

Answers to revision questions

1 Living organisms and cells

1. *Three similarities:*

- Both a car and a living organism release energy from fuel: a car releases energy from petrol (gasoline) and a living organism releases energy from food.
- Both a car and a living organism produce waste and harmful substances.
- Both a car and a living organism can change their positions, i.e. move.

Any three of the following differences:

- All living organisms are capable of obtaining or making food, whereas a car cannot do either.
- All living organisms are capable of increasing in size, whereas a car cannot change its size.
- All living organisms can detect and respond to changes in their environment, whereas a car cannot do either.
- All living organisms can produce new individuals of the same kind as themselves, whereas a car cannot produce new individuals.

2. A cell is the basic structural and functional unit of all living organisms.

3. a) A mitochondrion is where respiration occurs to release energy for the cell.
b) The endoplasmic reticulum transports substances throughout the cell.
c) A chloroplast is where photosynthesis occurs to produce food for the plant.
d) Ribosomes are where proteins are synthesised or produced.
e) The cell membrane controls what substances enter and leave the cell.

4. The cell would not be able to divide or properly control its characteristics and functioning.

5. *Any four of the following differences:*

- An animal cell does not have a cell wall. A plant cell has a cell wall.
- An animal cell does not have chloroplasts or chlorophyll. A plant cell has chloroplasts containing chlorophyll.
- An animal cell may have small vacuoles with differing contents scattered throughout the cytoplasm. A plant cell has one large, central vacuole containing cell sap.
- Animal cells may contain glycogen granules as a food store. Plant cells may contain starch grains as a food store.
- Animal cells can have a variety of different shapes. Plant cells are usually round, square or rectangular.

Any three of the following similarities:

- Both cell types are surrounded by a cell membrane.
- Both cell types possess cytoplasm.
- Both cell types possess a nucleus.
- Both cell types possess mitochondria throughout the cytoplasm.

- Both cell types have endoplasmic reticulum running throughout the cytoplasm.
- Both cell types possess ribosomes.

6. A bacterial cell would lack a true nucleus and other membrane-bound organelles such as a nucleus and mitochondria, which are found in other cells. Instead of a true nucleus, their DNA would be seen in a region called the nucleoid, which would lack a nuclear membrane, and also in smaller regions called plasmids throughout their cytoplasm.

7. a) Cells in the bodies of multicellular organisms become specialised to carry out specific functions to enable multicellular organisms to carry out all essential life processes efficiently. By becoming specialised, these cells are better able to carry out their specific functions.

b) *Any three of the following:*

- Epithelial cells. These cover and protect body surfaces.
- Sperm cells. These are the male gametes. Each sperm cell fuses with a female gamete during fertilisation to form a zygote.
- Eggs cells or ova. These are the female gametes. Each ovum fuses with a male gamete during fertilisation to form a zygote.
- Nerve cells or neurones. These transmit impulses throughout the body to control and coordinate the functioning of the body.
- Muscle cells. These contract to cause movement of parts of the body.

8. a) A tissue is a group of cells, usually all of the same type, which work together to carry out a particular function.

b) An organ is composed of several different types of tissues grouped together and it may perform one or more specific functions.

c) An organ system is composed of several different organs working together to carry out a major function.

9. 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, whereas osmosis is the movement of water molecules through a partially (differentially) permeable membrane from a solution containing a lot of water molecules, e.g. a dilute solution (or water), to a solution containing fewer water molecules, e.g. a concentrated solution.

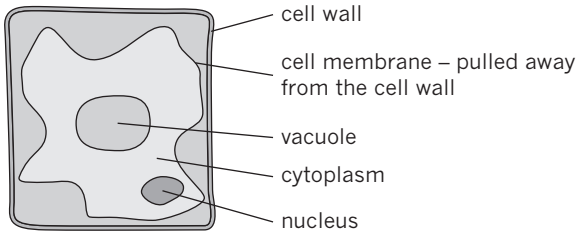
10. - Oxygen for use in aerobic respiration moves into cells by diffusion, and carbon dioxide produced in aerobic respiration moves out of cells by diffusion.

- Some of the glucose and amino acids produced in digestion are absorbed through the cells in the ileum and capillary walls and into the blood by diffusion.

- Carbon dioxide for use in photosynthesis moves into leaves and plant cells by diffusion, and oxygen produced in photosynthesis moves out of plant cells and leaves by diffusion.

11. Water enters the cytoplasm of the cell through the partially permeable cell membrane by osmosis. This causes the cell to swell and it may eventually burst.

12.



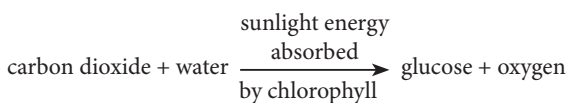
13. Any three of the following:

- Water moves into animal cells from blood plasma and body fluids by osmosis. This keeps them hydrated.
- Water is absorbed from the intestines into the blood by osmosis. This ensures that the body obtains the water it needs from food and drink consumed.
- Water is reabsorbed from the filtrate in the kidney tubules into the blood by osmosis. This prevents the body from losing too much water.
- Water moves into plant cells by osmosis. This keeps them turgid and causes non-woody stems to stand upright and keeps leaves firm.
- Water is absorbed from the soil by the root hairs of plants and moves through the cells of roots and leaves by osmosis. This ensures that leaves get a constant supply of water for photosynthesis.

14. If respiration cannot occur, the energy needed to move mineral ions from the soil (by active transport) through the membranes of the root cells into the root cannot be produced, so the root is unable to absorb mineral ions.

2 Photosynthesis, food chains and cycles

1. Photosynthesis is the process by which green plants convert carbon dioxide and water into glucose by using sunlight energy absorbed by chlorophyll in chloroplasts.



2. - Glucose can be used by the leaf cells in respiration to release energy.
 - Glucose can be condensed to starch by the leaf cells and stored for later use.
 - Glucose can be converted to other organic substances by leaf cells such as amino acids and protein, vitamins or chlorophyll.
 - Glucose can be converted to sucrose and transported to other parts of the plant such as growing parts and storage organs, where it can be converted to: glucose and used in respiration; starch and stored; amino acids and protein and used for growth; or lipids and stored, mainly in seeds.
3. a) A food chain is a diagram showing the flow of food and energy from one organism to the next.
 b) tomato plants → aphids → ladybird beetles → dragonflies → toads

4. a) Any one of the following:

- Ladybird beetle
- Dragonfly
- Toad

- b) Aphid
- c) Tomato plant
- d) Aphid
- e) Ladybird beetle

5. Any three of the following:

- The barracuda used some of the organic food it obtained from the flying fish in respiration and then used the energy released to carry out its own life processes, so this energy was not passed on to Jared.
- The barracuda used some of the organic food it obtained from the flying fish in respiration and then lost the energy as heat, so this energy was not passed on to Jared.
- Jared lost some of the organic compounds containing energy from the barracuda he ate in his faeces.
- Jared lost some of the organic compounds containing energy from the barracuda he ate in his excretory products such as urea.

6. It is important that these elements are recycled because they are present in nature in finite amounts, so recycling is essential to prevent them from running out.

7. The cycling of carbon occurs by carbon atoms being converted into different carbon-containing compounds. Carbon dioxide is removed from the air and converted to organic compounds by green plants during photosynthesis. Carbon dioxide may then be returned to the air by respiration occurring in the plants, or the plants may be eaten by animals and the carbon dioxide returned to the air as the animals respire the organic compounds consumed. Any plants or animals that are not eaten eventually die and decomposers return carbon dioxide to the air as they respire. Combustion of fossil fuels and other organic matter also returns carbon dioxide to the air.

8. - Nitrogen-fixing bacteria

- Denitrifying bacteria
- Saprophytic bacteria
- Nitrifying bacteria

9. a) The grass plants absorb the nitrates and use them to make proteins. When the grass plants die, decomposers or saprophytic bacteria and fungi in the soil decompose the dead plants and release ammonium compounds. Nitrifying bacteria in the soil then convert these ammonium compounds into nitrites and the nitrites into nitrates.

b) Nitrogen-fixing bacteria in the soil convert nitrogen from the air into ammonium compounds. After nitrifying bacteria in the soil have converted these ammonium compounds into nitrites and then into nitrates, denitrifying bacteria convert the nitrates into nitrogen, which they release into the air.

3 Nutrition

1.	Macronutrient	Two physical properties	Two sources	Two functions in the diet
	Starch	- Does not have a sweet taste. - Insoluble in water.	<i>Any two of the following:</i> - Yams - Potatoes - Rice - Pasta - Bread - Any other suitable source	- To provide energy. - For storage.
	Proteins	- Can be denatured by heat. - Some are soluble in water and some are insoluble.	<i>Any two of the following:</i> - Fish - Lean meat - Milk - Cheese - Eggs - Peas - Beans - Nuts - Any other suitable source	<i>Any two of the following:</i> - To make new cells for growth and to repair damaged tissues. - To make enzymes. - To make hormones. - To make antibodies.
	Lipids	<i>Any two of the following:</i> - Feel greasy. - Insoluble in water. - Leave a grease spot on paper.	<i>Any two of the following:</i> - Butter - Vegetable oils - Margarine - Nuts - Fatty meats - Any other suitable source	<i>Any two of the following:</i> - To make cell membranes of newly forming cells. - To provide energy. - For storage. - For insulation.

2. A reducing sugar reacts with Benedict's solution forming an orange-red precipitate, whereas a non-reducing sugar does not react with Benedict's solution.

Any one example of a reducing sugar from the following:

- Glucose
- Fructose
- Galactose
- Maltose
- Lactose.

One example of a non-reducing sugar is sucrose.

3. Test to confirm that X is starch:

Add a few drops of iodine solution to X and shake. It should turn blue-black.

Test to confirm that Y is glucose:

Add an equal volume of Benedict's solution, shake and heat the mixture. An orange-red precipitate should form.

Test to confirm that Z is gelatin (a protein):

Any one of the following:

- Add an equal volume of sodium hydroxide solution, shake, add drops of copper sulfate solution and shake again. It should turn purple.
- Add an equal volume of biuret reagent and shake. It should turn purple.

4. Vitamins A, D, E and K are fat soluble. Group B vitamins and vitamin C are water soluble.

5.

Micronutrient	One source	Functions
Vitamin B ₁	<i>Any one of the following:</i> - Whole-grain cereals and bread - Brown rice - Peas - Beans - Nuts - Yeast extract - Lean pork - Any other valid source	Aids in respiration to produce energy. Important for the proper functioning of the nervous system.
Vitamin C	<i>Any one of the following:</i> - West Indian cherries - Citrus fruit - Raw green vegetables - Any other valid source	Keeps tissues healthy, especially the skin and connective tissue. Strengthens the immune system. Helps the body absorb iron in the ileum.
Iron	<i>Any one of the following:</i> - Red meat - Liver - Eggs - Beans - Nuts - Dark green leafy vegetables - Any other valid source	To make haemoglobin, the red pigment in red blood cells which transports oxygen around the body for use in respiration.

6. a) Cause: Deficiency of vitamin A.
Symptoms: Poor vision in dim light. Vision adapts slowly between bright and dim conditions.
Treatment: Increase the intake of foods rich in vitamin A. Take vitamin A supplements.
- b) Cause: Deficiency of vitamin D and/or calcium.
Symptoms: Soft, weak, painful, deformed bones, especially limb bones. Bow legs.
Treatment: Increase the intake of foods rich in vitamin D and calcium. Take vitamin D and calcium supplements. Increase exposure to sunlight.
- c) Cause: Deficiency of iron.
Symptoms: A reduced numbers of red blood cells in the blood. Pale complexion. Tiredness. Lack of energy.
Treatment: Increase the intake of foods rich in iron. Take iron supplements. Increase the intake of foods rich in vitamin C.

7. Any three of the following:

- Water acts as a solvent to dissolve chemicals in cells so that they can react.
- Water acts as a solvent to dissolve substances so that they can be transported around the body.
- Water acts as a solvent to dissolve waste substances so that they can be excreted from the body.
- Water acts as a reactant in certain reactions occurring in the body, e.g. digestion.
- Water acts as a coolant, removing heat from the body when it evaporates from sweat.

8. Annette is more likely to suffer from constipation and her risk of suffering from colorectal or bowel cancer will increase.

9. Any three of the following consequences:

- Dehydration
- Electrolyte imbalance
- Impaired kidney function (kidney failure)
- Malnutrition in severe cases
- Any other suitable consequence

Any three of the following ways to reduce the chances of food poisoning:

- Wash hands, utensils and food preparation surfaces regularly.
- Wash fruits and vegetable thoroughly before cooking or eating.
- Keep uncooked foods, especially meat, poultry and fish, separate from ready-to-eat foods.
- Cook food thoroughly, especially meat, poultry and fish.
- Defrost frozen food thoroughly and safely, i.e. in a refrigerator, before cooking.
- Any other suitable way.

10. A balanced diet must contain carbohydrates, proteins, lipids, vitamins, minerals, water and dietary fibre in the correct proportions to supply the body with enough energy for daily activities and the correct materials for growth and development, and to keep the body in a healthy state.

11. a) Malnutrition occurs when a person's diet does not contain the right amount of nutrients.

b) Any three of the following:

- Obesity
- Anorexia

- Bulimia
- Protein-energy malnutrition
- Any other suitable condition

12. a)

$$\text{body mass index} = \frac{\text{body mass (in kilograms)}}{\text{height (in metres)} \times \text{height (in metres)}}$$

$$\therefore \text{Keenan's body mass index} = \frac{75}{1.5 \times 1.5} \text{ kg per m}^2$$

$$= 33.3 \text{ kg per m}^2$$

b) Keenan is obese.

13. a) Large pieces of food are broken down into smaller pieces by the teeth and contractions of the stomach walls.

b) Large, usually insoluble food molecules are broken down into small, soluble food molecules by enzymes.

14. The teeth break up large pieces of food into smaller pieces. This gives the pieces of food a larger surface area for digestive enzymes to act on, making chemical digestion quicker and easier, and it makes the food easier to swallow.

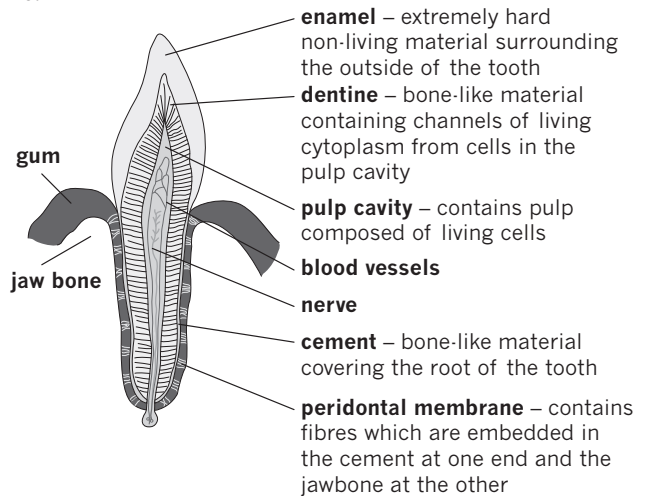
15. - Incisors. These are used to cut food and bite off pieces of food.

- Canines. These are used to grip food and tear off pieces of food.

- Premolars. These are used to crush and grind food.

- Molars. These are used to crush and grind food.

16.



17. Bacteria, saliva and food particles in Matthew's mouth form a sticky layer on his tooth called plaque. Bacteria in the plaque feed on sugars in food and make acid that begins to eat away the enamel of his tooth. The acid gradually eats through the enamel until it reaches the softer dentine and it eats this away more quickly, forming a cavity. The decay continues until the cavity reaches the pulp.

Any four of the following to prevent more cavities forming:

- Matthew should brush his teeth and gums in the proper way, twice a day.
- Matthew should use a fluoride toothpaste and good quality toothbrush when brushing.
- Matthew should use dental floss and an interdental brush once a day.

