Answers to the Student Book

* Supplement questions are indicated with an asterisk.

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These answers (excluding the past paper answers) were originally written by DG Mackean and were first published at www.biology-resources.com

1 Characteristics and classification of living organisms

Test yourself questions

Page 3

1
- N – nutrition
- S – sensitivity
- M – movement

2 It is an internationally agreed system of naming an organism:
- using two parts: genus and species
- any suitable example, e.g. *Copsychus fulicatus* is the Indian robin.

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3 X = slug
Y = earwig

4 Example of an alternative key:

1 Has it got graduations (measurements)?
- Yes – *go to 2*
- No – *go to 4*

2 Has it got sloping sides?
- Yes – **conical flask**
- No – *go to 3*

3 Has it got a broad base?
- Yes – **beaker**
- No – **measuring cylinder**

4 Has it got a rounded body?
- Yes – **round-bottomed flask**
- No – **boiling tube**

Page 8

*** 5 a** a string of genes

b DNA

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c amino acids

d **i)** Each species has a unique sequence of bases in its DNA.

ii) When species are very similar morphologically and anatomically.

e Chimps and humans have only 1.2% difference in their genome, while gorillas and humans are 1.6% different.

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6 invertebrate, exoskeleton, jointed limbs

7
- **insects** (2 from) 3 pairs of legs; wings; body divided into head, thorax and abdomen
- **arachnids** (2 from) 4 pairs of legs; several pairs of simple eyes; poison fangs (pedipalps)
- **crustaceans** (2 from) 5 or more pairs of limbs/legs; 2 pairs of antennae; body divided into cephalothorax/combined head and thorax, and abdomen; body often calcified/hard
- **myriapods** (2 from) 10 or more pairs of legs; body not divided into thorax and abdomen; simple eyes

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8 Example of a mnemonic for vertebrates:

For **B**reakfast **A**dd **M**ore **R**ice

9 **a** fish, amphibia, reptiles

b fish, reptiles, birds (on legs)

c fish, amphibia

d fish

10 At low temperatures the chemical reactions in cells slow down and this affects the whole animal, particularly movement.

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***11** Although both plants are in the same genus (*Lamium*), they are different species (*L. album* and *L. purpureum*) so you would not expect them to cross-pollinate successfully.

***12** Bracken reproduces vegetatively by means of underground stems (rhizomes), which are too deep in the soil to be affected by fire.

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***13** 1 Are chloroplasts present?

Yes – *go to 2*

No – *go to 3*

2 Does the organism have a single flagellum?

Yes – **Euglena**

No – **Chlamydomonas**

3 Is the body covered by cilia?

Yes – **Paramecium**

No – *go to 4*

4 Is the body attached to a long stalk?

Yes – **Vorticella**

No – **Amoeba**

***14**
- beetle: animal, arthropod, insect
- sparrow: animal, vertebrate, bird
- weasel: animal, vertebrate, mammal (carnivore)
- gorilla: animal, vertebrate, mammal (primate)
- bracken: plant, fern
- buttercup: plant, flowering plant, dicot

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***15 a** *Many cells*: plants, animals, fungi

b *Nuclei*: Protoctista, fungi, plants, animals

c *Cell walls*: plants, fungi, bacteria

d *Hyphae*: fungi

e *Chloroplasts*: plants, some Protoctista

Exam-style questions

Page 23

1 Any three from:

- movement, respiration, reproduction, growth. [3]

2 a A group of organisms that can reproduce to produce fertile offspring. [2]

b The binomial system of naming species is an internationally agreed system in which the scientific name of an organism is made up of two parts, showing the genus (in this case *Panthera*) and the species (*tigris*). [3]

3 a They are invertebrates, have exoskeleton/cuticle, bodies are segmented. [3]

b Any three differences from:

feature	**insects**	**myriapods**
number of pairs of legs	3	10 or more
wings	present (usually 2 pairs)	absent
eyes	compound	simple
body structure	divided into head, thorax and abdomen	not obviously divided into head, thorax and abdomen

[3]

***4 a** (Fungus) Any three from:

- made of hyphae; nuclei throughout cytoplasm of hyphae; cytoplasm can contain glycogen; no chloroplasts. [3]

b (Bacterium) Any three from:

- cell wall not made of cellulose; cytoplasm can contain glycogen; contains single DNA strand/chromosome; contains plasmids. [3]

*** 5** One possible way of making a key to divide vertebrates into classes:

1 Is the animal warm blooded?

Yes – *go to 2*

No – *go to 3*

2 Has the animal got feathers?

Yes – **bird**

No – **mammal**

3 Does the animal have scales?

Yes – *go to 4*

No – **amphibian**

4 Does the animal have gills?

Yes – **fish**

No – **reptile** [7]

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*** 6 a** **i)** plants [1]

ii) 1.2% [1]

iii) Any two reasons from:

- they do not have chloroplasts/cannot photosynthesise
- they are usually made of hyphae, rather than cells. [2]

b 64.4% of species are arthropods

4.5% are arachnids

(4.5/64.4) × 100 = 7.0% [2]

c **i)** amphibia, mammals, reptiles [3]

ii) gills [1]

d Insects represent 56.3% of all known species:

1.9 million × (56.3/100) = 1.07 million species of insects. [2]

*** 7 a** **i)** Any two comparisons from:

- monocots have long, narrow leaves, but dicots have broad leaves
- monocots have parallel veins, but dicots have branching veins
- monocots have one cotyledon, but dicots have two cotyledons
- monocots have flower parts in threes, but dicots have flower parts in fives. [4]

ii) Any two comparisons from:

- amphibians have moist skin, but reptiles have dry skin/scaly skin
- amphibians lay jelly-covered eggs/eggs in water, but reptiles lay eggs with dry/rubbery shells/eggs on land. [4]

b The scientific name is made of two parts: genus and species. [2]

One named example, e.g. *Panthera leo*, is the binomial name for the lion. [1]

2 Organisation of the organism

Test yourself questions

Page 29

1 **a** nucleus, cytoplasm, cell membrane

b cell wall, permanent vacuole, chloroplasts

2 cell membrane

3 The cell wall is freely permeable and is made of non-living cellulose; the cell membrane is partially permeable and is formed from living cytoplasm (or made of protein and fat).

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4 Bacterial cell – cell wall not made of cellulose; cytoplasm can contain glycogen; contains single DNA strand/chromosome; contains plasmids.

Plant cell – cell wall made of cellulose; cytoplasm can contain starch grains; contains nucleus; contains permanent vacuole.

5 Plant cell walls are made of cellulose, those of bacteria are not.

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6 The drawing should be at least a third of a page in size; all labels should be correct; label lines should be drawn with a ruler; each label line should all touch the cell part; drawing should be made with a sharp pencil; no sketchy lines.

7 *No answer needed.*

8 Example:

magnification of the eyepiece lens	×10
magnification of the objective lens	×40
total magnification provided by the microscope	×400

9 estimation of increase in size of the drawing = ×5

total magnification = 10 × 40 × 5 = ×2000

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10 The red blood cell has no nucleus.

11 The section must have been taken above the nucleus.

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12 **a** Tissues: xylem, phloem, cortex, root cap.

Organ: root.

b Tissues: lung tissue, liver tissue or pancreas tissue.

Organ: any named digestive organ, or tongue or diaphragm.

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13 **a** **C** ×100

b The widest part of the largest cell is 15 mm. This is 700 times larger than the real cell, so the cell would measure 15 mm ÷ 700 = 0.02 mm.

14 You can count the nuclei.

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***15** 0.05 × 1 000 = 50 µm

***16** 750 ÷ 10 000 = 0.075 cm

Practical Work

Page 32

1 You should be able to identify the cell wall and nucleus. It is difficult to distinguish between the sap vacuole and cytoplasm (but the nucleus is embedded in the cytoplasm). You could interpret the position of the cell membrane because it lies on the inside of the cell wall.

2 **a** The vacuole is full of fluid (sap), which is pushing the cytoplasm containing the

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chloroplasts against the cell wall of the cell.

b The chloroplasts contain the pigment chlorophyll, which is green.

3 Cells tend to be transparent and colourless, although some plant cells contain chloroplasts (which are green) and sometimes the cell sap is coloured (e.g. rhubarb). The stain makes cell structures such as the nucleus visible.

4 Plant upper epidermal leaf cells have a cell wall and a vacuole, which are not present in human skin epidermal cells.

Worked example

Page 38

1 The image is 4.5 cm long. Convert this to mm: 4.5 × 10 = 4.5

Its actual length is 1.5 mm

Magnification = image size ÷ actual size of the specimen = 45 mm ÷ 1.5 mm = ×30

2 Magnification = image size ÷ actual size of the specimen

So, actual size of the specimen = image size ÷ magnification

Change cm to mm: 2.5 × 10 = 25

25 mm ÷ 500 = 0.05 mm

***3** Convert the diameter of the drawing from mm to μm. There are 1000 μm in 1 mm.

14 × 1 000 = 14 000

14 000 μm ÷ 7 μm = ×2000

Exam-style questions

Page 40

1 **a** One mark for each correct definition [3]

b One mark for each plant example correct, one mark for each animal example correct. [6]

name of structure	**definition**	**example in a plant**	**example in an animal**
tissue	a group of cells with similar structures, working together to perform a shared function	epidermis, xylem	bone, muscle
organ	a structure made up of a group of tissues, working together to perform a specific function	leaf, stem	stomach, eye
organ system	a group of organs with related functions, working together to perform a body function	shoot, root, flower	circulatory, nervous

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2 **a** One mark for each correct row. [5]

part of cell	present in palisade cell	present in liver cell
nucleus	✓	✓
cell wall	✓	×
chloroplast	✓	×
cytoplasm	✓	✓
membrane	✓	✓
(sap) vacuole	✓	×

b One mark for each correct function. [3]

Any three from:

- nucleus – controls cell development/controls cell division/controls cell activities
- cell wall – prevents plant cell from bursting
- chloroplast – traps light energy for photosynthesis
- cytoplasm – contains cell organelles/site of chemical reactions
- membrane – controls what enters and leaves the cell/prevents cell contents from escaping
- (sap) vacuole – contains salts and sugars/keeps plant cell firm.

3 **a** One mark for each correct label identified with a label line touching the part. [4]

Any four labels from: cytoplasm, glycogen granule, cell wall, chromosome/strand of DNA, flagellum/flagella.

b One mark for correct working (even if answer is incorrect). [1]

One mark for correct answer, with units. [1]

Scale line on drawing is 22 mm long

Magnification = 22 mm ÷ 0.001mm = ×22 000

4 **a** One mark for drawing of plant cell with clean lines and reasonable size (at least 4 cm wide) [1]

Four marks for correctly labelled parts, with label lines touching the structures [4]

Any plant cell drawn, plus four labelled parts from: cell wall, cell membrane, cytoplasm, (sap) vacuole, chloroplast, nucleus.

b Correct function stated, e.g. palisade cell – photosynthesis. [1]

5 **a** A – nucleus, B – membrane, C – cytoplasm [3]

b mitochondrion [1]

c to fertilise an egg [1]

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6 **a**

	plant	**animal**
letters	A, D	B, C

[1]

b cell wall, (sap) vacuole [2]

c A – photosynthesis

B – transmitting nerve impulses

C – transport of oxygen

D – absorption of water/mineral salts [4]

***7** **a** One mark for correct working (even if answer is incorrect). [1]

One mark for correct answer, with ×. [2]

30 mm = 30 × 1000 = 30 000 µm

30 000 µm ÷ 60 µm = ×500

b 10 × 40 = 400 [1]

3 Movement into and out of cells

Test yourself questions

Page 47

1 The cells on the left are in a region of high oxygen concentration and, at the start, there is little or no oxygen in the red cells. The concentration gradient favours the passage of oxygen into the cells. The cells on the right are in a region of a lower oxygen concentration than that which exists in the red cells, so the concentration gradient favours the diffusion of oxygen out of the cells.

2 **a** Air that is freshly breathed in contains more oxygen than the red cells in the capillary. Oxygen will consequently diffuse into the cells. Red cells returning to the lungs contain higher concentrations of carbon dioxide than the air in the alveolus, so carbon dioxide diffuses out.

b If the blood flow increases, the exchange of oxygen and carbon dioxide would also increase.

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***3** As the plants take in water from the soil there is a build-up of mineral ions in the soil. The water potential of the mineral ions becomes lower than the water potential in the plant root cells. The cells lose water by osmosis, the cells become plasmolysed, and so the plant wilts and dies.

***4** When a plant cell is immersed in water it becomes turgid, but the cell wall stops it bursting. When an animal cell is immersed in water it becomes turgid, but there is no cell wall so it will burst.

***5** Plants root cells are living, they respire aerobically and so need oxygen. There are no air spaces in the soil to obtain oxygen, so the cells cannot get energy for cell functions.

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***6** **a** Carrier proteins may be damaged or denatured, or enzymes responsible for controlling respiration may be damaged or denatured.

b The poison stops respiration so no energy is available for active transport.

***7** **a** ribosomes

b mitochondria

c nucleus

d cytoplasm

Practical work

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1

Length of side (cm)	**Surface area (cm^2)**	**Volume (cm^3)**	**Depth dye has diffused (cm)**
3.0	3.0 × 3.0 × 6 = 36	3.0 × 3.0 × 3.0 = 9.0	(values from students' own observations)
2.0	2.0 × 2.0 × 6 = 24	2.0 × 2.0 × 2.0 = 8.0	
1.0	1.0 × 1.0 × 6 = 6	1.0 × 1.0 × 1.0 = 1.0	
0.5	0.5 × 0.5 × 6 = 1.5	0.5 × 0.5 × 0.5 = 0.125	

2 Only the 'animals' where the dye penetrated to the centre of the jelly would get enough oxygen to stay alive, because otherwise cells in the centre would not receive oxygen and they would die.

3 Flatworms have this body shape. They have a large surface area and get their oxygen by diffusion over their surface.

4 The dye spread out in both beakers. However, the dye spread out more quickly in the hot water. This is because the particles of dye gained more kinetic energy from the hot water so moved faster.

5 Water will diffuse from the 5% solution into the 10% solution because water moves from a weak solution to a stronger solution.

6 The cell membrane in a living cell controls the movement of substances (in this case a red pigment) into or out of the cell. Boiling kills the cell by denaturing its enzymes, and the cell membrane loses its ability to control the loss of pigment.

7 The concentrated ammonia solution travelled faster. This is because there is a greater concentration gradient.

8 The rate of diffusion slowed down. This is because the concentration gradient decreased.

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9 **a** If a stronger (more concentrated) solution was placed into the cellulose tube you would expect the rate of osmosis to increase. This would speed up the rise of liquid in the capillary tube.

b As long as the solution in the beaker is weaker (less concentrated) than the solution in the cellulose tube, osmosis will still happen and the water column will rise, but more slowly.

c If the sugar solution were in the beaker, water would leave the cellulose tube and the water column would go down.

10 When the pressure of the water column equals the osmotic pressure in the cellulose tube, the flow will stop. (Osmotic pressure is the difference between the water potentials of the sugar solution in the cellulose tube and the water surrounding it.)

11 The iodine got into the dialysis tubing by diffusion, from a higher concentration of iodine outside the tubing to a lower concentration inside.

12 The iodine in the test tube would turn blue as soon as the dialysis tubing was placed in it.

13 Water moved into the cells of the potato cylinder by osmosis, from a higher concentration of water outside the cylinder to a lower concentration in the cylinder. This made the cells swell up and increase in length, so the whole cylinder got longer.

14 Two safety precautions from:

- do not hold the potato in your hand when pushing the borer through it
- handle glassware with care/when not using the test tubes, keep them in a rack so they cannot roll off the bench and break
- wipe up or mop up any spillages on the floor to avoid anyone slipping.

15 [Answer to question based on the data in the table]

In pure water, the potato cylinder has gained 3.3% mass. This because water surrounding the potato cylinder has a higher water potential than the liquid inside the potato cells, so water moves into the potato cells by osmosis.

As the concentration of sucrose increases, the percentage increase in mass reduces.

There is no change in mass at a sucrose concentration of 0.18 mol dm^{-3}. This suggests that the solution inside the cell is an equivalent concentration because there is no net movement of water by osmosis.

As the sucrose concentration is increased above 0.18 mol dm^{-3}, the potato cylinder starts to lose mass. This is because the concentration of sucrose outside the cylinder is higher than the concentration of liquid inside the cells of the cylinder. Water passes out of the potato cells by osmosis.

Above 0.4 mol dm^{-3}, the graph is not as steep. Increasing the concentration of sucrose solution has less effect on osmosis from the cells of the cylinder, but they do continue to lose mass as a result of water moving out of them by osmosis.

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***16** **a** **i)** cell membrane

ii) vacuole

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b When the cells in a plant stem are turgid, the plant stays upright/does not wilt.

***17 a** The cell loses water. This happens when the water potential outside the cell is lower than the water potential of the cell sap. The water moves out of the cells by osmosis. The vacuole now contains less sap so it shrinks, pulling the cytoplasm away from the cell wall.

b The cell needs to be placed in pure water or a solution with a higher water potential than the cell sap. Water will then return to the vacuole by osmosis.

***18** The sucrose concentration will be equivalent to concentration of the cell sap where the line of the graph passes through the *x*-axis (horizontal).

***19** No, because the cell membranes would have been destroyed/damaged so they would not be able to control the entry or exit of solutes.

Worked example

Page 43

1 Distance X to Y = 340 mm (± 5 mm)

2 Distance V to W = 55 mm (± 2 mm)

3 (340 ÷ 55) × 100 = 618% increase.

Exam-style questions

Page 61

1 a, b [9]

name of process	**definition**	**example of a substance moved by the process in the plant**
diffusion	the net movement of particles from a region of their higher concentration to a region of their lower concentration, as a result of their random movement	e.g. carbon dioxide entering the leaf
osmosis	the net movement of water molecules from a region of higher water potential to a region of lower water potential through a partially permeable membrane	e.g. water being absorbed by root hairs
active transport	the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration using energy from respiration	e.g. mineral ions being absorbed by root hairs

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2 The build-up of sugar in the plant cell will lower its water potential, so it will absorb water by osmosis from its neighbours. This may harm the cell. Starch in the plastids is insoluble and so does not affect the cell's water potential. [3]

***3** If animal cells were placed in water, they would take up water by osmosis until they burst. The concentration of Ringer's solution is the same as the cell's cytoplasm so there is no net osmosis. If they were not in a liquid they would dry out. [2]

***4** The molecules (or ions) of the dissolved substance attract water molecules, leaving fewer 'free' water molecules in the solution. [2]

***5** **a** **i)** The cell wall would no longer swell outwards. [1]

ii) The cytoplasm would shrink and no longer touch the cell wall. [1]

iii) The sap vacuole would shrink. [1]

b There is a higher water potential inside the cell, so water moves out of the cell by osmosis to the lower water potential outside. As a result, the sap vacuole shrinks and the cytoplasm pulls away from the cell wall. [2]

c **i)** Diffusion moves substances down the concentration gradient, but active transport moves substances up the concentration gradient.

Diffusion does not need energy, but active transport uses energy. [2]

ii) Diffusion – e.g. movement of oxygen into red blood cells

Active transport – e.g. movement of glucose from the intestine into the blood stream. [2]

***6** **a** **i)** The potato would bend downwards/would feel soft, because it has lost water from a high water potential inside the cells to a lower water potential outside the cells. [3]

ii) The potato would bend downwards/would feel soft, because it has lost water from a high water potential inside the cells to a lower water potential outside the cells. [3]

b osmosis [1]

c Mineral ions are taken in against their concentration gradient by active transport, which needs energy.

Water is taken into the cells down the concentration gradient for water, which does not use energy. [2]

***7** **a** root hair cells [1]

b **i)** The absorption of phosphate ions increases steadily with time, and it is much higher than in nitrogen, reaching 10 arbitrary units in 26 hours. [2]

ii) The absorption of phosphate ions increases with time, but very slowly and it is much lower than in oxygen, reaching 1 arbitrary unit in 26 hours. [2]

c Active transport. The rate of absorption is higher in air, which contains oxygen. Oxygen is used in (aerobic) respiration to release the energy that is necessary for active transport. [3]

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4 Biological molecules

Test yourself questions

Page 66

1 **a** protein

b fat

c carbohydrates

d fat

2 protein

3 A polysaccharide has only one type of sub-unit (e.g. glucose) but a protein can contain up to 20 different amino acids, in different orders along the molecule.

4 **a** Both contain the elements carbon, hydrogen and oxygen.

b A fat molecule is made up of two types of sub-unit (a fatty acid and glycerol), while a carbohydrate molecule contains only one type of sub-unit (e.g. glucose).

c Proteins are long chains made up of up to 20 different sub-units (amino acids) which can be arranged in a large variety of sequences.

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***5** **A**

***6** **B** – phosphate, deoxyribose, base

***7** **C** – The number of C bases equals the number of G bases.

Practical work

Page 70

1 (blue-black) starch – positive test with iodine

(milky) fat – positive test with ethanol

2 **a** Handle sodium hydroxide carefully, as it is a strong alkali. Wash any spillage off hands immediately.

b Wear safety goggles when heating Benedict's solution to protect the eyes, as it is alkaline and can spit out of the test tube. Use protection if moving boiling water/use tongs to remove test tube to avoid burning the skin.

Exam-style questions

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1 **a** They are both composed of carbon, hydrogen and oxygen molecules. [2]

b The sub-units of carbohydrates are sugars, but the sub-units of fats are fatty acids and glycerol. [3]

2 **a** Both contain C, H, O atoms/are made of sub-units held together by chemical bonds. [1]

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b Proteins contain nitrogen/are made up of amino acids. [2]

3 **a** carbohydrates [1]

b

nutrient molecule	**function of nutrient molecule**	**where the nutrient molecule is found in a cell**
cellulose	forms plant cell walls/forms fibres	plant cell wall
glycogen	storage molecule in animals/fungi	in cytoplasm
starch	storage molecule in plants	in cytoplasm/chloroplasts

[6]

4 **a** blue [1]

b All contain vitamin C but the amounts vary. There is most in juice C and least in juice A because the strongest will need fewer drops to decolourise the DCPIP. [3]

c **i)** Carry out Benedict's test:

Add 2 cm^3 of Benedict's solution to 2 cm^3 of the fruit juice in a test tube.

Place the test tube in a beaker of boiling water.

Repeat with the other fruit juices. [3]

ii) Wear safety goggles. Use tongs to remove test tube from the boiling water. Wash spillages off skin immediately. [3]

iii) Changes from clear blue to cloudy green, then yellow, then red. [1]

***5** **a** Two stranded chains of nucleotides. Each nucleotide is made of a five-carbon sugar, a phosphate group and a base. The strands are joined by bonds between the bases. [3]

b A pairs with T, C with G, held together with chemical bonds. [3]

6

nutrient	**elements present**	**sub-unit(s) present**
carbohydrate	C, H, O	sugar/monosaccharide
fat	C, H, O	fatty acids, glycerol
protein	C, H, O, N, sometimes S	amino acids

[6]

7 **a** cellulose, glycogen, protein, starch [4]

b cellulose, glucose, glycogen, starch [4]

c amino acid, fatty acid, glucose, glycerol [4]

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5 Enzymes

Test yourself questions

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1

statement	enzymes	any other catalysts
Their activity is stopped by high temperature.	✓	×
They speed up chemical reactions.	✓	✓
They are proteins.	✓	×
They are not used up during the reaction.	✓	✓

2 **a** The rate would increase. Most chemical reactions speed up with a rise in temperature.

b The rate would fall to zero. Temperatures over 50 ºC denature most enzymes.

3 Dipping the apple into boiling water denatures the enzymes responsible for producing the brown discoloration.

4 The pH in the stomach is very low (it is very acidic), but amylase works in neutral or slightly alkaline conditions in the mouth, so the pH is not optimum.

5 No, because the pH in the small intestine is slightly alkaline. Pepsin works best in acid conditions.

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***6** (complimentary) The shape of the enzyme molecule at the active site exactly fits the shape of the substrate molecule on which it acts.

(active site) The part of the enzyme molecule that temporarily joins with the substrate molecule to form an enzyme-substrate complex.

***7** Enzyme molecules are proteins. At temperatures above 40°C, they start to denature. This permanently changes the shape of the molecule, so the active site is no longer complementary with the substrate/the substrate no longer fits in the enzyme's active site.

Exam-style questions

Page 82

1 **a** **i)** A protein that functions as a biological catalyst and is involved in metabolic reactions. [2]

ii) A catalyst is not a protein, it is not affected by high temperatures. [2]

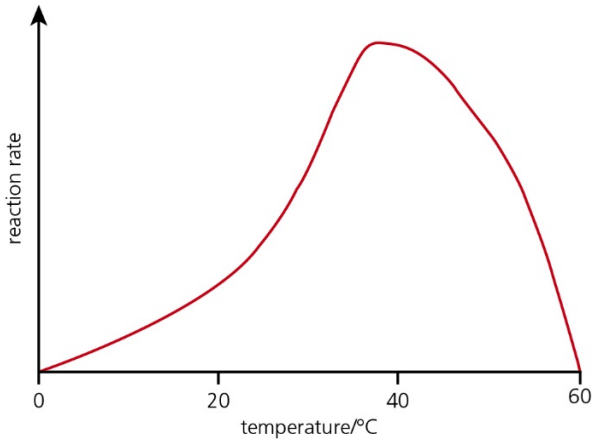
b **i)** At low temperatures the reaction is slow, because the substrate and enzyme molecules have low kinetic energy, so there are few collisions.

As the temperature is increased the reaction speeds up, because the substrate and enzyme molecules have higher kinetic energy, so there are more collisions.

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At temperatures above 37°C, the reaction starts to slow down as the enzyme molecules become denatured.

Suitable sketch graph with temperature on *x*-axis (horizontal) and reaction rate on *y*-axis (vertical). [3]

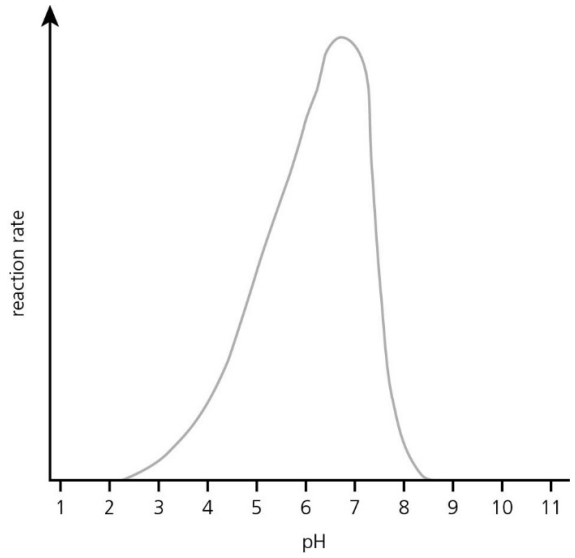


ii) At optimum pH the reaction happens fastest because conditions for the reaction are optimum.

Either side of optimum pH and the reaction slows down, because acid and alkaline conditions alter the chemical properties of the enzyme molecule.

Low and high pH can inactivate or denature the enzyme.

