Using Ohm's Law

A 3 Ω resistor has a current of 2 A passing through it. To find the voltage, cover the symbol *V*. This gives you the formula:

voltage = current × resistance

$\therefore$

$V = IR = 2 \times 3 = 6\,\text{V}$

Another problem

A 4 Ω resistor has *12 V* applied to it. You need to find the current through it. For this, you need to cover the I symbol. This gives you the formula:

$I = \frac{V}{R}$

$\therefore$

$I = \frac{12}{4} = 3\,\text{A}$

Key

A increases
B decreases
C stays the same
D not enough information to decide

1 **Use** the above key to complete the following statements.

(a) For a constant voltage, current _____ as resistance increases.

(b) For a constant resistance, voltage _____ as current increases.

(c) For a constant current, voltage _____ as resistance increases.

2 The graphs below were plotted for four different circuit components. **Identify** which graph represents a component that obeys Ohm's Law.

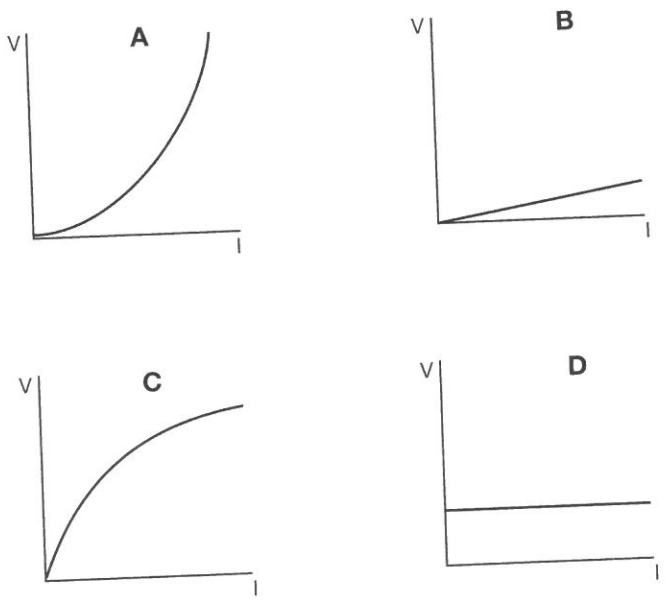


Figure 6.3.3

3 **Calculate** the voltage across the following resistors.

(a) A current of 4 A is flowing through a 5 Ω resistor.

(b) A current of 1.5 A is flowing through a 4 Ω resistor.

4 **Calculate** the current flowing through:

(a) a 3 Ω resistor when a voltage of 6 V is applied across it

(b) a 10 Ω resistor when a voltage of 12 V is applied across it.

5 **Calculate** the resistance of a wire if it carries:

(a) 2 A when a voltage of 6 V is applied across it

(b) 1.5 A when a voltage of 12 V is applied across it

(c) 50 mA (0.05 A) when a voltage of 6 V is applied across it.

6.4 Plotting Ohm's Law

Science inquiry

Visual/spatial Logical/mathematical

A team of Year 9 students measured the current through a light globe as the voltage applied to it increased. Their results are shown in the table below.

Voltage (V)	0	1.5	3.0	4.5	6.0	9.0	12.0
Current (A)	0	3.0	4.0	4.5	4.8	6.0	8.0

1 On the grid in Figure 6.4.1, **construct** a line graph showing these results.

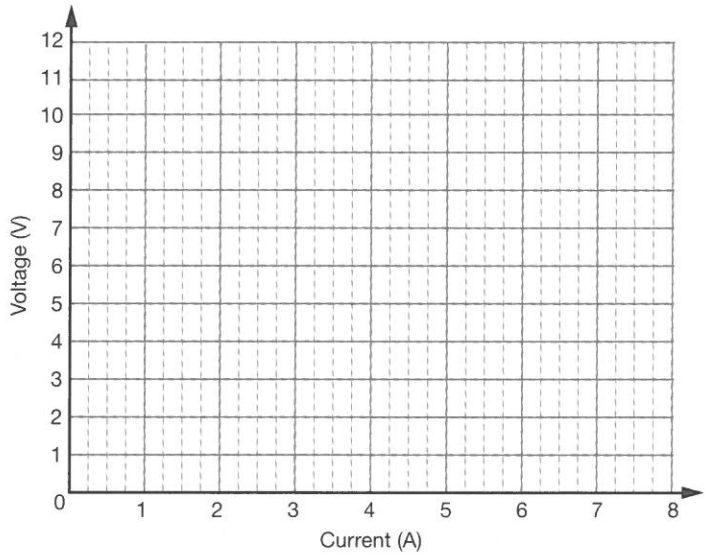


Figure 6.4.1

2 **Use** values from the above table or your graph to **calculate** the resistance (measured in ohms) at the following voltages.

(a) 1.5V

(b) 4.5V

(c) 9.0V

3 **(a)** **Assess** whether the light globe is obeying Ohm's Law or not.

(b) **Justify** your answer.

6.5 Predicting current and voltage

Science understanding

Logical/mathematical Visual/spatial

1 Predict the voltages of each of the light globes in the circuits shown in Figure 6.5.1. Write the voltage next to each globe.

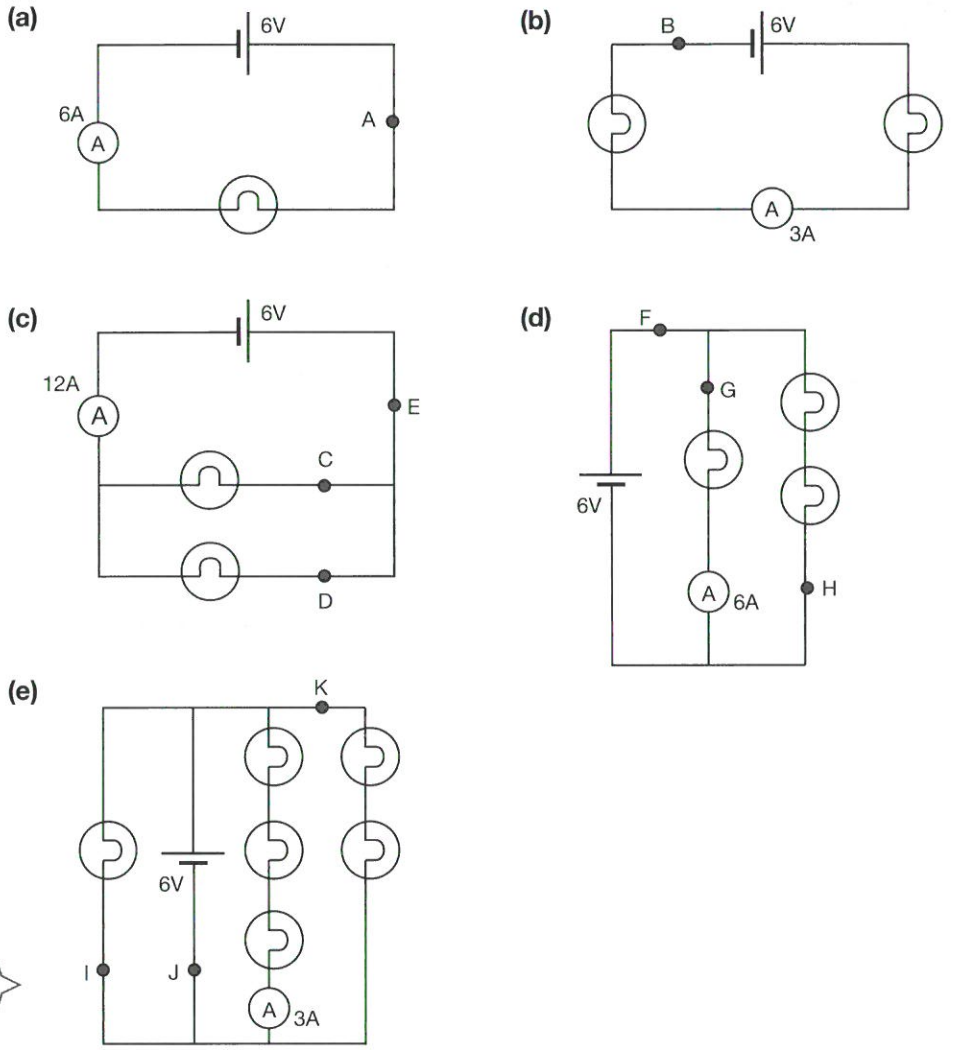


Figure 6.5.1

2 An ammeter is included in each circuit in Figure 6.5.1. From each ammeter reading, **predict** the current that is flowing through the points labelled A, B, C, D etc. in the circuits.

A = _____ A **B** = _____ A **C** = _____ A

D = _____ A **E** = _____ A **F** = _____ A

G = _____ A **H** = _____ A **I** = _____ A

J = _____ A **K** = _____ A

6.6 Keeping safe

Science inquiry

Verbal/linguistic

Electricity is so common that we all take it for granted. However, it is also incredibly dangerous. For example, a circuit can quickly overheat and catch fire if you piggyback double-adaptors or powerboards. To avoid this, use separate plugs. Likewise, coiled or looped-up leads and extension cords can rapidly heat up, possibly melting their insulation and exposing live wires. Straighten them out first. Electricity is most dangerous if you accidentally become part of the circuit! If that happens, current may flow through you to the ground. Serious burns or electrocution can result. To avoid this happening:

- never pull a plug from a power point that is on. Switch it off first.
- never use electrical appliances that have not been working properly or have been producing a burning smell
- never use anything with a lead or extension cord that looks old, or has been cut
- never use a plug with exposed wires
- don't stick metal or sharp objects into a power point or appliance. Turn off the toaster and shake out the slice of bread, instead of putting a knife in it.

Water can provide an easy route for electric current to flow through you to the ground. For this reason, never use an appliance or turn a switch on or off if you are wet. Dry yourself first. Likewise, never use electricity around swimming pools or filled basins or baths. For example, use your hairdryer in your bedroom, not the bathroom.

Never touch someone who has collapsed from electric shock, because they may still be part of the circuit! Turn off the power at the main switchboard and ring for an ambulance. Dial 000 from a landline phone. From a mobile, dial 000 or 112.

1 **List** the main safety devices that give some protection from electric shock and electrocution.

_____

_____

2 **Explain** why power leads should be straightened out and not left in loops.

_____

_____

3 **Propose** a reason why piggybacking double adaptors and powerboards off the one powerpoint can cause them to overheat.

_____

_____

4 **Explain** why putting a knife into a toaster is dangerous.

5 **Explain** why water is dangerous around electricity.

6 Imagine you have come across someone who has been electrocuted. You want to move them away from a live electrical cable but don't want to touch them because you might become part of the circuit too. **Propose** how you could safely get them away from the electricity.

7 **State** the emergency phone numbers that you should use if you come across an emergency.

8 **Assess** your use of electricity at home. **List** ways in which you could improve your electrical safety.

6.7 Media analysis

Science as a human endeavour

Verbal/linguistic

Rooftop travellers in for a 'shock' on Mumbai trains

Trains to switch over from 1500-volt DC to 25 000 AC from tomorrow

by Nithin Belle, 1 March 2010

MUMBAI—After ignoring it for years, Western Railway, one of the two suburban corridors in Mumbai, plans to once again crack down on rooftop travelling beginning Tuesday.

This follows the expected switchover on Monday from 1500-volt direct currect (DC) traction to 25 000-volt alternate current (AC), to speed up trains along the Borivali-Virar section. Suburban railway officials have warned that the changeover would endanger the lives of rooftop travellers, who could get electrocuted.

Girish Pillai, the newly appointed divisional railway manager, Western Railway, says a train would not be allowed to move out of a station even if a single commuter was seen atop the rooftop.

However, looking at the track record of the railway police and the railway staff, many commuters ridicule such claims. 'Whenever we complain about "rooftop romeos", the police just ignore us and say they are helpless,' says Anita Deshmukh, an office-goer from Malad. 'These rowdies can be spotted during the morning and evening peak hours, perched above the women's compartments and making lewd comments. But no action has been taken against them for years.'

Western Railway, which has seen a proliferation of residential colonies in the suburbs and extended suburbs and a consequent spurt in the number of commuters in recent years, sees the maxiumum number of rooftop travellers, especially between Borivali and Dadar.

It is a common sight during the peak hours to find youngsters perched above the women's compartments and trying to imitate Bollywood stars (Shah Rukh Khan's *Chaiyyan, chaiyyan*, number in *Dil Se*, for instance).

When a fast train speeds past a station, most of these youngsters start howling or whistling, especially when they see women on the platform. Many women commuters complain about these rooftop ruffians and their obscene acts and comments, but the police and the railway officials have failed to take action.

Many commuters say it should not be difficult to tackle these hooligans, especially if the police launch a coordinated drive across several stations and taking the help of motor-men and guards. But Mumbai's railway police are notorious for their inaction and there is always lack of coordination between the various agencies.

Of course, occasionally the authorities do launch a campaign against rooftop-travelling, nabbing hundreds of youngsters and jailing some of them. But within days it is back to normal as the daredeveil commuters continue their tryst with death.

Every year, over 3500 people get killed in railway accidents along Mumbai's suburban corridors. Surprisingly, the number of people electrocuted because of rooftop travelling is marginal. But this may change with the shift to AC traction.

Railway officials say that anybody in close proximity of the new system of overhead cables—about two metres—could be physically grabbed and electrocuted.

Authorities have now launched an educational campaign at several suburban stations, holding street-plays to make commuters aware about the dangers of rooftop-travel. But

there is need for a concerted drive during the peak-hours to discourage this dangerous habit among a section of Mumbai's commuters.

---

1 **Describe** how the electricity supply to some electric train lines in Mumbai (India) changed in March 2010.

2 **Explain** why the change was carried out.

3 India has a population of over 1 billion people and Mumbai is its biggest city. **Propose** reasons why many people travel on the roofs of trains instead of in the carriages, even though it is illegal.

4 **Explain** how people in Mumbai have been able to travel on the roof without being caught.

5 **State** the factor that has led to an increase in commuters.

6 **State** how many people are killed each year in railway accidents in Mumbai's suburbs.

7 Until the change of voltage, few of these people were killed by electrocution. **Propose** reasons why they died.

8 **Explain** why the number of electrocutions will probably rise with the change of voltage.

9 **Outline** how Indian authorities plan to tackle the problem of rooftop travellers.

6.8 Comparing methods of power generation

Science as a human endeavour

Visual/spatial Logical/mathematical

Electricity can be generated in many different ways. Study the table below.

