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EDEXCEL INTERNATIONAL GCSE BIOLOGY: QUESTIONS BY TOPIC

Structure and Functions in Living Organisms (2)

International GCSE Biology Section 2

167 questions · 1796 marks · Mark schemes included

Pearson Edexcel International GCSE (9–1) Biology 4BI1, Papers 1B, 1BR, 2B & 2BR, June 2019 - June 2025

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HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic; within each sub-topic they run from the lowest mark tariff to the highest.
Click any sub-topic heading or question row below to jump straight to it.
On every question page, click ANSWER in the top-right corner to jump to its mark scheme.
Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

167 questions · 1796 marks · grouped by sub-topic

SUB-TOPIC 2(b)

CELL STRUCTURE

9 questions in this sub-topic · 72 marks · lowest tariff first

7 As an embryo develops, its cells differentiate.

(a) Explain the importance of cell differentiation in the development of the growing embryo.

(2)

(b) (i) Which of these is a feature of adult stem cells?

(1)

- ☒ **A** they do not divide
- ☒ **B** they divide by meiosis
- ☒ **C** they can become all cell types
- ☒ **D** they are found in some tissues and organs

(ii) Adult stem cells or embryonic stem cells can be used in medical treatments.

Explain why the choice between these two types of stem cells can cause issues for doctors.

(2)

(Total for Question 7 = 5 marks)

1 The table lists values that can be obtained in practical investigations.

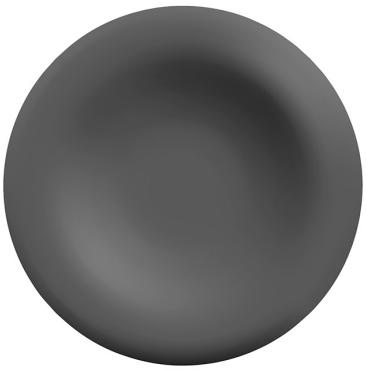
(a) Complete the table by naming pieces of laboratory apparatus that can be used to help obtain these values.

The first one has been done for you.

(4)

Value	Apparatus
magnification of a red blood cell	microscope
heat produced by germinating seeds	
surface area to volume ratio of a potato cylinder	
breathing rate of a human	
volume of gas produced by yeast in anaerobic respiration	

(b) The diagram shows a red blood cell viewed through a microscope.



(Source: © Artem_Graf/Shutterstock)

The actual width of this red blood cell is 8 µm.

The magnification of this red blood cell can be calculated using this formula.

$$\text{magnification} = \frac{\text{width of cell in drawing}}{\text{actual width of cell}}$$

Calculate the magnification of this red blood cell.

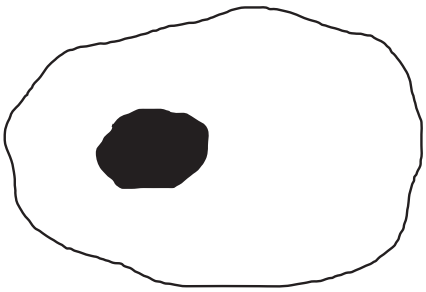
(2)

magnification = ...

(Total for Question 1 = 6 marks)

3 (a) A student uses a light microscope to look at a human cheek cell.

The student makes this drawing of the cell.



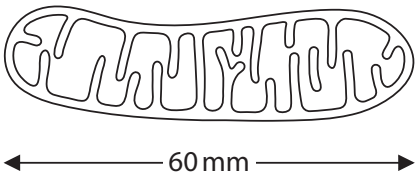
Name the organelle shown in the drawing.

(1)

.....

(b) Mitochondria are organelles that are too small to be seen using a light microscope.

The drawing shows a mitochondrion that has been magnified.



The actual length of this mitochondrion is 6 μm.

[1 μm = 0.001 mm]

Calculate the magnification of this drawing.

(2)

magnification = ...

(c) The table gives information about mitochondria in different human cells.

Cell	Mean number of mitochondria per cell	Mean volume of cell in μm^3	Mean number of mitochondria per μm^3
heart muscle	5000	15000	
sperm	75	30	2.50
egg	600000	4000000	0.15

(i) What is the mean number of mitochondria per μm^3 in a heart muscle cell?

(1)

- ☒ **A** 0.33
- ☒ **B** 3
- ☒ **C** 10000
- ☒ **D** 75000000

(ii) Comment on the differences in the data for the sperm and for the egg.

(3)

(Total for Question 3 = 7 marks)

6 (a) Describe how stem cells are different from other cell types.

(2)

(b) Stem cells from a donor can be used for stem cell therapy.

Human blood cells are produced in bone marrow.

Explain how using stem cells from the bone marrow enables doctors to treat a number of different blood conditions.

(3)

(c) One type of stem cell transplant uses a patient's own stem cells.

They can be used if the patient is producing enough healthy bone marrow cells. These cells can be collected, frozen and stored for later use.

Explain the advantage of using the patient's own stem cells rather than using stem cells from a donor.

(2)

(Total for Question 6 = 7 marks)

1 Plant and animal cells have some features in common and some differences.

(a) (i) Which of these structures is not found in animal cells?

(1)

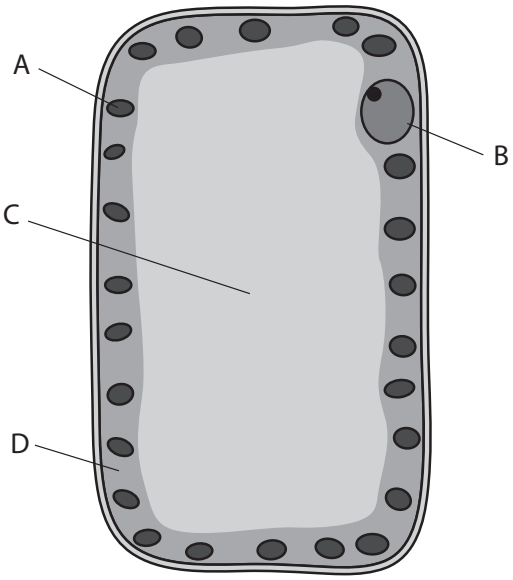
- ☒ **A** cell membrane
- ☒ **B** cell wall
- ☒ **C** mitochondrion
- ☒ **D** nucleus

(ii) Which of these substances is a carbohydrate stored in plant cells?

(1)

- ☒ **A** chlorophyll
- ☒ **B** glucose
- ☒ **C** glycogen
- ☒ **D** starch

(b) The diagram shows a leaf palisade mesophyll cell.



(i) Describe the function of the parts labelled A, B, C and D.

(4)

A .....

.....

B .....

.....

C .....

.....

D .....

.....

(ii) Explain two ways that the structure of this palisade mesophyll cell is adapted for its function.

(2)

1 .....

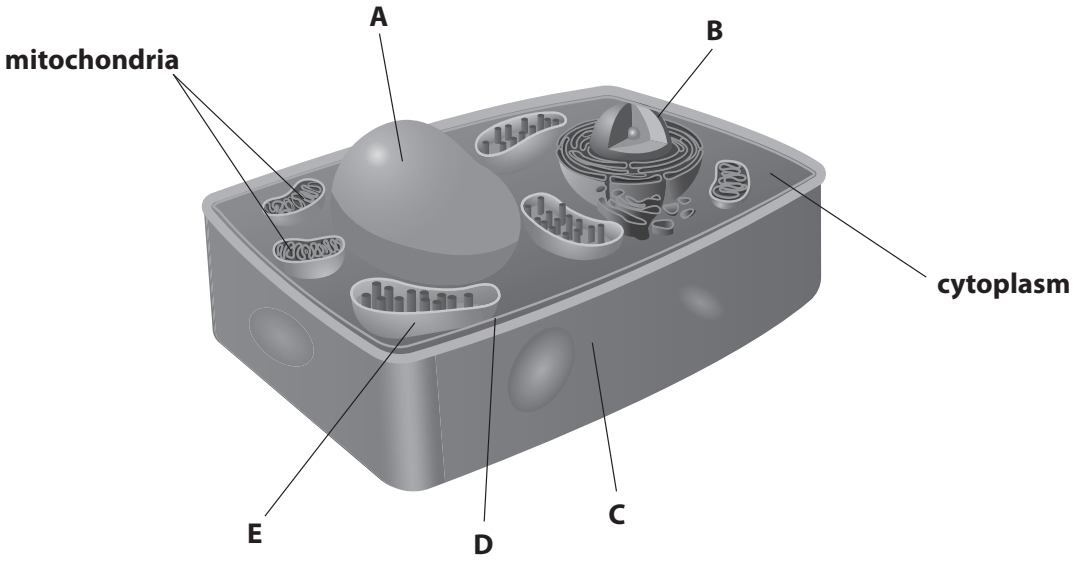
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2 .....

.....

(Total for Question 1 = 8 marks)

1 This is a three-dimensional diagram of a plant cell.



(a) Name the structures labelled A, B, C, and D.

(4)

A .....

B .....

C .....

D .....

(b) Structure E is a chloroplast.

Chloroplasts are not found in animal cells.

(i) Give the letter of another structure shown in the diagram but not found in animal cells.

(1)

.....

(ii) Explain why some plant cells contain many chloroplasts, some plant cells contain few chloroplasts and some plant cells contain no chloroplasts.

(3)

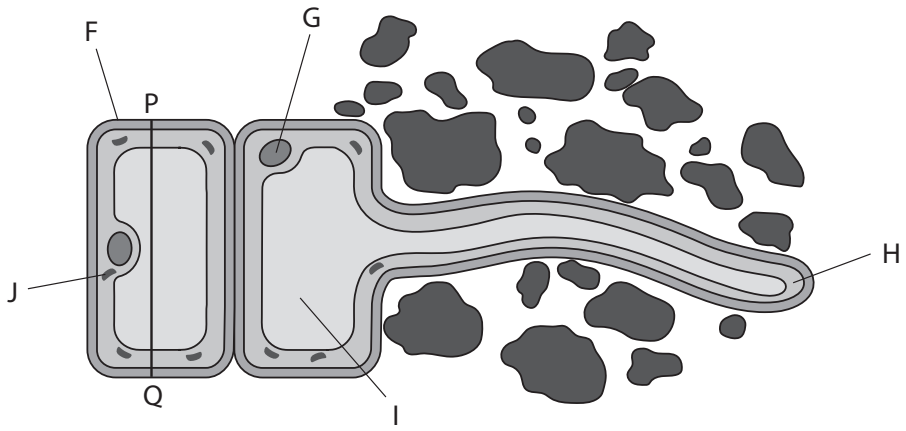
(c) Ribosomes are found in plant cells and in animal cells.

Name the process that occurs at the ribosomes.

(1)

(Total for Question 1 = 9 marks)

2 The diagram shows two cells from a plant root.



(a) (i) Which structure is the vacuole?

(1)

- ☒ **A** F
- ☒ **B** G
- ☒ **C** H
- ☒ **D** I

(ii) Which structure is the nucleus?

(1)

- ☒ **A** F
- ☒ **B** G
- ☒ **C** H
- ☒ **D** J

(b) The actual length of the root cell from P to Q is 80 μm.

Determine the magnification of the diagram.

[1000 μm = 1 mm]

(3)

magnification = × .....

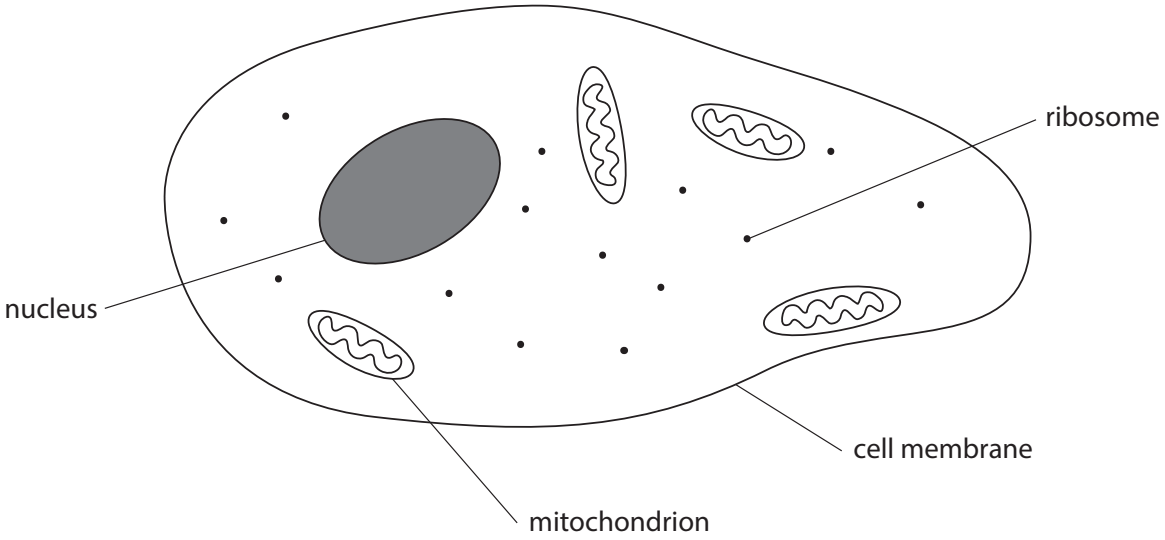
(c) Root hair cells are specialised cells adapted for their functions.

Explain how root hair cells are adapted for their functions in the plant.

(4)

(Total for Question 2 = 9 marks)

3 The diagram shows a human skin cell.



(a) (i) In which of the labelled structures does protein synthesis occur?

(1)

- ☒ **A** cell membrane
- ☒ **B** mitochondrion
- ☒ **C** nucleus
- ☒ **D** ribosome

(ii) All cells have cell membranes.

Which of the labelled structures are also found in plant cells?

(1)

- ☒ **A** mitochondrion and nucleus only
- ☒ **B** mitochondrion and ribosome only
- ☒ **C** mitochondrion, nucleus and ribosome
- ☒ **D** nucleus and ribosome only

(b) The table shows information about the number of mitochondria in different types of human cell.

Type of human cell	Number of mitochondria in one cell	Number of mitochondria in 10 μm³ of cell	Volume of cell in μm³
skin	510	3	1700
villus	2000	8	2500
sperm	75	12	

(i) The volume of a villus cell is 2500 μm^3.

Calculate the ratio of the volume of a villus cell to the volume of a sperm cell.

Give your answer in the form n : 1

(3)

ratio = ... : 1

(ii) Using the information in the table, comment on the importance of mitochondria to the activities of different cell types.

(4)

.....

.....

.....

.....

.....

.....

.....

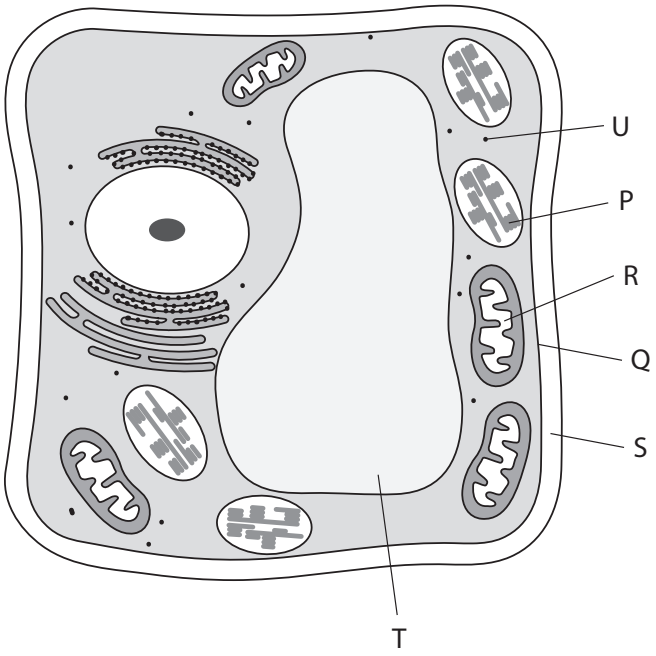
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(Total for Question 3 = 9 marks)

3 The diagram shows a plant cell with some structures labelled.



(a) (i) Which structure is the cell vacuole?

(1)

- ☒ **A** P
- ☒ **B** R
- ☒ **C** S
- ☒ **D** T

(ii) Which structure is the site of photosynthesis?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** T

(iii) Which structure is the cell wall?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** S
- ☒ **D** T

(iv) Structure U is the site of protein synthesis in the cell.

What is the name of structure U?

(1)

- ☒ **A** chloroplast
- ☒ **B** mitochondrion
- ☒ **C** ribosome
- ☒ **D** starch granule

(b) A cell is shaped like a cube.

Each side has a length of 0.053 mm.

Calculate the surface area to volume ratio of this cell.

Give your answer in the form n : 1

(3)

surface area to volume ratio = ... : 1

(c) Animal cells, unlike plant cells, do not have a cell wall.

(i) Explain how this difference affects red blood cells when placed in distilled water.

(3)

(ii) Explain how this difference affects red blood cells when placed in a concentrated salt solution.

(2)

(Total for Question 3 = 12 marks)

SUB-TOPIC 2(c)

BIOLOGICAL MOLECULES

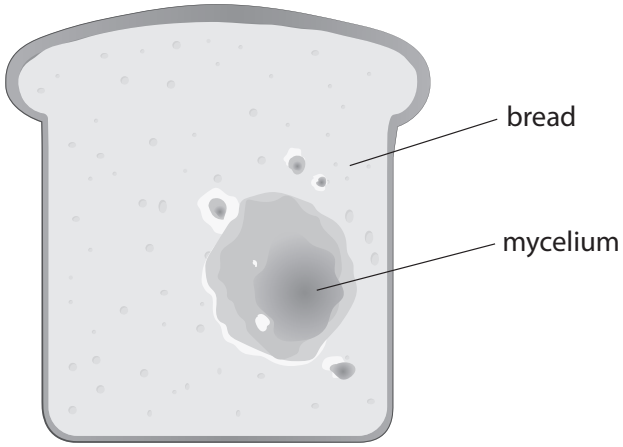
10 questions in this sub-topic · 103 marks · lowest tariff first

1 Bread contains starch.

(a) Describe how you would test a piece of bread to show it contains starch.

(2)

(b) The diagram shows the mycelium of an organism growing on a piece of bread.



(i) Which type of organism is shown growing on the bread?

(1)

- ☒ **A** bacterium
- ☒ **B** fungus
- ☒ **C** protoctist
- ☒ **D** virus

(ii) Which enzyme is released by the organism to digest starch?

(1)

- ☒ **A** amylase
- ☒ **B** ligase
- ☒ **C** lipase
- ☒ **D** protease

(Total for Question 1 = 4 marks)

11 Some cosmetic companies claim that adding argan oil to their shampoo increases the strength of human hair.

Design an investigation to find out if argan oil shampoo does increase the strength of human hair.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 11 = 6 marks)

2 A teacher uses Benedict's solution to investigate the concentration of glucose in four flavoured waters, A, B, C and D.

This is the teacher's method.

Step 1 add 5 cm^3 of flavoured water to a boiling tube

Step 2 add 5 cm^3 of Benedict's solution to the boiling tube

Step 3 keep the boiling tube at 70 °C for five minutes

Step 4 record the colour of the solution

The teacher uses this method for each of the four flavoured waters.

The table shows the teacher's results.

Flavoured water	Colour of the solution after heating for five minutes
A	yellow
B	brick red
C	blue
D	green

(a) (i) Give one variable that the teacher controls in the investigation.

(1)

.....

(ii) Give a method that the teacher could safely use to keep the boiling tube at 70 °C for five minutes in step 3.

(1)

.....

.....

(b) An athlete wants to drink flavoured water to help them run a long-distance race.

Explain which flavoured water, A, B, C or D, would be most suitable for the athlete to drink during the race.

(4)

(c) Some flavoured waters do not contain glucose.

Suggest why this may be an advantage for some people.

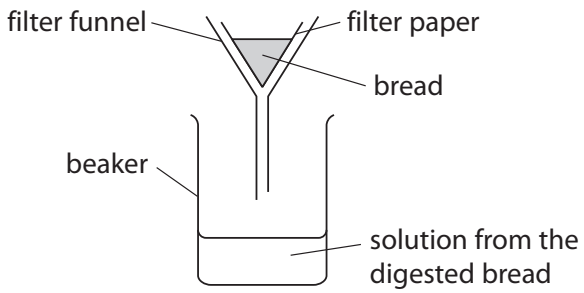
(2)

(Total for Question 2 = 8 marks)

7 Bread contains starch.

A student investigates how temperature affects the digestion of bread.

This is the apparatus he uses in his method.



This is the student's method.

- add amylase to a sample of bread
- put this bread in the filter funnel
- pour water onto the bread
- do a Benedict's test on the solution from the digested bread that collects in the beaker
- repeat the method at different temperatures

(a) Explain the results of Benedict's test if the amylase digests the starch.

(2)

(b) The student's method lacks detail.

Rewrite the method so that the student could make a valid conclusion about the effect of temperature on amylase.

(4)

(c) The student predicted that the rate of digestion of starch would keep increasing as temperature increased.

Comment on this prediction.

(4)

(Total for Question 7 = 10 marks)

7 (a) A student investigates the sugar content of four different fruit juices.

This is the student's method.

- add 5 cm^3 of fruit juice to a boiling tube
- add 5 cm^3 of Benedict's solution to the boiling tube
- place the boiling tube in a water bath at 70 °C for three minutes
- remove the boiling tube and record the colour of the solution

The student uses this method for each of the four fruit juices.

The table shows the student's results.

Fruit juice	Colour of solution after heating for three minutes
A	blue
B	brick red
C	yellow
D	green

(i) Give two variables that the student controls in his investigation.

(2)

1 .....

2 .....

(ii) Give the juices A, B, C and D in order of sugar content, from highest to lowest.

(2)

highest lowest

(iii) The student is now given sugar solutions with concentrations of 1%, 5%, 10% and 20%.

Explain how the student could use these solutions to estimate the concentration of sugar in the four fruit juices.

(3)

(b) Some fruit juices contain high concentrations of sugar.

These fruit juices increase the number of bacteria in the mouth.

This may lead to an increase in tooth decay.

(i) Suggest why high concentrations of sugar may increase tooth decay.

(2)

(ii) Explain another health risk to children who drink fruit juices with high concentrations of sugars.

(2)

(Total for Question 7 = 11 marks)

6 Catalase is an enzyme found in many cells.

It speeds up the breakdown of hydrogen peroxide into water and oxygen.

The equation for the reaction is

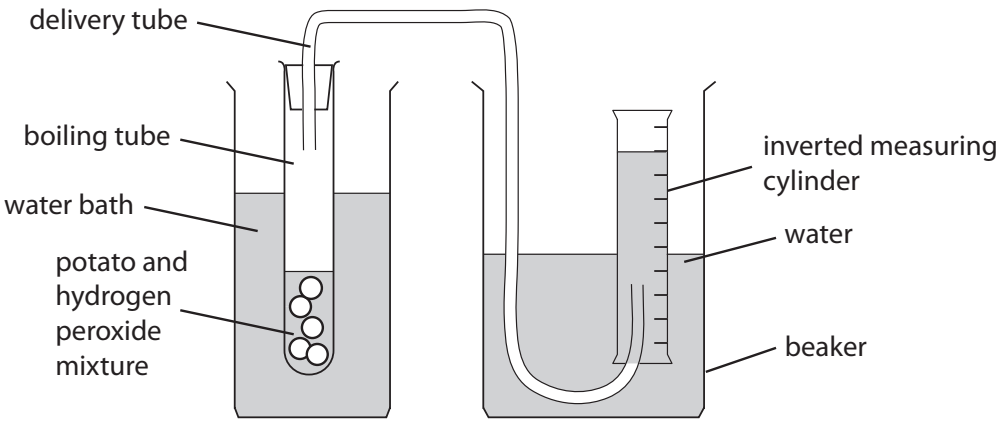
$$2H_2O_2 \rightarrow 2H_2O + O_2$$

A teacher demonstrates the effect of increasing catalase concentration on the initial rate of the reaction.

This is the teacher's method.

- cut five equal size discs from a potato, each 0.2 mm thick
- place the discs in a boiling tube with 5 cm^3 of buffer solution
- add 5 cm^3 of hydrogen peroxide solution to the boiling tube
- place a bung and delivery tube firmly into the boiling tube
- position the other end of the delivery tube under an inverted measuring cylinder
- start a timer as soon as the first bubble of oxygen enters the measuring cylinder
- measure the volume of oxygen produced in one minute

Repeat this method three times.



The teacher uses this method with different numbers of potato discs, making sure that other conditions are unchanged.

(a) Give the expected relationship between the named independent variable and the named dependent variable in this demonstration.

(2)

(b) Give **two** variables that the teacher controls in this demonstration.

(2)

1 .....

2 .....

(c) The table shows the teacher's results.

Enzyme concentration in number of discs	Volume of oxygen produced in one minute in cm^3				
	Reading 1	Reading 2	Reading 3	Reading 4	Mean reading
5	1.2	1.5	0.0	1.5	
10	3.5	4.5	6.0	5.5	4.9
15	6.5	7.0	7.5	8.0	7.3
20	9.0	8.5	8.0	7.5	8.3
25	15.0	11.0	11.5	12.0	12.4

(i) Calculate the mean volume of oxygen produced in one minute using 5 potato discs.

(2)

mean reading = ... cm^3

(ii) Calculate the percentage increase in mean volume of oxygen produced in one minute as the concentration of enzyme changes from 15 to 20 discs.

(2)

percentage increase = ... %

(iii) Explain the relationship between the concentration of enzyme and mean volume of oxygen produced in one minute.

(2)

(d) Suggest why the teacher measures the volume of oxygen after the first minute of the reaction rather than after 10 minutes.

(2)

(Total for Question 6 = 12 marks)

2 Catalase is an enzyme found in many cells.

This enzyme controls the breakdown of hydrogen peroxide into water and oxygen.

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

hydrogen peroxide — water — oxygen

A teacher uses this method to investigate the effect of pH on catalase.

Step 1 cut a cylinder of potato tissue into six equal sized discs

Step 2 measure 10 cm^3 of hydrogen peroxide solution and place into a boiling tube

Step 3 add a pH buffer solution to the tube to keep the pH at 7

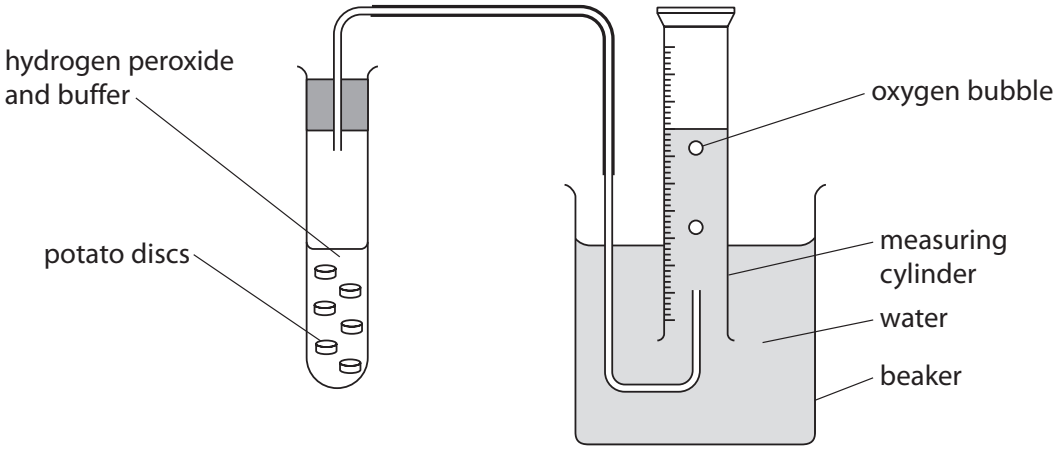
Step 4 add the six potato discs to the boiling tube

Step 5 collect the gas given off by the reaction in an inverted 20 cm^3 measuring cylinder

Step 6 measure the total volume of gas collected after five minutes

Repeat steps 1 to 6 using four different pH buffers (pH 4, pH 5, pH 6 and pH 8).

The diagram shows the teacher's apparatus.



(a) State what is meant by the term **enzyme**.

(1)

.....

.....

(b) Suggest why each potato cylinder was cut into six discs rather than left as one cylinder.

(1)

.....

.....

(c) (i) Give the dependent variable in this experiment.

(1)

.....

.....

(ii) The teacher controls the time for gas collection and also the volume of hydrogen peroxide used.

State two other abiotic variables the teacher should control in this experiment.

(2)

1 .....

2 .....

(d) The table shows the teacher's results.

pH of solution	Volume of oxygen after 5 minutes in cm^3	Mean rate of reaction in cm^3 per minute
4	4	0.8
5	6	1.2
6	7	1.4
7	12	2.4
8	3	0.6

(i) Calculate the percentage change in the mean rate of reaction as the pH is changed from pH 4 to pH 7.

(2)

percentage change = ... %

(ii) The teacher calculated the mean rate of reaction by collecting the oxygen released for the first five minutes of the reaction.

Explain why the mean rate of reaction changes beyond the first five minutes.

(2)

(iii) Explain the effect of changing pH on an enzyme-controlled reaction.

(3)

(Total for Question 2 = 12 marks)

7 Lipase digests lipid into fatty acids and glycerol. The fatty acids change the pH of the solution.

A student uses this method to investigate the effect of temperature on the activity of lipase.

Step 1 label a test tube with the temperature (20 °C)

Step 2 add 5 drops of phenolphthalein indicator to the test tube

Step 3 add 5 cm^3 of milk to the test tube

Step 4 add 7 cm^3 of sodium carbonate solution to the test tube (the contents of the test tube will now be pink)

Step 5 place a thermometer in the test tube

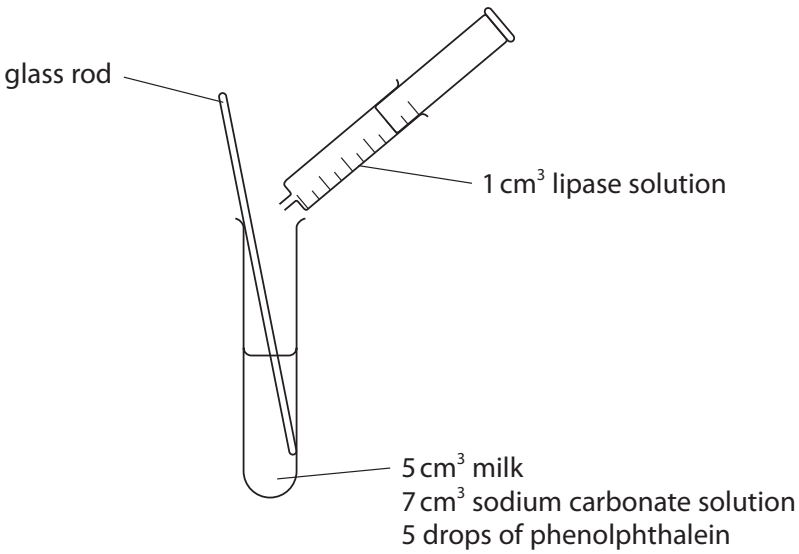
Step 6 place the test tube in a water bath at 20 °C for 5 minutes

Step 7 place a beaker containing lipase in the same water bath for 5 minutes

Step 8 replace the thermometer with a glass rod

Step 9 measure out 1 cm^3 of lipase from the beaker in the water bath

Step 10 add the lipase to the test tube, stir the contents and record the time until the contents lose their pink colour



The student repeats this method for five more temperatures, 25 °C, 30 °C, 35 °C, 40 °C and 45 °C.

(a) State why the student leaves the test tube and the beaker in the water bath for 5 minutes in steps 6 and 7.

(1)

.....

.....

(b) (i) Give the dependent variable in this investigation.

(1)

.....

(ii) State one variable the student controls in their investigation.

(1)

.....

(c) Suggest the purpose of the phenolphthalein indicator in the investigation.

(1)

.....

.....

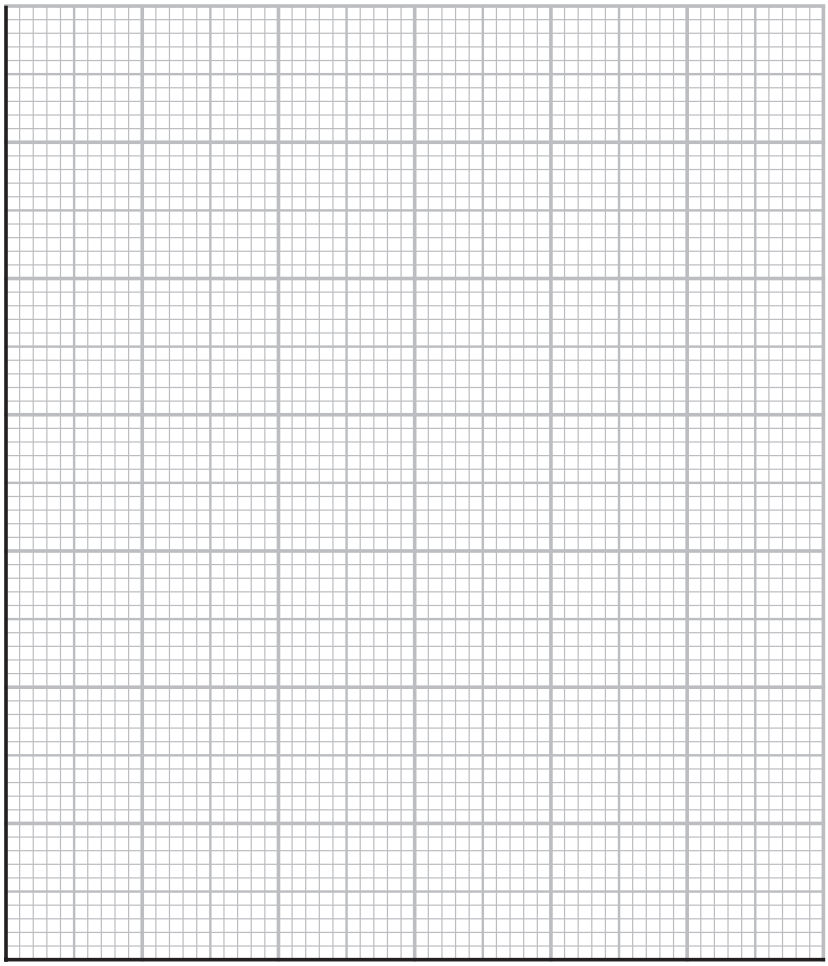
(d) The table shows the student's results.

Temperature in °C	Time taken for contents to lose the pink colour in seconds
20	385
25	340
30	300
35	250
40	275
45	360

Plot a line graph to show the effect of temperature on the time taken for the contents of the test tube to lose the pink colour.

Use a ruler to join your points with straight lines.

(5)



(e) Explain why increasing temperature affects the time taken for the contents of the test tube to lose the pink colour.

(4)

(Total for Question 7 = 13 marks)

6 Apples contain an enzyme called phenol oxidase.

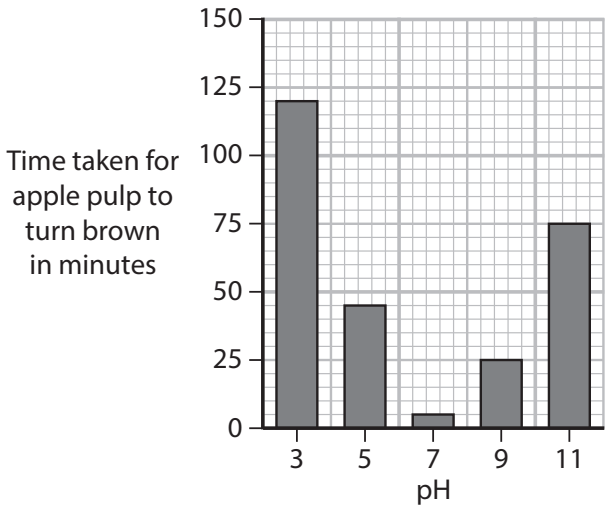
When apple tissue is exposed to oxygen in the air, this enzyme turns the apple tissue brown.

(a) A student uses this method to investigate the effect of pH on the time taken for apple tissue to turn brown.

- mash an apple to produce a pulp
- place 25 g of this pulp into a beaker
- mix a pH 7 buffer with the pulp to maintain the pH
- check the colour of the pulp every five minutes
- record the time when the pulp turns brown

The student repeats this method using pH buffers of 3, 5, 9, and 11.

The graph shows the student's results.



(i) Calculate the percentage increase in time taken for the apple pulp to turn brown at pH 11 compared with the time taken at pH 7.

(2)

percentage increase = ... %

(ii) Explain why the change in pH affects the time taken for the apple pulp to turn brown.

(3)

(iii) Explain how the student could modify this method to give a more accurate measure of the time taken for the apple pulp to turn brown.

(2)

QUESTION 6 CONTINUES ON NEXT PAGE.

(b) A genetically modified (GM) variety of apple has been produced that does not turn brown when exposed to air.

These apples have a gene in their DNA that produces a section of mRNA with a complementary sequence to the mRNA for the phenol oxidase gene.

(i) State two differences between DNA and mRNA.

(2)

1 .....

.....

2 .....

.....

(ii) Explain why these GM apples do not turn brown when the apple tissue is exposed to air.

Use your knowledge of protein synthesis to support your answer.

(4)

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(Total for Question 6 = 13 marks)

4 Enzymes are biological molecules that act as catalysts in metabolic reactions.

(a) (i) State what is meant by the term **catalyst**.

(1)

.....

.....

(ii) State what is meant by the term **metabolic**.

(1)

.....

.....

(b) A teacher investigates the effect of enzyme concentration on the rate of a reaction.

He uses the enzyme catalase, which is found in potato.

He changes the enzyme concentration by adding different numbers of potato discs.

Catalase breaks down hydrogen peroxide solution into water and oxygen.

This is his method.

- cut same-sized discs from a potato
- put 5 cm^3 of hydrogen peroxide solution into each of five test tubes
- add a different number of potato discs to the hydrogen peroxide
- measure the volume of oxygen gas produced in three minutes

The teacher repeats each test four times for each concentration.

He then calculates the mean rate of oxygen production for each concentration.

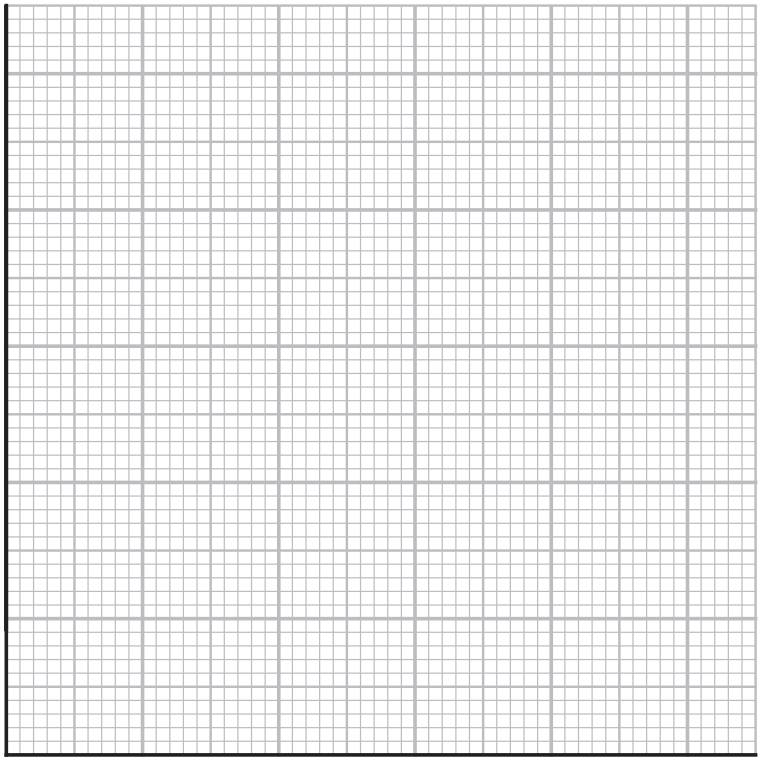
The table shows his results.

Enzyme concentration (number of potato discs)	Mean rate of oxygen production in cm^3 per minute
2	2.0
4	4.4
6	7.0
8	8.2
10	8.2

(i) Plot a line graph to show the effect of enzyme concentration on the mean rate of oxygen production.

Use a ruler to join the points with straight lines.

(5)



(ii) Explain the effect of increasing enzyme concentration on the rate of oxygen production.

(3)

(iii) Name a piece of apparatus suitable for measuring the volume of oxygen produced.

(1)

.....

.....

(iv) Explain why it is important for the teacher to keep the volume and concentration of the hydrogen peroxide constant.

(2)

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(v) Name another variable the teacher should keep constant in his investigation.

(1)

.....

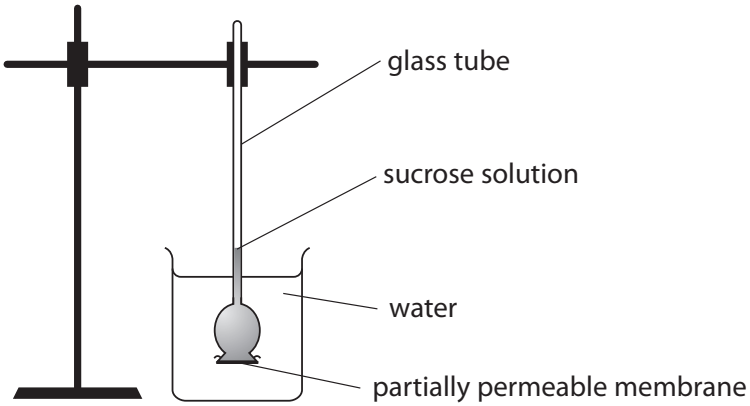
(Total for Question 4 = 14 marks)

SUB-TOPIC 2(d)

MOVEMENT OF SUBSTANCES INTO AND OUT OF CELLS

6 questions in this sub-topic · 61 marks · lowest tariff first

4 This apparatus can be used to show osmosis.



(a) Explain what happens to the level of the sucrose solution in the glass tube.

(3)

(b) Describe how this apparatus could be modified to measure the rate of osmosis at different temperatures.

(3)

(Total for Question 4 = 6 marks)

6 A teacher carries out a demonstration to show the effect of different concentrations of salt solution on red blood cells.

This is the teacher's method.

- dilute a sample of blood using a salt solution that has the same concentration as blood plasma
- place 1 cm^3 of the diluted blood into each of three test tubes labelled A, B and C
- add 10 cm^3 of water to tube A
- add 10 cm^3 of 1% sodium chloride solution to tube B
- add 10 cm^3 of 5% sodium chloride solution to tube C
- leave each tube for 5 minutes
- compare the cloudiness of the solutions in the three test tubes
- take a drop of liquid from each tube and put on separate microscope slides
- observe each slide under a microscope

(a) State the independent variable in this investigation.

(1)

.....

(b) Give one variable that the teacher controls in this investigation.

(1)

.....

(c) After 5 minutes, these are the teacher's observations.

- tube A – a clear red solution
- tube B – a cloudy red suspension
- tube C – a cloudy red suspension

(i) Explain the differences in the teacher's observations.

(2)

.....

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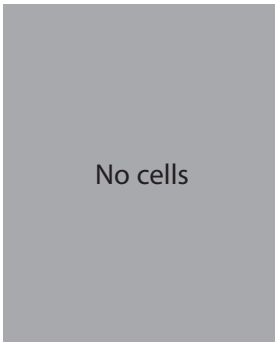
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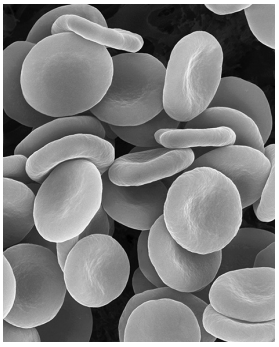
(ii) When the teacher looks down a microscope for cells on each slide, these are the teacher's observations.

- slide from tube A – no cells are seen
- slide from tube B – normal biconcave red cells are seen
- slide from tube C – red cells are seen but the cells have shrunken edges

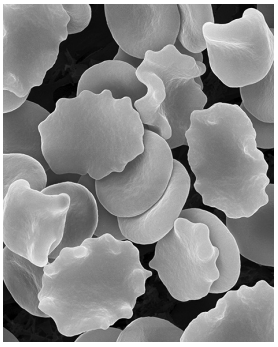
The photographs show the teacher's observations.



Tube A



Tube B



Tube C

(Source: © Dennis Kunkel Microscopy / Science Photo Library)

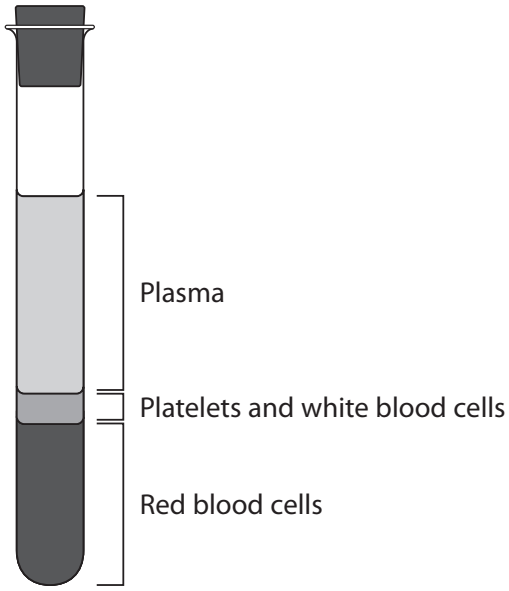
Explain the differences between the teacher's observations of the slides from each tube.

(2)

(d) Blood samples can be separated into different layers using a centrifuge.

This is a machine that spins blood at a high speed.

A new sample of blood is shown after it has been spun in a centrifuge.



Describe how the blood in tubes A, B and C from the teacher's demonstration would look after they had been spun in a centrifuge.

(2)

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.....

.....

.....

.....

(Total for Question 6 = 8 marks)

10 Substances can move into and out of cells by a variety of mechanisms.

(a) Explain the factors that affect the rate of movement of substances into and out of cells.

(5)

(b) Describe the differences between diffusion and active transport.

(4)

(Total for Question 10 = 9 marks)

2 A student investigates the effect of different concentrations of sucrose on potato tissue.

The student first makes a series of sucrose solutions using this dilution table.