Suitable sketch graph with pH on *x*-axis (horizontal) and reaction rate on *y*-axis (vertical). [3]



2 a shirt A = 15°C, shirt B = 70°C, shirt C = 35°C [1]

b (shirt A) low temperature, so less kinetic energy for substrate and enzyme molecules, less collisions, so reaction is slow. Only some of the fat stain is removed.

(shirt B) high temperature, enzyme molecules become denatured, so reaction stops. The fat stain is not removed.

(shirt C) optimum temperature, so more kinetic energy for substrate and enzyme molecules, more collisions, so reaction is fast. The fat stain is broken down effectively. [1]

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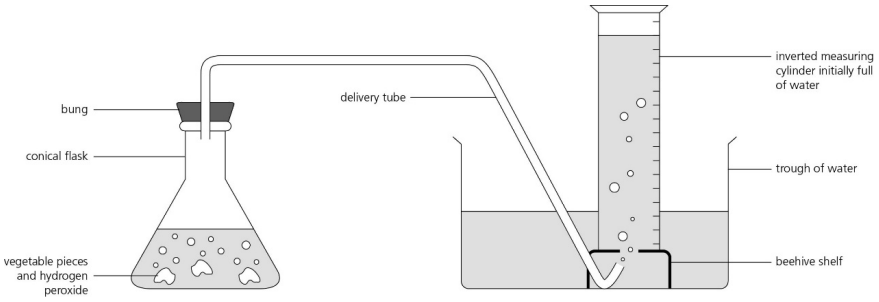
c Any two from:

- more time/temperature nearer 37°C
- more powder
- rub shirt with powder first
- suitable pH [2]

d i) lipase [1]

ii) protease/other named protein-digesting enzyme [1]

3 a i) Named vegetable. Cut equal-sized pieces of the vegetable. Set up equipment as shown below, for example, a conical flask or test tube with delivery tube leading to inverted measuring cylinder in water bath to trap gas produced.



Place measured volume of known concentration of hydrogen peroxide in flask/test tube and place in water bath at known temperature. Leave for 5 minutes. Add a piece of vegetable. Attach delivery tube to flask/test tube and collect gas for measured amount of time (e.g. 1 minute). Repeat with fresh pieces of vegetable and hydrogen peroxide at different temperatures. [6]

ii) Wash off any spillages of hydrogen peroxide immediately, take care when using scalpel to cut vegetable, wear safety goggles, handle hot flask/test tube/beaker with tongs. [2]

b Stomach pH is very acid. Amylase work best at neutral or slightly alkaline pH, so it is inactivated or denatured in the stomach. [2]

4 a i) The Visking bag is permeable to iodine. [1]

ii) starch [1]

iii) The Visking bag is not permeable to starch. [1]

b i) This is the optimum temperature for enzyme action. [1]

ii) All the starch has been digested by the amylase, so iodine that diffuses in does not change colour. [2]

5 a

temperature/°C	**mean volume of oxygen produced/cm^3**
20	8
30	37
40	51
50	34
60	9

[2]

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b *x*-axis – temperature and *y*-axis – volume of oxygen, labelled axes with units, points plotted correctly, line of best fit drawn [4]

c **i)** 40°C [1]

ii) No oxygen produced [1]

iii) The enzyme molecules are not all denatured at the same temperature. [2]

d **i)** hydrogen peroxide [1]

ii) oxygen, water [2]

6 Plant nutrition

Test yourself questions

Page 87

1 **a** carbon dioxide, water

b carbon dioxide from the air, water from the soil

c chlorophyll, enzymes

2 carbon dioxide, water, chlorophyll, light

Page 88

3 **a** The yield is increased from about 6 tonnes to 7.2 tonnes per hectare. This is a gain of 1.2 tonnes per hectare.

b The yield increases by about 1.5 tonnes per hectare (8.7 − 7.2).

c Increasing the applied nitrogen from 150 to 200 kg per hectare would increase the yield by about only 0.6 tonnes per hectare. The farmer needs to work out whether the income from this is more than the cost of the extra fertiliser.

4 nitrogen/nitrate

Page 93

5 The plant will die if it does not have water, other processes in the plant need water.

6 **a** oxygen (and water)

b carbon dioxide

Page 95

***7** **a** Include lamps to provide extra light, use a heater to increase temperature, include a source of carbon dioxide (from cylinder or heater burning fossil fuel).

b Any two from:

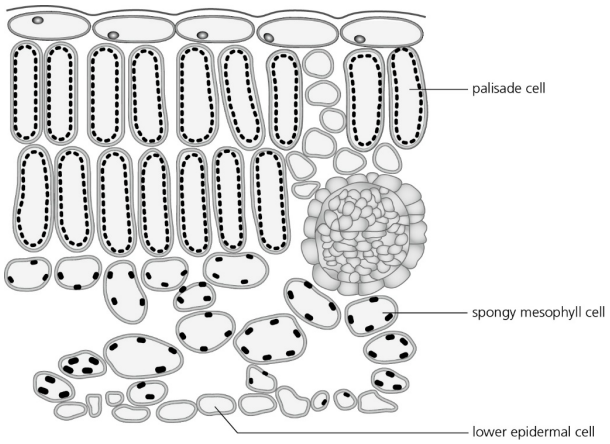
- lighting could require electricity
- cost of heating
- cost of CO_2 supply (or fuel for burning).

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***8** In darkness, from midnight to 4 a.m., only respiration will take place, so the carbon dioxide concentration will increase. From 4 a.m. to 8 a.m., photosynthesis will start as the light intensity increases, so more and more carbon dioxide is used by the crop. From 8 a.m. to 4 p.m., photosynthesis will be at its peak, using up carbon dioxide. As the light intensity reduces after 4 p.m., photosynthesis slows down while respiration stays the same, so that more carbon dioxide is released than is retained.

Page 104

9 a



b

Type of leaf cell	Would the cell photosynthesise most rapidly, less rapidly or not at all?	Reason
lower epidermal cell	not at all	no chloroplasts in the cells
palisade cell	most rapidly	most chloroplasts in the cells
spongy mesophyll cell	less rapidly	some chloroplasts in the cells

10 a (sun) light

b respiration

11 There are no chloroplasts in the epidermal cells.

Practical work

Page 92

1 In this experiment, the control is the part of the leaf with chlorophyll; the same leaf also has white areas, without chlorophyll.

2 a It means removing the starch from a leaf so there is none in the leaf at the start of an experiment.

b Two points from:

- starch is a product of photosynthesis
- so showing the factor being tested makes starch shows that factor is needed for photosynthesis to happen

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- if there was already starch in the leaves, we would not be able to tell whether any of it had been made during the experiment.

3 **a** Aluminium foil blocks out the light so no light can reach the covered area.

b Two points from:

- those areas did not receive light
- so no light energy was available for photosynthesis
- brown iodine indicates no starch was made.

4 **a** (soda lime) carbon dioxide absorber

b (sodium hydrogencarbonate) source of carbon dioxide

c (polythene bag) prevents the first plant obtaining carbon dioxide from the atmosphere/stops carbon dioxide getting to the plant from outside.

5 **a** The oxygen is produced as bubbles which can be counted/collected.

b It is not certain that land plants behave in the same way as pond plants.

Page 94

6 You would need to gradually increase the light intensity (e.g. by moving the light source closer to tube set up like tube 1), until the indicator just changed colour. Ideally you could then use a light meter to measure this intensity.

Page 99

7 **a** Sodium hydrogencarbonate provided carbon dioxide, so carbon dioxide was not a limiting factor.

b Heat may have been given off from the lamp.

8 Oxygen is produced during photosynthesis; this collected in the discs, making them more, buoyant/less dense.

9 Three points from:

- temperature/heat from lamp
- light intensity/distance of lamp from syringe
- amount of pondweed
- type/species of pondweed
- time for which the experiment is run.

10 Two points from:

- the higher the temperature, the more kinetic energy available
- molecules move faster
- more collisions between substrate molecules and enzyme molecules
- so more product/oxygen.

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Worked example
Page 97

1

distance from lamp/cm	mean number of bubbles/min^{-1}
10	39
20	16
30	7
40	3
50	2

2 Labelled axes with units (*x*-axis – distance of lamp from plant and *y*-axis mean number of bubbles), points plotted correctly, line of best fit drawn.

3 As the distance of the lamp from the plant is increased, the number of bubbles decreases. The greatest drop in bubble production was when the lamp was moved from 10 cm away from the plant to 20 cm.

4 As the lamp was moved further away from the plant, the plant received less light for photosynthesis. As the distance increased (and therefore the amount of light decreased) the rate of bubble production decreased.

Exam-style questions
Page 106

1 The carbon dioxide molecule would be combined with water to make glucose through the process of photosynthesis. Some of this glucose might be used in respiration, releasing the carbon dioxide molecule. [3]

2 **a** and **b**

light conditions	**gases taken in by the plant**	**gases given out by the plant**
bright sunlight	carbon dioxide	oxygen (+ water)
darkness	oxygen	carbon dioxide (+ water)

[4]

3 No. It may just mean that respiration is taking place faster than photosynthesis. [2]

4 **a** (epidermis) It is transparent to allow light to pass through to the photosynthesising cells.[2]

b (mesophyll) Photosynthesis. The palisade cells are packed with chloroplasts and are columnar to obtain maximum light. Spongy mesophyll cells lie between air spaces so carbon dioxide can diffuse into the cells for photosynthesis. [2]

5 Closure of the stomata prevents excessive loss of water, but the disadvantages are that it prevents intake of carbon dioxide (for photosynthesis) and removal of excess oxygen. [3]

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6 **a** The floating plant needs carbon dioxide and water for photosynthesis and its roots absorb water directly from the pond. [1]

b Upper epidermis. This gives access to gases in the air. If they were on the lower epidermis the plant leaf could become saturated with water. [2]

***7** **a** It is in shorter supply than nitrates, so if levels drop there is not enough present. [1]

b No effect, because it is present in excess. [1]

c Any two from:

- temperature
- carbon dioxide concentration
- competition for water. [2]

8 **a** V = palisade mesophyll

W = vascular bundle/xylem and phloem/vein

X = spongy mesophyll

Y = guard cells/stoma (accept stomata) [4]

b palisade mesophyll – elongated cells with large numbers of chloroplasts, main site of photosynthesis. [2]

vascular bundle – xylem vessels, tubular with no cell contents, transport water and minerals; phloem cells, tubular with cell contents, transport sugar and amino acids. [2]

spongy mesophyll – more circular cells with some chloroplasts for photosynthesis, many air spaces for gaseous exchange. [2]

guard cells – curved pairs of cells with thicker cell walls on inside, open and close stomata to control rate of transpiration/gaseous exchange. [2]

7 Human nutrition

Test yourself questions

Page 113

1 **a** milk, cheese, eggs, beans, meat substitute (e.g. Quorn), soya

b peas, beans, cereals (e.g. bread), meat substitute (e.g. Quorn), soya, falafel

2 Proteins are needed to make cytoplasm and all the tissues of the body. They also make the enzymes needed for chemical changes in the cells.

3 In theory, you could survive on proteins and fats. Both these foodstuffs can be converted into energy, which is normally provided by carbohydrates. You might be disadvantaged by a lack of dietary fibre and vitamin C.

4 **a** Proteins contain nitrogen. Fats do not.

b Proteins have about half the energy value of fats.

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c The main use of proteins is to provide the amino acids needed for building other proteins in the cytoplasm of the cells, which form the tissues of the body. They are also used to produce enzymes. Fats are a means of storing energy.

5 **a** (vitamin C) any two from:

- named citrus fruits, blackcurrants, cabbage, tomato, guava, mango

b (calcium) any two from:

- fish, milk or named milk products (e.g. cheese, yoghurt)

Page 115

6 Cells in the lining of the canal, in glands.

7 Mucus lubricates the lining of the canal.

Mucus protects the lining from attack by enzymes.

8 Blood vessels provide oxygen needed by the cells of the canal.

Blood vessels absorb digested food from the canal.

Page 118

9 **a** Physical digestion is the break-down of food into smaller pieces without chemical change to the food molecules.

b **i)** (incisors) bite off pieces of food

ii) (molars) chew and grind food

c Incisor is chisel-shaped, but the molar has three or four cusps.

Incisor has one root, but the molar has two or three roots.

***10** The stomach muscles carry out peristalsis to churn and squeeze the food and mix it with gastric juice. This gives the food a larger surface area for chemical digestion.

Bile emulsifies fats, breaking them down into smaller droplets. This gives the fat a larger surface area for chemical digestion.

Page 122

11 **a** The pancreas secretes pancreatic juice into the duodenum.

b The salivary glands secrete saliva into the mouth.

12 Example of a mnemonic:

I	Ingestion
Do	Digestion
Eat	Egestion
Any	Absorption
Apples	Assimilation

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13 *This question depends on personal data, so no general answer can be given.*

14 **a** **i)** Starch is digested in the mouth, the duodenum and the small intestine.

ii) Protein is digested in the stomach, the duodenum and the small intestine.

b The pH may be different. The properties of enzymes can be affected by a change in pH, e.g. from acid to alkaline. An enzyme that works at its optimum rate in a slightly alkaline environment, e.g. amylase in the mouth, may work very slowly in the acidic stomach (lower pH). It could even be denatured and not work at all.

Page 124

15 **a** Starch is digested to glucose.

b Proteins are digested to amino acids.

c Fats are digested to fatty acids and glycerol.

16 The small intestine is long; it is lined with vast numbers of villi. Both these factors give the small intestine a large absorbing surface. The epithelium is thin, which allows rapid diffusion or active uptake of digested food. There are many capillaries to carry off the products of digestion.

Practical work

Page 114

1 Possible faults include:

inaccuracy of measuring water and/weighing the nuts

inaccuracies in taking the temperature of the water

not stirring the water, so the heat is not evenly distributed

losing heat from the nut before it is placed under the boiling tube

losing heat to the atmosphere due to lack of insulation around the apparatus

the nut stops burning before all the nutrients in it have been burned.

2 into the atmosphere

3 Use insulation around the boiling tube, avoid draughts around the apparatus.

Page 126

4 Diffusion will continue only while there is a concentration gradient.

5 The cloudiness is due to solid particles of egg white. When they are digested into soluble substances, the cloudiness disappears.

6 You could prepare a series of test tubes in the same way as tube C and put them in controlled-temperature water baths, e.g. from 5ºC to 35ºC, to see which one cleared first.

7 **a** The variables are the presence or absence of hydrochloric acid (tubes A and C), and the presence or absence of unboiled pepsin (tubes C and D).

b Tube A could be the control in the experiment investigating the effect of acid.

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Tube D could be the control in the experiment investigating the effect of boiled and unboiled pepsin.

Exam-style questions

Page 128

1 **a** A diet that contains all the essential nutrients, in the correct proportions to maintain good health. [2]

b A – protein

B – fats

C – carbohydrates

D – fibre (roughage)/vitamins/mineral ions [4]

c They are rich in roughage (fibre), which is important to maintain the tone of the muscles in the alimentary canal and to prevent constipation. They may also contain vitamins. [2]

2 **a** bones and teeth

b all tissues or a named tissue, e.g. muscle

c red blood cells

d all growing tissues. [4]

3 **a** X – stomach – to digest protein, or for physical digestion.

Y – small intestine – to digest food, or to absorb digested food molecules or water.

Z – rectum, to store faeces. [6]

b **i)** protease [1]

ii) acidic pH. Squeezing of the stomach wall to break down large particles of food into small particles, or turn to liquid (chyme). [2]

4 **a** active transport/active uptake [1]

b energy [1]

5 **a** A, H [2]

b E [1]

c D, F [1]

d H [1]

e A, D [1]

f C, G [1]

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6

process	definition
absorption	the movement of nutrients from the intestines into the blood
assimilation	the uptake and use of nutrients by cells
digestion	the break-down of food
egestion	the removal of undigested food from the body as faeces
ingestion	the taking of substances, e.g. food and drink, into the body

[5]

***7** In the stomach, the enzyme pepsin breaks the protein down to form peptides. In the duodenum and small intestine, the peptides are broken down further by enzymes (trypsin and peptidase) to form amino acids. The amino acids are absorbed through the intestinal lining to reach blood vessels, which join up to form the hepatic portal vein. This vein carries the amino acids to the liver, which makes them into new proteins or alters their composition so that they can be used for energy production. [10]

8 Transport in plants

Test yourself questions

Page 133

1 Stem – in the vascular bundles arranged in the cortex near the outside of the stem, below the epidermis.

Root – in the vascular bundle in the centre of the root.

Leaves – in the vascular bundle in the midrib and veins of the leaf.

2 With the aid of a hand lens or microscope you would be able to see that the stem's vascular bundles were in a circle just below the epidermis. The root's vascular bundle would be in the centre.

***3** Vessels (xylem), sieve tubes (phloem), fibres.

***4** Cells have no end walls, so they form a continuous narrow tube for water to pass through. The cells have no cytoplasm to allow the free passage of water. The cell walls are impregnated with lignin to make them strong to help support the plant. There are fibres present which are also lignified for support of the plant.

Page 135

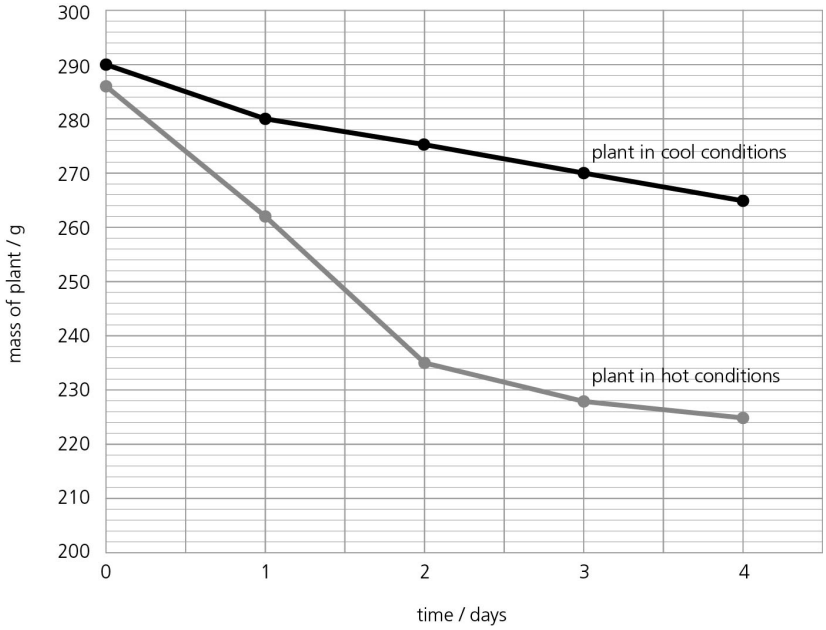
5 root hair cells, cortex cells, xylem, mesophyll cells

6 root hair cell → xylem vessel → midrib → leaf 'vein' → mesophyll cell

Page 142

7 **a** Line graph with time/days as the *x*-axis and mass of plant/g as the *y*-axis, with labels and units.

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b i) Both plants lost mass over 4 days. The plant in cool conditions lost less mass than the plant in hot conditions.

ii) The plants lost mass due to loss of water through transpiration. Hot conditions cause the plant to transpire faster and so lose more water and, therefore, more mass.

c The plants were not the same weight at the start of the investigation. Calculating percentage change in mass takes this into account.

d Water could evaporate from the soil in the pots. The bags prevent this happening.

8 a both surfaces (c), lower surface (a), upper surface (b), neither surface (d)

b There are more stomata on the lower epidermis of the leaf, so when the lower epidermis is not covered by the jelly it loses a lot of water and the leaf becomes shrivelled up. When both surfaces are left untreated, some water is also lost from the upper epidermis, so the leaf loses even more water. If only the lower epidermis is treated with the jelly, the leaf does not lose much water because there are fewer stomata on the upper surface which is also covered by a waterproof waxy cuticle .

Page 163

***9** The leaves would wilt, i.e. lose their turgidity and droop.

***10** The inside layers of the bark include the phloem. If this layer is removed, the food made in the leaves cannot reach the roots, which consequently die and cause the death of the entire tree.

***11** They are in the vascular bundles in the midrib (below the xylem vessels), and veins of the leaf.

***12** The roots; all the tissues in the shoot that do not contain chlorophyll (cortex, phloem, epidermis, etc.); flowers, fruits and seeds.

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Practical work

Page 135

1 Cut a flower, with stem, and place the stem in a beaker containing a dye, e.g. methylene blue. Leave it for 24 hours. Observe the petals. There should be fine blue lines, showing the presence of xylem vessels.

2 This should be a large diagram with clean lines, the areas of the xylem drawn and the xylem labelled (see Figure 8.4).

3 Two points from:

- the shoot that had its bark/phloem removed
- did not wilt
- showing it still managed to conduct water.

Page 136

4 Four points from:

- an increase in temperature results in faster/more transpiration
- water turns to water vapour faster
- because the molecules gain more kinetic energy
- larger diffusion gradient created between the leaf and atmosphere
- so, water vapour diffuses out of the leaf faster
- more water loss results in greater loss of mass.

Page 138

5 If left in the tubing the air bubble could reach the cut stem, which would cause an air lock, stopping uptake of water into the stem.

Page 141

***6** The petroleum jelly blocks the stomata/stomatal pores, so water vapour cannot diffuse out of the leaf.

Worked example

Page 137

1 **a** change in mass = 360.0 − 338.4 = 21.6 g

% change in mass = (change in mass ÷ mass at start) × 100

= (21.6 ÷ 360.0) × 100

= 6.0%

b The plant lost 21.6 g in 24 hours

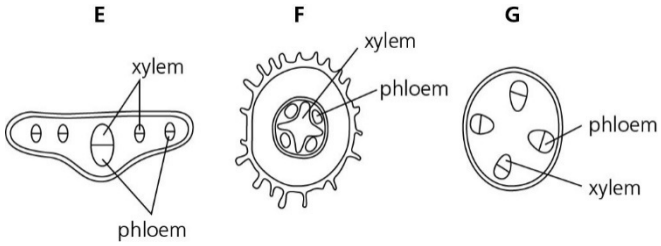
21.6 ÷ 24 = 0.9 g $hour^{-1}$

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Exam-style questions
Page 145

1 **a** E = leaf, F = root, G = stem [3]

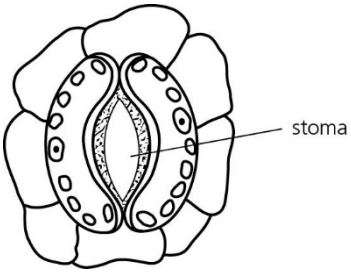
b [6]



c **i)** Root hair cells are present, which increase the surface area of the root for absorbing water and mineral ions. [2]

ii) The phloem in the leaf carries sucrose and amino acids from the leaf to other parts of the plant (sinks) for storage or assimilation. [3]

2 **a** X = epidermal cell, Y = chloroplast, Z = nucleus [3]



b **i)** guard cells drawn with thick cell walls curved outwards and stoma open [2]

ii) stoma labelled [1]

c There will be less water loss through transpiration, so the plant has less chance of wilting when gas exchange is not so important. CO_2 will be trapped for use in photosynthesis later and oxygen will be retained for respiration. [2]

3 **a** Any three different cells correctly labelled, e.g. upper epidermal cell, palisade (mesophyll) cell, spongy mesophyll cell, lower epidermal cell, guard cell, phloem, xylem [3]

b Water is transported into the leaf through the xylem vessels. It moves into the spongy mesophyll cell by osmosis. A water film develops on the surface of the cells. This evaporates into the air space. From here it diffuses through the stomatal pore into the atmosphere. [6]

c Any two from:

- increase in temperature
- increase in wind speed
- reduced humidity. [3]

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4 **a** A tissue is a group of cells with similar structures, working together to perform a shared function. [2]

b [3]

name of plant tissue	**function**
(phloem)	transport of sucrose and amino acids
xylem	(transport of water)
root hair cells	(absorption of water from the soil)

5 **a** Seal the pot and soil in a plastic bag. Weigh the whole plant. Place the plant in a sheltered place. Leave for a measured period of time, e.g. 24 hours. Re-weigh the plant then calculate the rate of water loss. Repeat in windy conditions, or using hair dryer on cold setting, keeping conditions / all other variables (e.g. temperature of room, amount of light) the same as in the first part of the investigation. [6]

b The plant in windy conditions will have a greater mass decrease showing a greater rate of water loss, and therefore transpiration. [2]

***6** **a** Water is absorbed by root hair cells by osmosis, from higher concentration of water outside the cell to a lower concentration inside the cell. The turgor pressure of the cell increases, forcing water out through the cell wall into the cortex cells. It then enters the xylem and passes up to the stem due to the transpiration pull. [6]

b Choose a plant with a storage organ, e.g. sweet potato, cassava, daffodil or any fruit plant. Sugars are made in the leaf, the source, by photosynthesis. Sucrose passes into the phloem tubes in the vascular bundles. It is translocated through the plant stem to the storage organ. [4]

***7** **a** Transpiration is the loss of water vapour from the leaves. [2]

b Xylem vessels are made from aligned cells which have lost their ends to form long thin tubes. They have no cytoplasm. The cell walls are impregnated with lignin. [3]

c Two points from:

- Transpiration involves the movement of water and mineral ions, whereas translocation involves the movement of sucrose and amino acids.
- With transpiration water moves up the plant from the roots to the leaves, whereas with translocation movement can be either way.
- Transpiration requires no energy (passive) whereas translocation requires energy (it is an active process). [2]

d Wilting is due to a shortage of water or a higher concentration of salts in the soil than in the plant roots. It can be caused by windy conditions or a high temperature. Such conditions result in more water loss than gain, so cells lose water and become flaccid. Then the leaves and stem are no longer rigid. [4]

***8** **a** In conditions of decreased humidity, the air around the leaves of the plant has a lower concentration of water than in the air spaces of the spongy mesophyll. Water diffuses down the gradient, through the stomatal pores and out of the leaf, so transpiration speeds up. [2]

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b In conditions of decreased temperature, the water molecules have less kinetic energy to form a vapour in the air spaces of the spongy mesophyll. They also have less kinetic energy to diffuse out through the stomatal pores, so transpiration rate slows down. [2]

9 Transport in animals

Test yourself questions

Page 147

1 Valves stop the blood flowing backwards or keep the blood flowing in one direction.

2 They can obtain materials like oxygen over their body surface by diffusion.

***3** **a** The heart of a fish only has one atrium and one ventricle, while the heart of a mammal has two of each.

b Blood must be pumped through the gills and the body before the blood pressure can be increased again. When the blood passes through the gills, pressure is lost.

***4** It maintains a high blood pressure to all the main organs of the body because blood flows through the heart twice for each complete circulation of the body. When blood flows through the lungs the blood pressure drops. It goes back through the heart and the blood pressure is raised before being pumped to the other organs of the body.

Page 152

5 left atrium, left ventricle, aorta, vena cava, right atrium, right ventricle, pulmonary artery, lungs, pulmonary vein

***6** c atria contract

e blood enters ventricles

b ventricles contract

g atrioventricular valves close

a blood enters arteries

f semi-lunar valves close

d ventricles relax

(You could alternatively start with d.)

***7** The pulmonary artery carries deoxygenated blood.

The pulmonary vein carries oxygenated blood.

