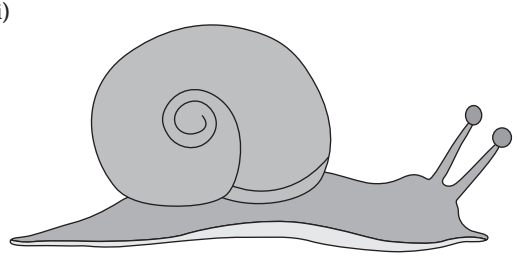
A1 Classification

1. a) i) Number of legs
Presence or absence of visible wings or number of visible wings **(2)**

ii) Number of legs:
6 legs: A, B, E and G
8 legs: D and F
Many legs: C and H
Or
Presence or absence of wings:
Visible wings present: A, E and G
Visible wings absent: B, C, D, F and H
Or
Number of visible wings:
No visible wings: B, C, D, F and H
2 visible wings: E
4 visible wings: A and G **(2)**

iii)



(2)

b) P: Kingdom: Protoctista
Characteristic: Unicellular organisms whose cells have a true nucleus surrounded by a membrane.

Q: Kingdom: Fungus
Characteristic: Multicellular organisms with a body composed of microscopic threads called hyphae.

R: Kingdom: Prokaryotae
Characteristic: Unicellular organisms whose cells lack a true nucleus; the DNA is free in the cells. **(6)**

c) i) A reptile has a dry, waterproof skin with scales. An amphibian has a moist, non-waterproof skin without scales. **(2)**

ii) The leaves of a monocotyledon are long and narrow with parallel veins. The leaves of a dicotyledon are broad and have a network of veins. **(2)**

iii) An insect has six legs. An arachnid has eight legs. **(2)**

d) A species is a group of organisms of common ancestry that closely resemble each other and are normally capable of interbreeding to produce fertile offspring. **(1)**

A2 Ecology

1. a) i) Ecology is the study of the relationships of living organisms to each other and to their environment. **(1)**

ii) The environment is composed of the factors which surround and act on an organism. **(1)**

iii) Abiotic factors are the non-living factors in the environment. Biotic factors are the living organisms in the environment. **(2)**

b) i) An organism's habitat is the place where the organism lives. An organism's niche is the position or role of the organism within its habitat. **(2)**

ii) A population is a group of organisms, all of the same species, living together in a particular habitat. A community is all the populations of different species living together in a particular habitat. **(2)**

c) i) An ecosystem is a community of living organisms interacting with each other and with their abiotic environment. **(1)**

ii) *Any one of the following:*
A forest
A coral reef
A mangrove swamp
A pond
A grassland
A woodland
Or other suitable example **(1)**

d) i) 1. A line transect
2. A belt transect **(2)**

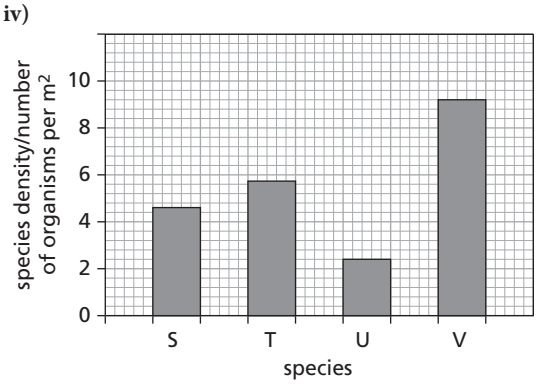
ii) The students placed the quadrat ten times at random within the area of scrubland and counted the number of organisms of each of the four plant species within the boundary of its sides.

iii)

Species	Species density/ number of organisms per m^2	Species frequency/%
S	4.6	90
T	5.8	50
U	2.4	80
V	9.2	100

(5)

iv)



(3)

v) T appears to be unevenly distributed with many organisms in some areas and none in other areas, whereas the other species are fairly evenly distributed throughout the area of scrubland. **(2)**

d) Size of the snail population
$= \frac{15 \times 18}{5} = 54$ individuals **(2)**

2. a) i) Soil is a complex mixture of inorganic rock particles, water, air, mineral salts, organic matter and living organisms. **(2)**

ii) Water: Water is essential for plants to carry out photosynthesis, it is needed to dissolve mineral salts so they can be absorbed by plant roots and it prevents desiccation of soil organisms that do not have waterproof body coverings. **(3)**

Air: Oxygen in the air is essential for plant roots and soil organisms to respire aerobically and for bacteria and fungi to decompose organic matter to form humus. Nitrogen in the air is necessary for nitrogen-fixing bacteria to form inorganic nitrogenous compounds. **(3)**

iii) Luke dried the two soil samples and put the same mass of each in two filter funnels lined with filter paper. He rested the funnels in two 50 cm^3 measuring cylinders and poured 50 cm^3 of water into each. He measured the volume of water which drained through each and subtracted this from 50 cm^3 to get the volume retained. **(3)**

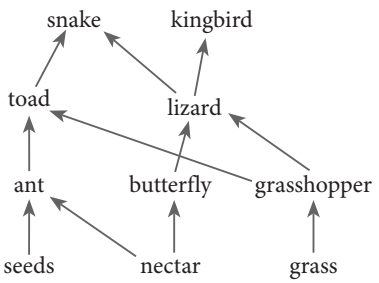
b) i) 1. Light intensity controls the rate of photosynthesis in plants.
2. Light synchronises the activities of plants and animals with the seasons. **(2)**

ii) 1. Temperature affects the rate of photosynthesis and germination in plants.
2. Temperature affects the activity of animals. **(2)**

c) 1. Salinity
2. Water movement, currents or wave action
3. Dissolved oxygen levels **(3)**

A3 Interrelationships between living organisms

1. a)



(3)

b) i) Herbivores: ant, butterfly, grasshopper **(1)**

ii) Secondary consumers: toad, lizard **(1)**

c) i) *Any one of the following:*
Toad and ant
Toad and grasshopper
Lizard and butterfly
Lizard and grasshopper
Snake and toad
Snake and lizard
Kingbird and lizard **(1)**

ii) *Any three of the following:*
Be able to move quickly
Be able to move with stealth
Be able to camouflage itself
Have highly developed senses
Have sharp, piercing mouthparts
Produce poison to kill its prey **(3)**

iii) It keeps the number of organisms in an ecosystem relatively constant. **(1)**

d) *Any two of the following:*
The kingbird population would decrease in number.
The grasshopper population would increase in number.
The butterfly population would increase in number. **(2)**

2. a) i)

Name of trophic level	Organisms found at trophic level
	shrimp, zooplankton, mussel
secondary consumer	crab, jellyfish, starfish
tertiary consumer	
quaternary consumer	tiger shark

(6)

ii) A primary producer or a green plant **(1)**

iii) The primary producer absorbs sunlight energy and incorporates it into organic food that it produces in photosynthesis. The food is then passed on to consumers through the food web. **(2)**

b) *Any two of the following:*
They both begin with at least one primary producer.
They both have at least one primary consumer.
They both have at least one secondary consumer.
They both usually have at least one tertiary consumer.
The number of organisms at each trophic level decreases up the food web.
The biomass at each trophic level decreases up the food web.
The energy at each trophic level decreases up the food web. **(2)**

c) *Any two of the following:*
The amount of space available
The prevalence of disease
The number of predators present **(2)**

d) i) Decomposers are micro-organisms that feed saprophytically on dead and waste organic matter, causing it to decompose. **(2)**

ii) 1. Bacteria
2. Fungi **(2)**

iii) Decomposers are essential to recycle chemical elements in ecosystems because they break down complex organic compounds into simple organic compounds and, at the same time, they release carbon dioxide and inorganic mineral ions into the environment. **(2)**

3. a) i) Any close relationship between two organisms of different species **(1)**

ii) In parasitism one organism, the parasite, gains benefit and the other organism, the host, is harmed. In commensalism one organism, the commensal, gains benefit and the other organism neither gains nor is harmed. In mutualism, both organisms gain benefit and they often cannot survive without each other. **(3)**

b) i) The tapeworm gains digested food, shelter and protection in the intestines. The infected person may suffer from loss of appetite, abdominal pains, loss of weight and nausea. **(2)**

ii) Ticks gain food by sucking the blood of the cow. The cow may suffer from damage to its hide, weakness, anaemia and tick paralysis. **(2)**

c) i) Mutualism **(1)**

ii) Nitrogen-fixing bacteria **(1)**

iii) Nitrogen-fixing bacteria live in the root nodules. The bacteria gain protection and food produced in photosynthesis from the plant. The bacteria use nitrogen in the soil to produce inorganic nitrogenous compounds, which the plant gains and uses to manufacture proteins. **(3)**

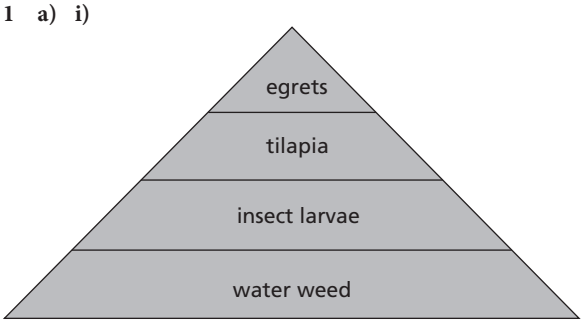
d) Green algae **(1)**

e) i) 1. The epiphyte gains support.
2. The epiphyte is closer to the sunlight for photosynthesis.
3. The epiphyte is out of the reach of herbivores living on the ground. **(3)**

ii) Commensalism **(1)**

A4 Energy flow in food webs

1 a) i)



(4)

ii) 1. Chemical energy and heat energy is lost in any organic matter present in faeces.
2. Energy is lost in organic excretory products.
3. Energy is released in respiration and then used by the organism. **(3)**

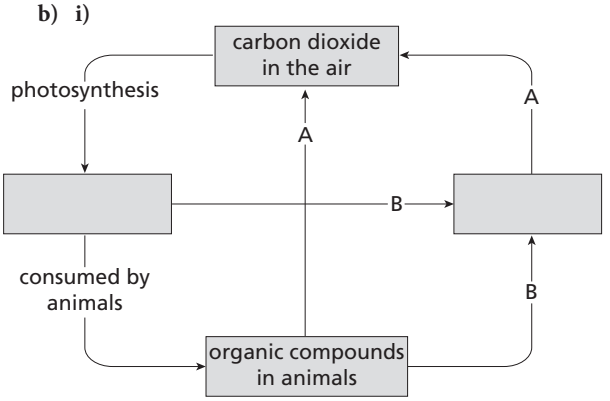
iii) 10 kJ **(1)**

b) They rarely contain more than four trophic levels because energy and biomass are lost at each successive level in the food chain. **(2)**

A5 Cycling and recycling materials

1. a) 1. So that plants have a constant supply of water for photosynthesis
2. So that all living organisms have a constant supply of water to keep their cells hydrated
3. So that aquatic organisms have a constant environment in which to live **(3)**

b) i)



(2)

ii) **A:** Respiration
B: Death and decomposition **(2)**

iii) 1. Saprophytic bacteria
2. Saprophytic fungi **(2)**

iv) *Any three of the following:*
Oxygen
Nitrogen
Hydrogen
Phosphorus
Sulfur
Calcium **(3)**

c) i) *Any three of the following:*
Recycling conserves natural resources because it reduces the quantity of raw materials that are used in manufacturing.

Recycling reduces the use of energy.

Recycling prevents the wastage of materials that are potentially useful.

Recycling reduces the amount of waste that has to be disposed of.

Recycling reduces pollution. **(3)**

ii) Difference: Biodegradable materials can be broken down by the action of micro-organisms. Non-biodegradable materials cannot be broken down by the action of micro-organisms.

Example of a biodegradable manufactured material:
Paper
Example of a non-biodegradable manufactured material
Any one of the following:
Plastic
Glass
Metal **(4)**

iii) *Any three of the following:*
Persuading households and industries to separate their waste into different types can be difficult.

Collecting, transporting and storing waste items that are separated into different types is difficult.

Cleaning and sorting items into their different types is time consuming.

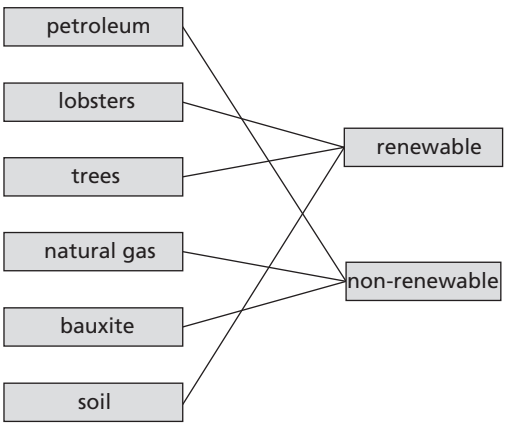
Separating recyclable materials from any toxic materials can be hazardous.

