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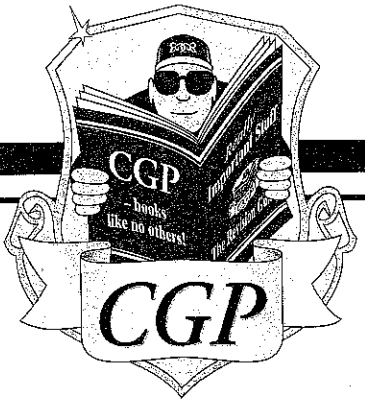

GCSE Biology

For AQA (Grade 9-1)

New!

Exam Practice Answer Book

Contents

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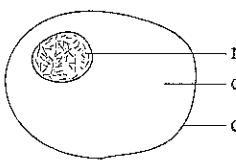
Topic 1 — Cell Biology

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.

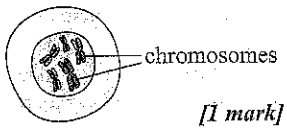
1 differentiation *[1 mark]*

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]*

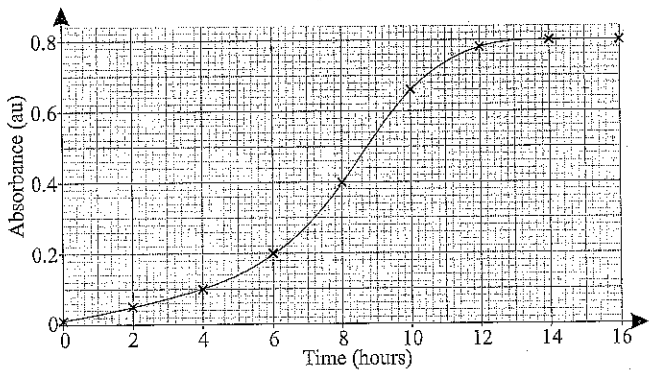
1.3 The number of subcellular structures is increasing *[1 mark]*.
The chromosomes are doubling *[1 mark]*.

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]*.

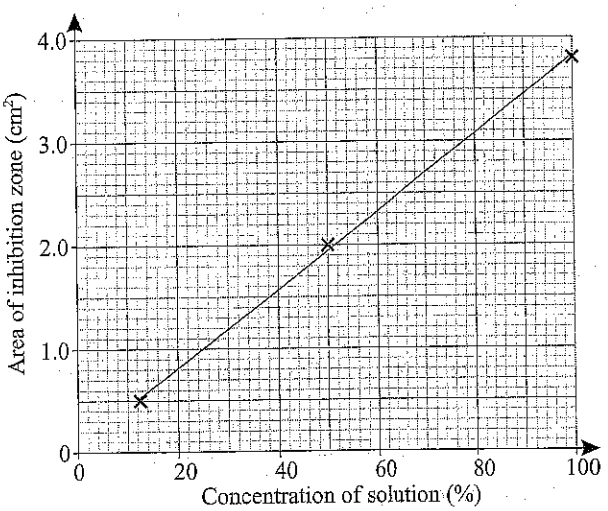
1.2 Any three from: e.g. used sterilised Petri dishes. / Used sterilised culture medium. / Sterilised the spreader/ inoculating loop (by passing it through a flame). / (Lightly) taped on the lid of the Petri dish. / Stored the plates upside down. *[3 marks]*

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]*.

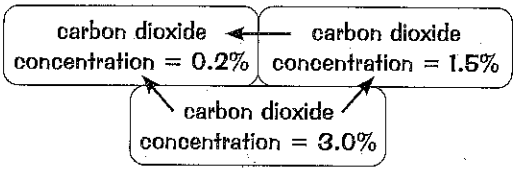
3.1 The production of an embryo with the same genes as a patient *[1 mark]*.

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 $X = (3 \times 3) \times 6 = \mathbf{54\ cm^2}$ *[1 mark]*
$Y = 3 \times 3 \times 3 = \mathbf{27\ cm^3}$ *[1 mark]*
2.2 $Z = 150 \div 125 = \mathbf{1.2}$ *[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]*.

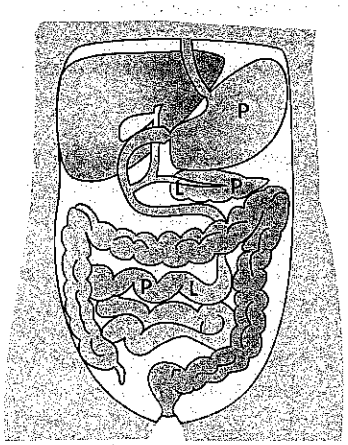
1.3 By putting the test tubes in a water bath *[1 mark]*.

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]*

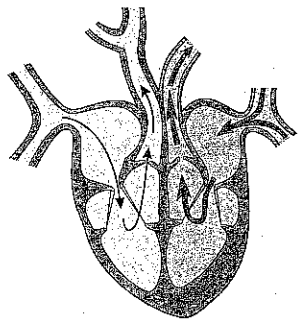
1.2 capillary *[1 mark]*

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]*.

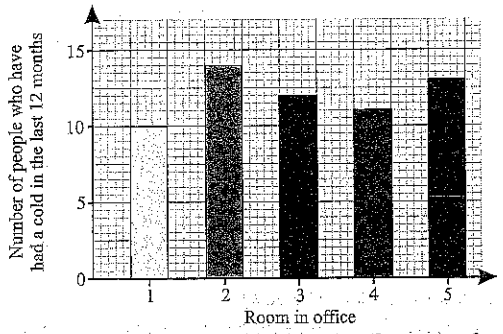
3.6 Advantage — e.g. natural donor hearts don't have any mechanical parts like electric motors that could wear out. / Blood flows more smoothly through natural hearts *[1 mark]*.
Disadvantage — e.g. natural donor hearts aren't always available straight away. / Natural donor hearts are more likely to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

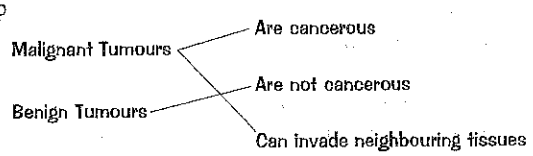
1.3 E.g. type 2 diabetes *[1 mark]*

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]*.

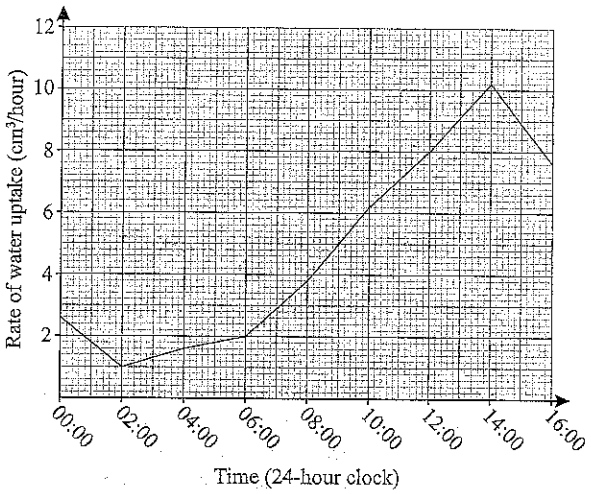
2.1 Mean width of stomata in leaf A = $(25.2 + 20.1 + 18.7 + 17.9 + 19.1 + 19.3 + 22.0 + 23.1 + 21.8 + 20.3) \div 10 =$ **20.8 µm** *[1 mark]*

Mean width of stomata in leaf B = $(14.7 + 12.8 + 14.1 + 13.2 + 12.9 + 11.9 + 12.1 + 13.4 + 10.9 + 11.7) \div 10 =$ **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

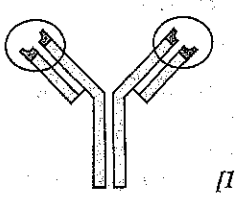
1.1 E.g. toxicity, efficacy and dosage ***[3 marks]***
1.2 cells, tissues and live animals ***[1 mark]***

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

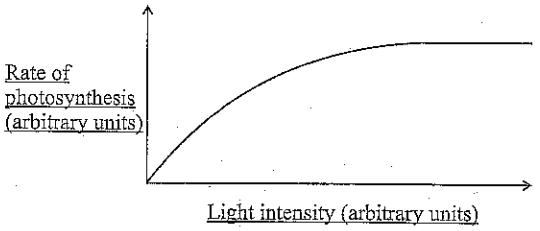
1.1 Any two from: e.g. adding a heater — to increase the temperature, which will increase the rate of photosynthesis. / Supplying artificial light — to increase the light intensity, which will increase the rate of photosynthesis. / Adding a paraffin heater — to increase the carbon dioxide concentration, 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]*.