***8** **a** Both ventricles pump blood into the arteries.

b The atrioventricular and semi-lunar valves prevent blood flowing the wrong way.

***9** **a** The ventricles must pump blood to the organs of the body. The atria must pump blood only into the ventricles.

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b The left ventricle must pump blood all around the body (apart from the lungs). The right ventricle must pump blood only to the lungs.

Page 154

10 a Maintain a good level of regular exercise, reduce your stress levels, maintain a healthy weight.

b Do not smoke, avoid an excess of fatty foods.

11 sex, genetic predisposition, age

Page 160

12 The pulmonary veins are not shown.

13 a Veins return blood to the heart. Arteries carry blood away from the heart.

b Veins are wider, are less elastic with thinner walls and have less muscle tissue than arteries. Some veins have valves in their linings.

***14** They are very narrow, so they slow down the flow of blood to allow the exchange of materials with the surrounding cells. Their walls are only one cell thick, so they are permeable and diffusion can happen quickly.

Page 164

15 a Some white blood cells can change their shape, and they all have a nucleus. Red blood cells have a fixed shape and no nucleus. White blood cells do not contain haemoglobin, whereas red cells do.

b The function of red blood cells is to carry oxygen. White blood cells are an important part of the immune system. They can produce antibodies, which combat foreign substances that get into the bloodstream. Some of them can ingest bacteria or damaged cells and other unwanted particles. White blood cells do not carry oxygen.

16 a i) Lungs

ii) In all the living, respiring cells of the body.

b If oxyhaemoglobin were a stable compound it would not readily break down to release its oxygen where needed.

c If a diet contains too little iron, an adequate supply of haemoglobin cannot be produced. Cellular respiration would be reduced, and the person would be anaemic and would lack energy.

***17 a** The blood plasma contains a soluble protein called fibrinogen. At the site of the cut, this changes to insoluble fibrin by enzymes released from platelets and damaged cells. The fibrin forms a network of fibres, which trap red blood cells.

b The clot stops further loss of blood and the entry of harmful pathogens.

Practical work

Page 150

1 a The atrioventricular valves have tendons attached.

The semi-lunar valves are crescent-shaped with no tendons.

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b The atrium wall is thinner and much smaller than the ventricle wall.

c The right ventricle wall is much thinner than the left ventricle wall.

The right ventricle is smaller than the left ventricle.

Page 156

2 **a** **i)** and **ii)** table completed.

reading	pulse rate/beats in 15 seconds	pulse rate/beats min^{-1}	Mean resting pulse rate/beats min^{-1}
1	19	76	76
2	20	80	
3	18	72	

b Three readings were taken to make sure the measurement was reliable and make it possible to identify if the first measurement was an outlier or a typical reading.

c **i)** Graph plotted, with axes and axis labels correct, points plotted accurately, line drawn between the points.

ii) Horizontal line drawn and labelled to represent the resting pulse rate.

d **i)** 5.5 minutes

ii) The pulse rate immediately after exercise would be higher and the time taken for the pulse to return to normal would be longer.

Page 162

3 Diameter of cell = 8 μm, so radius = 8 ÷ 2 = 4 μm

Area of the upper surface of the cell = πr^2

= 3.142 × 4 × 4 = 50 μm^2

There are two surfaces, so 50 × 2 = 100 μm^2

The circumference of the cell = $2\pi r$ = 2 × 3.142 × 4 = 25 μm

The thickness of the cell is 1.5 μm

The area of the depth of the cell is circumference × depth

= 25 × 1.5 = 38 μm^2

So, total surface area = 100 + 38 = 138 μm^2

Worked example
Page 163

1 The diameter of the largest cell is 10 μm.

There are 1 000 μm in 1 mm

10 ÷ 1 000 = 0.01 mm.

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In standard form this is 1.0×10^{-2} mm.

Exam-style questions

1 a i) [4] marks for vessels

ii) [1] for both ticks correct

[1] for both crosses correct

vessel	**name of vessel**	**blood in the vessel is oxygenated tick (✓) or cross (×)**
A	aorta	✓
B	coronary artery	✓
C	vena cava	×
D	pulmonary artery	×

b i) Any two from:

- too much fat in the diet, smoking, stress, genetic predisposition, lack of exercise, age, sex. [2]

ii) Any two from:

- reduce fat content of diet, stop smoking, develop ways of reducing stress, regular exercise. [2]

iii) The muscle of the left ventricle stops receiving oxygen and some of the tissue dies. The ventricle contracts less effectively or stops contracting. [2]

***2 a** U [1]

b V [1]

c R [1]

d one from: X, S [1]

e one from R, T [1]

f W [1]

g one from R, T. [1]

3 a Any three from:

- arteries have a smaller lumen, thicker wall, the wall has more muscle, no valves present. [3]

b Capillaries allow the diffusion of materials from the blood plasma into the surrounding tissues (e.g. glucose, oxygen, hormones) and from the tissues into the blood plasma (e.g. carbon dioxide, urea). [2]

4 a R – pulmonary vein

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S – aorta

T – renal vein

U – vena cava [4]

b There are two kidneys. [1]

c The artery (pulmonary artery) carries deoxygenated blood. [1]

***5** If the semi-lunar heart valves do not function properly, some of the blood in the arteries can flow back into the heart, so less blood is delivered to the body. If the atrioventricular valves do not work properly, when the ventricle contracts, some of the blood will pass back into the atrium and insufficient blood pressure will be created to move blood round the body. This means that less oxygen reaches the muscle cells, which limits vigorous activity. [4]

***6** The liver receives blood from the hepatic artery and hepatic portal vein. Blood passes out of the liver in the hepatic vein. The hepatic artery supplies oxygen. The hepatic portal vein supplies products of digestion, e.g. glucose, amino acids. The hepatic vein will carry more carbon dioxide and more urea than the other two vessels. [6]

10 Diseases and immunity

Test yourself questions

Page 175

1 An earthquake can damage sewage pipes and water pipes. This means that raw sewage may escape into drinking water, so this must be boiled to destroy pathogenic bacteria.

2 If a person is carrying an infectious respiratory disease, whether or not he or she is aware of it, coughs and sneezes will produce micro-droplets containing the pathogenic micro-organisms. The infectious droplets can remain in the air to be inhaled or fall on food and, consequently, infect other people.

3 **a** Hand: the skin is a natural barrier to bacteria unless it is damaged, in which case white cells engulf the bacteria.

b Bronchus: the film of mucus which lines the bronchi and trachea traps the bacteria, which are then carried away from the air passages by ciliary currents.

c The stomach produces hydrochloric acid, which kills most bacteria.

4 One type of white blood cell engulfs bacteria by a process called phagocytosis and digests them. Another type produces antibodies, which attack directly or attach themselves to the antigens on bacteria, making it easier for other white blood cells to engulf them.

Page 179

5 Immunisation against diphtheria stimulates the lymphocytes to produce antibodies to the diphtheria toxin. This antibody is specific to the diphtheria toxin and will not have any effect on the polio virus.

6 Diphtheria immunisation would be continued to protect against outbreaks of the disease originating from people who had not received the vaccine.

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7 The first injection stimulates the lymphocytes in the immune system to produce antibodies specific to the antigen in the vaccine. Some of the B lymphocytes are memory cells. When the second injection is received, the memory cells reproduce very rapidly and raise the level of antibodies.

Worked example

Page 170

1 $0.002 = 2 \times 10^{-3}$ mm

2 Other examples include: Figure 1.13 – Butterfly 5.0×10^{-1}, Cyclops 1.4×10^{1}; Figure 1.14 – Plaice 1.14×10^{1}, Kestrel 6×10^{-2}

Exam-style questions

Page 182

1 **a** **i)** A pathogen is a disease-causing organism.

ii) A transmissible disease is a disease in which the pathogen can be passed from one host to another. [2]

b Any three from:

- viruses, protozoans, bacteria, fungi. [3]

c Pathogens can damage the host's cells. They can produce toxins that damage the cells they are growing in. [2]

2 [6]

vector of pathogen	direct contact	indirect contact
air	×	✓
blood	✓	×
contaminated surface	×	✓
food	×	✓
housefly	×	✓
semen	✓	×

3 Any three from:

- carried on feet; present in faeces; saliva contains bacteria from previous feeding; bacteria carried on body hairs; fly sheds bacteria while cleaning its body. [3]

4 Many diseases can be transmitted by contaminated food. If a person who sells, handles or cooks food carries pathogenic micro-organisms in or on his or her body, particularly hands, they could introduce these pathogens to the food and to anyone who eats it. Good personal hygiene will reduce these risks. [3]

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5 [4]

term	**definition**
carrier	a person who carries pathogens without showing any signs of the disease
pathogen	a disease-causing organism
toxin	a poison which can be produced by some bacteria
transmissible disease	a disease in which the pathogen can be passed from one host to another

6 Any three from:

- skin acts as a barrier; hairs in the nose filter out bacteria; acid in the stomach kills bacteria; mucus in the trachea and bronchi traps bacteria; white blood cells engulf bacteria; white blood cells produce antibodies to clump bacteria together. [3]

***7** Active immunity is when the body has been exposed to a disease and the lymphocytes have made antibodies to fight the pathogen. If the person is exposed to the same disease, they already have antibodies to fight the infection. It can also be achieved by vaccination. It gives long-term protection from the disease.

Passive immunity is when antibodies against a disease which are present in the blood have not been made by the person. They have been gained by injection of a serum or from a mother's breast milk. It gives short-term protection from the disease. [6]

***8** **a** A harmless form of the pathogen, killed pathogens, a toxoid (inactivated toxin from the bacteria). [3]

b A vaccine is introduced into the body by injection or by swallowing. This causes white blood cells (lymphocytes) to make the correct antibodies against the disease, so that the person becomes immune to that disease. [3]

11 Gas exchange in humans

Test yourself questions

Page 185

1 nasal cavity, trachea, bronchus, alveolus

2 350 million in standard form is 3.5×10^8

0.2 mm in standard form is 2.0×10^{-1} mm (or 2.0×10^{-2} cm)

3 10 mm = 10 000 µm

actual size of the specimen = observed size ÷ magnification

= 10 000 ÷ 40 = 250 µm

In standard form this is 2.5×10^2 µm

4 The alveoli create a large surface area; there is a short distance (2 cells thick) for the gases to diffuse across; a diffusion gradient is maintained because the blood is moving and the alveoli are ventilated.

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Page 186

5 **a** **i)** (pulmonary artery) right ventricle

ii) (pulmonary vein) left atrium

b The pulmonary vein carries oxygenated blood whereas other veins carry deoxygenated blood. It also carries a smaller amount of carbon dioxide.

c The concentration of carbon dioxide is higher in the blood than in the alveolus, so it diffuses down the diffusion gradient into the alveolus.

6 Two points from:

- expired air contains more carbon dioxide; less oxygen; more water vapour.

7

My	mouth
Long	larynx
Toothed	trachea
Bear	bronchus
Bites	bronchiole
Apples	alveolus

Page 193

***8** **a** **i)** trachea

ii) bronchi

iii) lungs

iv) ribcage

v) diaphragm

b The bell jar is rigid: it does not move like the ribcage. The balloons inflate only slightly.

***9** The diaphragm muscle contracts and so do the external intercostal muscles.

***10** External intercostal muscles contract, ribs rise, thorax expands, lungs expand, air enters lungs.

***11** The alveoli would expand most. The bronchioles would expand very little.

Practical work

Page 190

1 Expired air still contains oxygen.

2 When breathing in, note which tube bubbles. This tube is testing the inspired air. When breathing out the other tube bubbles. This tube is testing the expired air.

3 The volume breathed out during relaxed breathing is between 0.5 and 1.0 litres.

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The volume of a forced exhalation will be at least 2.5 litres (this depends on the size, sex and fitness of the person).

The difference will therefore be at least 2.5 – 1.0 = 1.5 litres, with the precise value depending on the volumes measured in practice.

4 Two points from:

- air breathed out always contains carbon dioxide
- carbon dioxide is a product of aerobic respiration
- the lungs are responsible for excreting it.

Worked example
Page 190

1 **a** The volunteer was breathing through the spirometer for 140 seconds.

b Count the number of peaks on the trace for a period of time, e.g. 1 minute. If the number of peaks in, say, 30 seconds is counted, multiply the answer by 2 to give the rate per minute.

c The time taken is 137 − 10 = 127 seconds.

The change in volume is 4.7 − 3.8 = 0.9 dm^3.

0.9 ÷ 127 will give the volume consumed per second.

There are 60 seconds in 1 minute, so

0.9 ÷ 127 × 60 = 0.43 $dm^3\ min^{-1}$.

Exam-style questions
Page 194

1 ***a i)** E diaphragm, F intercostal muscle [2]

ii) B trachea/windpipe [1]

iii) B trachea/windpipe [1]

iv) C alveoli [1]

v) E diaphragm [1]

b i) Pour limewater into both boiling tubes to the same level/to cover longer tubes.

Gently breathe in and out through the mouthpiece

until the limewater in one of the boiling tubes changes colour.

Any two precautions from:

- (precaution) wash out the boiling tubes and other tubes thoroughly before starting
- (precaution) disinfect mouthpiece or use disposable mouthpiece
- (precaution) do not suck too hard through the mouthpiece (or wash out mouth immediately if you take in any limewater). [5]

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ii) The limewater in tube B changes colour first from colourless to milky. [2]

c Breathing rate increases.

Depth of breathing increases. [2]

2 **a** **i)** pulmonary artery [1]

ii) It carries deoxygenated blood. [1]

b **i)** alveoli/air sacs [1]

ii) gaseous exchange/diffusion [1]

iii) they have walls which are one cell thick

the walls are permeable

they have a narrow lumen, so the blood slows down [3]

***3** **a** **i)** trachea; nose/mouth

ii) diaphragm

iii) ribcage [3]

b Any three from:

- no rib action, or no intercostal muscle action, or barrel is rigid
- piston is not domed, or piston is rigid
- piston is not attached to the side walls
- no lungs
- no gas exchange. [3]

c The volume decreases inside the barrel, pressure of air increases, so the air pressure inside the barrel is higher than the air pressure outside the barrel, so air moves out. [4]

***4** More energy is required, so respiration increases producing more carbon dioxide as a waste product. This is carried in the blood. The brain detects the increase in carbon dioxide. It sends a signal to stimulate the breathing system. [4]

***5** Table with suitable headings.

[2] marks for suitable headings
For each gas: [1] mark for figures correct for inspired and expired air; [1] mark for each correct explanation

gas	**inspired air/%**	**expired air/%**	**reason**
oxygen	21	16	used up in respiration/ absorbed by blood
carbon dioxide	0.04	4	waste product of respiration/ released by blood into the lungs
water vapour	variable	higher	product of respiration/evaporates from the surface of alveoli

[8]

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12 Respiration

Test yourself questions

Page 197

1 **a** energy

b Respiration takes place in all the living cells of an organism.

2 **a** True (of most organisms).

b False. The organism is more likely to be producing heat.

c True

d True in most cases (some micro-organisms may use only anaerobic respiration).

e False. Respiration results in a loss of weight.

f False. Movement cannot occur without respiration, but respiration does not necessarily result in the entire organism moving about (e.g. plants, sleeping animals).

3 Respiration is a chemical process that takes place in all living cells. Resuscitation restores the process of breathing.

4 **a** **i)** $64.3 \times 134 = 8\,616.2$ kJ

ii) $0.018 \times 2\,736 = 49.3$ kJ

b The mouse

c The mouse has a large surface area compared to its body mass, so it loses heat much more rapidly than the man and therefore must generate heat more rapidly to maintain a constant body temperature.

Page 201

5 **a** **i)** A food substance and oxygen.

ii) Enzymes

b Carbon dioxide and water.

6 **a** Soda lime is used to absorb carbon dioxide.

b Test the gas breathed out by the organism with limewater. If carbon dioxide is present, the lime water will turn milky.

7 **a** In the absence of soda lime there will be a 2 cm^3 increase in volume.

b If soda lime is present there will be a decrease in volume of 5 cm^3.

Page 203

8 Aerobic respiration needs oxygen, anaerobic respiration does not. Anaerobic respiration does not completely oxidise the substance it acts on. Anaerobic respiration produces less energy than aerobic respiration.

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***9** You need more oxygen to oxidise the lactic acid that has built up during vigorous exercise. An increased heart rate and increased breathing rate deliver the oxygen more rapidly. Carbon dioxide produced during vigorous exercise also needs to be removed from the body, and an increased breathing rate will do this.

***10** During vigorous exercise, the body cannot provide enough oxygen for the muscles to respire aerobically. So, the muscles use anaerobic respiration to provide energy for the muscles to contract. This produces lactic acid as a waste product.

Practical work

Page 196

1 Two from:

- use the same mass of dough in each tube
- run all the tubes for the same time
- same amount of yeast in each dough sample/all dough from same batch.

2 **a** Bubble the gas through limewater/shake the gas in limewater.

b The limewater turns milky.

Page 200

3 volume of the capillary = $\pi r^2 l$

r = half the diameter = 1 ÷ 2 = 0.5 mm;

l = 2.5 cm = 25 mm.

$3.142 \times (0.5)^2 \times 25 = 19.6\ mm^3$ in 5 minutes

$= 19.6\ mm^3 \div 5 = 3.9\ mm^3$ per minute.

4 **a** There could be fungus or bacteria on the surface of the seeds which could respire and produce heat.

b Both flasks could have shown an increase in temperature.

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5 They stop any heat being lost.

They stop any heat getting into the container.

6 **a** The liquid paraffin stops any oxygen getting to the yeast, so it can only respire anaerobically.

b The limewater is used to test for carbon dioxide.

c The yeast uses glucose as a substrate for respiration.

Worked example

Page 199

1 **a** Diameter = 1.0 mm, so radius = 1.0 ÷ 2 = 0.5 mm

Distance moved = 2.55 cm

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Change to mm: $2.55 \times 10 = 25.5$ mm

Volume = $3.142 \times (0.5)^2 \times 25.5 = 20.0$ mm^3

b 20 seeds take up 20.0 mm^3

$20 \div 20 = 1.0$ mm^3

c One seed took up 1.0 mm^3 in 10 minutes.

$1.0 \div 10 = 0.1$ mm^3 min^{-1}

In standard form: 1.0×10^{-1} mm^3 min^{-1}.

Exam-style questions

Page 206

1 [5]

process	**product**
aerobic respiration	carbon dioxide, water
anaerobic respiration in yeast	carbon dioxide, alcohol
anaerobic respiration in muscles	lactic acid

2 **a** The chemical reactions in cells to break down nutrient molecules to release energy. [3]

b In aerobic respiration oxygen is used, but it is not used in anaerobic respiration.

In aerobic respiration more energy is produced than in anaerobic respiration.

In aerobic respiration carbon dioxide and water are produced.

In anaerobic respiration, lactic acid is produced. [4]

c Any four from:

- protein synthesis; cell division; active transport; growth; passage of nerve impulses; maintenance of a constant body temperature. [4]

3 **a** **i)** The function of the soda lime is to absorb carbon dioxide from the air passing into the apparatus. [1]

ii) The mass of the soda lime at the end of the investigation will be higher than its mass at the start because it has absorbed carbon dioxide. [2]

b **i)** The limewater in flask A will stay clear because the soda lime has absorbed all the carbon dioxide from the air entering the flask.

ii) The limewater in flask B will go cloudy/milky because the rat has produced carbon dioxide as a product of aerobic respiration. [4]

c Flask A was included in the investigation to show the rat is the source of the carbon dioxide. It was *not* present in the air being pumped through the flasks. [2]

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4 **C** carbon dioxide and alcohol [1]

5 **B** mitochondrion [1]

6 The muscles need energy to contract. This is supplied by respiration. The blood cannot supply oxygen to the muscles fast enough for aerobic respiration to continue. The muscle cells respire anaerobically, producing lactic acid. This builds up and diffuses into the blood plasma. The blood carries it away to the liver. An oxygen debt builds up. The blood stream continues to transport extra oxygen for use in respiration to break down the lactic acid that has built up. [8]

13 Excretion in humans

Test yourself questions

Page 209

1 carbon dioxide, urea, uric acid, water, salts/ions, spent hormones, toxins, bile pigments

2 **B** renal artery and renal vein

3 **C** Benedict's test

4 **a)** and **b)**

A – vena cava – carries blood to the heart

B – (left) kidney – filters blood

C – ureter – carries urine from the kidney to the bladder

D – bladder – stores urine

E – urethra – passes urine from the bladder

F – renal artery – carries blood from the aorta to the kidney

Page 212

***5** **A** glucose and water

***6** **a** **A** – cortex

B – renal artery

C – renal vein

D – ureter

E – medulla

b **i)** urine

ii) water, urea, ions, uric acid.

c Any three from:

B contains more oxygen, more urea, more water, more salts, less carbon dioxide (accept reverse responses for blood vessel C).

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d renal capsules/Bowman's capsules – cup-shaped structures into which plasma passes from the blood

glomeruli – knotted blood capillaries from which plasma passes into renal capsules,

renal tubules – tubes containing plasma from renal capsules, surrounded by twisted capillaries that reabsorb substances the body requires

collecting ducts – tubes containing urine, carrying it down to the pelvis to the ureter

***7** 95% of 400 cm^3 = 380 cm^3 water

Exam-style questions

Page 213

1 **a** Excretion is the removal of the waste products of metabolism and substances in excess of requirements. [3]

b **i)** three points from:

- the kidneys filter urea, ions and water from the blood; form urine; remove wastes; control the body's fluid balance; keep the right levels of mineral ions. [3]

ii) The lungs are involved in excreting carbon dioxide from respiration. [1]

c **i)** They both transport urine. [1]

ii) The ureter carries urine between the kidney and the bladder. The urethra carries urine from the bladder (through the penis in a male). [2]

2 **a** carbon dioxide – lungs

water – kidneys

urea – kidneys

toxins/hormones/drugs – kidneys [8]

b Excretion is the removal of the waste products of metabolism and substances in excess of requirements. Egestion is the removal of undigested or unabsorbed food from the body as faeces. [4]

***3** **a** **i)** After eating meat the levels of urea would increase because meat contains proteins. The excess amino acids from digestion of the protein will be broken down to form urea, which is excreted in the urine. [3]

ii) There will be more glucose in the blood. Not all of this will be reabsorbed in the kidneys, so there will be more glucose in the urine (and there will be less conversion of glucose to glycogen). [3]

b The liver assimilates amino acids, converting them to proteins. Excess amino acids are deaminated (that is, the nitrogen-containing part is removed) to form urea. [3]

***4** Blood containing water passes from the aorta into the renal artery. It enters the kidney through capillaries in the cortex. These form a knotted glomerulus. The water is filtered into a renal capsule and passes through the nephron in the medulla (some water is reabsorbed), into a collecting duct, then into a ureter. It passes down into the bladder for storage. It is released into the urethra to be expelled. [6]

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***5 a** A – glomerulus, B – renal capsule/Bowman's capsule [2]

b i) An epithelium is a thin layer of cells forming a lining. [1]

ii) The microvilli increase the surface area of the epithelium so that substances diffuse through faster. [2]

c The high concentration of ions creates a lower water potential outside the tubule than inside, so that water moves out of the tubule by osmosis and is reabsorbed back into the blood. [3]

d The diameter of the image was 15 mm. This needs to be converted to micrometres.
15 × 1 000 = 15 000 µm.

The actual diameter was 150 µm.

Magnification = observed size ÷ actual size

= 15 000 ÷ 150 = ×100 [3]

14 Coordination and response

Test yourself questions

Page 216

1 Example of a table to compare neurones:

feature	**sensory neurone**	**motor neurone**	**relay neurone**
sensory receptor	At the start of the neurone, embedded in e.g. skin or muscle	not present	not present
cell body	to the side of the nerve fibre (in a ganglion) near the end connected to the central nervous system	at the end of the neurone inside the grey matter of the central nervous system	in the centre of the neurone inside the central nervous system
dendrites	present at the end of the neurone nearest the cell body	present at both ends of the neurone	attached to the cell body
length	can be very long	can be very long	very short
myelin sheath	may be present to insulate the fibre	may be present to insulate the fibre	none
direction of nerve impulse	from sense organs or sense receptors to the central nervous system	from the central nervous system to muscles or glands	from sensory neurones to motor neurones

2 a 0.001 s = 1.0×10^{-3} s

100 ms^{-1} = 1.0×10^{2} ms^{-1}

b The myelin sheath is made of fatty material which acts as insulation, so the nerve impulse does not leak out of the neurone. It makes transmission more efficient.

3 a A nerve fibre is part of a single cell and is microscopic (about 1–20 µm diameter). A nerve consists of hundreds of nerve fibres bundled together in a protective sheath and is visible to the naked eye (in dissections).

b i) A nerve fibre can carry only sensory or motor impulses, not both.

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ii) A nerve (a mixed nerve) can carry both sensory and motor fibres and so can transmit both sensory and motor impulses.

4 **a** The nervous system coordinates and regulates the body's functions.

b **i)** (central nervous system) brain, spinal cord

ii) (peripheral nervous system) nerves outside the brain and spinal cord

Page 218

5 Example of a mnemonic:

Stimulus	**S**top
Receptor	**R**ed
Sensory (neurone)	**S**eals
Coordinator	**C**hasing
Motor (neurone)	**M**y
Effector	**E**lderly
Response	**R**abbit

6 **D** Receptor organ stimulated.

B Impulse travels in sensory fibre.

E Impulse crosses synapse.

A Impulse travels in motor fibre.

C Effector organ stimulated.

Page 224

7 **a** A – iris, B – pupil

b The function of part A is to control the size of the pupil.

c Part B appears to be black because light entering the eye is not reflected back out.

d The blood vessels provide the cells of the eye with oxygen and nutrients.

8 **a** A sense organ is a group of receptor cells responding to a specific stimulus.

b Any three sense organs from:

- ear – sound/body movement;
- tongue – chemicals;
- nose – chemicals;
- skin – temperature/pressure/touch/pain.

9 **a** A – retina, B – optic nerve, C – lens, D – cornea, E – iris

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b Part C (the lens) is different from the lens in a camera because it is flexible and can change its shape. The lens in a camera is plastic/glass and is rigid with a fixed shape.

c If part B (optic nerve) becomes damaged, the person may become blind because no nerve impulses could pass from the eye to the brain.

Page 227

10 a i) endocrine system

ii) nervous system.

b Any three from:

Endocrine	**Nervous**
transmission of chemicals	transmission of electrical impulses
transmission through blood	transmission in nerves
slow transmission	rapid transmission
hormones dispersed throughout body	impulse sent directly to target organ
long-term effects	short-lived effects

11

hormone	**gland**	**function**
adrenaline	adrenal	increases heart rate
insulin	pancreas	controls levels of glucose in the blood
oestrogen	ovaries	prepares the uterus for implantation of an embryo
testosterone	testes	development of testes

12 The patient would not be able to produce insulin, so would be diabetic/could not control blood sugar levels, and may also have problems with digestion because the pancreas produces a number of digestive enzymes and sodium hydrogen carbonate to neutralise stomach acid.