Recycling is labour and energy intensive, which can be uneconomical. **(3)**

A6 Human impact on the environment

1. a) i) Non-renewable resources are present in the Earth in finite amounts and they cannot be replaced. Renewable resources can be replaced by natural processes. **(2)**

ii)



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b) *Any three of the following:*
The destruction of plants and animals living in forests, some of which may become extinct
The loss of a habitat for plants and animals living in forests
A gradual increase in the percentage of carbon dioxide in the atmosphere
Disruption of the water cycle
Soil erosion **(3)**

c) i) Supplies of petroleum will eventually run out. **(1)**
ii) Elephants will eventually become extinct. **(1)**

2. a) i) Pollution is the contamination of the natural environment by the release of unpleasant and harmful substances. **(1)**
ii) Global warming **(1)**
iii) *Any three of the following:*
Pollutant: Sulfur dioxide
Harmful effect: *Any one of the following:*
Causes respiratory problems
Reduces the growth of plants
Forms acid rain, which damages plants and harms animals
Forms smog, which causes respiratory problems

Pollutant: Oxides of nitrogen
Harmful effect: *Any one of the following:*
Cause lung damage
Irritate the skin, eyes and respiratory system
Reduce the growth of plants
Form acid rain, which damages plants and harms animals

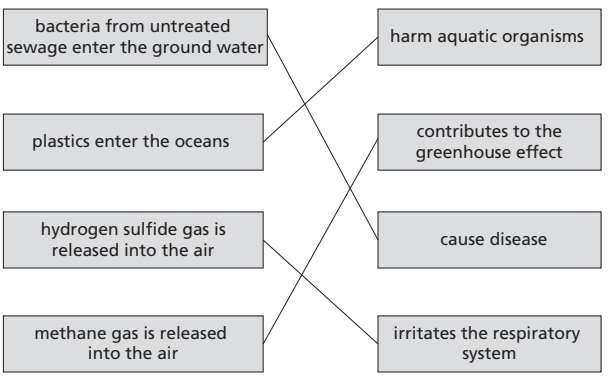
Pollutant: Carbon monoxide
Harmful effect: *Any one of the following:*
Reduces mental awareness
Causes visual impairment
Causes dizziness
Causes headaches

Pollutant: Carbon particles or smoke
Harmful effect: *Any one of the following:*
Covers leaves of plants, which reduces photosynthesis
Forms smog, which causes respiratory problems

Pollutant: Heavy metal ions
Harmful effect: *Any one of the following:*
Cause damage to many body tissues and organs
Concentrate up food chains, harming the top consumers **(6)**

b) i) Fertilisers are added to the soil to provide one or more mineral ions necessary for healthy plant growth. Pesticides are used to control pests. **(2)**
ii) Eutrophication **(1)**
iii) Algae in the lake had grown rapidly by building proteins using nitrate and phosphate ions present in the chemical fertilisers, which had washed off the land into the lake. **(2)**
iv) Plants and algae in the lake will begin to die and be decomposed by aerobic bacteria. These bacteria will use up the dissolved oxygen, leading to the death of other organisms in the lake, e.g. fish. **(2)**

c)

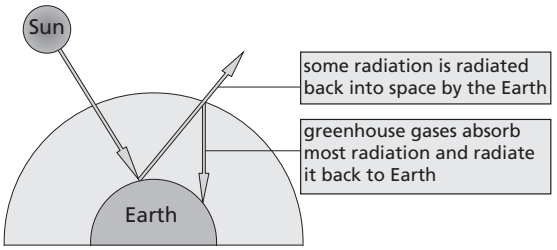


(4)

3. a) i) First photo: coral reef
Second photo: mangrove swamp
Third photo: seagrass bed **(3)**
ii) *Any three of the following:*
The loss of habitats for many organisms
The loss of natural resources such as fish
Increased coastal erosion
The loss of nursery grounds for reef fish

The loss of nesting and breeding grounds for birds
The loss of flood control
The loss of attractions and recreational sites for tourists **(3)**

b) i)



(3)

ii) 1. Burning of fossil fuels
2. Deforestation **(2)**

iii) *Any four of the following:*
Melting of polar ice caps and glaciers
A rise in sea levels
Flooding of low-lying coastal areas
Changes in global weather patterns
More severe weather events and natural disasters
Changes in ecosystems
A rise in sea temperatures resulting in coral bleaching **(4)**

c)

Ways to conserve natural resources	**Ways to reduce pollution**
Any four of the following: replace renewable resources recycle resources reuse materials use materials made from renewable resources use alternative energy sources reduce soil erosion reuse land used in mining and landfills impose closed seasons and restrict catch sizes for over-fished species set up breeding and aquaculture programmes for endangered and over-exploited species. set up nature reserves, national parks and marine sanctuaries legislate to make it illegal to kill endangered species	*Any four of the following:* use alternative, non-polluting energy sources instead of fossil fuels use organic fertilisers use biodegradable pesticides and herbicides or biological control dispose of waste using appropriate methods and methods which produce harmless or useful end products use aerosol propellants and refrigerants which do not contain chlorofluorocarbons clean gaseous emissions from factories before release into the environment

(8)

d) *Any three of the following:*
Use natural pesticides and fertilisers
Use crop rotations, which include legumes and a variety of different crops
Recycle organic matter back onto the soil
Practise soil conservation
Use preventative disease-control methods
Keep a variety of livestock and rotate them around the farm
Feed livestock only on certified organic foods and supplements **(3)**

A7 The growth and survival of populations

1. a) i) **A:** The birth rate was greater than the death rate.
B: The birth rate and the death rate were the same. **(2)**

ii) 1. Predators of the lizards started to increase in number.
2. Food shortages began to occur.
3. Overcrowding started to occur, resulting in competition for space, mates, food and shelter.
4. Diseases started to spread more rapidly. **(4)**

iii) A natural disaster could have occurred or a new predator of the lizard could have been introduced onto the island, causing the death rate to exceed the birth rate. **(2)**

b) i) Stage A **(1)**

ii) 1. Humans have improved their agricultural techniques, which have increased food production.
2. Humans have developed modern medicine, which has reduced death from disease and increased life expectancy.
3. Humans have improved water supplies and sanitation, which have reduced death from disease.
4. Humans have developed a better nutritional understanding, which has improved health and life expectancy. **(4)**

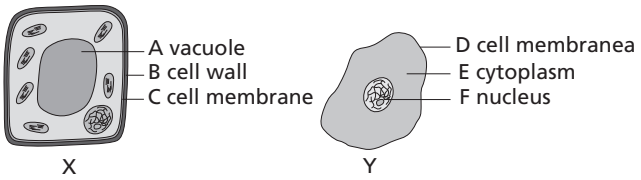
iii) *Any three of the following:*
Harmful substances are building up within the environment. These pollutants, such as sulfur dioxide, are gradually destroying the natural environment.
Both renewable and non-renewable natural resources are being depleted to the point where many will eventually run out, for example coal, oil and natural gas.
Vast areas of forest are being cut down and not replanted, which causes the loss of habitat for other organisms, the disruption of water cycles, soil erosion and a build-up of carbon dioxide in the atmosphere.
The balance of nature is being disrupted by organisms being removed from ecosystems or added into ecosystems where they are not naturally found.
Ecosystems are being destroyed for activities such as mining and construction, which results in the loss of habitat for other organisms and the loss of biodiversity. **(6)**

B1 Cells

1. a) i) Cell X **(1)**

ii) 1. Cell X has a large central vacuole.
2. Cell X has chloroplasts.
3. Cell X has a cell wall. **(3)**

iii)



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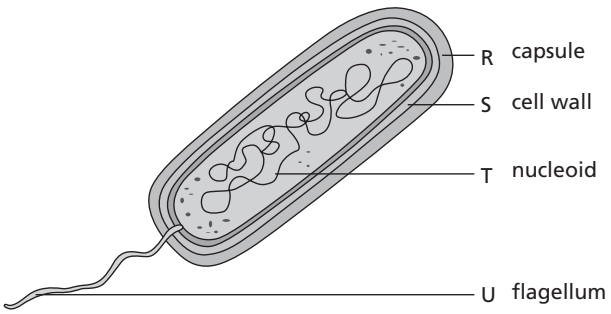
iv) Structure D is differentially permeable. **(1)**

v) 1. Supports the cell when it is turgid
2. May store food or cell waste **(2)**

vi) Red blood cells **(1)**

b)



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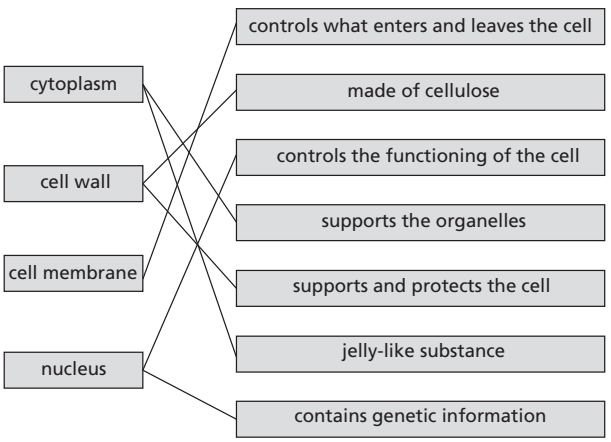
c)



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d) i) **V:** Mitochondrion
W: Chloroplast **(2)**

ii) Respiration occurs in the mitochondria and this produces energy. By having a lot of mitochondria, muscles cells can produce lot of energy so they can contract and bring about movement. **(2)**

iii) Chlorophyll **(1)**

iv) Photosynthesis occurs in the chloroplasts and requires light energy. The upper surface of the leaf is closest to the sunlight, so by having the most chloroplasts the cells can absorb a lot of light energy. **(2)**

2. a) By becoming specialised, cells are able to carry out their specific functions more efficiently than if each one was trying to carry out all essential life processes. **(2)**

b) i) A group of cells that are specialised to carry out a particular function working together **(1)**

ii)

Name of tissue	What the tissue is composed of	One function of the tissue
epithelial tissue		covers and often protects the inner and outer surfaces of the body
	muscle cells	to bring about movement
nerve tissue	nerve cells	

(6)

iii) *Any two of the following:*
Example: blood tissue
Function: a*ny one of the following:*
Transports various substances around the body
Helps fight disease

Example: Adipose or fat tissue
Function: *Any one of the following:*
Insulates the body
Serves as a food reserve
Cushions and protects the body against physical damage

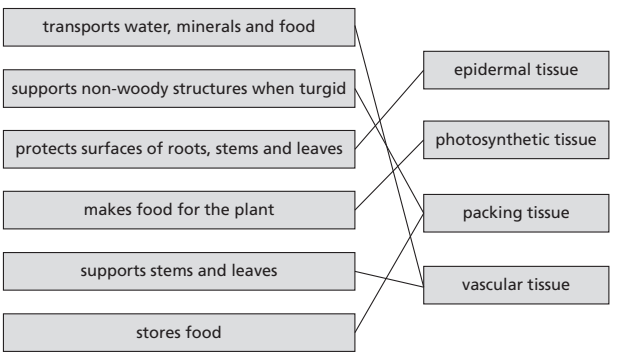
Example: Bone tissue
Function: *Any one of the following:*
Helps to bring about movement
Supports the body

Example: Cartilage tissue
Function: Covers the ends of bones in joints to prevent friction

Example: Areolar tissue
Function: Holds tissues together

Example: Fibrous tissue
Function: *Any one of the following:*
Forms ligaments, which hold bones together at joints
Forms tendons, which attach muscles to bones **(6)**

iv)



(6)

c) Different tissues are grouped together to form specialised **organs**. These specialised **organs** then work together to form **organ systems**, which all work together to form a **multicellular organism**. **(5)**

3. a) i) Diffusion is the net movement of particles from an area of higher concentration to an area of lower concentration until the particles are evenly distributed. **(1)**

ii) *Any four of the following:*
Oxygen for aerobic respiration moves into organisms and into cells by diffusion.
Carbon dioxide, produced in aerobic respiration, moves out of cells and organisms by diffusion.
Carbon dioxide for photosynthesis moves into leaves and plant cells by diffusion.
Oxygen, produced in photosynthesis, moves out of plant cells and leaves by diffusion.
Some glucose and amino acids produced in digestion are absorbed in the ileum by diffusion. **(4)**

b) i) Roots of maize plants require energy produced in aerobic respiration to absorb minerals from the soil. **(2)**

ii) Active transport **(1)**

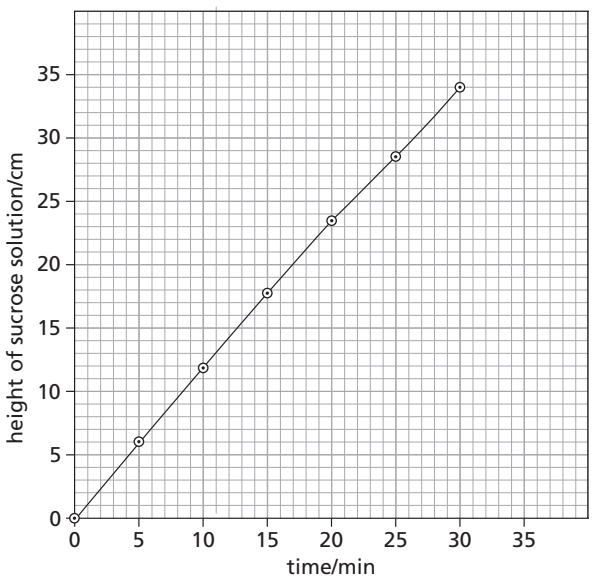
iii) It enables cells to absorb substances against a concentration gradient and therefore accumulate high concentrations of important substances. **(2)**

iv) 1. Sugars produced in photosynthesis move into the phloem in leaves by active transport.
2. Some glucose and amino acids produced in digestion are absorbed in the ileum by active transport.
3. Useful substances are reabsorbed from the filtrate in the kidney tubules by active transport. **(3)**

4. a) i) Osmosis is the movement of water molecules from a dilute solution or pure water to a more concentrated solution through a differentially permeable membrane. **(1)**

ii) *Any two of the following:*
Water moving into plant cells by osmosis keeps them turgid. This causes non-woody stems to stand upright and keeps leaves firm.
Water is kept moving through plants by osmosis occurring in the cells of roots and leaves. This ensures that the leaves get water for photosynthesis.
The size of stomatal pores is regulated by osmosis occurring in the guard cells. This controls how much water is lost from leaves. **(4)**

b) i)



(3)

ii) The differentially permeable membrane had minute pores in it, which only allowed water molecules to pass through, not the sucrose molecules. The water molecules diffused from the water in the beaker where there were more of them, into the sucrose solution through the membrane. This caused the volume of sucrose solution to increase, and this caused it to rise up the capillary tube. **(4)**

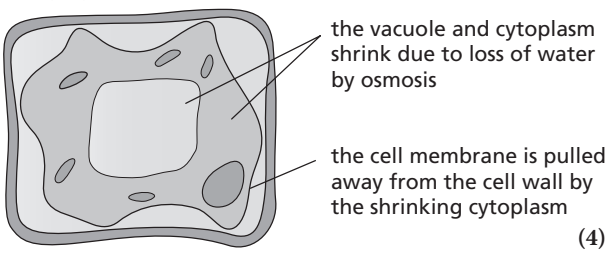
5. a) i) Solution **X**: The solution is more concentrated than the cell sap and cytoplasm of the cells in the potato cylinders.
Solution **Y**: The solution is more dilute than the cell sap and cytoplasm of the cells in the potato cylinders. **(4)**

ii) Solution **X**: Flaccid
Solution **Y**: Turgid **(2)**

iii) The cytoplasm and cell sap of all the potato cells contained more water than solution X, so each cell lost water to solution X by osmosis. This caused the volume of each cell to decrease slightly, which caused the cylinders to decrease in length. **(3)**

iv) Solution Y contained more water than the cytoplasm and cell sap of all the potato cells, so each cell gained water from solution Y by osmosis. This caused each cell to become turgid, which caused the cylinders to become firm and crispy. **(3)**

b) i)