Pages 63-64 — The Eye

Warm-up

Clockwise from top left: iris, retina, sclera, optic nerve, lens, pupil.

1.1 retina *[1 mark]*
1.2 brain *[1 mark]*
1.3 cornea *[1 mark]*
1.4 iris *[1 mark]*
1.5 Ciliary muscles *[1 mark]* and suspensory ligaments *[1 mark]*.
2.1 The pupil of eye B is bigger/wider than eye A *[1 mark]* and the iris is smaller/thinner *[1 mark]*.
2.2 Eye B, because the pupil is wider to let in more light *[1 mark]*.
2.3 So that the amount of light entering the eye can be controlled *[1 mark]* so that bright light cannot damage the retina / to allow sufficient light to enter the eye in dim conditions *[1 mark]*.
3 Level 0: There is no relevant information. *[0 marks]*
Level 1: There is a brief description of how accommodation works for either near vision or distant vision. *[1 to 2 marks]*
Level 2: There is some description of how accommodation works for both near and distant vision. *[3 to 4 marks]*
Level 3: There is a detailed description of how accommodation works for both near and distant vision. *[5 to 6 marks]*

Here are some points your answer may include:
Accommodation is the process of focusing light on the retina by changing the shape of the lens.
To focus on a near object:
- the ciliary muscles contract,
- the suspensory ligaments slacken,
- the lens becomes fat / more curved,
- the lens refracts light rays strongly.

To focus on a distant object:
- the ciliary muscles relax,
- the suspensory ligaments are pulled tight,
- the lens is then pulled thin / becomes less curved,
- the lens only refracts light rays slightly.

Page 65 — Correcting Vision Defects

1.1 short-sightedness / myopia *[1 mark]*
1.2 The spectacle lens refracts/bends light rays *[1 mark]* so that they focus on the retina *[1 mark]*.
1.3 behind the retina *[1 mark]*
1.4 convex lens *[1 mark]*
2.1 It changes the shape of the cornea *[1 mark]* to change how strongly light is refracted into the eye *[1 mark]*.
2.2 replacement lens surgery *[1 mark]*
2.3 E.g. the retina could be damaged. / The eye may become infected. *[1 mark]*
2.4 contact lenses *[1 mark]*

Page 66 — Controlling Body Temperature

1.1 brain *[1 mark]*
1.2 temperature of the blood *[1 mark]*
1.3 The skin contains temperature receptors *[1 mark]*. These send nervous impulses to the thermoregulatory centre *[1 mark]*.
2.1 When the body temperature becomes too high, energy is transferred from the blood and skin to the environment *[1 mark]*. The blood vessels dilate so more blood can flow near the surface of the skin *[1 mark]* and sweat evaporates from the skin *[1 mark]*.
2.2 When the body temperature becomes too low, the transfer of energy from the blood and skin to the environment is reduced *[1 mark]* by vasoconstriction (and lack of sweating) *[1 mark]*. The body also shivers, which uses respiration to transfer energy to the body (from glucose) *[1 mark]*.

Page 67 — The Endocrine System

1.1 Glands secrete hormones directly into the blood. *[1 mark]*
1.2 Hormones are chemical molecules. *[1 mark]*
1.3 E.g. the effects of the endocrine system are slower *[1 mark]*. The effects of the endocrine system are longer lasting *[1 mark]*.
2.1 A — pituitary gland *[1 mark]*
B — thyroid *[1 mark]*
C — adrenal gland *[1 mark]*
D — pancreas *[1 mark]*
E — ovary *[1 mark]*
2.2 pituitary gland *[1 mark]*
2.3 They act on other glands *[1 mark]* to direct them to release other hormones that bring about change *[1 mark]*.

Page 68-69 — Controlling Blood Glucose

1.1 pancreas *[1 mark]*
1.2 insulin *[1 mark]*
1.3 It moves into liver and muscle cells *[1 mark]* and is converted to glycogen for storage *[1 mark]*.
2.1 The pancreas produces little or no insulin *[1 mark]*.
2.2 Uncontrolled high blood glucose level *[1 mark]*.
2.3 E.g. the person's diet. / How active the person is. *[1 mark]*
2.4 The body cells no longer respond to the insulin produced by the pancreas *[1 mark]*.
2.5 Eat a carbohydrate-controlled diet *[1 mark]* and get regular exercise *[1 mark]*.
2.6 being overweight / obesity *[1 mark]*
3.1 The blood glucose concentration starts increasing as glucose from the drink is absorbed into the blood *[1 mark]*.
The pancreas detects a high blood glucose concentration and secretes insulin *[1 mark]*. Insulin causes the blood glucose concentration to fall back down *[1 mark]*.
3.2 glucagon *[1 mark]*
3.3 It increases the concentration of glucose in the blood *[1 mark]*.
3.4 Glucagon causes glycogen to be converted into glucose and be released into the blood *[1 mark]*.
3.5 E.g. after drinking the glucose drink, the blood glucose concentration would carry on increasing / stay high / not start to fall / fall more slowly *[1 mark]*.

Page 70-71 — The Kidneys

Warm-up

blood, cells, osmosis, ions, kidneys

1.1 filtration *[1 mark]*
1.2 urea *[1 mark]*
1.3 selective reabsorption *[1 mark]*
1.4 Any two from: glucose / water / ions *[2 marks]*
2.1 From the lungs when breathing out *[1 mark]*.
2.2 ions *[1 mark]* / urea *[1 mark]*
2.3 The body can't control water loss from the skin. *[1 mark]*
3.1 liver *[1 mark]*
3.2 protein in the diet *[1 mark]*
3.3 ammonia *[1 mark]*
3.4 It is toxic *[1 mark]*.
4 How to grade your answer:
Level 0: There is no relevant information. *[No marks]*
Level 1: There are some relevant points describing the body's response to low water content but the answer is missing some detail. *[1 to 2 marks]*
Level 2: There is a clear, detailed description of the body's response to low water content that includes the hormone and structures involved. *[3 to 4 marks]*

Here are some points your answer may include:
A signal is sent to the pituitary gland to release more ADH (anti-diuretic hormone).
ADH causes the kidneys/kidney tubules to reabsorb more water.
This means less water is lost in the urine.
So the water content of the blood is increased.