Page 232

13 a Homeostasis is the maintenance of a constant internal environment.

b Insulin is secreted in response to a rise in blood glucose levels. It helps to bring the level of blood glucose back to normal.

***14** Put on more or warmer clothing, take shelter in a warm environment, drink hot drinks, make use of external sources of heat, vigorous exercise.

***15 a** Heat is one of the forms of energy produced by respiration (in both active muscles and all other tissues).

b The heat is distributed around the body by the blood circulatory system.

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***16 a** The hairs.

b Vasoconstriction, stop sweating.

***17 a** Sweat will not evaporate if the air around the body is very humid or still.

b Sweat will evaporate more rapidly if the humidity is very low and if there is air movement to carry the water vapour away.

Page 237

***18 a** Light restrains the extension of the shoot but makes the leaves turn green.

b In positive phototropism, the unidirectional stimulus of light could restrain the growth of the shoot on the illuminated side. This would have the effect of causing the shoot to grow towards the light source.

Practical work

Page 221

1 a It may be brown, blue, green or hazel.

b Black, although it does not really have a colour because it is a hole.

2 a percentage change = (change in size ÷ original size) × 100

[using values from the practical]

change in size = 10 − 2 = 8 mm

original size = 10 mm

percentage change = (8 ÷ 10) × 100

= 80% decrease in diameter

b The pupil would enlarge to allow more light to enter.

Page 234

3 The clinostat effectively removes the influence of gravity on the radicles.

4 The seedlings would grow vertically.

The seedlings would grow taller than those exposed to light.

Exam-style questions

Page 239

1 a A synapse is a gap between two neurones. [2]

b Diffusion [1]

c speed = distance ÷ time

2.0×10^{-2} μm ÷ 4.0×10^{-10} s = 50×10^{6} μm s^{-1}.

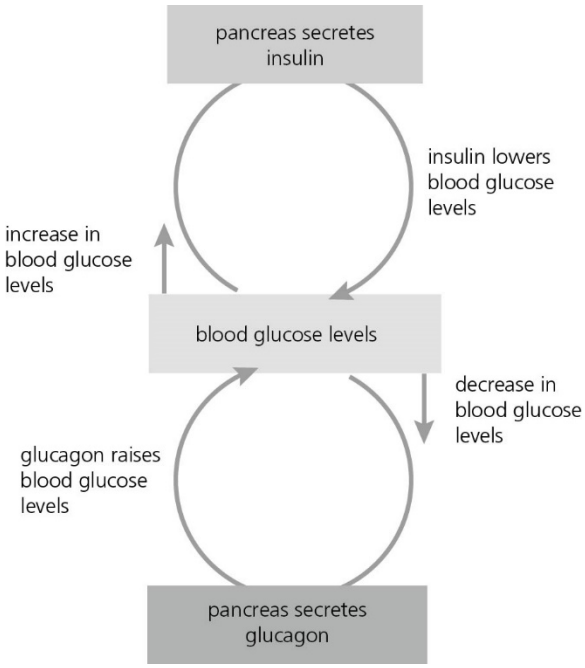
There are one million micrometres in a metre.

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$= 5.0 \times 10^3\ \mu m\ s^{-1}$

$5.0 \times 10^3 \div 1 \times 10^6 = 5.0 \times 10^{-3}\ m\ s^{-1}$ [3]

***2**



[4]

3 **a** **i)** Sensory and motor neurones are both single cells consisting of a cell body with a nucleus and a long nerve fibre usually running between the central nervous system and a peripheral structure. [4]

ii) Both neurones conduct electrical impulses. [1]

b Sensory neurones originate in a sensory structure and conduct impulses towards the central nervous system. Their cell bodies are not terminal, although they are still in the central nervous system. Motor neurones have their cell bodies in the central nervous system. They conduct impulses away from the central nervous system to an effector organ. [4]

4 **a** A reflex action is a means of automatically and rapidly integrating and coordinating stimuli with the responses of effectors. [3]

b **i)** stimulus → receptor → coordinator → effector → response [2]

ii)

		sensory neurone	relay neurone	motor neurone		
		↓	↓	↓		
stimulus →	receptor	→	coordinator	→	effector →	response

[3]

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c (sensory) receptor/pain receptor, is stimulated by/detects the sharp pin. An impulse is generated, which passes along a sensory neurone to the spinal cord. It links with a relay neurone through a synapse. The relay neurone links to a motor neurone through another synapse. The impulse travels to a muscle in the leg, which is the effector. It contracts, moving the leg away from the pin (the response). [9]

***5** **a** A synapse is a branch at the end of a neurone that is in close contact with the cell body/a dendrite of another neurone. The gap between them is called a synaptic gap/cleft. Vesicles in the cytoplasm of the first neurone contain neurotransmitter molecules. On the membrane of the neurone on the other side of the gap there are receptor proteins. [4]

b by diffusion [1]

c (advantage) The impulse can only travel in one direction.

(disadvantage) The impulse is slowed down. [2]

***6** **a** Table constructed with two headings and columns.

Any five parts and their functions from:

part of the eye	**function**
cornea	refracts light
iris	controls how much light enters the pupil
pupil	allows light to pass into the eye to reach the retina
lens	focusses light onto the retina
retina	contains light receptors which are sensitive to light
optic nerve	carries impulses to the brain
ciliary muscles	change the tension on the lens for focussing
suspensory ligament	attach the ciliary muscle to the lens

[5]

b Bright light stimulates cells of the retina. An impulse is generated that travels along sensory neurones to the central nervous system. The impulse then travels along motor neurones to the iris. Circular muscles contract, so the iris gets larger and the diameter of the pupil gets smaller. The process is a reflex action. [8]

***7** **a** **i)** They are both found in the retina, they are both light-sensitive cells. [2]

ii) (rods) Detect shades of grey, or are sensitive to low light intensity, and are distributed throughout the retina.

(cones) Detect colour, or are only sensitive to high light intensity, and are concentrated in the fovea. [2]

b Any three from:

- rods/cones/retina damaged – not receptive to light
- lens cloudy (cataracts)/damaged – light cannot pass through

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- cornea cloudy/damaged/scratched – light cannot pass through
- optic nerve damaged – no impulses transmitted to brain
- retina detached/neurones damaged – no impulses transmitted to the brain. [3]

***8 a** position 7 [1]

b The light is getting dimmer/light intensity gets lower. [1]

c The retina detects that the light intensity is increasing, sends an impulse to the CNS. An impulse is then sent back to the circular muscles of the iris, which are stimulated to contract, making the pupil smaller. [4]

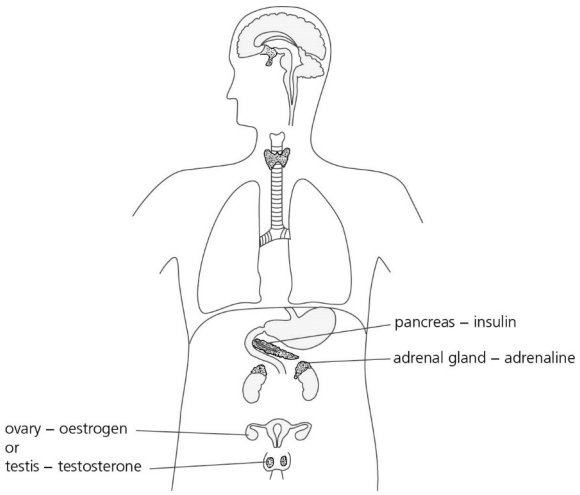
d i) reflex action [1]

ii) This response protects the light-sensitive cells of the retina from damage by bright light. [1]

9 a i) A chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs. [3]

ii) A system made up of ductless glands secreting hormones into the blood. [2]

b



[8]

***10 a** Increased heart rate to move blood faster. Blood brings more oxygen and glucose to the muscles. Increased breathing rate, so more oxygen brought into the blood and more carbon dioxide removed. [4]

b Increased sweating: sweat secreted from sweat glands onto the surface of the skin. Sweat evaporates, removing heat from skin. Vasodilation of arterioles, so more blood near surface of skin. Blood carries heat, so more heat lost. Skin hairs lower, so less insulation. [6]

***11 a** Homeostasis is the maintenance of a constant internal environment. [2]

b i) (glucose level rises) any 2 from: eating glucose, eating carbohydrate, becoming excited/nervous

ii) (glucose level falls) any 2 from: reduction in intake of carbohydrate, during exercise, no meals for a long time [4]

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c If the level is too low, adrenaline is secreted by the adrenal glands, glucagon is secreted by the pancreas, which stimulates the liver to convert glycogen to glucose.

If the level is too high, insulin is secreted by the pancreas, which stimulates the liver or muscles to convert glucose to glycogen. Cells stimulated to increase rate of respiration. [8]

12 a i) Roots respond to the directional pull of gravity (by growing towards it).

ii) Shoots respond to the direction of light (by growing towards it) and to the direction of gravity (by growing away from it). [2]

b i) (towards light) shoots

ii) (towards gravity) roots

iii) (away from gravity) shoots [3]

***13 a** Auxin is produced near the shoot tip, it moves to the shaded side of the shoot. The auxin speeds up cell elongation on the shaded side, so the shoot bends towards the light. The sprocess is called (positive) phototropism. [5]

b The shoot grows towards the light, so provides more light for photosynthesis. [2]

15 Drugs

Test yourself questions

Page 242

1 a

feature	**virus**	**bacterium**
size	0.15 µm	up to 5 µm (about 0.005 mm)
cell structure?	no	yes
genetic material	strand of RNA or DNA	strand of DNA
covering	protein coat (capsid)	cell wall
contain cytoplasm?	no	yes

b The scale for the bacterium is 0.001 mm. In standard form this is 1.0×10^{-3} mm.

The scale for the virus is 0.1 µm. In standard form this is 1.0×10^{-1} µm.

2 35 mm needs to be converted to µm. 35 × 1 000 = 35 000 µm

magnification = observed size ÷ actual size

magnification = 35 000 ÷ 2.0 = ×17 500

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***3** The first mutant appears after 40 minutes. From then it doubles in number every 20 minutes.

2^{20} is about one million, so the number of resistant bacteria will reach one million 20 periods of 20 minutes = 6 hours and 40 minutes after the first mutant appears: that is, 7 hours and 20 minutes from the time there was a single bacterium.

It will take 7 hours 20 minutes to reach one million mutated bacteria.

Exam-style questions

Page 245

1 **a** A drug is any substance taken into the body that modifies or affects chemical reactions in the body. [2]

b The treatment of bacterial infections. [1]

2 Antibiotics do not affect viruses. [1]

3 Over-use of antibiotics creates the risk of antibiotic-resistant bacteria developing. The antibiotics would then be ineffective against them. [2]

***4** Using an antibiotic only when essential can reduce the number of bacteria resistant to it. Such bacteria can pass antibiotic resistance on to other bacteria – harmless bacteria may pass resistance on to pathogens. If antibiotics are used frequently, some bacteria may acquire resistance to many antibiotics. [2]

***5** If a course of antibiotics is not completed some bacteria will not be killed but will have been exposed to the antibiotic. Some survivors may be drug-resistant mutants. They reproduce, and all the offspring will have antibiotic resistance. [4]

16 Reproduction

Test yourself questions

Page 252

1 Asexual reproduction in fungi involves the rapid production and release of large numbers of spores that can be distributed over a wide area and will grow rapidly into new individuals. Asexual reproduction in flowering plants takes place by relatively slow vegetative growth from the parent plant, eventually leading to the development of new plants not far from the parent.

2 Asexual reproduction does not involve gametes, meiosis or zygotes.

3 Rhizomes grow below the soil level and are unaffected by fire.

4 We use asexual reproduction in plants to produce new plants with all the characteristics of their parents, e.g. potatoes, strawberry plants. We also eat the products of asexual reproduction, such as potatoes and onions.

Page 262

5 sepal, petals, stamens, carpels

6 colour, scent, nectar

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7 **a** ovule

b ovary

8 **E** Anthers split open.

D Bee visits young flower.

A Bee gets dusted with pollen.

C Bee visits older flower.

B Pollen is deposited on stigma.

Page 266

9 The seedling will use the stored food for respiration to provide energy to drive all the processes involved in germination. The food provides the raw materials (proteins, carbohydrates, lipids) for the construction of new cytoplasm, new cells and new tissues, i.e. growth.

10 Once the first leaves appear in the seedling and start to produce food by photosynthesis, the seedling will become less dependent on the stored food.

11 **a** Warm, moist, well-aerated soil.

b By digging the soil, as this improves aeration and drainage.

Page 273

12 Sperm cells are much smaller than ova. They have much less cytoplasm, but they do have a long tail.

13 sperm duct, urethra

14 pelvic girdle, erectile tissue, foreskin, scrotum, rectum

15 A zygote can give rise to any of the tissues in the body and can grow into a complete organism.

16 vagina, cervix, uterus, oviduct

Page 275

17 Ovulating once per month, a woman with a reproductive life of 50 – 13 = 37 years might release 12 × 37 = 444 ova.

18 Menstruation results from a break-down of the uterine epithelium if fertilisation has failed. If fertilisation has taken place, the uterine lining will be retained and developed. (It is needed because it is the site of implantation of the embryo.)

***19**

hormone	**site of production in the menstrual cycle**	**site of production during pregnancy**
oestrogen	ovaries	ovaries
progesterone	corpus luteum	placenta

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Page 276

20 in the uterus, during birth, from the mother's milk

21 Any two from:

- avoid sexual intercourse, have one partner, practice safe sex e.g. condoms/Femidoms (female condoms)

22 HIV is a virus. Antibiotics only kill bacteria.

Practical work

Page 260

***1** It prevents the pollen from different species of flowers developing pollen tubes should it land on their stigmas.

Page 265

2 Two points from:

- same sized containers
- all containers kept at the same temperature
- all containers kept in the same light conditions
- all left for the same amount of time.

3 When the seeds in the carbon dioxide were transferred to the other container, with oxygen, they germinated.

4 Four points from:

- equal numbers of seeds
- in a number of rolls of blotting paper, e.g. 5
- leave each roll in place with a different temperature
- count the number of seeds germinated in each roll
- percentage germinated = (number germinated ÷ total number in roll) × 100.

5 One safety precaution for each:

a (growth of a pollen tube) Take care when handling cover slips and microscope slides to avoid cuts. Wash hands immediately if there is skin contact with sodium borate.

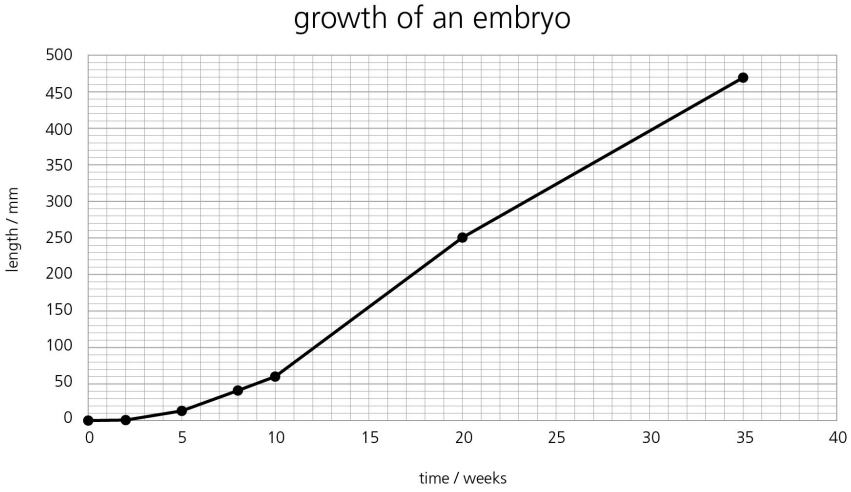
b (the need for water) Handle glassware with care. Wipe up spillages to avoid slip risk.

c (the need for oxygen) Wash hands immediately if there is skin contact with hydrochloric acid. Handle glassware with care.

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Worked example
Page 272

time/weeks	length/mm
0	0
2	1.5
5	12
8	40
10	60
20	250
35	470



1 a i) Length at 0 weeks = 0 mm, length at 5 weeks = 12 mm

Increase = 12 − 0 = 12 mm in 5 weeks

5 weeks = 5 × 7 = 35 days

12 ÷ 35 = 0.34 mm per day.

ii) Length at 15 weeks = 160 mm, length at 20 weeks = 250 mm

Increase = 250 − 160 = 90 mm in 5 weeks

90 ÷ 35 = 2.57 mm per day.

b Change in growth rate = 2.57 − 0.34 = 2.23 mm per day

% increase in growth rate = (change in growth rate ÷ starting growth rate) × 100

= (2.57 ÷ 0.34) × 100 = 756% increase in growth rate

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Exam-style questions

Page 279

1 **a** the stamens [1]

b the ovaries [1]

2 **a** Pollination is the transfer of pollen from an anther to a stigma.

Fertilisation is the fusion of the nuclei of gametes. [4]

b **i)** Yes, because the pollen can be transferred from an anther to a stigma but then fail to grow down to reach an ovule.

ii) No, because without pollination there would be no pollen nucleus to fuse with the ovule nucleus. [2]

3 **a** **i)** A – stigma, B – filament, C – anther [3]

ii) stamen [1]

b Wind pollination. The stigma is feathery and hangs out of the flower to catch pollen. The filament is long so that the stamens are outside the flower/exposed to the wind. The anthers are hanging so they are exposed to the wind. There are no petals. [5]

4

feature	**flowering plants**	**humans**
male reproductive organs	anthers	testes
female reproductive organs	ovaries	ovaries
male gamete	pollen nucleus	sperm
female gamete	egg cells in ovules	ovum
place where fertilisation occurs	ovules	oviduct
zygote grows into	seed	embryo/fetus

[5]

***5** Cuttings. If the mutant plant is self-pollinated it will not breed true and the offspring may show variation. If it can be reproduced by cuttings, the offspring will be identical and the mutant characteristic will be retained. [2]

***6** **a** Any three points from:

- asexual reproduction is rapid; only one plant needed; already in suitable habitat; no need to produce gametes; all plant's qualities passed to offspring. [3]

b reproduction is rapid; all features of parent plants are maintained in offspring. [2]

7 The umbilical vein will contain more oxygen, glucose, amino acids and mineral ions, and less carbon dioxide and urea (nitrogenous waste) than the umbilical artery. [4]

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***8 a i)** The placenta allows nutrients, oxygen and water to pass from the mother's blood to the blood of the fetus, and carbon dioxide and urea to pass from the blood of the fetus to the mother's blood. [3]

ii) Short distance for materials to travel, diffusion gradient maintained, large surface area. [3]

b The mother's blood group may be different from the blood group of the fetus and this could cause an immune response if they mixed. [2]

c Cigarette smoke contains toxins that can pass across the placenta to poison the fetus. If the mother contracted HIV, the virus could pass across the placenta and infect the fetus. [3]

9 a i) Any five parts from list below correctly identified and labelled (see Figures 16.39 and 16.40). [5]

ii) Any five from:

- prostate gland – adds fluids and nutrients to sperm to form semen
- urethra – passes semen (containing sperm) through the penis
- penis – inserted into vagina during sexual intercourse to transfer sperm
- scrotum – holds testes outside the body to keep them cooler than body temperature
- testis – produces sperm
- sperm duct – allows passage of sperm from testes to urethra [5]

b The mitochondria in the mid-piece of the sperm cell provides energy for the sperm to swim using their tail. They pass through the cervix and uterus, and then enter the oviduct. [4]

***10** The corpus luteum secretes progesterone, which maintains the thickness of the uterus lining. [3]

17 Inheritance

Test yourself questions

Page 284

1 The process of cell division in the testes rules out the possibility of X sperm only. There will be an equal number of X and Y sperm in the father's semen. There is a 50:50 chance of an XY or XX zygote, and the sequence of four girls is the result of chance alone.

2 The Y chromosome. A female (XX) is formed only when this chromosome is absent.

3 A chromosome is a molecule of DNA made up of sections, each of which is a gene.

4 Diagram drawn as in Figure 17.5.

***5** Each gene on a strand of DNA codes for one protein. The gene coding for the protein stays in the nucleus. A messenger RNA (mRNA) molecule is formed from the gene and carries a copy of that gene out of the nucleus, through a nuclear pore to the cytoplasm. The mRNA attaches itself to a ribosome. The ribosome uses the code from the mRNA to assemble amino acids into

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a protein molecule. The specific sequence of amino acids is determined by the sequence of bases in the mRNA.

Page 286

***6** Mitosis is nuclear division giving rise to genetically identical cells.

***7** **a** The exact duplication of chromosomes must take place; each chromosome remains joined to its copy at one point.

b During mitosis, the two copies of each chromosome (chromatids) separate. The daughter nuclei (each with the same number of chromosomes as the parent nucleus) separate and the cytoplasm divides.

c In a plant cell, a new cell wall develops to separate the two cells once the nucleus has divided. Vacuoles form in the cytoplasm of one of the cells. The animal cell does not have a cell wall or vacuoles, so these processes do not happen.

***8** **a** Stem cells are unspecialised cells that divide to produce daughter cells that can become specialised.

b Two sources of stem cells from:

- basal skin cells, red bone marrow, embryo.

Page 207

***9**

meiosis	**in a human**	**in a flowering plant**
site of meiosis	testes, ovaries	anthers, ovaries
products	sperm, eggs (ova)	pollen nuclei, egg cells

***10** The products of meiosis show variation, but the cells produced by mitosis are identical. The cells produced by meiosis are haploid (have half the number of chromosomes), while cells produced by mitosis are diploid.

Page 294

11 One possible choice is T for the dominant gene (allele) and t for the recessive gene.

12 Aa is heterozygous, AA is homozygous dominant and aa is homozygous recessive.

13 **a** Cob A: approximately 132 yellow, 47 black

Cob B: approximately 54 yellow, 53 black

b Cob A: 2.8 : 1

Cob B: 1 : 1

c **i)** yellow is dominant

ii) Y = yellow, y = black

d **i)** cob A parental genotypes: Yy and Yy

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ii) cob B parental genotypes: Yy and yy

e cob A – phenotype of both the parents was yellow, cob B phenotypes – one parent was yellow, the other was black.

Page 296

14 a i) H – hairy body, h – smooth body

ii) hairy bodied parent – HH, smooth bodied parent – hh

b i) parents: HH × hh

		HH	
		H	H
hh	h	Hh	Hh
	h	Hh	Hh

All offspring – Hh

ii) parents Hh × hh

		Hh	
		H	h
hh	h	Hh	hh
	h	Hh	hh

2 Hh to 2 hh = 1 : 1

***15** mother's genotype X^CX^C; father's genotype X^cY

		Mother X^CX^C	
		X^C	X^C
Father X^cY	X^c	X^CX^c	X^CX^c
	Y	X^CY	X^CY

The two girls have normal vision but are carriers. The two boys have normal vision.

Worked example

Page 293

1 a The parents did not show the symptoms of the disorder, but they have passed on alleles to their children so they must both be carriers (Cc).

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		carrier father Cc	
		C	c
carrier mother Cc	C	CC	Cc
	c	Cc	cc

b i) The ratio of phenotypes is 3 unaffected : 1 affected.

ii) The ratio of genotypes is 1 unaffected : 2 carriers : 1 affected.

2 a father cc, mother Cc

b

		affected father cc	
		c	c
carrier mother Cc	C	Cc	Cc
	c	cc	cc

i) The percentage = 50% with cystic fibrosis : 50% unaffected.

ii) The ratio is 1 : 1; 1 with disorder : 1 unaffected

However, the unaffected offspring will be carriers of the disorder.

Exam-style questions

Page 299

1 Tall is dominant, T = tall, t = dwarf, cross Tt (heterozygous tall) with tt (dwarf)

		heterozygous tall plant Tt	
		T	t
dwarf plant tt	t	Tt	tt
	t	Tt	tt

[5]

2 a i) A gene is a length of DNA that codes for a protein. An allele is an alternative form of a gene.

ii) An allele is dominant if it is expressed if it is present in the genotype. Recessive alleles are only expressed when there is no dominant allele of the gene present in the genotype.

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iii) Phenotype is the observable features of an organism. Genotype is the genetic make-up of an organism in terms of the alleles present. [6]

3 The gene for red, e.g. R, is dominant over the gene for white, r. [2]

4 **a** The gene for black hair is dominant over the gene for red hair, so the child would have) black hair. [1]

b bb (double recessive) [1]

c Yes, because if both parents are heterozygous (Bb) for black hair, there is a 25% chance of a child having red hair (bb). [1]

5 **a** Suitable example chosen, e.g. tall and short pea plants

Letters identified correctly, e.g. tall = T, short = t.

Tt × tt

		heterozygous tall plant Tt	
		T	t
dwarf plant tt	t	Tt	tt
	t	Tt	tt

This gives 2 tall (Tt) : 2 dwarf (tt), so 1 : 1.

b Tt × Tt

		heterozygous tall plant Tt	
		T	t
heterozygous tall plant Tt	T	Tt	Tt
	t	Tt	tt

This gives 3 tall (Tt) : 1 dwarf (tt), so 3 : 1. [8]

***6** **a** Co-dominance is a situation in which both alleles in heterozygous organisms contribute to the phenotype. [2]

b **i)** The woman must have the genotype I^AI^o and the man must be I^BI^o.

Half the eggs will be I^o, and half the sperm will be I^o.

If the I^o egg gets fertilised by the I^o sperm, the child will be I^oI^o, which is blood group O.

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		father I^BI^o	
		I^B	I^o
mother I^AI^o	I^A	$I^A\ I^B$	I^AI^o
	I^o	I^BI^o	I^oI^o

[6]

ii) 25% chance [1]

***7 a** A sex-linked characteristic is a feature in which the gene responsible is located on a sex chromosome. This makes the characteristic more common in one sex than in the other. [2]

b healthy: X^CX^C, X^CY

carrier: X^CX^c,

colour blind: X^cX^c, X^cY [5]

c The mother must be a carrier of the colour blindness condition: X^CX^c.

The father must have the healthy allele on his X chromosome: X^CY.

		father X^CY	
		X^C	Y
mother X^CX^c	X^C	X^CX^C	X^CY
	X^c	X^CX^c	X^cY

[5]

18 Variation and selection

Test yourself questions

Page 305

1 Discontinuous variation results in a limited number of phenotypes with no intermediates. Continuous variation results in a range of phenotypes between two extremes.

Discontinuous variation is usually caused by genes only, whereas continuous variation is caused by both genes and the environment.

2 Any two from:

- (discontinuous variation): ABO blood groups, tongue rolling, ear lobe type.
- (continuous variation): body height/length, body mass, shoe size, hand span.

***3 a** gene mutation

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b One of the bases has changed from T to C, ACG may code for a different amino acid to ATG, so the protein the gene makes could be different or faulty.

4 **a** In the whale, the humerus, radius and ulna are shorter, fingers are more spread out, bones appear to be fused together at joints. They do not have elbows.

b The limb is shorter, so the animal is more streamlined for swimming.

The bones are fused together, so stronger power strokes for swimming.

Fingers are more spread out, so bigger surface area of flipper to make swimming more efficient.

