Contents

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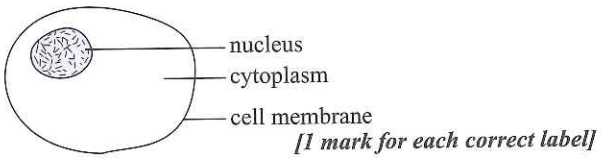
Topic 1 — Cell Biology

Pages 1-2 — Cells

Warm up

many, plant/animal, animal/plant, single, smaller/simpler, simpler/smaller

1.1



[1 mark for each correct label]

1.2 Cell membrane — controls what substances go in and out of the cell *[1 mark]*.
Cytoplasm — where most of the chemical reactions take place *[1 mark]*.
Nucleus — controls the activities of the cell / contains genetic material *[1 mark]*.

1.3 E.g. mitochondria *[1 mark]* where aerobic respiration takes place *[1 mark]*, ribosomes *[1 mark]* where protein synthesis occurs *[1 mark]*.

1.4 There is no cell wall/vacuole. / There are no chloroplasts. *[1 mark]*

2.1 bacterium *[1 mark]*

2.2 X – chromosome/DNA/genetic material *[1 mark]*
Y – cell wall *[1 mark]*
Z – plasmid *[1 mark]*

2.3 It contains genetic material *[1 mark]*.

2.4 10 times larger / 1 order of magnitude larger *[1 mark]*

2.5 1 mm × 1000 = 1000 µm
1000 µm ÷ 1 µm = **1000 cells** *[2 marks for the correct answer, otherwise 1 mark for correct working.]*

2.6 E.g. eukaryotic cells have a nucleus, prokaryotic cells do not. / DNA is found inside the nucleus of eukaryotic cells, but is not enclosed in prokaryotic cells. / Prokaryotic cells contain plasmids, eukaryotic cells do not. / Eukaryotic cells have mitochondria, prokaryotic cells do not. *[1 mark]*

Page 3 — Microscopy

1 length of cell A in image = 24 mm
24 / 0.012 = × **2000** *[2 marks for the correct answer, otherwise 1 mark for correct working.]*

2.1 size of real object = size of image ÷ magnification
actual length = 10 mm ÷ 1000 = **0.01 mm** *[2 marks for correct answer, otherwise 1 mark for correct working.]*

2.2 1 mm = 1000 µm
0.01 mm × 1000 = **10 µm** *[1 mark]*

2.3 Electron microscopes have a higher magnification *[1 mark]* and a higher resolution than light microscopes *[1 mark]*.

2.4 E.g. more cell structures can be seen under an electron microscope *[1 mark]* and they can be seen with greater detail *[1 mark]*.

Page 4 — More on Microscopy

1.1 When the specimen is colourless *[1 mark]*.

1.2 × 4 *[1 mark]*

Remember, you should always start with the lowest-powered objective lens — this makes it easier to get your specimen into view.

1.3 They bring the sample into focus by moving the stage up and down *[1 mark]*.

1.4 She should select the × 40 or × 10 objective lens *[1 mark]* and use the adjustment knobs to bring the sample back into focus *[1 mark]*.

1.5 Any two from: e.g. she should use a pencil with a sharp point. / She should make sure her drawing takes up at least half of the space available. / She should not colour or shade her diagram. / She should ensure that the subcellular structures are drawn in proportion. / She should include a title. / She should write down the magnification that it was observed under. / She should label the important features of her drawing using straight, uncrossed lines. ***[2 marks]***

Page 5 — Cell Differentiation and Specialisation

Warm up

root hair cell — Long finger-like projection increases surface area for absorption of water.
xylem — Cells that are hollow in the centre and have no end cell walls form a continuous tube for transporting water from roots to leaves.
phloem — Very few subcellular structures and holes in the end cell walls allow dissolved sugars to move from one cell to the next.

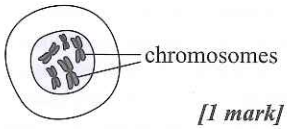
1 differentiation ***[1 mark]***

2.1 To fertilise an egg. / To carry the male DNA to the female DNA (in the egg). ***[1 mark]***

2.2 E.g. it has a tail to enable it to swim to the egg ***[1 mark]***.
It has lots of mitochondria to give it energy ***[1 mark]***.
It has a streamlined head to aid swimming ***[1 mark]***.
The head contains enzymes to help the sperm penetrate the egg ***[1 mark]***.

Page 6 — Chromosomes and Mitosis

1.1



[1 mark]

1.2 DNA ***[1 mark]***

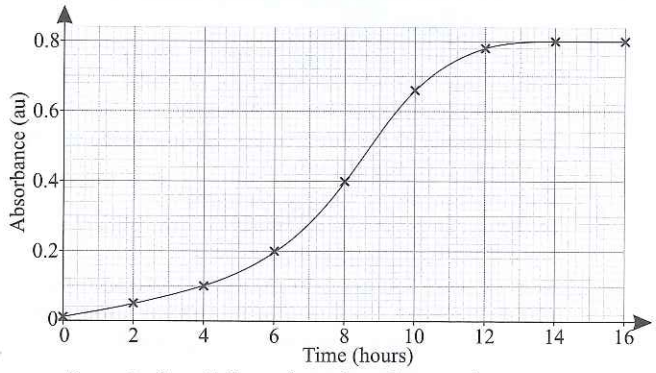
1.3 The number of subcellular structures is increasing ***[1 mark]***.
The chromosomes are doubling ***[1 mark]***.

1.4 The cytoplasm is dividing ***[1 mark]***.
The cell membrane is dividing ***[1 mark]***.

1.5 They are genetically identical ***[1 mark]***.

Page 7 — Binary Fission

1.1



[2 marks for all five points plotted correctly, otherwise 1 mark for 4 points plotted correctly. 1 mark for a suitable curved line of best fit.]

1.2 binary fission ***[1 mark]***

1.3 E.g. amount of nutrients / amount of oxygen / build-up of waste ***[1 mark]***

2 9 hours = 9 × 60 = 540 minutes
540 ÷ 45 = 12 divisions
$2^{12} = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$
$= 4096 = \mathbf{4.096 \times 10^3}$
[4 marks for correct answer, otherwise 1 mark for '540 minutes', 1 mark for '12 divisions' and 1 mark for '4096'.]

Pages 8-9 — Culturing Microorganisms

1.1 Because unwanted microorganisms may have affected the results of the experiment ***[1 mark]*** and contamination could have resulted in the growth of pathogens ***[1 mark]***.

