DOT POINT

HSC BIOLOGY

MULTIPLE CHOICE

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Introduction

What the book includes

In this book you will find nearly 700 typical multiple-choice examination questions, nearly 700 extension questions, plus summaries for the Year 12 Biology course. Answers to all questions are provided.

Questions follow the dot points in the Board of Studies syllabus and focus on the three core topics plus the option topic Communication:

- Maintaining a Balance
- Blueprint of Life
- The Search for Better Health
- Communication

Multiple-choice questions are presented in the HSC for the core topics, but there are usually no multiple-choice questions in the HSC for any of the option topics. They are included here as a source of quick revision.

The extension questions are designed to test and develop your understanding of the answers you give to the multiple-choice questions. Many of the questions also test various skills you are required to develop as you study each topic, for example analysing experimental results from first-hand investigations.

Format of the book

The book has been formatted in the following way:

1. Main topic statement (column 1 of syllabus)

1.1etc Syllabus requirement from columns 2 and 3.

Note that the numbering of these requirements is the author's choice and has been used to make referencing questions and answers clearer. The individual requirements are not numbered in the syllabus, they are simply bulleted – hence our use of 'dot points' when we refer to them.

1.1.1 First typical question which could be asked in an examination for this syllabus requirement.

1.1.2 Second typical question which could be asked in an examination for this syllabus requirement, etc.

Also note that some questions branch across more than one dot point in that the answer choices often relate to different dot points.

How to use the book

Completing all questions will provide you with a summary of all the work you need to know from the syllabus. You may have done work in addition to this with your teacher as extension work. Obviously this is not covered, but you may need to know this additional work for your school exams.

When working through the questions, write the answers you have to look up in a different colour to those you know without having to research the work. This will provide you with a quick reference to work you should spend more time revising later, and allow you to spend your study time more productively.

Verbs to Watch

account, account for
State reasons for, report on, give an account of, narrate a series of events or transactions.

analyse
Identify components and the relationships among them, draw out and relate implications.

apply
Use, utilise, employ in a particular situation.

appreciate
Make a judgement about the value of something.

assess
Make a judgement of value, quality, outcomes, results or size.

calculate
Determine from given facts, figures or information.

clarify
Make clear or plain.

classify
Arrange into classes, groups or categories.

compare
Show how things are similar or different.

construct
Make, build, put together items or arguments.

contrast
Show how things are different or opposite.

critically (analyse/evaluate)
Add a degree or level of accuracy, depth, knowledge and understanding, logic, questioning, reflection and quality to an analysis or evaluation.

deduce
Draw conclusions.

define
State the meaning of and identify essential qualities.

demonstrate
Show by example.

describe
Provide characteristics and features.

discuss
Identify issues and provide points for and against.

distinguish
Recognise or note/indicate as being distinct or different from, note difference between things.

evaluate
Make a judgement based on criteria.

examine
Inquire into.

explain
Relate cause and effect, make the relationship between things evident, provide why and/or how.

extract
Choose relevant and/or appropriate details.

extrapolate
Infer from what is known.

identify
Recognise and name.

interpret
Draw meaning from.

investigate
Plan, inquire into and draw conclusions about.

justify
Support an argument or conclusion.

outline
Sketch in general terms; indicate the main features.

predict
Suggest what may happen based on available data.

propose
Put forward (a point of view, idea, argument, suggestion etc) for consideration or action.

recall
Present remembered ideas, facts or experiences.

recommend
Provide reasons in favour.

recount
Retell a series of events.

summarise
Express concisely the relevant details.

synthesise
Put together various elements to make a whole.

Maintaining a Balance

Notes

Blueprint of Life

Notes

The Search for Better Health

Notes

Communication

Notes

DOT POINT

Maintaining a Balance

1. Most organisms are active in a limited temperature range.

1.1 Identify the role of enzymes in metabolism, describe their chemical composition and use a simple model to describe their specificity on substrates.

Enzymes are organic catalysts that reduce the amount of energy needed to start a chemical reaction and thus they control the rate of reactions in the body.

Enzymes are proteins and made of the elements carbon, hydrogen, oxygen and nitrogen.

Each enzyme controls a specific reaction.

The lock-and-key model is used to show how each enzyme is specific for a specific reaction. The enzyme has a specific shape which fits onto the substrate forming an enzyme-substrate complex. The reaction occurs and the enzyme breaks away from the product(s).

The lock-and-key model has been modified to the induced-fit model. Analysis of the shapes of molecules shows that the active site is more flexible than a 'keyhole' and can slightly alter its shape to fit more closely with the substrate.

Factors that affect enzyme activity include the amount of substrate present, temperature, pH, presence of coenzymes or cofactors, the presence of heavy metals, e.g. mercury, lead, zinc.

1.1.1 Which of the following would best describe the role of enzymes in cells?

(A) Controlling the rate of reactions.
(B) Storing the genetic code.
(C) Maintaining a constant body temperature.
(D) Breaking large molecules into smaller molecules.

Extension: Justify your choice of answer.

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1.1.2 Which of the following best shows the sequence of events in a reaction controlled by an enzyme?

(A) $S_1 + S_2 \rightarrow P + E$
(B) $S_1 + S_2 \xrightarrow{E} P$
(C) $S_1 + S_2 + E \rightarrow P$
(D) $S_1 + E \rightarrow P + S_2$

Key
E = enzyme
S_1 = substrate 1
S_2 = substrate 2
P = product

Extension: Justify your choice of answer.

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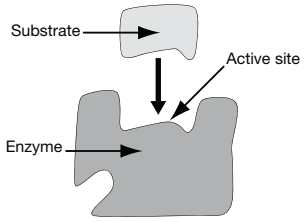
1.1.3 The following diagram shows a simple model to illustrate the specificity of enzymes on substrates.



Name this model.

(A) Enzyme-active site model.
(B) Substrate-enzyme complex.
(C) Catalyst reaction model.
(D) Lock-and-key model.

Extension: Justify your choice of answer.

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1.1.4 Some fruits and vegetables release enzymes when picked that convert the natural sugar content to starch. This means that many people find 'freshly picked' fruit much sweeter than stored fruits. To keep the sweetness, some types of freshly picked fruit are immersed in boiling water for a few minutes, then cooled.

Why would boiling for a few minutes retain the 'sweetness'?

(A) Boiling denatures the enzyme that converts sugar into starch.
(B) Boiling 'cooks' the sugar so it cannot change into starch.
(C) Boiling sterilises the fruit so surface bacteria cannot convert the sugar into starch.
(D) Boiling changes the osmotic balance so water is absorbed and sugars cannot convert to starch.

Extension: Explain your answer.

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1.1.5 Many enzymes are highly specific for particular substrates. What is the general advantage for having highly specific enzymes?

(A) They allow a biochemical reaction to occur in one step.
(B) The protein in the enzyme can be used in the reaction.
(C) The products of each step in a biochemical pathway are produced in correct order.
(D) The reactants in a particular reaction can be present in smaller concentrations.

Extension: Explain your answer.

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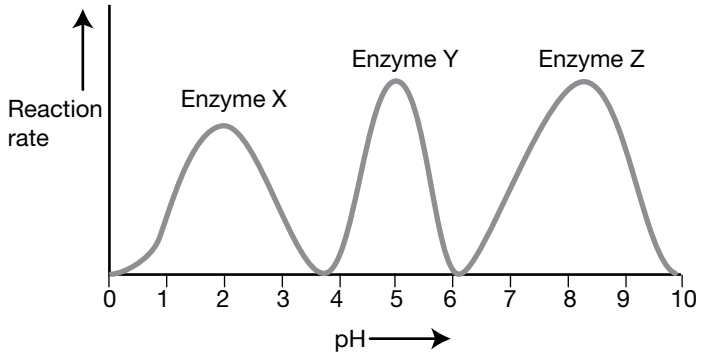
1.1.6 The diagram shows the reaction rates of three different enzymes at different pH values.



What would this data infer?

(A) Enzyme Z would be found acting in the stomach.
(B) Enzyme X would function at optimal levels in the blood.
(C) Enzyme Y is involved in respiration.
(D) Enzyme X would be found in the stomach.

Extension: Explain your answer.

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1.1.7 Which of the following would inhibit a reaction catalysed by an enzyme?

(A) Presence of cofactors.
(B) Presence of heavy metals such as mercury.
(C) Presence of coenzymes.
(D) Slight drop in temperature.

Extension: Explain your answer.

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1.1.8 Ligases are enzymes that catalyse the joining or 'sticking together' of two molecules. Hydrolases catalyse hydrolysis reactions where water is added and molecules are broken down to smaller molecules. What is a 'naming' rule for many enzymes?

(A) Enzyme names have the suffix 'ase'.
(B) Enzyme names have the suffix 'ose'.
(C) Enzyme are named after the geographic region where they were first isolated.
(D) Enzymes are named after the person who discovered them.

Extension: Explain your answer.

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1.2 Identify data sources, plan, choose equipment or resources and perform a first-hand investigation to test the effect of:

- **increased temperature**
- **change in pH**
- **change in substrate concentrations on the activity of named enzyme(s).**

There are a variety of first-hand experiments which can be performed to show the specificity of enzymes.

Details will depend on the chosen enzyme and the reaction it controls.

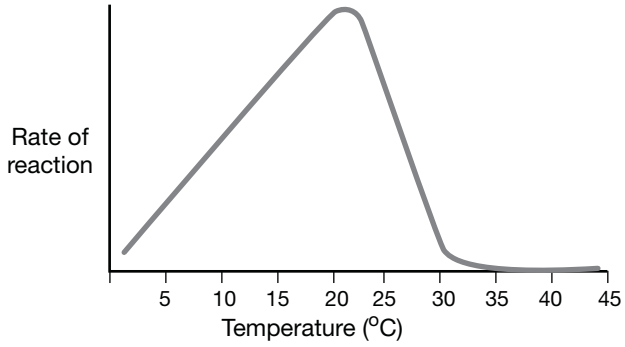
In every experiment, you need to be able to:

- **list the equipment used**
- **state a relevant safety precaution for the experiment**
- **outline the step-by-step method used**
- **identify the variables controlled and the control**
- **describe the results and conclusion.**

Typical conclusions

- **Each enzyme has an optimal temperature and optimal pH.**
- **Rate of reaction will increase until optimal conditions are reached and then rate will decrease.**
- **Increased substrate concentration will increase rate of reaction until another condition becomes a limiting factor.**

1.2.1 Some students carried out an experiment to test the effect of increased temperature on the activity of a particular enzyme. The graph shows their results.



What conclusion could the students draw for their experiment?

(A) The enzyme is from an ectotherm.
(B) Enzymes have optimal temperatures and optimal pH.
(C) Optimal temperature for this enzyme is 22°C.
(D) As temperature increases the activity of the enzyme increases.

Extension: Justify your answer.

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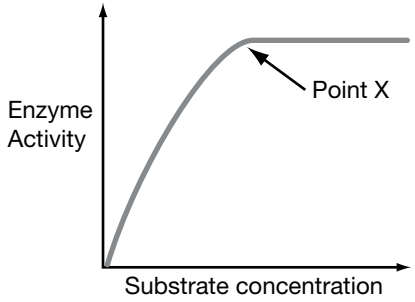
1.2.2 The graph shows the relationship between enzyme activity and substrate concentration.



What is the significance of point X?

(A) Increasing substrate concentration beyond point X will not increase the rate of the reaction.
(B) Increasing substrate concentration beyond point X will increase the rate of the reaction.
(C) Beyond point X the substrate concentration cannot increase.
(D) Optimal enzyme activity occurs below a specific substrate concentration.

Extension: Suggest a reason why enzyme activity will not increase beyond a certain substrate concentration.

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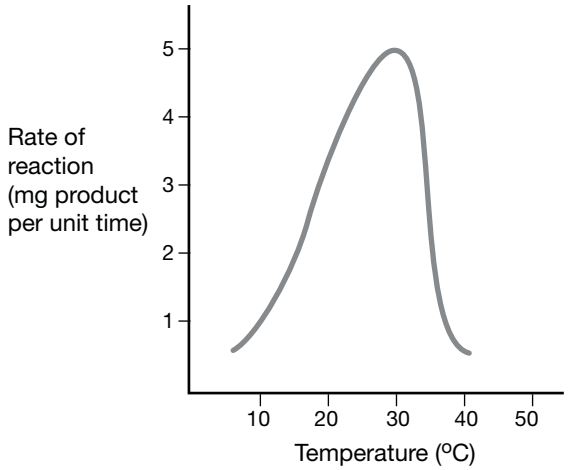
1.2.3 The graph shows the effect of temperature on the activity of an enzyme.



What can you deduce from this graph?

(A) The optimal temperature for this enzyme is 37°C.
(B) Increasing temperature increases the rate of reaction.
(C) High pH causes the enzyme to denature.
(D) Low temperatures cause a slow reaction rate.

Extension: Explain your answer.

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1.2.4 Some HSC Biology students wished to investigate the effect of pH on the activity of an enzyme. They made up a series of junket solutions and added 5 mL milk to each test tube. Each test tube was kept in a water bath at a specific temperature. Junket tablets contain the enzyme rennin. Rennin works in the stomach to clot milk.

Which design would be the most appropriate for this experiment?

KEY M = milk J = junket

Design A

Test tube	pH	Temp. (°C)	Contents
1	7	30	M +J
2	7	40	M + J
3	7	50	M + J
4	7	30	M
5	7	40	M
6	7	50	M

Design B

Test tube	pH	Temp. (°C)	Contents
1	2	40	M +J
2	7	40	M + J
3	10	40	M + J
4	2	40	M
5	7	40	M
6	10	40	M

Design C

Test tube	pH	Temp. (°C)	Contents
1	2	30	M +J
2	2	40	M + J
3	2	50	M + J
4	2	30	M
5	2	40	M
6	2	50	M

Design D

Test tube	pH	Temp. (°C)	Contents
1	2	40	J
2	7	40	J
3	10	40	J
4	2	40	M
5	7	40	M
6	10	40	M

(A) Design A.
(B) Design B.
(C) Design C.
(D) Design D.

Extension: Explain your answer.

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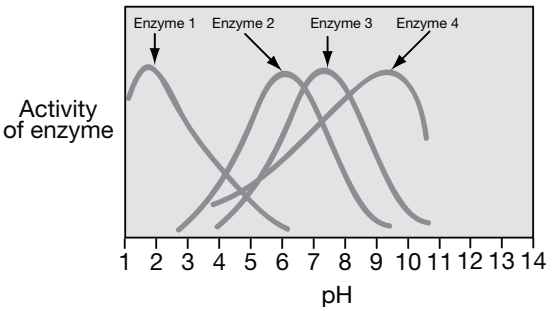
1.2.5 The graph shows the action of four different enzymes over a range of pH.

Which enzyme would be found in the alkaline small intestine?



(A) Enzyme 1.
(B) Enzyme 2.
(C) Enzyme 3.
(D) Enzyme 4.

Extension: What is the optimal pH for this enzyme?

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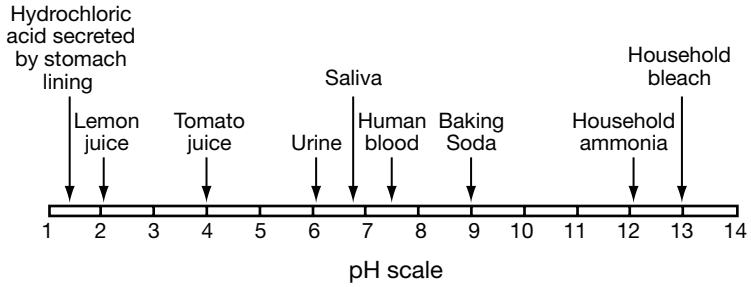
1.3 Identify the pH as a way of describing the acidity of a substance.

pH is a measure of the acidity of a substance.

The scale ranges from 1 (acid) to 7 (neutral) to 14 (base).

The diagram shows the pH scale and the pH of various common substances. **Use this diagram for the next THREE questions.**



1.3.1 Which list correctly shows substances in order of increasing acidity?

(A) Baking soda, saliva, tomato juice, lemon juice.
(B) Lemon juice, tomato juice, saliva, baking soda.
(C) Household bleach, baking soda, lemon juice, tomato juice.
(D) Tomato juice, human blood, saliva, household bleach.

Extension: Explain your answer.

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1.3.2 According to this pH scale, what is the pH of human blood?

(A) pH = 7 which is neutral.
(B) pH = 7.4 which is slightly acidic.
(C) pH = 7.4 which is slightly alkaline.
(D) pH = 8 which is neutral.

Extension: Explain your answer.

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1.3.3 From the diagram what is the most acidic substance produced by the human body?

(A) Urine.
(B) Hydrocholoric acid secreted by stomach lining.
(C) Saliva.
(D) Human blood.

Extension: Explain your answer.

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1.4 Explain why the maintenance of a constant internal environment is important for optimal metabolic efficiency.

The chemical reactions that support the processes of life require specific conditions, e.g. enzyme-catalysed reactions require optimal temperature, pH and substrate concentration.

A change in the internal environment can affect a biochemical pathway, e.g. if the process of respiration is disrupted, there will be a decrease in the release of energy and the body will not function correctly.

1.4.1 What will happen if an endotherm cannot maintain a constant internal environment for a period of time?

(A) Metabolic efficiency will increase.
(B) Metabolic efficiency will decrease.
(C) The animal will go to sleep.
(D) The animal will immediately die.

Extension: Explain your answer.

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1.4.2 What is meant by cell metabolism?

(A) All the chemical reactions that take place in a cell.
(B) The rate of biochemical reactions in the cell.
(C) A particular chemical pathway where the product of one reaction becomes the substrate of the next reaction.
(D) A process that releases energy for use in the cell.

Extension: Explain your answer.

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1.4.3 The diagram shows a biochemical pathway regulated by enzymes.

$$\text{Substrate 1} \xrightarrow{\text{enzyme 1}} \underset{\text{(substrate 2)}}{\text{product 1}} \xrightarrow{\text{enzyme 1}} \underset{\text{(substrate 3)}}{\text{product 2}} \xrightarrow{\text{enzyme 1}} \text{product 3}$$

If enzyme 2 requires a specific pH that is fairly low and the body cannot maintain that pH, what will happen?

(A) The reaction will proceed faster causing product 3 to accumulate.
(B) The reaction will be slower and product 2 will accumulate.
(C) Enzyme 1 will not be able to function.
(D) The reaction will halt and product 1 will accumulate.

Extension: Explain your answer.

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1.5 Describe homeostasis as the process by which organisms maintain a relatively stable internal environment.

Homeostasis is defined as the maintenance of a relatively stable internal environment.

Conditions controlled by homeostasis include body temperature, pH, water concentration, salt concentrations, sugar levels, levels of dissolved gases, e.g. oxygen and carbon dioxide.

1.5.1 What is the definition of homeostasis?

(A) Homeostasis is the maintenance of body sugar levels and temperature.
(B) Homeostasis is the process where the internal and external environment is controlled.
(C) Homeostasis is the maintenance of constant internal environment.
(D) Homeostasis is the process in plants and animals to control the internal environment.

Extension: Identify some conditions that are controlled by homeostasis.

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1.5.2 Which of the following is NOT an example of homeostasis?

(A) Body temperature maintained at 37°C.
(B) Eating a large lunch.
(C) pH of blood kept at 7.4.
(D) Breathing faster when carbon dioxide levels in the blood rise.

Extension: Explain your answer.

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1.5.3 What is an advantage of homeostasis?

(A) It helps an organism survive in an environment with changing conditions.
(B) It helps the body change shape when needed.
(C) It controls behaviour and responses to other members of the same species.
(D) It controls variation in a species and its ability to survive natural selection.

Extension: Explain your answer.

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1.5.4 What term best describes the maintenance of a stable, constant internal condition?

(A) Equilibrium.
(B) Osmosis.
(C) Homeostasis.
(D) Physiology.

Extension: What is the meaning of 'homoios" and 'stasis'?

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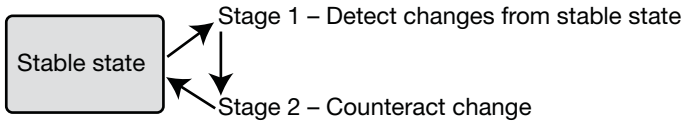
1.6 Explain that homeostasis consists of two stages:
• detecting changes from the stable state
• counteracting changes from the stable state.

Homeostasis consists of two stages – detecting changes from the stable state and counteracting changes from the stable state.



1.6.1 There are two stages in homeostasis. One stage is detecting changes from the stable state, what is the other stage?

(A) Negative feedback to turn off a response no longer needed.
(B) Sending a message along a sensory neurone to the brain.
(C) The central nervous system interprets the message from receptors.
(D) Counteracting changes from the stable state.

Extension: Explain your answer.

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1.6.2 In 1865 Claude Bernard wrote *Introduction to Experimental Medicine*. He determined there were enzymes present in gastric juice and that complex carbohydrates are broken down to sugars then absorbed into the blood. He noted that the 'constancy of the internal milieu was the essential condition to a free life'.

What do we now call the 'constancy of the internal milieu'?

(A) Metabolism.
(B) Coordination.
(C) Homeostasis.
(D) Enzyme specificity.