Test tube	Volume of 1 molar sucrose solution in cm^3	Volume of distilled water in cm^3	Concentration of sucrose solution in mole per litre
1	20	0	1.0
2	16		0.8
3	12	8	0.6
4	8	12	0.4
5	4	16	0.2
6	0	20	0.0

(a) Complete the table by writing the volume of distilled water for test tube 2.

(1)

(b) This is the student's method.

Step 1 cut six equal-size cylinders of potato each 5 cm in length

Step 2 dry the cut surfaces using filter paper

Step 3 measure the mass of each cylinder

Step 4 place one cylinder of potato in each of the six test tubes containing

- 20 cm^3 of 1 molar (1.0 mole per litre) sucrose solution
- 20 cm^3 of 0.8 molar sucrose solution
- 20 cm^3 of 0.6 molar sucrose solution
- 20 cm^3 of 0.4 molar sucrose solution
- 20 cm^3 of 0.2 molar sucrose solution
- 20 cm^3 of distilled water

Step 5 put a bung in each test tube and leave the test tubes for one hour

Step 6 remove the cylinders from each test tube

Step 7 dry the cylinders with filter paper

Step 8 measure the mass of each cylinder again

Explain the reason for step 7 in the student's method.

(2)

(c) The table shows the student's results.

Concentration of sucrose solution in mole per litre	Original mass in g	Final mass in g	Change in mass in g	Percentage change in mass (%)
1.0	2.1	1.8	–0.3	–14
0.8	2.1	1.9	–0.2	–9.5
0.6	2.2	2.2	0.0	0.0
0.4	2.2	2.3		
0.2	2.1	2.2	0.1	4.8
0.0	2.1	2.3	0.2	9.5

(i) Calculate the percentage change in mass for the 0.4 mole per litre sucrose solution.

(2)

percentage change = ... %

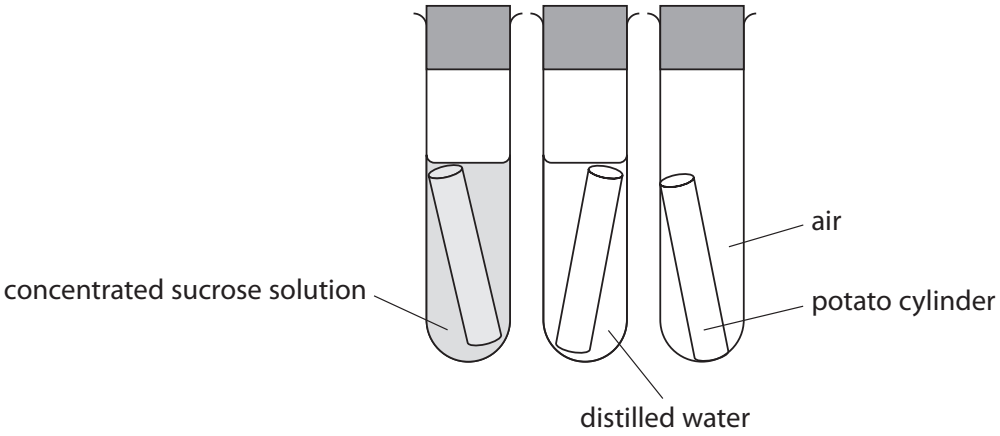
(ii) Comment on the effect of the different concentrations of sucrose on the potato tissue.

(5)

(Total for Question 2 = 10 marks)

6 A student uses this method to investigate osmosis in potato tissue.

- cut three 5.0 cm long cylinders from a raw potato
- dry the cut surfaces using filter paper
- measure the mass of each cylinder using a balance
- place one cylinder in a test tube containing 10 cm^3 of concentrated sucrose solution, one cylinder in a test tube containing 10 cm^3 of distilled water and one cylinder in an empty test tube
- put a bung in each test tube and leave them for one hour
- remove the cylinders and dry them with filter paper
- measure the mass of each cylinder again
- measure their lengths using a ruler



(a) (i) Describe what is meant by the term **osmosis**.

(2)

.....

.....

.....

(ii) State the independent variable in the student's investigation.

(1)

.....

(b) Osmosis is affected by the surface area and volume of the cylinders, so the student keeps the original surface area and volume of each cylinder the same.

At the start of the experiment each cylinder had a radius of 0.25 cm and a length of 5.0 cm.

(i) Calculate the surface area of each cylinder using this formula.

$$\text{surface area} = 2\pi rl + 2\pi r^2$$

[l = length of cylinder, r = radius of cylinder and $\pi = 3.14$]

(2)

surface area = ... cm^2

(ii) Explain how surface area would affect the rate of osmosis.

(2)

.....

.....

.....

.....

(iii) State another variable the student should control in the investigation.

(1)

.....

(c) The table shows the student's results for the mass of the cylinders.

Tube contents	Original mass in g	Final mass in g	Change in mass in g
concentrated sucrose solution	2.1	1.8	–0.3
distilled water	2.1	2.3	0.2
air	2.2	2.1	–0.1

(i) Explain the changes in the mass of the potato cylinder in each test tube.

(3)

(ii) The student also measured the change in length of each potato cylinder.

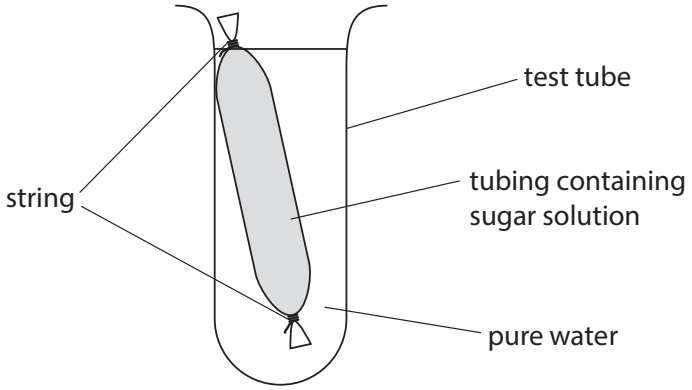
Assuming the length has the same percentage change as the mass, calculate the final length of the cylinder in the concentrated sucrose solution.

(3)

length = ... cm

(Total for Question 6 = 14 marks)

6 A student uses this apparatus to investigate osmosis in a non-living system.



This is the student's method.

- tie partially permeable tubing at one end with string to make a bag
- fill the bag with sugar solution
- tie the bag at the other end with string
- measure the mass of the bag, string, and sugar solution
- place the bag into a test tube filled with pure water
- after 5 minutes remove the bag and measure the mass
- return the bag to the test tube
- repeat the measurement of mass every 5 minutes for 30 minutes in total

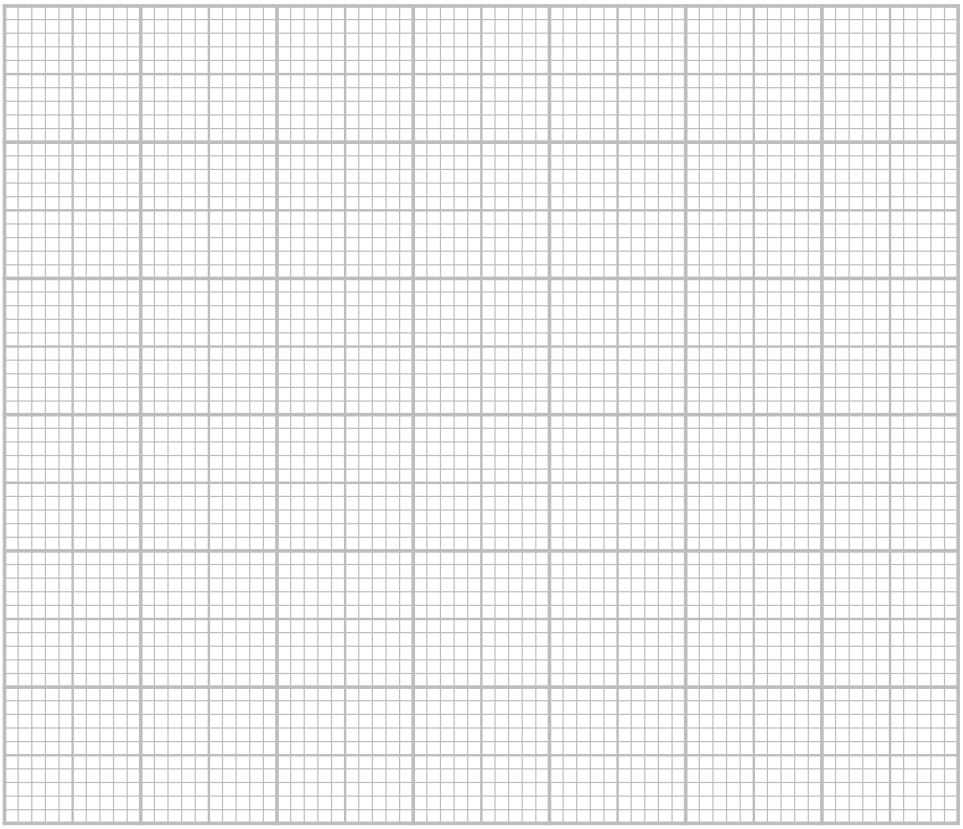
The table shows the student's results.

Time in minutes	Mass of bag in g
0	15
5	17
10	20
15	23
20	26
25	27
30	27

(a) (i) Draw a line graph to show the student's results.

Join your points with straight lines.

(5)



(ii) Describe the change in mass of the bag during the 30 minutes.

(2)

.....

.....

.....

.....

(iii) Explain the change in mass of the bag during the 30 minutes.

(2)

(b) The student decides to investigate how increasing the temperature would affect the results.

(i) Describe how the student could repeat the experiment safely at a higher temperature.

(2)

(ii) Explain how repeating the experiment at a higher temperature would affect the results.

(3)

(Total for Question 6 = 14 marks)

SUB-TOPIC 2(e)

NUTRITION

38 questions in this sub-topic · 421 marks · lowest tariff first

1 Organs in the human body have different functions.

(a) Name the organ that produces bile.

(1)

.....

(b) Which organ releases progesterone?

(1)

☒ **A** the brain

☒ **B** the ovary

☒ **C** the pituitary

☒ **D** the testis

(c) Which row of the table correctly shows whether the kidneys and skin are involved in excretion?

(1)

	kidneys	skin
☒ **A**	no	no
☒ **B**	no	yes
☒ **C**	yes	no
☒ **D**	yes	yes

(d) The stomach is an organ found in the alimentary canal.

Describe the role of the stomach.

(3)

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(Total for Question 1 = 6 marks)

5 Obesity is caused when energy input is greater than energy output.

A student likes to eat potato crisps but is concerned about obesity.

The student has a choice of two different types of crisp to eat.

Describe an experiment the student could use to determine which type of crisp contains the least energy.

(6)

(Total for Question 5 = 6 marks)

10 Plants absorb light energy for photosynthesis.

Some colours of light result in a higher rate of photosynthesis than other colours of light.

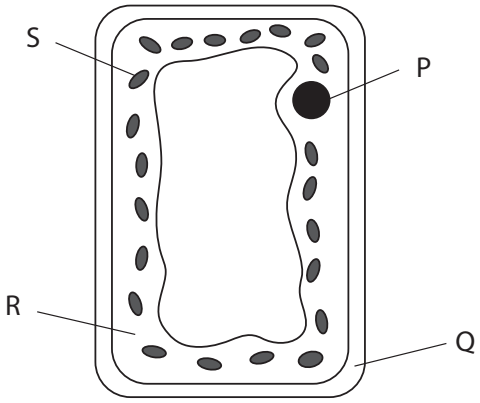
Devise an investigation to discover which colour of light results in a higher rate of photosynthesis.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 10 = 6 marks)

1 (a) The diagram shows a plant cell.



(i) Which part of this cell contains chlorophyll?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(ii) Which of these is found in chlorophyll?

(1)

- ☒ **A** calcium
- ☒ **B** iron
- ☒ **C** magnesium
- ☒ **D** water

(iii) Describe the role of chlorophyll.

(2)

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.....

.....

(b) Which of these is an example of positive phototropism?

(1)

- ☒ **A** a plant root growing away from light
- ☒ **B** a plant root growing downwards due to gravity
- ☒ **C** a plant stem growing towards light
- ☒ **D** a plant stem growing upwards due to gravity

(c) The table lists the roles of some substances found in living organisms.

Complete the table by naming each substance.

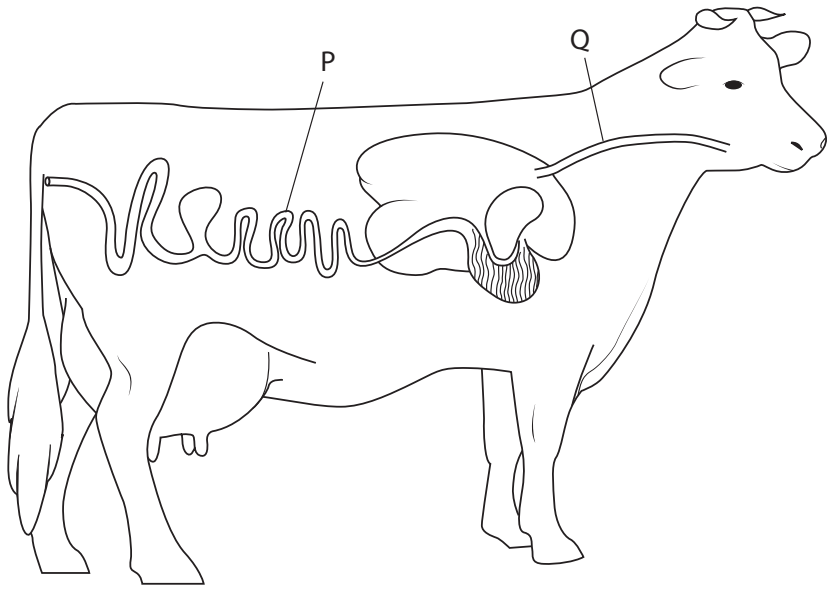
The first one has been done for you.

(3)

Role of substance	Name of substance
positive phototropism	auxin
digests fat	
diffuses across a synapse	
prevents scurvy	

(Total for Question 1 = 8 marks)

3 The diagram shows part of the digestive system of a cow.



(a) Name the parts labelled P and Q.

(2)

P .....

Q .....

(b) The cow's stomach contains microorganisms that digest plant cell walls.

Suggest why these microorganisms are useful to a cow.

(2)

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.....

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.....

(c) Farmers keep cows to produce milk.

Injecting cows with growth hormone (GH) will increase milk production.

This allows farmers to obtain the same volume of milk from fewer cows.

Digestion in cows releases methane gas into the atmosphere.

A scientist claims that injecting GH into cows would reduce climate change.

Comment on this claim.

(4)

(Total for Question 3 = 8 marks)

9 Plants manufacture carbohydrates by photosynthesis.

(a) Write the balanced chemical symbol equation for photosynthesis.

(2)

(b) A student investigates the need for light and carbon dioxide in photosynthesis.

This is his method.

- keep three plants, X, Y and Z, in the dark for 24 hours
- place plant X in a bell jar with a watch-glass containing potassium hydroxide
- leave plants Y and Z exposed to the atmosphere
- place plants X and Y in the light
- place plant Z in the dark



(i) Explain why the student keeps all three plants in the dark for 24 hours at the beginning of the investigation.

(2)

(ii) State the function of the potassium hydroxide.

(1)

(c) The student tests leaves from plants X and Y for starch using iodine solution.

(i) What is the colour of the leaves from plant X after the test?

(1)

- ☒ **A** white
- ☒ **B** orange
- ☒ **C** blue-black
- ☒ **D** brick red

(ii) What is the colour of the leaves from plant Y after the test?

(1)

- ☒ **A** white
- ☒ **B** orange
- ☒ **C** blue-black
- ☒ **D** brick red

(d) The student sets up another plant in the same conditions as plant X, but replaces the potassium hydroxide with water.

Explain why this improves the student's investigation.

(2)

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(Total for Question 9 = 9 marks)

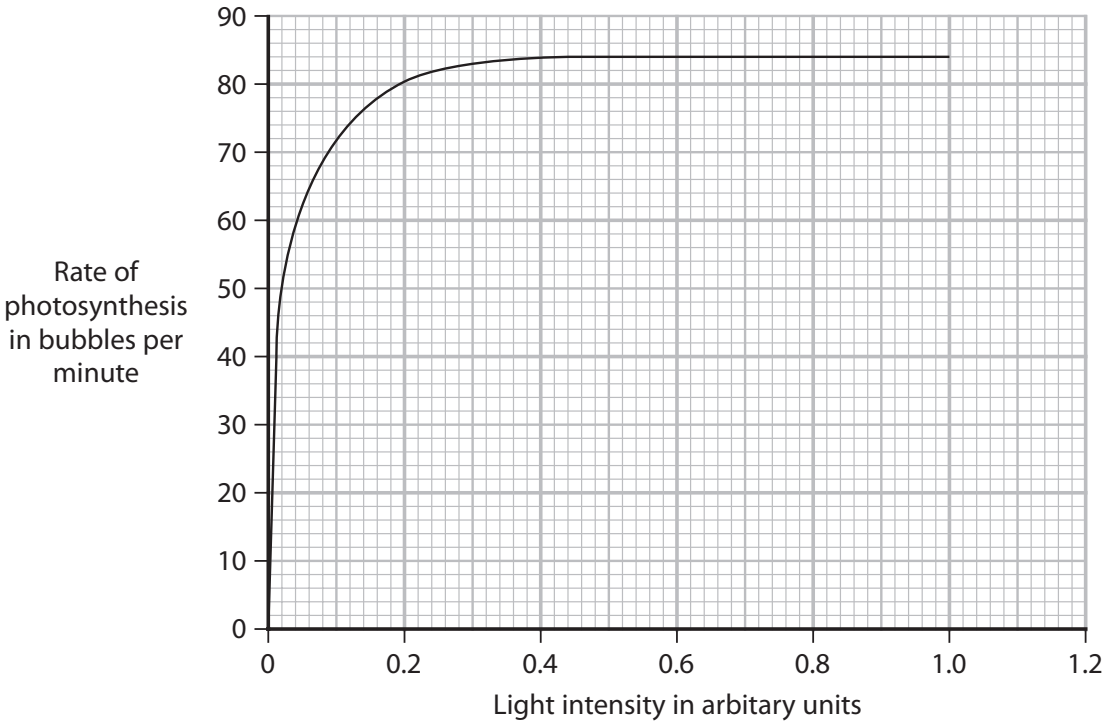
9 Plants need light for photosynthesis.

(a) Give the balanced chemical symbol equation for photosynthesis.

(2)

..... + ... ⟶ ..... + ...

(b) The graph shows the effect of light intensity on the rate of photosynthesis in a water plant.



The rate of photosynthesis is measured by counting the number of bubbles of gas released per minute.

The light intensity is decreased by moving a lamp further away from the water plant.

The light intensity is calculated as

$$= 1 \div (\text{distance in cm of lamp from plant})^2$$

(i) Using information from the graph, calculate the distance of the lamp from the plant when the rate of photosynthesis is 78 bubbles per minute.

(2)

distance = ... cm

(ii) Describe the relationship between the number of bubbles per minute and light intensity.

(3)

(iii) Explain the rate of photosynthesis between a light intensity of 0.4 arbitrary units and a light intensity of 0.8 arbitrary units.

(2)

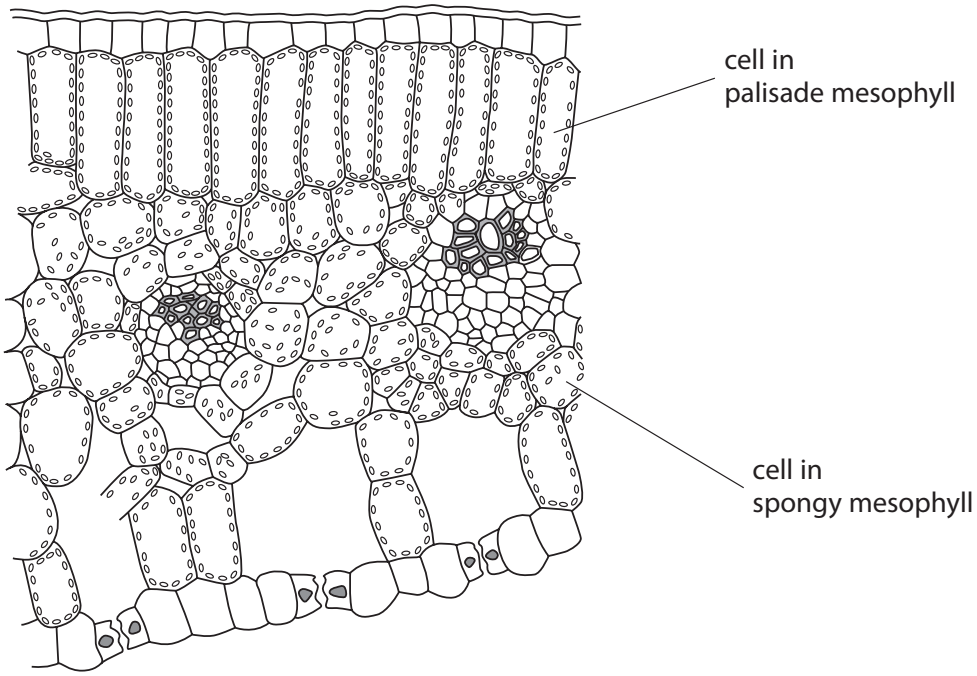
(Total for Question 9 = 9 marks)

2 The leaves of plants make starch.

(a) Describe how you would test a leaf to show that it contains starch.

(3)

(b) The diagram shows the structure of part of a leaf.

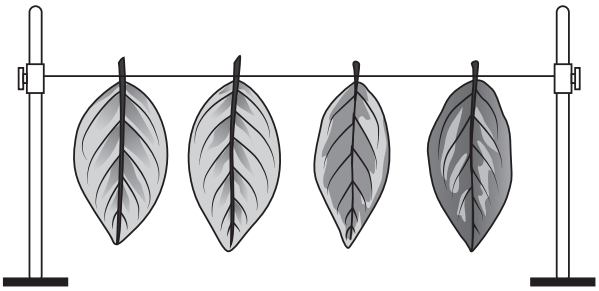


Explain the differences between the palisade mesophyll and the spongy mesophyll.

(4)

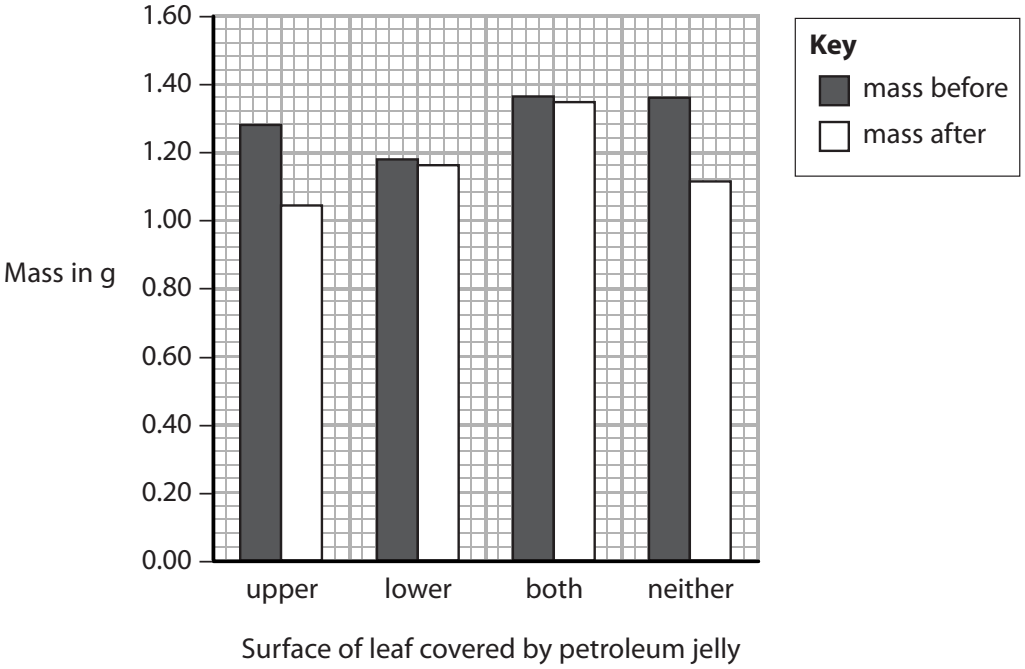
(c) A student uses this method to investigate the role of leaves in transpiration.

- remove four leaves from a plant
- cover the upper surface of one leaf with petroleum jelly
- cover the lower surface of one leaf with petroleum jelly
- cover both surfaces of one leaf with petroleum jelly
- keep one leaf uncovered
- measure the mass of each leaf
- suspend the leaves for several hours in air



After several hours, the student measures the mass of each leaf again.

The graph shows his results.



The student concludes that transpiration occurs mainly from the upper surface of leaves.

Evaluate this conclusion.

(3)

(Total for Question 2 = 10 marks)

6 The human liver produces bile.

(a) Explain the role of bile in digestion.

(4)

(b) These are the three main blood vessels attached to the liver.

- hepatic artery
- hepatic vein
- hepatic portal vein

How many of these blood vessels transport deoxygenated blood from the liver?

(1)

☒ **A** 0

☒ **B** 1

☒ **C** 2

☒ **D** 3

(c) A scientist investigates the glucose concentration in a person's hepatic portal vein and hepatic vein after the person has eaten a meal.

This is the scientist's method.

- give a person a meal to eat
- after one hour take a blood sample from the hepatic portal vein and a blood sample from the hepatic vein
- measure the glucose concentration in both samples
- after five hours take another blood sample from each of the two veins
- measure the glucose concentration in both samples

The table shows the scientist's results.

Time in hours	Concentration of glucose in blood sample in mmol per dm^3	
	hepatic portal vein	hepatic vein
1	9.0	6.6
5	5.0	7.1

(i) After **one** hour, the concentration of glucose in the hepatic portal vein is higher than the concentration of glucose in the hepatic vein.

Explain this difference in concentration.

(3)

(ii) After **five** hours, the concentration of glucose in the hepatic vein is higher than the concentration of glucose in the hepatic portal vein.

Explain this difference in concentration.

(2)

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(Total for Question 6 = 10 marks)

10 The body mass index (BMI) is a measure that uses your mass and height to calculate if your mass is appropriate for your height.

BMI is calculated using the formula

$$\text{BMI} = \text{mass in kg} \div (\text{height in m})^2$$

(a) (i) Person X has a mass of 60 kg and a height of 165 cm.

Calculate the BMI of person X.

(2)

BMI = ...

(ii) BMI values can be divided into categories.

The table shows these categories.

BMI value	Category
less than 18.5	thin
18.6 to 24.9	healthy
25 to 29.9	overweight
more than 30	obese

Give the category of person X.

(1)

.....

(b) One problem with the interpretation of BMI measurements is that people have different proportions of muscle compared with fat.

Muscle has a higher density than fat.

What effect would a high proportion of muscle in your body have on your BMI?

(1)

☒ **A** it would increase your BMI

☒ **B** it would decrease your BMI

☒ **C** it would not affect your BMI

☒ **D** it would make your BMI negative

(c) Some diets reduce carbohydrate intake and other diets reduce lipid intake.

(i) Explain how these diets can result in a reduction in body mass.

(3)

(ii) Explain why diets are more effective at reducing BMI if combined with regular exercise.

(3)

(Total for Question 10 = 10 marks)

8 The table gives the percentage composition by mass of human breast milk, and of cow's milk.

Substance	Percentage by mass (%)	
	Breast milk	Cow's milk
water	87.0	88.0
vitamins	trace	trace
fat	3.8	5.0
carbohydrate	7.9	3.0
minerals	0.2	0.7
protein	1.0	3.3

(a) Discuss whether cow's milk is a suitable alternative to breast milk for young babies.

Use data from the table and your own knowledge to support your answer.

(6)

(b) Human breast milk may contain insufficient vitamin D for a growing child.

Give two ways that additional vitamin D could be provided for the child.

(2)

1 .....

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2 .....

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(c) Describe how a sample of cow's milk could be tested for protein.

(2)

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(Total for Question 8 = 10 marks)

10 A student does an experiment to show that a leaf is only able to produce starch if it receives enough light.

(a) The student removes all the starch from the leaf before starting the experiment.

(i) Describe how the student could remove all the starch from the leaf.

(2)

(ii) State why the student removes all the starch from the leaf before starting the experiment.

(1)

(b) Before testing a leaf for starch, chlorophyll needs to be removed.

Give a safety precaution the student needs to take when removing chlorophyll.

(1)

(c) Give a suitable control the student should use in this experiment.

(1)

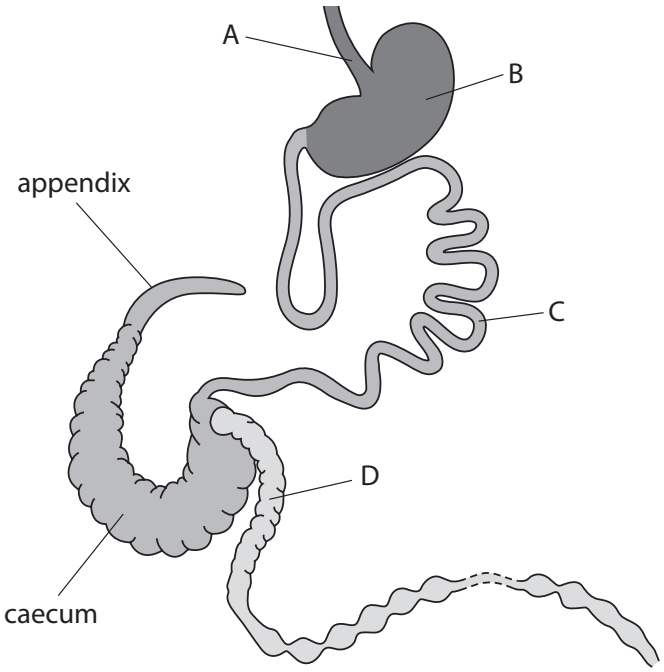
(d) Describe how the structure of the leaf is adapted for photosynthesis.

(5)

(Total for Question 10 = 10 marks)

6 The diagram shows part of the gut of a rabbit.

The rabbit is a primary consumer and eats mainly grass and other vegetable material.



(a) Name the parts labelled A, B, C and D.

(4)

A .....

B .....

C .....

D .....

(b) The gut of a rabbit has a large caecum and appendix. These contain bacteria that are able to produce the enzyme cellulase.

Explain how these bacteria help the rabbits with their diet of plant material.

(3)

(c) The human gut has a caecum and appendix but they are much smaller than those in the rabbit.

(i) Suggest why the human gut only has a small caecum and appendix.

(1)

(ii) In humans the appendix also acts as a store of useful bacteria. Scientists have discovered that patients who have had their appendix removed are more likely to develop infections of the colon.

Explain how having no appendix may increase the likelihood of bacterial infections of the colon.

(2)

(Total for Question 6 = 10 marks)

10 (a) The table gives some information about enzymes in the human digestive system.

Complete the table by giving the missing information.

(4)

Substrate	Enzyme	Products of digestion
starch		maltose
maltose	maltase	
	protease	amino acids
lipids	lipase	

(b) Some scientists have investigated the effect of vinegar (a weak acid) on the digestion of starch.

Design an investigation to discover the effect of vinegar on the digestion of starch.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 10 = 10 marks)

4 Cow's milk contains a mixture of nutrients, including protein, fat, sugar, vitamins, and minerals.

(a) (i) The main sugar in milk is a carbohydrate called lactose.

Which chemical elements are present in carbohydrates?

(1)

- ☒ **A** carbon and hydrogen only
- ☒ **B** carbon, hydrogen, and oxygen only
- ☒ **C** carbon, hydrogen, and nitrogen only
- ☒ **D** carbon, hydrogen, nitrogen, and oxygen

(ii) Describe how to test a sample of milk for protein.

(2)

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.....

(b) Some people drink a milk alternative produced from plants, such as soy and rice, instead of milk produced by animals.

The table shows nutritional information for different milk products.

Milk product	Nutrient content in 224 g of milk				
	Energy in kJ	Mass of protein in g	Mass of fat in mg	Mass of carbohydrate in g	Mass of calcium in mg
cow	146	8	8.0	11	250
soy	80	8	4.0	4	300
rice	120	1	2.5	14	0

(i) The recommended daily amount of calcium for a child is 1400 mg.

Calculate the mass of cow's milk that would contain 1400 mg of calcium.

(2)

mass = ... g

(ii) Discuss whether soy milk or rice milk is a suitable replacement for cow's milk in the diet of children.

(5)

(Total for Question 4 = 10 marks)

2 The photograph shows some seeds called lentils.



© Diana Taliun/Shutterstock

Lentils are a good source of protein and are often eaten as part of a balanced diet.

(a) Describe how lentils are transported from the mouth to the stomach after being eaten.

(2)

(b) The recommended daily amount (RDA) of a nutrient is the mass of that nutrient required by an individual each day.

The table shows some nutrients found in lentils.

It also shows the percentage of each RDA for 16-year-old humans provided by 50 g of lentils.

Nutrient	Percentage of RDA (%) provided by 50 g of lentils
fat	1
carbohydrate	11
protein	22
vitamin C	2
calcium	4

(i) Give one component of a balanced diet that is not shown in the table.

(1)

.....

(ii) Lentils do not contain large amounts of vitamin C and calcium.

State the long-term effect of a dietary shortage of vitamin C and of calcium.

(2)

vitamin C

.....

.....

calcium

.....

.....

(iii) Calculate the mass, in grams, of lentils that a 16-year-old needs to eat, each day, to provide their RDA of protein.

Give your answer to two significant figures.

(2)

mass of lentils needed each day = ... g

(iv) Describe how protein is digested in the human alimentary canal.

(3)

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(Total for Question 2 = 10 marks)

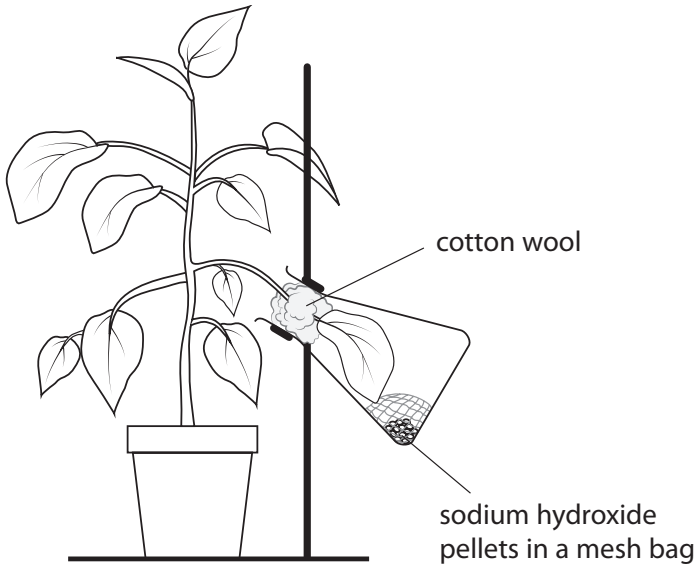
7 Different factors can affect the rate of photosynthesis in plants.

(a) Give the balanced chemical equation for photosynthesis.

(2)

.....

(b) A student uses this apparatus to investigate the need for carbon dioxide in photosynthesis.



(i) Explain how the student could use this apparatus to show that carbon dioxide is needed for photosynthesis.

(4)

(ii) The student is told that, after keeping the leaf in the flask for a day, he should cut the leaf into small shapes for testing.

Suggest why this is a good idea.

(2)

(c) The results of this investigation show whether carbon dioxide is needed for photosynthesis.

Explain how the student could modify his investigation to show that chlorophyll is needed for photosynthesis.

(3)

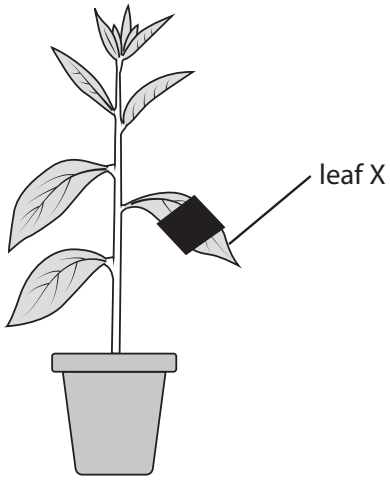
(Total for Question 7 = 11 marks)

3 A student investigates factors that affect photosynthesis.

(a) In his first experiment, the student uses this method to investigate the effect of light on photosynthesis.

- place a plant in the dark for 24 hours
- cover part of leaf X with black paper
- place the plant in the light for 24 hours

The diagram shows the plant in the light.



Describe how the student tests leaf X to show the effect of light on photosynthesis.

(4)

(b) In his second experiment, the student uses a water plant to investigate the effect of carbon dioxide concentration on the rate of photosynthesis.

He does the experiment at two different light intensities.

The table shows the student's results.

Carbon dioxide concentration in arbitrary units	Rate of photosynthesis in bubbles per minute	
	low light intensity	high light intensity
0.00	0	0
0.02	20	20
0.04	29	35
0.06	35	47
0.08	39	68
0.10	42	84
0.12	45	89
0.14	46	90
0.16	46	90
0.18	46	90

(i) Explain the student's results.

(4)

(ii) Describe how the student could change the light intensity in this investigation.

(1)

(iii) Give the dependent variable in this investigation.

(1)

.....

(iv) Give one way in which the student could control the biotic variable in this investigation.

(1)

.....

.....

(Total for Question 3 = 11 marks)

4 A balanced diet contains the correct proportion of vitamins.

(a) The table lists the functions of some vitamins.

Complete the table by stating the correct vitamins.

The first one has been done for you.

(2)

Function of vitamin	Vitamin
prevents scurvy	C
improves vision	
helps bone growth	

(b) Yeast is used to make bread.

A student investigates the effect of vitamin C on the growth of yeast cells.

This is his method.

- put 0.50 g of yeast into a flask containing 200 cm^3 of glucose solution and add 0.10 g of vitamin C
- put 0.50 g of yeast into another flask containing 200 cm^3 of glucose solution without vitamin C
- measure the dry mass of yeast in each flask after 30 hours

The table shows the student's results.

Time in hours	Dry mass of yeast in g	
	with vitamin C	without vitamin C
0	0.50	0.50
30	7.10	6.50

(i) The student calculates that the mean rate of yeast growth with vitamin C is 0.22 g per hour.

Calculate the mean rate of yeast growth without vitamin C.

(2)

mean rate = ... g per hour

(ii) Suggest how to find the dry mass of yeast in each flask.

(2)

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.....

(iii) State the dependent variable in this investigation.

(1)

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(iv) The method gives some variables that the student controlled.

Justify two other variables the student should control.

(4)

1 .....

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2 .....

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(Total for Question 4 = 11 marks)

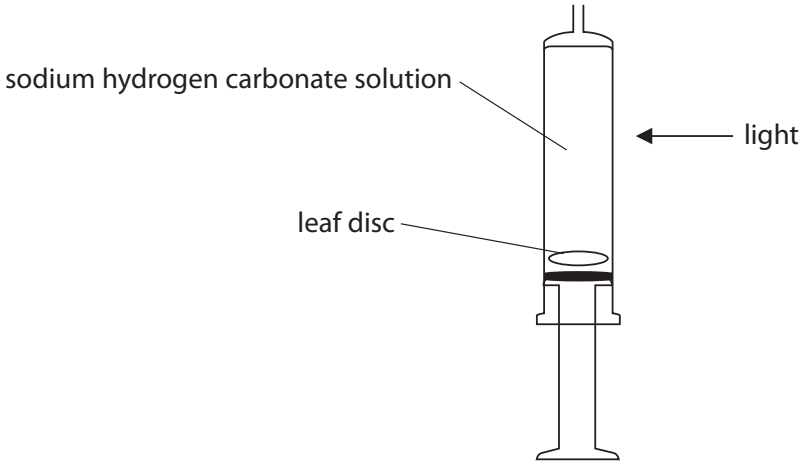
8 A student investigates the effect of light intensity on photosynthesis in leaf discs.

This is the student's method.

- cut equal sized discs from a leaf
- remove the plunger from a 20 cm^3 syringe and place a disc into the syringe
- replace the plunger in the syringe and fill the syringe with 2% sodium hydrogen carbonate solution, which provides carbon dioxide
- place thumb over the end of the syringe and pull the plunger back until the disc sinks
- position the syringe vertically
- place a lamp five centimetres from the syringe
- record the time taken for the leaf disc to rise to the top of the syringe
- repeat the experiment with the lamp at increasing distances from the syringe

The leaf discs rise in the solution due to the production of gas during photosynthesis.

The diagram shows some of the apparatus used.



(a) Give the balanced chemical symbol equation for photosynthesis.

(2)

.....

(b) (i) State how the student could improve the reliability of their results.

(1)

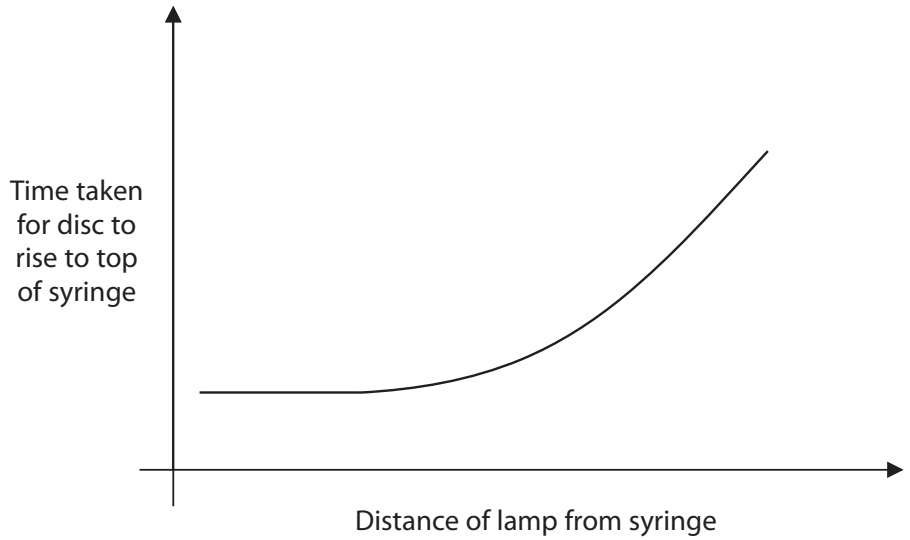
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(ii) Give the dependent variable in the investigation.

(1)

(c) The graph shows the results of the investigation.



Explain the effect of increasing the distance of the lamp on the time taken for the leaf disc to rise to the top of the syringe.

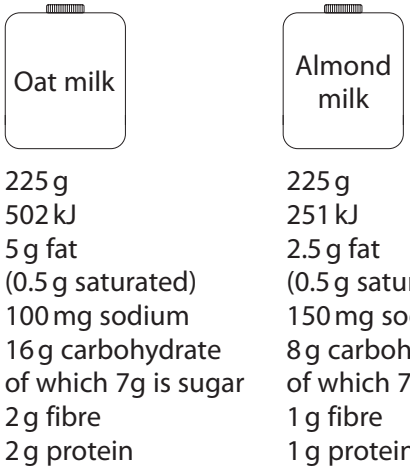
(4)

(d) Describe how the student could test the leaf discs for the presence of starch.

(3)

(Total for Question 8 = 11 marks)

3 The diagram shows the nutritional content of two non-dairy milk products, oat milk and almond milk.



(a) (i) A person is told by their doctor that they need to lose weight. Use the information from the milk contents and your own knowledge to discuss which milk would be the most suitable for this person.

(5)

(ii) Suggest why a person might drink a non-dairy milk such as oat or almond milk rather than cow's milk.

(1)

(b) Describe how a student could test a milk sample for glucose.

(2)

(c) Human breast milk contains special proteins that give immunity to the baby.

Explain how these proteins can help protect the baby from disease.

(3)

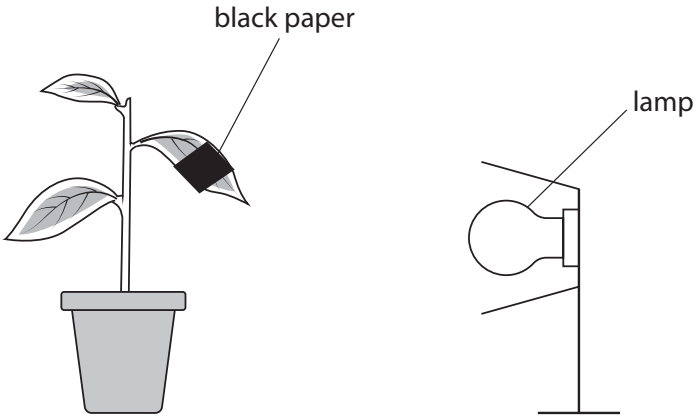
(Total for Question 3 = 11 marks)

6 Variegated leaves have areas that are green and areas that are white.

A student uses this method to investigate the effect of light on photosynthesis in a variegated leaf.

- place a plant in the dark for 24 hours
- wrap a strip of black paper across a leaf
- shine light on the plant for 24 hours
- remove the black paper
- use iodine solution to test the leaf for starch

The diagram shows the apparatus the student uses.



(a) Complete the balanced chemical symbol equation for photosynthesis.

(2)

..... + $6H_2O$ → ..... + ...

(b) (i) State why the plant was placed in the dark for 24 hours.

(1)

.....

.....

(ii) Diagram 1 shows the position of the black paper on the leaf.

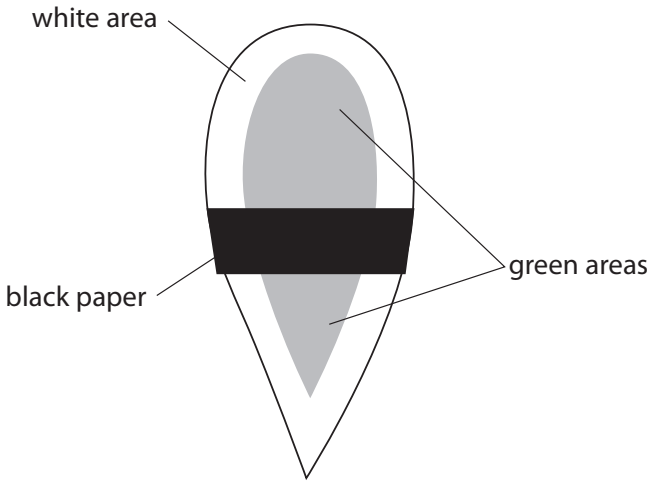


Diagram 1

Complete diagram 2 to show where the variegated leaf would appear black after testing with iodine solution.