5 **a** (Long-eared bat) Gives out high-pitched sounds, has large ears and sensitive patches on its face to detect these and thus has the ability to feed in the dark; forearms are covered by a membrane to form a wing, fingers are very long to increase the surface area of wing; body is covered with fur for insulation.

b (Hare) Has fur for insulation; colour of fur provides camouflage; long ears to increase sensitivity to sound and vibrations; eyes on sides of head provide good all-round vision to increase awareness of predators; hind legs are very long for running and defence; may have the ability to change fur colour in winter to maintain camouflage.

c (Polar bear) Has a large surface area to volume ratio to reduce heat loss; small ears to reduce heat loss; two types of hair to maximise insulating properties; long hairs are oily and water-resistant to make it easier to shake off water after swimming; presence of blubber layer with limited blood supply keeps warm blood away from skin surface; hollow hairs transmit sun's heat to black skin, which is an efficient absorber of heat; white fur provides camouflage; heat-exchange system in blood vessels of legs and feet to reduce heat loss; fat reserves used by lactating females to form rich milk.

6 Assuming that it is the male who is competing, his plumage might be brighter and his song louder than his rivals. He might also be more aggressive towards his competitors, so leaving him space to attract a female. He might also have a more striking display pattern.

Page 314

7 Good characteristics could include fertility, growth rate, disease resistance, wool texture, wool length, tasty meat.

8 The plant breeder would begin by crossing the two varieties. The outcome would depend on which of the genes were dominant and which were recessive. (In fact, it would almost certainly be a group of genes for each characteristic.) Assuming that the long stalk gene (L) and the good ear genes (G) are dominant, the genotypes LLgg and llGG would produce LlGg offspring, which would combine both desirable characteristics but would not breed true. If the parents were heterozygous for the dominant gene Llgg and llGg, there would still be desirable combinations of L and G among the offspring but in much smaller numbers (one in four). The breeder would need to keep on breeding the plants until they breed true (i.e. are all LLGG).

***9** Some of the bacteria in the population may carry a gene that protects them from antibiotics. When the bacterial population is exposed to the antibiotics, most of the bacteria die, but those with the advantageous gene survive – survival of the fittest – and pass their genes on to future generations.

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Practical work

Page 303

1 *Answer below is based on Figures 18.2, 18.2 and 18.4. Those based on class data will vary.* Height shows continuous variation with heights distributed symmetrically about a mode of around 168cm. Tongue-rolling shows discontinuous variation with rollers to non-rollers appearing in the ratio of about 3:1. Blood group shows discontinuous variation with the ratio being roughly 1 AB : 2 A : 3 O : 4 B.

Note: this ratio will vary around the world. In England the ratio is 1 AB : 10 A : 13 O : 3 B.

2 Possible answers include hair colour, length of a given digit, earlobes attached or not, etc.

Exam-style questions

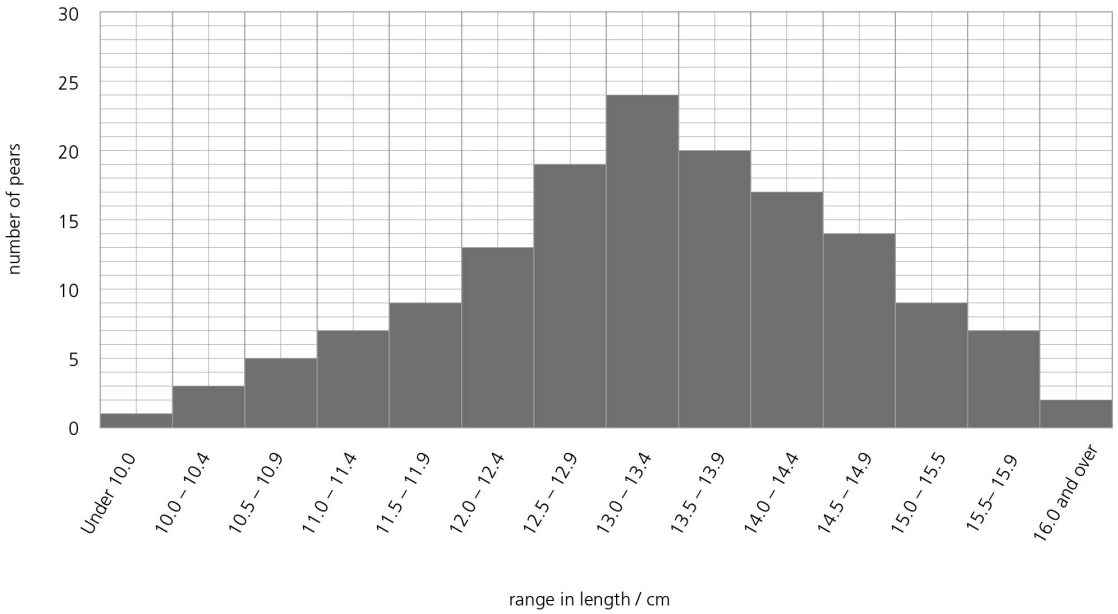
Page 316

1

adaptation	**function**
long roots	to find water
leaves curl up	to reduce transpiration/loss of water
thick cuticle in epidermis	to reduce evaporation of water
sunken stomata	to increase humidity, reducing transpiration
hinge cells	allow leaf to roll up
fine hairs on and around stomata	reduce air movement to reduce transpiration

[6]

2 **a** Graph with correct axes, labelled axes, correct plotting, plotted as histogram (blocks touch each other). [4]



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b i) 13.0–13.4 cm [1]

ii) continuous variation [1]

iii) Any three from:

- availability of water; availability of sunlight; availability of mineral ions; reference to disease; damage by pests. [3]

c Pollen may have come from other plants, reference to mutation. [2]

3 a i) genetic change [1]

ii) exposure to X-rays, UV light or other ionising radiation; exposure to certain chemicals/carcinogens, e.g. tar in cigarette smoke. [3]

b i) discontinuous variation [1]

ii) bar graph [1]

***4 a** short stem + large seeds, short stem + small seeds, long stem + large seeds, long stem + small seeds [1]

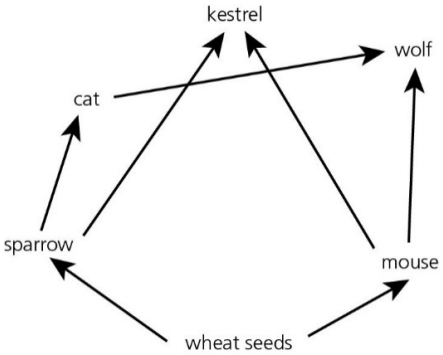
b short stem + small seeds, long stem + large seeds [2]

19 Organisms and their environment

Test yourself questions

Page 325

1 One possible solution:



2 The tree and grass depend on the soil for anchorage, water and mineral nutrients. The earthworm depends on the soil for making its burrows and for the humus it contains as a source of nutrients. The soil depends upon the fall of leaves from the tree to renew its humus content and the earthworm pulls leaves into its tunnels. The soil also depends on the earthworm's tunnels for drainage and aeration as well as the improvement and mixing of the soil structure that takes place as a result of it passing through the earthworm's alimentary canal.

The robin depends on the earthworms as a source of nutrition and the tree as a place to perch, make a nest and hide from predators.

3 Photosynthesis in grass → eaten by cow → milk from cow → converted to butter.

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Photosynthesis in wheat → production of wheat grains → eaten by chickens → lay eggs.

Photosynthesis in leaves of bean plant → seed production (beans).

4 (electric motor) Photosynthesis millions of years ago produced plants, which decomposed and fossilised to form petroleum or coal. Oil or coal is burned to raise steam and drive generators.

(car engine) Oil derived from fossilised plants (mainly algae or Protoctista) becomes petroleum. When this is distilled, one of the products is petrol.

(racehorse) Photosynthesis in oat plants results in the production of oat grains, which are eaten by racehorses and provide energy through respiration.

5 **a** and **b**

vegetation →	beetle →	snake →	eagle	
producer	primary consumer	secondary consumer	tertiary consumer	
vegetation →	beetle →	snake →	mongoose	
producer	primary consumer	secondary consumer	tertiary consumer	
vegetation →	beetle →	snake →	mongoose →	eagle
producer	primary consumer	secondary consumer	tertiary consumer	quaternary consumer
vegetation →	rat →	snake →	eagle	
producer	primary consumer	secondary consumer	tertiary consumer	
vegetation →	rat →	mongoose →	eagle	
producer	primary consumer	secondary consumer	tertiary consumer	
vegetation →	rat →	snake →	mongoose →	eagle
producer	primary consumer	secondary consumer	tertiary consumer	quaternary consumer
vegetation →	rat →	snake →	mongoose	
producer	primary consumer	secondary consumer	tertiary consumer	
vegetation →	hare →	mongoose →	eagle	
producer	primary consumer	secondary consumer	tertiary consumer	

6 Domestic carnivores such as cats can catch and eat organisms to the point that the population is drastically reduced. The animals above the victims in the food web will suffer or turn their attention to different prey.

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Goats can eat the parts of plants that are usually unaffected by the herbivores that were originally on the island. They may eat so much of the plants that they destroy the population altogether, or reduce it so much that it cannot support its natural population of herbivores or insects.

Page 328

7 **a** Carbon atoms form the 'backbone' of the molecules needed by living organisms for building all their body structures and supplying energy. For example, the glucose molecule $C_6H_{12}O_6$ has a C–C–C–C–C–C carbon 'backbone'.

b Glucose, sucrose, cellulose, starch, amino acids/proteins, fats (lipids).

c **i)** Animals get their carbon by eating plants or other animals.

ii) Plants get their carbon from carbon dioxide.

8 **a** $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

b $C + O_2 \rightarrow CO_2$

c $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

***9** The clover is a leguminous plant. These plants have root nodules which contain nitrogen-fixing bacteria. These bacteria can convert atmospheric nitrogen into nitrogenous compounds, which are needed for healthy growth. Grass does not have root nodules and therefore suffers from nitrogen deficiency.

***10** Nitrifying bacteria use ammonia from excretory products and decaying organisms as a source of energy. In the process they produce nitrates.

Nitrogen-fixing bacteria absorb nitrogen gas and convert it into compounds of ammonia.

Denitrifying bacteria obtain their energy by breaking down nitrates into nitrogen gas.

Page 336

11 A population is a group of organisms of one species, living in the same area at the same time.

12 Three points from:

- food supply, competition, predation, disease.

13 12 000 live births in a population of 400 000 is a birth rate of

(12 000 ÷ 400 000) × 1 000 = 30 per 1 000.

14 **a** An ecosystem is made up of the community of organisms in a habitat, plus the non-living part of the environment.

b A population consists of one species, a community consists of a number of species, including animals and plants.

15 **a** It takes about eight days for the mortality rate to equal the replacement rate.

b **i)** Approximately 6 per unit volume.

ii) About 194 per unit volume.

iii) There is no increase.

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c The population increases from about 30 to about 80 000 over a period of 2.5 days, so the average rate of increase (ignoring the 30) is 80 000 ÷ 2.5 = 32 000 per day.

***16 a** Few numbers of both populations, so no competition, e.g. for food.

b i) The stationary phase.

ii) The number born equals the number dying.

c *P. caudatum* is in competition with *P. aurelia* for food, but *P. aurelia* can ingest it faster, so the population of *P. caudatum* is beginning to fall because of lack of food.

d As the scale is linear and not logarithmic, we cannot tell if the increase in the population of *P. aurelia* goes through a strictly exponential phase. However, there is a lag phase for the first 2 days and a steady state by day 15, with the most rapid growth from days 3 to 8.

Worked example

Page 321

1 One possible chain is:

lime tree →	caterpillar →	lizard →	snake
producer	primary consumer	secondary consumer	tertiary consumer

2 a The number of organisms at each level.

b The top band of the pyramid (the fleas) would be much wider than the previous band (the hawks).

c Fewer robins, because there are no worms to feed on.

Fewer hawks, because there are fewer robins to feed on.

Exam-style questions

Page 338

***1 a** A trophic level is the position of an organism in a food chain, food web, pyramid of numbers or pyramid of biomass. [2]

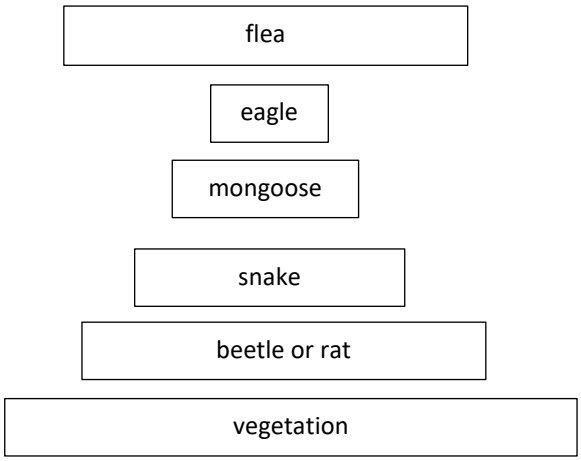
b Only about 10% of the energy available in a trophic level is passed on to the next level, so there is not enough energy to support any more levels. Animals at the top levels tend to be large, so need a lot of food. [2]

c i) vegetation → beetle or rat → snake → mongoose → eagle [2]

ii) fleas (or any other small parasite) [2]

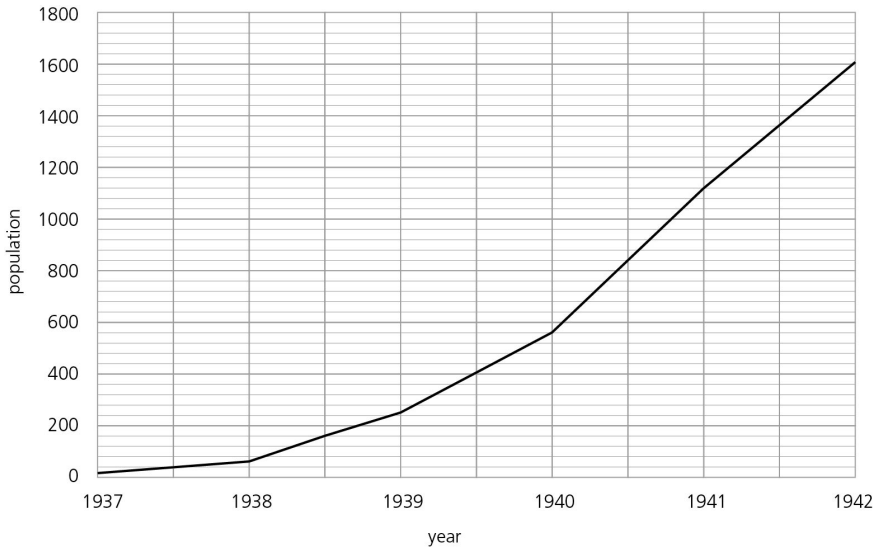
iii) Pyramid showing the food chain.

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[2]

2 Depending on the scales chosen, the graph should look like this:



It broadly fits the first two sections of the sigmoid curve (lag phase and exponential phase). There is likely to be a continued increase in the growth rate until the pheasant population reaches equilibrium with its resources. [6]

3 **a** A food chain shows the transfer of energy from one organism to the next, beginning with a producer.

A trophic level is the position of an organism in a food chain. [4]

b **i)** Named habitat.

Example of a food chain with at least four suitable organisms, beginning with a producer, with arrows pointing in the correct direction. [2]

ii) At least four trophic levels identified under the food chain. [4]

iii) Pyramid of numbers drawn, with at least four levels. Organism identified for each level. Levels get progressively smaller up the pyramid, unless a parasite has been used, e.g. flea. [3]

4 **a** **i)** Herbivore – an animal that gets its energy by eating plants. [2]

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ii) hare, beetle, rat [3]

iii) The eagle feeds at three levels:

secondary consumer (rat, hare)

tertiary consumer (mongoose, snake)

quaternary (mongoose through snake). [3]

b i) The populations of snakes and mongooses would go down because the eagle cannot feed on rats. The populations of hares and beetles may increase because the rats would not be in competition for the vegetation. [3]

ii) The populations of snakes and mongooses would increase because they do not have any predators. As they increase, the populations of hares, rats and beetles may decrease because there would be more snakes and mongooses feeding on them. [3]

5 a i) photosynthesis [1]

ii) respiration, decomposition, combustion/burning [1]

b) When conditions do not support decay, e.g. lack of oxygen, very dry or lack of decomposers, carbon in dead organisms gets trapped and decompressed. It eventually forms fossil fuels, e.g. coal, gas, oil. Some animals make shells or exoskeletons of calcium carbonate, containing carbon. These can become rock or fossils. [3]

***6** Nitrogen-fixing bacteria/lightning converts nitrogen in the air to nitrate. It is taken in by the roots of a plant by diffusion/active uptake. It moves up the xylem and is converted to plant protein. The plant is eaten by a herbivore and digested, using protease. The amino acids are absorbed into the blood stream and transported to the muscle. The amino acids are assimilated to make muscle protein. [9]

***7 a)** bacteria/fungi decompose dead material/organisms; they respire, producing carbon dioxide. [3]

b) Nitrogen-fixing bacteria take in gaseous nitrogen and convert it into nitrogen compounds. Nitrifying bacteria change the nitrogen compounds into nitrates that plants can absorb. Other bacteria/fungi are involved in the decay of dead organisms. Denitrifying bacteria break down nitrates to release nitrogen back into the atmosphere. [3]

20 Human influences on ecosystems

Test yourself questions

Page 343

1 a As the world's population rises there is an increased demand for food. Fertilisers increase crop yield. Using fertilisers can increase crop yield and a farmer's profits.

b When the crop is removed there is not enough organic matter to replace the nutrients in the soil. Sometimes another crop is planted on the same land immediately after the first crop has been removed, so the soil does not have time to recover. Animal manure is not always available in large enough quantities. The use of artificial fertilisers has increased to provide the nutrients for the next crop that is planted.

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c Use of animal manure, compost (broken down plant material), crop rotation involving plants with root nodules containing nitrogen-fixing bacteria, e.g. peas, beans, clover.

2 **a** A monoculture is a crop of a single species of plant. (Herbicides are used to prevent other plants growing and competing with the crop plant.)

b Herbicides are used to kill competing plants, so the biodiversity of plants is decreased. This reduces the range of animals because they do not have food, including flowers to collect pollen or nectar from. Sometimes pesticides are used; these kill off insects, affecting food chains.

Page 349

3 The trees intercept the rain and allow it to soak into the ground but not wash the soil away. Their roots also help to keep the soil together.

4 The furrows should run at a right angle to the direction of the slope, i.e. along contours. This helps to retain rain. If the furrows ran downhill, heavy rain could form channels and carry the soil away.

5 **a** On a hillside, the trees intercept heavy rain and allow it to soak into the soil. Removal of trees allows the rainwater to run off the slopes and flood the valley beneath. Rainwater run-off also causes soil erosion.

b Clear-felling the trees leaves huge areas of ground unprotected. The transpiration from the trees previously created water vapour, clouds and local rainfall. The bare soil heats up in the sunlight, disperses local cloud cover and reduces rainfall.

6 The mercury was taken up by the food chain and accumulated in fish until it reached levels where it was poisonous to those who ate the fish.

7 Extinction can result from excessive hunting, destruction of habitats, and introduction of alien species.

Page 354

8 **a** The term *non-biodegradable plastic* means a plastic that cannot be broken down by living organisms, so it causes pollution.

b **i)** Terrestrial ecosystems – fills up landfill, taking up valuable space; causes visual pollution; can trap small animals; if burned, causes air pollution.

ii) Aquatic ecosystems – causes problems for aquatic organisms, e.g. trapping mammals or seas birds; getting stuck in the stomachs of animals and making them ill; gradually breaks down into tiny pieces, which block the gills of fish and filter-feeding animals. Even smaller pieces may be absorbed into tissues and accumulate in the food chain with effects that are not yet known.

9 The use of alternative and renewable energy sources does not tend to generate waste products to the same extent as coal and oil. When coal and oil are burned they produce waste products, e.g. sulfur dioxide, oxides of nitrogen, and carbon dioxide. Alternative energy, such as wind farms and solar energy, generate no waste products. Burning wood and other biomass does not produce sulfur dioxide or oxides of nitrogen.

10 Carbon dioxide and methane both absorb long-wave radiation reflected from the Earth's surface and cause the atmosphere to warm up.

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11 a Biodiversity means the number of different plant and animal species that live in an area.

b A sustainable resource is defined as one which is produced as rapidly as it is removed from the environment, so that it does not run out.

12 a Logging for timber, cutting down trees to make way for agriculture, destruction of trees for firewood.

b Forest trees reduce erosion on sloping ground; their absorption of water and transpiration can affect the local climate; on a global scale, they help to slow down global warming by absorbing huge amounts of carbon dioxide; forests offer a habitat for a wide variety of animals not found elsewhere.

***13 a** education, enforcement of closed seasons, designating protected areas, control of fishing net types and mesh size, setting quotas for fish catches, monitoring of fishing.

b Three points from:

- maintaining/increasing biodiversity; reducing extinction; protecting vulnerable ecosystems; maintaining ecosystem functions, e.g. nutrient cycling or resource provision.

Page 362

***14** CITES concentrates on banning trade in endangered species by persuading countries to pass laws forbidding such trade. WWF adopts a variety of strategies for protecting endangered plants and animals: for example, they may attempt to prevent excessive hunting or the destruction of habitats. Both organisations may attempt to get laws passed to restrict human activities that threaten wildlife, and both are dedicated to the preservation of biodiversity.

***15 a** The extinction of certain wild plants may deny us the chance to develop new drugs from their products.

b If a plant becomes extinct, its genes are lost forever. Some of these genes (For example, those from drought-tolerant plants) could have been introduced to crop plants to make them more resilient.

16 a A sustainable resource is one which is produced as rapidly as it is removed from the environment, so that it does not run out., e.g. any named plant product, such as wood or paper made from fast-growing trees.

b i) Three points from:

- climate change, habitat destruction, hunting, overharvesting, pollution, introduced species

ii) named endangered species, e.g. giant panda, tiger

Monitoring the species; strategy for protecting the species; protecting the habitat; education; captive breeding programme; seed bank (for plant example).

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Exam-style questions
Page 364

1 **a** Advantages: Any three from:

- crop pests killed, results in healthier crops, higher yields, higher profits.

Disadvantages: Any three from:

- kills useful insects, named example, e.g. bees, may result in break-down of food chain, chemicals may accumulate in soil/water. [6]

b Any five points from:

- systemic pesticides diffuse into the leaf; pass along the xylem; to new growth area; pass into phloem; pesticides enter pest when it feeds on plant tissue; pesticide not toxic to plant. [5]

2 **a** Any four points from:

- possible flooding, soil erosion by wind, soil erosion by water, less protection from wind, climate change (temperature/rainfall/greenhouse effect). [4]

b Any four points from:

- habitat destruction, reduced biodiversity, extinction, animals move to farmland to feed, plants have no soil to grow due to soil erosion, shortage of insects to pollinate flowers, destruction of food chains. [4]

3 **a** plankton → small fish → large fish → (local) people [3]

b the levels of mercury in the body tissues of local people [2]

c increase = 10 000 − 80 = 9 920

% increase = (increase in mercury level ÷ starting mercury level) × 100

= (9 920 ÷ 80) × 100 = 12 400% [2]

d **i)** Cannot be broken down by decomposers (or named type of decomposer, e.g. fungi or bacteria), so will persist in the environment. [2]

ii) Any three from:

- will not break down/rot; litter/visual pollution; takes up space in landfill sites; can trap animals on land/in water; blocks fish gills; forms toxic gases when burned. [3]

4 Paper is made from trees. Trees can be produced as rapidly as they are removed from the environment, so they will not run out. Waste paper can be recycled. [3]

***5** Information in the form of a flow chart:

increased availability of nitrate (or phosphates), with a named source, e.g. sewage or nitrates from fertilisers,
increased growth of producers,
increased decomposition after death of producers,
increased aerobic respiration by decomposers,
reduction in dissolved oxygen,

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death of organisms/named organisms, e.g. fish, that need dissolved oxygen in water. [8]

21 Biotechnology and genetic modification

Test yourself questions

Page 3370

1 Bread-making makes use of the micro-organism yeast. Some of the starch in the flour is broken down by amylases present in the flour, forming sugar. The yeast respires using the sugar (and any sugar that has been added), producing carbon dioxide and ethanol. This process is called fermentation. The carbon dioxide makes the dough rise. Gluten is a protein present in the dough, giving it an elastic texture and trapping the bubbles of gas. When the dough is cooked, the heat kills the yeast and evaporates the ethanol.

2 DNA in a bacterium is in the form of a single chromosome, consisting of a circular strand. It is not contained by a nuclear membrane. DNA in animal cells is in the form of several chromosomes enclosed by a nuclear membrane.

3 Bacteria reproduce more rapidly (every 20 minutes), so any changes made to the DNA will be quickly copied. There are no ethical issues about modifying the DNA of bacteria.

***4** Lactase is used to remove lactose in milk. The lactase breaks down the lactose to glucose and galactose (monosaccharides). These sugars in the milk do not cause digestive problems in lactose-intolerant people. A large-scale method is to immobilise the lactase on the surface of beads. The milk is then passed over the beads and the lactose sugar is effectively removed. In this method, the enzyme remains on the beads and so avoids it being present in the milk.

Page 375

5 **a** The gene for the protein (e.g. insulin) is inserted into bacteria that then secrete the protein.

b Use a gene for a toxin from a bacterium and insert it into crop plants using a bacterial vector. The plants then produce the toxin and are so protected from attack from insect larvae.

c Insert genes for producing the protein, vitamin, (e.g. vitamin A or E), or mineral ion (e.g. iron) as above to boost levels in the crop plant.

***6** Some advantages and disadvantages of genetically modified (GM) crops are listed below:

Advantages	**Disadvantages**
GM crops are usually designed to increase yields	Vectors for delivering recombinant DNA contain genes for antibiotic resistance that could be transferred, potentially making harmful bacteria resistant to antibiotics
Food from GM crops can contain higher levels of proteins, mineral ions or vitamins than food from non-GM crops	GM crops may contain pesticide residues or substances that cause allergies

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Advantages	Disadvantages
GM crops can contain herbicide-resistant genes, so they can be sprayed with herbicides without them being damaged	The introduction of GM varieties could lead to a reduction in biodiversity
GM crops can carry pesticide genes to protect them from insect pests	Genes introduced to plants may escape to wild varieties, producing superweeds
Genes coding for drought resistance can be introduced into GM crops so they can be grown in dry places where other crops cannot survive	The precursor of vitamin A in golden rice may change into another, toxic, chemical once eaten
Fruit can be modified so it can be stored for longer without [over]-ripening	Insects can develop immunity to pesticide genes in GM crops
Crops such as oilseed rape can be modified so they are more suitable for manufacturing chemicals such as detergents	Subsistence farmers could be tied to large agricultural suppliers who may manipulate seed prices

***7** Genes that are responsible for producing a vitamin or mineral are identified. The gene is removed from a cell of the organism where it is found and inserted into a different crop species, e.g. rice, which grows well in the region where there is a vitamin or mineral deficiency and is eaten in substantial amounts by the local population. The consumers of the crop then benefit from the extra nutrients, and deficiencies are prevented.

Practical work

Page 377

1 Two points from:

- use the same variety of apples/apple purée for all temperatures
- weigh the pectinase – same mass for each temperature
- stir each mixture for the same amount of time
- leave for the same amount of time.