Extension: What is the main sugar absorbed into the blood?

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1.6.3 What structures in the body detect changes from the stable state?

(A) Sensory neurones.
(B) Receptors.
(C) Motor neurones.
(D) Effectors.

Extension: Explain your answer.

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1.7 Outline the role of the nervous system in detecting and responding to environmental changes.

The stimulus-response pathway consists of the steps :

Stimulus → receptor → central nervous system → effector → response

This pathway in the nervous system allows a change in the environment to be detected and a response made to counteract the change.

Receptors detect the stimulus, e.g. thermoreceptors in the skin detect a drop in ambient temperature. The receptors stimulate a sensory neurone which sends a nervous impulse to the central nervous system. The CNS can cause a reflex action to occur or the brain can interpret the information and a conscious decision can determine the response. A nervous impulse is sent to the effector, e.g. muscle or gland and the effector carries out the response, e.g. shivering to increase body temperature.

The negative feedback system will turn off the response once the stable state has been re-established.

1.7.1 What is the correct order of the stimulus-response pathway?

(A) stimulus → central nervous system → sensory neurone → effector → response.
(B) stimulus → motor neurone → central nervous system → effector → response.
(C) stimulus → receptor → central nervous system → effector → response.
(D) stimulus → receptor → central nervous system → sensory neurone → response.

Extension: Use an example to show the stimulus-response pathway.

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1.7.2 Which group correctly links the environmental stimulus and its detection.

	Stimulus	Receptor	Sense organ
(A)	Light	Cornea	Eye
(B)	Sound	Eardrum	Ear
(C)	Chemical vapour	Olfactory receptor	Tongue
(D)	Chemical liquid	Tastebud	Tongue

Extension: Explain why answer (C) is incorrect.

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1.7.3 Which part of the nervous system carries out the response?

(A) Effector.
(B) Receptor.
(C) Central nervous system.
(D) Motor neurone.

Extension: Explain your answer.

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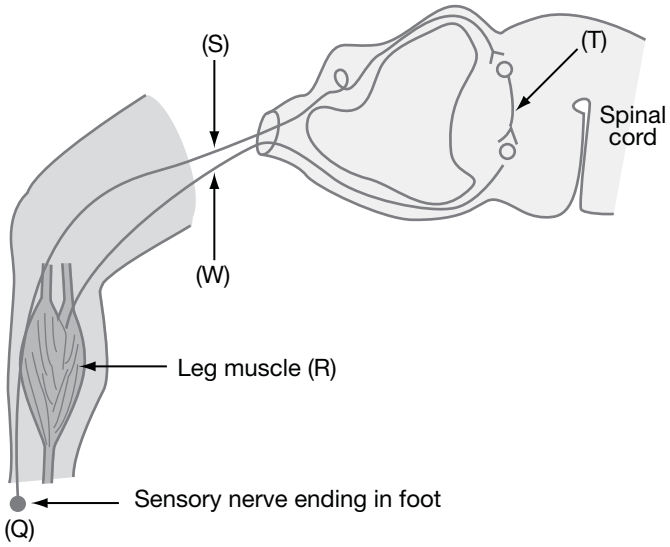
The diagram shows a section of the nervous system that controls a reflex arc in the leg. It shows a sensory nerve ending in the foot that can detect a stimulus and the pathway to the leg muscle via the spinal cord.

Use this diagram for the next TWO questions.



1.7.4 What is the pathway from sensory nerve to effector?

(A) Q, W, T, S, R.
(B) Q, T, W, S, R.
(C) Q, S, T, W, R.
(D) Q, W, S, T, R.

Extension: Explain your answer.

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1.7.5 What is the advantage of a reflex arc in detecting and responding to a change in the environment?

(A) It connects the nervous system to the endocrine system and enables a hormonal response.
(B) It means the body can respond very quickly without waiting for the brain to interpret the information.
(C) It protects the legs from changes in temperature.
(D) It enables sensory neurones to connect to other parts of the body to inform each part about the stimulus.

Extension: Explain your answer.

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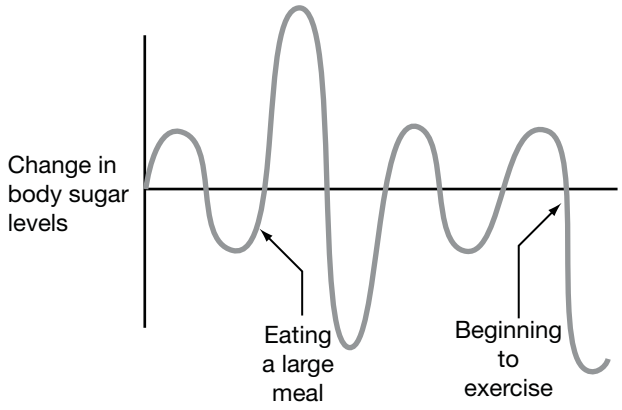
1.8 Gather, process and analyse information from secondary sources and use available evidence to develop a model of a feedback mechanism.

1.8.1 The graph shows the effect of a change in diet and exercise on the body sugar levels of an endotherm.



What does this graph represent?

(A) A feedback system.
(B) A nerve impulse.
(C) The digestive enzymes.
(D) The rate of respiration.

Extension: Justify your choice of answer.

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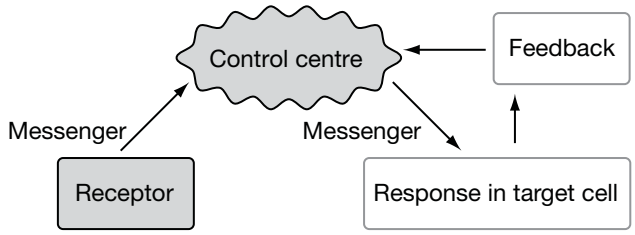
1.8.2 The diagram shows a feedback mechanism.



What is a possible example of this feedback model?

	Receptor	Control centre	Target cell
(A)	Sweat gland	Hypothalamus	Stomach wall
(B)	Thermoreceptor in skin	Hypothalamus	Sweat glands
(C)	Mechanoreceptor	Spinal cord	Kidney tubules
(D)	Sensory neurone	Brain	Liver

Extensio: Explain your answer.

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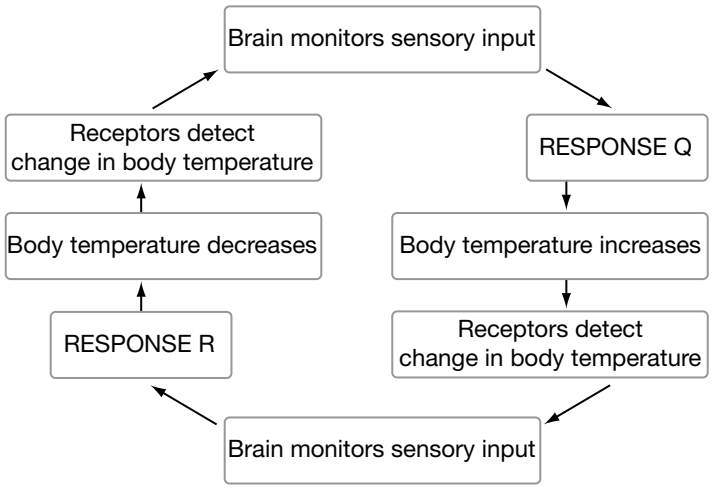
1.8.3 The flow chart shows a feedback mechanism in an endotherm.



What would response R represent?

(A) Constriction of muscles in walls of blood vessels.
(B) Increased urine production.
(C) Increased shivering and muscle contraction.
(D) Increased rate of sweat production.

Extension: Justify your choice of answer.

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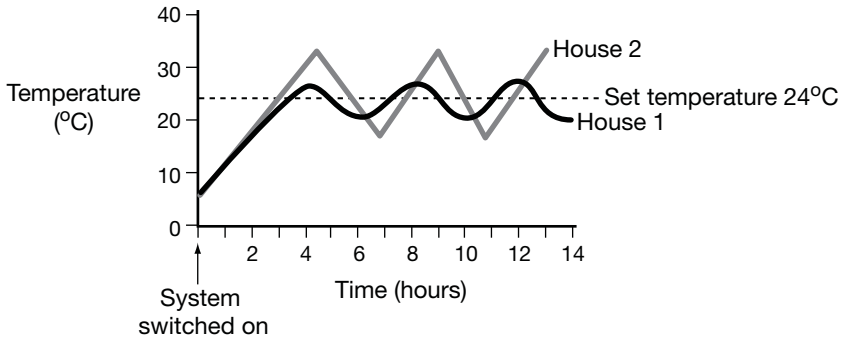
1.8.4 The diagram shows a graph of temperature changes in two similar houses that each had a thermostat system to regulate their home heating system. Both houses had set the desired temperature at 24°C.



What can you deduce about temperature regulation in these two houses?

(A) House 1 has greater temperature fluctuations than house 2.
(B) The temperature detectors in house 2 are more efficient than the temperature detectors in house 1.
(C) The temperature detectors in house 2 are more efficient than the temperature detectors in house 1.
(D) Only house 2 has a feedback mechanism.

Extension: Justify your choice of answer.

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1.9 Identify the broad range of temperatures over which life is found compared with the narrow limits for individual species.

Broad temperature range

Most organisms live in environments with temperatures between 0°C and 45°C.

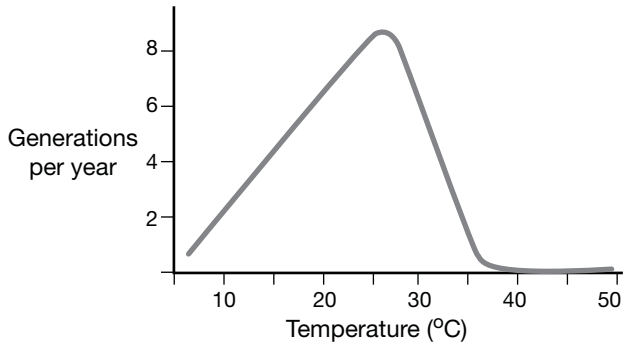
Some organisms have been found at the poles with temperatures below –70°C and around black smokers in oceanic trenches with temperatures above 200°C.

Narrow limits for individual species

There are many species that have a restricted temperature range.

A variety of responses are possible depending on the species researched by each student.

1.9.1 The reproductive rate of a certain species of fly was investigated and the results were graphed.



What conclusion can be drawn from these results?

(A) All flies cannot reproduce above 40°C.
(B) The species has an optimal temperature range.
(C) Flies need time to adapt to a broad temperature range.
(D) All flies have a limited temperature range.

Extension: Justify your choice of answer.

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1.9.2 If an HSC student wished to study the effect of temperature on the growth of a particular species, what would be the best experimental design?

(A) Several individuals of the same species kept at each temperature.
(B) One individual kept at each temperature for a specified time.
(C) One individual at each temperature.
(D) Several individuals of the same species at one temperature and then repeat at different temperatures.

Extension: Justify your choice of answer.

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1.10 Compare responses of named Australian ectothermic and endothermic organisms to changes in the ambient temperature and explain how these responses assist temperature regulation.

Endotherms

Endotherms use internal metabolic processes to control their body temperature, e.g. mammals and birds.

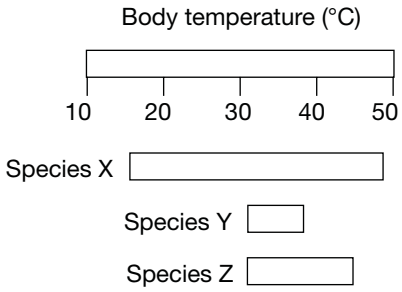
An Australian endotherm is the red kangaroo. If the temperature becomes too hot it will pant and lick its forelimbs, relying on the evaporation from the body surface for cooling.

Ectotherms

Ectotherms use the energy from their environment to regulate their body temperature, e.g. fish, reptiles, amphibians and all invertebrates.

An Australian ectotherm is the netted dragon which is a desert lizard. It lies in the sun to absorb warmth to heat its body until body temperature is around 36°C. It will then retreat to its burrow to stop becoming too hot.

1.10.1 The diagram shows the range of body temperature of three different species found in one habitat.



Which of the following is the best description?

(A) Species X and species Y are both endothermic.
(B) Species Y and species Z are ectothermic.
(C) Species X is ectothermic and species Y is endothermic.
(D) Species Z is ectothermic and species Y is endothermic.

Extension: Explain your answer.

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1.10.2 If an endotherm was exposed to a sudden and prolonged increase in ambient temperature, what homeostatic response could you expect?

(A) Increased blood flow to the skin.
(B) Increased release of carbon dioxide.
(C) Increased muscular activity.
(D) Constriction of blood vessels.

Extension: Explain your answer.

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1.10.3 The body temperature of many Australian skinks can vary by several degrees during the course of one day. What does this suggest about skinks?

(A) Skinks have a small surface area to volume ratio.
(B) Skinks are ectotherms.
(C) Skinks do not have any adaptations for temperature regulation.
(D) Skinks can only live in coastal areas.

Extension: Explain your answer.

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1.10.4 Which feature would be a response by an endotherm to a temporary drop in ambient temperature?

(A) Hibernation.
(B) Migration to warmer regions.
(C) Constriction of muscles in blood vessels in extremities.
(D) Increased sweating.

Extension: Explain your answer.

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1.10.5 There are a variety of adaptations used by endotherms and ectotherms to survive changing environmental temperature.

Which shows adaptations for an increase in ambient temperature?

	Endothermic animal	Ectothermic animal
(A)	Panting	Burrowing
(B)	Shivering	Sunbaking
(C)	Redirection of blood away from extremities	Sweating
(D)	Dilation of blood vessels in the skin	Flattening body to the ground

Extension: Explain your answer.

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1.10.6 Koalas do not have a layer of fat below their skin unlike bears or seals. If the ambient temperature drops below 10°C koalas begin to shiver. How does this assist temperature regulation?

(A) It decreases metabolic activity and the release of heat.
(B) It increases metabolic activity and the release of heat.
(C) It increases blood flow to extremities to keep them warm.
(D) It decreases the amount of water reabsorbed in the kidney tubules.

Extension: Explain your answer.

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1.10.7 Many Australian snakes bask in the sun at sunrise and sunset and move into the shade at other times of the day. What is the purpose of this behaviour?

(A) To prevent overheating or becoming too cold.
(B) To maintain a body temperature consistent with their environment.
(C) To maintain a constant body temperature at 37°C.
(D) To find food.

Extension: Explain your answer.

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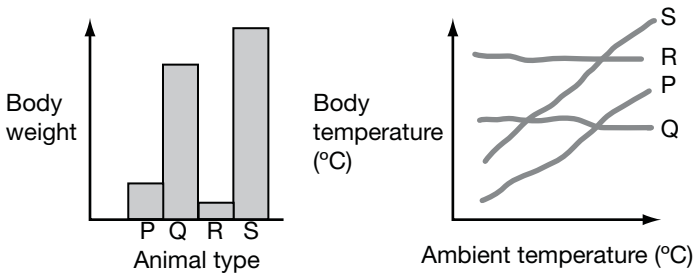
1.10.8 The two graphs show the body weight and how body temperature varies for four different Australian animals.



Which animal would most likely be a desert mammal?

(A) Animal P.
(B) Animal Q.
(C) Animal R.
(D) Animal S.

Extension: Explain your answer.

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1.10.9 Which adaptation would NOT assist a mammal maintain a body temperature lower than the environmental temperature in a hot environment?

(A) Shivering.
(B) Being only active at night.
(C) Licking paws and forelimbs.
(D) Burrowing.

Extension: Explain your answer.

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1.11 Analyse information from secondary sources to describe adaptations and responses that have occurred in Australian organisms to assist temperature regulation.

A variety of responses are possible for this section depending on the particular Australian organism chosen for study.

1.11.1 The diagram shows a wombat. The common wombat is found along the south-eastern coast of Australia, including Tasmania.

Which of the following adaptations show its suitability to cold alpine areas?

(A) Strong digging claws.
(B) Small eyes.
(C) Large molars.
(D) Short ears.

Extension: Justify your answer.

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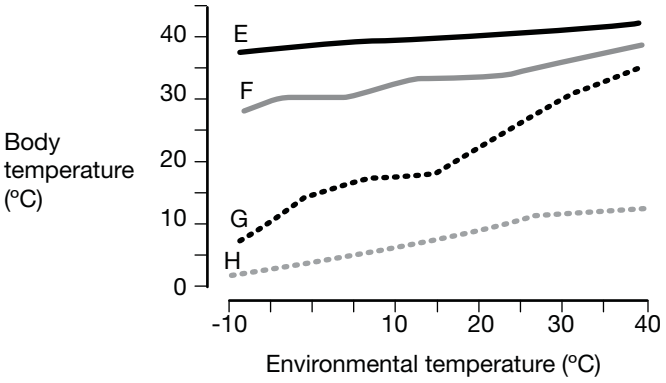
1.11.2 The graph shows the body temperature of four different Australian animals – animal E, animal F, animal G and animal H, over a range of temperatures.



What can be determined from this graph?

(A) Animals G and H are endotherms.
(B) Animals E and F are endotherms.
(C) Animal E is a mammal.
(D) Animal F maintains body temperature in the heat by panting.

Extension: Justify your answer.

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1.11.3 The shaded areas on the map of Australia shows the distribution of koalas, *Phascolarctus cinereus*. Koalas live in coastal eucalypt forests.

When ambient temperatures rise above 26-30°C, koalas use evaporative cooling in their airways to control their body temperature.

How does this evaporative cooling work?

(A) Water gives heat to the body when it goes from liquid to gas.
(B) Evaporation provides heat to the airways.
(C) Water in the airways takes heat from the body for the change of state to gas.
(D) There is a release of heat from water molecules as they change to a gas.

Extension: Justify your answer.

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1.11.4 Many animals found in Tasmania are larger versions of species found in Victoria and NSW. Explain how the surface area to volume ratio can affect body temperature of an organism.

(A) The smaller the organism, the greater the surface area to volume ratio and the greater the variations in body temperature.
(B) The smaller the organism, the smaller the surface area to volume ratio and the greater the variations in body temperature.
(C) The smaller the organism, the greater the surface area to volume ratio and the smaller the variations in body temperature.
(D) The smaller the organism, the smaller the surface area to volume ratio and the smaller the variations in body temperature.

Extension: Justify your answer.

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1.11.5 Core temperature is the temperature of the core organs such as those inside the skull, chest and abdominal cavity, while shell temperature is the temperature of the skin and the peripheral tissues.

Which of the following responses would lead to a quick drop in shell temperature?

(A) Constriction of muscles of surface blood vessels.
(B) Dilation of muscles of surface blood vessels.
(C) Shivering of muscles in extremities.
(D) Decreased respiration in the liver.

Extension: Justify your answer.

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1.12 Identify some responses of plants to temperature changes.

There are many different responses possible depending on the particular plants investigated.

Different climates determine the rate of photosynthesis, the rate of transpiration, surface area of stems, leaves, flowers etc and the length of life cycle.

1.12.1 Which of the following would assist temperature control in plants?

(A) Large leaves to retain heat.
(B) Faster movement of sugars in the phloem.
(C) Decreased flowering period.
(D) Transpiration from stomates.

Extension: Define transpiration.

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1.12.2 In many plants the rate of transpiration falls when the temperature rises above 40°C. How would a plant change the rate of transpiration?

(A) By closing stomates.
(B) By reducing the flow of organic substances in the phloem.
(C) By closing valves in the xylem.
(D) By sealing off root hairs.

Extension: Explain your answer.

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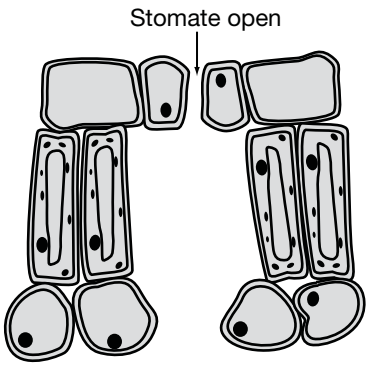
1.12.3 Some plants only open their stomates at night. During the night carbon dioxide enters the leaf to be used in photosynthesis in the next day. What is the advantage of this behaviour?



(A) It is an advantage in cold climates as stem structure has large air spaces to hold the carbon dioxide for warmth.
(B) It is an advantage in cold climates as it reduces heat loss during cold days.
(C) It is an advantage in hot climates as less water is lost during the night when it is cooler.
(D) It is an advantage in hot climates as it allows heat to leave the plant at night.

Extension: Explain your answer.

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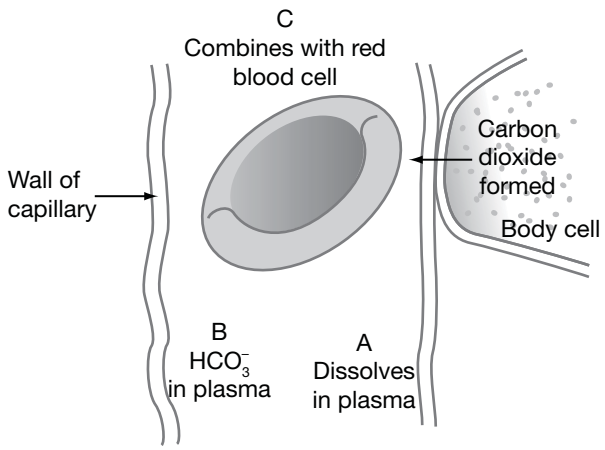
2. Plants and animals transport dissolved nutrients and gases in a fluid medium.