- Matthew should use an antibacterial mouthwash after brushing and flossing.
- Matthew should avoid eating sugary and starchy foods and drinking sugary drinks, especially between meals and before going to bed.
- Matthew should visit a dentist regularly for a checkup and cleaning.

18. Enzymes are biological catalysts produced by all living cells. They speed up chemical reactions occurring in living organisms without being changed themselves.

19. a) As temperature increases from 0 °C to about 37 °C, the rate of enzyme activity increases. As temperature increases above about 37 °C, the rate of enzyme activity decreases. The optimum temperature for human enzymes to work is about 37 °C. Enzymes begin to be denatured at about 40 °C to 45 °C and most are denatured by about 55 °C.

b) *Any three of the following:*

- Enzymes are specific, each type catalyses only one type of reaction.
- Enzymes work best at a particular pH.
- Most enzymes are denatured by extremes of acidity and alkalinity.
- The action of enzymes is helped by certain vitamins and minerals.
- The action of enzymes is inhibited by certain poisons.

20. a) The oesophagus transports food from the mouth to the stomach.

- b) The liver produces bile, which contains organic bile salts used to emulsify lipids.
- c) The colon absorbs water and mineral salts from any food that enters it and has not been digested.
- d) The rectum stores faeces for egestion.

21. The sandwich contains starch, protein and lipid, which need digesting. The sandwich is chewed in the mouth to break large pieces into smaller pieces and salivary amylase begins to digest the starch into maltose. The chewed pieces of sandwich are rolled into a ball and swallowed. In the stomach, pepsin begins to digest the protein into peptides. The partially digested sandwich enters the small intestine where bile salts emulsify the lipids, pancreatic amylase continues to digest the starch into maltose, maltase digests the maltose into glucose, trypsin continues to digest the protein into peptides, peptidase or erepsin digests the peptides into amino acids and pancreatic lipase digests the lipids into fatty acids and glycerol.

22. Each villus has a finger-like shape giving it a large surface area. The wall or epithelium of each villus is only one cell thick so food molecules can pass easily through it and the epithelial cells have minute projections called microvilli that further increase the surface area of the villus. The villus has a network of blood capillaries and a lacteal or lymph capillary inside to rapidly absorb the products of digestion.

23. The body uses the amino acids to make proteins, which it then uses for cell growth and repair. They can also be used by body cells to make enzymes, or be used by cells of endocrine glands to make hormones, or be used to make antibodies.

4 The respiratory system

1. Breathing refers to the movements that cause air to be moved in and out of the lungs. Breathing is important because it ensures that humans have a continual supply of oxygen to meet the demands of aerobic respiration. Breathing also ensures that the carbon dioxide produced in aerobic respiration is continually removed from the body so that it does not build up and poison cells.

- 2. a) The nasal cavities warm the inhaled air. Mucus traps dust and pathogens in the inhaled air and moistens the air. Cilia move the mucus to the throat to be swallowed.
- b) The bronchi carry air into and out of the lungs.
- c) The bronchioles carry air to and from the alveoli.

3. In a human, the gaseous exchange surface is composed of the walls of the alveoli. The surface is adapted in the following ways to perform its function efficiently:

- It has a very large surface area of about 90 m² because each alveolus has a pocket shape and a human has two lungs, each with over 350 million alveoli.
- Its walls are very thin because the wall of each alveolus is only one cell thick.
- It has a rich blood supply because each alveolus is surrounded by a network of capillaries.
- It is lined with moisture because each alveolus has a lining of moisture.

4. The external intercostal muscles between the ribs contract and the internal intercostal muscles relax, causing the ribs and sternum to move upwards and outwards. At the same time the diaphragm muscles contract, causing the diaphragm to move downwards or flatten. These movements cause the volume inside the thorax and lungs to increase and the pressure to decrease, which draws air into the lungs.

5. *Any four of the following factors that increase the rate:*

- Carrying out exercise.
- Taking drugs that are stimulants.
- Smoking cigarettes.
- Suffering from anxiety or fear.
- Being exposed to certain environmental factors such as being in a confined space or in polluted air.
- Being at high altitude.
- Being overweight.

Any two of the following factors that decrease the rate:

- Resting or sleeping.
- Taking drugs that are depressants.
- Being exposed to certain environmental factors such as being in fresh, unpolluted air.

- 6. a) Vital capacity is the maximum volume of air that can be exhaled from the lungs after inhaling as deeply as possible.
- b) Measuring vital capacity can be used to indicate lung function and if a person is suffering from lung disease.

7. Lie Kendra on her back and gently tilt her head backwards to open her airways by lifting her chin. Open her mouth and remove any debris and pinch her nostrils to close them. Inhale, seal your lips over Kendra's open mouth and breathe out into her mouth for 1 second. If her chest rises, breathe into her mouth a second time.

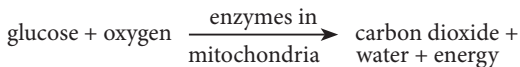
Continue rescue breathing by giving one breath every 5 seconds until normal breathing resumes or medical help arrives.

8. a) Nicotine, tar and carbon monoxide.
- b) Smoking cigarettes irritates and inflames the walls of the bronchi and bronchioles, causes mucus production to increase and paralyses the cilia, which stops them from beating so the mucus is not removed. This causes the airways to become obstructed making breathing difficult and leads to chronic bronchitis. Smoking also causes the walls of the alveoli to become less elastic and the walls between them to break down, which leads to emphysema, and it can also cause cancerous tumours to develop in the mouth, throat, oesophagus and lungs.

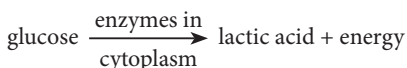
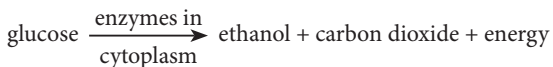
9. Aerobic respiration is the process by which energy is released from food by living cells using oxygen.

It takes place in the mitochondria of cells and always produces carbon dioxide, water and about 38 ATP molecules per molecule of glucose. Anaerobic respiration is the process by which energy is released from food by living cells without the use of oxygen. It takes place in the cytoplasm of some cells, the products vary and it produces considerably less energy per molecule of glucose than aerobic respiration.

Word equation for aerobic respiration:



Any one of the following word equations for anaerobic respiration:



10. ATP or adenosine triphosphate is known as the energy currency of cells. ATP molecules are energy carrying molecules. Energy released during respiration is used to produce ATP molecules in cells. These ATP molecules can then release the energy whenever and wherever the cell needs it.
11. During the strenuous exercise, the oxygen supply to Ché's muscle cells eventually became too low for the demands of aerobic respiration, so his cells began to respire anaerobically and produced lactic acid. The lactic acid built up in his muscle cells and began to harm them. Eventually the lactic acid stopped the cells from contracting, which caused him to collapse.

Ché had to rest before exercising again so that his muscle cells could get rid of the lactic acid by respiring it aerobically.

5 The circulatory system

1. a) Humans have a small surface area to volume ratio, so diffusion through the body surface is not adequate to supply all the body cells with their requirements and remove their waste. Also, most of the body is too far from its surface for substances to move through

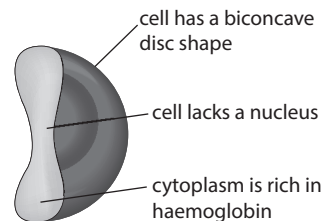
it by simple diffusion. Consequently, humans have developed a transport system to carry substances around their bodies.

- b) *Any four of the following:*

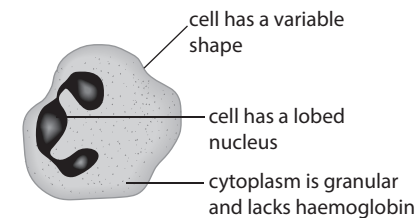
- Oxygen
- Water
- Digested food
- Vitamins
- Minerals
- Hormones
- Antibodies
- Plasma protein
- Carbon dioxide
- Nitrogenous waste or urea

2. Plasma is a yellowish fluid composed of about 90% water and a variety of dissolved substances including the products of digestion, waste products, hormones and plasma proteins. Serum has a similar composition to plasma, but it lacks the plasma protein, fibrinogen, and other factors needed for the blood to clot.

3. a)



a red blood cell



a phagocyte

- b) Red blood cell – transports oxygen from the lungs to body cells and transports small amounts of carbon dioxide from body cells to the lungs.
Phagocyte – engulfs and destroys pathogens, and engulfs pathogens that have been destroyed by antibodies.
4. When the skin is cut and bleeds, platelets in the blood at the cut become spiky in shape, stick to each other and begin to plug the cut. They also release an enzyme called thrombokinase or thromboplastin. Thrombokinase, with the help of calcium ions and vitamin K in the blood, converts the inactive plasma protein, prothrombin, into active thrombin. Thrombin converts the soluble plasma protein, fibrinogen, into insoluble fibrin which forms fibres. The fibrin fibres form a network across the cut which traps blood cells and forms a clot, preventing further loss of blood.
5. - Arteries have thick walls. Veins have thin walls. The walls of arteries are thick to withstand the high pressure of the blood, whereas veins only carry low pressure blood.

- Arteries have a narrow lumen. Veins have a wide lumen. The lumen of veins is wide so it does not restrict the flow of the low pressure blood, whereas arteries carry high pressure blood.
- Arteries do not possess valves. Veins possess valves. Veins possess valves to prevent the backflow of slow flowing, low pressure blood, whereas arteries carry fast flowing, high pressure blood.

- The bicuspid and tricuspid valves allow blood to flow from the atria to the ventricles but prevent the backflow of blood into the atria when the ventricles contract. The semi-lunar valves allow the blood to flow into the aorta and pulmonary artery but prevent the backflow of blood into the ventricles when they relax.
 - The right ventricle has to pump blood relatively short distances to the lungs, whereas the left ventricle has to pump blood longer distances around the body, so its wall needs to be thicker to pump the blood with sufficient pressure to travel these longer distances.
 - A group of specialised cells in the wall of the right atrium, called the pacemaker or sinoatrial node, spontaneously produce electrical impulses that travel through the heart muscle, causing it to contract about 75 times per minute.
 - The contraction of a chamber of the heart is called systole and its relaxation is called diastole.
 - Humans need a double circulation because blood loses pressure when it passes through a body organ to supply it with oxygen and remove carbon dioxide, so the blood goes back to the heart to be given enough pressure to reach the lungs to get rid of the waste carbon dioxide and pick up more oxygen. It then goes back to the heart to be given enough pressure to reach a body organ again.
9. lungs → pulmonary vein → left atrium ————
 right atrium ← body ← aorta ← left ventricle ←
 right ventricle → pulmonary artery → lungs
- During a heart attack a coronary artery is partially or completely blocked so that oxygenated blood cannot reach the section of the heart muscle supplied by the artery. This section of heart muscle then starts to die, resulting in a heart attack.
 - Blood plasma containing oxygen and nutrients is forced out of capillaries where they branch from arterioles in body tissues and organs. This forms tissue fluid that surrounds all body cells. Body cells absorb the oxygen and nutrients from the tissue fluid and give out carbon dioxide and other waste. Some of this tissue fluid containing waste then flows back into the capillaries before they join into venules and reforms plasma, and the rest flows into lymph capillaries and forms lymph.
 - Any four of the following:
 - Lymph removes cellular waste and cell debris from around body cells.
 - Lymph drains excess tissue fluid from tissues, which helps to prevent fluid from building up in them.
 - Lymph helps maintain normal blood volume and pressure.
 - Lymphocytes in lymph defend the body against pathogens.

- Lymph in the lacteals (lymph capillaries) in the ileum absorbs fatty products of digestion.
- Lymphocytes and phagocytes in lymph nodes help destroy pathogens in lymph.
- Lymph nodes filter dead cells and cancerous cells out of lymph.
- Lymph nodes release lymphocytes into lymph during times of infection.

6 The skeletal system

- Bone is composed of living cells surrounded by the non-living mineral, calcium phosphate, together with some collagen (protein) fibres. It is hard and has blood vessels running throughout. Cartilage is composed of living cells surrounded mainly by collagen fibres. It is more elastic and flexible than bone and does not have blood vessels running through it.
 - Any two of the following:
 - Cartilage covers the ends of bones at joints where its slipperiness helps to reduce friction.
 - Cartilage forms the skeleton of certain fleshy appendages such as the nose and outer ear, which maintains their shape.
 - Cartilage makes up the intervertebral discs between the vertebrae, enabling the discs to act as shock absorbers.
- Any three of the following:
 - The skeleton brings about movement of the body by being jointed and having muscles that work across these joints. Most movement is brought about by the legs and arms whilst the vertebral column allows some movement.
 - The skeleton protects the internal organs of the body. The skull protects the brain and sense organs of the head, the vertebral column protects the spinal cord, and the rib cage and sternum protect the lungs and heart.
 - The skeleton supports the soft parts of the body. This is mainly carried out by the vertebral column, pelvic girdle and legs.
 - Breathing is brought about by movements of the rib cage as a result of alternate contractions of the internal and external intercostal muscles between the ribs.
 - The skeleton produces blood cells. Red blood cells, most white blood cells and platelets are produced in the red bone marrow found in the spongy bone inside flat bones and in the ends of long bones.
- Tendons attach the ends of muscles to the bones of the skeleton. They are made of tough, fibrous connective tissue. They are strong and non-elastic. Ligaments attach bones together at joints. They are made of tough, fibrous connective tissue with some elastic tissue. They are strong but elastic.
- A joint is formed where two bones meet.
 - A hinge joint allows movement in one plane only. This limited movement provides strength and the joints are capable of bearing heavy loads. A ball and socket joint allows rotational movement in all planes. The free range of movement provides less support and makes the joints more susceptible to dislocation than a hinge joint.

- c) A hinge joint:
Any two of the following:
- The elbow
 - The knee
 - The finger joints
 - The toe joints

A ball and socket joint:

- The shoulder
- The hip

5. a) Two muscles are needed to bring about movement of a hinge joint because when a muscle contracts it exerts a pull, but it cannot exert a push when it relaxes. Therefore, one muscle contracts to bend the joint and the other muscle contracts to straighten the joint.
- b) The flexor muscle is found behind the femur and knee joint, and the extensor muscle is found in front of the femur and knee joint. When the flexor contracts, the extensor relaxes and the knee joint bends. When the extensor contracts, the flexor relaxes and the knee joint straightens.
6. The biceps muscle bends Jaden's elbow and the triceps muscle straightens it.
7. The insertion of a muscle is the attachment point of the end of the muscle to the bone that moves during contraction. The origin of a muscle is the attachment point of the end of the muscle to a bone that does not move during contraction.
8. Muscle tone is the unconscious low-level contraction of muscles while they are at rest.

Good muscle tone is important because it maintains balance and a good, upright posture, and it keeps muscles in an active state ready for coordinated action.

9. A poor posture strains muscles and causes them to need more energy to keep the body upright, which leads to fatigue and backache. It also changes the curvature of the spine, which leads to back, neck and shoulder pain, puts stress on certain joints and wears down the intervertebral discs in the spine causing a decrease in height.

Wearing shoes with high heels causes the body weight to shift forwards to the ball of the foot leading to painful arches and a change in the curvature of the spine, which causes bad posture and can result in lower back pain. High heels also cause calf muscles to shorten and bulge, and places excess pressure on knee and hip joints. Wearing badly fitting shoes, narrow pointed shoes or high heels can lead to corns, bunions, hammer toe or ingrown toenails.

7 Excretion and homeostasis

1. a) Excretion is the process by which waste and harmful substances, produced by the body's metabolism, are removed from the body.
- b) Egestion is the removal of undigested dietary fibre and other materials from the body as faeces. This dietary fibre is not produced in the body's metabolism, so its removal cannot be classed as excretion.
2. If excretion does not occur, toxic waste substances produced in the body's metabolism will build up in the

body and damage and kill cells, and the body will be unable to maintain a constant internal environment.

Excretory organ	Excretory products
Kidneys	Water, urea and salts as urine.
Lungs	Carbon dioxide and water vapour.
Skin	Water, urea and salts as sweat. Heat.
Liver	Bile pigments.

