to wear and tear, in joints which may cause pain, stiffness and swelling.

(x) osteoporosis – a loss of calcium from the bones, making fractures more likely. It is most common in post-menopausal women.

(xi) transfusion - the introduction of blood, serum or isotonic saline solution into a person's blood. Most often used to replace lost blood.

(xii) therapy – the treatment of a disease which has the potential to improve or cure the condition.

Review Questions

1. Excessive bleeding as a result of surgery or an accident. If the blood volume is too low to effectively carry oxygen to the body cells. Also in some cases of severe anemia and when the blood has too few platelets.

2. The donated blood must match the recipient's blood type. If they are different there is a possibility of complications, especially the donor blood cells clotting, which causes thrombosis in the recipient.

3. (i)

BLOOD GROUP	ANTIGEN/S ON RBCS	ANTIBODIES IN PLASMA	CAN RECEIVE BLOOD TRANSFUSION FROM GROUP/S	CAN DONATE BLOOD TO GROUP/S
A	Antigen A	Anti-B	A and O	A and AB
B	Antigen B	Anti-A	B and O	B and AB
AB	Antigen A and Antigen B	Neither	A, B, AB and O	AB
O	Neither	Antibody A and Antibody B	O	A, B, AB and O

(ii) Group O can donate blood to all the other groups.

(iii) Group AB can receive blood from the other groups.

4.

(i) Rh^+ (Rh positive) refers to another antigen on RBC's called the Antigen D. A person who does not have this antigen is referred to as Rh^- (Rh negative). The Rh^+ person does not have Anti-D in their plasma whereas the RH^- has Anti-D in their plasma.

(ii) Unless the Rh negative person has been exposed to the Rh antigen before, they will not have developed antibodies (Anti-D). The donor's blood will be dispersed in the recipient without clotting. However, antibodies will be produced by the Rh negative person and subsequent transfusions of Rh positive blood will cause problems.

(iii)

BLOOD GROUP	CAN RECEIVE BLOOD TRANSFUSION FROM GROUP/S	CAN DONATE BLOOD TO GROUP/S
A Rh^-	A Rh^-, O Rh^-	A Rh^-, A Rh^+, AB Rh^-, AB Rh^+
A Rh^+	A Rh^+, A Rh^-, O Rh^-, O Rh^+	A Rh^+, AB Rh^+
B Rh^-	B Rh^-, O Rh^-	B Rh^-, B Rh^+, AB Rh^-, AB Rh^+
B Rh^+	B Rh^+, B Rh^-, O Rh^-, O Rh^+	B Rh^+, AB Rh^+
AB Rh^-	AB Rh^-, A Rh^-, B Rh^-, O Rh^-	AB Rh^-, AB Rh^+
AB Rh^+	AB Rh^+, A Rh^-, A Rh^+, B Rh^-, B Rh^+, AB Rh^-, O Rh^-, O Rh^+	AB Rh^+
O Rh^-	O Rh^-	O Rh^-, A Rh^-, A Rh^+, B Rh^-, B Rh^+ AB Rh^-, AB Rh^+, O Rh^+
O Rh^+	O Rh^+, O Rh^-	O Rh^+, AB Rh^+, B Rh^+, A Rh^+

5. *Some of the foetus's Rh positive blood is likely to leak into the mother's blood. Her system will produce Anti-D antibodies. These can move across the placenta and attack the foetus's red blood cells causing serious anemia in the foetus. Subsequent pregnancies are likely to be more problematic as she will already have antibodies in her blood.*

6.

(i) *Early diagnosis of dementia can provide the following benefits:*

- *it enables the patient to adjust to and understand the problem. Their family can also plan for the future and learn how to best assist the patient.*
- *it enables the possible cause of the dementia to be identified. It may be due to diet or to medications. In these cases early treatment can begin.*
- *it allows the patient and their family to make sure that other medications for existing medical conditions are continued and not forgotten as memory loss can result in their neglect.*
- *in the case of Alzheimer's disease it allows medications to be given quickly. It is believed that this may in some cases slow the decline.*

(ii) *Physical therapy*
Physiotherapists often assist people who have had strokes to regain the use of skeletal muscles. This is particularly important in helping those who have lost the ability to walk, regain the use of their legs and become mobile again.

(iii) *Removal and/or replacement of affected parts.*
One of the most successful transplanted organs is the kidney. A diseased or dysfunctional kidney can be removed and replaced by one from a living or deceased donor whose tissues match those of the recipient.

7.

	OSTEOPOROSIS	OSTEOARTHRITIS
possible causes	Bone tissue and minerals are lost faster than the bone is replaced. This is influenced by oestrogen (in women) as well as by the levels of calcium and vitamin D. It frequently develops with menopause	Cartilage in joints breaks down. This can be due to repetitive movement, wear and tear or begin as the result of an injury.
resulting disabilities	Bones can break more readily than normal. Back pain is also common.	Aching joints following physical work or exercise. Pain, swelling and inflammation after exercise, stiffness after rest, sounds of bones rubbing in a joint. The pain may make movement very difficult.
prevention	Appropriate intake of calcium and Vitamin D. Weight bearing exercises help strengthen bone. Avoid excessive alcohol and smoking as these also contribute to the development of this disease.	Maintainenance of a correct body weight through regular exercise and good diet. Avoidance of repetitive stress on the joints and where possible avoidance of activities that may cause injury to joints.
management	Medications may be used to treat some cases of osteoporosis. Increased calcium and vitamin D. intake and exercise may also be recommended.	A combination of exercise, lifestyle modification (especially weight reduction) and analgesics. If the pain becomes extreme, joint replacement may be carried out.

8. *People are living longer. Less people are dying from infectious diseases, e.g. tuberculosis, and therefore diseases associated with ageing are becoming more frequent in the population. This is due to modern medicines, including vaccines, better health including less smoking and better diet and exercise, especially when young.*

9. *Persistent high blood pressure.*

10.

(i)
- *diet - high salt, saturated fat and cholesterol*
- *obesity*
- *age (signs often appear after 40 years)*
- *heredity*
- *stress*
- *smoking*

(ii)
- *reduce salt, fat and cholesterol intake*
- *lose weight*
- *reduce/stop smoking*
- *manage stress more effectively*
- *antihypertensive drugs*

11. *Atherosclerosis is the laying down of fatty deposits inside the lumen, which can lead to blockage and hardening of arteries.*

Arteriosclerosis is laying down of calcium deposits in lumen (the build up of these deposits can cause a blockage and hardening of arteries).

12.

(i) *Smoking*

Physiological effects –

- *Nicotine constricts bronchioles.*
- *CO binds to haemoglobin and reduces the oxygen carrying capacity.*
- *Smoke causes more mucus secretion in the bronchi.*
- *Tracheal and bronchial cilia are inhibited.*
- *Loss of elasticity of lungs and development of emphysema.*

Resultant Cardiovascular Disease – *Hypertension which may result in arteriosclerosis*

(ii) *Lack of exercise*

Physiological effects –

- *Reduced cardiovascular output.*
- *Reduced levels of oxygen delivery to body tissues.*
- *Reduced rate of metabolism, higher cholesterol in blood, higher blood pressure.*

Resultant Cardiovascular Disease *- Reduced metabolism results in obesity and together with raised cholesterol levels may lead to greater incidence of atherosclerosis.*

(iii) *Poor diet e.g. high intake of fats*

Physiological effects –

- *Less cholesterol is lost.*
- *Liver uses saturated fats to produce cholesterol.*

Resultant Cardiovascular Disease *– High cholesterol promotes fatty plaques growing in the arteries. The lumen gradually narrow reducing blood flow and encouraging blood clots.*

(iv) *Stress*

Physiological effects –

- *Raises blood pressure and breathing rate and increases blood flow to muscles at the expense of other organs (e.g. digestive system).*

Resultant Cardiovascular Disease – *Hypertension, congestive heart failure.*

13. ***Exercise*** *– reduces osteoporosis, increases muscle, tendon and ligament strength and improves joint flexibility, improves strength of heart muscle and delivery of blood to tissues, maintains healthy lungs.*

Diet *– control amount of food eaten to avoid obesity, eat food with adequate fibre to assist peristalsis in intestines, reduce the amount of animal fats eaten.*

Alcohol *- drink in moderation, if at all.*

Smoking *- avoid smoking to reduce the likelihood of developing lung cancer, cardiovascular disease and emphysema.*

Salt *– reduce salt intake to avoid hypertension.*

14.

(i) *This means keeping our bodies clean, taking care not to infect others with diseases we may have and taking precautions not to contract infections.*

(ii) *Washing hands after going to the toilet, handling tampons, before eating, cooking or handling food, after being near someone who has a cough or a cold and after handling pets.*

(iii) *Change tampons and sanitary napkins four to five times per day and wash hands before and after changing. Avoid soaps which irritate the vaginal skin as this may make infections such as thrush more likely. Urination after sexual intercourse can flush out bacteria in the bladder and urethra which can cause cystitis.*

(iv) *Men who are uncircumcised should roll back the foreskin and clean underneath with mild soap and plenty of water.*

15.

(i) *Synthetic compounds which are similar to testosterone.*

(ii) *Yes; they are sometimes prescribed by doctors for men who have abnormally low testosterone levels. They may also be used to treat some forms of anaemia.*

(iii) *Occasionally people who are attempting to improve performances in sport or produce a more muscular body shape use them illegally (as they need to be prescribed by a doctor).*

(iv) *Loss of hair, severe acne. Males may develop enlarged breasts, testicles may reduce in size, reduced sperm production. Females may become more masculine – voice deepens, increased body hair (including facial). If the adolescent using anabolic steroids has not stopped growing, the use of these drugs may cause the body to stop growing prematurely. Kidneys and liver may become cancerous, heart attacks and strokes due to increased atherosclerosis. Anabolic steroid abuse may also weaken the immune system leading to a greater susceptibility to disease. Steroid abuse may also cause depression and violent behaviour.*

10: SCIENCE INQUIRY SKILLS 2

Terminology

(i) *anti vivisection – opposed to the use of live animals for scientific experiments.*

(ii) *ethics – using moral principles to evaluate conduct.*

(iii) *experimental control – an experiment which is set up in order to compare its results with that of the experiment. It is conducted in exactly the same way except that the independent variable is not changed.*

(iv) karyotype – the total number and general appearance of chromosomes within the nucleus of a cell at metaphase.
(v) peer review – a procedure in which experts in the same field of research examine and evaluate the work (e.g. the experimental procedure and conclusions) of a fellow scientist.
(vi) prediction – what you expect to happen if the hypothesis is supported.
(vii) primary data – data collected directly by researchers from experiments conducted themselves.
(viii) qualitative data – data which has no numerical values associated with it, e.g. to describe the production of heat energy by active animals as high is to assign a qualitative value to the production.
(ix) quantitative data – data which has numerical values, e.g. to express the heat energy released by an organism as 15 J/hour is to assign a quantitative value to this variable.
(x) reliable data – data that are consistent; results are the same or similar each time the procedure or experiment is done.
(xi) valid data – results obtained from an experiment that is testing what it is supposed to test and that is properly controlled.
(xii) variable – a factor which can change. e.g. temperature.

Review Questions

1. Scientific methodology uses controlled experiments which are designed to test hypotheses in seeking the truth.

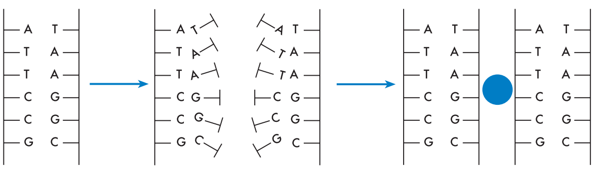
2.
(i) A hypothesis is a testable, educated guess put forward to explain an observation, whereas a prediction is an educated guess as to what might happen in the future (usually based on a hypothesis).
(ii) A person who is under stress is more likely to become ill.
(iii) If a person lives a more stress-free lifestyle then she is less likely to require medical assistance during her lifetime.
(iv) a) dependent variable: medical assistance.
b) independent variable: lifestyle

3.
(i) Collect data from the population; compare the incidence of lung cancer in a group chosen at random which does not smoke with the incidence of lung cancer in a similar group which does smoke.
(ii) A significantly greater percentage of people who smoke develop lung cancer than those who do not smoke.
(iii) The percentage of people who develop lung cancer in the group who do not smoke is the same or significantly greater than in the group of people who do smoke.

4.
a) Title: Describes very briefly, the nature of the research.
b) Aim: Describes why the experiment is to be conducted – may include a hypothesis to be tested.
c) Materials: Details what equipment and resources are needed to carry out the investigation.
d) Procedure: Lists the steps needed to conduct the investigation. Details of controls used are also given.
e) Results: Clearly presents the data collected using tables and/or graphs to display findings.
f) Conclusion: Provides analysis of the results, including an assessment of whether or not the hypothesis is supported.
g) References: This lists resource materials that may have been used/quoted in the text of the report.

5.
(i) The sequence of nitrogenous bases in DNA is important because it determines the type of proteins for which the DNA molecule codes. Using this code the cell can synthesis proteins that determine its structure and metabolism.
(ii) A gene.
(iii) A DNA molecule is a double strand of thousands of nucleotides. The strands are held together by weak hydrogen bonds between matching base pairs. The structure is ladder-like with the rungs consisting of matching base pairs i.e. A-T and C-G. The sides of the ladder consist of alternative phosphate and deoxyribose sugar molecules. The sugar molecule is attached to the nitrogen base in each nucleotide. The structure coils to form a double helix. The DNA molecule wraps around protein molecules called histones forming a long chain with beads along its length. The combination of DNA and histone molecules makes up a chromosome.

6.



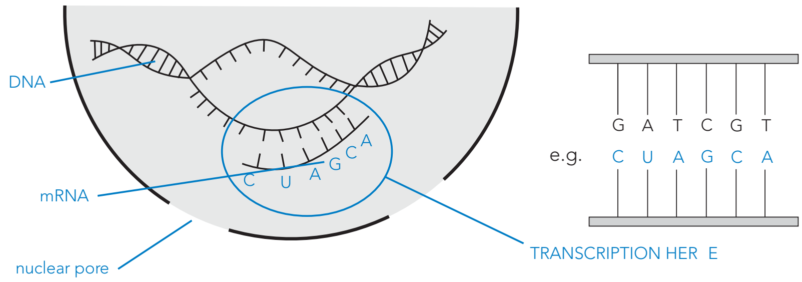
a) b) c)

7.
(i) See next page.
(ii) A peptide bond
(iii) The diagram would be very big. It would need at least 100 amino acids (proteins generally have more than 100). Therefore there would need to be over 100 codons – over 300 bases shown on each mRNA molecule and over 100 tRNA molecules.

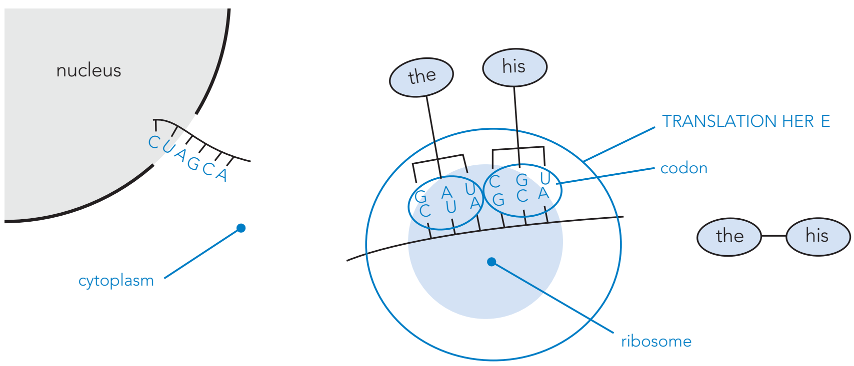
7.
(i)

Protein synthesis has two stages.

Stage 1:



Stage 2:



8. *(i)*

	A	a
A	AA	Aa
a	Aa	aa

(ii) Prob. (child has genotype AA) = 0.25
Prob. (child has genotype Aa) = 0.5
Prob. (child has genotype aa) = 0.25

(iii)
P (child is homozygous dominant, AA) =0.25
P (child is heterozygous, Aa = 0.50
P (child is homozygous recessive, aa) =0.25
Therefore, P (child has normal pigmentation) = 0.75 and P (child is albino) = 0.25

9.
(i) The total number and general appearance of chromosomes within the nucleus of a cell at metaphase.

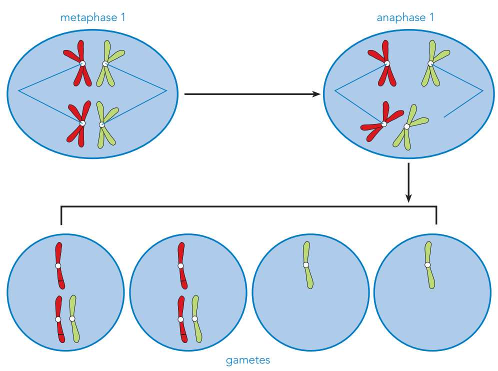
(ii)
- *cells are fixed and stained during cell division – mitosis*
- *chromosomes undergoing metaphase when fixed are photographed.*
- *chromosomes are cut from the micrograph*
- *chromosomes matched in their homologous pairs, based on their length and position of their centromere.*

(iii) Karyotypes may be used to determine whether there are serious genetic abnormalities in the number of chromosomes and if there are parts of chromosomes that are missing or present where they should not be present.
- *Amniocentesis is used to collect foetal cells from which Karyotypes can be seen. The normality of the foetus for some conditions can then be determined.*

(iv)
- *there are 23 pairs of chromosomes.*
- *they all appear to be complete with no added pieces.*
- *last pair (XY) indicates that the karyotype is that of a male.*

10.
(i)
a) The karyotype has an extra chromosome number 21 – giving it three chromosomes instead of the normal two.
b) This Karyotype is the same in every other respect. It is that of a male person with twenty one other pairs of autosomal chromosomes that are normal.

(ii)



The homologous chromosomes are not separated by their spindles at anaphase during the first division of meiosis (or in some cases the chromatids are not separated in the *second division of meiosis). This results in some gametes having an extra chromosome (or part of a chromosome) and some gametes missing a chromosome (or missing part of a chromosome).*

(iii) *During anaphase 1 (or occasionally anaphase 11) of meiosis*

(iv) *The extra chromosome number 21 (or a part of chromosome 21) gives rise to Down Syndrome.*

11: DNA

11.1 DNA

Terminology

(i) *base pair – two nucleotides that pair in DNA or RNA, e.g. C with G, T or U with A.*

(ii) *chromosome – chromatin which has shortened and thickened ("condensed") to become visible (with the aid of a microscope) as a separate body during cell division.*

(iii) *complimentary DNA strand – a single strand of DNA which has nucleotides along its length that compliment those on another single DNA strand.*

(iv) *DNA replication – a process that involves the splitting or 'unzipping' of a DNA molecule along it entire length and the movement of free nucleotides onto the exposed nitrogen bases so that two identical copies of the original DNA are formed. Normally occurs in the early stage of interphase.*

(v) *histone – protein which together with a DNA molecule makes up a chromosomes. DNA is wrapped around these protein molecules.*

Review Questions

1. *A – Nitrogenous base*
   B – phosphate group
   C – ribose sugar.
2. *(i) nucleotide (ii) found in nucleoplasm.*
3. *Cytosine, guanine, adenine, thymine.*
4. *If A is cytosine*
   Then B is guanine
   If C is thymine
   Then D is adenine
5. *The sequence of nitrogenous bases in DNA is important because it provides a code which determines the sequence of amino acids in the proteins the cell can synthesise.*
6. *Nucleus and mitochondrion.*
7. *Mitochondrial DNA directs the production of several enzymes which are needed in cellular respiration.*
8. *(i) The ovum.*
   (ii) The nucleus and the mitochondria.
   (iii) The mother.

11.2 Protein synthesis

Terminology

(i) *anticodon – three nitrogenous bases alongside each other on a tRNA molecule. The anticodon pairs with a matching codon of three nitrogenous bases on the mRNA molecule during protein synthesis.*

(ii) *codon – three nitrogenous bases on the mRNA molecule that code for a particular amino acid.*

(iii) *mRNA – a single strand nucleic acid formed in the nucleus of a cell which carries a code from a DNA molecule through a nuclear pore to a ribosome and from which a particular protein molecule is assembled according to the code which it carries.*

(iv) *ribosome – an organelle, which is either attached to endoplasmic reticulum or free in the cytoplasm, on which protein synthesis occurs.*

(v) *tRNA – transfer RNA, a nucleic acid which transports free amino acids in the cytoplasm to the ribosomes where the amino acids are linked to form proteins. Specific tRNA molecules lock onto each amino acid and transport it to a particular part of the mRNA, on the ribosome, which has a codon matching the anti-codon on the tRNA.*

(vi) *transcription – the copying of part of a DNA molecule by the formation of mRNA. This occurs in the nucleus and is the first main stage in protein synthesis.*

(vii) *translation – the process in which tRNA carry amino acids to the mRA on the ribosome, where the amino acids are joined using peptide bonds so that a particular protein is synthesised according to the DNA code. This is the second main stage in protein synthesis.*

Review Questions

1. *enzymes (biological catalysts); structural components of the body (such as muscles, hair); some hormones; haemoglobin in red blood cells; antibodies; carrier proteins involved in facilitated diffusion and active transport of substances through the cell membrane.*
2.

(i) *Deoxyribonucleic acid, Ribonucleic acid*

(ii) *DNA is a twisted ladder shape – a double helix. The backbone of the ladder is made up of alternative deoxyribose sugar molecules and a phosphate molecule. Between each pair of sugar molecules is a pair of nitrogenous bases, forming the 'rungs' of the ladder. These bases bond in a particular way- always adenine and thymine together, guanine and cytosine together. The group composed of a deoxyribose sugar molecule, a phosphate* *group and a nitrogenous base is known as a nucleotide. DNA is found as chromosomes in the nucleus of a eukaryotic cell and in mitochondria, or in the cytoplasm of a prokaryotic cell. It is capable of replication and is a more stable molecule than RNA.*

RNA is made up of a single strand of nucleotides. Each nucleotide consists of a ribose sugar molecule, a phosphate group and a nitrogenous base (adenine, guanine, cytosine or uracil).

(NOTE: uracil replaces thymine). RNA is found in the nucleus, cytoplasm and in ribosomes.

3. *(See next page).*

4.

TRANSCRIPTION	TRANSLATION
• occurs inside the **nucleus**. • is the process that copies the code on part of the **DNA** onto a strand of mRNA. • the **DNA** molecule unwinds and one strand of the helix is used as a template. • an enzyme (DNA **polymerase**) joins **nucleotides** together to form a strand of messenger-RNA. • the sequence of bases on mRNA is complimentary to the sequence of bases on the strand of **DNA**.	• occurs in the **cytoplasm**. • is the process in which **amino** acids are assembled to form proteins. • **mRNA** leaves the nucleus and moves into the cytoplasm. • mRNA attaches onto a **ribosome**. • the anticodon on **tRNA** attaches to the **codon** on the mRNA. • the amino acids from the tRNA are linked together to form the amino acid chain or **protein**.

5. *It is a triplet because three bases specify each amino acid. It is degenerate because most of the 20 possible amino acids are determined by more than one codon.*

6.

(i) (a) met(START)- his- gly- lys- ile- leu- asp- STOP

(b) gly-his-ile-val-ile-STOP

(ii)

STRAND OF DNA THAT IS 'READ'	TRANSCRIBED mRNA STRAND	tRNA ANTICODONS
G	C	G
G	C	G
G	C	G
T	A	U
A	U	A
G	C	G
T	A	U
T	A	U
A	U	A

(iii) pro – ile – asp (Remember: read the code from the mRNA!)

11.3 Epigenetics

Terminology

(i) epigenome – changes to the genome that do not involve any change in the nucleotide sequence, e.g. DNA methylation and histone modification

(ii) genome – one complete set of chromosomes and their genes.

(iii) inheritable – describes a trait or characteristic that can be passed down from parent to offspring through parental genes or genetic tags.

(iv) methyl group – a chemical group ($-CH_3$) which can attach to nucleotides (where cytosine is directly followed by guanine) on the DNA molecule and affect translation.

(v) nucleosome – a short length of DNA and a histone unit (made up of 8 proteins).

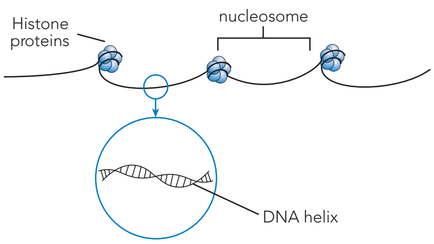
Review Questions

1. *Every cell in an organism is identical genetically but only some of the genes are active in a specific cell type. The end result of the active gene(s) is the "expression" of the gene(s) and determines the function (phenotype) of that cell. E.g. bone cells produce bone cells, liver cells produce liver cells, etc. Consequently, the phenotype of organism is the total sum of all the gene activity of that organism.*
2. *Mutation and disease.*
3. *Epigenetics is a developing area of research because it may be implicated in the development of cancer, human embryology, diseases such as obesity, heart disease and diabetes, and these diseases may be inherited.*
4.

(i) The effect of ultraviolet light on melanin production

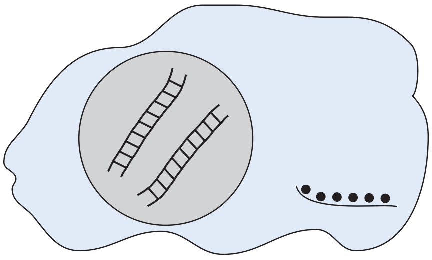
(ii) The effect of diet on adipose tissue

5. *Melanocytes are cells in the skin that produce melanin, a pigment that gives the skin its colour. When skin is exposed to sunlight, the ultraviolet light in it stimulates the melanocytes to produce melanin pigment. This then absorbs the UV light and protects the cells.*
6. *The DNA molecule is wound around clusters of 8 histone molecules as shown. This forms a long chain that resembles a necklace of beads.*



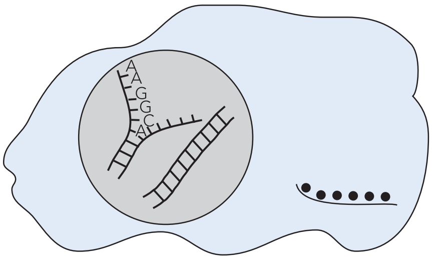
3.

(a)



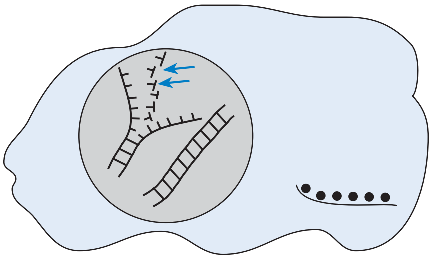
Chromosomes are in their normal condition in the nucleus. Ribosomes are located on endoplasmic reticulum (or free in the cytoplasm).

(b)



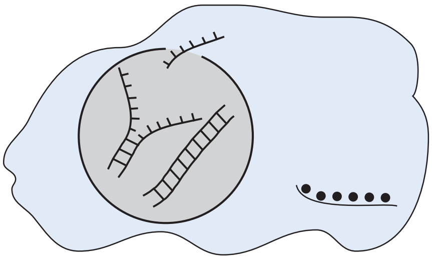
A section of the DNA unzips, exposing a number of nitrogenous basis (in this example AAGGCA).

(c)



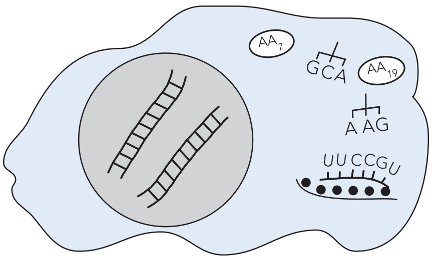
Free nucleotides which are in the nucleoplasm move to the exposed nitrogen bases. mRNA forms along the exposed section of DNA (this is called transcription). Note: the uracil (U) nucleotide replaces the thyamine (T) nucleotide in the formation of mRNA.

(d)



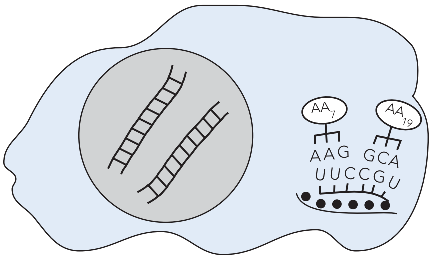
The mRNA moves out of the nucleus, through a nuclear pore to a ribosome. (The nuclear pores are too small to allow DNA molecules to escape).

(e)



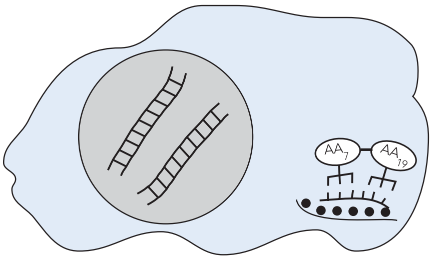
*The mRNA is 'read' by the ribosome and acts like a template on the ribosome. Transfer RNA (tRNA) molecules bond to specific amino acids and carry them over to their matching exposed nitrogenous bases (this is called **translation**). The anticodons on the tRNA match the codons on the mRNA.*

(f)



A specific amino acid (numbered 7 in the diagram) is brought by the tRNA to the beginning of the mRNA molecule shown. The next amino acid (here numbered 19) is brought by a second tRNA and positioned next to amino acid 7.

(g)



A chemical bond forms between the amino acids (called a peptide bond). In this example two amino acids are joined to form a dipepide molecule (proteins have at least 100 amino acids). Longer peptides and proteins require a much longer mRNA molecule and therefore a greater length of DNA molecule to unzip.

7.