2.1 Identify the form(s) in which each of the following is carried in mammalian blood:

- **carbon dioxide**
- **oxygen**
- **water**
- **salts**
- **lipids**
- **nitrogenous wastes**
- **other products of digestion**

Substance	Form carried in mammalian blood
Carbon dioxide	Carbon dioxide travels in different forms in the blood – around 7% carbon dioxide dissolves directly in the plasma, about 23% combines with haemoglobin forming carbaminohaemoglobin and about 70% forms hydrogen carbonate ions (HCO_3^-) and travels in the plasma.
Oxygen	Oxygen combines with haemoglobin to form oxyhaemoglobin in red blood cells.
Water	Water travels in plasma as water molecules.
Salt	Salts travel as either positive or negative ions, e.g. potsssium ions K^+.
Lipids	Many lipids are water insoluble and only travel in the blood when they are coated with proteins becoming lipoproteins and travel as high-density lipoproteins (HDL) or low-density lipoproteins (LDL).
Nitrogenous waste	The nitrogenous waste is ammonia, but as this is toxic most mammals convert the ammonia to urea. The conversion occurs in the liver and the kidneys filter the urea from the blood.
Other products of digestion	Many products of digestion are soluble and travel dissolved in the plasma, e.g. amino acids, glucose, vitamins.

2.1.1 The diagram shows a red blood cell, plasma and the transport of carbon dioxide in the blood. It shows three ways (A, B, and C) in which carbon dioxide travels in the blood.



What is the correct order of the forms to show least amount to most amount of carbon dioxide carried in the blood?

(A) A, B, C.
(B) C, B, A.
(C) B, C, A.
(D) A, C, B.

Extension: Explain your answer.

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2.1.2 The reaction between oxygen and haemoglobin can be written in the following equation.

$$\text{Haemoglobin} + \text{oxygen} \underset{\text{low-oxygen}}{\overset{\text{high-oxygen}}{\rightleftharpoons}} \text{oxyhaemoglobin}$$

If there are approximately 280 million haemoglobin molecules in each red blood cell, and each haemoglobin can combine with four oxygen molecules, how many oxygen molecules can be carried by one red blood cell?

(A) 70 million oxygen molecules.
(B) 280 million oxygen molecules.
(C) 1120 million oxygen molecules.
(D) 4480 million oxygen molecules.

Extension: Explain your answer.

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2.1.3 Salts travel in the blood as ions. Which list correctly shows positive and negative ions carried in the blood?

	Positive ions	Negative ions
(A)	Chloride, hydrogen carbonate	Sodium, potassium, calcium
(B)	Sodium, potassium, calcium	Chloride, hydrogen carbonate
(C)	Magnesium, sodium, chloride	Potassium, chloride
(D)	Hydrogen carbonate, potassium	Magnesium, chloride

Extension: Explain your answer.

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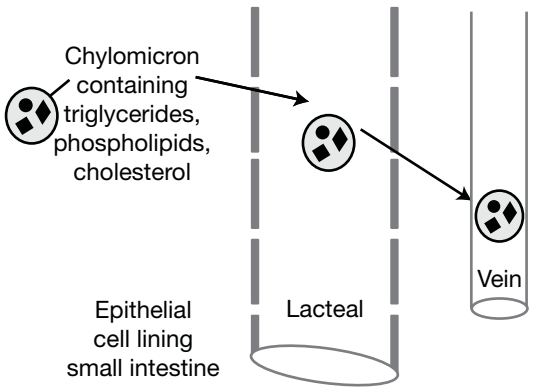
2.1.4 The diagram shows the transport of lipids in the blood. Chylomicrons are formed in the epithelial cells lining the small intestine. Chylomicrons have a protein coat and contain triglycerides, phospholipids and cholesterol.

Which nutrient is transported as a chyhlomicron?



(A) Nitrogenous waste.
(B) Digested carbohydrate.
(C) Digested protein.
(D) Digested lipid.

Extension: Explain your answer.

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2.1.5 What is the main form of transport of nitrogenous compounds in the blood in humans?

(A) Urea.
(B) Ammonia.
(C) Uric acid.
(D) Nucleic acid.

Extension: Explain your answer.

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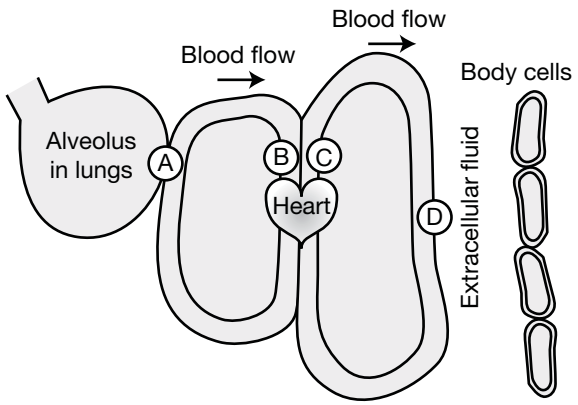
2.1.6 The diagram shows a model of the circulatory system of humans.

Where does oxygen enter the circulatory system?



(A) Site A.
(B) Site B.
(C) Site C.
(D) Site D.

Extension: Explain your answer.

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2.1.7 Which list shows the products of digestion that are transported in plasma?

(A) Lipids, amino acids and vitamins.
(B) Glucose, cellulose and nucleic acids.
(C) Glucose, amino acids and vitamins.
(D) Sucrose, lipids and starch.

Extension: Explain your answer.

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2.2 Explain the adaptive advantage of haemoglobin.

Haemoglobin is an iron-containing protein that is a respiratory pigment responsible for the red colour of blood.

Haemoglobin carries oxygen needed for respiration.

2.2.1 What is haemoglobin?

(A) A red-coloured pigment found in all blood cells.
(B) An iron-containing protein in red blood cells.
(C) The protein that enables platelets to clot blood.
(D) A carbohydrate that lets blood cells pick up oxygen.

Extension: What is a 'globin'?

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2.2.2 What is the major adaptive advantage of haemoglobin?

(A) Haemoglobin increases the oxygen carrying capacity of blood.
(B) Haemoglobin gives blood its red colour.
(C) Haemoglobin increases the ability of blood cells to fight infection.
(D) Haemoglobin increases the ability of blood to remove carbon dioxide .

Extension: Justify your choice of answer.

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2.2.3 Haemoglobin is composed of four units of protein called globin and near the centre of each globin is a haem unit. Haem has an iron in the centre of a ring structure.

What is the function of the iron ions in the haem group?

(A) To give red blood cells their red colour.
(B) Oxygen molecules attach to the globin and the haem group provides energy.
(C) Iron ions make the haem unreactive so the globin can pick up oxygen.
(D) Oxygen molecules attach to the iron ions in the haem group.

Extension: Justify your choice of answer.

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2.2.4 Carbon monoxide can bind more effectively to haemoglobin than oxygen. What causes carbon monoxide poisoning?

(A) Carbon monoxide reacts with oxygen so oxygen cannot join with haemoglobin.
(B) Carbon monoxide replaces oxygen on haemoglobin depriving tissues of oxygen.
(C) Carbon monoxide stops the flow of a nervous impulse.
(D) Carbon monoxide reacts with carbon dioxide to form carbon trioxide.

Extension: Why does carbon monoxide cause death?

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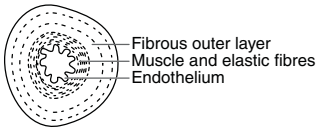
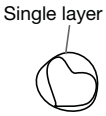
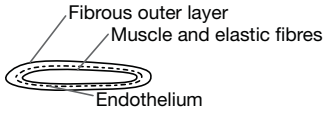
2.3 Compare the structure of arteries, capillaries and veins in relation to their function.

Feature	Arteries	Capillaries	Veins
Diagram.			
Definition.	Carry blood away from the heart.	Thin-walled blood vessels linking arteries to veins.	Carry blood to the heart.
Wall structure.	Thick elastic muscular wall with three main layers with muscle and elastic tissue.	Walls are only a single cell in thickness with no elastic or muscular fibres.	Thin walls with fewer elastic and muscle fibres than the equivalent layers in arteries.
Blood pressure.	Highest blood pressure is in arteries near the heart, e.g. aorta.	Small diameter causes high frictional resistance, restricts blood flow and lowers blood pressure.	Lower blood pressure, insufficient to return all blood from extremities to the heart.
Diameter of blood vessel.	Small bore.	Bore is diameter of one red blood cell.	Large bore.
Function.	Distribute blood away from the heart, e.g. to arterioles that carry blood to capillaries.	Exchange vessels, e.g. gases exchange between blood and interstitial fluid surrounding cell.	Return blood to the heart from capillaries to venules to veins.
Composition of blood present.	Most arteries carry oxygenated blood (except pulmonary artery).	Gas exchange occurs, e.g. oxygen from blood into tissues and carbon dioxide from tissues into blood.	Most veins carry deoxygenated blood (except pulmonary vein).
Valves.	No valves.	No valves.	Valves present to prevent backflow.

2.3.1 Which of the following correctly describes arteries, veins and capillaries?

	Artery	Capillary	Vein
(A)	Highest blood pressure is in arteries near the heart.	Small diameter restricts blood flow and raises blood pressure.	Highest blood pressure is in veins near the heart.
(B)	Thick muscular wall with elastic tissues.	Thin wall with valves.	Thin muscle wall.
(C)	Relatively small bore.	Bore is diameter of one red blood cell.	Relatively large bore.
(D)	Always carries oxygenated blood.	Carries equal amounts of oxygenated and deoxygenated blood.	Always carries deoxygenated blood.

Extension: Explain why is it incorrect to state that arteries always carry oxygenated blood.

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2.3.2 Which blood vessel is most likely to contain valves?

(A) Veins.
(B) Arteries.
(C) Capillaries.
(D) Arterioles.

Extension: Why does this vessel need valves?

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2.3.3 Which blood vessels are under the highest pressure and how does the vessel withstand this pressure?

(A) Veins and they have valves to withstand the pressure.
(B) Veins and they have thick muscular walls to withstand the pressure.
(C) Arteries and they have valves to withstand the pressure.
(D) Arteries and they have thick muscular walls to withstand the pressure.

Extension: Explain your choice of answer.

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2.3.4 Why do capillaries have very thin walls?

(A) To allow rapid transport between blood and cells.
(B) To help increase blood pressure.
(C) To allow gravity to assist gas exchange.
(D) To increase the speed of blood flow through blood vessels.

Extension: Explain your choice of answer.

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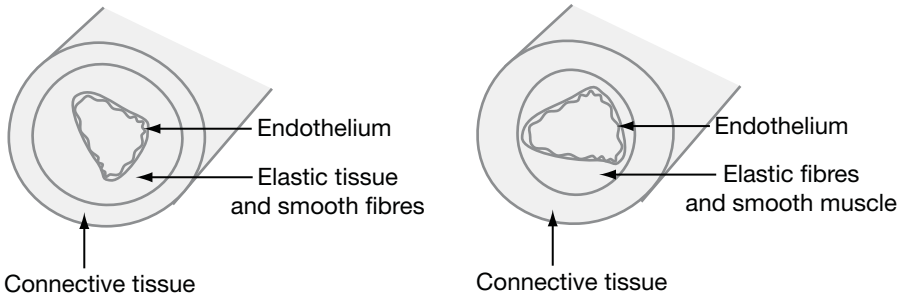
2.3.5 The diagram shows a cross-section of TWO different blood vessels.



Identify each blood vessel.

	Blood vessel X	Blood vessel Y
(A)	Vein	Artery
(B)	Artery	Vein
(C)	Capillary	Artery
(D)	Vein	Capillary

Extension: Explain your choice of answer.

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2.4 Describe the changes in the chemical composition of blood as it moves around the body and identify tissues in which these changes occur.

Location	Chemical that changes concentration	Why the change in concentration occurs
Lungs	Carbon dioxide	Carbon dioxide increases in concentration as it diffuses into the lungs from the blood returning from respiring body cells.
Lungs	Oxygen	Oxygen decreases in concentration as it diffuses out of the alveoli in the lungs into the blood to be taken to cells for respiration.
Villi of small intestine	Amino acids and glucose	Glucose and amino acids decrease in concentration as they diffuse from the small intestine into the blood to be taken away to be used by the body.
Liver	Glucose	Glucose concentration can decrease in the liver when there is too much glucose in the bloodstream and the glucose is removed to be stored as glycogen. Glucose concentration can increase in the liver when there is not enough glucose in the blood for maintaining stable body conditions.
Kidneys	Water	Water can be removed from blood or reabsorbed back into blood during the filtration process in the kidneys. Osmoregulation maintains a constant water balance in the body.
Kidneys	Nitrogenous waste	Most mammals produce urea as the main nitrogenous waste. It is formed when excess amino acids accumulate after the digestion of proteins and when cells metabolise proteins into amino acids. The excess amino acids cannot be stored and are taken to the liver where they are deaminated. The concentration of urea increases in the kidneys as it is filtered from the blood and accumulated to be excreted.
Glands	Hormones	Endocrine glands secrete hormones directly into blood, e.g. hypothalamus, pituitary gland, thyroid gland, pancreas, ovaries, testes. The hormone travels around the body in the blood until it reaches the target cell/tissue.

2.4.1 Blood was analysed as it passed through several organs. Results showed that the composition on chemicals changed in a particular organ with an increase in oxygen levels and a decrease in carbon dioxide levels. What is the most likely organ where this would occur?

(A) Liver.
(B) Spleen.
(C) Lungs.
(D) Small intestine.

Extension: Explain your answer.

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2.4.2 Which location would have the highest concentration of glucose?

(A) Capillaries around small intestine.
(B) Hepatic portal vein leaving the liver.
(C) Pulmonary artery from the lungs.
(D) Jugular vein from the brain.

Extension: Explain your answer.

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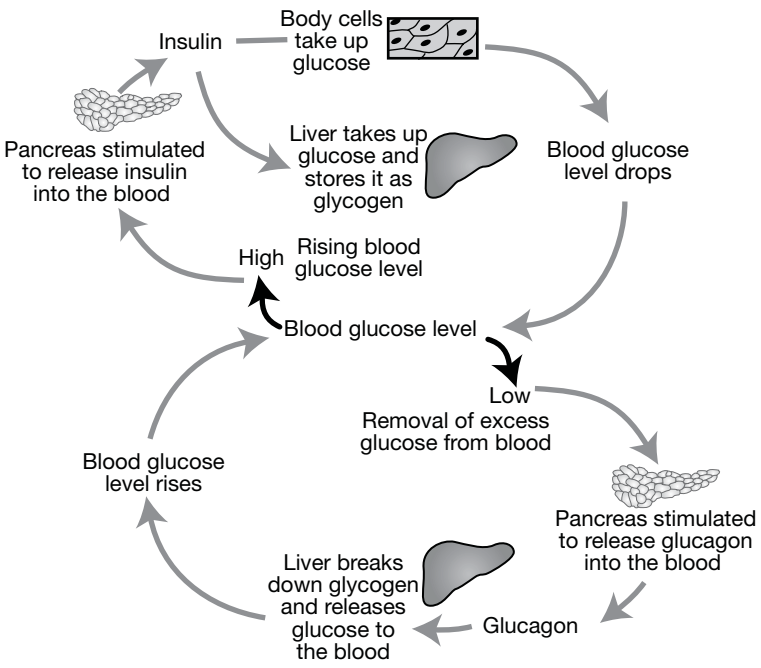
2.4.3 The diagram shows how glucose levels change over time.

From the diagram, what is the function of insulin?



(A) Insulin stimulates the liver to break down glycogen and release glucose into the blood.
(B) Insulin makes the blood glucose level rise.
(C) Insulin causes negative feedback to increase blood sugar levels.
(D) Insulin makes the liver take up glucose and store it as glycogen.

Extension: Explain your answer.

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2.4.4 Which of the following blood vessels would have the lowest concentration of urea?

(A) Renal artery.
(B) Renal vein.
(C) Hepatic portal vein.
(D) Pulmonary artery.

Extension: Explain your answer.

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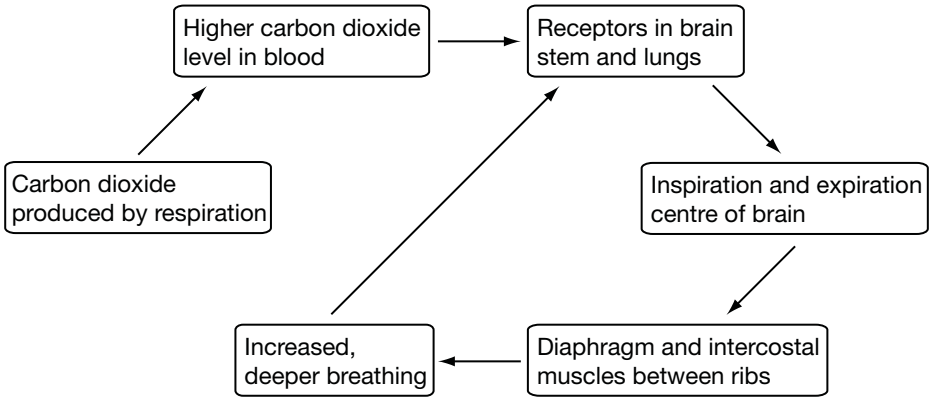
2.4.5 The diagram shows the control of carbon dioxide levels in the blood.



From the flow chart, what can increase carbon dioxide levels in the blood?

(A) Increased respiration rate.
(B) Decreased respiration rate.
(C) Decreased inspiration.
(D) Increased receptors in the brain stem stimulated.

Extension: Explain your answer.

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2.4.6 Which substances enter the blood in the capillaries around the intestines?

(A) Glucose, amino acids and lipids.
(B) Vitamins, urea, phospholipids.
(C) Sucrose, cellulose, water.
(D) Amino acids, glucose, vitamins.

Extension: Explain your answer.

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2.4.7 Where is the lowest concentration of oxygen?

(A) Pulmonary vein.
(B) Pulmonary artery.
(C) Hepatic portal vein.
(D) Renal artery.

Extension: Explain your answer.

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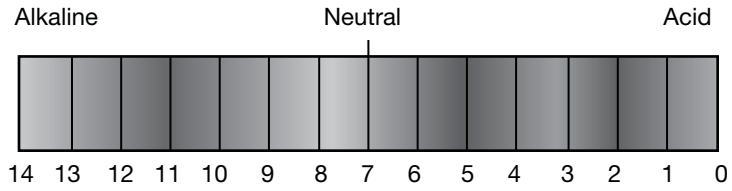
2.5 Perform a first-hand investigation to demonstrate the effect of dissolved carbon dioxide on water.

There are several ways to demonstrate the effect of carbon dioxide on water. The equipment used will depend on the apparatus available in the school at the time.

Expected results should show that increased carbon dioxide concentrations lower the pH of water.



2.5.1 What happens to the pH of water as carbon dioxide is added?

(A) pH becomes more acidic in the range pH = 13.
(B) pH becomes more alkaline in the range pH = 13.
(C) pH becomes more acidic in the range pH = 4.
(D) pH becomes more alkaline in the range pH = 13.

Extension: Explain your answer.

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2.5.2 What is the distinguishing test for carbon dioxide gas?

(A) It turns limewater milky.
(B) It goes 'pop' when exposed to a naked flame.
(C) It will relight a glowing splint.
(D) It turns blue litmus paper red.

Extension: Each answer is the distinguishing test for a particular chemical. Identify each substance.

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2.5.3 When testing the effect of dissolved carbon dioxide on the pH of water, which measurement would give the most accurate results?

(A) Blue litmus paper.
(B) Red litmus paper.
(C) Universal indicator.
(D) pH probe and data logger.

Extension: Explain your answer.

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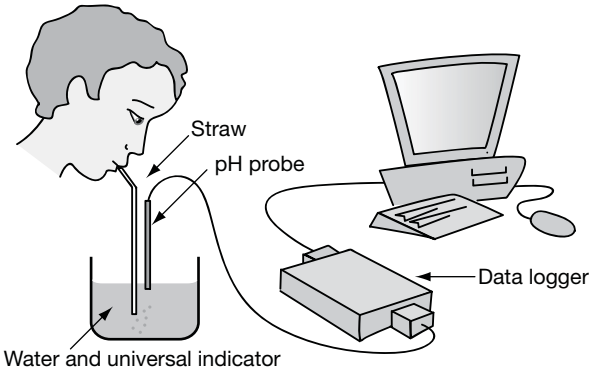
The diagram shows the equipment used by a group of HSC Biology students to carry out a first-hand investigation.

Use this diagram for the next TWO questions.



2.5.4 What is the function of the pH probe?

(A) To see how dissolved oxygen affects the pH of water.
(B) To see how dissolved carbon dioxide affects the pH of water.
(C) To see how universal indicator affects the pH of water.
(D) To detect any changes in temperature.

Extension: Explain your answer.