4. In Marissa's kidneys, the diameter of the capillary entering each glomerulus from an arteriole decreases causing the pressure of the blood to increase. Small molecules including glucose, amino acids, hormones, vitamins, water, salts and urea are forced from the blood into Bowman's capsule forming filtrate.

Glucose, amino acids, hormones, vitamins, some water and some salts are reabsorbed from the filtrate back into the blood in the first convoluted tubule. Some water is reabsorbed in the loop of Henle and some salts and some water are reabsorbed in the second convoluted tubule. Water is reabsorbed by osmosis, the other substances are reabsorbed by diffusion and active transport. Filtrate containing urea, excess water and excess salts enters a collecting duct where some water can be reabsorbed from it by osmosis.

The filtrate, now called urine, travels down the collecting duct to the ureter and then to Marissa's bladder where it is stored.

5. Treatment must occur at regular intervals to prevent waste products, mainly urea, from building up in the body and poisoning cells, and also to regulate the concentration of blood plasma and body fluids to prevent water moving into and out of body cells unnecessarily.
6. a) The epidermis protects the body against pathogens, water loss, the sun's harmful ultraviolet rays and harmful chemicals in the environment.
- b) The subcutaneous layer protects the body against heat loss in low environmental temperatures and against damage by acting as 'padding'.
- c) The sebaceous glands secrete sebum, which is an oily substance that helps to keep the skin soft, supple and waterproof, and inhibits the growth of bacteria.
7. a) Homeostasis is maintaining a constant internal environment.
- b) Negative feedback mechanisms are important in homeostasis because if the level of something in the body changes, receptors in the body detect the change and send messages to the appropriate effectors, causing them to respond by exerting an opposite or negative effect that returns the level to normal.
8. a) Osmoregulation.
- b) Tyler will produce a very small quantity of urine that contains a high concentration of urea and salts.
- Playing tennis in the hot sun all day without drinking will cause Tyler's body fluids to become too concentrated. The hypothalamus of his brain will detect this and stimulate his pituitary gland to secrete ADH. Tyler's blood will transport the ADH

to his kidneys 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 in Tyler's kidneys back into the blood.

9. a) Heat is the total amount of energy contained by an object and it is measured in joules or J. Temperature is a measure of how hot or how cold an object is and it is measured in degrees Celsius or °C.
 - b) The person's skin starts to produce more sweat, and the arterioles supplying the capillaries in the skin dilate, increasing the blood flow through them and the heat loss from the person's body.
10. The pancreas detects the rise in the blood glucose level and increases secretion of insulin into the blood. The insulin stimulates the body cells to absorb glucose for respiration and the liver cells to convert glucose to glycogen and store the glycogen. As a result, the blood glucose level returns to normal.

8 Coordination and control

1. Any three of the following:

- Messages are carried as electrical impulses along nerves in the nervous system, whereas they are carried by chemicals called hormones in the blood in the endocrine system.
- Messages are transmitted rapidly by the nervous system, whereas they are usually transmitted slowly by the endocrine system.
- Messages are carried to precise places in the body by the nervous system, whereas they are carried to more general regions of the body by the endocrine system.
- Messages carried by the nervous system have an immediate effect on the body, whereas those carried by the endocrine system usually have a slow effect on the body.
- Messages carried by the nervous system have a shorter lasting effect on the body, whereas those carried by the endocrine system usually have a longer lasting effect on the body.

2. The nervous system is divided into the central nervous system or CNS and the peripheral nervous system or PNS. The CNS consists of the brain and the spinal cord and the PNS consists of cranial and spinal nerves that connect the central nervous system to all parts of the body. The PNS is divided into the autonomic nervous system and the voluntary or somatic nervous system.

3. a) Controls automatic, involuntary actions such as heart rate, breathing rate, blood pressure and peristalsis.
- b) Any one of the following:
 - Controls balance and posture.
 - Coordinates movement.
- c) Any one of the following:
 - Controls conscious thought, problem solving, decision making, planning and emotions.
 - Responsible for intelligence, memory, learning, speech and language.
 - Processes visual, auditory and other external information.
 - Coordinates voluntary actions.

4. a) A neurone is a specialised cell that conducts nerve impulses. The nervous system is composed of neurones. A nerve is a cord-like bundle of the nerve fibres of neurones surrounded by connective tissue through which impulses pass between the central nervous system and the rest of the body.
 - b) - Sensory neurones transmit impulses from receptors to the central nervous system.
 - Motor neurones transmit impulses from the central nervous system to effectors.
 - Relay or intermediate neurones transmit impulses throughout the central nervous system, linking sensory and motor neurones.
 - c) - Irritability
 - Conductivity
5. Synapses are tiny gaps between the synaptic knobs at the end of one axon and the dendrites or cell body of adjacent neurones. Synapses are important because they ensure that impulses travel in one direction only and they allow many neurones to interconnect.
6. A voluntary action is an action that is consciously controlled by the brain, whereas an involuntary action is an action that occurs without conscious thought.

Any two of the following examples of a voluntary action:

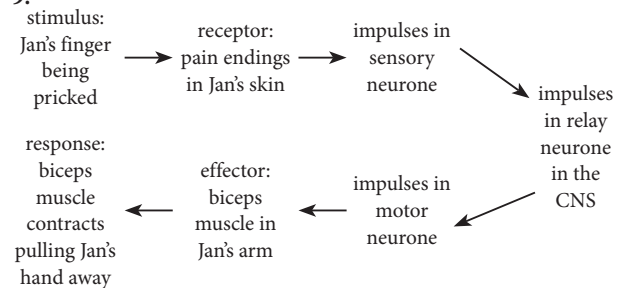
- Talking
- Writing
- Running
- Any other suitable example

Any two of the following examples of an involuntary action:

- Blinking
- Sneezing
- Coughing
- Any other suitable example

7. The autonomic nervous system is part of the peripheral nervous system. It is composed of motor nerves only and regulates the functioning of internal organs, for example, it controls breathing rate, heart rate, digestion, peristalsis and blood pressure.
8. A reflex action is a rapid, automatic, involuntary response to a stimulus by a muscle or gland.

9.



10. The eyes detect light.

- The ears detect sound waves and the position of the head.
- The nose detects chemicals in the air.
- The tongue detects chemicals in food.
- The skin detects touch, texture, pressure, pain, itching, and hot and cold.

Part of the eye	Function
Conjunctiva	Protects the cornea.
Sclera	Protects the eyeball.
Pupil	Allows light to enter the eyeball.
Choroid	Blood vessels supply the retina with food and oxygen. Melanin prevents refraction of light inside the eye.
Optic nerve	Carries impulses from the retina to the brain.
Vitreous humour	Maintains the shape of the eyeball.

12. Omari's cornea refracts the light rays from an object as they enter his eye and the lens refracts them again to focus them on his retina. An image of the object is formed on his retina which is inverted, reversed and smaller than the object.

13. a) The circular muscles in Samara's irises contract and the radial muscles relax. This reduces the size of her pupils so as to reduce the amount of light entering her eyes.
 b) The ciliary muscles in Samara's eyes contract, which causes the suspensory ligaments to slacken. This allows her lenses to spring into a bulged shape to focus light rays from the book onto her retinas.

14. Malik's short sight is caused because one or both of his eyeballs are too long from front to back or one or both of his lenses are too curved so that light rays from near objects focus on his retinas whereas light rays from distant objects focus in front of his retinas.

Malik's short sight can be corrected by wearing diverging or concave lenses as spectacles or contact lenses so that the light rays are bent outwards before they enter his eyes.

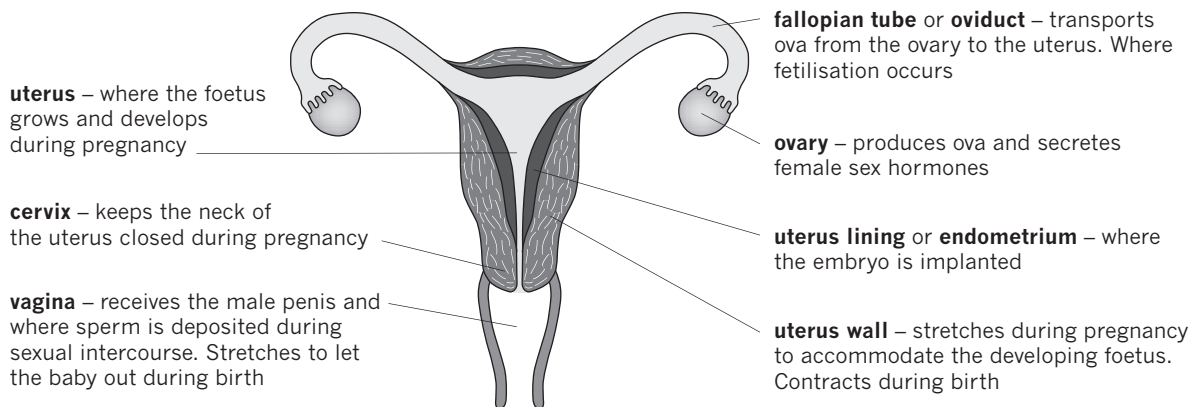
15. A cataract is a cloudy area that forms in the lens. It can be corrected by having surgery to remove the clouded lens and to replace it with an artificial lens.

16. a) The thyroid gland is located in front of the trachea in the neck and it produces thyroxine. Thyroxine controls the rate of metabolism and energy production in cells, and physical growth and mental development, especially in children.
 b) The adrenal glands are located immediately above the kidneys and they produce adrenalin. Adrenalin speeds up metabolism, mainly respiration, and increases blood sugar levels, heartbeat, breathing rate and blood supply to muscles. It triggers the fight-or-flight response and gives the feeling of fear.
 c) The testes are located in the scrotal sacs and they produce testosterone. Testosterone controls the development of male reproductive organs and secondary sexual characteristics at puberty such as the development of a deep voice, facial and body hair, muscles and broad shoulders. It also controls sperm production in the testes.

9 The reproductive system

1. Asexual reproduction involves only one parent whereas sexual reproduction involves two parents.
 Advantage of asexual reproduction: it is a rapid process.
 Disadvantage of asexual reproduction: all the offspring are genetically identical, they do not show any variation.
 Advantage of sexual reproduction: the offspring receive genes from both parents therefore they show variation or are all different.
 Disadvantage of sexual reproduction: it is a slow process.

2.



3. a) The epididymis stores sperm.
 b) The sperm ducts carry sperm to the urethra.
 c) The prostate gland secretes a fluid that mixes with sperm and stimulates the sperm cells to swim.
 d) The penis becomes erect during intercourse to deposit sperm in the female vagina.
4. a) Cancer is caused by abnormal cells developing and dividing in an uncontrolled way. These cells replace normal cells and usually produce a tumour or lump. Some of the cells can also spread to other parts of the body.

- b) *Any two of the following parts of the female reproductive system:*
- Ovary
 - Cervix
 - Uterus
 - Breast

Two parts of the male reproductive system:

- Prostate gland
- Testis

5. a) An ovum is released from an ovary during ovulation. The uterus lining breaks down and is lost from the body during menstruation.
- b) Oestrogen stimulates the uterus lining to thicken and its blood supply to increase after menstruation, and it causes the pituitary gland to stop secreting follicle stimulating hormone and to secrete luteinising hormone. Progesterone causes the uterus lining to increase slightly in thickness and to remain thick during the third week of the cycle. Its level decreases during the fourth week and this causes the uterus lining to begin to break down and the pituitary gland to secrete follicle stimulating hormone at the end of the fourth week.
6. The male becomes sexually excited and blood spaces in the penis fill with blood. His penis becomes erect and is placed into the female's vagina. Semen containing sperm is ejaculated into the top of the vagina by muscular contractions of the tubules of the epididymis and sperm ducts. The sperm swim through the cervix and uterus and into the fallopian tubes. If an ovum is present in one of the fallopian tubes, one sperm enters leaving its tail outside and the nuclei of the ovum and sperm fuse to form a zygote.
7. The placenta allows the exchange of substances between the mother's blood and the embryo's blood. Food and oxygen diffuse from the mother's blood in the uterus lining into the embryo's blood in the placenta, and carbon dioxide and other waste diffuse from the embryo's blood into the mother's blood.
8. The foetus turns to lie head down. The placenta reduces the secretion of progesterone and this stimulates the pituitary gland to secrete the hormone oxytocin. Oxytocin stimulates muscles in the uterus wall to start contracting. The amnion bursts and the contractions strengthen and cause the cervix to gradually dilate. When fully dilated, strong contractions push the baby, head first, through the cervix and vagina. The baby starts to breathe and the umbilical cord is clamped and cut. The placenta is expelled as the afterbirth by further contractions of the uterus wall.
9. a) Sabrina should attend regular prenatal checkups with her doctor or clinic to monitor her health and the development of her baby. She should eat a balanced diet containing adequate quantities of protein, carbohydrates, vitamins and minerals, especially calcium and iron, she should not use drugs of any kind, and she must protect herself against infectious diseases. She should exercise regularly to maintain fitness, and attend prenatal classes to prepare her body for the birth and to learn how to care for her baby after the birth.
- b) *Any four of the following:*
- Breast milk contains all the nutrients the baby needs in the correct proportions.
 - Breast milk contains antibodies that protect the baby against bacterial and viral diseases.
 - Breast milk is sterile, which reduces the risk of infection.
 - Breast milk is at the correct temperature.
 - Breast milk is available whenever needed.
 - Breastfeeding lowers the baby's risk of developing asthma, allergies and other non-communicable diseases as it grows older.
 - Breastfeeding creates a strong emotional bond between mother and baby.

10.

Method	How the method works	One advantage	One disadvantage
The contraceptive pill	It prevents ovulation and makes the cervical mucus thicker and more difficult for sperm to swim through.	<i>Any one of the following:</i> - Almost totally reliable if taken daily. - Menstruation is lighter, shorter and less painful.	<i>Any one of the following:</i> - Ceases to be effective if one pill is missed. - May cause side effects in some women, especially those who smoke.
Surgical sterilisation	Prevents sperm leaving the male body or ova passing down the oviducts.	<i>Any one of the following:</i> - Totally reliable. - No need to think further about contraception. - No artificial device needs to be used or pills taken.	- Usually irreversible.
The rhythm method	Intercourse is restricted to times when ova should be absent from the oviducts.	- No artificial device needs to be used or pills taken, therefore, it is acceptable to all religious groups.	<i>Any one of the following:</i> - Unreliable since the time of ovulation can vary. - Restricts the time when intercourse can occur. - Unsuitable for women with an irregular menstrual cycle.
The condom	It acts as a barrier to prevent sperm entering the female body.	<i>Any one of the following:</i> - Very reliable if used correctly. - Easy to use. - Readily available. - Protects against sexually transmitted infections.	<i>Any one of the following:</i> - May reduce sensitivity so interferes with enjoyment. - Condoms can tear allowing sperm to enter the vagina. - Latex may cause an allergic reaction.

11. *Any three of the following:*

- If the family is small, parents have more time to spend with each child, so each child receives greater emotional and physical care and a better education from their parents.
- It is less expensive to have a small family.
- Family planning enables parents to decide at what age they have a family.
- Family planning decreases health risks to women and maternal deaths caused by unintended pregnancies and unsafe abortions.
- Family planning enables women to complete their education before having a family.
- Family planning enables women to participate fully in society and advance in the workplace by allowing them to plan when they have a family.
- Any other suitable reason.

12. a) Spontaneous abortion is the natural termination of a pregnancy.

b) *Any three of the following:*

- The foetus has a chromosomal abnormality.
- The mother has a uterine abnormality so the embryo cannot implant properly in the lining.
- The mother has a weak cervix that cannot hold the foetus in the uterus as it grows.
- The mother suffers from certain medical conditions such as diabetes or thyroid disease that can make conditions in the uterus difficult for the embryo to survive.
- The mother has an immune system disorder causing the foetus not to be accepted by her body.
- The mother smokes very heavily, drinks too much alcohol or overdoses on illegal drugs during pregnancy.

