Section A: Living Organisms in the Environment

A1: An Introduction to Living Organisms

No.	Answers	Further Explanations
1	B	
2	C	
3	C	A genus Closely related species are grouped into genera (singular genus). Related genera are then grouped into families, related families are grouped into orders, related orders are grouped into classes and related classes are grouped into phyla.
4	C	I and II only **I**: Organisms W and Y have 3 pairs of legs each, organisms X and Z have many pairs of legs, so they could be classified using the number of pairs of legs each possesses. **II**: The bodies of organisms W and Y are each divided into 3 segments, the bodies of organisms X and Z are each divided into many segments, so they could be classified using the number of body segments each possess. **III**: All four organisms have one pair of antennae, so the presence or absence of antennae could not be used to classify them.
5	A	Insects Organisms W and Y are insects because they have 3 pairs of legs, their bodies are divided into a head, thorax and abdomen, and they have one pair of antennae.
6	D	They possess mitochondria Members of the Prokaryotae kingdom are unicellular organisms whose cells lack any membrane-bound organelles, including mitochondria.

No.	Answers	Further Explanations
7	B	Protoctista The organism is unicellular and has a true nucleus, both characteristics of members of the Protoctista kingdom.
8	D	
9	A	The leaves of dicotyledons are usually long and narrow. The leaves of dicotyledons are usually broad and have a network of veins. It is the leaves of monocotyledons that are usually long and narrow.

A2: Living Organisms in Their Environment

No.	Answers	Further Explanations
1	C	
2	B	
3	C	II and III only **II** and **III**: Abiotic environmental factors are the non-living chemical and physical factors. Both light intensity and humidity are physical environmental factors. **I**: Competitors are other living organisms in the environment, so are not non-living factors.
4	B	An ecosystem A mangrove swamp is a community of living organisms interacting with each other and with their abiotic environment, so is best described as an ecosystem.
5	A	
6	D	
7	A	
8	A	

No.	Answers	Further Explanations
9	B	X Organism X was found in all five quadrats and the numbers in each quadrat were similar, ranging between 5 and 8, indicating that it was fairly uniformly distributed within the ecosystem.
10	C	Number of organisms per m^2 The area of the quadrat used was 1 m^2, so the number of organisms per m^2 can be very easily calculated by finding the total number of organisms in the five quadrats, whose total area is 5 m^2, and dividing by 5.
11	D	The species frequency of X is greater than Y. The species frequency is the percentage of quadrats in which the particular species is found. X was found in all five quadrats, so had a species frequency of 100%. Y was found in four quadrats, so had a species frequency of 80%.
12	D	27 Estimated millipede population = $\frac{16 \times 20}{12}$ = 26.67 or 27 to the nearest whole number.
13	C	
14	D	II, III and IV only **II**: The size of soil particles influences the air content of the soil because it determines the size of air spaces between the particles. **III**: The size of soil particles influences how easy it is for earthworms to burrow because it determines how loosely packed the soil is. **IV**: The size of soil particles influences the mineral ion content because it affects how easy it is for the minerals to be leached through the soil. **I**: The size of soil particles has no influence on the pH of the soil.

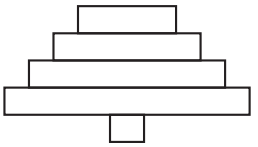
No.	Answers	Further Explanations
15	A	Volume of water draining through: 17 cm^3 Time taken for water to drain through: 14 min Clay particles are the smallest particles found in soil. The lowest volume of water drained through soil A, so soil A retained the greatest volume of water indicating that it had the smallest particles with the largest surface area to retain water around them by capillarity and chemical forces. It also took the longest time for the water to drain through soil A, indicating that the soil had the smallest spaces for the water to pass through.
16	B	I and III only **I**: Earthworms live in the soil and obtain oxygen for respiration from the oxygen in the air present between the soil particles. **III**: Nitrogen-fixing bacteria live in the soil and obtain nitrogen to make nitrates from the nitrogen in the air present between the soil particles. **II**: The leaves of hibiscus plants carry out photosynthesis and they obtain the carbon dioxide they need from the air surrounding them, not from the air in the soil.
17	B	Humidity Aquatic organisms live in water, so they would not be affected by the percentage of water vapour in the air.
18	A	

A3: Interrelationships Between Living Organisms

No.	Answers	Further Explanations
1	B	
2	D	
3	D	

No.	Answers	Further Explanations
4	C	Stingrays are secondary consumers. Stingrays feed on crabs, crabs feed on shrimp, and shrimp feed on plant plankton. Stingrays therefore occupy the fourth trophic level, so they are tertiary consumers, not secondary consumers.
5	C	I and III only **I**: Sweet lime leaves capture sunlight energy and use it in photosynthesis to produce food. The leaves are then eaten by the slug and the ant, supplying them with energy. **III**: The leaves of green plants absorb sunlight energy and use it in photosynthesis to produce glucose which their flowers then convert to nectar. The nectar is then eaten by the ant and the butterfly, supplying them with energy. **II**: The ants obtain their energy by eating sweet lime leaves and nectar, so they are not the primary source of energy in the food web.
6	A	
7	D	*Paramecium* feeds on yeast cells As the number of yeast cells increases, the number of *Paramecium* increases because they have more food available to them. The number of yeast cells then begins to decrease as a result of overconsumption by the increased number of *Paramecium*, so the number of *Paramecium* then decreases due to reduced food availability. As the number of *Paramecium* decreases, the number of yeast cells begins to increase again as a result of reduced consumption by *Paramecium*, and the cycle continues.

No.	Answers	Further Explanations
8	C	I and II only **I:** The numbers of organisms in ecosystems are kept relatively constant by predator/prey relationships because if a predator overhunts its prey, the prey population will decrease and this will cause the predator population to decrease because they have less food to eat. The prey population will then begin to increase again and this will allow the predator population to increase. **II**: Humans can use predator/prey relationships to control pests by introducing a natural predator of the pest into the environment. **III**: Predator/prey relationships can exist between a herbivore and a carnivore or between carnivores, they do not only exist between a herbivore and a carnivore.
9	B	
10	A	
11	B	Oxygen The algae gain carbon dioxide from the polyps as the polyps respire, nitrogenous compounds excreted by the polyps and protection within the polyps' tissues. The polyps gain oxygen from the algae as the algae photosynthesise, so the algae do not gain oxygen from the polyps.
12	D	
13	C	
14	A	II only **II**: Because organisms at the top of a food chain consume organisms below them in the chain, they are generally bigger than those lower down. **I**: The activity of organisms in a food chain varies, those at the top are not usually more active than those lower down. **III**: The number of organisms at each trophic level usually decreases going up a food chain, so organisms at the top of a chain are fewer in number than those lower down, they are not more numerous.

No.	Answers	Further Explanations
15	D	 Mango trees are very large and a very large number of aphids can feed on the many leaves of one tree, so there are significantly fewer mango trees than there are aphids.
16	B	
17	B	
18	A	Reduced availability of natural resources Recycling manufactured materials conserves natural resources by reducing the quantity of fresh raw materials used in manufacturing, meaning that the availability of natural resources would increase, not be reduced.
19	C	II and III only **II**: Recycling manufactured materials can be labour and energy intensive, making it uneconomical for many of the small islands of the Caribbean. **III**: It is more difficult to collect, transport and store waste manufactured materials when they are separated into different types, making recycling of these materials difficult. **I**: There are very many different types of manufactured raw materials which could be recycled, not very few.