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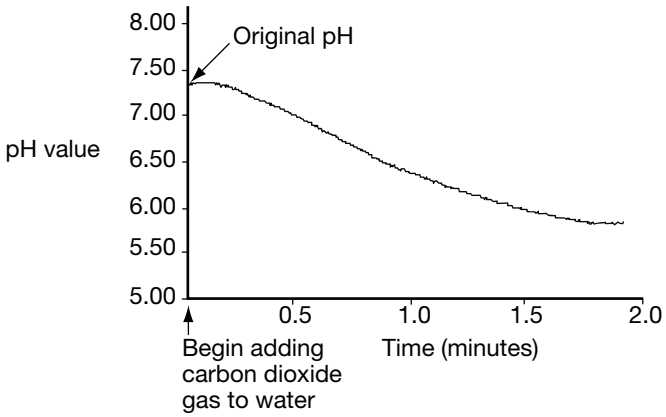
2.5.5 The graph shows the results recorded by the data logger in the experiment.

What can you deduce from this graph?



(A) pH of water is 7.0.
(B) Dissolved carbon dioxide makes water more alkaline.
(C) Dissolved carbon dioxide makes water more acidic.
(D) Dissolved carbon dioxide does not affect the pH of water.

Extension: Explain your answer.

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2.6 Perform a first-hand investigation using the light microscope and prepared slides to gather information to estimate the size of red and white blood cells and draw scaled diagrams of each.

To estimate the size of red and white blood cells you need to use a light microscope, a prepared slide of blood and a mini-grid microscope slide.

You need to follow safety precautions such as avoiding looking down the objective lens while adjusting the light source as very bright light can damage the retina.

You need to follow a step-by-step method to set up the microscope, measure the field of view and estimate the size of the blood cells.

Typical conclusions should show that the diameter of a red blood cell is approx 8µm and the red blood cell appears as a biconcave disc without a nucleus.

2.6.1 What is a safety precaution you would need to take if you carried out a first-hand investigation using prepared slides of blood to estimate the size of red and white blood cells?

(A) Carry the microscope using two hands to avoid dropping it.
(B) Do not eat in the laboratory.
(C) Always add acid to water.
(D) Wear goggles and gloves when handling human body fluids.

Extension: Explain your answer.

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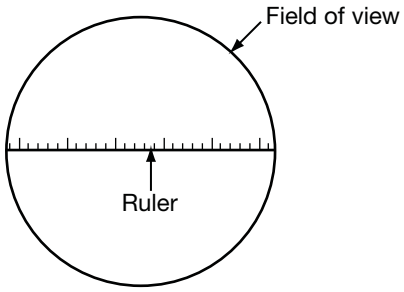
2.6.2 The diagram shows a ruler with millimetre divisions under low power of a light microscope. The ocular lens has a magnification of 10× and the objective lens has a magnification of 5×.

What is the diameter of the field of view for this microscope?



(A) 28 mm.
(B) 140 mm.
(C) 160 mm.
(D) 280 mm.

Extension: Explain your answer.

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2.6.3 How do you convert millimetres to micrometres?

(A) Multiply the millimetres by 100 000.
(B) Multiply the millimetres by 1000.
(C) Divide the millimetres by 100 000.
(D) Divide the millimetres by 1000.

Extension: Explain your answer.

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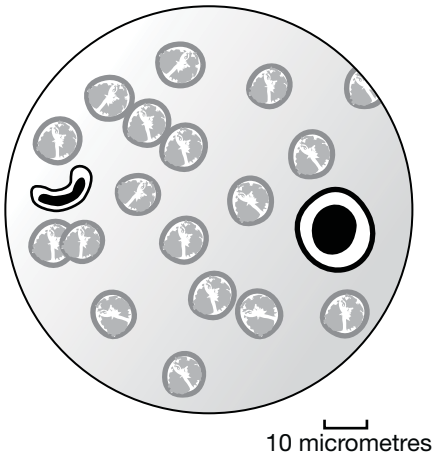
2.6.4 The diagram shows red and white red blood cells as seen on a prepared slide of human blood using a light microscope.



What are the respective dimensions of the red and white cells?

(A) Red blood cell diameter is about 8 μm and white blood cells about 16 μm.
(B) Red blood cell diameter is about 16 μm and white blood cells about 8 μm.
(C) Red blood cell diameter is about 5 mm and white blood cells about 12 mm.
(D) Red blood cell diameter is about 12 mm and white blood cells about 5 mm.

Extension: Explain your answer.

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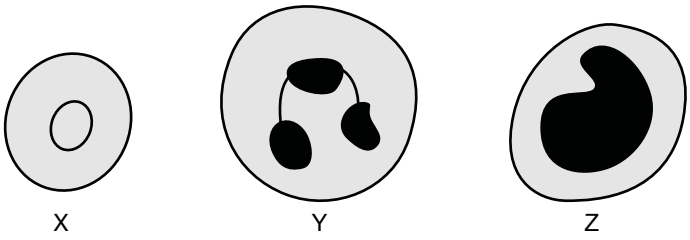
2.6.5 A student drew the following cells after observing a prepared slide of human blood.



What is the main function of each cell type?

	Cell X	Cell Y	Cell Z
(A)	Defence against disease.	Defence against disease.	Carry oxygen.
(B)	Carry oxygen.	Carry carbon dioxide.	Defence against disease.
(C)	Carry oxygen.	Defence against disease.	Defence against disease.
(D)	Carry carbon dioxide.	Carry oxygen.	Defence against disease.

Extension: Name each cell type.

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2.6.6 In a healthy adult human, how many red blood cells would you expect per white blood cell?

(A) 5 red blood cells : 1 white blood cell.
(B) 50 red blood cells : 1 white blood cell.
(C) 500 red blood cells : 1 white blood cell.
(D) 5000 red blood cells : 1 white blood cell.

Extension: Why would a person have a very high white blood cell count?

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2.7 Outline the need for oxygen in living cells and explain why removal of carbon dioxide from cells is essential.

All living things use the process of respiration to release energy to be used by the cells to maintain life processes. Aerobic respiration uses oxygen in the equation:

Glucose + oxygen → carbon dioxide + water + energy

High levels of carbon dioxide are toxic and damage cell metabolism. High carbon dioxide decreases pH and changes the ability of haemoglobin to bind with oxygen.

2.7.1 Living cells need oxygen for aerobic respiration. What is the equation for respiration?

(A) Protein + oxygen → carbon dioxide + water
(B) Glucose + oxygen → carbon dioxide + water
(C) Water + oxygen → carbon dioxide + glucose
(D) Carbon dioxide + oxygen → glucose + water

Extension: Identify the site of aerobic respiration in eucaryot cells.

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2.7.2 Carbon dioxide is a waste product of a chemical reaction. High levels of carbon dioxide can be toxic to the body and carbon dioxide must be removed from cells. What process produces carbon dioxide?

(A) Photosynthesis.
(B) Transcription.
(C) Respiration.
(D) Translocation.

Extension: Write the equation for photosynthesis.

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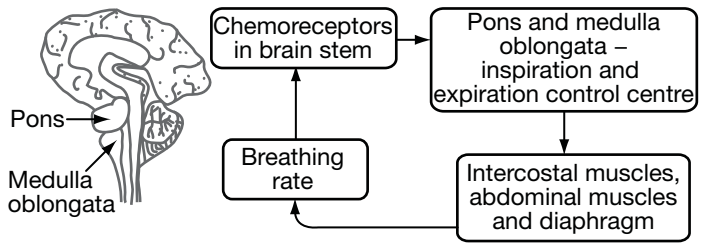
2.7.3 The diagram shows the brain and the negative feedback system to control carbon dioxide levels in the body.



According to this flow chart, what are the effectors that control breathing rate?

(A) Intercostal muscles and diaphragm.
(B) Neurones travelling from brain stem to abdominal muscles.
(C) Expiration centre in the brain.
(D) Chemoreceptors in the brain stem.

Extension: Which gas seems to have the strongest effect on breathing rate?

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2.8 Analyse information from secondary sources to identify current technologies that allow measurement of oxygen saturation and carbon dioxide concentrations in blood and describe and explain the conditions under which these technologies are used.

Measuring oxygen saturation levels

Pulse oximetry is a current technology that allows measurement of oxygen saturation. It is a non-invasive probe that is attached to the patient's finder or ear lobe to monitor the percentage of haemoglobin saturated with oxygen. The computer in the oximeter uses the different amounts of absorption of two wavelengths of light (e.g. 650 nm and 805 nm) to produce a graph of the flow rate.

Pulse oximeters can be used in many situations but are very important for monitoring oxygenation and pulse rates during operations using anaesthesia and during the recovery phase. They can be less accurate if the patient is suffering from vasoconstriction, e.g. due to cold temperatures or cardiac failure when peripheral blood vessels have a reduced flow.

Measuring carbon dioxide concentrations

A capnometer is an instrument with an infra-red detector, used to analyse carbon dioxide gas concentration. It is used in medical applications to monitor air exchange in the lungs of patients on ventilators or under anaesthesia. It can evaluate the respiratory condition of spontaneously breathing patients. It is non-invasive and portable capnometers can be used for in-home care and in general wards.

2.8.1 When researching information from websites, what details should you check to ensure the quality and accuracy of the information you obtain?

(A) Author's qualification and reputation.
(B) Check URL to see if it a government or educational site.
(C) Currency of documents and when it was produced and last updated.
(D) All of the above.

Extension: Identify another detail you should include when you research information.

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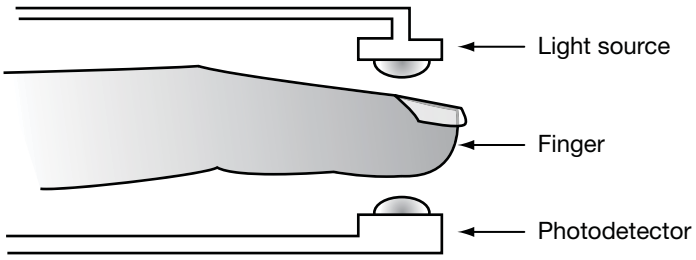
2.8.2 The diagram shows a pulse oximeter.



What is the function of a pulse oximeter?

(A) Measure carbon dioxide saturation levels.
(B) Measure oxygen saturation levels.
(C) Measure the rate of blood flow in capillaries.
(D) Measure blood pH.

Extension: What is meant by non-invasive instrument?

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2.8.3 Under what conditions would a capnometer NOT be used to measure carbon dioxide concentrations?

(A) For monitoring air exchange in the lungs of patients on ventilators.
(B) For checking people for in-home care.
(C) For long and complicated surgery operations.
(D) For spontaneously breathing patients in general wards.

Extension: Identify a way carbon dioxide concentrations are measured in long and complicated surgical procedures.

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2.8.4 A pulse oximeter was used on the finger of a person suffering from extreme cold. The person had vasoconstriction of blood vessels in their extremities. How would this affect the readings given by the pulse oximeter?

(A) Give a falsely high reading for carbon dioxide saturation level.
(A) Give a falsely low reading for carbon dioxide saturation level.
(A) Give a falsely high reading for oxygen saturation level.
(A) Give a falsely low reading for oxygen saturation level.

Extension: Explain your choice of answer.

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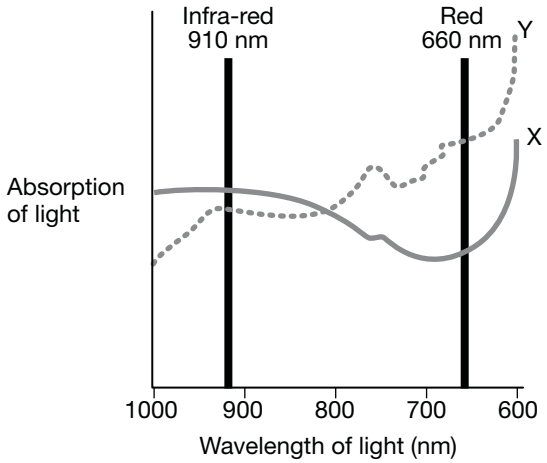
2.8.5 Pulse oximetry is based on the absorption properties of oxygenated and deoxygenated haemoglobin. When comparing the two haemoglobins, oxygenated haemoglobin absorbs more infra-red light while deoxygenated haemoglobin absorbs more red light. Red light is 660 nm wavelength and infra-red light is 910 nm wavelength.

The graph shows the absorption of light by deoxygenated haemoglobin and by oxygenated haemoglobin.



Identify X and Y.

(A) X is deoxygenated haemoglobin as it absorbs more infra-red light.
(B) X is oxygenated haemoglobin as it absorbs more infra-red light.
(C) Y is oxygenated haemoglobin as it absorbs more red light.
(D) Y is deoxygenated haemoglobin as it absorbs more infra-red light.

Extension: Explain your choice of answer.

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2.9 Analyse and present information from secondary sources to identify the products extracted from donated blood and discuss the uses of these products.

Product extracted from donated blood	Plasma or blood cells component	Use
Plasma proteins, e.g. albumins.	From plasma.	Used for burns, volume expansion as albumins contribute to osmotic balance, transport lipids.
Red blood cells.	From blood cells.	Used for anaemia. Red blood cells transport oxygen.
Platelets.	From blood cells.	Used for severe bleeding. Platelets contain factors that control blood clotting.
Granulocytes, e.g. lymphocytes, neutrophils.	From blood cells.	Used for low neutrophil count. Neutrophils are involved in defence against disease.

2.9.1 Which of the following lists THREE products extracted from donated blood to be used for medical purposes?

(A) Plasma, red blood cells, platelets.
(B) Platelets, lymphocytes, hormones.
(C) Plasma proteins, white blood cells, urea.
(D) Salts, water, proteins.

Extension: Choose one product extracted from donated blood and describe its use.

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2.9.2 Who needs to be treated with the products of donated blood?

(A) A person with massive blood loss due to trauma.
(B) To replace blood lost during surgery.
(C) To treat severe anaemia.
(D) All of the above.

Extension: Identify another use for the use of the products of donated blood.

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2.9.3 What is the correct correlation between blood product and its use?

	Blood product	Its use
(A)	Red blood cells	Promote clotting of blood.
(B)	Factor VIII	Increase volume of fluid in the body.
(C)	Red blood cells	Increase oxygen-carrying capacity.
(D)	Plasma	Increase ability to fight infection.

Extension: How are red blood cells removed from whole blood?

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2.10 Analyse and present information from secondary sources to report on progress in the production of artificial blood and use available evidence to propose reasons why such research is needed.

Artificial blood

Artificial blood is a term to describe 'man-made' products that fulfil some of the functions of biological blood. Biological blood performs many functions, e.g. transports oxygen, defends against disease, causes clotting etc.

Blood substitutes only perform some function of biological blood and are classified by function. Volume expanders increase blood volume and oxygen therapeutics are chemicals that can carry oxygen.

Oxygen carriers

There are two basic types of oxygen carriers – perfluorochemicals (PFCs), e.g. Oxygent, and haemoglobin-based oxygen carriers, e.g. PolyHeme. Each type of oxygen carrier has its own benefits and problems associated with its use.

PFCs have a benefit in that the amount of oxygen picked up is directly proportional to the amount of oxygen breathed in and thus patients can be given higher levels of oxygen. However, this can cause a problem as higher oxygen in tissues can damage cells.

Haemoglobin-based oxygen carriers can load and unload oxygen and carbon dioxide under normal body conditions. However, there may be associated kidney problems and there needs to be a source supply of haemoglobin.

Why artificial blood is needed

There are several reasons why we need research into the development of blood substitutes:

- **The amount of blood needed for transfusions is rising each year faster than the amount of blood being donated.**
- **There is also a chance in some places around the world of undetected blood bank contamination from AIDS, hepatitis C, Creutzfeldt-Jacob disease and other emergent diseases.**
- **In emergency trauma situations, e.g. battlefield, terrorist attack, there is a need for rapid treatment of patients without determining blood type for immunologic reactions as blood substitutes do not contain any antigens.**
- **Blood has storage problems – it must be kept at 4°C and only stays fresh for 42 days.**

2.10.1 'Artificial blood' is often classified as either 'volume expanders' or 'oxygen therapeutics'. What is the difference between these two groups of substances?

	Volume expanders	Oxygen therapeutics
(A)	Increase water content of blood for osmoregulation.	Carry oxygen and carbon dioxide.
(B)	Increase water and decrease salt concentrations.	Remove carbon dioxide from blood.
(C)	Increase blood volume.	Carry oxygen.
(D)	Decrease blood volume.	Remove oxygen from blood.

Extension: Identify three features that are needed for a successful blood substitute.

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2.10.2 Perfluorocarbons can dissolve large quantities of oxygen and carbon dioxide. They can passively pick up oxygen in the lungs and release it by diffusion in the capillaries.

Why is there research into perfluorocarbons and the development of blood substitutes?

(A) Concern that donated blood supplies contain infectious agents and allergens.
(B) Demand for donated blood is beginning to outpace supply.
(C) Donated blood has a limited shelf life and needs refrigeration.
(D) All of the above.

Extension: Name a perfluorocarbon.

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2.10.3 PolyHeme is a haemoglobin-based oxygen therapeutic blood substitute. In 2005 the USA Food and Drug Administration reported that the Phase III trials showed no statistical evidence of safety concerns for its use.

What is one disadvantage of blood substitutes?

(A) They can only replace one function of blood.
(B) They have a shorter shelf life than donated blood.
(C) They have more demanding refrigeration problems than donated blood.
(D) Infectious pathogens are found in blood substitutes.

Extension: Name another haemoglobin-based blood substitute.

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2.10.4 Scientists have been inserting the gene for human coagulation factors, e.g. factor VIII into pig embryos. The adult pigs synthesise the corresponding proteins in their milk. The milk is then purified and the coagulation factor purified.

Who would benefit from this new source of factor VIII?

(A) People in surgery with large blood loss.
(B) People with asthma.
(C) Haemophiliacs.
(D) People with leukaemia.

Extension: Identify other benefits of this form of synthesised factor VIII.

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2.10.5 To make artificial haemoglobin-based blood, a strain of *E.coli* bacteria is used. This bacteria has the ability to produce human haemoglobin. The bacteria is placed in a seed tank and filled with growth media. What process would have been involved in producing this strain of bacteria?

(A) Genetic engineering.
(B) Artificial selection in breeding program.
(C) Mutation by X-rays.
(D) Hybridisation.

Extension: Define genetic engineering.

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2.11 Describe current theories about processes responsible for the movement of materials through plants in xylem and phloem tissue.

Xylem

Xylem conducts water and mineral ions up the plant from roots to leaves.

Water enters the root by osmosis and then transpiration pull draws the water up the stem. Cohesion between the water molecules causes the water to form a continuous stream up the plant and 'pulls' the water up. Adhesion between the water molecules and the walls of the xylem vessels also helps draw water up the plant.

Phloem

Phloem translocates the products of photosynthesis and other organic products both up and down the plant.

Phloem translocates organic products in a 'source-to-sink' movement. At the 'source' (e.g. leaf) phloem loading involves sugars moving by active transport into the sieve tube. Water follows due to osmosis and thus raises the pressure in the tube. Pressure causes the contents flow to the sink. At the sink (e.g. storage or growing area) the sugars are unloaded by active transport.

Water then moves out by osmosis and moves to the xylem.

2.11.1 Where is the majority of water transported throughout plants and mammals?

	Animals	Plants
(A)	Blood	Phloem
(B)	Lymph	Mesophyll
(C)	Xylem	Phloem
(D)	Blood	Xylem

Extension: Explain your choice of answer.

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2.11.2 Which of the following correctly identifies examples of active and passive transport?

(A) Translocation and transpiration are active transport while diffusion is passive transport.
(B) Transpiration and osmosis are active transport while translocation is passive transport.
(C) Transpiration is active transport while translocation and osmosis are passive transport.
(D) Translocation is active transport while transpiration and osmosis are passive transport.

Extension: Describe an example of active transport in plants.

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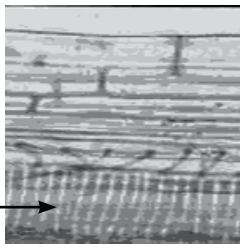
2.11.3 The diagram shows a longitudinal section through a plant stem.

Identify structure Y.

(A) Xylem.
(B) Phloem.
(C) Cortex.
(D) Epidermis.



Extension: Outline the feature that enabled you to identify structure Y.

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2.11.4 How is energy involved in the movement of materials in the phloem?

(A) Sugars are actively loaded down a concentration gradient into the phloem at the site of photosynthesis.
(B) Sugars are actively loaded against a concentration gradient into the phloem at the site of photosynthesis.
(C) Water is actively loaded against a concentration gradient into the phloem at the roots.
(D) Water enters the sieve tube by osmosis.

Extension: What is the name for the movement of sugars through a plant?

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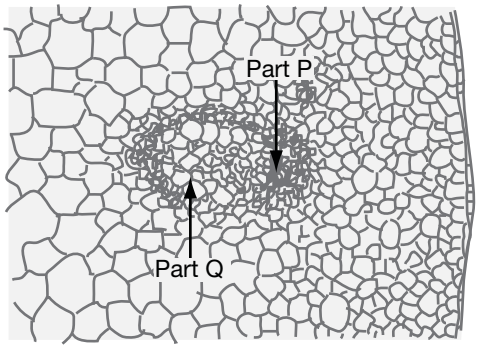
2.11.5 The diagram shows a line drawing made by a student observing a cross-section of a plant stem under low power of a light microscope.