10 Cell division and variation

1. a) Mitosis is the type of cell division that results in the formation of two daughter cells each with the same number and kind of chromosomes as the parent cell.

b) Meiosis is the type of cell division that results in the formation of four daughter cells each with half the number of chromosomes as the parent cell.

2. The chromosomes shorten, thicken and duplicate themselves so that each consists of two chromatids joined by the centromere. The centrioles separate forming a spindle, composed of spindle fibres, between them. The nuclear membrane disintegrates and the chromatid pairs line up around the equator of the spindle. The spindle fibres pull the chromatids to opposite poles of the cell. The cell constricts the equator to form two new cells and a nuclear membrane develops around each group of chromatids, now known as chromosomes.

3. *Any three of the following:*

- It maintains the species number of chromosomes in all members of a species.
- It ensures that each daughter cell has an identical combination of genes.
- It is essential for growth and to repair damaged tissues in multicellular organisms.
- It is the method by which organisms reproduce asexually.

4. Four genetically unidentical cells are produced in meiosis, whereas two genetically identical cells are produced in mitosis. Each cell produced in meiosis has the haploid number of chromosomes, whereas each cell produced in mitosis has the diploid number of chromosomes. During meiosis homologous chromosomes pair and chromatids of homologous pairs cross over each other and exchange genetic material, whereas there is no pairing of homologous chromosomes, nor exchange of genetic material during mitosis.

5. - Each cell produced in meiosis has the haploid number of chromosomes so that the diploid number can then be restored when fertilisation occurs.

- Each daughter cell has a different combination of genes which leads to variation among offspring. This enables species to constantly change and improve or to evolve.

6. Genetic variation is controlled by genes and can be passed on from one generation to the next or it can be inherited. Environmental variation is caused by environmental factors. It is not caused by genes and cannot be passed on from one generation to the next.

7. a) A mutation is a change in the structure of a single gene, the structure of part of a chromosome containing several genes or the number of chromosomes in a cell.

b) Mutations cause variation because they cause new characteristics to develop in organisms. For example, albinism is caused by a mutation in a gene controlling the production of melanin. People with albinism produce very little or no melanin in their skin, eyes and hair. Another example is Down's syndrome which occurs when an individual has an extra chromosome 21 in each of their cells because pair 21 fails to separate properly during meiosis and both chromosomes pass into one gamete. Individuals with Down's syndrome have several distinctive characteristics.

8. *Any four of the following:*

- The type and quantity of food that the person eats.
- The diseases that a person suffers from.
- The drugs that a person takes.
- The climate that a person is exposed to, particularly the amount of sunlight.
- The person's upbringing and living conditions.
- The education that the person receives.
- The amount of exercise that a person gets and their daily activities.
- Any other suitable factor.

9. Continuous variation is where characteristics show continuous gradation from one extreme to the other without a break, whereas discontinuous variation is where characteristics show clear cut differences with no intermediates. Characteristics showing continuous variation are usually controlled by many genes, whereas characteristics showing discontinuous variation are usually controlled by a single gene. Characteristics showing continuous variation can be affected by environmental factors, whereas environmental factors have little, if any, influence on characteristics showing discontinuous variation.

10. Variation enables species to remain well adapted to their environment or to gradually change and improve by becoming better adapted, in other words it enables species to evolve. This is because there are individuals within any species with variations that make them better suited to their environment than others and these individuals have a better chance of survival than the others. More of these individuals will survive to reproduce and when they do, they pass on the genetic information for their beneficial characteristics to their offspring. For example, some species of bacteria have become resistant to almost all commonly available antibiotics, enabling them to survive when antibiotics are used to treat bacterial infections.

11 Inheritance and genetic engineering

1. a) Genotype refers to the combination of alleles present in an organism. Phenotype refers to the observable characteristics of an organism.
 - b) A gene is the basic unit of heredity which is composed of DNA, occupies a fixed position on a chromosome and determines a specific characteristic. An allele is either of a pair, or series, of alternative forms of a gene that occupy the same position on a particular chromosome and that control the same characteristic.
 - c) A homozygous individual has two identical alleles in corresponding positions on a pair of homologous chromosomes. A heterozygous individual has two different alleles in corresponding positions on a pair of homologous chromosomes.
2. To produce a child who is unable to taste PTC both parents must be heterozygous with the genotype Tt.

Gametes	T	t
T	TT	Tt
t	Tt	tt

The child with genotype tt is unable to taste PTC.

3. Let: Hb^{A} represent the allele that stimulates the production of normal haemoglobin A.
 Hb^{S} represent the allele that stimulates the production of abnormal haemoglobin S.

There is a 25% chance that each child will not suffer from sickle cell trait or sickle cell anaemia.

Parental phenotype: sickle cell trait \times sickle cell trait

Parental genotype: $\text{Hb}^{\text{A}}\text{Hb}^{\text{S}}$ \times $\text{Hb}^{\text{A}}\text{Hb}^{\text{S}}$

Gametes: Hb^{A} Hb^{S} \times Hb^{A} Hb^{S}

Random fertilisation:

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

F₁ genotype: $\text{Hb}^{\text{A}}\text{Hb}^{\text{A}}$ $\text{Hb}^{\text{A}}\text{Hb}^{\text{S}}$ $\text{Hb}^{\text{A}}\text{Hb}^{\text{S}}$ $\text{Hb}^{\text{S}}\text{Hb}^{\text{S}}$

F₁ phenotype: normal sickle cell sickle cell sickle cell
 trait trait anaemia

4. The father determines the sex of the children because only the father can pass on the Y chromosome.

Parental phenotype: female \times male

Parental genotype: XX \times XY

Gametes: X X \times X Y

Random fertilisation:

Gametes	X	Y
X	XX	XY
X	XX	XY

F₁ genotype: XX XY XX XY

F₁ phenotype: female male female male

5. Sex-linked characteristics are characteristics determined by genes carried on the sex-chromosomes which have nothing to do with determining sex or gender.
6. It is only possible if the mother is heterozygous with the genotype $\text{X}^{\text{R}}\text{X}^{\text{r}}$. The colour blind father must have the genotype $\text{X}^{\text{r}}\text{Y}$.

Gametes	X^{r}	Y
X^{R}	$\text{X}^{\text{R}}\text{X}^{\text{r}}$	$\text{X}^{\text{R}}\text{Y}$
X^{r}	$\text{X}^{\text{r}}\text{X}^{\text{r}}$	$\text{X}^{\text{r}}\text{Y}$

The female child with the genotype $\text{X}^{\text{r}}\text{X}^{\text{r}}$ and the male child with genotype $\text{X}^{\text{r}}\text{Y}$ would both be colour blind.

7. Genetic engineering involves changing the traits of one organism by inserting genetic material from a different organism into its DNA.
8. Any two of the following:
 - By inserting two genes into rice plants, one from maize and one from a soil bacterium, the endosperm of the rice grains is stimulated to produce beta-carotene which the body converts to vitamin A. This produces golden rice, which should help fight vitamin A deficiency.
 - By transferring the gene that controls the production of bovine somatotrophin (BST) hormone from cattle into bacteria, the bacteria produce the hormone which is then injected into cattle to increase milk and meat production.
 - By transferring the gene that controls the production of chymosin from calf stomach cells into bacteria or fungi, the microorganisms produce chymosin which is used in cheese production and has considerably increased the production of cheese worldwide.
 - Any other suitable way.
9. The insulin-producing gene is cut out of a chromosome from a human pancreas cell and a plasmid is removed from a bacterial cell. The plasmid DNA is cut using restriction enzymes and the insulin-producing gene is inserted into the plasmid DNA forming recombinant DNA. The recombinant DNA is then reintroduced into a bacterium, which multiplies and the bacteria produce insulin. The insulin is separated and purified.

10. Any three of the following advantages:

- Yields can be increased by genetic engineering, which should increase the world food supply and reduce food shortages.
- The nutritional value of foods can be increased by genetic engineering, which should reduce deficiency diseases worldwide.
- The need for chemical pesticides that harm the environment can be reduced by genetically engineering crops to be resistant to pests.
- Vaccines produced by genetic engineering are generally safer than vaccines containing live and weakened, or dead pathogens.
- Larger quantities of drugs in a safer and purer form can be produced than were previously produced from animal sources, resulting in more people worldwide having ready access to safe, life-saving drugs.
- It overcomes ethical concerns of obtaining certain drugs from animals.
- Any other suitable advantage.

Any three of the following disadvantages:

- Plants genetically engineered to be toxic to a pest may also be toxic to useful organisms such as insects that bring about pollination and this could reduce reproduction in crops, reducing food production.
- Plants genetically engineered to be resistant to pests and herbicides could create unpredictable environmental issues such as the development of pesticide-resistant insects or herbicide-resistant superweeds.
- Once a genetically modified organism is released into the environment it cannot be contained or recalled, meaning that any negative effects cannot be reversed.
- The number of allergens in foods could be increased by transferring genes causing allergic reactions between species.
- As yet unknown health risks may occur as a result of eating genetically modified plants and animals.
- Large companies with funds and technology to develop genetically modified organisms could make large 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.
- Any other suitable disadvantage.

12 Health and disease

1. a) Health is a state of complete physical, mental and social wellbeing and not merely the absence of disease and infirmity.
b) A disease is a condition that impairs the normal functioning of part or all of an organism and leads to a loss of good health.
2. a) A communicable disease is caused by a pathogen and can be passed from one person to another, e.g. sexually transmitted infections and vector-borne diseases. A non-communicable disease is not caused by a pathogen, and cannot be passed from one person to another, e.g. nutritional deficiency diseases and degenerative diseases.

- b) Signs of a disease can be detected by someone other than the person affected by the disease, e.g. a rash and low blood pressure. Symptoms of a disease are experienced by the person affected by the disease. They are what the person feels, e.g. pain and nausea.
3. During an asthma attack, the muscles surrounding the bronchi and bronchioles contract, causing these airways to become narrower. The bronchial lining also becomes inflamed and there is increased mucus secretion.
4. a) Any four of the following signs/symptoms:
 - Breathing difficulties
 - Increased sweating
 - Back pain
 - Joint pains
 - Chronic fatigue
 - Elevated blood pressure
 - Inability to cope with physical exerciseb) Any two of the following diseases:
 - Type II diabetes
 - Hypertension
 - Stroke
 - Coronary heart disease
5. Type I diabetes may be treated by regularly monitoring blood glucose levels and taking regular insulin injections or using an insulin pump. A healthy diet low in sugar and saturated fats and high in dietary fibre, as well as regular exercise and regular medical checkups are also used to treat Type I diabetes.
Type II diabetes is treated by taking oral medication to help lower blood glucose levels. Weight management, a healthy diet low in sugar and saturated fats and high in dietary fibre, regular exercise and regular medical checkups are also treatment measures for Type II diabetes.
6. Diet and exercise are important components of the prevention and treatment of lifestyle-related diseases. Eating a healthy, balanced diet ensures that excess carbohydrates and fats, which contribute to these diseases, are not consumed. This limits weight gain and helps in the maintenance of normal heart rate and blood pressure. In particular, the diet should be low in saturated fats and high in dietary fibre supplied by fresh fruits, vegetables and whole grains. Regular, aerobic exercise also limits weight gain, promotes more efficient gaseous exchange, a faster metabolic rate and a lower heart rate. These lower the likelihood of the development of lifestyle-related diseases.

7. a) Influenza – virus
b) Ringworm – fungus (*Tinea*)
c) Typhoid – bacterium (*Salmonella typhi*)
d) Tuberculosis – bacterium (*Mycobacterium tuberculosis*)
8. a) Any four of the following signs/symptoms:
 - Severe watery diarrhoea
 - Vomiting
 - Dark-coloured urine
 - Stomach pain
 - Muscle cramps
 - Thirst

b) To prevent further spread of cholera, a cholera vaccine should be administered to uninfected persons in the community. Infected persons should be treated with antibiotics and should drink rehydration fluids. Drinking water should be chlorinated to kill the bacteria that cause cholera. Faeces should also be disposed of properly.

9. Gonorrhoea is caused by a bacterium (*Neisseria gonorrhoeae*). Signs and symptoms include pus discharge from the vagina or penis, blindness in babies infected during childbirth, sterility and itching and burning sensations when urinating. The disease is treated with antibiotics. No vaccine exists.

10. Any four of the following reasons:

- There is currently no vaccine or cure for HIV/AIDS.
- The virus has a long incubation period between when it enters the body and when symptoms develop. This can be 10 years or more. During this time, the infected person can pass on the virus without knowing it.
- It can be very difficult to convince persons to change their sexual behaviour.
- Anti-retroviral drugs are relatively expensive and have to be taken daily for the remainder of the infected person's life. Side effects are severe in some persons and include fatigue, nausea and vomiting, diarrhoea, headaches and insomnia.
- There is still a social stigma associated with HIV/AIDS so persons who have the disease may not disclose this to others or seek medical assistance.

11. Any two of the following ways:

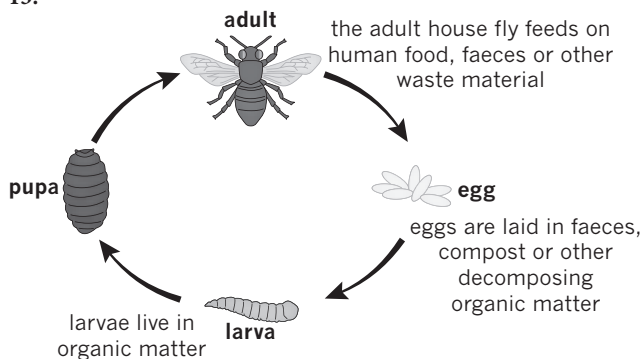
- From the mother to her foetus across the placenta, e.g. syphilis and HIV
- From the mother to her baby during birth, e.g. herpes, gonorrhoea (baby's eyes), HIV
- From the mother to her baby while breastfeeding, e.g. HIV

12. a) A vector is an organism that carries pathogens in or on its body and transmits the pathogens from one host to another.

b) Any two of the following diseases and vectors:

- Malaria – *Anopheles* mosquito
- Dengue fever/chikungunya/zika – *Aedes aegypti* mosquito
- Leptospirosis – rat
- Gastroenteritis – housefly

13.



14. Control measures for any two of the following stages:

Larvae or pupae

- Draining all areas of standing water.
- Adding insecticides to breeding areas to kill the larvae and pupae.
- Introducing fish into breeding areas to feed on the larvae and pupae (biological control).
- Spraying oil onto the surface of standing water to prevent the larvae and pupae from breathing.

Adults

- Spraying with insecticides to kill the adults.
- Removing dense vegetation to remove the adults' protection.

15 Diseases have several socio-economic impacts on the human population. They result in increased demand on health services, as well as job losses and loss of earnings for affected persons. Diseases also shorten the life expectancies of affected persons. Fewer persons working as a result of disease will lead to reduced productivity of businesses and reduced foreign exchange earnings for the country. This will also contribute to lower standards of living.

13 Hygiene and defences against disease

1. Maintaining personal hygiene is important because it helps to ensure good health, prevent the spread of infections, eliminate body odours, prevent dental caries and promote social acceptance.

2. Any three of the following measures for each of the following:

a) Skin and hair hygiene

- Regular washing of the body, especially the armpits, genitalia and between the toes.
- Regular washing of the hair.
- Drying the skin and hair thoroughly after washing.
- Applying a deodorant to clean, dry skin of the armpits.
- Changing and washing clothing frequently.

b) Dental hygiene

- Brushing teeth and gums in the proper way, twice a day.
- Using a fluoride toothpaste and good quality toothbrush when brushing.
- Using dental floss and an interdental brush once a day.
- Using an antibacterial mouthwash after brushing and flossing.
- Avoiding eating sugary and starchy foods and drinking sugary drinks, especially between meals and before going to bed.
- Visiting a dentist regularly for a checkup and cleaning.

c) Hands hygiene

- Washing hands before preparing and eating meals.
- Washing hands after using the toilet.
- Keeping fingernails short and clean.