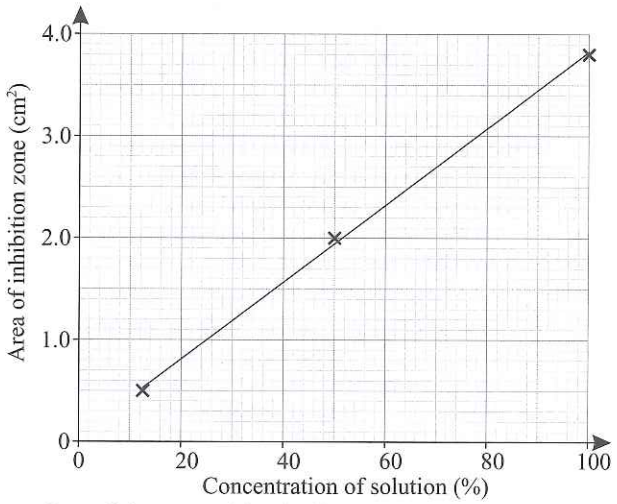
1.2 Any three from: e.g. used sterilised Petri dishes. / Used sterilised culture medium. / Sterilised the spreader/ inoculating loop (by passing it through a flame). / (Lightly) taped on the lid of the Petri dish. / Stored the plates upside down. ***[3 marks]***

1.3 To reduce the chance of growing harmful pathogens ***[1 mark]***.

1.4 10 + 15 + 14 = 39
39 ÷ 3 = **13 mm** ***[1 mark]***

1.5 5 mm = 0.5 cm ***[1 mark]***
$3.14 \times 0.5^2 = \mathbf{0.8\ cm^2}$ ***[1 mark]***

1.6



[1 mark for axes with suitable scale and labelled correctly, 1 mark for all points plotted correctly, 1 mark for a suitable straight line of best fit.]

1.7 3.1 cm^2 ***[1 mark. Accept answers between 3.0 and 3.2 cm^2.]***

1.8 The higher the concentration of the antiseptic, the more effective it is at preventing bacterial growth ***[1 mark]***.

Pages 10-11 — Stem Cells

1.1 meristems ***[1 mark]***

1.2 E.g. plants can be produced quickly and cheaply ***[1 mark]***. Rare species can be cloned to protect them from extinction ***[1 mark]***. Large numbers of identical crop plants with desirable features, e.g. disease resistance, can be grown ***[1 mark]***.

2.1 Stem cells can differentiate into many types of body cell ***[1 mark]***.

2.2 To increase the number of cells (available for use) ***[1 mark]***.

2.3 E.g. because body cells that are already differentiated are not capable of changing into any other types of cell ***[1 mark]***.

2.4 E.g. human embryos ***[1 mark]***

2.5 E.g. diabetes / paralysis ***[1 mark]***

2.6 E.g. the cells in the culture medium may become infected with a virus that may then be transferred to the patient ***[1 mark]***.

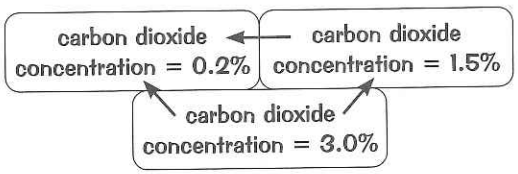
3.1 The production of an embryo with the same genes as a patient ***[1 mark]***.

3.2 The stem cells produced by therapeutic cloning won't be rejected by the patient's body ***[1 mark]*** because they contain the same genes as the patient ***[1 mark]***.

3.3 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: One or two ethical issues surrounding the use of embryonic stem cells are briefly described, but only one point of view is given. *[1 to 2 marks]*
Level 2: A detailed discussion of issues surrounding the use of embryonic stem cells is given, including an account of both points of view. *[3 to 4 marks]*
Here are some points your answer may include:
Some people feel that embryonic stem cells from human embryos shouldn't be used for experiments since each embryo is a potential human life.
Some people may argue that there are other sources of stem cells that scientists could use, so using embryos to create stem cells is unjustified.
Some people think that using embryonic stem cells to cure patients who already exist and who are suffering is more important than the rights of embryos.
Some people argue that many embryonic stem cells are sourced from unwanted embryos from fertility clinics, which would probably be destroyed anyway.

Page 12 — Diffusion

Warm up



1 protein *[1 mark]*
2.1 The spreading out of particles of a gas *[1 mark]*, resulting in net movement *[1 mark]* from an area of higher concentration to an area of lower concentration *[1 mark]*.
2.2 Increasing the concentration of ammonia increases the rate of diffusion *[1 mark]*.
2.3 Any two from: e.g. the surface area of the cell. / The temperature. / The distance for diffusion. / The permeability of the membrane. *[2 marks]*
2.4 By repeating the experiment and calculating a mean *[1 mark]*.

Page 13 — Osmosis

1.1 The movement of water molecules *[1 mark]* across a partially permeable membrane *[1 mark]* from a region of higher water concentration (a dilute solution) to a region of lower water concentration (a more concentrated solution) *[1 mark]*.
1.2 A plant is absorbing water from the soil *[1 mark]*.
2.1 So that all the pieces of potato have the same water concentration. / Because different potatoes will have different water concentrations. *[1 mark]*
2.2 $\frac{(6.58 - 5.73)}{5.73} \times 100$
= **14.8 %** (3 s.f.) *[2 marks for the correct answer, otherwise 1 mark for correct working.]*
2.3 E.g. 4% *[1 mark. Accept a percentage between 2% and 5%.]*

Page 14 — Active Transport

1.1 The movement of a substance from a more dilute solution to a more concentrated solution (against a concentration gradient) *[1 mark]*.
1.2 For energy/respiration *[1 mark]*.
1.3 It needs energy from respiration *[1 mark]*.
2.1 For growth *[1 mark]*.
2.2 The concentration of minerals is higher inside the plant cells than in the soil (outside the plant cells) *[1 mark]* so the minerals would move out of the plant cells by diffusion *[1 mark]*.
2.3 Active transport occurs against a concentration gradient but diffusion occurs down a concentration gradient *[1 mark]*. Active transport needs energy from respiration but diffusion doesn't *[1 mark]*.
2.4 The function of root hair cells is to take up substances from the soil *[1 mark]*. Root hair cells have elongated 'hairs' that stick out into the soil *[1 mark]*. These 'hairs' give the root a large surface area for absorbing substances *[1 mark]*.

Page 15 — Exchange Surfaces

Warm up
1 — blue whale, 2 — tiger, 3 — domestic cat, 4 — bacterium
1 A large surface area. / A thin membrane. / An efficient blood supply. / Being ventilated. *[4 marks]*
2.1 X = (3 × 3) × 6 = **54 cm²** *[1 mark]*
Y = 3 × 3 × 3 = **27 cm³** *[1 mark]*
2.2 Z = 150 ÷ 125 = **1.2** *[1 mark]*
2.3 5 × 5 × 5, because it has the smallest surface area to volume ratio / it has the most volume for the least surface area / it has the longest diffusion distance to the centre *[1 mark]*.

Page 16 — Exchanging Substances

1.1 A = carbon dioxide *[1 mark]*
B = oxygen *[1 mark]*
1.2 diffusion *[1 mark]*
1.3 short diffusion pathway — the walls of the alveoli are thin / one cell thick *[1 mark]*
large surface area — lots of alveoli *[1 mark]*
2 As the walls of the alveoli are broken down, the surface area in the lungs is reduced *[1 mark]*, so the amount of oxygen that can diffuse into the blood (from the air in the alveoli) at any one time is reduced *[1 mark]*. This means that their body cells are not getting enough oxygen for respiration during exercise, which results in lower energy levels *[1 mark]*.
3 The small intestine is covered in villi *[1 mark]* which increases the surface area for absorption *[1 mark]*.
There is a good blood supply *[1 mark]* which maintains the concentration gradient so absorption can happen quickly *[1 mark]*. The villi have a single layer of surface cells *[1 mark]* which give a short diffusion pathway *[1 mark]*.