What processes are occurring in the movement of materials in part P and part Q?

	Part P	Part Q
(A)	Passive transport	Passive transport
(B)	Passive transport	Active transport
(C)	Active transport	Passive transport
(D)	Active transport	Active transport

Extension: How was the movement of sugars tracked through the plant?

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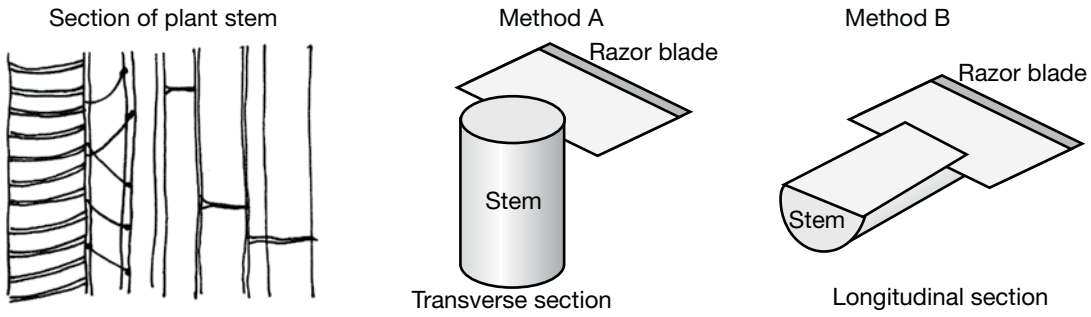
2.12 Choose equipment or resources to perform a first-hand investigation to gather first-hand data to draw transverse and longitudinal sections of phloem and xylem tissue.

There are several plants that are suitable for sectioning to show transverse and longitudinal sections of phloem and xylem tissue.

You need to identify the equipment needed, safety precautions and follow a step-by-step method to prepare a stained slide and set up the light microscope.

2.12.1 The diagram shows a drawing made by an HSC Biology student after making a wet mount slide of a section of plant stem. The student followed one of the methods to make the section.



What section has been drawn and which method was used to cut the section?

(A) Longitudinal section using method A.
(B) Longitudinal section using method B.
(C) Transverse section using method A.
(D) Transverse section using method B.

Extension: Explain your answer.

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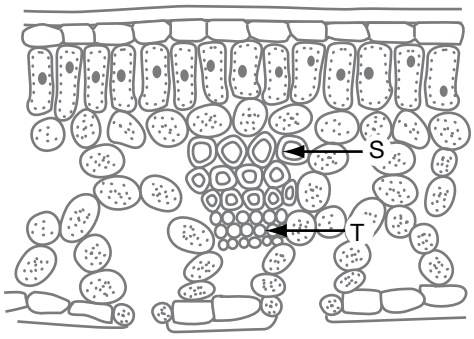
2.12.2 The diagram shows a section through a leaf of a terrestrial plant.

Identify tissue S and tissue T.



	Tissue S	Tissue T
(A)	Epidermis	Mesophyll
(B)	Palisade mesophyll	Spongy mesophyll
(C)	Phloem	Xylem
(D)	Xylem	Phloem

Extension: Explain your answer.

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3. Plants and animals regulate the concentration of gases, water and waste products of metabolism in cells and in interstitial fluid.

3.1 Explain why the concentration of water in cells should be maintained within a narrow range for optimal function.

Water is the main solvent – organic and inorganic compounds dissolve in water.

Water is part of the heating/cooling system of organisms – evaporation causes cooling and because it has a relatively high specific heat, it holds heat and reduces fluctuations in body temperature.

Water is involved in many reactions as either product or reactant, e.g. respiration, photosynthesis, synthesis of polymers (releases one water molecule for each bond formed between monomers).

Cell metabolism is controlled by enzymes. Each enzyme requires specific conditions for optimal efficiency, e.g. specific pH, temperature, ion concentrations. A change in the concentration of water in cells could interfere with the functioning of enzymes and metabolism would be disrupted.

3.1.1 Life cannot exist without water. What is the general range of water content by volume for most living cells?

(A) 0-10% water.
(B) 10-30% water.
(C) 60-80% water.
(D) 95-99% water.

Extension: Identify some compounds which dissolve in water.

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3.1.2 What is osmoregulation?

(A) The movement of water across a semipermeable membrane.
(B) The control of water and salt concentrations in body cells for homeostasis.
(C) Diffusion of water from an area of high concentration of water to an area of low concentration of water.
(D) The control of oxygen and carbon dioxide levels in body cells.

Extension: Osmoregulation is partially controlled by hormones. Identify a hormone that helps to control the water balance in cells.

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3.1.3 How is water involved in the cooling mechanisms of an organism?

(A) Evaporation removes heat as the water changes from liquid to gas.
(B) Evaporation removes heat as the water changes from gas to liquid.
(C) Evaporation adds heat as the water changes from liquid to gas.
(D) Condensation removes heat as the water changes from liquid to gas.

Extension: What is evaporation?

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3.2 Explain why the removal of wastes is essential for continued metabolic activity.

The main metabolic wastes are carbon dioxide, excess salts, excess water and nitrogenous wastes (e.g. urea, ammonia or uric acid).

Waste accumulation is toxic or can disrupt metabolic activity, e.g. high levels of ammonia or urea will kill cells and excess water will change concentrations affecting enzyme activity.

3.2.1 What is a 'metabolic waste'?

(A) Useless reactant in a biochemical reaction.
(B) A chemical involved in a reaction.
(C) A large molecule formed by a number of small molecules.
(D) Useless product formed after a biochemical reaction.

Extension: Explain why (C) is not a correct answer.

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3.2.2 Metabolic processes produce waste substances as by-products.

Why is the removal of wastes essential for cells?

(A) Wastes alter the internal conditions and can halt chemical reactions.
(B) Wastes lower the pH and denature enzymes.
(C) Wastes cause dehydration due to water loss by osmosis.
(D) Wastes cause temperature fluctuations due to negative feedback.

Extension: Explain your answer.

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3.2.3 Metabolic processes maintain an isotonic environment for living cells. What is meant by an isotonic environment?

(A) External environment has higher solute concentration than the cell.
(B) Internal environment of cell has higher solute concentration than outside cell.
(C) Internal environment of cell has same concentration as outside cell.
(D) Water is taken into the cell to increase volume.

Extension: Explain your answer.

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3.2.4 What is the correct link between metabolic waste and its organ of excretion for humans?

(A) Urea from the liver.
(B) Urea from the kidney.
(C) Carbon dioxide from the skin.
(D) Salt from the skin.

Extension: Explain your answer.

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3.3 Identify the role of the kidney in the excretory system of fish and mammals.

Feature	Mammal	Saltwater fish	Freshwater fish
Kidney	An excretory organ that filters blood and removes nitrogenous wastes.	An excretory organ that filters blood and removes nitrogenous wastes.	An excretory organ that filters blood and removes nitrogenous wastes.
Structure	Many nephrons.	Simple structure with few small glomeruli.	Simple structure with many large glomeruli.
Filtration	High blood pressure in glomerulus forces ultrafiltration.	Low filtration rate.	High filtration rate.
Urine produced	Amount and concentration depends upon water intake and activities.	Small quantity urine produced.	Large amounts of very dilute urine.

3.3.1 Freshwater fish have a higher salt concentration than their environment. What problem does this cause and how do they overcome the problem?

	Problem	How problem is overcome
(A)	Water is absorbed across the gills by osmosis.	Produce small amounts of concentrated urine.
(B)	Water is lost by osmosis from gills.	Produce small amounts of concentrated urine.
(C)	Water is lost by osmosis from gills.	Produce copious amounts of dilute urine.
(D)	Water is absorbed across the gills by osmosis.	Produce copious amounts of dilute urine.

Extension: What would happen if the freshwater fish moved into salt water?

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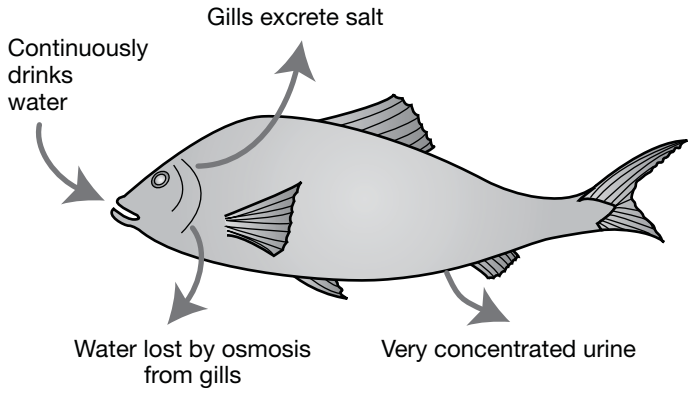
3.3.2 The diagram shows a fish and some water balance mechanisms.



What is the most likely environment of this fish?

(A) Salt water as the fish is trying to remove excess water.

(B) Salt water as the fish is trying to conserve water.

(C) Fresh water as the fish is trying to remove excess water.

(D) Fresh water as the fish is trying to conserve water.

Extension: What is the problem for saltwater fish?

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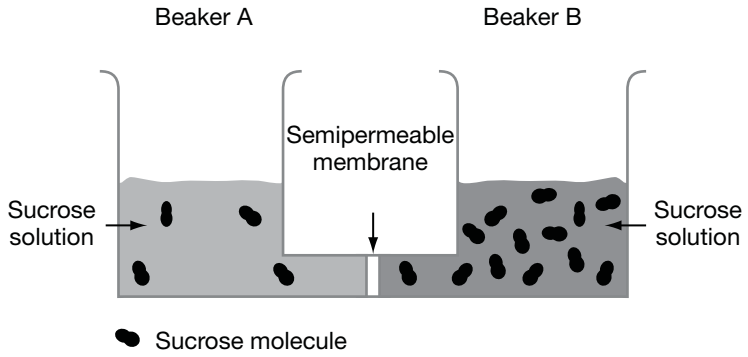
3.4 Explain why the processes of diffusion and osmosis are inadequate in removing dissolved nitrogenous wastes in some organisms.

Diffusion and osmosis are passive processes and will not occur unless a sufficient concentration gradient is present.

These processes can also be quite slow.

Large, active, multicellular animals quickly accumulate toxic levels of nitrogenous wastes and thus need other mechanisms, e.g. ultrafiltration in the kidneys, are needed to maintain suitable concentrations of water and solutes for removal of wastes and efficient metabolism.

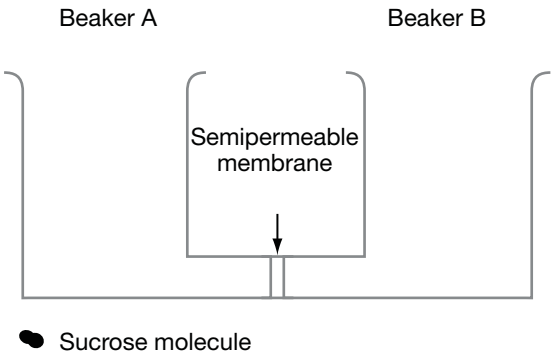
3.4.1 The diagram shows two beakers, each with a different concentration of sugar solution. The two beakers are separated by a semipermeable membrane.



What would most likely happen in this situation?

(A) Water will move by osmosis from beaker A to beaker B.
(B) Water will move by osmosis from beaker B to beaker A.
(C) Sugar will move by osmosis from beaker A to beaker B.
(D) Sugar will move by osmosis from beaker B to beaker A.

Extension: On the diagram draw your expected result.



3.4.2 Which animal would have the greatest difficulty if it could only remove nitrogenous wastes by diffusion?

(A) Saltwater fish removing ammonia across its gills.
(B) Grasshopper removing uric acid from Malpighian tubules.
(C) An amoeba removing ammonia across cell membrane.
(D) Human removing urea from the kidney.

Extension: Name the main forms of nitrogenous waste.

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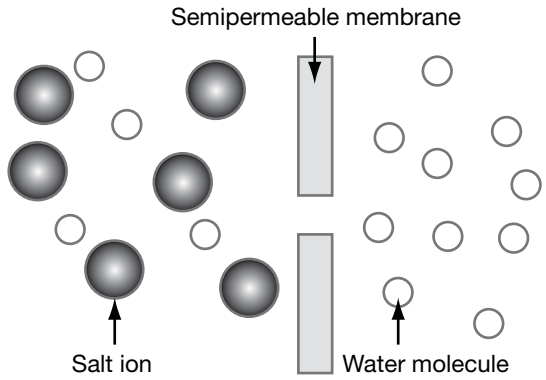
3.4.3 The diagram shows a semipermeable membrane with water molecules and salt molecules on either side of the membrane.



Predict what would happen in this situation.

(A) Water molecules move by osmosis from the area of high solute concentration to the area of low solute concentration.

(B) Water molecules move by osmosis from the area of high water concentration to the area of low water concentration.

(C) Salt ions move by diffusion from the area of high solute concentration to the area of low solute concentration.

(D) Salt ions move by osmosis from an area of high water concentration to an area of low water concentration.

Extension: Define osmosis.

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3.4.4 Why are the processes of diffusion and osmosis inadequate in removing dissolved nitrogenous wastes in some organisms?

(A) Osmosis and diffusion are passive transport mechanisms and can be too slow in removing toxic wastes for large multicellular organisms.

(B) Osmosis and diffusion are active transport mechanisms and the needed energy input is too great for unicellular organisms.

(C) Kidneys are the only organ that can remove nitrogenous wastes and kidneys need active transport to return some ions to the blood.

(D) Nitrogenous wastes are not water soluble and cannot move across semipermeable membranes in osmosis or diffusion.

Extension: What is meant by a diffusion gradient?

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3.4.5 In what way are the processes of osmosis and diffusion similar?

(A) Both involve movement of particles from an area of low to high concentration.

(B) Both involve movement across a semipermeable membrane.

(C) Both involve the input of energy in active transport.

(D) Both involve movement of particles down a concentration gradient.

Extension: Define diffusion.

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3.5 Distinguish between active and passive transport and relate these to processes occurring in the mammalian kidney.

Active transport requires an input of energy for the movement of materials across a cell membrane while passive transport does not require an input of energy for movement across a membrane, e.g. osmosis and diffusion.

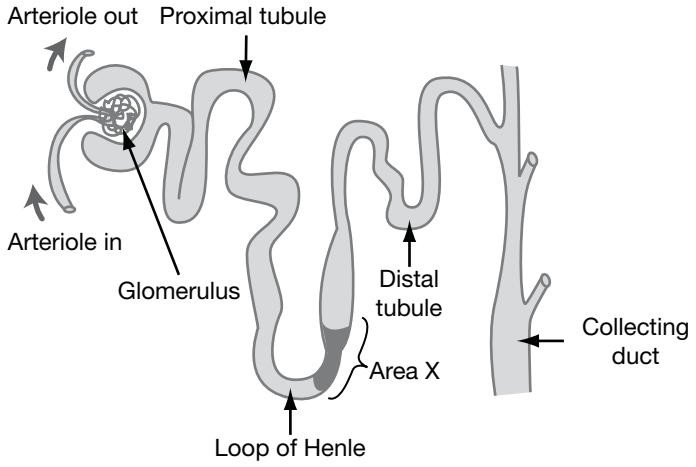
Pressure in the glomerulus causes water, ions and small molecules to filter into Bowman's capsule.

Reabsorption of glucose, amino acids and inorganic salts occurs by active transport.

As solutes move out of the nephric filtrate, water follows by osmosis.

Active transport of sodium ions causes more osmosis and the levels of salt and water are thus adjusted to maintain homeostasis.

3.5.1 The diagram shows the structure of a nephron.



What process is most likely occurring in area X?

(A) Blood pressure forces water, salts and other small solutes from the blood.
(B) Concentrated urine is produced.
(C) Salt is passively reabsorbed.
(D) Water moves by active transport across the membrane.

Extension: Where does filtration occur?

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3.5.2 How are nutrients such as glucose and amino acids moved from the kidney tubules back into the blood?

(A) Passive movement by osmosis.
(B) Passive movement by diffusion.
(C) Bonded to carrier molecules.
(D) Active transport.

Extension: Why does glucose need to be reabsorbed into the blood?

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3.6 Explain how the processes of filtration and reabsorption in the mammalian nephron regulate body fluid composition.

Ultrafiltration occurs when high blood pressure in the glomerulus forces water, ions and small molecules into Bowman's capsule.

Components that are needed by the body are then selectively reabsorbed into the bloodstream in the kidney tubules. By controlling reabsorption into the bloodstream, the salt and water levels of body fluids are controlled.

3.6.1 What is the function of a nephron?

(A) Removes carbon dioxide from the blood.
(B) Removes wastes from the blood.
(C) Collects urea from the cells where it is produced.
(D) Removes urine from the blood.

Extension: What is the difference between urine and urea?

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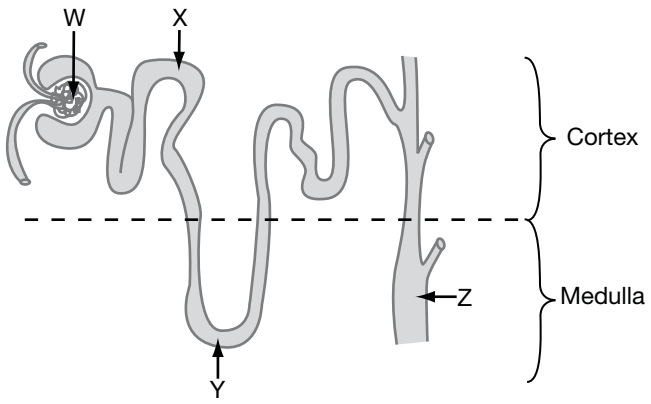
3.6.2 The diagram shows a nephron.

Where does reabsorption occur?

(A) Areas X and Y.
(B) Areas W, X and Y.
(C) Areas X, Y and Z.
(D) Area Y only.



Extension: What happens at area Z?

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3.6.3 In the descending loop of Henle, the walls are permeable to water but not to salt. Water moves across by osmosis. In the ascending part of the loop, the wall is permeable to salt but not water and salt passes across the thin wall. The next area of the ascending wall is thicker and salt needs to be actively reabsorbed.

How is reabsorption involved in regulating body fluid composition?

(A) The movement of water is the control mechanism.
(B) The movement of salts is the control mechanism.
(C) The movement of water and salts regulate body fluid composition.
(D) All substances are reabsorbed in the loop of Henle.

Extension: In which part of the kidney is the loop of Henle?

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3.7 Perform a first-hand investigation of the structure of a mammalian kidney by dissection, use of a model or visual resource and identify the regions involved in the excretion of waste products.

To perform a dissection of a mammalian kidney:

Equipment you will need – a sheep kidney, dissecting board, scalpel, rubber gloves, probe, goggles, laboratory coat, newspaper, magnifying glass.

Safety precaution – be careful using the scalpel as the blade could cut skin leading to potential infection.

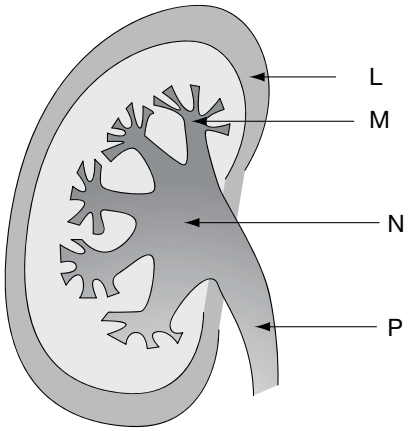
For method, follow these steps:

- **Observe the outer shape of the kidney and the capsule (outer protective layer of skin).**
- **Identify the tubes entering the kidney – ureter, renal artery and renal vein – use the magnifying glass to check the thickness of the walls of the blood vessels.**
- **Cut the kidney in half lengthwise using the scalpel.**
- **Use the magnifying glass to observe the internal structure of the kidney and draw observations.**
- **Use the probe to follow the pathway from ureter into pelvis of kidney.**
- **Record observations.**
- **Draw a labelled diagram of your observations.**
- **Wrap the dissected kidney in newspaper and dispose of it appropriately.**

3.7.1 Some HSC Biology students dissected a kidney. They drew the following diagram.

Identify part L.

(A) Medulla.
(B) Pelvis.
(C) Ureter.
(D) Cortex.



Extension: Name all parts in the diagram.

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3.7.2 While dissecting a kidney, students used a probe to follow the ureter into the white section in the middle of the kidney. What is the function of this white section?

(A) Filtration.
(B) Collection of urine.
(C) Reabsorption.
(D) Deamination of proteins.

Extension: What is urine?

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3.8 Gather, process and analyse information from secondary sources to compare the process of renal dialysis with the function of the kidney.

In renal dialysis waste products are removed from the blood when a person has mild kidney failure.