(i) *Histone modification refers to process in which the DNA is made to be more or less closely wrapped around histones. This tightening or loosening is brought about by chemical "tags" that attach to the histone molecules. If DNA is tightly wrapped then in that location it is unavailable to the cell for expression. Genes in that location are not expressed. If the same DNA in another cell is loosened then it will be expressed and the protein for which it codes will be synthesized.*

(ii) *The methyl group (CH_3) attaches to strands of DNA that is not associated with histone molecules. These chemical tags can switch genes on or off in a process called DNA methylation.*

(iii) *Tags can be acquired cumulatively through life. Many of them are stripped from the chromosomes in the gametes but not all. Some are inherited. Therefore offspring do not inherit just the DNA of their parents but also some of the tags which are present due to parental environments and parental lifestyle choices.*

(iv) *Every somatic cell in a person's body has the same genome, the same DNA. This represents the hardware of a computer. How the genome functions, which proteins it produces and when they are produced is determined by which chemical tags the particular cell has at the time, its epigenome. The epigenome therefore corresponds to a computer's software. A bone cell divides to produce new bone cells because of its particular chemical tags. A skin cell, with the same DNA, divides to produce new skin cells because it has different chemical tags.*

(v) *The DNA that a person has is from both parents. When a zygote divides by mitosis the resulting cells have identical copies of that DNA (unless a mutation occurs). As a multicellular organism, a person has the same DNA in each somatic cell. Their genome remains constant. Their epigenome does change however, as they grow and develop different genes are expressed. The person changes in appearance. Some organs begin to function differently, some may stop functioning at some stage, e.g. menopause.*

(vi) *Identical twins have the same DNA, as they are monozygotic they come from the same original zygote but chemical tags they have acquired through exposure to different diets and environments result in slight variations between their phenotypes.*

(vii) *The accumulation of chemical tags through time implies that identical twins living in different environments , exposed to different chemicals and diets, will gradually become less phenotypically alike although their DNA will remain identical.*

12: CELL REPRODUCTION

12.1 Mitosis

Terminology

(i) *carcinogenic agent – a cancer causing factor, e.g. U.V. radiadiation.*

(ii) *differentiation – the development of specialised cells in multicellular organisms from unspecialised cells in the early stages of the organism's growth.*

(iii) *neoplasm - a new and abnormal growth of tissue, e.g. cancer.*

(iv) *tissue – a group of similar cells which together perform a particular function. Organs are composed of various tissues, e.g. muscle, nervous, connective.*

Review Questions

1.

(i) *They are (normally) identical.*

(ii) *They are (normally) identical.*

(iii) *Ninety two (92).*

(iv) *The original 46 chromosomes have made copies of themselves. They have 'replicated'.*

2.

(i) *The molecule appears to have 'unzipped' along its length. The matching nitrogenous bases have become separated.*

(ii) *'Free' nucleotides which are present in the nucleoplasm are attracted to their corresponding exposed nitrogenous base and are attaching to the unzipped DNA halves.*

(iii) *Each new DNA molecule is identical to the original DNA molecule and identical to the other copy.*
Each is held to the other identical copy by a protein molecule called the 'centromere'.

(iv) *Replication.*

(v) *They replicate during 'interphase' so that when chromosomes begin to appear in the early prophase at the beginning of both mitosis and meiosis, the amount of DNA is doubled.*

(vi) *(a) 46, 46 (b) 23, 23, 23, 23*

3.

(i) *A stem cell is one which can divide by mitosis many times and form undifferentiated daughter cells. The daughter cells can then differentiate into specialized cells.*

(ii) *A stem cell's capacity to differentiate into other cell types. The more cell types it can differentiate into, the greater its potency.*

(iii) *These are the cells which can give rise to either of the three types of dermal cells– endoderm, mesoderm or ectoderm. They are either the cells from the morula or the inner cell mass of the blastocyst.*

(iv) *These are cells found in a developed person which are able to divide and make copies of themselves but the copies must be able*

to further differentiate into cells which are more specialized. Adult stem cells may be pluripotent like those in the umbilicial cord blood or more commonly multipotent like those found in the bone marrow that give rise to the various blood cells (red, white and platelets).

4. Mitosis is necessary for:
- the growth of the body.
- the development of specialized cells in development.
- for the replacement of damaged tissue and worn out cells.

5. Cancer is uncontrolled mitotic cell division. The cells may grow into a large mass, damage nearby normal tissue and invade other organs.

6. A benign tumour is contained within a membrane which prevents the abnormal cells from migrating to other parts of the body. A malignant cancer has no confining membrane. The cancerous cells may spread to other parts of the body. This process is called metastasis and can result in secondary tumours. The cells may move in the lymphatic system or the blood's circulatory system.

7. Risk factors associated with cancer:
- smoking, e.g. tobacco.
- alcohol consumption – excess
- diet, e.g. processed food with insufficient fruit and vegetables – obesity.
- some viruses, e.g. HPV in some people.
- radiation, e.g. excess exposure to UV and X-Rays.
- faulty genes, e.g. tumour suppressor genes that have mutated.
- certain chemicals, e.g. asbestos, benzene.

12.2 Meiosis

Terminology

(i) cell division – occurs when a cell's nucleus divides followed by its cytoplasm. Each time a division occurs two cells are formed.

(ii) chromatid – a chromosome replicate held to its copy by a centromere after replication.

(iii) chromatin – thin uncoiled strands of DNA as it exists during the interphase.

(iv) cytokinesis – when the cytoplasm of a cell divides into two to produce two daughter cells (usually occurs during the telophase of mitosis and meiosis).

(v) daughter cell – a cell produced as a result of a cell division.

(vi) homologous chromosomes – paired chromosomes which are similar and have the same type of genes although they are not necessarily identical. In the pair, one chromosome originates from the mother (maternal) and one originates from the father (paternal).

Review Questions

1.

(i) Haploid refers to a cell with half the normal number of chromosomes. One of each homologous pair. In humans, the haploid number of chromosomes is 23.

(ii) Only the gametes (sperm and ova) are haploid.

(iii) Diploid refers to a cell with the full compliment of chromosomes, two of each homologous pair. In humans the diploid number of chromosomes is 46.

(iv) All the cells in the body other than gametes have two of each chromosome and are therefore diploid. This includes muscle cells, nerve cells, skin cells, etc. These cells are collectively called the somatic cells.

2.

(i) (1) At this stage chromosomes are not visible. Chromosomes replicate (each copy is called a chromatid), chromatids are attached by a centromere (protein molecule).
(2) Chromosomes appear. Each chromosome, recognisable as a pair of chromatids, begins to shorten and thicken. Centrioles move towards opposite 'poles' of nucleus, begin to form spindles. Chromosomes pair with homologous partner. Nuclear membrane disintegrates.
(3) Homologous chromosome pairs arranged together across the 'equator' of cell. Each chromosome is attached at its centromere to spindle fibres.
(4) Spindles draw homologous chromosomes apart. Whole cell begins to constrict around the equator.
(5) Whole cell divides. New nuclear membranes appear around separated chromosomes. Each cell contains only one of each homologous pair (but it consists of two chromatids). Centrioles duplicate and move towards opposite poles once again. Nuclear membranes disintegrate.
(6) Individual chromosomes arrange themselves on spindles across cell equator.
(7) Spindles separate chromatids as centromeres are divided. A copy of each chromosome moves towards the opposite pole.
(8) New nuclear membranes appear. Each cell has one copy of each homologous chromosome in its nucleus. Four 'daughter' cells formed from single 'parent' cell.

(ii) four (two pairs)

(iii) two (one of each homologous pair)

(iv) eight.

(v) Each chromosome was replicated (duplicated) in the interphase before the first division.

(vi) Two gametes fuse to form the zygote. The zygote then undergoes mitosis to form *a multicellular organism. If the species is to maintain a constant number of chromosomes, before fertilisation takes place, the number of chromosomes must be reduced in the gamete (and then restored in the zygote when fertilisation has occurred).*

3. *Meiosis occurs in sexually reproducing organisms, including humans, so that the number of chromosomes in the gametes is halved (it becomes haploid). When fertilization occurs, the number of chromosomes in the zygote is restored to the diploid number.*
4. *Unless individuals are identical twins, it is highly unlikely that any two people even within the same family will be exactly the same. These differences between people are called variations.*
5.

(i) *During the first division of meiosis, at metaphase I, chromatids may overlap and exchange part of their genetic material. An exchange is evident in anaphase I. During the second division, the chromatids are separated as normal and four gametes are formed. It is clear that two gamete types are normal, however two gametes show chromosomes that have combinations of genetic material that are not present in either parent. If either of the new chromosomes is involved in the formation of a zygote, genes that may not usually be inherited together may be inherited by the new individual. Genes that are normally linked and inherited together have separated and been linked to different genes. This will cause variations in the offspring.*

(ii) *The diagram shows a cell with a diploid number of 4 (2 pairs). In (a) the chromosomes have arranged themselves so that the paternal chromosomes are in line on the left and the maternal chromosomes are in line on the right. However because this arrangement is random, another parent cell may show the assortment of the chromosomes as in (b).*
These diagrams show therefore that gametes will carry different combinations of maternal and paternal chromosomes. There are 4 types of gametes produced by this parent cell which has a diploid number of 4. The number of different gametes can be calculated using the formula:
No. of gamete types $= 2^N$
where N is number of pairs
Here No. of types of gametes $= 2^2$
No. of types of gametes $= 4$
In humans, the number of pairs is 23.
Therefore No. of types of gametes $= 2^{23}$
No. of types of gametes = 8,388,608
(Check this calculation on your own calculator).
This shows that each individual person, without any other change like crossing over occurring during meiosis, produces over eight million different gamete types. Therefore the chance of a couple producing two genetically identical children, unless they are monozygotic twins, is very, very small.

(iii) *This shows the spindle has not successfully separated the homologous pairs of chromosomes in anaphase I. This has resulted in some gametes having an extra chromosome and others having one chromosome too few. If a zygote has more or less than the normal number of chromosomes, this may result in the development of an individual who is different from his/her parents. This is what causes Down Syndrome.*

(iv) *They all result in variations in the offspring. They may make offspring different from their parents and different from other children.*

12.3 Differences between mitosis and meiosis

Terminology

(i) *gamete – a mature sex cell; sperm or ovum. Gametes are haploid.*

(ii) *gonad – the organs (testes and ovaries) which produce gametes.*

(iii) *ovary – female reproductive organ which produces ova.*

(iv) *parent cell – a single original cell that begins to divide and produces new cells*

(v) *random assortment – the pairing of homologous chromosomes that occurs during the first prophase of meiosis. It occurs such that the chromosomes have either the maternal or the paternal chromosome on either side in an unbiased arrangement.*

(vi) *reduction division – meiosis. This is often called 'reduction division' because the number of chromosomes in the gametes is reduced (by half).*

(vii) *sex chromosome – a chromosome which helps determine the sex of the individual. In humans, one pair of chromosomes determines the sex. A female has two X chromosomes while a male has an X and a Y chromosome in each body (somatic) cell.*

(viii) *testis – male reproductive organs which produce spermatozoa. (Plural is testes)*

(ix) *zygote – the fertilised ovum, which results from the fusion of a sperm and an ovum.*

Review Questions

1.

	MITOSIS	MEIOSIS
FUNCTION	repair and growth	gamete production
LOCATION	in most parts of body, where cells are repaired, replaced or growing	gonads (ovaries and testes)
CHROMOSOME NUMBER IN PARENT CELL	Diploid (46)	Diploid (46)
CHROMOSOME NUMBER IN DAUGHTER CELLS	Diploid (46)	Haploid (23)
NUMBER OF DAUGHTER CELLS	2	4
NUMBER OF DIVISIONS	One	Two

2.

(i) 50%

(ii) 50%

(iii) 100%

(iv) Because 50% of the sperm contain an X chromosome, approximately 50% of all people born are females and because 50% of the sperm contain a Y chromosome, approximately 50% of all people born are males.

3.

(i) Fertilization is the fusion of an ovum nucleus and a sperm nucleus

(ii) Meiosis halves the number of chromosomes in the gametes i.e. it creates haploid cells. Fertilisation restores the number of chromosomes in the zygote to the normal diploid number.

(iii) There are potentially millions of different ova produced by each individual female. Similarly there are millions of different sperm produced by an individual male. This is due largely to the random assortment of homologous chromosomes in meiosis. Therefore when fertilization occurs there are millions of possible combinations of gametes and therefore millions of different zygotes which are all equally likely.

4. *Variation in offspring results from the fact that when fertilization occurs, each sperm type that is produced has an **equal** likelihood of fertilization and each **ovum** type that is produced also has an **equal** likelihood of fertilization.*
*The way in which individual couples meet and form relationships is also a **random** process which therefore creates variation. If blondes were only attracted to blondes, there would be less variation in hair colour.*

13: HUMAN REPRODUCTION

13.1 The structure and function of the male and female reproductive systems

Terminology

(i) bulbourethral glands – also called Cowper's gland, two small glands which contribute alkaline fluid and mucus to semen. These are emptied into the urethra and assist in lubricating the vagina and neutralizing the acidity of the vagina.

(ii) endocrine gland – a ductless gland which secretes a hormone, directly into the circulatory system. The hormone usually targets cells which are usually well removed from it.

(iii) exocrine gland – a gland which empties its product into a duct, e.g. salivary gland, gastric glands.

(iv) fertilization – the union of the ovum and sperm to produce a fertilised egg or zygote

(v) hormone – a chemical released in small amounts from special tissue, an endocrine gland, which brings about change in another part of the organism.

(vi) menstrual cycle – the female reproductive cycle in which changes occur to the ovary, uterus, hormonal levels, breasts and cervix on a monthly basis (approx. 28 days on average).

(vii) ovarian cycle – the series of changes which occur in the ovary during the maturation of an ovum. The process occurs over twenty eight days on average.

(viii) ovulation – the release of a mature ovum with its supporting cells (which form the corona radiata) into the uterine tube.

(ix) prostate gland – a gland which is attached to the male urethra which adds alkaline fluid to the sperm. It activates the sperm and assists in neutralising the acidity of the vagina.

(x) seminal vesicle – one of two glands attached to the vas deferens that produce a sugary fluid which contributes to the semen and provides the sperm with an energy source.

(xi) target organ – an organ whose activity is controlled by a particular hormone.

(xii) testosterone – a male sex hormone, produced by the testes, which promotes the development of male secondary sexual characteristics and stimulates sperm production.

Review Questions

1.

(i) Female Reproductive System

a) uterine tube/Fallopian tube

b) ovary

c) uterus

d) bladder
e) pubic bone
f) ureter
g) clitoris
h) vaginal opening
i) vagina
j) anus
k) rectum
l) cervix
m) vertebra
n) fimbriae/infundibulum

(ii) Male Reproductive System

a) pubic bone
b) prostate gland
c) vas deferens
d) spongy tissue/erectile tissue
e) urethra
f) foreskin
g) testis
h) scrotum
i) epididymis
j) bulho-urethral gland/Cowper's gland
k) anus
l) rectum
m) seminal vesicle
n) bladder
o) ureter
p) vertebra

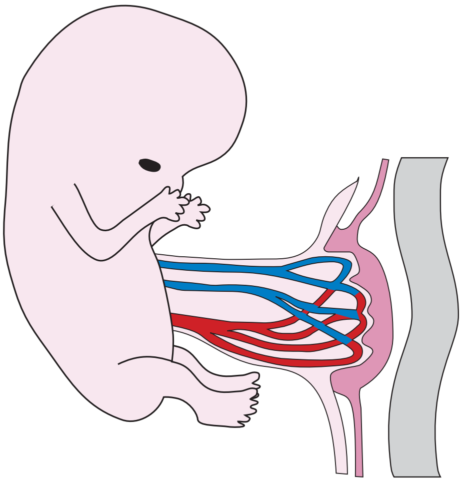
2.

(i) a) produce ova and release one ovum every twenty eight days on average.
b) transports the ovum from the ovary to the uterus. If sperm meet the ovum on its way to the uterus, fertilization may occur in the uterine tube. The ovum is moved by cilia and peristalsis.
c) protects and provides nutrients to the developing embryo and foetus during pregnancy.
d) birth canal – it allows the baby to move from the uterus to the outside environment. Also the uterus receives the penis during coitus so that sperm can enter the female reproductive system. It also allows the lining of the uterus, the endometrium, to be discharged every 28 days (on average).

(ii) a) produce sperm continuously during male adult life.
b) network of tubules in which sperm mature.
c) carry sperm up from the epididymis to the urethra.
d) tubule which carries the sperm from the male reproductive system(or urine from the bladder).

3. The foetal blood remains in the arteries, capillaries and veins that connect the umbilical cord to the foetus. The blood cells of the mother and foetus are separated by a membrane which allow nutrients and oxygen and wastes and carbon dioxide to cross but not the larger blood components.

4.



5.

(i) The lobes of the breast increase in size and complexity, the nipple areola darkens and oil glands emerge producing more oil.
(ii) Oestrogen and progesterone.
(iii) Prolactin production increases during pregnancy but while progesterone is present in the blood it inhibits prolactin acting on the breasts. After birth, when the level of progesterone falls, prolactin causes the milk to be secreted.
(iv) From the pituitary (anterior lobe of the pituitary).
(v) Promotes growth and development of breast and milk secretion.

6.

(i) **umbilical cord –** carries blood from foetus to placenta and back to foetus.
(ii) **placenta –** site for exchange of nutrients and wastes.
(iii) **mucus plug –** closes the cervix.
(iv) **uterus –** muscular organ which protects foetus.
(v) **foetus –** the developing individual.
(vi) **amnion –** encloses embryo and produces amniotic fluid.
(vii) **amniotic fluid –** liquid which cushions, protects and supports developing foetus.

7.

(i) Acts as a cushion/shock absorber protecting the developing foetus, provides constant temperature and allows movement.
(ii) Not main source of nutrient for embryo. It forms part of the digestive tract, produces first blood cells, source of first germ cells which move into the gonads.
(iii) Helps form the foetal portion of the placenta.

8.

(i) A large quantity of blood must flow through the placenta (to supply nutrients and oxygen to foetus).
(ii) She must be careful because some of the things she eats and drinks will pass across the placenta into the foetal blood. These may affect the foetus.

(iii) *During this period all the organ systems develop and are operating. Alcohol and other drugs can interfere with their normal development.*

9.

(i) *A hormone is a chemical produced in very small quantities from an endocrine gland which affects the functioning of the body in some way.*

(ii) *The endocrine gland is a cluster of cells (that are ductless) whose products (called hormones), are released directly into the blood, e.g. thyroid gland releases thyroxine into the blood.*

(iii) *Because they are in the blood, hormones can potentially reach every cell in the body – but not all cells respond to every hormone. Hormones have specific target cells, other cells do not respond to a particular hormone.*

10. ***Hormone:*** *FSH (follicle stimulating hormone)*
Where hormone is released: *Pituitary (anterior lobe)*
Target organs: *Ovaries in females, testes in males.*
Effect of hormone: *Stimulates the development of the ovarian follicle, stimulates sperm production.*

Hormone: *LH (luteinising hormone)*
Where hormone is released: *Pituitary (anterior lobe)*
Target organs: *Ovaries (ripe follicle and corpus luteum), testes.*
Effect of hormone: *Completes ripening of ovarian follicle, induces ovulation and formation of corpus luteum. Stimulates testes to produce testosterone.*

Hormone: *Oestrogen*
Where hormone is released: *Developing follicle (ovary)*
Target organs: *Uterus (endometrium)*
Effect of hormone: *Causes cell development and thickening of endometrium.*

Hormone: *Progesterone*
Where hormone is released: *Corpus luteum (ovary)*
Target organs: *Uterus (endometrium)*
Effect of hormone: *Maintains the endometrium.*

Hormone: *HCG (human chorionic gonadotrophin)*
Where hormone is released: *Developing embryo.*
Target organs: *Ovary (corpus luteum)*
Effect of hormone: *Maintains the corpus luteum (in event of a pregnancy).*

Hormone: *Oxytocin*
Where hormone is released: *Pituitary (posterior lobe)*
Target organs: *Uterus (muscles), breasts*
Effect of hormone: *Causes labour contractions and milk ejection.*

Hormone: *Prolactin*
Where hormone is released: *Pituitary (anterior lobe)*
Target organs: *Breasts*
Effect of hormone: *Causes milk production in breasts.*

Hormone: *Testosterone*
Where hormone is released: *Testes (interstitial cells)*
Target organs: *Testes (seminiferous tubules) muscles and skin.*
Effect of hormone: *Stimulates sperm production, promotes the development of male secondary sex characteristics.*

11. *The corpus luteum releases progesterone which helps to maintain the endometrium so that the developing embryo remains in place after implantation.*

13.2 Spermatogenesis and oogenesis

Terminology

(i) *diploid – the possession of two of each chromosome type. In human cells the diploid number of chromosomes is 46.*

(ii) *dormant – a condition in which a cell ceases its activity and growth.*

(iii) *epididymis – a duct system in the testes which receives sperm from the seminiferous tubules and in which the sperm mature before moving into the vas deferens.*

(iv) *flagellum – a whip-like organelle which generally propels a cell forward. Human sperm have one flagellum.*

(v) *follicle – a large fluid-filled sac which contains an immature ovum surrounded by supporting cells.*

(vi) *gametogenesis – the formation of gametes by meiosis; either spermatogenesis or oogenesis.*

(vii) *haploid – one set of chromosomes containing one of each homologous pair. In humans the haploid number is 23.*

(viii) *meiosis – the type of cell division which results in gametes (sperm or ova). The number of chromosomes in the original cell (the germ cell) is reduced to half, i.e. the gametes produced are haploid.*

(ix) *menarche – the time of the first menstruation.*

(x) *menopause – the time of life at which menstrual cycles cease.*

(xi) *mitosis – cell division in which the two daughter cells produced are identical to the parent cell. Mitosis is for growth and repair.*

(xii) *spermatid – an immature male sex cell formed from a spermatocyte.*

Review Questions

1.

(i) *Cell which develops from an embryonic stem cell in the ovary before birth.*

(ii) *They multiply by mitosis.*

(iii) *The diploid number, which in humans is 46.*

(iv) *Each oogonium pauses at prophase I.*

(v) *It is called a primary (1°) oocyte.*

(vi) *Until puberty (variable age 10-12 years).*

(vii) *One oocyte completes the first meiotic division. Now called a secondary (2°) oocyte, it is released under the influence of a surge in LH (a hormone produced by the pituitary gland).*

(viii) *Meiosis is only completed if the secondary (2°) oocyte is fertilised by a sperm cell.*

(ix) *When meiosis occurs in the oocytes, it is uneven, one cell always inherits most of the cytoplasm. The other cell, called a polar body, degenerates.*

(x) *One cell the ovum receives almost all the cytoplasm – an extra large "packed lunch" – it improves the chance of its survival when, after fertisation it begins to divide. Until it becomes implanted in the endometrium, the blastula has no source of food apart from what is in the cytoplasm.*

(xi) *The ovum is wafted along by the ciliated lining of the uterine tube (or Fallopian tube) and its peristaltic muscle contractions. Unlike sperm the ovum has no means of locomotion itself.*

(xii) *The ovum moves fairly slowly and it does not require an internal source of energy for movement, its food supply is reserved for growth.*

(xiii) *Fertilisation normally occurs in the uterine tube.*

2.

(i) *In the testes.*

(ii) *By mitosis.*

(iii) *At puberty.*

(iv) *Testosterone (which itself is produced under the influence of LH from the pituitary).*

(v) *They mature in the seminiferous tubules and the epididymis.*

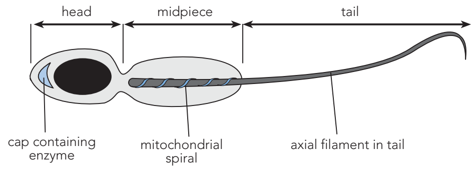
(vi) *Spermatozoa (or sperm).*

(vii) *A flagellum.*

(viii) *A sperm uses its flagellum to propel itself forward in a whip-like motion.*

(ix) *The energy is provided by the mitochondria in the middle section of the sperm cell. They produce ATP from the aerobic respiration of fructose which is present in semen (fructose is part of the fluid released by the seminal vesicles).*

(x)



3. *Similarities*

Spermatogenesis: One cell divides to produce 4 gametes (spermatozoa) by meiosis.

Oogenesis: One cell divides to produce 4 cells by meiosis.

Differences

Spermatogenesis: Four small motile cells are produced. They do not have much cytoplasm, have little stored energy.

Oogenesis: Only one viable cell is produced, the ovum and three polar bodies (non-viable). The ovum acquires most of the cytoplasm from the original germ cell and is very large by comparison to a spermatozoa.

13.3 Development

Terminology

(i) *blastocyst – a hollow fluid-filled ball of cells developed from the zygote which embeds into the endometrium and develops into the embryo.*

(ii) *cervical dilation – the widening of the cervical opening into the uterus which takes place during the first stage of birth; due to uterine muscular contractions.*

(iii) *conception – fertilisation of an ovum and implantation of the resulting embryo.*

(iv) *embryo – the fertilised ovum until about week 8 of development.*

(v) *foetus – from week 8 until birth, the developing human. The period during which the developing young in the uterus is recognisably human.*

(vi) *foramen ovale – a hole that closes over at birth connecting the right atrium to the left atrium. Blood flows from the right atrium into the left atrium which assists the ductus arteriosis in diverting blood away from the foetal lungs.*

(vii) *implantation – when the blastocyst embeds in endometrium of the uterine wall.*

(viii) *optimum – the best or most favourable condition, e.g. the temperature at which an enzyme has its maximum effect on a substrate is called the optimum temperature for that enzyme.*

(xi) *pituitary gland – the "master" endocrine gland. It is attached to the underside of the hypothalamus (on the lower side of the brain) and produces several hormones; some of which control other endocrine glands. Hormones released by the pituitary include FSH, LH, oxytocin and prolactin.*

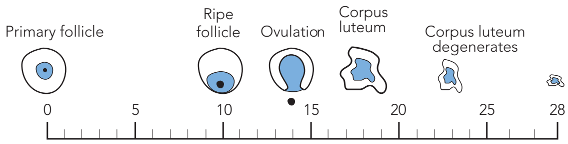
(x) *placenta – an organ formed from cells of the chorion which attaches to the uterus and provides for the exchange of nutrients and oxygen from the mother's blood and carbon dioxide and urea from the foetus' blood.*

(xi) *umbilicus – the scar left where the umbilical cord attaches to the foetus.*

(xii) *viable gamete – a sperm or ovum having the potential to mature and produce healthy offspring.*

Review Questions

1.



2.

(i) *Stage – Menstruation (menses)*

Important Events – Lasts ~5 days. Blood, tissue, fluid, epithelial cells and mucus are shed from the uterus.

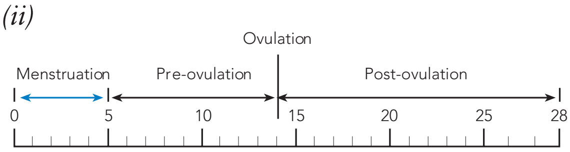
Stage – Preovulation

Important events – Lasts between menstruation and ovulation (days 6-14). Oestrogens, released by the developing follicle, stimulate repair of endometrium by promoting cell division (to thicken the endometrium) and the growth of the endometrial glands and blood vessels (ovulation usually occurs around day 14).

Stage – Postovulation

Important events – Lasts between ovulation and menstruation (days 15-28). Progesterones, released by the developing corpus luteum, continue the growth of the endrometrium in preparation for implantation. Endometrial glands are filled with fluid, further blood vessel development or vascularisation occurs and there is an increase in the amount of tissue fluid. If implantation does not occur, levels of progesterone fall after day 23 (as corpus luteum degenerates) and the endometrium begins to break down.

(ii)



3.

(i) *12-24 hours.*

(ii) *As long as 72 hours.*

(iii) *About 72 hours (about 3 days).*

(iv) *Up to 1 day.*

(v) *One sperm contains insufficient enzyme in its tip to break down the acid which holds together the cells of the corona radiata which surrounds the mature ovum. Thousands of sperm are needed to provide the amount of enzyme that is needed.*

(vi) *Fertilisation or implantation or both.*

(vii) *Each nucleus swells and is called a pronucleus, these fuse and the maternal and paternal chromosomes join to make a diploid zygote.*

4. *If it is known when ovulation occurs, sexual intercourse can be avoided at about this time. However since the day on which ovulation occurs is variable, this method is not always reliable.*

5.

(i) *The developing blastocyst does not have an external supply of nutrient. It is not until it embeds in the lining of the uterus (the endometrium) that it gets a supply of oxygen and food that enables the cells to grow in size.*

(ii) *The cells are produced by mitosis.*

(iii) *Diploid. As the parent cell, the zygote is diploid, the cells that are produced by mitosis will also be diploid.*

6.

(i) *7-8 days.*

(ii) *The blastocyst produces an enzyme which breaks down a tiny section of the uterine endometrium. A small pool of blood forms into which the blastocyst sinks to obtain nutrients and oxygen.*

7. *zygote, morula, blastocyst*

8.

(i) *inner-cell mass*

(ii) *fluid filled cavity*

(iii) *trophoblast*

9.

(i) *After implantation, the inner cell mass forms three 'germ' layers. These are called the endoderm (inner), mesoderm (middle) and ectoderm (outer).*

(ii) *These three layers later become the embryo.*

10.

(i)
- *Epithelium of the digestive tract (except mouth and anus)*
- *the urethra and bladder, vagina*
- *the respiratory tract, auditory canal*
- *the tonsils, thyroid, thymus and parathyroid glands*

(ii)
- *Smooth, striated and cardiac muscle*
- *Dermis of skin and other connective tissue*
- *Bones and cartilage*
- *Blood, bone marrow, lymph tissue*
- *Epithelium of kidneys and ureters*

(iii)
- *Nerve tissue (brain, spinal cord, spinal nerves)*
- *Skin epidermis, hair, nails, glands of skin*
- *Epithelium of mouth and anus*

- *Tooth enamel*
- *Anterior lobe of pituitary gland.*

11. *differentiated*
12. *(i) Totipotent*
    (ii) Pluripotent
    (iii) Multipotent
    (iv) Unipotent
    (v) Totipotent and Pluripotent

13.
(i) During this stage rhythmic uterine muscular contractions occur until the cervix is fully dilated. The foetus' head turns as it moves down through the cervix.
(ii) The expulsion stage - baby is pushed out of the uterus, through the vagina to the outside environment.
(iii) The placenta, membranes and fluid are expelled from the uterus. The placenta is then called the "afterbirth".

14.
(i) Some (about one third) of the blood flows from the right atrium to the left atrium via the foramen ovale. Most of the blood flows from the pulmonary trunk to the aorta via the ductus arteriosus.
(ii) Because while in the uterus the foetal lungs are not functioning, they are growing and fluid filled.
(iii) The foramen ovale normally closes shortly after birth. The ductus arteriosus closes, atrophies and becomes a ligament.
(iv) a) Ductus venosus
b) It is a branch of the umbilical vein which drains into the inferior vena cava.
c) Most of the blood returning from the placenta is diverted away from the foetal liver by the ductus venosus.