(2)

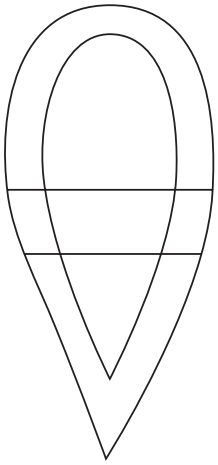


Diagram 2

(c) The student observes that the leaves on different ivy plants seem to be different sizes depending on the amount of sunlight the plants receive.

Design an investigation to test whether the amount of sunlight received by ivy plants affects the size of their leaves.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 6 = 11 marks)

4 Fruit juice drinks contain a range of nutrients.

The table shows some of the nutrients in a fruit juice drink and the percentage of the recommended daily allowance (RDA) of these nutrients for a 16 year old.

Nutrient	Mass of nutrient in 400 cm^3 of drink in g	Percentage of RDA in 400 cm^3 of drink
starch	2.8	2
sugar	6.4	4
fat	7.0	10
fibre	9.2	35

(a) (i) Vitamins and minerals are not listed in the table.

Name one other component of a balanced diet that is not listed in the table.

(1)

.....

(ii) Calculate the RDA of fibre for a 16 year old.

Give your answer in grams and to the nearest whole number.

(2)

RDA of fibre = ... g

(iii) State the function of fibre in the human diet.

(1)

.....

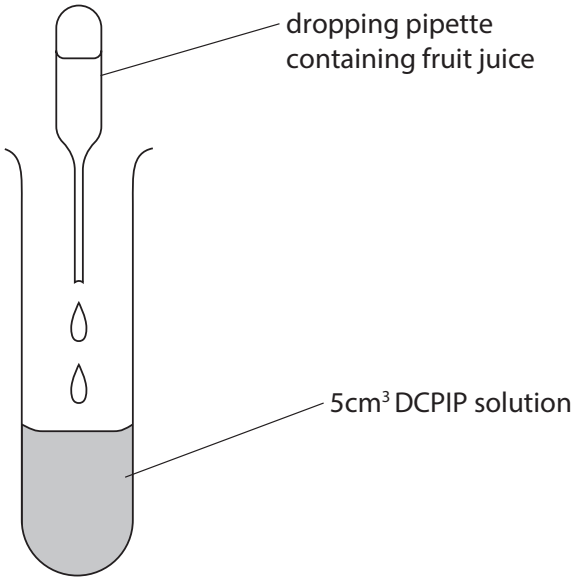
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(b) Describe how starch is digested into glucose in the human alimentary canal.

(3)

(c) DCPIP is a blue solution that turns colourless when enough vitamin C is added.

A student uses this apparatus to compare the concentrations of vitamin C in different fruit juices.



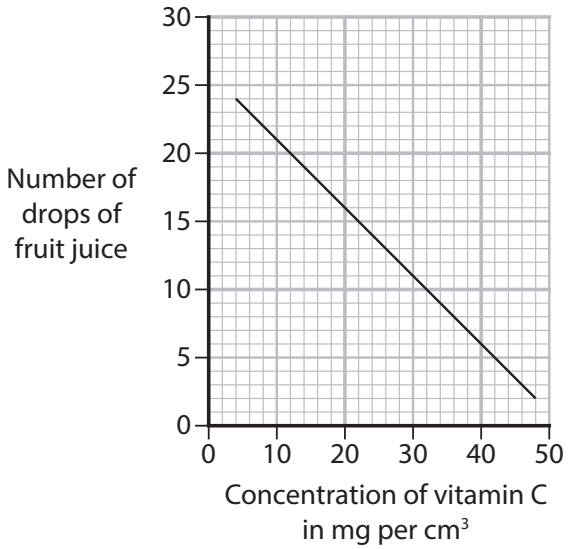
This is the student's method.

- place 5 cm^3 of blue DCPIP solution in a test tube
- fill a dropping pipette with fruit juice
- add drops of fruit juice to the DCPIP solution
- record the number of drops of fruit juice added until the DCPIP solution turns colourless

The table shows the student's results.

Fruit juice	Number of drops of fruit juice needed to turn DCPIP solution to colourless
apple	18
grape	22
lemon	4
lime	7
orange	3

(i) The graph shows the effect of concentration of vitamin C on the number of drops needed to change DCPIP solution to colourless.



Determine the concentration of vitamin C in lime juice.

(1)

concentration of vitamin C = ... mg per cm^3

(ii) Give the fruit juices in order of increasing concentration of vitamin C.

One has been done for you.

(1)

highest concentration .....



.....

lime

.....

lowest concentration .....

(iii) Explain how the student could modify the experiment to give a more accurate measure of the concentrations of vitamin C in the fruit juices.

(2)

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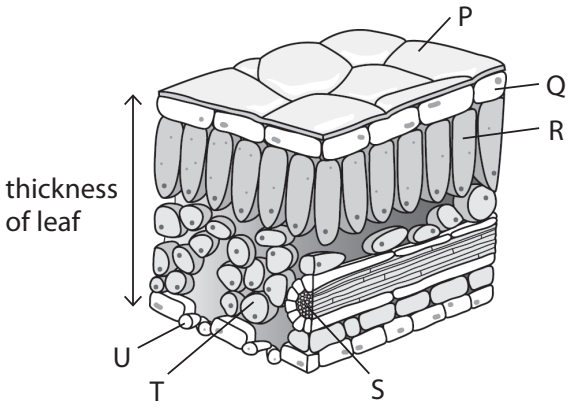
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(Total for Question 4 = 11 marks)

8 The diagram shows a section through a leaf with different parts labelled P to U.



Magnification ×100

(a) (i) Which part of the leaf transports amino acids? **(1)**

- ☒ **A** R
- ☒ **B** S
- ☒ **C** T
- ☒ **D** U

(ii) Which part absorbs the most sunlight? **(1)**

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(iii) Which part transports the products of photosynthesis? **(1)**

- ☒ **A** Q
- ☒ **B** R
- ☒ **C** S
- ☒ **D** T

(iv) Which part reduces the amount of water escaping? **(1)**

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(b) Explain how the structure and position of cells in parts R and T help the leaf to photosynthesise.

(4)

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(c) The diagram of the leaf section is magnified 100 times.

Determine the actual thickness of the leaf.

(2)

thickness = ... mm

(d) The photograph shows water lilies, plants that float on the surface of ponds.



Suggest why the leaves of the water lily only have stomata on their upper surface.

(2)

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(Total for Question 8 = 12 marks)

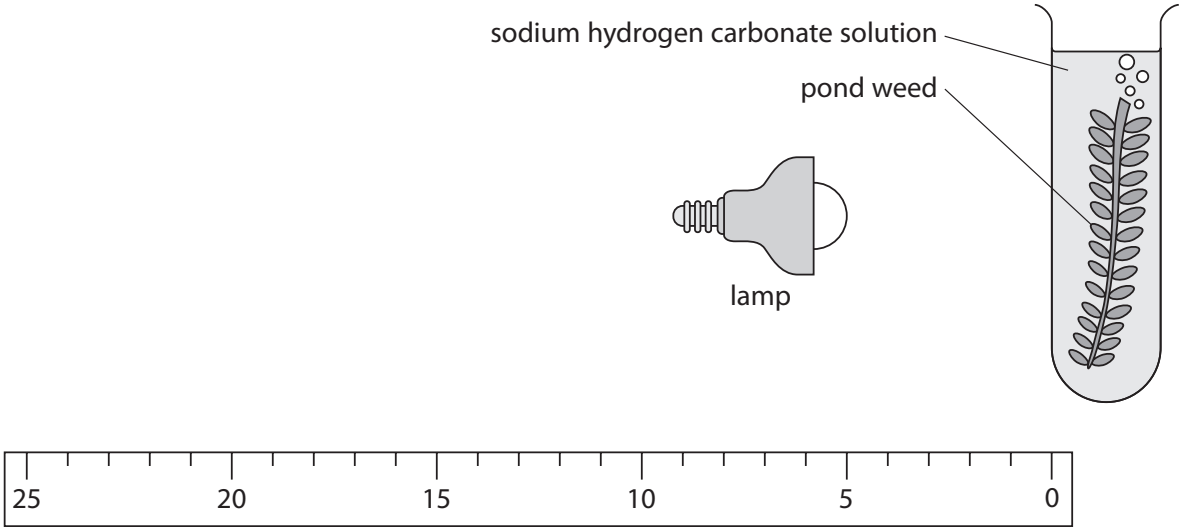
10 A student investigates factors affecting the rate of photosynthesis.

(a) Complete the balanced chemical symbol equation for photosynthesis.

(2)

..... + ... ⟶ ..... + $6O_2$

(b) The diagram shows apparatus that can be used to measure the rate at which a piece of pond weed produces bubbles of oxygen.



The student uses this apparatus to investigate the effect of changing light intensity and carbon dioxide concentration on the rate of photosynthesis in pond weed.

This is the student's method.

Step 1 fill the test tube with 5% sodium hydrogen carbonate solution

Step 2 place a piece of pond weed into the test tube

Step 3 place a lamp 5 cm from the test tube

Step 4 count the number of bubbles produced by the pond weed in two minutes

Step 5 repeat steps 1 to 4 with the lamp at distances of 10 cm, 15 cm, 20 cm, and 25 cm

This method is repeated using 10% sodium hydrogen carbonate solution.

The table shows the results of the investigation.

Distance of lamp from test tube in cm	Number of bubbles of oxygen produced in 2 minutes	
	Concentration of sodium hydrogen carbonate	
	5%	10%
5	30	50
10	30	40
15	30	32
20	26	25
25	14	14

The student used the same colour of light in the investigation.

(i) Describe how the student could control one other relevant, named abiotic factor.

(2)

(ii) Explain the effect of changing the distance of the lamp on the rate of photosynthesis of pond weed in both concentrations of carbon dioxide.

(4)

(iii) Describe one way the student could modify this method to obtain more accurate data.

(2)

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.....

(iv) Describe how the student could ensure that the results of the investigation are reliable.

(2)

.....

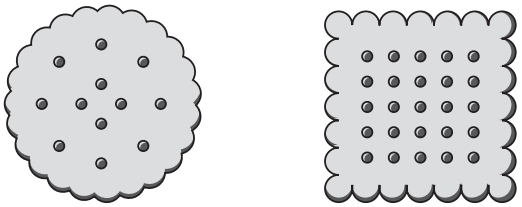
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(Total for Question 10 = 12 marks)

3 The picture shows two biscuits, A and B.



Biscuit A Biscuit B

The table shows some nutritional information supplied by the manufacturers of the two biscuits.

Biscuit	Energy in kJ per 100 g	Lipid in g per 100 g	Carbohydrates in g per 100 g			Protein in g per 100 g	Salt in g per 100 g
			starch	sugars	total		
A	1860	13.6	66.5	1.5	68.0	10.0	1.2
B	1653	3.7	75.8	1.2	77.0	10.5	0.9

(a) Calculate the percentage of the total carbohydrate in biscuit A that is starch.

(2)

percentage = ... %

(b) A doctor has advised a person to lose weight.

Comment on which biscuit, A or B, would be most suitable for the person to maintain a healthy diet and to lose weight.

Use the information in the table and your own knowledge in your answer.

(4)

(c) A teacher tells some students to carry out an experiment to compare the energy values of biscuit A and biscuit B.

(i) Describe a suitable method the students could use for their experiment.

(4)

(ii) The energy values the students determined for the biscuits were much lower than the energy values supplied by the manufacturers.

Give two reasons why this is the case.

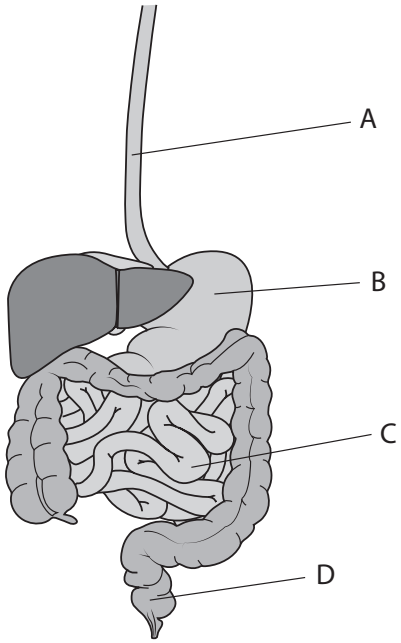
(2)

1 .....

2 .....

(Total for Question 3 = 12 marks)

3 (a) The diagram shows part of the human digestive system.



(i) In which of these parts is hydrochloric acid produced?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) In which of these parts are faeces stored?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b) The liver produces bile.

Explain the role of bile in digestion.

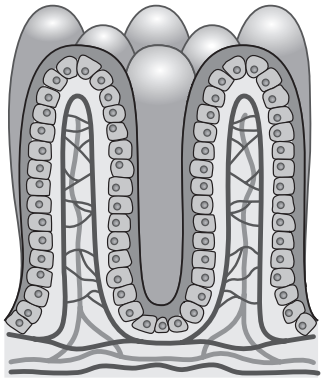
(3)

(c) Some people have a condition called coeliac disease.

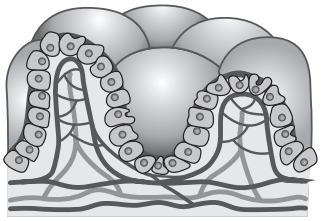
In this condition the body reacts to eating gluten, a protein found in wheat.

This reaction damages the villi in the small intestine.

The diagram shows how the villi in the small intestine are damaged.



Undamaged



Damaged

(i) Explain how the undamaged villi are adapted for their function.

(4)

(ii) Explain why children with untreated coeliac disease may grow more slowly and become tired more easily than children without coeliac disease.

Use the information from the diagram and your own knowledge to support your answer.

(4)

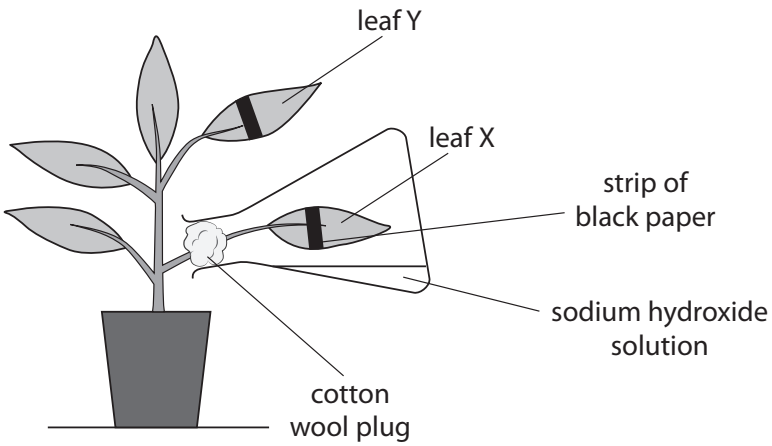
(Total for Question 3 = 13 marks)

4 A teacher does an investigation to show that plants require carbon dioxide and light for photosynthesis.

This is the teacher's method.

- place a potted plant in the dark for 24 hours
- place a strip of black paper over two of the plant's leaves
- pour some sodium hydroxide solution into a flask
- insert one of the leaves into the flask
- seal the flask with a cotton wool plug
- place the plant in bright light for 12 hours
- remove the two leaves and safely test them for starch

This diagram shows the teacher's apparatus.



(a) (i) Explain why the potted plant is placed in the dark for 24 hours.

(2)

(ii) Explain one role of leaf Y in the investigation.

(2)

(iii) Describe how to test the leaves for starch safely.

(4)

(b) Explain how the results of this investigation would show that light is required for photosynthesis.

(3)

(c) Plants convert the glucose they produce into starch.

Explain why plants store carbohydrate as starch rather than as glucose.

(2)

(Total for Question 4 = 13 marks)

8 The rate of photosynthesis is affected by different factors. One factor is the concentration of carbon dioxide in the air.

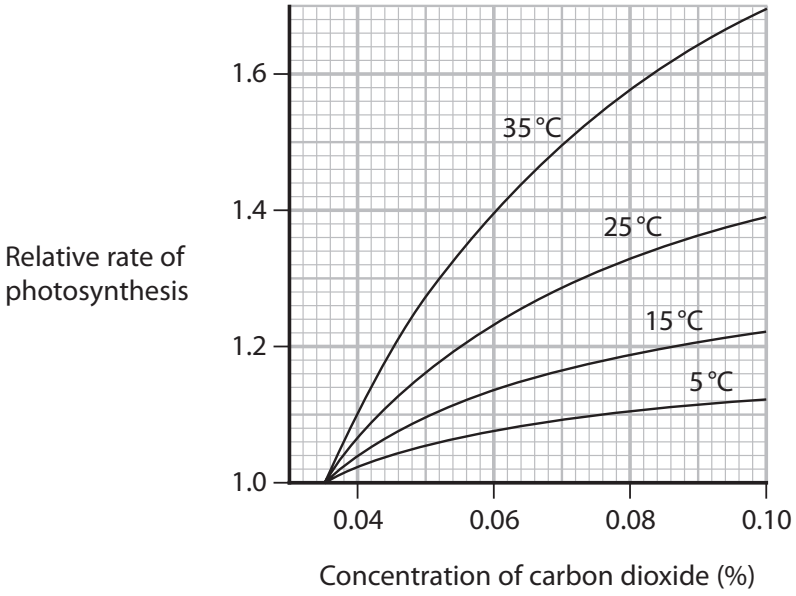
(a) The percentage of oxygen in the air is 21%. This is equivalent to a concentration of 210 000 parts per million.

The percentage of carbon dioxide in the air is 0.04 %. Calculate this concentration in parts per million.

(2)

concentration = ... ppm

(b) The graph shows the effect of increasing the concentration of carbon dioxide in the air on the relative rate of photosynthesis at different temperatures.



(i) Describe the effect of increasing the concentration of carbon dioxide on the relative rate of photosynthesis at 5 °C.

(2)

(ii) Describe how the effect of increasing the concentration of carbon dioxide on the relative rate of photosynthesis changes when the temperature is increased.

(2)

(iii) Explain the effect of increasing the temperature from 5 °C to 35 °C on the relative rate of photosynthesis.

(3)

(c) The scientists who carried out this study concluded that the effect of increasing the concentration of carbon dioxide on the rate of growth of a plant is dependent on temperature and also on the minerals that the plants can absorb.

(i) Explain how lacking a named mineral might affect plant growth.

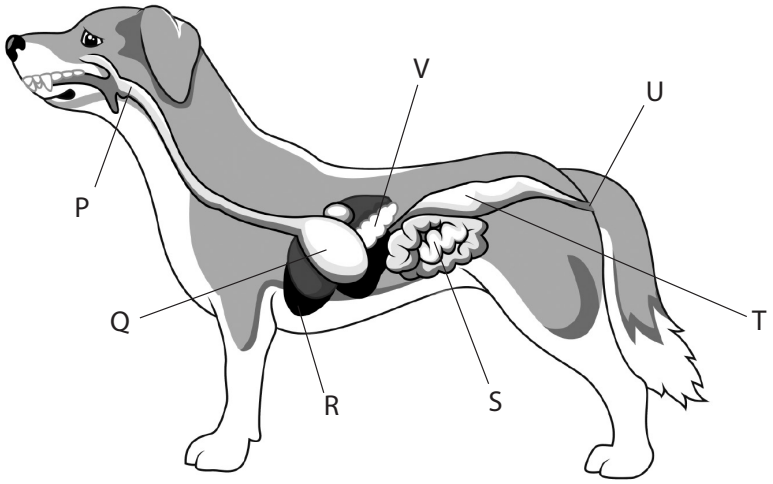
(2)

(ii) Explain how a named factor can affect the rate of photosynthesis, other than carbon dioxide concentration, temperature and minerals absorbed.

(2)

(Total for Question 8 = 13 marks)

3 The diagram shows the digestive system of a dog with some structures labelled. The digestive system of the dog is similar to that of a human.



(Source: © Teguh Mujiono / Shutterstock)

(a) (i) Which structure is the oesophagus?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** U

(ii) Which structure is part of the large intestine?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** T

(iii) Which structure contains villi?

(1)

- ☒ **A** Q
- ☒ **B** R
- ☒ **C** S
- ☒ **D** V

(iv) Which structure is the stomach?

(1)

- ☒ **A** Q
- ☒ **B** S
- ☒ **C** T
- ☒ **D** V

(b) Describe how food is moved along the gut of the dog.

(2)

.....

.....

.....

.....

(c) The table lists some ingredients in food given to young dogs and in food given to adult dogs.

Ingredient	Percentage by mass of each ingredient	
	young dog food	adult dog food
protein	22	18
fat	8.0	5.0
calcium	1.0	0.6
phosphate	0.8	0.5

(i) Discuss the differences between the composition of the two foods.

(4)

(ii) The diet of wild dogs consists of prey animals and a small amount of plant material contained in the gut of their prey.

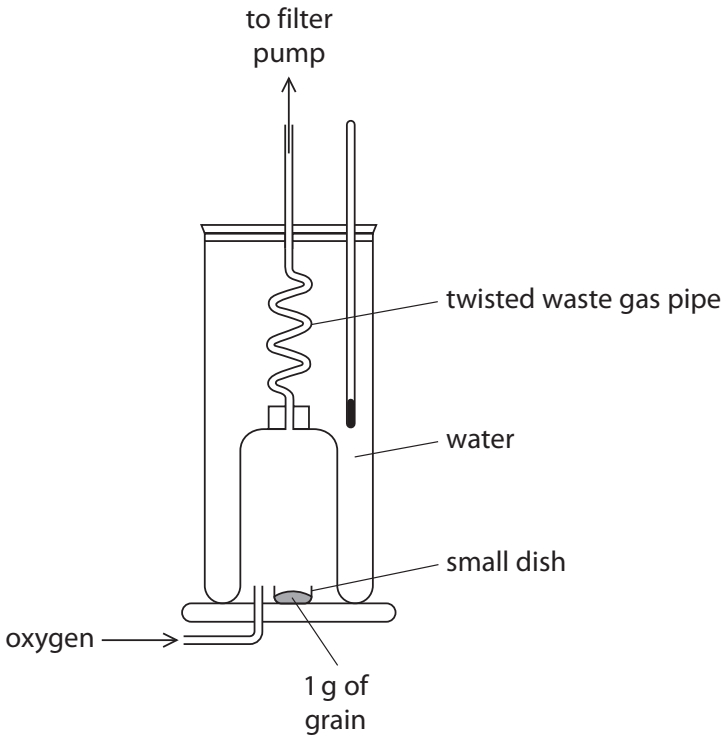
Domesticated dogs are often given a diet that contains large amounts of carbohydrates such as starch.

Explain the possible effects of feeding domestic dogs large quantities of carbohydrates such as starch.

(3)

(Total for Question 3 = 13 marks)

2 Scientists use a calorimeter to compare the energy content of different types of grain.



This is the scientists' method

- put 20 cm^3 of water into the calorimeter
- measure the initial temperature of the water
- place 1 g of a grain type in the small dish
- place the small dish in the calorimeter
- light the grain in the small dish
- allow the grain to completely burn
- measure the final temperature of the water

They repeat this method with different types of grain.

(a) Explain how the scientists could use these measurements to calculate the energy released by 1 g of the grain.

(3)

(b) State how the scientists can make sure that their results are reliable.

(1)

(c) (i) This calorimeter has a twisted waste gas pipe passing through the water.

Explain how the twisted waste gas pipe improves the accuracy of the scientists' results compared with a straight pipe.

(2)

(ii) This calorimeter burns the grain in oxygen. Give a reason why this improves the accuracy of the scientists' results.

(1)

.....

.....

(d) The scientists also collected data on the protein, fat, carbohydrate and fibre content of the grains.

The table shows some of the scientists' results.

Grain type	Protein in g per 100 g	Fat in g per 100 g	Carbohydrate in g per 100 g	Fibre in g per 100 g	Total energy in kJ per 100 g
oats	13	7.0	62	7	1549
rye	8	2.0	60	14	1260
rice	7	2.5	74	3	1481
wheat	28	9.4	32	14	1347

(i) Calculate the mass of protein in 65 g of rice.

(2)

mass = ... g

(ii) A long-distance athlete wants to choose a grain to add to their diet.

Comment on the suitability of each grain type for the diet of a long-distance athlete.

(4)

(Total for Question 2 = 13 marks)

3 Plant cells use photosynthesis to produce carbohydrates.

(a) Give the energy conversion that occurs during photosynthesis.

(2)

from ..... energy to ..... energy

(b) A student investigates whether carbon dioxide is needed for photosynthesis.

(i) Firstly, the student needs to remove all the starch from the plant's leaves.

Explain how the student could do this.

(2)

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(ii) After the starch has been removed from the leaves, the student uses the apparatus in diagram 1 to prevent carbon dioxide from reaching part of one of the leaves.

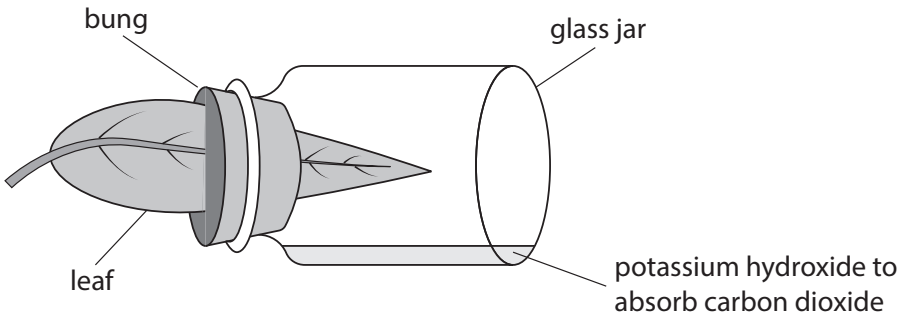


Diagram 1

The student places the apparatus in the light for 24 hours, and then tests the leaf for starch.

Complete and label diagram 2 to show the results of the starch test.

(2)

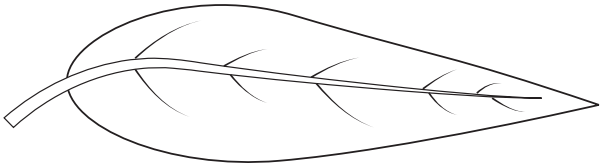


Diagram 2

(c) Plants need mineral ions as well as carbon dioxide and water.

Give the functions of two named mineral ions that a plant needs.

(4)

1 .....

.....

.....

2 .....

.....

.....

(d) The concentration of mineral ions in the soil is often lower than the concentration in the plant.

Waterlogged soil does not contain air.

Explain why plants in waterlogged soil cannot absorb mineral ions.

(3)

(Total for Question 3 = 13 marks)

10 A balanced diet should include the correct proportions of each component.

(a) Two of these components are vitamins and minerals.

Describe the functions of the **other** components of a balanced diet.

(5)

(b) Explain why a pregnant woman may need to take extra minerals and vitamins.

(4)

(c) People can be put into body mass categories by comparing their body mass to their height.

Categories include overweight, ideal weight and underweight.

The table shows the recommended daily energy requirement for each body mass category.

Body mass category	Recommended daily energy requirement per kg of body mass in kJ
overweight	84
ideal weight	126
underweight	167

(i) Person A has a mass of 70 kg and is categorised as ideal weight.

Calculate the recommended daily energy requirement for person A.

(1)

energy requirement = ... kJ

(ii) Person B has a mass of 80 kg but, because he is tall, he is categorised as underweight.

Person C also has a mass of 80 kg but, because he is short, he is categorised as overweight.

Calculate the percentage increase in the recommended daily energy requirement of person B compared to person C.

(2)

percentage increase = ... %

(iii) Explain why a person's body mass decreases if they do not have their recommended daily energy requirement.

(2)

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(Total for Question 10 = 14 marks)

3 Squirrels are animals that live in woodland. They feed on nuts produced by the trees.

The diagram shows a squirrel eating a nut.



(a) Describe a method you could use to show that the nut contains fat.

(3)

(b) The table lists substances found in two types of nut, A and B.

The mass of each substance is given in milligram per gram of nut.

Substance	Mass of substance in milligram per gram of nut	
	nut A	nut B
carbohydrate	167	143
protein	150	78
fat	587	693
fibre	96	86
iron	0.05	0.03

(i) Explain the role of fibre in the squirrel's diet.

(2)

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(ii) Explain which nut is better at helping the squirrel make red blood cells.

(2)

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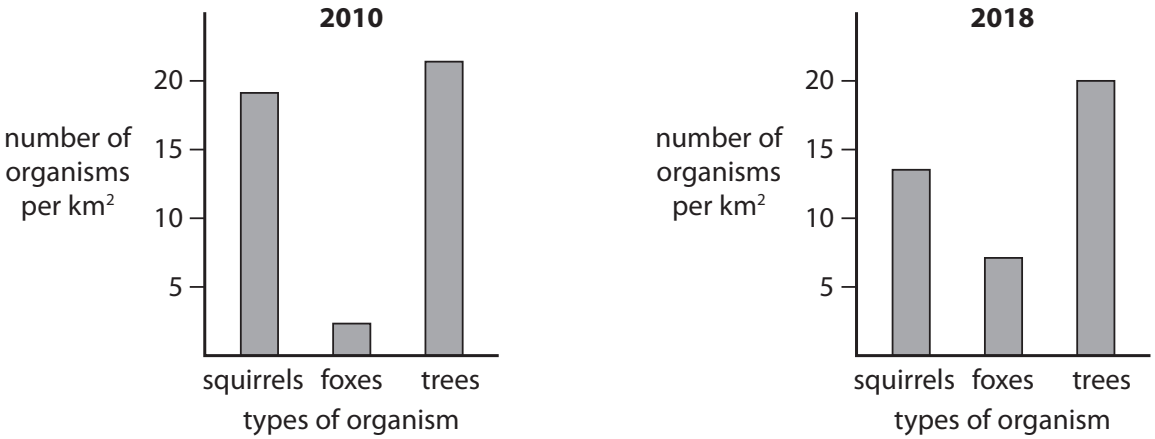
(iii) Nut A has a mass of 28.0 grams.

Calculate the total mass of carbohydrate in this nut.

(2)

total mass of carbohydrate = ... grams

(c) The graphs show the number of squirrels, foxes and trees in a woodland in 2010 and in 2018.



Discuss possible reasons why there is a decrease in the number of squirrels from 2010 to 2018.

Use information from the graphs and your own knowledge in your answer.

(5)

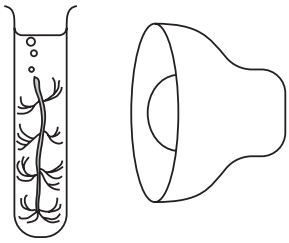
(Total for Question 3 = 14 marks)

4 A student investigates the effect of different colours of light on the rate of photosynthesis in a water plant.

This is the student's method.

- place a 1% sodium hydrogen carbonate solution in a boiling tube
- cut a 5 cm length of pondweed and place it in the tube
- place a lamp 10 cm from the tube containing the pondweed
- leave the pondweed for 10 minutes until it starts to produce bubbles from the cut end
- count the bubbles produced in one minute
- count the bubbles for two more one minute periods

The student repeats the experiment three more times using filters in front of the lamp that let through either red light, blue light or green light.



These are the student's results.

Colour of filter	Number of bubbles per minute			
	Test 1	Test 2	Test 3	Mean
no filter	47	84	80	
red	48	48	42	46
blue	55	56	50	54
green	9	8	10	9

(a) Write the balanced symbol equation for photosynthesis.

(2)

.....

(b) (i) Anomalous results are not included in the calculation of the mean.

Calculate the mean number of bubbles per minute for the lamp with no filter.

(2)

number = ... bubbles per minute

(ii) Explain the student's results.

(4)

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(iii) Give two abiotic variables that the student should control in her experiment.

(2)

1 .....

2 .....

(c) (i) Explain why measuring the rate of photosynthesis by counting bubbles may not be an accurate method to use.

(2)

(ii) Suggest an alternative method that the student could use to measure the rate of photosynthesis in her experiment.

(2)

(Total for Question 4 = 14 marks)

2 The photograph shows a type of fish called a salmon.



(Source: © Alexander Raths/Shutterstock)

Some humans eat salmon as a source of protein.

Protein is a component of a balanced diet.

(a) Which statement describes what happens to salmon protein in the human stomach?

(1)

☒ **A** it is digested into amino acids

☒ **B** its surface area is increased by bile

☒ **C** its pH is raised by hydrochloric acid

☒ **D** it is absorbed by villi

(b) The table lists other components of a balanced diet and their functions.

Complete the table by giving a function of each component.

The first one has been done for you.

(3)

Component	Function
lipid	store of energy
vitamin D	
iron	
fibre	

(c) A student investigates the effect of genetic modification on the growth of salmon.

The student measures the mass and length of one normal salmon and one genetically modified salmon when both salmon are 18 months old.

The table shows the student's results.

Type of salmon	Mass in g	Length in cm
normal	1250	33
genetically modified	3000	61

(i) It is recommended that a 15-year-old person needs 50 g of protein per day for a balanced diet.

A normal salmon contains 20% protein.

Calculate how many 15-year-olds can have their recommended daily allowance of protein supplied by the 18-month-old normal salmon.

(2)

number = ...

(ii) The student concludes that his results show that genetically modified (GM) salmon are useful in providing a balanced diet.

Discuss the student's conclusion.

(6)

(d) The passage describes the role of enzymes involved in the genetic modification of salmon.

Complete the passage by writing a suitable word in each space.

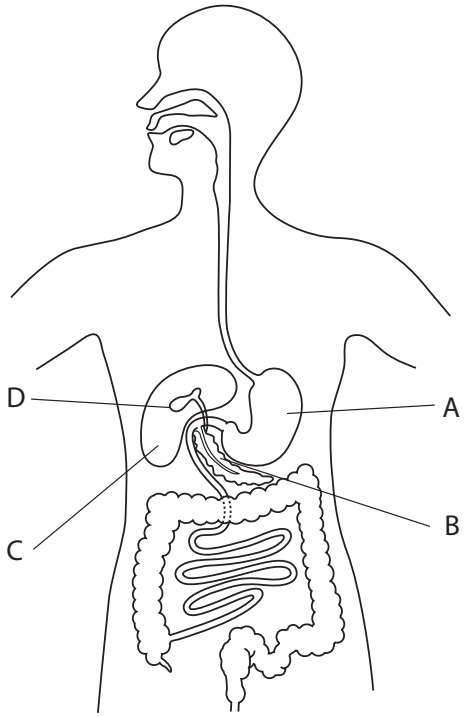
(3)

All salmon contain a length of DNA called a ..... , which controls the production of growth hormone. Another length of DNA, from a different species of fish, is cut out using a ..... enzyme. This DNA is then joined to the salmon DNA using an enzyme called ..... .

This causes the salmon to produce growth hormone at all times.

(Total for Question 2 = 15 marks)

4 The diagram shows the human alimentary canal.



(a) (i) Explain how food passes down the oesophagus.

(2)

.....

.....

.....

.....

(ii) Which labelled structure produces bile?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(iii) Describe the role of bile in digestion.

(3)

(b) Lipase inhibitors are chemicals that bind to lipase enzymes.

To test the effect of a lipase inhibitor, equal masses of full fat milk are placed into two test tubes.

Lipase inhibitor is added to one test tube.

Lipase is added to both test tubes and the pH of each solution is measured every five minutes.

The results are shown in the table.

Time in minutes	pH of solution	
	without lipase inhibitor	with lipase inhibitor
0	8.0	8.0
5	7.6	7.8
10	7.2	7.8
15	6.3	7.7
20	5.8	7.5

(i) Calculate the mean rate of pH change per minute of the solution without lipase inhibitor.

(2)

mean rate of pH change = ... per minute

(ii) Explain the difference in the changes of pH of the solutions in the two test tubes during the 20-minute period.

(2)

(iii) Doctors use this method to investigate the use of lipase inhibitor as a treatment for obesity.

- give three volunteers a tablet containing the lipase inhibitor
- give another three volunteers a tablet with no lipase inhibitor
- give all the volunteers 100 cm^3 of olive oil to drink
- measure the lipid concentrations in the blood of the volunteers after three hours

Some of the volunteers reported abdominal pains three hours after drinking the olive oil.

The table shows the doctors' results.

Tablet contents	Blood lipid concentration in mg per dm^3		Abdominal pains
	at start	after 3 hours	
inhibitor	35	38	yes
inhibitor	37	42	no
inhibitor	37	43	yes
no inhibitor	35	62	no
no inhibitor	37	64	no
no inhibitor	35	45	yes

Discuss the use of the lipase inhibitor as a treatment for obesity.

Use the data from the table to support your answer.

(5)

(Total for Question 4 = 15 marks)

6 Some scientists investigate the effect of temperature on the growth of maize seedlings.

The scientists keep the seedlings in two rooms, A and B.

- in room A, they keep the temperature between 10 °C and 30 °C for 120 days
- in room B, they keep the temperature between 10 °C and 30 °C for 82 days and above 30 °C for 38 days.

The scientists measure the leaf area in square centimetres for each seedling every 20 days.

(a) (i) Calculate the percentage of the total days that the temperature in room B is between 10 °C and 30 °C.

(2)

percentage = ... %

(ii) Explain why the scientists allow the temperature to vary within a range in each room.

(2)

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(iii) Give the dependent variable in this investigation.

(1)

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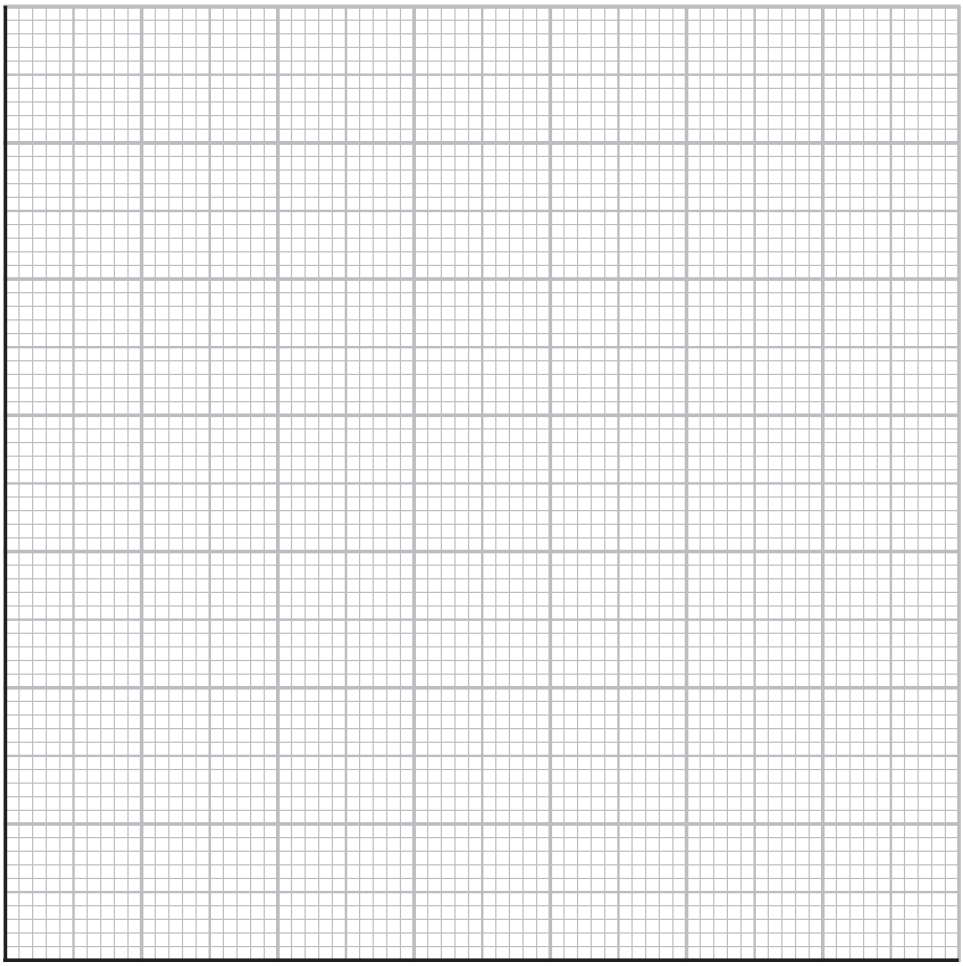
(b) The table shows the scientists' results.

Time in days	Mean leaf area in cm^2	
	room A	room B
20	6	10
40	50	800
60	700	1700
80	2000	4800
100	5000	6000
120	5700	6800

(i) Plot **two** line graphs to show the mean leaf area in each room at each time.

Use a ruler to join your points for each room with straight lines.

(5)



(ii) For room B, calculate the increase in mean leaf area per day from day 20 to day 120.

(2)

increase = ... cm^2 per day

(iii) Explain the effect of temperature on the growth rate of the seedlings.

(2)

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(iv) Describe how the scientists could measure the surface area of a leaf.

(2)

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(Total for Question 6 = 16 marks)

SUB-TOPIC 2(f)

RESPIRATION

8 questions in this sub-topic · 96 marks · lowest tariff first

5 Wheat seeds contain stores of a large insoluble molecule.

This molecule is digested by amylase as the seeds germinate.

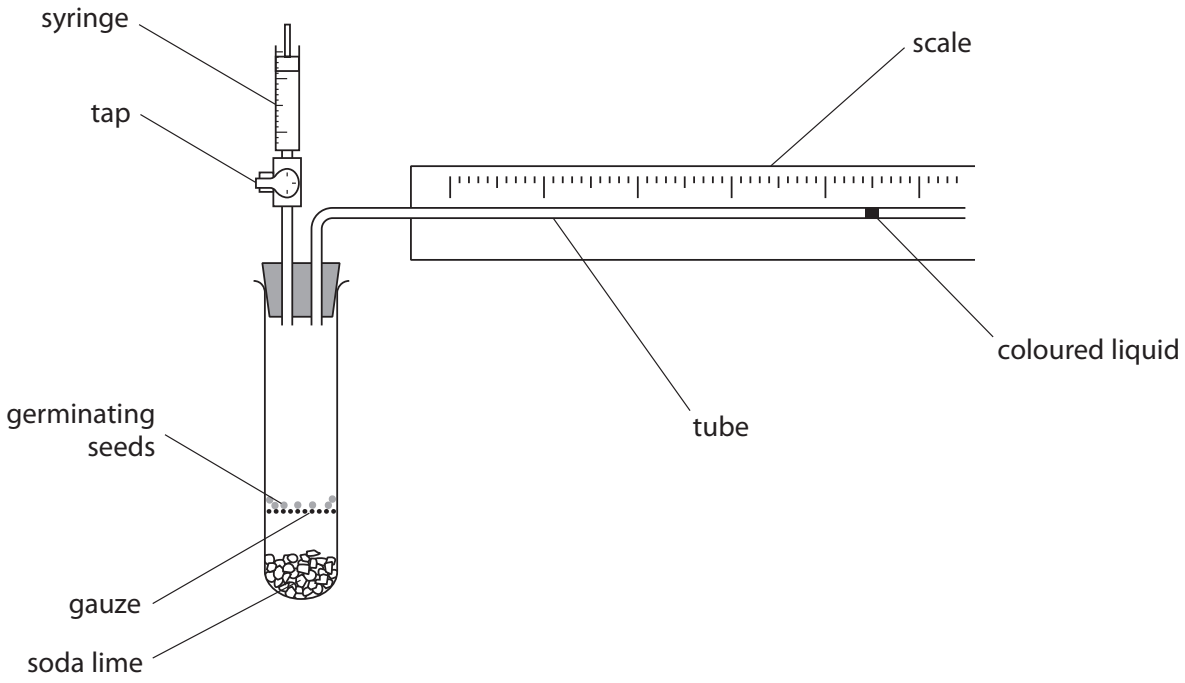
(a) What is the name of this large insoluble molecule?

(1)

- ☒ **A** glucose
- ☒ **B** lipid
- ☒ **C** protein
- ☒ **D** starch

(b) A student investigates the oxygen absorbed by germinating seeds at different temperatures.

The diagram shows some of the student's apparatus.



(i) Suggest why the student opens the tap after obtaining one set of results.

(2)

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.....

(ii) What is the function of the soda lime?

(1)

- ☒ **A** it absorbs carbon dioxide
- ☒ **B** it absorbs oxygen
- ☒ **C** it releases carbon dioxide
- ☒ **D** it releases oxygen

(iii) The student measures the distance moved by the coloured liquid and converts this to volume of oxygen absorbed.

The volume of oxygen absorbed can be calculated using the formula

volume = $\pi \times \text{radius}^2 \times \text{distance}$

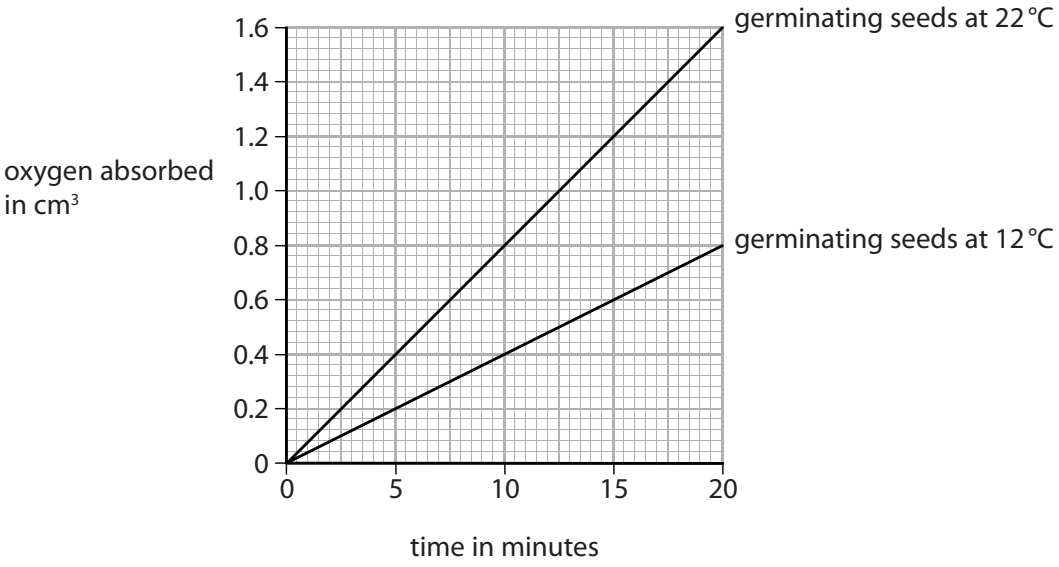
Calculate the volume of oxygen absorbed when the coloured liquid moves a distance of 6.0 mm.