	Method				
	Coal	Nuclear	Wind	Hydro	Solar
Maximum power output (MWh)	1 000	1 300	150	100	100
Average power output (MWh)	800	1 105	47	50	20
Cost to build (in 2007) (A$ millions)	$1590	$2145	$732	$236	$900
Cost of every megawatt of power produced (in 2007) (A$)	$40	$46	$42	$48	$245
Average life of plant (years)	30	35	25	40	25
CO_2 emitted (tonne)	247 383	50 215	207	248	448

1 **List** the methods in order from:

(a) cheapest per megawatt of power produced to most expensive

_____

(b) least CO_2 emitted to the most CO_2 emitted

_____

(c) lowest average power output to highest average power output.

_____

2 There is a large difference between the maximum power output and average output from wind, hydro and solar plants. The difference is much smaller for coal and nuclear power plants. **Propose** reasons why.

_____

_____

3 Hydro, wind and solar power plants still contribute to carbon dioxide being released, even though none is released in the actual generation of electricity. **Propose** where this carbon dioxide comes from.

_____

_____

4 **(a)** **Use** the information on the previous page to decide which is the best method or range of methods of power generation for Australia.

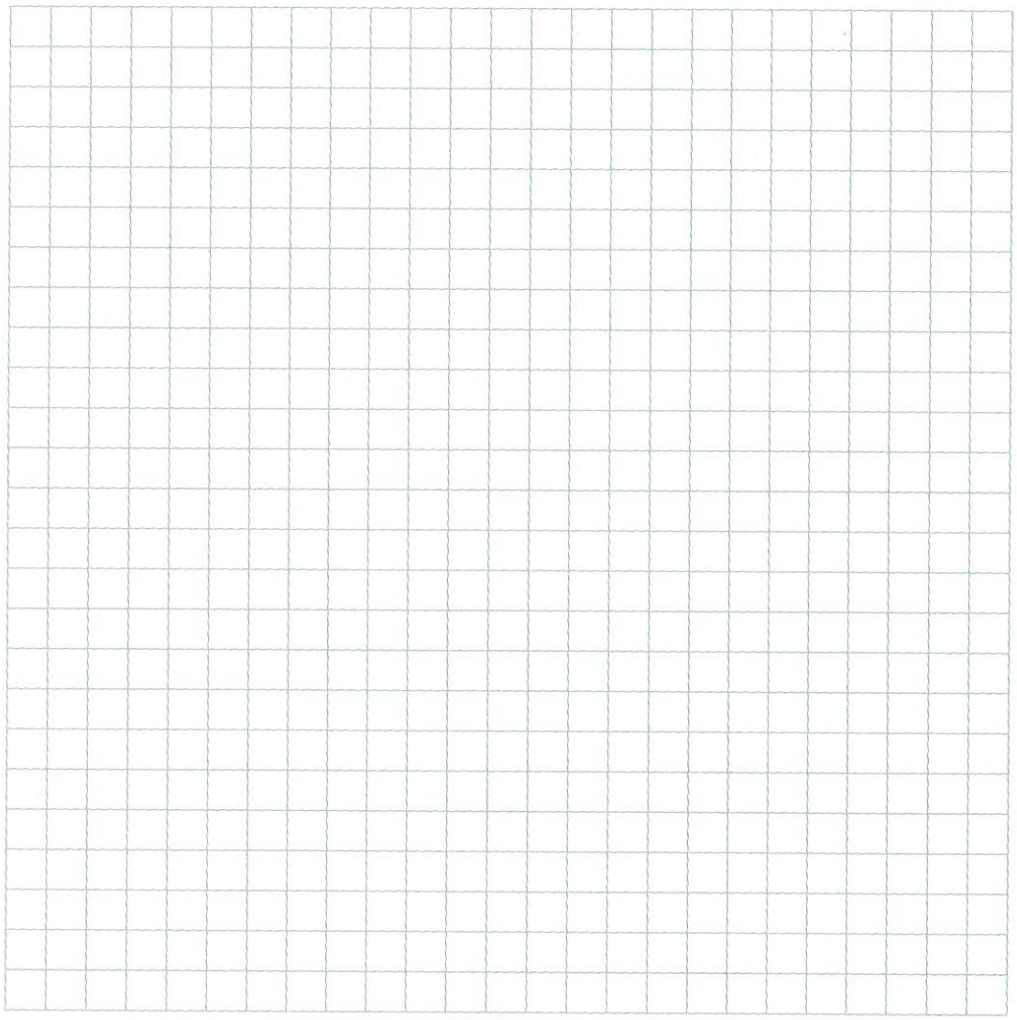
_____

(b) **Justify** your answer.

_____

_____

5 Select one horizontal row of information (e.g. cost to build) from the table on the previous page and accurately **construct** a bar or column graph on the grid below showing that information.

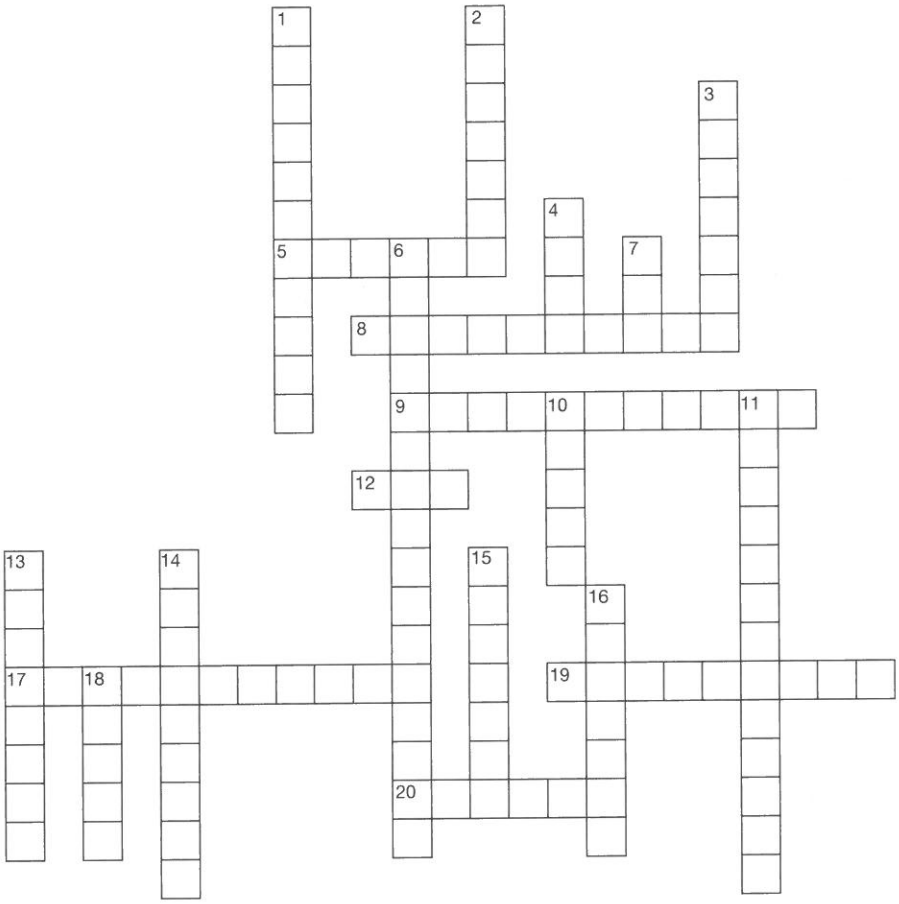


6.9 Literacy review

Science understanding

Verbal/linguistic

Use the clues given below to complete the crossword.



Across

5 Unit for electric current
8 Heat from the Earth
9 Device that increases or decreases voltage
12 Charged atom
17 Solution or liquid that conducts electricity
19 Substance that allows electric current to flow
20 When components are arranged one after the other

Down

1 Current that shuffles back and forth repeatedly
2 Large generator
3 Not charged
4 Thin wire that melts when too much current flows
6 The relationship between electricity and magnetism
7 Unit for resistance
10 Photovoltaic
11 Death by electricity
13 Coil that carries a current
14 Instrument that measures voltage
15 Instrument that measures electric current
16 Biological material that comes from living or recently dead organisms
18 The green and yellow wire in a power lead

7.1 The nervous system

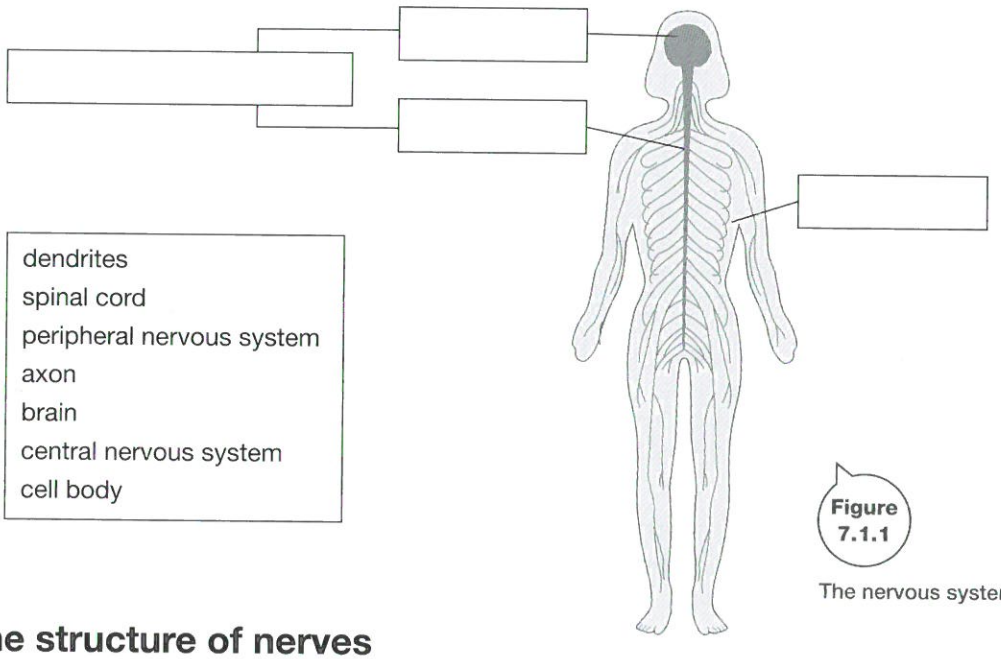
Science understanding

Visual/spatial Verbal/linguistic

Parts of the nervous system

Use words from the list below to answer questions 1 and 2.

1 **Use** words from the box to **label** the parts of the nervous system (Figure 7.1.1).



dendrites
spinal cord
peripheral nervous system
axon
brain
central nervous system
cell body

Figure 7.1.1 The nervous system

The structure of nerves

Use Figure 7.1.2 to assist you in answering questions a–d.

2 **(a)** **Name** the parts of Figure 7.1.2 labelled A, B and C.

(b) **Use** arrows to show the direction of the nerve impulse.

(c) **Label** the sensory neurone and the motor neurone.

(d) Circle two positions where there are synapses.

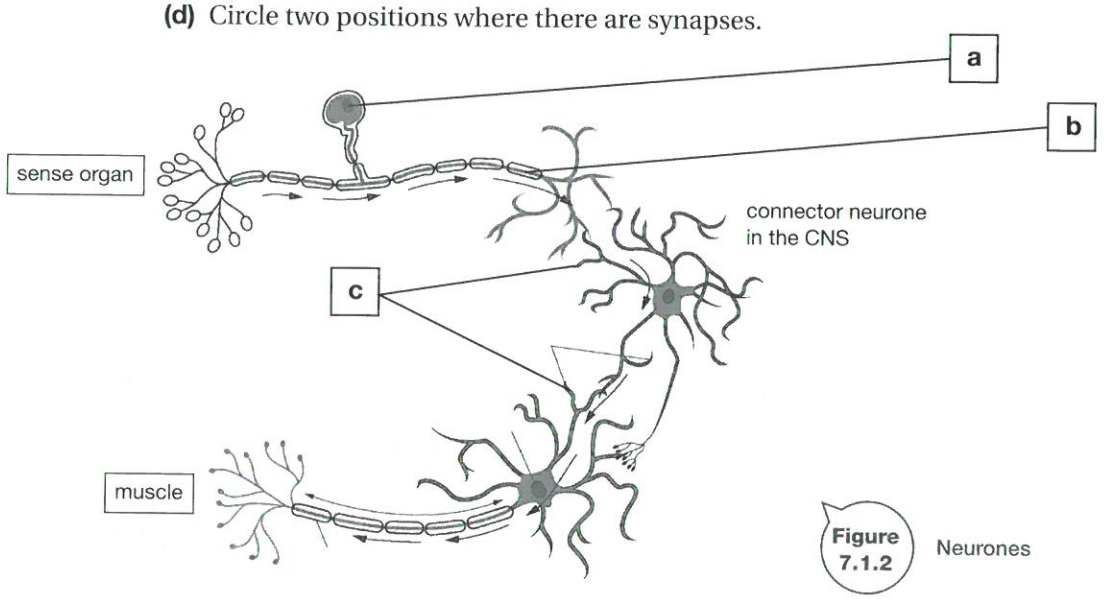


Figure 7.1.2 Neurones

7.2 Reflexes

Science understanding

Visual/spatial Verbal/linguistic

Reflexes are messages that travel from where they are received, along a sensory neurone to the spinal cord. Within the spinal cord, a relay neurone transmits the message straight back along motor neurones to the first place they were received. This causes a response.

Because reflexes do not have to pass all the way up to the brain and back, they are very fast. Reflexes also help protect you from danger. Examples of reflexes are: pulling your hand away from a hot object, blinking your eyes to stop something getting into them, and pulling your foot away after standing on a sharp object. A message is sent to the brain shortly afterwards. Only then can the brain register pain!

1 **Compare** a reflex action with normal stimulus–response reactions of the nervous system.

2 **Explain** why this makes the reflex action so much faster.

3 Use Figure 7.2.1 to demonstrate the path of a reflex action.

(a) **Identify** the pathway of motor neurones in red.

(b) **Identify** the relay neurone in green.

(c) **Identify** the pathway of the sensory neurones in blue.

(d) Use arrows to **demonstrate** the direction of the stimulus.

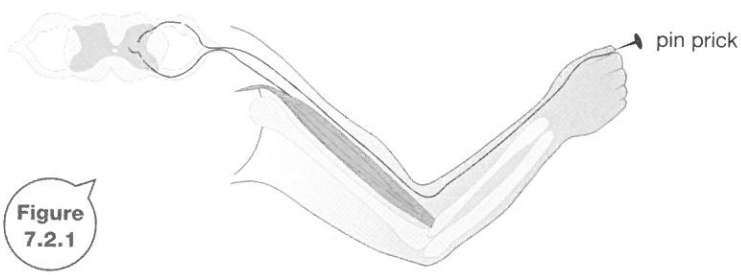


Figure 7.2.1

4 **Explain** why you still feel the pain even after you have moved away from the problem.