Page 72 — Kidney Failure

1.1 Because their kidneys don't work properly to control the levels of dissolved substances in their body (and remove waste products) *[1 mark]*.
1.2 urea / excess ions / excess water *[1 mark]*
1.3 Proteins are too large pass through the partially permeable membrane *[1 mark]*.
1.4 So that useful substances won't be lost from the person's blood during dialysis *[1 mark]*.
1.5 Any two from: glucose / water / ions *[2 marks]*
2 Advantage — e.g. the person can lead a normal life after the transplant. / The patient doesn't need to spend hours on dialysis any more. *[1 mark]*
Disadvantage — e.g. waiting lists are long. / It is not always easy to find a donor. / The donor organ could be rejected by the patient's immune system. *[1 mark]*

Page 73 — Puberty and the Menstrual Cycle

1.1 oestrogen *[1 mark]*
1.2 ovulation *[1 mark]*
1.3 Every 28 days *[1 mark]*
1.4 luteinising hormone *[1 mark]*
1.5 testosterone *[1 mark]*
1.6 testes *[1 mark]*
2.1 oestrogen *[1 mark]*, progesterone *[1 mark]*
2.2 pituitary gland *[1 mark]*
2.3 It causes an egg to mature in one of the ovaries *[1 mark]* and stimulates the ovaries to produce hormones/oestrogen *[1 mark]*.
2.4 oestrogen *[1 mark]*

Pages 74-75 — Controlling Fertility

Warm-up

Hormonal	Non-hormonal
contraceptive injection plastic intrauterine device contraceptive patch	abstinence condom diaphragm sterilisation

1.1 As a tablet taken by mouth. *[1 mark]*
1.2 The hormones inhibit FSH production *[1 mark]*.
1.3 progesterone *[1 mark]*
1.4 It stops the maturation/release of eggs. / It makes it hard for sperm to swim to the egg. / It stops any fertilised egg implanting in the uterus. *[1 mark]*
2.1 condom *[1 mark]*
2.2 female condom / diaphragm *[1 mark]*
2.3 They prevent the sperm reaching an egg *[1 mark]*.
2.4 spermicidal agents / spermicides *[1 mark]*
2.5 Avoiding intercourse when the woman is at the most fertile point in her menstrual cycle *[1 mark]*.
2.6 sterilisation *[1 mark]*
2.7 condom *[1 mark]*
3.1 E.g. the woman does not have to remember to take the contraceptive every day *[1 mark]*.
3.2 E.g. the injection lasts for several months, so if she has any side effects they may last for a long time *[1 mark]*.
3.3 E.g. barrier methods do not have the possible side effects associated with taking hormones *[1 mark]*.

Page 76 — More on Controlling Fertility

1.1 FSH is needed to stimulate eggs to mature. / No eggs would be released so the woman would not be able to become pregnant. *[1 mark]*
1.2 Luteinising hormone / LH *[1 mark]* because it stimulates the release of an egg *[1 mark]*.
1.3 Advantage: e.g. the woman may become pregnant naturally / without needing IVF *[1 mark]*.
Disadvantage: e.g. some women need several treatments so it can be expensive. / Too many eggs may be stimulated resulting in unexpected multiple pregnancies. *[1 mark]*
2.1 The mother is given FSH and LH *[1 mark]* to stimulate the maturation of several eggs *[1 mark]*. Several eggs are collected from the mother and fertilised by sperm from the father in a laboratory *[1 mark]*. The fertilised eggs are grown into embryos in the laboratory *[1 mark]*. At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother's uterus *[1 mark]*.
2.2 Any two from: e.g. the treatment may not work so repeated attempts are needed, which could be upsetting/stressful for the couple. / It can result in multiple births which can be a risk to the mother's health. / The mother may have a strong reaction to the hormones (e.g. pain, vomiting). *[2 marks]*

Page 77 — Adrenaline and Thyroxine

Warm-up
Clockwise from top left: high, inhibited, normal, stimulated, low.
1.1 Thyroxine regulates basal metabolic rate *[1 mark]*.
1.2 thyroid gland *[1 mark]*
2.1 adrenal glands *[1 mark]*
2.2 E.g. it increases heart rate *[1 mark]*, which boosts the delivery of oxygen to the brain and muscles *[1 mark]* and also boosts the delivery of glucose to the brain and muscles *[1 mark]*.
2.3 flight or fight *[1 mark]*

Page 78 — Plant Hormones

1.1 The seedlings in Set A have grown straight up but the seedlings in Set B have grown sideways (towards the light) *[1 mark]*.
1.2 phototropism *[1 mark]*
1.3 It allows the plant to receive maximum light for photosynthesis *[1 mark]*.
1.4 Auxin moved towards the shaded side of the shoot / away from the light side of the shoot *[1 mark]*. The auxin made the cells elongate/grow faster on the shaded side *[1 mark]* so the shoot bent towards the light *[1 mark]*.
2.1 positive gravitropism/geotropism *[1 mark]*
2.2 shoot *[1 mark]*
2.3 downwards / away from light *[1 mark]*

Page 79 — Commercial Uses of Plant Hormones

1.1 ethene *[1 mark]*
1.2 seed germination *[1 mark]*
2 To end seed dormancy / cause seeds to germinate *[1 mark]*. To induce flowering *[1 mark]*. To grow larger fruit *[1 mark]*.
3.1 ethene *[1 mark]*
3.2 The fruit is firmer and so it is less easily damaged *[1 mark]*. It can then be ripened on the way to the supermarket so that it's perfect when it reaches the shelves *[1 mark]*.
4.1 auxin *[1 mark]*
4.2 To stimulate the cutting to develop roots *[1 mark]*.
4.3 selective weedkiller *[1 mark]*

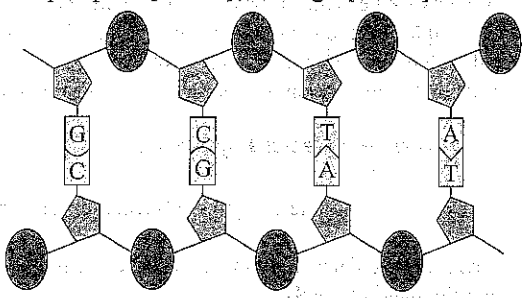
Topic 6 — Inheritance, Variation and Evolution

Page 80 — DNA

1.1 DNA is located in the nucleus of animal and plant cells *[1 mark]*.
1.2 The structures that contain DNA *[1 mark]*.
2.1 Genes code for particular sequences of amino acids *[1 mark]*, which are put together to make specific proteins *[1 mark]*.
2.2 The entire set of genetic material in an organism *[1 mark]*.
2.3 E.g. it allows scientists to identify genes that are linked to different types of diseases *[1 mark]*. Knowing which genes are linked to inherited diseases could help us to develop effective treatments for them *[1 mark]*.

Pages 81-82 — The structure of DNA and Protein Synthesis

1.1 A, C, G and T *[1 mark]*
1.2 A = phosphate *[1 mark]*, B = sugar *[1 mark]*
1.3



[1 mark for correct labelling of both C bases, 1 mark for correct labelling of both T bases. Maximum of 2 marks available.]

1.4 Each sequence of three bases codes for one specific amino acid *[1 mark]*, so the order of the bases in the gene decides the order of the amino acids in the chain *[1 mark]*.
2.1 ribosomes *[1 mark]*
2.2 They switch specific genes on or off *[1 mark]*.
3.1 A molecule called mRNA is made by copying the code from the DNA *[1 mark]*. The mRNA carries the code from the DNA to the site of protein synthesis *[1 mark]*.
3.2 Carrier molecules *[1 mark]* bring the amino acids coded for by the messenger molecule/mRNA to the site of protein synthesis *[1 mark]* in the correct order *[1 mark]*.
3.3 It folds up into a unique shape *[1 mark]*, which allows the protein to perform the task it is meant to do *[1 mark]*.
3.4 E.g. hormones *[1 mark]*. These are used to carry messages around the body *[1 mark]*.
E.g. enzymes *[1 mark]*. These act as biological catalysts to speed up chemical reactions in the body *[1 mark]*.

Page 83 — Mutations

Warm-up
False, True, False
1.1 AAGCTTCCGA *[1 mark]*
1.2 Because mutations change the sequence of DNA bases in a gene *[1 mark]*, and it is this sequence that codes for the specific amino acids in a protein *[1 mark]*. A change in the amino acids coded for could lead to a change in the protein *[1 mark]*.
1.3 E.g. the mutation could cause the structural protein to lose its strength *[1 mark]*, meaning that it may no longer be able to carry out its job of providing structure and support *[1 mark]*.
1.4 E.g. the shape of the enzyme's active site could be changed *[1 mark]*, meaning that its substrate may no longer be able to bind to it *[1 mark]*, so the enzyme would no longer be able to catalyse the reaction *[1 mark]*.