A4: The Impact of Humans on the Environment

No.	Answers	Further Explanations
1	A	
2	C	I and II only **I**: Deforestation destroys the habitats of both plants and animals living in the forest. **II**: Deforestation leads to soil erosion because leaves that break the force of the rain and roots that bind the soil together have been removed. **III**: Deforestation causes a reduction in photosynthesis, which causes a reduction in oxygen being released into the atmosphere, it does not lead to an increase in atmospheric oxygen levels.
3	B	There would be an increase in the numbers of other organisms that feed on tadpoles. If the trout population is almost completely eliminated, the tadpole population would increase because one of their predators has been removed. This would mean that there is more food available to any other organisms feeding on the tadpoles, so their populations would increase. Any other organisms feeding on the tadpoles have also had one of their competitors almost completely eliminated, reducing competition for the tadpoles.
4	D	Changes in the balance of atmospheric gases The main pollutants produced by industry are gases that are released into the atmosphere where they change the balance of the gases present.
5	A	
6	C	
7	B	
8	D	Large fish Pesticides become higher in concentration moving up food chains and are most likely to harm consumers at the top of the chain, in this case the large fish.

No.	Answers	Further Explanations
9	C	A drop in sea levels Burning fossil fuels releases carbon dioxide into the atmosphere. This carbon dioxide is building up in the upper atmosphere, enhancing the greenhouse effect and leading to global warming. Global warming is causing polar ice caps and glaciers to melt, resulting in rising sea levels, not dropping sea levels.
10	D	I, II and III **I**: Garbage disposed of incorrectly creates an eyesore which has a negative impact on eco-tourism, reducing the number of tourists wishing to visit the islands. **II**: Garbage disposed of incorrectly can attract rodents, which spread disease and can also lead to disease-causing bacteria entering water supplies, which increases their spread. **III**: Greenhouse gases such as methane and carbon dioxide are released into the atmosphere from garbage which is disposed of incorrectly.
11	A	
12	A	Providing souvenirs for tourists Providing souvenirs for tourists would involve removing organisms from the ecosystems and this would ultimately harm the ecosystems and have a negative impact on the economies of the islands, not a positive one.
13	B	Increased coastal erosion Coral reefs provide protection for coastal areas against wave action. If the coral reefs off the coast are destroyed, the coastal region will be more exposed to wave action, resulting in increased erosion.
14	A	A rise in sea levels The graph shows a steady increase in global atmospheric carbon dioxide levels. This build-up of carbon dioxide in the atmosphere is enhancing the greenhouse effect and leading to global warming. Global warming is causing polar ice caps and glaciers to melt, resulting in rising sea levels. Rising sea levels will have a significant impact on the low-lying coastal regions of Caribbean islands.

No.	Answers	Further Explanations
15	C	Using alternative energy sources The major use of fossil fuels in today's world is to produce energy. By using alternative energy sources, the use of fossil fuels would be considerably reduced.
16	D	Increasing the use of fossil fuels Burning fossil fuels releases many different pollutants into the atmosphere, so increasing the use of fossil fuels would lead to increased destruction of the environment; it would not help to conserve and restore it.
17	D	
18	B	
19	B	

Section B: Life Processes and Disease

B1: Cells

No.	Answers	Further Explanations
1	A	
2	C	
3	C	Muscle cell Aerobic respiration releases energy from food and occurs in the mitochondria. Muscle cells require large amounts of energy to bring about movement, so need the greatest number of mitochondria.
4	D	Mitochondria: Have no internal membranes Chloroplasts: Have many internal membranes A mitochondrion has a folded inner membrane and a chloroplast has many internal membranes, so both mitochondria and chloroplasts have internal membranes.
5	A	

No.	Answers	Further Explanations
6	B	The chromatin threads Chromatin threads are composed of deoxyribonucleic acid (DNA) molecules wrapped around proteins called histones. DNA molecules contain genetic information in the form of genes.
7	D	Typical plant cell: Has no mitochondria Typical animal cell: Contains mitochondria Both plant and animal cells carry out respiration, so mitochondria are found in both types of cells.
8	A	
9	B	
10	D	
11	C	
12	A	An organ A leaf is classified as an organ because it is composed of different tissues, i.e. epidermal tissue, ground tissue and vascular tissue.
13	C	II and III only **II**: Vascular tissue transports water and mineral salts from the roots to the leaves in plants. **III**: Blood tissue transports water and mineral ions dissolved in the plasma around the bodies of humans. **I**: Adipose tissue is composed of fat cells. It insulates the bodies of animals, serves as a food reserve and protects against injury by acting as padding; it does not transport substances around the bodies of animals.

No.	Answers	Further Explanations
14	A	I only **I**: Oxygen to be used in respiration enters the bodies of living organisms by diffusion. **II**: Carbon dioxide is used in photosynthesis, not produced in photosynthesis. Diffusion is important to absorb the carbon dioxide needed for photosynthesis, not get rid of it. **III**: Water needed for photosynthesis is absorbed by the roots of plants by osmosis, not diffusion.
15	D	
16	D	R: 20% Sucrose solution S: 10% Sucrose solution T: Water Water must have entered the Visking tubing in L by osmosis, so liquid S outside the Visking tubing must be a more dilute solution than liquid R inside the Visking tubing. Water must have left the Visking tubing in M by osmosis, so liquid T inside the Visking tubing must be a more dilute solution than liquid S outside the Visking tubing.
17	B	P is more concentrated than the cytoplasm and cell sap of the cell. The cell has become plasmolysed, so water must have left the cell by osmosis. Solution P must, therefore, have been more concentrated, i.e. contained less water, than the cytoplasm and cell sap of the cell.
18	C	
19	B	

B2: Nutrition (1)

No.	Answers	Further Explanations
1	B	

No.	Answers	Further Explanations
2	C	I and III only **I**: Water is one of the basic materials from which glucose is made in photosynthesis, so is one of the raw materials for the process. **III**: Carbon dioxide is one of the basic materials from which glucose is made in photosynthesis, so is one of the raw materials for the process. **II**: Chlorophyll is used to absorb the sunlight energy during photosynthesis, but glucose is not made from it, so it is not one of the raw materials for the process.
3	D	
4	D	Temperature affects both the light and dark stages. Temperature affects the rate of enzyme activity. Enzymes are required for the dark stage, so temperature affects the dark stage only, not the light stage.
5	A	To study the effect of light intensity on the rate of photosynthesis The waterweed is being illuminated by a light source, so it would be photosynthesising, and the light source can be adjusted to provide different light intensities. The temperature and carbon dioxide concentration would both remain relatively constant because the transparent heatproof shield prevents heat passing through, and the water contains sodium hydrogencarbonate which releases carbon dioxide. Light intensity has no effect on the rate of respiration.
6	C	Oxygen Because the plant is being illuminated it would be photosynthesising. Photosynthesis produces oxygen, which the plant releases, and it collects in the inverted test tube.
7	D	Iodine solution A hibiscus plant is a dicotyledon. Leaves of dicotyledons convert excess glucose produced in photosynthesis to starch and store the starch. Iodine solution is used to test for the presence of starch.
8	A	
9	B	

No.	Answers	Further Explanations
10	C	X transports water to the leaf. X is the phloem which transports soluble food made in photosynthesis away from the cells of the leaf; it does not transport water.
11	C	Carbon dioxide concentration is the limiting factor up to point Q. Before point Q, as carbon dioxide concentration increases, the rate of photosynthesis increases, indicating the carbon dioxide concentration is limiting the rate of photosynthesis. After point Q, as carbon dioxide concentration increases, the rate of photosynthesis remains constant, indicating some factor other than carbon dioxide concentration has started to limit the rate of photosynthesis.
12	B	I and II only **I**: Leaf cells can convert the glucose produced in photosynthesis into amino acids by adding nitrogen from nitrates and sulfur from sulfates which the plant obtains from the soil. **II**: Glucose produced in photosynthesis can be converted to sucrose and transported by the phloem to the roots where it is converted back to glucose and used in respiration. **II**: Leaf cells do not store sucrose.
13	A	Carbon Plants obtain carbon in the form of carbon dioxide from the air around them and use it to manufacture food during photosynthesis. They obtain hydrogen from the soil in the form of water, and sulfur and nitrogen from the soil in the form of sulfate and nitrate ions.
14	D	
15	D	S contained starch only. Reducing sugars cause Benedict's solution to change colour from blue to orange. Proteins cause biuret solution to change colour from blue to purple. Starch causes iodine solution to change colour from orange-brown to blue-black. Because the only solution that S caused to change colour was the iodine solution, S contained starch only.
16	C	

No.	Answers	Further Explanations
17	A	I only The catalase in the liver in tube I would break down the hydrogen peroxide into water and oxygen because the contents of the tube are at room temperature and neutral. As oxygen is produced it causes effervescence. The hydrochloric acid in tube II would cause hydrogen peroxide to be very acidic and this would denature the enzymes. The liver was boiled in tube III, which would denature the enzymes.
18	B	As temperature increases, the rate of amylase activity increases to a certain temperature and then decreases. As temperature increases from 10 °C to 35 °C, the time taken for starch to be broken down decreases, therefore the rate at which the starch is broken down by amylase increases. As temperature increases from 35 °C to 45 °C, the time taken for starch to be broken down increases, therefore the rate at which the starch is broken down decreases.