[diameter of tube = 1.0 mm]

(3)

volume = ... cm^3

(c) The graph shows the results of the student's investigation.



(i) Calculate the percentage increase in the rate of oxygen absorption at 22 °C compared to the rate of oxygen absorption at 12 °C.

(2)

percentage = ...

(ii) Suggest why the rate of oxygen absorption is greater at 22 °C than at 12 °C.

(2)

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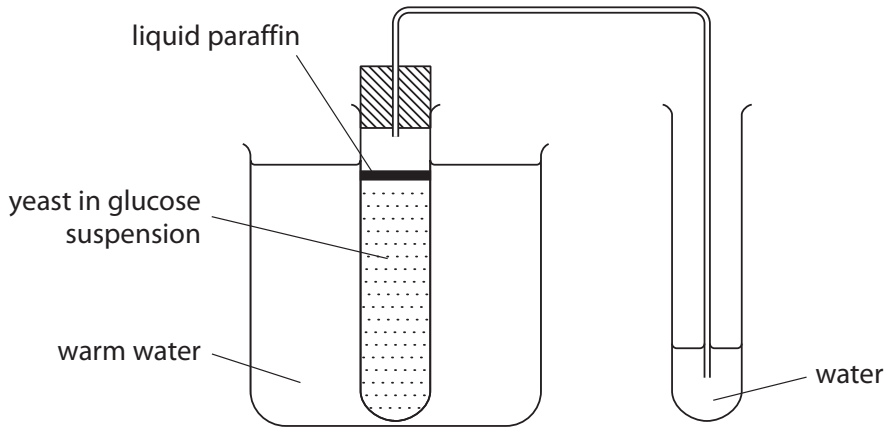
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(Total for Question 5 = 11 marks)

5 A student investigates the effect of temperature on gas production in yeast.

The student uses this apparatus to count the number of gas bubbles produced per minute at different temperatures.



(a) (i) Name the process in yeast that produces the gas bubbles.

(1)

.....

(ii) What gas is produced by the yeast?

(1)

☒ **A** carbon dioxide

☒ **B** nitrogen

☒ **C** oxygen

☒ **D** water vapour

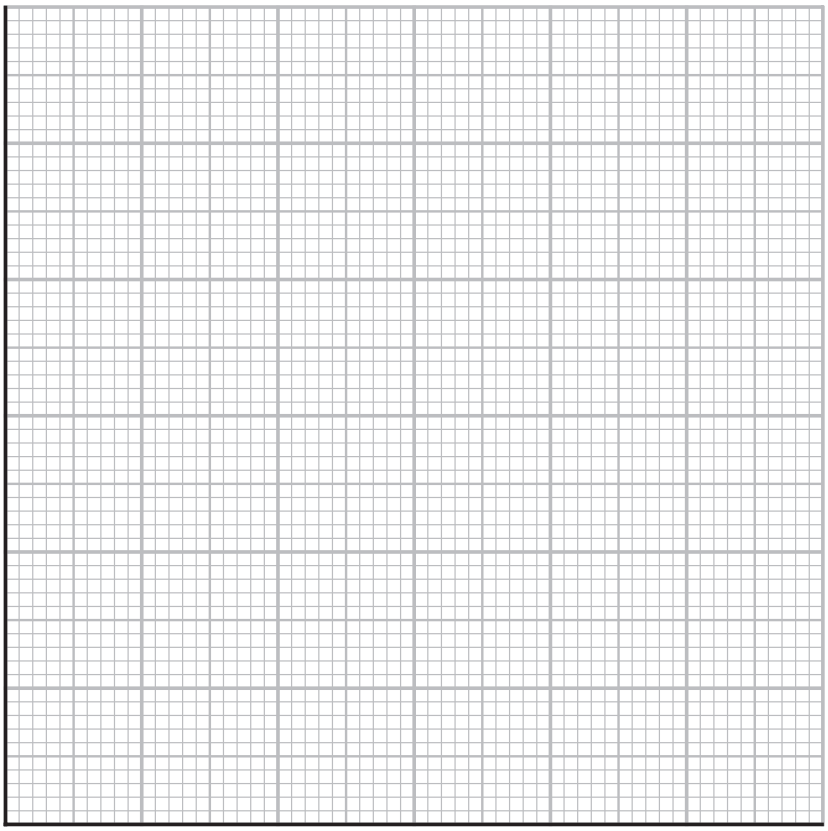
(b) The table shows the student's results.

Temperature in °C	Number of bubbles per minute
20	2
25	6
30	8
35	10
40	14
45	20
50	no data
55	2

(i) Plot a graph to show these results.

Join the points with straight lines.

(5)



(ii) Explain the result at 55 °C.

(2)

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(c) Describe how the student should modify the investigation to obtain a more accurate measure of the optimum temperature.

(2)

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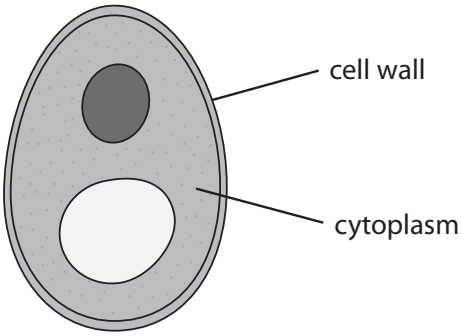
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(Total for Question 5 = 11 marks)

4 The diagram shows a yeast cell.



(a) (i) Which row of the table is correct for this yeast cell?

(1)

		Substance in cell wall	Substance stored in cytoplasm
☒	**A**	cellulose	glycogen
☒	**B**	cellulose	starch
☒	**C**	chitin	glycogen
☒	**D**	chitin	starch

(ii) Which type of organism is a yeast cell?

(1)

☒ **A** a bacterium

☒ **B** a fungus

☒ **C** a plant

☒ **D** a protoctist

(b) Biofuel is made from ethanol.

Scientists use genetically modified (GM) yeast to produce biofuel.

The GM yeast contains an enzyme that digests plant cell walls to produce glucose.

The yeast uses the glucose in respiration to produce ethanol.

(i) Which of these equations shows the respiration in the yeast?

(1)

- ☒ **A** glucose → ethanol
- ☒ **B** glucose → ethanol + carbon dioxide
- ☒ **C** glucose + oxygen → ethanol
- ☒ **D** glucose + oxygen → ethanol + carbon dioxide

(ii) Name an enzyme used by scientists to genetically modify the yeast.

(1)

.....

(iii) The GM yeast is a recombinant strain.

State what is meant by the term **recombinant**.

(1)

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.....

(iv) Suggest why biofuel produced using glucose from plants could reduce global warming.

(2)

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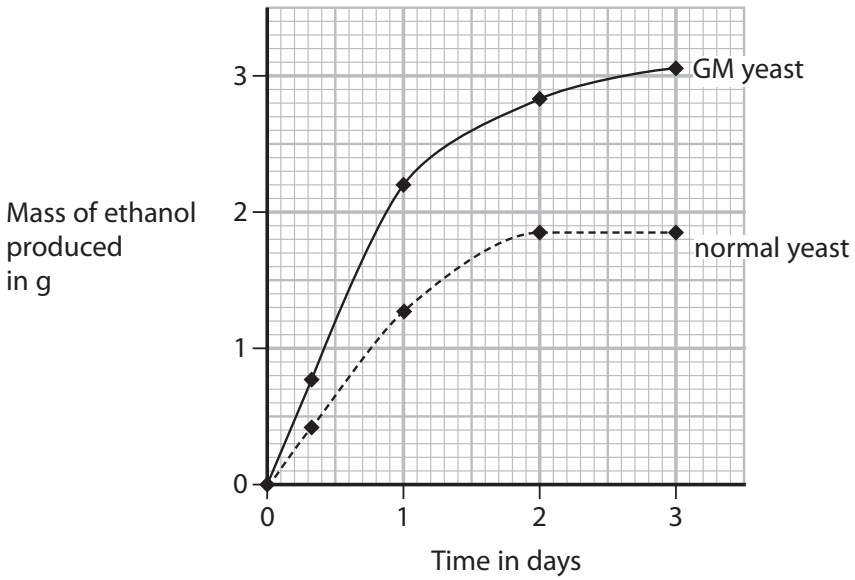
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(c) The graph shows the mass of ethanol produced by GM yeast and by normal yeast over a period of 3 days.



(i) Calculate the percentage increase in the mass of ethanol produced by GM yeast compared to normal yeast after 1 day.

(2)

percentage increase = ... %

(ii) Give two reasons why the rate of ethanol production decreases after 1 day.

(2)

1 .....

.....

2 .....

.....

(Total for Question 4 = 11 marks)

9 Aerobic respiration uses oxygen and produces ATP.

(a) Complete the word equation for aerobic respiration.

(2)

oxygen + ... ⟶ ..... + ... + ATP

(b) A scientist investigates the rates of aerobic respiration of some animals.

The scientist calculates the rate of respiration per gram of each animal.

The results are shown in the table.

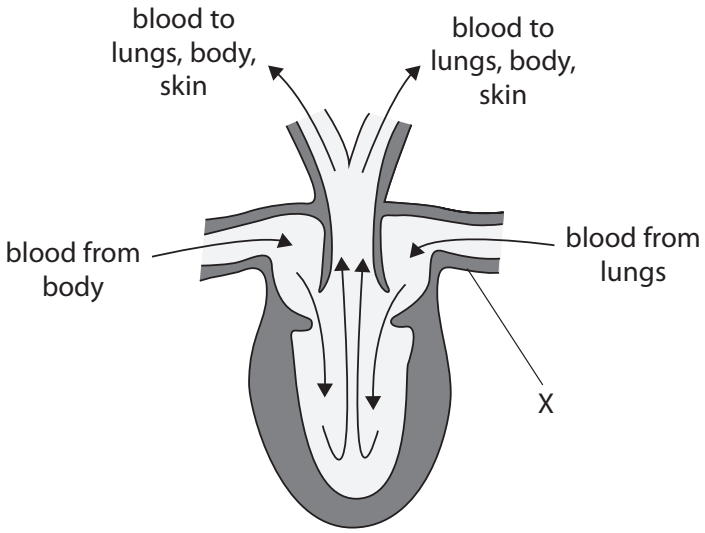
Animal	Rate of aerobic respiration per gram of animal in arbitrary units
frog	150
human	200
mouse	1500

Explain why a mouse uses more oxygen per gram than a human.

(3)

(c) The structure of a frog heart is different from the structure of a human heart.

The diagram shows a section of a frog heart with arrows showing the direction of blood flow.



(i) What is the name of the blood vessel labelled X?

(1)

- ☒ **A** aorta
- ☒ **B** pulmonary artery
- ☒ **C** pulmonary vein
- ☒ **D** vena cava

(ii) Give one difference between the structure of the frog heart and a human heart.

(1)

.....

.....

(iii) Humans can run for long periods of time. Frogs can only move for short periods of time.

Explain how the structure of the heart of a frog means that it is unable to move for long periods of time.

(5)

(Total for Question 9 = 12 marks)

8 Yeast can be used in food production.

(a) (i) Which group of organisms does yeast belong to?

(1)

- ☒ **A** bacteria
- ☒ **B** fungi
- ☒ **C** plants
- ☒ **D** protoctists

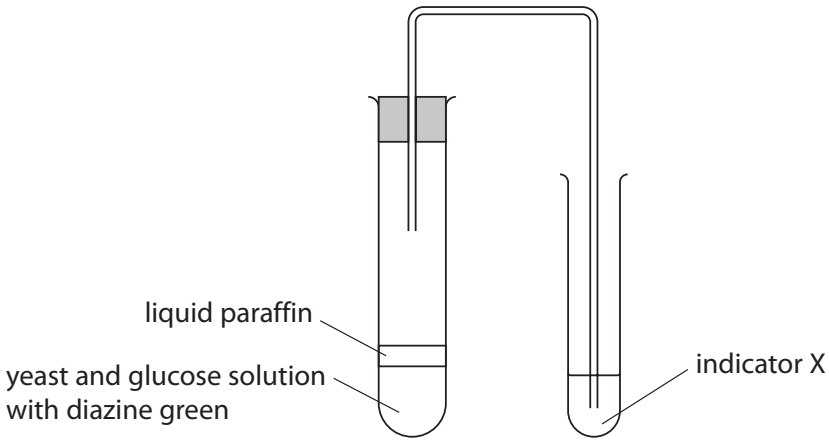
(ii) Which substance is the cell wall of a yeast cell made of?

(1)

- ☒ **A** cellulose
- ☒ **B** chitin
- ☒ **C** sucrose
- ☒ **D** starch

(b) A teacher sets up an experiment to investigate the effect of temperature on the rate of respiration in yeast.

The diagram shows part of the apparatus the teacher uses.



(i) Explain what additional apparatus the teacher will need to investigate the effect of temperature on the rate of respiration in this experiment.

(2)

(ii) State the purpose of the liquid paraffin on the surface of the glucose solution.

(1)

(iii) Give the name of a suitable chemical that could be used as indicator X to show that the yeast is respiring.

(1)

(iv) Diazine green changes colour from blue to pink as the oxygen levels in the yeast and glucose solution reduce.

Explain how this colour change gives information about the respiration in the yeast.

(2)

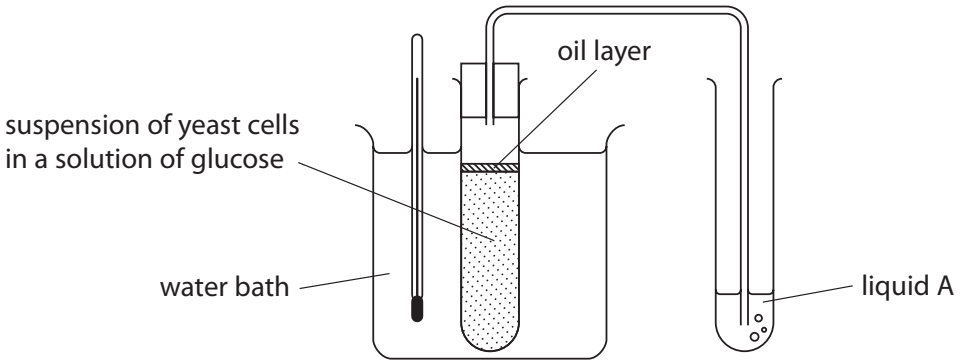
(c) Explain why the rate of respiration in the yeast will change as the temperature is increased.

(4)

(Total for Question 8 = 12 marks)

8 Yeast can be used in experiments to investigate the effect of different concentrations of glucose solution on the rate of anaerobic respiration.

The diagram shows apparatus used to measure the rate of anaerobic respiration in yeast.



(a) Give the function of the water bath.

(1)

(b) Liquid A can be used to identify the gas released during anaerobic respiration by the yeast.

Explain which substance can be used as liquid A.

(2)

(c) A student wants to accurately measure the rate of anaerobic respiration in yeast using this apparatus.

State what additional apparatus they would require.

(1)

(d) The process of anaerobic respiration is sometimes referred to as fermentation.

Industrial fermenters are used to grow microorganisms. These microorganisms produce penicillin, an antibiotic that is used to treat bacterial infections.

(i) Explain how named conditions in an industrial fermenter are controlled.

(4)

(ii) Some antibiotics are becoming less effective at controlling bacterial infections.

Explain how bacteria have evolved so that antibiotics are less effective.

(4)

(Total for Question 8 = 12 marks)

6 Aerobic respiration is a process in living organisms.

(a) Which of these is the balanced chemical symbol equation for aerobic respiration?

(1)

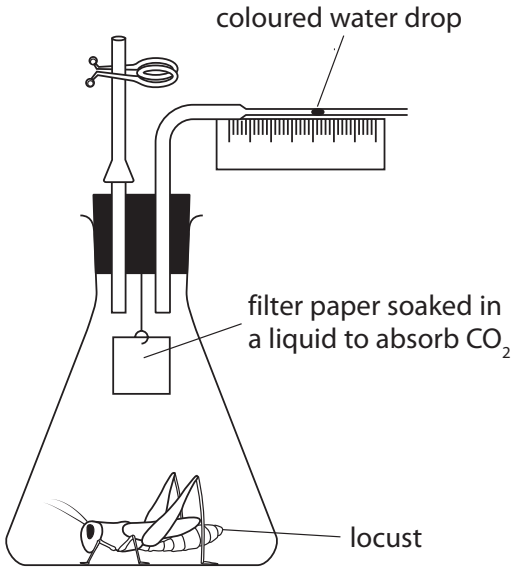
☒ **A** $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2$

☒ **B** $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$

☒ **C** $C_6H_{12}O_6 + 6CO_2 \longrightarrow 6O_2 + 6H_2O$

☒ **D** $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

(b) A student uses this apparatus to investigate aerobic respiration in a locust.



(i) The coloured water drop moves during the investigation.

Explain why the coloured water drop moves during the investigation.

(2)

(ii) The student compares the aerobic respiration of male and female locusts.

He uses three male locusts and three female locusts.

He uses locusts of the same age and the same species.

Explain three other variables that the student needs to control.

(6)

1 .....

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2 .....

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.....

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3 .....

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(c) The table shows the student's results.

	Distance moved by coloured water drop in mm	
	male	female
trial 1	5.0	5.4
trial 2	4.9	5.2
trial 3	2.0	5.2
mean	5.0	

(i) Complete the table by giving the missing mean value.

(1)

(ii) Comment on the reliability of the data in the table.

(3)

(Total for Question 6 = 13 marks)

4 Yeast is a fungus that can respire anaerobically.

(a) (i) What substance is the cell wall of a yeast cell made of?

(1)

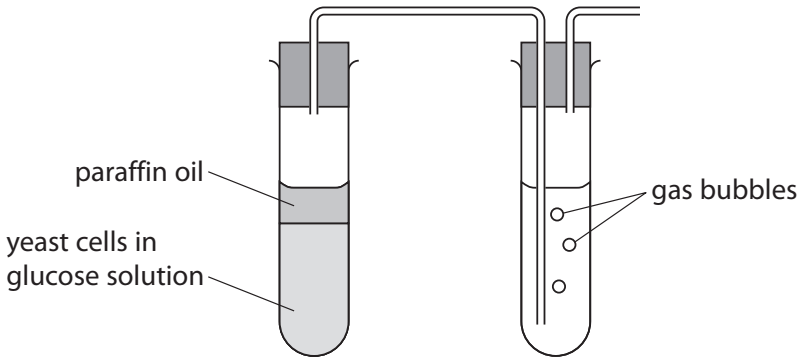
- ☒ **A** cellulose
- ☒ **B** chitin
- ☒ **C** glycogen
- ☒ **D** starch

(ii) Which row of the table shows the substances produced by yeast during anaerobic respiration?

(1)

	Ethanol	Carbon dioxide	Lactic acid
☒ **A**	✓	✓	×
☒ **B**	✓	×	×
☒ **C**	×	✓	✓
☒ **D**	×	×	✓

(b) A student uses this apparatus to investigate the effect of temperature on anaerobic respiration by yeast.

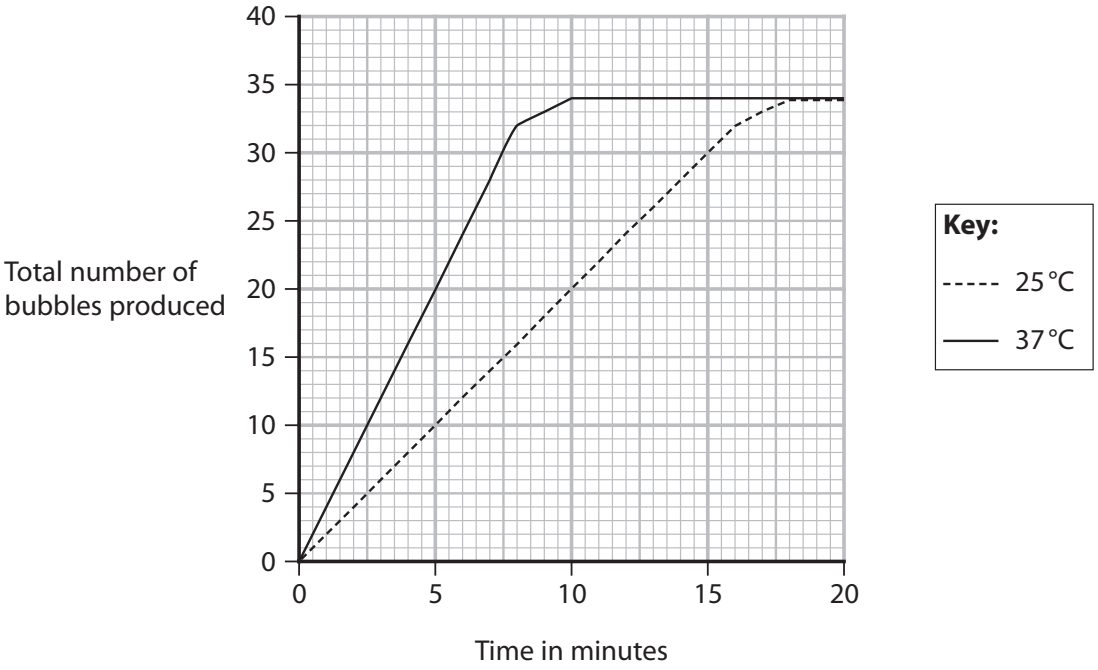


This is the student's method.

- place yeast cells and glucose solution into a test tube
- keep the test tube at a temperature of 25 °C
- cover the yeast and glucose solution with paraffin oil
- count the number of bubbles produced each minute for 20 minutes
- repeat at a temperature of 37 °C

The student draws a graph to show the total number of bubbles that have been produced by the end of each minute for the 20-minute period.

The graph shows the student's results.



(i) State the function of the paraffin oil.

(1)

.....

.....

(ii) Describe a method the student could use to keep the temperature of the yeast and glucose mixture constant.

(2)

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.....

(iii) Calculate the rate of bubble production from 0 minutes to 8 minutes when the yeast is at 37 °C.

(2)

rate of bubble production = ... bubbles per minute

(iv) Explain the change in the total number of bubbles produced from 0 minutes to 20 minutes at 25 °C.

(2)

.....

.....

.....

.....

(v) Explain the difference in the rate of bubble production between 0 and 10 minutes at 37 °C compared with 25 °C.

(3)

(vi) Describe how the student could modify the experiment to give more accurate results.

(2)

(Total for Question 4 = 14 marks)

SUB-TOPIC 2(g)

GAS EXCHANGE

20 questions in this sub-topic · 219 marks · lowest tariff first

2 Complete the passage about the lungs by writing a suitable word in each blank space.

(6)

The organs of gas exchange in humans are the lungs.

A single tube called the ..... allows air to move towards the lungs.

This tube splits into two tubes called ..... which then divide into many narrow tubes called ..... .

At the end of these narrow tubes are air sacs called ..... .

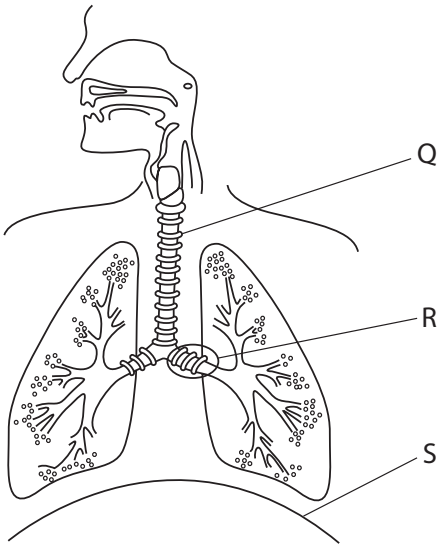
These are where gas exchange takes place.

The lungs are inflated by the contraction of a muscular sheet called the ..... .

The ..... muscles also contract to move the ribs to expand the chest cavity.

(Total for Question 2 = 6 marks)

10 The diagram shows the human thorax.



(a) (i) Which of these are structures Q and R?

(1)

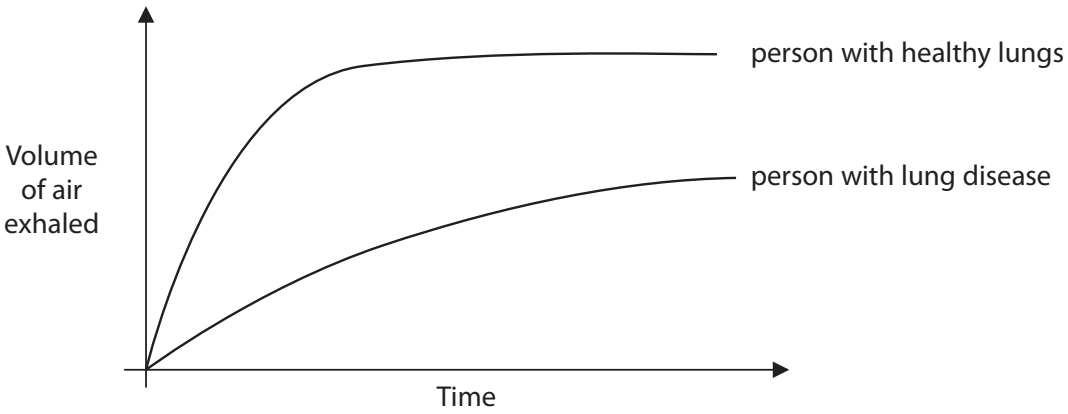
		Q	R
☒	**A**	bronchiole	trachea
☒	**B**	bronchus	trachea
☒	**C**	trachea	bronchiole
☒	**D**	trachea	bronchus

(ii) Explain how structure S helps a person to exhale.

(3)

(b) The graph shows how the volume of air exhaled varies with time during one breath.

This is shown for a person with a lung disease and a person with healthy lungs.



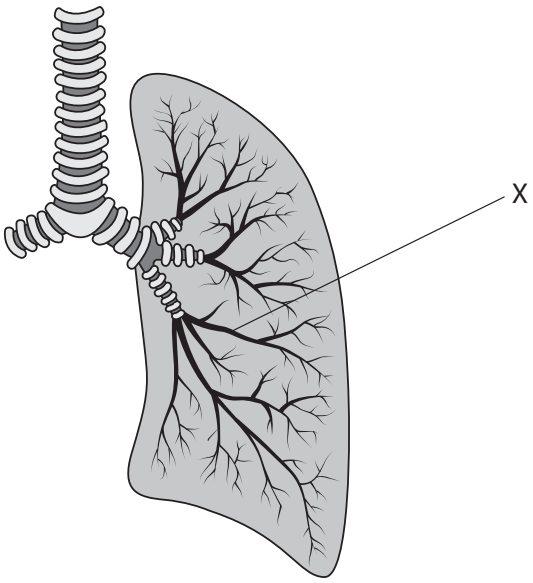
Explain why the person with lung disease is often breathless and unable to exercise.

(3)

(Total for Question 10 = 7 marks)

1 Gas exchange occurs in the respiratory system. The human respiratory system is located in the thorax.

(a) The diagram shows some of the structures in the human thorax.



(i) What is the name of the structure labelled X?

(1)

- ☒ **A** alveolus
- ☒ **B** bronchiole
- ☒ **C** bronchus
- ☒ **D** trachea

(ii) Which of these describes what happens when a person breathes in?

(1)

- ☒ **A** diaphragm contracts and moves downwards
- ☒ **B** diaphragm contracts and moves upwards
- ☒ **C** diaphragm relaxes and moves downwards
- ☒ **D** diaphragm relaxes and moves upwards

(b) The table shows the percentage of some of the gases in inhaled air and exhaled air.

Gas	Percentage of gas (%)	
	inhaled air	exhaled air
oxygen	20	16
carbon dioxide	0.04	4
nitrogen	79	79

(i) Explain the differences between the percentages of gases in inhaled air and in exhaled air.

(3)

(ii) Air in the alveoli has a composition of 14% oxygen and 7% carbon dioxide.

Suggest why the composition of air in the alveoli is different from exhaled air.

(2)

(Total for Question 1 = 7 marks)

6 The surface area of a lung is increased because there are many small alveoli rather than one large one.

(a) A student uses cubes as a model to estimate the additional surface area gained by having many small alveoli.

He uses this method.

- calculate the volume of a large cube with side length 20 cm
- calculate the number of small cubes with side length 1 cm that have the same total volume as the large cube
- calculate the surface area of the large cube
- calculate the total surface area of all the small cubes

The student assumes that the small cubes are not touching so all their surfaces are exposed.

The table shows the student's results.

(i) Complete the table by giving the missing information.

(2)

Side length in cm	Surface area of one cube in cm^2	Total surface area in cm^2	Volume of one cube in cm^3	Total volume in cm^3
20	2400	2400	8000	8000
1			1	8000

(ii) Calculate the ratio of the total surface area of the small cubes to the surface area of the large cube.

(1)

ratio = ...

(b) Evaluate the student's model as a representation of the lungs.

(2)

(c) The results show that many alveoli increase the surface area, which will increase the rate of diffusion.

Explain three other ways that alveoli are adapted to maximise gas exchange.

(3)

1

2

3

(Total for Question 6 = 8 marks)

7 Gas exchange in a flowering plant changes depending on conditions.

(a) Complete the passage by writing a suitable word or words in each blank space.

(5)

Plants carry out photosynthesis to produce ..... . To enable this process to occur the leaf cells absorb carbon dioxide and release oxygen.

At the same time the cells in the leaves are respiring. This means that they are using ..... and producing carbon dioxide. If the leaves are in bright sunlight, then the rate of photosynthesis will be ..... than the rate of respiration.

If the leaves are in dim light, then the rate of respiration will be greater than the rate of photosynthesis and there will be a net production of ..... .

In conditions when there is no net absorption or release of carbon dioxide the rate of photosynthesis and respiration are ..... and the plant is at its compensation point.

(b) Describe how you could use hydrogen-carbonate indicator to investigate the effect of light intensity on net gas exchange in a leaf.

(3)

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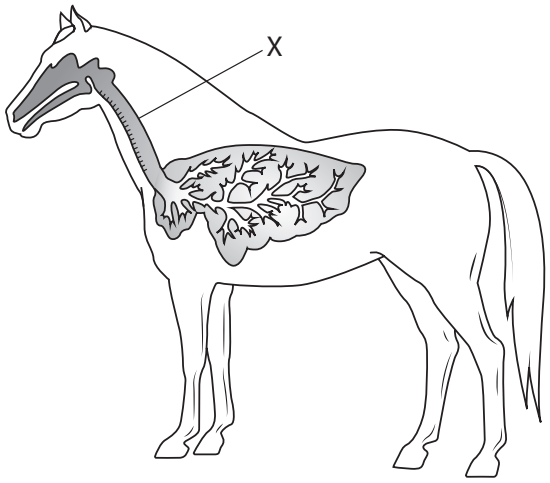
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(Total for Question 7 = 8 marks)

3 The diagram shows the location of the lungs in a horse.



(a) (i) The part labelled X is the

(1)

- ☒ **A** bronchiole
- ☒ **B** bronchus
- ☒ **C** oesophagus
- ☒ **D** trachea

(ii) Which blood vessel transports blood to the horse's lungs?

(1)

- ☒ **A** aorta
- ☒ **B** pulmonary artery
- ☒ **C** pulmonary vein
- ☒ **D** vena cava

(iii) Which row of the table describes what happens when the horse breathes in?

(1)

		Diaphragm	External intercostal muscles
☒	**A**	contract	contract
☒	**B**	contract	relax
☒	**C**	relax	contract
☒	**D**	relax	relax

(b) The table shows the percentage of total blood flow in different body parts of a horse at rest and when running.

Body part	Percentage of total blood flow (%)	
	at rest	when running
leg muscle	15	82
intestine	30	3

Comment on the changes in the percentage of total blood flow in these body parts.

(4)

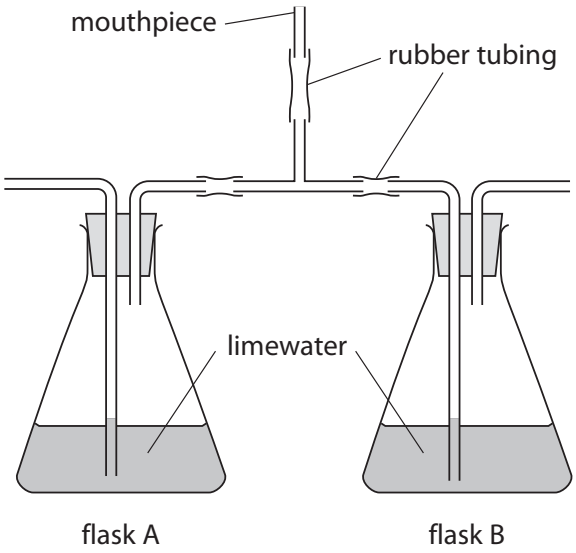
(c) The horse breathes faster and deeper when running.

Explain why the horse continues to breathe faster and deeper for a period of time after it has stopped running.

(2)

(Total for Question 3 = 9 marks)

1 (a) The diagram shows apparatus a student uses to compare inhaled and exhaled air.



The student breathes into and out of the mouthpiece for one minute.

(i) Explain which flask exhaled air passes through.

(2)

(ii) Explain the changes that will happen in the limewater in flask A and in flask B.

(2)

(iii) The student uses limewater to compare the composition of exhaled and inhaled air.

Suggest an alternative substance that they could use.

(1)

(b) Describe the role of the diaphragm and the intercostal muscles in inhalation.

(4)

(Total for Question 1 = 9 marks)

4 The data in the table was collected in Japan during a seven-year study.

Scientists collected data on the age of mothers and whether they smoked during pregnancy.

They also recorded the percentage of the babies that had a low birth mass.

Age of mother in years	Data for mothers who did not smoke during pregnancy		Data for mothers who did smoke during pregnancy	
	number of mothers	percentage of babies with low birth mass	number of mothers	percentage of babies with low birth mass
19 and under	1331	11.5	356	16.0
20–24	11243	9.8	1677	13.2
25–29	24099	9.0	2211	13.3
30–34	28695	9.2	1847	14.5
35–39	16537	10.5	934	21.1
40 and over	3242	12.3	181	22.1

(a) (i) Calculate the percentage of mothers aged 19 years and under who smoked during pregnancy.

(2)

percentage (%) = ...

(ii) Determine the ratio of non-smokers to smokers used in the study.

Give the ratio as the nearest whole number (n) in the form n:1

(2)

ratio = ...:1

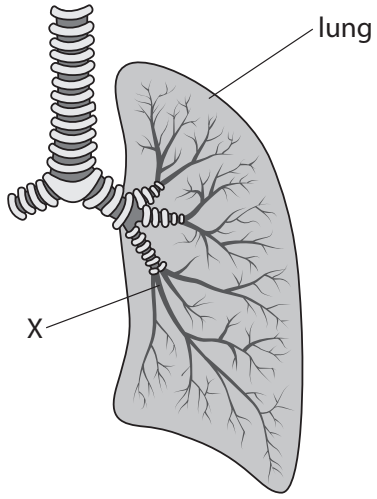
(b) A student examines this data and concludes that smoking is the main factor that causes low birth mass.

Use the data and your own biological knowledge to comment on this conclusion.

(6)

(Total for Question 4 = 10 marks)

2 The diagram shows parts of the human respiratory system with some structures labelled.



(a) (i) Which of these is the structure labelled X?

(1)

- ☒ **A** alveolus
- ☒ **B** bronchiole
- ☒ **C** bronchus
- ☒ **D** trachea

(ii) State why a lung is described as an organ.

(1)

.....

.....

(iii) Explain how contraction of the diaphragm causes air to move into the lungs.

(3)

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(b) A scientist compared the rate at which oxygen is used during exercise by a person who is a non-smoker with a person who is a smoker.

The rate is measured in cm^3 per minute for each kilogram of body mass.

The table shows the scientist's results.

Human	Rate of oxygen use during exercise in cm^3 per minute for each kilogram of body mass
non-smoker	35
smoker	27

(i) Calculate the volume of oxygen used in 30 minutes by a non-smoker with a mass of 70 kg.

(2)

volume = ... cm^3

(ii) Explain the effect of cigarette smoking on the rate at which oxygen is used.

(3)

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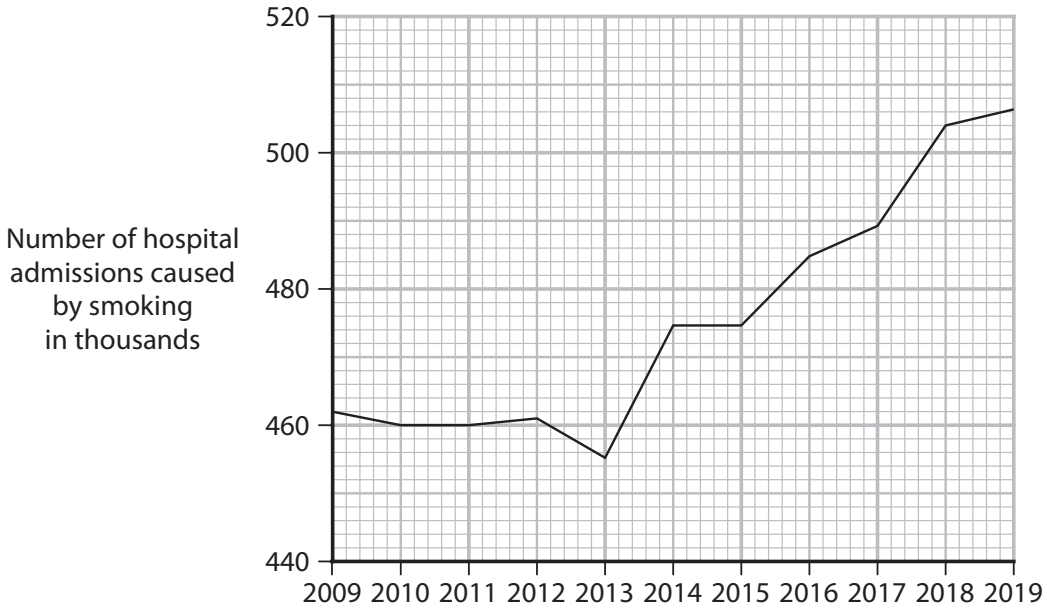
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(Total for Question 2 = 10 marks)

6 Smoking cigarettes has harmful effects on the body.

Graph 1 shows the number of hospital admissions in thousands due to conditions caused by smoking each year from 2009 to 2019.



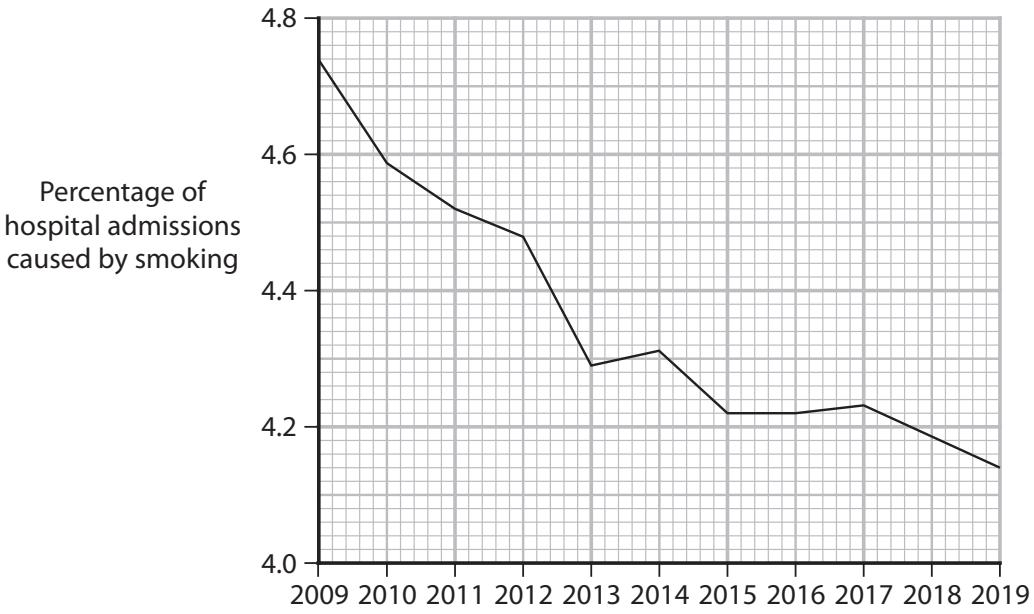
Graph 1

(a) Using information from Graph 1, calculate the percentage increase in the number of hospital admissions caused by smoking in 2019 compared with 2009.

(2)

percentage increase = ... %

(b) Graph 2 shows the percentage of all hospital admissions that were due to conditions caused by smoking each year from 2009 to 2019.



Graph 2

Comment on the changes in the number of hospital admissions caused by smoking and the percentage of all hospital admissions that were caused by smoking.

Use data from graph 1 and graph 2 in your answer.

(4)

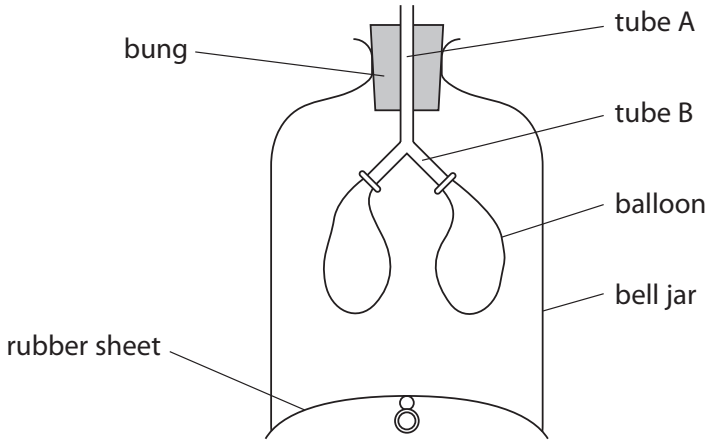
(c) Smoking causes harmful effects on the lungs.

Describe the consequences of smoking cigarettes for the functioning of the lungs.

(5)

(Total for Question 6 = 11 marks)

8 A teacher uses this bell jar model of the thorax to show the process of ventilation.



(a) (i) State how the teacher could demonstrate breathing in using this model.

(1)

.....

.....

(ii) Explain why the balloons inflate during this demonstration.

(3)

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(b) Evaluate whether the bell jar model can completely demonstrate the process of ventilation.

(4)

(c) Some people have problems with their breathing system.

They struggle to breathe and can become breathless.

These people may use inhalers to reduce their symptoms.

The inhalers deliver drugs called bronchodilators into their lungs.

The photograph shows a person using an inhaler.



(Source: © Ljupco Smokovski/Shutterstock)

(i) Suggest how bronchodilators help these people to breathe.

(2)

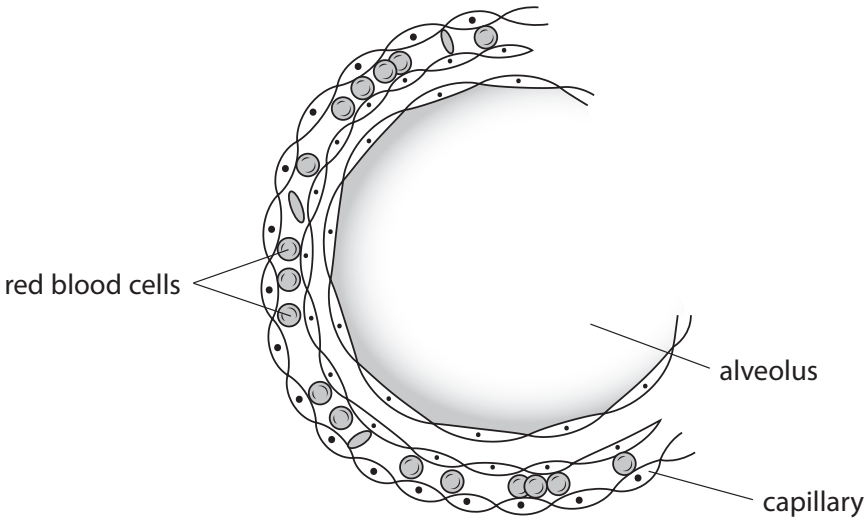
(ii) Explain why these people can become more breathless during exercise.

(2)

(Total for Question 8 = 12 marks)

3 Alveoli are involved in gas exchange.

The diagram shows a section through one alveolus and its associated blood capillary.



(a) Name the organ that contains alveoli.

(1)

.....

(b) There are 5 000 000 red blood cells per mm^3 of blood in the capillary.

Give the number of red blood cells per mm^3 in standard form.

(1)

number = ...

(c) Explain why gas exchange is possible at the alveolus.

(3)

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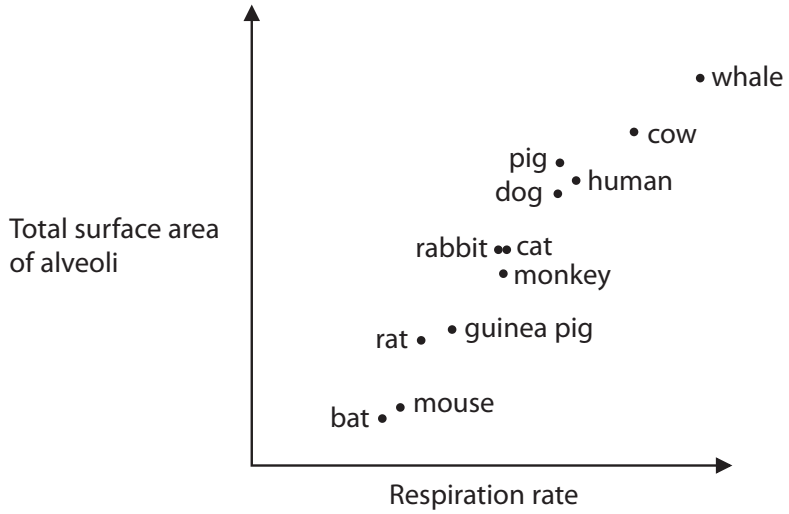
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(d) The graph shows the relationship between the total surface area of alveoli and the respiration rate in different sized animals.