Page 17 — More on Exchanging Substances

1.1 stomata *[1 mark]*
1.2 Carbon dioxide diffuses into the leaf *[1 mark]*.
Water vapour diffuses out of the leaf *[1 mark]*.
Oxygen diffuses out of the leaf *[1 mark]*.
1.3 They increase the surface area for carbon dioxide to diffuse into the cells *[1 mark]*.
2.1 They increase the surface area *[1 mark]*.
2.2 To (further) increase the surface area of the gills *[1 mark]*.
2.3 A good blood supply *[1 mark]*.
2.4 A fast-moving fish has more, longer gill filaments than a slow-moving fish. / A slow-moving fish has fewer, shorter gill filaments than a fast-moving fish. *[1 mark]*
2.5 Fast-moving fish are more active than slow-moving fish / Fast-moving fish do more respiration than slow-moving fish *[1 mark]* so they require more oxygen *[1 mark]*.

Topic 2 — Organisation

Page 18 — Cell Organisation

Warm-up
Organ system – 4, Tissue – 2, Cell – 1, Organ – 3
1.1 X = Liver *[1 mark]*
Y = Large intestine *[1 mark]*
Z = Small intestine *[1 mark]*
1.2 A group of organs working together to perform a particular function *[1 mark]*.
1.3 A group of similar cells that work together to carry out a particular function *[1 mark]*.

1.4 It breaks down and absorbs food ***[1 mark]***.
1.5 A group of different tissues that work together to perform a certain function ***[1 mark]***.

Page 19 — Enzymes

1.1 active site ***[1 mark]***
1.2 Part X/the active site is where the substrate involved in the reaction fits ***[1 mark]***.
2.1 Line 2 ***[1 mark]***
2.2 Line 2 shows an enzyme with a higher optimum temperature than the enzyme shown by Line 1 ***[1 mark]*** and it doesn't denature until a higher temperature ***[1 mark]***. This suggests that the enzyme is adapted to working at the higher temperatures of a thermal vent than the enzyme represented by Line 1 ***[1 mark]***.
2.3 The enzyme has been denatured ***[1 mark]***, which has changed the shape of its active site ***[1 mark]***. This means that the substrate will no longer fit the active site ***[1 mark]***, so the enzyme will no longer catalyse the reaction ***[1 mark]***.

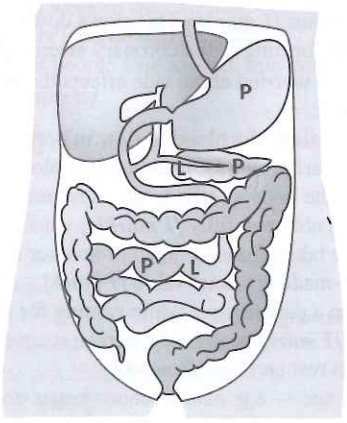
Questions 2 asks you to apply your knowledge of enzymes to a context you've probably not met before. Don't panic in the exam if you get questions like this. Just stop and think about what you know about enzymes, and it'll all become clear.

Page 20 — Investigating Enzymatic Reactions

1.1 pH 6 as this was the pH at which the iodine solution stopped turning blue-black first ***[1 mark]***, meaning the starch had been broken down the fastest ***[1 mark]***.
1.2 E.g. the amylase was denatured by the high pH, so the starch was not broken down ***[1 mark]***.
1.3 By putting the test tubes in a water bath ***[1 mark]***.
1.4 Any two from: e.g. the concentration of starch solution / the concentration of amylase / the volume of starch and amylase solution added to the iodine / the volume of iodine solution in the wells ***[2 marks]***
1.5 E.g. test the solutions more frequently (e.g. every 10 seconds) ***[1 mark]***.

Page 21-22 — Enzymes and Digestion

Warm-up



1.1 Carbohydrases ***[1 mark]***
1.2 Sugars ***[1 mark]***
2.1 They break down big molecules from food into smaller, soluble molecules that can pass easily through the walls of the digestive system ***[1 mark]***, allowing them to be absorbed into the bloodstream ***[1 mark]***.
2.2 Any two from: to make new carbohydrates. / To make new proteins. / To make new lipids. / Some glucose is used in respiration ***[2 marks]***.
3.1 Produced: liver ***[1 mark]***
Stored: gall bladder ***[1 mark]***
3.2 It neutralises the acid from the stomach in the small intestine and makes the conditions in the small intestine alkaline ***[1 mark]***. This is important because the enzymes in the small intestine work best in these conditions ***[1 mark]***. It emulsifies fat ***[1 mark]***, which increases the surface area of fat for the enzyme lipase to work on, which makes its digestion faster ***[1 mark]***.
4 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief description which includes the names of one or more of the relevant enzymes or where in the body they are produced. ***[1 to 2 marks]***
Level 2: There is some description of how one or more of carbohydrates, proteins or lipids are digested, including where in the body the relevant enzymes are produced. ***[3 to 4 marks]***
Level 3: There is a clear and detailed description of how carbohydrates, proteins and lipids are digested, including reference to where in the body the relevant enzymes are produced and to the end products of the reactions. ***[5 to 6 marks]***

Here are some points your answer may include:
Carbohydrate digestion begins in the mouth, where amylase is produced by the salivary glands.
Carbohydrate digestion also occurs in the small intestine, which produces its own supply of amylase and also contains amylase produced by the pancreas.
Amylase converts the carbohydrates into sugars.
Protein is digested in the stomach, where proteases are produced.
Protein digestion also occurs in the small intestine, which produces proteases and also contains proteases produced by the pancreas.
Proteases convert protein into amino acids.
Lipids are digested in the small intestine, which produces lipases and also contains lipases produced by the pancreas.
Lipases convert lipids to fatty acids and glycerol.
The products of the digestive enzymes are absorbed into the bloodstream.

Page 23 — Food Tests

Warm-up
Biuret test — Proteins, Benedict's test — Reducing sugars,
Sudan III test — Lipids, Iodine test — Starch
1 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief description of how to carry out the investigation. ***[1 to 2 marks]***
Level 2: There is some description of how to carry out the investigation but some details are missing. ***[3 to 4 marks]***
Level 3: There is a clear and detailed description of how to carry out the investigation. ***[5 to 6 marks]***

Here are some points your answer may include:
Grind up a sample of the egg white using a pestle and mortar.
Put the sample into a beaker and add some distilled water.
Stir well with a glass rod to allow some of the food to dissolve in the water.
Filter the mixture through a funnel lined with filter paper.
Transfer 2 cm^3 of the filtered solution into a clean test tube.
Add 2 cm^3 of Biuret solution and gently shake the test tube.
If the food sample contains protein, the solution will change from blue to pink or purple.
If no protein is present, the solution will stay bright blue.

2.1 He should add some Benedict's solution to each test tube using a pipette ***[1 mark]***. He should then place the test tubes in a water bath set at 75 °C and leave them for 5 minutes ***[1 mark]***. He should look out for a colour change and note which of a range of colours the solutions become ***[1 mark]***.

Glucose is a reducing sugar so the Benedict's test can be used to determine the relative concentrations of glucose in the test tubes.