Page 84 — Reproduction

1.1 sperm *[1 mark]*
1.2 egg (cell) *[1 mark]*
1.3 meiosis *[1 mark]*
1.4 clones *[1 mark]*
1.5 mitosis *[1 mark]*
2.1 Because gametes only have half the number of chromosomes of a normal cell *[1 mark]*, so when two gametes fuse together the fertilised egg cell has the full number of chromosomes *[1 mark]*.
2.2 Any four from: e.g. asexual reproduction only involves one parent, whereas sexual reproduction involves two. / Unlike in sexual reproduction, there is no fusion of gametes in asexual reproduction. / Unlike in sexual reproduction, there is no mixing of chromosomes in asexual reproduction. / Unlike sexual reproduction, asexual reproduction doesn't give rise to genetic variation (as the offspring are genetically identical to the parent). / Asexual reproduction doesn't involve meiosis, whereas sexual reproduction does. *[4 marks — 1 mark for each correct answer.]*

Page 85 — Meiosis

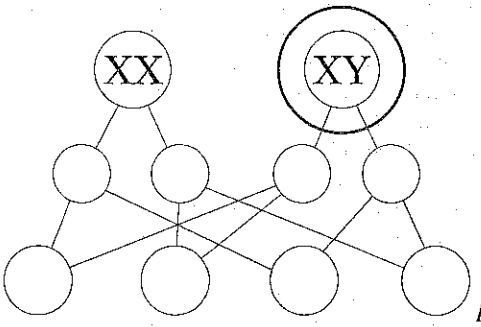
1.1 In the reproductive organs / ovaries and testes *[1 mark]*.
1.2 It is duplicated *[1 mark]*.
1.3 two *[1 mark]*
1.4 Four gametes are produced *[1 mark]*, each with only a single set of chromosomes *[1 mark]*. Each of the gametes is genetically different from the others *[1 mark]*.
2.1 two *[1 mark]*
2.2 mitosis *[1 mark]*
2.3 They differentiate into different types of specialised cell *[1 mark]*.

Page 86 — More on Reproduction

Warm-up
runners, seeds, identical, different
1.1 asexual *[1 mark]*
1.2 Malaria parasites reproduce asexually in the human host, but sexually in the mosquito *[1 mark]*.
2.1 Any two from: e.g. asexual reproduction uses less energy than sexual reproduction because organisms don't have to find a mate. / Asexual reproduction is faster than sexual reproduction because organisms don't have to find a mate. / Many identical offspring can be produced in favourable conditions. *[2 marks — 1 mark for each correct answer.]*
2.2 Because it creates genetic variation in the offspring *[1 mark]*. Variation means it's likely that some individuals in the population will have a gene that makes them better adapted to survive in the new environment *[1 mark]*. Individuals with this gene are more likely to survive and breed successfully *[1 mark]* and pass the gene on to future generations, which will allow them to also survive in the environment *[1 mark]*.

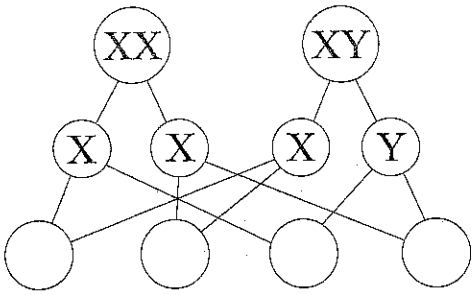
Page 87 — X and Y Chromosomes

1.1 23 pairs of chromosomes *[1 mark]*
1.2



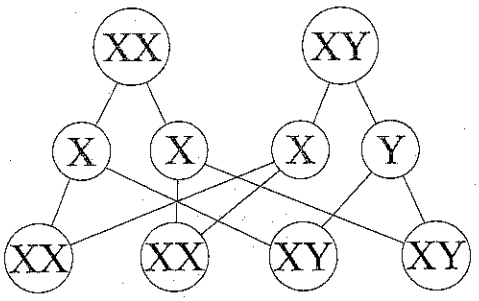
[1 mark]

1.3



[1 mark for all gametes correct]

1.4



[1 mark if all the offspring genotypes are correct]

1.5 50:50 / 1:1 *[1 mark]*

1.6 E.g.

	X	X
X	XX	XX
Y	XY	XY

[1 mark for correct gametes of parents, 1 mark for correct genotypes of offspring.]

Pages 88-89 — Genetic Diagrams

Warm-up

alleles, recessive, homozygous, heterozygous, a single gene, multiple genes

1.1 Because there are carriers who don't have the disease *[1 mark]*.

1.2

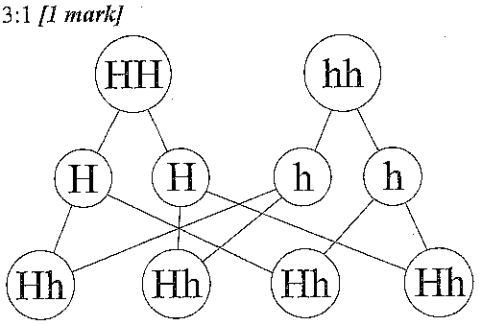
	D	d
D	DD	Dd
d	Dd	dd

probability = **25%**

[1 mark for correct genotypes of parents, 1 mark if all gametes are correct, 1 mark if all offspring genotypes are correct, 1 mark for correct probability.]

2.1 3:1 *[1 mark]*

2.2



number of puppies = **8**

[1 mark for correct gametes, 1 mark for correct offspring genotypes, 1 mark for correct number of puppies.]

2.3 E.g.

	H	h
h	Hh	hh
h	Hh	hh

ratio = **1:1**

[1 mark if all gametes are correct, 1 mark if all offspring genotypes are correct, 1 mark for correct probability.]

Page 90 — Inherited Disorders

1.1 Being born with extra fingers or toes *[1 mark]*.

1.2 That the allele for polydactyly is dominant *[1 mark]*.

1.3 Because the allele for cystic fibrosis is recessive *[1 mark]*, so the offspring must have two copies of the allele to have the disorder *[1 mark]*. There is only a 1 in 4 chance of this occurring when each parent has one copy of the allele *[1 mark]*.

2.1 E.g. it implies that people with genetic problems are undesirable, which could increase prejudice *[1 mark]*. Screening is expensive *[1 mark]*. There could become a point where everyone wants to screen their embryo in IVF to pick the most desirable one *[1 mark]*.

2.2 E.g. it will help to stop people suffering from genetic disorders *[1 mark]*. Treating disorders costs the government and taxpayer a lot of money. Screening to reduce the number of people with disorders could save money *[1 mark]*. Parents cannot use it to select desirable characteristics for their baby, as there are laws to stop screening going too far *[1 mark]*.

Page 91 — The Work of Mendel

Warm-up

genetics, mid-19th century, plants, passed on

1.1 Because the scientists of the day didn't have the background knowledge necessary to properly understand his findings. / Because the scientists of the day didn't know about genes, DNA and chromosomes. *[1 mark]*

1.2 In the late 1800s, scientists were able to observe how chromosomes behaved during cell division *[1 mark]*. Then in the early 20th century, scientists realised that there were striking similarities in the way that chromosomes and Mendel's 'hereditary units' acted *[1 mark]*. Based on this, it was proposed that the 'units' were found on chromosomes, and we now know these 'units' as genes *[1 mark]*. In the mid-20th century, the structure of DNA was determined *[1 mark]*. This allowed scientists to go on and find out exactly how genes work *[1 mark]*.