(4)

ii) Plasmolysed **(1)**

B2 Nutrition

1. a) Autotrophic nutrition occurs when organisms use simple inorganic compounds and a source of energy to manufacture complex organic food substances. Heterotrophic nutrition occurs when organisms obtain ready-made organic food from their environment. **(2)**

b) i) Saprophytic nutrition occurs when organisms obtain organic food from the dead remains of other organisms by digesting the complex organic food outside their bodies and then absorbing the simpler organic substances produced. **(2)**

ii) 1. Bacteria
2. Fungi **(2)**

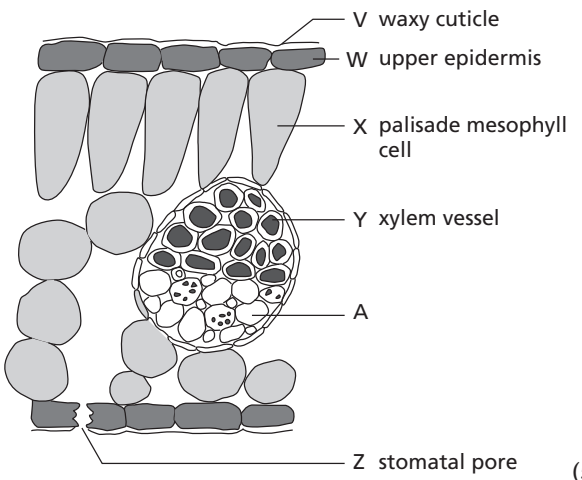
2. a) i) Photosynthesis is the process by which green plants make glucose by combining carbon dioxide and water using sunlight energy absorbed by chlorophyll in chloroplasts. **(1)**

ii) **(5)**

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight energy}} C_6H_{12}O_6 + 6O_2$$

iii) Name of 1st stage: The light stage or light-dependent stage
What happens: Chlorophyll in the chloroplasts absorbs sunlight energy and the energy is used to split water molecules into hydrogen and oxygen. The oxygen is released as a gas.
Name of 2nd stage: The dark stage or light-independent stage
What happens: With the help of enzymes, the hydrogen atoms that were produced in the light stage react with carbon dioxide molecules to form glucose. **(6)**

b) i)



(5)

ii) 1. Phloem sieve tubes
2. Companion cells **(2)**

iii) To transport water and mineral salts to the leaves **(1)**

iv) *Any three of the following:*
The waterproof waxy cuticles on the outside of both the upper and lower epidermis prevent the loss of water needed for photosynthesis.
The stomatal pores which are present throughout the lower epidermis allow carbon dioxide to diffuse into the leaf and oxygen to diffuse out.
The palisade mesophyll cells, which are closest to the sunlight, contain the largest number of chloroplasts to maximise the amount of light energy absorbed.
The spongy mesophyll cells have intercellular air spaces between them, which allow carbon dioxide to diffuse to all the mesophyll cells and oxygen to diffuse away.
The xylem vessels present in the veins running throughout the leaf supply all the mesophyll cells with water and mineral ions. **(6)**

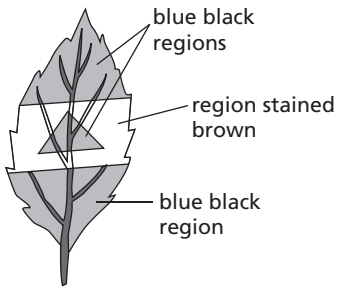
c) 1. They use the glucose in respiration to provide them with energy.
2. They convert the glucose to starch and store it.
3. They convert the glucose to other organic substances such as amino acids and chlorophyll. **(3)**

d) These plants have more chlorophyll than normal, which would be necessary to absorb as much light energy as possible, since the light intensity under trees in forests is very low. **(2)**

3. a) i) Light **(1)**

ii) Iodine solution **(1)**

iii)



(2)

iv) Experiment: The uncovered sections
Control: The covered section **(2)**

b) i) 1. Light intensity
2. Water availability
3. Temperature
4. Concentration of carbon dioxide in the air **(4)**

ii) Light is the limiting factor controlling the rate of photosynthesis, and as the light intensity is increasing the rate of photosynthesis is increasing. **(2)**

iii) Light is no longer the limiting factor and another factor begins to limit the rate of photosynthesis, for example carbon dioxide concentration, temperature or water availability. **(2)**

c)

Element	One function in plants	One symptom of deficiency
nitrogen	*Any one of the following:* to make proteins for plant growth to make chlorophyll	*Any one of the following:* poor growth chlorosis or yellowing of the leaves underdeveloped leaves
magnesium	to make chlorophyll	chlorosis or yellowing of the leaves

(4)

4. a)

Test reagent(s)	Results of test if		
	Jay's suggestion is correct	**Ron's suggestion is correct**	**Ben's suggestion is correct**
Benedict's solution	turns opaque orange	remains blue	remains blue
iodine solution	remains orange-brown	turns blue-black	remains orange-brown
sodium hydroxide and copper sulfate solutions or biuret reagent	remains blue	remains blue	turns purple

(9)

b) i) Enzymes are biological catalysts produced by all living cells. They speed up chemical reactions occurring in cells without themselves being changed. **(1)**

c) i)

pH	Time taken for starch to be broken down/min
	10
	5
	4
	10

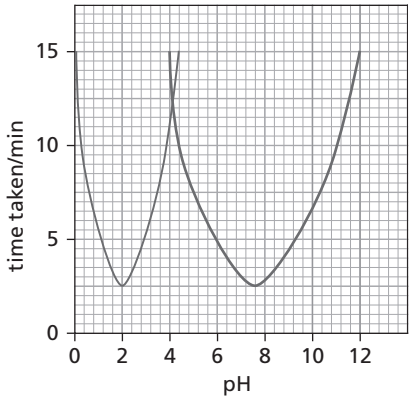
(4)

ii) As pH increases from 4.0 to 7.6 the rate at which amylase breaks down starch increases. As pH increases above pH 7.6 the rate at which amylase breaks down starch decreases. **(2)**

iii) 7.6 **(1)**

iv) Amylase is denatured **(1)**

v)

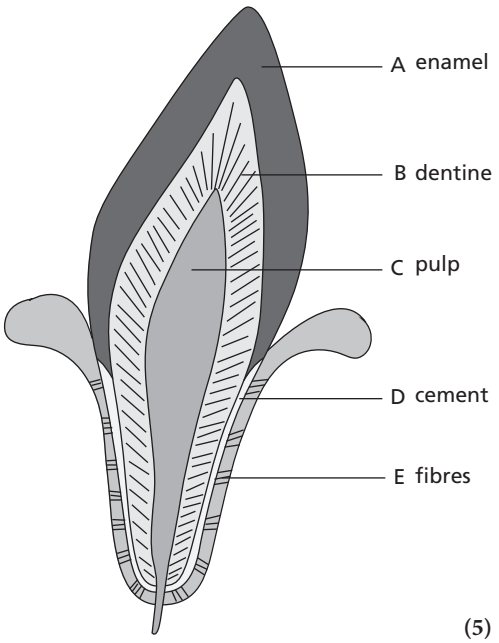


(2)

vi) Temperature **(1)**

5. a) Large, usually insoluble food molecules are broken down into small, soluble food molecules. **(1)**

b) i)



(5)

ii) Nerves and blood vessels **(2)**

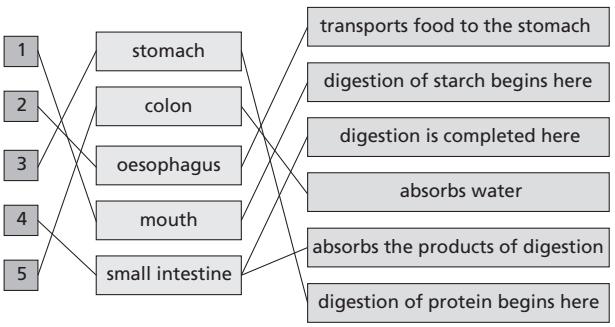
iii) So that it can resist being chipped when biting on hard foods and it can resist decay caused by acid produced in the mouth **(2)**

iv) 1. To anchor the tooth in the jawbone
2. To act as a shock absorber **(2)**

v) They break down large pieces of food into smaller pieces to give digestive enzymes a larger surface area on which to act **(2)**

vi) *Any two of the following:*
Incisor
Pre-molar
Molar **(2)**

c)



(7)

d) Enzyme 1: Pancreatic amylase
Function: Breaks down starch into maltose

Enzyme 2: Trypsin
Function: Breaks down proteins into peptides

Enzyme 3: Pancreatic lipase
Function: Breaks down lipids into fatty acids and glycerol **(6)**

6. a) i) The products of digestion pass into the body fluids. **(1)**

ii) Monosaccharides or simple sugars, i.e. glucose, fructose and galactose, amino acids, fatty acids, glycerol, vitamins, mineral ions and water **(4)**

iii) 1. Diffusion
2. Active transport **(2)**

iv) *Any three of the following:*
It is very long, which gives it a large surface area for the products of digestion to be absorbed through.
Its inner surface has thousands of finger-like projections called villi, which increase the surface area to absorb the products of digestion.
Each villus has a network of blood capillaries and a lacteal inside, which rapidly transport the products of digestion away from the ileum.
The epithelium surrounding each villus is only one cell thick, so that the products of digestion can pass rapidly through into the capillaries and lacteal beneath.
The epithelial cells covering each villus have minute projections called microvilli, which increase the surface area to absorb the products of digestion. **(6)**

v) The hepatic portal vein **(1)**

b) i) Assimilation is the process by which the body uses the products of digestion. **(1)**

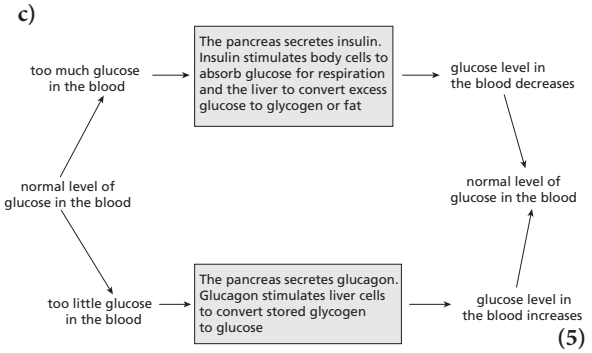
ii) Respiration to provide body with energy **(1)**

iii) *Any three of the following:*
They are used by body cells to make proteins, which are used for growth and repair.
They are used by body cells to make enzymes to catalyse reactions occurring in the cells.
They are used to make hormones to control various processes in the body.
They are used to make antibodies to fight disease. **(3)**

iv) The nitrogen-containing amine groups are removed from the excess amino acid molecules by the liver and converted to urea, which is excreted by the kidneys. What is left of the molecules is converted to glucose and used in respiration, or is converted to glycogen or fat and stored. **(3)**

v) It is stored under the skin or around body organs. **(1)**

c)



(5)

7. a) i) A diet that contains carbohydrates, proteins, lipids, vitamins, minerals, water and roughage in the correct proportions to supply the body with enough energy for daily activities and the correct materials for growth and development, and to maintain the body in a healthy state **(3)**

ii) 1. Occupation or daily activity
2. Gender
3. Age

b) i) Roughage is food that cannot be digested, consisting mainly of the cellulose, lignin of xylem vessels and husks of unpolished rice and whole-grain cereals. **(2)**

ii) Roughage adds bulk to the food, which keeps the food moving through the digestive system by stimulating peristalsis. This prevents constipation and reduces the risk of colon cancer. **(2)**

c) i) Malnutrition is a condition caused by eating a diet in which certain nutrients are either lacking, are in excess or are in the wrong proportions. **(2)**

ii)

Name of deficiency disease	Cause of deficiency disease	Two symptoms of deficiency disease
anaemia		*Any two of the following:* reduction in the number of red blood cells pale complexion tiredness lack of energy
	lack of vitamin C in the diet	*Any two of the following:* bleeding from gums and other membranes loss of teeth wounds do not heal painful muscles and joints
rickets	lack of calcium in the diet	soft, weak limb bones with swollen ends

(9)

iii) 1. Increasing the consumption of foods rich in iron, such as liver and green leafy vegetables
2. Taking dietary supplements containing iron **(2)**

iv) 1. Consuming an excess of vitamin A on a regular basis can cause health problems such as dry and cracked skin, liver damage, blurred vision, nausea and fatigue.
2. Consuming an excess of vitamin D on a regular basis can cause calcification of soft tissues, excessive thirst and urination, loss of appetite and can cause health problems such as kidney stones. **(4)**

v) Excess food is converted to fat and stored in fat deposits under the skin and around organs, which can lead to being overweight and obese. It can also lead to other health problems such as diabetes, hypertension and heart disease. **(3)**

d) i) Vegetarianism is the practice of not eating flesh foods.

ii) 1. A vegetarian diet is low in saturated fats and cholesterol, so Mikaela will be less prone to obesity, heart disease, hypertension, diabetes and gall stones.
2. A vegetarian diet is high in dietary fibre, so Mikaela is less likely to suffer from constipation, colon cancer and certain other types of cancer. **(4)**

e) Increases in her diet: fresh fruit, vegetables, whole grains, low fat dairy products, fish and lean meat; food stuffs which are rich in dietary fibre, potassium, calcium and magnesium
Decreases in her diet: foods rich in saturated fat, cholesterol and salt **(4)**

B3 Respiration

1 a) i) Respiration is the process by which energy is released from food by all living cells. **(1)**

ii) Adenosine triphosphate **(1)**

iii) *Any two of the following:*
Energy can be released rapidly
Exactly the right amount of energy can be released when needed
Energy can be released exactly where it is needed in a cell **(2)**

iv) *Any three of the following:*
To manufacture complex, biologically important molecules
To enable cells to grow
For cells to divide
In active transport to move molecules and ions in and out of cells
For special functions, depending on the cell type, e.g. contraction of muscle cells **(3)**

b) i) $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ + **energy** **(4)**

ii)

	Aerobic respiration	**Anaerobic respiration**
oxygen requirements	uses oxygen	does not use oxygen
site of respiration	mitochondria	cytoplasm
quantity of energy produced per glucose molecule	large amounts	small amounts
products	carbon dioxide and water	variable, one is always organic

(8)

iii) The oxygen supply to Saul's muscle cells became insufficient for the demands of aerobic respiration and they began to respire anaerobically, producing harmful lactic acid. The lactic acid built up in the muscles cells, causing them to stop contracting and Saul collapsed. **(3)**

iv) Saul must rest and breathe deeply so that the lactic acid can be removed by being respired aerobically. **(2)**

c) i) Effervescence **(1)**

ii) From purple-red to yellow **(2)**

iii) The yeast cells respired the glucose anaerobically and produced carbon dioxide, which went through the delivery tube into the bicarbonate indicator solution. **(2)**

iv) Ethanol **(1)**

v) To prevent oxygen from the air in the boiling tube from entering the glucose and yeast mixture, therefore ensuring the conditions were anaerobic **(2)**

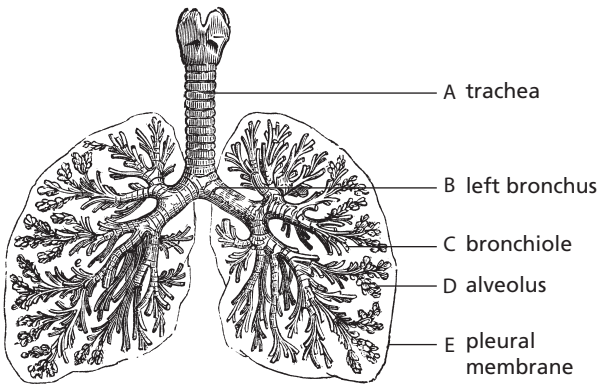
vi) Using yeast that had been heated to denature the enzymes **(1)**

d) Biogas is a mixture of mainly methane and carbon dioxide produced when certain bacteria break down waste organic matter anaerobically. **(2)**