2.2

	Tube 1	Tube 2	Tube 3	Tube 4
substance observed	yellow precipitate	blue solution	red precipitate	green precipitate
glucose concentration (M)	**0.1**	**0**	**1**	**0.02**

[1 mark]

The higher the concentration of glucose in the solution, the further the colour change goes along the following scale: blue — green — yellow — brick red. If no precipitate forms then there are no reducing sugars in the solution.

Page 24 — The Lungs

Warm-up

bronchi, alveoli, oxygenates, carbon dioxide

1.1 A = trachea ***[1 mark]***
B = bronchus ***[1 mark]***
C = alveolus/alveoli ***[1 mark]***

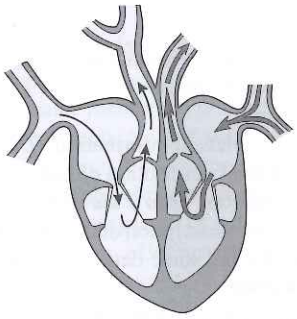
1.2 capillary ***[1 mark]***

1.3 The capillary carries blood that is returning from the rest of the body and contains a higher concentration of carbon dioxide than in the lungs ***[1 mark]***. The carbon dioxide diffuses into the alveoli, where there is a lower concentration, to be breathed out ***[1 mark]***. The capillary also picks up oxygen from the alveoli, which contain a higher concentration of oxygen than in the blood ***[1 mark]***. Oxygen diffuses from the alveoli into the blood, where there is a lower concentration, to be carried to the body cells ***[1 mark]***.

Page 25 — Circulatory System — The Heart

1.1 X = aorta
Y = pulmonary vein
Z = (right) ventricle

1.2



[1 mark for arrow(s) showing blood flow from the vena cava, through the right atrium and ventricle, then up through the pulmonary artery.]

1.3 Because it consists of two circuits joined together ***[1 mark]***. The first one pumps deoxygenated blood to the lungs to take in oxygen and returns oxygenated blood to the heart ***[1 mark]***. The second one pumps oxygenated blood around all the other organs of the body and returns deoxygenated blood to the heart ***[1 mark]***.

2.1 The heartbeat is controlled by a group of cells in the right atrium wall ***[1 mark]*** that act as a pacemaker ***[1 mark]***.

2.2 An artificial pacemaker could be fitted ***[1 mark]***. This produces an electric current to keep the heart beating regularly ***[1 mark]***.

Page 26 — Circulatory System — Blood Vessels

1.1 A ***[1 mark]***

1.2 The walls of arteries contain thick layers of muscle to make them strong ***[1 mark]*** and elastic fibres to allow them to stretch and spring back ***[1 mark]***.

1.3 veins ***[1 mark]***

1.4 To prevent the blood flowing backwards / to keep the blood flowing in the right direction ***[1 mark]***.

1.5 Capillaries carry blood close to cells to exchange substances with them ***[1 mark]***. Having thin walls increases the rate at which substances can diffuse across them by decreasing the distance over which diffusion occurs ***[1 mark]***.

Page 27 — Circulatory System — Blood

1.1 Because white blood cells defend against infection ***[1 mark]***.

1.2 Some white blood cells can change shape to engulf microorganisms in a process called phagocytosis ***[1 mark]***. Others produce antibodies to fight microorganisms ***[1 mark]*** or antitoxins to neutralise any toxins produced by the microorganisms ***[1 mark]***.

1.3 They have a biconcave disc shape to give a large surface area for absorbing oxygen ***[1 mark]***. They don't have a nucleus, which allows more room to carry oxygen ***[1 mark]***. They contain haemoglobin, which binds to oxygen and transports it to cells in the body tissues ***[1 mark]***.

1.4 plasma ***[1 mark]***

1.5 Platelets are small fragments of cells with no nucleus ***[1 mark]***. They help the blood to clot at a wound ***[1 mark]***.

Pages 28-29 — Cardiovascular Disease

Warm-up

blood vessels, coronary heart disease, coronary arteries, fatty material

1.1 Because it restricts the blood flow to the heart muscle ***[1 mark]***, leading to a lack of oxygen reaching it ***[1 mark]***.

1.2 The doctor might recommend a stent ***[1 mark]***. Stents are tubes that are inserted inside arteries to keep them open to make sure that blood can pass through to the heart muscle ***[1 mark]***.

2.1 They reduce the amount of 'bad' cholesterol present in the bloodstream ***[1 mark]***. This slows down the rate of fatty deposits forming in the coronary arteries ***[1 mark]***.

2.2 E.g. he is worried about side effects the statins might cause ***[1 mark]***.

3.1 It would allow the blood to flow in both directions in part of the heart ***[1 mark]***, meaning that blood doesn't circulate around the body as effectively as normal ***[1 mark]***.

3.2 It might not open fully ***[1 mark]***.

3.3 A valve taken from a human or another mammal ***[1 mark]***.

3.4 A man-made/artificial valve ***[1 mark]***.

3.5 To keep a patient alive while waiting for a donor heart to be found ***[1 mark]*** or to help a person recover by allowing their heart to rest and heal ***[1 mark]***.

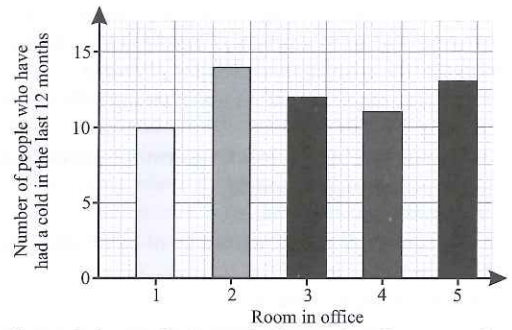
3.6 Advantage — e.g. natural donor hearts don't have any mechanical parts like electric motors that could wear out. / Blood flows more smoothly through natural hearts ***[1 mark]***. Disadvantage — e.g. natural donor hearts aren't always available straight away. / Natural donor hearts are more likely to be rejected by the body's immune system ***[1 mark]***.

Page 30 — Health and Disease

1.1 A disease that can spread from person to person or between animals and people ***[1 mark]***.

1.2 Any two from: whether you have a good, balanced diet. / The stress you are under. / Your life situation ***[2 marks]***.

2.1



[1 mark for each correctly drawn bar for rooms 3 and 5.]

Room 1	Room 2	Room 3	Room 4	Room 5	Total
10	**14**	12	11	**13**	60

[1 mark for each number filled in correctly.]

You're given the total number of people who have had colds in the table (60). So to work out the figure for Room 5, you'd take the total for Rooms 1–4 away from 60.

2.2 It would increase the chance of the person getting a communicable disease *[1 mark]* because their body is less likely to be able to defend itself against the pathogen that causes the disease *[1 mark]*.

Page 31 — Risk Factors for Non-Communicable Diseases

1.1 Something that is linked to an increase in the likelihood that a person will develop a certain disease during their lifetime *[1 mark]*.