13.4 Contraception, STI's, Assisted Reproductive Technologies, Screening Embryos and Foetuses

Terminology

(i) abortion – termination of a pregnancy. A spontaneous abortion is called a miscarriage. An artificial abortion is one that is induced.
(ii) chorionic villi – tiny finger-like projections that form from the developing placenta and fuse with the mother's endometrium. Foetal blood flows through the villi which absorbs nutrient from the maternal blood.
(iii) contraception – birth control which involves the prevention of conception i.e. fertilisation and implantation.
(iv) incubation period – the time between when a pathogen (e.g. virus) enters the body and when the symptoms of the disease that it causes first appear.
(v) infectious – refers to a disease which is communicable i.e. when it can be transferred from one person to another.
(vi) in situ – occupying a natural place.
(vii) intrauterine device (I.U.D) – A mechanical device made from plastic and or metal which is inserted into the uterus and which renders implantation of the embryo into the endometrium unlikely to occur. I.U.D.'s are used to avoid pregnancy.
(viii) lesion – damaged tissue e.g. a cancerous tumour, an ulcer, a "cold sore"
(ix) oxytocin – hormone released by the pituitary which causes uterine contractions during child birth and milk release during suckling.
(x) progesterone – a hormone released by the corpus luteum which helps maintain the endometrium in a spongy vasculated state. When the corpus luteum breaks down, the endometrium is shed in menstruation. The placenta also produces progesterone.
(xi) spermicide – a chemical used in birth control to kill sperm
(xii) symptom – a specific sign of a particular disease which can often be used to help diagnose the particular disorder.
(xiii) urethritis – an infection and inflammation of the urethra (which may be caused by a sexually transmitted infection)

Review Questions

1.
(i) Diaphragm: circular rubber cap inserted in the upper part of the vagina to prevent sperm moving into the uterus.
(ii) Condom: rubber sheath fitted over the erect penis to prevent sperm reaching the cervical region during sexual intercourse.

2. *Chemical barriers alone are unreliable, they do not prevent all sperm from entering the uterus.*
3. *During the normal menstrual cycle a rise in the oestrogen level in the blood inhibits FSH production by the pituitary. By introducing oestrogen and progesterone artificially, the pill prevents FSH production, the follicle does not develop and ovulation does not occur.*
4. *An IUD is a plastic and/or metal device placed in the uterus (by a doctor). It prevents the implantation of a fertilised ovum into the endometrium.*

5.
(i) Both vas deferens are cut and a small piece removed. This prevents sperm getting to the urethra. Ejaculation can still occur but the semen does not contain sperm.
(ii) Both uterine tubes are cut, a small piece taken out, then the ends are tied. This prevents the ovum and the sperm coming into contact.

6. *Procedure – Vasectomy*
Advantages – Very reliable, relatively simple surgical procedure. No side effects.
Disadvantages – Permanent, except for expensive microsurgical reversal.
Procedure – Tubal ligation
Advantages – Very reliable. No side effects.Disadvantages – More invasive surgical procedure than vasectomy. Difficult to reverse.
7.

CONTRACEPTIVE METHOD	LIMITATIONS	RISKS	BENEFITS
Oestrogen and progesterone pill (combined pill or "the Pill")	Does not protect from STIs. A prescription is needed. Cost.	Slight risk, in some women, of developing deep vein thrombosis. Small increase in blood pressure.	Pregnancy rates of less than 1% per year. Regular predictable menstrual cycles. Reduced menstrual cramps. Easily reversible.
Progesterone only pill (POP or "mini pill")	Does not provide regular predictable menstrual cycles or reduced menstrual cramps. It has to be taken meticulously at the same time each day. Safe to use when breastfeeding. A prescription is needed. Cost may be greater than other methods	Some women experience vaginal bleeding –"breakthrough bleeding."	Risk of clots is less than with combined pill. When stopped, fertility returns to normal level immediately. Useful for women who can't use combined pill due to oestrogen in it. Safe to use when breastfeeding.
Male condom	Some people are allergic to latex rubber or to lubricant. May slip off or break. Perishable.	Risk of STIs not totally removed (but probably the safest.)	Good protection from STIs. No prescription needed. Condoms are easy to obtain and inexpensive.
Diaphragm	After intercourse diaphragm must be left in place for several hours. Not normally as effective as male condom.	Does not provide protection against STIs. An increase in urinary tract infections in women who are prone to these. Rare cases of toxic shock syndrome.	Side effects are rare. No delay in return to fertility. It is a safe alternative.
Chemical spermicides	Should be used with a barrier method – not singularly reliable.	Some chemicals may cause vaginal irritation. Does not provide protection against STIs. Damage to the delicate surface of the vagina may make it easier for the HIV virus to be contracted.	Cheap. No prescription needed.
Intrauterine devices (IUD)	Generally not recommended for women who have painful or long-lasting periods or who are anaemic. In small percentage of users the IUD is pushed out of uterus into vagina. Specially trained doctor must insert the device.	Does not provide protection against STIs. Periods may be heavier, longer and more painful. Very small chance of getting a pelvic infection at time of I.U.D. insertion.	Reliable, long-term. Suitable for women who cannot use hormonal methods and women who are breastfeeding.
Morning-after pill (emergency contraception)	Not totally reliable (approx. 85%). Should be used within 24 hours of unprotected sex.	Does not provide protection against STIs.	No doctor's prescription needed.

8. *STI – A disease which is only contracted through sexual contact with an infected person.*
9. ***Infection – Syphilis***
Causative agent – Bacterium (Treponema pallidum)
Effect on the body – Damages brain, heart, eyes.
Treatment – Antibiotics will cure early stages (in two months). Surgery, in later stages, may be needed.
Control – Condoms, avoid casual sex.
Infection – Gonorrhoea
Causative agent – Bacterium (Neisseria gonorrhoea)
Effect on the body – Males – inflamed urethra, bladder, prostate. Females – inflamed cervix, uterine tubes, uterus, may cause sterility.
Treatment – Antibiotics.
Control – Condoms.
Infection – Chlamydia
Causative agent – Bacterium (Chlamydia trachomatis)
Effect on the body – Male – inflamed urethra, epididymis.
Female – inflamed urethra, vagina, uterine tubes. In both it may lead to infertility (due to blockages).
Treatment – Antibiotics.
Control – Condoms.
Infection – Genital herpes
Causative agent – Virus (herpes simplex type 2)
Effect on the body – Sores on penis and in vagina.
Treatment – No available cure.
Control – Spread only when sores are present.
Infection – HIV
Causative agent – Virus (HIV)
Effect on the body – Reduces the efficiency

of immune system by attacking lymphocytes.
Treatment – No really effective treatment. Researchers are trialling a cocktail of drugs that slow the reproduction of the virus.
Control – Use of condoms, clean needles, effective blood screening.

10.
(i) AIDS, genital herpes and genital warts.
(ii) Syphilis, gonorrhea, chlamydia
(iii) Fungi, protozoa, insects (e.g. pubic lice)

11.
(i) Viruses, some bacteria and/or the toxins they produce may cross the placenta from mother to foetus and affect the unborn. Babies may be infected at birth e.g. by a mother's genital warts or genital herpes.
(ii) A pregnant woman who suspects that she may have an STI should seek medical advice immediately she becomes aware of her pregnancy. Some STI's can be cured even during pregnancy with the appropriate drugs (especially those caused by bacteria). Herpes and HIV can be controlled. A caesarian delivery may be required in the case of STI's which can be transmitted to the baby at birth (herpes, gonorrhea, hepatitis B).

12
(i) A person who has HIV may also have contracted other STI's through unprotected sex.
(ii)
- *No sex with infected partners*
- *Decrease the number of partners, preferably to one*
- *Practise safe sex (e.g. use condoms)*
- *Frank discussions with prospective partners regarding their sexual history*
- *Avoid having concurrent sexual partners*

13.
(i) The inability of a couple to conceive naturally after at least twelve months of regular, unprotected intercourse or the inability to carry a pregnancy to a live birth.
(ii) Ova do not mature/not released
Endometriosis
Uterine tube blockage
Sperm production absent/very low
Chromosomal abnormalities in either sperm/ova
(iii) In Vitro Fertilization
(iv) IVF – 'In vitro fertilisation' is Latin for 'fertilisation in glass'. Sperm and ova are brought together in sterile dishes; the embryo or embryos which may form are then transferred to a woman's uterus. The ova and/or sperm may have been sourced from the couple involved or from other people.
(v) The timing of the implantation of the embryo is crucial to the success of IVF. The oocytes are fertilised in the laboratory less than a day after they are obtained from the woman's ovary and returned to her uterus within a few days, so that the endometrium is in a thick and well vasculated state to receive them for implantation.

14.
(i) Approximately 20%.
(ii) Human chorionic gonadotrophin (HCG) which is first produced by the embryo at implantation, then by the placenta as it develops. It helps to keep the corpus luteum in the ovary intact and functioning after day twenty three of the ovarian cycle. The corpus luteum therefore continues to produce progesterone which keeps the lining of the uterus (endometrium) intact and therefore prevents the loss of the embryo as well.

15.
(i) The embryo/foetus may naturally abort (miscarry).
(ii) Such women may need to inject HCG during the two weeks following ovulation and progesterone following the detection of a pregnancy in order to maintain the pregnancy.

16. ***Technique –*** *Maternal blood testing*
Description – *This is a test carried out on the mother's blood serum, which can reveal the likelihood of abnormalities in her foetus. This test is frequently used to help decide whether further tests are needed. It does not give conclusive results.*
Technique – *Amniocentesis*
Description – *Removal of a small sample of amniotic fluid from the amniotic sac around a developing foetus. Foetal cells in the fluid are cultured so that their chromosomes can be studied. Chromosomal abnormalities can be observed and many genetic diseases detected if present. Used around 16 weeks. Can be used to diagnose Down syndrome, Tay Sachs and cystic fibrosis.*
Technique – *Chorionic villus sampling*
Description – *A small sample of the placenta is removed using a needle and examined to detect foetal abnormalities. Used earlier in the pregnancy (10-15 weeks) generally to detect similar abnormalities as amniocentesis.*

14: TYPES OF INHERITANCE

14.1 Predicting genotypes and phenotypes

Terminology

(i) co-dominance (or incomplete dominance) - when two different alleles are present in an organism but neither is dominant. Both genes are expressed, e.g. group AB, in the ABO blood grouping, results from the genotype I^AI^B, where both the gene for A and the gene for B are expressed.

(ii) dominant – a trait expressed by a heterozygote, which hides or masks another trait.
(iii) frequency – the proportion of a particular type in a population.
(iv) genetics – the study of heredity.
(v) genotype – the genetic makeup in an organism for a particular trait, e.g. I^AI^B.
(vi) haemophilia – an X-linked disease in which the person's blood does not clot as rapidly as it should, due to the lack of a coagulation factor. This can lead to excessive bleeding from a small injury.
(vii) hereditary – capable of being passed on through gametes from parents to offspring. A hereditary trait is controlled by genes.
(viii) heterozygous – an organism with two different alleles for a particular trait, e.g. I^Ai.
(xi) homozygous – when two alleles are the same, the organism is described as homozygous (or pure) for that particular trait, e.g. TT, tt or I^AI^A.
(x) phenotype – the expression of a particular genotype. Phenotype may also be influenced by the environment.
(xi) red green colour blindness – a common form of colourblindness in which red and green are indistinguishable. It is X-linked and recessive.
(xii) sex-linked trait – refers to genes which have their loci on the X chromosome. (Also called X-linked).

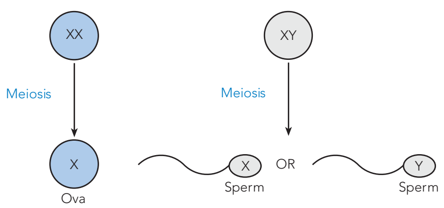
Review Questions

1.
a) Inheritance controlled by genes on the chromosomes numbers 1 to 22. These chromosomes are described as non-sex chromosomes.
b) Inheritance controlled by genes on the X chromosome.

2.

	TOTAL NUMBER OF AUTOSOMAL CHROMOSOMES IN EACH SOMATIC CELL	TYPE OF SEX CHROMOSOMES IN EACH SOMATIC CELL	TOTAL NUMBER OF CHROMOSOMES IN EACH SOMATIC CELL
Female	44 (22 pairs)	XX	46 (23 pairs)
Male	44 (22 pairs)	XY	46 (23 pairs)

3. Female parent cell Male parent cell



All ova contain an X chromosome
Sperm may contain an X or a Y chromosome

4.
- Females have two XX chromosomes in each somatic cell (plus twenty two pairs of autosomes). Males have one X and one Y chromosome in each somatic cell (plus twenty two pairs of autosomes).
- When meiosis occurs in the female gonads (ovaries) the ova all contain one X chromosome (plus 22 autosomes). When meiosis occurs in the male gonads (testes) 50% of the sperm contain an X chromosome and 50% of the sperm contain a Y chromosome (plus 22 autosomes).
- There is an approximately equal likelihood of an X carrying sperm or a Y carrying sperm meeting the X carrying ovum.
- Therefore, there is a 50% chance of an XY or an XX zygote.

5.
(i) Woman Rr
Man rr
(ii)

Man

Woman	r	r
R	Rr	Rr
r	rr	rr

(iii) Right handed : Left handed = 1:1
(iv) Expected: Two right handed and two left handed.
(v) The observed ratios do not always match the expected ratios due to the laws of probability.

6. (i)

BLOOD GROUP	POSSIBLE GENOTYPES
A	I^AI^A or I^Ai
B	I^BI^B or I^Bi
AB	I^AI^B
O	ii

(ii) 4 (iii) 6 (iv) I^Ai and I^Bi (v) I^AI^B

7.
(i) Man group O : genotype ii
Woman group O : genotype ii

∴ Parents : ii × ii

Man

Woman	i	i
i	ii	ii
i	ii	ii

This shows the probability of the couple having a group B child is zero, i.e. P(child group B)=O.

(ii) Woman, group O : genotype ii
Man, group B : genotypes I^BI^B or I^Bi
If parents are $ii \times I^BI^B$

Woman \ Man	I^B	I^B
i	I^Bi	I^Bi
i	I^Bi	I^Bi

∴ Probability (child with group A) = O.
If parents are $ii \times I^Bi$

Woman \ Man	I^B	i
i	I^Bi	ii
i	I^Bi	ii

∴ Probability (child with group A) = O.
(Either way, there is a zero probability of them having a child with group A).

(iii) Man, group AB : genotype I^AI^B.
Woman, group B : genotypes I^BI^B or I^Bi.
If parents are $I^AI^B \times I^BI^B$

Woman \ Man	I^A	I^B
I^B	I^AI^B	I^BI^B
I^B	I^AI^B	I^BI^B

∴ Probability (child will be A) = O.
If parents are $I^AI^B \times I^Bi$

Woman \ Man	I^A	I^B
I^B	I^AI^B	I^BI^B
i	I^Ai*	I^Bi

** (Child with I^Ai genotype is group A.)*
∴ Probability (child will be group A) = ¼.

(iv) Man group B : genotype I^Bi (not I^BI^B as one of his parents is ii)
Woman group A : genotype I^AI^A

Woman \ Man	I^B	i
I^A	I^AI^B	I^Ai
I^A	I^AI^B	I^Ai

Ratio of genotypes: I^AI^B : I^Ai = 1:1
Ratio of phenotypes: Group AB : Group A = 1:1

8.
(i) Man, genotype X^hY
Woman, genotype X^HX^H
(not X^HX^h as there is no history of haemophilia in her family)

Woman \ Man	X^h	Y
X^H	X^HX^h	X^HY
X^H	X^HX^h	X^HY

∴ Genotypic ratio : X^HX^h : X^HY = 1:1
Phenotypic ratio : female normal (but 'carrier') : male normal = 1:1

(ii) Woman, genotype X^HX^h
Man, genotype X^HY.
∴ parentsare $X^HX^h \times X^hY$.

Woman \ Man	X^H	Y
X^H	X^HX^H	X^HY
X^h	X^HX^h	X^hY

Probability (child has X^hY) = ¼.

9. (i)

	Autosomal/ Sex linked	**Dominant/ Recessive/ Codominant**
Huntingtons disease	autosomal	dominant
red-green colour blindness	sex linked	recessive
PKU	autosomal	recessive
sickle-cell anaemia	autosomal	codominant
haemophilia	sex linked	recessive

(ii)

PHENOTYPE	APPROPRIATE SYMBOLS	GENOTYPE
Male with red-green colour blindness	X^C, X^c, Y	X^cY
Female with Huntingtons disease	H,h	HH or Hh
Female with red-green colour-blindness	X^C, X^c, Y	$X^c X^c$
Male with normal colour vision	X^C, X^c, Y	X^CY
Male with PKU	P,p	pp
Male with haemophilia	X^H, X^h, Y	X^hY
Female with sickle-cell anaemia	Hb^N, Hb^S	Hb^sHb^s
Male with sickle-cell trait	Hb^N, Hb^S	Hb^NHb^S
Female normal for blood clotting	X^H, X^h, Y	X^HX^H or X^HX^h
Female without PKU	P,p	PP or Pp

14.2 Pedigree charts

Terminology

(i) *disease – an absence of health in the body. The body does not function as well it should due to some factor e.g. stress, a pathogen*

(ii) *dizygotic twins – twins which originate from two separate ova and two separate sperm. They are no more alike genetically than two brothers, two sisters, or a sister and a brother.*

(iii) *mode of inheritance – how a trait is inherited. Whether it is autosomal or X-linked and whether dominant or recessive.*

(iv) *monozygotic twins – twins that originate from the same zygote. They have identical genotypes and very similar phenotypes which are often indistinguishable to the casual observer.*

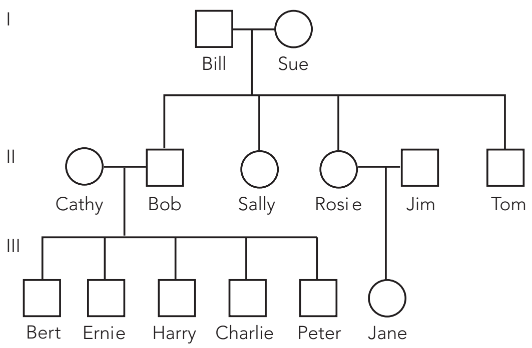
(v) *probability – the likelihood of an event.*

(vi) *recessive trait – a characteristic which is not expressed in the heterozygote. The recessive trait is hidden due to the expression of the allele for the dominant trait.*

Review Questions

1.

(i)



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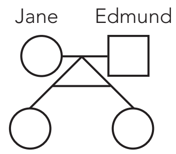
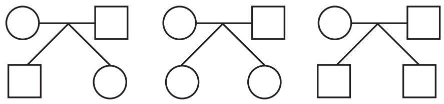


(iii)



non-identical (dizygotic)

2.

(i) *(a) Recessive and autosomal.*

(b) It appears to be recessive as individuals II 4 and II 5 are not bald but have offspring some of which are bald (IV 1 and 2 confirm this). It appears to be autosomal as individuals IV 1 and IV 2 are normal but have female offspring V2 who is bald. If this was a sex-linked trait, male individual IV 2 would have to be bald too.

(ii) *Key: Let B = normal hair gene*
b = bald gene

I 1 Bb, 2 bb
II 1 Bb, 2 bb, 3 Bb, 4 Bb, 5 Bb
III 1 bb, 2 bb, 3 BB/Bb
IV 1 Bb, 2 Bb, 3 Bb
V 1 BB/Bb, 2 bb, BB/Bb

(iii) *twins II 1 and II 2 and III 1 and III 2.*

(iv) *monozygotic III 1 and III 2*
dizygotic II 1 and II 2

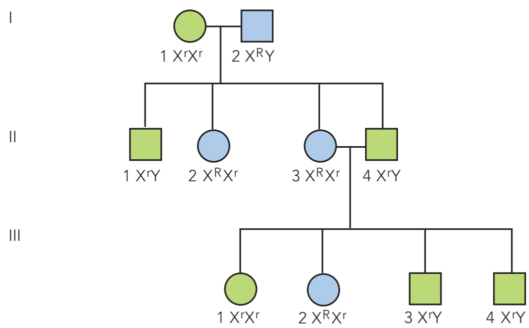
(v) *From V 2's parents, but they received the genes from individual III 2 since they were siblings.*

3.

(i) *This gene is dominant.*

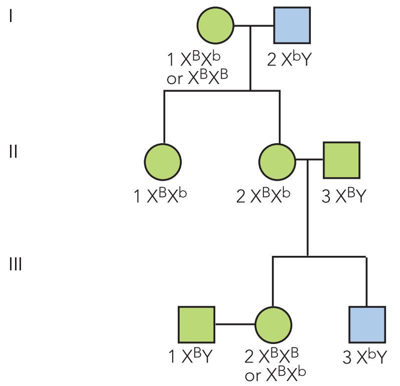
(ii) *I 2*

(iii) *Key: Let X^R = gene for rickets*
X^r = gene for normal development.



(iv) *More females would be expected to inherit this dominant disease as they have two X chromosomes (and therefore two chances to inherit the rare disease) whereas males have only one X chromosome (and therefore have only one chance to inherit it).*

4.
(i)



(ii) *If III 2 is X^BX^B then:*

Man

Woman

	X^B	Y
X^B	X^BX^B	X^BY^B
X^B	X^BX^B	X^BY

OR if III 2 is X^BX^b then:

Man

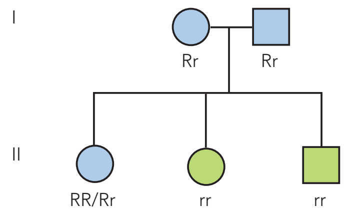
Woman

	X^B	Y
X^B	X^BX^B	X^BY
X^b	X^BX^b	X^bY

∴ probability of X^bY = 0 or ¼
X^BY = ½ or ¼
X^BX^B = 1 or ½
X^BX^b = 0 or ½
X^bX^b = 0 or 0

5.
(i) *Since I 1 and I 2 give rise to II 2 the shaded characteristic must be recessive. If it were dominant I 1 or I 2 would have to have the condition. Since II 2 is female it cannot be sex-linked, because if it were I 1 would have the characteristic. Therefore it is recessive and autosomal.*
(ii) *It is recessive because, for example, II 4 and II 5 do not show the condition but III 4 and III 5 do. It may also be sex-linked as only males in the pedigree inherit the condition. I 1 may therefore have genotype X^bY where b = condition. None of his sons would have the condition if I 2 has the genotype X^BX^B. All his daughters II 3, II 4 and II 6 would be "carriers" X^BX^b. III 4, III 5 and III 8 could then be X^bY.*
∴ the most likely mode of inheritance is recessive and sex-linked.
(iii) *This condition is dominant because II 1 and II 2 both have the condition but III 1 does not. It cannot be recessive. It is not sex-linked because II 2 would have to be X^BY (where B is the dominant gene) and he would have to have acquired the X^B from I 2 (his mother), then she would have to be either X^BX^B or X^BX^b which she clearly is not (as she does not show the condition). It is dominant and autosomal.*

6.
(i)



(ii) *Parents genotypes Rr × Rr*

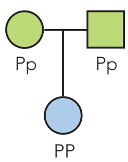
Man

Woman

	R	r
R	RR	Rr
r	Rr	rr

∴ P (child is RR or Rr) = ¾ (0.75)
∴ P (child will have condition) = ¾ (0.75)
(iii) *P (Child is RR or rr) = ½*
(iv) *P (RR) = ⅓*
(v) *P (rr) = 1*
(vi) *P (Inherits the condition and is Rr) = ¾ × ⅔ = ½*

7.
(i)



(ii)

Man

Woman

	P	p
P	PP	Pp
p	Pp	pp

(iii) *The genetic counsellors would need to know her partner's genotype for this condition. The probability of any child they have in having PKU is shown below:*
If his genotype was PP
P (Child with PKU) = 0
If his genotype was Pp
P (Child with PKU) = 0.5
If his genotype was pp
P (Child with PKU) = 1
(iv) *At birth children have a small amount of blood tested (for excess phenylalanine).*

(v) *The child is put on a special diet. As a baby, special milk formula is needed. The child will need a diet that is low in phenylalanine (and high in tyrosine) as he or she gets older. Blood tests are required to check the level of phenylalanine on a regular basis.*

(vi) *Left untreated, because the child lacks an enzyme (Phenylalanine hydroxylase) which is necessary for the metabolism of phenylalanine, this amino acid accumulates in the blood. It becomes toxic and interferes with brain development causing irreversible learning difficulties.*

15: SCIENCE AS A HUMAN ENDEAVOUR 2

Terminology

(i) *foetal development – the period during which the developing young in the uterus is recognisably human.*

(ii) *gene expression – the effects of a gene as displayed by the phenotype of an organism. It relates to the proteins that are determined by the sequence of bases on the DNA and what their roles are.*

(iii) *genetic screening – the study of a person's DNA. The data may show differences from the normal DNA which suggest the person could develop particular diseases.*

(iv) *genetic tags – DNA methylation and histone modification are chemical marks or tags on the DNA molecule which determine which genes are switched on and which are switched off.*

(v) *human papillomavirus (HPV) – a virus , the cause of a common sexually transmitted infection (STI). HPV may give rise to genital warts and cancers.*

(vi) *prenatal diagnosis – a diagnostic procedure used to determine whether or not a foetus or embryo has a genetic abnormality.*

(vii) *spina bifida – a genetic disease in which the vertebrae do not fully enclose the spinal cord.*

(viii) *syndrome – a group of symptoms which generally occur together e.g. Down syndrome is normally characterized by a number of symptoms.*

(ix) *vaccine – an inoculation, often a weakened form of a pathogen used to stimulate the body to produce its own antibodies in response to the particular disease pathogen.*

Review Questions

1.

(i) *Genetic screening involves tests which look for abnormalities in a person's genes, proteins which might indicate abnormal genes or RNA. Results may indicate a genetic disease. Tests may be carried out for children and adults.*

(ii) *Genetic screening of embryos is used mostly in IVF and can indicate whether an embryo has a genetic disorder.*

2.

(i) ***Advantages:*** *Adults who are aware of their propensity to develop a particular disease may take precautions e.g. a special diet in order to minimize the likelihood of its development or lessen it effects. They can plan their lives and prepare both themselves and their families for the disease. Young adults may be better placed to decide whether or not to have children and whether screening their embryos or foetuses is desirable.*

Disadvantages: *The person's present quality of life may be diminished by the knowledge that an inevitable disease is likely to affect them in the future. Health insurance may become difficult to obtain in the future for those who have defective genes that may lead to disease.*

(ii) ***Advantages:*** *This is used in IVF to select embryos that are genetically healthy. Those embryos that show defective genes are not selected for implantation. It improves the success rate of such implantations and the likely health of the child.*

Disadvantages: *If used solely to select the embryo for its sex or some physical advantage, this has serious ethical implications for the use of resources that could be used elsewhere. The tests are a costly addition to IVF costs.*

3.

(i) *Parents may wish to prevent genetic diseases which may be passed on to either a boy or a girl.*

(ii) *a) Sperm Separation: This involves separating Y carrying sperm from X carrying sperm. A centrifuge is used to do this. The sperm which are required, either X or Y, are then used in either IVF techniques or artificially inseminated.*

b) Staining: This can also indicate whether the type of sperm is X or Y. The required sperm can be selected and used in IVF techniques. The separation techniques are not totally effective in separating X and Y carrying sperm – best 90% effective.

c) Pre-Implantation Genetic Diagnosis (PGD): This involves IVF. Drugs are used to stimulate the female's ovaries, a number of ova are removed and fertilized in the laboratory. The sex of the developing embryos is determined and a number of selected embryos of the desired sex are placed in the uterus.

4.

(i) *The birth of an affected foetus can be prevented through termination of an affected foetus or by using reproductive choices. The later means that a couple may choose not*

to have children if the risk to them of an affected child is unacceptably high.

(ii) *This is the determination of a genetic disease at the embryonic or foetal stage.*

(iii) *Through amniocentesis or chorionic villus biopsy, by maternal blood sampling and by ultrasound scanning.*

5.

(i) *Some genetic tags that form a person's epigenome through histone modification or DNA methylation may be passed down through gametes to the next generation. Children are believed to inherit not just the DNA and but also some genetic tags from their parents. The children's children may inherit tags from their grandparents and so on.*

(ii) *The genetic tags are acquired partly through parental lifestyle choices. It is possible therefore that if a person smokes tobacco or drinks alcohol, chemical tags, acquired through these activities that may be harmful, could be passed on to the next generation.*

6.

(i) *In males FSH is essential for sperm production. The vaccine administered to a male stimulates his immune system to attack and remove FSH. As a result, his sperm do not mature. In females, a vaccine was designed to remove HCG. However this has proven less effective. These methods involve intravenous injections.*

(ii) *One method is for the male to orally inject a progesterone pill and also have a testosterone skin patch. This combination results in sperm production being reduced to zero, however, it does have some side effects. These include depression, cramps and headaches.*

7.

(i) *Cervical screening test: Cells are collected from the cervical region and examined microscopically. Sometimes they show abnormalities that indicate that they may be precancerous. These cells can be removed through fairly routine surgery before they become more dangerous.*

(ii) *Breast screening: the best way to detect breast cancer in its early stages. It involves low doses of X-radiation which are used to produce an image of the inside tissue of the breast. Images of lumps which are too small to be felt can be detected. Further tests can be carried out, including biopsies to determine whether treatment is necessary.*

(iii) *Blood tests for prostate cancer: prostate cancer can be diagnosed using a blood test for a protein called prostate-specific antigen (PSA). The normal healthy prostate synthesises PSA. If the blood has abnormally large quantities of PSA this may indicate prostate cancer. Early detection, as with other cancers, results in improved outcomes for the patient.*

8.

(i) *Folate is essential to the development of a foetus in its early stages. If folate is taken before and after conception, it can prevent the development of spina bifida.*

(ii) *Foods which contain this bacteria include soft cheeses (camembert, brie), unpasteurised milk, pate, cooked chicken, smoked salmon and smoked mussels. An infection for a pregnant woman can cause a miscarriage, stillbirth or a very sick baby at birth.*

(iii) *Fish that are likely to contain higher levels of mercury (in the form of a compound called methylmercury). Mercury compounds slow the baby's development and adversely affect the brain and nerves. Fish that are higher in the food chain may contain higher levels of mercury as it is a compound that accumulates in the body of fish and is not excreted. Sharks, Barramundi, Orange Roughy, Southern Bluefin Tuna and Snapper may contain high levels (tinned Tuna, Salmon, Prawns contain lesser amounts).*

9.

(i) *Smoking during pregnancy affects the developing foetus because it reduces the supply of oxygen to the placenta and allows many harmful chemicals to cross the placenta into the developing foetus. Smoking results in an increase in the likelihood of an ectopic pregnancy, miscarriages, premature births and SIDS. The smoker's baby is likely to have lower birth weight than expected (smokers have babies that are on average 200g less than normal). The baby is likely to be more prone to infections and more likely to suffer from asthma.*

(ii) *Foetal alcohol syndrome (FAS) is a condition which may affect babies whose mothers drink alcohol heavily during their pregnancies. This is particularly critical during the early months of pregnancy. The alcohol readily crosses the placenta restricting the foetal growth and reducing brain development. It leads to abnormal facial features, heart defects and behavioural and learning problems during childhood. There is no safe level of alcohol consumption during pregnancy.*

SOLUTIONS TO TRIAL TESTS

TT 1 – SCIENCE INQUIRY SKILLS 1

Section 1: Multiple Choice (10 marks)

1.	*c*	6.	*b*
2.	*d*	7.	*c*
3.	*a*	8.	*b*
4.	*d*	9.	*c*
5.	*a*	10.	*a*

Section 2: Short Answer (50 marks)

1.