Page 92 — Variation

1.1 genetic *[1 mark]*

1.2 environmental *[1 mark]*

2 The mutation could lead to a new phenotype *[1 mark]*. If the environment changes, the new phenotype could make the individual more suited to the new environment *[1 mark]*. It could then become common throughout the species relatively quickly by natural selection *[1 mark]*.

Pages 93-94 — Evolution

1.1 speciation *[1 mark]*

1.2 The populations can no longer interbreed to produce fertile offspring *[1 mark]*.

2.1 More than 3 billion years ago *[1 mark]*

2.2 New knowledge of fossils *[1 mark]* and geology *[1 mark]*.

2.3 New phenotypes occur because of genetic variants produced by mutations *[1 mark]*.

2.4 Characteristics are passed on in genes from parents to offspring *[1 mark]*.

3 The environment changes too quickly *[1 mark]*. A new predator kills them all *[1 mark]*. A new disease kills them all *[1 mark]*. They can't compete with another new species for food *[1 mark]*. A catastrophic event occurs that kills them all *[1 mark]*.

4 Species show a wide variation in their characteristics because of differences in their alleles/genes *[1 mark]*. In this case, hares with smaller ears have more suitable characteristics for a cold environment because they will lose less heat *[1 mark]*, so are more likely to survive and successfully reproduce *[1 mark]* and pass on the genes controlling smaller ears to the next generation/their offspring *[1 mark]*. Over time, these genes will have become more common in the species, causing the hares to evolve *[1 mark]*.

Page 95 — More About Evolution

1.1 On the Origin of Species *[1 mark]*

1.2 Because it went against the common religious beliefs at the time about how life on Earth developed / it was the first explanation for the existence of life on Earth without the need for God *[1 mark]*. There also wasn't enough evidence to convince many scientists because not many other studies had been done *[1 mark]*.

1.3 Lamarck believed that changes that an organism acquires during its lifetime will be passed on to its offspring *[1 mark]*.

1.4 E.g. the fossil record, which allows you to see how changes in organisms developed slowly over time *[1 mark]*. The discovery of how bacteria are able to evolve to become resistant to antibiotics *[1 mark]*.

Page 96 — Selective Breeding

1.1 Artificial selection *[1 mark]*

1.2 The breeding of organisms so that the genes for particular useful or attractive characteristics stay in the population *[1 mark]*.

1.3 To produce cows that produce lots of milk/have a high milk yield *[1 mark]*.

2.1 How to grade your answer:

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

Level 1: There are some relevant points describing selective breeding but the answer is missing some detail. *[1 to 2 marks]*

Level 2: There is a clear, detailed description of selective breeding that explains how dogs can be selectively bred for good, gentle temperament. *[3 to 4 marks]*

Here are some points your answer may include:
He could have selected two individuals from the population with the best temperaments.
These two individuals would have been bred together.
He would then have selected the individuals from the offspring with the best temperaments and bred them together.
He would have repeated this process over several generations.
This would make the good temperament trait become stronger over time.
Eventually all the puppies would have the good, gentle temperament trait.

2.2 Because selective breeding leads to there being a reduced number of different alleles in the population / a reduced gene pool *[1 mark]*, so there's more chance of the puppies inheriting a genetic defect if it's present in the population *[1 mark]*.

2.3 There is less variation in a selectively bred population *[1 mark]*, so there's less chance of there being any alleles in the population that would give the puppies resistance to the disease *[1 mark]*, so if one individual gets the disease, the others are also likely to succumb to it *[1 mark]*.

Pages 97-98 — Genetic Engineering

Warm-up

False, False, True, True

1.1 The transfer of a gene responsible for a desirable characteristic *[1 mark]* from one organism's genome into another organism's genome *[1 mark]*.

1.2 Enzyme are used to isolate/cut the desired gene from the organism's genome *[1 mark]*.

1.3 The gene is first inserted into a vector *[1 mark]*. The vector is then introduced to the target organism *[1 mark]* and this inserts the gene into the organism's cells so that the organism develops with the desired characteristic *[1 mark]*.

1.4 Any two from: e.g. bacteria have been genetically engineered to produce human insulin that can be used to treat diabetes. / Sheep have been genetically engineered to produce drugs in their milk that can treat human diseases. / Scientists are researching genetic modification treatments (gene therapy) for inherited diseases caused by faulty genes *[2 marks — 1 mark for each correct answer.]*.

2.1 genetically modified *[1 mark]*

2.2 Any two from: e.g. to make them resistant to herbicides. / To make them resistant to disease. / To make them resistant to insects. *[2 marks — 1 mark for each correct answer.]*.

2.3 Mean fruit circumference of Plant 1 =
(16.4 + 16.8 + 15.9 + 16.2 + 15.7 + 16.4 + 16.3 + 16.0 + 15.9 + 16.0) ÷ 10 = **16.2 cm (3 s.f.)** *[1 mark]*
Mean fruit circumference of Plant 2 =
(20.2 + 20.4 + 19.8 + 19.6 + 20.4 + 20.6 + 20.2 + 19.9 + 20.1 + 20.0) ÷ 10 = **20.1 cm (3 s.f.)** *[1 mark]*

2.4 20.1 – 16.2 = 3.9 cm
(3.9 ÷ 16.2) × 100 = **24.1% (3 s.f.)**
[1 mark for correct working, 1 mark for correct answer]

To calculate percentage change, you first need to work out the difference between the two figures. You then need calculate what percentage that difference is of the first figure.

2.5 Any one from: e.g. some people say that growing GM crops will affect the number of wild flowers, and so the population of insects, that live in and around the crops — reducing farmland biodiversity. / Some people are concerned that we might not fully understand the effects of eating GM crops on human health. / People are concerned that transplanted genes might get out into the natural environment. *[1 mark]*

Pages 99-100 — Cloning

1.1 Taking cuttings is an older and simpler method than tissue culture *[1 mark]*.

1.2 Plant cells from the plant being cloned *[1 mark]*.

2.1 E.g. to preserve rare plants that are hard to reproduce naturally *[1 mark]*.

2.2 Disease could wipe out an entire plant population *[1 mark]* because the reduced gene pool resulting from cloning *[1 mark]* reduces the chance of there being an allele in the population that gives the plants resistance to a new disease *[1 mark]*.

3.1 Sperm cells could be taken from the male pig with the desired characteristics and egg cells could be taken from the female pig with the desired characteristics *[1 mark]*. The sperm would be used to artificially fertilise an egg cell *[1 mark]*. The embryo that develops could then be split many times to form clones *[1 mark]* before any of the cells become specialised *[1 mark]*. These cloned embryos could then be implanted into lots of female pigs, where they could develop into identical piglets *[1 mark]*.

3.2 An unfertilised pig egg cell would have its nucleus removed *[1 mark]*. An adult body cell would then be taken from the pig being cloned and its nucleus would be removed *[1 mark]*. The nucleus from the adult body cell would then be inserted into the empty egg cell *[1 mark]*. The egg cell would then be stimulated by an electric shock to make it divide like a normal embryo *[1 mark]*. When the embryo was a ball of cells, it would be implanted into the womb of an adult female pig, where it would develop into a genetically identical copy of the prize-winning pig *[1 mark]*.

Page 101 — Fossils

Warm-up

False, True, True

1.1 Because decay microbes can't survive in the sap or amber *[1 mark]* as there isn't any oxygen or moisture *[1 mark]*.

1.2 From gradual replacement of parts of an organism by minerals *[1 mark]*. From the preserved casts and impressions of things like burrows/footprints/rootlet traces in a soft material (like clay) *[1 mark]*.

1.3 Many early life-forms were soft bodied and decayed completely, without forming fossils *[1 mark]*. Fossils that did form may have been destroyed by geological activity *[1 mark]*. This means that the fossil record is incomplete *[1 mark]*.