1.2 Aspects of a person's lifestyle *[1 mark]*. Substances in the body *[1 mark]*.

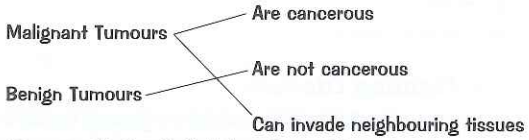
1.3 E.g. type 2 diabetes *[1 mark]*

2.1 Any two from: e.g. a high fat diet / a lack of exercise / smoking *[2 marks]*

2.2 Any two from: e.g. the cost of researching and treating non-communicable diseases is huge. / Families may have to move or adapt their home to help a family member with a non-communicable disease, which can be costly. / If someone has to give up work or dies because of a non-communicable disease, family income will be reduced. / A reduction in the number of people able to work may affect a country's economy *[2 marks]*.

Page 32 — Cancer

Warm-up



1.1 Uncontrolled cell division *[1 mark]*

1.2 E.g. genetic risk factors *[1 mark]*

2.1 malignant *[1 mark]*

2.2 Cells break off a tumour and spread to other parts of the body by travelling in the bloodstream *[1 mark]*. The malignant cells then invade healthy tissues elsewhere in the body and form secondary tumours *[1 mark]*.

Page 33 — Plant Cell Organisation

1.1 An organ system *[1 mark]*

1.2 Water *[1 mark]*, mineral ions *[1 mark]*

2.1 Growing tips of roots *[1 mark]*
Growing tips of shoots *[1 mark]*

2.2 It can differentiate into lots of different types of plant cells *[1 mark]*.

3.1 A: palisade mesophyll tissue *[1 mark]*
B: spongy mesophyll tissue *[1 mark]*

3.2 It contains lots of chloroplasts, which are the structures where photosynthesis takes place *[1 mark]* and is located near the top of the leaf so that the chloroplasts can get the most light *[1 mark]*.

3.3 They increase the rate of diffusion of gases *[1 mark]*.

Page 34 — Transpiration and Translocation

Warm-up

transpiration, evaporation, leaves, translocation, sugars, phloem

1 How to grade your answer:

Level 0: There is no relevant information. *[No marks]*

Level 1: There is a brief description of either the structure or the function of one or both of the plant tissues. *[1 to 2 marks]*

Level 2: There is some description of both the structure and the function of both plant tissues. *[3 to 4 marks]*

Level 3: There is detailed description of both the structure and the function of both plant tissues. *[5 to 6 marks]*

Here are some points your answer may include:
Xylem is made of dead cells joined together end to end.
The walls are strengthened with lignin.
The dead cells have no end walls between them, so there is a hole down the middle of the tissue.
Water and mineral ions travel through the xylem tubes from the roots to the stem and leaves.
This is called the transpiration stream.
Phloem is made of columns of elongated living cells.
The cells have small pores in the end walls to allow cell sap to flow through.
This means that dissolved sugars made in the leaves can travel to the rest of the plant.
Phloem can transport dissolved sugars in both directions in the tissue.
Transport of dissolved sugars in phloem is called translocation.

Page 35-36 — Transpiration and Stomata

1.1 X = stomata *[1 mark]*
Y = guard cells *[1 mark]*

1.2 They are responsible for opening and closing the stomata *[1 mark]* in order to control gas exchange and water loss from a leaf *[1 mark]*.

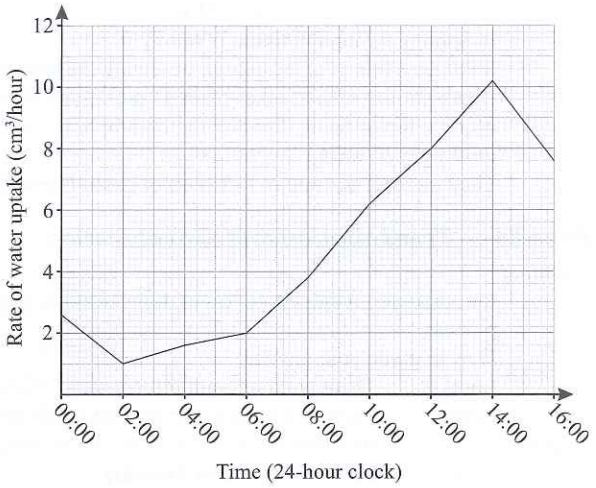
2.1 Mean width of stomata in leaf A = (25.2 + 20.1 + 18.7 + 17.9 + 19.1 + 19.3 + 22.0 + 23.1 + 21.8 + 20.3) ÷ 10 = **20.8 µm** *[1 mark]*

Mean width of stomata in leaf B = (14.7 + 12.8 + 14.1 + 13.2 + 12.9 + 11.9 + 12.1 + 13.4 + 10.9 + 11.7) ÷ 10 = **12.8 µm** *[1 mark]*

2.2 Leaf B *[1 mark]*

2.3 Because stomata begin to close when it gets darker / Less carbon dioxide is needed for photosynthesis at lower light intensities *[1 mark]* and so the leaf with the lower mean will have had the measurements taken in a lower light intensity *[1 mark]*.

3.1



[1 mark for using a sensible scale for the y-axis, 1 mark for labelling the y-axis, 1 mark for accurately plotting the points, 1 mark for connecting the points with straight lines through the centre of each point.]

It might sound a bit obvious, but make sure you always use a sharp pencil to draw graphs like this. Your graph might turn out inaccurate if your pencil is blunt, which could lose you marks.

3.2 5.0 cm^3/hour ***[1 mark]***

3.3 5.1 cm^3/hour ***[1 mark]***

3.4 Any two from: e.g. light intensity increased. / Temperature increased. / Air flow around the leaf improved. / Humidity decreased ***[2 marks]***.

Topic 3 — Infection and Response

Page 37 — Communicable Disease

1.1 Both bacteria and viruses can reproduce quickly in the body ***[1 mark]***.

1.2 It can cause the cells to burst ***[1 mark]***.

2 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief description of either how the housefly picks up pathogens or how it spreads them to humans. ***[1 to 2 marks]***

Level 2: There is some description of how the housefly picks up pathogens and how it spreads them to humans. ***[3 to 4 marks]***

Level 3: There is a detailed description of how the housefly picks up pathogens and how it spreads them to humans. ***[5 to 6 marks]***

Here are some points your answer may include:

Picking up pathogens:

The housefly uses its wings to fly to a dirty place, e.g. animal faeces, dustbin, rubbish dump, etc.

Pathogens stick to the fly's body.

Pathogens stick to the hairs on the fly's legs.

Pathogens are picked up on the fly's wings.

Pathogens are eaten by the fly.

Transfer to humans:

The fly uses its wings to travel to a human food source.

The fly secretes saliva on a human food source along with pathogens that the fly ate.

The housefly transfers pathogens onto a human food source from its body/leg hairs/wings.

The housefly deposits faeces onto a human food source.

Humans then eat the contaminated food source and take in the pathogens.

Pages 38-39 — Viral, Fungal and Protist Diseases

Warm-up

protist, vectors, fever, breeding

1.1 virus ***[1 mark]***

1.2 The infected person coughs/sneezes ***[1 mark]***. The virus is carried in the air in droplets ***[1 mark]***. Other people on the train breathe in/inhale the droplets ***[1 mark]***.

Remember, pathogens can be spread by water, through the air, by vectors, or by direct contact.