(i) A.

(ii) This is a testable statement, an educated guess which explains an observation.

(iii) B is not a definite statement that can be tested, C is an observation, D is a question, E is an observation.

2.

(i)

- *Measure the blood pressure of a sample of the population (200) selected at random.*
- *Randomly divide the group into two groups of 100.*
- *Allow the experimental group to consume excess salt for a limited time (say 2 weeks).*
- *Allow the control group to consume a normal salt intake.*
- *During the two weeks measure the blood pressure of each person in each group, average the results and compare the experimental group with that of the control group.*

  Note: This is only one of many possible designs.

(ii) Average age in each group, health of the participants, the way in which blood pressure is measured, stress levels in each group, diets should be similar, time of day blood pressure is measured.

(iii) Salt intake

(iv) The experimental group has a significantly higher average blood pressure than that of the control group, while on the excess salt diet.

(v) The experimental group has the same or significantly lower average blood pressure than that of the control group while on the excess salt diet.

(vi) Repeat the experiment or use a larger sample (i.e. more people) or continue the experiment for a longer period.

(vii) Select participants randomly without bias.

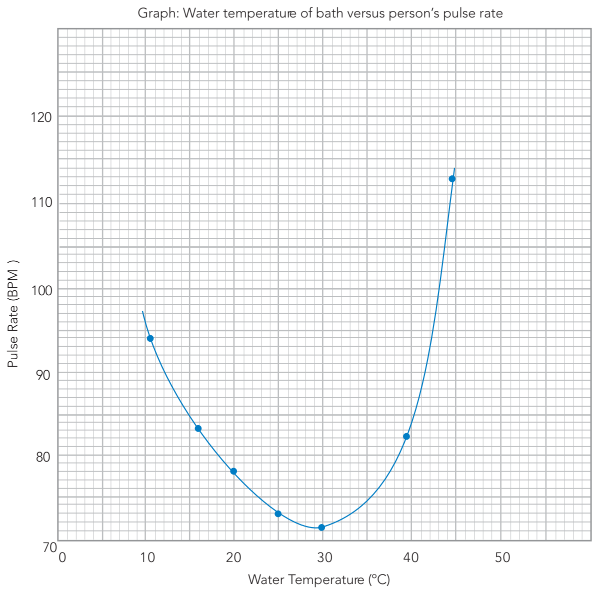
3.

(i) That as the temperature of the bath increases the subject's pulse rate increases.

(ii) a) The temperature of the bath

b) Pulse rate

(iii)



Mark allocation:

- *Appropriate graph title (with both variables mentioned) [1 mark]*
- *Axes correctly labeled including units [2 marks]*
- *Line neatly joining all points [1 mark]*

(iv) The hypothesis was not supported by the data. The subject's pulse rate dropped as the bath temperature increased but then began to rise when the temperature exceeded 30°C.

(v) Repeat the experiment a number of times and randomly select more subjects to test.

4.

(i) A control is a "set up" in which all the variables are made the same as in the experiment except the independent variable.

(ii) The control enables comparison to be made between the control "set up" and the experimental "set up". In this way we can determine the effect any change to the independent variable may have on the dependent variable.

(iii)

a) Increase the reliability of the experiment; if the sample size is too small it may not be typical of the whole population.

b) Avoid bias. If samples are selected with a particular feature then the experiment may be invalid.

5. (i) 125/5 = 25μm
(ii) a) 1250 b) 2500 c) 6250

6. (i) a) 4000 b) 2667 c) 1600 d) 400 (e) 267
(ii) 400μm/5 = 80μm

7. (i)
- Animals are easier to treat than humans
- Animals are more expendable – their loss does not create as much anxiety.
- Animals may benefit from the research as well as humans.

(ii)
- Results from animal research do not necessarily apply to humans.
- Animals may be kept in unnatural or harsh confinement – treatment may be cruel.
- Animals may have rights which are not considered in such treatment.

8. Newspaper reports are notoriously inaccurate and often sensational. It would be better to read scientific reports, search the internet for reliable information and to consult with your doctor before reaching your own conclusions regarding such reports.

9.
(i) primary data: this is first hand data collected by a student or scientist in doing an experiment or conducting an investigation themselves.
(ii) scientific error: this is a measure of the accuracy of a measurement. No matter how good a measuring instrument is, there is always a difference between the true measurement and the instrument's measurement. The closer these two are the smaller the scientific error.
(iii) system: a group of organs which together carry out a major function (or functions) within the body, e.g. circulatory system
(iv) risk assessment: determination of the dangers associated with a particular experiment or activity in order to plan to reduce the likelihood of damage or injury to people near to or associated with the experiment

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

- Select 100* participants (* large number).
- Randomly from the population
- Divide the group randomly
- 50 in experimental group
- 50 in the control group
- Remove vitamin A from diet of each group – allow several days
- Each group to be treated in every other way possible, the same
- Administer vitamin A tablets to experimental group
- Administer placebo tablets to control group
- Devise means to test night vision, e.g. dimly lit maze – each participant has to negotiate by finding way out using vision only [3 marks]
- Repeat experiment with another randomly selected group
- Compare results from each group
- Results which support hypothesis – experimental group have significantly more success than control
- Results which refute hypothesis: no difference between groups or control group better
- Second hypothesis: Colour vision is affected by vitamin A intake
- Third hypothesis: Increased quantities of vitamin A will further improve night vision
- For presentation, grammar and clarity [2 marks].

TT 2 – CELLS AND TISSUES

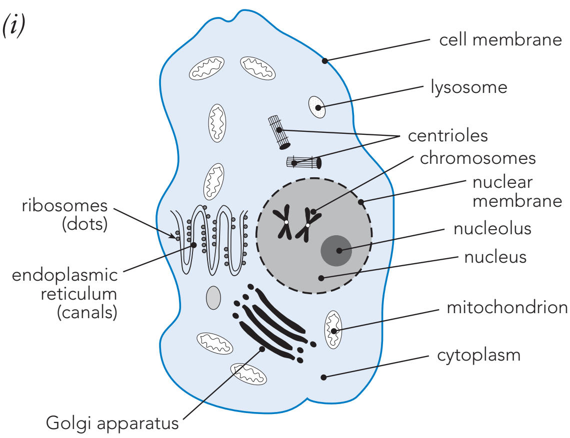
Section 1: Multiple Choice (10 Marks)

1.	d	6.	d
2.	a	7.	c
3.	c	8.	b
4.	d	9.	a
5.	c	10.	d

Section 2: Short Answer (50 marks)

1. The circulatory system is closely connected to the respiratory system in that a network of blood filled capillaries wrap around each air filled alveolus. Oxygen and carbon dioxide are exchanged at this interface. The circulatory system delivers carbon dioxide to the respiratory system and the respiratory system delivers oxygen to the circulatory system. With this integration of systems, life is maintained.

2.
(i)



(ii) Endoplasmic reticulum – Acts as a canal system of membranes which transport substances, e.g. proteins from the site of protein synthesis (ribosome).

Ribosomes – sites where amino acids are bonded to form proteins.

Golgi apparatus – Flat sacs which process, sort and package proteins and lipids into vesicles which are either secretory or lysosomes (ie. contain intracellular enzymes).

Mitochondria – Main sites for the generation of ATP (using aerobic respiration to provide energy to synthesis ATP from ADP and P).

Lysosome – Membrane bounded vesicle formed by the Golgi apparatus containing enzymes, used for intracellular digestion.

Centrioles – Cylindrical structures containing microtubules which are used to form the spindles during cell division.

3.

(i)

TISSUE TYPE	IMPORTANT STRUCTURAL AND FUNCTION FEATURES	EXAMPLES
Epithelial	Various shapes - thin, cubic, column shaped. Many secretory. Cells tightly packed together. Cover or line body parts.	Squamous - line blood vessels, columnar - line much of the digestive tract.
Connective	Often cells embedded in a matrix. Holds various organs together, connects.	Areolar, dense connective, blood.
Muscular	Long and thin cells. Contracts. May move bones.	Skeletal, cardiac, smooth.
Nervous	Cells that have long and short processes extending from a cell body. Conduct nerve impulses.	Brain, spinal cord, spinal nerves, cranial nerves.

(ii) a) Smooth/involuntary/unstriated

b) Cardiac

c) Skeletal/voluntary/striated

4.

(i) "A" does not penetrate right through the two lipid layers. It is "floating" on the outer lipid layer. "B" penetrates right through the two lipid layers.

(ii) Part D is referred to as the hydrophilic region of the lipid molecule. It is attracted to water (water is a major component of the extracellular fluid and the intracellular fluid). Part E is hydrophobic.

(iii) Lipids and proteins.

(iv)

- *The 'fluid mosaic' model of the cell membrane describes the fluid nature of the membrane molecules in that their structure can change shape, sometimes forming infolds as in pinocytosis or pseudopods as in phagocytosis.*
- *It is called a mosaic because it is made up of many different molecules, mainly two layers of lipids (a bilipid structure) which has proteins spread throughout; some of these proteins passing completely through the lipids, others floating on either the outer or inner layer.*
- *There are also other macromolecules adding to the mosaic e.g. glycoproteins, phospholipids, lipoproteins.*

(v) a) fat-soluble particles pass through the membrane by first dissolving in the bilipid layer.

b) small uncharged atoms fit through the spaces between the lipid molecules.

c) water is a relatively small molecule which can move by osmosis between the lipid molecules.

(vi) Protein molecules are too large to fit between the lipid molecules. Therefore, only those proteins that are fat-soluble pass through easily.

(vii) Alcohols dissolve lipids and detergents emulsify lipids.

5.

(i) Phagocytosis.

(ii) Active. The cell must expend energy to bring about this change to its plasma.

(iii) Solid.

(iv) Endocytosis. This is because something has been taken into the cytoplasm.

6.

(i) The very long extension of the cell cytoplasm enables nerve impulses to travel along the cell.

(ii) The bioconcave disc can bend as it passes through narrow blood capillaries and has a large surface area for diffusion.

(iii) The intestinal cell has micro-convolutions (shown here on the top surface) of its plasma membrane. These are called microvilli and increase the surface area for absorption of nutrients from the food.

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

a) Passive transport

- *Substances tend to move through a plasma membrane from where they are concentrated to where they are less concentrated.*
- *This requires no input of energy (the kinetic energy of the particles is sufficient).*
- *Only small molecules or ions may pass between the lipid molecules of the membrane in this way.*

Facilitated diffusion

- *Occurs if the molecule is too large or carries a charge that prevents the movement.*
- *A carrier molecule is required to facilitate.*

- *Facilitated diffusion, as with normal diffusion, occurs down a concentration gradient.*

(any 5 dot points)

b) Osmosis
- *A special case of (passive) diffusion.*
- *Solvent molecule (water usually) moves from where it is most concentrated to where it is less concentrated.*
- *Through a semi-permeable membrane (in living things - the plasma membrane).*

c) Active transport
- *Movement of substances through a plasma membrane against a concentration gradient i.e. from where they are less concentrated to where they are more concentrated:*
- *energy is required*
- *energy is supplied by ATP.*

d) Endocytosis
- *Some molecules or particles are too big or unsuited to be drawn in by facilitated diffusion.*
- *Shape of membrane changes to engulf the particle either by:*
- *phagocytosis – where a false 'foot' or pseudopod grows out in the direction of the particle to engulf it or,*
- *pinocytosis – where an infold called an invagination forms and the particle (here usually a droplet of oil or liquid) is captured.*
- *endocytosis requires energy – it is an active process*
  (you may use diagrams to illustrate these ideas – clearly labelled – and therefore you need not describe them in detail).

e) Exocytosis
- *Some secretions/wastes are too large to leave the cell by diffusion.*
- *They are packaged in a single membrane spherical bag or sac (called a vesicle) usually created by a Golgi body.*
- *The vesicle moves to the plasma membrane, bursts and its contents are pushed out through the membrane.*

TT 3 – METABOLISM

Section 1: Multiple Choice (10 marks)

1. *d*	6. *d*
2. *c*	7. *d*
3. *b*	8. *b*
4. *d*	9. *b*
5. *a*	10. *d*

Section 2: Short Answer (50 marks)

1.

(i) Glucose → Lactic Acid + Energy

(ii) Lactic acid changes the pH of the cell cytoplasm and therefore affects enzyme function.

(iii) Anaerobic respiration occurs in the cytoplasm.

(iv) If one molecule of glucose is respired aerobically 36-38 molecules of ATP can be formed. This compares to 2 molecules of ATP if one molecule of glucose is respired anaerobically.

(v) No, about 50% is lost as heat.

2.

(i) Subtance 5 would form but the final product lactic acid would not.

(ii) The accumulation of lactic acid is likely to inhibit the action of the enzymes, resulting in less glucose being broken down.

(iii) The heat will denature the enzymes and the breakdown of glucose will cease.

(iv) Enzymes fit on to their substrates because they have an appropriate shape. Part of their three dimensional shape is called an 'active site' or 'catalyic site'. This is where the substrate locks on to the enzyme. Heat can change the overall shape of an enzyme, and when it is extreme heat, the change is permanent. The enzymes are 'denatured' and no longer fit with the substrate.

3.

(i) Glucose + oxygen → carbon dioxide + water + energy

(ii) Energy + ADP + P → ATP

(iii) ATP → ADP + P + energy

(iv)
- *Active transport*
- *Endocytosis and exocytosis*
- *Cell division (mitosis and meiosis)*
- *Protein synthesis (anabolic reactions)*
- *Nerve impulses*
- *Movement of organelles/cells*

4.

(i) Proteins contain essential amino acids. These are necessary for growth and repair and the synthesis of enzymes, antibodies and some hormones

(ii) Lipids are a concentrated energy source. They are also required for the absorption of fat-soluble vitamins (vitamins A, D, E & K)

(iii) Carbohydrates (refined)are used as a source of energy. Unrefined carbohydrates are high in fibre and contain vitamins

(iv) Vitamins are organic compounds that the body needs in small amounts but cannot synthesise itself. Some are enzyme cofactors and coenzymes, others regulate mineral metabolism, cell and tissue growth and differentiation and some are antioxidants.

(v) Oxygen is needed for aerobic respiration, a source of energy to synthesise enough ATP for the cell's activities

(vi) Water is the universal medium in which all cell metabolism takes place.

(vii) Minerals are inorganic substances that the body requires. Some are needed in larger amounts, others as trace elements. Calcium, phosphorus, and magnesium are important

for bone development. Sodium, chloride and potassium ions help maintain the osmotic pressure within cells. Sulfur helps stabilize protein structures.

5.

(i) pH: enzymes have an optimum pH, a pH at which they work best. Generally in body cells this is slightly more than 7 (slightly alkaline), although stomach enzymes (e.g. pepsin) optimum pH is close to 2 (very acidic)

(ii) Temperature: enzymes have an optimum temperature, a temperature at which they work best. For most enzymes in the human body this is around 37°C.

(iii) Presence of inhibitors: these are chemicals that bind to enzymes and prevent the substrate from entering its active site. Some occur naturally in the body and regulate metabolism. Their action is often reversible so that the enzyme can resume its required catalytic activity.

(iv) Co-enzymes and co-factors: coenzymes are organic compounds (e.g. a vitamin) which assists enzymes by carrying chemical groups or atoms from one enzyme to another. Co-factors are mainly inorganic, e.g. metal ions. Some enzymes only work in the presence of a particular cofactor. The cofactor may bind the enzyme and the substrate together or it may serve as the active site of the enzyme itself.

(v) The concentration of reactants and products: the more concentrated the reactants are the faster the forward reaction will proceed and vice versa. Products have the opposite effect. If allowed to accumulate they slow the forward reaction. Some act as enzyme inhibitors.

6.

(i) Two properties of catabolic reactions –
a) products are less complex molecules than the reactant/s (or have less energy than reactants)
b) overall energy is released

(ii) Aerobic respiration

(iii) In mitochondrion

(iv) Two properties of anabolic reactions –
a) products are more complex than reactants (or have more energy than reactants)
b) overall energy is absorbed

(v) Protein synthesis

(vi) On ribosomes

(vii) Metabolism refers to all the chemical processes that occur in the body both anabolic and catabolic.

(viii) More heat energy is released through catabolic reactions than is taken up through anabolic reactions. There is therefore net heat production by the body.

(ix) The metabolism in living cells is controlled by enzymes and most of these operate best at about 37°C (a temperature well above normal ambient temperatures). The heat released in metabolism produces this temperature.

7. A competitive enzyme inhibitor is a substance that occupies the active site of an enzyme and therefore prevents the substrate from entering the enzyme. A non-competitive enzyme inhibitor attaches to the enzyme but not to the active site. It may change the shape of the active site and make it unlikely to fit the substrate. Both inhibitors stop or slow down the catalysing action of the enzyme.

Section 3: Extended Answer (20 marks)

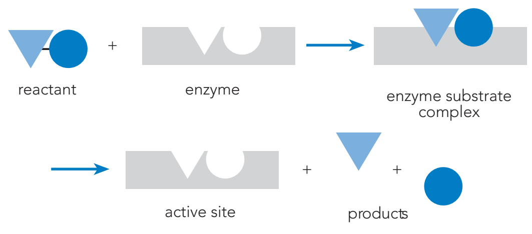
(each dot point = 1 mark unless otherwise stated).

(i) **The 'Lock and Key' model**

- Every enzyme is a protein (with more than 100 amino acids).
- Each enzyme has a 'tertiary' – three dimensional shape determined by the total number of its amino acids and their arrangement in a long chain-like structure.
- Within this shape is an area called the 'active site' which is also a particular shape. This is called the 'key'.
- Into the active site the reactant/reactants (the 'lock') fit temporarily to form an 'enzyme substrate complex'.
- While held in the active site, the substrate is more likely to combine or dissociate (break apart).
- After doing so, the resulting product/products move out of the active site.
- The active site is then ready to accept more reactant/s and so the enzyme is recycled.

This can be illustrated as shown below:

•••



(Note: this is a catabolic reaction – the reverse of the diagram could be used to show an anabolic one.)

(ii)

- Enzymes have an optimum temperature.
- The shape of the active site is critical to its efficiency in accepting the reactant/s.
- If the shape of the active site changes, it will no longer catalyse a reaction as rapidly. It will cease to do so if the shape changes significantly.

- *Temperature may cause the enzyme to alter its shape, as its amino acid molecules vibrate and move within the macromolecule.*
- *If this change is too extreme, the shape may not return to its normal shape and the enzyme is described as "denatured".*

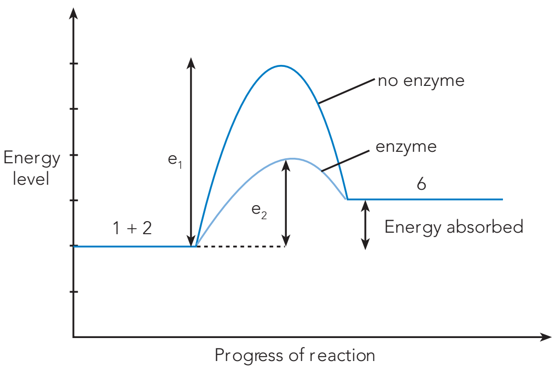
(iii)

- *The activation energy is the energy which is necessary to begin the reaction.*
- *Heat may be supplied to provide this energy. (However excess heat is detrimental to enzyme action as it changes the shape of the enzyme).*
- *Enzymes have the effect of lowering the activation energy necessary for a reaction to proceed.*
- *Therefore enzyme controlled reactions proceed rapidly without the need for excessive heat input.*
- *They do not require as much energy.*

[4 marks]

The diagram below shows, in a graphical form, the energy changes that occur when substances 1 and 2 react with and without an enzyme (e_1 and e_2 indicate the activation energy in each case).

••



TT 4 – RESPIRATORY SYSTEM

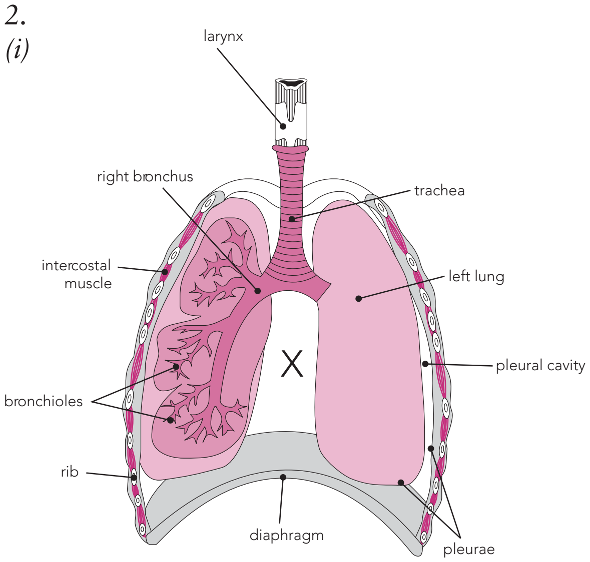
Section 1: Multiple Choice (10 marks)

1. c	*6. c*
2. a	*7. a*
3. d	*8. b*
4. c	*9. d*
5. b	*10. c*

Section 2: Short Answer (50 marks)

1.
(i) Olfactory receptors
(ii) Vocal cords
(iii) Cartilage
(iv) Pleurae
(v) Diaphragm
(vi) Intercostal muscles
(vii) Haemoglobin
(viii) Bicarbonate ions

2.
(i)



(ii) Heart (the space is called mediastinum).
(iii) Ciliated epithelium help to remove dust etc. in mucus from the bronchi and trachea.
(iv) Nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveoli, lung capillaries.

3.
(i) Warms air.
(ii) Moistens air.
(iii) Remove some dust, pollen, etc.
(iv) Detects odours.

4.
(i)

- *Diaphragm and external intercostals contract.*
- *This increases volume of thoracic cavity and lungs.*
- *Causes decrease of pressure in lungs.*
- *Air flows from higher pressure region outside lungs into the lower pressure region inside lungs.*

(ii)

- *Diaphragm relaxes and internal intercostals contract.*
- *This decreases volume of thoracic cavity and lungs.*
- *Causes increase of pressure in lungs.*
- *Air flows from higher pressure region inside lungs out to the lower pressure region outside lungs.*

(iii) Intercostals (muscles between the ribs).

5. As it is breathed in it is warmed, filtered and moistened. It has a high level of oxygen and a low level of carbon dioxide. As it is breathed out it has a lowered level of oxygen and an increased level of carbon dioxide.

6.
(i) Greater concentration of oxygen in X than in Y causes oxygen to diffuse from X to Y. The greater concentration of carbon dioxide in Y than in X causes carbon dioxide to diffuse from Y to X.
(ii) Most oxygen (97%) attaches to haemoglobin in the erythrocytes and travels as oxyhaemoglobin, only 3% dissolves in the plasma.

(iii) So that oxygen can first dissolve in this fluid then move by diffusion into the plasma in the capillaries.

(iv)

- Each alveolus is thin (one cell thick)
- There are many alveoli (large surface area)
- Alveoli have a lining of moisture (for diffusion)
- There is always a diffusion gradient while blood moves past in the capillaries.

7.

(i) Nitrogen, inert gases.

(ii) From 4.5% to 9.5%, an increase of 5% by volume of air exhaled (ie. a 111% increase).

(iii) From 5% to 10%, an increase of 5% (ie.a 100% increase)

(iv) More energy is required during exercise. The energy is provided by respiration. Respiration uses oxygen and produces carbon dioxide as waste.

(v) Breathing air that is relatively dry causes water to evaporate from the lungs, we therefore normally lose water when breathing.

8.

(i) Its efficiency would decrease as the concentration gradient between oxygen in the alveoli and the blood could not be maintained.

(ii) Shortness of breath, laboured breathing and lack of energy.

(iii) Removal of the source of atmospheric irritation. A smoker should immediately stop smoking.

9.

(i) Narrowing the airways makes it more difficult to inhale and exhale air.

(ii) The inhalants cause the muscles in the bronchioles to relax and some inhalants also reduce or dry up the mucus that exacerbates the problem.

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

- *Gases concentration gradients must be maintained.*
- *Oxygen levels in the alveolus must be kept greater than in the blood of the capillaries around them.*
- *Alveoli must have a large S.A.*
- *Alveoli need to be moist.*
- *Alveoli need to be elastic.*
- *Alveoli must be protected physically.*
- *Alveoli must be kept free from pathogens.*
- *Alveoli must be kept free of dust etc.*
- *Alveoli need to be well supplied with deoxygenated blood.*

To achieve these:

- *Alveoli are continuously filled and flushed by the respiratory action of inhaling and exhaling.*
- *Alveoli are wrapped in capillaries with a flow of new blood which is continuously replaced by the pumping action of the heart.*
- *Alveoli must be microscopic and numerous.*
- *Alveoli need to be removed from air (deep in the body) – kept moist.*
- *Alveoli can stretch and return to original size.*
- *Ribs protect the lungs.*
- *White blood cells (macrophages) live on the inner surface of the alveoli – removing most pathogens that reach them.*
- *Cilia which line the lower nasal passage, trachea and bronchi trap dust and pathogens – waft it upwards.*
- *Cilia have a coating of mucus, produced by the mucosa lining these areas, to help trap foreign particles.*
- *Air is warmed in the nasal passage which increases the rate of diffusion in the alveoli.*
- *Air is also moistened in the upper respiratory tract which reduces evaporation from the surface of the alveoli.*
- *Grammar, clarity. [2 marks]*

TT 5 – CIRCULATORY SYSTEM

Section 1: Multiple Choice (10 marks)

1. d	6. d
2. c	7. c
3. d	8. b
4. b	9. b
5. c	10. d

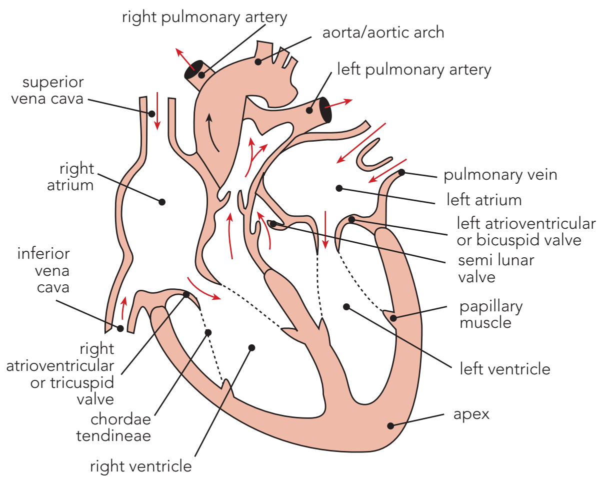
Section 2: Short Answer (50 marks)

1.

(i) Pericardium
(ii) Systole
(iii) 0.8 seconds
(iv) Pulmonary circulation
(v) Sphygmomanometer
(vi) Nucleus
(vii) Extracellular
(viii) 55%

2.

(i)



(ii) *Prevent backflow of blood from the ventricles into the atria when the ventricles contract (i.e. during ventricular systole).*

(iii) *These valves prevent backflow of blood from the arteries (aorta and pulmonary) into the ventricles during ventricular diastole.*

(iv) *The first sound is the atrioventricular valves closing and the second sound is the semi-lunar valves closing.*

3.

(i) *C*

(ii) *A*

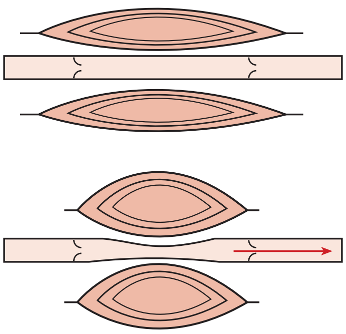
(iii) *B*

(iv) *X – Endothelium*
Y – Elastic fibres and smooth muscle
Z – Elastic and collagen fibres.

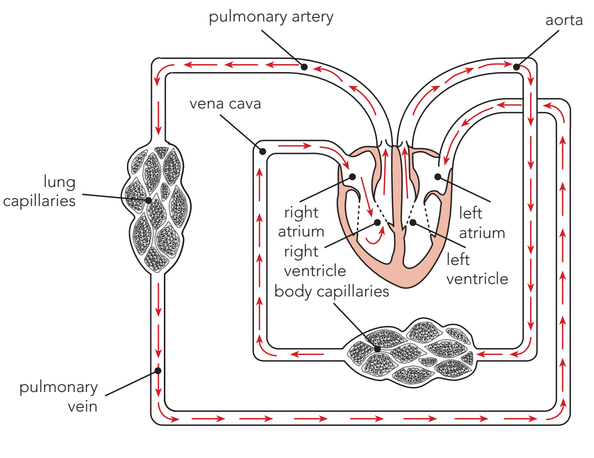
(v) *Artery – Must expand to allow for the extra pressure and then contract to keep the blood flowing.*
Vein – Contains valves to prevent backflow of slowly moving blood and has less muscle and elastic fibres as blood in the veins is at a lower pressure
Capillary – Thin layer of cells to enable substances to diffuse to and from the plasma

(vi) *To direct the blood forward, towards the heart.*

(vii)



4. *(i) and (ii)*



(iii) *a) Pulmonary arteries, lung capillaries, pulmonary veins*
b) Aorta, other arteries branching from the aorta, body capillaries and vena cavae.

5.

(i) *Carry oxygen (as oxyhaemoglobin) from the lungs to the body tissues and carry carbon dioxide from the body tissues to the lungs (as carbaminohaemoglobin).*

(ii) *Provide protection from diseases.*

(iii) *Assist with the clotting of blood. They adhere to the fibres which form at the site of an injury and help to form a clot.*

6. *Because more fluid leaves the blood at the arterial end than returns at the venous end of the capillary network, excess fluid must be drained away via the lymph vessel.*

7.