3. a) Sterilisation is the complete destruction of all of the microorganisms present in a specified region. Disinfection is the use of chemicals to reduce the number of microorganisms that are present in a specified region to a level that cannot cause infection.

- b) Disinfectants are chemicals used to destroy microorganisms in or on non-living objects, e.g. in water and on counter tops. Antiseptics are chemicals used to destroy microorganisms on living tissues, e.g. on the surface of the skin.
- c) Antibiotics are chemicals that are used to kill bacteria or to slow their growth. Antifungal agents (fungicides) are chemicals that are used to kill fungi that cause infections or to slow their growth.

4. *Any three of the following methods:*

- Ultra-high temperature treatment (UHT): This method is used for the sterilisation of liquid food items such as milk, soups, sauces and baby food. This method can affect the flavour of food. The food is heated to temperatures higher than 135 °C for 1 to 2 seconds, cooled rapidly and packaged in pre-sterilised containers.
- Pasteurisation: This method kills most of the microorganisms in food and drinks while maintaining the quality of the product. It is a commonly used method for sterilising milk. The process involves heating the milk to 72 °C for 15 to 25 seconds and then cooling it very quickly.
- Canning: This method is used to protect a wide variety of foods from the action of microorganisms. Containers are filled with the food, covered with lids and placed into a boiling water bath or a steam bath. The heat kills the microorganisms in the food and the lids seal the containers after removal from the bath, preventing further entry of microorganisms.
- Autoclaving: This method is also referred to as steam sterilisation, and involves the use of pressurised steam in an autoclave to kill microorganisms in/on liquids, equipment and instruments such as hospital equipment and surgical instruments. An autoclave is similar to a pressure cooker. Inside the autoclave, the high pressure ensures that high temperatures of above 121 °C are maintained in order to destroy all microorganisms and their spores.
- Boiling: This method involves boiling materials to be sterilised, such as surgical instruments, in water at 100 °C for 15 to 30 minutes. It is also used for the purification of drinking water. Boiling kills all bacteria and some spores.

5. Antibody – a specific protein produced by lymphocytes in response to a specific antigen.

Antigen – a substance that is recognised as foreign to the body and stimulates lymphocytes to produce antibodies.

6. Antibodies are produced by lymphocytes.

When antigens are detected in the body, the appropriate lymphocytes multiply quickly and produce specific antibodies for these antigens. These antibodies bind to the antigens and cause the pathogens to clump together so that the phagocytes can engulf them, or they cause the pathogens to disintegrate. Antibodies can also neutralise the toxins produced by the pathogens.

7. a) Natural active immunity – When Kryssie contracted chicken pox the lymphocytes produced the specific antibody. When enough antibodies were produced, they destroyed the pathogens and she recovered.

The antibodies gradually disappeared from the blood and some lymphocytes developed into lymphocyte memory cells that remember the specific antigen. When the same pathogen re-entered the body, the memory cells recognised the antigen, multiplied and produced large amounts of the specific antibody rapidly. The antibodies destroyed the pathogen so quickly that Kryssie did not develop any signs or symptoms of the disease.

- b) Artificial passive immunity – Enrique was injected with a serum containing antibodies or antitoxins produced in the body of another organism. They provided immediate relief of symptoms of the snake bite. The immunity provided was short-term as the antibodies or antitoxins eventually disappeared from his blood.
- c) Artificial active immunity – Shiann was injected with a small amount of the weakened or dead influenza pathogen which stimulated lymphocytes in her body to produce the specific antibody needed. Lymphocyte memory cells also developed that will provide protection against future infection by that pathogen.

14 Drug use and misuse

1. A drug is any chemical substance that affects the functioning of the body.
2. Drug dependence is a condition that takes place when a person takes a drug over a period of time and needs the drug in order to function.
3. Physical dependence occurs when the body adapts to the drug and the body's cells cannot function without it. The person will experience withdrawal symptoms if drug use stops suddenly.

Psychological dependence occurs when the person feels the constant need for the drug and feels he or she cannot function without it.

4. a) Antibiotics are drugs that are used to treat bacterial infections, as they either kill or inhibit the growth of bacteria.
- b) Sedatives are drugs that are used to treat anxiety and insomnia. They slow down body functions, cause the user to feel calm and induce sleep.

5. *Any five of the following effects:*

- Increased heart rate
- Increased breathing rate
- Increased blood pressure
- Increased body temperature
- Sudden death by a heart attack or stroke
- Weight loss
- Destruction of the septum of the nose
- Reduced need for sleep
- Paranoia, anxiety or depression
- Schizophrenia and other mental illnesses

6. *Any two of the following drugs:*

- LSD (acid): This drug causes the user to go on a 'trip' or a state of altered consciousness during which colours seem more intense and lights seem brighter. The pupils become

dilated and the body temperature and blood pressure increase. Users may also become disoriented, anxious and have impaired judgement.

- Ecstasy: This drug causes heightened perception, sexual stimulation, reduced appetite, mood changes and the reduction of inhibitions. It also causes increased heart rate, blood pressure and body temperature. Heat exhaustion may occur, which could lead to death. Long-term ecstasy use often results in an irregular heartbeat, brain damage and kidney failure.
- Marijuana (cannabis, ganja, herb, pot): This drug produces a feeling of well-being (a 'high') followed by a feeling of despair (a 'low'). Short-term effects include dilated pupils, red eyes due to dilation of capillaries in the eyes, dizziness, increased appetite, slowed reflexes, increased heart rate and hallucinations. Heavy marijuana use may cause long-term lung and heart problems, mental disorders in vulnerable individuals, as well as reduced fertility in males.

7. Alcohol is considered a drug because it alters the normal functioning of the body. Alcohol is a depressant of the central nervous system, as it slows down the transmission of nervous impulses. Its misuse has several short-term and long-term effects on the body.

8. Any five of the following short-term effects:

- Slowed reflexes and reduced muscular coordination
- Impaired concentration and judgement
- Lack of self-control and aggression
- Slurred speech, distorted vision and hearing
- Dehydration due to frequent urination
- Memory lapses (blackouts)
- Vomiting
- Drowsiness
- Loss of consciousness

Any five of the following long-term effects:

- Fatty liver disease and cirrhosis (scarring) of the liver
- Increased blood pressure, heart attack and stroke
- Cancer of the mouth, throat and oesophagus
- Ulcers and other intestinal disorders
- Permanent brain damage
- Long-term memory loss
- Alcohol poisoning
- Malnutrition

9. Drug misuse in my country often leads to broken relationships, loss of parents from households, personal neglect and neglect of family members. Higher suicide rates and antisocial behaviour are also associated with drug use. Babies born to drug addicts may have developmental problems or they may be addicted to the drug as well.

Drug addicts may suffer the negative health effects associated with the misuse of drugs and require treatment and rehabilitation. The cost to the country to provide these services is very high. Drug use may also lead to loss of jobs and reduced productivity. This affects families directly and the society as a whole. In the case of Caribbean countries, it often means reduced foreign exchange earnings.

Drug addicts often carry out criminal acts such as murder, burglary and prostitution in order to obtain money to buy drugs. Thus, the crime rate is higher in areas where drug misuse is prevalent. There are also more automobile accidents when people drive under the influence of drugs.

15 Pollution and its effects

1. a) Pollution is the unfavourable alteration of the environment by the release of harmful substances or forms of energy into the environment.
b) A pollutant is a harmful substance or form of energy that causes unfavourable changes to the environment.
2. Any three of the following pollutants and their effects:

Air pollutant	Harmful effects
Carbon dioxide (CO ₂)	- Builds up in the atmosphere and enhances the greenhouse effect, which contributes to global warming. - Some is absorbed by oceans and causes ocean acidification, which harms aquatic organisms.
Carbon monoxide (CO)	- Combines with haemoglobin in the blood more readily than oxygen. This reduces the amount of oxygen being carried to body cells and results in headaches, dizziness, loss of consciousness and death.
Sulfur dioxide (SO ₂)	- Combines with water vapour, smoke and other air pollutants to form smog, which causes respiratory problems, e.g. asthma, bronchitis and lung disease, and irritates the skin and eyes. - Dissolves in rainwater to form acid rain. Acid rain lowers the pH of the soil and bodies of water such as lakes, streams and rivers, and makes them unsuitable for organisms. It also damages plants, harms animals and corrodes buildings.
Oxides of nitrogen	- Combine with water vapour, smoke and other air pollutants to form smog. - Reduce plant growth. - Dissolve in rainwater to form acid rain.
Volatile organic compounds (VOCs)	- Combine with water vapour, smoke and other air pollutants to form smog.
Dust and other particulate matter	- Cause respiratory problems, e.g. asthma, bronchitis and lung disease. - Coat leaves, which reduces photosynthesis.

3. Global warming refers to an increase in the Earth's temperature over time due to human activities that release carbon dioxide, such as burning fossil fuels and deforestation. Carbon dioxide enhances the greenhouse effect and leads to an increase in the Earth's temperature.

4. Fertilisers used in agriculture contain plant nutrients. When it rains and these nutrients, especially nitrates and phosphates, enter bodies of water, they cause an overgrowth of aquatic plants and algae, which give the water a green appearance. When the plants and algae die, decomposers in the water break them down. These decomposers are aerobic bacteria, which multiply quickly and use up the dissolved oxygen in the water. This causes other aquatic organisms, e.g. fish, to suffocate and die.

Pesticides that enter bodies of water can harm beneficial aquatic organisms as well as harmful ones. They also become higher in concentration up food chains and can harm top consumers.

5.

Pollutant	Sources	Harmful effects
a) Suspended solids	<ul style="list-style-type: none"> - Soil erosion causes silt and soil to wash into bodies of water when it rains - Domestic and industrial waste 	<ul style="list-style-type: none"> - Reduce light penetration, which reduces photosynthesis in aquatic plants - Block rivers and lakes
b) Organic matter	<ul style="list-style-type: none"> - Sewage - Manure and other farm waste - Industrial waste 	<ul style="list-style-type: none"> - Reduces the amount of oxygen dissolved in water, leading to the death of fish and other aquatic organisms
c) Heavy metal ions	<ul style="list-style-type: none"> - Industrial waste 	<ul style="list-style-type: none"> - May be toxic to organisms and kill them directly - May become higher in concentration up food chains and can harm top consumers - Damage many body tissues and organs, especially parts of the nervous system

6. Any four of the following:

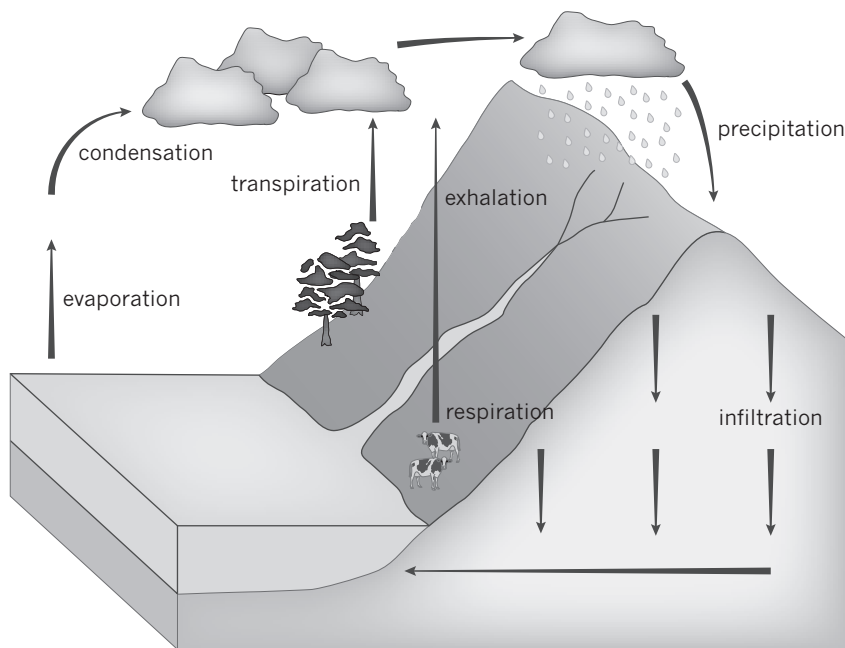
- Reduce the use of fossil fuels by using alternative energy sources, e.g. solar and wind energy, which do not cause air pollution.
- Pass laws with strict penalties that limit the release of air pollutants by industry, e.g. a Clean Air Act.
- Clean gaseous emissions from factories before releasing them into the atmosphere.
- Equip motor vehicles with pollution control devices and modify engines to make them more fuel efficient.
- Ban smoking or restrict the activity to specific locations.
- Put public education programmes in place.

7. Any four of the following:

- Carry out proper treatment of sewage before releasing it into bodies of water. Untreated sewage is a source of several water pollutants, including plant nutrients, organic matter and pathogens. Treating sewage removes these harmful substances or reduces them to harmless levels.
- Compost plant waste, such as vegetable peelings and crop residues. This will reduce the amount of organic matter that is released into bodies of water.
- Use farm waste and waste from the food industry to produce biogas. Farm waste is a source of organic matter, plant nutrients and pathogens. If this waste is converted to biogas, it will be serving as an energy source while reducing water pollution.
- Use organic fertilisers instead of inorganic chemical fertilisers. Organic fertilisers will remain in the soil for a longer time than inorganic chemical fertilisers, as the organic fertilisers are generally insoluble and take a fairly long time to be broken down. Chemical fertilisers tend to move through soil easily and enter water bodies, where they cause pollution.
- Use biodegradable detergents. These detergents will be broken down quickly in water and will not have a long-term negative impact.
- Use biological control or natural, biodegradable pesticides instead of synthetic pesticides. Biological control does not involve the use of chemicals which can contaminate water sources. It is also specific and will not harm beneficial organisms. Biodegradable pesticides will be broken down quickly and will not have a long-term negative impact.
- Pass laws with strict penalties that limit the release of water pollutants by industry, e.g. a Clean Water Act. This will make it less likely for companies to release pollutants into bodies of water.
- Put public education programmes in place to make people aware of the negative effects of water pollutants and ways in which they can minimise water pollution.

16 The cycling and treatment of water

1.



2. Any two of the following:

- Filtration – Muslin cloth can be used as a filter to remove suspended material from water. This makes water safe for domestic purposes, such as bathing and washing clothes. Also, domestic filters can be attached to taps. Their pore sizes are tiny enough to remove suspended material, including bacteria and protozoa.
- Boiling – Water is brought to a ‘rolling boil’ for 10–20 minutes. This kills bacteria, spores, cysts and ova of intestinal parasites. It also removes hardness of water, producing soft water.
- Chlorination – Chlorine tablets are very effective for disinfecting small quantities of water. One 500 mg tablet can be used to kill microorganisms in 20 litres of water. Chlorine bleach is also effective for killing microorganisms in water. One teaspoon of bleach should be added to one litre of water.

3. There are four steps involved in the large-scale purification of water:

1. Screening – Water from rivers, lakes and reservoirs passes through grid screens to remove large floating materials and suspended solids.
2. Sedimentation – The water is then pumped to a settlement tank where fine suspended solid particles coagulate (clump together) and settle.
3. Filtration – The clear water from the settlement tank passes through sand filters containing microorganisms. These microorganisms remove organic matter from the water by feeding on it.
4. Chlorination – The filtered water is treated with chlorine to kill all harmful microorganisms that are still in the water. Fluoride is sometimes added at this stage to reduce tooth decay. The water is then pumped to storage tanks for distribution to consumers.

4. The steps involved in testing water for bacteria are as follows:

1. Collect a sample of the water to be tested in a sterile container.
2. Pour a small amount of the water onto an agar plate. Cover the plate and tape the lid to ensure it does not come off.
3. Incubate the plate at 35 °C for 24 hours.
4. Count the number of colonies of bacteria.