1.3 The person can be vaccinated against the pathogen ***[1 mark]***.

2.1 antiretroviral drugs ***[1 mark]***

2.2 the immune system ***[1 mark]***

2.3 sexual contact ***[1 mark]***, exchange of blood when people share needles ***[1 mark]***

3.1 E.g. tomato plant ***[1 mark]***

3.2 The leaves have a mosaic pattern (where parts of the leaves become discoloured) ***[1 mark]***.

3.3 The discolouration of the leaves means that the plant can't carry out photosynthesis as well, so growth is affected ***[1 mark]***.

3.4 E.g. the diameter of the fruit from the infected plant is smaller than the healthy plant ***[1 mark]***. The fruit from the infected plant has a lower/smaller mass than the healthy plant ***[1 mark]***.

4.1 Purple or black spots develop on the leaves ***[1 mark]***. These leaves can then turn yellow ***[1 mark]*** and drop off ***[1 mark]***.

4.2 Because the disease can spread to other plants in water or by the wind ***[1 mark]***.

4.3 If any leaves are left, the fungus could spread to other living rose plants ***[1 mark]***.

By destroying the fungus, there won't be any left to spread to other plants.

Page 40 — Bacterial Diseases and Preventing Disease

1.1 Any two from: e.g. fever / stomach cramps / vomiting / diarrhoea ***[2 marks]***.

1.2 toxins ***[1 mark]***

1.3 The vaccination prevents the spread of the disease in poultry ***[1 mark]***. This means that the poultry that humans eat won't be contaminated with the *Salmonella* bacteria ***[1 mark]***.

1.4 E.g. by washing hands thoroughly after using the toilet. / By avoiding preparing food. / By the infected person being isolated from other individuals ***[1 mark]***.

There's more than one right answer here — just think of any sensible way of preventing the bacteria from being transferred from person to person.

2.1 Through sexual contact ***[1 mark]***.

2.2 E.g. pain when urinating ***[1 mark]***. A thick yellow or green discharge from the vagina ***[1 mark]***.

2.3 penicillin ***[1 mark]***

2.4 Strains of the gonorrhoea bacteria have become resistant to it ***[1 mark]***.

2.5 condoms ***[1 mark]***

Page 41 — Fighting Disease

1.1 It acts as a barrier to stop pathogens getting inside the body ***[1 mark]***. It secretes antimicrobial substances, which kill pathogens ***[1 mark]***.

1.2 It has hairs and mucus, which trap particles that could contain pathogens ***[1 mark]***.

2 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief description of either the body's defences or the role of the immune system. ***[1 to 2 marks]***

Level 2: There is at least one correct description of the body's defences and at least one correct description of the role of the immune system. ***[3 to 4 marks]***

Level 3: There is more than one correct description of the body's defences and more than one correct description of the role of the immune system. ***[5 to 6 marks]***

Here are some points your answer may include:
The body's defences:
The trachea and bronchi secrete mucus to trap pathogens that have entered the body.
The trachea and bronchi are lined with cilia.
Cilia are hair-like structures which waft mucus up to the back of the throat where it can be swallowed.
The stomach produces hydrochloric acid, which kills pathogens that have been swallowed.
The role of the immune system:
The immune system contains white blood cells, which travel round the body in the blood.
White blood cells can engulf pathogens and digest them — this is called phagocytosis.
White blood cells can produce antibodies that can kill pathogens.
White blood cells can produce antitoxins that counteract toxins produced by invading bacteria.

You wouldn't get marks for talking about the skin or about the hairs in the nose — they're there to stop pathogens getting inside your body in the first place. This question is asking you to describe that defences that the body has for pathogens that have managed to make it inside your body.

Page 42 — Fighting Disease — Vaccination

1.1 small amounts of dead/inactive pathogens ***[1 mark]***
1.2 White blood cells are stimulated to produce antibodies ***[1 mark]***.
2.1 Because the body would be able to rapidly mass-produce antibodies to kill off the mumps pathogens ***[1 mark]***.
2.2 The large proportion of the population who have been vaccinated against the pathogen won't catch the disease ***[1 mark]***. This means that the people who aren't vaccinated are unlikely to catch the disease because there are fewer people able to pass it on ***[1 mark]***.
3.1 It would prevent the traveller from catching cholera whilst they are visiting the country ***[1 mark]*** and then bringing it back to their own country ***[1 mark]***.
3.2 It prevents anyone from bringing certain diseases into the country ***[1 mark]***.

Page 43 — Fighting Disease — Drugs

1.1 Viruses reproduce using your body cells ***[1 mark]***, which makes it very difficult to develop drugs that destroy just the virus without killing the body's cells ***[1 mark]***.
1.2 E.g. painkiller / cold remedy ***[1 mark]***
1.3 Because the drug is unable to kill pathogens ***[1 mark]***.
2.1 Bacteria that can't be killed by an antibiotic ***[1 mark]***.
2.2 The number of antibiotic-resistant infections increased between 2013 and 2015 ***[1 mark]***.
2.3 $153 - 84 = 69$
$(69 \div 84) \times 100 = 82.14 =$ **82%** ***[2 marks for correct answer, otherwise 1 mark for correct working]***

Page 44 — Developing Drugs

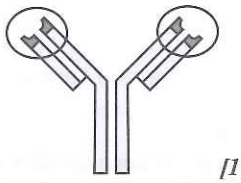
1.1 E.g. toxicity, efficacy and dosage ***[3 marks]***
1.2 cells, tissues and live animals ***[1 mark]***

It'd be no use testing on dead animals, as their cells and tissues won't respond in the same way as living tissues. You also wouldn't want to test on humans or patients at this stage, just in case the drug proves to be dangerous.

2.1 In case the drug has any harmful effects ***[1 mark]***.
2.2 In double blind trials, patients would be randomly split into two groups ***[1 mark]***. One group would be given a placebo and the other group would be given the drug ***[1 mark]***. Neither the patients or the doctors would know who was in which group until after the results had been gathered ***[1 mark]***.
2.3 It allows for the placebo effect. / It prevents the patient expecting the treatment to work and therefore feeling better, even though the treatment isn't doing anything. / It prevents the doctors who are analysing the results from being subconsciously influenced by their knowledge. ***[1 mark]***
2.4 E.g. it helps to check that the work is valid. / It helps to prevent false claims ***[1 mark]***.
2.5 E.g. to prevent them showing bias ***[1 mark]*** in their analysis of the results, and giving support to the results when in fact they weren't valid ***[1 mark]***.