(i) *ventricular systole.*

(ii) *intracellular fluid.*

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

a)

- *a single celled animal has a large SA:Vol ratio.*
- *inputs and outputs move by diffusion or active transport efficiently and rapidly.*
- *a larger multicellular organism has a smaller SA:Vol ratio.*
- *many cells in the body of a multicellular organism are deep in the body and removed from oxygen and food sources.*
- *diffusion to and from these cells would occur too slowly.*
- *multicellular organisms therefore need a system to deliver nutrients and remove wastes – the circulatory system carries out this function.*

b)

- *circulatory system carries deoxygenated blood to the alveoli.*
- *oxygen is exchanged for carbon dioxide.*
- *oxyhaemoglobin in red blood cells (erythrocytes) carries oxygen to the body cells.*
- *the heart pumps deoxygenated blood to the lungs and oxygenated blood to the body cells.*
- *blood passing through the capillaries of the villi in the digestive tract absorb nutrients.*
- *blood vessels carry blood to the body cells under pressure from the heart.*
- *fluid moves out of the arterial end of the capillary network carrying oxygen (and nutrients) to the body cells.*
- *fluid moves back into the capillaries at the venous end, carrying wastes including carbon dioxide back into the blood.*
- *carbon dioxide travels dissolved in the plasma, as bicarbonate ions and attached to haemoglobin in the erythrocytes (carbaminohaemoglobin).*

- *blood carries the deoxygenated blood with its carbon dioxide back to the heart then to the lungs*
- *other wastes are removed from the blood as it passes through the kidneys.*
- *excess fluid and some wastes are removed from the intercellular spaces by the lymphatic system which empties into the circulatory system near the superior vena cava.*
- *For presentation, grammar and clarity [2 marks].*

TT 6 – DIGESTIVE SYSTEM

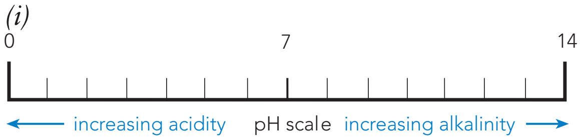
Section 1: Multiple Choice (10 marks)

1. *c*	6. *a*
2. *a*	7. *c*
3. *c*	8. *d*
4. *c*	9. *c*
5. *d*	10. *b*

Section 2: Short Answer (50 marks)

1. (i) *Chemical digestion*
(ii) *Metabolism*
(iii) *Enzyme*
(iv) *Liver*
(v) *Hydrochloric*
(vi) *Lipase*
(vii) *Amino acids*
(viii) *Villi*
(ix) *Peristalsis*
(x) *Molar*

2.
(i)

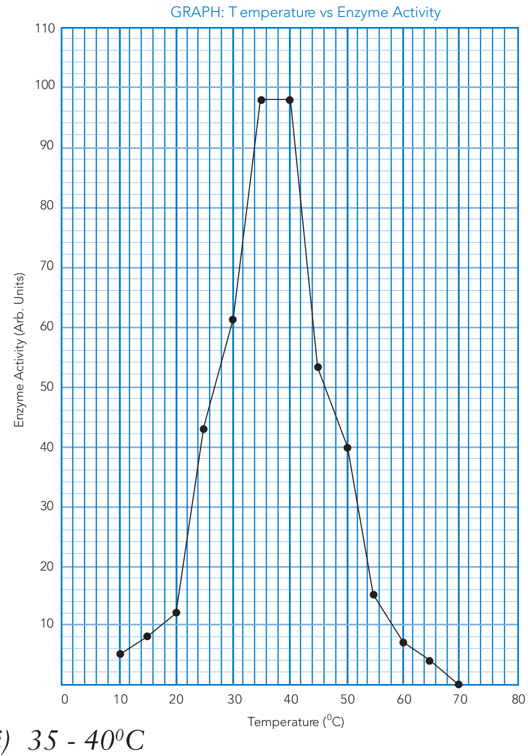


(ii) *Inactive pepsinogen is converted to pepsin by the acidic environment created by hydrochloric acid in the stomach. Pepsin digests protein.*
(iii) *Most human enzymes work best in the slightly alkaline environment of the cell fluids.*

3.
(i) *The net movement of water is into the bag. Water moves in by diffusion (this process is called osmosis) and causes the liquid pressure inside the bag to increase. This makes the bag turgid.*
(ii) *Water moves into the bag at a faster rate than the sugar can diffuse out. However, as the water reaches an equilibrium, the sugar continues to leave the bag for some time before its movement reaches an equilibrium. (Sugar molecules are smaller than starch molecules; they can diffuse through the membrane).*

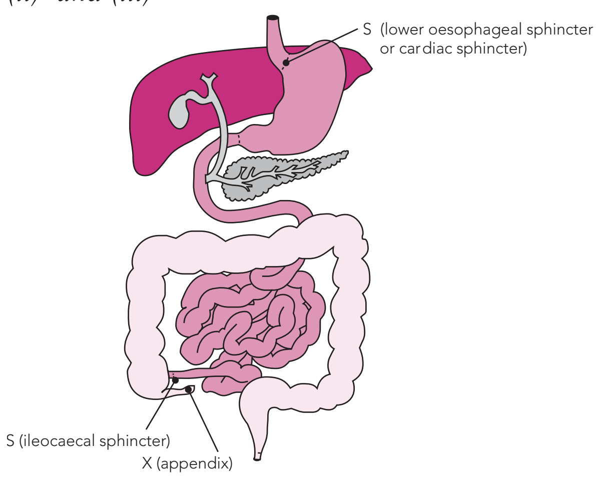
4.
(i) *a) Glycerol.*
b) Fatty acids.
(ii) *As glycogen.*
(iii) *Polysaccharide.*

5.
(i)



(ii) *35 - 40^{0}C*

6.
(i) *a) Liver – stores glycogen, breaks down excess amino acids and old red blood cells, produces bile, detoxifies poisons*
b) Gall bladder – stores and concentrates bile
c) Small intestine – digests and absorbs food
d) Large intestine – stores wastes, reabsorbs water and absorbs some vitamins
e) Rectum – stores faeces before elimination
f) Stomach – digests protein
g) Pyloric sphincter – prevents food moving into duodenum until ready
h) Pancreas – produces digestive enzymes and two hormones (insulin and glucagon)
(i) Anus – sphincter which allows faeces to leave rectum
(ii) *and (iii)*



7.

(i)

a) Intestinal gland – produces enzymes for digestion of food in the small intestine, e.g., lipase, amylase, peptidase.

b) Blood capillary – absorbs the products of protein and carbohydrate digestion.

c) Lacteal – carries away triglycerides (fatty acids and glycerol combined).

(ii) They have microvilli, microscopic folds in their cell membranes on the absorption surface, that increases the rate at which they can absorb digested materials.

8.

Organ	Enzyme	Acts Upon	Products
Salivary glands	(i) salivary amylase	Starch	Disaccharide (maltose)
Stomach	Pepsin	(ii) proteins	Peptides
Pancreas	Pancreatic - amylase - lipase - protease - nucleases	starch (iv) lipids protein (v) nucleic acids	(iii) disaccharide fatty acids & glycerol peptides sugar & nitrogen bases
Small Intestine	Maltase Sucrase nuclease lactase peptidase	(vi) disaccharide disaccharide nucleic acids disaccharide peptides	monosaccharide monosaccharide sugar & nitrogen bases (vii) monosaccharide amino acids

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

- *ingestion involves taking food into the mouth.*
- *mechanical digestion – food is broken down into smaller particles to increase SA:Vol for chemical digestion and to make swallowing easier.*
- *mechanical digestion – largely carried out by teeth.*
- *mechanical digestion also occurs in the churning processes of the stomach and peristalsis along the entire intestine. Peristalsis propels the food down the digestive tract.*
- *mechanical digestion is also carried out by bile when it emulsifies fats.*
- *chemical digestion begins in the mouth with salivary amylase (starch → maltose).*
- *salivary glands (3 pairs) secrete a mixture of mucus and salivary amylase.*
- *stomach (gastic pits) secrete inactive pepsinogen, mucus and HCL which begins chemical digestion of proteins.*
- *duodenum receives pancreatic juices containing lipase, protease, amylase, nuclease which break down lipids, peptides, polysaccharides, disaccharides, nucleic acids.*
- *intestinal glands in the small intestine also produce enzymes which complete the chemical digestion of all classes of food.*
- *absorption of the products of chemical digestion occurs mainly in the first half of the small intestine (ileum).*
- *these products include amino acids, simple sugars (monosaccharides), fatty acids and glycerol, and nitrogenous bases (from nucleic acids).*
- *other nutrients which are not digested chemically because they are small enough to be absorbed include minerals and vitamins.*
- *the villi of the small intestine have secretory cells and absorptive cells which absorb these small molecules.*
- *microvilli which are microscopic folds in the absorptive cells further increase the efficiency of the absorption.*
- *the amino acids, sugars, vitamins and minerals pass into the capillaries in the villi (then to the hepatic portal vein).*
- *the products of lipid digestion mostly pass into the lacteals in the villi which are part of the lymphatic system.*
- *in the large intestine some vitamins are absorbed but more importantly much of the water is absorbed and passed into the blood.*
- *the large intestine forces the wastes (now called faeces) towards the last section of the digestive tract called the rectum.*
- *the faeces remain in the rectum until the voluntary relaxation of the anal sphincter allows it to be eliminated.*

TT 7 – MUSCULOSKELETAL SYSTEM

Section 1: Multiple Choice (10 marks)

1.	d	6.	b
2.	a	7.	c
3.	d	8.	c
4.	d	9.	d
5.	a	10.	c

Section 2: Short Answer (50 marks)

1.

(i) Articulation/joint

(ii) Yellow marrow

(iii) Sutures

(iv) Coccyx

(v) Acetabulum

(vi) Calcaneous

(vii) Periosteum

(viii) Foramen magnum

(ix) Contract

(x) Antagonistic

2.

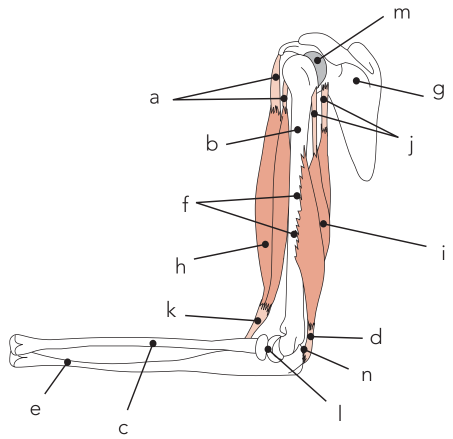
(i) Flexion.

(ii) Extension.

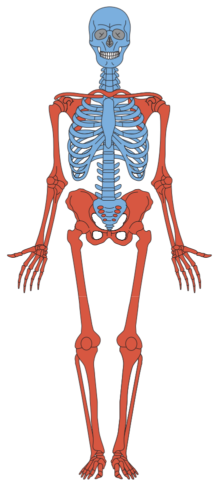
(iii) Tough connective tissue which connects muscle to bone.

(iv) Tough connective tissue which connects bone to bone.

3.



4.



5.
(i) a) Epiphysis b) Diaphysis c) Epiphyseal line
(ii) Periosteum
It provides cells which repair broken bones, and it helps anchor ligaments and tendons. It contains a rich supply of blood and lymph vessels and nerves.
(iii) Z – Compact, X – Spongy/cancellous
(iv) Articular cartilage
Reduce the friction between articulating surfaces.

6.
(i) Cruciate ligaments
(ii) Synovial fluid
(iii) Lubricates and provides nutrients to the cells of the joint
(iv) Meniscus (plural – menisci)
(v) To add stability to the joint

7.
(i) Carrying angle
(ii) The centre of gravity does not shift from left to right as we walk.
(iii) Acetabulum
(iv) Because humans are bipedal it has a greater proportion of the total weight to support.

8.
(i) To support the weight of the internal organs above it and the weight of a foetus when necessary.
(ii) This adds stability as humans are bipedal.

9. The skeleton:
- protects delicate internal organs
- enables movement
- supports other systems
- manufactures blood cells
- stores minerals and fat.

10. The vertebral column
- has an "s" shape for stability
- the sacral vertebrae are fused to the pelvis for stability
- has wedge shaped vertebrae for balance
- has progressively larger vertebrae as it descends from the cervical vertebrae to the lumbar vertebrae section for weight bearing strength

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

(i) Sliding filament model of muscle contraction
- Filaments pass/slide over each other. This causes a shortening of the muscle.
- ATP provides the energy needed
- Thick filaments are composed of the protein myosin
- Thin filaments are composed of the protein actin
- Actin filaments slide over the myosin filaments
- Sarcomere shortens
- Calcium is released from the sarcoplasmic reticulum

(ii) Three types of joints

Immoveable/sutures/fibrous/fixed
- have very little movement
- bones are held together tightly by fibrous connective tissue

Cartilaginous/slightly moveable
- limited movement in one plane
- held in place by cartilage
- located between vertebrae – part of spinal column

Synovial/freely moveable
- synovial fluid fills a cavity between the articulating bones
- movement varies depending on ligaments, bone shape, muscles and other adjoining bones but has the greatest movement of the three types

(iii) Three types of muscle

Smooth/unstriated/involuntary
- located in alimentary canal, iris, blood vessels, bladder
- moves food along tract, promotes fluid flow, opens and closes apertures
- under involuntary control

Skeletal/striated/voluntary
- located in limbs – arms, legs, face
- enables body movement
- under conscious control

Cardiac

- only in heart
- causes heart to contract forcing blood into arteries
- under involuntary control

TT 8 – EXCRETORY SYSTEM

Section 1: Multiple Choice (10 marks)

1. b	6. d
2. d	7. a
3. b	8. b
4. c	9. c
5. b	10. d

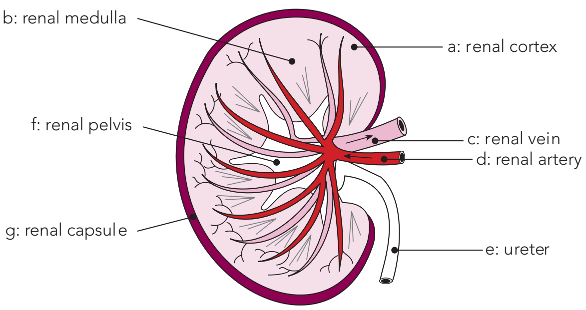
Section 2: Short Answer (50 marks)

1.
(i) deamination
(ii) urea
(iii) diabetes
(iv) nephron
(v) renal artery
(vi) dialysis machine
(vii) water
(viii) sphincter
(ix) ammonia
(x) lungs

2.

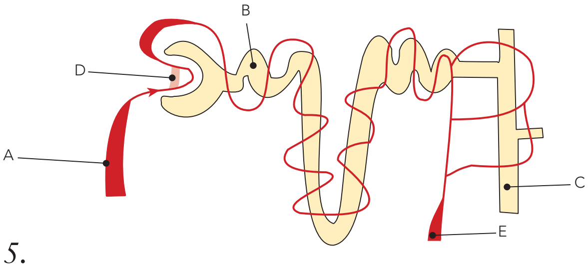
STRUCTURE	NAME	FUNCTION
a	kidney	filters blood and regulates blood's water levels
b	bladder	store urine
c	ureter	transfers urine to bladder
d	urethra	transfers urine to outside body
e	aorta	carries blood towards kidney

3. (i) & (ii)



(iii) filtration (and reabsorption and secretion).
(iv) kidney pelvis.
(v) protects the kidney from physical damage.
(vi) it has a greater amount of muscle and elastic fibres in it.
(vii) because the rental artery is a branch of the aorta. The aorta carries blood from the left ventricle.

4.



5.
(i) Deamination
(ii) It is highly toxic
(iii) It may be used as a source of energy
(iv) Into the blood circulation
(v) It is a waste product of respiration
(vi) The reactants CO2 and NH3 are relatively small molecules, whereas the product urea is more complex (its chemical formula is (NH2)2CO)
(vii) Ammonia is highly toxic. It must be converted to the less toxic urea so that it does not damage the liver cells.
(viii) Generally the more concentrated a toxic substance is, the more toxic it becomes.
(ix) On a hot, dry day when you are sweating profusely, less water is available for diluting the urea, therefore the urine becomes more concentrated.

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

Kidneys

- Blood enters kidney via renal artery, a branch of aorta.
- Nephrons filter the blood.
- Filtrate is pushed into the glomerular (Bowman's) capsule.
- High pressure is created by heart (mainly) and arteries.
- Pressure is increased by the narrow lumen of glomerulus and the narrow efferent arteriole.
- Substances in the filtrate that are still needed are reabsorbed in the tubules of nephron.
- Glucose and amino acids are reabsorbed in the proximal convoluted tubule.
- Water may be reabsorbed in proximal and distal convoluted tubules, also in the loop of Henle and the collecting duct.
- Excess minerals, urea and other metabolic wastes move to the collecting ducts and are excreted via the ureters, bladder and urethra.
- Some molecules are reabsorbed by diffusion, some by active transport.
- Hydrogen ions and other ions that may be in excess in the blood are actively secreted into the convoluted tubules

- *Nephrons are able to regulate the pH of the blood*
- *Long proteins and blood cells are too large to be filtered and remain in the blood*
- *Filtered blood leaves kidney via renal vein*

Liver

- *Proteins and amino acids cannot be stored in the body*
- *The liver deaminates excess amino acids (and proteins)*
- *Deamination produces urea and useful carbohydrates*
- *Urea is toxic and must be removed from the blood*

Lungs

- *CO_2 produced by cells is a metabolic waste that needs to be excreted*
- *The blood carries CO_2 to the lungs*
- *In the lungs CO_2 is exchanged for O_2*
- *CO_2 is exhaled*

Skin

- *Some urea and other metabolic wastes are lost with sweat from the skin*
- *This is only a secondary function of sweat glands – their primary function being temperature control*

(Must have at least 2 points from each organ to get full marks))

TT 9 – SCIENCE AS A HUMAN ENDEAVOUR 1

Section 1: Multiple Choice (10 marks)

1.	*b*	6.	*c*
2.	*d*	7.	*b*
3.	*b*	8.	*b*
4.	*b*	9.	*a*
5.	*d*	10.	*d*

Section 2: Short Answer (50 marks)

1.

(i)	*coronary artery*	*(ii)*	*stroke*
(iii)	*heart attack*	*(iv)*	*angina*
(v)	*emphysema*	*(vi)*	*cirrhosis*
(vii)	*hypertension*	*(viii)*	*malignant*
(ix)	*roughage*	*(x)*	*hygiene*

2.

(i) Step 1: 3 × 1.5 × 10 = 4.5 × 10 = 45 (Peter has consumed 45g of alcohol)
Step 2: 2 × 7.5 = 15 (Peter's liver has broken down 15g of alcohol in the 2 hours)
Step 3: 45 - 15 = 30 (Peter still has 30g of alcohol in his blood)
Step 4: 77 × 6.8 = 523.6 (this is a measure of the mass of Peter's blood)
Step 5: 30 /523.6= 0.057% (this is Peter's BAC)
Peter's blood alcohol concentration is approximately 0.06 %

(ii) A blood alcohol concentration of this level increases a person's reaction time and makes them slower to react to emergencies. Peter would risk his life and other peoples if he were to drive a car immediately after drinking 3 cans of beer over a two hour period.

(iii) The best thing for Peter to do is to wait so that his liver has time to break down the alcohol he has consumed. (If he waited for one hour without having any further alcohol his BAC should be approx 0.043 % , you can calculate this adding the hour and therefore changing Step 3 to 3 × 7.5 = 22.5)

3.

(i) a) calcium b) calcium c) iron

(ii) a) vitamin C b) vitamin D c) vitamin A

(iii) Diet (e.g., high salt intake), being overweight, high alcohol consumption.

(iv) High saturated fats intake, high salt intake, low levels of physical exercise, being overweight, smoking, excessive alcohol intake.

(v) We need water to metabolise fat, to eliminate waste and toxins, lubricate joints, medium in which metabolic processes occur.

4. (i)

- *Alcohol dampens the central nervous system. It is therefore described as a depressant.*
- *Speech becomes slurred.*
- *Vision blurred, unable to fix on particular point. Telescopic or 'tunnel vision' develops.*
- *Balance disturbed.*
- *Loss of consciousness (if alcohol intake is very high).*
- *Blood vessels on periphery of the body dilate – causing more blood to flow to skin – causing a red 'glow' to appear.*
- *Blood pressure drops first, but then the heart rate rises and blood pressure increases (any 5 dot points – maximum 5 marks).*

(ii) The loss of consciousness prevents the person from further intake and may prevent death through poisoning.

5.

(i) Brain cells can be destroyed leaving the person with a loss of memory and an inability to concentrate.

(ii) An increase in blood pressure, an increase in fatty compounds in the blood and as a consequence atherosclerosis develops, coronary heart disease and strokes occur.

(iii) Reduced absorption of nutrients – may cause malnutrition. Absorption of vitamin B becomes impaired. This causes damage to the nervous system, heart failure and impaired balance. Alcohol exacerbates stomach and duodenal ulcers.

(iv) Prolonged use of excessive alcohol causes cirrhosis of the liver, when healthy liver cells are replaced by fibrous tissue. The liver is then unable to synthesise the many enzymes which are essential for good health.

6. Size of person, Age, Metabolic rate, Sex.

Section 3: Extended Answer (20 marks)

(Answer could be presented in a table as below. Must have at least 2 dot points for each quadrant to get full marks)

	OSTEOARTHRITIS	OSTEOPOROSIS
causes and risk factors [max 6 marks]	• cartilage in joints breaks down – bone rubs on bone • can be due to repetitive movement – work or sport • wear and tear due to ageing • may begin as result of an injury often affects elderly	• living bone is continuously broken down and replaced, with osteoporosis bone tissue and minerals are lost faster than the bone is replaced • this imbalance is influenced by oestrogen (in women) • also by the levels of calcium and vitamin D. • frequently develops with menopause.
prevention [max 8 marks]	• a correct body weight through • regular exercise and good diet • avoid repetitive stress on the joints • avoid injury to joints.	• appropriate intake of calcium & Vitamin D • weight bearing exercises help • strengthen bone • exercise should be continued where possible throughout life • avoid excessive alcohol and smoking which contribute to the development of this disease.
management [max 6 marks]	• a combination of exercise and lifestyle modification, especially weight reduction • analgesics • joint replacement may be carried out.	• medications may be used to treat some cases of osteoporosis. • increased calcium and vitamin D intake • exercise may also be recommended. • regular bone density checks to monitor progress of exercise and medication.

TT 10 – SCIENCE INQUIRY SKILLS 2

Section 1: Multiple Choice (10 marks)

1. *d*	6. *c*
2. *a*	7. *b*
3. *b*	8. *a*
4. *c*	9. *d*
5. *a*	10. *c*

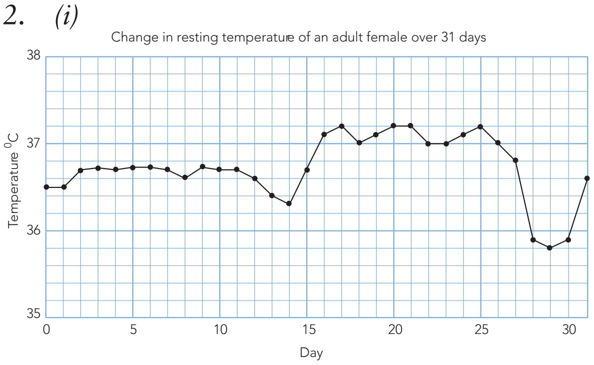
Section 2: Short Answer (50 marks)

1. (i)

- *Identify the dangers and problems associated with the experiment*
- *Assess the risks of exposure to the dangers*
- *Control any risks by adopting safe procedures and using suitable precautions*

(ii) *A risk assessment is necessary so that the person/s carrying out the experiment and others in the vicinity are not exposed to unnecessary danger. If there are dangers associated with the experiment, procedures must be taken to minimize the likelihood of injury.*

2. (i)



(ii) *The resting temperature of an adult female does not remain constant over the month. There is a sharp drop on the 25th day of these readings.*

(iii) *Repeat the measurements with a large number of women taken at random from the population.*

(iv) *Temperature varies with the cyclical change in the menstrual cycle.*

(v) *Resting temperature variation over the same time will not be as great in an adult male.*

(vi) *Randomly select a number of adult males from the population and measure their resting temperatures over a thirty one day period.*

3. *Secondary data is data that has been collected by others that may be used or studied by someone who did not conduct the experiment or gather the data themselves.*

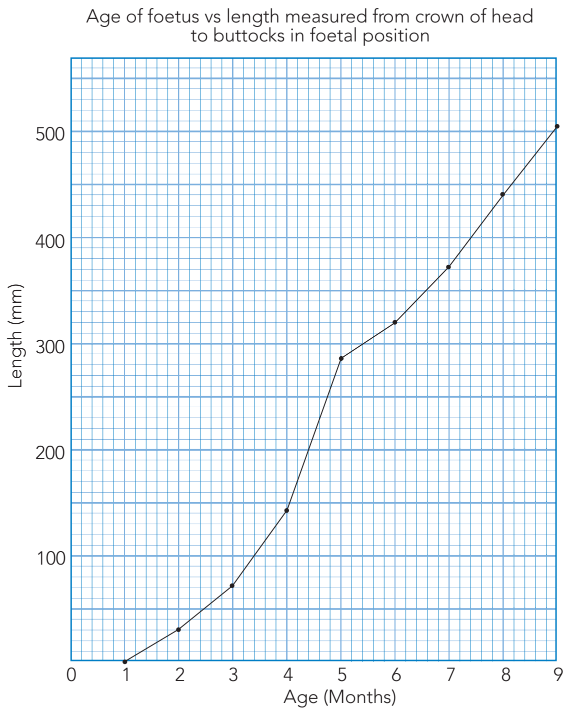
- *A scientist who visits Rottnest to do a bird count could publish his results in a scientific journal. Others may use this data to compare bird populations on islands elsewhere in the world. The later are using his data as secondary data.*
- *Primary data is data collected by the person/s conducting the research themselves. In the example above the scientist doing the bird count will have collected primary data.*

4.

(i)

Age (mths)	1	2	3	4	5	6	7	8	9
Length (mm)	6	30	73	143	286	320	373	440	506

(ii)



5. a) Observation: Something which is seen, heard, smelt, felt, tasted or detected using an instrument.
b) Hypothesis: An educated guess which provides a testable explanation for observations.
c) Prediction: A forecast of what a future observation might be.
d) Data: Observations (e.g. numerical measurements) obtained in an experiment used to arrive at a conclusion.
e) Random: Without bias; usually used to describe the way in which samples are chosen.
f) Placebo: Something that is often used in drug trials. Although it resembles the drug being tested, it is not the drug and is used to see if the effect is due to the drug itself rather than a positive attitude by an individual because they are taking 'something'.
g) Variable: A factor which changes or can change, e.g. temperature.
h) Sample: A small part taken from the whole which represents the whole.
i) Replicate: To carry out a similar/copy of an experiment.
j) Procedure: The order in which an experiment is carried out – method used.

6.
(i)
- Randomly pick several hundred pea pods, e.g. 500.
- Divide these randomly into two equal groups.
- Place half, the experimental group, into a freezer and keep the other half, the control group, in a room at normal temperature, e.g. 20°C.
- Leave both groups at their respective temperatures for one week.
- Remove both samples and using an appropriate test, test each for the amount of Vitamin C.
- Calculate the average Vitamin C concentration in both the control seeds and the experimental seeds.
- Record all the results obtained.
- Determine whether the results support or refute the hypothesis.

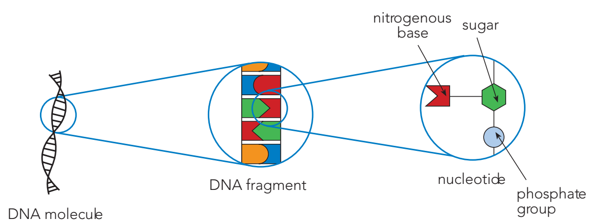
(ii) Age of pea pods, the pea variety, soil in which peas are grown, the light pea plants receive, amount of water given to plants, time of treatment.
(iii) a) Temperature at which peas are kept after picking.
b) Concentration of Vitamin C in peas.
(iv) a) The peas which were frozen should have a greater concentration of vitamin C than those which were kept at room temperature for several days.
b) The peas which were frozen have less or the same concentration of vitamin C in them as those which were kept at room temperature for several days.
(v) A larger sample, e.g. 1000 pea pods or replicates from which similar results were obtained.

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

1. (i) The DNA molecule
- It takes the form of a double helix.
- Contains four nitrogenous bases (adenine, thymine, cytosine, guanine)
- Bases are paired – adenine with thymine, guanine with cytosine
- It has a backbone of deoxyribose sugar and a phosphate group
- A nitrogen base, sugar molecule and phosphate group make up a nucleotide
- It is double stranded
- Very long molecule – has tens of thousands of base pairs
- Hydrogen bonds join the nitrogen bases.

••••



- *The sequence of nitrogen bases forms a code*
- *The code is for an amino acid sequence in protein synthesis*
- *Each amino acid in the protein sequence is coded for by 3 bases on the DNA*
- *The DNA code for an amino acid is called a triplet code (or codon)*
- *A small change to the order of bases (or if one base was added or deleted) might change an amino acid in the protein chain*
- *The mRNA formed in the transcription stage would be different*
- *The order or number of amino acids linked in the translation stage would probably be different*
- *The protein synthesized would be different – it may not function in the body's metabolism as efficiently as it should or it may not function at all.*

(ii)

- *If the abnormal protein formed was an enzyme that did not function normally (or the enzyme was missing altogether)*
- *The cell's metabolism may be different, chemical processes may not occur at the correct rate, a waste may not be broken down, an essential product may not be formed*
- *As a result the whole body may perform poorly*
- *E.g. the body may have an intolerance to a important nutrient due to a missing enzyme*
- *This could lead to ill health if alternative nutrients were not available*
- *If a metabolite was to accumulate in the body because of a missing enzyme, it may interfere with other metabolic processes – this is likely to lead to ill health.*

TT 11 – DNA

Section 1: Multiple Choice (10 marks)

1.	*d*	6.	*a*
2.	*c*	7.	*d*
3.	*a*	8.	*a*
4.	*d*	9.	*c*
5.	*c*	10.	*d*

Section 2: Short Answer (50 marks)

1.

(i) *Transfer RNA (tRNA)*
(ii) *DNA replication*
(iii) *Mother*
(iv) *Nitrogen bases (on template strand of DNA)*
(v) *Nucleoplasm*
(vi) *Deoxyribose*
(vii) *Transcription*
(viii) *Hydrogen bonds*
(ix) *Epigenetics*
(x) *Histone modification.*

2.

(i)

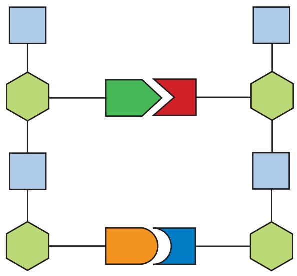
- *Each of the 46 chromosomes replicates during interphase.*
- *The result is a total of 92 chromosomes.*
- *Each daughter cell receives one copy of each pair of chromosomes. Therefore each daughter cell receives 46 chromosomes.*

(ii) *From the nucleoplasm.*

3.