2 Each piece of cloth could be weighed on a top-pan balance before the investigation. After the investigation, each piece of cloth should be dried, then weighed again. Then calculate the percentage loss in mass and compare these for the different temperatures.

***3 a** Use Benedict's test. Add 2 cm^3 Benedict's solution to an equal volume of the sample. Heat the mixture gently. If glucose is present the colour will change from clear blue to cloudy green, then yellow, and finally to a red precipitate.

b If a sample contained a lot of glucose it would go red, but if it only contained a trace of glucose it would only turn cloudy green.

Exam-style questions

Page 379

1 a V = cell wall, W = plasmid/circular DNA, X = cytoplasm, Y = DNA strand/chromosome. [4]

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b Two points from:

- bacterial cells reproduce quickly
- there are no ethical issues when using bacteria
- bacteria contain plasmids into which genes can be inserted
- bacteria have the ability to make complex molecules, e.g. proteins. [2]

2 a i) ethanol

ii) carbon dioxide [2]

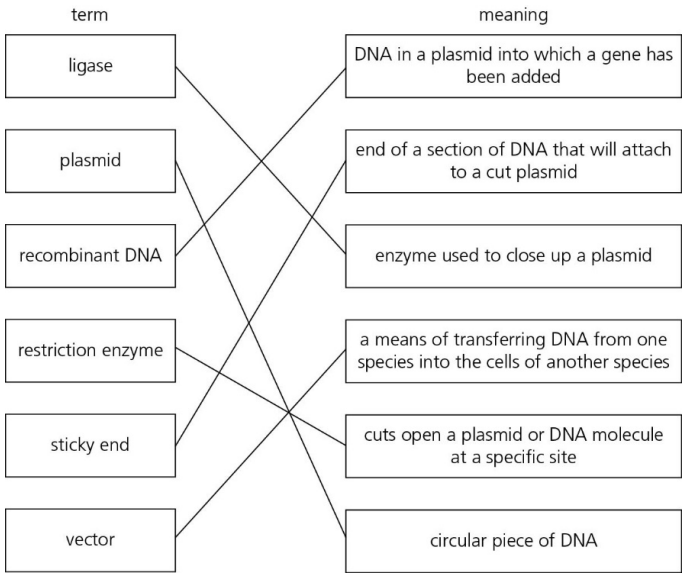
b Biological washing powders contain enzymes. The enzymes can digest any proteins or fats which are present in the stains making them more easily removed from the fabric/more soluble. They are effective at low temperatures. [4]

3

	present in	
cell part	bacterial cell	animal cell
cell wall	✓	×
membrane	✓	✓
nucleus	×	✓
plasmid	✓	×
cytoplasm	✓	✓

[5]

***4** Match the terms to their meanings.



[6]

***5 a i)** provides oxygen

ii) contains nutrients for the growth of the bacteria

iii) mix the bacteria and nutrients/distributes the oxygen through the liquid

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iv) monitors the temperature of the liquid

iv) separates the insulin from the bacterial residue. [4]

b i) To make sure there are no foreign bacteria or fungi to interfere with the process. [1]

ii) There may be traces of antibiotic present. If this got into any organisms, bacteria could become resistant to the antibiotic. [2]

iii) The bacteria are respiring aerobically, which produces heat. If the liquid gets too hot, the bacteria could die. [3]

***6 a** Changing the genetic material of an organism by removing, changing or inserting individual genes. [2]

b i) ligase, restriction enzyme. [2]

ii) Ligase – is used to close up a plasmid when a piece of DNA has been inserted.

Restriction enzyme – is used to cut open a plasmid or DNA molecule at a specific site, so isolating a gene and leaving it with sticky ends. [3]

***7** Any two advantages from:

- They can increase yields.
- Food grown can contain higher levels of proteins, minerals or vitamins than food from non-GM crops.
- They can contain herbicide-resistant genes, so they can be sprayed with herbicides without them being damaged.
- They can carry pesticide genes to protect them from insect pests.
- Genes coding for drought resistance can be introduced into them so they can be grown in dry places where other crops cannot survive.
- Fruit can be modified so it can be stored for longer without [over]-ripening.
- Crops such as oilseed rape can be modified so they are more suitable for manufacturing chemicals, e.g. detergents.

Any two disadvantages from:

- Vectors for delivering recombinant DNA contain genes for antibiotic resistance. These could be transferred, potentially making harmful bacteria resistant to antibiotics.
- They may contain pesticide residues or substances that cause allergies.
- Their introduction could lead to a reduction in biodiversity.
- Genes introduced to plants may escape to wild varieties, producing superweeds.
- The precursor of vitamin A in golden rice may change into another, toxic, chemical once eaten.
- Insects can develop immunity to pesticide genes in GM crops.
- Subsistence farmers could be tied to large agricultural suppliers who may manipulate seed prices. [4]

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Theory past paper and exam-style question answers

Cambridge Assessment International Education bears no responsibility for the example answers to questions taken from its past question papers which are contained in this publication.

1 Characteristics and classification of living organisms

Page 380

1 a i) **One** point from:

- fur, or hair
- (external) ears
- mammary glands

ii) **Two** points from:

- give birth (to live young)
- suckle young, or, or feed young on milk
- inner ear ossicles
- differentiated teeth
- sets of teeth (deciduous and permanent)
- diaphragm
- sweat glands
- sebaceous glands

b i) bison

ii) 3 600 (kg)

iii) number between 1 300–1 400 (kg)

iv) the large(r) the body mass, the long(er) the life span

c **Three** points from:

- water, or potable water, or clean water, or drinkable water
- adequate food supply, or balanced diet, or eating healthily, or access to food, or no famine
- medical facilities, or doctors, or hospitals, or treatments
- personal hygiene
- sanitation, or sewage treatment, or removal of rubbish
- exercise facilities, or taking regular exercise
- shelter from elements; or housing
- absence of pollution; or safe or clean environment
- use of modern technology
- improved education; or schools
- avoidance of smoking, or alcohol, or drugs

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- avoidance of hazardous behaviour, or promiscuity, or risky activities, or crime; or no war
- reduction in poverty

***2**

difference	**monocotyledons**	**eudicotyledons (dicotyledons)**
number of cotyledons in the seed	1	2
pattern of leaf veins	parallel	branching, or network
number of petals present	three, or multiples of three	five, or multiples of five

3 Any **four** correct from:

A *M. ermine*

B *V. vulpes*

C *O. cuniculus*

D *M. vison*

E *M. leucurus*

***4** G *Nymphaea alba*

H *Lupinus arboreus*

J *Plantago maritima*

K *Plantago lanceolata*

L *Ilex aquifolium*

M *Trifolium pratense*

1 correct = 1 mark; 2 correct = 2 marks; 3 correct = 3 marks; 4 or 5 correct = 4 marks; 6 correct = 5 marks

2 Organisation of the organism

Page 382

1 **a** **i)** A – membrane
B – cytoplasm

ii) DNA

b (diffuses in)

oxygen, or glucose

(diffuses out)

carbon dioxide, or water

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c Accept reverse arguments **One** point from:

- diffusion is passive, or does not need oxygen, or respiration, or energy
- diffusion involves movement (of particles) from high to low concentration, or down a concentration gradient

2 a i) C – cell wall

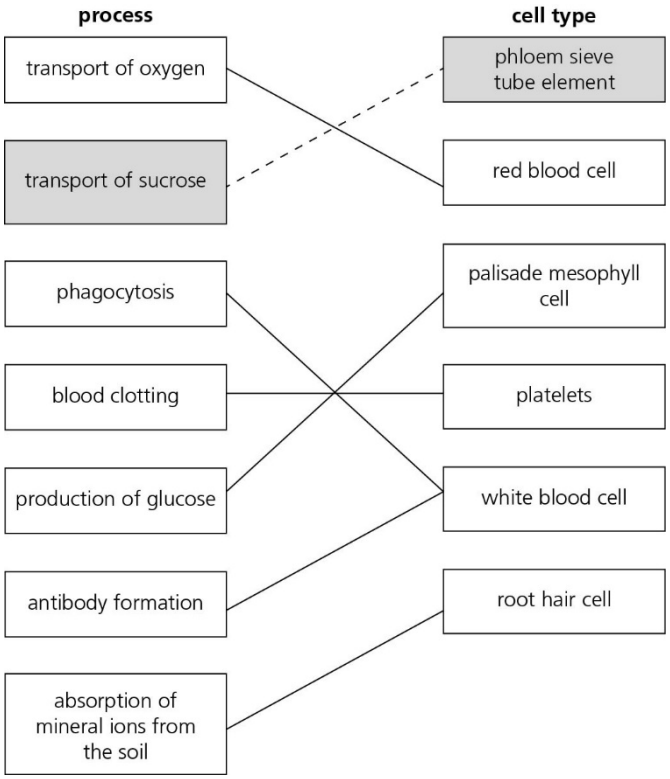
D – vacuole

ii) processes: photosynthesis

animal dependence **Four** points from:

- chloroplasts contain chlorophyll to absorb, or use, or trap light or energy
- produce glucose, or carbohydrate, or food; or plants are producers
- photosynthesis removes carbon dioxide or adds oxygen
- primary consumers, or herbivores or animals, gain energy, or food, as they eat plants or producers
- secondary consumers, or carnivores, eat herbivores or primary consumers or other animals
- animals need, or use, oxygen for respiration

3 a



b i) line ending on a guard cell labelled G

line ending on a stoma labelled S

ii) gas exchange, or diffusion of gases, or for transpiration, or movement of correct substance in correct direction described

4 a i) in the blood (stream)

ii) in a leaf or palisade layer

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b Words below in gaps in this order:

- wall
- cellulose
- chloroplasts
- vacuole
- cell sap

c **i)** kidney, or bladder, or ureter, or urethra labelled

ii) Any **three** from:

(named organ)

- composed of different tissues
- tissues together carry out a function

(excretory system)

- composed of two, or many, organs
- carrying out separate functions
- functions combining to achieve major process

3 Movement in and out of cells

Page 384

1 **a** Any **two** from:

- the movement of molecules
- from a region of higher to a region of lower concentration
- this movement is random

b **i)** any four points plotted accurately

remaining four points plotted accurately
line of best fit drawn and labelled

ii) sample C

iii) sample B

as the rate of diffusion was fastest

c only water molecules move in osmosis

a partially permeable membrane is needed for osmosis

***2** **a** **i), ii)**

- (resist turgor pressure of the cell): A cell wall
- (controls the activities of the cell): C nucleus
- (site of chemical reactions): D cytoplasm

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b i) **Three** points from:

- cytoplasm, or vacuole, decreases in size or volume
- cell membrane, or cytoplasm, pulls away from cell wall
- plasmolysis, or cells are plasmolysed
- cells are flaccid, or not turgid, or lose turgor
- cell walls no longer pushed outward, or withstand pressure

ii) **Three** points from:

- salt solution has a lower water potential than the cell
- water moves out of the cells by osmosis
- down a water potential gradient, or from a high(er) water potential to a low(er) water potential
- through a partially permeable membrane

***3 a** **Three** points from:

(lungs)

- oxygen
- from alveolus or air sac
- to blood (capillary)

OR

- carbon dioxide
- from blood (capillary)
- to alveolus or air sac

b **Three** points from:

(small intestine)

- glucose, or amino acids, or mineral ions
- from lining of small intestine, or villus
- into blood (plasma)

c **Three** points from:

(kidney)

- glucose or urea
- from glomerulus
- into nephron or Bowman's capsule

OR (for glucose)

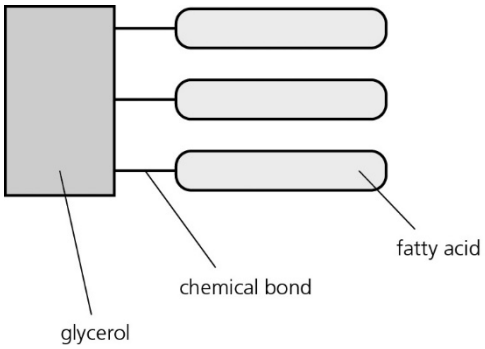
- glucose
- from nephron or tubule
- into blood (plasma)

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4 Biological molecules

Page 385

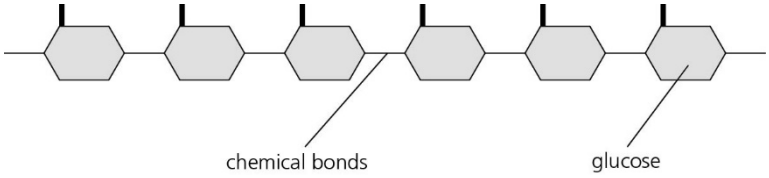
1 **a** (fat)



correct diagram

correct labels

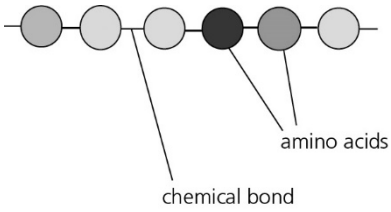
b (carbohydrate polymer, e.g. starch)



correct diagram

correct labels

c (protein)



correct diagram, showing range of amino acids

correct labels

***2** **a** **Three** points from:

- two strands
- coiled together, or double helix
- each strand contains bases
- bonds between pairs of bases
- A bonds with T, C bonds with G

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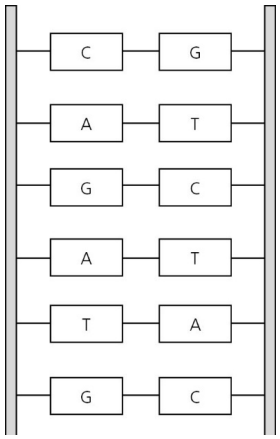
b controls production of proteins

- **Two** points from:
- enzymes
- haemoglobin
- membrane carriers
- neurotransmitters

c **i)** correct in the sequence (from the top) G T C T A C

One mark each for:

- G
- T x 2
- C × 2
- A



ii) **Two** points from:

the sequence of bases determines the sequence of amino acids

to make a specific protein

different sequences of amino acids give protein molecules with different shapes

***3** C lipase

5 Enzymes

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1 **a** **Two** points from:

protein

acts as a (biological) catalyst

speeds up, or alters, rate of (chemical) reaction; or is not altered, or used up, by reaction

b L: pH 2

M: pH 8

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c

name of enzyme	**substrate**	**one end-product**
amylase	• starch	• maltose or glucose
lipase	• fat	• glycerol or fatty acids
protease	• protein	• amino acids

6 Plant nutrition

Page 386

1 a

cuticle	waterproofs the leaf
stoma	allows gaseous exchange with surroundings
palisade cell	produces glucose
phloem tissue	transports sugar out of the leaf
spongy mesophyll	allows diffusion of gases within the leaf

1 correct = 1 mark; 2 correct = 2 marks; 3 correct = 3 marks; 4 or 5 correct = 4 marks

b transport of minerals, or ions, or named mineral or ion (into the leaf)

support

c starch or sucrose

d **Two** points from:

- evaporation of water
- from the surfaces of mesophyll cells
- (followed by) loss of water vapour
- out of stomata

2 a i) X = epidermis

Y = palisade (mesophyll)

ii) to let light through, or so light can reach (palisade) mesophyll cells or chloroplasts

b i) Z = stoma

ii) diffusion

iii) carbon dioxide into leaf

oxygen out of leaf

water vapour out of leaf

c i) glucose

oxygen

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ii) chlorophyll

***3** **a** **i)** **Two** points from:

- maintain constant temperature, or prevent heat from the lamp heating the sodium hydrogencarbonate solution, or water absorbs heat from the lamp, or water acts as a heat shield
- (thermometer) to measure water temperature
- prevent temperature (change) affecting the results or the rate of photosynthesis
- temperature is controlled or a controlled variable

ii) **Two** points from:

- maintain constant light intensity
- (light meter) to measure the light intensity
- prevent light intensity (change) affecting the results or the rate of photosynthesis
- make sure the lamp is always in the same place, or at right distance
- light intensity is dependent on distance
- light intensity is controlled or a controlled variable

b **i)** **Three** points from:

Rate, or photosynthesis, or bubbles:

- at first increases as carbon dioxide concentration increases or increases with concentration to 0.40%
- and then levels off or rate remains constant above 0.40%
- initially, or up to 0.1%, increase is low or little
- one data point quoted with CO_2 concentration and rate with units

ii) carbon dioxide concentration, or %, or level, or availability

iii) **Four** points from:

- reference to limiting factor in suitable context
- light level or intensity could be limiting
- reference to light providing energy for photosynthesis
- temperature could be limiting
- reference to temperature influencing the activity of enzymes
- chloroplast, or chlorophyll, concentration, or number of leaves, or size of plant, could be limiting factor

c **Three** points from:

- measure volume (of oxygen, or gas)
- use inverted test tube, or measuring cylinder, or syringe (barrel)
- with graduations, or markings
- filled with water
- attached by (delivery) tube to flask
- gas collects (at the top) and pushes out the water or gas syringe
- oxygen sensor
- data logger for any other suitable electronic method
- reference to equilibration, or process described
- reference to time period

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d **i)** **Two** points from:

- use, or combustion, or burning, of fossil fuels
- reason for increased demand for energy
- carbon dioxide from volcanoes
- deforestation
- burning of trees

ii) **Four** points from:

- carbon dioxide is a greenhouse gas
- (enhanced) greenhouse effect (in context of carbon dioxide)
- heat, or infra-red, or long wavelength radiation, radiated, or emitted, from Earth
- trapped by carbon dioxide or greenhouse gases, or heat cannot leave (from the atmosphere)
- travels back to the surface

***4** **a** **Two** points from:

- variation (in radishes) is not a (confounding) factor
- any differences are due to non-genetic factors
- example of non-genetic factors (environment or mineral ions)
- so it was possible to make comparisons

b **Three** points from:

- humidity (of air)
- temperature
- light
- carbon dioxide
- pH (of nutrient solution(s))
- rate of aeration, or oxygen supply
- depth or volume of solution
- spacing or density (of radishes or plants)
- one mark available for another valid point

c **Four** points from:

- less growth than the control, or complete medium, or group 1
- leaf, or root, mass per plant is less than control or group 1
- comparative figures per plant from the table, stated with units
- nitrate (ions), or nitrogen, required to make amino acids or proteins
- any one use of proteins in plants

d **Three** points from:

- yellow(–green) leaves , or chlorosis , or stunted , or short
- magnesium is needed for chlorophyll
- chlorophyll is a green pigment or makes plants, or chloroplasts, green
- plant cannot trap (enough) light for photosynthesis
- less, or no, photosynthesis or sugar production
- less material for growth or making (new) cells
- less sugar for respiration

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e **Two** points from:

- less, or no, DNA or RNA (is produced)
- (new) DNA is needed for cells to divide (by mitosis)
- genes, or chromosomes, are made of DNA
- mitosis, or cell division, is one way in which organisms grow
- DNA, or RNA, needed for protein synthesis
- protein is needed for growth
- one mark available for another valid point

7 Human nutrition

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1 **a** 1 mark for each correct link

- calcium rickets
- vitamin C scurvy
- vitamin D rickets
- iron anaemia

b **Three** points from:

(iron)

- part of haemoglobin
- present in red blood cells
- used to transport, or hold, oxygen
- component of myoglobin, or some enzymes, or electron carriers
- (myoglobin) present in muscle cells

***2** **a**

- **A** substrate
- **B** active site
- **C** enzyme–substrate complex
- **D** product(s)

b **Two** points from:

- production of small(er), or soluble, or simple(r), molecules
- (small molecules) can be absorbed, or move through cell membranes, or wall of intestine, or into blood, or into cells

c

function	**letter from Figure 7.3**	**name of structure**
site of starch digestion	• A or • J or • E	• mouth (A) or • small intestine or duodenum (J) or • small intestine or ileum (E)

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function	letter from Figure 7.3	name of structure
reabsorption of water	• E or • H or • F	• small intestine or ileum (E) or • colon or large intestine (H) or • large intestine or rectum (F)
secretion of pepsin	• C	• stomach
site of maltose digestion	• J or • E	• small intestine or duodenum (J) or • small intestine or ileum (E)
secretion of bile	• K or • L	• liver (K) or • gall bladder (L)
storage of faeces	• F	• rectum
secretion of lipase and trypsin	• D	• pancreas

***3 a** **Three** points from:

- (for) energy or respiration
- storage (of fat, or vitamins, or energy)
- insulation, or maintains temperature, or reference to myelin
- protection (against mechanical damage), or cushions organs, or shock absorber
- one mark available for another valid point

b i) lipase

ii) fatty acids and glycerol

iii) bile

iv) gall bladder

c **Two** points from:

- (bile) emulsifies fats
- breaks it down into smaller globules
- increases surface area (to volume ratio)
- available for enzyme(s), or lipase

d **Three** points from:

- fatty acids, or glycerol, or fats
- (fatty acids or/and glycerol) enter capillaries, or blood (vessels), or circulatory system
- (fats) enter lacteals, or lymphatic capillary
- (travel via) lymph, or in lymph vessels, or in lymph(atic) system
- lymph empties into blood

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e **Three** points from:

- fat is deposited in arteries (on walls)
- coronary arteries
- arteries are blocked, or blood flow is restricted i
- less, or no, blood flow to heart muscle, or cardiac muscle, or wall of heart
- less, or no, nutrients, or glucose, or oxygen, reaches heart muscle, or walls, or cells
- one mark available for another valid point

f **Three** actions and **three** explanations from list below.
One mark for action, one mark for explanation in each case:

- healthier, or less fatty, diet – to reduce level of fat, or cholesterol, in blood OR reduce, or prevent, obesity and thus strain on heart or reduce blood pressure
- (more) exercise – to reduce, or prevent, obesity and thus strain on heart or reduce blood pressure
- stopping smoking – chemicals in cigarette smoke damage artery linings allowing atheroma to form
- avoiding stress – to reduce blood pressure
- medicine or named drug (e.g. statins) – to reduce blood pressure or cholesterol level
- surgery or inserting stent – to repair damaged or blocked artery or to hold weakened artery open

8 Transport in plants

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1 **a** **Three** points from:

- evaporation of water from leaf, or stem, or plant
- diffusion of water vapour
- through stomata
- down concentration gradient

b Any **two** points relating to each of any **two** factors. Accept reverse argument in each case.

(factor 1)

- temperature rise increases the rate of transpiration or evaporation
- warm air can contain more water (vapour)
- increases concentration gradient

(factor 2)

- increasing light increases the rate of transpiration
- in increasing light, stomata open further
- allows more diffusion

(factor 3)

- decreasing humidity increases the rate of transpiration or evaporation
- drier air increases concentration gradient
- more water vapour lost

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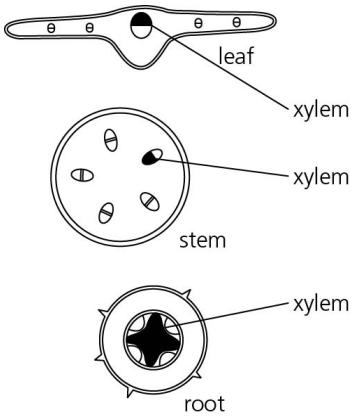
(factor 4)

- increasing wind speed increases the rate of transpiration
- more air movement removes saturated air
- away from stomata or (leaf) surface

***2 a** **Three** points from:

- movement of sugars or amino acids
- in phloem
- from region of production, or leaves, or source
- to region of utilisation, or storage, or growth
- energy required

b



Correctly labelled:

- xylem in leaf
- xylem in stem
- xylem in root

3 a xylem

b i) **One** point from:

- rate of transpiration increases as temperature rises
- rate of increase becomes faster as temperature rises
- the higher the temperature the greater the distance moved by the meniscus

ii) **Two** points from:

- enzymes will be destroyed, or cease to function
- shoot, or plant, or leaf, or cells, die, or no transpiration
- water loss greater than water intake
- difficulty in achieving temperature (in lab)

c i) less transpiration, or (meniscus) will not move as fast or as far, or slower rate of movement, or less water loss, or less water uptake

ii) **Two** points from:

- smaller leaves
- fewer leaves
- less surface area (for transpiration)
- fewer stomata (through which transpiration can occur)

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d **One** from: humidity or wind speed or light level.