(i) Give two conclusions that can be made from this graph.

(2)

1 .....

.....

2 .....

.....

(ii) The respiration rate shown on the graph is measured in cm^3 of oxygen used per minute.

When the respiration rate is measured in cm^3 per minute, a human has a higher respiration rate than a mouse.

When the respiration rate is measured in cm^3 per minute per gram of body mass, a human has a lower respiration rate than a mouse.

Explain why a human has a lower respiration rate than a mouse when the rate is measured in cm^3 per minute per gram of body mass.

(2)

.....

.....

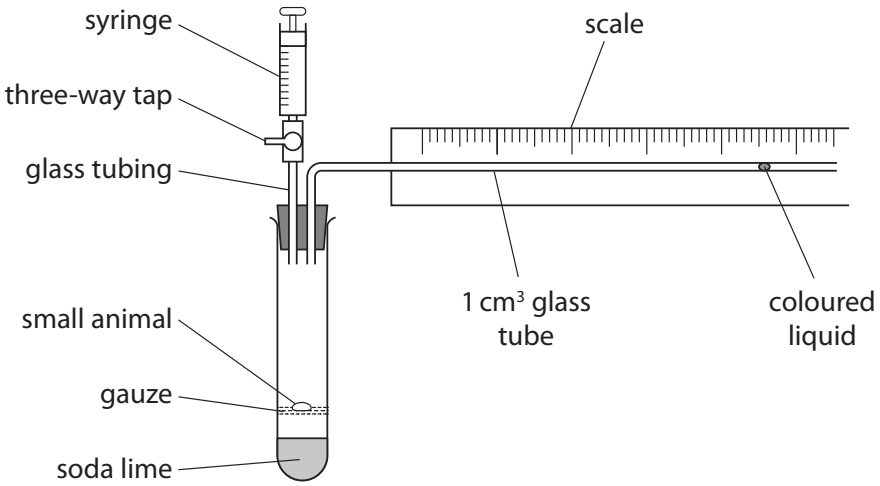
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(e) This apparatus can be used to measure the respiration rate of a small animal.

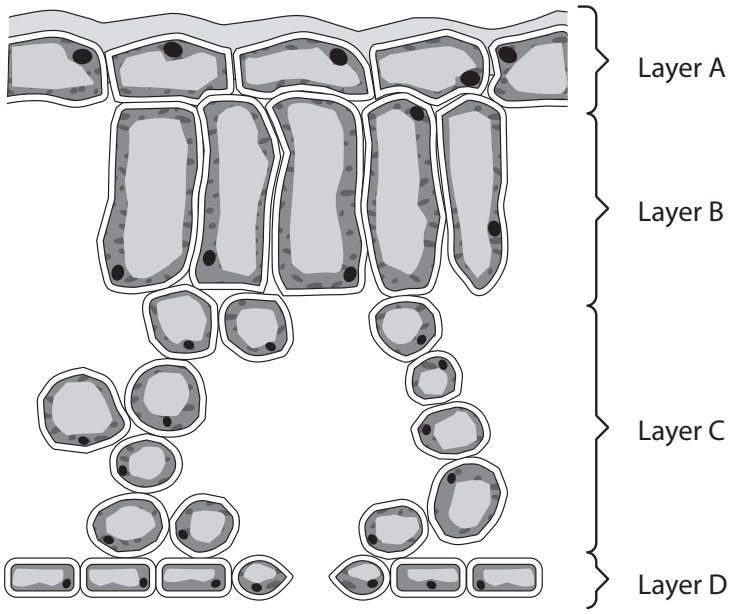


Explain how the apparatus should be used to obtain reliable data.

(3)

(Total for Question 3 = 12 marks)

4 The diagram shows a transverse section through a leaf.



(a) Explain how layer A is adapted for its role.

(2)

(b) Explain how layers B and C are adapted for photosynthesis and gas exchange.

(4)

(c) Explain how layer D is able to regulate gas exchange.

(2)

(d) Gardeners sometimes apply a spray called an anti-transpirant to plant leaves.



The spray is impermeable to water vapour but allows other gases to pass through.

Discuss whether an anti-transpirant spray will promote plant growth.

(4)

(Total for Question 4 = 12 marks)

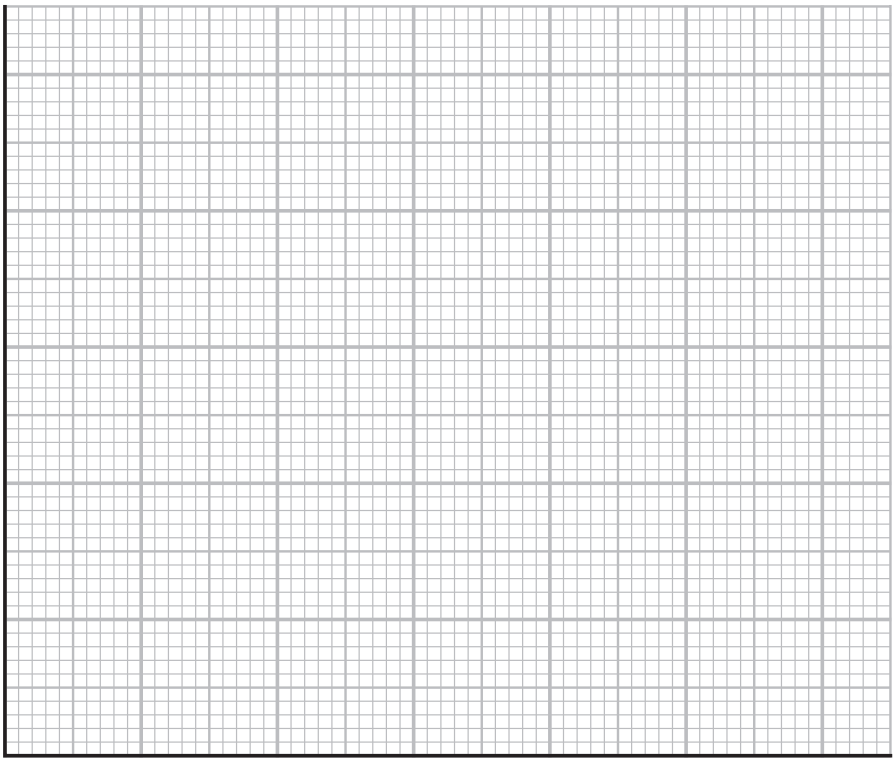
9 The scientist, Richard Doll, collected data about deaths from cancer in the 1950s.

The table shows data for four groups.

Cause of death	Number of deaths				
	non-smokers	light smokers	medium smokers	heavy smokers	total
lung cancer	0	12	11	13	36
other cancers	15	35	24	18	92
all deaths	82	345	206	157	790

(a) (i) Plot a bar chart to show the number of deaths from lung cancer and from other cancers for each of the four groups.

(5)



(ii) Calculate the difference in the percentage of all deaths caused by lung cancer in heavy smokers compared to the percentage of all deaths caused by lung cancer in light smokers.

(3)

difference = ... %

(b) This table gives no information about the age of the people who died.

Suggest why age may affect the likelihood of dying from lung cancer.

(2)

.....

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.....

(c) Explain one effect, other than lung cancer, that smoking has on health.

(2)

.....

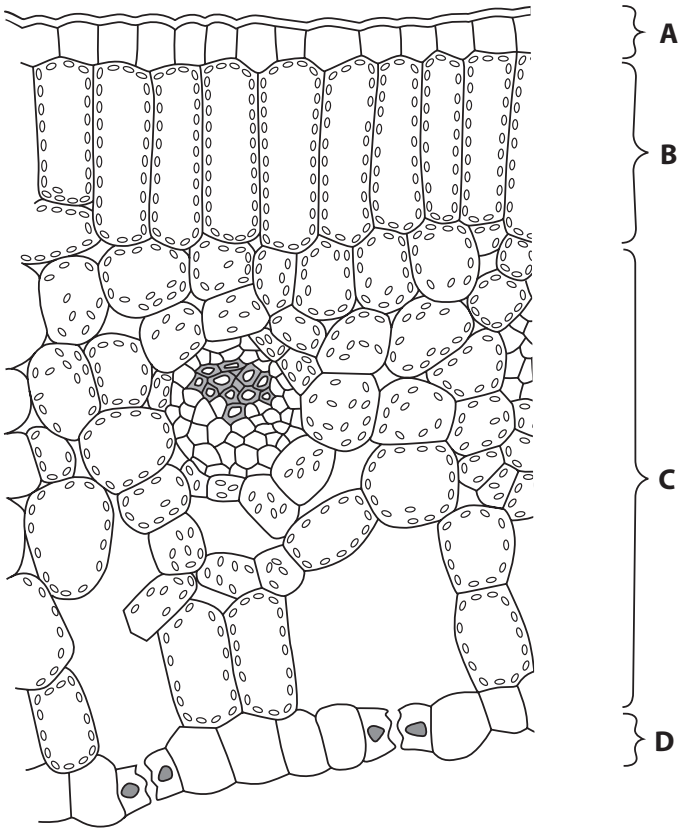
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(Total for Question 9 = 12 marks)

3 The diagram shows a cross-section through a leaf.



(a) (i) Which layer contains palisade mesophyll cells?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) Which set of environmental conditions would produce the fastest rate of transpiration from this leaf?

(1)

	Humidity	Temperature
☒ **A**	High	High
☒ **B**	High	Low
☒ **C**	Low	High
☒ **D**	Low	Low

(b) Scientists investigate the effect of changing carbon dioxide concentration on the density of stomata of wheat plants.

They grow wheat plants from seed in different concentrations of carbon dioxide.

After three weeks, they take a leaf from each plant and calculate the mean density of stomata.

(i) State the independent variable in this investigation.

(1)

.....

.....

(ii) Give two abiotic variables that the scientists could control.

(2)

1 .....

2 .....

(iii) To calculate the mean density of stomata, leaf sections are viewed with a microscope.

The number of stomata within six circular areas of the leaf are counted.

The results for one leaf are shown in the table.

Leaf area number	Per number of stomata
1	68
2	72
3	66
4	75
5	76
6	63

The radius of each circular area is 0.40 mm.

area of circle = πr^2

[$\pi = 3.14$]

Calculate the mean density of stomata on the leaf surface.

(3)

mean density = ... stomata per mm^2

(iv) The investigation shows that in increased carbon dioxide concentrations there is a lower mean density of stomata.

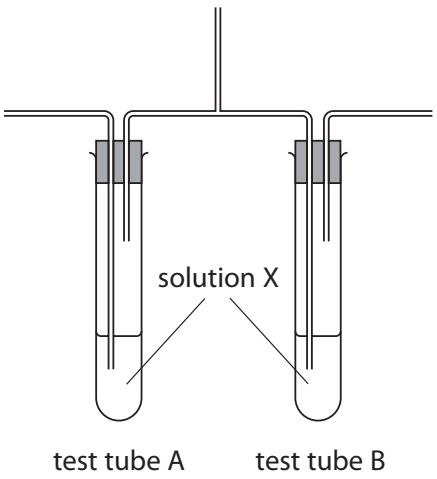
The scientist concludes that in hot dry areas, with increased carbon dioxide concentrations, it would be an advantage for wheat to have a lower mean density of stomata.

Discuss the scientist's conclusion.

(4)

(Total for Question 3 = 12 marks)

3 (a) A student investigates the differences between inhaled and exhaled air using this apparatus.



(i) They use solution X to compare the concentration of carbon dioxide in inhaled and exhaled air.

Give the name of solution X.

(1)

(ii) Explain the changes that will take place in solution X in test tube A and in test tube B.

(3)

(iii) Other than concentration of carbon dioxide, state one other difference between exhaled air and inhaled air.

(1)

.....

.....

(b) Another student investigated the effect of the duration of exercise on their breathing rate.

These are their results.

Duration of exercise in seconds	Breathing rate in breaths per minute
0	22
30	26
60	28
90	32
120	35
150	38
180	42
210	40
240	40

(i) Give the independent variable in this investigation.

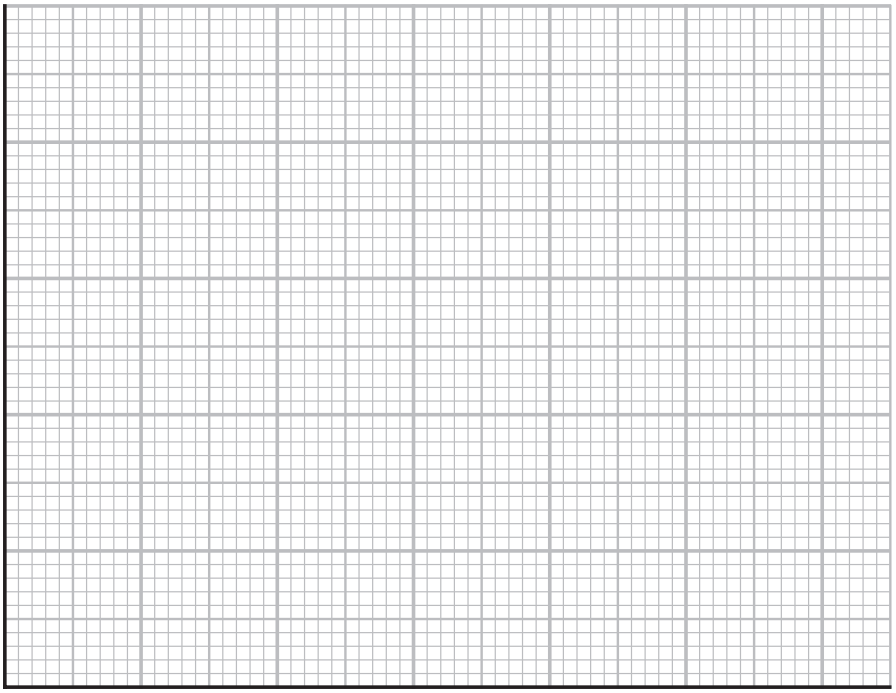
(1)

.....

(ii) Plot a line graph to show the effect of duration of exercise on breathing rate.

Join the points with straight lines.

(5)



(iii) Describe the effect of duration of exercise on breathing rate.

(2)

(iv) Give one way the student could improve the reliability of their investigation.

(1)

(Total for Question 3 = 14 marks)

5 Scientists can investigate the effect of exercise on breathing rate.

An athlete wears a face mask that covers their nose and mouth. The mask contains electronic sensors that measure and record the athlete's breathing rate as they exercise.

An investigation using this mask produces these results.

Time since start of exercise in minutes	Breathing rate in breaths per minute
0	20
2	28
4	35
6	45
8	48
10	50
12	50

(a) (i) Calculate the percentage change in the breathing rate from the start of exercise to the breathing rate at 10 minutes.

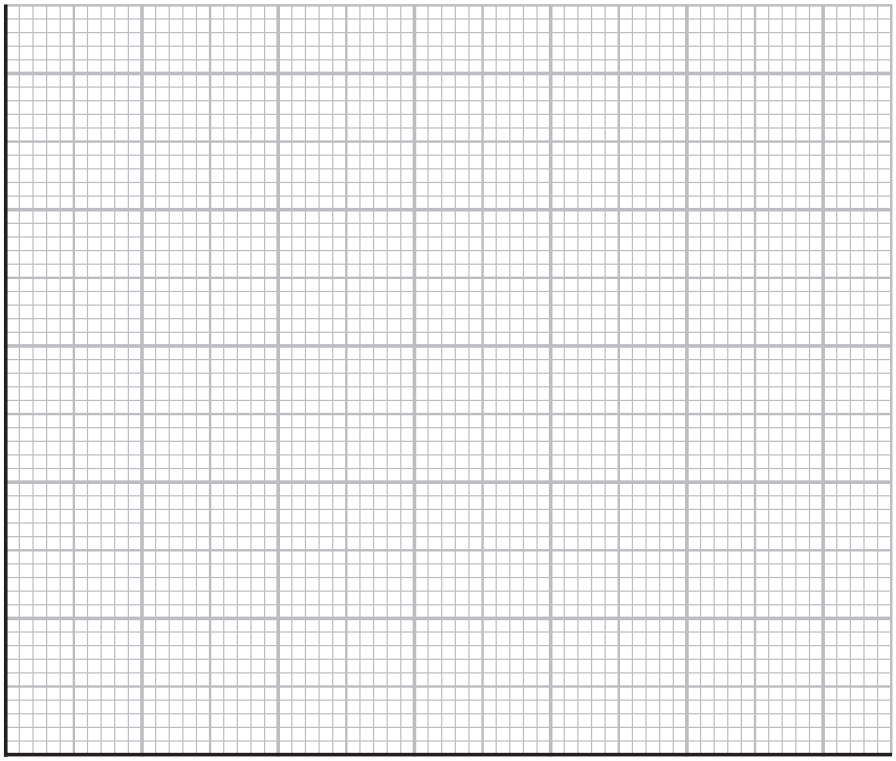
(2)

percentage change = ... %

(ii) Plot a line graph to show how breathing rate changes during exercise.

Join your points with straight lines.

(5)



(iii) Explain the change in breathing rate during the 12 minutes of exercise.

(3)

(b) Explain why the breathing rate would remain high for a few minutes after the exercise has finished.

(2)

(c) The difficulty with measuring breathing rate during exercise is that wearing a mask may affect breathing rate and performance.

A different method of recording breathing rate is to wear a shirt that contains sensors that record chest movements.

Suggest one advantage and one disadvantage of using a shirt that measures breathing rate by recording chest movements.

(2)

advantage

disadvantage

(Total for Question 5 = 14 marks)

8 A scientist investigates the effect of exercise on breathing rate.

She measures the breathing rate in breaths per minute of two people, P and Q, every 5 minutes for 30 minutes.

This is her method.

- measure their breathing rate every 5 minutes while they exercise for 20 minutes
- measure their breathing rate every 5 minutes for a further 10 minutes while they recover from the exercise

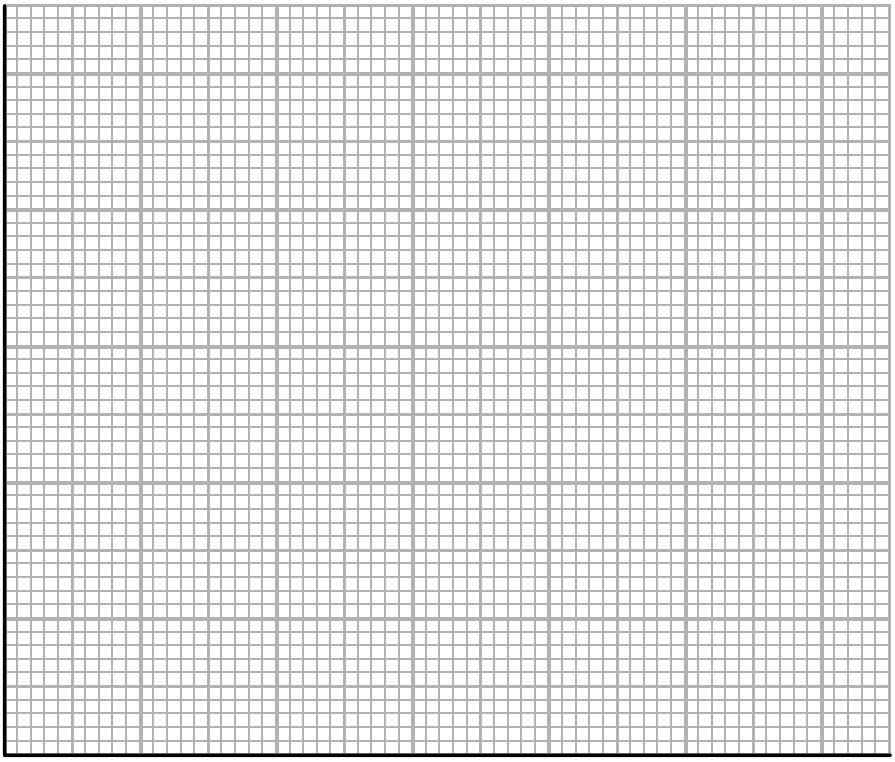
The table shows her results.

Time in minutes	Breathing rate in breaths per minute	
	Person P	Person Q
0	12	15
5	20	24
10	22	24
15	25	23
20	24	20
25	16	19
30	12	15

(a) (i) Plot a line graph of the results for person P and person Q.

Use a ruler to join your points with straight lines.

(6)



(ii) Explain the change in breathing rate during exercise.

(3)

(iii) Explain why the breathing rates of persons P and Q remain high for five minutes after they have finished exercising.

(2)

(b) The time taken to recover from exercise is often a good measure of fitness.

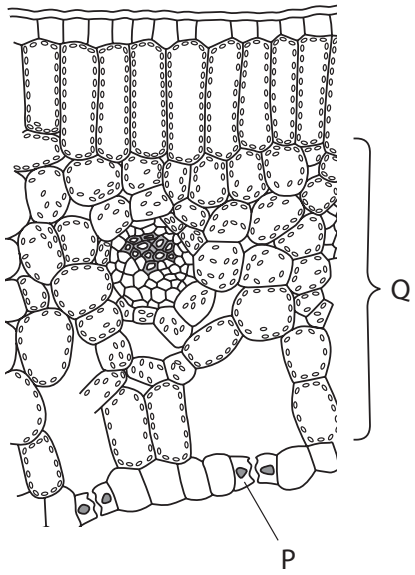
The scientist concluded that person P is much fitter than person Q.

Comment on the validity of this conclusion.

(4)

(Total for Question 8 = 15 marks)

4 (a) The diagram shows a cross-section through part of a plant leaf.



(i) What is the name of the cell labelled P?

(1)

- ☒ **A** cuticle
- ☒ **B** guard
- ☒ **C** palisade
- ☒ **D** stoma

(ii) Explain how part Q is adapted for photosynthesis in the leaf.

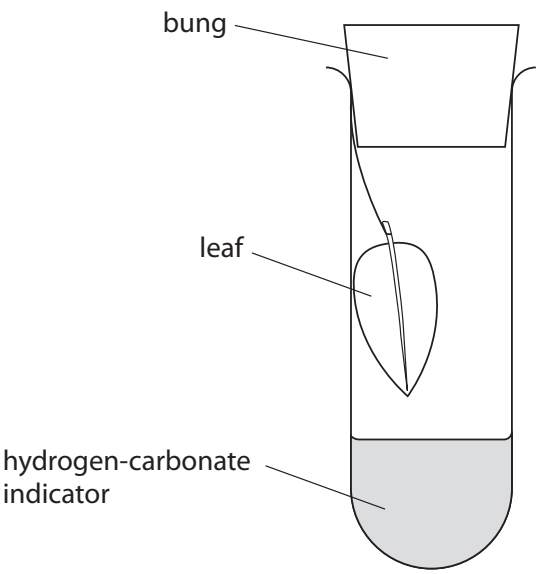
(3)

(b) A student uses this method to investigate the effect of temperature on the rate of gas exchange in leaves.

- pour 10 cm^3 of hydrogen-carbonate indicator into each of six test tubes
- hang a leaf in five of the test tubes
- place a bung in each test tube
- place the five tubes with leaves into separate water baths at temperatures of 15 °C, 20 °C, 25 °C, 30 °C, 35 °C, and 40 °C
- place the tube with no leaf in a water bath at 25 °C
- place all tubes in bright sunlight
- record the time taken for each of the hydrogen-carbonate indicator solutions to change from orange to red

The student repeats the experiment two more times.

The diagram shows one of the tubes with a leaf.



(i) State the independent variable.

(1)

.....

(ii) The species and size of leaf were the same in each tube.

Give a reason for controlling one other named factor. (2)

factor

.....

reason

.....

.....

(iii) State the function of the tube with no leaf. (1)

.....

.....

(c) The table shows the student's results.

Temperature in °C	Time taken for indicator in tubes with leaves to change from orange to red in minutes			
	1	2	3	mean
15	50	40	40	43
20	35	40	35	37
25	25	30	25	
30	10	10	15	12
35	15	10	10	12

(i) Calculate the mean time taken for the indicator to change from orange to red at 25 °C.

Give your answer to two significant figures.

(2)

mean time = ... minutes

(ii) Explain the effect of increasing the temperature on the mean time taken for the indicator to change from orange to red.

(3)

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.....

(d) In another experiment, the student places a test tube containing a leaf and hydrogen-carbonate indicator in a 25 °C water bath.

The student then places all this apparatus in the dark for one hour.

Explain why the indicator solution changes from orange to yellow.

(2)

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.....

.....

.....

(Total for Question 4 = 15 marks)

8 An electronic cigarette (e-cigarette) has been invented.

E-cigarettes are held in the hand like normal cigarettes. Instead of burning tobacco, e-cigarettes heat a liquid that contains nicotine and flavourings to produce a vapour that is inhaled.

Scientists carried out an investigation to see how the smoking habits of students changed between 2011 and 2016.

Each year they determined the percentage of students who used e-cigarettes and the percentage of students who smoked normal cigarettes during the year.

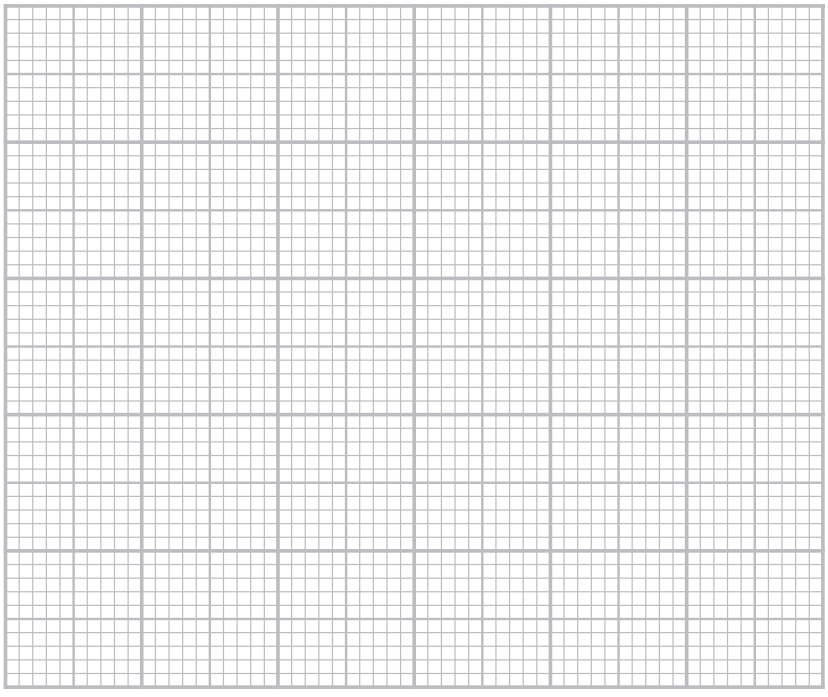
The results are shown in the table.

Year	Percentage of students	
	using e-cigarettes	smoking normal cigarettes
2011	1.5	15.8
2012	2.8	14.0
2013	4.5	12.7
2014	13.4	9.5
2015	16.0	9.3
2016	11.3	8.0

(a) Plot a line graph to show how the percentage of students who used e-cigarettes and the percentage of students who smoked normal cigarettes changed between 2011 and 2016.

Join the points with straight lines.

(6)



(b) Describe the changes in the percentages of students smoking cigarettes and using e-cigarettes between 2011 and 2016.

(2)

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.....

(c) The scientists interviewed 60 000 students each year during the period of the investigation.

Calculate the change in the number of students who were smoking normal cigarettes from 2011 to 2016.

(2)

number of students = ...

(d) Some people are promoting e-cigarettes as a healthier alternative to smoking normal cigarettes.

(i) Suggest why using e-cigarettes may be thought to be less harmful than smoking normal cigarettes.

(4)

(ii) Suggest why many doctors are concerned about promoting the use of e-cigarettes to young people.

(2)

(Total for Question 8 = 16 marks)

SUB-TOPIC 2(h)

TRANSPORT

34 questions in this sub-topic · 406 marks · lowest tariff first

3 Plant roots absorb water from soil.

This water is transported to the leaves and then moves into the air.

(a) Which of these processes is used to absorb water from the soil?

(1)

☒ **A** active transport

☒ **B** diffusion

☒ **C** evaporation

☒ **D** osmosis

(b) Name the tissue that transports water to the leaves.

(1)

.....

(c) Name the process that moves water vapour into the air.

(1)

.....

(d) Which of these reduces the movement of water from the leaves into the air?

(1)

☒ **A** high light intensity

☒ **B** low air humidity

☒ **C** low air temperature

☒ **D** windy conditions

(e) Give two uses of water in a plant.

(2)

1 .....

.....

2 .....

.....

(Total for Question 3 = 6 marks)

2 Human blood contains red blood cells and white blood cells.

(a) The table shows the number of these blood cells in a sample of blood.

Type of cell	Number of cells per mm^3	Number of cells per mm^3 in standard form
red blood cell	5 000 000	5.0×10^6
white blood cell	6000	

(i) Complete the table to give the number of white blood cells per mm^3 in standard form.

(1)

(ii) What is the number of red blood cells in 1000 cm^3 of this person's blood?

(1)

☒ **A** 5.0×10^6

☒ **B** 5.0×10^9

☒ **C** 5.0×10^{11}

☒ **D** 5.0×10^{12}

(b) The table gives names, descriptions and symptoms of two blood conditions.

Name of condition	Description	Symptom
anaemia	low red blood cell count	often tired
leukopenia	low white blood cell count	likely to get infections

(i) Explain why a person with anaemia is often tired.

(2)

(ii) Explain why a person with leukopenia is more likely to get an infection.

(2)

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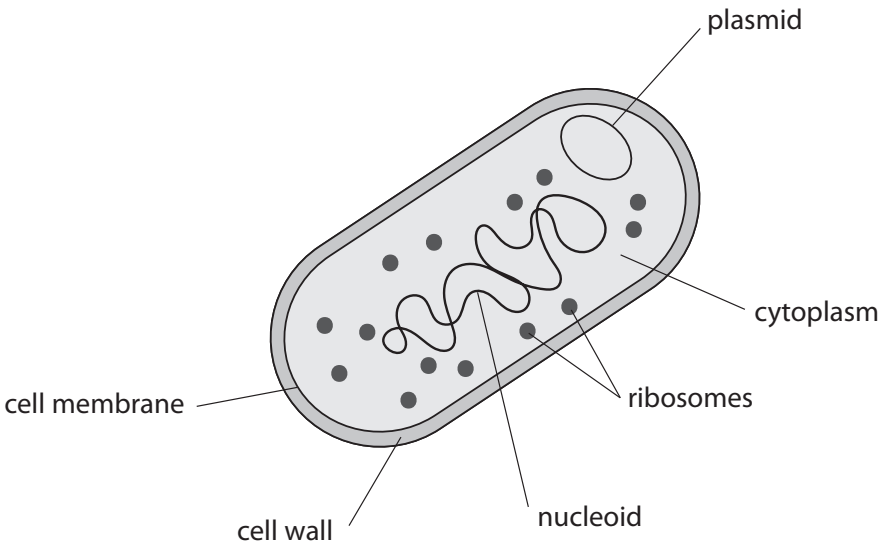
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(Total for Question 2 = 6 marks)

2 *P. multocida* is a bacterium that causes cholera in chickens.

The diagram shows the bacterium.



(a) Give two structures in this bacterium that are also found in all eukaryotic cells.

(2)

1 .....

2 .....

(b) Scientists investigated the survival of chickens injected with normal *P. multocida* or with weakened *P. multocida*.

The table shows the scientists' results.

Type of injection	Result
normal *P. multocida*	chickens die
weakened *P. multocida*	chickens stay alive

(i) What is a correct conclusion about *P. multocida* from these results?

(1)

- ☒ **A** they are decomposers
- ☒ **B** they are pathogens
- ☒ **C** they are microscopic
- ☒ **D** they are non-living

(ii) The scientists took the living chickens that had been injected with weakened *P. multocida* and then injected them with normal *P. multocida*.

The chickens did not die, as they were now immune.

Explain why these chickens did not die.

(4)

(Total for Question 2 = 7 marks)

3 The human heart pumps blood when its muscle tissue contracts.

Diagram 1 shows a human heart and a cross-section through its ventricles.

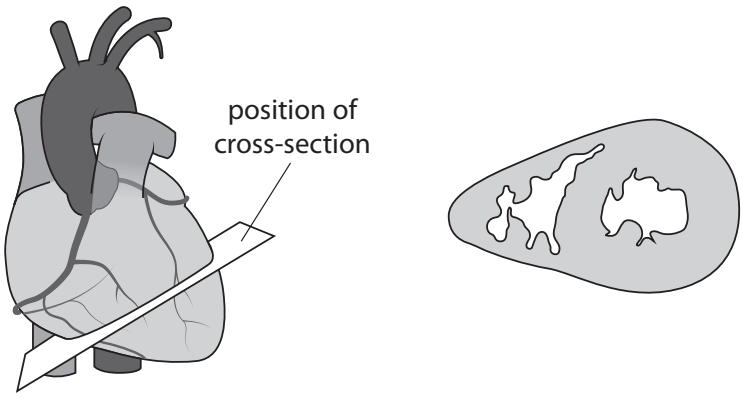


Diagram 1

(a) Which of these statements about the ventricles is correct?

(1)

☒ **A** the left ventricle wall is thick because it has to pump blood to the body

☒ **B** the left ventricle wall is thin because it has to pump blood to the lungs

☒ **C** the right ventricle wall is thin because it has to pump blood to the body

☒ **D** the right ventricle wall is thick because it has to pump blood to the lungs

(b) Ventricle muscle tissue is damaged if the blood supply is reduced.

Diagram 2 shows the damaged part of a human heart and a cross-section through its ventricles.

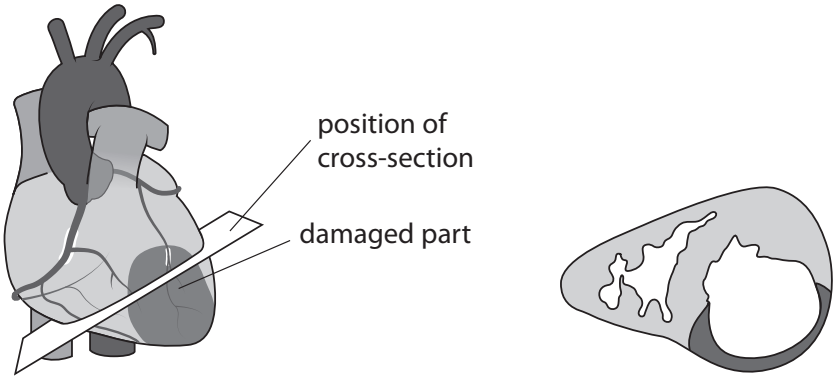


Diagram 2

Explain the cause of the change in the appearance of the muscle tissue in diagram 2.

(3)

(c) Scientists are investigating the use of stem cells to repair damaged hearts.

The stem cells are injected into the ventricle muscle tissue.

(i) Explain why stem cells could repair a damaged heart.

(2)

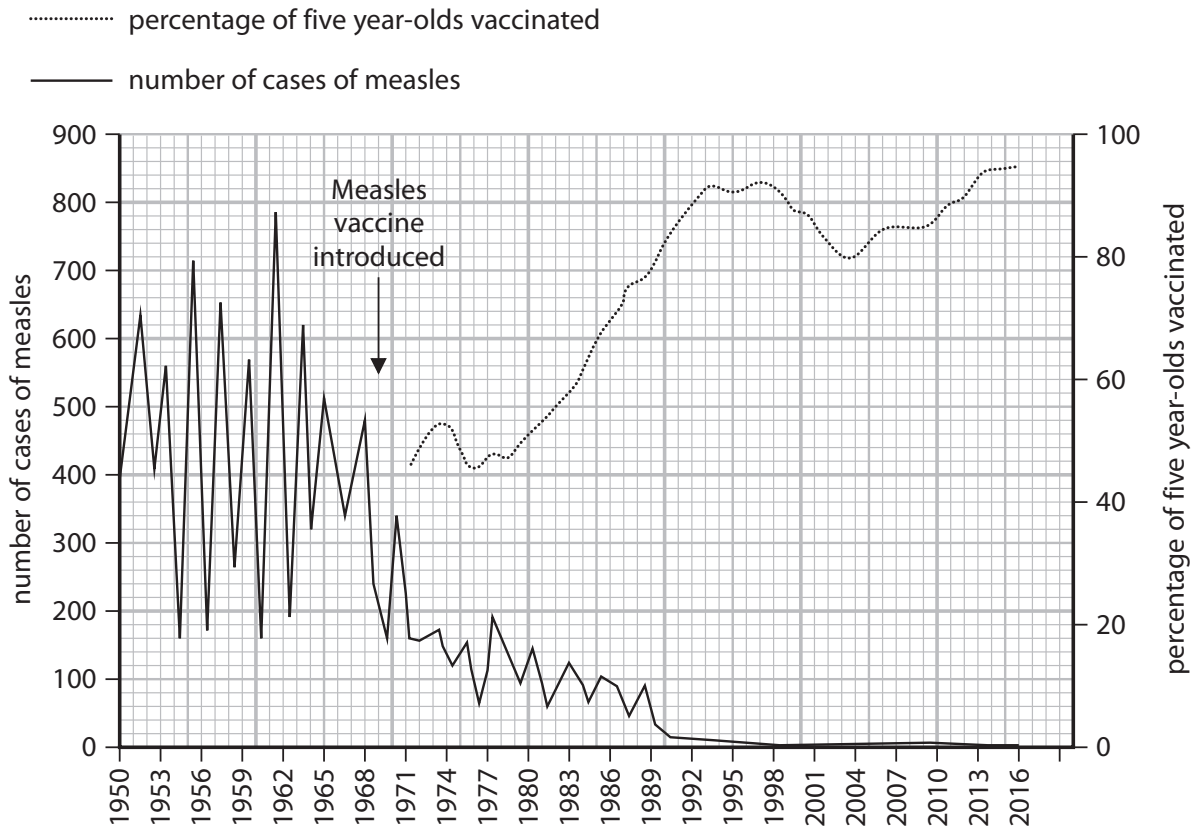
(ii) The stem cells are obtained from the person who has the damaged heart.

Explain why using stem cells from the same person is better than using stem cells from a different person.

(2)

(Total for Question 3 = 8 marks)

6 Measles is a disease caused by a virus. The graph shows the number of cases of measles each year and the percentage of five year-olds vaccinated between 1950 and 2016 in the United Kingdom.



(a) Determine the difference in the percentage change in the number of cases of measles between 1950 and 1965 and the percentage change in the number of cases of measles between 1968 and 1983.

(3)

difference = ...

(b) Explain the relationship between the number of cases of measles and the percentage of five year-olds vaccinated.

Use information from the graph in your answer.

(4)

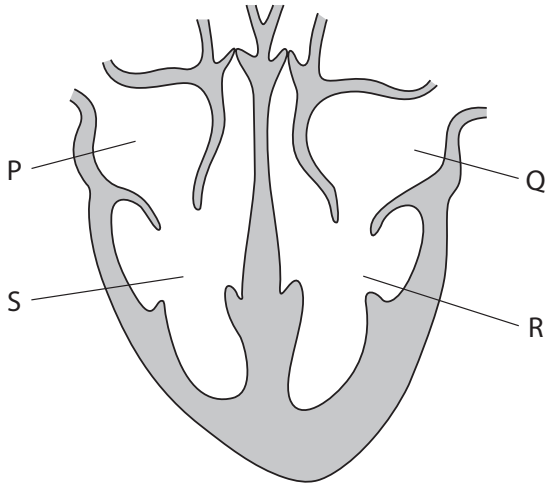
(c) Some children are receiving treatments that reduce the activity of their immune system.

Explain why vaccinations are not used on these children.

(2)

(Total for Question 6 = 9 marks)

2 The diagram shows a section through a human heart with the chambers labelled P, Q, R and S.



(a) (i) Which chambers contain deoxygenated blood?

(1)

- ☒ **A** P and Q
- ☒ **B** P and S
- ☒ **C** R and S
- ☒ **D** Q and R

(ii) Explain why two of the valves in this heart are closed.

(2)

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.....

(b) Heart disease is a major risk to health in the United Kingdom.

In a study, the number of people with heart disease was recorded.

The table shows the results of the study.

Age range in years	Number of people with heart disease per 1000 in population	
	males	females
18 to 44	5	3
45 to 64	138	118
65 to 74	305	220
over 75	422	358

(i) Give two conclusions that can be made from this study.

(2)

1 .....

.....

2 .....

.....

(ii) The population of the United Kingdom is 65 million, of which half are male.

Calculate the number of males with heart disease in the age range 18 to 44.

(2)

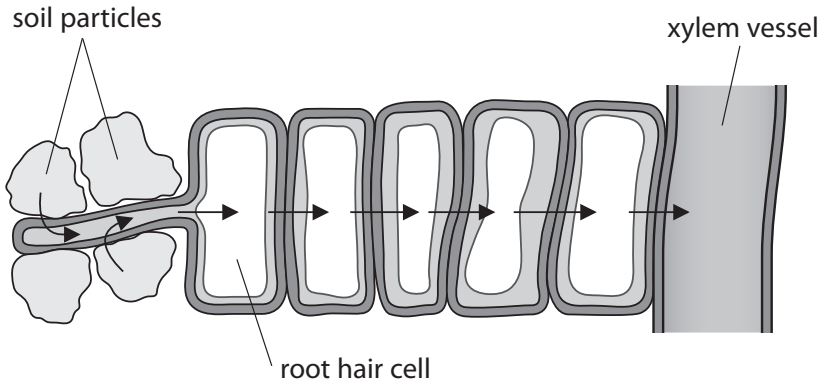
number of males = ...

(c) Explain how heart disease can affect a person's health.

(3)

(Total for Question 2 = 10 marks)

6 The diagram shows the path that the water takes when it is absorbed from the soil into the xylem of a plant.



(a) (i) Explain how root hair cells are adapted for efficient absorption of water.

(2)

(ii) Explain how water is transported from the soil to the leaves.

(4)

(b) Describe how you could determine the rate of water loss from a leafy shoot.

(4)

(Total for Question 6 = 10 marks)

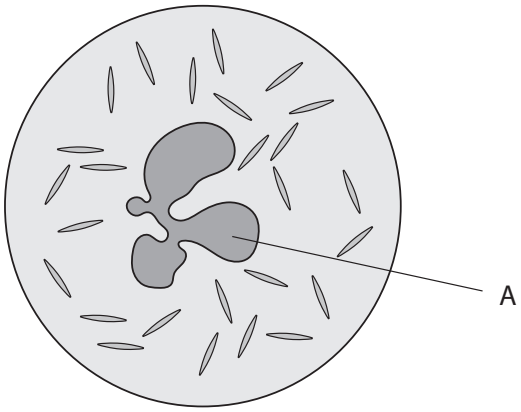
10 Blood consists of cells and plasma.

(a) Plasma transports various substances to and from different parts of the body.

Describe the function of plasma in transporting named substances in the body.

(4)

(b) The diagram shows a white blood cell called a phagocyte.



(i) The magnification of the cell is calculated using this formula.

$$\text{magnification} = \frac{\text{diameter of cell in diagram}}{\text{actual diameter of cell}}$$

The actual diameter of the cell is 0.013 mm.

Calculate the magnification of the cell.

(2)

magnification = ...

(ii) Name the structure labelled A in the diagram.

(1)

.....

(iii) Describe the function of this cell in defending the body from infection.

(2)

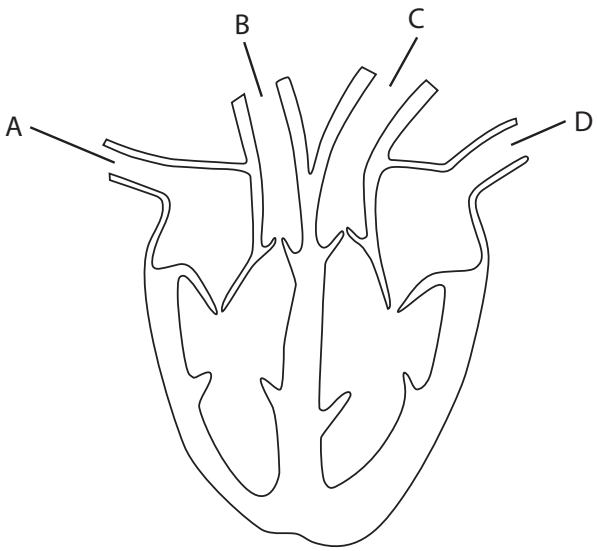
(c) Other white blood cells produce proteins called antibodies.

State how you could test a sample of plasma for protein.

(1)

(Total for Question 10 = 10 marks)

2 The diagram shows the human heart with four blood vessels labelled A, B, C and D.



(a) (i) Which blood vessel brings oxygenated blood to the heart?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) Which blood vessel contains blood at the highest pressure?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b) (i) Draw a label line on the diagram to show the position of a semi-lunar valve.

(1)

(ii) Describe the function of the semi-lunar valves.

(2)

(c) In the heart of a foetus, the two upper chambers (atria) are linked by a hole so that blood can pass between them.

(i) Explain why this hole is normally closed before the baby is born.