(i) *Each nucleotide shown has a different nitrogenous base.*

(ii)



(iii) *The genetic information is in the sequence of nucleotides.*

(iv) *The information is stored in the number and order of the nucleotides. These form a code. The code is translated in the following way:*
a) A section of the molecule unzips along part of its length (a gene).
b) Free nucleotides in the nucleoplasm move in to fit on to the exposed nitrogenous bases.
c) These nucleotides join to form mRNA.
d) The mRNA moves out of the nucleus through the nuclear pores and onto ribosomes in the cytoplasm.
e) The mRNA forms a 'template' on the ribosomes. The ribosome 'reads' its three bases at a time.
f) Molecules of tRNA combine temporarily to specific amino acids in the cytoplasm and deliver each to matching parts of the mRNA. Each tRNA molecule will only fit on to a particular section of the mRNA.
g) The order and number of amino acids which are assembled at the ribosome is therefore determined by the type of mRNA which is there.
h) The type of mRNA is determined by the type of DNA which is in the nucleus. Therefore the DNA determines the type of proteins which are synthesised at the ribosomes.

4. *No. Amoeba's chromosomes have few genes.*

5.

(i) *When protein synthesis occurs, the DNA molecule only unzips along part of its length.*

e.g.

(ii) *Adenine, uracil, cytosine, guanine.*

(iii) *Messenger RNA (mRNA).*

(iv) *It peels away from the DNA segment on which it is formed, then moves through a nuclear pore to a ribosome.*

(v) *Each amino acid will link to a particular transfer RNA (tRNA) molecule (like an enzyme fits its substrate). The particular tRNA has a anti-codon which will only match its corresponding codon on the mRNA. So a particular amino acid is carried to its appropriate position by tRNA.*

(vi) *Amino acids chemically bond to adjacent amino acids by 'peptide' bonds.*

(vii) *Some proteins are structural, e.g. they may form part of membranes. Many proteins are enzymes, e.g. amylase. Some proteins are hormones, e.g. insulin.*

(viii) *Amino acid, tRNA, proteins, mRNA, DNA.*

6.

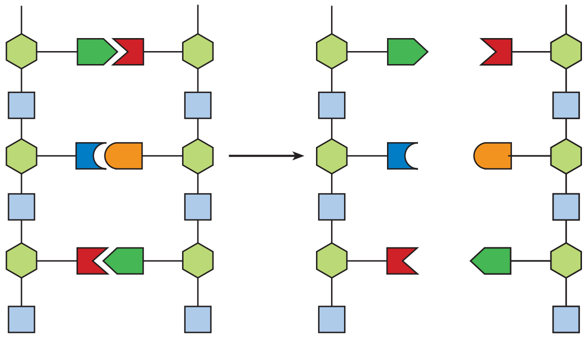
(i) *Epigenetics refers to changes in the phenotype which are not due to changes in the DNA sequence of bases. The changes are due to 'something else' that causes the genes to be expressed differently, e.g. cell differenciation – the cells in the zygote all have exactly the same genome but a variety of cells and tissues develop. [2 marks]*

(ii) *It is significant because these non-genetic factors seem to be involved in a range of biological processes [1 mark] and may be involved in the development of diseases such as cancers, heart disease, obesity and diabetes as well as birth defects [1 mark]. If the causative agents could be identified, perhaps some of these diseases could be prevented [1 mark].*

Section 3: Extended Answer (20 marks)

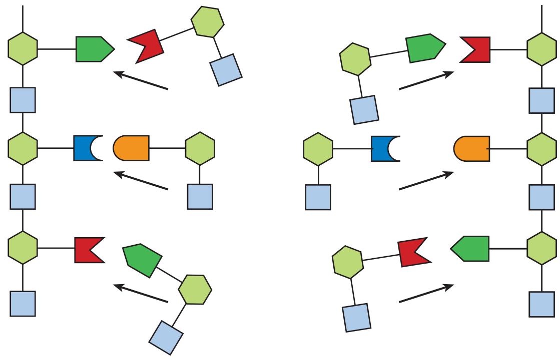
(each dot point = 1 mark unless otherwise stated).

(i) • *The DNA unzips along its entire length.*



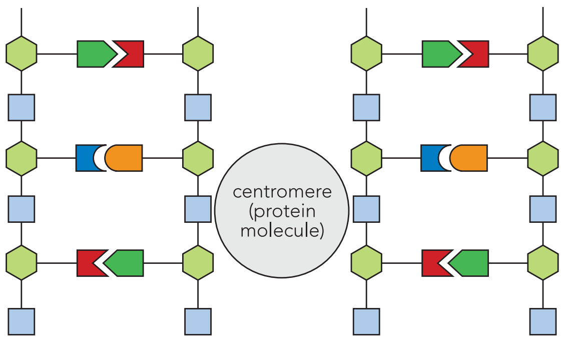
[Diagram – 2 marks]

- *Free nucleotides from the nucleoplasm fill the exposed nitrogen bases.*



[Diagram – 2 marks]

- *The two identifical copies are held together by a centromere molecule.*



[Diagram – 2 marks]

- *This process (replication) occurs during the later stages of interphase in both meiosis and mitosis before any sign of cell division becomes evident.*

(ii)

Transcription

- *part of the DNA unwinds and unzips*
- *RNA polymerase attaches to DNA at a specific region*
- *DNA code is used as a template*
- *only template strand of DNA is transcribed*
- *free nucleotides from nucleoplasm are used to form mRNA*
- *mRNA forms single strand which is complementary to unzipped template strand of DNA*

- *uracil replaces thymine in mRNA*
- *transcription stops on DNA strand at a terminator sequence.*

Translation

- *mRNA attaches to a ribosome*
- *bases on mRNA are in groups of three*
- *each three is called a codon*
- *start codon (mRNA) indicates where the first amino acid is to be delivered by tRNA*
- *tRNA contains an anti-codon which matches codon of mRNA*
- *tRNA brings a specific amino acid to mRNA*
- *tRNA anticodon binds to complimentary codon on mRNA*
- *a peptide bond forms between adjacent amino acids*
- *as more amino acids arrive, an amino acid chain forms a polypeptide or protein.*

TT 12 – CELL REPRODUCTION

Section 1: Multiple Choice (10 marks)

1. *a*	6. *c*
2. *c*	7. *b*
3. *c*	8. *d*
4. *a*	9. *c*
5. *a*	10. *a*

Section 2: Short Answer (50 marks)

1.

(i) *Growth occurs as cells increase in number by mitosis then grow to their potential size before dividing again.*

(ii) *a) Telophase*
b) Anaphase
c) Prophase
d) Metaphase

(iii) *Prophase, metaphase, anaphase, telophase.*

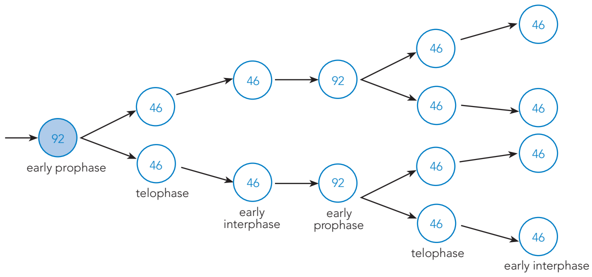
2.

(i) *Cells in the interphase have a nucleus with a grainy like appearance. The DNA is not organised as chromosomes but exists as long thin molecules and is called chromatin. In the early prophase, the DNA coils into chromosomes which therefore become visible (with the aid of a light microscope). In the prophase the nuclear membrane begins to disappear and the centrioles replicate and move to opposite poles of the cell. In late prophase spindles form and attach to the centromere of each chromosome.*

(ii) *Cells in the metaphase have their chromosomes arranged across the equator of the cell. In the anaphase the spindles appear to pull the centromere apart so that each chromatid is separated from its replicate and moves to opposite sides of the cell.*

3.

(i)



(ii) *Three.*

(iii) *184.*

(iv) *The original DNA molecules have replicated before each cell division.*

4.

(i) *4 (2 pairs)* (ii) *2 (one of each pair).*

(iii) *8.*

(iv) *Each chromosome replicates before the prophase so that when they appear in the prophase they appear as two attached chromosomes (called chromatids).*

(v) *So that when they fuse during fertilization the number of chromosomes in the zygote is restored to the diploid number (i.e., 23 pairs in a human zygote).*

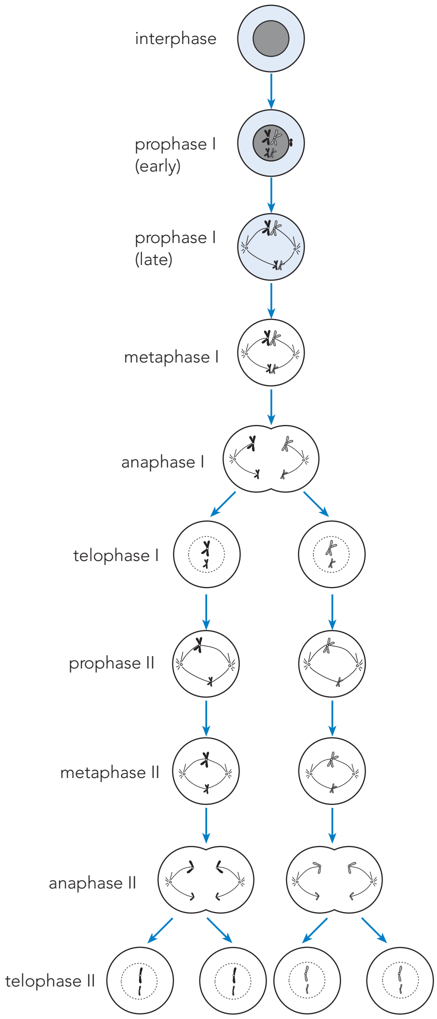
5.

(i) *Stem cells vary in their capacity to differentiate into different kinds of cells. Some stem cells can differentiate into many different types of cells, whereas others can only develop into a limited number of cells. Cells with the greatest potency can differentiate into all the body's cell types.*

(ii) ***Totipotent cells*** *can become any kind of cell in the body. The zygote and the cells which make up the morula are totipotent (stem) cells.* ***Pluripotent*** *cells can become almost any kind of cell in the body. The cells which make up the 'inner cell mass' in a blastocyst are pluripotent (stem) cells. They cannot become placenta cells.* ***Multipotent*** *cells can become a limited range of cell types. Cord stem cells from the umbilical cord and adult stem cells are both multipotent cells. Blood stem cells are multipotent as they can become a range of white blood cells, e.g. B cells, T cells, monocytes and neutrophils but they cannot differentiate into muscle cells, bone cells, adipose cells, etc.*

6.

(i)



(ii) prophase I, metaphase I

(iii) anaphase I, anaphase II

7. (i) ME (ii) MI
(iii) N (iv) ME
(v) N (vi) B
(vii) MI (viii) ME
(ix) MI (x) ME
(xi) B (xii) MI

8.

(i) Prophase I or Metaphase I
Homologous chromosomes aligned, have 'crossed over' and exchanged some genetic material.

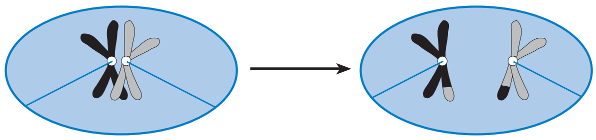
(ii) Telophase I
Homologous chromosomes are now separated.

(iii) Telophase II
Chromatids have become separated. Genes which are normally linked A and B and a and b, have become separated in the middle two cells (gametes) in diagram.

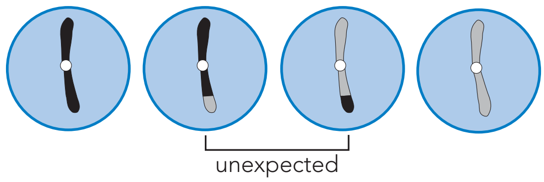
Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

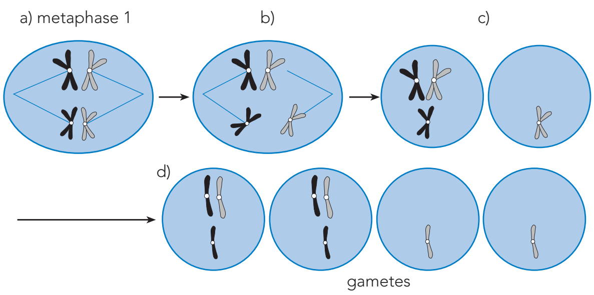
- *Variations are generally small differences between individuals of the same species.*
- *E.g. no two people have the same facial appearance (even identical twins).*
- *Variations are either due to differences in genes (and chromosomes), differences in the environment or differences in both.*
- *Genetically caused variations include those due to 'crossing over' during meiosis* **OR**
- *Random assortment of chromosomes during meiosis* **OR**
- *Non-disjunction in the separation of homologous chromosomes during meiosis* **OR**
- *Random combinations of gametes during fertilisation.*
- *Crossing over occurs in meiosis when homologous chromosomes exchange genetic material during prophase I or metaphase I.*
- *Genes which are linked become separated and linked to other genes.*
- *An example: where in a family history brown eyes and dark hair are traits which have always been inherited together, they become separated; a child may be born with brown eyes and blonde hair.*
- *This may be illustrated by the drawing below:*



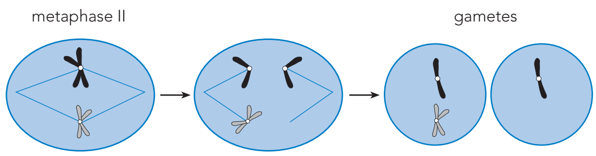
- *Crossing over gives rise to gametes which are expected and gametes which are unexpected.*



- *Non-disjunction may occur when the spindles pull homologous chromosomes apart (in anaphase I or anaphase II) but some are not separated.*
- *This may be illustrated as shown:*



(some stages have been deliberately omitted) or



- *Both of the above produce gametes with unexpected numbers of chromosomes – some may result in abnormal traits e.g. Down Syndrome. Sometimes very small variations occur as in men who are XYY (ie. who have an extra Y chromosome in each cell – super males).*
- *Variations result in the random combination of gametes, which occurs because all the different gamete variations have an equal probability of fertilisation – rare combinations come about with unexpected results.*
- *Variations occur due to the effects of the environment on phenotypes e.g. skin colour may darken because added exposure to the sun increases the activity of melanocytes, cells which produce melanin.*
- *clarity, grammar, expression [2 marks].*

TT13 – HUMAN REPRODUCTION

Section 1: Multiple Choice (10 marks)

1. *a*	6. *c*
2. *c*	7. *a*
3. *d*	8. *b*
4. *d*	9. *a*
5. *d*	10. *a*

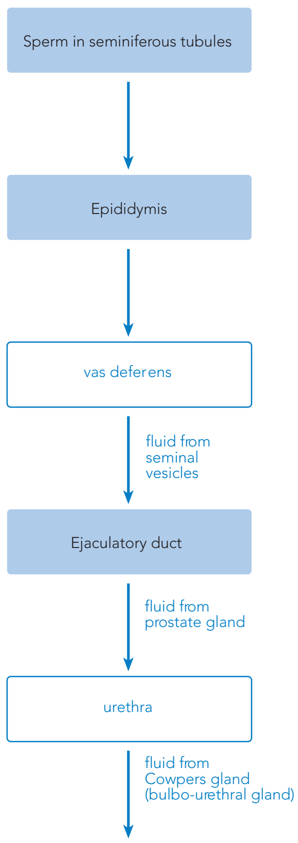
Section 2: Short Answer (50 marks)

1. *a) Seminal vesicle*
   b) Vas deferens
   c) Prostate gland
   d) Erectile tissue/penis
   e) Epididymis
   f) Testis
   g) Scrotum
   h) Prepuce/foreskin
   i) Bulbo-urethral gland/Cowper's gland
   j) Urethra
2. *Prostate gland, seminal vesicles, bulbo-urethral glands.*
   All produce fluid which is added to the sperm. Prostate adds - milky, slightly alkaline fluid. Seminal vesicles - secrete alkaline fluid containing fructose. The alkali neutralises the acidity of the vagina which would kill the sperm. The fructose provides energy for the sperm. The bulbo-urethral glands - secrete a clear mucus and alkaline fluid.
3. *a) Fimbriae/infundibulum*
   b) Uterine tube/Fallopian tube
   c) Ovary
   d) Hymen
   e) Vagina
   f) Cervix
   g) Muscular wall of uterus
   h) Endometrium

4.

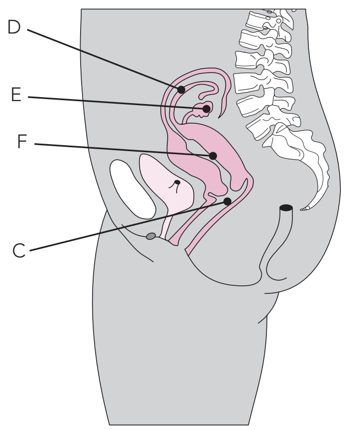
HORMONE	WHERE PRODUCED	ORGANS TARGETED	EFFECT
FSH	anterior lobe of pituitary	Ovaries and testes	Stimulates production of ova and oestrogen secretion by ovaries. Stimulates production of sperm by testes.
LH	anterior lobe of pituitary	Ovaries and testes	Stimulates secretion of oestrogen by ovaries. Stimulates ovulation and formation of corpus luteum. Stimulates production of progesterone by corpus luteum. Stimulates testosterone production by testes.
Oestrogen	ovaries (and placenta and male testes)	Uterus (and vagina, breasts)	Stimulates the development, thickening and vascularisation of endometrium. Produces female secondary characteristics.
Progesterone	corpus luteum (and placenta)	Endome-trium of uterus	Maintains the thick, spongy endometrium. Stimulates development of mammary gland.

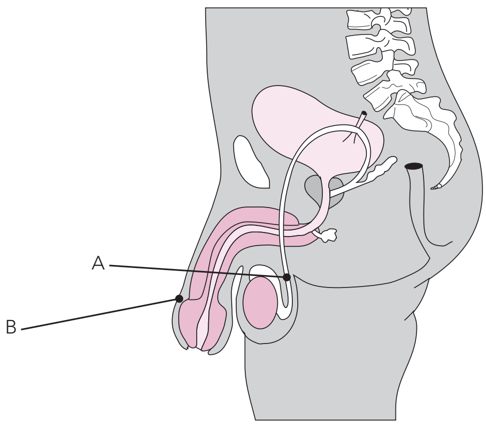
5.



6.
(i) *Deoxygenated and low in nutrients (like glucose), high in wastes.*
(ii) *Oxygenated and high in nutrients, low in wastes.*

7.
(i) *Organ which enables the exchange of food and oxygen and wastes between the mother and the foetus.*
(ii) *Foetal heart.*
8.
(i) *Ductus venosus*
(ii) *It is a branch of the umbilical vein which drains into the inferior vena cava.*
(iii) *Most of the blood returning from the placenta is diverted away from the foetal liver by the ductus venosus.*
9.
(i) *mesoderm*
(ii) *ectoderm*
(iii) *endoderm*
10.
(i) *Cervical dilation means the opening of the cervix up to about 10cm in diameter. This occurs as a result of uterine contractions during the first stage of labour.*
(ii) *6 – 12 hours.*
11.
(i) *10 minutes – several hours.*
(ii) *The baby's head.*
(iii) *Oxytocin.*
(iv) *From the pituitary gland (the posterior lobe of the pituitary).*
12.





Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

- *Oogenesis: the germ cells (embryonic stem cells) begin to divide by mitosis before birth.*
- *At birth, a female has all her primary oocytes (future ova) but they have not begun to divide by meiosis.*
- *From birth to puberty, the oocytes are inactive.*
- *Spermatogenesis: germ cells begin to differentiate, undergo mitosis.*
- *Continue to divide by mitosis from before birth to puberty, form primary spermatocytes.*
- *At puberty in girls, a spike in LH causes oocytes to begin meiosis.*
- *Each month a secondary oocyte which has begun the second meiotic division is released.*
- *At puberty in boys, an increase in LH production causes testosterone to be produced.*
- *Testosterone with FSH induces the primary spermalocytes to begin to divide and form spermatozoa (sperm).*
- *When the supply of oocytes is exhausted in women and levels of FSH and LH fall no further ovulation occurs – this is called the menopause.*
- *In men, the production of sperm generally continues but with ageing diminishes in quantity and viability.*
- *The gametes (ova) produced by females are huge compared to the sperm.*
- *Ova contain a large quantity of cytoplasm, which represents a store of food required before the dividing cell mass (the future embryo) begins to obtain nutrition from the endometrium.*
- *Ova also have a large number of mitochondria which become part of the cytoplasm of the zygote.*
- *Sperm have mitochondria in their middle section which release energy for the flagellum to propel the cell forward but this part is lost when fertilisation occurs.*
- *Ova are not motile (they cannot move themselves) but are propelled towards the uterus by the cilia which line the uterine tube and the muscular contractions (peristalsis) of the uterine tube walls.*
- *Sperm are motile. They can move themselves forward towards the ovum, using energy from the sugary semen around them which is broken down by the mitochondria in the middle part near the tail.*
- *Both sperm and ova are haploid so that when their nuclei fuse, the diploid number of chromosomes is restored in the zygote.*
- *grammar, expression [2 marks].*

TT 14 – TYPES OF INHERITANCE

Section 1: Multiple Choice (10 marks)

1.	*c*	6.	*b*
2.	*b*	7.	*a*
3.	*c*	8.	*b*
4.	*b*	9.	*a*
5.	*d*	10.	*d*

Section 2: Short Answer (50 marks)

1.

(i) *Bb*

(ii) *BB or Bb. He has brown eyes but without more information, he could be either a heterozygote or a homozygote for this trait.*

(iii) *The husband must be Bb. Since the couple now have a blue-eyed child, that child must be bb. Therefore that child has a b from its father (and one b from its mother).*

(iv)

Man

Woman	B	b
B	BB	Bb
b	Bb	bb

2.

(i) *autosomal and recessive*

(ii) *Both parents' genotypes are Ss.*
Parent's genotypes Ss × Ss

Man

Woman	S	s
S	SS	Ss
s	Ss	ss

∴ Probability (child is Ss) = ½ (0.5)

(iii) *Parents genotypes Ss x SS*

Man

Woman	S	S
S	SS	SS
s	Ss	Ss

∴ Probability (child is ss) = 0

3.

(i) X^BX^B *or* X^BX^b

(ii) X^BY

(iii) X^BX^b

(iv) X^bY

(v) *If Alison had children and any of them were colour blind (either* X^bY *or* X^bX^b*) then we would know that she was* X^BX^b*. However if she had children all of whom were not colour blind, we could not say whether or not she was* X^BX^b *as by coincidence all of her children may inherit the* X^B *chromosome.*

4.

(i) *Multiple alleles for a particular trait means that there are more than two alleles for the trait in the population. In the ABO system of blood grouping there are three alleles:* I^A, I^B *and i. This means that in this system, blood group is controlled by multiple alleles.*
Any one of the three alleles could occupy the same locus on a chromosome. If there were only two alleles available in the ABO system, e.g. just I^A *and* I^B*, it would not be multiple allelic.*

(ii) I^AI^A, I^AI^B, I^Ai, I^BI^B, I^Bi, ii

(iii) *Many traits show a multitude of discrete phenotypes, as in polymorphism. This indicates that these traits may be controlled by multiple alleles.*

5.

(i) *recessive, X-linked*

(ii) ¼

(iii) 0

(iv) *4 is* X^HY *and 3 is probably* X^HX^H *(as it is a rare gene, she is unlikely to be a carrier* X^HX^b*)*

(v)

1 X^HY	2 X^HX^b
4 X^HY	6 X^bY
10 X^HX^b	11 X^HY
12 X^bY	13 X^HY

(vi) *For a female to inherit the disease, she would have to have a father with the disease (*X^bY*) (which would be unlikely as haemophiliacs rarely reached maturity) and a mother who would be either* X^HX^b *or* X^bX^b*, the later being most unlikely.*

6 *(i) genotype, (ii) phenotype, (iii) dominant, (iv) autosome, (v) multiple alleles, (vi) co-dominant, (vii) allele, (viii) homologous, (ix) hereditary.*

Section 3: Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

(i)

- *By researching (and drawing) a family pedigree, genetic counsellors may be able to determine the probability of a couple having a child with a particular genetic disease.*
- *E.g. if the couple are determined by the pedigree to be heterozygous for a particular recessive disease, the likelihood of any child having the disease would be 0.25.*

- *PKU, cystic fibrosis and sickle cell anaemia are diseases which can be identified in this way.*
- *If the probability of having a child with a serious genetic disease is unacceptably high, the couple may choose to adopt or use assisted reproductory technology (e.g. IVF, GIFT, etc), combined with donor gamete/s if necessary.*
- *Genetic testing provides a profile of an individual's DNA though it is not entirely complete.*
- *Genetic testing can show chromosomal abnormalities or the presence of abnormal proteins (which are indicators of abnormal genes).*
- *These tests can be carried out on both the parents and foetus (prenatal).*
- *Prenatal testing may involve amniocentesis, umbilical blood sampling or chorion biopsy to examine the karyotype of the developing child.*
- *Karyotypes can be used to test for a number of conditions including Down Syndrome.*
- *Karyotypes can be used to determine the sex of the foetus and therefore in cases of X-linked diseases, help to determine probabilities of inheritance.*
- *Infant screening for metabolic factors may detect genetic diseases e.g. PKU which can be treated and in this case cured if detected early.*
- *Clarity, grammar, expression.*

(ii)

- *Probability (boy) = ½.*
- *Probability (2 boys) = ½ × ½ = ¼.*
- *Probability (4 boys) = ½ × ½ × ½ × ½ = $(½)^4$ = 1/16.*
- *Each child is an independent event.*
- *If a co-ed primary school had 400 boy students only, P (all boys) = $(½)^{400}$ = 0.000000238.*

(iii)

- *Father is X^bY*
- *Mother is X^BX^b*
- *Possible offspring*

Man

Woman	X^b	Y
X^B	X^BX^b	X^BY
X^b	X^bX^b	X^bY

- *∴ Probability (colour blind boy) = ¼*
- *∴ Probability (4 colour blind boys) = $(¼)^4$ = 0.0039*

TT 15 – SCIENCE AS A HUMAN ENDEAVOUR 2

Section 1: Multiple Choice (10 marks)

1.	*a*	6.	*a*
2.	*d*	7.	*b*
3.	*d*	8.	*b*
4.	*b*	9.	*d*
5.	*a*	10.	*b*

Section 2: Short Answer (50 marks)

1.

(i) Because these substances may pass from her blood through the placenta into the foetal blood and affect the foetus, e.g. alcohol.

(ii) a) Required for structural growth of new cells and synthesis of enzymes.
b) Needed for bone and teeth growth and blood clotting.
c) Needed for synthesis of haemoglobin.
d) Needed for normal red blood cell formation and reduces the risk of spina bifida in foetus.

2.

(i) If there is an unacceptable risk that the child will inherit a serious sex-linked disease.

(ii) Duchenne muscular dystrophy, haemophilia.

(iii) red-green colour blindness, congenital cataract, gout.

3.

(i) The sperm determines the sex of the child because they can be either X carrying or Y carrying.Therefore, if a particular sex is required, the sperm need to be separated ie. separate X carrying sperm from the Y carrying sperm. Then with assisted reproductory technology, use the appropriate sperm to fertilise an ovum. If a female is required, use X carrying sperm. If a male is required, use Y carrying sperm

(ii) Its sex can be determined through amniocentesis, ultrasound or chorion biopsy. Genetic diseases can be detected through analysis of the foetal karyotype, gene analysis, protein analysis and observation of ultrasound scans.

4.

(i) A: fertilisation
B: cleavage
C: differentiation

(ii) No. The nucleus from the adult somatic cell is diploid and the ovum nucleus is haploid.

(iii) A clone.

(iv) The person from whom the somatic cell was taken.

(v) Mitochondrial DNA from the ovum
Nuclear DNA from the somatic cell

(vi) a) Between stages A and C (zygote-morula)
b) After stage C – blastocyst – cells in the inner cell mass)

(vii) Stem cells.

5. *There is a possibility that when an infection clears up, scarring will remain in the uterine tubes that prevents the passage of ova to the uterus and sperm in the other direction. This could lead to infertility.*

6.

(i) conception: when a sperm and an ovum combine

(ii) implantation: when the fertized egg imbeds in the lining of the uterus, (endometrium)

(iii) pregnancy: the time in which an embryo and foetus develops in the uterus

(iv) contraception: birth control, use of drugs (e.g. hormones) mechanical devices and/ or surgery to prevent conception or implantation.

7.

(i) The "morning after pill" does not always prevent fertilisation from occurring. If a zygote is formed when a sperm nucleus and an ovum nucleus unite, the "morning after pill" prevents the developing embryo's implantation. Individuals, who are opposed to any form of abortion, including those belonging to some religious groups, may find this process unacceptable. However, the "morning after pill" sometimes suppresses ovulation, in which case it is not different from other methods of birth control that prevent fertilization.

(ii) Early signs of pregnancy include –

- *a missed period*
- *nausea and/or vomiting*
- *breast tenderness and enlargement*
- *tiredness*
- *frequent urination*
- *food cravings*

(iii) A medical test for pregnancy – a blood or urine test for the hormone HCG (human chorionic gonadotropin). HCG is produced by the developing placenta in the early stages of a pregnancy almost immediately after implantation has occurred. It can be detected in the blood or urine of the pregnant woman using a chemical test.

8.

TECHNOLOGY	EXPLANATION OF THE TECHNOLOGY	HOW THE TECHNOLOGY MAKES EARLY DETECTION OF CANCERS POSSIBLE
Cervical screening test	Cells are collected by a doctor from the cervical region. These are examined in a medical laboratory to determine whether normal or abnormal cells are present.	Abnormal cells may be precancerous i.e. potentially dangerous. They are recognisable when stained and viewed with a microscope. Abnormal cells are an early warning that medical intervention may be necessary. These cells can be removed by straightforward surgery.
Breast screening	Images are made of the breast tissue using x-rays.	Clusters of abnormal cells which are too small to be felt can be detected in these images. Cancerous cells can therefore be detected early in this way.
Blood tests for prostate cancer	Cancerous prostate tissue, even in its early stages produces an elevated level of a particular protein called PSA. Blood samples can be taken and the PSA concentration in the blood measured.	A higher level of PSA than normal may indicate that further tests are necessary to determine whether or not a person has the early stages of prostate cancer.

[6 marks]

9.