7.3 Reaction time

Science understanding

Logical/mathematical Verbal/linguistic

Reflex actions seem to happen very fast, while all the other actions by the body in response to danger seem to take much longer. Sometimes you process the information very quickly, so the reaction appears to be very fast.

You are travelling very fast on your skateboard or bike and suddenly see someone walk in front of you. You have to make judgements about how far away the person is, what actions you can take to avoid them, which action is the best in the situation, and do you have the time and skills to carry it out. You then have to follow through on your decision.

The time it takes for you to do all these things is your *reaction time.*

Experiments show that when you are attentive you have a reaction time of between 0.2 and 0.5 seconds. However, the police estimate that the average driver takes up to one second to react in an emergency.

Once you have reacted, you have to bring your skateboard or bike to a stop. The distance you travel before stopping is the *reaction distance.* This distance depends on your reaction time and the speed at which you are travelling.

Note: reaction distance (metres, m) = reaction time (seconds, s) × speed (metres/second, m/s)

1 Calculate the reaction distance for each situation in the table below.

Speed (m/s)	1.7	4.2	11.1	13.9	27.8	5.6
Speed (km/h)	6	15	40	50	100	20
What travels at this speed	walking	running	car in school zone	car in residential street	car on highway	recreational cyclist
Reaction time (s)	1	0.7	0.5	0.5	0.7	0.6
Reaction distance (m)						

2 Consider what would happen if a driver was distracted and took longer to react. **Calculate** the reaction distances with the slower reaction times in the table below.

Speed (m/s)	11.1	11.1	13.9	13.9	27.8	27.8
Speed (km/h)	40	40	50	50	100	100
What travels at this speed	car in school zone	car in school zone	car in residential street	car in residential street	car on highway	car on highway
Reaction time (s)	1.5	2	1.5	2	1.5	2
Reaction distance (m)						

3 **Deduce** why speed limits are lower (40–50 km/h) near schools and in residential streets.

4 **Propose** factors that reduce the attentiveness of drivers:

(a) in a school zone

(b) in a residential street

(c) on a highway.

7.4 Bionic ear and eye

Science as a human endeavour

Verbal/linguistic **Visual/spatial**

Refer to the Science as a Human Endeavour on pages 232 and 233 of your student book to answer the following questions.

1 **Identify** the events that led to Professor Clark's interest in the causes of deafness.

2 **State** the branch of medicine that studies diseases of the ear and throat.

3 **Describe** what a cochlear implant does.

4 **Construct** a flow diagram that identifies the steps in the process from a sound being made to the person hearing it.

5 Use Figures 7.4.1 and 7.4.2 to **compare** the human ear and bionic ear. Complete the table on page 87. Propose which parts of the human ear are equivalent (similar/the same) to the parts of the bionic ear. Where you do not think there is a direct equivalent, explain why.

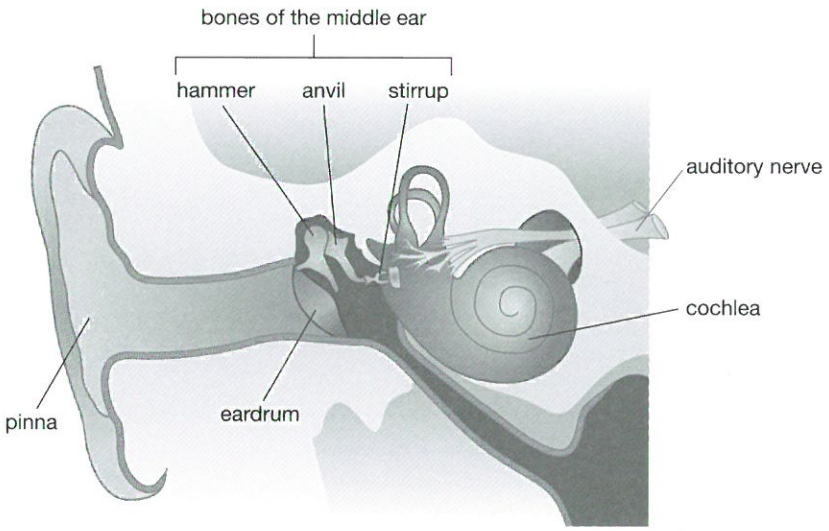


Figure 7.4.1 Structure of the human ear

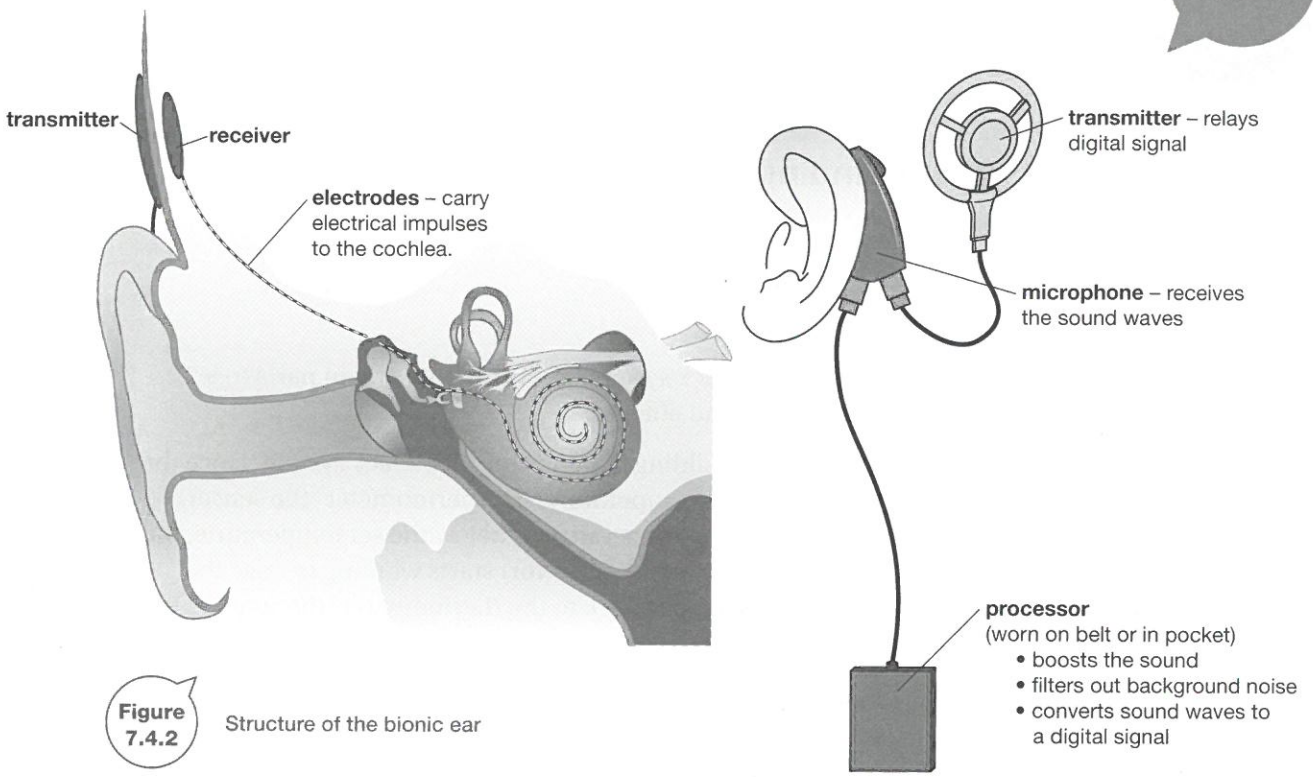


Figure 7.4.2 Structure of the bionic ear

Part of bionic ear	Equivalent in human ear	Justification
microphone		
processor		
transmitter		
receiver		
electrode		

6 Although the bionic ear and bionic eye have different functions, they have some things in common. **Compare** the bionic ear and the bionic eye.

7 **Propose** some advantages for the patient in having a bionic eye. Include those mentioned in the text.

7.5 Temperature control

Science understanding

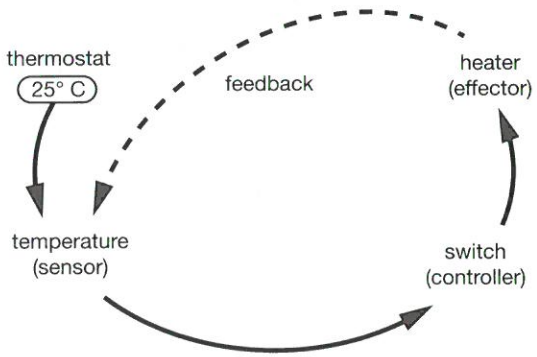
Visual/spatial Verbal/linguistic

Feedback systems

The control of temperature is a feedback system. There are three main parts to a feedback system: sensor, controller and effector.

Automatic heating and cooling of a building depends on a feedback system. Once the thermostat has been set at a particular temperature, the thermometer (the sensor) detects (senses) the temperature. If the temperature is below the set temperature, the switch (controller) is activated and the heater (effector) starts working to raise the temperature. The rise in temperature feeds back to the thermometer (the sensor). When the set temperature is reached, the switch turns the heater off.

This information can be summarised in a simple diagram.



1 Imagine the thermostat is still set at 25°C. **Construct** the feedback system that would cool the room if the sensor detected that the room was too warm (35°C).

Temperature control in the body

The temperature control system of the body is more complex.

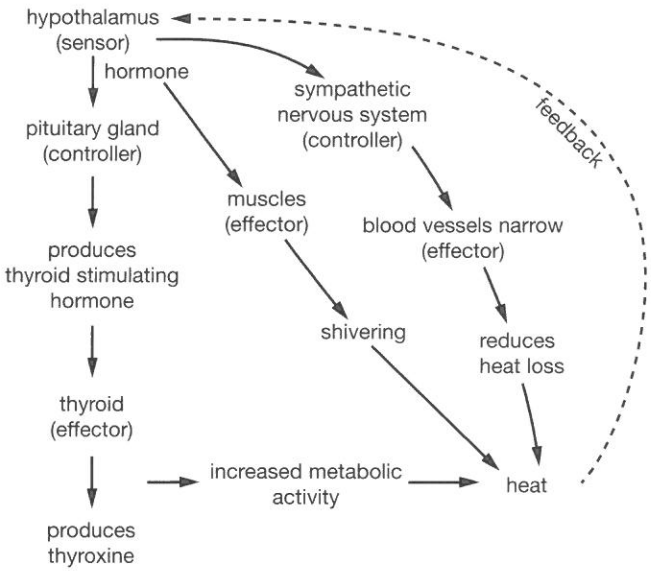


Figure 7.5.1 The body's feedback system when the core temperature falls

2 To the right of Figure 7.5.1, **construct** a similar diagram showing the body's feedback system when the core temperature (the temperature within the body) starts to rise.

Your skin also has temperature sensors. These temperature sensors send nerve impulses to the brain. The brain 'tells' the body to react in the same ways as a stimulus from the hypothalamus. The brain also causes the hypothalamus to become more sensitive to changes in core temperature.

3 **Discuss** the advantages of having two types of temperature sensors—the hypothalamus and receptors in the skin.

7.6 Glycaemic index

Science inquiry, Science as a human endeavour

Logical/mathematical Verbal/linguistic

Glycaemic index

The glycaemic index (GI) is a measure of the effects of carbohydrates on blood sugar levels. Foods that are digested slowly release glucose into the bloodstream at a steady rate. They are rated as low GI. Compare this with foods that have a high GI. These foods are digested quickly and release glucose into the bloodstream rapidly. High glucose levels mean that the pancreas has to produce more insulin.

High-GI foods are suitable as a means of recovery after endurance exercise when the body needs to replenish its energy stores.

Studies have shown that sustained spikes in blood sugar and insulin levels may lead to an increased risk of developing type 2 diabetes. In type 2 diabetes, the pancreas still produces insulin, and levels in the bloodstream are normal. However, the body no longer responds to the hormone, and glucose levels remain high in the blood.

A diet with low-GI foods helps to avoid blood sugar spikes. This is good for the person's general health. For diabetics it is also a way to manage their blood sugar levels.

The data in Table 7.6.1 show what happens to insulin levels in the blood when low-GI and high-GI foods are metabolised.

Table 7.6.1 Insulin levels in the blood

Time (min)	Insulin level in the blood (pM/L)	
	Low-GI food	High-GI food
0	48	48
15	90	110
30	165	250
45	150	240
60	145	220
90	75	135
120	65	85
150	55	75
180	50	55

1 **Construct** a graph of the data in Table 7.6.1. Place time on the horizontal axis and insulin level on the vertical axis, with both high and low GI levels on the same set of axes.

2 **Analyse** the graph to compare the effect of low-GI food and high-GI food on insulin levels in the body.

3 **Predict** what would happen to insulin levels if data had been collected beyond 3 hours (180 minutes).

GI level of foods

The GI levels of food are classified as shown in Figure 7.6.1.

4 **Classify** the foods in Table 7.6.2 according to their GI by placing them into the appropriate section of Table 7.6.3.

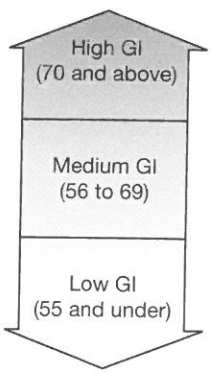


Figure 7.6.1

Table 7.6.2 GI values of food

Food	GI value
Apple	33
Banana	51
Bread (white)	70
Bread (wholemeal)	74
Carrot	39
Chocolate	40
Cornflakes	81
Ice-cream	61
Milk (full-cream)	39
Milk (skim)	37
Pasta	45
Peanuts (salted)	14
Popcorn	65
Porridge	55
Potato (boiled)	70
Potato chips (hot)	75
Pumpkin (boiled)	64
Rice (white)	73
Sultanas	56
Watermelon	76
Weetbix	70
Yoghurt (low-fat)	14

Table 7.6.3 Classification of food

Classification	GI range	Examples
Low GI	55 or less	
Medium GI	56–69	
High GI	70 or more	

5 Potatoes, rice and pasta are all good sources of carbohydrate. **Explain** why sports people eat pasta a few hours before a big game, rather than rice or potatoes.

6 (a) Identify the food that would cause the largest glucose spike in your blood.

(b) Explain why this would happen.

7.7 Kidney function

Science understanding

Verbal/linguistic Visual/spatial

Filtering wastes

In the kidneys are millions of microscopic filters known as *nephrons*. The function of the nephrons is to filter your blood to remove harmful wastes. The nephrons also ensure that useful substances are returned to the blood and not excreted with the wastes. Figures 7.7.1 a and b show the structure and function of a nephron.