Feature	Kidney	Renal dialysis
Structure.	Consists of about 1 million nephrons which filter the blood.	Haemodialysis occurs in a hospital where the patient is attached to a machine that circulates blood through semipermeable filters that take out the toxins in the blood. The procedure takes 3 to 4 hours. Dialysers consist of three parts: a compartment for the blood, a compartment for the dialysate, and a semipermeable membrane separating the two.
Function and nitrogenous wastes.	Removes urea from blood.	Removes urea from blood.
Other functions.	Maintains body's balance of various salts, e.g. sodium, potassium, and releases hormones that regulate vital functions including blood pressure, red blood cell production.	Concentrations of desired solutes can be adjusted by altering the composition of the dialysis fluid to maintain natural concentration for healthy blood.
How often it occurs.	Each day two kidneys excrete about 1.5 to 2.5 litres of urine.	Haemodialysis works more quickly than peritoneal dialysis, and can be done in short sessions, e.g. 3 to 4 hours in hospital while peritoneal dialysis needs to be performed every day.
Filtration and reabsorption.	Filters and reabsorbs required materials.	Filters but no reabsorption.

3.8.1 What is renal dialysis?

(A) A process which allows solutes dissolved in blood to diffuse across a semipermeable membrane.
(B) The filtration of wastes out of the liver.
(C) The movement of salt across a semipermeable membrane from an area of high concentration of salt to an area of low concentration of salt.
(D) The collection of urine in kidney tubules.

Extension: What is a semipermeable membrane?

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3.8.2 When is renal dialysis needed?

(A) Liver failure.
(B) Lung failure.
(C) Bladder failure.
(D) Kidney failure.

Extension: Renal dialysis is often considered a short-term solution. What is needed in the long term?

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3.8.3 In renal dialysis, the chemical heparin is added to the patient's blood as it enters the dialysis machine. Heparin is an anticoagulant. Heparin is not added during the final hour of dialysis.

Why is heparin added only in the first stage of dialysis?

(A) To assist the clotting of blood in the early stages of dialysis and allow the person's blood to be able to clot normally when dialysis is finished.

(B) To assist the clotting of blood in the early stages of dialysis and prevent the person's blood clotting when dialysis is finished.

(C) To prevent the clotting of blood in the early stages of dialysis and prevent the person's blood clotting when dialysis is finished.

(D) To prevent the clotting of blood in the early stages of dialysis but allow the person's blood to be able to clot normally when dialysis is finished.

Extension: What is an anticoagulant?

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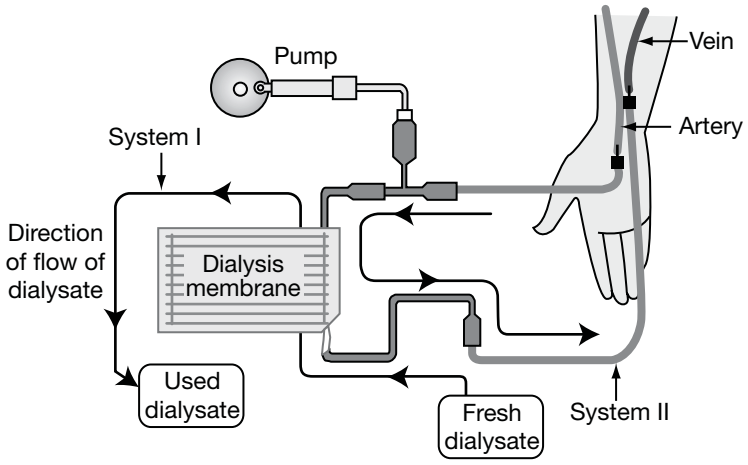
3.8.4 The diagram shows the process of renal dialysis.



Why does the equipment for renal dialysis need two separate systems separated by a dialysis membrane?

(A) To prevent blood clotting in the dialysis machine.

(B) To keep the blood separated from the dialysate which receives the wastes.

(C) To protect blood cells from damage as they pass through the plastic tubes.

(D) To maintain the correct ion concentration in the blood.

Extension: Why is it important for the dialysate to contain ions in similar concentration to blood plasma?

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3.9 Outline the role of the hormones, aldosterone and ADH (antidiuretic hormone) in the regulation of water and salt levels in blood.

Aldosterone

Aldosterone is produced in the adrenal cortex of the adrenal gland.

It is produced when there is a decrease in blood volume and fall in blood pressure.

The fall in blood pressure can cause rennin secretion in the kidney that causes the adrenal gland to release aldosterone.

Aldosterone causes increased active transport of sodium ions from nephron distal tubules. Water follows and is reabsorbed from the tubules. This causes concentration of solutes in blood to decrease and blood pressure rises.

Negative feedback stops secretion of aldosterone.

Antidiuretic hormone (ADH)

ADH is produced by neurosecretory cells in the hypothalamus in the brain.

It is produced when there is a rise in blood solutes or a decrease in water concentration in the blood.

ADH increase the permeability of distal tubules and collecting ducts to water which increases the amount of water reabsorbed and solute concentration decreases.

Negative feedback stops secretion of ADH.

3.9.1 What is the role of aldosterone in the kidney?

(A) Aldosterone causes active transport of sodium ions from distal tubules causing water to be reabsorbed and blood pressure to rise.
(B) Aldosterone detects a decrease in blood volume and a fall in blood pressure and causes blood pressure to increase.
(C) Aldosterone is released when blood pressure increases and causes an increase in sodium ions so less water is absorbed and blood pressure decreases.
(D) Aldosterone causes permeability of walls of distal tubules to change to increase the amount of water reabsorbed.

Extension: What causes aldosterone to be produced?

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3.9.2 What is the role of antidiuretic hormone in the kidney?

(A) ADH decreases the amount of water reabsorbed in the kidney.
(B) ADH decreases the sugars and salts reabsorbed in the kidney.
(C) ADH increases the amount of water reabsorbed in the kidney.
(D) ADH increases the sugars and salts reabsorbed in the kidney.

Extension: Explain your answer.

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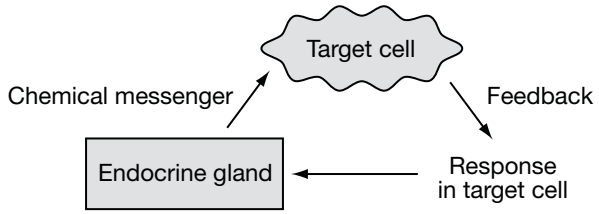
3.9.3 The diagram shows a feedback mechanism.



What is a possible example of this feedback model?

	Endocrine gland	Chemical messenger	Target cell
(A)	Hypothalamus	Aldosterone	Testes
(B)	Hypothalamus	ADH	Kidney tubules
(C)	Pancreas	Insulin	Kidney tubules
(D)	Adrenal gland	Aldosterone	Liver

Extension: Justify your choice of answer.

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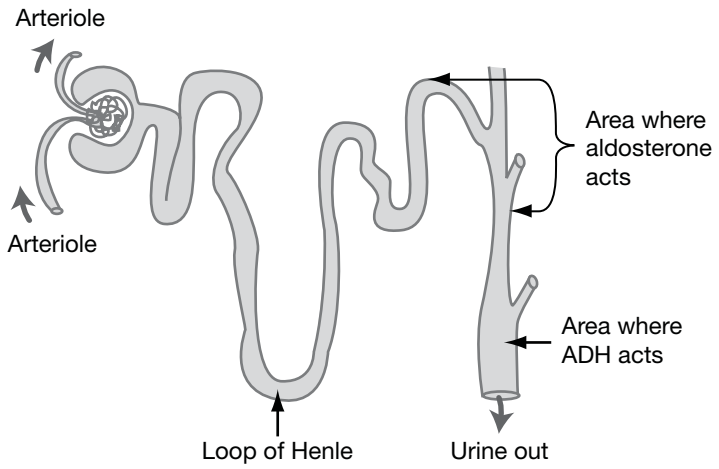
3.9.4 The diagram shows where ADH and aldosterone act in the kidney.



Which hormone acts on the collecting ducts?

(A) Aldosterone to increase reabsorption of sodium to increase the concentration in the interstitial fluid.

(B) Aldosterone to increase reabsorption of water to prevent dehydration.

(C) ADH to increase reabsorption of sodium to increase the concentration in the interstitial fluid.

(D) ADH to increase reabsorption of water to prevent dehydration.

Extension: Justify your choice of answer.

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3.10 Present information to outline the general use of hormone replacement therapy in people who cannot secrete aldosterone.

Hormone replacement therapy is a treatment given when a gland is not producing enough of a particular hormone.

A deficiency in aldosterone, by itself or combined with a glucocorticoid deficiency, can lead to Addison's disease. Without treatment, the condition is lethal as incorrect sodium levels cause electrolyte imbalances, hypertension and cardiac failure. Treatment of Addison's disease involves replacing the hormones, e.g. oral doses of fludrocortisone acetate (Florinef). The medication is taken once a day and the dose is adjusted to meet the needs of individual patients.

3.10.1 What is hormone replacement therapy?

(A) Hormone treatment for people who cannot secrete a particular hormone for themselves.
(B) Supplying hormones to people who overabundantly produce a particular hormone.
(C) Removing a particular hormone and replacing it with a different hormone.
(D) Replacing a gland by surgery with a synthetic alternative.

Extension: What is a hormone?

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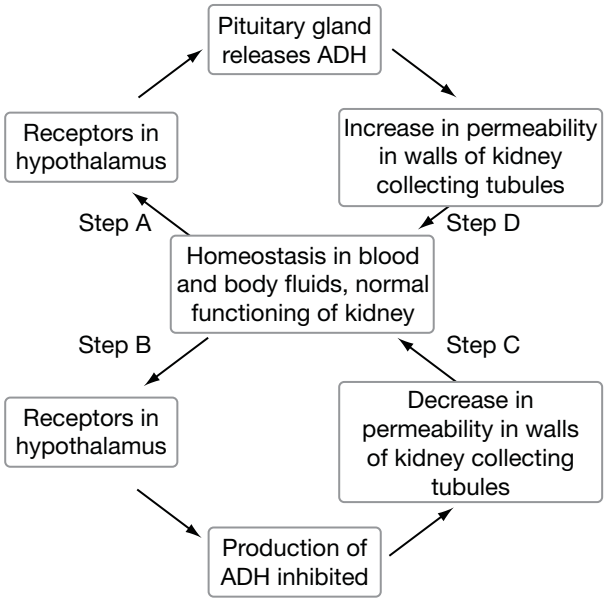
3.10.2 The diagram shows the control of water concentrations by ADH.



Which step involves more water retained with water levels in blood and tissues increasing?

(A) Step A.
(B) Step B.
(C) Step C.
(D) Step D.

Extension: What is happening at step A?

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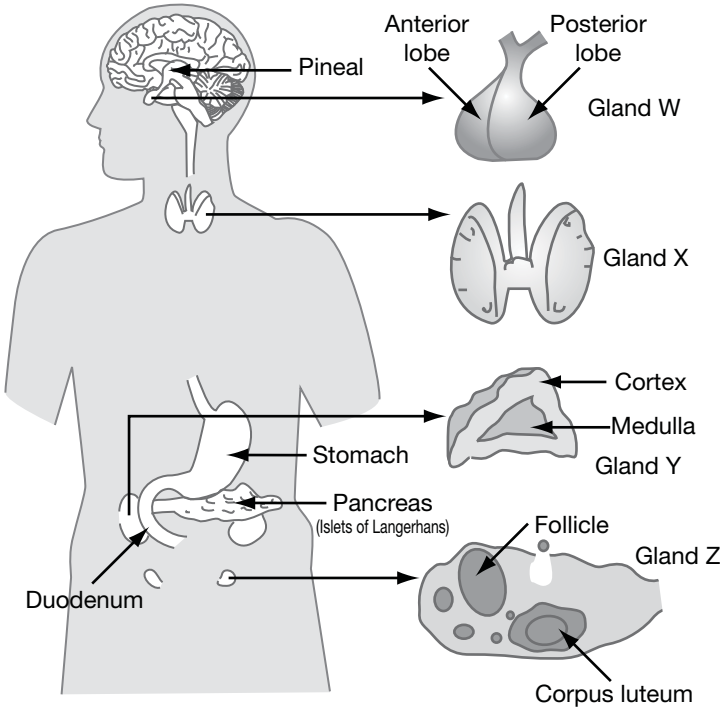
3.10.3 The diagram shows the endocrine system in a human female.



Where are the hormones aldosterone produced?

(A) Gland W.
(B) Gland X.
(C) Gland Y.
(D) Gland Z.

Extension: Explain your answer.

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3.10.4 A deficiency in aldosterone, by itself or combined with a glucocorticoid deficiency, can lead to Addison's disease. Treatment of Addison's disease involves replacing the hormones, e.g. oral doses of fludrocortisone acetate (Florinef).

What problems are caused by a deficiency in aldosterone?

(A) Incorrect sodium levels cause electrolyte imbalances, hypertension and cardiac failure.
(B) Incorrect water levels cause puffiness, shortness of breath and blurred vision.
(C) Increased blood volume causes raised blood pressure and blisters under the skin.
(D) High alkaline levels in the blood cause increased heart rate.

Extension: Explain your answer.

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3.11 Analyse information from secondary sources to compare and explain the differences in urine concentration of terrestrial mammals, marine fish and freshwater fish.

Urine	Terrestrial mammal	Saltwater fish, e.g. bony fish	Freshwater fish
Concentration of urine.	Concentration varies greatly depending on environment and water availability.	Concentrated urine.	Dilute urine.
Amount of urine released.	Amount varies greatly depending on environment and water availability.	Very little urine produced.	Copious amounts of urine produced.
Reason for amount and concentration.	Water availability on land depends on the ecosystem. Rainforests have abundant water while deserts have limited water supplies.	Body solute concentration is less than the surrounding environment, so water moves out of the fish by osmosis.	Body solute concentration is higher than the surrounding environment, so water moves into the fish by osmosis.

3.11.1 Which observations show the differences in urine concentration between marine fish and freshwater fish?

	Freshwater fish	Marine fish
(A)	Drinks large amounts of water and produces concentrated urine.	Drinks large amounts of water and produces large amounts of dilute urine.
(B)	Drinks little water and produces large amounts of dilute urine.	Drinks large amounts of water and produces concentrated urine.
(C)	Drinks little water and produces large amounts of concentrated urine.	Drinks little water and produces dilute urine.
(D)	Drinks large amounts of water and produces concentrated urine.	Drinks little water and produces large amounts of dilute urine.

Extension: Explain your answer.

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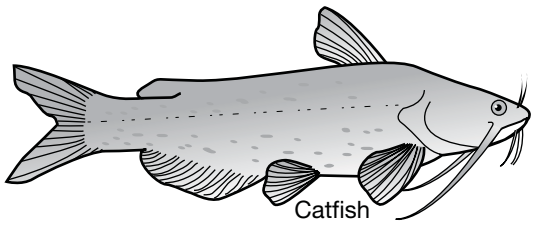
3.11.2 Why do most freshwater fish die quickly when placed in sea water?

(A) Ions move out of the fish by osmosis.
(B) Water diffuses into the fish from the sea water.
(C) Water diffuses out of the fish into the sea water.
(D) There is less oxygen in sea water than fresh water.


Catfish

Extension: Explain your answer.

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3.11.3 Many desert mammals produce urine that is highly concentrated. Why is this feature an adaptation for these animals?

(A) Urea is insoluble in water and high concentration conserves water.
(B) Highly concentrated urine stops osmosis of water out through the skin.
(C) The urine removes many salts due to the high salt diet of desert animals.
(D) Urea is soluble in water and high concentration conserves water.

Extension: Explain your answer.

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3.11.4 The table shows urine concentration as compared to body fluids. What can you deduce about these animals from this data?

Animal	Urine concentration compared to body fluids
Australian hopping-mouse	20
Human	3 - 4
Camel	10
Cattle	8
North American kangaroo rat	18

(A) The Australian hopping-mouse is the most efficient at conserving water in urine.
(B) North American kangaroo rat drinks more water than cattle.
(C) Humans have more nephrons than camels.
(D) The loop of Henle is longer in cattle than in camels.

Extension: Which of these animals is least adapted physiologically to an arid environment? Why?

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3.11.5 The table shows different forms of nitrogenous wastes. How could this data explain the difference in nitrogenous wastes of fish and mammals?

Nitrogenous compound	Ammonia	Uric acid	Urea
Toxicity	Very toxic.	Not very toxic.	Less toxic than ammonia.
Solubility	Highly soluble in water.	Not very soluble in water.	Soluble – can be moderately concentrated to conserve water.

(A) Mammals excrete ammonia as it dissolves easily in blood.
(B) Fish can easily remove toxic ammonia as it dissolves in the water around the gills.
(C) Mammals excrete uric acid as it dissolves easily in the blood.
(D) Fish can easily remove uric acid as it dissolves in the water around the gills.

Extension: Explain your answer.

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3.11.6 The table shows different nitrogenous wastes in terrestrial mammals, marine fish and freshwater fish.

Feature	Terrestrial mammal	Marine fish	Freshwater fish
Main nitrogenous waste.	Urea	Ammonia	Ammonia
Where nitrogenous waste is excreted.	Kidney	Gills – but since a lot of water is needed to remove ammonia (only one nitrogen in each molecule) some ammonia is converted into urea which accumulates in blood to help maintain osmotic balance, e.g. sharks.	Gills where fresh water easily flushes ammonia from gills.

Which organ in fish removes the majority of nitrogenous waste?

(A) Kidney.
(B) Bladder.
(C) Gills.
(D) Anus.

Extension: Explain your answer.

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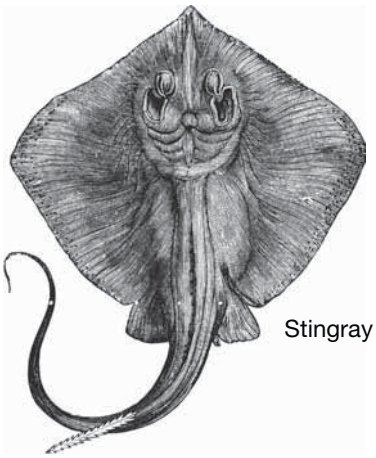
3.11.7 Some marine fish, e.g. cartilaginous fish such as sharks and rays are isotonic with their environment. What is the benefit of this adaptation?

(A) It allows them to swim faster in the water.
(B) It helps provide more buoyancy.
(C) It increases the rate of respiration.
(D) It means there is no net movement of water in or out of the fish.


Stingray

Extension: Explain your answer.

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3.11.8 What is the primary role of the fish kidney?

(A) Osmoregulation.
(B) Excretion of nitrogenous wastes.
(C) Control of motor responses.
(D) Converting blood glucose to glycogen.

Extension: Explain your answer.

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3.12 Use available evidence to explain the relationship between the conservation of water and the production and excretion of concentrated nitrogenous wastes in a range of Australian insects and terrestrial mammals.

Insects have Malpighian tubules which collect water and uric acid from the haemolymph and empty it into the gut. Useful substances and water are reabsorbed by the intestines and the wastes leave the body from the anus.

Uric acid is insoluble in water which means insects conserve water while excreting nitrogenous wastes. This is an important advantage in Australian environments which have a limited water supply.

3.12.1 The koala can survive without drinking water.

What other adaptation assists the koala with the conservation of water?

(A) Eating eucalypt leaves.
(B) Producing small amounts of concentrated urine.
(C) Having a thick layer of fur.
(D) Absorption of water through skin pores.

Extension: Explain your answer.

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3.12.2 The spinifex hopping-mouse *Notomys alexis* lives in the desert and can survive by eating seeds, insects and plant roots and not drinking water. Their urine is one of the most concentrated found in mammals and they eliminate an almost dry faeces.

What is the relationship between urine concentration and the conservation of water?

(A) The more concentrated the urine, the higher the water conservation.
(B) The more concentrated the urine, the less water conserved.
(C) The more concentrated the urine, the greater the amount of urine produced.
(D) The more concentrated the urine, the less water reabsorbed in the kidneys.

Extension: Explain your answer.

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3.13 Define enantiostasis as the maintenance of metabolic and physiological functions in response to variations in the environment and discuss its importance to estuarine organisms in maintaining appropriate salt concentrations.

Enantiostasis is the maintenance of metabolic and physiological functions in response to variations in the environment.

Estuarine organisms live in an environment with varying salt and water concentrations. Estuarine organisms need adaptations to survive their changing environment.

3.13.1 Salt water contains approximately 3.5% salt content. The salt content of many fish is approximately 1.1%. What processes would you expect to occur for these fish living in salt water?

(A) Fish would gain water and lose salts.
(B) Fish would gain both water and salts.
(C) Fish would lose water and gain salts.
(D) Fish would lose both water and salts.

Extension: Explain your answer.