(i) If the prospective female parent has the disease and it is autosomal she must be homozygous for the trait. It is therefore important for the couple to know if the male partner is homozygous dominant or heterozygous. If he is heterozygous there is a 50% chance that any child they have will develop the disease. If the prospective female parent has the disease and it is X–linked recessive, she will also be homozygous for the trait. As he does not have the disease, her partner can only contribute a dominant gene on his X chromosome to his daughters (and a y chromosome to his sons). Therefore all their daughters will not have the disease but will be carriers of the disease, but all their sons will inherit the disease. There is no need to screen him as the probabilities of these outcomes are known.

(ii) In the case of PKU, the potential mother will be pp, her partner either PP or Pp. If he is PP then all the children will be heterozygotes, Pp and they will not develop the disease. If he is heterozygous Pp, there is a 50% chance that each child they have will be pp and will develop the disease. As PKU is potentially a serious disease it may be important for the couple to find out what his genotype for this condition is before they have children.

Section 3 – Extended Answer (20 marks)

(each dot point = 1 mark unless otherwise stated).

(i)

- *Birth control methods can be categorised into two broad types, physical and behavioural methods.*
- *Behavioural methods include the rhythm method, symptom based methods (basal body temperature and cervical mucus), coitus interruptus and abstinence.*
- *Physical methods include barriers (condoms, diaphragms, cervical cap), hormonal methods, intrauterine devices (IUD's), morning after pill, sterilization (tubal ligation, vasectomy).*
- *Rhythm method is based on using a calendar to estimate when ovulation may occur. It is not on its own regarded as reliable.*
- *One symptom based method involves measuring the basal (resting) temperature. When basal temperature drops then rises, this corresponds with ovulation.*
- *Mucus method involves monitoring the consistency of cervical mucus, it changes at the time of ovulation.*
- *Coitus interruptus means the withdrawal of the penis just before ejaculation, not a reliable means of birth control.*
- *Abstinence is considered by some to be a means of birth control, highly reliable but unlikely.*
- *Symptom based methods can be made more reliable if combined and considered with the rhythm based method.*
- *The barriers, such as condoms, diaphragms, cervical caps and spermicides all prevent, to a greater or lesser extent, the sperm from entering the uterine tube.*
- *The male condom is reliable and has the added advantage in that it is most likely to prevent STI's.*
- *Hormonal methods – for women, these generally involve the ingestion of hormones on a regular basis. The hormones which mimic oestrogen and progesterone or a synthetic progesterone have the effect of preventing ovulation and make the endometrium less receptive to implantation.*
- *Some hormonal methods may involve the injection of hormones into the muscle every few months or implants which slowly release hormones into the blood.*
- *Intrauterine devices (IUD's) are devices placed in the uterus, some are spermicidal and some release progestin. These have lost popularity in Australia due to their previous unreliability and infections which some makes have caused. But their use is likely to become more widespread as they are improved.*
- *'Morning after pill', hormonal pill which can be used after intercourse to suppress ovulation or prevent a blastocyst from implanting.*
- *Sterilization in women involves cutting, tying or clamping the uterine tubes so that an ovum cannot reach the uterus and sperm cannot reach the ovum.*
- *In men, sterilization involves cutting or burning and removing a small section of each vas deferens. This prevents sperm reaching his urethra and ultimately the ovum.*
- *Vaccines are presently being developed to stimulate the immune system to attack the FSH in men and HCG in women. In men, this would have the effect of preventing the maturation of sperm and in women, it would prevent the maintenance of the corpus luteum causing a drop in progesterone levels and as a consequence the breakdown of the endometrium as would normally occur (regardless of implantation).*
- *Clarity, grammar, expression.*

(ii)

- *Tubal ligation and vasectomy are not easily reversed.*
- *If a person who has had such an operation wishes to have children (and microsurgery is not successful), 'assisted reproductory technology may have to be applied.*
- *This involves IVF (In Vitro Fertilization), GIFT (Gamete Intrafallopian Transfer) or AI (Artificial Insemination) depending on the circumstances – expensive and sometimes difficult procedures.*
- *Microsurgery may be used to rejoin the tubes but it is not always successful and people who undergo these operations should regard them as permanent.*
- *Clarity, grammar, expression.*

GLOSSARY

Abortion: Termination of a pregnancy. A spontaneous abortion is called a miscarriage. An artificial abortion is one that is induced.

Absorption: The intake of substances by cells.

Acquired immune deficiency disease (AIDS): The disease caused by the Human Immunodeficiency virus.

Activation Energy: The energy needed for a chemical reaction to begin. Enzymes (organic catalysts) lower the activation energy.

Active site: The part of an enzyme into which the substrate fits.

Active transport: The movement of a substance (e.g. glucose) across a cell membrane from a region of low concentration to a region of high concentration. This process requires energy.

Adaptation: A trait which assists an organism to survive and reproduce in its particular environment.

Adult Stem Cell: These cells are sometimes called somatic stem cells. They are cells found throughout the body, after embryonic development, which are undifferentiated. They replace dead cells and are used in repairing tissue. They are generally regarded as multipotent.

Aerobic respiration: The chemical breakdown of organic matter (usually glucose) in cells using oxygen to release energy.

Afterbirth: The placenta, fluid and blood which is expelled from the uterus in the third stage of parturition.

Agglutination: The clumping together of cells in an antigen – antibody reaction.

Agonist: A muscle which causes movement.

Alimentary canal: A tube beginning at the mouth and terminating at the anus. Also called gastro-intestinal tract or digestive tract.

Alveolus: A microscopic air sac in lungs.

Allele: Alternative form of a gene which occurs at a particular locus on homologous chromosomes.

Amino acid: An organic acid (containing nitrogen) which is the basic building block of proteins.

Amnion: A membrane which surrounds the developing embryo and foetus and contains amniotic fluid.

Amniocentesis: A medical procedure in which a small sample of amniotic fluid is removed from the amniotic sac of a pregnant woman. Foetal cells are collected from this fluid, cultured and examined to determine possible genetic disorders and the sex of the foetus.

Amniotic fluid: The fluid inside the amniotic sac which protects the embryo and later the foetus. Sometimes referred to as the "waters".

Anabolic Steroid: A synthetic form of testosterone used to increase protein storage, muscle size and strength. Must be prescribed as its use can be very harmful.

Anabolism: The production of more complex molecules from simpler ones. Anabolism may be called 'synthesis' and it requires energy input (cf. catabolism).

Anaphase: A stage in both mitosis and meiosis in which the chromatids or chromosomes move from the equator of the cell to the opposite poles of the cell.

Anaerobic respiration: The chemical breakdown of organic matter (usually glucose) in cells in the absence of oxygen to release energy.

Anal Sphincter: Circular muscle in the anus which prevents faeces from leaving body.

Anatomy: The branch of biology and medicine which involves the study of bodily structure.

Antagonist: Term used to describe the opposite action of some muscles, e.g. biceps and triceps are antagonists.

Anthropology: The study of human societies, culture and evolution.

Antibody: A protein (immunoglobulin) produced by lymphocytes in response to the presence of an antigen. It is released into the blood stream.

Antigen: A foreign substance, often a protein, which is not produced by the body. Its presence stimulates the production of antibodies.

Anus: The opening of the rectum from which faeces is expelled.

Arteriole: A small artery.

Arteriosclerosis: A hardening of large and medium sized arteries (atheroselerosis is a form of arteriosclerosis).

Artery: Vessel that carries blood away from the heart.

Artificial Insemination (AI): Medical procedure in which sperm are placed into the uterus or cervix generally using a small plastic tube, in order to artificially create a pregnancy.

Asthma: A narrowing of the bronchioles which results in difficulty in breathing. Muscles in the bronchioles contract involuntarily due to allergies - foreign substances that are inhaled or ingested.

Atherosclerosis: Condition in which fatty substances (plaque) builds up on the lining of arteries. The plaque thickens, hardens and may eventually block the lumen of the artery, limiting or preventing blood flow through it. Inflammation of the artery also occurs.

ATP (Adenosine Triphosphate): An important source of energy in many cells. It releases energy when it breaks down to ADP and P (Adenosine diphosphate and inorganic phosphate).

Atrioventricular valve: Valve which prevents blood flow from a ventricle back into an atrium (e.g. bicuspid and tricuspid valves).

Autosome: A chromosome which is not a sex chromosome.

Bacteria (singular: bacterium): Microscopic organisms which have no membrane bounded organelles. Bacteria are therefore called prokaryotes. Most bacteria are useful, many however are pathogens.

Basal metabolic rate (BMR): The rate of metabolism under resting condition.

Benign: Not malignant. Often used to refer to a tumour which is enclosed within a membrane and therefore unable to spread in the body.

Bile: A fluid secreted by the liver containing the pigments and salts produced as breakdown products of haemoglobin from used erythrocytes.

Biopsy: The removal of a small piece of tissue for medical examination, often to culture and diagnose disease.

Blastocyst: A hollow fluid-filled ball of cells which embeds into the endometrium and develops into the embryo.

Blood clotting: The formation of a gelatinous mass to prevent the escape of blood from an injury.

Blood Clotting Factors: About twelve different proteins which together with calcium ions (Ca^{++}), circulate in the blood and bring about a blood clot when a blood vessel is damaged or severed e.g. fibrinogen.

Blood pressure: The force per unit area of the blood against the inner walls of the arteries and veins.

Bolus: A rounded mass of food that is swallowed.

Bone: Connective tissue which is dense, light and very strong. It has a number of functions including body support, providing a framework for muscle attachment, manufacture of blood cells, storage of minerals and fat.

Bronchiole: A branch of a bronchus which has no cartilage and carries air into the alveoli.

Bronchitis: An inflammation of the bronchus.

Bronchus: Branch of the trachea which is reinforced and prevented from collapsing by cartilage.

Bulbo-urethral (Cowper's) glands: Two small glands which contribute alkaline fluid and mucus to semen. These are emptied into the urethra and assist in lubricating the vagina and neutralising the acidity of the vagina.

Caecum: The first part of the large intestine.

Cancellous bone: Spongy less dense bone which is made up of many spaces often filled with red bone marrow and trabeculae (small needle-like rods of bone).

Capillary: A very thin-walled blood vessel which connects arteries to veins.

Carbaminohaemoglobin: Compound formed when carbon dioxide combines with haemoglobin in the red blood cells.

Carbohydrate: An organic compound containing C, H and O, with the general formula $(CH_2O)_n$.

Carcinogen: A substance which causes cancer.

Carcinoma: Epithelial cells which have become cancerous.

Cardiac arrest: The situation in which the heart stops beating.

Cardiac cycle: The changes which the heart undergoes during one heart beat. It consists of systole and diastole of both atria plus systole and diastole of both ventricles.

Cardiac muscle: Involuntary muscle tissue which is striated, has cross connections and forms the walls of the heart in the atria and ventricles.

Cardiac output: The volume of blood pumped from one ventricle of the heart in one minute.

Cardiovascular disease: Any disease of the heart or circulatory system e.g. atherosclerosis.

Cartilage: A tough flexible tissue which makes up part of the skeletal system.

Catabolism: The chemical breakdown of complex molecules into simpler substances. This type of process gives out energy (cf. anabolism).

Catalyst: A chemical which speeds up chemical reactions, but which is itself not used up (e.g. enzyme).

Cell: The basic 'building block' of living things (except viruses). Consists of membrane-bounded protoplasm.

Cell differentiation: The development of specialised cells in multicellular organisms from unspecialised cells in the early stages of the organism's growth.

Cell/Plasma membrane: The protective layer of lipids and proteins which encloses a cell's protoplasm.

Cellular respiration: Breakdown of organic matter (usually glucose) in cells to release energy.

Centrioles: Two small cylindrical organelles which lie just outside the nucleus. They form spindles during cell division.

Cervical dilation: The widening of the cervical opening into the uterus which takes place during the first stage of birth; due to uterine muscular contractions.

Cervix: The lower neck of the uterus.

Chemical digestion: The breakdown of molecules into smaller molecules in the digestive system.

Chlamydia: A sexually transmitted disease caused by a bacterium. In males it infects the urethra and may invade the epididymis if left untreated. In females it infects the cervical area and may move to the urethra and uterine tubes.

Cholesterol: A lipid found in animal tissues, mainly in cell membranes.

Chondrocyte: A cartilage maintaining cell.

Chorion: A membrane in the early embryonic development which becomes the placenta.

Chromatid: A chromosome replicate held to its copy by the centromere after replication.

Chromatin: Thin uncoiled strands of DNA as it exists during the interphase.

Chromosome: Chromatin which has shortened and thickened ("condensed") to become visible (with the aid of a microscope) as a separate body during cell division.

Chyme: The partly digested food in the stomach which passes into the small intestine as a semi-fluid mixture.

Cilia (singular: cilium): Short hair like structures protruding from specialised cells which often beat rhythmically to move the cell or move substances over the cell (e.g. in the trachea ciliated cells help clear the lungs of mucus and dust).

Clitoris: A highly vasculated erectile tissue (similar to the penis) located at the front junction of the labia minora.

Codominance (or Incomplete dominance): When two different alleles are present in an organism but neither is dominant. Both genes are expressed, e.g. group AB, in the ABO blood grouping, results from the genotype I^AI^B, where both the gene for A and the gene for B are expressed.

Coenzyme: An organic compound (e.g. a vitamin) which assists enzymes by carrying chemical groups or atoms from one enzyme to another.

Cofactor: Often metal ions (e.g. Zn^{++}, Fe^{++}) or vitamins which help bind an enzyme to its substrate or the cofactor may serve as the active site on the enzyme itself.

Coitus (sexual intercourse): The introduction of an erect penis into the vagina. Also called copulation.

Coitus interruptus: An ineffectual attempt at birth control in which the penis is withdrawn from the vagina immediately prior to ejaculation.

Collagen fibres: These are strong strands of protein which are found in the connective tissue (e.g. cartilage, tendons, bone).

Colon: The main part of the large intestine made up of ascending, transverse and descending sections.

Conchae: Thin shelf-like bony projections on either side of the nasal cavity.

Conclusion: A decision reached by reasoning. The analysis of data.

Condom: A mechanical barrier to sperm which is a rubber sleeve placed over an erect penis as a method of birth control. Condoms are also recommended as a reasonably effective means of reducing the spread of sexually transmitted infections.

Contraception: Birth control which involves the prevention of conception i.e. fertilisation and implantation.

Control: An experiment which can be used as a comparison to test the effect of one variable on another variable.

Concentration gradient: The change in the concentration of a solute that may occur from one part of a solution to another part of that same solution.

Consanguinity: Closely related, being descended from the same ancestor.

Corona radiata: Cells which are attached around the surface of the ovum and form a barrier to sperm.

Coronary heart disease: Disease, e.g. arteriosclerosis, of the coronary arteries.

Compact bone: Dense bone which is made up of Haversian systems or osteons.

Corpus luteum: The remaining, "yellow body", tissue which forms where the follicle releases the ovum. It produces progesterone which maintains the endometrium until the placenta develops fully.

Cortex: The outer part of an organ e.g. kidney cortex

Crossing over: The exchange of genes which often occurs between two homologous chromatids during metaphase I of meiosis. It results in greater variation in the offspring than would be expected.

Cystosol: The liquid inside cells. Liquid part of cytoplasm.

Cytokinesis: When the cytoplasm of a cell divides into two to produce two daughter cells (usually occurs during the telophase of mitosis and meiosis).

Cytology: The study of the structure and function of cells.

Cytoplasm: All the organelles (excluding the nucleus), cytosol (fluid) and inclusions in a cell.

Deamination: The breakdown of amino acids.

Defaecation: The expulsion of faeces from the rectum.

Deficiency disease: A disease caused by the insufficient intake of a particular nutrient in the diet.

Dementia: A loss of brain tissue function which generally becomes progressively worse and adversely affects memory, behaviour and communication.

Deoxygenated blood: Blood which has lost most of its oxygen to the body tissue.

Deoxyribonucleic Acid DNA: This is a type of compound (nucleic acid) which contains the genetic code used to determine the type of proteins that a cell can synthesise. Chromosomes are made mostly of DNA.

Dependent Variable: The variable which responds to changes in the independent variable.

Diagnosis: Medical procedure used to determine the presence of a disease.

Diaphragm:

1. A circular rubber mechanical barrier to sperm which is fitted across the top of the vagina as a means of birth control.

2. The dome-shaped muscle which separates the abdominal cavity from the thoracic cavity, used for breathing normally.

Disaccharide: Organic compound consisting of two bonded monosaccharides, e.g. sucrose.

Diastole: Phase when heart muscle is relaxed during the cardiac cycle.

Differentiation: The development of specialised cells as they mature.

Diffusion: The passive movement of particles from an area of high concentration to an area of low concentration.

Digestion: The breakdown of larger more complex organic matter into simpler smaller compounds so that they can be absorbed.

Digestive juice: Mixture of enzymes (and bile in the duodenum) which breakdown food in the digestive tract.

Digestive tract: The tube along which digestion takes place. Also called alimentary canal or gastrointestinal tract.

Dipeptide: Organic compound consisting of two bonded amino acids.

Diploid: The possession of two of each chromosome type. In human cells the diploid number of chromosomes is 46.

Dizygotic Twins: Twins which originate from two separate ova and two separate sperm. They are no more alike genetically than two brothers, two sisters, or a sister and a brother.

DNA fragment: A short section of DNA which can be created by cutting a DNA molecule with a restriction enzyme. A DNA fragment may be double or single stranded.

Double circulation system: Circulation system in which blood flows from the heart to the lungs (in the pulmonary circulation) and back to the heart, then from the heart to the tissues (systemic circulation) and back to the heart.

Dominant: A trait expressed by a heterozygote, which hides or masks another trait.

Ductus arteriosis: A blood vessel in the foetus which connects the pulmonary trunk to the aorta, diverting foetal blood away from the lungs.

Ductus venosus: A blood vessel in the foetus which diverts blood away from the foetal liver.

Duodenum: The first section (~10cm) of small intestine following the stomach.

Ectoderm: The outer layer of the developing embryo which gives rise to the skin, nails, sense organs, nervous system.

Ejaculation: The expulsion of semen from the penis during a male orgasm.

Embryo: The fertilised ovum until about week 8 of development.

Embryonic stem cell: Cells in a blastocyst, which are capable of developing into any tissue type except those that form the placenta (i.e. they are pluripotent).

Emphysema: Loss of elasticity of the alveoli, the formation of fibrous material in the lungs and the breakdown of alveoli which reduces the efficiency of the lungs. Commonly caused by smoking.

Endocrine gland: A ductless gland which secretes its product, a hormone, directly into the circulatory system. The hormone usually targets cells which are well removed from the gland.

Endocytosis: The process whereby a cell's membrane either folds inwards to absorb a fluid (pinocytosis) or protrudes outwards and engulfs a large solid particle (phagocytosis).

Endoderm: The inner layer of the developing embryo which gives rise to the digestive tract, respiratory tract, bladder, liver, pancreas.

Endometrium: The spongy, highly vasculated lining of the uterus which helps nourish the embryo during its early development.

Endoplasmic reticulum (ER): A network of membranes which forms channels within the cytoplasm of a cell. It is used to transport materials about the cell.

Enzyme substrate complex: Temporary molecule in which reactant/s are bonded to the active site of an enzyme.

Epididymis: A duct system in the testes which receives sperm from the seminiferous tubules and in which the sperm mature before moving into the vas deferens.

Epigenome: Changes to the genome that do not involve any change in the nucleotide sequence, e.g. DNA methylation and histone modification

Epiglottis: A flat sheet of cartilage attached to the pharynx which covers the opening of the trachea (the glottis) when food is swallowed.

Epithelium: Tissue which forms the skin, lines blood vessels and hollow organs and lines passageways from the body.

Erection: The engorgement of the spongy tissue in the penis and clitoris which results in each organ becoming enlarged during sexual arousal.

Erythrocyte: Red blood cell. Carries oxygen in blood.

Essential amino acid: Amino acids which cannot be made by the body – must be included in the diet.

Ethics: Using moral principles to evaluate our conduct.

Evolution: The gradual change in a species which occurs usually over millions of years due to the effect of mutations and natural selection.

Excretion: The removal of metabolic wastes, which include CO_2, urea and uric acid.

Extracellular fluid: The fluid which surrounds a cell inside the body, e.g. plasma, intercellular fluid and lymph.

Exocrine glands: A gland which empties its product into a duct, e.g. salivary gland, gastric glands (cf. endocrine glands).

Exocytosis: The removal, by means of a vacuole, of wastes or secretions via a cell's membrane (cf. endocytosis).

Experiment: A scientific procedure undertaken to test an hypothesis.

Expiration (exhalation): The expulsion of air from the lungs.

Facilitated diffusion: The passive movement of substances through a cell membrane which is assisted by a transport molecule (a protein imbedded in the membrane).

Faeces: Wastes expelled from the rectum consisting largely of bacteria and undigested food.

Fat: A solid lipid consisting of one glycerol and three fatty acid molecules.

Fatty acid: An organic compound consisting of C, H and O which may make up part of a lipid molecule.

Fertilisation: The fusion of two gametes to produce a zygote during sexual reproduction.

Fibre: Undigested cellulose which provides roughage in the diet.

Fibrinogen (blood clotting factor I): A soluble protein which occurs in blood plasma. When converted to fibrin, by thrombin, it plays a major role in forming a blood clot.

Filial: Offspring produced by two parents in a particular genetics study. The first generation is called the F_1 or first filial generation. When the F_1 are crossed, their offspring are called the second filial generation, F_2 and so on.

Fimbriae: Finger-like structures at the top of the uterine tube which help to funnel ova into the uterine tube.

First class protein: A protein containing all the essential amino acids.

Flagella (sing. Flagellum): Whip-like organelles which generally propel a cell forward. Human sperm have one flagellum.

Foetus: From week 8 until birth, the developing human. The period during which the developing young in the uterus is recognisably human.

Follicle: A large fluid-filled sac which contains an immature ovum surrounded by supporting cells.

Follicle stimulating hormone (FSH): A hormone released by the pituitary gland which targets the ovaries and initiates the development of the ova. In males FSH stimulates sperm production by the testes.

Fluid mosaic model (of cell membrane): The basic structure of the cell membrane, which is believed to consist mainly of two lipid layers with proteins floating in the layers.

Folic acid/Folate: A B vitamin which is required for cell growth and cell division. It is found in green plants, fruit, yeast and liver.

Foramen: An opening in bone through which blood vessels and nerves may pass.

Foramen ovale: A hole which closes over at birth connecting the right atrium to the left atrium. Blood flows from the right atrium into the left atrium which assists the ductus arteriosis in diverting blood away from the foetal lungs.

Formed element: Red blood cells, white blood cells and platelets.

Fructose: A simple sugar or monosaccharide.

Fungus: An organism belonging to a phylum in which members are either single or multi celled and live by decomposing organic matter. Some fungi are parasites, others live on dead matter and are called saprophytes.

Gall bladder: A small bag which contains bile produced by the liver. It pushes bile into the duodenum via the bile duct and pancreatic duct.

Gamete: A mature sex cell; sperm or ovum. Gametes are haploid.

Gametogenesis: The formation of gametes by meiosis; either spermatogenesis or oogenesis.

Gastric glands: Glands in the stomach which secrete gastric juice.

Gastric juice: A mixture of pepsinogen, mucus and hydrochloric acid, active in the stomach.

Gastric pits: Small depressions in the stomach wall which secrete gastric juice.

Gastric protease: Protein digesting enzyme produced in the stomach (pepsin).

Gamete Intrafallopian Transfer (GIFT): Ova which are first removed from a woman's ovary are transferred with a man's sperm back to her Fallopian (uterine) tube.

Gene therapy: This is the treatment of a genetic disease by inserting normal genes into the cells or tissue of an affected individual.

Genetics: The study of heredity.

Genetic tags: DNA methylation and histone modification are chemical marks or tags on the DNA molecule which determine which genes are switched on and which are switched off.

Genital herpes: A sexually transmitted disease caused by a virus (HSV2) related to the 'cold sore' virus (HSV1). In males it may cause painful blisters on the penis and foreskin. In females the vulva and vagina may become infected. The virus appears periodically but remains in the body.

Genome: One complete set of chromosomes and their genes.

Genotype: The genetic makeup in an organism of a particular trait, e.g. I^AI^B.

Germline cell: Cells which contain genetic material which can be passed on to a child, e.g. sperm, ovum, oogonium, oocyte, spermatogonium, spermatocyte.

Gestation: The period of time during which development in the uterus occurs from fertilisation to parturition (40 weeks in humans).

Glottis: The opening of the trachea (between the vocal cords).

Glucose: Simple sugar $C_6H_{12}O_6$. Monosaccharide – main source of energy in the blood and cells.

Glomerular filtration: Process which occurs between the glomerulus and the glomerular capsule in which small molecules are forced through the capillary wall into the capsule by the blood pressure in the capillary. The filtrate consists of water, urea, uric acid, amino acids, glucose, Na^+, K^+, Cl^- and other ions, small hormones and small proteins.

Glycerol: The part of a lipid molecule onto which fatty acids attach.

Glycogen: A polysaccharide consisting of a long chain of glucose molecules. Humans store glucose as glycogen in liver and muscle cells.

Goblet cell: Cell present in the respiratory and digestive systems which secretes mucus.

Golgi apparatus (Golgi body): An organelle found in the cell which "packages" substances (e.g. enzymes) into vesicles which the cell may secrete.

Gonads: The organs (testes and ovaries) which produce gametes.

Gonorrhoea: A sexually transmitted infection in which the urethra becomes inflamed by a bacterium. Symptoms include a discharge of pus and pain in micturition. May cause blockage of the uterine tubes.

Granulocyte: A type of white blood cell (leucocyte) which has a grainy cytoplasm.

Growth: An increase in the number (by mitosis) and the size of cells.

Haemoglobin: A compound made of protein and iron which carries oxygen and carbon dioxide in red blood cells.

Haemorrhage: The loss of blood from a damaged blood vessel.

Haploid: One set of chromosomes containing one of each homologous pair. In humans the haploid number is 23.

Haversian system: The microscopic building block of compact bone. Each system contains a tube (called the Haversian canal) which contains blood vessels, lymph vessels and nerves. Each canal is surrounded by concentric layers of bone called lamellae. In spaces, called lacunae, found between the lamellae are osteocytes, the bone cells.

Heart attack: A total interruption of blood delivery to part of the heart muscle. An area of heart muscle dies through lack of oxygen.

Hereditary: Capable of being passed on through gametes from parents to offspring. A hereditary trait is controlled by genes.

Heterozygous: An organism with two different alleles for a particular trait e.g. I^Ai.

Histamine: A chemical ($C_5H_9N_3$) found in body cells. Histamine can cause vasodilation. It is also a neurotransmitter and activates smooth muscle.

Histology: The branch of biology which involves the study of tissues.

Histone: Protein which together with a DNA molecule makes up a chromosome. DNA is wrapped around these protein molecules.

Homologous chromosomes: Paired chromosomes which are similar and have the same type of genes although they are not necessarily identical. In the pair, one chromosome originates from the mother (maternal) and one originates from the father (paternal).

Homozygous: When two alleles are the same, the organism is described as homozygous (or pure) for that particular trait e.g. TT, tt or I^AI^A.

Hormonal contraception: The use of synthetic hormones, e.g. oestrogen and progesterone, in order to suppress ovulation as a means of birth control.

Hormone: A chemical released in small amounts from special tissue, an endocrine gland, which brings about change in another part of the organism.

Human chorionic gonadotrophin (HCG): A hormone which is produced by the chorion of a developing embryo which keeps the corpus luteum from degenerating and therefore maintains the production of progesterone.

Human Genome Project: This was an international scientific study which identified all the genes in the human DNA of a small group of people. This entailed identifying the sequence of nitrogen bases along their chromosomes.

Human immunodeficiency virus (HIV): The virus which causes AIDS. Infected people develop a reduced lymphocyte count which lowers their resistance to other diseases.

Hygiene: Activities that promote the preservation of good health.

Hymen: A thin membrane at the vaginal opening.

Hypertension: High blood pressure.

Hypothesis: An educated guess put forward to explain an observation. A hypothesis must be testable.

Ileocaecal sphincter: Valve at the junction of the small and large intestines which prevents the contents of the small intestine (chyme) from moving into the large intestine, until it has been processed.

Ileum: The last part of the small intestine.

Immune System: The system which protects the body from pathogens and foreign molecules. It includes the skin, mucous membranes, lymphocytes, lymph tissue, antibodies, tonsils and adenoids.

Immunization: When a vaccine is used to create an immunity to a particular disease which protects the person against future infection by the pathogen causing the disease.

Incisor: A cutting tooth in the front of dental arcade. In humans there are four incisors in both the top and bottom jaws.

Independent variable: The variable which is deliberately changed or manipulated to determine its effect on a dependent variable in an experiment.

Infection: When pathogenic organisms (e.g. bacteria, viruses) enter the body and begin to multiply.

Infertility: A couple who have not been able to become pregnant or maintain a pregnancy after twelve months of unprotected sex.

Inflammation: A red, swelling region which occurs in the vicinity of damaged tissue. It is caused by the dilation of blood vessels in the area, the delivery of more white blood cells and plasma to the tissue bed and a subsequent increase in the temperature in the area.

Infundibulum: The open end of the Fallopian tube which is funnel shaped.

Inheritable: Describes a trait that can be passed down from parent to offspring through genes (or genetic tags)

Inorganic compound: A compound which generally does not contain carbon and is not of plant or animal origin.

Insertion (of a muscle): Structure, often bone, onto which a muscle attaches and which is moved when that muscle contracts.

Insemination: The introduction of semen into the female reproductive system, usually in the area of the cervix.

Intercostal muscles: The muscles found between the ribs, which move them.

Inspiration (inhalation): The drawing of air into the lungs.

Interdependence: The reliance that one has on other people.

Interphase: A stage during the life of a cell when it is actively carrying out its normal functions and not dividing – DNA replicates during this stage.

Intracellular: Inside a cell. Organelles are intracellular structures.

Intracytoplasmic Sperm Injection (ICSI): A means of allowing men who were previously infertile to father children. The procedure involves the injection of the male sperm nuclei into an ovum.

Intrauterine device (I.U.D.): A mechanical device made from plastic and or metal which is inserted into the uterus and which renders implantation of the embryo into the endometrium unlikely to occur. I.U.D.'s are used to avoid pregnancy.

In situ: To examine something in the place where it occurs.

Intercellular: Gaps between cells which are filled with fluid which surrounds the cells.

In vitro fertilisation (IVF): To fertilise an ovum and a sperm in glass (e.g. petri dish).

Involuntary muscle (Smooth/Non-striated): A muscle which cannot be controlled by the will.

Jejunum: The second part of the small intestine after the duodenum and before the ileum.

Karyotype: The total number and general appearance of chromosomes within the nucleus of a cell at metaphase.

Kilojoule: 1000 joules often used to measure the amount of energy in food.