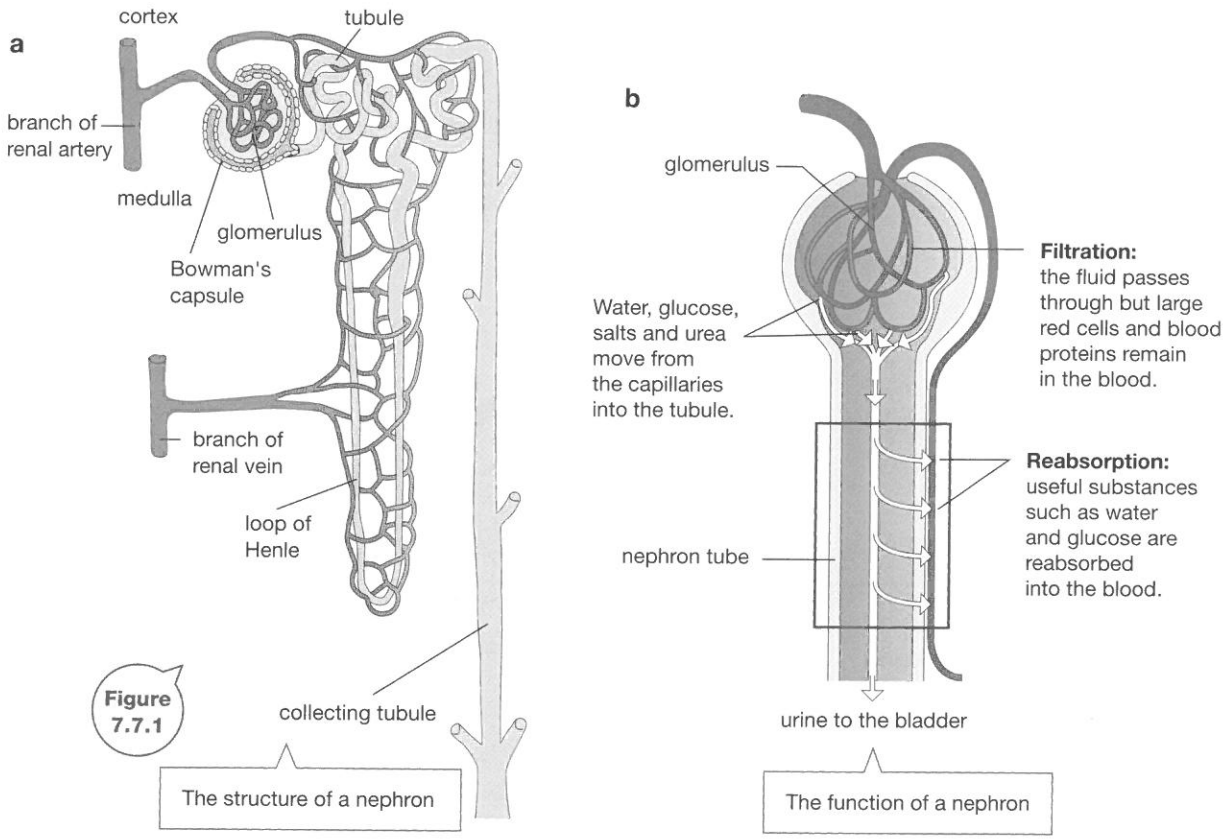


Figure 7.7.1

Blood in the glomerulus is under a lot of pressure. The blood (fluid) is forced through the walls of the capillaries and the walls of the glomerulus into the Bowman's capsule.

As the blood (fluid) passes down through the tubule, about 99% of the water, glucose, amino acids and salts are returned to the blood. Your body uses energy to move the glucose, amino acids and some of the salts back into the blood. These molecules are too valuable to waste.

Water returns to the blood by *osmosis* (a term used to describe the diffusion of water in cells). Diffusion depends on the concentration gradient. Therefore the amount of water in the blood will control the amount of water that is returned from the tubules.

However, the rate of diffusion is influenced by antidiuretic hormone (ADH). ADH changes the ability of the tubule to let water pass through its walls. ADH also changes the concentration of salts in the tissues of the kidney. When your body needs to retain water, ADH levels are high, the walls of the tubules let more water pass through and changes to the levels of salts increase the concentration gradient again, allowing more water to be returned to the body.

7.7

1 **Explain** how the endocrine system is involved in excretion.

_____

2 **Explain** how the circulatory system is involved in excretion.

_____

3 **Predict** how excretion would be affected if:

(a) the kidneys were further from the heart

_____

(b) the tubule was shorter

_____

(c) the tubule was not surrounded by so many capillaries.

_____

4 Figure 7.7.2 is a simplified diagram of a nephron.

On Figure 7.7.2:

(a) Use green arrows to **demonstrate** the direction filtered blood moves.

(b) Use blue arrows to **identify** the pathway the materials filtered from the blood follow until they leave the body.

(c) Use red arrows to **identify** where useful materials are returned to the blood, and the pathway they then follow.

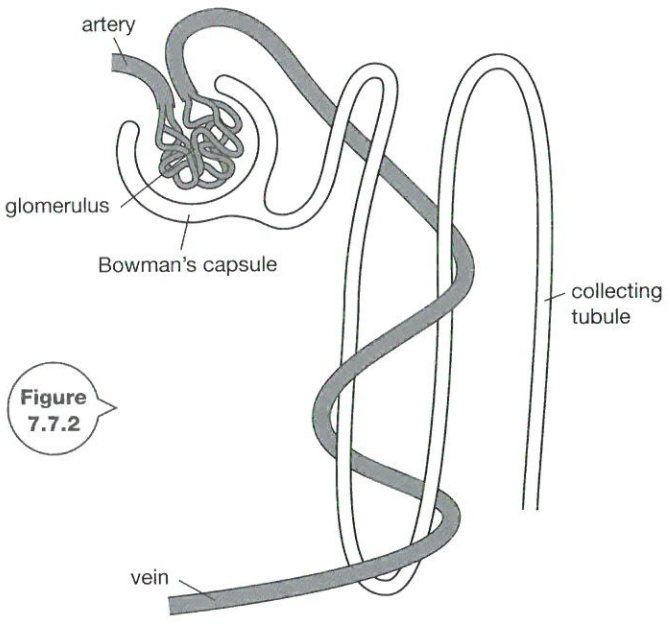


Figure 7.7.2

5 **List** four materials returned to the blood from the filtered material.

_____

7.8 Sweating

Science understanding

Verbal/linguistic Visual/spatial

Excretion through the skin

Read the information below and then answer the questions.

Your skin, in particular the sweat glands, is part of the excretory system.

Figure 7.8.1 shows a sweat gland. When a sweat gland is working, the cells produce a fluid similar to plasma, the liquid part of blood. It is mostly water but it also contains salts and a very small amount of urea. There are high concentrations of sodium ions (Na^+) and chloride ions (Cl^-) and a low concentration of potassium ions (K^+). The fluid used to produce sweat comes from the spaces between the body cells. It moves into the coiled part of the sweat gland and moves up through the straight duct. As it moves up through the duct, the fluid is changed. The amount it is changed depends on how much sweat is produced.

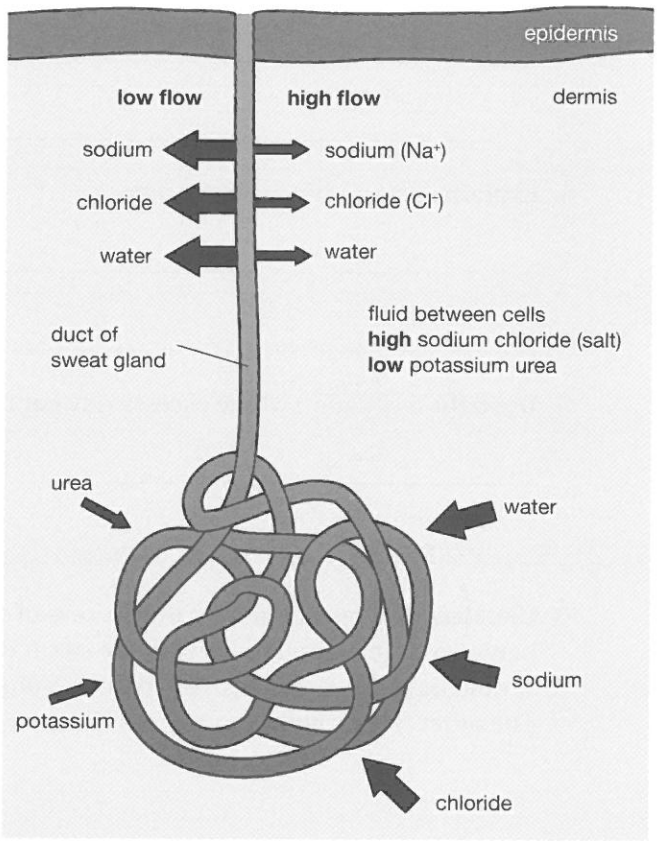


Figure 7.8.1

When you are cool and at rest, you are still sweating at a very low rate. In this situation the fluid moves up through the duct slowly. There is time for water and most of the sodium and chlorine to be reabsorbed (taken back in) before the sweat leaves the body. Potassium and urea are not reabsorbed.

On hot days or after exercise, you sweat a lot. Then the fluid moves quickly through the duct. There is no time for reabsorption of chlorine and sodium. The water is released to help cool your body.

As sweat evaporates from the surface of your skin, excess heat is removed from your body. This helps keep your body at a constant temperature. Only the water evaporates. Sodium, chlorine and potassium remain on the skin. This is why your skin tastes salty when you have been sweating.

Losing large amounts of water and salts from your body can quickly cause dehydration. Without the salts, your body cannot regulate the water content of the blood. It is important to drink plenty of water when you exercise, or are outside in high temperatures.

7.8

1 **List** the excretory products that leave the body through the skin.

2 **Explain** where the fluid that forms sweat comes from.

3 (a) **Propose** whether your skin would taste saltier on hot days or cool days.

(b) **Justify** your answer.

4 **Explain** why sweating is necessary.

5 **Describe** a situation where excessive sweating could be harmful.

6 **Construct** a flow diagram for the process of sweat production. Start with the fluid between the cells and finish with the sweat dried on your skin. The flow diagram should have two branches. One branch should show the process when you are cool. The other should show the process when you are very hot.

7.9 Literacy review

Science understanding

Verbal/linguistic

Recall your knowledge of human body systems by matching the word in the left-hand column with its correct meaning in the right-hand column.

Autonomic nervous system	The brain and spinal cord
Catalyst	A muscle or gland that puts the message into effect
Central nervous system	Branch from the cell body that receives messages from other neurones
Dendrite	A portion of the brain that constantly checks the internal environment of the body
Diffusion	Hormone produced in the pancreas that causes the liver and muscles to extract glucose from the bloodstream and store it in the liver and muscles
Effector	System controlling involuntary actions such as the heartbeat
Endocrine gland	The nerves that carry messages to and from the central nervous system and other parts of the body
Hormones	Movement of particles of a substance from an area of high concentration to an area of low concentration of that substance
Hypothalamus	Glands that produce hormones
Insulin	Chemical substances that act as messengers in the body
Mitochondria	Substance that speeds up the rate of reaction without being used up in the process
Neurotransmitter	Endocrine gland that controls the activities of other endocrine glands; often called the 'master' gland
Peripheral nervous system	The space between neurones
Pituitary gland	A chemical message released by the axon when the signal reaches the end of a neurone
Ribosomes	Organelle where proteins are manufactured
Synapse	Organelles that are the site of cellular respiration

8.1 Growing bacteria

Science inquiry

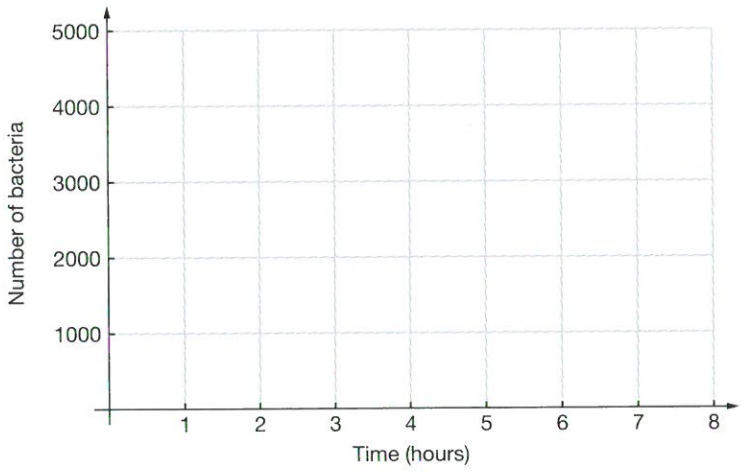
Logical/mathematical

Bacteria reproduce by dividing into two. In ideal conditions, one bacterium can become two every 20 minutes. If you left the milk out of the fridge when you went to school, and there was one bacterium in the container, how many would there be when you came home 8 hours later?

1 Use your calculator to **calculate** the number of bacteria you would have at the end of each hour for the next 8 hours. Complete the second row of the table below.

Time (h)	0	1	2	3	4	5	6	7	8
No. of bacteria	1								
Length of vertical axis (cm)									

2 **Construct** a graph showing the increase in number of bacteria for the first 4 hours.



3 If 1 cm = 1000 bacteria, **calculate** the length of the vertical axis needed to plot the numbers for the remaining 4 hours. Add your calculations to the third row of the table above.

4 **Describe** the shape of the graph.

_____

5 If food was infected with bacteria that cause food poisoning, it is unlikely that there would be only one bacterium to begin with. There would be thousands.

Calculate the number of bacteria on food after 8 hours if 1000 bacteria were present to begin with.

_____

8.2 Immunisation

Science as a human endeavour

Verbal/linguistic

Two success stories

The two diseases below are viral diseases. The principles of immunisation are the same for viruses and bacteria.

Smallpox

In the 18th century, smallpox was a disease that killed many people. In 1788 an epidemic of smallpox went through the part of England where Edward Jenner lived. He was a doctor and he noticed that people who caught cowpox, a similar but mild disease, did not get smallpox.

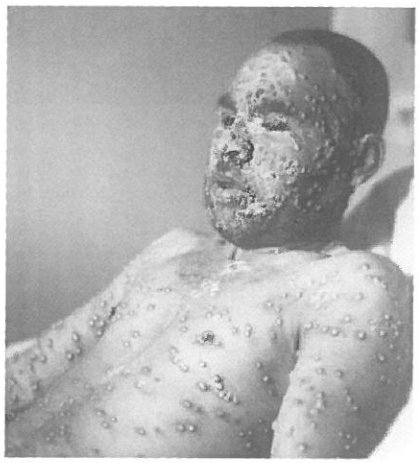


Figure 8.2.1 Smallpox was a viral disease that caused raised fluid-filled blisters. Estimates suggest that smallpox was responsible for between 300 and 500 million deaths during the 20th century.