2. a) i) Breathing: The movements in animals that bring oxygen to a gaseous exchange surface and remove carbon dioxide from the surface
Gaseous exchange: The diffusion of oxygen into an organism, and the diffusion of carbon dioxide out of an organism, through a gaseous exchange surface **(2)**

ii) They ensure that the organisms have a continual supply of oxygen to sustain aerobic respiration and ensure that the carbon dioxide produced is continually removed so that it does not build up and poison the cells. **(2)**

b)



(5)

c) i) Whilst resting: Total volume = 15×500 cm^3 = 7500 cm^3
During exercise: Total volume = 35×1200 cm^3 = 42 000 cm^3 **(2)**

ii) Whilst resting: Volume = $\frac{4}{100} \times 7500$ cm^3 = 300 cm^3
During exercise: Volume = $\frac{4}{100} \times 42\,000$ cm^3 = 1680 cm^3 **(2)**

iii) More oxygen was needed because the rate of aerobic respiration in Jacob's muscle cells increased so that they produced the extra energy needed for them to contract and bring about movement. **(2)**

d)

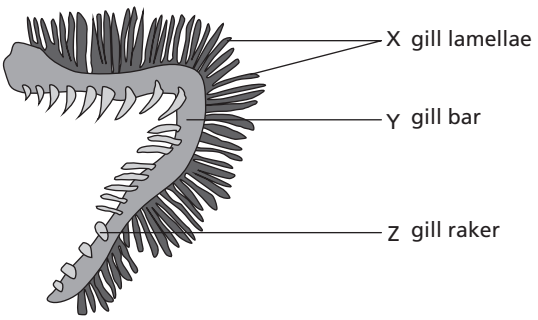
	Inhalation	**Exhalation**
	contract	relax
internal intercostal muscles		
	up and out	down and in
	contract	relax
	flattens	domes upwards
	increases	decreases
	decreases	increases
	air is drawn into the lungs	air is pushed out of the lungs

(8)

e) i) Cigarette smoke contains nicotine, which is an addictive substance and leads to people smoking more and more cigarettes and makes it very difficult to stop. **(2)**

ii) *Any three of the following:*
Cigarette smoke contains carbon monoxide, which reduces the amount of oxygen carried by the blood, which reduces respiration and the smoker's ability to exercise.
Cigarette smoke causes the production of mucus to increase and the cilia to stop beating, which leads to persistent coughing as the smoker tries to remove the excess mucus.
Cigarette smoke irritates and inflames the walls of the bronchi and bronchioles, which leads to chronic bronchitis developing.
Cigarette smoke leads to emphysema in which the walls between the alveoli become less elastic and break down. This reduces gaseous exchange and makes exhaling difficult.
Cigarette smoke contains a large number of carcinogenic chemicals, which can lead to the development of cancerous tumours in the respiratory system. **(6)**

3. a) i)



(3)

ii) *Any three of the following:*
They have very thin walls, which are only one cell thick.
They are moist, since the fish lives in water.
Each one has a network of blood capillaries down the centre.
Their long thin shape and large number give them a large total surface area. **(3)**

b) i) The walls and membranes of all the cells inside the leaves, stems and roots **(1)**

ii) By direct diffusion between the atmosphere and the air spaces inside leaves, stems and roots through stomata and lenticels, and by direct diffusion between these air spaces and the cells **(2)**

iii) During the day
Direction of movement: Carbon dioxide diffuses in and oxygen diffuses out.
Reason: The rate of photosynthesis is greater than the rate of respiration.
During the night
Direction of movement: Oxygen diffuses in and carbon dioxide diffuses out.
Reason: Only respiration is occurring. **(4)**

iv) The rates of respiration and photosynthesis are the same so there is no movement of gases in or out of the leaf. **(2)**

B4 Transport

1. a) i)

	A	**B**	**C**
surface area/cm^2		6.0	600
volume/cm^3		1.0	1000
surface area to volume ratio		6.0 : 1.0 = 6 : 1	600 : 1000 = 0.6 : 1

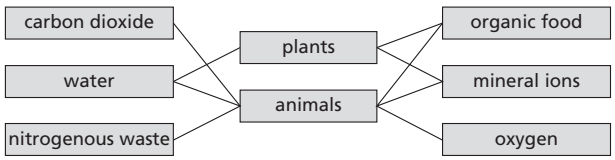
(6)

ii) The ratio decreases. **(1)**

iii) Cube C **(1)**

iv) Because of its small surface area to volume ratio, diffusion through its body surface is not adequate to supply all the body cells with their requirements and remove their waste. Also, most of its body is too far from its surface for substances to move through it by diffusion.

b)



(3)

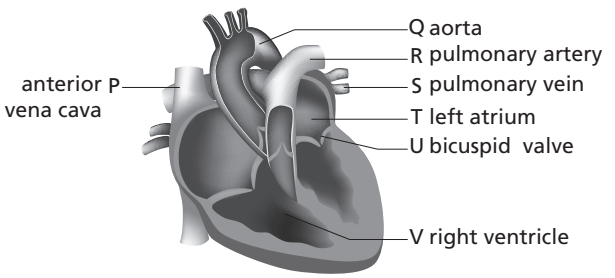
2. a) 1. Blood
2. Blood vessels
3. The heart **(3)**

b) i) To pump the blood around the body **(1)**

ii) Cardiac muscle **(1)**

iii) It never tires and it has its own inherent rhythm. **(1)**

iv)



(7)

v) The left ventricle pumps blood over much longer distances than the right ventricle, since it pumps blood around the body, whereas the right ventricle only pumps blood to the lungs, so the left ventricle has to pump blood with greater force than the right ventricle. **(3)**

vi) To prevent the backflow of blood into the atria when the ventricles contract **(1)**

vii) The left side **(1)**

c) As Mia exercised, the rate of respiration in her muscles increased in order to produce the extra energy she needed. This caused the demand for oxygen in her muscles to increase, which then caused her heart to beat faster in order to supply her muscles with the extra oxygen that they needed. **(3)**

3. a) i)

	Artery	**Vein**
direction of blood flow	away from the heart	towards the heart
pressure of blood carried	high	low
speed of blood flow	fast	slow

(6)

ii) Diagram Y **(1)**

iii) The blood flowing through X is under high pressure, so the walls are thick to withstand the high pressure. **(2)**

iv) Muscle and elastic layer **(1)**

v) The blood flowing through Y is under low pressure; the lumen is wide so that it does not restrict the flow of this low-pressure blood. **(2)**

vi) Valves **(1)**

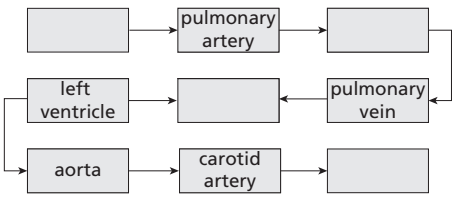
vii) The blood flowing through veins is under low pressure and valves are needed to prevent this low-pressure blood from flowing backwards. **(2)**

viii) 1. So that substances can pass easily through them between the blood and body cells
2. So that the capillaries are narrow enough to pass between all body cells **(2)**

b) i) During one complete circulation around the body the blood flows through the heart twice. **(1)**

ii) Blood loses pressure as it passes through any body organ, so after it has passed through the lungs it has to return to the heart to be given enough pressure to reach all body cells to supply them with oxygen. It then has to return to the heart to be given enough pressure to return to the lungs to lose waste carbon dioxide and pick up more oxygen. **(3)**

c) i)



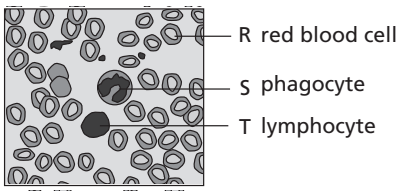
(5)

ii) Oxyhaemoglobin **(1)**

4. a) i) Blood plasma is the fluid part of the blood in which the blood cells float. It is composed of about 90% water and 10% dissolved substances, such as the products of digestion and waste products. **(2)**

ii) *Any three of the following:*
The products of digestion are carried from the ileum to the body cells.
Carbon dioxide is carried from the body cells to the lungs.
Urea is carried from the liver to the kidneys.
Hormones are carried from the glands that produce them to the body cells that need them.
Heat is carried from the liver and muscles to all parts of the body. **(6)**

b) i)



(3)

ii)

Red blood cell	Phagocyte
has no nucleus	has a lobed nucleus
has a biconcave disc shape	has a variable shape, which can change
the cytoplasm contains haemoglobin	the cytoplasm does not contain haemoglobin

(6)

iii) To transport oxygen from the lungs to the body cells **(1)**

iv) Red blood cells do not contain a nucleus and so they are unable to divide. **(2)**

v) In the red bone marrow found in flat bones and at the ends of long bones **(2)**

c) i) Platelets: On exposure to air at a cut, platelets produce the enzyme thromboplastin. Thromboplastin then changes soluble fibrinogen in the blood into insoluble fibrin. Fibrin forms a network of fibres across the cut, forming a clot, which prevents the entry of pathogens. **(3)**
Phagocytes: Using pseudopodia, phagocytes squeeze out of capillaries and engulf and digest pathogens in body tissues. **(2)**

ii) Blood vessels supplying the site of infection dilate and blood flow to the area increases. This makes the area swollen and red, brings more phagocytes to the area and makes the capillary walls more permeable to the phagocytes. The phagocytes can then easily squeeze out of the capillaries into the tissues, where they engulf and digest the pathogens. **(4)**

d) i) Immunity is the temporary or permanent resistance to a disease. **(1)**

ii) Natural immunity results from a person having been exposed to a disease-causing pathogen. Artificial immunity is acquired by a person being vaccinated against a pathogenic disease. **(2)**

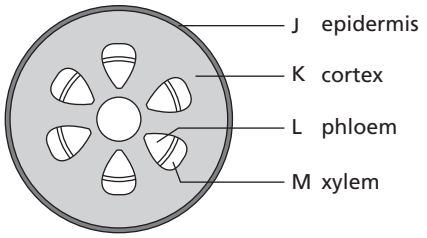
iii) Amber's lymphocytes produced antibodies against the antigens of the chicken pox virus, which destroyed the virus. Production of the antibodies took time and Amber suffered symptoms of chicken pox. On recovery, some of her lymphocytes formed memory lymphocytes, which produce large quantities of antibodies rapidly to destroy the chicken pox virus each time it re-enters her body. **(4)**

iv) A communicable disease is a disease that passes from person to person. **(1)**

v) *Any three of the following:*
Live pathogens that have been weakened or attenuated
Pathogens that have been killed
Fragments of pathogens
Toxins from pathogens that have been made harmless
The specific antigen from the coat of the pathogen **(3)**

vi) Vaccines stimulate lymphocytes to make antibodies against the antigens and cause memory lymphocytes to develop, so an immune response is set up whenever the pathogen enters the body. **(2)**

5. a) i)



(6)

ii) Water and mineral ions or mineral salts **(2)**

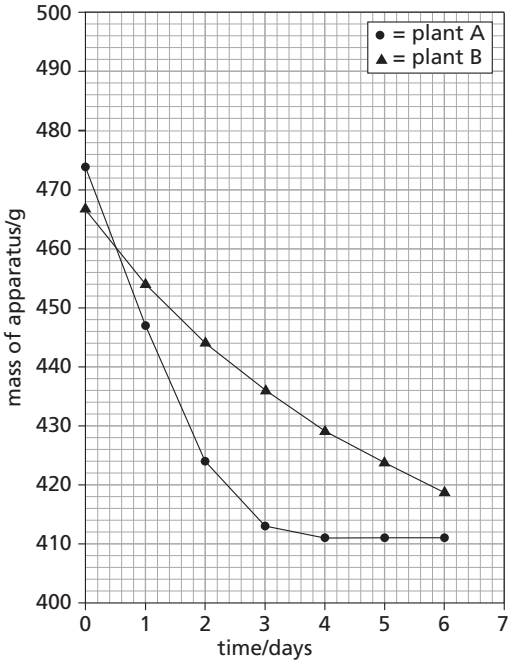
iii) They are long, hollow tubes with no cross walls so water can flow continuously through them. They are also extremely narrow so capillarity helps the water move through them. **(2)**

iv) Root hairs **(1)**

v) They increase the surface area of the root through which water can be absorbed. **(1)**

b) i) Transpiration is the loss of water vapour to the atmosphere from the surface of leaves. **(1)**

ii)



(4)

iii) To prevent weight loss caused by water evaporating from the soil **(1)**

iv) The roots were absorbing water from the soil and at the same time the leaves were transpiring and losing water vapour to the atmosphere. The loss of water vapour created a pull, which drew water up the stem from the roots. The loss of water caused the mass of A to decrease. **(3)**

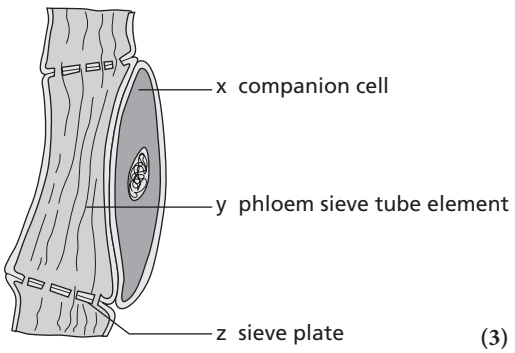
v) There was no more water left in the soil for the leaves to draw up and lose by transpiration. **(1)**

vi) *Any three of the following:*
Extra thick waxy cuticles
Very few stomata
Groups of stomata in sunken pits that trap water vapour
Fine hairs on the surface to trap water vapour
A reduced surface area **(3)**

vii) 1. Temperature
2. Humidity
3. Wind speed
4. Light intensity **(4)**

c) Transpiration draws water up to the leaves for photosynthesis and the moving water carries mineral ions up to the leaves. It supplies plant cells with water to keep them turgid, which supports non-woody plant parts, and it cools the plant when the water evaporates. **(4)**

6. a) i)



(3)

ii) Longitudinal section through a phloem sieve tube and companion cell. **(1)**

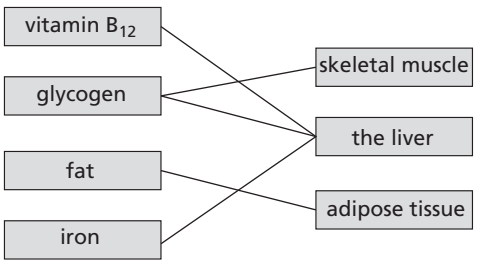
iii) The phloem sieve tube element lacks a nucleus, but the companion cell contains a nucleus.
The nucleus of the companion cell controls the functioning of both cells. **(2)**

b) i) Sugar sources are parts of plants that produce sugars or parts that release sugars. Sugar sinks are parts of plants that need sugars. **(2)**

ii) Sugars move from the cells of the sugar source into the phloem by active transport and water is drawn into the phloem by osmosis. This increases the pressure in the phloem, which pushes sugars to sugar sinks, where they move out of the phloem into the cells by active transport. **(3)**

c) i) *Any two of the following:*
To overcome the need for continuous food intake or continuous food manufacture
To provide reserves for times of food scarcity or when food cannot be manufactured
To provide food reserves for special functions **(2)**

ii)