***4** **a** **i)** label line and X pointing to any part of the 'star' in the centre of the root section

ii) composed of (group of) cells with similar structures

working together to perform shared functions

b **Three** points from:

- xylem supplies water to leaf
- air spaces between spongy mesophyll cells
- give a large (internal) surface area
- water evaporates from surface of mesophyll cells
- guard cells open, or close, stomata
- water vapour diffuses, or moves, out through stomata

9 Transport in animals

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***1** **a** **i)** buffalo

ii) 300

iii) elephant

iv) rabbit heart rate ÷ buffalo heart rate = 200 ÷ 50

= 4

b (idea of) the smaller the mass (or weight, or size) of a mammal the higher, or faster, or larger is its heart rate (or vice versa)

c

label	**component name**	**function of component**
F	red (blood) cell	transports oxygen or O_2
G	white (blood) cell	antibody formation, or phagocytosis, or kills bacteria or pathogens
H	plasma	transport of blood cells, or soluble nutrients, or hormones, or urea, or carbon dioxide, or plasma proteins, or heat

d label line to aorta (line leaving heart)

label line to hepatic portal vein (line between alimentary canal and liver)

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e **Three** points from:

- more muscle contraction, or muscle activity (in exercise)
- more energy required and so more respiration (occurs)
- more oxygen, or oxygenated blood, or glucose, or sugar, needed (by muscle cells)
- more carbon dioxide, or heat, produced
- (and so) more blood pumped round body, or blood pumped round body faster

***2 a**

function	**letter on Figure 9.4**	**name**
structure that separates oxygenated and deoxygenated blood	F	septum
structure that prevents backflow of blood from ventricle to atrium	D	bicuspid, or mitral, or atrioventricular, valve
blood vessel that carries oxygenated blood	A	aorta
blood vessel that carries deoxygenated blood	One from: B H	pulmonary artery vena cava
structure that prevents the backflow of blood from the pulmonary artery to the right ventricle	K	semilunar valve
chamber of the heart than contains oxygenated blood	One from: C E	left atrium left ventricle
chamber of the heart that pumps deoxygenated blood	One from: J G	right atrium right ventricle

b i) Any **three** points from:

- immediate, or sudden, or steep, or rapid, increase in pulse rate (from 44–48 bpm to 164–170 bpm) when race begins
- maximum, or 164–170 bpm, at 4 minutes or 2 minutes after race starts
- remains (roughly) constant through race
- immediate, or sudden, or steep, or rapid, fall in pulse rate (from 164–170 bpm to 72–80 bpm) when race ends or in first minute after end of race
- then falls more slowly or still higher than before (60 bpm) three minutes after end of race

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ii) **Four** points from:

- adrenaline stimulates increase in heart, or pulse, rate
- increase in blood carbon dioxide (concentration), or acidity, detected
- nerves stimulate heart to beat faster
- reference to muscle contraction
- muscles require more energy, or muscles are doing more work
- (rate of aerobic) respiration increases
- increase demand for oxygen, or glucose
- reference to removal of carbon dioxide, or lactic acid, or heat
- more blood, or carbon dioxide, to lungs (per unit time)
- more blood, or oxygen, or glucose, to muscles
- one mark available for another valid point

***3** **a** blood travels through the heart once in a circuit or cycle (of the body)

b D

c **Two** points from:

- large surface area
- thin (surface), or one cell thick
- short diffusion distance
- good blood supply, or many capillaries
- good ventilation, or good movement of air or water, or good oxygen supply
- permeable
- moist

10 Diseases and immunity

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1 **a** **i)** **(pathogen)** a disease-causing organism

ii) **(transmissible disease)** a disease in which the pathogen can be passed from one host to another

b Four defences and four explanations linked to them, from:

body defence against disease	**how the defence works**
skin	acts as a barrier
hairs in nose	filter out bacteria that are breathed in
mucus	traps bacteria
stomach acid	destroys bacteria
white blood cells	engulf, or digest, bacteria OR produce antibodies to make bacteria clump together, or to make it easier for other white blood cells to engulf them

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2 **a** **i)** (directly) in blood, or other body fluid, or by skin contact

ii) (indirectly) on contaminated surfaces, or in food, or by animals, or in air, or in contaminated water

b **Four** points from:

- clean water supply
- good waste disposal
- sewage treatment
- hygienic food preparation
- good personal hygiene
- development of vaccines
- one mark available for another valid point, e.g. social distancing, period of isolation

***3** **a** reference to infection by pathogen

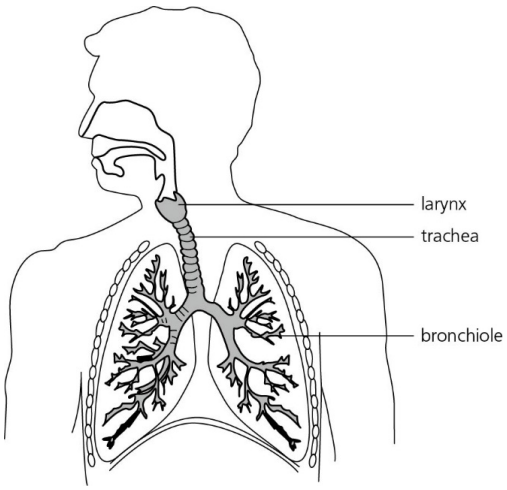
b **Five** points from:

- weakened pathogens, or antigens, or dead pathogens, or fragments of pathogen
- injected or taken orally
- antigens on surface of pathogen
- (stimulate) lymphocytes
- to produce antibodies
- which attack antigens or pathogen
- some lymphocytes remain after infection, or reference to memory cells
- which give long-term immunity
- further exposure triggers lymphocytes to multiply, or an immune response
- to prevent infection

11 Gas exchange in humans

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1 **a**



- bronchiole
- larynx
- trachea

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b **Three** points from:

- large surface area (per volume)
- thin, or small diffusion distance
- moist, or wet, or liquid film
- (alveolar) wall permeable
- well ventilated, or diffusion gradient maintained
- well supplied with capillaries, or diffusion gradient maintained

c **i)** 88.75 – 5.80 = 82.95 (dm^3 per min)

ii) breaths more rapid

breaths deeper or heavier

iii) **One** point from:

- more oxygen needed
- more (cell) respiration carried out
- more energy is required
- more muscle contraction

***2** **a** (diaphragm is) lowered, or flattened

(volume of thorax) increases

(pressure of air in the lungs) decreases

(atmospheric pressure is) higher, or greater, or more

(air moves) into, or inside

(air enters the) alveoli

b **Four** points from:

(A, goblet cell)

- secretes, or produces, mucus
- sticky
- collects, or traps, particles (in the air)

(B, ciliated cells)

- cilia move, or beat, or waft
- removing mucus, or moving mucus away from alveoli, or out of trachea, or towards larynx, or towards mouth

***3** **a** release of energy from food, or named food

with oxygen

b **Four** points from:

- external intercostal muscles contract
- ribcage raised
- volume of thorax, or chest, or lungs, increases
- pressure of air inside lungs decreases

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- pressure of atmospheric air is greater than air in lungs
- air moves into lungs

c **Two** points from:

- (external) intercostal muscles relax
- ribs fall, or move down, and in
- (internal) intercostal muscles contract
- reference to elasticity of lungs

d **i)** $20.0 \times 3.5 = 70$

ii) **Four** points from:

- requires more oxygen
- to repay oxygen debt
- lactic acid produced during exercise
- (as a result of) anaerobic respiration
- not enough oxygen supplied to muscles (during running)
- lactic acid lowers pH of blood
- high concentration of carbon dioxide in blood
- from aerobic respiration
- (carbon dioxide) detected by brain, or receptors
- (carbon dioxide) stimulates high ventilation rate
- (carbon dioxide) increases depth of breathing
- lactic acid is broken down, or converted to glucose, or removed by aerobic respiration
- reference to homeostasis

12 Respiration

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1 **a** **Three** points from:

- muscle contraction
- protein synthesis
- cell division
- active transport
- growth
- passage of nerve impulses
- maintaining constant body temperature

b **i)** glucose → alcohol + carbon dioxide

ii) **Three** points from:

- reference to fermentation
- carbon dioxide produced
- makes bubbles in dough
- makes the bread light in texture

c anaerobic respiration releases less energy than aerobic respiration

per glucose molecule

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***2 a** One mark for correct symbols, one mark for correct balancing:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ (+ energy released)

b One mark for correct working if answer wrong:

change = 50 – 20 = 30

% increase = (30 ÷ 20) × 100 = 150 (%)

c **Three** points from:

- demand for, energy, or oxygen, increases
- (rate of) respiration increases
- limited supply of oxygen to muscle (tissue)
- idea that heart, or pulse, or breathing, rate not increased enough
- muscles respire anaerobically
- lactic acid is produced

d **Four** points from:

- horses continue to breathe at high rate, or more deeply
- continue to have a high heart, or pulse, rate
- to provide (enough or extra) oxygen to 'pay off' the debt
- lactic acid moves, or diffuses, (from muscle) into blood
- lactic acid transported to the liver
- (in the liver) lactic acid is broken down, or oxidised, or used for (aerobic) respiration

***3** glucose; lactic acid; alcohol; carbon dioxide (last two may be in either order)

***4 a** Three marks for:

- correct formulae for glucose and oxygen
- correct formulae for carbon dioxide and water
- balancing the equation

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

b **Three** points from:

- temperature
- mass of soda lime
- volume of air in the syringe
- volume, or size, of syringe
- mass or number of seeds
- idea of reading from same edge of droplet (each time)

c **i)** **Three** points from:

- moves to the right, or towards seeds or syringe
- seeds absorb oxygen
- give out carbon dioxide, absorbed by soda lime
- total volume of air, or gas, decreases
- pressure of air, or gas, decreases

ii) **Two** points from:

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- slows down, or stops
- rate of respiration decreased
- oxygen being used up
- aerobic respiration slows, or reference to anaerobic respiration

13 Excretion in humans

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1

structure	name of structure	function
V	renal vein	carries blood from the kidney (back to the heart)
W	(left) kidney	filters blood
X	ureter	carries urine from the kidney, or to the bladder
Y	bladder	stores urine
Z	urethra	carries urine from the bladder

***2** **a** **Two** points from:

- metabolic processes produce waste products
- which are toxic, or poisonous
- or surplus to requirements
- the system is also needed to remove drugs

b **i)** (glomerulus) ensure large surface area available for filtration of blood

ii) (renal tubule)

reference to selective reabsorption

reabsorption of glucose

reabsorption of water

c **Three** points from:

- urea
- water
- mineral ions
- other named nitrogenous compound, e.g. uric acid, ammonia

***3** **a** removal of:

- waste (products) of metabolism, or chemical reactions
- harmful, or toxic, or poisonous, substances
- substance(s) in excess of requirements

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b i) F on cortex, or white area between fibrous capsule and stippled medulla

R on renal artery including after it divides

U on ureter

ii) **Two** points from:

- reference to blood in capillaries
- reference to blood pressure due to the heart
- forcing (named) small molecules out (of blood)

one named substance from:

- urea, water, amino acids, glucose or sugar, salts or ions or minerals, uric acid, ammonia, any named (spent) hormone

iii) **Two** points from glucose, **one** point for water:

(glucose)

- diffusion
- active uptake, or active transport
- selective reabsorption, or selective uptake

(water)

- osmosis

14 Coordination and response

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1 **a** A – iris

B – pupil

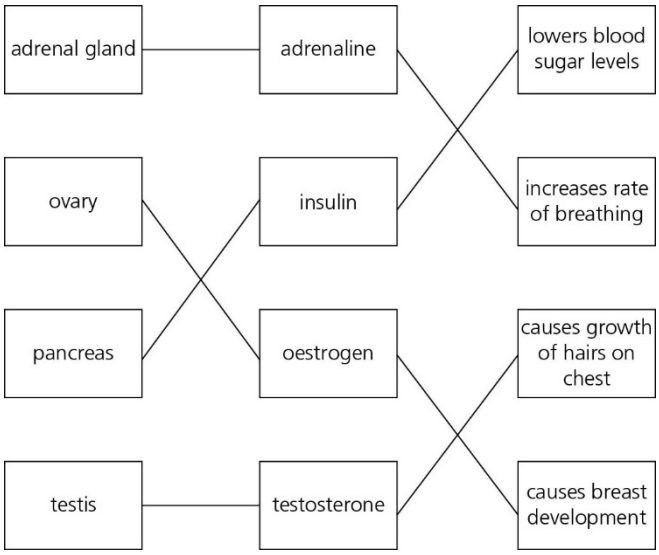
b i) (pupil, or B) becomes smaller, or constricts

ii) reduces the amount of light (entering the eye), or stops too much light (entering eye)

protects retina (cells), or receptors, or sensors, from damage

1 **a** For each column of lines: 3 or 4 correct = 3 marks 2 correct = 2 marks 1 correct = 1 mark

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b in the blood, or in the plasma

3 glands; blood; target; insulin; blood

***4** **a** 1 mark for each name and each function

structure	**name of structure**	**function in the skin**
F	capillary	transports blood, or heat
G	receptors, or sensory neurone	detect changes in external environment, or stimulus, or touch, or pressure, or temperature
H	(sweat gland)	(produces sweat for cooling the body)
J	adipose tissue, or fat, or fatty tissue	insulation, or prevention of heat loss, or keeps body warm, or shock absorber, or energy store

b **i)** (with no back-pack) 6 arbitrary units

(with 9 kg back-pack) 13 arbitrary units

% change = 100 × (13 – 6) ÷ 6 = 117 (%)

ii) more, or increased volume of, sweat produced

c **Three** points from:

- reference to evaporation
- (of) water, or sweat
- (idea of) need for heat, or latent heat, or energy (for evaporation)
- this (heat, or latent heat, or energy for evaporation) taken from body, or skin, or blood
- blood carries heat (from core tissues to skin)

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***5 a i)** **One** point from:

- eaten, or absorbed, a (sugary, or high carbohydrate) meal
- (secretion, or effect, of) adrenaline
- (secretion, or effect, of) glucagon
- dehydration, or loss of water

ii) **One** point from:

- used in respiration
- (named) exercise, or physical activity
- hungry, or fasting, or starvation
- (secretion, or effect, of) insulin

iii) **Two** points from: liver; muscle; kidney; testes

b **Three** points from:

- pancreas, or islets of Langerhans, detects increase in glucose concentration; (pancreas, or islets) secretes, or produces, insulin
- transported in blood, or plasma
- liver, or muscle, or cells, convert glucose to glycogen
- reference to enzymes (converting glucose to glycogen)
- homeostasis, or negative feedback

c **Three** points from:

- water diffuses out (of red blood cells)
- through partially permeable membrane
- by osmosis
- down water potential gradient, or from high water potential to low water potential
- (red cells) decrease in volume, or shrink, or are crenated

15 Drugs

Page 402

1 a any substance taken into the body

that modifies or affects chemical reactions in the body

b treats bacterial infections

c **One** point from:

- HIV is a virus
- viruses are not killed by antibiotics

***2 a** bacteria, or bacterium

b asexual reproduction, or binary fission

c i) **One** point from:

- reference to mutation
- reference to having resistance to antibiotics.

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ii) **Two** points from:

- they have resistance to antibiotics
- so they cannot be treated with antibiotics
- they will pass on the resistance to future generations

16 Reproduction

Page 402

1 **a** **i)** labelled line to one ovule

labelled line to petal

ii) carpel, or ovary

sepal

b line from the anther of one flower

line to stigma of another flower

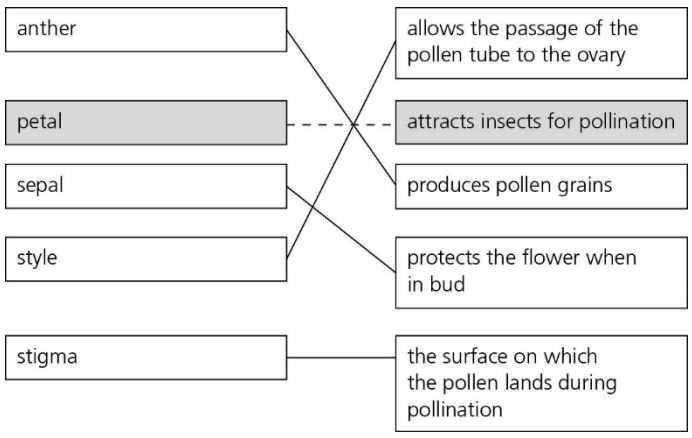
c **Two** points from:

- (large) petals
- stamens, or anthers, or filaments, inside flower; or stamens, or filaments, short; or small anthers
- stigma inside flower, or short style
- stigma broad, or wide, or not feathery

d **Four** points from:

- reference to being taken up root hair (cell)
- moves across (root) cortex
- reference to xylem
- moves up the stem
- (into) mesophyll (cells)
- one mark available for another valid point

***2** **a**



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b **Two** points from:

- (wind-pollinated stigma) feathery, or hairy; (insect-pollinated stigma) not feathery, or hairy
- (wind-pollinated) large(r); (insect-pollinated) small(er)
- (wind-pollinated) outside flower; (insect-pollinated) inside flower

explanation – **one** mark:

- to catch pollen (in the wind)
  accept for pollen to attach (to stigma); or make pollination more likely, or easier; or to increase chance of pollination

c **Three** points from:

- little, or less, or no, variation
- reference to becoming homozygous
- example of 'good' or 'bad' consequence, e.g. less chance of adapting to changing conditions, or less ability to evolve, or may become extinct, or adapted variety spreads
- greater chance of pollination, or ensures pollination occurs
- useful if no other plants (of same species) nearby
- less wastage of pollen
- not dependent on (named) agent of pollination

***3** **a** **i)**

process, or event	**letter from Figure 16.3**
meiosis	R
fertilisation	S
implantation	V

ii) oviduct

b **i)** image size ÷ actual size

ii) 0.055 mm = 55 μm

c **Two** points from:

- haploid, or n, or one set of chromosomes, or half the diploid number, or 23 chromosomes
- (produced by) meiosis
- so number of chromosomes remains the same, or does not double, at fertilisation

d **Six** points from:

(flagellum)

- (flagellum) propels the sperm
- to oviduct, or site of fertilisation, or egg (cell), or ovum

(mitochondria)

- aerobic respiration
- provides, or releases, or supplies, energy or ATP

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(acrosome)

- (contains, or has, or releases) enzyme(s)
- (enzymes) digest, or break down, or dissolve, jelly coat, or protein layer, surrounding egg (cell) or ovum
- so sperm nucleus can enter the egg (cell), or so sperm and egg membranes can fuse together

e **Two** points from:

- idea that sex is determined by X and Y chromosomes, or males are XY and females are XX
- all egg cells have an X chromosome, or females can only provide X chromosome
- sperm cells have X or Y chromosome, or only the males can provide X or Y chromosome, or only males can provide the Y chromosome

4 **a** fusion of the nuclei of two gametes

to form a zygote

production of genetically different offspring

b **i)**

letter on Figure 16.5	name of tube	name of substance or substances transported
A	rectum, or colon, or large intestine	faeces
B	sperm duct	sperm
C	urethra	sperm and urine
D	ureter	urine

ii) line labelled P ending on prostate gland

c protects, or holds, or contains, testis; or idea maintains testes at lower temperature (than that of body)

17 Inheritance

Page 404

1 **a** mutation: a change, or error,

in a gene, or chromosome, or DNA
heterozygous: having two different alleles, or a dominant allele and a recessive allele of a particular gene
recessive allele: alternative form of a gene only expressed,
in absence of the dominant (allele), or if homozygous

b **One** point from:

(sun-cream)

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- absorbs, or blocks, or stops, Sun's rays
- prevents ionising radiation, or harmful Sun's rays, from reaching skin, or cells, or body; reference to cancer, or melanoma, or mutation

c i)

numbered person on Figure 17.3	**genotype of person**
1	aa
2	Aa
3	aa
9	Aa

ii) couple R

iii) if it was recessive all their offspring would have shown the condition,

but individual 11 is normal, so must be dominant

***2 a i)** meiosis

ii) (gametes) are haploid, or n, or contain one set of chromosomes, or contain half the number of chromosomes of other body cells

b male XY

female XX

c i) (two or more) alternative, or different, forms of a gene

ii)

- parental genotype: Bb × Bb
- gametes: B and b × B and b
- offspring genotype: BB Bb Bb bb
- offspring phenotype: black black black white
- ration: 3 black : 1 white

d Bb

3 a transfer of pollen

from stamen, or anther, to stigma

b i) white

ii) (plant) A

iii) **Two** points from:

- cover flower
- to prevent pollen from other flowers arriving
- transfer pollen by hand

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c

- parent genotypes: Rr × Rr
- gametes: R r + R r
- offspring genotypes: RR Rr Rr rr
- offspring phenotypes: red red red white

***4** **a** (gene) a length of DNA that codes for a protein

(gene mutation) a change in the base sequence of DNA

b **i)** 1 Bb; 2 bb; 3 Bb

ii)

- parental genotypes Bb and bb give gametes B, b + b, b
- Punnet square – see below – gives offspring genotypes as Bb and bb

	b	b
B	Bb	Bb
b	bb	bb

- offspring phenotypes are 50% normal, or carrier, and 50% acatalasia

iii) test (cross)

18 Variation and selection

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1 **a** Merino

it has good wool yield, or good meat yield, or very good wool quality

b **Four** points from:

- use Awassi (very god milk yield) and Merino (good/very good wool) sheep
- breed, or cross, or mate (together)
- pick, or select, or choose, the offspring with required characteristics
- allow these (chosen) offspring to breed
- breed the (chosen) offspring with Awassi, or Merino sheep
- repeat for (many, or several) generations

2 **a** One mark for identified feature

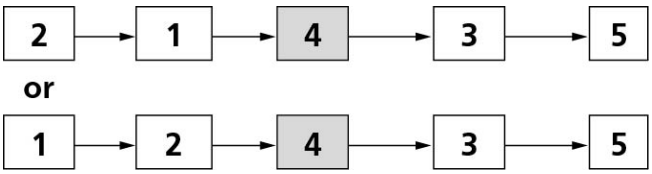
one mark for related explanation for each animal.

Accept reasonable features not in table if explained.

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Animal	adaptive feature	help in survival
D	(canine) teeth	seize, or eat, prey
	large mouth, or jaws, or beak	swallow, or catch, or grip large prey
		swimming, or defence
	(long, or strong) tail	
	webbed toes or feet	prevent dehydration, or waterproof
	scaly, or rough, skin, or has scales	for camouflage
	markings	vision when submerged
	eyes on top	
E	claws, or nails, or talons	catch, or tear, prey; or perching; or defence
	beak	tear, or hold, food; or offence or defence
		flight; or search for, or hunt, prey; or escape predators
	wings	retain body heat, or helps in flight
		helps in flight
	feathers	to see prey from a distance
	tail (feathers)	
	forward-facing eyes	

b 1 and 2 at start in either order, 3 after 4, 5 at the end



***3 a i)** accept converse argument

One point from:

(more)

- black moths eaten (by, predators, or consumers)

(because)

- black moths, are not camouflaged, or do not 'blend in'

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ii) Either

- more black moths would be caught
- black moths have better camouflage

or

- less of both varieties recaptured
- death due to the pollution

b i) (first heading) phenotype; (second heading) genotype

ii) (dominant wing colour)

- pale, or speckled

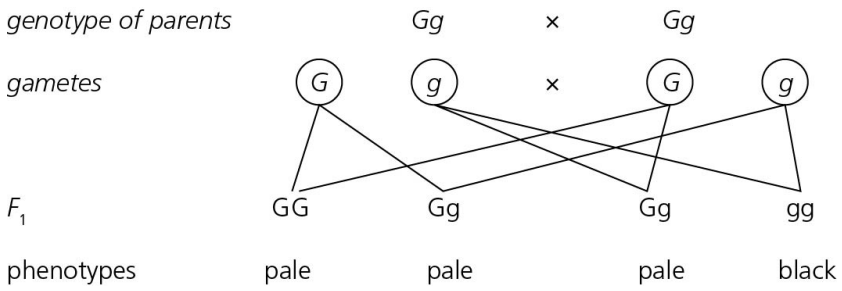
(explanation) **One** point from:

- (pale, or speckled) appears when the dominant allele, or G, is present
- in heterozygous, or Gg, (moths)
- black only appears when homozygous, or gg

c **Three** points from:

- discontinuous variation
- (wing colour determined by) a gene, or a few genes
- black is recessive, or pale is dominant
- reference to sexual reproduction, or meiosis
- explanation of inheritance
- (pale) inherited when only one copy of dominant allele, or G

d



proportion = 0.25 / ¼ / 25% / 1 in 4

e i) mutation

ii) UV light, or (ionising) radiation, or X rays, or (named radioactive) chemical(s)

19 Organisms and their environment

1 a i)

- food chain starting with fig tree and ending with hawk
- caterpillar before blackbird
- three correct arrows

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ii) (the) Sun

iii) decomposer(s)

b i) **Two** changes and **two** explanations from the list below:

One mark for change and **one** mark for explanation in each case.

- habitat destruction – hard to find food or nutrients, lack of shelter from environmental conditions or predators
- hunting, or poaching, (of animals) or introduction of new predator, or increased number of predators, or lack of food – directly reduces number of animals
- disease, or (named) pollution – reduced numbers by killing directly, or making too weak to reproduce or maturity
- (named) pollution – cause genetic mutations that affect survival or reproduction
- climate change, or global warming – leads to loss of habitat or environmental conditions in habitat changing more quickly than species can adapt to survive there
- hard to find a mate – animals unable to reproduce

ii) **One** point from:

- monitoring, or protecting, species
- remove predators
- remove vectors of disease
- protecting, or preserving, or making new habitats
- education
- captive breeding
- seed banks
- DNA banks
- zoos, or wildlife parks, or conservation areas
- preserved embryos
- banning hunting

2 a i) finch (in a box) above level of tree and grass

arrowed line from tree to finch

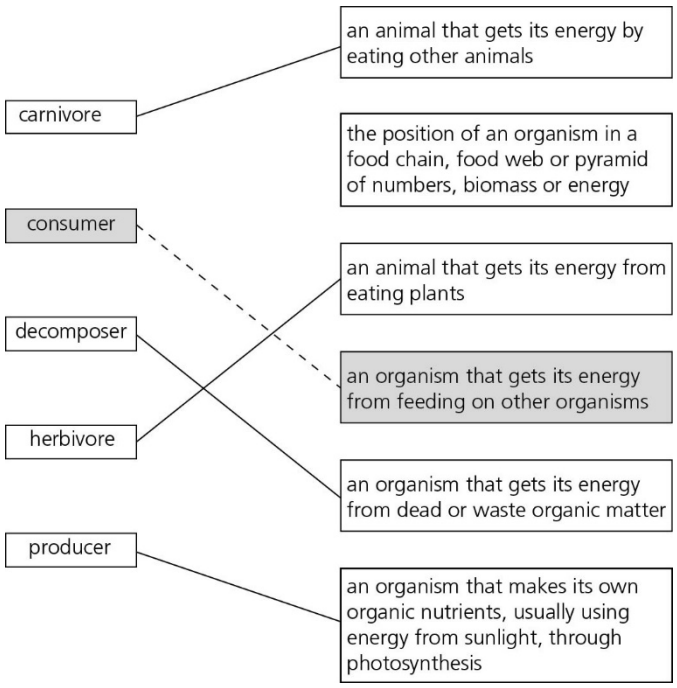
two arrowed lines from finch to hawk and eagle

ii) **Four** points (2 changes, 2 related reasons) from:

- increase in hawks
- as not eaten (by eagles, or no predators)
- decrease in crows, or finches
- as more hawks to eat them
- increase in finches
- as fewer eagles to eat them
- increase in aphids and locusts
- as fewer crows to eat them
- any logical suggestion
- with reason

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b



3 a

	name of process
A	respiration, or excretion, or decay, or decomposition, or rotting
B	photosynthesis
C	feeding, or nutrition, or eating
D	respiration, or excretion, or decay, or decomposition, or rotting

b i) glucose, or fat, or protein, or amino acid, or starch, or one mark available for another valid answer

ii) glucose, or fat, or protein, or amino acid, or glycogen, or one mark available for another valid answer

c **Three** points from:

- (body) rotted, or decayed, or decomposed, or action of decomposers
- bacteria, or fungi, or saprophytes, or saprotrophs, or microbes
- respire using, or gain energy from body, or use body as food, or equation for respiration
- carbon dioxide released as result of respiration, or as waste product, or excreted

OR

- body eaten by carnivores
- digested, or absorbed
- (carnivore) cells carry out respiration, or respiration equation
- as a result of respiration, carbon dioxide released as waste, or excreted

OR

- body decomposed, or rotted, by plants

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- plants respire, or respiration equation
- as a result of respiration (carbon dioxide released) as waste, or excreted

d **Two** points from:

- deforestation
- respiration
- burning (fossil) fuels, or named example
- driving vehicles, or generating electricity, or factories, or industrialisation

***4** **a** **i)** arrows point from food to feeder

organisms are in the correct order in the food chain (willow shoot/aquatic plant, moose, wolf)

ii) willow tree, or aquatic plants, or shoots, or plants – producer

- moose – primary consumer
- wolf – secondary consumer

iii) **Two** points from:

- competition
- food supply, or food for moose, or food for wolves
- water
- shelter, or 'nest' sites, or space, or territory
- mates
- competition with other types of predators
- disease, or parasites
- hunting, or poaching
- pollution
- rate of reproduction
- habitat loss or destruction
- one mark available for another valid point

b **i)** Two marks for the correct answer.

If no answer or incorrect answer, one mark for correct working.

- answer for 2 marks: 1.3%, or **A** 1.30%
- working for 1 mark, either

(56 000 ÷ 4 320 000) ×100 = 1.3%

or

A 1.296 %, or 1.2963%, etc., ignore 1.29.