B3: Nutrition (2)

No.	Answers	Further Explanations
1	B	III only **III**: Teeth break large pieces of food into smaller pieces. This increases the surface area of the pieces of food, making them easier to digest. **I** and **II**: Teeth do not have any effect on food molecules, so they cannot turn insoluble food molecules into soluble food molecules nor break down large food molecules into smaller molecules.
2	A	 A is a canine tooth which is used to grip food and tear off pieces of food. It plays the least significant role in helping to break down large pieces of food into smaller pieces.
3	C	

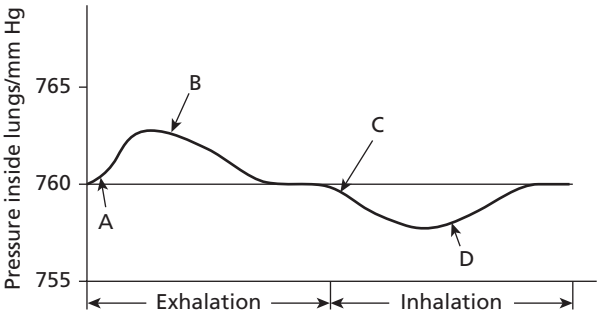
No.	Answers	Further Explanations
4	A	
5	D	
6	B	
7	B	Fried bacon The gall bladder stores bile, which contains organic bile salts. These salts emulsify lipids, increasing their surface area for digestion. If the gall bladder is removed lipids would remain as large droplets and their digestion would be more difficult. Fried bacon contains a lot of lipid, therefore without a gall bladder a person would find its digestion very difficult, so should avoid eating it.
8	A	
9	D	Lactase The sugar found in milk is lactose, which is broken down by lactase in the ileum. Some people have difficulty breaking down the lactose in milk because they do not produce lactase.
10	A	
11	C	Monosaccharides, amino acids, minerals and vitamin C Z is a blood capillary. Water-soluble substances are absorbed into the blood travelling through the blood capillaries. Monosaccharides, amino acids, minerals and vitamin C are all water soluble.
12	D	
13	D	
14	A	The food with 450 mg of calcium Brittle and weak bones are a sign that a person is not getting sufficient calcium in his or her diet, so that person should have a diet rich in calcium.
15	C	The food with 95 g of fat A person with obesity should reduce his or her consumption of fat, so a food high in fat would be unsuitable for them.

No.	Answers	Further Explanations
16	B	
17	B	
18	C	Age: 25 years Energy requirements: 10,000 kJ per day To be an office worker the person should be 25 years old, not 12 years old. The manual labourer should need more energy per day than the two office workers and a male office worker should need more energy per day than a female office worker.
19	C	
20	B	Increased consumption of: Fresh fruits and vegetables Decreased consumption of: Fried foods A person who has hypertension should eat a diet high in dietary fibre, which would be supplied by fresh fruits and vegetables. The person should eat a diet low in saturated fat and cholesterol, which would be present in fried foods.

B4: Respiration

No.	Answers	Further Explanations
1	C	The release of energy from food Respiration is the process by which energy is released from food by all living cells, it is not the process by which energy is used by cells or synthesised from food. There are two types: aerobic respiration which requires oxygen and anaerobic respiration which occurs without oxygen, so it does not always involve the oxidation of glucose.
2	B	
3	D	
4	B	

No.	Answers	Further Explanations
5	B	Aerobic respiration: Always produces carbon dioxide and water Anaerobic respiration: Always produces ethanol The products of aerobic respiration are always carbon dioxide and water, but the products of anaerobic respiration vary. Only anaerobic respiration occurring in yeast cells, known as fermentation, produces ethanol; anaerobic respiration occurring in other organisms produces other products.
6	A	
7	C	
8	C	I and III only **W** is a cluster of alveoli. **I**: The walls of the alveoli are made of a single layer of cells, so they are extremely thin and gases can diffuse through them rapidly. **III**: The alveoli are surrounded by a network of blood capillaries, so they have a rich blood supply to quickly transport gases between the alveoli and the body cells. **II**: The alveoli are lined with a layer of moisture so that gases can dissolve before they diffuse through their walls, they are not surrounded by a layer of moisture.
9	A	Into the lungs because air pressure in the thoracic cavity is decreased **X** is the diaphragm and when it contracts it moves downwards or flattens. This helps to increase the volume inside the thoracic cavity. As the volume increases, the pressure inside the thoracic cavity decreases and this causes air to be drawn into the lungs.

No.	Answers	Further Explanations
10	C	 The ribs begin to be raised when the person begins to inhale. This causes the volume inside the chest cavity to begin to increase and the pressure to begin to decrease so that air can be drawn into the lungs.
11	B	
12	A	
13	D	
14	D	Carbon dioxide diffuses into a leaf during the day because photosynthesis is occurring at a faster rate than respiration. During the day leaves carry out both photosynthesis and respiration, and the rate of photosynthesis is faster than the rate of respiration. The carbon dioxide made by the leaves in respiration is used in photosynthesis, but because photosynthesis is occurring at a faster rate than respiration, the leaves need more carbon dioxide than they make, so they obtain this by diffusion from the air surrounding them.

No.	Answers	Further Explanations
15	A	Tube I: Red-purple Tube II: Red-purple Tube III: Yellow-orange Carbon dioxide causes hydrogencarbonate indicator to change colour from red-purple to yellow-orange. Tube I is uncovered, so the leaf is exposed to light and would be photosynthesising faster than respiring. It would be absorbing carbon dioxide from the air in the tube, so the indicator remains red-purple. There is no living organism in Tube II to produce any carbon dioxide to change the colour of the indicator, so it remains red-purple. Tube III is surrounded by black paper, so the leaf is in the dark and would be respiring, but not photosynthesising. Carbon dioxide, produced in respiration, would diffuse out of the leaf and cause the indicator to change colour from red-purple to yellow-orange.
16	D	

B5: Transport (1)

No.	Answers	Further Explanations
1	B	They have a small surface area to volume ratio Multicellular organisms have a small surface area to volume ratio so diffusion through their body surface is not adequate to supply all their body cells with their requirements and remove their waste. These organisms have developed transport systems to carry useful substances from specialised organs that absorb them to body cells, and to carry waste products from body cells to specialised organs that excrete them.
2	C	
3	C	
4	D	Pump blood greater distances Chamber Z is the left ventricle and it has to pump blood all around the body. It needs a thick wall to give the blood enough pressure to travel these long distances. Chamber X is the right ventricle and it only has to pump the blood short distances to the lungs, which are next to the heart. The blood does not need to be pumped with as much pressure.