In 1796, Jenner carried out an experiment on one of his young patients, eight-year-old James Phipps. Jenner made two small cuts on James's arm and rubbed into them a small amount of pus from a cowpox infection. James developed the slight fever that is normal for a cowpox infection, and soon recovered. A few weeks later, Jenner again made small cuts on James's arm. This time pus from a smallpox infection was rubbed into them. James remained healthy—he was immune to smallpox. Vaccination as a treatment to prevent disease had begun.

Within a few years, vaccination against smallpox was widespread. However, nearly 200 years later, about 2 million people still died from the disease each year. In the 1960s the World Health Organization began a worldwide vaccination campaign to eradicate smallpox. In December 1979 the disease was declared extinct in nature.

Polio

Polio is a viral disease that causes muscle wasting, paralysis and sometimes death. In the early 1950s an American researcher, Jonas Salk, inactivated the polio virus using the chemical formaldehyde and created a vaccine. In 1954 there was nationwide testing of the vaccine on hundreds of thousands of schoolchildren. Unfortunately, one batch of the vaccine had not been made correctly and some children became ill, and a few died. Once the manufacture had improved, the vaccine successfully reduced the number of cases of polio.

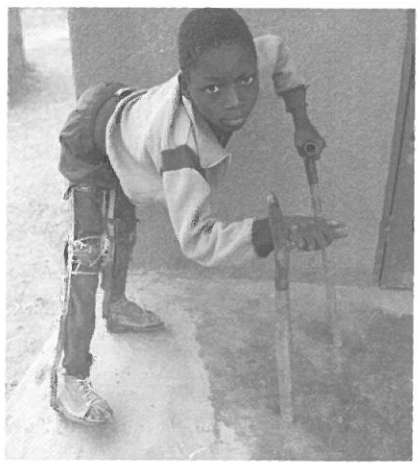


Figure 8.2.2 This boy has been crippled by polio.

In 1958, after 20 years of research, a Polish-American doctor, Albert Sabin, tested an alternative polio vaccine. Sabin's vaccine used weakened viruses and could be taken by mouth rather than by injection. It became the more popular vaccine because it was cheaper to manufacture and easier to give.

The two vaccines between them have eradicated polio from most countries of the world.

8.2

1 **Calculate** the number of years between the vaccination process being tested by Jenner and the eradication of smallpox.

2 **Explain** the term *eradication.*

3 **Create** a flow diagram of the process Jenner used to make James Phipps immune to smallpox.

4 **Predict** any dangers with Jenner's experiment.

5 Look at Figure 8.2.2. The muscles of the boy's legs are wasted. **Explain** the concept of *wasting of the muscles.*

6 **(a) Explain** why the first trials of the Salk vaccine for polio caused problems.

(b) Recall what was done to prevent these problems happening again.

7 The two vaccines for polio were made in different ways. **Describe** how each vaccine was made.

8.3 Pandemic

Science understanding

Verbal/linguistic Logical/mathematical

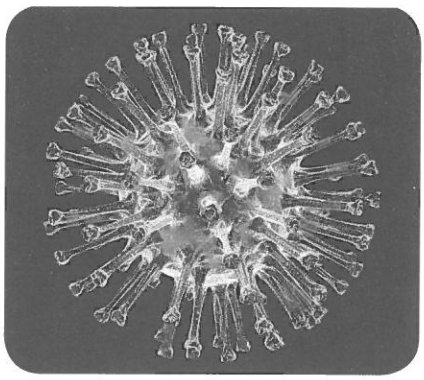


Figure 8.3.1 An H1N1 virus

On 24 April 2009, the United States government reported that a flu-like illness had reached the United States, with seven people confirmed as having influenza H1N1. Meanwhile, in Mexico there were 12 confirmed cases. Flu is not unusual, but this strain of flu was different. While the very young and very old are normally the people worst affected by flu, H1N1 was affecting young adults. The strain of flu was called swine flu, but it is not the same as the virus detected in pigs (swine). It was a new strain. An H1N1 virus is shown in Figure 8.3.1.

The numbers of reported infections increased rapidly. Only two days later, the United States reported cases in five states, and Mexico had 18 confirmed cases, with many more people displaying flu-like symptoms. Some people had died, but doctors were unsure whether the flu they had was H1N1.

The disease spread to other countries, and by the end of April there were cases in Canada, New Zealand, the United Kingdom, Israel and Spain. The World Health Organization (WHO) suggested that people should avoid unnecessary travel, wash their hands regularly, and seek medical advice if they felt unwell.

Australia recorded its first case in early May 2009. A month later the infection was declared a pandemic by the WHO. A *pandemic* is an infectious disease that spreads very rapidly over a very wide area, and this infection was spreading very rapidly, as shown by the data in Table 8.3.1 and the graph in Figure 8.3.2.

By late July 2009, very few countries were unaffected and the number of people with the disease was so high that testing was no longer compulsory. Infected people travelling to other countries caused the rapid spread of the virus throughout the world. This was a new strain of flu virus, and therefore nobody had resistance to it. Most people who came in contact with the virus became ill. Most people suffered only a mild illness, but the infection was potentially fatal.

Table 8.3.1 How H1N1 numbers grew

Date (2009)	Cases worldwide	Deaths worldwide
24 April	19	–
26 April	38	–
27 April	67	7
3 May	787	20
10 May	4379	49
17 May	8480	79
17 June	39620	167
27 July	134503	816
4 August	162380	1154
4 September	254206	2837
4 October	378223	4525

The number of deaths from the disease continued to rise for the next few months, as shown in Figure 8.3.3.

On 10 August, the WHO Director-General Dr Margaret Chan announced that the H1N1 influenza event had moved into the post-pandemic period and that although the disease would continue to be monitored there would no longer be weekly public updates.

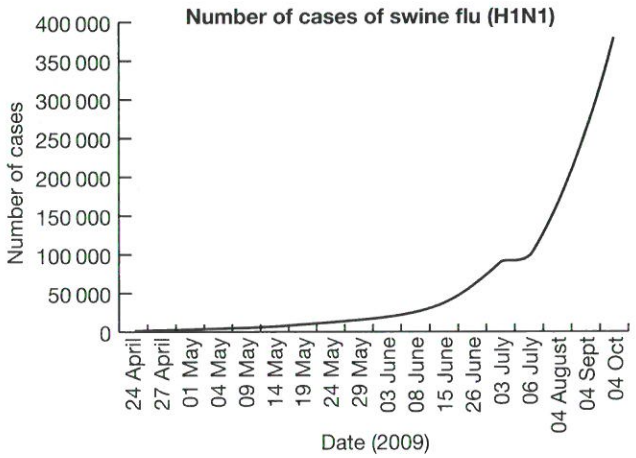


Figure 8.3.2 The number of cases of H1N1 virus increased slowly to begin with. The rate of infection then increased rapidly.

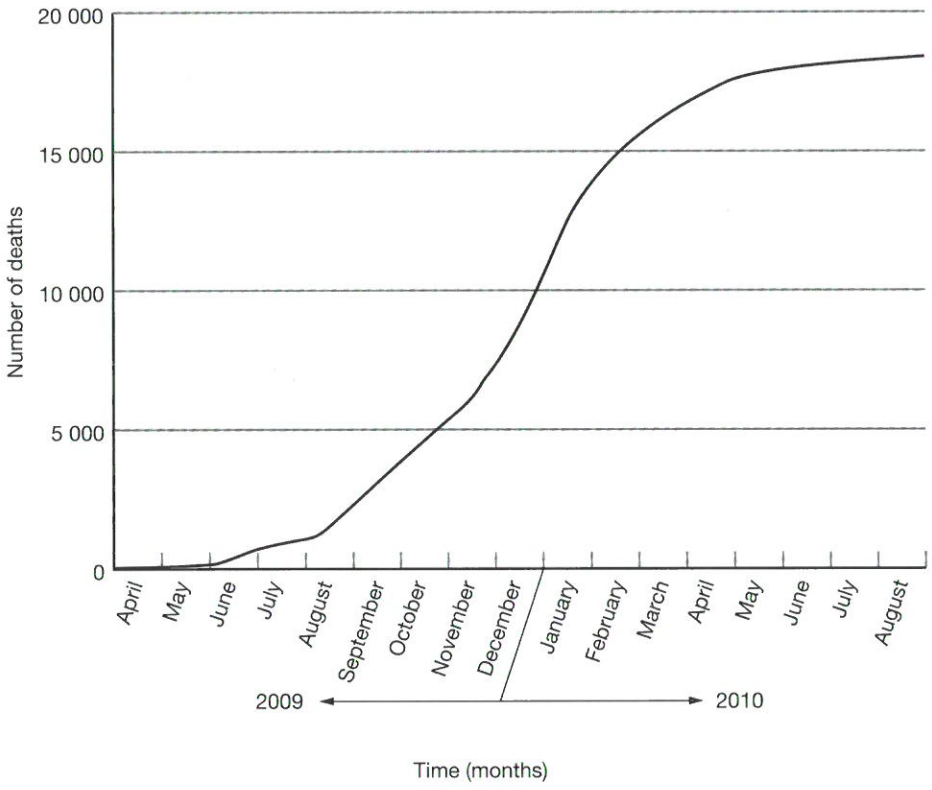


Figure 8.3.3 Number of deaths from H1N1 influenza

1 **Outline** the differences between swine flu and normal flu.

2 **Deduce** the reasons for the WHO suggesting that people avoid unnecessary travel.

3 **Explain** why so many people became ill even though many had been vaccinated against flu viruses.

4 **Explain** why the spread of swine flu was called a pandemic.

5 Figure 8.3.2 shows the increase in the number of cases over the first few weeks of the H1N1 pandemic.

(a) **Evaluate** what happened to the number of people diagnosed with swine flu between 24 April and 17 June.

(b) **Compare** the slope of the graph between 24 April and 17 June with the graph from 4 August to 4 October.

(c) **Explain** what the differences mean.

(d) **Suggest** reasons for the change.

6 Using the information in Figure 8.3.3, **describe** what happened to the number of deaths from H1N1 influenza from February 2010 to August 2010.

7 **Deduce** why the announcement was made that 'the event has moved into the post-pandemic period'.

8.4 Food hygiene

Science as a human endeavour

Verbal/linguistic

A frequent cause of food poisoning is bacteria contaminating food that has not been stored or handled correctly. Freezing, canning and pasteurisation keep food safe for longer.

Cooling and freezing

Bacteria that cause food poisoning grow and multiply most rapidly at temperatures between 5°C and 60°C. In a fridge at temperatures below 5°C, bacteria continue to multiply very slowly. It takes a few days before there are enough bacteria to make the food dangerous to eat.

Freezers should keep food below –15°C. At this temperature, bacteria are not killed; they are inactive and cannot multiply. Food taken out of the freezer should be defrosted or thawed in the fridge. Bacteria in the food will start to multiply but only very slowly. Food thawed on the kitchen bench will quickly reach temperatures in the range that causes rapid growth of bacteria.

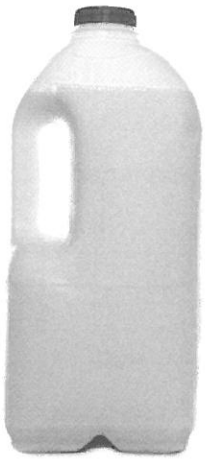
Food thawed at room temperature should be cooked as soon as possible and heated to a temperature well above 60°C so that the bacteria are killed. Food taken from the freezer and allowed to reach temperatures greater than 5°C should never be re-frozen. It will have more bacteria present when the food is thawed the next time. The bacteria will all multiply rapidly and there is a good chance that there will be enough to cause food poisoning.

Canning

Napoleon, a French military and political leader of the 19th century, was looking for a way to supply his army with healthy food. To meet this need, the canning process was developed by a chef named Nicolas Appert. He experimented with heating food in jars which he then sealed. He found that the food stayed fresh for months or even years, as long as the jar remained airtight.

In the canning process, food is cooked, then sealed, in sterile cans. The cans are then boiled to kill any remaining bacteria. Food inside the can is sterile—that is, all the bacteria have been killed. The can is only sterile while it is sealed. Dents in the can may cause the can to become punctured (get holes).

Pasteurisation



Pasteurisation is a heat treatment that slows bacterial growth in food. It is most commonly used on milk. The milk is heated to 71.7°C and kept at that temperature for 15–20 seconds. Pasteurisation is not sterilisation. However, the small number of bacteria remaining are unlikely to cause disease. Milk pasteurised in this way has to be kept refrigerated or the remaining bacteria will multiply, causing the milk to spoil.

Milk in cartons on supermarket shelves has been pasteurised at a much higher temperature. This UHT (ultra high temperature) milk can be stored in airtight containers for months before serving.

The process of pasteurisation was named after its creator, French chemist and microbiologist Louis Pasteur.

Australian Microscopy and Microanalysis Research Facility, March 2009

1 **State** what causes food poisoning.

2 **Compare** pasteurisation and sterilisation.

3 **Recall** the temperatures at which bacteria are most active.

4 Food was removed from a container and tested. No bacteria were present.

(a) **State** the method probably used to preserve it.

(b) **Explain** your answer.

5 Use your understanding of the growth of bacteria to **explain** each situation outlined below.

(a) *Scenario*: Jan poured a glass of milk before going to bed and didn't put the milk back in the fridge. In the morning the milk had a really bad smell.

Explanation:

_____

_____

_____

(b) *Scenario*: Ziva picked a can of fruit from the supermarket shelf, but her mother asked her to choose a different can because that one was dented.

Explanation:

_____

_____

_____

(c) *Scenario*: Dino thawed some meat on the kitchen bench. Then he changed his mind about what to cook for dinner. He put the thawed meat back in the fridge. Four days later he cooked the meat but the whole family were unwell the next day.

Explanation:

_____

_____

_____

(d) *Scenario*: Grandad thinks that the food in the old fridge is not as cold as it used to be, but he doesn't think it is worth buying a new fridge. What would you advise?

Explanation:

_____

_____

_____

8.5 Stomach ulcers

Science as a human endeavour

Verbal/linguistic

Use the Science as a Human Endeavour on page 264 of your student book to answer the following questions.

1 **Explain** what a stomach ulcer is.

_____

2 **Explain** what doctors thought caused stomach ulcers.

_____

3 **Explain** why many doctors were unwilling to accept the idea that bacteria were the cause of stomach ulcers.

_____

_____

4 **Summarise** the evidence that Dr Warren and Dr Marshall used to suggest a link between the bacterium and ulcers.

_____

_____

5 **Explain** why the discovery of *Helicobacter pylori* is considered such a significant event for Australian science.