5. Any three of the following impacts:

- Humans use water supplies for agricultural and industrial uses. As agriculture and industry grow in size, they place increased demand on water supplies. It’s possible that at some periods of the year, demand will outstrip supply, leading to shortages.
- Humans use water for domestic purposes, including washing and for drinking. As the human population increases, demand on water supplies increases, which can lead to shortages.
- Humans carry out deforestation, often for industrial or agricultural purposes. This reduces transpiration, which interrupts the water cycle and can lead to reduced precipitation.
- Humans often release harmful wastes into the water supplies, from agricultural and industrial activities. These wastes contaminate the water supply.
- Humans release harmful wastes into the water supplies, from domestic activities. These wastes contaminate the water supply and require purification processes to make the water useable again.

6. Include at least three of the following reasons:

- Contaminated water is detrimental to human health because it may contain:
- Pathogens that cause diseases such as typhoid, cholera and gastroenteritis.

- Pesticides that may harm the nervous and endocrine systems.
- Heavy metal pollutants, e.g. mercury and lead, that affect many body tissues, especially those of the nervous system, resulting in mental illnesses and brain damage.
- Nitrates that are especially harmful to infants and pregnant women because they reduce the amount of oxygen that is carried in the blood and can lead to blue baby syndrome.
- Radioactive waste that may result in genetic defects and even death.

17 The treatment and disposal of human waste

1. Any three of the following components:

- Human faeces
- Human urine
- Household wastewater
- Wastewater from some industries
- Rainwater

2. Improper sewage disposal takes place when untreated sewage is released directly onto the land, is released directly into open water or leaks from cracked sewage pipes. Sewage is disposed of properly when it is removed from houses and other buildings through underground pipes or sewers, which take it to sewage treatment plants or into areas that are far enough from homes and water sources to not be problematic.

3. Any three of the following impacts:

- Untreated sewage that is released into water is directly responsible for the spread of infectious diseases such as cholera, typhoid and dysentery.
- Untreated sewage that is released onto the land promotes the breeding of vectors such as flies and rats, which transmit diseases.
- Untreated sewage that is released into water may float on the surface of the water and reduce the amount of light that is absorbed by aquatic plants. This reduces the amount of photosynthesis taking place in the water and affects aquatic food chains.
- Nutrients in untreated sewage may contribute to eutrophication of water bodies.
- Sewage that is not disposed of properly gives off a foul odour which contaminates the environment.

4. Any one of the following similarities:

- Both methods begin with the same steps: screening, grit settling and sedimentation.
- Both methods involve the use of aerobic microorganisms to break down organic matter.

Difference:

- The biological filter method involves spraying the effluent onto small stones that are covered with a film of aerobic bacteria and protozoa. The activated sludge method involves passing the effluent into aeration tanks containing aerobic bacteria, where compressed air is forced through it. Paddles are also used to help with the mixing of air and effluent.

- a) Ventilation pipe – allows gases and odours produced during decomposition in the pit to escape
 - b) Lid – keeps out vectors
 - c) Cement lining – prevents the sides from caving in
- The pit should be dug to at least three metres (3 m) deep in order to reduce odours coming up and to ensure that it can be used for a long time before it fills up.
 - The pit should be placed in sandy soil because bacteria in the latrine break down the faeces and convert them into liquids. Sandy soil will allow the liquids to drain away.
 - The pit should be placed downhill and far enough away from wells and other sources of drinking water so that it does not contaminate these water sources.

7. Advantages of pit latrines:

- They require less water than flush toilets.
- They are relatively cheap to construct.

Any two of the following disadvantages:

- They contribute to the risk of water and food contamination.
- They can contribute to the spread of infectious diseases.
- The rapid growth of the Caribbean population makes it difficult to site pit latrines. There is now limited land space available in appropriate locations.

8. Any three of the following methods:

- Landfill
- Incineration
- Composting
- Recycling

9. A landfill consists of a large, deep pit in which compacted solid waste is buried to isolate it from the surrounding environment. The pit is lined with an impermeable material that forms the bottom liner to prevent leachate seeping into the ground and contaminating soil and water. Two sets of pipes are installed, one to help drain off any leachate and carry it to a treatment plant, and the other to remove any waste gases, e.g. methane, which can be used as a fuel to produce electricity.

On arrival at the landfill, the refuse is sorted to remove materials that can be recycled. The remaining refuse is then compacted to make it difficult for vectors to penetrate and to reduce its volume so the landfill can be used for a long time. The compacted refuse is then placed into the landfill and is covered with a layer of soil at the end of each day, so that it is not exposed to the wind and vectors, and to reduce smells.

10. Any three of the following impacts:

- Toxic chemicals in the waste can leach out and contaminate the soil, aquatic environments and water sources.
- Greenhouse gases, e.g. methane and carbon dioxide, can be released into the atmosphere where they contribute to the greenhouse effect.
- Hydrogen sulfide gas can be released into the air. This gas is extremely toxic, and even low concentrations irritate the eyes and respiratory system.
- Plastics can enter waterways and oceans where they are harmful to aquatic organisms.

- Refuse attracts rodents that can spread disease.
- Refuse creates an eyesore that impacts negatively on tourism, especially eco-tourism.

- 11. a)** Reduce means to cut down on the purchase and use of materials.
- b)** Reuse means to use again for the same or for a different purpose.
- c)** Recycle means to separate and reprocess a resource into new products.

- 12.** Biodegradable materials can be broken down by microorganisms into harmless materials, which can be recycled into the environment.

Any two of the following examples:

- Food waste
- Paper
- Garden and farmyard waste
- A few plastics

Non-biodegradable materials cannot be broken down by microorganisms so they remain in the environment.

Any two of the following examples:

- Most plastics
- Rubber
- Metal
- Glass

Exam-style questions – Chapters 1 to 2

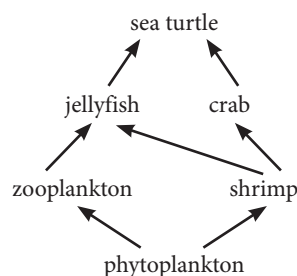
STRUCTURED QUESTIONS

1. a) i) W is the cell membrane.
X is a chromatin thread. (2 marks)
- ii) Y transports substances throughout the cell.
Z is where respiration occurs to release energy for the cell. (2 marks)
- iii) W is partially or differentially permeable, whereas the cell wall is freely permeable. (2 marks)
- b) i) A is a neurone or nerve cell. (1 mark)
- ii) Any two of the following: (2 marks)
- B has a tail for swimming.
 - B has mitochondria in its middle piece which supply energy for swimming.
 - B has an acrosome in its head that contains enzymes to dissolve a passage into the ovum.
- iii) It is important that the human body is made of specialised cells so that the cells can carry out specific functions and this enables the body to carry out all essential life processes as efficiently as possible. (1 mark)
- c) i) A virus is not considered to be a living organism because it lacks the ability to reproduce outside a living cell. (1 mark)
- ii) Any two of the following: (4 marks)
- Anton and Elijah are displaying respiration. Their body cells, especially their muscle cells, are releasing energy from food to enable them to run around and hit the ball.
 - Anton and Elijah are displaying excretion. They are producing carbon dioxide in respiration and excreting it as they exhale.
 - Anton and Elijah are displaying movement. They are changing the position of their entire bodies and parts of their bodies as they run around the court and hit the ball.
 - Anton and Elijah are displaying irritability as they detect the position of the ball and respond by running to hit it.
- Total 15 marks**
2. a) i) Substance C is chlorophyll.
Substance D is carbon dioxide.
Substance E is glucose. (3 marks)
- ii) Any two of the following:
- Substance E (glucose) can be used by the leaf cells in respiration to release energy.
 - Substance E (glucose) can be converted to starch by the leaf cells and stored.
 - Substance E (glucose) can be converted to other useful organic substances by the leaf cells such

as amino acids and proteins, vitamins and chlorophyll. (2 marks)

- iii) Tasha and Mia depend both directly and indirectly on plants to supply them with food because plants are the only living organisms capable of producing their own food. When Tasha and Mia eat any food of plant origin such as fruits and vegetables, they are depending directly on plants. When they eat any food of animal origin such as meat or fish, they are depending indirectly on plants. (2 marks)

b) i)



(2 marks)

- ii) The sea turtle. (1 mark)

- iii) Energy and biomass are lost at each trophic level in a food chain. Energy released in respiration from organic food is used by the organisms at each level to carry out life processes, so is not passed on. Organic matter containing energy is also lost in faeces and excretory products by organisms at each level, so is not passed on. As a result, fewer organisms can be supported at each trophic level. (3 marks)

- c) Ramon's grass cuttings that he leaves on his lawn will be decomposed by saprophytic bacteria and fungi or decomposers. During this decomposition, the chemical elements such as nitrogen, which are present in the dead grass, are released back into the soil. These elements can then be absorbed and used by the grass plants growing in Ramon's lawn. However, by removing his grass cuttings, the elements present are not returned to Sean's soil for use by the grass plants growing in his lawn. (2 marks)

Total 15 marks

STRUCTURED ESSAY QUESTION

3. a) i) There were more water molecules in the water in the beaker than in the 25% sucrose solution in the Visking tubing bag, so water molecules diffused through the Visking tubing from the water in the beaker into the sucrose solution. They were able to do this because the partially permeable Visking tubing had tiny holes that only allowed the water molecules to pass through. The sucrose molecules tried to diffuse the other way from the solution into the water, but were unable to pass through the holes in the Visking tubing. As the water

entered the bag, the volume of the sucrose solution increased causing it to move up the capillary tube.

(4 marks)

ii) The process occurring in the apparatus is osmosis. Differences:

- During osmosis only water molecules are capable of moving, whereas during diffusion any molecules or ions are capable of moving once they are in gases, liquids or solutions.
- During osmosis the water molecules move through a partially permeable membrane, whereas the particles do not move through a partially permeable membrane during diffusion.

(5 marks)

b) i) Active transport is the movement of particles through cell membranes against a concentration gradient using energy released in respiration.

(2 marks)

ii) Active transport is important for the following reasons.

- Some of the glucose and amino acids produced in digestion are absorbed from the ileum into the blood by active transport. This ensures that body cells get the glucose and amino acids they need from the food consumed.
- Useful substances are reabsorbed from the filtrate in the kidney tubules into the blood by active transport. This prevents them from being lost from the body in urine.

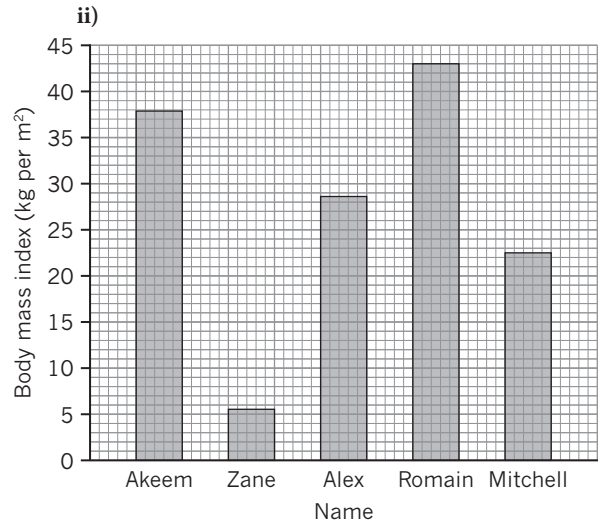
(4 marks)

Total 15 marks

Exam-style questions – Chapters 3 to 9

STRUCTURED QUESTIONS

1. a) i) A is the colon. Its function is to absorb water and mineral salts from any undigested food. (2 marks)
- ii) *Any one of the following:*
- Nikoli could increase his intake of foods rich in vitamin D such as oily fish.
 - Nikoli could take vitamin D supplements. (1 mark)
- iii) Structure number 4. (1 mark)
- iv) Structure 4 is the ileum and vitamin D promotes the absorption of calcium and phosphorus in the ileum, both of which are needed to help build strong bones and prevent rickets. (1 mark)
- b) i) Mitchell. (1 mark)



(3 marks)

iii) Zane and Romain. (2 marks)

iv) - Zane is most likely to suffer from anorexia. This is possibly caused by Zane eating very little, vomiting, using laxatives and exercising excessively.

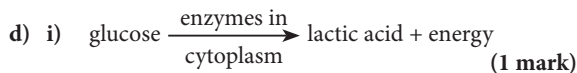
- Romain is most likely to suffer from obesity. This is possibly caused by Romain's excessive consumption of energy rich foods high in sugar and fat, and by him not getting any exercise.

(4 marks)

Total 15 marks

2. a) Respiration is the process by which energy is released from food by all living cells, whereas breathing refers to the movements that cause air to be moved in and out of the lungs. (2 marks)
- b) i) B is the trachea. C is a bronchiole. (2 marks)
- ii) To inhale, the external intercostal muscles and diaphragm muscles **contract** causing the ribcage to move upwards and **outwards**, and the diaphragm to **flatten**. (3 marks)
- iii) *Any two of the following:*
- They have a large surface area.
 - Their walls are only one cell thick, so they are very thin.
 - They are surrounded by a network of blood capillaries giving them a rich blood supply.
 - They are lined with moisture. (2 marks)
- c) i) Individuals who smoked 40 cigarettes per day for 40 years are most at risk of dying from lung cancer. (1 mark)
- ii) *Any two of the following:*
- Smoking cigarettes increase a person's chances of developing lung cancer.
 - Smoking cigarettes is not the only cause of lung cancer or people who don't smoke can also develop lung cancer.

- A person's chances of developing lung cancer increases as the number of cigarettes smoked per day increases.
- A person's chances of developing lung cancer increases as the length of time they smoke for increases. (2 marks)



ii) Any two of the following:

- Carbon monoxide in the smoke that Tamara inhales combines more readily with the haemoglobin in her blood than oxygen does and this reduces the amount of oxygen that her blood can carry to her body cells, causing her to feel breathless.
- Smoke causes mucus production to increase and paralyses the cilia, which stops them from beating and removing the mucus. As the mucus builds up in Tamara's bronchi and bronchioles it obstructs them, making her feel breathless.
- Smoke irritates and inflames the walls of Tamara's bronchi and bronchioles; this obstructs them, making her feel breathless.
- Smoke causes the walls of Tamara's alveoli to become less elastic and the walls between them to break down, which decreases their surface area. This reduces gaseous exchange, makes exhaling difficult and makes Tamara feel breathless.

(2 marks)

Total 15 marks

3. a) i) R is the right atrium.
S is the left ventricle. (2 marks)

ii) Q prevents blood in the left ventricle from flowing back into the left atrium when the left ventricle contracts. (1 mark)

iii)

	Aorta	Anterior vena cava
Pressure of blood carried	High	Low
Thickness of the walls	Thick	Thin

(2 marks)

iv) Humans have a double circulation because during one complete circulation around the body, the blood flows through the heart twice. In the pulmonary circulation, blood travels from the heart to the lungs and then back to the heart. In the systemic or body circulation, the blood travels from the heart to the body and then back to the heart again. (2 marks)

b) i) A heart attack. (1 mark)

ii) Fatty deposits called atheromas built up on the inside of the walls of Jerome's coronary arteries causing their lumens to narrow. A blood clot then formed in one of the narrow arteries which partially or completely blocked the blood flow through the artery. This prevented oxygen from getting to the section of the heart muscle supplied

by the artery and so the muscle started to die, causing Jerome to suffer from a heart attack.