Page 102 — Speciation

1.1 Natural selection *[1 mark]*

1.2 Charles Darwin published 'On the Origin of Species' in 1859 *[1 mark]*.

1.3 warning colouration *[1 mark]*

2 Environmental conditions for each population will be slightly different and so natural selection will act differently on each population *[1 mark]*. The genetic variation between individuals in each population will mean that some individuals are better adapted than others to their new environment *[1 mark]*. These individuals have a better chance of survival, so are more likely to breed successfully *[1 mark]*, passing on the alleles that control the beneficial characteristics *[1 mark]*. Eventually, individuals from the different populations will have changed so much that they won't be able to breed with each other to produce fertile offspring, so will have become separate species *[1 mark]*.

Page 103 — Antibiotic-Resistant Bacteria

1.1 E.g when they are prescribed for viral infections *[1 mark]* or non-serious conditions *[1 mark]*.

1.2 Because this ensures that all bacteria are destroyed *[1 mark]*, so there are none left to mutate *[1 mark]* and develop into antibiotic-resistant strains *[1 mark]*.

2.1 Because the rate of development of new antibiotics is slow *[1 mark]* and it is a costly process *[1 mark]*.

2.2 Bacteria develop random mutations in their DNA *[1 mark]*, some of which lead to the bacteria becoming less affected by antibiotics *[1 mark]*. These bacteria are better able to survive and reproduce in hosts undergoing antibiotic treatment *[1 mark]*, meaning that the gene becomes more common in the population, forming antibiotic-resistant strains *[1 mark]*. As there is no effective treatment for these strains, they can spread very easily between individuals *[1 mark]*.

Page 104 — Classification

1.1 E.g. current classification data *[1 mark]* and information from the fossil record *[1 mark]*.

1.2 B *[1 mark]*

1.3 G and H *[1 mark]*

2.1 kingdom, phylum, class, order, family, genus, species *[1 mark]*

2.2 (Carl) Woese *[1 mark]*

2.3 Archaea *[1 mark]*

2.4 plants *[1 mark]*, animals *[1 mark]*, protists *[1 mark]*

Topic 7 — Ecology

Page 105 — Competition

1.1 the soil *[1 mark]*

1.2 light *[1 mark]* and space *[1 mark]*

1.3 Any three from: space/territory / food / water / mates *[3 marks]*

2.1 interdependence *[1 mark]*

2.2 E.g. the number of blue tits might decrease *[1 mark]* because there would be no caterpillars for them to eat *[1 mark]*. The numbers of plants might increase *[1 mark]* because there would be no caterpillars to eat them *[1 mark]*.

2.3 A stable community is one where all the species and environmental factors are in balance *[1 mark]* so that the population sizes remain fairly constant *[1 mark]*.

Page 106 — Abiotic and Biotic Factors

1.1 Light intensity, temperature and carbon dioxide level are all examples of abiotic factors. *[1 mark]*

The other answers are incorrect because they mix up examples of biotic and abiotic factors. Remember, abiotic factors are non-living factors and biotic factors are living factors.

1.2 E.g. oxygen level *[1 mark]*

1.3 Any two from: e.g. moisture level / soil pH / soil mineral content / carbon dioxide level *[2 marks]*

2 E.g. because the grey and red squirrels were in competition *[1 mark]* for the same resources such as food and shelter *[1 mark]*. The grey squirrels out-competed the red squirrels *[1 mark]*.

3 The birds would not be feeding on the insects *[1 mark]*, so insects would breed and increase in numbers *[1 mark]*. More insects would eat more grass so the grass plant numbers might decrease *[1 mark]*.

Pages 107-108 — Adaptations

1.1 extremophiles *[1 mark]*

1.2 bacteria *[1 mark]*

1.3 high pressure *[1 mark]*

2.1 Long eyelashes stop sand getting into the eyes *[1 mark]*. Large feet stop the camel sinking into the sand / make it easier for the camel to walk in sand *[1 mark]*.

2.2 It reduces water loss *[1 mark]*.

2.3 A swollen stem stores water *[1 mark]*.

2.4 Shallow, wide-spreading roots allow water to be absorbed over a larger area *[1 mark]* while long, deep roots allow the plant to absorb water from deep below the surface *[1 mark]*.

3.1 E.g. they would seek shade *[1 mark]*.

3.2 dark coloured skin *[1 mark]*

3.3 functional adaptation *[1 mark]*

Page 109 — Food Chains

Warm-up

producer — seaweed, secondary consumer — shark

1.1 primary consumer *[1 mark]*

1.2 They produce glucose *[1 mark]* by carrying out photosynthesis *[1 mark]*. They then use this glucose to make biological molecules that make up the plant's biomass *[1 mark]*.

2.1 The number of lynx increases *[1 mark]* because the number of snowshoe hares is increasing and so they have lots of food *[1 mark]*.

2.2 An increase in the number of lynx, which mean more hares are eaten *[1 mark]*.

Page 110 — Using Quadrats

1.1 It avoids the data being biased *[1 mark]*.

1.2 13 buttercups *[1 mark]*

1.3 15.5 buttercups *[1 mark]*

1.4 $(15 + 13 + 16 + 23 + 26 + 23 + 13 + 12 + 16 + 13) \div 10 =$
$170 \div 10 =$ **17 buttercups per 0.5 m²** *[1 mark]*

1.5 Mean number of buttercups per $m^2 = 17 \times 2 = 34$
Estimated population size = mean number of buttercups per $m^2 \times$ total area of the field in m^2
Estimated population size $= 34 \times 1750$
= 59 500 buttercups *[3 marks for correct answer, otherwise 1 mark for '34 buttercups per m^2' and 1 mark for '34×1750'.]*

Page 111 — Using Transects

1.1 Zones B and C. *[1 mark]*

1.2 long grass *[1 mark]*

1.3 Zone A is closest to the pond where the soil has more moisture *[1 mark]*. Zone A also has a higher light intensity *[1 mark]*.

1.4 Zone B *[1 mark]* because only short grass grows in zone B *[1 mark]*.

1.5 The light levels may be too low. / The moisture level may be too low. *[1 mark]*

1.6 Record the number of times each of the four species touch the transect line. / Count the number of species/measure the percentage cover of each species using a quadrat placed along the transect. *[1 mark]*

Page 112 — Environmental Change & The Water Cycle

Warm-up

evaporate, water vapour, cools, precipitation

1.1 one *[1 mark]*

1.2 The further away from the road the greater the number of lichen species *[1 mark]*, because the concentration of sulfur dioxide from cars gets lower further from the road *[1 mark]*.

1.3 25 m *[1 mark]*

Page 113 — The Carbon Cycle

1.1 photosynthesis *[1 mark]*

1.2 (green) plants *[1 mark]*

1.3 burning *[1 mark]*

1.4 Any one from: e.g. leather / wool. *[1 mark]*

1.5 Carbon dioxide is returned back to the atmosphere *[1 mark]* when the microorganisms involved in decay respire *[1 mark]*.

Page 114 — Decay

Warm-up

Grass cuttings and food peelings.

1.1 methane *[1 mark]*

1.2 Biogas is produced by anaerobic decay. *[1 mark]*

1.3 To keep the temperature in the generator steady / to protect the generator from extremes of temperature *[1 mark]*.

1.4 As a fertiliser / to add nutrients to the soil *[1 mark]*.

1.5 It should be warm / not too hot or too cold *[1 mark]*.
There should be water/moisture available *[1 mark]*.
There should be lots of oxygen available *[1 mark]*.