Kwashiorkor: An infancy/childhood disease due to lack of protein in the diet which results in a distended stomach and often red wispy hair.

Labia majora: Two outer folds of skin lying on each side of the vagina.

Labia minora: Two inner folds of mucous membrane lying on the inside of the labia majora on each side of the vagina.

Lactation: Milk production, secretion and delivery to a baby.

Lacteal: Lymphatic vessel that absorbs the products of fat digestion. Lacteals are found in the small intestinal villi.

Large intestine: Part of the digestive tract between the small intestine and the anus.

Laryngitis: Inflammation of the larynx.

Larynx (voice box): A passage between the trachea and the pharynx containing vocal cords.

Leucocyte: A white blood cell.

Leukaemia: An accumulation of leucocytes in the blood caused by a malignant cancer of the tissue forming the leucocytes. Type of cancer resulting in a large overproduction of white blood cells which results in anaemia.

Lipase: Any enzyme which catalyses the breakdown of lipids.

Lipid: An organic compound containing carbon, hydrogen and oxygen. Lipids include natural oils, waxes and steroids. They are fats (solid) and oils (liquid) and are made up of glycerol and fatty acids.

Lifestyle: The way in which a person lives including their diet and exercise regime.

Ligament: An elastic tissue that joins bone to bone. It allows bending at joints.

Linked Genes: Genes which have their loci on the same chromosome. They are normally inherited together.

Liver: Large organ in the abdominal cavity which produces bile, detoxifies poisons, stores glycogen, minerals and vitamins, deaminates excess amino acids and controls the amount of sugar in blood.

Locus (plural: loci): The place occupied on a chromosome by a particular gene.

Lumen: The space within a tube, e.g. inside of artery.

Lung: The main organ in the thoracic cavity for gas exchange.

Luteinising hormone (LH): A hormone released by the pituitary which causes ovulation and maintains the corpus luteum (which in turn produces progesterone). In males LH stimulates the testes to produce testosterone.

Lymph: The colourless fluid similar to plasma in the lymphatic system.

Lymph node: An oval shaped structure into which several lymph vessels drain. One lymph vessel drains the node.

Lymphatic system: System of tubes or vessels which drain excess fluid from tissue beds and carries it back into the circulatory system.

Lymphocyte: A white blood cell that resides in the lymphatic tissue. Can be either of two types; T-lymphocyte or B-lymphocyte.

Lymphoma: A malignant tumour formed by the cancerous growth of lymph tissue.

Lysosome: A single membrane bounded organelle in the cytoplasm containing digestive enzymes.

Malignant tumour: A cancer which spreads, invades other organs (metastases) and may form secondary tumours.

Marasmus: A disease in which a child is underweight due to a lack of nutrients.

Mechanical digestion: The physical breakdown of food into small particles which assists the chemical digestion by increasing the surface area available to the enzymes, e.g. bile emulsifies lipids, mastication.

Medulla: The inner part of an organ e.g. adrenal medulla.

Meiosis: The type of cell division which results in gametes (sperm or ova). The number of chromosomes in the original cell (the germ cell) is reduced to half, i.e. the gametes produced are haploid.

Menarche: The time of the first menstruation.

Menopause: The time of life at which menstrual cycles cease.

Menstrual cycle: The female reproductory cycle in which changes occur to the ovary, uterus, hormonal levels, breasts and cervix on a monthly basis (approx. 28 days on average).

Menstruation: Discharge of the lining of the uterus (epithelial cells, blood, mucus and fluid) which occurs on a monthly basis. Often called a 'period'.

Mesoderm: The middle layer of the developing embryo which gives rise to the skeletal system, muscles, gonads, blood, kidneys.

Metabolism: The chemical processes which occur within the body of an organism. These include both anabolic and catabolic processes.

Metaphase: The stage in cell division at which chromosomes are aligned along the equator of the cell.

Metastasis: The spread of cancer cells to other tissue.

Methyl group: A chemical group (-CH_3) which can attach to nucleotides (where cytosine is directly followed by guanine) on the DNA molecule and affect translation.

Microbiology: The branch of biology which involves the study of microorganisms.

Microvilli (sing. Microvillus): Very small projections of cytoplasm from some cells, which increases the cells' total surface area for absorption, e.g. epithelial cells of the small intestine.

Miscarriage/Spontaneous Abortion: See abortion.

Mineral: An inorganic substance which may be essential to life, e.g. iron, calcium.

Mitochondria (sing. Mitochondrion): A cell organelle enclosed in a double membrane in which aerobic respiration occurs.

mDNA: The DNA which is present in the mitochondria which enables mitochondria to divide independently of the nucleus and which controls the synthesis of enzymes associated with respiration.

Mitosis: Cell division in which the two daughter cells produced are identical to the parent cell. Mitosis is for growth and repair (cf. meiosis).

Molar: A grinding tooth at the rear of the dental arcade.

Monocyte: A macrophage, a large white blood cell capable of phagocytosis.

Monoglyceride: A lipid consisting of glycerol with only one fatty acid attached.

Monosaccharide: The basic building block of a carbohydrate; a simple sugar with only five or six carbon atoms in each molecule, e.g. glucose, fructose, galactose.

Monozygotic twins: Twins that originate from the same zygote. They have identical genotypes and phenotypes which are often indistinguishable to the casual observer.

Mucosa: A membrane that lines any body cavity opening to the exterior, e.g. digestive, respiratory systems.

Mucous membrane: Another name for mucosa.

Mucus: A liquid which is usually viscous that contains mucin (a glycoprotein), water, ions and white blood cells. It protects and lubricates internal surfaces (e.g. stomach) and external surfaces (e.g. nasal cavity).

Mucus method (birth control): Birth control which involves the monitoring of the texture or consistency of vaginal mucus secretions which change during the menstrual cycle. At ovulation the mucus is clearer and stretches more before breaking between the fingers. Coitus is avoided a few days on either side of this change.

Multipotent: Cells which can become a limited range of cell types. Cord stem cells from the umbilical cord and adult stem cells are both multipotent cells.

Muscular Dystrophy: A wasting disease of the muscles.

Mutant: An organism which has a mutation.

Mutation: A sudden change to genetic matter which makes an organism notably different from its parents. When the change occurs in a germline cell, it may be inherited by future generations.

Myocardial infarction: Heart attack.

Nasal cavity: The cavity in the nose into which air is inhaled and exhaled.

Nephron: A microscopic structure found in the kidneys (each kidney has about one million nephrons) which is the fundamental filtering and water regulating unit in the cortex and medulla of the kidney.

Nitrogenous base: Organic substances containing nitrogen which make up the genetic code in DNA and RNA molecules (e.g. cytosine, guanine, adenine, thymine and uracil).

Non-disjunction: The failure of chromatids or homologous chromosomes to separate in the anaphase stage of mitosis or meiosis.

Nuclear membranes: Double layer of membranes perforated by holes or pores sufficiently large to allow the passage of messenger RNA, surrounding the nucleus of cells.

Nuclear pores: The holes in the nuclear membranes through which mRNA passes out of the nucleus.

Nucleolus: A spherical body in the nucleus which synthesises and stores RNA.

Nucleoplasm: The protoplasm of the nucleus of a cell.

Nucleosome: A short length of DNA and a histone unit (made up of 8 proteins).

Nucleus: An organelle in the cell enclosed within a double-membrane, which contains the hereditary material (chromosomes) of the cell.

Nutrient: A chemical substance which is ingested to provide energy, contribute to growth or assist in the metabolism of the body.

Nutrition: The process in which nutrients are ingested and assimilated into the body.

Obesity: Overweight by more than 20% above normal for height, body type and age due to excess fat.

Obligatory reabsorption: The reabsorption of water in the proximal convoluted tubule and the loop of Henle which occurs passively from the filtrate into the peritubular capillary network (by osmosis).

Observation: Something which is seen, heard, smelt, felt or tasted using our senses or detected using an instrument.

Oesophageal sphincter (Cardiac sphincter): Circular muscle between the oesophagus and stomach which controls the movement of food into the stomach.

Oesophagus: The muscular tube connecting the mouth to the stomach, which is part of the alimentary canal.

Oestrogen: A hormone released by a developing follicle which stimulates the development of the endometrium and helps to produce secondary sexual characteristics. Some oestrogen is produced in small amounts by the testes.

Oogenesis: The process in which an ovum is produced which includes meiosis.

Oogonia: The diploid 'stem' cells or germ cells which give rise to ova.

Organ: A collection of tissues which together carry out one or more major functions in an organism, e.g. kidney, heart.

Organelle: A small permanent structure within the cytoplasm of a cell which carries out a particular function, e.g. mitochondrion.

Organic compound: A relatively complex chemical compound which contains carbon (exceptions include CO_2 and CO) and hydrogen; includes carbohydrates, proteins, lipids, ATP, nucleic acids, vitamins.

Organism: A living thing, e.g. plant, animal, microorganism.

Origin (of a muscle): Structure, often bone, onto which a muscle attaches but is fixed and stable. Usually this is at the proximal end of the muscle.

Orgasm: The climax of sexual stimulation which involves pleasurable physiological responses in the genitalia.

Osmosis: The movement of a solvent (usually water) by diffusion through a semi-permeable membrane.

Osteoarthritis: Breakdown of cartilage, usually due to wear and tear, in joints which may cause pain, stiffness and swelling.

Osteocyte: A mature bone cell located in the small cavities called lacunae in bone.

Ovarian cycle: The series of changes which occur in the ovary during the maturation of an ovum. The process occurs over twenty eight days on average.

Ovaries: Female reproductory organs which produce ova.

Ovulation: The release of a mature ovum with its supporting cells (which form the corona radiata) into the uterine tube.

Oxygen debt: The amount of oxygen required to break down the lactic acid formed during anaerobic respiration.

Oxygenated blood: Blood which has absorbed oxygen from the lungs and is carrying it as oxyhaemoglobin in the red blood cells.

Pacemaker: (sinoatrial node) A small area of tissue in the right atrium which controls heart rate.

Pancreas: A leaf shaped organ connected by the pancreatic duct to the duodenum. It secretes enzymes into the duodenum (and the hormones insulin and glucagon into the blood).

Pancreatic amylase: An enzyme produced by the pancreas that breaks down carbohydrates.

Pancreatic Juice: The mixture of several enzymes (including pancreatic amylase) which is secreted by the pancreas into the duodenum.

Parturition: Giving birth.

Pathogen: A disease causing organism (e.g. bacterium, virus, protozoan, fungus).

Pedigree: A chart of an individual's ancestors and relations which may be used in genetics to study the inheritance patterns within a family.

Peer review: A procedure in which experts in the same field of research examine and evaluate the work (e.g. the experimental procedure and conclusions) of a fellow scientist.

Pellagra: A deficiency disease caused by a lack of the vitamin niacin. Symptoms include dermatitis, nervous disorder and diarrhoea.

Penis: Male copulatory organ which transfers sperm to vagina during coitus.

Pepsin: Enzyme produced (as pepsinogen) by the gastric glands in the stomach which breaks down proteins in to polypeptides.

Pepsinogen: The inactive form of pepsin produced by cells in the gastric glands. It is inactive to avoid "self -digestion" but becomes active when mixed with the hydrochloric acid in the stomach.

Peptidase: An enzyme which speeds up the breakdown of peptides to amino acids.

Peptide bond: A bond between two amino acids.

Pericardium: A membrane that encloses the heart.

Periosteum: Membrane which covers the outer surface of the shaft or diaphysis of a long bone.

Peristalsis: Muscular contractions which move along tubes such as the digestive tract and the oviduct, to move the contents, food and ova respectively.

Pharynx: That part of the digestive and respiratory system between the rear of the nasal cavity and the mouth and the larynx. These two systems have the pharynx in common.

Phagocytosis: A process in which a cell extends part of its cytoplasm (a pseudopod) to engulf food, which is enclosed within a vacuole (until it is digested).

Phenotype: The expression of a particular genotype. Phenotype may also be influenced by the environment.

Pinocytosis: A process which occurs when a cell membrane forms an infold (invagination) which engulfs a liquid droplet (e.g. a lipid) (cf phagocytosis).

Pituitary: The "master" endocrine gland. It is attached to the underside of the hypothalamus and produces several hormones; some of which control other endocrine glands. Hormones released by the pituitary include FSH, LH, oxytocin and prolactin.

Placenta: An organ formed from cells of the chorion which attaches to the uterus and provides for the exchange of nutrients and oxygen from the mother's blood and carbon dioxide and urea from the foetus' blood.

Plaques: Fatty mounds which form on the lining of the arteries (especially the coronary arteries and aorta).

Plasma: The fluid part of blood (55% by volume).

Platelet: (thrombocyte) A small volume of cytoplasm bounded by a cell membrane, but lacking a nucleus.

Pleurae (sing: pleura): Two thin membranes which cover the lungs and line the thoracic cavity and diaphragm.

Pleural cavity: Fluid filled space between two pleurae.

Pluripotent: Cells which can become almost any kind of cell in the body. The cells which make up the 'inner cell mass' in a blastocyst are pluripotent (stem) cells.

Polar body: When human oocytes divide they do so unevenly. One cell acquires most of the cytoplasm, the second cell which acquires very little is inviable and is called a polar body.

Polypeptide: A chain of 10 to 2000 amino acids.

Polysaccharide: A long chain of monosaccharides (sometimes hundreds).

Population: A group of the same species living together at a particular time.

Postnatal care: The care given to both mother and child following parturition (cf. prenatal care).

Premolar: Grinding teeth with two cusps and one root, between canine and molars.

Prenatal care: Care given to both expectant mother and developing progeny while in uterus (cf. postnatal care).

Predisposition: Susceptibility to a particular disease. This may be due to the inheritance of a particular gene or set of genes.

Prescription drug: A medicine which can only be obtained legally with a doctor's signed permission or script.

Primary germ layers: The three layers which develop in the embryo called the ectoderm, mesoderm and endoderm.

Prophase: A stage in mitosis and meiosis when chromosomes first become visible (under staining and microscopic examination). They consist of two chromatids attached by a centromere and in the later stages (following the breakdown of the nuclear membrane) of prophase they become attached to spindle fibres at their centromeres.

Progesterone: A hormone released by the corpus luteum which helps maintain the endometrium in a spongy vasculated state. When the corpus luteum breaks down, the endometrium is shed in menstruation. The placenta also produces progesterone.

Prolactin: A hormone produced by the pituitary which stimulates the production of milk by the mammary glands after parturition.

Prostate gland: A gland which is attached to the male urethra which adds alkaline fluid to the sperm. It activates the sperm and assists in neutralising the acidity of the vagina.

Protease: Any enzyme which catalyses the breakdown of a protein.

Protein: An organic compound containing C, H, O, N and sometimes S. Proteins are made of long chains of amino acids joined by peptide bonds. They make up many structures and enzymes in all cells.

Prothrombin (blood factor II): A protein found in blood plasma which is converted to thrombin, when blood vessels are damaged or haemorrhaged. The thrombin is responsible for the conversion of fibrinogen (blood factor I) to fibrin in the clotting process.

Puberty: The changes which occur in the child's body which result in an ability to reproduce.

Pulmonary circulation: The circulation of blood from the right ventricle to the lungs then back to the left atrium.

Pyloric sphincter: The circular muscle between the stomach and the duodenum which prevents food from leaving the stomach until it has been processed.

Random assortment: The arrangement of homologous chromosomes during the first prophase in meiosis. The chromosome pair may be arranged with the maternal chromosome or the paternal chromosome on the left, nothing determines the order of this chromosome arrangement it is therefore random.

Reabsorption: The absorption of required molecules from the filtrate in the nephron tubules back into the plasma of the peritubular capillaries.

Recessive: A trait which is not expressed in the heterozygote. The recessive trait is hidden due to the expression of the allele for the dominant trait.

Rectum: The last 20 centimetres of the digestive tract between the colon and the anus.

Red bone marrow: Area in some bones (e.g. proximal ends of long bones) where blood cells are synthesised.

Replicated experiment: An experiment which is repeated a second or subsequent time.

Replication (DNA): Process whereby a DNA molecule unzips along its entire length and two copies of that DNA are formed. Occurs during the interphase of the cell cycle.

Restriction enzyme: An enzyme which cuts DNA at a particular base sequence (called the recognition site). Different restriction enzymes have different recognition sites.

Rhythm method (birth control): Birth control which involves anticipation of when ovulation occurs and avoiding coitus a few days before and a few days after ovulation in order to reduce the likelihood of fertilisation.

Ribosome: An organelle, which is either attached to endoplasmic reticulum or free in the cytoplasm, on which protein synthesis occurs.

Rickets: A deficiency disease caused by lack of vitamin D in children. The bones are soft and often deformed.

Rough endoplasmic reticulum: Endoplasmic reticulum which appears grainy-like along its length because of the presence of grain-like ribosomes.

Roughage: Indigestible matter (e.g. cellulose fibres) in the diet, which gives the contents of the digestive system bulk and promotes peristalsis (and regular bowel 'motions').

Salivary amylase: An enzyme produced by the salivary glands which catalyses the breakdown of starch to maltose (a disaccharide) in the mouth.

Salivary glands: Glands in the oral cavity (mouth) which release salivary amylase.

Sample: A small part of a population intended to show what the whole (of a population) is like.

Sarcoma: A tumour of connective tissue often malignant.

Scrotum: Muscular sac which contains testes externally from the abdominal cavity.

Scurvy: A deficiency disease caused by a lack of sufficient vitamin C in the diet. Symptoms include tender, swollen gums, loose teeth, slow wound healing.

Sebaceous gland: An oil gland in the skin associated closely with hair follicles, which produces an oil (sebum) which lubricates the hair follicle and the skin.

Secondary sexual characteristics: Characteristics associated with the sex of an individual which are not essential to reproduction, e.g. facial hair of male.

Semen: A fluid containing sperm and the products of the accessory glands. These products include sugar, mucus and an alkaline fluid.

Semilunar valves: Valves at the beginning of the arteries which prevent blood flow from the arteries back into the ventricles during ventricular diastole.

Seminal vesicles: Two glands attached to the vas deferens that produce a sugary fluid which contributes to the semen and provides the sperm with an energy source.

Seminiferous tubules: The tubules inside the testes in which sperm are formed.

Serum: Blood plasma which has its clotting proteins removed.

Sex chromosome: A chromosome which helps determine the sex of the individual. In humans, one pair of chromosomes determines the sex. A female has two X chromosomes while a male has an X and a Y chromosome in each body (somatic) cell.

Sex-linked (X-linked): Refers to genes which have their loci on the X chromosome.

Sexually transmitted infection (STI or venereal disease): Disease spread by sexual contact, e.g. syphilis and gonorrhoea.

Shock: A condition in which insufficient oxygen is delivered to the body tissue.

Short tandem repeat (STR): A section of double stranded DNA with repeating sequences of 2-5 base pairs.

Sickle cell anaemia: A genetic disease controlled by an autosomal, co-dominant gene. In the homozygous state, the condition is usually fatal. In the heterozygous condition, the condition is only debilitating when the individual is under physical stress. Red blood cells, which are normally biconcave discs, have a sickle shape and are not as efficient in carrying oxygen.

Small intestine: Section of the digestive tract between the stomach and the large intestine. Much digestion and absorption of nutrients take place in the small intestine (consists of duodenum, jejunum and ileum).

Somatic: Cells in the body which are not gametes. They are diploid and make up muscle, nerve, connective and epithelial tissue.

Spermatogenesis: The process in which sperm are produced which includes meiosis.

Spermatogonia: The diploid 'stem' cells or germ cells which give rise to spermatozoa.

Spermatozoa: Male gametes. Haploid cells produced in the testes by meiosis (or spermatogenesis).

Sphincter: A ring of muscle which closes an opening in the body, e.g. anal sphincter, pyloric sphincter.

Sphygmomanometer: An instrument used to measure blood pressure in the arteries.

Stem cell: A cell which can divide by mitosis and replace old or damaged cells. It may be able to differentiate into a number of types of cells depending on its potency.

Stem cell potency: Some stem cells can differentiate into ectoderm, endoderm or mesoderm cells. These stem cells are described as pluripotent. Other stem cells, (e.g. blood stem cells) may differentiate into a limited number of cell types (e.g. red blood cells, white blood cells and platelets) and are called multipotent. The cells with the greatest potency are those in the early stages of cleavage (totipotent), e.g. zygote, morula.

Stomach: Large muscular J-shaped organ between the oesophagus and duodenum. Much digestion of proteins takes place in this part of the digestive system.

Stroke: A condition in which part of the brain is not supplied with blood. May be due to a blockage or clot or a haemorrhage in a cerebral artery.

Stroke volume: The volume of blood pushed from either ventricle during a ventricular systole.

Substrate: A molecule (reactant) which fits into the active site of an enzyme.

Syndrome: A group of symptoms which generally occur together, e.g. Down syndrome is normally characterized by a number of symptoms.

Synergist: A muscle that helps another muscle to move a bone often by steadying a joint.

Synovial fluid: A clear fluid secreted by membranes in synovial joints. The fluid is a lubricant.

Synthesis: The making of new substances from absorbed nutrients, e.g. a protein is synthesised using many amino acid molecules.

Syphilis: A sexually transmitted infection which is caused by a bacterium. The infection progresses through four stages and may persist for many years during which organs (e.g. heart, cerebellum) are damaged.

System: A group of organs which together carry out a major function (or functions) within the body, e.g. circulatory, respiratory.

Systemic circulation: The circulation of blood from the left ventricle to the body tissues then back to the right atrium (cf. pulmonary circulation).

Systole: Phase of cardiac cycle in which contraction of atria and/or ventricles occurs.

Target organ: An organ whose activity is controlled by a particular hormone.

Telophase: The last stage in a meiotic or mitotic division, when new nuclear membranes enclose the separated chromosomes and the cytoplasm divides (cytokinesis) into two daughter cells.

Temperature method (birth control): This method of birth control involves measuring the resting (basal) temperature each day during the menstrual cycle. At the time of ovulation basal temperature falls slightly. Coitus is avoided a few days on either side of this drop in temperature (cf. Rhythm method).

Tendon: A connective tissue that joins muscles onto bones. It is inelastic. Shortening of a muscle pulls on the tendon resulting in the movement of bone.

Teratogenic: An agent (chemical or radiation) which may have a detrimental effect of the development of an embryo or foetus.

Testes (sing. Testis): Male reproductive organs which produce spermatozoa.

Testosterone: A male sex hormone, produced by the testes, which promotes the development of male secondary sexual characteristics and stimulates sperm production.

Therapy: The treatment of a disease which has the potential to improve or cure the condition.

Thoracic cavity: Chest cavity, containing lungs and heart. Enclosed between rib cage and diaphragm.

Thrombin: An active enzyme formed by the action of prothrombin activator on prothrombin. Thrombin converts fibrinogen into fibrin.

Thrombocyte: (platelet) A small volume of cytoplasm bounded by cell membrane.

Thrombosis: The formation of a clot in a blood vessel in which no haemorrhaging has occurred.

Tidal volume: The volume of air inhaled and exhaled in a normal resting condition.

Tissue: A group of similar cells which together perform a particular function. Organs are composed of various tissues, e.g. muscle, nervous, connective.

Totipotent: Cells which can become any kind of cell in the body. The zygote and the cells which make up the morula are totipotent (stem) cells.

Toxin: A chemical acting as a poison, therefore described as toxic.

Trachea: Windpipe. Tube supported by rings of cartilage between the larynx and bronchi.

Trait: A feature or characteristic possessed by an individual.

Transcription: The copying of part of a DNA molecule by the formation of mRNA. This occurs in the nucleus and is the first main stage in protein synthesis.

Transfusion: The introduction of blood, serum or isotonic saline solution into a person's blood. Most often used to replace lost blood.

Translation: The process in which tRNA carry amino acids to the mRNA on the ribosome, where the amino acids are joined using peptide bonds so that a particular protein is synthesised according to the DNA code. This is the second main stage in protein synthesis.

Trypsin: An enzyme released from the pancreas (in an inactive form called trypsinogen) which assists in the breakdown of protein to peptides. Trypsin is a pancreatic protease.

Tubal ligation: A medical procedure in which both uterine (Fallopian) tubes are tied and cut, in order to sterilise a woman.

Tubular secretion: The active secretion of ions from the peritubular capillaries into the tubules of the nephron. This occurs when certain ions are in excess in the plasma and includes H^+, which therefore reduces the acidity of the plasma.

Umbilical cord: Structure containing foetal arteries and vein connecting the foetus to the placenta.

Umbilicus (navel): The scar left where the umbilical cord attaches to the foetus.

Unipotent: Cells which are only capable of dividing (by mitosis) and producing multiple copies of themselves are unipotent. They can therefore only produce one cell type.

Uterine (Fallopian) tube: Tube which transports ova from an ovary to the uterus by peristalsis and ciliary movement.

Uterus (womb): An inverted pear-shaped muscular organ in which the embryo, and later the foetus, develop.

Urea: A nitrogenous waste formed in the liver. Its formula is $CO(NH_2)_2$ and it is a waste product of the breakdown of excess amino acids. It is toxic and is excreted by the kidneys.

Urine: The liquid waste produced by the kidneys. Urine generally contains water, urea, uric acid, excess minerals, salts and hormones.

Vaccine: An inoculation, often a weakened form of a pathogen used to stimulate the body to produce its own antibodies in response to the particular disease pathogen.

Vagina: A muscular tube which connects the uterus to the vestibule and opens between the anus and the urethral opening.

Variation: Generally a small difference between two members of the same species. Variation in the offspring of sexually reproducing organisms is greater than that found in the offspring of asexually reproducing organisms.

Variable: A factor which can change, e.g. temperature.

Vas deferens: A duct which carries sperm from the epididymis up towards the urethra.

Vasectomy: The cutting and removal of part of each vas deferens in order to sterilise a man.

Vein: A major blood vessel which carries blood from body tissue to the heart.

Ventilation: Breathing, inhaling fresh air into the lungs and exhaling that air.

Venule: A small vein which connects blood capillaries to a vein.

Vestibule: A cavity formed by the labia at the beginning of the vagina.

Vernix: A waxy substance which covers a baby when it is born.

Viable: Having the potential to mature and produce healthy offspring.

Villi (singular Villus): Very small finger-like projections from the small intestine which absorb nutrients from the digestive tract. Villi increase the total surface area for absorption.

Virus: A parasite which is smaller than a bacterium consisting of a protein coat and a core of RNA or DNA. Viruses are not normally considered as living things; they are reproduced by their host cell.

Vitamin: Small organic molecule needed to promote health. Plants produce all their vitamins. Animals must eat vitamins produced by plants. Vitamins may act as cofactors or coenzymes in metabolism.

Vocal cords (or folds): Two membranes which stretch across the larynx, which are used to produce sounds for communication.

Vulva: External female genitalia.

X-chromosome: One of two sex chromosomes found in human cell nuclei. Females have two X-chromosomes in each nucleus (apart from their ova which contain one X-chromosome). Males have an X- and Y-chromosome in each somatic cell (sperm have either an X or a Y chromosome).

Y-chromosome: A short sex chromosome containing very few chromosomes, found only in male cells.

Yolk sac: A membrane sac that connects to the embryo.

Zygote: The fertilised ovum, which results from the fusion of a sperm and an ovum.

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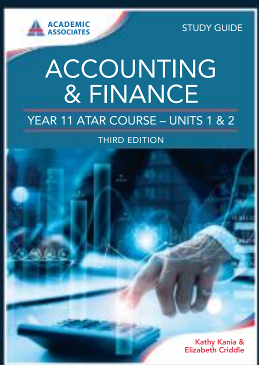

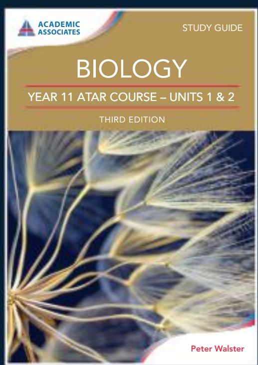

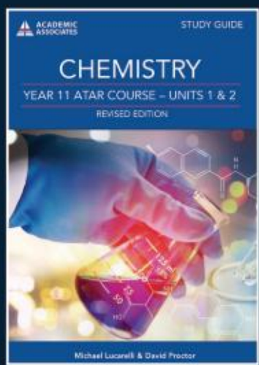

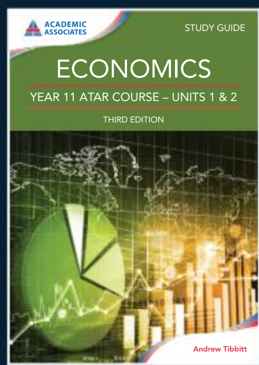

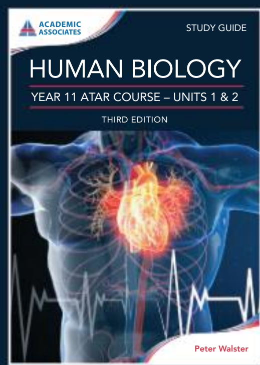

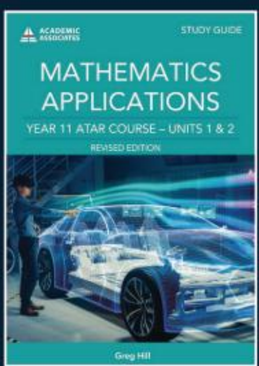

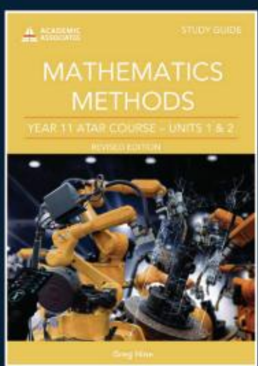

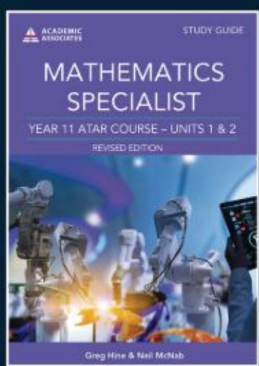

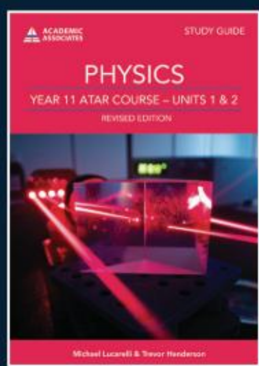

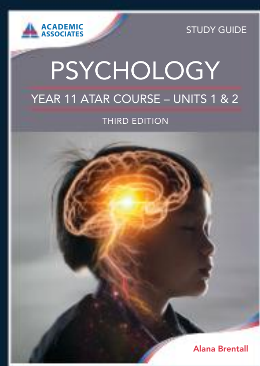

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