(2)

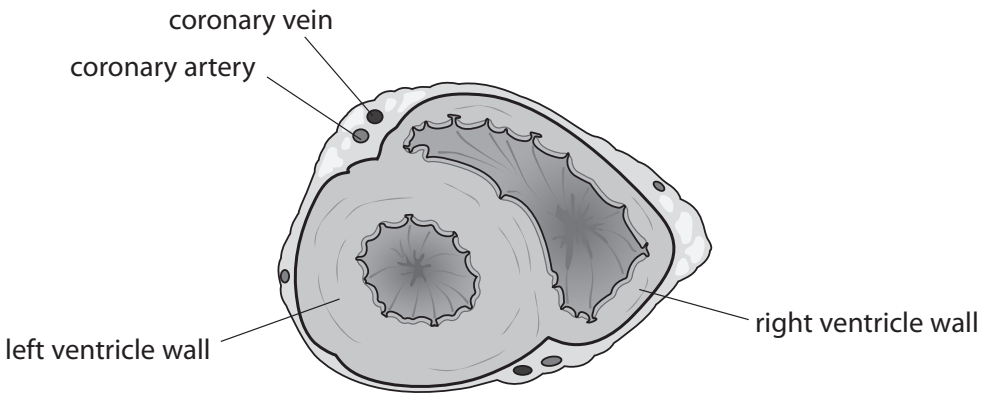
(ii) Sometimes the hole does not close.

Explain what effect this will have on the baby.

(3)

(Total for Question 2 = 10 marks)

2 The diagram shows a transverse section through a human heart.



(a) (i) Draw an X on the diagram to show the position of the septum.

(1)

(ii) State two differences between the composition of the blood in the coronary artery and the composition of the blood in the coronary vein.

(2)

1 .....

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2 .....

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(iii) Explain the differences between the left ventricle wall and the right ventricle wall.

(3)

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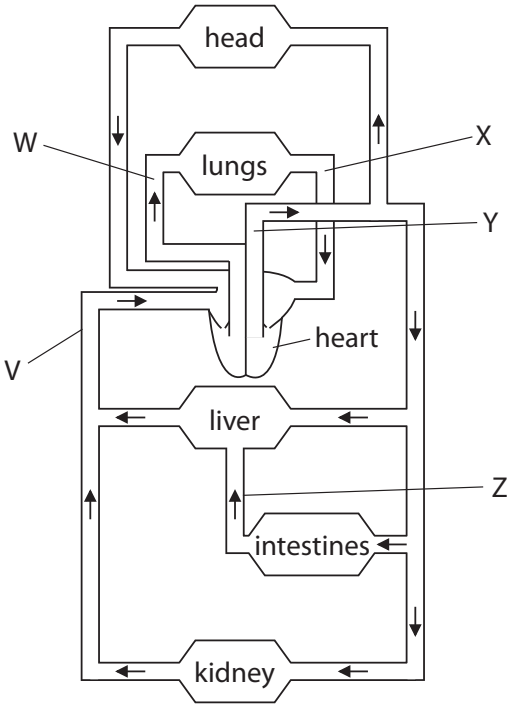
(b) The development of coronary heart disease is linked to a number of factors.

Explain how these factors can increase the risk of developing coronary heart disease.

(4)

(Total for Question 2 = 10 marks)

9 The diagram shows the human blood circulation system.



(a) (i) What is the name of the blood vessel labelled Z?

(1)

.....

(ii) Which labelled blood vessel contains blood with the lowest concentration of carbon dioxide?

(1)

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(b) Give two differences in the structure of the blood vessel labelled V and the structure of the blood vessel labelled Y.

(2)

1 .....

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2 .....

.....

(c) High blood pressure and the presence of certain genes are risk factors for coronary heart disease.

(i) Give two **other** risk factors for coronary heart disease.

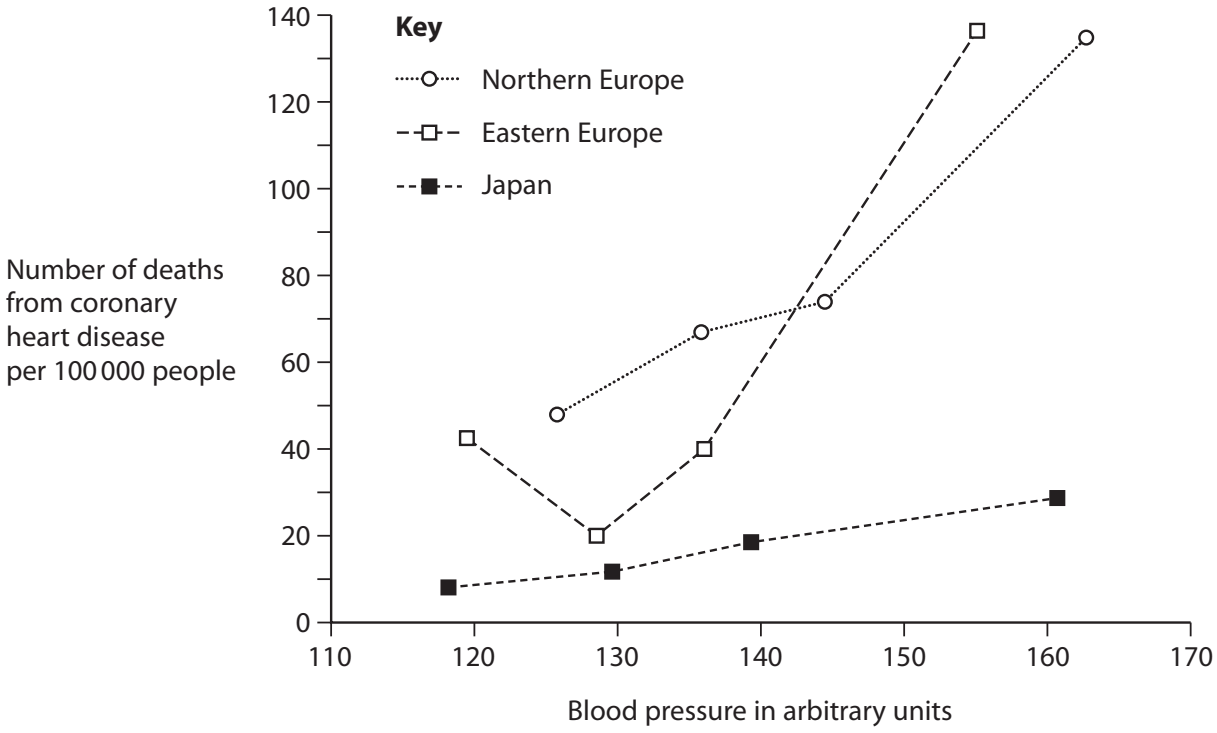
(2)

1 .....

2 .....

(ii) Scientists compared the relationship between blood pressure and the number of deaths from coronary heart disease in Northern Europe, Eastern Europe and Japan.

The graph shows their results.



A high blood pressure is considered to be above 130 arbitrary units.

Use the graph and your own knowledge to comment on the causes of death due to coronary heart disease in each region.

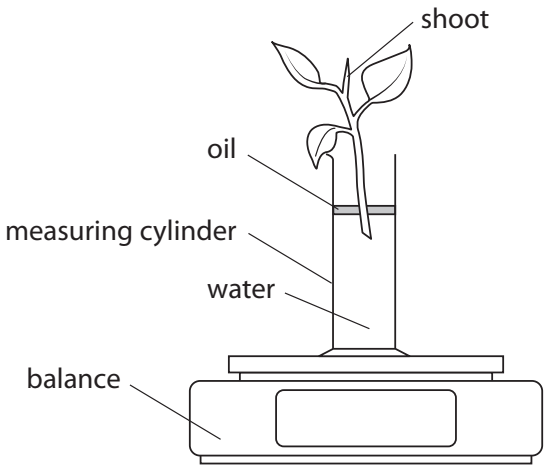
(4)

(Total for Question 9 = 10 marks)

2 A student uses this method to investigate water uptake and water loss by a plant shoot.

- pour 100 cm^3 of water into a measuring cylinder
- place a plant shoot into the measuring cylinder
- cover the surface of the water with oil
- place the measuring cylinder and plant shoot on a balance and record the total mass
- shine light on the plant shoot using a lamp
- record the volume of the water in the measuring cylinder after four days, and after eight days
- record the total mass of the measuring cylinder and plant shoot after four days, and after eight days

The diagram shows the student's apparatus.



(a) State the reason for using the oil.

(1)

.....

.....

(b) The table shows the student's results.

	Volume of water in measuring cylinder in cm^3	Total mass of measuring cylinder and plant shoot in g
start (day 1)	100	175
day 4	75	165
day 8	65	155

(i) The volume of water taken up by the plant shoot is equal to the change in volume of water in the measuring cylinder. This is called the water uptake.

Calculate, in cm^3 per day, the mean rate of water uptake by the plant shoot during the eight days.

(2)

mean rate = ... cm^3 per day

(ii) Comment on the changes in total mass of the measuring cylinder and plant shoot, compared with the changes in volume of water in the measuring cylinder.

[1 cm^3 of water has a mass of 1 g]

(4)

(c) Explain why the rate of water loss would be different if a working fan is placed in front of the plant shoot.

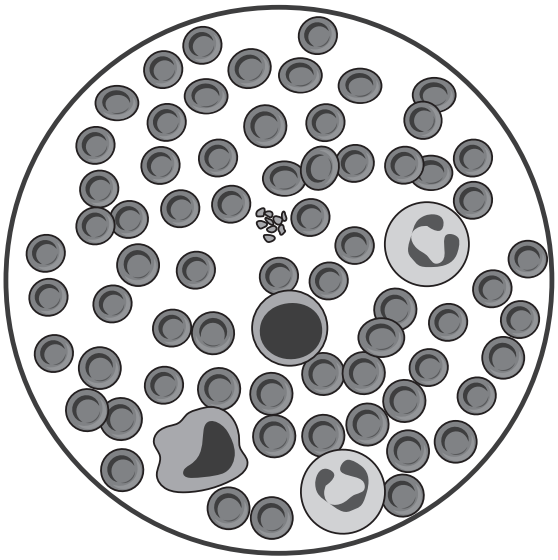
(3)

(Total for Question 2 = 10 marks)

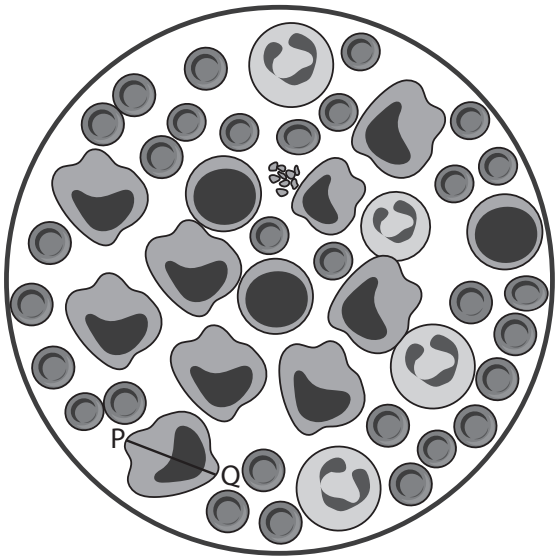
4 The diagram shows two samples of blood seen using a high power microscope.

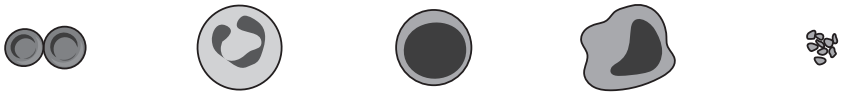
One sample is of normal blood and the other sample is from a patient with a blood condition.

Normal blood



Blood condition





Erythrocytes Neutrophil Lymphocyte Monocyte Platelets

(a) State two differences between the normal blood sample and the sample from the patient with the blood condition.

(2)

1 .....

.....

.....

2 .....

.....

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(b) The line P–Q shown on the diagram has an actual length of 25 µm.

[1000 µm = 1 mm]

Calculate the magnification of the diagram.

(2)

magnification = × .....

(c) In a healthy person 1 cm^3 of blood contains 5.0×10^9 red blood cells.

An adult has 5.0 litres (5.0 dm^3) of blood in their body.

Calculate the number of red blood cells in the body of a healthy adult.

Give your answer in standard form.

[1 dm^3 = 1000 cm^3]

(2)

number .....

(d) Using the information from the diagram and your own knowledge, comment on the likely effect of the blood condition on the patient.

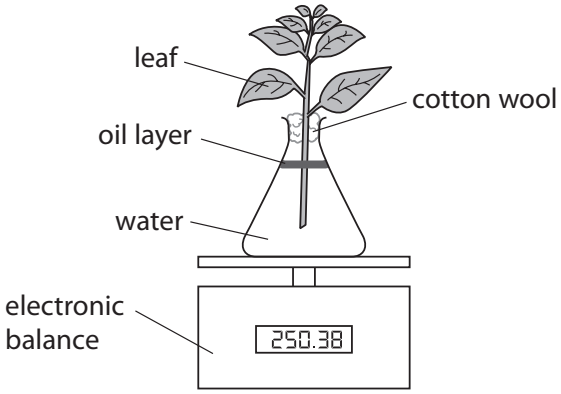
(4)

(Total for Question 4 = 10 marks)

2 Transpiration is the evaporation of water from the surface of a plant.

(a) Explain why transpiration is useful for plants. **(2)**

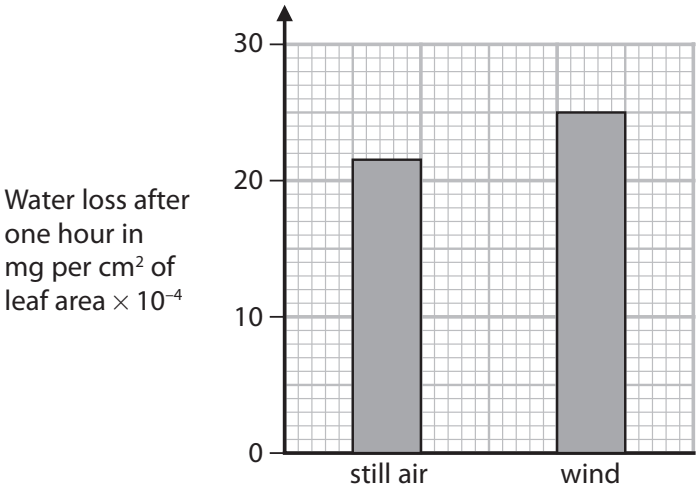
(b) A student uses this apparatus to measure the rate of transpiration in still air and the rate of transpiration in windy conditions.



The student calculates the total loss of water after one hour in mg per cm^2 of leaf area $\times 10^{-4}$ for the plant in still air.

He then repeats this calculation for the plant in windy conditions.

The graph shows the student's results.



(i) The total leaf surface area from which transpiration occurs is 250 cm^2.

Calculate the loss of water from this plant in still air in mg per hour.

(2)

loss of water = ... mg per hour

(ii) Explain the results shown by the graph.

(3)

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(c) Justify two factors that the student needs to control to make a valid comparison of transpiration in still air and in windy conditions.

(4)

1 .....

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2 .....

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(Total for Question 2 = 11 marks)

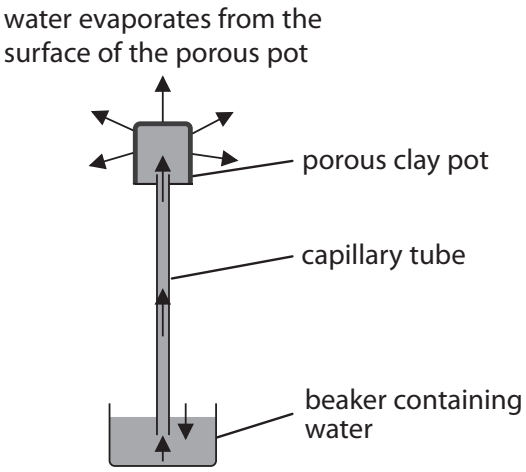
2 A student investigates the rate of evaporation from a clay pot and the rate of transpiration by a plant. The clay pot is porous and has small holes that allow water to evaporate.

The student keeps the clay pot and the plant in the same conditions next to a closed window. He measures the rates at different times of the day.

The table shows the student's results.

Time of day	Rate of evaporation from clay pot in cm^3 per hour	Rate of transpiration from a plant in cm^3 per hour
02 00 to 03 00	0.8	14
06 00 to 07 00	3.9	93
14 00 to 15 00	9.5	198
22 00 to 23 00	3.4	19

(a) The student uses this apparatus to measure the rate of evaporation from the clay pot.



(i) Explain the changes in the rate of evaporation from the clay pot.

(2)

(ii) Suggest how the student could measure the rate of evaporation from the clay pot.

(3)

(b) (i) Explain one factor that affects transpiration from the plant that does not affect evaporation from the clay pot.

(2)

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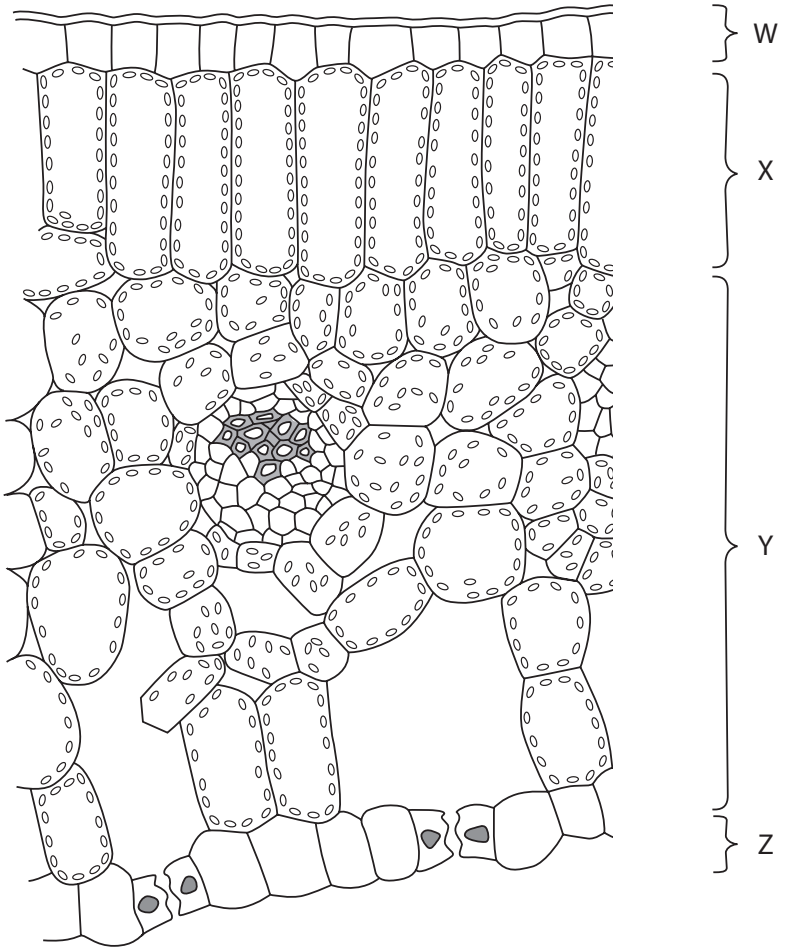
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(ii) Draw a labelled diagram of the apparatus the student could use to determine the rate of transpiration by a plant.

(4)

(Total for Question 2 = 11 marks)

5 The diagram shows a cross section through a plant leaf.

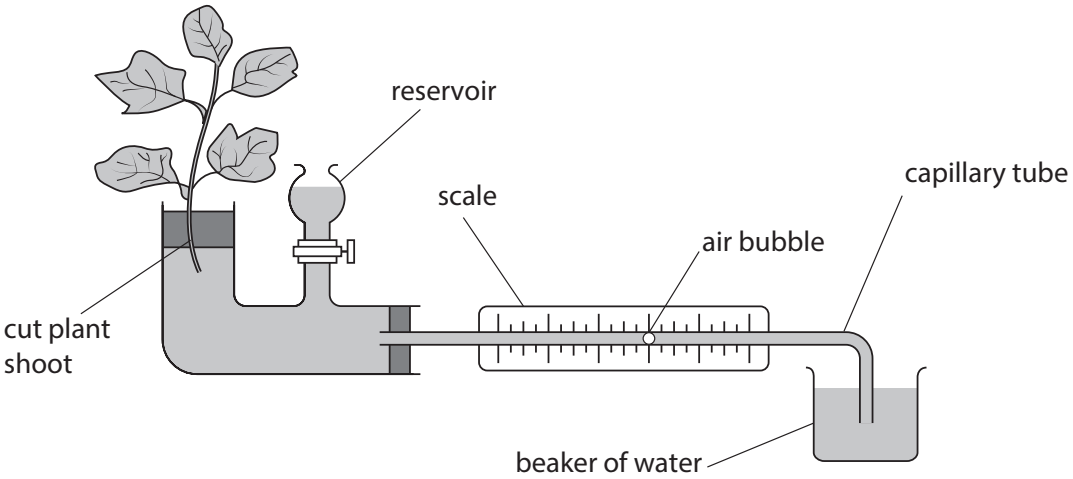


(a) Which area of the leaf contains xylem vessels?

(1)

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

(b) A student uses this apparatus to measure the water uptake by a cut plant shoot.



(i) The inside of the capillary tube is a cylinder shape.

The air bubble moves a length, l, of 5.2 cm in 5 minutes.

The inside of the capillary tube has a radius, r, of 0.50 mm.

Calculate the rate of water uptake, in mm^3 per minute, by the cut plant shoot.

[volume of cylinder = $\pi r^2 l$]

[π = 3.14]

(2)

rate = ... mm^3 per minute

(ii) Describe how the student can use the apparatus to investigate the effect of changing wind speed on water uptake by the cut plant shoot.

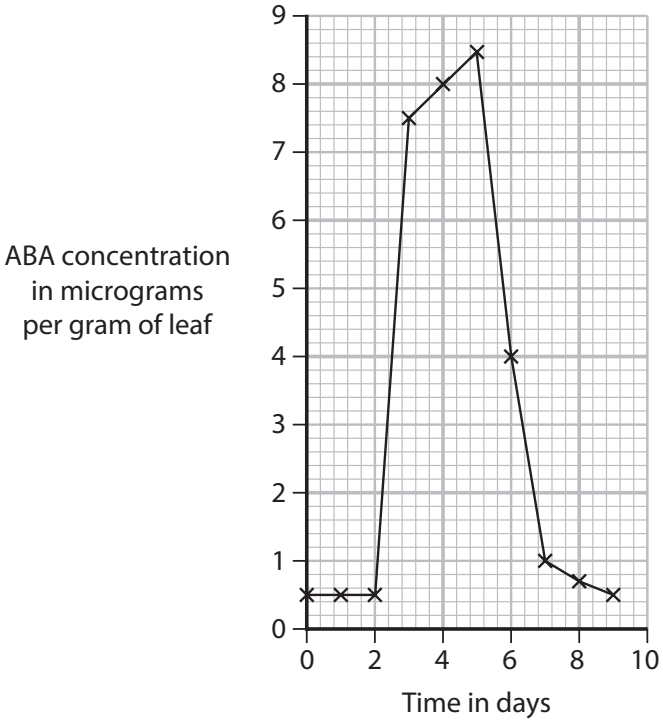
(4)

(c) A scientist investigates how ABA, an auxin-like substance, affects plant growth.

The scientist does not water a plant for 4 days.

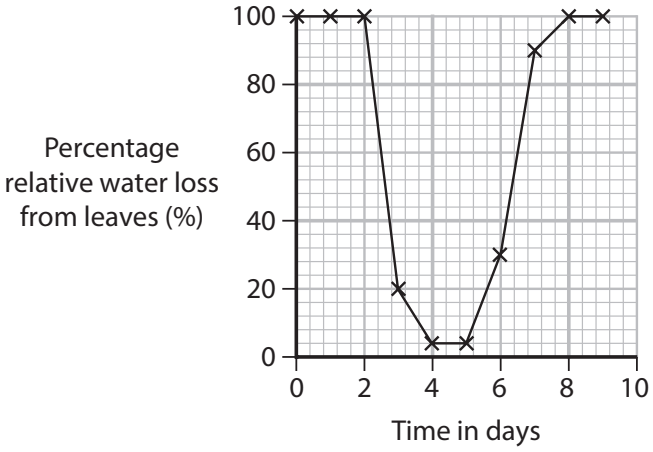
They then water the plant on day 5.

Graph 1 shows the changes in the ABA concentration in the leaves of the plant.



Graph 1

Graph 2 shows the changes in percentage relative water loss from the leaves of the plant.



Graph 2

Comment on the changes in ABA concentration and water loss in the scientist's investigation.

Use information from both graphs in your answer.

(4)

(Total for Question 5 = 11 marks)

5 Arteries and veins are involved in the circulation of blood.

(a) How do arteries differ from veins?

(1)

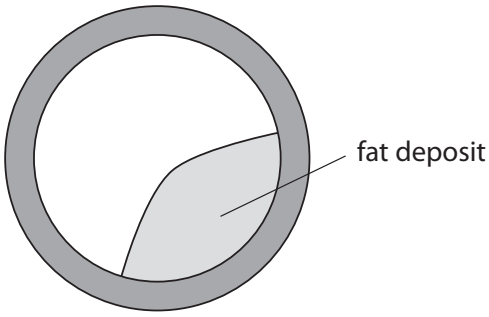
☒ **A** arteries transport blood to the heart

☒ **B** arteries have a wider lumen

☒ **C** arteries contain valves

☒ **D** arteries have thicker walls

(b) The diagram shows a section through a coronary artery from a person who has heart disease.



(i) Using measurements from the diagram, calculate the percentage decrease in the diameter of the lumen where the fat deposit is thickest.

(3)

percentage decrease = ... %

(ii) Explain how the fat deposit would affect the type of respiration in the heart muscle.

(2)

.....

.....

.....

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.....

.....

(c) A high fat diet increases the risk of heart disease.

Give two other factors that can increase the risk of heart disease.

(2)

1 .....

2 .....

(d) Small arteries in the skin have a role in homeostasis.

In an investigation, the diameter of a small artery in the skin is measured in a cold environment and then in a warm environment.

The blood flow in this artery is also measured.

The table shows the results.

Environment	Diameter of small artery in μm	Blood flow in cm^3 per minute
cold	280	0.50
warm	320	1.65

Explain these changes in diameter and blood flow when moving from a cold environment to a warm environment.

(4)

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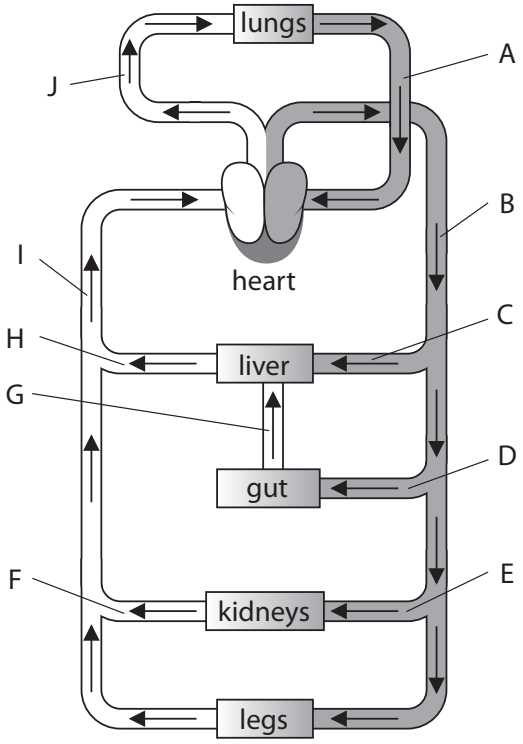
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(Total for Question 5 = 12 marks)

3 The diagram shows the human circulation system with some blood vessels labelled A to J. The arrows show the direction of blood flow.



(a) The table gives some statements about the content of blood vessels in this circulation system.

(i) Complete the table by giving the letter of the blood vessel that matches each statement.

(5)

Statement	Letter
contains the least carbon dioxide	
contains the most glucose after a meal	
contains the least oxygen	
contains the least urea	
contains blood at the highest pressure	

(ii) State two ways in which the structure of blood vessel A differs from the structure of blood vessel J.

(2)

1 .....

2 .....

(b) Muscles in the legs contain capillaries.

A scientist investigates how long-term training affects the number of capillaries in an athlete's leg muscles.

The scientist determines the mean number of capillaries per mm^2 in samples of leg muscle from the athlete before and after a period of training.

The table shows the scientist's results.

Muscle sample	Mean number of capillaries per mm^2
before training	313
after training	349

The scientist concludes that training improves the athletic performance.

Discuss this conclusion.

(5)

(Total for Question 3 = 12 marks)

3 Plant root hair cells absorb water from the soil by osmosis.

(a) (i) Explain how the structure of a root hair cell is adapted to absorb water.

(2)

(ii) Give one difference between osmosis and diffusion.

(1)

(b) A student investigates the effect of light on the volume of water taken up and lost by a plant shoot in one hour.

The table shows the student's results.

	Volume of water in cm^3	
	taken up	**lost**
Dark	2.0	1.6
Light	10.2	9.1

(i) Explain these results.

(3)

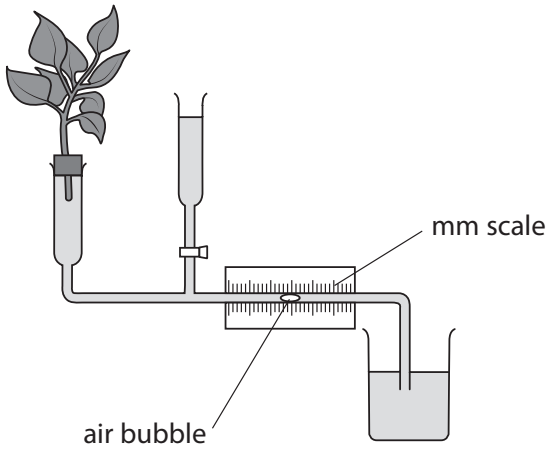
(ii) Give two abiotic variables the student should control.

(2)

1 .....

2 .....

(c) Another student uses this apparatus and a stop clock to find the mean (average) rate of water taken up by a plant shoot.



(i) Name the apparatus used by the student.

(1)

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(ii) Describe how the student could use this apparatus to find the mean rate of water taken up by the plant.

(3)

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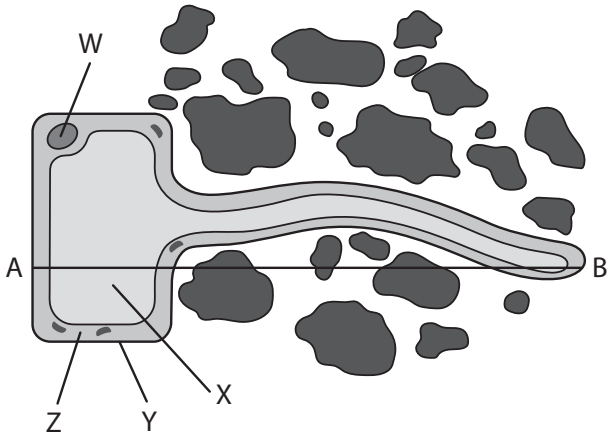
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(Total for Question 3 = 12 marks)

3 The diagram shows a magnified image of a root hair cell from a young plant.



(a) Give the names of structures labelled W, X, Y and Z.

(4)

W .....

X .....

Y .....

Z .....

(b) The actual length of the cell, along the line between A and B, is 1000 μm.

Calculate the magnification of this drawing.

(2)

magnification = ...

(c) (i) Explain the role of the root hair cell in absorption of water from the soil.

(3)

(ii) Sometimes gardeners give their plants too much water. The water fills up the air spaces in the soil around the plant roots.

Explain how this can lead to plants failing to grow properly.

(3)

(Total for Question 3 = 12 marks)

6 Rabies is a dangerous disease caused by a virus.

(a) The rabies virus is a pathogen.

Which other groups of microorganisms include pathogens?

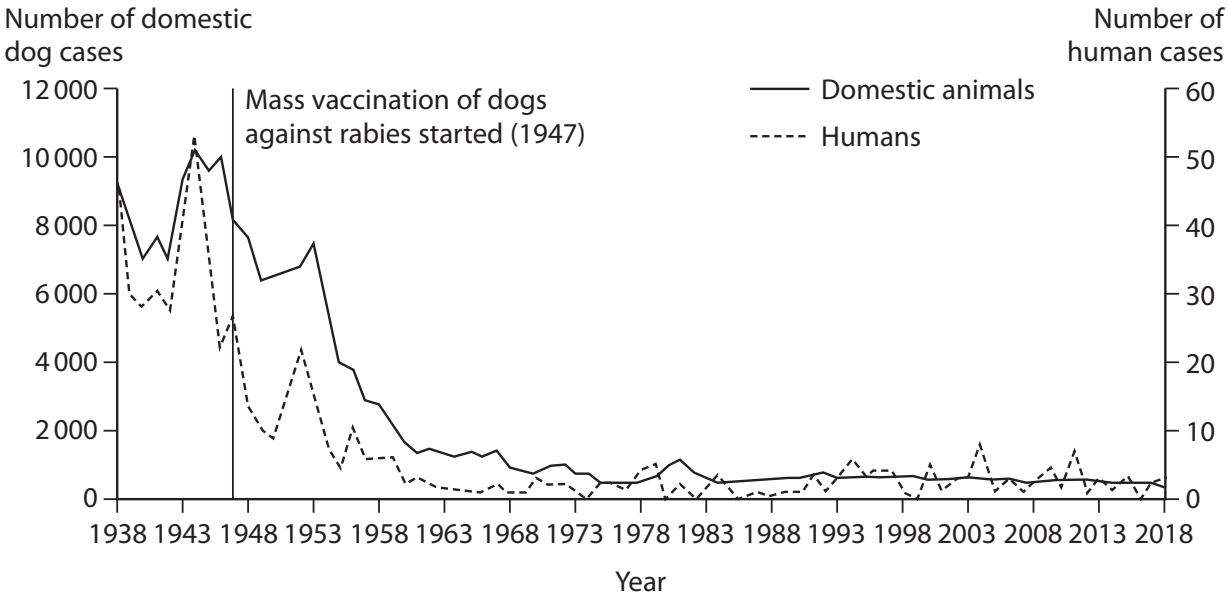
(1)

- ☒ **A** bacteria and fungi only
- ☒ **B** bacteria, fungi, and protoctists
- ☒ **C** bacteria and protoctists only
- ☒ **D** fungi and protoctists only

(b) Rabies is transmitted to humans when they are bitten by an infected animal. Domestic dogs are dogs kept by people as pets or as working animals. Dogs and some wild animals are known to transfer rabies to humans.

In the 1940s, a rabies vaccine for animals was introduced in the United States and most domestic dogs were vaccinated.

The graph shows the number of cases of human rabies and domestic dog rabies in the United States from 1938 to 2018.



(i) The immune system of dogs works in a similar way to the immune system of humans.

Explain how the rabies vaccine prevents dogs from developing rabies.

(3)

(ii) Discuss the effects of the use of the rabies vaccine to immunise domestic dogs on the number of cases of rabies in humans.

Use information from the graph to support your answer.

(4)

(iii) A new RNA vaccine is being developed to treat rabies.

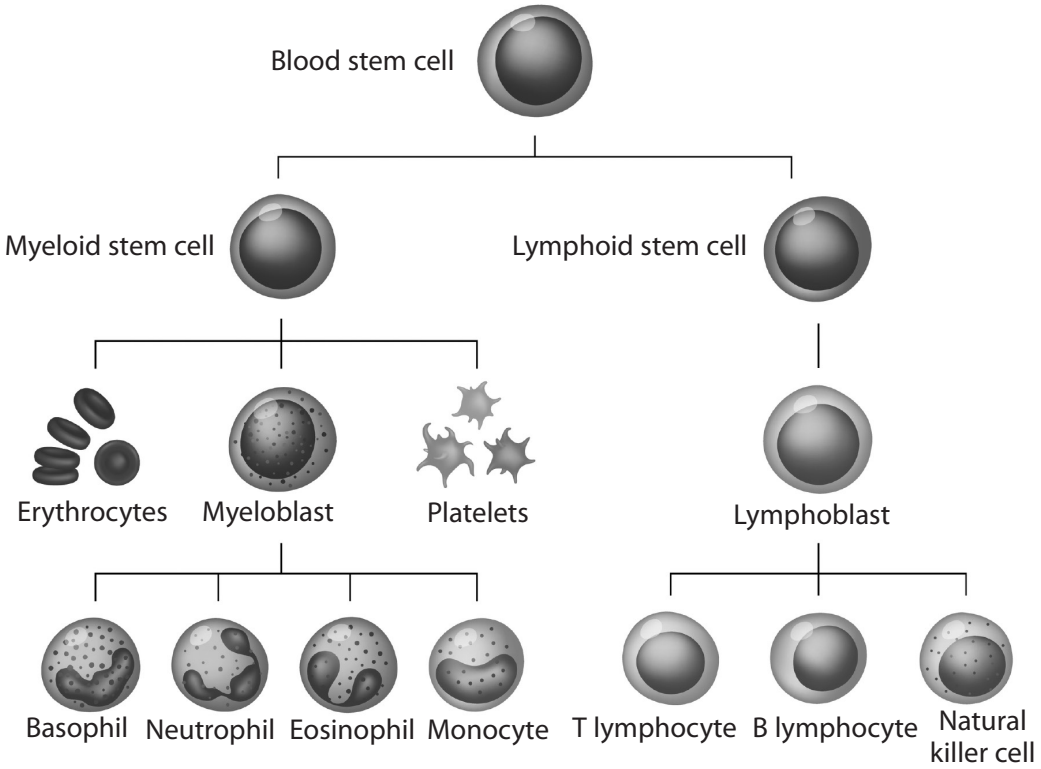
RNA that codes for parts of the rabies virus protein coat are injected into the body. Cells then take up the RNA and produce the viral proteins.

Describe how the cells use the RNA to produce the viral proteins.

(4)

(Total for Question 6 = 12 marks)

3 The diagram shows how human blood develops from blood stem cells.



(Source: © LDarin / Shutterstock)

(a) Describe how stem cells are different from most body cells.

(2)

(b) Describe the role of platelets in the body.

(3)

(c) Explain how vaccination protects the body from disease.

(4)

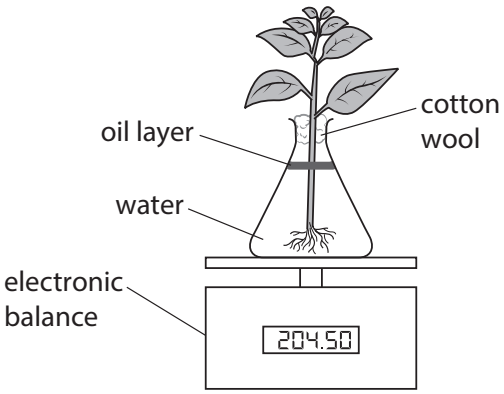
(d) Blood stem cells can be used to treat blood disorders such as sickle cell anaemia which affects red blood cells and leukaemia which affects white blood cells.

Explain why blood stem cells can be used to treat a variety of blood disorders.

(3)

(Total for Question 3 = 12 marks)

3 A student uses this apparatus to investigate water loss from a plant.



This is the student's method.

step 1 measure the total mass of the flask, water, oil, cotton wool and plant

step 2 leave the apparatus for 48 hours

step 3 measure the new total mass of the flask, water, oil, cotton wool and plant

step 4 calculate the rate of change of mass during the 48 hours

Repeat steps 1–4 with the same conditions.

(a) Name the piece of apparatus used in this investigation.

(1)

☒ **A** bubble potometer

☒ **B** hydrometer

☒ **C** osmometer

☒ **D** weight potometer

(b) The total mass changes from 207.25 g to 204.50 g in the first 48 hours.

Calculate, in grams per hour, the rate of change of mass.

Give your answer to two significant figures.

(2)

rate of change of mass = ... grams per hour

(c) Explain why the student repeats the investigation with the same conditions.

(2)

(d) The student then changes the conditions surrounding the plant.

(i) Describe how the student could investigate the effect that moving air has on the change in mass.

(2)

(ii) Explain the effect that faster moving air has on the change in mass.

(3)

(e) Describe how the student could modify the investigation to study the role of roots in the loss of water from a plant.

(2)

(Total for Question 3 = 12 marks)

9 Phagocytes and lymphocytes are white blood cells involved in the immune response.

(a) Explain the role of lymphocytes in the immune response.

(3)

(b) Phagocytes ingest bacteria.

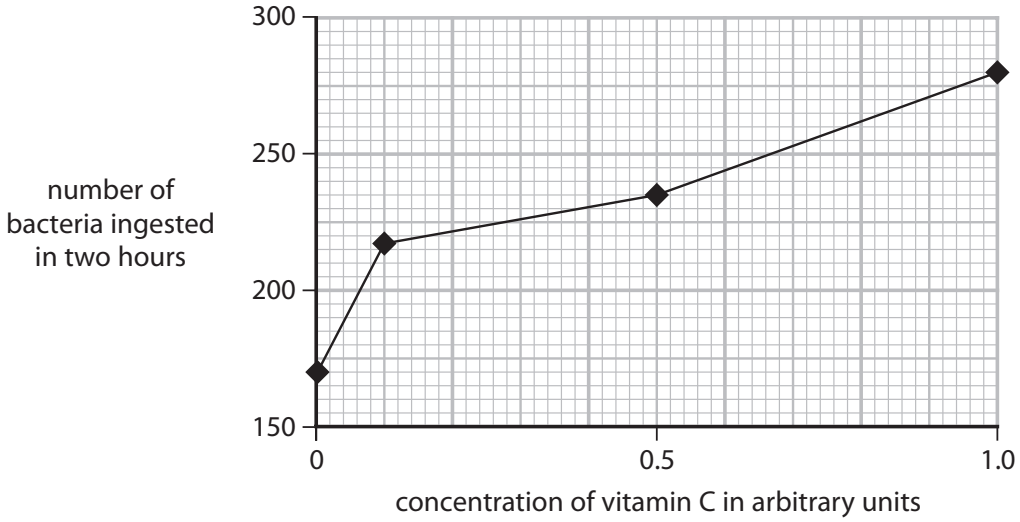
Explain what happens to bacteria after they have been ingested by phagocytes.

(3)

(c) A scientist uses this method to investigate how vitamin C affects ingestion of bacteria by phagocytes.

- add different concentrations of vitamin C solution to three test tubes
- add distilled water to a fourth test tube
- add phagocytes to each tube
- leave the tubes for one day
- add 10 cm^3 of a culture of non-pathogenic bacteria to each tube
- keep each tube at 35 °C for two hours
- measure the number of bacteria ingested

The graph shows the scientist's results.



(i) Which of these is the rate of ingestion of bacteria in the control?

(1)

- ☒ **A** 85 per hour
- ☒ **B** 140 per hour
- ☒ **C** 170 per hour
- ☒ **D** 280 per hour

(ii) State the independent variable in this investigation.

(1)

.....

(iii) State two biotic variables the scientist should control.

(2)

1 .....

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2 .....

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(iv) The scientist concludes that vitamin C in a person's diet will protect people from pathogens.

Comment on this conclusion.

(4)

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(Total for Question 9 = 14 marks)

5 Red blood cells and white blood cells are two of the components found in human blood.

(a) State two other components of blood.

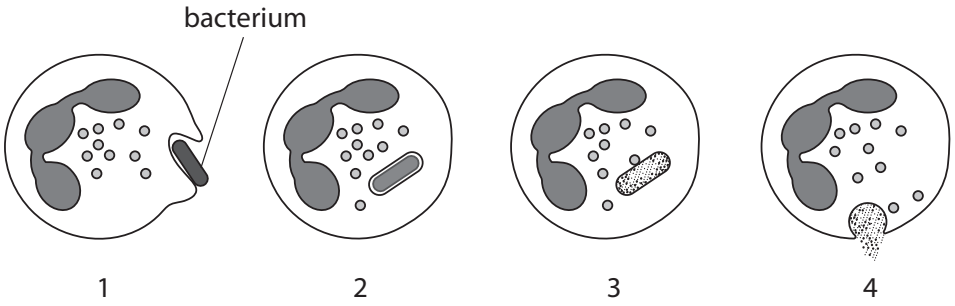
(2)

1 .....

2 .....

(b) Some white blood cells destroy pathogens.

The diagram shows four stages in this process.



Describe what is happening in each stage of this process.

(4)

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(c) The picture shows a human red blood cell.



© Artem_Graf/Shutterstock

(i) The actual diameter of this human red blood cell is 8.1 μm.

Determine the magnification of the picture.

[1 mm = 1000 μm]

(3)

magnification = ...

(ii) Patients with reduced numbers of red blood cells are described as anaemic.

In an investigation, scientists measure the percentage oxygen saturation of the blood and the rate of tissue deoxygenation. The rate of tissue deoxygenation is a measure of how fast oxygen is lost from the tissues.

They use four groups of patients.

- non-anaemic patients with normal blood flow
- anaemic patients with normal blood flow
- non-anaemic patients with slow blood flow
- anaemic patients with slow blood flow

The table shows the scientists' results.

	Patient Group			
	normal blood flow		slow blood flow	
	non-anaemic	anaemic	non-anaemic	anaemic
Number of patients	251	30	48	10
Mean percentage oxygen saturation of blood (%)	81	76	77	68
Mean rate of tissue deoxygenation in percentage per minute	17	20	15	17

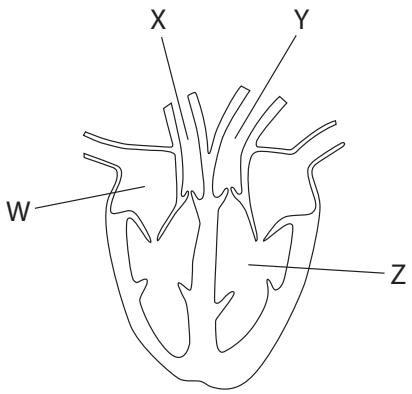
Discuss the relationships between anaemia, blood flow, percentage oxygen saturation of blood and rate of tissue deoxygenation.

You should refer to data in the table and use your biological knowledge in your answer.

(5)

(Total for Question 5 = 14 marks)

5 The diagram shows the structure of a human heart, with two chambers labelled W and Z and two blood vessels labelled X and Y.



(a) (i) Which row of the table correctly identifies chambers W and Z?

(1)

		W	Z
☒	**A**	left atrium	right ventricle
☒	**B**	left ventricle	right atrium
☒	**C**	right atrium	left ventricle
☒	**D**	right ventricle	left atrium

(ii) Give two differences between the composition of the blood in X and Y.

(2)

.....

.....

.....

.....

(b) A scientist investigates the effect of exercise on the heart rate of two people.