(3)

d) i) Stem tuber **(1)**

ii) The iodine solution changed from orange-brown to blue-black. **(1)**

iii) The stem tuber of yam stored starch, which causes iodine solution to turn blue-black. **(1)**

e) *Any three of the following plant organs*

Plant organ	Named example	One type of food stored by the named example
fruit	mango	sugars
	breadfruit	starch
	olive	lipids
seed	pea or bean	protein
	peanut	lipids
	rice	starch
stem	sugar cane	sucrose
root	sugar beet	sugars
	turnip	starch

(9)

Or any other suitable example of each organ

B5 Excretion

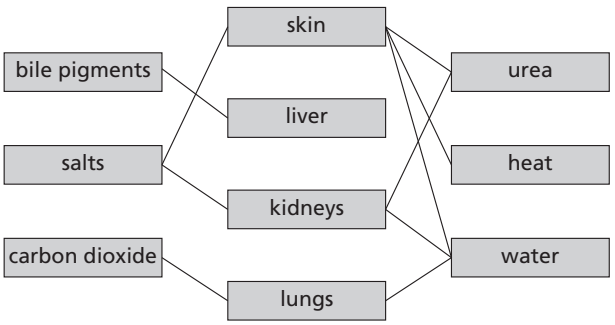
1. a) i) Excretion is the process by which waste and harmful substances, produced by the body's metabolism, are removed from the body, whereas egestion is the removal of undigested dietary fibre from the body as faeces. **(2)**

ii) Many waste products are harmful to organisms and must be removed, because if they build up in cells they can damage and kill the cells. **(2)**

iii) *Any four of the following;*
Carbon dioxide
Oxygen
Water
Organic waste products such as tannin, alkaloids, anthocyanins
Salts of organic acids such as calcium oxalate **(4)**

iv) Carbon dioxide, oxygen and water vapour diffuse out through the stomata of leaves and lenticels of stems and roots. Organic waste and salts of organic acids are converted to oils and insoluble crystals and are stored in the cells of leaves, bark, petals, fruits and seeds. When the plant sheds these structures the waste products are removed. **(4)**

v)

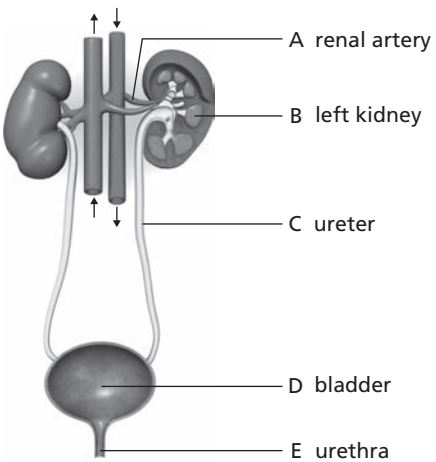


(5)

vi) Excess amino acids **(1)**

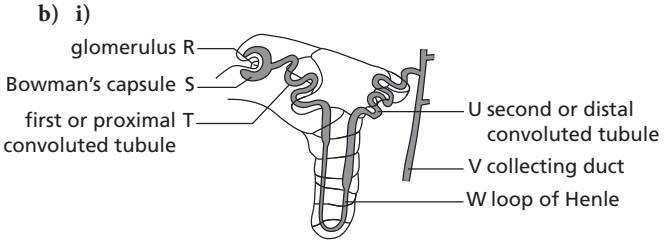
vii) Deamination **(1)**

2. a)



(5)

b) i)



(6)

ii) **R:** The capillaries in the glomerulus narrow causing the pressure of the blood to increase, and this forces small molecules out into Bowman's capsule.
T: Glucose, amino acids, hormones, vitamins and some salts are reabsorbed into the blood by active transport and some water is reabsorbed by osmosis.
W: Some water is reabsorbed into the blood by osmosis. **(6)**

iii) Process in **R:** Ultra-filtration or pressure filtration
Process in **T:** Selective reabsorption **(2)**

iv) Urine, which is composed of water, urea and salts **(2)**

3. a) i) Osmoregulation is the regulation of the concentration of blood plasma and body fluids, and it is important to prevent unnecessary movements of water into and out of body cells. **(2)**

ii) Homeostasis is keeping the conditions that surround cells constant. **(1)**

iii)

Water gain	Water loss
from drink	from the kidneys in urine
from food	from the skin in sweat
produced in respiration occurring in body cells	from the lungs during exhalation

(6)

b) i) Alison would produce a very small volume of urine, which would have very little water in it and a high concentration of urea and salts. **(2)**

ii) Alison loses water in sweat, which causes her body fluids to become concentrated. The hypothalamus of her brain detects that her blood plasma is too concentrated and causes her pituitary gland to secrete antidiuretic hormone. Alison's blood carries the hormone to her kidneys, where it causes most of the water in the filtrate to be reabsorbed into her blood. **(4)**

iii) Alison would produce a much larger volume of urine than on the previous day, which would contain a large amount of water and a low concentration of urea and salts. **(2)**

c) i) Kidney failure **(1)**

ii) To remove waste products from her blood to prevent them building up and reaching toxic levels, and to regulate the volume and composition of her blood plasma and body fluids **(2)**

B6 Movement

1. a) i) Movement is the change in position of parts of an organism or of the entire organism. **(1)**

ii) Growth movements occur as a result of parts of the plant growing, whereas locomotion is the movement of the entire body from one location to another. **(2)**

b) i) An endoskeleton **(1)**

ii) 1. Bone
2. Cartilage **(2)**

iii) *Any three of the following:*
Function: Protection of the internal organs of the body
Part of the skeleton: The skull or the vertebral column or the ribs and sternum
Function: Support for the soft parts of the body
Part of the skeleton: The vertebral column or the pelvic girdle and legs
Function: Movement
Part of the skeleton: The limbs or the vertebral column

Function: Manufacture of blood cells
Part of the skeleton: The red bone marrow in flat bones such as the pelvis, scapula, ribs, sternum, cranium and vertebrae, or the red bone marrow in the ends of long bones such as the femur and humerus **(6)**

c) i) Feature 1: The bones being very long
Feature 2: The bones having joints between them at their ends **(2)**

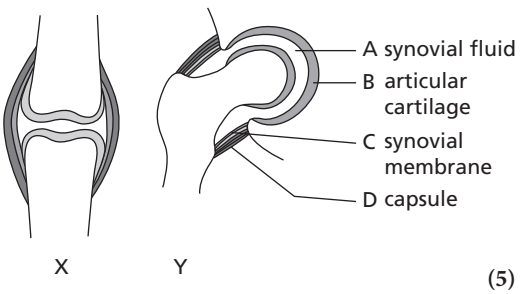
ii) Feature 1: Being long gives the bones a large surface area for muscles to attach to or allows long strides.
Feature 2: The joints allow the bones to move easily. **(2)**

d) *Any two of the following:*
Animals move to search for food, whereas plants make their own food by photosynthesis; their roots must be anchored in the soil to obtain water and mineral salts.
Animals move to search for a mate for sexual reproduction, whereas plants rely on external agents, such as the wind and insects, to carry their pollen grains for reproduction.
Animals move to escape from predators, whereas some plants have developed mechanisms to protect against being eaten, such as spines.
Animals move to distribute their offspring, whereas many plants rely on external agents, such as animals, wind and water, to disperse their seeds. **(4)**

2. a) i) A joint is a place where two bones meet. **(1)**

ii) 1. Immovable joints or sutures
2. Partially moveable joints
3. Moveable joints or synovial joints **(3)**

iii)



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iv) **X:** Hinge joint
Y: Ball-and-socket joint **(2)**

v) **A:** To lubricate the joint to allow movement without friction
B: To reduce friction between the bones and prevent damage to the articulating surfaces
C: To secrete synovial fluid **(3)**

vi) X, the hinge joint, allows movement in one plane only. Y, the ball-and-socket joint, allows movement in all planes. **(2)**

b) i) Ligaments form the capsule which holds bones together at joints. Tendons join muscles to bones. **(2)**

ii) Ligaments are slightly elastic to enable the bones to move at joints. Tendons are non-elastic so that when a muscle contracts the force is transmitted directly to the bone, causing it to move. **(2)**

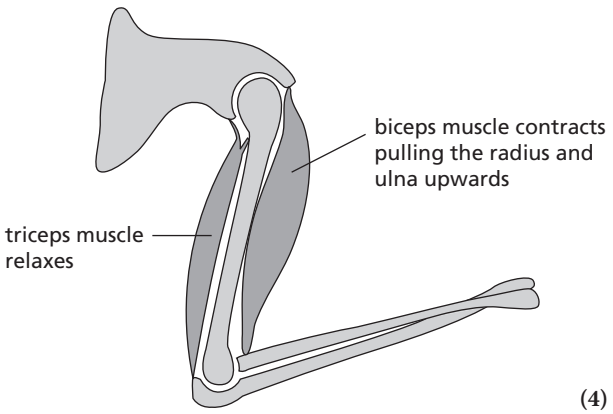
iii) The end attached to the bone that moves at a joint: insertion
The end attached to the bone that does not move at a joint: origin **(2)**

iv) Antagonistic pairs **(1)**

v) When a muscle contracts it exerts a pull; however, when it relaxes it cannot exert a push. Therefore, one muscle is needed to bend a joint when it contacts and another muscle is needed to straighten the joint when it contracts. **(3)**

vi) The muscle that bends a joint is called the **flexor** muscle. The muscle that straightens a joint is called the **extensor** muscle. **(2)**

vii)



(4)

viii) The biceps muscle would relax and the triceps muscle would contract. **(2)**

B7 Irritability

1. a) i) A stimulus is a change in the internal or external environment of an organism that initiates a response.

ii) A response is a change in an organism or part of an organism brought about by a stimulus. **(2)**

b) i) Y, X, Y **(1)**

ii) It ensures that it receives the maximum amount of light available for photosynthesis, which maximises food production. **(2)**

iii) Growth movement **(1)**

iv) Gravity **(1)**

v) It ensures that they grow downwards into the soil to anchor the plant and to absorb the water needed for photosynthesis and the mineral salts needed for healthy growth. **(2)**

vi) They fold together. **(1)**

vii) It protects the leaves from damage. **(1)**

c) i) In the moist side **(1)**

ii) Woodlice move away from dry areas into moist areas to prevent them from losing water from their bodies and becoming desiccated. **(2)**

iii) In the part covered with dark paper **(1)**

iv) Woodlice move away from well-lit areas into darker areas so that it is harder for predators to see them. **(2)**

2. a) i) Receptor: The part of an organism that detects a stimulus.
Effector: The part of an organism that responds to a stimulus. **(2)**

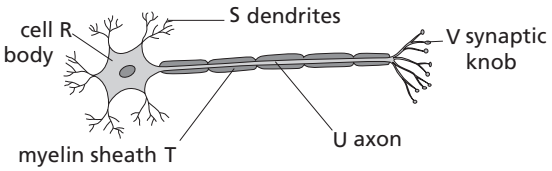
ii)

	Plants	Animals
receptor	apical meristems in the tips of roots and shoots	the eyes or the ears or the tongue or the nose or the skin
effector	1. the region just behind the tips of roots and shoots 2. the petiole of leaves	1. muscles 2. glands

(6)

b) The human nervous system is divided into the central nervous system, which consists of the **brain** and the **spinal cord**, and the peripheral nervous system, which consists of **cranial nerves** and **spinal nerves**. **(4)**

c) i)



(5)

ii) A motor neurone **(1)**

iii) 1. Sensory neurones
2. Relay or intermediate neurones **(2)**

iv) Sensory neurones conduct impulses from receptors to the central nervous system. The impulses pass into relay neurons, which carry them throughout the central nervous system. The impulses then pass into motor neurones, which carry them from the central nervous system to effectors. **(3)**

v) 1. To insulate the axon
2. To speed up the transmission of nerve impulses **(2)**

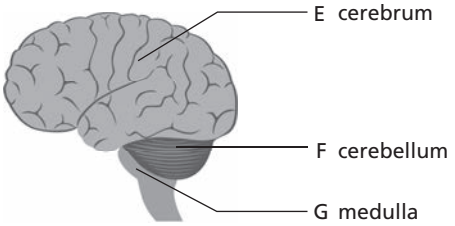
vi) Chemicals are released from the synaptic knobs of one axon into the synapses between adjacent neurones. These chemicals cause impulses to be set up in the adjacent neurones. **(2)**

d) The central nervous system gathers information from receptors via sensory neurones. It then processes this information and sends messages out to effectors via motor neurones so that the most appropriate action can be taken. **(3)**

3. a) i) A reflex action is a rapid, automatic response to a stimulus by a muscle or gland that does not require conscious control. **(2)**

ii) 1. Pain receptors in John's skin are stimulated by the prick of the pin.
2. Impulses travel along a sensory neurone to John's spinal cord.
3. Impulses travel through a relay neurone in John's spinal cord.
4. Impulses travel out of John's spinal cord through a motor neurone.
5. Impulses cause the biceps muscle, or effector, in John's arm to contract, withdrawing his hand. **(5)**

b) i)



(3)

ii)

(2)

iii) **F:** *Any one of the following:*
Coordinates movement
Controls balance and posture
G: Controls automatic activities such as breathing, heartbeat and peristalsis **(2)**

c) i) Any chemical substance that alters the functioning of living tissues **(1)**

ii)

Short-term effects	Long-term effects
Any three of the following:	*Any three of the following:*
slowed muscular skills	cirrhosis of the liver
loss of muscular coordination	stomach ulcers
impaired mental functioning	hypertension
slowed reflexes	intestinal disorders
slurred speech	nervous system disorders
loss of memory	delirium tremens
loss of consciousness	

(6)

iii) *Any four of the following:*
Antibiotics
Tranquilisers
Diet pills
Painkillers
Steroids **(4)**

iv) Drug abuse leads to personal neglect, job loss, financial problems, increased crime and reduced standards of living. It disrupts relationships between abusers and their families and friends, places increased demands on health services and shortens the life span of the abuser. It can also lead to prostitution, which exposes the drug abuser to sexually transmitted infections. **(4)**

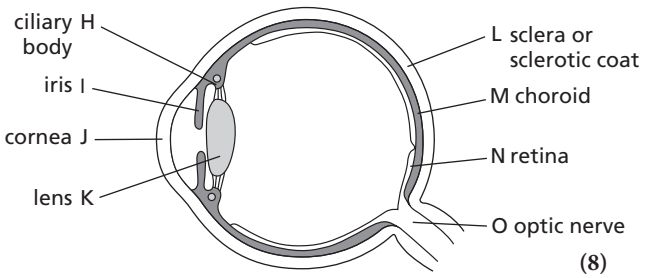
d) i) Percentage = 17.1 + 12.17 = 29.27% **(1)**

ii) Dominica **(1)**

iii) Haiti **(1)**

iv) The percentage of males who had used marijuana was higher than females in all countries surveyed. **(1)**