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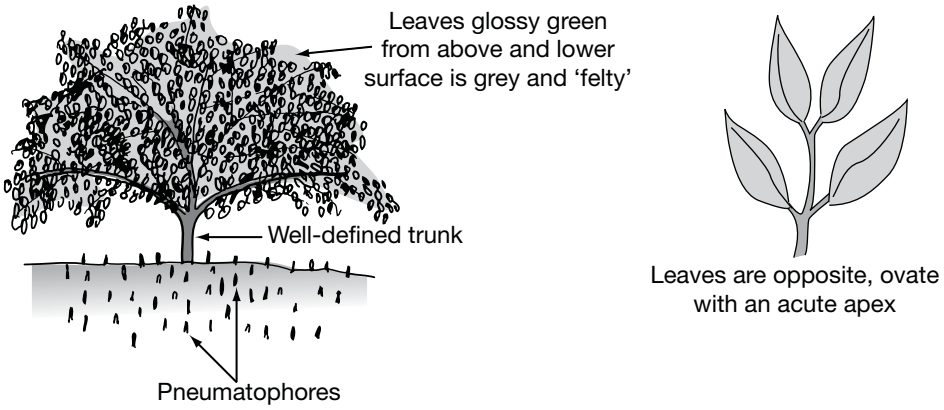
3.13.2 Mangroves are trees and shrubs which need a large supply of water to cope with their high transpiration rate. Their roots are immersed in soil saturated with salt water. *Avicennia marina*, the grey mangrove, excludes about 95% of the salt contained in the water it absorbs through its roots.

The diagram shows the structure of *Avicennia marina* and its leaf form.



What other mechanism is used by mangroves to excrete excess salt?

(A) Salt is excreted from salt glands in the leaf.
(B) Salt is combined with starch and stored in the root.
(C) Salt is evaporated out of stomates in the leaf.
(D) Salt is used as an energy source in respiration.

Extension: Explain your answer.

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3.13.3 What is an estuary?

(A) An estuary is the region around a freshwater lake which is covered by water after flooding rains but exposed when it is drought.
(B) An estuary is the region off the coast where the continental shelf extends into the sea.
(C) An estuary is the region between rainforest and woodland where the trees become less dense.
(D) An estuary is the region where fresh water meets salt water such as the tidal mouth of a large river.

Extension: Identify some organisms found in an estuary.

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3.13.4 Osmoconformers are aquatic animals that maintain the concentration of their internal fluids at approximately the same level as the external environment. Estuarine crabs and sharks are osmoconformers and use small molecules such as amino acids and glucose to vary the concentrations in their cells to match their environment.

What change in the body concentration of osmoconformers would you expect when the tide 'comes in'?

(A) Body fluid concentration would decrease as salt water has a higher solute concentration.
(B) Body fluid concentration would increase as salt water has a higher solute concentration.
(C) Body fluid concentration would decrease as salt water has a lower solute concentration.
(D) Body fluid concentration would increase as salt water has a lower solute concentration.

Extension: Explain your answer.

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3.13.5 Some fish migrate between fresh water and salt water. The spotted mountain trout, *Galaxias truttaceus*, lays eggs in freshwater rivers in Australia. When the young hatch, they swim to the sea.

What adaptive change will the fish need when they migrate to the sea?

(A) Reduce water loss due to lower salt concentration in the surrounding water.
(B) Increase water loss due to lower salt concentration in the surrounding water.
(C) Reduce water loss due to higher salt concentration in the surrounding water.
(D) Increase water loss due to higher salt concentration in the surrounding water.

Extension: Explain your answer.

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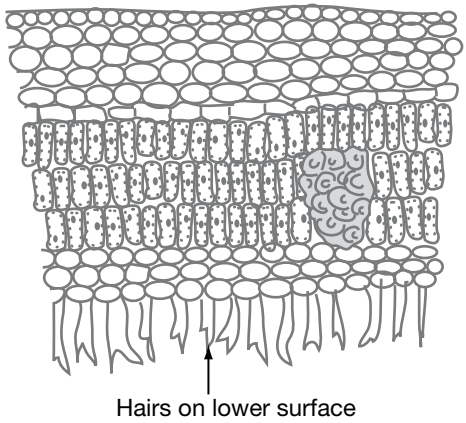
3.14 Process and analyse information from secondary sources and use available evidence to discuss processes used by different plants for salt regulation in saline environments.

There are a variety of responses possible for this section depending on the plants chosen for study.

***Avicennia marina*, the grey mangrove, is the mangrove found in Sydney estuaries and has several adaptations to survive in its saline environment. *A. marina* secretes salt through secretory glands on their lower leaf surfaces.**

***Aegiceras corniculatum*, the river mangrove, is found on the NSW coast and has simple knob-like protuberances on its roots to help supply oxygen to the root system. Oxygen is needed for respiration which provides the energy for active transport. Energy is needed to prevent salt diffusing into the plant down the concentration gradient.**

3.14.1 The diagram shows a cross-section of a leaf of *Avicennia marina*.



Salt is secreted through secretory glands on the lower leaf surface. What happens to this salt?

(A) The salt crystallises on evaporation and forms a protective layer on the leaf.
(B) The salt combines with the waxy cuticle to form a crust on the leaf.
(C) The salt dissolves in water being absorbed through the leaf.
(D) The salt crystallises on evaporation and is washed or blown away by the sea breeze.

Extension: Explain your answer.

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3.14.2 The swamp oak, *Casuarina glauca*, is more salt-tolerant than many other casuarinas. In which habitat would you expect *C. glauca* to grow, but not necessarily other casuarinas?

(A) Wet sclerophyll forest.
(B) Tropical rainforest.
(C) Near beachfront.
(D) Woodland.

Extension: Explain your answer.

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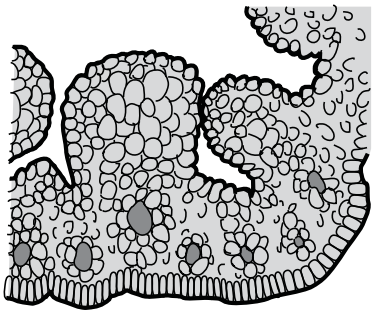
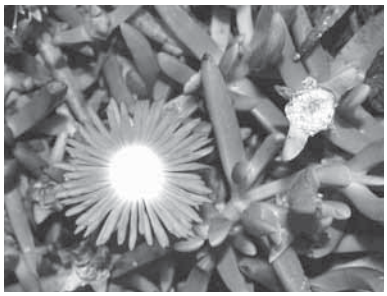
3.15 Describe adaptations of a range of terrestrial Australian plants that assist in minimising water loss.

There are many possible responses depending on which terrestrial Australian plants were studied.

Plant and feature	Diagram	How feature minimises water loss
Spinifex grass Leaf can coil around underside.		Stomates on underside are protected from heat, wind etc and water loss by transpiration is reduced.
Hakea multilineata (grass-leaf hakea) Leaves are long, thin blades.		Long, thin blades reduces surface area and reduces SA:V. This reduces water loss by transpiration.
Carpobrotus rossii (pigface) Leaves are thick, succulent.		Thick, succulent leaves store water allowing plant to grow in arid areas and have water available when needed.
Actinotus spp (flannel flower) Leaves have dense covering of pale woolly hairs.		Dense covering of woolly hairs reduces the ability of water to evaporate and move away from the plant. This decreases water loss by transpiration.

3.15.1 The diagram shows a vertically hanging leaf from a eucalypt.

Identify an advantage for this adaptation.

(A) Assists reduction in water loss.
(B) Prevents insect nesting.
(C) Increases transpiration.
(D) Allows faster rate of photosynthesis.

Extension: Describe how this adaptation assists eucalypts.

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3.15.2 Which adaptation to conserve water would you most likely find in a succulent?

(A) Leaves are darker green due to increased number of chloroplasts.
(B) Thin needle-like leaves with small surface area to volume ratio.
(C) Short life cycle to germinate, flower, seed when water is available.
(D) Fleshy stem or leaves to store water.

Extension: Explain your answer.

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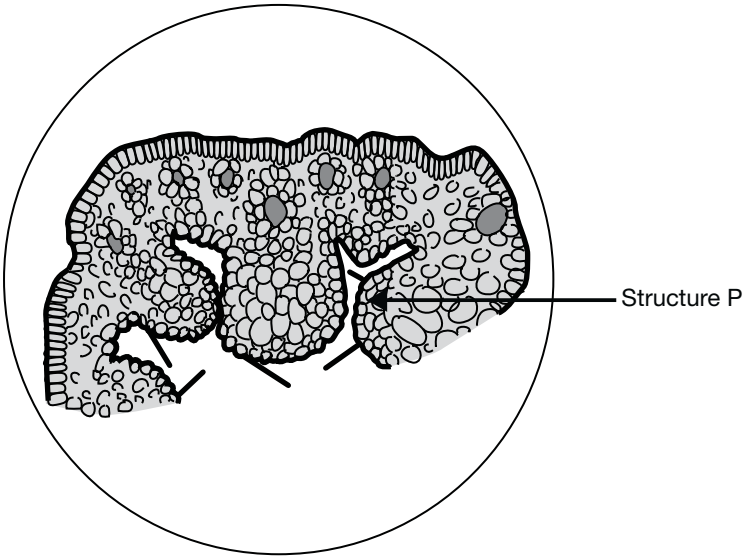
3.15.3 The diagram shows the field of view of a leaf of spinifex grass as viewed under low power of a light microscope.



Which answer correctly identifies structure P and how its structure assists the reduction of water loss?

	Structure P	How it assists reduction of water loss
(A)	Spongy mesophyll	Tightly packed cells reduce ability of water to move out of the leaf.
(B)	Stomate	Location in a crypt means it has reduced ability to release water by transpiration.
(C)	Stomate	It is further away from xylem to receive water from the roots.
(D)	Palisade mesophyll	Tight packing means more sunlight can be absorbed and the energy used for photosynthesis.

Extension: Identify the function of stomates and mesophyll tissues.

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3.15.4 Many desert plants are very slow-growing. Which of the following adaptations would cause a slow growth rate?

(A) Thick waxy cuticle to reduce water loss.
(B) Extensive root system to find as much water as possible.
(C) Closing of stomates to reduce water loss.
(D) Leaves needle-shaped to decrease surface area to volume ratio.

Extension: Justify your choice of answer.

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3.15.5 On hot dry days the leaves of many non-native Australian plants will droop and lose their turgidity.

Why does this occur?

(A) More water is lost through the stomates than is absorbed by the roots.
(B) Drooping reduces the surface area facing sunlight and helps cool the plant.
(C) The rate of respiration is greater than the rate of photosynthesis.
(D) The rate of translocation is greater than the rate of transpiration.

Extension: Explain your answer.

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3.15.6 An analysis of many desert plants shows that they usually have very small leaves with small stomates. How does this assist living in desert conditions?

(A) It reduces the rate of translocation.
(B) It reduces the rate of transpiration.
(C) It increases the rate of photosynthesis.
(D) It prevents grazing animals from eating the leaves.

Extension: Explain your answer.

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3.15.7 Hakeas are small trees and shrubs that belong to the genus *Hakea* and are native to Australia. Their leaves are arranged in a spiral, and many of the eastern Australian species are noted for their hardiness. Their fruits are woody and the fruits of most species remain on the plant until fire or damage makes them split open to release the seeds.

Hakea multilineata (grass-leaf hakea)
Leaves are long, thin blades.

What is the benefit of woody fruits that remain on the plant until fire or damage?

(A) A woody fruit protects the seed from drying out in hot, dry conditions.
(B) A woody fruit stores water.
(C) A woody fruit has increased photosynthesis and produces water.
(D) A woody fruit remaining on the tree increases the transpiration pull.

Extension: Explain your answer.

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3.16 Perform a first-hand investigation to gather information about structures in plants that assist in the conservation of water.

There are many possible responses for this section depending on the plants chosen to be investigated.

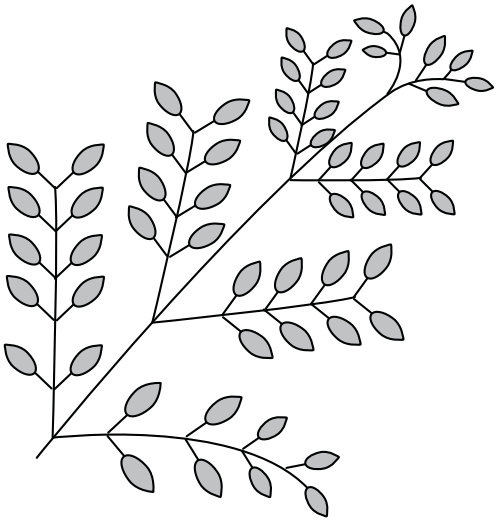
Adaptations can include:

- **Wide dense root networks to obtain as much water as possible.**
- **Succulents store water in stems, leaves or trunks.**
- **Leaves have reduced surface area.**
- **Sunken stomates create a humid environment outside the pore.**
- **Thick waxy cuticles prevent water loss and maintain leaf shape even if the cells are dehydrated.**
- **Reduced flower size or flowers with no petals.**

3.16.1 Many acacias, e.g. wattles, have phyllodes and bipinnate leaves. Phyllodes are petioles with a flat leaf-like appearance, but no blade.

The diagram shows bipinnate leaves.

How do phyllodes and bipinnate leaves assist the conservation of water?



(A) They increase the amount of water that can be stored in the plant.
(B) They increase the amount of vascular tissue and rate of translocation.
(C) They increase surface area and the rate of transpiration.
(D) They reduce surface area and the ability of the plant to transpire.

Extension: Explain your answer.

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3.16.2 Many Australian plants are sclerophylls. What does this mean?

(A) Sclerophylls have large leaves with increased numbers of chloroplasts.
(B) Sclerophylls have tough leaves with thick cuticles for reducing water loss.
(C) Sclerophylls have extensive root systems.
(D) Sclerophylls have fruits in a gumnut.

Extensio: Explain your answer.

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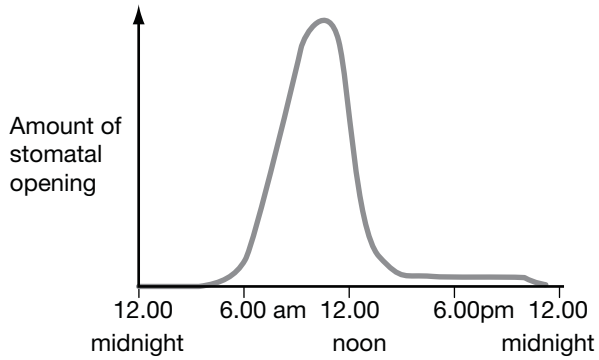
3.16.3 The graph shows the opening and closing of stomates in an Australian plant during one day.



What can be deduced from this graph?

(A) There is less carbon dioxide in the air in the afternoon than in the morning for photosynthesis.
(B) There is more sunlight in the morning than in the afternoon for photosynthesis.
(C) Dry soil causes stomates to close in the afternoon to reduce transpiration.
(D) Increased heat in the afternoon closes stomates to reduce respiration.

Extension: Explain your answer.

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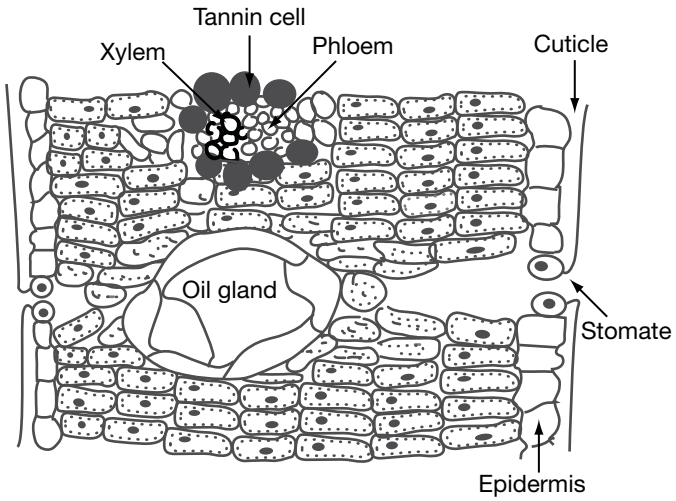
3.16.4 The diagram shows a cross-section of a eucalypt leaf.



What feature does NOT show a vertically hanging leaf?

(A) There are stomates on either side of the leaf.
(B) There is an oil gland.
(C) There are palisade mesophyll cells next to each epidermis.
(D) Both sides have a thick waxy cuticle.

Extension: Explain your answer.

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Notes

DOT POINT

Answers

Notes

1.1.1 (A) Enzymes are specialised proteins that reduce the amount of energy needed to start a chemical reaction. Each enzyme controls the rate of a specific reaction. Some are involved in maintaining body temperature and others break large molecules into smaller molecules.

1.1.2 (B) An enzyme controls the rate of the reaction but is not consumed in the reaction. To show the presence of the enzyme without it being used up in the reaction, it is placed on top of the arrow.

1.1.3 (D) The model shows how a substrate and enzyme fit like a lock and key. The active site is the region where the actual reaction occurs.

1.1.4 (A) High temperatures, e.g. boiling, cause enzymes to denature. This inactivates the enzyme and it can no longer convert sugars to starch.

1.1.5 (C) Each enzyme only catalyses one step in a biochemical pathway. This means that the steps of the reaction occur in order as each product is produced.

1.1.6 (D) Enzyme X has optimal pH = 2 which is acidic, as in the stomach. The blood has a pH = 7.5. There is no information about respiration.

1.1.7 (B) Cofactors and coenzymes assist enzymes. A slight drop in temperature would slow the reaction. Heavy metals inhibit the action of enzymes.

1.1.8 (A) Enzymes end with the suffix 'ase'. Sugars end with the suffix 'ose'. Enzymes are not named after the person who discovered them or a geographic location.

1.2.1 (C) The graph shows an optimal temperature of 22°C. There is no information about the organism that produced the enzyme or about the pH maintained during the experiment. The activity of the enzyme increases as temperature increases until the optimum temperature after which, enzyme activity rapidly decreases.

1.2.2 (A) Beyond a certain substrate concentration other limiting factors will restrict enzyme activity so the reaction will not be able to go any faster, e.g. the ability of the product to be removed could limit the reaction.

1.2.3 (D) At 37°C the reaction rate is falling and the enzyme is already denaturing. Increasing temperature only increases the rate of reaction until the optimum temperature. pH is not part of the data for this graph.

1.2.4 (B) To test the effect of pH, you need to keep the temperature constant (e.g. 40°C is close to body temperature), there needs to be a range of pH, including pH = 2 (rennin is an enzyme found in the stomach where the pH = 2) and you need milk plus junket in each test tube and then a second set with only milk to be used as controls.

1.2.5 (D) Optimal pH for enzyme 4 is pH = 9.5.

1.3.1 (A) Increasing acidity means the pH values must become smaller. The substances need to be in order.

1.3.2 (C) pH of blood according to the scale is pH = 7.4. pH = 7 is neutral and higher values are alkaline.

1.3.3 (B) According to the diagram, hydrochloric acid secreted by the stomach lining has a pH = 1.3. This is the most acidic on the diagram.

1.4.1 (B) Endotherms need to maintain a constant internal environment for optimal metabolic efficiency. If conditions change metabolic efficiency will decrease. This does not necessarily lead to sleep or immediate death.

1.4.2 (A) Metabolism is defined as all the chemical reactions that occur. The metabolic rate is the speed of the reactions and the reactions can follow a particular metabolic pathway. Respiration releases energy for use in the cell.

1.4.3 (D) If enzyme 2 cannot function, then substrate 3 (product 2) cannot be formed and product 1 will accumulate.

1.5.1 (C) Homeostasis controls body temperature, blood sugar level, blood pH, water retention and salt levels.

1.5.2 (B) Maintaining body temperature, and regulating blood pH and carbon dioxide levels are all examples of homeostasis. Eating a large lunch is not homeostasis.

1.5.3 (A) Homeostasis adjusts internal conditions depending on changes in the environment. It does not change body shape, control behaviour or control variation in a species.

1.5.4 (C) Homoios is Greek and means 'same, like' and stasis means 'to stand, or posture'.

1.6.1 (D) Sending messages along a sensory neurone, interpretation by CNS and negative feedback are all part of the second stage of homeostasis – the process of counteracting changes from the stable state.

1.6.2 (C) Main sugar absorbed into the blood is glucose.

1.6.3 (B) Receptors detect changes from the stable state. They send the message to sensory neurones and the message is then passed along the stimulus-response pathway.

1.7.1 (C) Stimulus can be a drop in ambient temperature. Thermoreceptors in the skin detect the change. Sensory neurone is stimulated and a message goes to CNS. Brain sends a message along a motor neurone to jaw muscles that begin a shivering response.

1.7.2 (D) Olfactory receptors are part of the sense organ for smell. They detect chemicals.

1.7.3 (A) The effector carries out the response – it can be either a gland or a muscle.

1.7.4 (C) The pathway is Q (sensory nerve ending), S (sensory neurone), T (connector neurone), W (motor neurone), R (effector).

1.7.5 (B) Reflex arcs make quick responses possible. If the sensory nerve ending detects pain, high heat etc, the reflex arc will allow the leg muscles to quickly pull the leg away from danger.

1.8.1 (A) The graph shows the homeostatic change of blood sugar. After eating a large meal the blood sugar rises. After beginning exercise the blood sugar level drops.

1.8.2 (B) Thermoreceptors in the skin will detect change in environmental temperature, e.g. rise in temperature. A message is sent to the brain and the cooling centre in the hypothalamus will send a message to the sweat glands to produce sweat as a cooling mechanism.

1.8.3 (D) Response R happens when the body detects a rise in body temperature. Sweating will help reduce body temperature.

1.8.4 (C) The quicker response to temperature change shows house 2 has more sensitive temperature detection devices. Both houses have a feedback system.