OR

- answer for 2 marks: 1.4%, or **A** 1.42%
- working for 1 mark, either

4 320 000 − 380 000 = 3 940 000

(56 000 ÷ 3 940 000) ×100 = 1.42%

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or

A 1.421, or 1.4213, etc.

ii) **Five** points from:

- energy is lost between, or within, trophic levels, or along food chain
- energy lost in respiration, or as heat, or in metabolism
- use of figure with units to illustrate (from Table 6.2, or 1.3%, or 1.4%)
- energy used in maintaining body temperature
- moose, or wolf, is an endotherm, or homeotherm
- energy lost in movement
- energy used in muscle contraction
- energy in food, left in parts not eaten, or egested, or passed out in faeces
- energy lost in excretion, or urine
- wolves not very successful at catching prey
- more energy available for moose (than for wolf)
- no other source of food for wolves (but moose)
- one mark available for another valid point
- with low numbers of wolves, there is little predation
- more moose reach reproductive age, or have offspring
- numbers of moose increase
- more food for wolves
- more wolves reach reproductive age, or have offspring
- numbers of wolves increases
- more predation
- greater competition between wolves
- idea that wolf population reaches carrying capacity, or reaches maximum for resources available

20 Human influences on ecosystems

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1 a i) **Two** points from

- nitrates, or ammonium, or magnesium, or phosphates, or potassium

ii) **Four** points from:

- leaching, or runoff into stream
- reference to eutrophication
- excessive algal growth
- light to lower layers cut off, or reduced light below surface
- (submerged) plants die
- bacteria thrive, or reproduce, or multiply
- (bacteria) use up oxygen (for respiration, or decay)
- anaerobic conditions occur, or aquatic animals die, or emigrate

iii) **Three** points from:

- reduces numbers of weeds, or unwanted plants
- crop has less competition (with weeds)
- for light

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- for water
- for minerals, or salts, or named example

iv) **Two** points from:

- may destroy (useful) species
- e.g. pollinators, or predators, or named example
- causes disruption of food chains
- (pesticide) may accumulate in food chain
- allow other species to flourish and become pests

b (artificial selection) humans choose which individuals (with desired features) to interbreed

(modification) genes, or alleles, or DNA within cells, are modified, or changed, or altered, or replaced, or inserted in an organism

2 **a** **Four** points from:

- use of machinery
- to use larger areas of land, or improve efficiency
- improved irrigation
- use of glasshouses, or polytunnels
- use of chemical fertilisers
- to improve yield; (award mark once)
- use of insecticides
- to kill crop pests, or improve yield, or improve quality
- use of herbicides
- to reduce competition with weeds
- reference to selective breeding
- to improve production
- one mark available for another valid point

b **i)** (biodiversity*)*

- the number of different species
- that live in an area

ii) **Three** points for statements about ways humans have affected natural habitats. **Three** points for extra details or examples.

- clearance of land for agriculture
- clearance of land for housing
- extraction of natural resources
- e.g. mining, oil extraction
- water pollution
- example of water pollution
- damage to food chain, or food web
- through removal of a trophic level (or example)
- damage to seabed through trawling
- one mark available for another valid point

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3 a i)

component	**food**
(fat)	(olive oil)
protein	(meat)
carbohydrate	(pasta)
(fibre (roughage))	any example of plant cell wall material, or any fruit or vegetable

ii) **Two** points from:

- minerals, or ions, or named mineral
- vitamins, or named vitamin
- water

b **Four** points (2 changes, each with associated reason) from:

- Use of agricultural machinery, or tractors, or trucks
- has improved efficiency, or greater land area cultivated, or plant more seeds, or harvest more of the crop, or harvest faster, or spray pesticides, or irrigate the crop.
- Use of (artificial) fertilisers
- has improved yields, or grow faster.
- Use of herbicides, or pesticides, or insecticides
- means no competition from weeds, or pests, or increases yields.
- Selective breeding
- improves quality, or quantity, of produce.
- Use of glass houses, or polytunnels
- protects crops from adverse environment, or provide optimum growing environment, or grow out of season, or increased yields.
- Any other valid example
- with related improvement.

c **Two** points from:

- death of organisms
- disrupts food chains, or webs, or eutrophication
- habitat destruction, or soil erosion
- changes in precipitation

***4 a i)**

- vertical axis – numbers, or population
- horizontal axis – time, or years
- curve showing exponential increase, or log phase

ii) **Four** points from:

- idea that 'birth', or reproduction, or breeding, rate is greater than death rate
- no limiting factors
- no, or little, competition

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- plenty, of food, or nutrients, or space, or mates, or oxygen, or resources
- no, or few, predators
- no, or few, parasites, or pathogens, or disease
- one mark available for another valid point

b **Three** points from:

- between 1950 and 2012 mass of fish caught increased and levels off
- 17 to 90 million tonnes, or increase = 73 million tonnes
- fluctuates, or increases and decreases, or this described
- e.g. short-term increases (local maxima) around 1970, or any time after 1990
- maximum catch, 94 million tonnes, or in 1996
- steep increase between, 1950–1970, or 1973–1989

c **Six** points from:

- international agreements, or treaties
- quotas, or permits, or licences
- fines, or sanctions, for overfishing, or illegal, or unauthorised, fishing
- fishery protection vessels, or wardens, or patrols
- restrictions on times when fishing can occur
- exclusion zones, or nursery zones, or 'no take' zones, or reserves
- total ban for some species
- regulations on method of fishing
- e.g. mesh size of nets, or ban nets, or use of lines instead, or size of fishing vessel, or 'fishing effort' education, or raise awareness, or any appropriate example
- monitoring fish stocks
- captive breeding (of wild fish)
- re-stocking (of wild stocks)
- encourage farmed fish
- one mark available for another valid point

d **Three** points from:

- resource, does not, or will not, run out or become exhausted
- definition of sustainable resource as renewable, or self-renewing, or regenerates; or sustainability described, e.g. produced as rapidly as it is removed
- replanting, or reseeding, or regrowing
- one mark available for another valid point

***5** **a** **i)** *Aloe*

ii) **Three** points from:

- (isolated) group of individual plants
- of, one, or the same, species
- living in the same area
- at the same time

b **Three** points from:

- deforestation
- climate change, or global warming
- change in land use, or described change
- desertification

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- pollution
- plant hunters
- increase in (new, or invasive) grazers, or predators
- competition with introduced species, or alien species
- (new) disease or pests
- lack of pollinators
- one mark available for another valid point

c **Three** points from:

- high risk of extinction
- less chance of reproduction, or pollination
- high risk of genetic diseases
- less, or little, or no, (genetic) variation
- (small population so) more vulnerable to pests, or disease, or catastrophe
- reduced number of alleles
- less likely to adapt to, or evolve to respond to, or cope with (named) change in environment
- one mark available for another valid point

d **i)** Decrease = 9 – 5 = 4

percentage decrease (4 ÷ 9) × 100 = 44 (%)

ii) **Three** points from:

- decrease in population (at all sites)
- use of data from last column to illustrate above – minimum of two rows, or loss of trees from at least two sites, or one site between two years
- comparative data: quote A 12 to 4, or B 9 to 5, or C 5 to 3, or D 6 to 5 (in whole population) there is no (net) increase in number of trees
- difficult to compare changes over time as start numbers and years are different for different sites
- D has highest mortality, or B has the lowest mortality
- site A has lost the highest number of trees, or site D has lost the lowest number of trees
- site A has most trees in original photograph, or site C has the least trees in the original photo
- in 2004, B and D had the most trees, or site C had the least trees

21 Biotechnology and genetic modification

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1 **a** **Two** points from:

- rapid reproduction rate
- have the ability to make complex molecules, or proteins
- no ethical concerns about their use

b **i)** **Three** points from:

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- reference to pectinase
- can be extracted from fungi
- work by breaking down pectin
- which sticks plant cell walls to each other
- enzymes clarify fruit juice, or make fruit juice more transparent
- process releases polysaccharides
- (pectinase) breaks these down to sugar
- makes the juice clearer
- makes the juice sweeter.

ii) **Three** points from:

- contain protein-digesting enzymes, or proteases
- and fat-digesting enzymes, or lipases
- remove stains in clothes caused by proteins
- and fats
- protein, or fat, molecules are large, or insoluble
- enzymes digest these to produce small, or soluble, molecules
- which can pass out of the cloth
- biological washing powders save energy as can be used to wash clothes at lower temperatures, or no need to boil water

***2** **a** (water jacket) **Three** points from:

- maintain optimum, or constant temperature
- to prevent enzymes denaturing
- loss of shape, or reference to active site
- (because as) fungus respires
- releases heat
- so temperature in the fermenter increases
- which would kill fungus
- (therefore) no, product, or penicillin

(addition of acids and alkalis) **Three** points from:

- maintains pH, or keeps pH constant
- enzymes need optimum pH
- to give maximum yield
- (otherwise) enzyme activity, or rate of reaction, slows

b **i)** 40–50, or 40–60, or 40–80

ii) mitosis

iii) **Three** points from:

- nutrients are used up

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- limiting (factors)
- explanation of limiting factor
- waste products accumulate
- wastes are toxic
- penicillin could inhibit growth
- population reaches carrying capacity
- one mark available for another valid point

c i) **Two** points from:

- fungus grows when no penicillin produced
- during first 20 hours
- only nutrients and fungus added at the beginning, or no penicillin added at start

ii) penicillin production stopped, or no more penicillin produced

d **Three** points from:

- purifying, or separating, penicillin
- from, waste, or toxins
- increasing concentration of penicillin
- making into, pills, or packaging
- one mark available for another valid point

e **Two** points from

- viruses are not cells
- viruses have no metabolism
- idea that viruses have no target for antibiotics
- antibiotics stop cell wall growth
- viruses have no cell wall
- antibiotics stop enzymes working

***3 a i)** (resistance)

- resistance has increased, or bacteria are more resistant
- reference to resistance has doubled every 2 years, or ×4 over 5 years, or 300% more bacteria are resistant, or 400% increase in resistance, or exponential rise, or geometric rise

ii) **Four** points from:

- reference to mutation, or variation, or DNA change
- (new strain) has resistance
- (new strain) not killed by treatment
- reference to natural selection, or survival of fittest, or resistant bacteria have less competition if most normal bacteria have died
- (new strain) reproduces
- increased proportion of population have resistance
- reference to over-prescription, or not completing antibiotic course
- reference to use in animal husbandry

b i) **One** point from:

- yoghurt
- cheese
- curds, or sour milk

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- tofu
- single cell protein, or SCP

ii) **Three** points from:

- reference to nitrogen-fixing bacteria
- change nitrogen into nitrate, or ammonium salts
- reference to role of saprophytes, or decay, or decomposition, or release of nutrients or named minerals
- reference to nitrifying bacteria
- reference to nitrification, or conversion of ammonia to nitrates

c

description of stage	**number of each stage**
all the plasmids are removed from the bacterial cell	• 5
a chromosome is removed from a healthy human cell	• 2
plasmids are returned to the bacterial cell	• 8
restriction endonuclease enzyme is used	• 3 or 6
bacterial cells are allowed to reproduce in a fermenter	• 9

***4** **a** changing the genetic material of an organism

by removing, or changing, or inserting, individual genes

b **Eight** points from:

- remove human gene coding for insulin from DNA
- using restriction enzymes
- forming sticky ends
- remove plasmids from bacteria
- cut plasmids open
- using restriction enzymes
- forms complementary sticky ends
- human DNA inserted into plasmid
- using ligase
- recombinant plasmid formed
- inserted back into bacterial cell
- bacteria reproduce
- gene for insulin expressed in bacteria

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Alternative to practical past paper questions

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2 Organisation of the organism

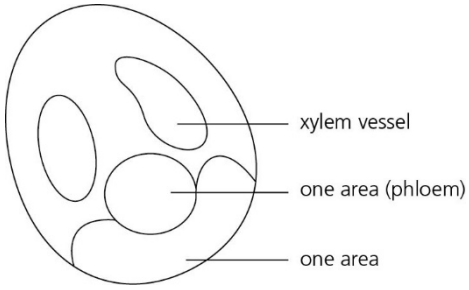
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1 a i) Outlines – all lines single, clear and unbroken

Size – occupies at least half of the space provided

Detail – oval shape + phloem + 1 other area

Two other areas shown:



- Label – line to correct area on drawing to show position of xylem (vessel) and line labelled 'xylem'

ii) measurement of AB = 43 mm

- line on their drawing and length measured with correct unit
- correct magnification calculation

iii) **One** point from:

- (xylem) walls thick(er), or large(r), or wide(r)
- (xylem vessels) round(er)
- (xylem) has large(r) cross section area, or big(ger)

b **Four** points from:

- use of any suitable plant material
- put stem, or material chosen, in (red) dye, or add dye to cut stem surface
- time for absorption of dye
- cut (sections) of stem or material chosen
- (red stained xylem) will indicate position of vascular bundle

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3 Movement in and out of cells

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1 a i)

- description of curvature in 0.8 M solution
  (e.g. curved with outer surface longer than inner surface)
- description of curvature in 0.0 M solution
  (e.g. curved with inner surface longer than outer surface)

ii) **Four** points from:

- osmosis
- definition of osmosis (must refer to gradient and partially permeable membrane)
- outer surface has wax, or a waterproof layer, or is impermeable
- loss of water, or exosmosis, (at inner surface) in 0.8 molar salt solution
- reference to (cells) shrinking, or becoming flaccid or plasmolysed
- increase in water (in cells), or endosmosis, (at inner surface) in 0.0 molar solution
- reference to (cells) swelling or becoming turgid

b **Four** points from:

- range of salt solutions, or different concentrations
- same time
- same plant, or type, or species, or dandelion
- same size, or length, or mass at start
- measure curvature, or length of inner side, or mass to find when no change
- plot graph of concentration against change in length or mass
- repeat (experiment, or more stems per concentration)

4 Biological molecules

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1 a i) **One** point from:

- skin, or peel, or outer wall, or shell; outer layer darker than inside
- side buds, or spots, or 'eyes' present
- inner tissue – similar colour

ii) **Two** points from:

difference	**sweet potato**	**Irish potato**
• inner tissue	spotted, or speckled	no spots, or uniform
• skin, or peel, or wall	darker, or thicker	lighter, or thinner
• shape of ends	pointed, or slanted (both ends)	rounded (both ends)
• overall shape	long, or narrow	short, or round, or more circular, or oval

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difference	**sweet potato**	**Irish potato**
• margin	two layers visible, not smooth, or uneven	one layer, smooth
• section shape	circular, or rounded, smaller	oval, larger

b **Three** points from:

(starch)

- equal sample size of each potato
- iodine solution, or iodine in potassium iodide, or iodine reagent
- same concentration, or volume of iodine solution
- expected colour change; (yellow, or orange, or red brown to blue, or blue black, or purple) compare colour change

Safety

One point from:

- tie back hair, or tuck in tie
- safety goggles, or spectacles, or lab coat

(reducing sugar)

Three points from:

- equal samples – same volume of water, or same preparation, or grinding
- Benedict's reagent
- same volume, or amount of Benedict's solution
- heating
- expected colour change; (blue → green, or orange, or red)

Safety

One point from:

- water bath
- test tube holders

5 Enzymes

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1 **a**

- one table drawn with at least three columns and a line separating headings from data
- column, or row headings with appropriate units for each heading
- five correct clot records for each of three test-tubes

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Time/minutes	Test tube P (acid)	Test tube Q (neutral)	Test tube R (alkaline)
1	some clotting, or (stage) B	no clotting, or (stage) A	no clotting, or (stage) A
2	all clotted, or (stage) C	no clotting, or (stage) A	no clotting, or (stage) A
3	all clotted, or (stage) C	no clotting, or (stage) A	no clotting, or (stage) A
4	all clotted, or (stage) C	some clotting, or (stage) B	no clotting, or (stage) A
5	all clotted, or (stage) C	some clotting, or (stage) B	no clotting, or (stage) A

b **Two** points from:

- idea that rennin, or enzyme, acts, or forms clots quickest, or is optimum, or is best, in acid conditions
- idea that rennin, or enzyme, acts, or forms clots more slowly, in water or neutral conditions
- idea that rennin, or enzyme, does not act, or does not form clots, in alkaline, or basic, conditions

c **i)** idea of equilibration, or allowing time for test tube contents to reach the same temperature, or all test tubes at the same temperature

ii) **Two** points from:

- volume, or 5 cm^3, or mass, of milk
- volume, or 2 drops, of acid, or alkali, or distilled water
- volume, or 1 cm^3, of enzyme, or rennin
- concentration, or 0.1%, of enzyme, or rennin
- temperature, or 40°C
- equilibration time, or 3 minutes, or total time, or 5 minutes (for investigation)

d **Four** points from:

- subjective nature of deciding on clotting point
- three test-tubes observed at different times (step 11), or Q and R longer in water bath before being tested, or different mixing times (step 9)
- no repeats
- insufficient time intervals
- drops (of acid, or water, or alkali) could be of different volumes, or sizes, or amounts
- some contents remain in the test tube when adding to other tube, so volumes vary
- tip and rotate not standardised
- same dropping pipette (for acid, or water , or alkali) could have been used, leading to contamination
- temperature of water bath not maintained
- no control (to show that milk does not clot without rennin)

e use of acid, or alkali, or enzyme

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f add biuret (reagent) (to liquid part)

purple, or mauve, or lilac, colour indicates presence of protein , or is a positive result

g ethanol emulsion test, or add ethanol and white emulsion forms

h **Six** points from:

- at least 3 stated temperature values: 37°C and at least one above and one below
- method of maintaining temperature given
- clot, or white solid, or changed milk, from same sample of milk
- same pH (pH 7) of solutions
- same concentration, or volume, of enzyme or (named) protease
- equilibrate temperature of enzyme and milk solutions before mixing
- time how long for samples to become colourless, or shortest time has greatest activity, or is the optimum, or if optimum is 37ºC the hypothesis is correct
- repeat at least twice (and calculate the mean)
- valid safety precaution, e.g. eye protection, or gloves

2 **a** **i)** Three marks if all volumes are correct

Two marks if one volume is incorrect

One mark if two volumes are incorrect

temperature/°C	**volume of juice collected/cm^3**
10	2
15	11
20	15
25	20
30	26
35	27

ii)

- graph plot axes – orientation and labels
- suitable scale, plots to fill ½ or > ½ grid
- plots all correct (2 marks)
- neat line passing through all points

iii) **Two** points from:

- increase in temperature – greater volume of juice collected
- almost the same volume, or lowest increase in volume, between 30°C and 35°C
- larger volume, or largest increase, between 10°C and 15°C

b **Six** points from:

- range of different pH
- detail of method planned, or control of pH – use of buffers
- same type of pulp, or apple, or same volume, or amount, of pulp or apple
- same volume, or mass, of enzyme

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- same concentration of enzyme
- same temperature
- same timings
- filtration
- allow for repeat readings
- calculate mean
- plot data in graph form
- safety feature, e.g. goggles, or lab. coat, or tongs

3 a i)

- graph: orientation and label of axes
- suitable scale to fill ½ or > ½ grid
- plot points
- neat line passing through plotted points

ii) **Two** points from:

- optimum, or 7, is fastest, or best
- increase rate as change pH 3–7, or less acid, or more alkaline; or decrease rate as change pH 7–3, or more acidic
- decrease rate as change pH 7-8, or more alkaline; or increase rate, as change pH 8–7, or more acidic, or less alkaline
- one mark available for another valid point

b **Four** points from:

- control temperature
- same size of apparatus, or tube
- same size, or type, or mass, of paper; or same concentration of catalase
- buffer
- more sophisticated timer, or stopwatch, or data logger
- safety features: includes use forceps to handle pieces of paper, or goggles, or gloves, or lab coats
- repeats
- oxygen collected, or volume measured
- increase number of intermediate pH values, or more values between 3 and 8

c **Six** points from:

- one pH
- range of temperatures
- control temperature, e.g. keep tubes in water bath throughout investigation, or at same temperature
- equilibrate tubes in different water baths for e.g. 5 minutes – way of achieving steady temperature before starting; same volume, or concentration, of hydrogen peroxide
- same enzyme source or concentration; or same size, or type, or mass, of filter paper
- same size of tubing, or apparatus, or test tube
- repeats, or find average
- volume of oxygen measured, or plot a graph of activity
- safety features: includes use forceps to handle pieces of paper, or goggles, or gloves, or lab coat

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6 Plant nutrition

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1 a drawing: size and proportion (drawing should be same size as Figure 6.1)

outline clear and serrated, to include petiole

Labels – **Two** points from:

- midrib, or main vein
- network of veins, or branched veins
- petiole, or (leaf) stalk

b i) calculation 30–38

ii) **Two** points from:

- means of scoring squares to avoid counting twice
- whole squares counted
- part squares included in total leaf area

alternative method:

- count number of empty squares
- subtract from total

c i) epidermal cell

guard cell

ii) two guard cells labelled on Figure 6.2, or copy of diagram, or sketched, or described

d **Four** points from:

- use of microscope, or ref to magnification
- preparation of epidermis for viewing, e.g. epidermal peel, or nail varnish, or wax, or reference to photograph
- count number of stomata in a given area
- determine the area (viewed under the microscope)
- calculate the total area of the leaf
- calculate total number of stomata for whole leaf
- description of some sort of calculation

7 Human nutrition

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1 a iodine solution, or reagent, or iodine in potassium iodide

brown, or orange, or yellow, to blue, or purple, or black

b **Three** points from:

- Safety – use a water bath
- Benedict's (solution)
- heat, or boil

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- blue to green, or yellow, or orange, or (brick)red

c optimum temperature or temperature at which enzyme works best

d i) one or two colours correct = 1 mark; 3 or 4 colours correct = 2 marks;

all colours correct = 3 marks

sample	time/min	observations	conclusion
1	0	• blue	none
2	10	• green	very little present
3	20	• yellow	some present
4	30	• orange	more sugar present
5	40	• red, or brick red, or reddish brown	larger amount present

ii) no starch present (in the water, or outside tubing), or starch had not passed out (of tubing)

e **Four** points from:

- (idea of break-down of) starch to (reducing, or simple) sugar
- (idea of) sugars move through walls of tubing, or out (into water)
- diffusion (of sugars)
- starch too large, or sugars small enough (to pass through)
- (membrane is) permeable, or partially, or semi-, permeable

f i) to remove any contents, or starch, or enzyme (from outside of tube)

ii) to see colour change easily or clearly

g i) small intestine, or ileum, or villus

selectively permeable walls; or idea of where absorption, or diffusion, takes place

ii) amylase, or carbohydrase, or maltase

h i) axis labelled and scaled evenly

size – plots for 'time' must use half or more of the axis

all points plotted accurately

line through all points

ii) pH 7(.0)

iii) **Three** points from:

- below optimum, or pH 7, or neutral, as pH increases the activity increases, or time decreases
- above optimum, or pH 7, or neutral, as pH increases the activity decreases, or time increases
- credit use of figures

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- above pH 7, decrease in activity, or increase in time, occurs more rapidly, or graph has steeper curve

iv) water to replace the enzyme, or boiled enzyme

9 Transport in animals

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1 a i) **two** sites marked on Fig 9.1, from:

- wrist
- neck
- groin
- temple
- finger
- toe
- elbow
- thumb
- armpit
- back of knee

ii) arteries near surface or skin, or arteries can be pressed against bone or hard structure beneath

b apply pressure (using finger) to pulse site

count pulse, or number of beats per unit time

c i) 65 ± 1 (mm)

ii) (65 ± 1) ÷ 125 = 0.51 – 0.53 mm

iii) take multiple (more than one) readings for diameter across different positions

calculate average length and use this value in calculation

iv) 1 mark for choice of 3 correct features

1 mark for each pair of appropriate differences

feature	**vein**	**artery**
shape	round	oval
wall	thin	thick
(detail) of layers	smooth, or single layer	uneven, or two or more layers
lumen, or inner space, or internal diameter	large, or circular	small, or oval

d i) **Four** points from:

- heart, or pulse, rate taken before exercise
- heart, or pulse, rate taken immediately after exercise
- exercise – same type, or same length of time
- students – same age, or gender, or clothing
- repeat for each type of student, or use groups of students

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ii) **Three** points from:

- table drawn with (ruled) lines and distinct columns, or rows
- column, or row, headings for type of student
- columns, or rows, for pulse, or heart rate, before and after exercise with unit (i.e. beats per min, or bpm, or beats per unit time) in the heading
- column, or row, for increase, or difference, in pulse rate, or for average pulse rate for all students in category, with appropriate heading including units as before

2 **a** **i)** Any site where pressing against bone, or cartilage a pulse can be measured

ii) Any **two** points from:

- artery
- surge, or wave, of blood
- near the surface
- pressure against bone or cartilage

b **i)** calculation x 3 for rate per minute (72, 76, 68)

mean calculated (72)

ii) reliability, or to reduce error, or to show anomalies

iii) **Two** points from list below. One mark for factor, one mark for explanation in each case.

- exercise, or physical work, or activity – increases heart rate, or demand for extra supply of blood, or oxygen, or glucose, or energy (for muscles)
- relaxation, or sleeping, or inactivity – decreases heart rate, or lowers demand for blood supply
- adrenaline, or stress, or anxiety, or fear, or fright – increases heart rate
- alcohol – slows heart rate
- coffee, or caffeine – increases heart rate
- smoking, or nicotine – increases heart rate
- illness, or raised body temperature – increases heart rate
- being fit – lowers heart rate

c **i)** graph S – suitable scale to fill over half of printed grid
P – plotted correctly: one mark for all but one plots correct
one extra mark if all plots correct
B – bars separate, not touching
C – columns of equal width

ii) higher body mass, or heavier – slower heart rate, or reverse argument, or negative correlation

d lower body mass + higher heart rate + link to shorter life span, or higher body mass + lower heart rate + link to longer life span

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11 Gas exchange in humans

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1 a i) (vertical bar) 8 mm ±1 and (horizontal bar) 9 mm ±1

(average) 8.5 mm ±1

ii) calculation of actual average diameter using average value above

value of 0.005–0.007 mm

converted to µm to give 7 ±1 (µm)

iii) outline: clear continuous outline with no shading

size: occupies at least half the space available

drawing showing most of three alveoli and one or more capillaries, walls of alveoli drawn as double lines or showing thickness

b i) 31

ii) **Five** points from:

- independent variable: varying type, or intensity, or duration, of exercise
- dependent variable: measure chest, or circumference
- controlled variables – two from: same number each sex, or all same sex, or same age, or same mass, or same fitness, or same time after eating or drinking, or no caffeine, or no medication, or no alcohol, or no other named chemical, or same environment, or same temperature, or same altitude, or exercise for same amount of time if type or intensity varied, or same type of exercise if duration changed
- methodology: idea of measuring increase in chest circumference, as soon as exercise is complete, or before chest circumference returns to normal
- rest before carrying out higher intensity of exercise
- detail of the exercise completed, e.g. running
- two or more repeats for each person, or three or more people doing the test
- relevant safety precaution, e.g. all healthy, or suitable footwear

18 Variation and selection

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1 a

- more with straight thumb
- correct reference to figures for gender, e.g. straight: 84 males and 87 females, or more females, or fewer males; or hitch hiker: 12 males and 14 females, or more females, or fewer males
- independent of their age

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b **Three** points from:

- discontinuous variation
- no range of results, or only two types
- hitch hiker thumb recessive (allele); straight thumb dominant (allele)
- not linked to sex, or gender
- not affected by age

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