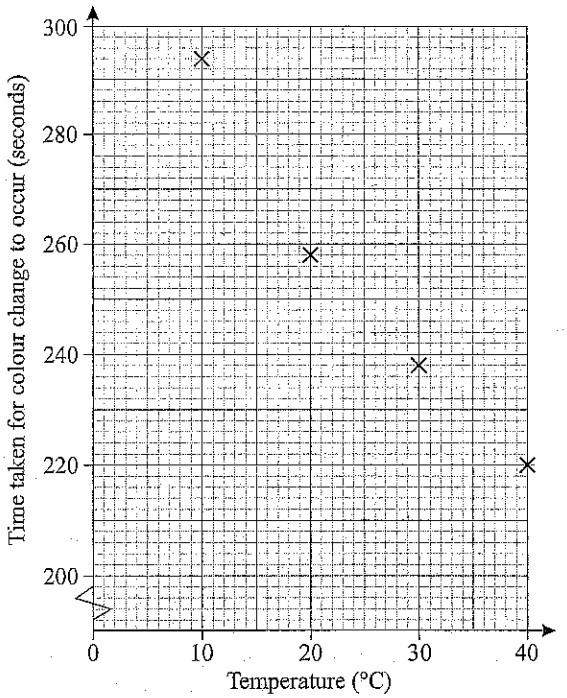
Page 115 — Investigating Decay

1.1 From pink to colourless.

Phenolphthalein itself changes from pink to colourless, but because the rest of the contents of the tube are white, the colour of the mixture in the tube goes from pink to white.

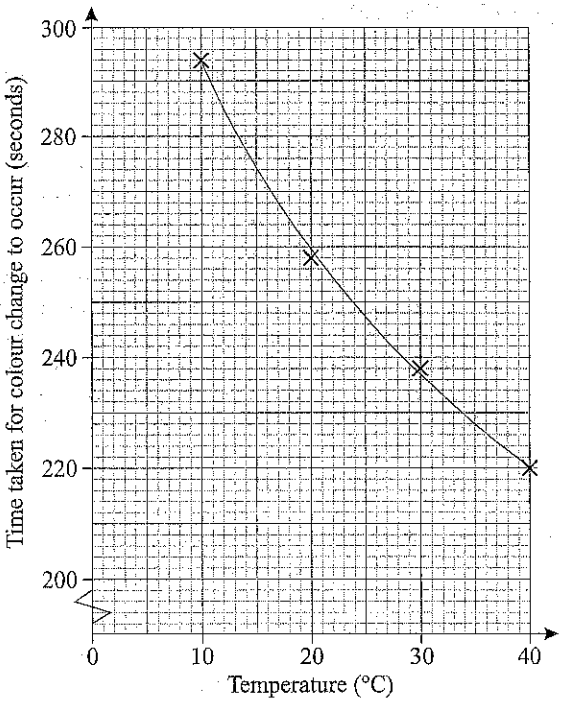
1.2 $\text{mean} = \dfrac{(217 + 224 + 219)}{3}$
= 220 seconds *[1 mark]*

1.3



[2 marks for all four points plotted correctly, otherwise 1 mark for 2 points plotted correctly.]

1.4



[1 mark for a smooth curve of best fit that passes through or as near to as many points as possible.]

1.5 228 seconds *[1 mark]*

Your curve of best fit may differ slightly so accept any answer between 226 and 230 seconds as long as the curve of best fit has been read from correctly.

Page 116 — Biodiversity and Waste Management

1.1 The variety of different species of organisms on Earth, or within an ecosystem. *[1 mark]*

1.2 E.g. deforestation / waste production *[1 mark]*

2.1 The human population is growing *[1 mark]* and the standard of living is increasing *[1 mark]*.

2.2 Any two from: e.g. sewage / fertilisers / pesticides / herbicides *[2 marks]*

2.3 E.g. smoke *[1 mark]* and acidic gases *[1 mark]*.

3.1 It reduces the variety of plants on the land (by killing the weeds) *[1 mark]* and it may kill plants and animals if it is washed into nearby water / it pollutes nearby water *[1 mark]*.

3.2 Because all the different species in the ecosystem depend on each other (e.g. for shelter and food) *[1 mark]*. Different species can also help to maintain the right physical environment for each other *[1 mark]*.

Page 117 — Global Warming

Warm-up
the Sun, space, gases, increases

1.1 carbon dioxide and methane *[1 mark]*

1.2 Higher temperatures could cause seawater to expand / ice to melt *[1 mark]*, which could cause the sea level to rise above low-lying land *[1 mark]*.

1.3 Any two from: e.g. changes in the distribution of species where temperature/rainfall has changed. / Changes to the migration pattern of some animals. / Reduction in biodiversity as some species become extinct.
[2 marks — 1 mark for each correct answer.]

Page 118 — Deforestation and Land Use

1 Any two from: e.g. building / farming / quarrying / dumping waste *[2 marks — 1 mark for each correct answer]*.

2.1 E.g. to use the land as farmland. / To use the peat as compost. *[1 mark]*

2.2 Carbon dioxide is released *[1 mark]*, which contributes to global warming *[1 mark]*.

2.3 It reduces biodiversity *[1 mark]* because it destroys habitats / reduces the area of habitats *[1 mark]*.

3.1 To clear land to grow the crops needed to produce biofuels *[1 mark]*.

3.2 E.g. to provide land for cattle (to raise for food) *[1 mark]*. To provide land to grow crops, e.g. rice (to provide more food) *[1 mark]*.

4 Any two from: e.g. it increases the amount of carbon dioxide in the atmosphere *[1 mark]* because carbon dioxide is released by burning wood and the decomposing of wood by microorganisms *[1 mark]*. / It reduces the rate at which carbon dioxide is removed from the atmosphere *[1 mark]* because there are fewer trees taking it up for photosynthesis *[1 mark]*. / It leads to a reduction in biodiversity in the area *[1 mark]* because trees/habitats are destroyed *[1 mark]*.

Page 119 — Maintaining Ecosystems and Biodiversity

1.1 Burning fewer fossil fuels. *[1 mark]*

1.2 E.g. this could reduce the amount of land taken over for landfill *[1 mark]*, leaving ecosystems in place *[1 mark]*.

2.1 It decreases biodiversity *[1 mark]*, because the habitat wouldn't be able to support a wide range of organisms *[1 mark]*.

2.2 The strips of grassland and hedgerows increase the biodiversity by providing more habitats / food sources *[1 mark]*.

3 E.g. it costs money to protect biodiversity (and make sure that the programmes are being followed) and some people may feel that the money should be spent on other things *[1 mark]*. Protecting biodiversity may have a negative impact on local people's livelihood (e.g. if they're employed in tree-felling), which could affect the local economy *[1 mark]*. Some people (e.g. farmers) may want to kill organisms that are regarded as pests to protect crops and livestock *[1 mark]*. Some people may want to use land for new housing or agricultural land *[1 mark]*.

Page 120 — Trophic Levels

Warm-up

Producer	Herbivore	Carnivore
plankton algae	barnacle limpet winkle	dog whelk crab gull

1.1 herbivores *[1 mark]*

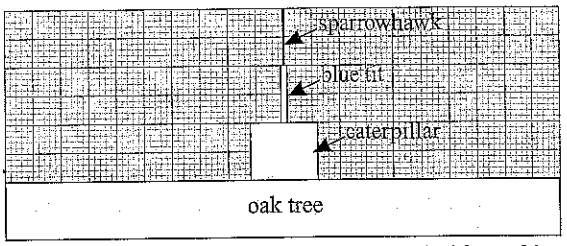
1.2 level 4 *[1 mark]*

1.3 A carnivore that has no predators *[1 mark]*.

2 Decomposers break down/recycle any dead plant or animal material in the environment *[1 mark]*. They do this by secreting enzymes *[1 mark]* which break down the dead material into small soluble molecules *[1 mark]*. They take up these molecules by diffusion *[1 mark]*.

Page 121 — Pyramids of Biomass

1.1



[1 mark for pyramid of biomass constructed with trophic level 1 at the bottom of the pyramid. 2 marks for all four trophic levels plotted correctly to scale, otherwise 1 mark for three trophic levels plotted correctly to scale. 1 mark for correctly labelled bars (and axis if one is used).]

1.2 The biomass decreases as the trophic level increases *[1 mark]*, so there's not enough energy/biomass to support more trophic levels *[1 mark]*.