1.9.1 (B) The graph shows there is an optimal temperature for reproductive rates and generations per year. The graph does not apply to all species of flies and the results do not give any information about evolution rates and adaptations.

1.9.2 (A) To test the effect of temperature on the growth of a particular species, it is advisable to have several individuals set up at each temperature and then observe the growth of each individual.

1.10.1 (C) Species X has a body temperature range of about 15-47°C. This is a very large range and would belong to an ectotherm which cannot internally control its body temperature. Species Y has a temperature range of about 33-37°C. This is a small range and would belong to an endotherm.

1.10.2 (A) An increase in ambient temperature means the endotherm will need to begin a cooling mechanism. Increased blood flow to the skin will allow more heat to be radiated from the body.

1.10.3 (B) The body temperature of ectotherms approximates the external environment and thus can vary by several degrees during the day. Skinks are reptiles and have behavioural adaptations to help maintain body temperature. Skinks are found in many ecosystems. Many are small, thin animals with large surface area to volume ratio.

1.10.4 (C) Constriction of blood vessels reduces blood flow to the body surface and thus less heat is lost. Hibernation and migration occur as a seasonal response, not a temporary drop. Sweating will cool the body.

1.10.5 (A) If environmental temperature gets hotter, endotherms will pant and ectotherms will hide from the heat of the sun by burrowing. Shivering, sunbaking, blood away from extremities and flattening body to the ground assist warming the body when the environmental temperature gets colder.

1.10.6 (B) Shivering increases metabolism and respiration in the muscles. Respiration releases heat and thus it is a means to warm the body. In the cold, koalas reduce blood flow to extremities to conserve heat.

1.10.7 (A) Reptiles are ectotherms and their body temperature is dependent upon their environment. They bask in the sun to become warmer and hide from the sun in the middle of the day to prevent overheating.

1.10.8 (C) Endotherms maintain a relatively constant body temperature. In the desert small body weight would be an advantage for an endotherm as this would infer larger surface area : volume ratio which means heat is more easily lost.

1.10.9 (A) Burrowing, being nocturnal and licking paws and forelimbs are all cooling mechanisms. Shivering raises body temperature.

1.11.1 (D) Strong digging claws and small eyes are adaptations for burrowing. Large molars are needed to chew tough fibrous leaves and bark. Short ears help reduce surface area in cold areas.

1.11.2 (B) Animals E and F maintain body temperature over a large range of environmental temperatures and thus they must be endotherms. Endotherms include mammals and birds. The body temperatures of animals G and H change with the environment and they must be ectotherms. There is no data to say how animal F maintains body temperature.

1.11.3 (C) Evaporation of water from liquid to a gas requires an input of energy. Water in the koala airways takes heat from the body of the koala for evaporation. This removal of heat cools the koala.

1.11.4 (A) Small body size means that there is a large surface area to volume ratio. This means heat can easily be gained and lost. This means that the organism will have greater variations in body temperature as heat is lost/gained.

1.11.5 (B) Dilation of blood vessels allows more blood to flow to the skin, causing a 'flushed' appearance and heat is lost. Shivering and constriction of blood vessels increases temperature in extremities. Respiration in the liver affects core temperature.

1.12.1 (D) Transpiration is the loss of water from the leaves of plants.

1.12.2 (A) Closing stomates stops transpiration. Movement in the phloem does not involve water loss. There are no valves in xylem and root hairs are not sealed off with high outside air temperature.

1.12.3 (C) In hot climates plants can lose large amounts of heat during the day due to transpiration. Opening stomates at night is an advantage in hot climates as it reduces water loss during the day.

2.1.1 (D) About 7% carbon dioxide dissolves in blood plasma, about 23% combines with haemoglobin, 70% travels as the hydrogen carbonate ion.

2.1.2 (C) 280 million haemoglobin molecules each picking up 4 oxygen molecules means $280 \times 4 = 1120$ million molecules of oxygen can be picked up by each red blood cell.

2.1.3 (B) Positive ions include sodium, potassium, calcium, magnesium. Negative ions include chloride ions and hydrogen carbonate.

2.1.4 (D) Digested lipids are resynthesised into triglycerides in the epithelial cell that line the small intestine. With phospholipids and cholesterol they form chylomicrons which travel in the lymph.

2.1.5 (A) Ammonia is toxic, uric acid is insoluble in water and nucleic acid is a part of DNA/RNA. In humans urea is the main form of transport of nitrogenous compounds.

2.1.6 (A) Site A is where oxygen goes from the lungs into the capillaries surrounding the alveolus.

2.1.7 (C) Glucose is the basic unit of digested carbohydrates and amino acids are the basic unit of digested proteins. Lipids are transported initially in the lymph. Vitamins can cross into the blood from the digestive system.

2.2.1 (B) A 'globin' is a group of oxygen-carrying proteins, e.g. haemoglobin.

2.2.2 (A) Oxygen can combine with haemoglobin to form oxyhaemoglobin. This increases the oxygen-carrying capacity of the blood. It is an adaptive advantage as it allows an increased rate of respiration due to a larger supply of oxygen.

2.2.3 (D) Oxygen molecules attach to the iron ions in the haem group. This enables the haemoglobin to transport oxygen.

2.2.4 (B) Carbon monoxide poisoning prevent oxygen reaching cells; this leads to death of cells.

2.3.1 (C) Most arteries carry oxygenated blood but not the pulmonary artery. Because the human circulatory system is a double system with right side of the heart pumping blood to the lungs and the left side of the heart pumping to the body, the pulmonary artery carries deoxygenated blood to the lungs from the heart.

2.3.2 (A) Veins need valves to stop backflow.

2.3.3 (D) Arteries have thick muscular walls to withstand the high pressure created by the beating of the heart.

2.3.4 (A) Capillaries are the site of gas exchange between cells and blood. A thin wall means diffusion can occur more easily and quickly.

2.3.5 (B) The walls of capillaries are only one cell thick – therefore neither of these diagrams is a capillary. The walls of arteries are thicker with more elastic fibres and arteries have a smaller bore.

2.4.1 (C) In the lungs oxygen increases in concentration as it diffuses out of the alveoli into the capillaries and carbon dioxide diffuses from the capillaries into the alveoli and lungs.

2.4.2 (A) Carbohydrates that are eaten are broken down into glucose in the digestive system. The glucose is absorbed into the blood through the villi in the small intestine. The highest concentration of glucose will be in the capillaries around the small intestine.

2.4.3 (D) Insulin is released by the pancreas as a response to high blood glucose levels. It causes body cells to take up glucose and the liver to store glucose as glycogen.

2.4.4 (B) Urea is filtered out of the blood in the kidney. The lowest concentration of urea will be in the renal vein that returns blood from the kidney to the heart.

2.4.5 (A) Increased respiration releases extra carbon dioxide. Receptors in the brain detect carbon dioxide levels and if the levels are too high, increased and deeper breathing removes the excess carbon dioxide from the lungs.

2.4.6 (D) The products of digestion are glucose from carbohydrates, amino acids from proteins and many vitamins enter in the large intestines.

2.4.7 (B) The pulmonary artery takes the deoxygenated blood to the lungs where carbon dioxide is released and oxygen is picked up.

2.5.1 (C) Carbon dioxide added to water makes the water more acidic. More acidic means lowering the pH value.

2.5.2 (A) Hydrogen gas goes 'pop' when exposed to a naked flame. Oxygen gas will relight a glowing splint. Acid turns blue litmus red.

2.5.3 (D) Most pH probes and data loggers will give the pH value to decimal points. This is more accurate than either a simple colour change of litmus paper or determining the colour of universal indicator.

2.5.4 (B) The diagram shows a person exhaling through a tube into a beaker of water. Exhaled breath contains carbon dioxide and the pH probe will detect any change in the pH of the water.

2.5.5 (C) The graph shows that the pH drops from around 7.2 to 5.8. This means the solution was becoming more acidic.

2.6.1 (A) You need to carry the light microscope with one hand on the base and the other hand holding the arm of the microscope as the microscope is heavy and if dropped if could damage exposed body parts or dropping could break glass components which could cut skin and cause bleeding. The precaution should not be a generic rule for working in laboratories.

2.6.2 (D) The ruler shows a distance of 280 mm.

2.6.3 (B) 1 millimetre = 1000 micrometres.

2.6.4 (A) Red blood cells are biconcave discs, smaller than the white blood cells that show on a prepared slide with a stained nucleus. Using the scale the RBC have a diameter of about 8 μm and WBC have a diameter of about 16 μm.

2.6.5 (C) Cell X is a red blood cell, cell Y and cell Z are both white blood cells.

2.6.6 (D) A high white blood cell count means the person has been exposed to a pathogen and has produced more white blood cells to fight the infection.

2.7.1 (B) In eucaryot cells, aerobic respiration occurs in the mitochondria.

2.7.2 (C) Carbon dioxide + water → glucose + oxygen.

2.7.3 (A) Carbon dioxide levels seem to have the greatest effect on breathing rate.

2.8.1 (D) When researching information you need to include a bibliography to show sources and the background information that was used.

2.8.2 (B) A non-invasive instrument means it is attached to the outside of the body and does not enter tissues.

2.8.3 (C) Blood gas analysis is used in long and complicated surgeries.

2.8.4 (D) Vasocontriction will reduce the amount of blood flowing in the finger which means the pulse oximeter will give a falsely low reading for oxygen saturation level.

2.8.5 (B) If you follow the vertical line for infra-red light at 910 nm, curve X has a higher value. According to the given information oxygenated haemoglobin absorbs more infra-red light.

2.9.1 (A) Red blood cells are extracted from donated blood and used for people who are suffering from anaemia. The red blood cells are needed to increase the transport of oxygen.

2.9.2 (D) People suffering from haemophilia need the products of donated blood.

2.9.3 (C) Red blood cells are removed from whole blood by centrifuging. The RBC will settle to the bottom as they weigh the most.

2.10.1 (B) Successful blood substitutes need to be non-toxic, have a long shelf life and be easily stored.

2.10.2 (D) Oxygent is a perfluorocarbon.

2.10.3 (A) PEG-Hemoglobin is a haemoglobin-based blood substitute.

2.10.4 (C) Producing factor VIII from purified pig milk would have unlimited production, low costs and would be free from human infectious diseases.

2.10.5 (A) Genetic engineering is the manipulation of genes to introduce new characteristics for a particular purpose.

2.11.1 (B) The majority of water is transported in blood in animals and in xylem in plants.

2.11.2 (D) Organic compounds such as sugars are actively loaded into the phloem at the 'source', e.g. from photosynthesising mesophyll cells in a leaf. The sugars travel by mass flow to the 'sink'. At the 'sink' the sugars are actively unloaded to be used by a cell for respiration or to be changed into a storage carbohydrate.

2.11.3 (A) The rings of lignin thickening in xylem assist in identifying structure Y as xylem.

2.11.4 (B) Translocation is the movement of sugars through a plant.

2.11.5 (C) Radioactive tracers were used to track the movement of sugars through plants. The plants were usually given carbon-14 in carbon dioxide to follow the production of glucose and then other carbohydrates.

2.12.1 (B) The diagram shows longitudinal section of a vein as shown by the rings of lignin thickening. Method B cuts a longitudinal section.

2.12.2 (D) The arrows are pointing to a vascular bundle in the leaf. The xylem is on the top side of the leaf and is identified by the thick walls.

3.1.1 (C) Salts dissolve in water, e.g. sodium chloride forms sodium ions and chloride ions in water.

3.1.2 (B) ADH (antidiuretic hormone) is involved in maintaining the water balance in the body.

3.1.3 (A) Evaporation is a change of state from liquid to gas.

3.2.1 (D) A polymer is a large molecule made by joining a number of small molecules (monomers) together with specific types of bonds.

3.2.2 (A) There are a variety of wastes, e.g. carbon dioxide can lower blood pH, excess water changes osmotic balance, all wastes alter the internal conditions that will affect optimal conditions for enzymes and thus affect chemical reactions.

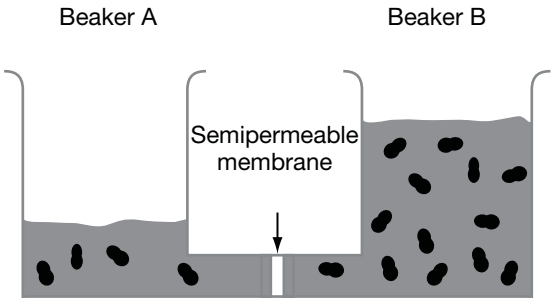
3.2.3 (C) Isotonic means having the same concentration of solutes inside and outside the cell.

3.2.4 (B) Urea is filtered from the blood in the kidney.

3.3.1 (D) If the freshwater fish moved into salt water the fish would not survive. The fish would dehydrate as it loses water and is unable to produce a concentrated urine.

3.3.2 (B) Many saltwater fish have an internal salt concentration lower than the surrounding water. They lose water by osmosis to their environment.

3.4.1 (A)



3.4.2 (D) Main forms of nitrogenous waste are urea, uric acid and ammonia.

3.4.3 (B) Osmosis is the movement of water across a semipermeable membrane from an area of high water concentration to an area of low water concentration.

3.4.4 (A) The diffusion gradient refers to the difference in concentration between the two areas. The greater the difference in concentration the quicker the diffusion.

3.4.5 (D) Diffusion is the movement of particles from an area of high concentration to an area of low concentration of particles.

3.5.1 (C) Filtration occurs in the glomerulus to Bowman's capsule.

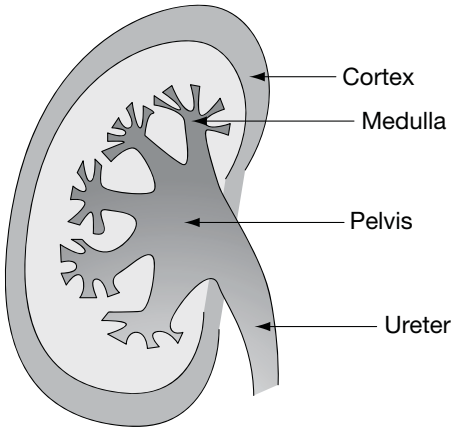
3.5.2 (D) Glucose is needed for respiration. Respiration releases energy to be used by the body to maintain body functions.

3.6.1 (B) Urea is a specific nitrogen compound. Urine is a urea-rich fluid that also contains salts and other substances that will be excreted.

3.6.2 (A) Urine is collecting in the collecting tubule at area Z.

3.6.3 (C) The loop of Henle is in the medulla of the kidney.

3.7.1 (D)



3.7.2 (B) Urine consists of urea, water, salts and other substances that need to be excreted, e.g. any drugs in the body, poisons, water-soluble vitamins.

3.8.1 (A) A semipermeable membrane allows some substances through but not others.

3.8.2 (D) Long term, the person will need a kidney transplant.

3.8.3 (D) An anticoagulant prevents the clotting of blood.

3.8.4 (B) The dialysate needs to have the same ion concentration as blood plasma to make sure that osmosis or diffusion do not occur to deplete the blood of essential ions or change the osmotic balance for metabolic reactions.

3.9.1 (A) Aldosterone is produced when there is a decrease in blood volume and a fall in blood pressure.

3.9.2 (C) ADH increases the permeability of distal tubules and collecting ducts to water that increases the amount of water reabsorbed.

3.9.3 (B) ADH is produced in the hypothalamus and acts on the kidney tubules. Aldosterone is produced in the adrenal glands and acts on the kidney tubules. Insulin is made in the pancreas and acts on the liver.

3.9.4 (D) ADH acts on the collecting ducts to regulate the concentration of urine. If the body is becoming dehydrated, ADH is secreted and increases the permeability of the collecting duct membranes to water. Water is reabsorbed into the tissues and blood by osmosis.

3.10.1 (A) A hormone is a chemical produced by an endocrine gland that causes an effect on its target organ or tissue.

3.10.2 (D) At step A there are lower water levels and higher solute levels in the blood.

3.10.3 (C) Aldosterone is produced in the adrenal cortex.

3.10.4 (A) Lack of aldosterone causes incorrect sodium levels, causes electrolyte imbalances, hypertension and cardiac failure.

3.11.1 (B) In salt water fish lose water by osmosis and thus fish that are not isotonic with their environment drink water and release a concentrated urine to conserve water. In fresh water, water moves into the fish by osmosis and they drink little water and release large amounts of water to release the excess water.

3.11.2 (C) When placed in sea water, the concentration of salts is now greater outside the fish. The fish will lose water by osmosis and will dehydrate and die.

3.11.3 (D) Urea is water-soluble. In the desert water needs to be conserved and thus desert mammals release concentrated urine to conserver water. Osmosis only occurs through the skin when the organism is immersed in water. Desert diets do not necessarily contain more salt.

3.11.4 (A) The human is least adapted physiologically to an arid environment as they have the least ability to concentrate their urine. Behavioural adaptations, e.g. building dams and storing water, mean they can survive in the desert.

3.11.5 (B) Ammonia is toxic but its high solubility means it can easily dissolve in the water around the gills. Ammonia needs to be converted into urea in mammals as it is toxic to remain in high concentrations in the blood.

3.11.6 (C) In fish, some ammonia is converted into urea to help maintain the osmotic balance in the blood. Most nitrogenous wastes remain as ammonia and dissolved in water around the gills.

3.11.7 (D) Isotonic means the body fluid of the fish is the same as its external environment. This means the fish does not have to worry about water loss or gain due to osmosis.

3.11.8 (A) In fish the kidneys regulate the amount of water and salt concentrations in the body. This is osmoregulation. Nitrogenous wastes, e.g. ammonia, are removed from the gills.

3.12.1 (B) Like many other Australian marsupials, the koala releases small amounts of concentrated urine as a way of conserving water.

3.12.2 (D) Urea is highly soluble in water. Therefore by releasing a very concentrated urine the spinifex hopping-mouse will conserve water and can survive in that environment.

3.13.1 (C) The surrounding water has a higher salt concentration tham the fish, thus the fish will lose water by osmosis. Salts will try to diffuse into the fish to equalise the concentrations.

3.13.2 (A) The leaves of *Avicennia marina* have salt glands and salt is secreted from the lower surface of the leaf.

3.13.3 (D) An estuary is the region where fresh water meets salt water such as the tidal mouth of a large river or coastal inlet. Organisms present in estuaries include mangroves, seagrasses, marine worms, oysters, mussels, seahorses, crabs, prawns, fish, wading birds, gulls etc.

3.13.4 (B) The concentration of salts and other solutes is higher in salt water. Therefore osmoconformers will increase their body fluid concentration when the tide 'comes in'.

3.13.5 (C) Moving to the sea means the fish will be in an environment with a high external salt concentration. They will need adaptations to reduce water loss.

3.14.1 (D) The salt is secreted and the heat causes evaporation of the water content. The salt crystallises. The crystals are then blown away by the wind or washed away.

3.14.2 (C) A beachfront has high soil salinity due to sea spray and storms pushing sea water onto the land. The other areas are not necessarily 'salty'.

3.15.1 (A) Vertically hanging leaves have a reduced surface area facing the hot midday sun and thus less transpiration will occur in the hottest time of the day. This reduces water loss from the plant.

3.15.2 (D) Succulents store water in stems or leaves. Increased chloroplasts are for shade plants, needle-like leaves reduce water lost, but do not store water necessarily. Short life cyle means most time is spent as a dormant seed.

3.15.3 (B) The function of stomates is to open to allow gas exchange for photosynthesis and they will close to reduce water loss. Mesophyll cells contain chloroplasts and their function is to photosynthesise.

3.15.4 (C) When stomates close, gas exchange stops and less carbon dioxide diffuses into the leaf thus causing a reduction in photosynthesis. This reduces the growth rate. Thick waxy cuticle, needle-shaped leaves and extensive root system are adaptations to reduce water loss or find water but do not reduce the rate of photosynthesis.

3.15.5 (A) Loss of turgidity is caused by loss of water. Water is lost by transpiration through the stomates and if there is not sufficient water taken in through the root then there is a net loss of water. Respiration releases water as a by-product.

3.15.6 (B) Reducing leaf size and the size of stomates means that transpiration is reduced. This reduces water loss, which is essential in desert conditions. Photosynthesis would decrease since stomates cannot let in as much carbon dioxide. Translocation is the movement of sugars in the plant. Grazing animals will still eat leaves regardless of stomate size.

3.15.7 (A) The fruit protects the seed. Many fruits are fleshy and hold a lot of water. The woody fruit of the hakea protects the seed until conditions are suitable for germination. After a fire there is space and added nutrients to the soil (ash) for germination.

3.16.1 (D) Phyllodes and bipinnate leaves reduce the total surface area and thus there is reduced transpiration and conservation of water.

3.16.2 (B) Sclerophyll means vegetation with tough leaves with thick waxy cuticles. Forests in Australia are described as wet sclerophyll forest and dry sclerophyll forest.

3.16.3 (C) The graph shows stomates close in the afternoon. The most likely reason for this is lack of water, e.g. dry soil. Closure of stomates will reduce transpiration and water loss.

3.16.4 (B) A vertically hanging leaf photosythesises in the morning and in the evening. It will need a waxy cuticle on each side of the leaf, stomates on each side and palisade mesophyll on each side for photosythesis. The oil gland is not involved in this aspect of leaf functioning.