No.	Answers	Further Explanations
5	D	
6	A	The tendons The tendons prevent the valves from turning inside out when the ventricles contract, but they are not directly responsible for keeping the blood flowing in one direction.
7	C	
8	A	
9	D	
10	B	2 Blood circulating from the right ventricle would travel along the pulmonary artery to the lungs where it would travel through one set of capillaries. The blood would then return to the left side of the heart via the pulmonary vein. It would be pumped from the left ventricle through the aorta and carotid artery to the brain where it would travel through a second set of capillaries before returning to the right side of the heart via the jugular vein.
11	B	III only **III**: Carbon dioxide is a waste product that is produced by body cells during respiration. It passes from the tissues producing it through capillary walls into the blood, it does not pass through capillary walls into tissues. **I** and **II**: Phagocytes and glucose both pass from the blood through capillary walls into tissues.
12	A	It contains less urea and more carbon dioxide The renal vein transports blood away from the kidney and the renal artery transports blood to the kidney. Blood loses oxygen and urea in the kidney, so the blood leaving in the renal vein would contain less oxygen and less urea than the blood entering in the renal artery. Blood picks up carbon dioxide in the kidney, so blood leaving in the renal vein would contain more carbon dioxide than blood entering in the renal artery.

No.	Answers	Further Explanations
13	A	Since A has a lobed nucleus, it is a phagocyte. Phagocytes engulf and destroy pathogens in the blood, including bacteria.
14	B	Since B has a large nucleus, it is a lymphocyte. Lymphocytes produce antibodies to destroy disease-causing pathogens in the blood.
15	C	They are discus shaped Red blood cells are shaped like biconcave discs. They are thinner in the centre than at the edges. They are not discus shaped because a discus is very slightly thicker in the centre than at the edges.
16	D	
17	A	
18	B	II only **II**: Lymphocytes bring about immunity by producing antibodies in response to the presence of foreign antigens in the walls of pathogens present in the body. **I**: Platelets protect the body against pathogens entering at a cut by helping the blood to clot, they do not help in the development of immunity. **III**: Phagocytes protect the body against pathogens by engulfing and digesting any that are present in a cut or wound, or that have entered the body, they do not help in the development of immunity.
19	C	II and III only Vaccines must contain antigens from the disease-causing pathogens, but they must not cause symptoms of the disease to develop. **II**: Fragments of pathogens would contain antigens, but the entire pathogens would not be present to cause symptoms of the disease to develop. **III**: Live weakened pathogens would contain antigens, but the pathogens would be too weak to cause symptoms of the disease to develop. **I**: Whole live pathogens would contain antigens, but would also cause symptoms of the disease to develop.

No.	Answers	Further Explanations
20	D	

B6: Transport (2)

No.	Answers	Further Explanations
1	B	
2	D	III and VI The vascular bundle shown in the longitudinal section is the one at the top of the transverse section. Structures I and IV are the phloem tissue of the vascular bundle, structures II and V are the cambium and structures III and VI are the xylem tissue. The xylem tissue is responsible for transporting water through the stem.
3	D	
4	C	
5	B	
6	B	Changes in turgidity of the guard cells When the guard cells surrounding the stomatal pores become turgid they curve and the stomatal pores open. When the guard cells around the stomatal pores become flaccid they straighten and the stomatal pores almost close.
7	D	The rate of transpiration of the lower surfaces of the leaves is faster than the upper surfaces. The cobalt chloride paper changed colour completely in a shorter length of time when attached to the lower surface of the leaves of all three plants than when attached to the upper surfaces. This shows that the lower surfaces of the leaves were losing water at a faster rate than the upper surfaces. It does not show that transpiration takes place through the stomata, or that the lower surfaces have more stomata than the upper surfaces.

No.	Answers	Further Explanations
8	A	Y, Z, X, W The air temperature surrounding leaves Y and Z is higher than that surrounding leaves W and X, and the relative humidity of the atmosphere surrounding leaves Y and Z is lower than that surrounding leaves W and X, therefore Y and Z would transpire faster than W and X. The relative humidity of the atmosphere surrounding leaf Y is lower than that surrounding leaf Z, so Y would transpire faster than Z. The relative humidity of the atmosphere surrounding leaf X is lower than that surrounding leaf W, so X would transpire faster than W.
9	A	
10	C	Narrow, succulent leaves with few stomata and a thick cuticle. Plants living in dry conditions need to conserve water. Transpiration would be reduced in the leaves by them being narrow, therefore having a reduced surface area, and by them having few stomata and a thick waxy cuticle. The leaves being succulent would enable them to store water.
11	A	Phloem always transports dissolved food downwards. Phloem not only transports dissolved food downwards. It transports dissolved food downwards to structures such as roots and underground storage organs, but it also transports dissolved food upwards to structures such as fruits and seeds.
12	B	
13	B	

No.	Answers	Further Explanations
14	D	I, II and III **I:** The pressure flow hypothesis states that sugars move from sugar sources to sugar sinks. **II:** Stem tubers serve as sugar sources at the beginning of the growing season when stored starch is broken down into sugars, which can then move into the phloem sieve tubes. They also serve as sugar sinks when sugars made in photosynthesis during the growing season pass into them from the phloem sieve tubes, and are converted into starch and stored. **III:** Fruits serve as sugar sinks when sugars made in photosynthesis during the growing season pass into them from the phloem sieve tubes and are stored.
15	B	I and II only **I**: Food stored in plants provides reserves for the dry season when there is insufficient water available in the soil for them to photosynthesise and make food. **II**: Plants store food in the cotyledons and endosperm of their seeds for the embryonic plant to use during germination. **III**: Food stored in plants does provide food for animals when they eat the plants, but being eaten is of no benefit to the plant, so it is not a reason why plants store food.
16	C	

B7: Excretion

No.	Answers	Further Explanations
1	D	Dietary fibre is not produced by the body's metabolism Excretion is the removal from the body of waste and harmful substances produced by the body's metabolism. The body's metabolism does not produce dietary fibre, so its removal cannot be considered excretion.
2	D	
3	A	

No.	Answers	Further Explanations
4	C	
5	B	
6	B	The liver Urea is produced in the liver by deamination of amino acids. This urea then enters the blood and is transported to the kidneys where it is excreted.
7	C	
8	A	R The part of the kidney labelled R is the cortex. Ultra-filtration occurs in the glomeruli, which are present throughout the cortex.
9	B	
10	D	Less urea, less glucose, less water As the blood in X enters the glomerulus it loses urea, glucose and water by ultra-filtration into Bowman's capsule. The capillaries surrounding the nephron reabsorb the glucose and some of the water, but none of the urea, and some of the glucose is used by the cells of the nephron in respiration. As a result, the blood leaving the nephron in Y has less urea, glucose and water than the blood entering in X.
11	C	Fibrinogen Fibrinogen is a plasma protein whose molecules are too big to be forced out of the blood in a glomerulus into Bowman's capsule.
12	B	Respiration Glucose molecules are reabsorbed into the blood in the first convoluted tubule of each nephron by active transport, which uses energy produced in respiration.
13	A	

No.	Answers	Further Explanations
14	A	Become more concentrated If the blood contains insufficient water, i.e. it is too concentrated, the pituitary gland will secrete ADH which will be taken to the kidneys in the blood where it will make the walls of the second convoluted tubules and collecting ducts more permeable to water. Most of the water will be reabsorbed from the filtrate back into the blood so the urine will become more concentrated.
15	B	Increased urine production If the concentration of body fluids decreases, i.e. it becomes too dilute, the pituitary gland stops secreting ADH and the walls of the second convoluted tubules and collecting ducts become almost impermeable to water. Very little water is reabsorbed from the filtrate into the blood and a large quantity of dilute urine is produced.
16	C	I and II only **I** and **II**: The kidneys remove waste products from the body and regulate the concentration of body fluids. If they are not functioning properly then waste cannot be removed from the body and the concentration of body fluids cannot be regulated properly. **III**: The kidneys remove waste from the body, they do not produce waste.