_____

_____

6 **Explain** why scientists need to be:

(a) tenacious _____

(b) good salespeople. _____

7 **Construct** a flow diagram showing the major events between Dr Warren observing the bacterium and the awarding of the Nobel prize.

8.6 Traditional and modern medicine meet

Science as a human endeavour

Verbal/linguistic

Read the following article and then answer the questions.

Indigenous medicine meets biomaterials development

Australian native plants, traditional Aboriginal culture, biotechnology and improved healthcare all come together in a uniquely Australian good news story.

Prof. Hans Griesser and his collaborators at the University of South Australia have identified a suite of novel antibacterial serrulatane diterpenes, from the resin and leaves of many species of *Eremophila*, and are using them to prevent bacterial growth on medical implants. Over 216 species of *Eremophila* have been found across arid regions of inland Australia. Aboriginal people have used extracts from several of them to treat skin sores and sore throats for generations. It was this pattern of use that had suggested an antibacterial action, and this was subsequently confirmed in the lab. All the active compounds isolated were able to prevent proliferation of dangerous multi-drug resistant strains of bacteria, such as MRSA, which are often the cause of serious hospital infections.

By employing specially designed adhesive interlayers, the active compounds isolated from the plants were attached covalently to the surfaces of polymer and ceramic implant materials through amine groups, retaining their antibacterial activity in the process.

[Specific tests] were used to confirm the presence of ... specific diterpenes on the surfaces, and ... the linkage chemistry was as it should be. Culturing bacteria on treated and untreated surfaces was the next step and ... bacteria were very unhappy on the diterpene-coated surfaces.

In practice, the surfaces of implanted biomedical devices are particularly prone to the build up of bacteria and this can happen weeks or even months after a device is put in. Bacterial infections are routinely controlled with antibiotics, but by the time an infection has been identified on an implant deep inside the body, the patient can already be seriously ill. 'If someone in their seventies has an artificial hip inserted and then they have an infection and have to go back to get the hip taken out and another put in, that's traumatic for someone who is already compromised health-wise,' says Hans. It also causes avoidable expense and wasted time for the healthcare system. The covalent binding of the antibacterial diterpenes to the surface of the implants circumvents these problems and will hopefully provide permanent protection, stopping the implant from ever harbouring infection. Preliminary results also suggest that mouse cells, unlike the bacteria, can attach and grow on some of the modified surfaces.

Hans's PhD student Hardi Ys recently presented this work at a biomaterials conference hosted at the University of New South Wales. Multi-national healthcare companies have expressed interest in the technology and patents have been taken out. However, Hans is clear that he and the rest of the team want to ensure that the Aboriginal community also benefits from the exploitation of these novel compounds. 'We can learn so much from nature and traditional knowledge.'

Australian Microscopy and Microanalysis Research Facility 2009

1 Serrulatane diterpenes are complex chemicals. **Explain** the characteristics they have that are of great interest to scientists.

2 **State** what ailments Aboriginal people used *Eremophila* extracts to treat.

3 **Explain** the term *active compound.*

4 **Outline** the process used to confirm the antibacterial properties of the active compounds in *Eremophila.*

5 **Explain** why it was important to test the effect of the active compounds on polymer and ceramic materials.

6 **Explain** why bacteria were cultured on surfaces treated with diterpenes and on untreated surfaces.

7 **Describe** where in the body these compounds are used to prevent growth of bacteria.

8 An artificial hip is an implanted biomedical device. **Propose** three other biomedical implants that may be used in the human body.

9 **Explain** why infections related to biomedical implants are of particular concern.

8.7 Medieval science

Science as a human endeavour

Verbal/linguistic

Read the Science as a Human Endeavour on pages 273 and 274 of your student book to answer the following questions.

1 **Explain** the relationship between humours and disease.

_____

_____

2 **Deduce** why phlegm may have been associated with winter and considered to be a cold moist humour.

_____

_____

3 Using your knowledge of the causes of disease, **propose** why there was some logic in thinking there was a link between bad smells and disease.

_____

_____

4 **Calculate** how long Aristotle's ideas about spontaneous generation survived before they were finally discredited.

_____

Louis Pasteur

Read the following description of the experiment carried out by Pasteur, which disproved spontaneous generation.

Pasteur knew that:

- bacteria grow in open containers of meat broth
- if the container of meat broth is boiled for an hour and then sealed, bacteria do not grow in the broth
- bacteria are found in dust particles floating in air.

In his famous experiment, Pasteur first prepared a meat broth. Next, he placed equal amounts of the broth into two long-necked flasks. One flask was left with a straight neck. The neck of the other flask was bent into an 'S' shape, as shown in Figure 8.7.1.

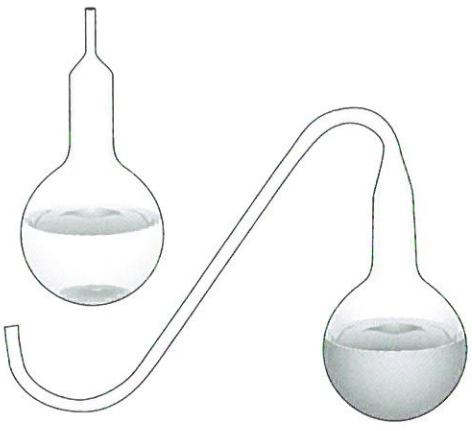


Figure 8.7.1

He boiled the contents of each flask to kill any microorganisms and then left the sterile flasks and contents on a bench.

After a few weeks, the broth in the straight-necked flask was cloudy. The contents in the flask with the S-shaped neck were unchanged.

Pasteur concluded that bacteria from the air were able to enter the straight-necked flask and contaminate the broth. The S-shape of the neck in the other flask trapped the bacteria, preventing them from reaching the broth, as shown in Figure 8.7.2.

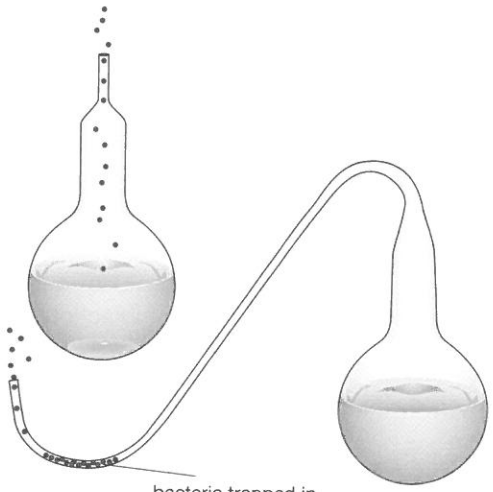


Figure 8.7.2

He argued that if spontaneous generation were true, then both flasks should have become contaminated. When bacteria were prevented from reaching the broth there was no contamination, demonstrating that bacteria could only come from other bacteria.

5 **Explain** what Pasteur did to ensure that there were no microorganisms in the broth at the start of the experiment.

6 **Explain** how the S-shape of the neck prevented bacteria from entering the flask.

7 (a) **Propose** what would have happened if the S-shaped neck was broken off, leaving a straight neck on the flask, and the flask was then left on the bench for a few weeks.

(b) **Justify** your suggestion.

8.8 Literacy review

Science understanding

Verbal/linguistic

Use words from the list to complete the sentences below. Words may be used more than once.

antibiotics	infectious	pathogens	stomach acid
contagious	lymphocytes	quarantine	vaccines
disease	neutrophils	saliva	
immunity	parasites	skin	

1 A _____ is anything that causes your body to stop working correctly.

2 Bacteria and viruses are two types of _____ that cause _____.

3 Diseases passed easily from one person to another are _____ diseases. The most easily passed on are known as _____.

4 People who are contagious are put in _____. Separating them from others helps control the spread of the disease.

5 Bacterial diseases are treated with _____.

6 _____, _____ and _____ are all part of the body's first line of defence.

7 _____ in the blood are an important part of the body's second line of defence.

8 When your body is infected with a pathogen, your immune system makes antibodies, which give you _____ the next time you meet the same pathogen. Antibodies are made by _____.

9 _____ are often given by injection. They cause your body to make antibodies.

10 Some diseases are caused by microscopic _____ such as Plasmodium.

9.1 Smoke and germination

Science as a human endeavour

Verbal/linguistic

Seeds of some plant species (wattles) germinate better after bushfires. Germination is the process of seeds growing and sprouting. For most seeds, germination just involves coming into contact with water. These seeds absorb water, swell up and begin growing. Some Australian plants, especially wattles, have seeds with tough waterproof coats. Scientists discovered that if this coating is split, water can enter. Experiments showed that soaking wattle seeds in boiling water for a few minutes could split the seed coat. So, for a long time, ecologists thought it was only heat that causes so many wattles to germinate after a bushfire. They also thought this should be true for other plant species as well.

Before 1990, many species that the horticultural industry and researchers had been trying to grow would not germinate very well. For these 'problem species', heat treatment did not work, and the researchers had no idea why. For example, in Western Australia, about 20% of the native species were difficult to germinate. This meant that these species could not be:

- grown in plant nurseries and sold to the public
- widely used in repairing natural ecosystems such as after mining.

Anyone who wanted to use these species had to obtain their seeds from the wild. This put pressure on the natural ecosystems.

In 1990, two South African scientists discovered that smoke alone, rather than heat, improved the germination of some South African plants. The climate, flora and bushfire history of South Africa is similar to that of Western Australia. So scientists at King's Park and Botanic Gardens in Western Australia decided to try smoke on Western Australian plants. They discovered a dramatic response of many species to smoke. This caused more research around Australia. Over 400 species have been shown to germinate better after smoke treatment. Because of this research, smoke is now widely used in nursery production, bushland management and mine-site restoration in Australia. It is even being used by home gardeners and farmers who are interested in native plants.

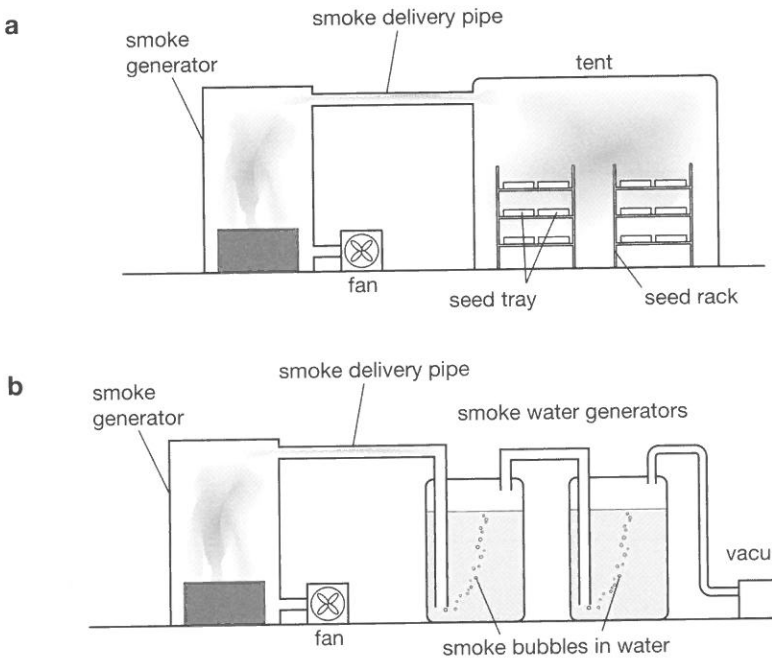


Figure 9.1.1

Smoke can be applied to the seeds by (a) air (called 'aerosol') or (b) water (called 'smoke water'). These methods can be applied to trays of seed in soil, bushland soil or directly to seeds. The method used depends on what suits the situation.

9.1

1 **Define** germination.

2 **Explain** why, before 1990, Australian scientists thought it was probably heat that was causing wattles to germinate following a fire.

3 **Explain** why Western Australian scientists didn't know what to do with 'problem species'.

4 **Describe** three benefits of improving the germination of 'problem species'.

5 **Explain** why scientists at Kings Park and Botanic Gardens decided to try smoke to improve germination of Western Australian native plants.

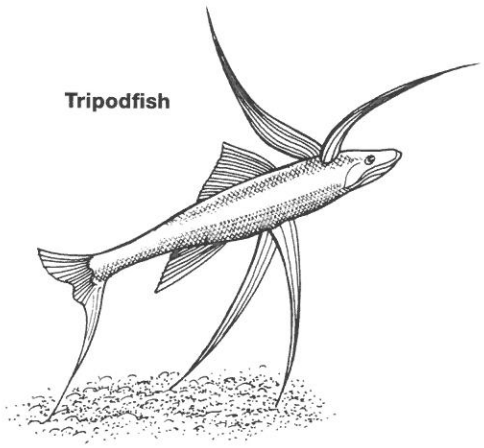
6 **Describe** the two methods by which smoke is applied to the seeds.

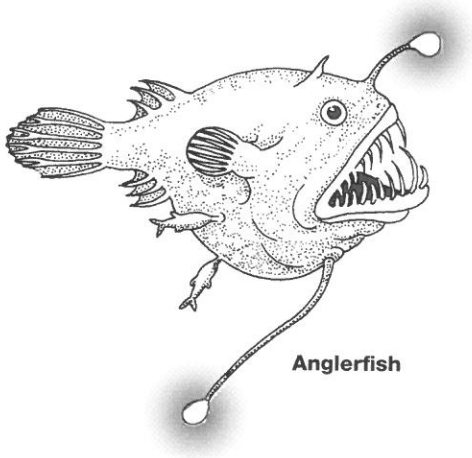
9.2 Deep-sea fish

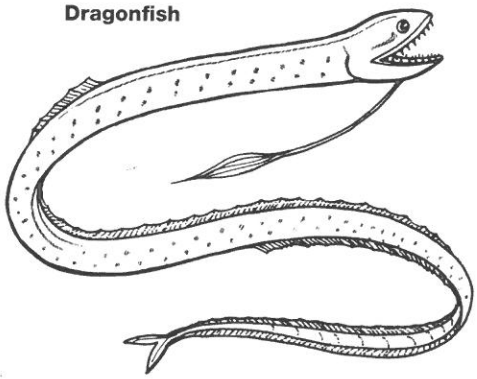
Science inquiry

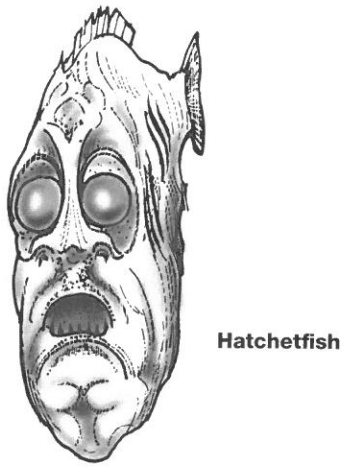
Logical/mathematical Verbal/linguistic

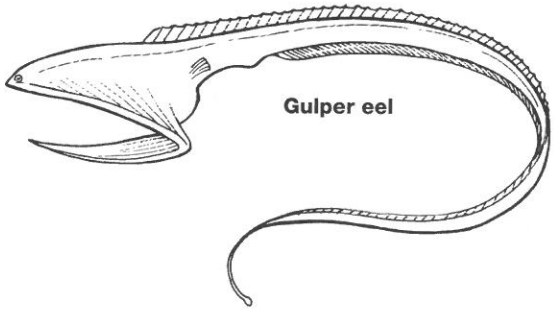
Study the diagrams of some fish from the ocean depths.