(3 marks)

c) i) Tissue fluid is constantly being formed in Sabrina's feet from blood plasma flowing through blood capillaries. Some of this tissue fluid then flows into lymph capillaries and forms lymph, which then flows into lymphatic vessels and is transported away from Sabrina's feet. Since Sabrina is sitting still all day, the muscles in her legs are not contracting to help the lymph to move through her lymphatic vessels away from her feet. This causes tissue fluid to build up in her feet and causes her feet and ankles to swell. (3 marks)

ii) Sabrina should ensure that she walks around regularly during the day to help the lymph to flow away from her feet. (1 mark)

Total 15 marks

4. a) Any two of the following:

- The skeleton protects internal organs.
- The skeleton provides support for the soft parts of the body.
- The skeleton brings about movements that enable breathing.
- The skeleton produces blood cells. (2 marks)

b) i) A hinge joint. (1 mark)

ii) F is synovial fluid.
The main function of the synovial fluid is to lubricate the joint allowing friction free movement. (2 marks)

iii) The knee joint allows movement in one plane or direction only, whereas the hip joint allows movement in all planes. (2 marks)

iv) Any two of the following:

- The articular cartilage over the ends of the bones in Jordan's knee may have worn away so there is increased friction between the bones as he walks, which may cause pain.
- The synovial membrane in Jordan's knee may have reduced its secretion of synovial fluid resulting in increased friction between the bones as he walks, which may cause pain.
- The ligaments that make up the capsule around Jordan's knee may have become weaker so the bones are not held together as firmly as they should be, which may cause pain when he walks. (2 marks)

c) i) To lift the dumbbells, the biceps muscle in Shakira's upper arm contracts and the triceps muscle relaxes. To lower the dumbbells, the triceps muscle contracts and the biceps muscle relaxes. (4 marks)

ii) Any two of the following:

- Shakira may develop painful arches in her feet.
- The curvature of Shakira's spine may change, resulting in lower back pain.
- Shakira's calf muscles may shorten and bulge.
- Excess pressure may be placed on Shakira's knee and hip joints.

- Shakira may develop corns or bunions on her feet.
- Shakira may develop hammer toe or ingrown toenails. (2 marks)

Total 15 marks

5. a) i) Excretion is the process by which waste and harmful substances, produced by chemical reactions occurring inside body cells (i.e. the body's metabolism), are removed from the body. (2 marks)

- ii) Any one of the following:
- The lungs excrete carbon dioxide or water vapour.
 - The skin excretes urea or salts or water.
 - The liver excretes bile pigments. (2 marks)

b) i) G is Bowman's capsule.
H is a collecting duct.
J is the loop of Henle. (3 marks)

ii) Ultra-filtration occurs in structure Y, the glomerulus. The diameter of the capillary entering structure Y from the arteriole decreases causing pressure on the blood to increase. Small molecules are forced from the blood into Bowman's capsule forming filtrate which contains glucose, amino acids, hormones, vitamins, water, salts and urea.

Selective reabsorption occurs in structure Z, the first convoluted tubule. Glucose, amino acids, hormones, vitamins and some salts are reabsorbed back into the blood travelling through the capillaries wrapped around the tubule by active transport. Some water is reabsorbed into the blood by osmosis. (4 marks)

- c) i) Playing football. (1 mark)
ii) Antidiuretic hormone. (1 mark)
ii) The hormone made the walls of the second convoluted tubules and collecting ducts in Andrew's kidneys more permeable to water, so that most of the water was reabsorbed from the filtrate back into his blood. (2 marks)

Total 15 marks

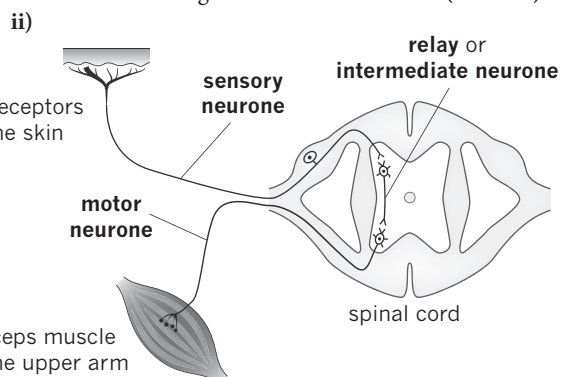
6. a) The nervous system can be divided into the **central** nervous system and the **peripheral** nervous system. (2 marks)

- b) i) K is a dendrite.
L is an axon. (2 marks)
ii) The function of L is to carry nerve impulses from the cell body to adjacent neurones. (1 mark)
iii) Impulses pass across synapses between M, the synaptic knobs, and adjacent neurones by chemicals called neurotransmitters being released into the synapses by vesicles in the synaptic knobs. These neurotransmitters then cause impulses to be set up in the adjacent neurones. (1 mark)

Region of the brain	One function
Medulla oblongata	• Controls automatic, involuntary actions
Cerebrum	• Controls conscious thought
Cerebellum	• Controls balance and posture or • Coordinates movement

(3 marks)

d) i) Dana's actions are voluntary because they involve conscious thought. (2 marks)



(3 marks)

iii) Reflex action. (1 mark)

Total 15 marks

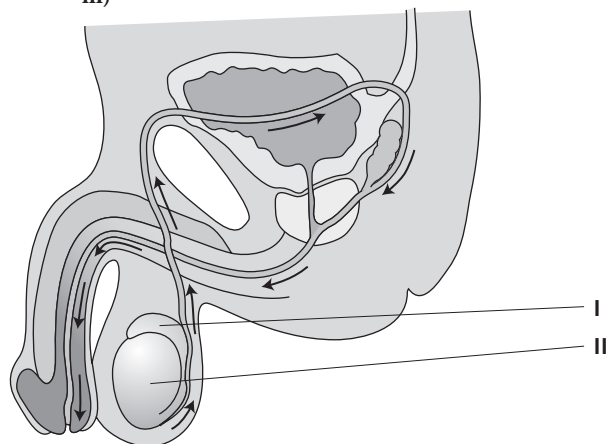
7. a) i)

	Name of structure	One function
I	Epididymis	Stores sperm
III	Fallopian tube or oviduct	Transports ova from the ovary to the uterus or The place where fertilisation occurs

(4 marks)

- ii) - Both structures produce gametes.
- Both structures produce hormones. (2 marks)

iii)



(2 marks)

- b) i) 1980 to 1984. (1 mark)
ii) Between 1990 to 1994, and 1995 to 1999. (1 mark)

iii) - The total number of births to teenage mothers aged 16 and 17 years recorded over five-year periods showed a continuous decrease from 1980 to 2009.

- In each five-year period, the number of births to teenage mothers aged 16 years was less than the number to mothers aged 17 years. (2 marks)

iv) The condom acts as a barrier to prevent sperm from entering the female body.

Any one advantage of using condoms:

- Condoms are very reliable if used correctly.
- Condoms are easy to use.
- Condoms are readily available.
- Condoms protect against sexually transmitted infections.

Any one disadvantage of using condoms:

- Condoms may reduce sensitivity so interfere with enjoyment.
- Condoms can tear allowing sperm to enter the vagina.
- The latex rubber from which condoms are made can cause an allergic reaction in some people.

(3 marks)

Total 15 marks

STRUCTURED ESSAY QUESTIONS

8. a) i) Breast milk is considered the complete food for babies because it contains carbohydrates, proteins, lipids, vitamins, minerals and water in the correct proportions to supply the baby with enough energy daily and the correct materials for the baby to grow and develop, and to keep him or her healthy. (2 marks)

ii) After Jay swallows the milk it enters his stomach where rennin clots the soluble protein to keep it in his stomach and pepsin then starts to digest the protein into peptides. The partially digested milk then leaves his stomach and enters his small intestine, where organic bile salts emulsify the lipids present and pancreatic lipase digests the emulsified lipids into fatty acids and glycerol. Trypsin continues to digest the proteins into peptides and then erepsin digests the peptides into amino acids. Lactase also digests the lactose into glucose and galactose. (6 marks)

iii) - Powdered milk possibly contains a higher percentage of lipid than breast milk.
- Powdered milk possibly contains a higher percentage of lactose than breast milk. (2 marks)

b) i) Jay needs to develop teeth before he can properly digest any solid food in his diet because the teeth break up large pieces of food into smaller pieces. This gives the pieces of food a larger surface area for digestive enzymes to act upon, which makes chemical digestion quicker and easier. (3 marks)

ii) It is important that the enamel of Jay's teeth is the hardest substance in his body so that his teeth can break up hard pieces of food without the enamel

being chipped or damaged, and also so that it is resistant to decay. (2 marks)

Total 15 marks

9. a) Homeostasis is maintaining a constant internal environment.

Negative feedback mechanisms play an important role in homeostasis because if the level of something in the body changes, receptors in the body detect the change and send messages to the appropriate effectors. These messages cause the effectors to respond by exerting an opposite or negative effect to return the level to normal. (4 marks)

b) As Jason's body temperature drops below 37 °C, the hypothalamus of his brain detects a drop in the temperature of the blood passing through it and sends messages to his skin and other effectors. His skin stops producing sweat and the arterioles supplying the capillaries in his skin constrict, which decreases the flow of blood through them and decreases heat loss through the skin. Messages also cause respiration to increase in his muscle and liver cells to increase heat production and he begins to shiver, which also generates heat. (6 marks)

c) As Britnee is running the 200 m race, respiration speeds up in her muscle cells and she produces increasing amounts of carbon dioxide. This carbon dioxide reacts with water in the plasma of her blood and forms carbonic acid. As the carbon dioxide levels increase, Britnee's blood becomes more acidic so its pH decreases. Receptors, mainly in the medulla of her brain, detect this decrease in pH and send messages to her intercostal muscles and diaphragm causing them to contract more rapidly. This speeds up her breathing rate and depth of breathing. (5 marks)

Total 15 marks

10. a) *Any three of the following:*

- Messages are carried as electrical impulses along nerves in the nervous system, whereas they are carried by chemicals called hormones in the blood in the endocrine system.

- Messages are transmitted rapidly by the nervous system, whereas they are usually transmitted slowly by the endocrine system.

- Messages are carried to precise places in the body by the nervous system, whereas they are carried to more general regions of the body by the endocrine system.

- Messages carried by the nervous system have an immediate effect on the body, whereas those carried by the endocrine system usually have a slow effect on the body.

- Messages carried by the nervous system have a shorter lasting effect on the body, whereas those carried by the endocrine system usually have a longer lasting effect on the body. (3 marks)

b) i) The ciliary muscles in Aiden's eyes relax, which causes the suspensory ligaments to be pulled tight. This pulls his lenses into a flattened shape so that the light rays from the bird are only bent slightly to focus them onto his retinas. (4 marks)

- ii) As Aiden gets older, his lenses lose their elasticity and his ciliary muscles weaken. As a result, his lenses are less able to curve and focus the light rays from the smart phone in his hand onto his retinas. To correct his sight defect Aiden must wear converging lenses as spectacles or contact lenses, so that the light rays from near objects are bent inwards before entering his eyes. (4 marks)

c) Any two of the following:

- Aiden's pituitary gland will reduce production of antidiuretic hormone. As a result, he will be unable to regulate the water content of his blood plasma and body fluids.
- Aiden's pituitary gland will reduce production of growth hormone. As a result, his bone and muscle mass will decrease.
- Aiden's pituitary gland will reduce production of follicle stimulating hormone. As a result, he will be unable to properly control the production of sperm in his testes.
- Aiden's pituitary gland will reduce production of luteinising hormone. As a result, he will be unable to properly control the production of testosterone by his testes which will affect his control over sperm production in his testes. (4 marks)

Total 15 marks

11. a) i) Events in Rasheeda's ovaries:

During the first two weeks an immature ovum undergoes meiosis and one cell matures to form a mature ovum inside a Graafian follicle. Ovulation occurs on day 14 as the Graafian follicle bursts and releases the mature ovum into one of Rasheeda's oviducts. The empty Graafian follicle forms the corpus luteum, which remains for the third week and then degenerates.

Events in Rasheeda's uterus:

During the first week menstruation occurs as Rasheeda's uterus lining breaks down and is lost from her body. During the second week the uterus lining thickens and its blood supply increases. The lining remains thick for the third week and begins to break down during the fourth week, but it remains in Rasheeda's body. (5 marks)

ii) - Oestrogen

Oestrogen stimulates the uterus lining to thicken and its blood supply to increase during the week after menstruation, and it causes the pituitary gland to stop secreting follicle stimulating hormone and to secrete luteinising hormone.

- Progesterone

Progesterone causes the uterus lining to increase slightly in thickness and to remain thick during the third week of the cycle. Its level decreases during the fourth week and this causes the uterus lining to begin to break down and the pituitary gland to secrete follicle stimulating hormone at the end of the fourth week. (4 marks)

b) The placenta allows the exchange of substances between Rasheeda's blood and the embryo's blood.

Food and oxygen diffuse from Rasheeda's blood in her uterus lining into the embryo's blood in the placenta, and carbon dioxide and other waste diffuse from the embryo's blood into Rasheeda's blood.

The umbilical cord joins the embryo to the placenta. The umbilical vein in the umbilical cord carries dissolved food and oxygen to the embryo from the placenta, and the umbilical artery carries dissolved carbon dioxide and other waste away from the embryo to the placenta.

The amniotic fluid, contained in the amniotic sac, supports and protects the embryo. (6 marks)

Total 15 marks

Exam-style questions – Chapters 10 to 11

STRUCTURED QUESTIONS

1. a) A chromosome is a thread-like structure composed of deoxyribonucleic acid (DNA) and protein that contains genetic information in the form of genes. A gene is the basic unit of heredity that is composed of DNA, occupies a fixed position on a chromosome and determines a specific characteristic. (2 marks)
- b) i) X is a chromatid. (1 mark)
- ii) Meiosis. (1 mark)
- iii) - Four of the chromatids have exchanged end segments, therefore they have exchanged genetic information.
- Homologous chromosomes, each composed of two chromatids, are being pulled apart to opposite poles of the cell. (2 marks)
- iv) Any one of the following:
- In the testes. (1 mark)
- In the ovaries. (1 mark)
- v) Each daughter cell would have 2 chromosomes. (1 mark)
- vi) - Each cell produced in meiosis has the haploid number of chromosomes so that the diploid number can be restored when fertilisation occurs.
- Each daughter cell has a different combination of genes, which leads to variation among offspring. (2 marks)
- c) i) Variation is the differences that exist between individuals. (1 mark)
- ii) Continuous variation is where characteristics show continuous gradation from one extreme to the other without a break. Discontinuous variation is where characteristics show clear cut differences with no intermediates, therefore individuals can be divided into distinct categories. (2 marks)
- iii) Down's syndrome is caused when an individual has an extra chromosome 21 in each of their cells, because pair 21 fails to separate properly during meiosis and both chromosomes pass into one gamete. (2 marks)

Total 15 marks

2. a) i) A dominant allele is an allele which, if present, produces the same phenotype whether its paired allele is identical or different. (2 marks)

ii)

gametes	r	r
R	Rr	Rr
r	rr	rr

(4 marks)

- iii) A 1 in 2 chance or a 50% chance. (1 mark)

- iv) Heterozygous. (1 mark)

- b) i) Discontinuous variation. (1 mark)

- ii) Any one of the following:

- Gender
- ABO blood groups
- Rhesus blood groups
- Tongue rolling
- Any other suitable characteristic (1 mark)

- iii) Tara and Ashlee's phenotypes are determined by their genotype and the influences of their environments. From the day they were conceived, they were under different environmental influences. For example, whilst in their mother's womb they were not getting exactly the same food and they were in different positions. After they were born and whilst growing up they did not eat exactly the same type and quantity of food, they were not exposed to exactly the same medicines and climatic conditions, they did not receive exactly the same education and they got different amounts of exercise. (3 marks)

- iv) It is important that living organisms show variation because variation enables species to remain well adapted to their environment or to gradually change and improve by becoming better adapted, in other words it enables species to evolve. (2 marks)

Total 15 marks

STRUCTURED ESSAY QUESTION

3. a) i)

gametes	X^{H}	Y
X^{H}	$\text{X}^{\text{H}}\text{X}^{\text{H}}$	$\text{X}^{\text{H}}\text{Y}$
X^{h}	$\text{X}^{\text{H}}\text{X}^{\text{h}}$	$\text{X}^{\text{h}}\text{Y}$

(4 marks)

- ii) The offspring have the following phenotypes:

- $\text{X}^{\text{H}}\text{X}^{\text{H}}$ – female with normal blood clotting
- $\text{X}^{\text{H}}\text{Y}$ – male with normal blood clotting
- $\text{X}^{\text{H}}\text{X}^{\text{h}}$ – female with normal blood clotting
- $\text{X}^{\text{h}}\text{Y}$ – male with haemophilia. (4 marks)