Pages 45-46 — Monoclonal Antibodies

Warm-up
lymphocytes, fluorescent dye, attach to

1.1  ***[1 mark]***
1.2 Antigen A ***[1 mark]***
2 Monoclonal antibodies are antibodies produced from lots of clones of a single white blood cell ***[1 mark]***. This means all the antibodies are identical and will only target one specific protein antigen ***[1 mark]***.
3.1 An anti-cancer drug/a radioactive substance/a toxic drug/ a chemical that stops cancer cells growing and dividing ***[1 mark]*** is attached to the monoclonal antibodies ***[1 mark]***. The monoclonal antibodies target the cancer cells ***[1 mark]*** and deliver the substance without killing any normal body cells near the tumour ***[1 mark]***.
3.2 They cause more side effects than were originally expected ***[1 mark]***.
3.3 Any two from: e.g. in pregnancy tests. / Measuring the levels of hormones/chemicals in the blood. / Detecting pathogens. / Locating specific molecules on a cell/in a tissue ***[2 marks]***.
4 How to grade your answer:
Level 0: There is no relevant information. ***[No marks]***
Level 1: There is a brief description of how monoclonal antibodies are made, but many details are missing. ***[1 to 2 marks]***
Level 2: There is some description of how monoclonal antibodies are made, but details are missing. ***[3 to 4 marks]***
Level 3: There is a clear and detailed description of how monoclonal antibodies are made. ***[5 to 6 marks]***
Here are some points your answer may include:
A mouse is injected with a specific antigen to make specific antibodies.
Lymphocytes are taken from the mouse.
A lymphocyte is fused with a tumour cell.
This creates a cell called a hybridoma.
The hybridoma cell can be cloned to get lots of identical cells.
These identical hybridoma cells produce monoclonal antibodies.
These antibodies can be collected and purified.

Pages 47-48 — Plant Diseases and Defences

1.1 E.g. tobacco mosaic virus ***[1 mark]***
1.2 E.g. (rose) black spot ***[1 mark]***
1.3 E.g. aphids ***[1 mark]***
2.1 Any four from: e.g. stunted growth / patches of decay/ rot / abnormal growths / malformed stems or leaves / discolouration ***[4 marks]***.
2.2 Taking the plant to a laboratory where scientists can identify the pathogen ***[1 mark]***. Using a testing kit that identifies the pathogen using monoclonal antibodies ***[1 mark]***.

2.3 $(6 \div 42) \times 100 = 14.29 =$ **14%** ***[2 marks for correct answer, otherwise 1 mark for correct working]***

3.1 They provide a physical barrier against pathogens to stop them from entering cells ***[1 mark]***.

3.2 Antibacterial chemicals ***[1 mark]*** kill bacterial pathogens that could damage the plants ***[1 mark]***. Poisons ***[1 mark]*** deter herbivores from eating the plants ***[1 mark]***.

3.3 Any two from: e.g. thorns or hairs on its surface — these stop animals from touching and eating the plant. / Leaves that droop or curl when something touches them — this means that plants can knock insects off themselves and move away from things that might eat them. / Mimicry of other organisms — this tricks other organisms into not eating or laying eggs on the plant ***[1 mark for each correct adaptation and 1 mark for each correct explanation linked to an adaptation, up to 4 marks]***.

4.1 E.g. nitrates ***[1 mark]***

4.2 E.g. nitrates are needed to make proteins ***[1 mark]***, which plants need to grow ***[1 mark]***.

4.3 E.g. magnesium ions ***[1 mark]***

4.4 E.g. the plant will have a lack of chlorophyll/suffer from chlorosis ***[1 mark]*** and will have yellow leaves ***[1 mark]***.

Topic 4 — Bioenergetics

Page 49 — Photosynthesis and Limiting Factors

1.1 the Sun / the environment ***[1 mark]***

1.2 **carbon dioxide** ***[1 mark]*** + water → glucose + **oxygen** ***[1 mark]***

1.3 cellulose ***[1 mark]***

1.4 Any two from: e.g. for respiration. / For making amino acids (which are used to make proteins) by combining the glucose with nitrate ions. / It is converted to lipids (fats and oils) for storage. / It is turned into starch for storage ***[2 marks]***.

2.1 An endothermic reaction is where energy is transferred from the environment during the process ***[1 mark]***.

2.2 nitrate concentration ***[1 mark]***

2.3 The rate of photosynthesis would decrease ***[1 mark]*** because the chloroplasts wouldn't be able to absorb as much light ***[1 mark]***.

Pages 50-52 — The Rate of Photosynthesis

Warm-up

low, slowly, high, damaged

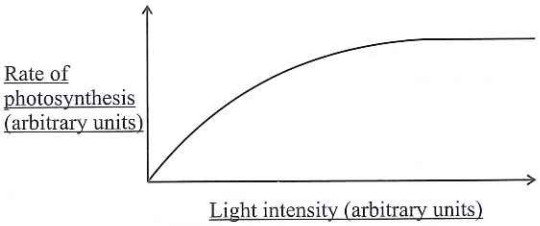
1.1 Any two from: e.g. adding a heater — to increase the temperature, which will increase the rate of photosynthesis. / Supplying artificial light — to increase the light intensity, which will increase the rate of photosynthesis. / Adding a paraffin heater — to increase the carbon dioxide concentration, which will increase the rate of photosynthesis. ***[1 mark for each correct improvement and 1 mark for each correct explanation, up to 4 marks]***.

1.2 Because the farmer will get a better yield ***[1 mark]***, which means they will also make more money/profit ***[1 mark]***.

2.1 At first, as the carbon dioxide concentration increases, the rate of photosynthesis increases as well ***[1 mark]***. Then, at 0.10 arbitrary units of carbon dioxide, the graph flattens out — as the carbon dioxide concentration increases, the rate of photosynthesis no longer increases ***[1 mark]***.

2.2 E.g. temperature ***[1 mark]***, light intensity ***[1 mark]***

2.3



[1 mark for correctly labelled axes, 1 mark for correctly sketched line]

3.1 It will increase ***[1 mark]***.

3.2 distance = 20 cm, so $20^2 = 400$ ***[1 mark]***

$1 \div 400 =$ **0.0025 arbitrary units** ***[1 mark]***

3.3 How to grade your answer:

Level 0: There is no relevant information. ***[No marks]***

Level 1: There is a brief description of a method used to investigate the effect of temperature on the rate of photosynthesis, with no control variables mentioned. ***[1 to 2 marks]***

Level 2: There is some description of a method used to investigate the effect of temperature on the rate of photosynthesis, including an example of a variable to control. ***[3 to 4 marks]***

Level 3: There is detailed description of a method used to investigate the effect of temperature on the rate of photosynthesis, including more than one example of variables to control. ***[5 to 6 marks]***

Here are some points your answer may include:

A test tube is clamped in place in a water bath at a particular temperature, e.g. 10 °C.

Once the water in the test tube has reached the correct temperature, the pondweed is added to the test tube and the test tube is sealed.

A capillary tube and syringe are attached to the test tube.

The pondweed is left to photosynthesise for a set amount of time.

At the end of the experiment, the syringe is used to draw the gas bubble in the capillary tube up alongside a ruler and the length of the gas bubble that has formed is measured. This is proportional to the volume of oxygen produced.

The experiment is repeated twice at this starting temperature.

Then the whole experiment is repeated at different temperatures, e.g. 15 °C, 20 °C, 25 °C.

The variables that should be controlled in this experiment include light intensity and the concentration of carbon dioxide.

Page 53 — Respiration and Metabolism

1.1 exothermic (reaction) ***[1 mark]***

1.2 E.g. to build up larger molecules from smaller ones ***[1 mark]***. To allow the gull's muscles to contract ***[1 mark]***. To keep the gull's body temperature steady in cooler surroundings ***[1 mark]***.