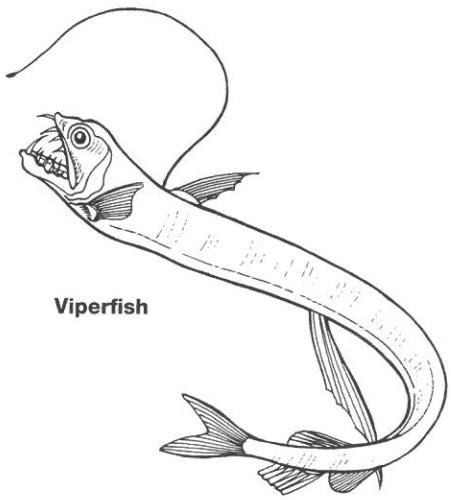












9.2

1 The animals are all predators, but they live in places that are completely dark. To be able to see, some of these animals make their own light in a process called 'bioluminescence'. Some animals also have lures, which are parts they wave about. The lures can make light and so glow in the dark. Study the diagrams and **name** three fish that you think have a lure. **Describe** how the lure may be an adaptation.

2 The tripodfish stands on the bottom of the ocean on three stiff fins and waits for its prey to bump into it. It has tiny eyes and poor vision. **Explain** how its behaviour can be considered an adaptation.

3 The tripodfish lives a solitary life a long way apart from others of its kind. It has both male and female parts on the one animal, so it can fertilise its own eggs. **Explain** how this method of reproduction may be an adaptation.

4 The hatchetfish is a predator that has excellent vision. Its eyes face forwards, just like ours, so it can judge distances quite well. It is preyed upon by many predators as it is a small fish about 8 cm long. Cells on its belly can make blue light. This colour light matches the faint blue glow from areas where some light comes through the water. **Explain** how producing the blue light may be an adaptation.

5 The gulper eel has a huge mouth. It normally eats small, slow prey such as prawns and small fish. It can unhinge its jaw to make its mouth open extremely wide, and it can eat a fish as large as itself. **Explain** how its jaw may be an adaptation.

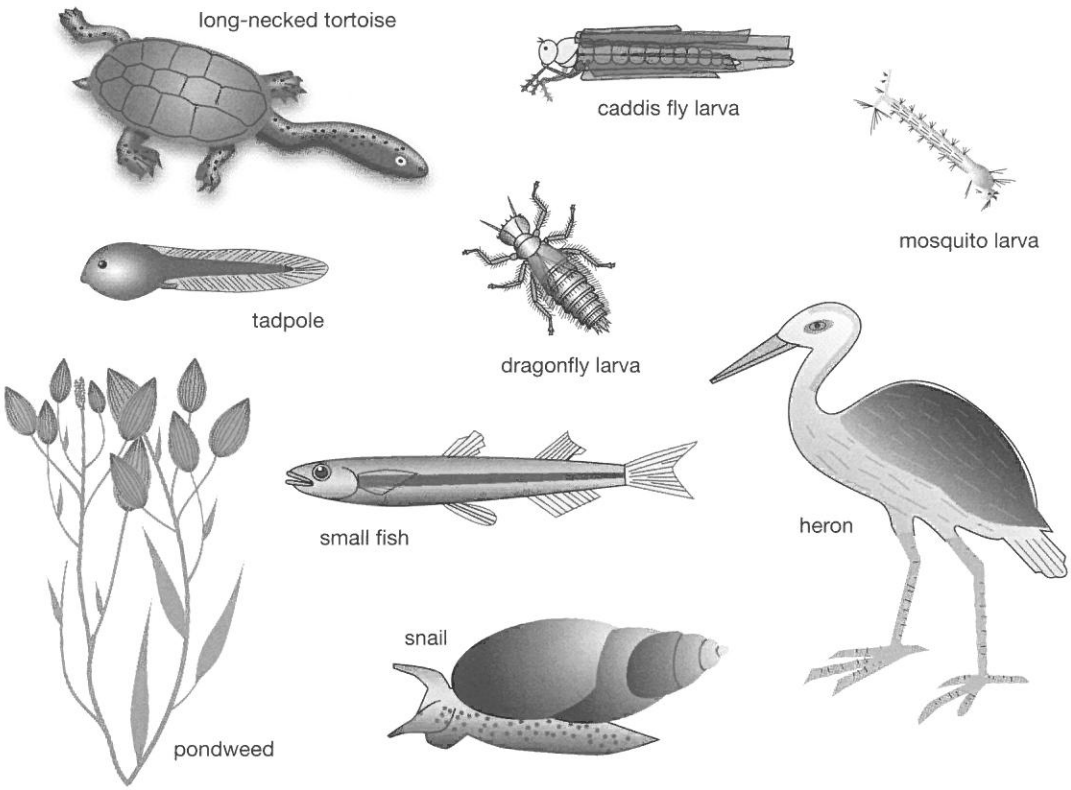
6 Many of the fish in this environment have extremely long and sharp teeth. **Explain** how the teeth may be an adaptation.

9.3 Food webs

Science understanding

Logical/mathematical Visual/spatial

1 **Use** the table and diagrams to help you create a food web. Write the names of the organisms and connect them with arrows to show the direction in which food and energy passes. **Use** the space on page 118 to draw your food web.



Organism	Food
Long-necked tortoise	Snails, mosquito larvae, dragonfly larvae, tadpoles, caddis fly larvae, small fish
Caddis fly larva	Pondweed
Mosquito larva	Pondweed
Tadpole	Pondweed
Dragonfly larva	Caddis-fly larvae
Small fish	Dragonfly larvae, mosquito larvae
Heron	Small fish, tadpoles
Snail	Pondweed
Pondweed	Photosynthesis

9.3

1 **Construct** your food web here.

2 **Explain** where and how energy enters this food web.

3 Choose any organism in the web and **explain** how the non-living surroundings may affect the organism in its environment.

4 From the web, **draw** one food chain with five levels in it and another with three levels.

5 Choose one of your food chains from question 4. **Describe** what happens to the amount of energy in the food materials passing along the chain.

6 **Draw** the approximate shape of a pyramid of biomass for any three-level food chain in the food web. (No actual masses are needed.)

9.4 Counting kangaroos

Science as a human endeavour

Visual/spatial **Logical/mathematical**

Ecologists want to know how events such as fires, floods and drought affect kangaroo populations in natural ecosystems. They also want to know whether hunting is having serious effects on the kangaroo populations. To manage kangaroos in a sustainable way, scientists have to be able to estimate how many there are in a particular area. They also need to know how much food and water is available and how that is affected by the weather. This information can help ecologists to predict kangaroo numbers in the future.

In Australia, kangaroos are counted from the air. Fixed-wing aircraft (planes) and helicopters are used. For this technique to be scientifically valid, the same standard procedure has to be used every time.

The survey

The technique used is a 'strip transect', as shown in Figure 9.4.1. Using a fixed-wing plane, the aircraft flies in a straight line at a particular speed (185 km/h) and height above the ground (76 m). Two observers are used, one viewing from each side of the plane. The observers count the kangaroos they see that fall in a strip that is marked by rods or streamers attached to the wing. This strip will be 200 m wide on the ground, as long as the plane maintains its height. The observers count in sets of 97 seconds. This time must be exact, so that the area that has been counted is equal to 1 square kilometre.

With the number of kangaroos counted in many of these strips, the density can be estimated for a much larger area. Density means the number in a particular area, for example 20 kangaroos/km^2. There is no way that all the kangaroos could be directly counted in large areas of thousands of square kilometres. So an estimate is made using density figures.

The following will help you understand how to calculate a population size.

Imagine that the figures obtained from many strip transects in an area gave an average of 20 kangaroos per square kilometre (20 kangaroos/km^2). If this is a reasonable estimate of kangaroos in an area of 1000 square kilometres, then the population estimate would be:

20 kangaroos/km^2 × 1000 km^2 = 20 000 kangaroos.

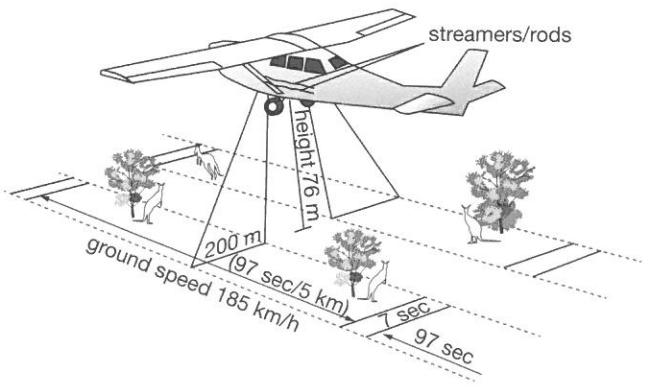


Figure 9.4.1 Using a strip transect to count kangaroos from a fixed-wing aircraft

9.4

1 **Explain** why ecologists count the number of kangaroos in an area.

2 **List** two things that ecologists need to know so that kangaroos can be hunted in a sustainable way.

3 **Propose** why unlimited hunting of kangaroos is not allowed.

4 **Explain** how weather patterns in a region help ecologists to predict kangaroo numbers over the next few years.

5 **Explain** why the fixed wing plane must fly at an exact speed and height, and the count must be for exactly 97 seconds.

6 If the density of kangaroos is 60 per square kilometre and the total area is 200 square kilometres, **calculate** the population size of kangaroos.

9.5 Recovery plans for endangered species

Science as a human endeavour

Verbal/linguistic

The Australian government and state and territory governments have laws that protect endangered species. The Australian government requires a document called a recovery plan for each species that is recognised as endangered. In the states and territories, there are similar laws about recovery plans for endangered species. A recovery plan for a species is a document that:

- describes the current conservation status
- summarises current biological and ecological knowledge of the species
- gives details of past and current management actions undertaken
- details a program for the next 5 years to help the recovery of the species.

To better understand how recovery plans work, let us look at the New South Wales government recovery plan for the Wollemi pine. The Wollemi pine is of international importance because its ancestors date back to the time of the dinosaurs. Figure 9.5.1 shows a Wollemi pine. The discovery of the Wollemi pine was a surprise because trees like the Wollemi pine had been thought extinct. But about 100 adult trees and about 300 young trees were found in one spot in the Blue Mountains north-west of Sydney. No other populations of the species have been discovered even after intensive searches. Consequently, the New South Wales government acted fast to try to save the species. A fire in the area could have wiped out the entire world population. The Wollemi recovery plan has six objectives:

Figure 9.5.1 The Wollemi pine

1 To ensure long-term protection against processes that threaten the wild plants and their habitat
2 To understand the biology of the Wollemi pine in its environment (its ecology) to make informed decisions to protect it
3 To breed more of the species in other places to assist in its long-term survival
4 To educate the public about the plant and its fragile environment
5 To support commercial production of Wollemi pines for sale
6 To coordinate the recovery of the Wollemi pine.

9.5

1 Objective 5 recommended commercial production of Wollemi pines. The decision was made to propagate as many plants as possible and sell them to nurseries throughout Australia. **Propose** how this may help to protect the wild population.

2 Consider Objective 3. **Propose** how this could be of benefit to the conservation of the species.

3 **Justify** why knowing the ecology of the Wollemi pine (or any species) is essential to its recovery.

4 The recovery plan (Objective 5) considers the commercial value of the Wollemi pine. For example, does it contain useful chemicals? **Justify** the inclusion of this objective in the recovery plan.

5 Wollemi National Park has been established in the area around the Wollemi pine population. Only a few researchers are allowed into the area where the trees are found. Aircraft are forbidden from flying overhead. **Justify** why these rules are included in the recovery plan.

6 **Discuss** economic benefits from conserving the Wollemi pine.

7 Maintaining the ban on visiting the Wollemi pine in the park is costly. **Propose** why a state government would be willing to spend this money.

8 **Justify** the protection of species such as the Wollemi pine.

9.6 Biotic and abiotic factors

Science understanding

Verbal/linguistic

1 Complete the following table that shows some physical factors in an ecosystem. **Explain** at least one way each factor can affect living organisms.

Physical factor (abiotic factor)	One way in which this factor can affect living organisms
Water	
Temperature	
Fire	
Light	
Soil minerals	
Gas level	

Table 9.6.1 Effects of abiotic factors on living organisms

2 Complete the following table. **Describe** the meaning, or **recall** an example of each of the biotic factors listed.

Biotic factor	Meaning/definition	Example
Competition		Baby birds in the nest trying to get food from the parent
Predation	One organism (predator) killing and eating another (prey)	
Mutualism		The flagellates in termite guts
Commensalism	Organisms living together where one benefits and the other is unharmed	
Parasitism		Tapeworm and human
Decomposers		Fungus decaying a dead tree

Table 9.6.2 Meanings of biotic factors

9.7 Dung beetles

Science inquiry

Logical/mathematical Verbal/linguistic

Dung beetles are insects whose young eat animal dung (faeces). There are many different species. The adult beetles bury the dung under the soil and lay their eggs in it. This removes dung from the soil surface and takes away a food source for bushflies. Bushflies also lay their eggs in animal dung. Bushflies cause disease in farm animals such as sheep. Dung beetles are widely used throughout Australia as biological control agents for bushflies. You can see some dung beetles in Figure 9.7.1 rolling some dung.

Figure 9.7.1

Some agricultural scientists thought that there may be another benefit of dung beetles. The scientists proposed that the beetles could be making the soil more fertile when they buried the dung. They knew that plant nutrients such as nitrogen are found in animal dung. The scientists predicted that these nutrients could make the soil better for growing pasture plants that feed farm animals. The scientists conducted an experiment in a cattle paddock in Merton, Victoria, to test their proposition (hypothesis).

The experiment used a grid of 54 rectangular 'plots' about 50 cm by 50 cm in a paddock for cattle grazing. Each plot had three replicates and was covered by a metal mesh cage. You can see them in Figure 9.7.2.

Each plot was given one of three treatments: 'dung and beetles', 'dung only' or 'control' (no dung or beetles). There were 54 plots in total, 18 for each treatment.