- b) i) Genetic engineering is used to produce large quantities of the hormone insulin, which is used to treat Kumar's diabetes. To produce insulin by genetic engineering, the insulin-producing gene is cut out of a chromosome from a human pancreas cell and a plasmid is removed from a bacterial cell. The plasmid DNA is cut using restriction enzymes and the insulin-producing gene is inserted into the plasmid DNA forming recombinant DNA. The recombinant DNA is then reintroduced into a bacterium which multiplies and the bacteria produce insulin. The insulin is separated and purified. (5 marks)

- ii) Any two of the following concerns:

- Plants genetically engineered to be toxic to a pest may also be toxic to useful organisms such as insects that bring about pollination and this could reduce reproduction in crops, reducing food production.
- Plants genetically engineered to be resistant to pests and herbicides could create unpredictable environmental issues such as the development of pesticide resistant insects or herbicide resistant superweeds.
- Once a genetically modified organism is released into the environment it cannot be contained or recalled, meaning that any negative effects are irreversible.
- The number of allergens in foods could be increased by transferring genes causing allergic reactions between species.
- As yet unknown health risks may occur as a result of eating genetically modified plants and animals.
- Large companies with funds and technology to develop genetically modified organisms could make large 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. (2 marks)

Total 15 marks

Exam-style questions – Chapters 12 to 14

STRUCTURED QUESTIONS

1. a) i) A non-communicable disease is not caused by a pathogen and cannot be passed from one person to another. (1 mark)
- ii) Any two of the following:
- Obesity
 - Diabetes mellitus
 - Cardiovascular disease (hypertension, coronary heart disease) (2 marks)

iii) Eating a healthy, balanced diet that is low in saturated fats and high in dietary fibre ensures that excess carbohydrates and fats, which contribute to lifestyle-related diseases, are not consumed. This limits weight gain and helps in the maintenance of normal heart rate and blood pressure. Regular, aerobic exercise also limits weight gain and promotes more efficient gaseous exchange, a faster metabolic rate and a lower heart rate. **(3 marks)**

b) i) The vector that spreads dengue fever is the *Aedes aegypti* mosquito. **(1 mark)**

ii) Any two of the following:

- Severe headache
- Severe joint and muscle pains
- Skin rash

(2 marks)

iii) Any three of the following measures:

- Draining all areas of standing water.
- Adding insecticides to breeding areas to kill the larvae and pupae.
- Introducing fish into breeding areas to feed on the larvae and pupae.
- Spraying oil onto the surface of standing water to prevent the larvae and pupae from breathing.
- Spraying with insecticides to kill the adults.
- Removing dense vegetation to remove the adults' protection.
- Protecting against mosquito bites, e.g. long sleeves, insect repellents, mosquito nets.
- Public education.

(3 marks)

c) The dengue vaccine will provide artificial active immunity by the deliberate introduction of a small amount of the weakened or dead pathogen, or the antigen itself into a person's body. The antigen or toxin present in the vaccine does not cause disease, but it will stimulate lymphocytes in the person's body to produce the specific antibody needed. Lymphocyte memory cells will also develop and provide protection against future infection by the dengue virus.

(3 marks)

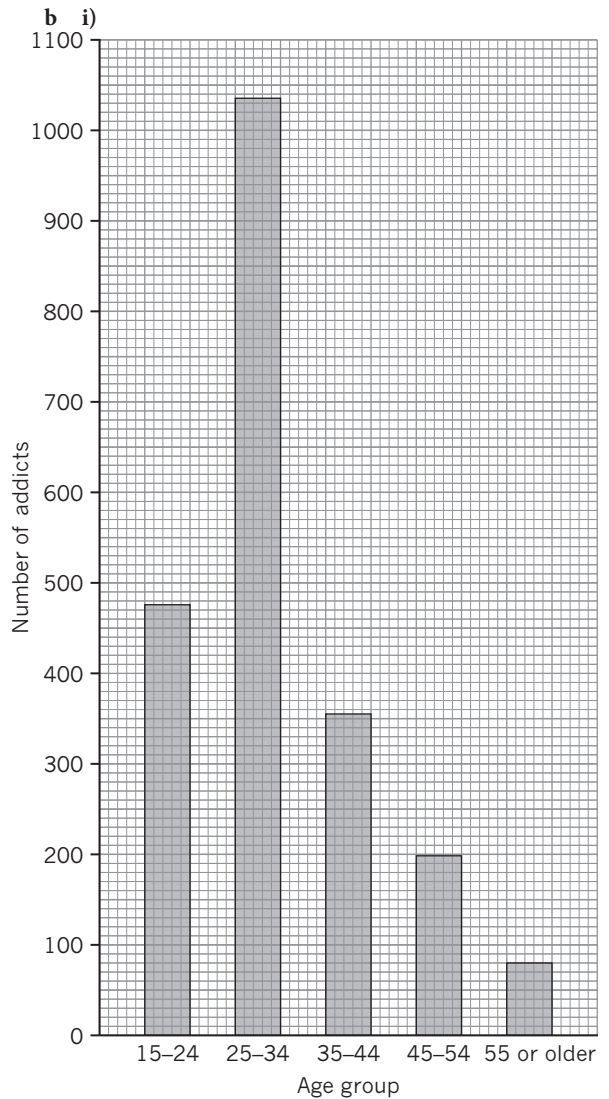
Total 15 marks

2. a) i) Drug misuse refers to the use of a drug for purposes for which it was not intended or using a drug in excessive quantities. **(1 mark)**

ii) Any three of the following:

- Cocaine
- LSD (acid)
- Ecstasy
- Marijuana (cannabis)
- Alcohol
- Sedatives
- Prescription pain killers

(3 marks)



(3 marks)

ii) Most heroin addicts are in the 25-34 age group, with the second largest number in the 15-24 age group. The age group with the smallest number of heroin addicts is the 55 or older group. From 35 years and upwards, there is a decline in the number of heroin addicts. **(3 marks)**

iii) Any three of the following:

- There will be a very high cost to society to provide treatment and rehabilitation for young heroin addicts.
- Heroin addiction may lead to loss of jobs and reduced productivity among young persons who should be working and contributing to the economy. This affects families directly and the society as a whole. In the case of Caribbean countries, it may mean reduced foreign exchange earnings.

- The country may have to implement more crime-prevention strategies, as heroin addicts may commit crimes in order to obtain money to buy the drug.
- Young heroin addicts may operate vehicles under the influence of the drug and contribute to more automobile accidents and road fatalities.
- The high incidence of heroin addiction in the younger age groups may lead to broken relationships, loss of parents from households, personal neglect and neglect of family members. This will place a strain on the society to care for neglected persons.
- The country may have higher suicide rates and antisocial behaviour associated with heroin addiction, especially among members of the younger age groups.
- Babies born to heroin addicts may have developmental problems. There will be a cost to society to provide the care needed for these affected babies. **(3 marks)**

c) *Any two of the following:*

- Unprotected sexual intercourse with an infected person.
- Transfusions of infected blood.
- Infected mother to baby during pregnancy and breastfeeding.
- Using infected needles or cutting instruments.

(2 marks)

Total 15 marks

STRUCTURED ESSAY QUESTION

3. a) i) Differences:

- Sterilisation is the complete destruction of all of the microorganisms present in a specified region. Disinfection is the reduction of the number of microorganisms that are present in a specified region to a level that cannot cause infection.
- Sterilisation is carried out using physical and chemical methods. Disinfection involves the use of chemicals only. **(4 marks)**

ii) Sterilisation

Any one of the following:

- Autoclaving or steam sterilisation can be used to kill microorganisms on hospital equipment and surgical instruments. Inside the autoclave, the high pressure ensures that high temperatures of above 121 °C are maintained in order to destroy all microorganisms and their spores.
- Surgical instruments can be sterilised by boiling them in water at 100 °C for 15 to 30 minutes. Boiling kills all bacteria and some spores.
- The patient's drinking water can be boiled to kill bacteria and spores.
- The patient's liquid food items can be sterilised using ultra-high temperature treatment (UHT). The food is heated to temperatures higher than 135 °C for 1 to 2 seconds, cooled rapidly and packaged in pre-sterilised containers.
- Pasteurisation can be used to sterilise the patient's food and drinks.

Disinfection

Any one of the following:

- Disinfectants such as chlorine and ethanol can be used to destroy microorganisms in or on non-living objects in the hospital, e.g. the counter tops and floors.
- Antiseptics such as hydrogen peroxide and rubbing alcohol can be used to destroy microorganisms in the patient's mouth and on the surface of the patient's skin, respectively.

(2 marks)

iii) *Any one of the following:*

- Disinfectants are chemicals used to destroy microorganisms in or on non-living objects. Antiseptics are chemicals used to destroy microorganisms on living tissues.
- Disinfectants are stronger and more toxic than antiseptics and can be harmful to living tissues. Antiseptics are milder and cause little or no harm to living tissues. **(2 marks)**

b) *Any three of the following reasons for maintaining good personal hygiene:*

- To ensure good health.
- To prevent the spread of infections.
- To eliminate body odours.
- To prevent dental caries.
- To promote social acceptance.

Any two of the following methods of skin hygiene:

- Wash the body regularly, especially the armpits, genitalia and between the toes.
- Wash the hair regularly.
- Dry the skin and hair thoroughly after washing.
- Apply a deodorant to clean, dry skin of the armpits.
- Change and wash clothing frequently.

Any two of the following methods of dental hygiene:

- Brush teeth and gums in the proper way, twice a day.
- Use a fluoride toothpaste and a good quality toothbrush when brushing.
- Use an antibacterial mouthwash after brushing and flossing.
- Avoid eating sugary and starchy foods and drinking sugary drinks, especially between meals and before going to bed.
- Visit a dentist regularly for a checkup and cleaning.

(7 marks)

Total 15 marks

Exam-style questions – Chapters 15 to 17

STRUCTURED QUESTIONS

- a) i) A pollutant is a harmful substance or form of energy that causes unfavourable changes to the environment. **(1 mark)**
- ii) *Any two of the following:*
 - Suspended solids
 - Plant nutrients (e.g. nitrates and phosphates)

- Organic matter
 - Pesticides
 - Heavy metal ions (e.g. mercury and lead)
 - Pathogens
 - Heat
 - Radioactive waste (2 marks)
- b) i) The steps involved in testing water for bacteria are:
1. Collect a sample of the water to be tested in a sterile container.
 2. Pour a small amount of the water onto an agar plate. Cover the plate and tape the lid to ensure it does not come off.
 3. Incubate the plate at 35 °C for 24 hours.
 4. Count the number of colonies of bacteria. (4 marks)
- ii) *Any one of the following methods:*
- Filtration – Muslin cloth can be used as a filter to remove suspended material from water. This makes water safe for domestic purposes such as bathing and washing clothes. Domestic filters can be attached to taps. Their pore sizes are tiny enough to remove suspended material, including bacteria and protozoa.
 - Boiling – Water must be brought to a ‘rolling boil’ for 10–20 minutes. This kills bacteria, spores, cysts and ova of intestinal parasites. It also removes hardness of water, producing soft water.
 - Chlorination – Chlorine tablets are very effective for disinfecting small quantities of water. One 500 mg tablet can be used to kill microorganisms in 20 litres of water. Chlorine bleach is also effective for killing microorganisms in water. One teaspoon of bleach should be added to one litre of water. (2 marks)
- c) *Any three of the following methods:*
- Carry out proper treatment of sewage before releasing it into bodies of water.
 - Use biodegradable detergents.
 - Pass laws with strict penalties that limit the release of water pollutants by industry, e.g. a Clean Water Act.
 - Put public education programmes in place.
 - Compost plant waste, such as vegetable peelings and crop residues.
 - Use farm waste and waste from the food industry to produce biogas.
 - Use organic fertilisers instead of inorganic chemical fertilisers.
 - Use biological control or natural, biodegradable pesticides instead of synthetic pesticides. (3 marks)
- d) Humans harvest freshwater for agricultural, industrial and domestic use, and as the human population grows, the demands for freshwater increase.
- Humans carry out deforestation, which reduces the amount of transpiration and precipitation that take place to replenish water sources.
 - Humans release different types of waste and harmful substances into bodies of water, and make them unsuitable habitats for other organisms and unsafe for future use. (3 marks)
- Total 15 marks**
2. a) i) *Any three of the following to fill in the blank spaces:*
- Human faeces
 - Human urine
 - Household wastewater
 - Wastewater from some industries
 - Rainwater (3 marks)
- ii) *Any one of the following practices:*
- The release of untreated sewage directly onto the land.
 - The release of untreated sewage directly into open water.
 - Untreated sewage leaking from cracked sewage pipes. (1 mark)
- iii) - Untreated sewage that is released into water is directly responsible for the spread of infectious diseases such as cholera, typhoid and dysentery.
- Untreated sewage that is released onto the land promotes the breeding of vectors such as flies and rats, which transmit diseases.
 - Sewage that is not disposed of properly gives off a foul odour, which contaminates the environment and may trigger respiratory illnesses. (3 marks)
- b) Advantages of pit latrines:
- They can be used in areas with limited water supply or where no sewage treatment system is in place.
 - They are relatively cheap to construct.
 - They require less water than flush toilets. (3 marks)
- c) i) Sedimentation. (1 mark)
- ii) *Similarities:*
- Both methods begin with the same steps: screening, grit settling and sedimentation.
 - Both methods involve the use of aerobic microorganisms to break down organic matter.
- Differences:*
- The biological filter method involves spraying the effluent onto small stones that are covered with a film of aerobic bacteria and protozoa. Only aerobic bacteria are involved in the breakdown of organic matter in effluent in the activated sludge method.
 - The activated sludge method involves passing compressed air through the effluent and the use of paddles to mix air and effluent. The biological filter does not involve active mixing, but passive trickling of effluent by the action of gravity. (4 marks)
- Total 15 marks**
- ### STRUCTURED ESSAY QUESTION
3. a) i) Biodegradable refers to materials that can be broken down by microorganisms into harmless materials, which can be recycled into the environment. (1 mark)
- ii) Biodegradable
- Any one of the following examples:*
- Food waste
 - Paper
 - Garden and farmyard waste
 - A few plastics

Non-biodegradable

Any one of the following examples:

- Most plastics
- Rubber
- Metal
- Glass

(2 marks)

- b) i) To make a landfill, topsoil is removed and a large, deep pit is dug into the ground.

The pit is lined with an impermeable material which forms the bottom liner to prevent liquids from the waste, known as leachate, seeping into the ground and contaminating soil and water.

Two sets of pipes are installed, one to help drain off any leachate and carry it to a treatment plant, and the other to remove any waste gases, e.g. methane, which can be used as a fuel to produce electricity.

(3 marks)

- ii) On arrival at the landfill, the refuse is sorted to remove materials that can be recycled.

The remaining refuse is then compacted to make it difficult for vectors to penetrate and to reduce its volume so the landfill can be used for a long time.

The compacted refuse is then placed into the landfill.

The compacted refuse is covered with a layer of soil at the end of each day so it is not exposed to the wind and vectors, and to reduce smells.

(4 marks)

- c) Any five of the following points:

- If solid waste is not disposed of properly it becomes a threat to human health and the environment.
- Proper disposal of solid waste reduces the likelihood of the spread of infectious diseases.
- Proper disposal of solid waste reduces the emission of greenhouse gases and other toxic gases into the atmosphere.
- Proper disposal of solid waste limits the reproduction of vectors of disease.
- Before collection, solid waste should be placed into bins with tight-fitting lids to prevent the entry of rats and flies.
- The solid waste should be collected at least once per week, and the bins should be inspected and cleaned regularly.
- Solid waste may be properly disposed of in a landfill, by incineration or composting.
- The volume of solid waste produced in the community may be controlled by using 'The Three R's' of waste management – reduce, reuse and recycle.

(5 marks)

Total 15 marks