2.1 Plants, e.g: cellulose / starch / proteins ***[1 mark]***
Animals, e.g: glycogen / proteins ***[1 mark]***

2.2 A lipid is made from one molecule of glycerol ***[1 mark]*** and three fatty acids ***[1 mark]***.

2.3 Glucose is combined with nitrate ions ***[1 mark]*** to make amino acids, which are then made into proteins ***[1 mark]***.

2.4 urea ***[1 mark]***

Pages 54-55 — Aerobic and Anaerobic Respiration

Warm-up

Aerobic respiration — Respiration using oxygen.

Anaerobic respiration — Respiration without oxygen.

Fermentation — Respiration without oxygen.

1.1 E.g. the snail must have enough oxygen for two hours / the snail must not dry out ***[1 mark]***.

1.2 The percentage of carbon dioxide in the air has increased over the two hours because the snail gives out carbon dioxide as it respires *[1 mark]*.

1.3 The percentage of carbon dioxide in the air has stayed the same over the two hours because the glass beads were not respiring *[1 mark]*.

1.4 It will have decreased *[1 mark]* because the snail will have used up oxygen as it respired *[1 mark]*.

1.5 To show that it's the snail producing carbon dioxide (and not just the presence of something in the beaker) *[1 mark]*.

2.1 glucose *[1 mark]*

2.2 Ethanol — to make alcoholic drinks *[1 mark]*.
Carbon dioxide — to make bread rise *[1 mark]*.

3 Aerobic respiration in muscle cells uses oxygen, whereas anaerobic respiration doesn't *[1 mark]*. Aerobic respiration in muscle cells forms carbon dioxide and water, whereas anaerobic respiration forms lactic acid *[1 mark]*. Aerobic respiration in muscles cells transfers a lot of energy, whereas anaerobic respiration in muscle cells transfers a small amount of energy *[1 mark]*.

Pages 56-57 — Exercise

Warm-up

muscles, oxygen debt, oxygen, lactic acid

1.1 $(12 + 11 + 12) \div 3 = 11.6... =$ **12** breaths per minute *[1 mark]*

1.2 During exercise the breathing rate increased *[1 mark]* to get more oxygen into the blood *[1 mark]*, which was needed for increased respiration in the muscles *[1 mark]*.

1.3 The breathing rate remained high one minute after exercise *[1 mark]* because there were still high levels of lactic acid and carbon dioxide in the blood *[1 mark]*. The high breathing rate helps remove these from the body *[1 mark]*. The breathing rate had returned to normal by five minutes after exercise *[1 mark]* because the oxygen debt had been paid off *[1 mark]*.

1.4 breath volume *[1 mark]*, heart rate *[1 mark]*

2.1 $80 - 20 = 60$
$(60 \div 20) \times 100 =$ **300%** *[2 marks for correct answer, otherwise 1 mark for correct working.]*

2.2 The muscles started to respire anaerobically *[1 mark]*, which formed lactic acid *[1 mark]* as a result of the incomplete oxidation of glucose *[1 mark]*.

2.3 They become fatigued *[1 mark]* and stop contracting efficiently *[1 mark]*.

2.4 Blood transports the lactic acid to the liver *[1 mark]*, where it is converted back to glucose *[1 mark]*.

Topic 5 — Homeostasis and Response

Page 58 — Homeostasis

1.1 The regulation of the conditions inside the body/cells to maintain a stable internal environment *[1 mark]* in response to changes in internal and external conditions *[1 mark]*.

1.2 They maintain the right conditions for cells to function properly. / They maintain the right conditions for enzyme action. *[1 mark]*

1.3 receptor *[1 mark]*

1.4 The receptors detect that the blood pressure is too high and send a signal to the coordination centre *[1 mark]*.
The coordination centre processes the information and organises a response / stimulates an effector *[1 mark]*. The effector produces a response to decrease the blood pressure (back to its optimum level) *[1 mark]*.

You don't need to know all about the regulation of blood pressure to answer this question — you just need to know the sequence of events in a negative feedback response, from receptors to effectors.

2.1 15 minutes *[1 mark]*

2.2 $30 - 20 = 10$ min
$35.0 - 34.5 = 0.5$ °C
$0.5 \div 10 =$ **0.05 °C/min** *[2 marks for correct answer, otherwise 1 mark for correct working.]*

Page 59 — The Nervous System

1.1 X — brain *[1 mark]*
Y— spinal cord *[1 mark]*

1.2 central nervous system/CNS *[1 mark]*

1.3 It receives information from receptors and coordinates a response (which is carried out by effectors) *[1 mark]*.

2.1 It allows organisms to react to their surroundings *[1 mark]* and coordinate their behaviour *[1 mark]*.

2.2 Spinal cord — coordinator *[1 mark]*
Bright light — stimulus *[1 mark]*
Blinking — response *[1 mark]*

2.3 Sensory neurones *[1 mark]* and motor neurones *[1 mark]*.

2.4 Muscles — contract *[1 mark]*
Glands — secrete hormones *[1 mark]*

Page 60 — Synapses and Reflexes

Warm-up

Dropping a hot plate. The pupil widening in dim light.

1 Reflex reactions are rapid and automatic. *[1 mark]*

2.1 X — sensory neurone *[1 mark]*
Y — relay neurone *[1 mark]*
Z — motor neurone *[1 mark]*

2.2 stimulus — flame/fire *[1 mark]*
coordinator — spinal cord / relay neurone *[1 mark]*
effector — muscle *[1 mark]*

2.3 synapse *[1 mark]*

2.4 Chemicals diffuse across the gap and transfer the nerve signal *[1 mark]*.

Page 61 — Investigating Reaction Time

1.1 Student 2 $= (0.16 + 0.13 + 0.15) \div 3 = 0.1466...$
$=$ **0.15 s** *[1 mark]*
Student 3 $= (0.20 + 0.22 + 0.19) \div 3 = 0.2033...$
$=$ **0.20 s** *[1 mark]*

1.2 Student 1, Test 3 (0.43 s) *[1 mark]*

1.3 The students' reaction times without caffeine would act as a control for each student *[1 mark]*. The results from each student's tests could then be compared to the control to see if caffeine actually had an effect on reaction time *[1 mark]*.

1.4 E.g. the reaction times of student 1, 2 and 3 will be affected to different extents by caffeine due to natural variation between them *[1 mark]*, so the investigation isn't a fair test *[1 mark]*. / Two variables (the caffeinated drink and the student) are being changed *[1 mark]*, so the investigation isn't a fair test *[1 mark]*.

1.5 Any three from: e.g. the hand that the student used to catch the ruler. / The height from which the ruler was dropped. / The ruler used. / The person dropping the ruler. / The way that the student was positioned to catch the ruler. / The time between the consumption of caffeine and the test.
[3 marks — 1 mark for each correct answer.]

You wouldn't get a mark for saying that the amount of caffeine given to each student should be the same each time, because this was said in the question.

Page 62 — The Brain

1.1 neurones *[1 mark]*

1.2 medulla *[1 mark]*

1.3 E.g. breathing, heart beat *[2 marks]*

2.1 A *[1 mark]*

2.2 B *[1 mark]*

2.3 The brain is very complex *[1 mark]*.
The brain is very delicate *[1 mark]*.

2.4 Electrically stimulating different parts of the brain *[1 mark]*.
Studying patients with brain damage *[1 mark]*.