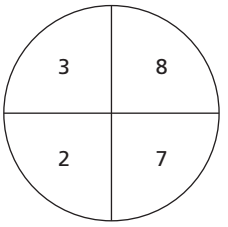
B8: Movement

No.	Answers	Further Explanations
1	D	
2	C	
3	B	

No.	Answers	Further Explanations
4	C	II and III only **II**: The bones of the limbs have joints between them to enable movement, e.g. the elbow and knee joints. **III**: The limb bones are long and fairly thin to provide a large surface area for muscle attachment and allow long strides to be taken. **I**: Some limb bones have projections at their ends for muscle attachment, but they do not have projections along the entire length of the bones.
5	D	
6	B	
7	A	
8	B	I and III only **I:** I is synovial fluid which lubricates the joint, helping to prevent friction. **III:** III is articular cartilage which is slippery, so helps to reduce friction. **II:** II is the capsule composed of ligaments. It holds the bones together, but does not help to reduce friction.
9	A	The joint allows movement in two planes. The joint is a hinge joint which allows movement in one plane only, not two planes.
10	A	It is elastic and joins bone to bone. Ligaments hold bones together at joints. They are elastic to allow the bones in the joint to move.
11	D	
12	C	T The extensor is the muscle that straightens a joint when it contracts. When T contracts it pulls on the end of the ulna causing the radius and ulna to be lowered and the elbow joint to straighten. At the same time S, the flexor, relaxes.

No.	Answers	Further Explanations
13	A	
14	B	Biceps muscle: Contracted Triceps muscle: Relaxed The biceps muscle is the flexor and the triceps is the extensor. When the biceps contracts, the triceps relaxes and the radius and ulna are pulled upwards causing the elbow to bend.

B9: Irritability (1)

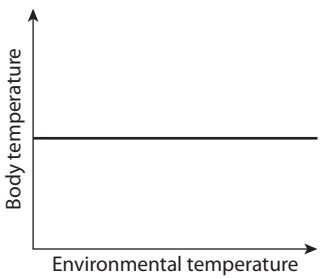
No.	Answers	Further Explanations
1	C	
2	B	The retina of the eye An effector is the part of an organism that responds to a stimulus. The retina of the eye contains light-sensitive cells which detect colour and intensity of light. The retina is, therefore, a receptor, not an effector.
3	D	
4	B	 When the invertebrates were given choices between two different environments, they showed a clear preference for the moist environment over the dry environment, but showed no clear preference for the dark or the light environment. Choice chamber B shows almost the same results when the invertebrates were given a choice of four environments; in total 5 organisms gathered in the dry side and 15 gathered in the moist side, and 11 gathered in the dark side and 9 gathered in the side with light.

No.	Answers	Further Explanations
5	A	Earthworms move away from moisture to avoid desiccation. Because earthworms do not have a waterproof skin, they move towards moisture to avoid desiccation caused by them losing water by evaporation through their skin, they do not move away from moisture.
6	C	
7	D	
8	A	
9	C	
10	B	I and II only **I**: Synapses are tiny gaps between the synaptic knobs of one neurone and the dendrites or cell bodies of adjacent neurones. **II**: Chemicals are released into the synapses by the synaptic knobs and these chemicals cause impulses to be set up in the adjacent neurones, ensuring impulses travel in one direction. **III**: Impulses pass across synapses by chemical means, not electrical means.
11	A	A dog salivating when his master says 'bone'. A simple reflex action happens without conscious thought and is not learnt. A dog salivating when he smells food such as a bone is a simple reflex, however, a dog has to learn to associate the sound of the word 'bone' with the smell of the bone before he will salivate when he hears the word 'bone'.
12	D	
13	D	Region of Central Nervous System: Spinal cord Function: Control of balance The cerebellum controls balance and posture, not the spinal cord.
14	A	
15	C	

No.	Answers	Further Explanations
16	A	Taking drugs of any kind is illegal. It is legal to take prescription drugs, over the counter drugs, alcohol and certain other drugs, so it is only illegal to take certain kinds of drug, not drugs of any kind.
17	D	

B10: Irritability (2)

No.	Answers	Further Explanations
1	A	
2	C	
3	C	3 The structure labelled 3 is the cornea. The cornea bends the light rays entering the eye to the greatest extent, the lens then refracts the rays to a much lesser extent to focus them onto the retina.
4	D	
5	C	Circular muscles of the iris: Contract Radial muscles of the iris: Relax Pupil: Constricts When a bright light is shone into a person's eyes, the pupil constricts to reduce the amount of light entering the eye and prevent damage to the retina. To cause it to constrict, the circular muscles of the iris contract and this reduces their circumference, hence the circumference of the pupil. At the same time the radial muscles relax.
6	A	

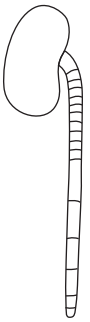
No.	Answers	Further Explanations
7	A	Ciliary muscle: Relaxes Suspensory ligaments: Pulled tight Lens: Flattens When focusing on a distant object, the lenses must be as flat as possible so that the light rays are only bent slightly to focus them onto the retina. To achieve this, the ciliary muscle of each eye relaxes, which increases the muscles' circumference. This pulls the suspensory ligaments tight, and these pull on the edge of the lens and pull it into a flattened shape.
8	B	It is caused by the lens being too bulged. The light rays are focused in front of the retina which means they are being refracted too much by the lens. A lens which is too bulged for the size of the eyeball would refract the rays too much.
9	D	 A person suffering from long-sightedness cannot focus on near objects because the light rays from the near objects are not refracted enough, so they focus behind the retina. It is corrected by wearing converging lenses to refract the light rays inwards before they enter the eye. If contact lenses are being used to correct the sight defect, the lenses must be curved in such a way that they can sit comfortably over the cornea.
10	A	 Mammals are homeotherms so their body temperatures remain almost constant regardless of the environmental temperature.
11	B	Heat from the body Sweat is produced when the body temperature rises above 37 °C. Water in the sweat then evaporates, removing heat from the body.

No.	Answers	Further Explanations
12	B	Layer B is the malpighian layer, which produces the pigment melanin. Being brown in colour, melanin helps the epidermis of the skin to protect the layers below against the harmful ultra-violet rays of the Sun.
13	D	Layer D is the subcutaneous layer composed of fat cells, which protects against heat loss in low environmental temperatures, such as those experienced by polar bears.
14	C	
15	B	**B** I and II only **I**: Ageing skin starts to lose moisture, and become thinner and looser. Good skin care can help prevent these things from happening to a certain extent. **II**: Moisturising the skin helps to increase the water content of the epidermis, making it softer and more pliable, and so should be done as part of a daily skin care routine. **III**: Many skin bleaching products contain hydroquinone, which can irritate the skin, and cause skin sensitivity and blue-black discolouration. Some skin bleaching products also contain steroids, which can cause the skin to become thin. Therefore, skin bleaching products are not completely harmless to the skin.
16	B	

B11: Growth

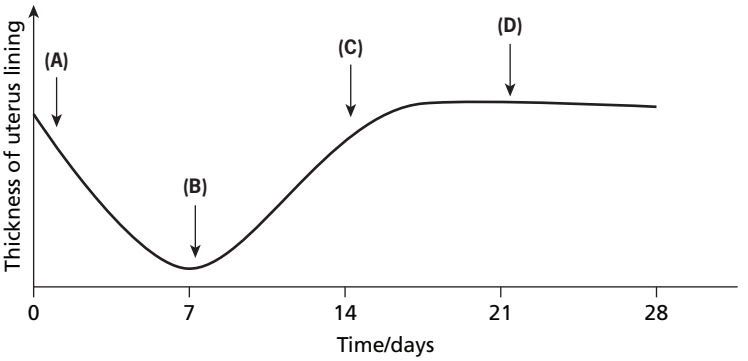
No.	Answers	Further Explanations
1	D	Z Measuring dry mass would give the most accurate measurement of growth because it measures the increase in total cellular and extracellular material without water.
2	D	