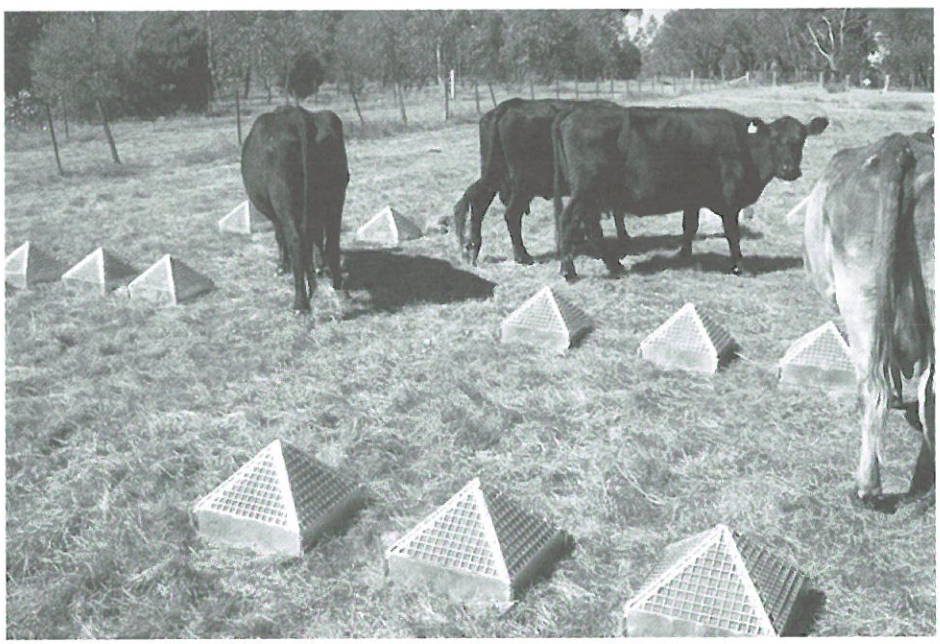


Figure 9.7.2

Early results

The experiment is still continuing, but some results have been found. The pasture plants in each of the 54 plots were cut off at ground level and placed in bags. The plants were then dried and weighed. The data collected is shown in the table.

Treatment	Average dry weight per plot (g)
Control	90.96
Dung	122.95
Dung and beetles	148.24

1 **State** the proposition (hypothesis) that the scientists were testing in their experiment.

2 **Identify** the two experimental variables tested in this experiment.

3 **Explain** the use of the control plots in this experiment.

4 **Explain** what is meant by a *replicate*.

5 **State** how many replicates were used in this experiment.

6 **Evaluate** whether the results support the scientists' proposition (hypothesis).

7 **Explain** two uses of dung beetles.

9.8 Literacy review

Science understanding

Verbal/linguistic

1 **Recall** ecosystems by rearranging the jumbled letters to find a science word that matches the clue.

Jumbled word	Clue	Answer
locoegy	Study of how organisms interact with each other and with their environment	
sycomeets	Place where the organisms and their physical surroundings form a balanced environment that is different from others nearby	
odatpainat	Any feature that helps an organism survive and reproduce in its environment	
diboyistrive	The range of different species in a community	
iconventsoar	Managing and protecting ecosystems so they continue to exist	
insulateabs	To be able to continue to function on its own	
propcongiver	Killing more animals than the population can replace by its normal breeding cycle	
yospintheshots	Introduces energy into food webs	
editurndoc	Species brought to Australia from other countries	

2 **Identify** the definition in Column 1 with the correct term in Column 2 by drawing a line between them.

Column 1		Column 2
Organisms trying to use the same resource		Abiotic factor
A feature of an organism's habits, actions or way of life that helps it survive		Environment
All the factors in an organism's surroundings that affect it		Behavioural adaptation
Where one organism benefits and the other is unharmed		Ecological footprint
Non-living factors		Interdependence
To cause damage to the place that an organism depends on for survival		Commensalism
The area of land and water required to supply the resources needed for survival and to cope with the wastes produced		Competition
Organisms that break down dead bodies and wastes and recycle material		Habitat destruction
Where organisms affect each other's survival		Decomposers

10.1 Rebuilding Gondwana

Science as a human endeavour

Visual/spatial

Alfred Wegener's theory of continental drift was based on two main observations.

- Some continents seemed to fit together a bit like a jigsaw.
- Fossils of the same species were found in countries that were a long way apart.

Wegener could see no way the organisms could cross the oceans to reach all these places. He joined the continents up so that each species occurred in one continuous strip across the land. That made sense because species live in a particular home range rather than scattered widely in separated places.

In this activity, you will try a simplified version of how Wegener joined the countries together. In Figure 10.1.1 you can see the shapes of modern-day land masses of the different continents and islands that Wegener thought belonged together in one large land mass, called Gondwana. The different shadings show the distribution of the fossils of four species that lived at the same time. Wegener thought these four fossil species must have lived in the time the land masses were joined together.

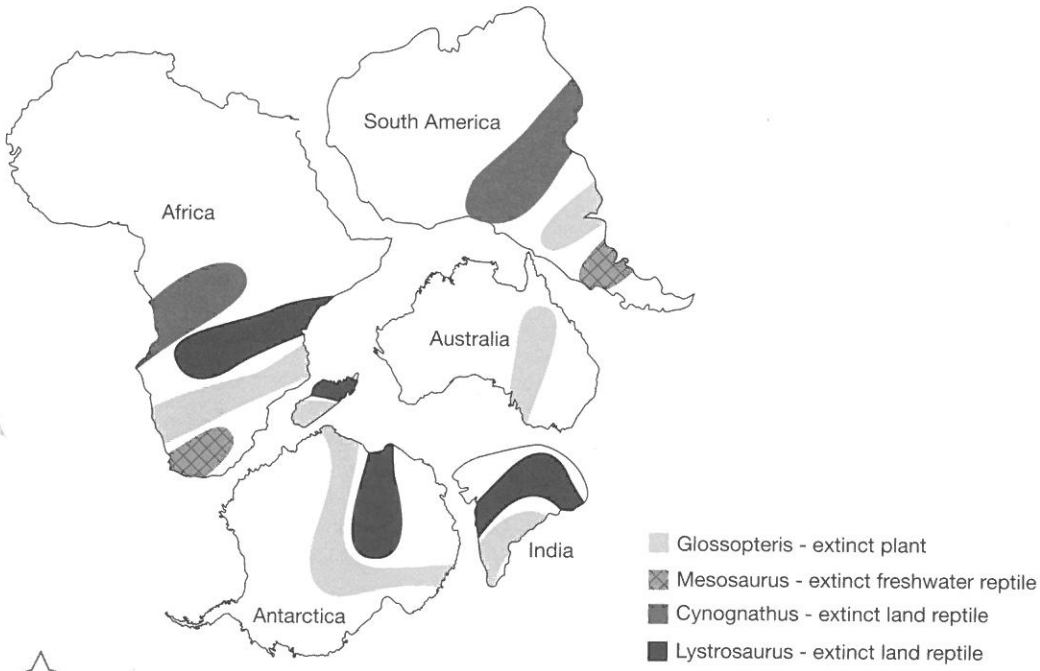


Figure 10.1.1

1a Cut out the land masses on this page.

b Rearrange the land masses into one large land mass.

c Glue the one large land mass in the space on page 129.

Glue your Gondwana land mass here.

2 **Describe** how the shapes of the land masses and the fossil distribution helped you create your Gondwana land mass.

3 **Explain** why Wegener thought that the land masses of today (continents) were joined together in the past.

4 Based on your findings in this activity, **justify** Wegener's theory.

5 **Evaluate** the importance of Wegener's contribution to science.

10.2 Magnetic evidence

Science inquiry, Science understanding

Logical/mathematical **Verbal/linguistic**

Earth has a magnetic field around it (see Figure 10.2.1). Scientists have concluded that this field is likely due to the flow of iron and nickel in the liquid (containing iron and nickel) part of the Earth's core. As the liquid moves, it creates the magnetic field around it.

Geophysicists have studied rocks of different ages from around the Earth that contain magnetite particles. These are like tiny magnets that are trapped in the rock. These magnetic particles would normally point in one direction—the north. Studies of these rocks have shown that at times, in rocks of particular ages, the magnetite particles were pointing in the opposite direction. From this, scientists realised that the Earth's magnetic field has reversed its orientation many times. A compass in this reversed field would point the opposite way.

Geophysicists have used radioactive dating methods and the magnetic records in the rocks to construct a time strip. This time strip shows when the rocks had normal or reversed magnetism (polarity). A small part of the time strip, called the *Geomagnetic Polarity Timescale (GPTS)*, is shown in Figure 10.2.2. The dates on the left are in millions of years ago (Ma). *Chron* refers to a major time period, while *subchron* is a subsection of the major time period. The dates on the subchron side are in millions of years. The time scale was constructed using information from rocks of the ocean floor and from land.

The magnetic field is becoming weaker at a rate that will probably cause it to begin to reverse in about 1000–2000 years from now. Some scientists have proposed that this reduced magnetic field strength will expose the Earth to more dangerous cosmic radiation and could lead to extinction of some species. However, other early human ancestors must have survived previous reversals because the last one was 780 000 years ago.

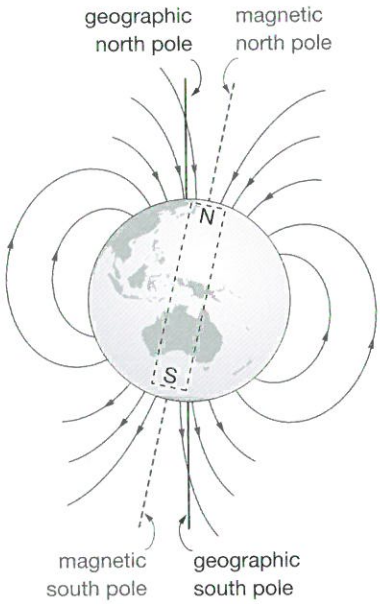


Figure 10.2.1 The Earth's magnetic field

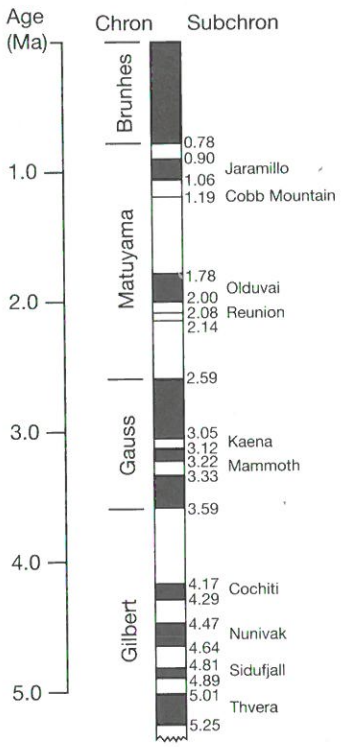


Figure 10.2.2 The GPTS strip for the past 5 million years. The dark areas are normal polarity and the white areas are reversed polarity. The names identify the places where the rocks were found that were used to measure the magnetic field direction.

The Earth's magnetic north at present is shifting from northern Canada towards Siberia. It is currently moving at about 40 km/year, four times faster than it was doing at the start of the 20th century.

1 **Explain** the likely reason for the Earth having a magnetic field.

2 **Explain** the importance of magnetite particles to the discovery of the reversal of the Earth's magnetic field.

3 **Describe** how the GPTS scale was created.

4 Use the GPTS strip to **deduce** how many times the Earth's magnetic field has reversed in the past 5 million years.

5 *Homo erectus* (or *Homo ergaster*), an early member of the human family, is known from fossils that date back to Africa about 1.9 million years ago. The youngest fossils of this species date back to about 70 000 years ago. **Deduce** how many times the magnetic field changed while *Homo erectus* existed.

10.5

1 **Define** a *tsunami.*

2 **State** the cause of the tsunami of 26 December 2004.

3 **Define** *epicentre.*

4 **Identify** the type of plate boundary that exists between the Indo-Australian Plate and the Sunda Plate.

5 **State** how far the Indo-Australian Plate and the Sunda Plate moved during the earthquake.

6 **State** the speed of a tsunami in deep water.

7 **Explain** what effects shallow water has on a tsunami.

8 **Discuss** some warning signs that a tsunami could be approaching a beach.

10.6 Structure of the Earth

Science as a human endeavour

Verbal/linguistic Visual/spatial

Refer to the Science as a Human Endeavour on page 337 of your student book to answer the following questions.

1 **Describe** what seismologists study.

2 **Name** the instruments used by seismologists.

3 **State** what the study of S-waves and P-waves by seismologists has helped them to discover about the Earth.

4 **Explain** the observations that led seismologists to propose that the centre of the Earth was made of a liquid outer core.

5 **Explain** the observations that led seismologists to propose that the Earth had a solid inner core.

6 **Describe** how mineralogists have contributed to our knowledge of the structure of the Earth.

7 **Explain** how geologists searching for minerals and petroleum have contributed to our knowledge of the Earth's structure.

10.7 Literacy review

Science understanding

Verbal/linguistic

1 Rearrange the jumbled word letters to **identify** a science word that matches each clue.

Jumbled word	Clue	Answer
nothersheepas	A layer of 'plastic' semi-solid rock in the upper mantle	
fingirt	Process of continents breaking up, subsiding and allowing the sea in	
docunubits	Areas where the crust is sinking down into the Earth	
sotopmice	Volcano that may explode with great force due to the magma being very thick and containing a lot of gas	
gongnervoc	Boundary where plates are colliding	
toh stop	Isolated places away from plate boundaries where a lot of hot magma is being created	
recipeten	The point on the Earth's surface directly above the focus	
ucofs	The place where the quake starts below ground	
teemissomer	An instrument for detecting the seismic waves from an earthquake	
nusmati	A huge wave in the ocean caused by an undersea earthquake	

2 **Recall** the word that matches each clue.

Clue	Word
When continents separate and drift across the oceans	c _ _ t _ _ _ n _ _ l d _ _ f _
Theory that the Earth's crust is cracked into many large pieces that move on the asthenosphere	p _ _ t _ t _ _ t _ _ _ c _
New crust being formed at the ocean ridges and spreading outwards	s _ _ f _ _ _ r s _ r _ _ d _ _ g
The crust forming the continents	_ o _ _ i _ _ n t _ _
Chain of islands formed at the edges of colliding tectonic plates where one plate subducts	i _ _ _ _ d _ r _
Longitudinal seismic waves that travel fast through the Earth	p _ _ m _ _ y waves
The shaking, wavelike movement of the ground in an earthquake	s _ _ _ m _ c w _ _ e
Transverse seismic waves that travel through the Earth	s _ _ _ _ d _ _ y waves