Page 122 — Biomass Transfer

1.1 It will be egested as faeces *[1 mark]*.

1.2 E.g. urea *[1 mark]*, water *[1 mark]*

2.1 Glucose *[1 mark]* is used in respiration to provide energy, rather than to make biomass *[1 mark]*. Also, respiration produces carbon dioxide and water as waste products *[1 mark]* which are lost from the body and therefore not passed on as biomass *[1 mark]*.

2.2 $(0.60 \div 6.40) \times 100 = 0.09375 \times 100 = 9.375$
$= \mathbf{9.38\%}$ **(3 s.f.)** ***[2 marks for correct answer, otherwise 1 mark for correct working.]***

2.3 $(11.6 + 9.38 + 10.0) \div 3$ *[1 mark]* $= \mathbf{10.3}$ **(3 s.f.)** *[1 mark]*

If you get the wrong answer for the first part of a calculation question and then have to use that value in a following question part (like you do above) it's unlikely that you'll lose marks for getting the wrong answer for the second part due to using the wrong value (as long as all your working is correct). So it's worth giving all parts of the question a go, even if you're not sure whether your answer to the first part is correct... and make sure you always write down your working.

Pages 123-124 — Food Security and Farming

1.1 Decreasing birth rate. *[1 mark]*

1.2 E.g. reduction of rainfall *[1 mark]*

2.1 To prevent species from disappearing *[1 mark]*.

2.2 E.g. there are limits on how small the mesh sizes of nets can be *[1 mark]* and fishing quotas have been introduced *[1 mark]*.

3.1 It reduces the transfer of energy from the fish to the environment *[1 mark]*, meaning that more energy is available for growth *[1 mark]*.

3.2 Carnivorous fish are a higher trophic level than plant-eating fish *[1 mark]*, so more biomass/energy will have been lost from the food chain by that level (because there are more trophic levels) *[1 mark]*.

3.3 E.g. disease is spread more easily between closely-packed animals *[1 mark]*.

4.1 Chicken *[1 mark]* because it requires the least amount of feed to produce 1 kg of meat *[1 mark]*.

4.2 chicken : cattle = 2.1 : 10.5. $2.1 \div 2.1 = 1$. $10.5 \div 2.1 = 5$
So the ratio in its simplest form is **1 : 5** *[1 mark]*.

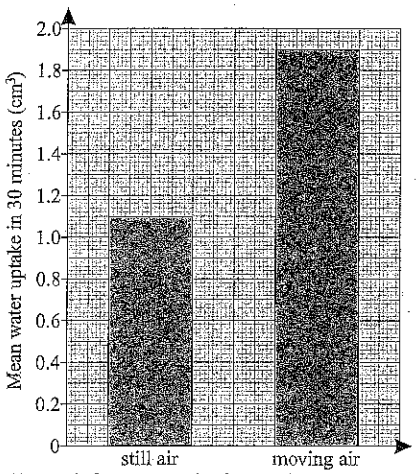
4.3 It could decrease/weaken global food security *[1 mark]* because more crops are needed to produce more meat to meet the increasing demand *[1 mark]*, so there are fewer crops / less land for crops available to produce food for the global population *[1 mark]*.

Page 125 — Biotechnology

1.1 E.g. producing human insulin *[1 mark]*
1.2 E.g. they could provide more food *[1 mark]* and they could provide food with an improved nutritional value (such as Golden Rice) *[1 mark]*.
2.1 *Fusarium* *[1 mark]*
2.2 aerobic *[1 mark]*
2.3 glucose *[1 mark]*
2.4 purification of the product *[1 mark]*

Mixed Questions

1.1 E.g. producing bile / converting lactic acid to glucose / storing glucose as glycogen / breaking down amino acids *[1 mark]*
1.2 Enzymes speed up chemical reactions in living organisms. *[1 mark]*
1.3 pH 9 *[1 mark]*
1.4 The enzyme will not work *[1 mark]* because the acid will change the shape of its active site/denature the enzyme *[1 mark]* and the substrate will no longer fit *[1 mark]*.
1.5 Alcohol is a risk factor for lung cancer. *[1 mark]*
2.1 To stop the loss of water by evaporation *[1 mark]*.
2.2



[1 mark for correctly drawn bars, one mark for correctly labelled axes.]

2.3 The greater the air flow around the plant, the greater the transpiration rate *[1 mark]*.
2.4 E.g. increasing air flow carries more water vapour away from the plant / reduces the concentration of water vapour outside the leaves *[1 mark]*. This increases the rate of diffusion of water from the leaf cells from an area of higher water concentration to an area of lower water concentration *[1 mark]*.
2.5 $1.2 - 0.8 = \mathbf{0.4\ cm^3}$ *[1 mark]*
The range is the difference between the highest and lowest values.
2.6 30 minutes ÷ 60 = 0.5 hours
$1.9 \div 0.5 = \mathbf{3.8\ cm^3/hour}$ *[2 marks for correct answer, otherwise 1 mark for correct working.]*

3.1 mitochondria *[1 mark]*
3.2 glucose + oxygen → carbon dioxide + water *[1 mark for both reactants correct, 1 mark for both products correct.]*
3.3 Glucose is combined with nitrate ions *[1 mark]* to make amino acids *[1 mark]*, which are then joined together to make proteins *[1 mark]*.
4.1 The hormone is secreted directly into the blood *[1 mark]*. It is then carried in the blood to the target organ *[1 mark]*.
4.2 C *[1 mark]*
4.3 B *[1 mark]*
4.4 It stimulates ovulation / the release of an egg from an ovary *[1 mark]*.
4.5 ovaries *[1 mark]*
4.6 A constantly high level of oestrogen inhibits the production of FSH *[1 mark]*, so there are no mature eggs for fertilisation to take place *[1 mark]*.
5.1 oxygen *[1 mark]*
5.2 light intensity *[1 mark]*
5.3 Tube 1 *[1 mark]*
5.4 Tube 1 shows that in the dark, the algae are producing more carbon dioxide than they take in *[1 mark]*. The concentration of carbon dioxide is high because the cells are respiring, but not photosynthesising (as there's no light for photosynthesis to take place) *[1 mark]*. Tube 2 shows that in the light, the algae are taking up more carbon dioxide than they produce *[1 mark]*. The concentration of carbon dioxide has reduced because the cells are photosynthesising faster than they are respiring *[1 mark]*.
5.5 Any two from: e.g. the temperature of the boiling tubes / the volume of hydrogencarbonate indicator / the concentration of hydrogencarbonate indicator / the number of beads in each tube / the concentration of algal cells in each bead *[2 marks]*.
5.6 Light intensity *[1 mark]* because the rate of photosynthesis is increasing as the light intensity increases *[1 mark]*.
5.7 carbon dioxide concentration *[1 mark]*
6.1 RR *[1 mark]*
6.2 round seed shape *[1 mark]*
6.3

	R	R
r	Rr	Rr
r	Rr	Rr

[1 mark]
The parents' genotypes were **RR** *[1 mark]* and **rr** *[1 mark]*.
7.1 E.g. using mosquito nets (to prevent biting) *[1 mark]*.
7.2 mitosis *[1 mark]*
7.3 There are fewer red blood cells to carry oxygen to all the cells in the body *[1 mark]*. This means that the cells aren't receiving enough oxygen for respiration/transferring energy from glucose *[1 mark]*.
7.4 E.g. a flushing agent is used to help the blood sample flow from one end of the stick to the other through the paper strip *[1 mark]*.
7.5 Antibodies complementary to the malaria antigen are stuck to the strip at point B *[1 mark]*. Malaria antigens bound to the dye-labelled antibodies have flowed along the strip from point A to point B *[1 mark]* where they have bound to antibodies that are stuck to the strip *[1 mark]*. Because the antibodies containing dye have bound at point B they are visible there as a coloured line *[1 mark]*.

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