One person is a trained athlete and the other is an untrained volunteer.

The heart rates of both individuals are measured at rest (0 minutes). Both individuals then exercise for six minutes and then rest for another six minutes.

The table shows the heart rates of the untrained volunteer and the trained athlete at rest, during and after exercise.

Time in minutes	Heart rate in beats per minute (bpm)	
	untrained volunteer	trained athlete
0 (rest)	65	55
2	120	95
4	130	115
6	150	135
10	100	80
12	80	60

(i) The cardiac output is the volume of blood pumped out by the left ventricle in one minute.

The stroke volume is the volume of blood pumped out by the left ventricle in one beat.

The cardiac output of a resting human is 4900 cm^3 per minute.

Calculate the stroke volume of the trained athlete when at rest when their cardiac output is 4900 cm^3 per minute.

Use this formula.

cardiac output = stroke volume × heart rate

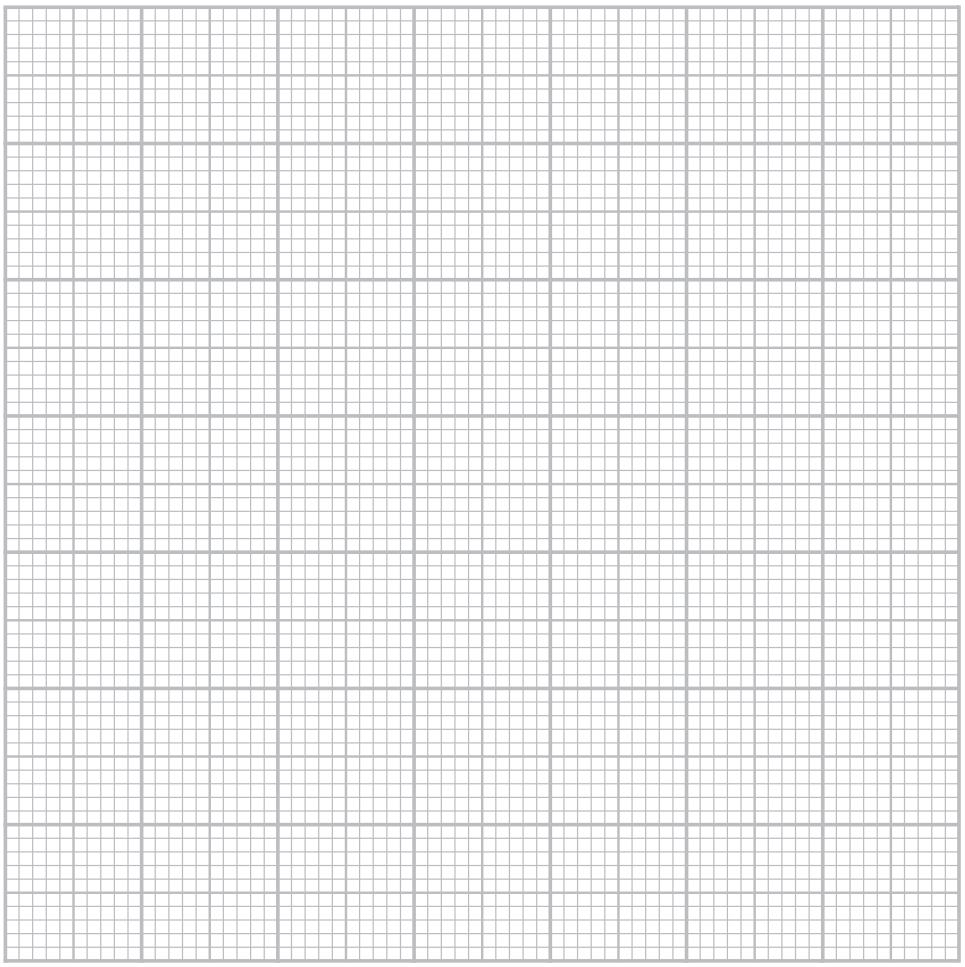
(2)

stroke volume = ... cm^3

(ii) Plot a graph to show the heart rate of the untrained volunteer and the trained athlete when resting and during exercise from 0 minutes (when at rest) to 12 minutes.

Use a ruler to join the points with straight lines.

(5)



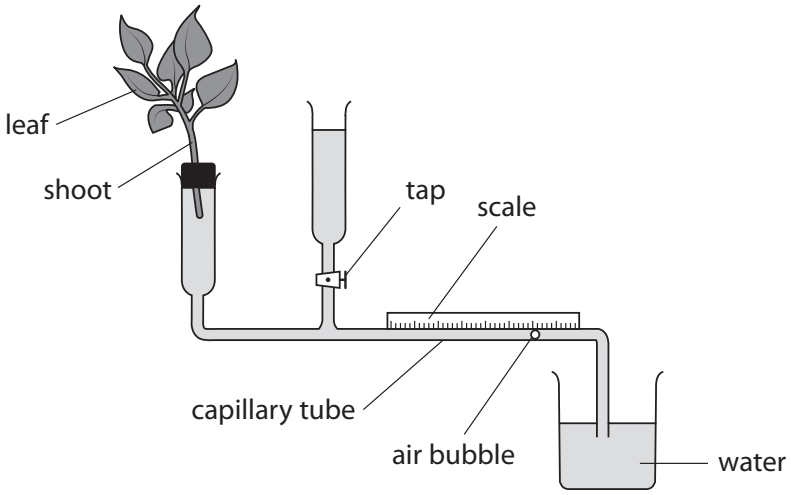
(iii) Explain why the trained athlete can run faster than the untrained volunteer.

Use the information in the table to support your answer.

(4)

(Total for Question 5 = 14 marks)

4 A student uses this apparatus to investigate the effect of windy conditions on transpiration.



This is the student's method.

- measure water uptake for 30 minutes without a fan blowing air at the shoot
- measure water uptake for 30 minutes with a fan blowing air at the shoot
- measure the total surface area of the leaves

The student divides the water uptake by the total surface area of the leaves.

The table shows the student's results.

Conditions	Water uptake after 30 minutes in cm^3 per $cm^2 \times 10^{-4}$
without fan	10.5
with fan	12.5

(a) Explain how the student sets up and uses this apparatus to measure the water loss.

(4)

(b) Give two abiotic factors that the student should control in his investigation.

(2)

1 .....

2 .....

(c) The total surface area of the plant leaves is 200 cm^2.

Calculate the time in minutes for the plant to take up 1.0 cm^3 of water without a fan.

(3)

time = ... minutes

(d) The student concludes that plants will grow better in windy conditions.

Evaluate this conclusion.

(6)

(Total for Question 4 = 15 marks)

6 Cholesterol is needed in the diet for making cell membranes.

(a) State the role of the cell membrane.

(1)

.....

.....

(b) Too much cholesterol is a health risk because fatty deposits build up in arteries.

The lumen of an artery had a diameter of 4.0 mm before the build-up of a fatty deposit.

The fatty deposit covers 45% of the original area of the lumen.

Calculate the area in mm^2 of the lumen that is available for blood flow.

[area of the lumen = πr^2]

[$\pi = 3.14$]

(2)

area = ... mm^2

(c) A scientist tests the blood cholesterol concentration in a sample of men between 25 and 34 years old.

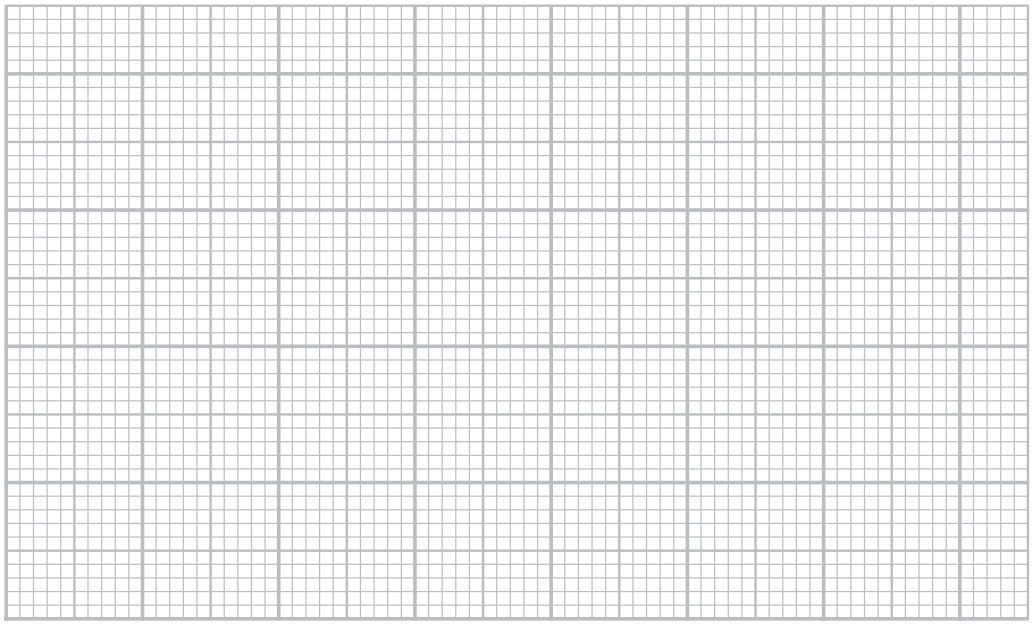
The scientist groups the men in ranges of blood cholesterol concentration and counts the number of men in each range.

The table gives the scientist's results.

Range of blood cholesterol concentration in mg per cm^3	Number of men in each range
80 to 119	13
120 to 159	150
160 to 199	442
200 to 239	299
240 to 279	115
280 to 319	34
320 to 359	9
360 to 399	5

(i) Plot a suitable graph on the grid to show these results.

(5)



(ii) Which range of blood cholesterol levels is the mode for this sample?

(1)

- ☒ **A** 80 to 119
- ☒ **B** 80 to 379
- ☒ **C** 160 to 199
- ☒ **D** 360 to 399

(iii) A blood cholesterol level greater than 239 mg per 100 cm^3 means a person has a higher risk of heart disease.

Calculate the percentage of men in the sample at a higher risk of heart disease.

(2)

percentage = ... %

(d) Statins are drugs that reduce blood cholesterol levels.

A scientist investigates the use of one type of statin on the risk of having a heart attack.

He gives the statin to one group of people and gives a control substance to another group of people.

He calculates the percentage of people in each group that have a heart attack during the next four years.

The table gives the scientist's results.

Group	Percentage (%) having heart attacks
statin	2.2
control substance	3.8

A conclusion from this data is that statins reduce the risk of heart attacks.

Discuss this conclusion.

(4)

(Total for Question 6 = 15 marks)

1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Badgers and bovine tuberculosis

The bacterium *Mycobacterium bovis* causes the lung disease bovine tuberculosis (TB) in cattle. Infected cattle have damaged lungs, which causes gas exchange problems and makes them cough into the air. The pathogen spreads to humans if they inhale air containing the bacterium. Humans also become infected if they drink unpasteurised milk from infected cattle. Milk is usually pasteurised by heating it for a period of time at a high temperature.

Bovine TB can kill humans. In one year, 13 400 people died from a total of 149 000 reported cases of TB. Some of these cases were from Europe, where 103 people died from 1290 reported cases. The rest of the cases were from outside Europe.

Some farmers in the United Kingdom are concerned that badgers spread the TB pathogen to cattle.

The photograph shows a badger.



Badgers act as a reservoir for the TB pathogen and can live for several years without showing any signs of TB. Some farmers want badgers to be culled (killed) to stop the spread of bovine TB to cattle.

However, some scientists claim that only a fraction of cattle catch TB from badgers, and that culling badgers could spread the disease to new areas. This is because badger culling changes the behaviour of the badgers that survive. Normally, badgers live in social groups and will defend their territory from other badgers by being aggressive. This territorial behaviour reduces the spread of disease between groups. If badgers are culled, then their territories cannot be defended. Surviving badgers could move in to occupy the undefended territory, bringing TB with them. This could spread TB to new animals and new areas.

Some people believe that badgers should be vaccinated to stop the spread of TB. However, there is some concern that vaccination may increase the spread of TB because it might also change badger behaviour.

An investigation is needed to find out if badger vaccination can reduce TB both in badgers and in cattle.

(a) Explain why cattle with damaged lungs have gas exchange problems (lines 2 to 3).

(2)

(b) Explain the advantage of drinking pasteurised milk rather than unpasteurised milk (lines 4 to 5).

(2)

(c) Suggest two reasons why there were fewer cases of bovine TB in Europe compared with outside Europe (lines 7 to 9).

(2)

1

2

(d) The case to death ratio in Europe is 12.5 : 1 (lines 7 to 9).

Calculate the case to death ratio from outside Europe.

(2)

case to death ratio = ...

(e) Territorial behaviour reduces the spread of disease between badger groups (lines 19 to 20).

Suggest two other ways that badgers benefit from territorial behaviour.

(2)

1 .....

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2 .....

.....

(f) Explain how vaccination reduces the risk of infection in badgers (line 24).

(3)

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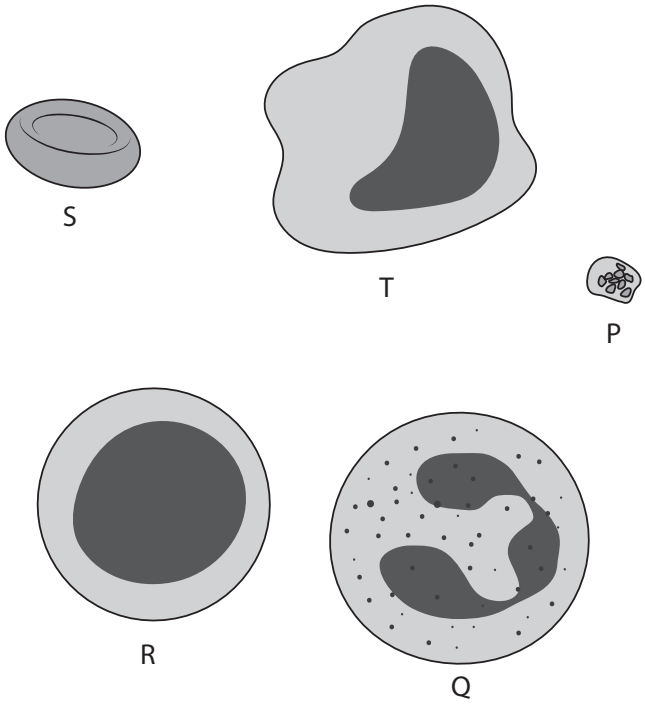
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(g) Describe how scientists could find out if badger vaccination reduces TB in cattle (lines 27 to 28).

(3)

(Total for Question 1 = 16 marks)

7 The diagram shows five components of human blood.



(a) (i) Which component is a red blood cell?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** S
- ☒ **D** T

(ii) Which component is a platelet?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** T

(iii) Which component is a lymphocyte?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(iv) Which mineral ion is found in haemoglobin?

(1)

- ☒ **A** calcium
- ☒ **B** iron
- ☒ **C** magnesium
- ☒ **D** sodium

(b) Some types of blood cells are involved in the human immune response.

Describe how the human immune system reacts to an infection.

(4)

(c) Scientists collect blood samples from two people.

One person does not have a blood condition and the other person has a blood condition.

The scientists count the number of platelets, phagocytes, lymphocytes, and red blood cells for each sample.

The table shows the scientists' results.

Blood component	Number of each component in 1 dm^3 of blood	
	person without blood condition	person with blood condition
platelets	2.5×10^{11}	2.5×10^{11}
phagocytes	5.5×10^{11}	1.2×10^{12}
lymphocytes	3.0×10^{11}	9.2×10^{11}
red blood cells	5.0×10^{12}	5.0×10^{12}

(i) Each blood sample has a volume of 2 mm^3.

Calculate the number of red blood cells in a 2 mm^3 sample of blood.

Give your answer in standard form.

[1 $dm^3 = 1 \times 10^6$ mm^3]

(3)

number = ...

(ii) Comment on the effects that the numbers of each blood component could have on the person with the blood condition.

Use the data in the table and your own knowledge to help with your answer.

(5)

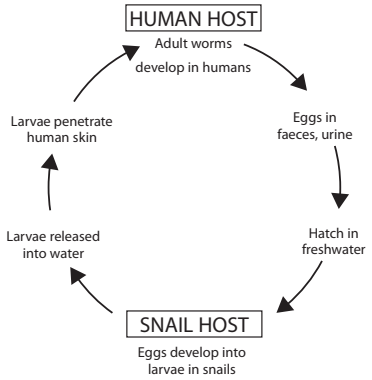
(Total for Question 7 = 16 marks)

1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Schistosomiasis

Schistosomiasis is an infection caused by a parasitic worm called a schistosome. The immature or larvae of the worm live in rivers and lakes in tropical parts of the world.

The diagram shows the life cycle of the schistosome worm.



Some people in tropical parts of the world use water from these rivers and lakes for their daily lives. These people risk infection because the larvae burrow into their skin. The larvae are then transported to other parts of the body where they damage organs such as the kidneys, intestines, lungs and brain. The larvae develop into adult worms.

The adult worms lay eggs in the human body. Some of these eggs are destroyed by the immune system, but most eggs survive. These eggs can get into water if faeces or urine from infected people pass into rivers or lakes. In the water, the eggs develop into small larvae which grow inside freshwater snails. Larvae are released from the snails and infect any person they contact. These larvae develop into adult worms inside the human body.

Doctors diagnose schistosomiasis when they find eggs in the faeces or urine of infected people. Infected people also have blood cells in their urine and antibodies for the pathogen in their blood.

At present, the drug praziquantel is used to kill the worms. A dose of 0.040 g per kg of body mass is usually effective. With no treatment, affected organs can be permanently damaged, leading to death. It is estimated that 240 million people (in the world) have schistosomiasis. Every year 8×10^{-4} per cent of infected people die from the disease.

A vaccine is being developed using a plasmid. The plasmid has DNA inserted that makes a protein found on the body surface of the adult schistosome worm.

In one investigation, a vaccine made using the DNA plasmid was given to a group of infected people. The results showed a mean number of 21.53 worms per person in this group. In the control group, a mean number of 40.53 worms per person was found.

(a) Which process is affected if kidneys are damaged (line 8)?

(1)

- ☒ **A** digestion
- ☒ **B** mutation
- ☒ **C** ultrafiltration
- ☒ **D** vaccination

(b) Suggest three ways to reduce the risk of being infected by schistosomes.

(3)

1 .....

.....

2 .....

.....

3 .....

.....

(c) Name two different blood cells that would be found in the urine of infected people (line 17).

(2)

1 .....

2 .....

(d) An infected person has a body mass of 120 kg.

What dose of drugs would be effective for this person (lines 19 to 20)?

(1)

- ☒ **A** 0.04 mg
- ☒ **B** 4.8 mg
- ☒ **C** 40 mg
- ☒ **D** 4800 mg

(e) Using the estimated number of people in the world who have schistosomiasis (lines 21 to 22), calculate the number of people who die each year from schistosomiasis.

(2)

number = ...

(f) Which of these is the correct description of a plasmid?

(1)

- ☒ **A** a circle of DNA
- ☒ **B** a circle of mRNA
- ☒ **C** a circle of protein
- ☒ **D** a circle of tRNA

(g) Explain how a vaccine could protect people from schistosomiasis (lines 24 to 25).

(3)

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(h) (i) Suggest what is given to the control group (lines 27 to 29).

(1)

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(ii) A scientist claims that the investigation proves the vaccine is effective against schistosomiasis (lines 27 to 29).

Comment on this claim.

(3)

(Total for Question 1 = 17 marks)

1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Making Enough Blood for the World

A blood transfusion is the transfer of blood from a donor into a patient. Blood transfusions are routine medical procedures that save the lives of millions of people every year.



(Source: beerkoff/Shutterstock)

The first successful blood transfusions were performed in the early twentieth century after scientists discovered that there are four main blood groups, A, B, AB and O. The blood groups are due to the presence of proteins, called antigens, on the surface of red blood cells. There are two main protein antigens called A and B. If a patient is given blood with antigens different to their own cells, their immune system will make antibodies against that antigen. The antigens present on the surface of red blood cells for each blood group are shown in the table.

Blood group	Antigens present
A	A
B	B
AB	A and B
O	neither A nor B

Currently, blood transfusions are carried out with blood that has been donated by healthy people. The World Health Organisation calculates that there are 118.5 million blood donations collected globally every year. Of these donations, 40% are collected from a small group of high-income countries. This means that there is a shortage of blood in many countries so the hunt is on to find an alternative.

Scientists have found a way to make artificial red blood cells. They made spheres of cell membranes filled with haemoglobin. These artificial cells are then suspended in sodium chloride solution. These artificial red blood cells have no proteins on their surface. Another way of making red blood cells is being developed in the United Kingdom. A research team has used stem cells to produce red blood cells with blood group O. The red blood cells produced are then suspended in sodium chloride solution.

Both methods produce large quantities of safe red blood cells. There may be other advantages as well, artificial blood would always have the same concentration of solutes and will not clot when stored. Critics have pointed out that the artificial blood will only transport oxygen and that blood has many more functions.

(a) Name the type of cell that produces antibodies. (Lines 8 and 9)

(1)

.....

(b) Human blood groups are controlled by three alleles, I^A, I^B and I^O. The I^A and I^B alleles are codominant and the I^O allele is recessive.

(i) State what is meant by the term **codominant**.

(1)

.....

.....

.....

(ii) Two parents have genotypes of I^AI^O and I^BI^O.

Which of these are all the possible blood groups of their children?

(1)

- ☒ **A** A and B
- ☒ **B** A, B and O
- ☒ **C** AB and O
- ☒ **D** A, B, AB and O

(c) Calculate the number of blood donations collected per year from the high-income countries. (Lines 14 and 15)

Give your answer in standard form.

(2)

(d) Some scientists have suggested that spherical artificial red blood cells transport oxygen less efficiently than normal human red blood cells.

Explain why the shape of the artificial red blood cells reduces the efficiency of oxygen transport compared to normal human red blood cells. (Lines 18 and 19)

(3)

(e) Suggest why artificial blood does not clot when stored. (Lines 26 and 27)

(1)

(f) Explain why the artificial red blood cells are suspended in sodium chloride solution instead of in water. (Line 20)

(2)

(g) (i) Explain why stem cells can be used to make large quantities of red blood cells. (Lines 22 and 23)

(2)

(ii) Suggest why the scientists made red blood cells with blood group O. (Lines 22 and 23)

(2)

(h) Give two substances found in blood plasma that are not present in the artificial blood. (Lines 28 and 29)

(2)

1 .....

2 .....

(Total for Question 1 = 17 marks)

1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Antitranspirants

Antitranspirants are substances applied to plants to reduce water loss. There are three types of antitranspirant, film-forming compounds, stomatal regulators and reflective compounds.

The first type of antitranspirant contains film-forming compounds. These compounds are oils or waxes that are mixed with water to form an emulsion. This emulsion is then sprayed onto the leaves of plants. The emulsion forms a physical barrier that covers the stomata. The film is designed to prevent water loss but allow gas exchange. Scientists have found that that the film-forming antitranspirant is effective in increasing yield and increasing photosynthesis in drought conditions. The increased leaf turgor in plants sprayed with film, compared to control plants, shows that the film decreases water loss and maintains turgor in drought conditions.

Film-forming antitranspirants are used in horticulture to reduce water stress. This can occur during storage, transport and planting of container grown plants. Application of the antitranspirant before transplanting, helps the plant survive until the root system is established. The film-forming compounds are used to reduce drying out in rolled turf and in transporting flowering plants and trees with root balls.

The second type of antitranspirants are stomatal regulators that reduce the size of the stomatal pore. Stomatal pores affect diffusion as well as transpiration. Therefore, photosynthesis and growth may change when stomatal regulators are applied to leaf surfaces. If the stomatal pores close completely this will stop photosynthesis. However, if stomatal openings are only reduced in size, transpiration will be reduced but some photosynthesis will continue.

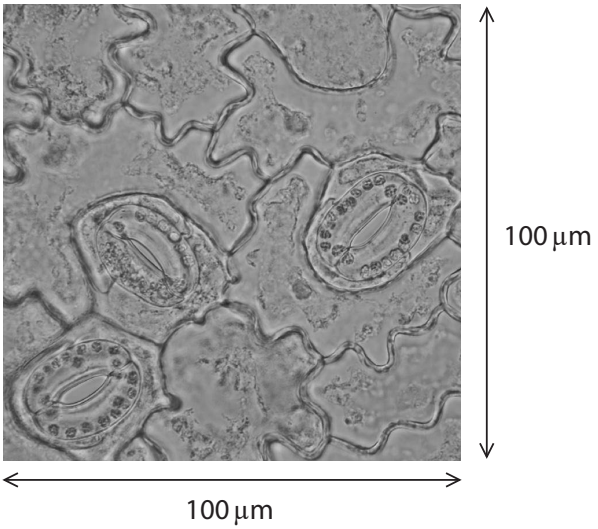
The third type of antitranspirants are reflective compounds. These work by adding a white coating to leaves. This changes the amount of light that is reflected by the leaf surface. The coating is only applied to the upper surface of leaves so does not block the stomatal pores. Coating a leaf with a reflective chemical can reduce leaf temperature, transpiration rate and also increase the efficiency of water use. Experiments show that transpiration rate can be reduced by up to 30% and leaf temperature reduced from 40 °C to 30 °C after a coating of reflective compound is applied to leaf surfaces.

Crops depend on photosynthesis for growth and final yield. Therefore, it is unlikely that currently available antitranspirants would increase the yield of a crop unless the crop suffers from a low water supply or very high rates of evaporation. Spraying film-forming or stomata regulating antitranspirants on a field-grown cereal crop under drought conditions, produced a grain yield increase of 17%. Experiments also show that any effect that antitranspirants have on the minerals supplied to the leaves has little effect on plant growth.

(a) Explain why plants that have been dug up and transported are at most risk of drying out (Lines 13 to 18).

(2)

(b) The photograph shows some stomata on a leaf surface.



(Source: © Dew_gdragon/Shutterstock)

Use the photograph to determine the number of stomata per mm^2 on this leaf surface.

[1 mm = 1000 µm]

(3)

number of stomata per mm^2 = ...

(c) Explain why stomatal regulators reduce photosynthesis (Lines 19 to 24).

(2)

(d) (i) Explain why reflective compounds should only be applied to the upper surface of a leaf (Lines 27 and 28).

(2)

(ii) Explain why reducing leaf temperature reduces transpiration rate (Lines 28 to 32).

(2)

(e) Describe the role of one named mineral ion in plant growth.

(2)

(f) Describe how water is transported from the soil to the leaves in plants.

(4)

(Total for Question 1 = 17 marks)

1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Heart transplant

A heart transplant is an operation to replace a damaged or failing heart with a healthy heart from a donor who has recently died. In the United Kingdom, 200 heart transplants are carried out each year.

A heart transplant may be considered if you have severe heart failure and medical treatments are not helping. Conditions that may eventually require a heart transplant include coronary heart disease and cardiomyopathy, where the walls of the heart have become stretched, thickened or stiff. Some people born with an abnormal heart may also benefit from a heart transplant.

A heart transplant needs to be carried out as soon as possible after a donor heart becomes available. The procedure is performed under general anaesthetic where the patient is unconscious. During the operation, a heart-lung bypass machine is used to keep the patient alive.

A cut is made in the middle of the patient's chest. The patient's heart is removed, leaving behind a section of the right and left atria, the two upper chambers of the heart. The new heart is connected to the aorta, the pulmonary artery, and the remaining part of the atria. The new heart is stimulated to start beating and the patient is taken off the bypass machine.

The patient will need to stay in hospital for around two or three weeks after a heart transplant. The patient will also need to take medicines called immunosuppressants for the rest of their life. Without these medicines, the transplant will not be successful.

After going home, the patient is encouraged to take part in a cardiac rehabilitation programme. This involves following an exercise plan to help regain strength and mobility. They should avoid strenuous activities such as pushing, pulling or lifting anything heavy for 6 to 12 weeks. Most people can start returning to many of their normal activities within a few months.

The patient does not usually need to have a special diet after a heart transplant. A balanced diet can ensure they stay as healthy as possible. They should not smoke and should avoid drinking alcohol.

A balanced diet may also help reduce the risk of some of the side effects of the immunosuppressant drugs including weight gain, osteoporosis and diabetes. Immunosuppressants also make the patient more vulnerable to infections, including food poisoning.

Most people can return to their normal activities after a heart transplant and experience a significant improvement in their symptoms for many years. After a heart transplant, 75% of people will live at least five years.

(a) Suggest why cardiomyopathy can cause heart failure (lines 6 to 7).

(1)

(b) During the transplant procedure the patient's heart is removed, leaving behind a section of the right and left atria.

Describe the functions of the atria in the body.

(3)

(c) Describe how the blood in the pulmonary artery differs from the blood in the aorta.

(2)

(d) Explain the function of the heart-lung bypass machine (lines 11 to 12).

(3)

(e) Explain why the patient needs to be given immunosuppressants (lines 19 to 20).

(2)

(f) Explain why patients should not smoke after their heart transplant (lines 28 to 29).

(2)

(g) State what is meant by the term **balanced diet**.

(1)

(h) Calculate the number of patients in the United Kingdom who have a heart transplant in one year that are still alive five years later (lines 2 to 3 and lines 35 to 36).

(2)

number of patients = ...

(i) Suggest why patients are advised to avoid strenuous activities after their heart transplant (line 24).

(1)

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(j) Suggest why patients are more likely to be at risk of food poisoning after their heart transplant (lines 32 to 33).

(1)

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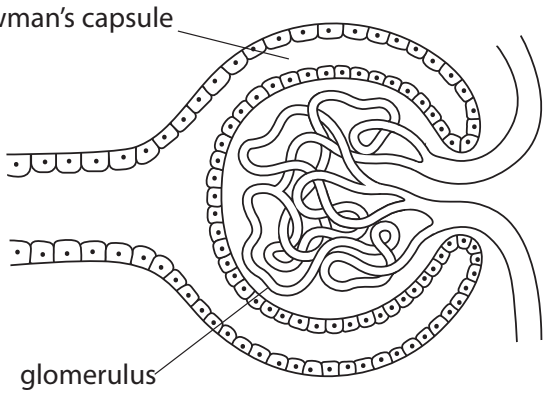
(Total for Question 1 = 18 marks)

SUB-TOPIC 2(i)

EXCRETION

18 questions in this sub-topic · 186 marks · lowest tariff first

3 The diagram shows part of a kidney nephron.



(a) Where is this part of a kidney nephron located?

(1)

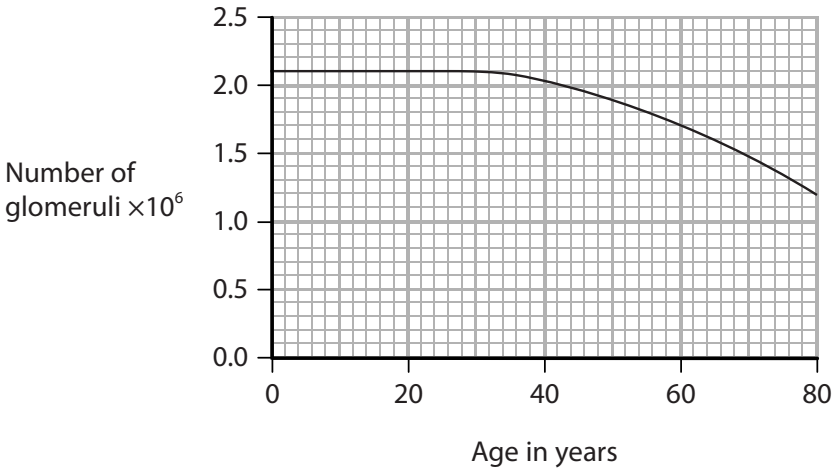
☒ **A** in the cortex

☒ **B** in the collecting duct

☒ **C** in the loop of Henle

☒ **D** in the medulla

(b) The graph shows the effect of age on the number of glomeruli in the kidneys.



Using the graph, determine the age of a person with 1 600 000 glomeruli in their kidneys.

(1)

age =..... years

(c) The table lists three molecules. It also gives their concentrations in the glomerulus, the Bowman's capsule and the bladder.

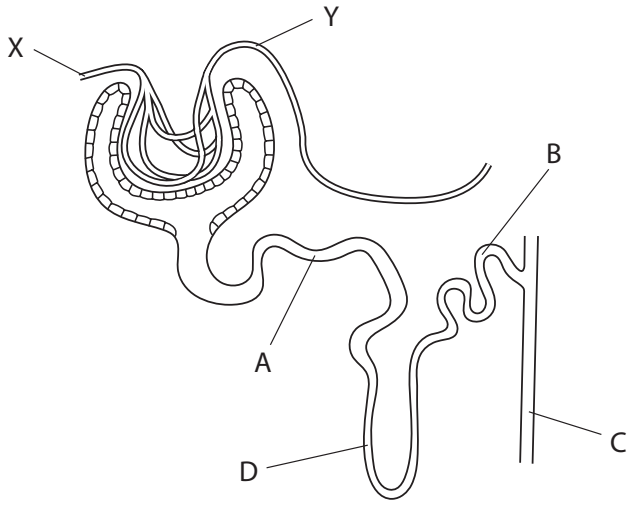
Molecule	Concentration in glomerulus (%)	Concentration in Bowman's capsule (%)	Concentration in bladder (%)
protein	8.00	0.00	0.00
glucose	0.10	0.10	0.00
urea	0.03	0.03	2.00

Explain the difference between the concentration of each substance in the glomerulus and in the bladder.

(4)

(Total for Question 3 = 6 marks)

3 The diagram shows part of a human nephron.



(a) Which structure is the proximal convoluted tubule?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b) The hollow space inside a blood vessel is called the lumen.

(i) The blood vessel labelled X has a lumen with a radius of 100 μm.

Use this formula to calculate the cross-sectional area, in mm^2, of the lumen of this blood vessel.

$$\text{area of circle} = \pi \times (\text{radius})^2$$

[$\pi = 3.14$]

[1 mm = 1000 μm]

(2)

cross-sectional area = ... mm^2

(ii) The lumen of blood vessel X is wider than the lumen of blood vessel Y.

Explain why this difference in the width of the lumen of the two blood vessels is important for kidney function.

(2)

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(c) Protein is often found in the urine of people who have high blood pressure.

Describe how urine could be tested for protein.

(2)

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(Total for Question 3 = 7 marks)

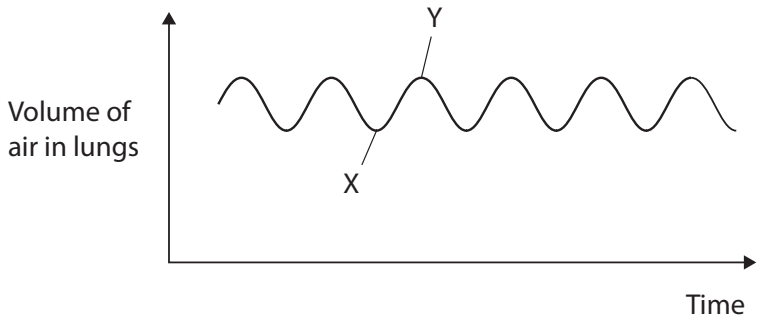
2 The lungs and the kidneys are excretory organs.

(a) (i) Which substances are excreted by the lungs?

(1)

- ☒ **A** carbon dioxide and urea
- ☒ **B** carbon dioxide and water
- ☒ **C** carbon dioxide, urea, and water
- ☒ **D** urea and water

(ii) The graph shows how the volume of air in the lungs changes over time.



Explain the change in volume of air in the lungs from point X to point Y.

(3)

(b) People with a condition called diabetes often have very high blood sugar.

Urine from people with diabetes attracts ants but urine from people without diabetes does not attract ants.

Ants are insects that are attracted to glucose.

Explain why people with diabetes produce urine that can attract ants.

(3)

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(Total for Question 2 = 7 marks)

7 The human kidney is an organ that is able to process excretory products from human metabolism.

(a) Concentration of urine is calculated using this formula.

$$\text{concentration in milliosmoles per dm}^3 = \frac{\text{amount of waste in milliosmoles}}{\text{volume in dm}^3}$$

The amount of waste the kidneys produce per day is 600 milliosmoles.

The maximum concentration that the human kidneys can produce is 1400 milliosmoles per dm^3.

Calculate the minimum volume of urine that must be produced each day.

Give your answer in cm^3.

(2)

minimum volume = ... cm^3

(b) Name another organ that carries out excretion in the human body.

(1)

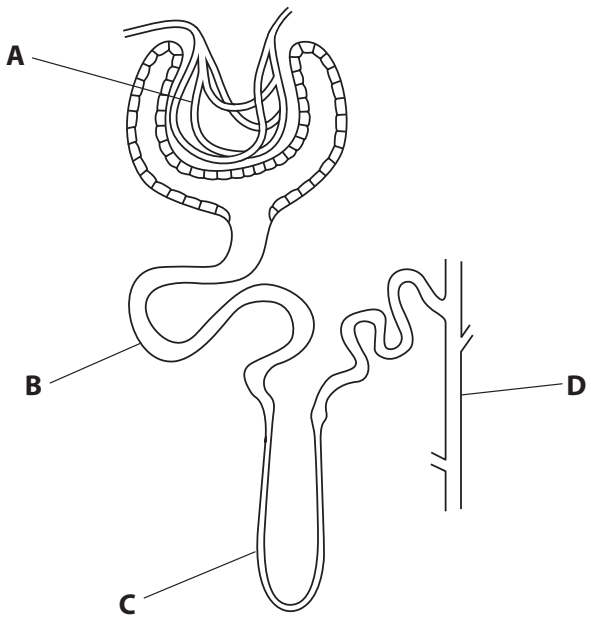
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(c) Explain the role of the nephron in osmoregulation.

(5)

(Total for Question 7 = 8 marks)

4 The diagram shows a nephron from a human kidney, with parts labelled A, B, C and D.



(a) Use the diagram and your knowledge of kidney function to answer these questions.

(i) Where does ultrafiltration take place?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) Where does reabsorption of glucose take place?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(iii) Which part responds to a change in ADH?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b) A kangaroo rat is a mammal that lives in hot desert regions of America.

(i) In kangaroo rats, the tissue surrounding the collecting duct contains a high concentration of ions.

Explain how this feature enables kangaroo rats to survive in the desert.

(3)

(ii) Kangaroo rats stay underground during the day and only come out to feed at night.

Explain how this behaviour enables kangaroo rats to survive in the desert.

(2)

(iii) Kangaroo rats rarely drink water.

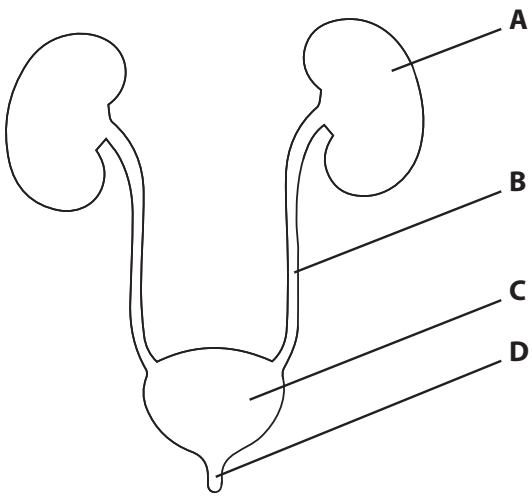
Suggest where they get their water from.

(1)

(Total for Question 4 = 9 marks)

2 The urinary system is used in excretion.

The diagram shows the urinary system with parts labelled A, B, C and D.



(a) Which part of the urinary system contains nephrons?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b) The urinary system produces urine.

Name a substance found in urine.

(1)

.....

(c) A scientist uses this method to investigate the effect of drinking different liquids on urine production.

- drink 600 cm^3 of water in the morning
- measure the volume of urine produced during the next two hours
- drink 600 cm^3 of 0.8 % salt (NaCl) solution at the same time the following morning
- measure the volume of urine produced during the next two hours

The table shows the scientist's results.

Liquid	Volume of urine produced during two hours in cm^3
water	560
salt solution	254

(i) Explain the scientist's results.

(5)

(ii) Give **two** other factors that affect the volume of urine produced.

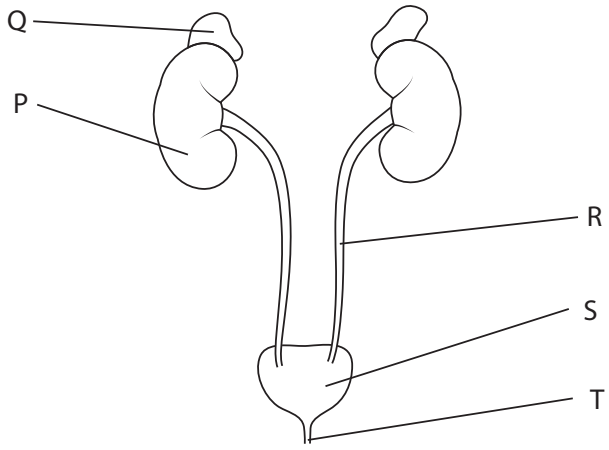
(2)

1 .....

2 .....

(Total for Question 2 = 9 marks)

6 The diagram shows some structures in the human abdomen.



(a) Which structure is used to store urine?

(1)

- ☒ **A** organ P
- ☒ **B** organ Q
- ☒ **C** organ R
- ☒ **D** organ S

(b) Which structure produces adrenaline?

(1)

- ☒ **A** organ P
- ☒ **B** organ Q
- ☒ **C** organ R
- ☒ **D** organ S

(c) (i) Identify two substances that would be carried in structure R.

(2)

1 .....

2 .....

(ii) Tube T is used for excretion and reproduction in males, but only for excretion in females.

Explain this difference in function.

(2)

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(d) The volume and concentration of urine produced varies depending on the water content of the body.

Explain how very warm weather results in a change in the concentration and volume of the urine.

(4)

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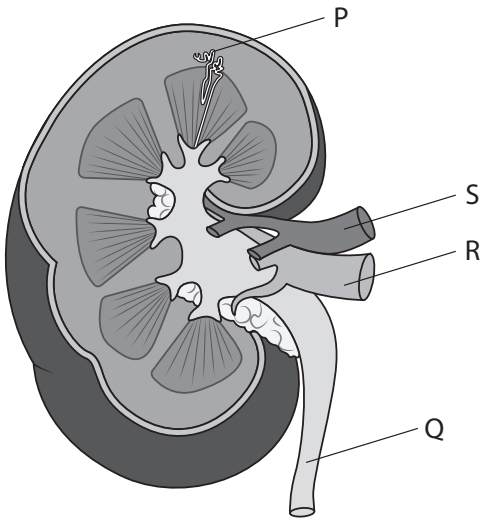
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(Total for Question 6 = 10 marks)

2 The diagram shows a section through a human kidney with some structures labelled.



(a) (i) Which structure is labelled P in the diagram?

(1)

- ☒ **A** bladder
- ☒ **B** nephron
- ☒ **C** ureter
- ☒ **D** urethra

(ii) Which fluid is carried in tube S?

(1)

- ☒ **A** bile
- ☒ **B** blood
- ☒ **C** filtrate
- ☒ **D** urine

(iii) Which tube is labelled Q in the diagram?

(1)

- ☒ **A** renal artery
- ☒ **B** renal vein
- ☒ **C** ureter
- ☒ **D** urethra

(b) Analysis of the composition of urine can be used in the diagnosis of problems with kidney function.

Urine samples are taken from three patients and the results are shown in the table.

Patient	Glucose	Water content of urine	Protein
W	absent	normal	present
X	present	normal	absent
Y	absent	very high	absent

(i) Discuss which processes in the kidney may be affected to produce the results shown.

Include in your answer where in the nephron the processes occur.

(5)

(ii) Describe how to test for glucose in a sample of urine.

(2)

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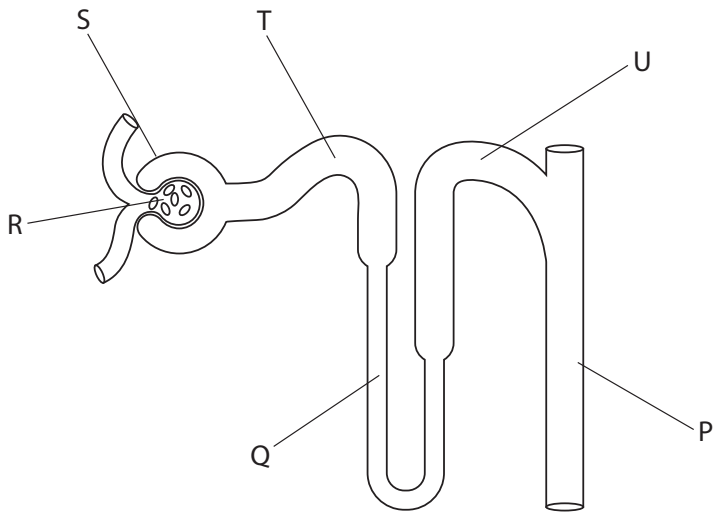
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(Total for Question 2 = 10 marks)

3 The diagram shows a nephron from a human kidney with some structures labelled.



(a) (i) Which structure is the Bowman's capsule?

(1)

- ☒ **A** P
- ☒ **B** R
- ☒ **C** S
- ☒ **D** T

(ii) Which structure is the loop of Henle?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** S
- ☒ **D** U

(iii) Which structure is affected by ADH?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** S
- ☒ **D** T

(b) (i) Blood plasma contains much glucose, but urine normally does not.

Explain what happens to glucose in the kidney.

(3)

(ii) Describe how a sample of urine could be tested for glucose.