4. a) i)

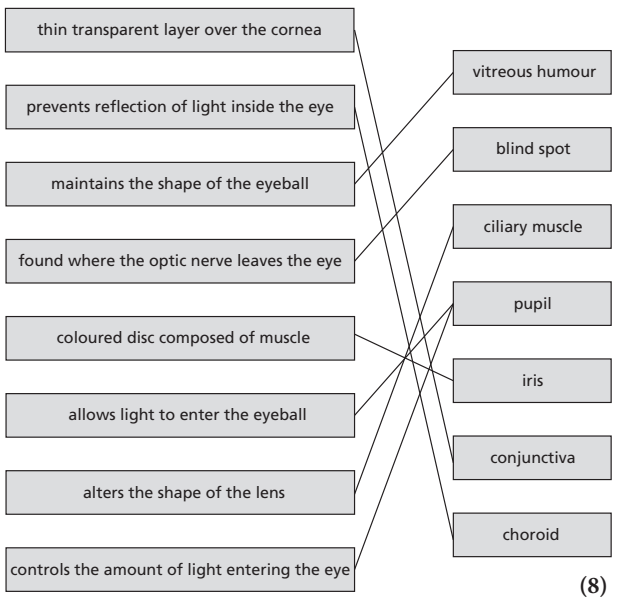


(8)

ii) 1. Rods
2. Cones
Difference: Rods function in low light intensities and are sensitive to the brightness of light. Images falling on the rods are seen in shades of black and white. Cones function in high light intensities and are sensitive to colour. Images falling on the cones are seen in colour. **(4)**

iii) To carry nerve impulses from the retina to the brain **(1)**

iv)



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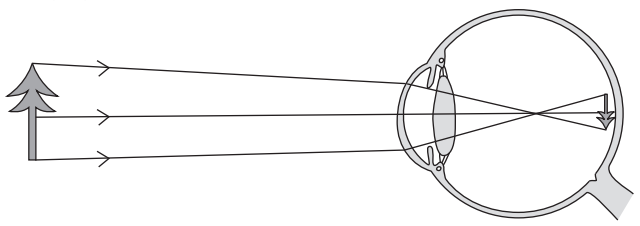
b) i)



(3)

ii) The image is smaller than the object, inverted and reversed. **(2)**

iii) The radial muscles in the irises of Kayla's eyes contract and the circular muscles relax. This causes her pupils to dilate to allow as much light as possible to enter her eyes. **(3)**

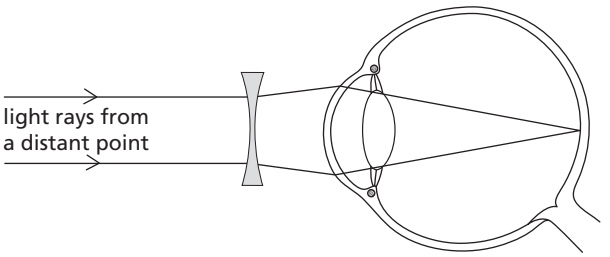
iv) The ciliary muscles in the ciliary bodies of Brian's eyes relax, which causes the circumference of each ciliary body to increase. This pulls the suspensory ligaments tight. The ligaments pull each lens into a flattened shape so that light rays from the plane focus on the retinas of Brian's eyes. **(3)**

v) Accommodation **(1)**

c) i) Short sight or myopia **(1)**

ii) 1. The eyeball is too long from front to back.
2. The lens is too curved. **(2)**

iii)



(3)

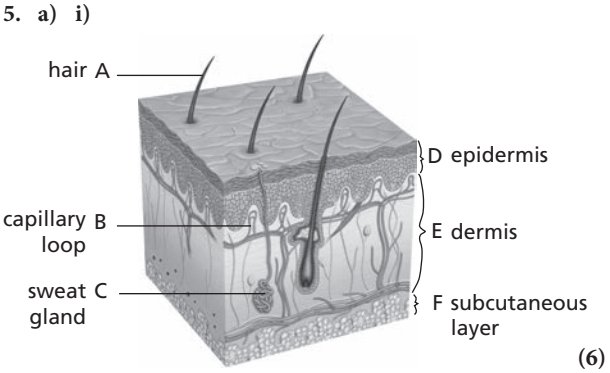
iv) As a person ages their lenses lose their elasticity and the ciliary muscles become weaker. This results in their lenses being less able to curve and they have difficulty focusing on near objects. **(3)**

v) Converging lenses **(1)**

vi) The flow of aqueous humour from the front of the eyeball is blocked, which causes an increase in the pressure of the fluid within the eye. **(2)**

vii) The optic nerve becomes damaged, and this can lead to blindness. **(1)**

5. a) i)



(6)

ii) **D:** *Any three of the following:*
It prevents pathogens from entering the body.
It prevents the loss of water from the body fluids by evaporation.
It protects the body against the sun's harmful ultraviolet rays.
It protects the body against harmful chemicals in the environment.
F: It protects the body against the loss of heat when environmental temperatures are low.
It protects the body against physical damage by acting as padding. **(5)**

iii)

Body temperature rises above 37 °C	Body temperature drops below 37 °C
sweating occurs	sweating stops
the blood vessels in the dermis dilate	the blood vessels in the dermis constrict
the hairs lie flat	the hairs stand erect

(6)

iv) *Any two of the following:*
Osmoregulation or the control of the concentration of blood plasma and body fluids
Control of blood glucose levels
Control of the level of carbon dioxide in the body **(2)**

b) i) 1. Sarah should clean her skin daily using warm water and a mild cleanser.
2. Sarah should moisturise her skin daily with a moisturiser suitable for her skin type.
3. Sarah should apply sunscreen daily to protect her skin against the sun's harmful ultraviolet rays. **(3)**

ii) 1. Alcohol.
2. Synthetic chemicals thought to be harmful to the body, e.g. parabens. **(2)**

iii) Sun protection factor **(1)**

iv) A measure of the effectiveness of the sunscreen. **(1)**

c) i) Skin bleaching involves using chemical substances to lighten skin tone or to provide an even skin complexion. **(2)**

ii) Chemicals in the skin-bleaching products reduce the production of melanin in the skin by inhibiting the action of an enzyme that is necessary for its formation. **(2)**

iii) *Any three of the following:*
Hydroquinone, found in many bleaching products, can irritate the skin.
Hydroquinone can cause skin sensitivity.
Hydroquinone can cause blue-black skin discolouration.
Hydroquinone may cause cancer.
Steroids, found in some bleaching products, can cause the skin to become thin. **(3)**

B8 Growth

1. a) i) Growth is a permanent increase in the size of an organism. **(1)**

ii) 1. Cell division by mitosis
2. Growth of cells by the manufacture of more protoplasm **(2)**

b) i) Wet mass measures the mass of cellular and extracellular material with water. Dry mass measures the mass of cellular and extracellular material without water. **(2)**

ii) Dry mass **(1)**

iii) 1. Measurements may be inconsistent because the water content in the bodies of organisms varies.
2. The growth is disturbed when plants are uprooted and the roots are cleaned. **(2)**

iv) *Any two of the following:*
The organisms have to be killed.
Large numbers of organisms are required.
It is time consuming. **(2)**

v) *Any two of the following:*
Height
Length
Counting the number of leaves of a plant
Surface area of leaves
Circumference of stems **(2)**

c) i) Sigmoid-shaped curve, or S-shaped curve **(1)**

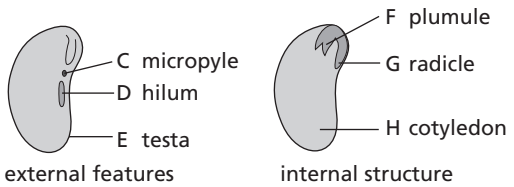
ii) **A:** Cells are dividing and growing rapidly, and few are dying.
B: Cells are dividing and growing at the same rate as mature cells are dying. **(2)**

d)

Growth in plants	Growth in animals
usually continuous throughout their lifetime	usually stops when a maximum size is reached
occurs mainly by cells absorbing water and expanding	occurs mainly by cells increasing in number
occurs only in meristems	occurs in most tissues

(6)

2. a) i)



(6)

ii) Germination is the process by which the embryonic plant in a seed grows into a seedling. **(1)**

iii)

Condition	Role in germination
oxygen	for use in aerobic respiration to produce energy
water	to activate enzymes to catalyse chemical reactions
suitable, warm temperature	to activate enzymes to catalyse chemical reactions

(6)

b) i) The dry mass decreased. **(1)**

ii) Water, absorbed through the micropyle, activated the enzymes, which started to break down stored food. Proteins were broken down into amino acids, starch into glucose and lipids into fatty acids and glycerol. The soluble foods were translocated to the embryo. The embryo used the amino acids for growth and the glucose, fatty acids and glycerol for respiration. **(4)**

iii) Jared saw the radicle emerging through the testa and growing downwards. **(1)**

iv) Jared saw lateral roots developing from the radicle. He then saw the top of the radicle increase in length, arch upwards and pull the cotyledons and plumule upwards behind it. The top of the radicle then straightened, the cotyledons turned green and the plumule developed into the first foliage leaves. **(3)**

c) i) Meristems are groups of immature cells in plants that retain the ability to actively divide and grow. **(1)**

ii) 1. In the tips of roots and shoots
2. In the cambium found between the xylem and phloem tissue of roots and shoots **(2)**

iii) **X:** Cells are constantly dividing by mitosis.
Y: New cells are developing vacuoles and elongating, mainly by absorbing water into their vacuoles.
Z: Elongated cells are differentiating into xylem and phloem. **(3)**

iv) To protect the tip of the root **(1)**

B9 Reproduction

1. a) i) Reproduction is the process by which living organisms generate new individuals of the same kind as themselves. **(2)**

ii) 1. Sexual reproduction involves two parents, whereas asexual reproduction involves one parent.
2. Offspring produced sexually show variation, whereas offspring produced asexually are genetically identical. **(2)**

iii) Asexual reproduction is described as being **conservative**. **(1)**

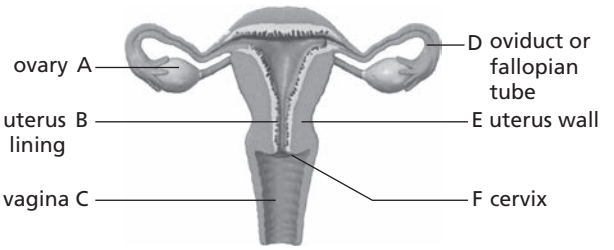
iv)

	Asexual reproduction	**Sexual reproduction**
advantages	1. If the parent is well adapted to the environment all offspring will be. 2. It is a rapid process.	*Any two of the following:* If environmental conditions change some offspring may be better adapted. It enables species to change and adapt to changing environments. Offspring are usually widely dispersed, which reduces competition.
disadvantages	*Any two of the following:* If environmental conditions change for the worse, all offspring will be affected. It does not enable species to change and adapt to changing environments. It can lead to overcrowding and competition.	1. Not all offspring have an equal chance of survival. 2. It is a slow process.

(8)

2. a) i) Ovum **(1)**

ii)



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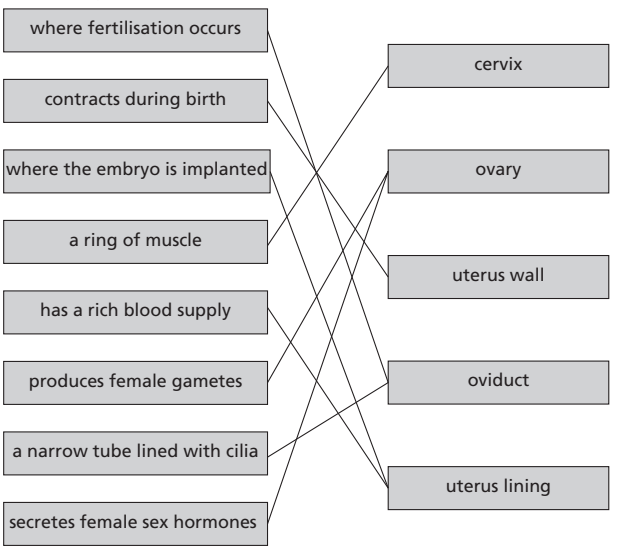
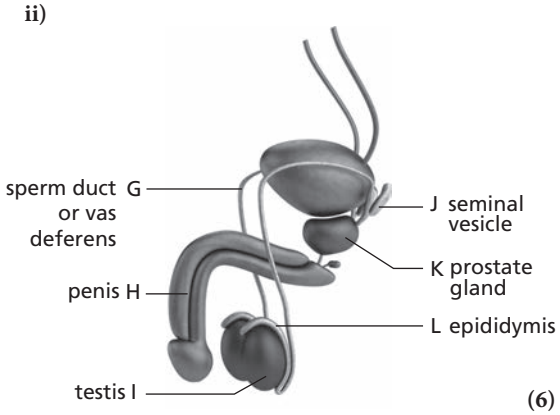
iii)



(4)

b) i) Sperm **(1)**

ii)



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iii) **G**: Carries sperm to the urethra
I: 1. Produces sperm
2. Produces the male sex hormones
J and **K**: Produce secretions, which stimulate the sperm to swim
L: Stores sperm **(5)**

c) i) Ovulation: The release of an ovum from the ovary. Menstruation: The loss of the uterus lining from the body. **(2)**

ii)

Time	Events in the ovaries	Events in the uterus
day 1 to day 5	an immature ovum undergoes meiosis and one cell begins to mature	the uterus lining breaks down and is lost from the body
day 6 to day 13	the Graafian follicle develops around the ovum as it continues to mature	the uterus lining thickens
day 14	the mature ovum is released and the Graafian follicle forms the corpus luteum	_____
day 15 to day 25	the corpus luteum remains	the uterus lining remains thick
day 26 to day 28	the corpus luteum degenerates	the uterus lining begins to break down

(9)

iii) **Q**: Oestrogen
R: Progesterone **(2)**

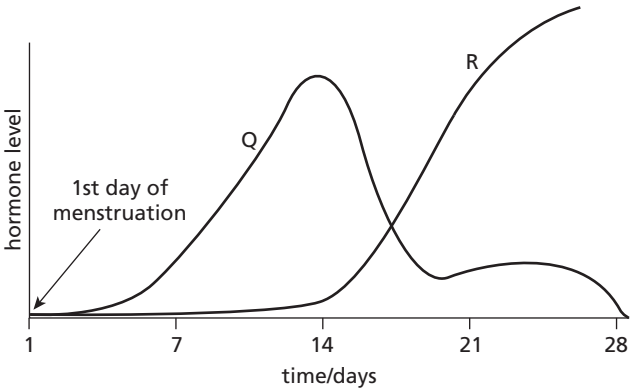
iv) **Q**: Stimulates the uterus lining to thicken and its blood supply to increase after menstruation
R: Causes the uterus lining to remain thick **(2)**

v)