No.	Answers	Further Explanations
3	A	Sigmoid The number of living cells increased slowly up to day 8 and then started to increase more rapidly up to day 24. The increase in number then slowed down until there was no further increase after day 36, creating an S-shaped or sigmoid growth curve.
4	B	I and II only **I**: As the number of cells was increasing their demands on the nutrients in the solution was also increasing, causing the supply of nutrients to gradually become depleted. This caused cells to die due to a lack of nutrients, and fewer to be produced. **II**: As the number of cells was increasing they were producing increasing quantities of waste products which were accumulating and poisoning the cells, causing them to start to die and fewer to be produced. **III**: Bacteria do not need light to grow and reproduce, so if the solution did become opaque it would have had no effect on the number of cells present.
5	A	
6	A	Growth in plants occurs mainly by cell division. Most growth in plants occurs by newly formed cells taking water into their vacuoles and expanding, it does not occur by cell division because the new cells formed during division are very small in comparison to the size of the cells after they have taken in water.
7	B	
8	C	
9	C	Seeds need oxygen to germinate. Waterlogged soils contain only very limited quantities of dissolved oxygen in the water, so the best conclusion is that oxygen is needed for seeds to germinate.
10	B	

No.	Answers	Further Explanations
11	D	 Cell division occurs in the very tip of the radicle and the newly formed cells then elongate in the region directly behind the tip, so the distance between the marks increases in the region where cell elongation takes place behind the tip. Once the cells have fully elongated they begin to differentiate into xylem and phloem and do not elongate anymore. This takes place in the region behind where the cells elongated, so the distance between marks on the top part of the radical does not change.
12	C	Respiration The dry mass decreases up to day 8 because the embryonic plants are using the food stored in their cotyledons in respiration to release energy to grow. Respiration also produces carbon dioxide and water, neither of which contributes to the dry mass of the seeds. The embryonic plants have not yet developed their first foliage leaves, so are not photosynthesising and making food to replace the food used.
13	B	Photosynthesis The dry mass increases after day 8 because the seedlings have started to develop their first foliage leaves, so begin to photosynthesise and produce food, which contributes to the dry mass.

B12: Reproduction (1)

No.	Answers	Further Explanations
1	B	It produces variation among offspring. Offspring produced sexually show variation. This enables species to change and adapt to changing environmental conditions, which is of utmost importance to the survival and improvement of species. Offspring produced asexually show no variation. This does not enable species to change and adapt to changing environmental conditions, so does not enable species to improve.
2	B	I and II only **I**: Asexual reproduction conserves the characteristics of the parent, so is conservative. **II**: Offspring produced asexually usually remain close to the parent and this can lead to the parent and offspring being overcrowded. **III**: All offspring produced asexually are genetically identical, so species will not be able to change and adapt to changing environmental conditions.
3	A	
4	A	
5	D	
6	A	Structure A is the bladder, which produces urine, and urine is not one of the components of semen. Semen is composed of secretions from the seminal vesicles (structure B) and the prostate gland (structure C), together with sperm from the testes (structure D).
7	D	
8	D	

No.	Answers	Further Explanations
9	C	 Ovulation occurs when the uterus lining is almost at its thickest so that the embryo has a thick layer of tissue with a rich blood supply to be able to sink into.
10	C	
11	A	
12	D	
13	B	
14	C	Structure: Umbilical artery Function: Transports food to the foetus The umbilical artery carries blood away from the foetus to the placenta so the blood it contains would be transporting dissolved carbon dioxide and waste, it would not be transporting food to the foetus.
15	B	I and II only **I**: Progesterone is secreted by the placenta to prevent ova being released from the ovaries during pregnancy. **II**: Progesterone is secreted by the placenta to keep the uterus lining thick during pregnancy so that there is an adequate blood supply to provide the developing embryo with food and oxygen, and remove carbon dioxide and other waste products from the developing embryo. **III**: A reduction in secretion of progesterone by the placenta stimulates the pituitary gland to secrete oxytocin which initiates labour, progesterone itself does not initiate labour.

No.	Answers	Further Explanations
16	B	
17	C	Protect against sexually transmitted infections Condoms are the only contraceptive device that protect against the transmission of sexually transmitted infections, so this gives them a distinct advantage over all other contraceptive devices.
18	A	The spread of HIV/AIDS can be controlled by setting up immunisation programmes. There is currently no vaccination available to provide immunity against HIV/AIDS, so it cannot currently be controlled by setting up immunisation programmes.
19	C	I and III only **I**: Condoms provide a barrier during sexual intercourse which protects against the transmission of the bacteria that cause gonorrhoea, and this helps to control the spread of the disease. **III**: Educating populations about gonorrhoea can help control its spread. **II**: Gonorrhoea is not transmitted by sharing infected hypodermic needles, so implementing needle and syringe exchange programmes for drug addicts would not help to control the spread of the disease.
20	D	Father to his unborn daughter. It is possible for a mother to transmit the HIV/AIDS virus to her unborn daughter because the virus can pass across the placenta during pregnancy, a father cannot transmit it to his unborn daughter in this way or any other way.

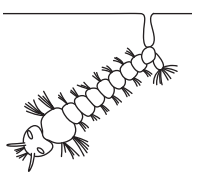
B13: Reproduction (2)

No.	Answers	Further Explanations
1	C	
2	C	
3	D	

No.	Answers	Further Explanations
4	A	
5	B	Produce male gametes The stamen is the male part of a flower composed of the anther and filament. Its main function is to produce pollen grains, which contain the male gametes.
6	D	
7	D	Wind pollinated: Anthers are firmly attached to the filaments Insect pollinated: Anthers are loosely attached to the filaments In a wind-pollinated flower the anthers usually hang outside the flower and are loosely attached to the filaments so that the wind can shake them when it blows and easily blow the pollen grains off them, they are not firmly attached. In an insect-pollinated flower the anthers are usually inside the flower and firmly attached to the filaments so that they are not damaged as the insect brushes past them as it goes to get nectar, they are not loosely attached.
8	C	Flower R: Bee Flower S: Wind The bright red petals of flower R would attract animals flying during the day, e.g. bees or hummingbirds, but because they are unscented, they would not attract bats that fly at night. The feathery stigmas of flower S would trap pollen grains blowing in the wind, and the large anthers hanging outside the flower would enable the wind to easily blow the pollen grains off them.
9	D	

No.	Answers	Further Explanations
10	B	The plant is only cross-pollinated. Plant X did not produce seeds when the anthers were present and the buds were enclosed in paper bags indicating that the flowers could not pollinate themselves. Plant Z produced seeds when it had no anthers and the buds were uncovered because pollen from other flowers could reach the stigmas indicating the flowers could be cross-pollinated. Plant Y did not produce seeds when the anthers were removed and the buds were enclosed in paper bags because pollen from other flowers could not reach the stigmas due to the paper bags. This supports the fact that the flowers had to be cross-pollinated. It cannot be deduced from the results whether the wind or insects carried the pollen grains between flowers.
11	A	The sepals remain around the fruit. An avocado fruit does not have sepals around it at the point where it is attached to the pedicel.
12	B	
13	D	
14	A	Fleshy and brightly coloured with several small seeds. Birds would be attracted to eat the fruit because of it being brightly coloured and fleshy. The small seeds would also be eaten and pass, unharmed, through the digestive system of the bird. The seeds would then be deposited in a different location in the faeces of the bird.
15	C	W: Wind X: Mechanical means The parachute of hairs of fruit W provides a large surface area to help the wind to carry the fruit. Fruit X has split open along the lines of weakness causing it to eject its seeds.

B14: Disease

No.	Answers	Further Explanations
1	D	
2	A	
3	C	Scurvy is caused by a deficiency of calcium in the diet. Scurvy is caused by a deficiency of vitamin C in the diet, not by a deficiency of calcium.
4	A	Caused by a pathogen Pathogens are microscopic organisms that cause disease. Most pathogens can be easily passed on from person to person, resulting in diseases caused by them spreading easily and quickly through populations.
5	C	
6	B	
7	A	
8	B	 Stage B is the larval stage. The larvae feed on micro-organisms and organic matter in the water and grow rapidly as they feed.
9	D	Spraying areas where adult mosquitoes are found with insecticides. Insecticides sprayed into the air can cover only limited areas, and they rapidly disperse away from the areas where they were sprayed so their effectiveness quickly decreases. Also, because adult mosquitoes fly, they can quickly fly away from the spray or hide in small nooks and corners.