Hormone	Functions
follicle stimulating hormone	1. stimulates a Graafian follicle to develop and an ovum to mature inside 2. stimulates the Graafian follicle to produce oestrogen
luteinising hormone	1. causes ovulation to occur 2. stimulates the corpus luteum to develop and secrete progesterone

(6)

vi)



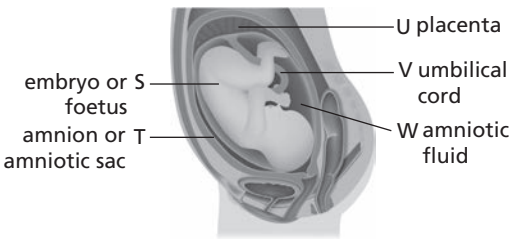
(1)

3. a) i) The penis becomes erect and is placed into the female vagina. Semen is ejaculated into the top of the vagina and the sperm swim through the cervix and uterus and into the oviducts. If an ovum is present in one of the oviducts, one sperm enters, leaving its tail outside. The nuclei of the ovum and sperm fuse, forming a zygote. **(4)**

ii) The zygote divides repeatedly by mitosis to form the embryo. The embryo moves down the oviduct and is implanted into the uterus lining. It gains food and oxygen by diffusion from the mother's blood and carbon dioxide and waste diffuses back into the mother's blood. **(3)**

iii) Menstruation would stop. **(1)**

iv)



(6)

v) **U:** *Any one of the following:*
To obtain food and oxygen for the embryo by diffusion from the mother's blood
To remove carbon dioxide and waste from the embryo by diffusion into the mother's blood
V: To carry food and oxygen to the embryo and carbon dioxide and waste away from the embryo
T and **W**: To support and protect the embryo **(3)**

b) i) Any method that prevents pregnancy from occurring **(1)**

ii) Contraception **(1)**

iii)

Method	How the method works	One advantage of the method	One disadvantage of the method
contraceptive pill	prevents ovulation	*Any one of the following:* almost totally reliable menstruation is lighter, shorter and less painful	*Any one of the following:* stops being effective if one pill is missed may cause side effects
rhythm method	intercourse occurs when ova are absent from the oviducts	no artificial device is used or pills taken	*Any one of the following:* very unreliable restricts the time when intercourse can occur unsuitable for women with irregular cycles
condom	prevents sperm entering the female	*Any one of the following:* very reliable if used correctly easy to use readily available protects against sexually transmitted diseases	*Any one of the following:* may reduce sensitivity condoms can tear and allow sperm through latex may cause an allergic reaction
surgical sterilisation	sperm ducts or oviducts are cut and tied	*Any one of the following:* totally reliable no need to think further about contraception no artificial device is used or pills taken	usually irreversible

(12)

iv) They protect against the transmission of sexually transmitted infections. **(1)**

v) *Any two of the following:*
It enables the couple to restrict the size of their family so they can adequately provide emotionally, physically and educationally for each child.
It enables the female partner in particular to participate fully in society and advance in the workplace by allowing her to plan for her future and invest in her career.
It enables the couple to increase the spacing between their children, which should improve each child's health and overall care. **(2)**

4. a) i) Infections passed on during sexual intercourse **(1)**

ii) AIDS: A virus known as the human immunodeficiency virus
Gonorrhoea: A bacterium known as *Neisseria gonorrhoeae* **(2)**

iii) Aquired immune deficiency syndrome **(1)**

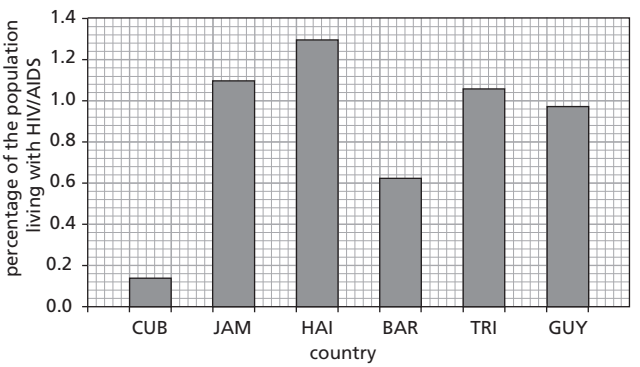
iv) The virus attacks and destroys lymphocytes, which weakens the immune system; it does not attack reproductive organs. **(1)**

b) i)

Country	Country code	Estimated population to the nearest 10 000	Estimated number of people living with HIV/AIDS	Percentage of the population living with HIV/AIDS
Cuba	CUB	11 210 000	16 000	**0.14**
Jamaica	HAI	2 720 000	30 000	**1.10**
Haiti	JAM	10 740 000	140 000	**1.30**
Barbados	BAR	280 000	1 700	**0.61**
Trinidad and Tobago	TRI	1 330 000	14 000	**1.05**
Guyana	GUY	790 000	7 700	**0.97**

(3)

ii)



(4)

iii) Highest: Haiti
Lowest: Cuba **(2)**

iv) *Any three of the following:*
Having unprotected sexual intercourse with an infected person
Using a hypodermic needle or cutting instrument infected with the virus
Receiving a transfusion of a blood product infected with the virus
A baby may become infected during pregnancy and breast feeding if the mother is infected **(3)**

v)

Country	Estimated number of adults age 15 and up living with HIV/ AIDS	Estimated number of women age 15 and up living with HIV/AIDS	Estimated number of men age 15 and up living with HIV/AIDS
Jamaica	30 000	11 000	**19 000**
Cuba	15 000	3 600	**11 400**
Dominican Republic	43 000	22 000	**21 000**
Belize	3 000	1 400	**1 600**
Guyana	7 500	4 000	**3 500**
Surinam	3 100	1 500	**1 600**

(3)

vi) Difference: The percentage of males with HIV/ AIDS is much higher than females in Jamaica and Cuba whereas the percentages are approximately the same in the other countries.
Reason: Transmission between males is much higher in Jamaica and Cuba than in the other countries, where it appears to be mainly between males and females. **(4)**

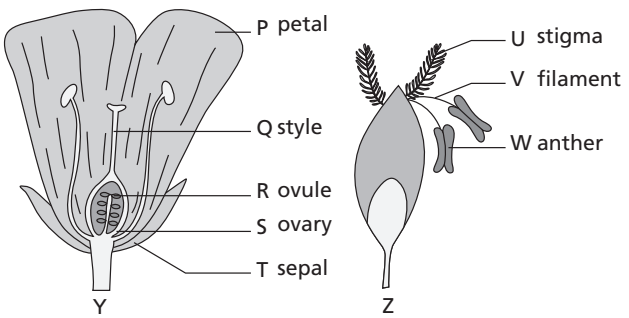
vi) *Any two of the following:*
There is no vaccine or cure.
Symptoms can take several years to show, so an infected person may spread the disease for several years without knowing.
Treatment drugs are relatively expensive and must be taken for life, making the cost ongoing.
It can be difficult to persuade people to change their sexual behaviour. **(2)**

c) i) *Any one of the following:*
The bacteria that cause gonorrhea are readily destroyed by antibiotics, whereas there are no drugs currently available to destroy HIV.
Gonorrhoea has a fixed combination of symptoms to treat, whereas the symptoms of AIDS vary considerably, making treatment harder. **(2)**

ii) *Any three of the following:*
By abstaining from sexual intercourse or keeping to one, uninfected sexual partner
By using condoms during sexual intercourse
By tracing and treating all sexual contacts of infected persons
By setting up education programmes **(3)**

5. a) i) Flowers are essential for sexual reproduction in plants. **(1)**

ii)



(8)

iii) To protect the flower when it is a bud **(1)**

iv) The transfer of pollen grains from the anthers to the stigmas of flowers **(1)**

v) In self pollination, pollen is transferred to the stigma of the same flower or to stigmas of flowers on the same plant. In cross pollination, pollen is transferred to the stigmas of flowers on a different plant of the same species. **(2)**

vi) **Y:** Insects
Z: Wind **(2)**

vii) **Y:** *Any two of the following:*
The petals have honey guides to attract the insects.
The anthers are inside the flower so the insect brushes past them and picks up pollen.
The stigma is lobed for the pollen grains to be transferred onto.
The stigma is inside the flower so the insect brushes past it and deposits pollen onto it.
Z: *Any two of the following:*
The anthers hang outside the flower so the pollen can be easily blown away by the wind.
The anthers are large, suggesting they produce a lot of pollen grains.
The stigmas are feathery to catch the pollen grains being blown by the wind. **(4)**

b) i) The pollen grain absorbs nutrients from the stigma and grows a pollen tube. This tube, with two male nuclei in its tip, grows down the style by digesting a pathway using digestive enzymes. The tube grows through the ovary wall and through the micropyle of the ovule and bursts. One male nucleus fuses with the female gamete to form a zygote. **(4)**

ii) 1. The plumule
2. The radicle
3. One or two cotyledons **(3)**

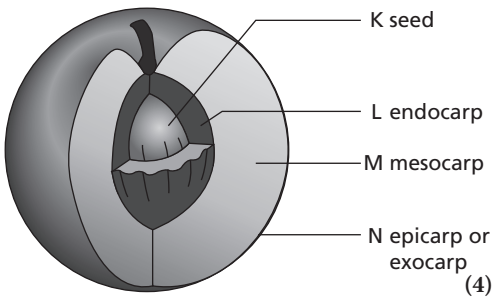
iii) 1. The cotyledon or cotyledons
2. The endosperm **(2)**

iv) The ovule: Forms the seed
The ovary: Forms the fruit
The stigma and style: Shrivel and drop off
The sepals: May drop off or may remain **(4)**

6. a) i) To disperse their seeds **(1)**

ii) 1. Succulent or fleshy fruits
2. Dry fruits **(2)**

iii)



(4)

iv) 1. To prevent overcrowding and competition for sunlight, carbon dioxide, water and minerals
2. To colonise new habitats **(2)**

b) i) **Q**: Water
R: Animals
S: Wind
T: Animals **(4)**

ii) **Q**: The fruit is buoyant so it can float on the water.
R: The fruit has hooks to catch onto the fur of animals.
S: *Any one of the following:*
The fruit is small and light so it is easily carried by the wind.
The fruit has a parachute of hairs, which gives it a large surface area to be carried by the wind.
T: *Any one of the following:*
The fruit is fleshy to attract animals to eat it.
The seeds are small so they pass easily through the digestive system of an animal. **(4)**

iii) Mechanical dispersal by the fruit splitting along lines of weakness and flicking out its seeds. **(1)**

iv) Any suitable example, e.g. sandbox, crotalaria, pigeon pea, pride of Barbados **(1)**

v) The seeds are not dispersed very far away from the plant. After germination the new plants become overcrowded and start competing for light, water, minerals and space and few survive. **(2)**

vi) Water **(1)**

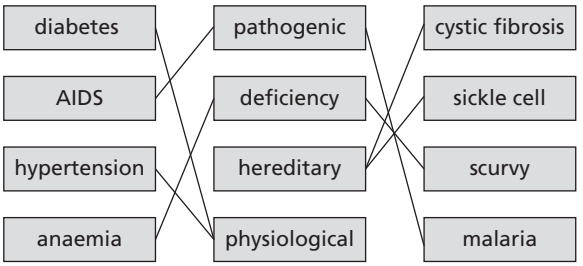
vii) The fruits dispersed by water have waterproof outer coverings so can remain in water for very long periods of time without decomposing and can travel hundreds or thousands of miles in the large oceans. **(3)**

B9 Disease

1. a) i) A disease is a condition that impairs the normal functioning of cells, tissues or organs and leads to the health of an organism being damaged. **(2)**

ii) Pathogenic diseases: Microscopic, parasitic organisms known as pathogens
Deficiency diseases: The shortage or lack of a certain nutrient in the diet
Hereditary diseases: An abnormal gene passed from one generation to the next
Physiological diseases: The malfunctioning of a body organ or a change in the structure of certain body cells over time, which causes them not to function correctly **(4)**

iii)



(4)

iv) Communicable diseases can be passed on from person to person, whereas non-communicable diseases cannot be passed from person to person. **(2)**

b) i) 1. To relieve the symptoms of the disease
2. To destroy the pathogen causing the disease **(2)**

ii) 1. Consume a diet rich in the missing nutrient
2. Take supplements rich in the missing nutrient **(2)**

iii) Her diet should be high in dietary fibre, potassium, calcium and magnesium, contain plenty of fresh fruits, vegetables and whole grains, and include low fat dairy products, fish and lean meat.
Her diet should be low in saturated fat, cholesterol and salt, and alcohol consumption should be minimal. **(4)**

iv) Ryan is correct. Regular, moderate aerobic exercise increases muscular activity and reduces blood glucose levels by increasing respiration in muscle cells. It also reduces obesity, improves circulation and keeps the diabetic person fit, all of which help to control the disease. **(3)**

c) The outbreak will result in decreased banana production, loss of income for plantation owners and will reduce the economy of the country, especially if the bananas are produced for export. It will also lead to decreased availability of the fruit on the local market, possibly resulting in increased prices and reduced standards of living of those whose livelihood depends on banana production. **(4)**

2. a) i) A vector is an organism that carries pathogens in or on its body but is not usually harmed by the pathogen. **(1)**

ii)

	Name of stage	Habitat	Mode of life
A	adult or imago	air	feeds on nectar and sugars from the phloem of plants and mates female sucks blood from humans to mature each batch of eggs
B	egg	water	floats on the surface of the water
C	larva	water	hangs from the surface of the water breathing air and feeds on micro-organisms and organic matter in the water grows between moults
D	pupa	water	hangs from the surface of the water breathing air larval tissue in the body reorganises into adult tissue

(12)

iii) *Any three of the following:*
Malaria
Dengue
Yellow fever
Chikungunya **(3)**

iv) *Any two symptoms of any three of the following:*
Malaria: feeling cold and shivering followed by a high fever and sweating
periodic attacks of high fever, which can last for years
Dengue: high fever lasting several days
severe headaches
pain behind the eyes
severe joint and muscle pain
skin rash
nausea
Yellow fever: fever
aching muscles, especially back muscles
yellowing of the skin and eyes
bleeding from the nose, mouth, eyes and internally
kidney and liver failure
Chikungunya: sudden high fever
severe joint and muscle pain, the joint pain, which can last for months, particularly affecting wrists, hands, ankles and feet
skin rash
nausea **(3)**

v) If the blood obtained by a female mosquito to mature her eggs contains pathogens, these move into her salivary glands and multiply. The next time she bites someone, she can transmit the pathogen to that person as she injects saliva into the blood to prevent it clotting. **(3)**

vi) *Any three of the following:*
Drain all areas of still water
Add insecticides to water to kill the larvae and pupae or spray with insecticides to kill adults
Introduce fish into breeding areas to feed on the larvae and pupae
Spray oil, kerosene or lecithins onto still water to prevent larvae and pupae from breathing
Remove dense vegetation to reduce protection for adults **(3)**