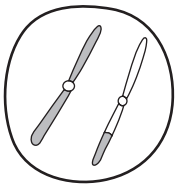
No.	Answers	Further Explanations
10	B	III only **III**: The role of insulin is to reduce blood glucose levels if they rise too high, mainly by stimulating the body cells to absorb glucose for respiration. **I**: Insulin has no effect on the kidneys in a person with or without diabetes. **II**: Insulin injected into the body by a diabetic does not have any effect on the pancreas.
11	D	
12	C	Practising good personal hygiene. Diabetes and hypertension are physiological diseases caused by the malfunctioning of body organs. They are not caused by pathogens which can be reduced in numbers and controlled by practising good personal hygiene.
13	A	Quarantine persons with the disease. Most viral infections pass from person to person by direct or indirect bodily contact, i.e. they are contagious. Isolating or quarantining persons with the disease would be the most effective way to prevent the virus spreading from person to person.
14	B	

Section C: Continuity and Variation

C1: Inheritance and Variation (1)

No.	Answers	Further Explanations
1	C	
2	A	
3	B	32 The diploid number is the number of chromosomes per body cell, and the haploid number is half the diploid number.
4	B	Each cell produced in mitosis contains the haploid number of chromosomes. Mitosis is the process by which body cells divide, and each daughter cell produced in mitosis contains the same number of chromosomes as the parent cell. Because body cells all contain the diploid number of chromosomes, daughter cells produced by mitosis would all contain the diploid number of chromosomes, not the haploid number.
5	C	
6	D	
7	C	6 The diagram shows 6 chromatids reaching each pole of the cell. As they reach the poles a nuclear membrane forms around each group and the cell divides across the equator forming two daughter cells. At this stage the chromatids in each cell become known as chromosomes, so each daughter cell would have 6 chromosomes, i.e. the diploid number.
8	B	8 The first division would produce 2 cells. These cells would each divide, so the second division would produce a total of 4 cells. These cells would each divide, so the third division would produce a total of 8 cells.

No.	Answers	Further Explanations
9	B	I and II only **I**: Grass plants produced asexually from a single parent are produced by mitosis, and because mitosis produces genetically identical cells, all the plants would have the same genetic makeup as the parent. **II**: All offspring produced asexually from one parent are collectively known as a clone. **III**: The appearance of an organism is determined by its genetic makeup and the influences of its environment. Grass plants produced asexually from a single parent may be under slightly different environmental influences, so they are not necessarily going to be identical in appearance.
10	A	
11	C	II and III only **II**: Growing sweet potato plants asexually from stem cuttings produces offspring in a shorter time than by sexual means, which should decrease the time it takes the farmer to produce a crop of sweet potatoes. **III**: All sweet potato plants grown asexually from stem cuttings will be genetically identical to the parent plant, so farmers can take stem cuttings from plants with desirable characteristics and all offspring will have the same desirable characteristics. **I**: Because all sweet potato plants grown asexually from stem cuttings will be genetically identical to the parent plant, it does not lead to variation.
12	D	

No.	Answers	Further Explanations
13	A	II only **II**: Each gamete produced by meiosis has the haploid number of chromosomes, i.e. half the diploid number of chromosomes which are present in body cells. This is important so that the diploid number of chromosomes can be restored when fertilisation occurs. **I**: Meiosis is not a faster process than mitosis, so gametes are not formed in a faster time. **III**: A cell divides twice during meiosis to produce four cells. Four cells are also produced when a cell divides twice by mitosis. Meiosis does not enable more cells to be produced.
14	C	 The diploid number of the parent cells was four, i.e. it had two pairs of chromosomes, one long pair and one short pair. The nucleus of a viable mature ovum must have one chromosome from each pair, i.e. one long and one short, not two long chromosomes.
15	B	I and II only **I**: When adjacent chromatids cross over each other, they break at the crossover points and rejoin with the opposite chromatids, thereby exchanging genes. **II**: When chromosome pairs arrange themselves around the equators of the spindles, they do so in totally random ways so that no two gametes have the same combination of genes. **III**: Chromatids do not disintegrate during meiosis.

C2: Inheritance and Variation (2)

No.	Answers	Further Explanations
1	D	
2	D	

<table>
<tr><th>No.</th><th>Answers</th><th>Further Explanations</th></tr>
<tr><td>3</td><td>A</td><td></td></tr>
<tr><td>4</td><td>C</td><td></td></tr>
<tr><td>5</td><td>C</td><td>3 : 1
Representing the alleles using B and b, a heterozygous individual has one dominant allele and one recessive allele, i.e. genotype Bb. If two heterozygous individuals are crossed, 25% of the offspring would be homozygous dominant, BB, 50% would be heterozygous, Bb, and 25% would be homozygous recessive, bb. The homozygous dominant and heterozygous offspring would all have the dominant trait, i.e. 75% of the offspring would have the dominant trait, and 25% would have the recessive trait.
Shown as a Punnett square:
<table>
<tr><th>gametes</th><th>B</th><th>b</th></tr>
<tr><td>B</td><td>BB</td><td>Bb</td></tr>
<tr><td>b</td><td>Bb</td><td>bb</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>B</td><td>60 are tall and 60 are dwarf.
Representing the alleles using T and t, the tall plant must be heterozygous, Tt. Because it is tall it must have at least one dominant allele, T, but because one of its parents was dwarf, it must have received one recessive allele, t, from its dwarf parent. The dwarf plant must be homozygous recessive, tt. If a heterozygous individual is crossed with a homozygous recessive individual, 50% of the offspring are heterozygous, i.e. tall, and 50% of the offspring are homozygous recessive, i.e. dwarf.
Shown as a Punnett square:
<table>
<tr><th>gametes</th><th>t</th><th>t</th></tr>
<tr><td>T</td><td>Tt</td><td>Tt</td></tr>
<tr><td>t</td><td>tt</td><td>tt</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>No.</th><th>Answers</th><th>Further Explanations</th></tr>
<tr><td>7</td><td>D</td><td>100% red-eyed.
Representing the alleles using R and r, if the red-eyed fly was homozygous dominant, RR, it could only pass on the dominant allele for red eyes, so all the offspring would receive one dominant allele from this fly and would have red eyes.
Shown as a Punnett square:<table><tr><th>gametes</th><td>(r)</td><td>(r)</td></tr><tr><td>(R)</td><td>Rr</td><td>Rr</td></tr><tr><td>(R)</td><td>Rr</td><td>Rr</td></tr></table></td></tr>
<tr><td>8</td><td>C</td><td>Both parents are heterozygous.
Representing the alleles using B and b, the brown mouse produced in the second litter must be homozygous recessive, bb, so it must have received one recessive allele, b, from each of its parents. Both parents were black, so each must also have one dominant allele, B.
Shown as a Punnett square:<table><tr><th>gametes</th><td>(B)</td><td>(b)</td></tr><tr><td>(B)</td><td>BB</td><td>Bb</td></tr><tr><td>(b)</td><td>Bb</td><td>bb</td></tr></table></td></tr>
</table>

<table>
<tr><th>No.</th><th>Answers</th><th>Further Explanations</th></tr>
<tr><td>9</td><td>B</td><td>Nn

The male parent, R, has normal pigmentation, so must have at least one dominant allele, N. Because two of the offspring have albinism, individual R must also have a recessive allele, n, to pass on to these offspring, the offspring having got the other recessive allele from their albino mother who has the genotype nn.

Shown as a Punnett square:

<table>
<tr><td>gametes</td><td>(n)</td><td>(n)</td></tr>
<tr><td>(N)</td><td>Nn</td><td>Nn</td></tr>
<tr><td>(n)</td><td>nn</td><td>nn</td></tr>
</table>
</td></tr>
<tr><td>10</td><td>B</td><td>25%

Person S must have the genotype Nn. Because he has normal pigmentation, he must have at least one dominant allele, N. His mother had albinism, so he must have received one recessive allele, n, from her. His wife is also heterozygous, so must have the genotype Nn. There is a 25% chance that each offspring produced by two heterozygous individuals will have the recessive trait, i.e. albinism.