C1 Inheritance and variation

1. a) i) Deoxyribonucleic acid **(1)**

ii) DNA is hereditary material that contains genetic information necessary for the development and functioning of an organism. **(2)**

iii) Chromosomes are composed of DNA. **(1)**

iv) A gene is a specific region of a DNA molecule that controls a specific characteristic. An allele is an alternative form of a gene. **(2)**

v) Diploid number, or 2n number **(1)**

2. a) i) The cell divides into two genetically identical cells. **(1)**

ii) A chromatid **(1)**

iii) Two chromatids are produced by the DNA of a chromosome duplicating itself. **(1)**

iv) **A:** The pairs of chromatids are lined up around the equator of the spindle.
B: The chromatids are being pulled to opposite sides of the cell.
C: A nuclear membrane forms around each group of chromosomes and the cytoplasm of the original cell divides across the middle to form two cells. **(4)**

v) 1. Growth
2. Asexual reproduction **(2)**

b) i) A clone is the name given to all the offspring produced asexually from one parent. **(1)**

ii) Asexual reproduction occurs as a result of mitosis and because mitosis produces genetically identical cells, all offspring produced asexually from one parent are genetically identical. **(2)**

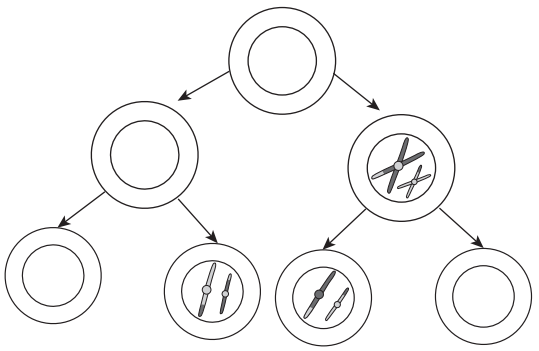
iii) Plantlets, produced by mitosis, develop around the margin of the leaf. Each plantlet then drops off and grows into a new plant. **(2)**

c) i) In the reproductive organs during the production of gametes. **(1)**

ii) 9 **(1)**

iii) 1. Each cell produced by meiosis has half the number of chromosomes of the parent cell, so that the species number or diploid number can be restored when fertilisation occurs.
2. Each daughter cell has a different combination of genes, which leads to variation among offspring, and this enables species to constantly change and adapt to changing environmental conditions. **(2)**

iv)



(4)

v) *Any two of the following:*
Mitosis produces two genetically identical cells, whereas meiosis produces four genetically unidentical cells.
Each cell produced in mitosis has the diploid number of chromosomes, whereas each cell produced in meiosis has the haploid number of chromosomes.
The homologous chromosomes do not pair and the chromatids do not exchange genetic material in mitosis, whereas they pair and the chromatids exchange genetic material in meiosis. **(4)**

3. a) i) A dominant trait is an inherited trait that results from the presence of a single dominant allele. A recessive trait is an inherited trait that results from the presence of two recessive alleles. **(2)**

ii) Genotype is the combination of alleles present in an organism. Phenotype is the observable characteristics of an organism. **(2)**

iii) Homozygous means that the two alleles in corresponding positions on a pair of homologous chromosomes are identical. Heterozygous means that the two alleles are different. **(2)**

b) i) **(4)**

Parental phenotype: can taste PTC × cannot taste PTC

Parental genotype: Tt × **tt**

Gametes: (**T**) (**t**) × (**t**) (**t**)

Random fertilisation:

Gametes	**t**	**t**
T	**Tt**	**Tt**
t	**tt**	**tt**

F_1 genotype: **Tt** **Tt** **tt** **tt**

F_1 phenotype: **can taste PTC** **can taste PTC** **cannot taste PTC** **cannot taste PTC**

ii) There is a **50**% chance that the offspring will be able to taste PTC. **(1)**

c) i) Individual 2: **Nn**
Individual 6: **nn**
Individual 9: **Nn** **(3)**

ii)

Parental phenotype: normal pigmentation × normal pigmentation (individual **10**)

Parental genotype: **Nn** × **Nn**

Gametes: (**N**) (**n**) × (**N**) (**n**)

Random fertilisation:

Gametes	**N**	**n**
N	**NN**	**Nn**
n	**Nn**	**nn**

F_1 genotype: **NN** **Nn** **Nn** **nn**

F_1 phenotype: **normal** **normal** **normal** **albino**

There is a **25**% chance that their first child will have albinism. (6)

iii) It is not possible. Individual **3** must have passed a dominant allele to individual **10**. He could have done this if he had been either homozygous dominant or heterozygous. **(2)**

4. a) i) Codominance occurs when neither allele dominates the other, such that the influence of both alleles is visible in the heterozygous individual. **(1)**

ii)

Parental phenotype: sickle-cell trait × sickle-cell trait

Parental genotype: $\mathbf{Hb^A\ Hb^S}$ × $\mathbf{Hb^A\ Hb^S}$

Gametes: ($\mathbf{Hb^A}$) ($\mathbf{Hb^S}$) × ($\mathbf{Hb^A}$) ($\mathbf{Hb^S}$)

Random fertilisation:

Gametes	$\mathbf{Hb^A}$	$\mathbf{Hb^S}$
$\mathbf{Hb^A}$	$\mathbf{Hb^A\ Hb^A}$	$\mathbf{Hb^A\ Hb^S}$
$\mathbf{Hb^S}$	$\mathbf{Hb^A\ Hb^S}$	$\mathbf{Hb^S\ Hb^S}$

(5)

F_1 genotype: $\mathbf{Hb^A\ Hb^A}$ $\mathbf{Hb^A\ Hb^S}$ $\mathbf{Hb^A\ Hb^S}$ $\mathbf{Hb^S\ Hb^S}$

F_1 phenotype: **normal** **sickle-cell trait** **sickle-cell trait** **sickle-cell anaemia**

There is a **25**% chance that they will produce a child with sickle-cell anaemia. (6)

iii)

Parental phenotype: blood group AB × blood group O

Parental genotype: I^AI^B × $I^O I^O$

Gametes: (I^A) (I^B) × (I^O) (I^O)

Random fertilisation:

Gametes	I^O	I^O
I^A	$I^A I^O$	$I^A I^O$
I^B	$I^B I^O$	$I^B I^O$

F_1 genotype: $I^A I^O$ $I^A I^O$ $I^B I^O$ $I^B I^O$

F_1 phenotype: **blood group A** **blood group A** **blood group B** **blood group B**

The man's claim has a 50% chance of being true. **(6)**

b) i) Female: XX
Male: XY **(2)**

ii) The father **(1)**

iii) Only the father can pass on the Y chromosome. **(1)**

c) i) Sex-linked characteristics are characteristics controlled by genes carried on the sex chromosomes. **(1)**

ii) Males have one X chromosome, so if this carries a recessive allele it will be expressed in the phenotype. In a female both X chromosomes must carry a recessive allele for the trait to be seen. **(2)**

iii) Queen Victoria: X^HX^h
Prince Albert: X^HY **(2)**

iv)

Parental phenotype: female, normal clotting (Queen Victoria) × male normal clotting (Prince Albert)

Parental genotype: X^HX^h × X^HY

Gametes: (X^H) (X^h) × (X^H) (Y)

Random fertilisation:

Gametes	X^H	Y
X^H	X^HX^H	X^HY
X^h	X^HX^h	X^hY

(5)

F_1 genotype: X^HX^H X^HY X^HX^h X^hY

F_1 phenotype: **normal female** **normal male** **normal female** **haemophiliac male**

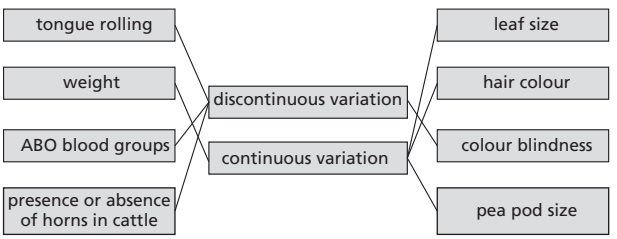
5. a) i) 1. The genotype of the organism
2. Environmental influences **(2)**

ii) *Any three of the following:*
Crossing over and exchange of genetic material during meiosis
The random arrangement of chromosomes around the equator of the spindles during meiosis
Random fertilisation of female gametes by male gametes
Mutations **(3)**

iii) *Any two of the following:*
It allows organisms to adapt to changing environmental conditions, which improves their chances of survival.
It provides the raw material on which natural selection can work, so is essential for species to remain well adapted to their environment or to gradually change and improve.
It makes it less likely that any adverse changes in environmental conditions will wipe out an entire species, since some organisms may be able to adapt to the new conditions. **(4)**

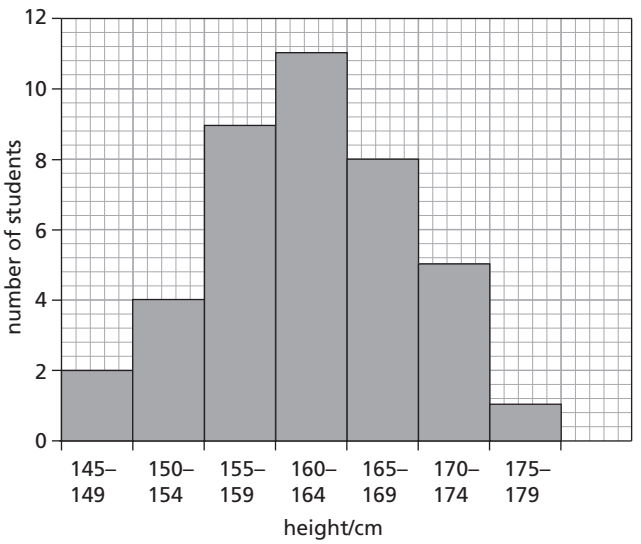
iv) Continuous variation is where characteristics show continuous gradation from one extreme to the other. Discontinuous variation is where characteristics show clear-cut differences with no intermediates. **(2)**

v)



(4)

b) i)



(4)

ii) Continuous variation **(1)**

iii) Normal distribution **(1)**

C2 Species, selection and genetic engineering

1. a) i) If members of two different species interbreed their offspring are usually sterile or are so biologically weak that they rarely produce offspring. **(2)**

ii) Speciation **(1)**

iii) A river started flowing through the forest, creating a valley that separated the two groups of trees and stopped the flow of genes between them. Genetic differences gradually developed and a point was reached where members of the groups could no longer successfully interbreed. **(3)**

iv) *Any one of the following:*
If two groups of organisms of the same species inhabit the same region but become adapted to different habitats in that region, this reduces gene flow so the groups become different species.
If animals exhibit elaborate courtship behaviours before mating and small differences occur in any of the stimuli involved it can prevent mating, which prevents gene flow. **(3)**

b) i) All the organisms in the species die, such that the species no longer exists. **(1)**

ii) *Any three of the following:*
Loss of habitat
Spread of disease
Predation by species that have been introduced into the habitat
Competition with species that have been introduced into the habitat
Overexploitation by humans **(3)**

iii) Caribbean monk seal **(1)**

2. a) i) Natural selection is the process by which populations change over time, or evolve, so they remain well adapted to their environment. **(1)**

ii) A dominant mutation **(1)**

iii) Variety Y was well camouflaged against the tree trunks, which were blackened with soot in industrialised areas. This gave the variety Y a selective advantage in these areas and its numbers gradually increased. Variety X was no longer well camouflaged and was at a selective disadvantage and its numbers gradually decreased. **(3)**

iv) As a result of mutations, bacteria have developed that are resistant to all antibiotics used to treat gonorrhoea. When exposed to antibiotics, these resistant mutants survive, reproduce and pass on their resistant mutant alleles to their offspring, creating populations of resistant bacteria. **(3)**

b) i) Artificial selection is the process by which humans select and breed organisms showing characteristics that are desirable to suit human needs. **(1)**

ii) *Any three of the following:*
Increased yields
Increased quality of the product
Faster growth rates
Increased resistance to pests and disease
Increased number of offspring
Shorter time to reach maturity
Increased suitability to the environment **(3)**

iii) Hybrid vigour **(1)**

iv) 1. They are tolerant to heat.
2. They have a high resistance to ticks and tick-borne diseases.
3. They produce high yields of milk when grazing on poor pasturelands. **(3)**

v) *Any one of the following:*
It reduces variation, which makes individuals more vulnerable if environmental conditions change.
Inbreeding reduces the gene pool, which increases the frequency of undesirable genes. **(1)**

3. a) i) Genetic engineering involves changing the traits of one organism by inserting genetic material from a different organism into its DNA. **(1)**

ii) A genetically modified organism or a transgenic organism **(1)**

iii) Golden rice: Two genes, one from maize and one from a soil bacterium, are introduced into rice plants. The genes cause the endosperm of the rice grains to produce beta-carotene. The human body then converts the beta-carotene to vitamin A.
Insulin: The gene that controls the production of insulin in humans is transferred into bacteria. The bacteria then produce human insulin. **(4)**

b) i) *Any three of the following:*
It can be used to increase yields, which should then increase the world food supply and reduce food shortages.
It can be used to increase the nutritional value of foods, which should then reduce deficiency diseases worldwide.
Vaccines produced by genetic engineering are generally safer than vaccines containing live and weakened, or dead pathogens.
It can be used to produce larger quantities of drugs in a safer and purer form than previously produced from animal sources so more people worldwide have access to these drugs.
It overcomes ethical concerns of obtaining certain drugs from animals.
Crops genetically engineered to be resistant to pests reduce the need for chemical pesticides, which harm the environment. **(3)**

ii) *Any three of the following:*
Plants genetically engineered to be toxic to a pest may also be toxic to useful organisms. This could negatively affect wild plants, reduce reproduction in crops and reduce food production.

Plants genetically engineered to be resistant to pests and herbicides could create unpredictable environmental issues, such as pesticide-resistant insects or herbicide-resistant superweeds.
Once a genetically modified organism is released into the environment it cannot be contained or recalled. Any negative effects are irreversible.
The number of allergens in foods could be increased by transferring genes, causing allergic reactions between species.
Unknown health risks may occur as a result of eating genetically modified plants and animals.
It is not possible to predict the exact nature of a genetically modified organism. If there is something inherently harmful about a new organism released into the environment, the results could be disastrous.
Large companies with funds and technology to develop genetically modified organisms could make huge profits at the expense of smaller companies and poorer nations.
Future steps in genetic engineering might allow the genetic makeup of higher organisms, including humans, to be altered leading to difficult moral and ethical issues. **(3)**

c) Gene therapy is an experimental technique that involves altering genes inside body cells to cure a disease or to help the body fight a disease. **(1)**

d) **i)** DNA testing involves analysing DNA. The DNA could have been taken from cells of individuals, from scenes of accidents or from crime scenes. **(1)**

ii) *Any three of the following:*
To help solve crimes
To identify a body
To help determine paternity
To detect genetic disorders or diseases before birth or in early childhood
To help genetic counsellors predict the likelihood of children suffering from genetic disorders
To identify family relationships
To create family trees **(3)**