Shown as a Punnett square:

<table>
<tr><td>gametes</td><td>(N)</td><td>(n)</td></tr>
<tr><td>(N)</td><td>NN</td><td>Nn</td></tr>
<tr><td>(n)</td><td>Nn</td><td>nn</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>No.</th><th>Answers</th><th>Further Explanations</th></tr>
<tr><td>11</td><td>D</td><td>One quarter red, one quarter white and half pink.
Because all the offspring of the cross between pure breeding red- and white-flowered plants had pink flowers, an intermediate colour, the two alleles controlling flower colour must show co-dominance. Representing the alleles using R and W, the pink-flowered plants must be heterozygous, RW. Self-pollinating one of these heterozygous plants would produce 25% homozygous red-flowered plants, RR, 50% heterozygous pink-flowered plants, RW, and 25% homozygous white-flowered plants, WW.
Shown as a Punnett square:
<table>
<tr><th>gametes</th><td>(R)</td><td>(W)</td></tr>
<tr><td>(R)</td><td>RR</td><td>RW</td></tr>
<tr><td>(W)</td><td>RW</td><td>WW</td></tr>
</table></td></tr>
<tr><td>12</td><td>A</td><td>I^AI^B
ABO blood groups are controlled by three alleles, I^A, I^B and I^O. I^A and I^B are co-dominant and are both dominant to I^O. The mother had blood group O, so must have the genotype I^OI^O. She must have passed one I^O allele to each child. The child with blood group A must have received an I^A allele from his or her father, and the child with blood group B must have received an I^B allele from his or her father.
Shown as a Punnett square:
<table>
<tr><th>gametes</th><td>(I^A)</td><td>(I^B)</td></tr>
<tr><td>(I^O)</td><td>I^AI^O</td><td>I^BI^O</td></tr>
<tr><td>(I^O)</td><td>I^AI^O</td><td>I^BI^O</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>No.</th><th>Answers</th><th>Further Explanations</th></tr>
<tr><td>13</td><td>A</td><td>II only
II: Alleles Hb^A and Hb^S show co-dominance. Individual U has one of each allele so will produce about 55 to 65% normal haemoglobin A and 35 to 45% abnormal haemoglobin S and have the intermediate characteristic, i.e. sickle-cell trait.
I: Individual U has two Hb^A alleles, so will produce 100% normal haemoglobin A, and will not suffer from either sickle-cell trait or sickle-cell anaemia.
III: Individuals U and W are both heterozygous, i.e. genotype Hb^AHb^S. 25% of their children would have the genotype Hb^AHb^A, so would be normal, 50% of their children would have the genotype Hb^AHb^S, so would have sickle-cell trait, and 25%, not 50%, of their children would have the genotype Hb^SHb^S, so would have sickle-cell anaemia.
III shown as a Punnett square:
<table>
<tr><th>gametes</th><th>Hb^A</th><th>Hb^S</th></tr>
<tr><td>Hb^A</td><td>Hb^AHb^A</td><td>Hb^AHb^S</td></tr>
<tr><td>Hb^S</td><td>Hb^AHb^S</td><td>Hb^SHb^S</td></tr>
</table>
</td></tr>
<tr><td>14</td><td>B</td><td></td></tr>
</table>

<table>
<tr><th>No.</th><th>Answers</th><th>Further Explanations</th></tr>
<tr><td>15</td><td>B</td><td>1 in 2 chance

Representing the alleles using H and h, the heterozygous mother would have the genotype X^HX^h and the father with normal clotting would have the genotype X^HY. There is a 50% chance that the mother would pass an X chromosome containing the dominant allele, X^H, on to each son and a 50% chance she would pass an X chromosome containing the recessive allele, X^h, on to each son. The father would pass the Y chromosome on to each son, and this does not carry an allele controlling blood clotting.

Shown as a Punnett square:

<table>
<tr><td>gametes</td><td>(X^H)</td><td>(Y)</td></tr>
<tr><td>(X^H)</td><td>X^HX^H</td><td>X^HY</td></tr>
<tr><td>(X^h)</td><td>X^HX^h</td><td>X^hY</td></tr>
</table>
</td></tr>
<tr><td>16</td><td>A</td><td>Identical genotypes only.

Asexual reproduction produces organisms by mitosis. Because each daughter cell produced in mitosis has an identical combination of genes, all organisms produced asexually from a single parent will have identical genotypes. The phenotype of an organism is determined by its genotype and the influences of its environment, so organisms with identical genotypes are not necessarily going to have identical phenotypes because the influences of their environments will not be identical.</td></tr>
<tr><td>17</td><td>D</td><td></td></tr>
</table>

No.	Answers	Further Explanations
18	C	I and III only **I:** If organisms show variation, some may be better adapted to their environment than others. The well adapted organisms are more likely to survive and reproduce and pass on their advantageous characteristics to their offspring, which results in species gradually changing and becoming better adapted to their environment. **III:** If organisms show variation and environmental conditions change adversely, some may be better adapted to the new conditions and survive the adverse change, so the entire species will not be wiped out. **II:** If organisms show variation, some may not be well adapted to their environment, and if the environmental conditions remain unchanged, they will possibly not survive and reproduce in the struggle for survival.
19	C	
20	A	

C3: Species, Selection and Genetic Engineering

No.	Answers	Further Explanations
1	B	
2	D	
3	A	II only **II**: Until the mid-twentieth century, the Caribbean monk seal was hunted by humans for its fur, meat and oil and its extinction is attributed to overhunting. **I**: An increase in the number of prey of the seal would provide it with more food to eat so would possibly lead to an increase in its numbers, not a decrease to the point of extinction. **III**: The habitat of the seal was the warm waters of the Caribbean, and these waters still exist.

No.	Answers	Further Explanations
4	C	
5	D	They are sudden changes in genetic material. Genetic variation provides the raw material for natural selection. Mutations are sudden changes in a gene or part of a chromosome containing several genes and, therefore, result in an increase in genetic variation.
6	B	III only **III**: Beef cattle showing desirable characteristics have been selected and bred by humans in the Caribbean to produce varieties with characteristics to suit human needs, they have not evolved as a result of natural selection. **I**: The melanic variety of the peppered moth in Britain arose out of a beneficial mutation which provided the raw material for natural selection and resulted in the melanic variety becoming more numerous than the speckled variety in polluted, industrialised regions. **II**: As a result of natural selection, anole lizards on Cuba, Hispaniola, Jamaica and Puerto Rico independently evolved into different species with similar characteristics that enabled them to fit similar ecological niches on each island.
7	B	
8	C	
9	A	
10	C	
11	B	I and II only **I**: Genetic engineering is being used to improve crop yields, e.g. by making crops resistant to certain pests or herbicides crop yields can be increased. **II**: Genetic engineering is being used to make certain vaccines containing antigens of the pathogen. **III**: Genetic engineering has not yet been used to protect crops against a shortage or lack of certain mineral ions in the soil which causes deficiency diseases.

No.	Answers	Further Explanations
12	D	Help fight vitamin A deficiency in developing countries. By inserting two genes into the DNA of rice plants, the endosperm of the rice grains is stimulated to produce beta-carotene, which the body converts to vitamin A. This results in the production of rice rich in beta-carotene, which can help fight vitamin A deficiency in developing countries where rice is a staple food.
13	A	
14	A	Decreased resistance of crops to disease. Genetic engineering is being used to increase the resistance of crops to disease, which is an advantage of genetic engineering; decreasing the resistance of crops to disease would not be an advantage.
15	D	
16	B	To treat a physiological disease. Analysing specific regions of DNA would not treat a physiological disease caused by the malfunctioning of a body organ or a change in the structure of certain body cells over time causing them to not function correctly.