(2)

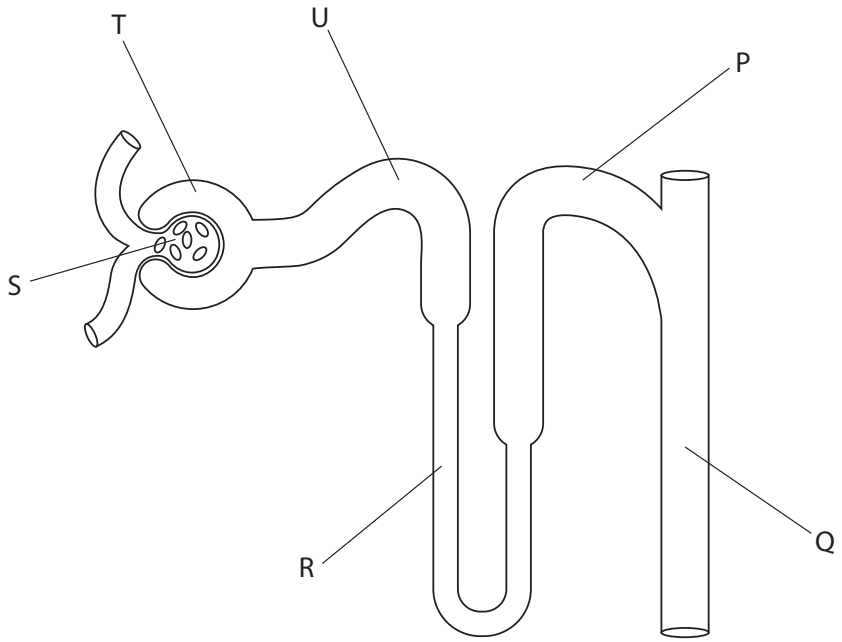
(c) As a person sweats, they may become dehydrated.

Describe the changes in a person's urine if they become dehydrated.

(2)

(Total for Question 3 = 10 marks)

6 The diagram shows a nephron from a human kidney with some structures labelled.



(a) (i) Which of these is structure U?

(1)

- ☒ **A** Bowman's capsule
- ☒ **B** collecting duct
- ☒ **C** loop of Henle
- ☒ **D** proximal convoluted tubule

(ii) Which process occurs between structure S and structure T?

(1)

- ☒ **A** ADH production
- ☒ **B** selective reabsorption
- ☒ **C** transpiration
- ☒ **D** ultrafiltration

(iii) Which structure is the collecting duct?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** S
- ☒ **D** T

(b) The table shows the concentrations of protein and glucose in blood plasma, in glomerular filtrate and in urine.

Substance	Concentration of substance in grams per 100 cm^3		
	blood plasma	glomerular filtrate	urine
protein	8.0	0.0	0.0
glucose	0.1	0.1	0.0

(i) Calculate the mass of glucose in 5 dm^3 of blood plasma.

(2)

[1000 cm^3 = 1 dm^3]

mass = ... grams

(ii) Explain why there is **no** protein in the urine.

(2)

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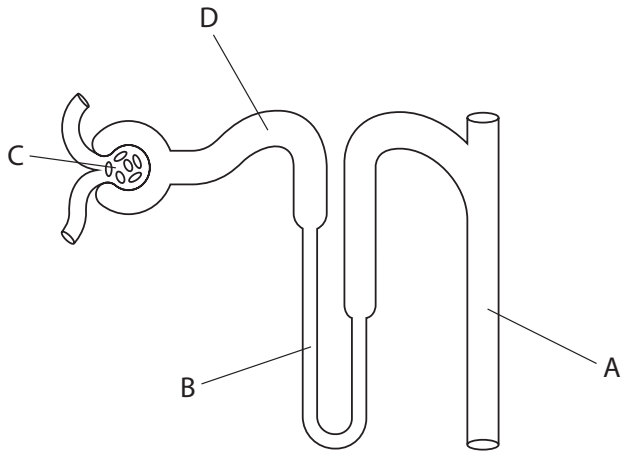
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(iii) Explain why there is glucose in the glomerular filtrate but **no** glucose in the urine.

(3)

(Total for Question 6 = 10 marks)

6 The diagram shows a nephron of a kidney, with some of the structures labelled.



(a) (i) From which structure are substances forced out of the blood by ultrafiltration?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) From which structure is glucose reabsorbed into the blood by selective reabsorption?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(b) In homeostasis, the kidney is involved in the control of blood concentration.

(i) State the name for the control of blood concentration.

(1)

.....

(ii) Another function carried out by the kidney is excretion.

State what is meant by the term excretion.

(1)

.....

(c) Diabetes insipidus is a medical condition in which the body is unable to produce ADH.

Explain how diabetes insipidus affects the control of blood concentration.

(4)

(d) Desmopressin is a drug used to reduce the symptoms of diabetes insipidus.

(i) Suggest what effect the drug would have on the nephron.

(1)

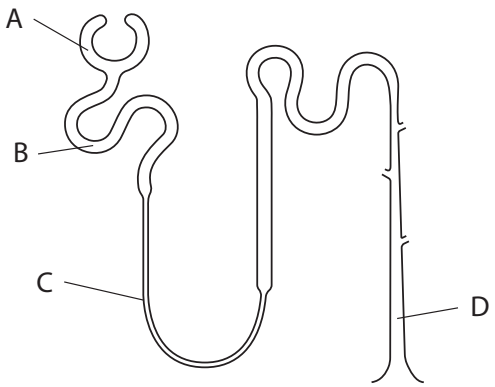
(ii) Describe the effects the drug would have on urine production.

(2)

(Total for Question 6 = 11 marks)

3 The kidney contains nephrons involved in osmoregulation and excretion.

The diagram shows a nephron.



(a) Which part is the Bowman's capsule?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) The table gives the mass of three substances transported in part A and in part D for all kidney nephrons during one day.

Substance	Mass of substance in g	
	part A	part D
glucose	180	0
water	180 000	1500
urea	53	25

(i) Explain the change in the mass of glucose from part A to part D.

(3)

(ii) Calculate the percentage reabsorption of water by kidney nephrons.

(2)

percentage = ... %

(iii) A substance containing nitrogen is broken down in the liver to produce urea.

Which substance is broken down to produce urea?

(1)

- ☒ **A** fat
- ☒ **B** glucose
- ☒ **C** protein
- ☒ **D** water

(c) A drug called MDMA increases the secretion of ADH.

Explain how this increase affects urine production.

(4)

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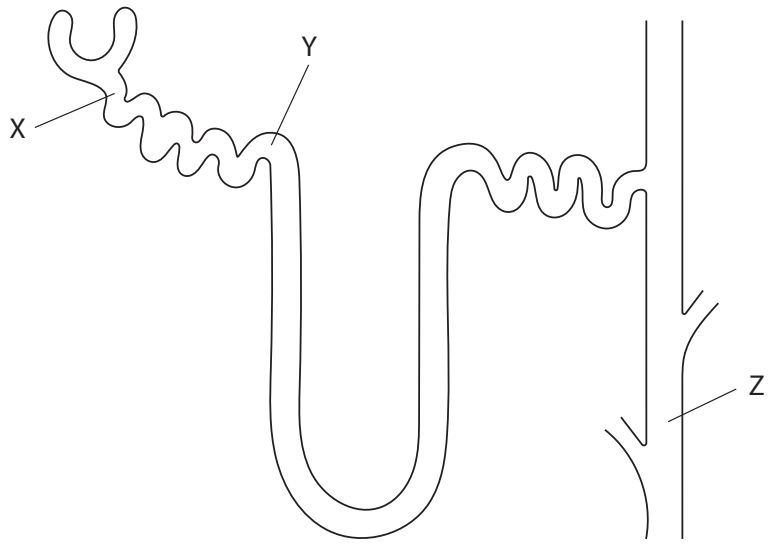
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(Total for Question 3 = 11 marks)

5 The diagram shows a nephron from a kidney with three different areas, X, Y and Z.



The table gives the concentration of glucose and urea at X, Y and Z.

Area of nephron	Concentration of glucose in mg per 100 cm^3	Concentration of urea in mg per 100 cm^3
X	90	32
Y	0	440
Z	0	1700

(a) Explain the difference in concentration of glucose between X and Y.

(3)

(b) (i) Calculate how many times more concentrated the urea is in area Z compared to area Y.

Give your answer to two significant figures.

(2)

answer = ...

(ii) Explain the difference in urea concentration in the filtrate found in Y and Z.

(2)

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(c) High blood pressure during pregnancy can result in the production of urine that contains protein.

(i) Describe how a sample of urine could be tested to see if it contains protein.

(2)

(ii) Protein is not normally found in urine.

Suggest why high blood pressure could cause protein to be present in urine.

(2)

(Total for Question 5 = 11 marks)

4 Chocolate contains small amounts of a substance called theobromine.

In high amounts, theobromine is poisonous to animals.

The table shows the mass of theobromine per kg of body mass that is poisonous for five different species.

Species	Mass of theobromine per kg of body mass in mg
cat	200
dog	300
mouse	837
human	1000
rat	1265

(a) (i) The mass of theobromine per kg that is poisonous differs between species.
Compare the poisonous effect in cats and rats.

(2)

(ii) A small bar of chocolate contains 200 mg of theobromine.

Explain why eating chocolate bars is unlikely to poison a man of mass 70 kg.

Include a calculation in your answer.

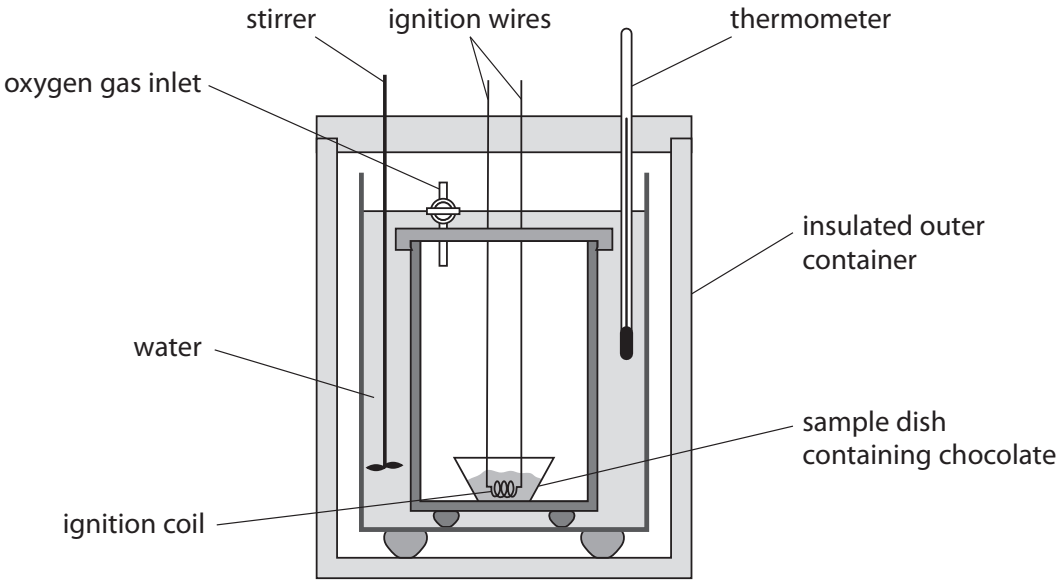
(2)

(b) Theobromine prevents the release of ADH.

Explain why preventing the release of ADH can be harmful to humans.

(4)

(c) The diagram shows a calorimeter, which is used to measure the energy content of a food sample.

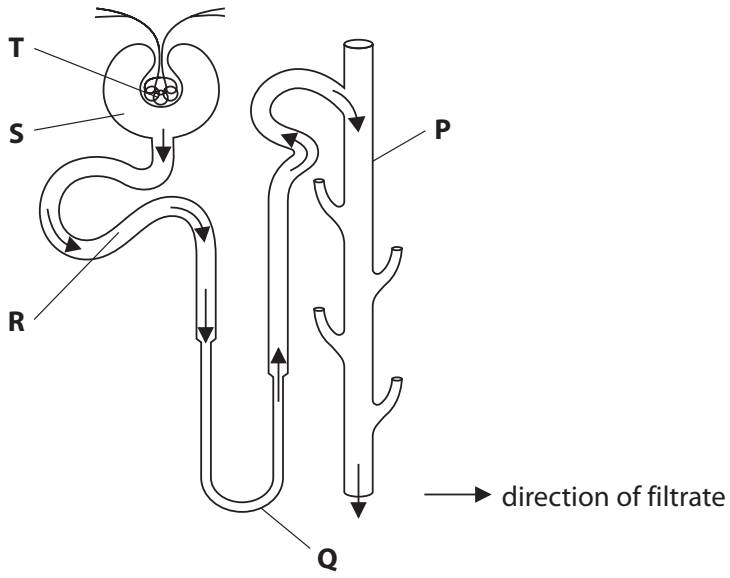


Explain the measurements and the calculations you would use to compare the energy content of milk chocolate and dark chocolate.

(4)

(Total for Question 4 = 12 marks)

5 The diagram shows part of a human nephron, with parts labelled P, Q, R, S and T.



(a) (i) What is the name of part P?

(1)

- ☒ **A** collecting duct
- ☒ **B** glomerulus
- ☒ **C** proximal convoluted tubule
- ☒ **D** renal artery

(ii) Where does ultrafiltration occur?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** T

(iii) Where is permeability affected by ADH?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(iv) Where is glucose selectively reabsorbed into the blood?

(1)

- ☒ **A** Q
- ☒ **B** R
- ☒ **C** S
- ☒ **D** T

(b) Scientists investigate the relationship between birth mass and the number of nephrons in the kidney.

The scatter diagram shows their results.



(i) Describe the relationship shown by the scatter diagram.

(2)

(ii) Babies born with low birth mass are more likely to develop high blood pressure when they become adults.

Explain why protein in the urine of these adults may be an indication of kidney damage caused by high blood pressure.

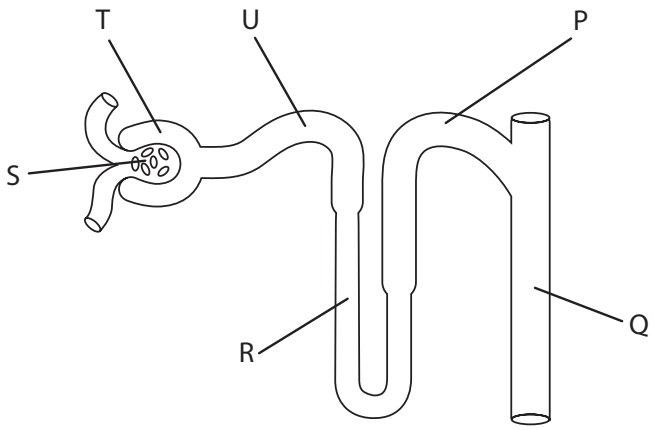
(4)

(iii) Describe a simple test to show that a urine sample contains protein.

(2)

(Total for Question 5 = 12 marks)

2 The diagram shows a nephron from a human kidney.



(a) (i) From which structure does ultrafiltration take place?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(ii) From which structure is glucose reabsorbed?

(1)

- ☒ **A** Q
- ☒ **B** R
- ☒ **C** S
- ☒ **D** U

(iii) Which structure is the loop of Henle?

(1)

- ☒ **A** P
- ☒ **B** R
- ☒ **C** S
- ☒ **D** U

(b) The table gives the mean values of mass filtered per day and excreted per day for different plasma components that are filtered and reabsorbed in the nephron.

Plasma component	Mass filtered per day in g	Mass excreted per day in g	Percentage reabsorbed
water	180 000	1800	99.0
sodium	630	3.0	99.5
glucose	180	0	100.0
urea	54		44.0

(i) State what is meant by plasma components.

(1)

.....

.....

(ii) Calculate the mean mass of urea excreted per day.

(2)

mean mass of urea = ... g

(iii) Explain why glucose is reabsorbed in the nephron.

(2)

.....

.....

.....

.....

.....

(iv) The concentration of urine is determined by the volume of water present and the mass of dissolved substances.

A person eats a meal with a high protein and salt content and drinks a small volume of water.

Comment on how this may change the values in the table and the effect it will have on urine production.

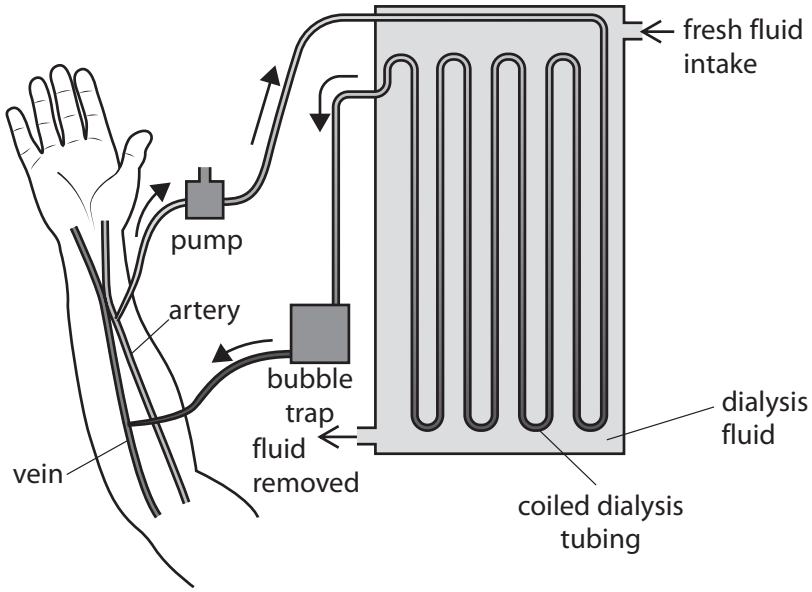
(5)

(Total for Question 2 = 13 marks)

1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Treating Kidney Disease

Chronic kidney disease affects approximately 12% of the world's population and many people are unable to obtain treatment. One method of treating chronic kidney disease is by dialysis. The diagram shows how kidney dialysis is done.



During dialysis, blood is taken from an artery in the arm and is pumped through a dialyser. In the dialyser, the blood passes through a long, coiled dialysis tube made of a thin partially permeable membrane. The tube is surrounded by dialysis fluid. The dialysis fluid contains glucose and ions at concentrations normally found in blood plasma, but does not contain urea. The urea passes from the blood into the dialysis fluid. The temperature in the dialyser is kept at 40 °C. After passing through the dialyser, the blood is returned to a vein in the arm. Kidney dialysis can take up to three hours and must be done three times a week.

Scientists have now designed a new bioartificial kidney. This artificial kidney is a combination of engineering and living cells. This artificial kidney has a haemofilter made from artificial membranes that filter the blood. The substances filtered out of the blood then pass through a device called a bioreactor. This bioreactor absorbs useful substances back into the blood. The bioreactor is made of living nephron cells that are grown from stem cells. These cells are separated from the patient's blood by a silicon membrane to prevent the immune system rejecting them. Bioartificial kidneys are the same size as a human kidney and will be fitted inside the body to replace a kidney. The bioartificial kidney can react to changes in the body in the same way as a normal kidney.

(a) In 2021, the world's population was 7 900 000 000.

Calculate the number of people in the world who have chronic kidney disease (Lines 1 and 2).

Give your answer in standard form.

(2)

number of people = ...

(b) Urea is an excretory product that is released by the kidneys.

Give the name of an excretory product that is released by the lungs.

(1)

.....

(c) Explain two ways that the dialyser is designed to increase the rate of removal of urea from the blood (Lines 5 to 11).

(4)

1 .....

.....

.....

.....

2 .....

.....

.....

.....

(d) (i) The haemofilter in the bioartificial kidney filters the blood (Lines 13 and 14).

Where does ultrafiltration occur in a nephron?

(1)

- ☒ **A** Bowman's capsule
- ☒ **B** collecting duct
- ☒ **C** distal convoluted tubule
- ☒ **D** loop of Henle

(ii) The cells in the bioreactor absorb glucose from the filtrate in a way that is similar to the cells in a nephron (Lines 14 to 17).

Describe how the nephron absorbs glucose back into the blood from the filtrate.

(2)

.....

.....

.....

.....

(iii) The bioartificial kidney is connected to blood vessels and to the tube that transports urine to the bladder in the same way as the human kidney.

Which row of the table is correct?

(1)

		Blood vessel bringing blood into bioartificial kidney	Tube transporting urine to bladder
☒	**A**	renal artery	ureter
☒	**B**	renal artery	urethra
☒	**C**	renal vein	ureter
☒	**D**	renal vein	urethra

(e) Explain how the pituitary gland and the nephron cells in the bioreactor will respond in a patient who is dehydrated (Lines 20 and 21).

(3)

(Total for Question 1 = 14 marks)

1 Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Kidney transplants

The main role of the kidneys is to filter waste products from the blood. If the kidneys lose this ability, waste products can build up, which could lead to death. This loss of kidney function, known as kidney failure, is the most common reason for needing a kidney transplant.

It is possible to use a kidney machine to partially perform the functions of the kidney, using a blood filtering procedure known as dialysis. However, this can be inconvenient and it takes a long time. A kidney transplant is a better solution for kidney failure whenever possible.

A kidney transplant is suitable for people of all ages who need to have one, if they are fit enough for surgery. If a patient has an infection this will need to be cured before the transplant. The person who receives the transplant must agree to continue with the recommended treatments after the transplant. These treatments include taking medication known as immunosuppressant drugs.

People have two kidneys, but they can survive well with only one kidney. This means it is possible for a person to donate a kidney while they are alive. This is known as a living donation. People who want to be considered as a living donor are carefully tested to make sure they are a suitable donor and are fit for the operation needed to remove a kidney. Living donations are best from a close relative as this reduces the risk of the body rejecting the kidney. In the United Kingdom, the number of living donations in 2020 was 1040. In 2021 the number of living donations was 429.

Kidney donations are also possible from people who have recently died. This is known as deceased kidney donation. However, this type of kidney donation has a slightly lower chance of long-term success. In the United Kingdom, the number of deceased donations in 2020 was 2283. In 2021 the number of deceased donations was 1836.

People who need a kidney transplant, but do not have a suitable living donor, will have to wait until a suitable deceased donor kidney becomes available. In the United Kingdom, the average waiting time for a deceased donor kidney transplant is between 30 months and 36 months.

Kidney donors are particularly required from people of non-white ethnic origin, as kidney disease is more common in people of South Asian, African and Afro-Caribbean ethnic origin. However, there are not many donors from these communities.

When a person receives a kidney from a living donor, this is a carefully planned operation. If they are waiting for a deceased donor kidney, they will be contacted when a suitable kidney becomes available. The patient then has surgery to insert the new kidney and connect it to their blood vessels and bladder. The new kidney will be placed in the lower part of the abdomen. The patient's own failed kidneys will usually be left in place.

(a) State two waste products that kidneys remove from the blood. (Line 1)

(2)

1 .....

2 .....

(b) Dialysis can be inconvenient and takes a long time. (Lines 6 and 7)

Suggest two other reasons why a kidney transplant is a better solution for kidney failure than dialysis.

(2)

1 .....

.....

2 .....

.....

(c) The patient receiving the transplant must take immunosuppressive drugs after the operation. These drugs reduce the action of the immune system. (Lines 12 and 13)

Describe how the immune system responds to disease.

(3)

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(d) Explain why the chances of rejection are lower if the kidney comes from a close relative. (Lines 18 and 19)

(2)

.....

.....

.....

.....

(e) The number of donations changed between 2020 and 2021. (Lines 20 and 21 and lines 25 and 26)

(i) Calculate the difference between the percentage change in **living** donations from 2020 to 2021 and the percentage change in **deceased** donations from 2020 to 2021.

(3)

difference = ...

(ii) Suggest a reason why there are fewer transplant operations from living donors than from deceased donors.

(1)

.....

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.....

(f) Suggest what is meant by a suitable kidney. (Line 37)

(1)

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.....

.....

.....

(g) Explain why kidney donors are particularly required from people of South Asian, African and Afro-Caribbean ethnic origin. (Lines 32 to 34)

(2)

.....

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.....

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(Total for Question 1 = 16 marks)

SUB-TOPIC 2(j)

COORDINATION AND RESPONSE

24 questions in this sub-topic · 232 marks · lowest tariff first

3 The passage describes how plants respond to stimuli.

Complete the passage by writing a suitable word in each blank space.

(6)

Plant responses to directional stimuli are known as ..... .

Plant shoots respond to light coming from one direction by growing

..... the light. This is known as a positive

..... response. It is caused when a plant growth substance

called ..... diffuses away from the light. This increases the

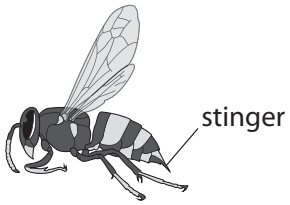
rate of growth on the side of the shoot furthest away from the light.

Shoots also respond to ..... . This is known as

a ..... geotropic response.

(Total for Question 3 = 6 marks)

11 The diagram shows an insect called a wasp.



Wasps kill their prey by injecting a poison called venom through a small tube called a stinger.

Some scientists believe that the smell of venom attracts other wasps.

Design an investigation to find out if the smell of venom attracts other wasps.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 11 = 6 marks)

11 The photograph shows a small animal called a woodlouse.



(Source: paulrommer. Shutterstock/PAL)

Woodlice often live under pieces of dead wood in dark, humid conditions.

Design an investigation to find out if light intensity affects the speed at which woodlice move.

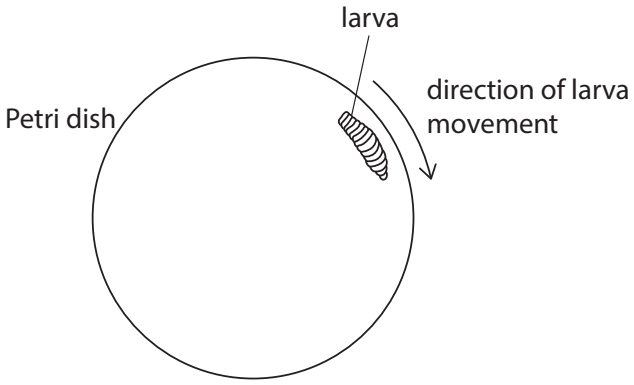
Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 11 = 6 marks)

10 Fly larvae will continuously move around the edge of a Petri dish when placed under a lamp.

The diagram shows a fly larva in a Petri dish.



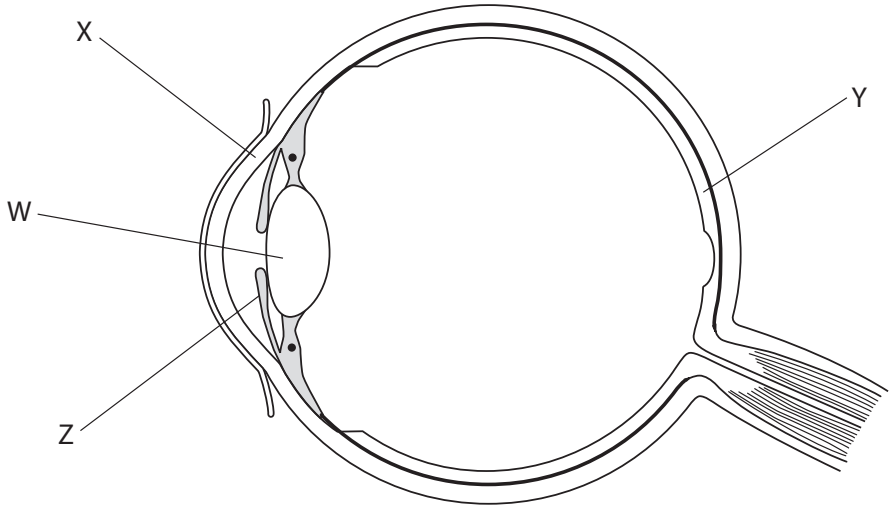
Design an investigation to find out if changing the colour of light from the lamp affects the speed that the larvae move.

Include experimental details in your answer and write in full sentences.

(6)

(Total for Question 10 = 6 marks)

2 The diagram shows a section through an eye with some parts labelled.



(a) Name parts W, X and Y.

(3)

W .....

X .....

Y .....

(b) Describe how structure Z changes when a person moves into a dark room.

(3)

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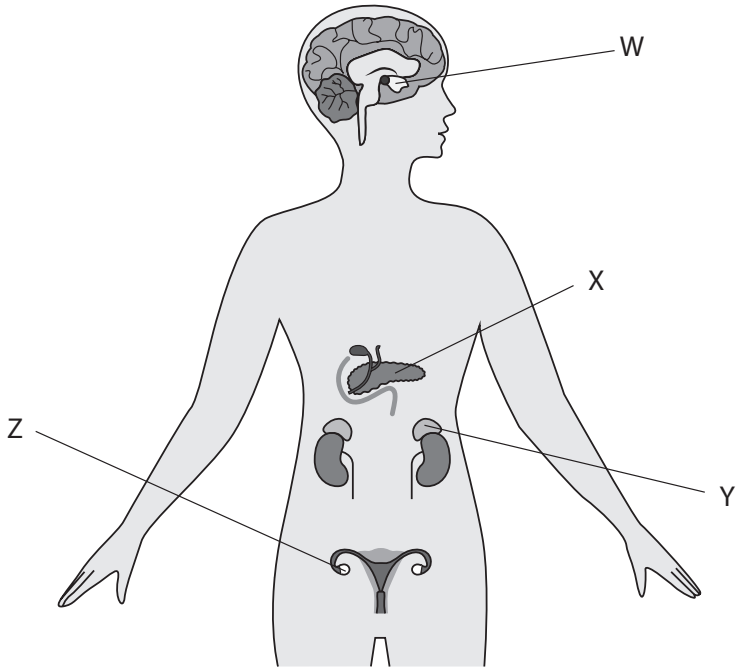
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(Total for Question 2 = 6 marks)

2 The diagram shows the position of some hormone producing glands in the female body.



(a) Which of these structures is the adrenal gland?

(1)

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

(b) The adrenal gland is an organ that secretes adrenaline.

State what is meant by the term **organ**.

(1)

.....

.....

(c) Adrenaline is released into the blood when there is danger.

The list gives the effects of adrenaline on different parts of the body.

- dilates the pupil in the eye
- increases heart rate
- narrows small arteries in the intestine
- converts glycogen into glucose in the liver

Explain the advantages of these effects to a person in danger.

(5)

(Total for Question 2 = 7 marks)

6 The following passage is about chemical coordination in animals and plants.
Complete the passage by writing a suitable word in the blank space.

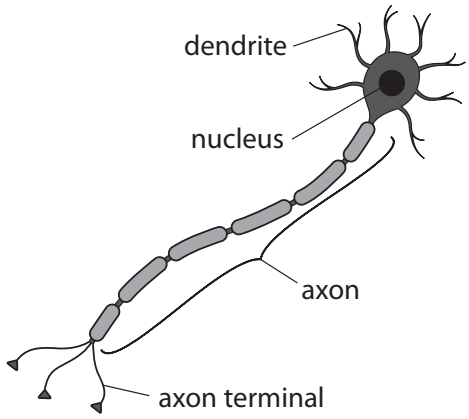
Animals and plants use chemicals to coordinate responses. In animals, some glands produce hormones which are transported in the ..... of the blood. A high glucose concentration in the blood stimulates the release of a hormone called ..... from the ..... . This causes an organ called the ..... to remove glucose from the blood and store it as a substance called ..... .

Plant shoots grow towards light. This response is called ..... . The movement of a chemical called ..... to the shaded side of the shoot causes the shoot to grow towards the light.

(Total for Question 6 = 7 marks)

6 Neurones transmit nerve impulses.

The diagram shows a neurone.



(a) This neurone is involved in the withdrawal reflex of a finger from a hot object.

The neurone transmits electrical impulses from the central nervous system to the effector.

(i) Draw a circle on the diagram to show the part of the neurone where the impulses are transferred to the effector.

(1)

(ii) What is the name of this type of neurone?

(1)

- ☒ **A** association
- ☒ **B** motor
- ☒ **C** relay
- ☒ **D** sensory

(iii) Explain the advantage of a withdrawal reflex when a finger touches a hot object.

(2)

.....

.....

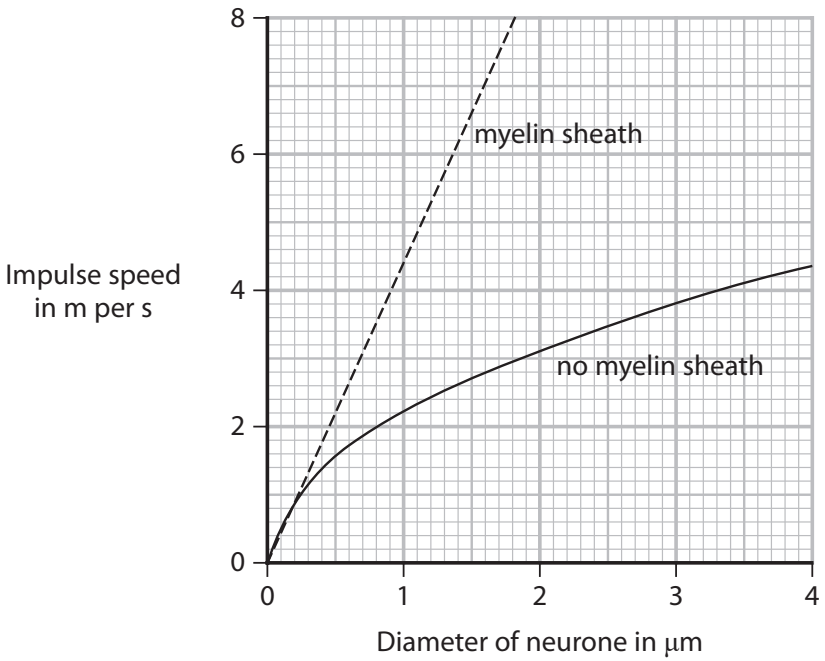
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(b) Some neurones do not have a myelin sheath.

A scientist investigates the impulse speed for neurones with different diameters. She does this for neurones with a myelin sheath and neurones without a myelin sheath.

The graph shows the scientist's results.



(i) Which conclusion is supported by the graph?

(1)

- ☒ **A** impulses are always faster in neurones with a myelin sheath
- ☒ **B** neurones always have a myelin sheath
- ☒ **C** wider neurones have a myelin sheath
- ☒ **D** wider neurones have faster impulses

(ii) A neurone with a myelin sheath has a diameter of 1.0 µm.

Use the graph to determine the speed of an impulse in this neurone.

(1)

speed = ... m per s

(iii) The neurone is 90 cm long.

Calculate the time taken for an impulse to travel along this neurone.

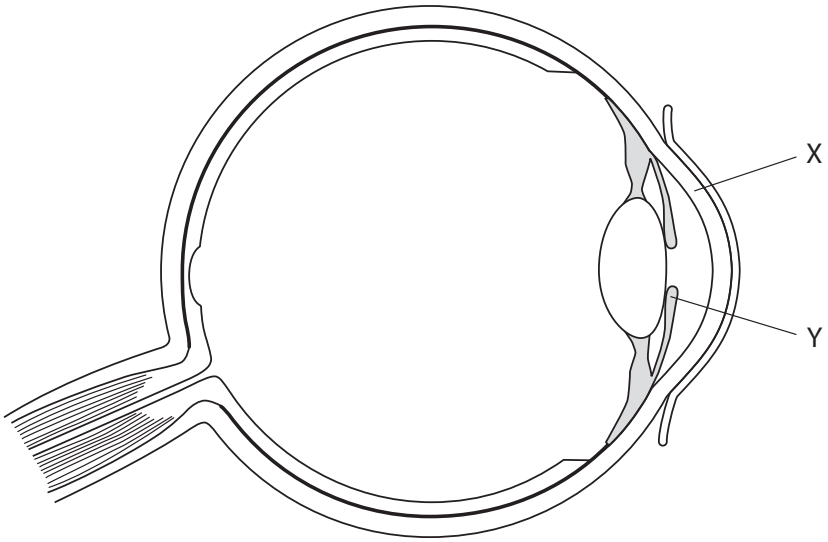
Give your answer in standard form.

(3)

time = ... s

(Total for Question 6 = 9 marks)

2 (a) The diagram shows the structure of a human eye.



(i) Which of these is the structure labelled X?

(1)

- ☒ **A** conjunctiva
- ☒ **B** cornea
- ☒ **C** lens
- ☒ **D** retina

(ii) When looking at a close object, which row of the table shows the state of the ciliary muscles and suspensory ligaments?

(1)

	Ciliary muscles	Suspensory ligaments
☒ **A**	contracted	loose
☒ **B**	contracted	tight
☒ **C**	relaxed	loose
☒ **D**	relaxed	tight

(iii) Explain how structure Y controls the light entering the eye when someone walks into a dark room.

(2)

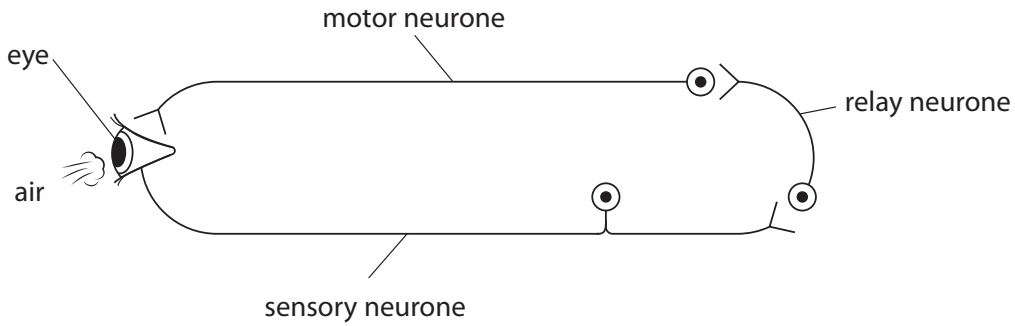
(b) Multiple sclerosis is a condition that can slow down the speed at which electrical impulses travel along neurones.

The time taken for the blink reflex to occur can be used to help diagnose if someone has multiple sclerosis.

The blink reflex causes the eyelid to close.

Air is blown on to the eye and the time taken for the eyelid to close is recorded.

The diagram shows the reflex pathway.



The speed the impulse moves along the reflex arc consisting of all three neurones in a person without multiple sclerosis is 77 metres per second.

The time taken for the blink reflex to occur in a person with multiple sclerosis is 0.0050 s.

The total length of the neurones in the reflex arc for the person with multiple sclerosis is 25 cm.

(i) Calculate the difference between the speed of impulse for the person with multiple sclerosis and for the person without multiple sclerosis, in metres per second.

(3)

..... m / s

(ii) The speed of an impulse along the axon of the motor neurone for someone without multiple sclerosis is 120 metres per second.

Suggest why the speed of the impulse calculated along all three neurones is less than the speed of the impulse along only the motor neurone.

(2)

.....

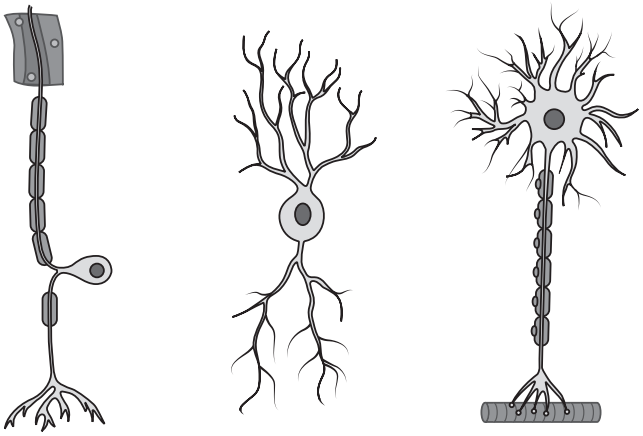
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(Total for Question 2 = 9 marks)

10 (a) The diagram shows three types of neurone.



A B C

(i) Give the names of these neurones.

(3)

A .....

B .....

C .....

(ii) Explain the role of these neurones in the withdrawal reflex of a finger from a hot object.

(3)

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(b) A teacher uses this method to estimate the speed of a nerve impulse.

- students stand in a circle and hold hands
- student A in the circle starts a timer and at the same time squeezes the hand of student B on his left
- when student B feels his hand being squeezed, he immediately squeezes the hand of the student on his left
- this process continues around the circle of students until student A feels his hand being squeezed and he stops the timer

(i) Explain what other measurements the teacher would need to make in order to calculate the speed of a nerve impulse.

(2)

(ii) Describe whether the teacher's method is likely to give an accurate estimate of the speed of a nerve impulse.

(2)

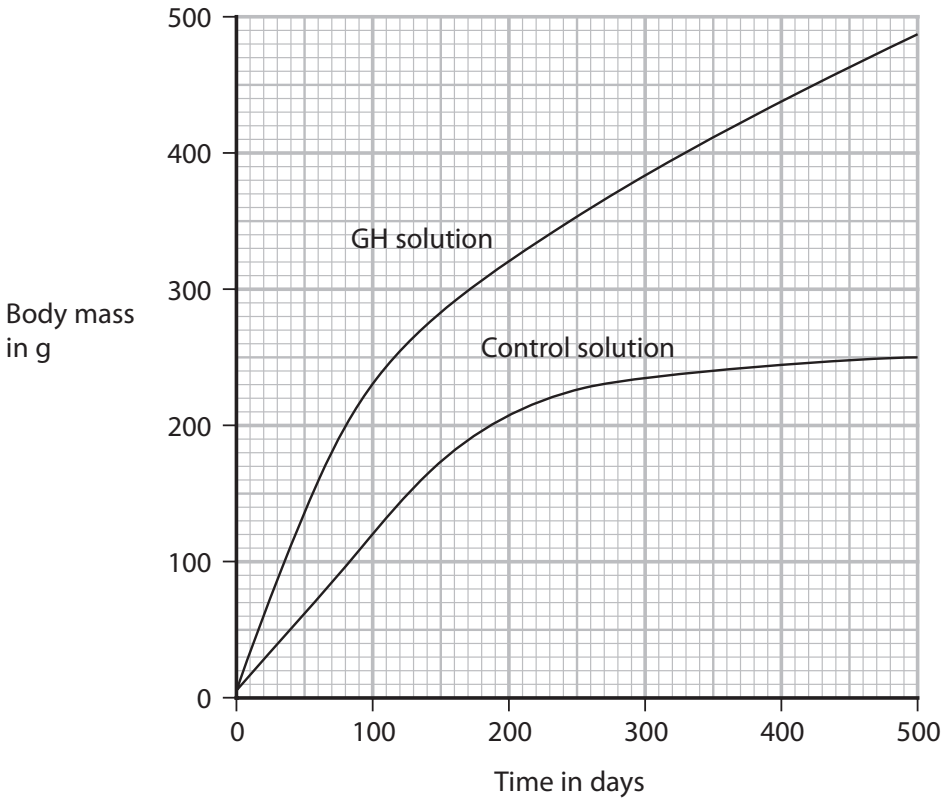
(Total for Question 10 = 10 marks)

4 A scientist investigates the effect of growth hormone (GH) on the body mass of rats.

This is his method.

- give one rat a GH solution every day for 500 days
- give another rat a control solution every day for 500 days
- measure the mass of each rat each week for 500 days

The graph shows his results.



(a) Suggest how the control solution differs from the GH solution.

(1)

.....

.....

(b) Calculate the average rate of growth of the rat given GH solution from 100 days to 500 days.

Give your answer in g per day.

(2)

rate of growth = ... g per day

(c) The scientist controlled all the variables in his investigation.

Suggest two abiotic variables he controls.

(2)

1 .....

2 .....

(d) The scientist repeats his investigation using more rats.

Explain why using more rats improves his investigation.

(2)

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(e) GH increases transcription in cells.

Explain why this affects the growth of rats.

(3)

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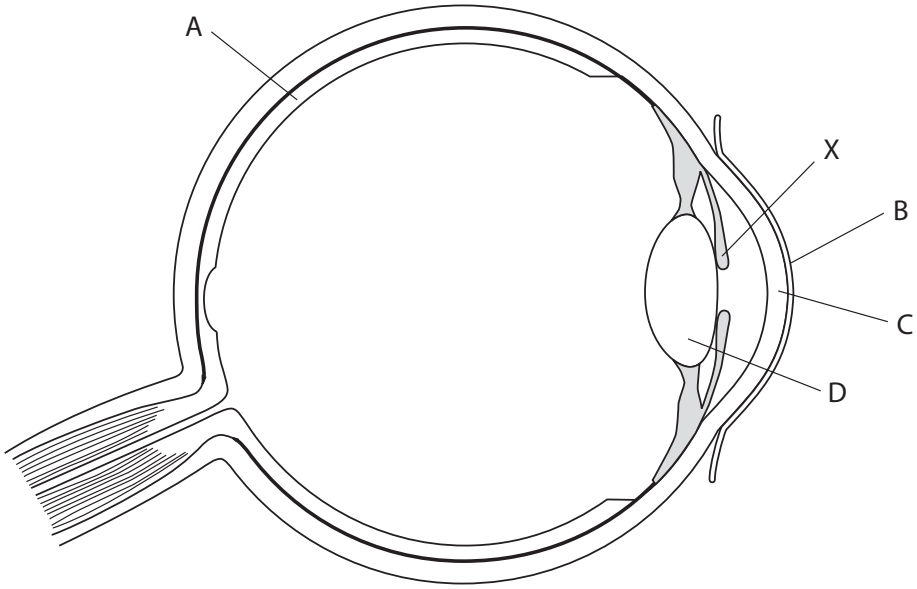
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(Total for Question 4 = 10 marks)

2 (a) The diagram shows a human eye.



(i) Which labelled structure is the cornea?

(1)

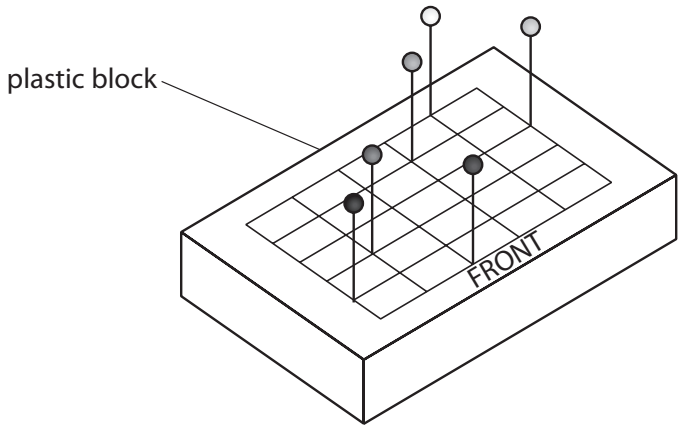
- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) Explain the changes in structure X as a person moves from a room where the light is dim to a room where the light is bright.

(2)

(b) A student investigates if using one eye or using two eyes is better for judging the distance of objects.

The student uses the plastic block shown in the diagram. The block has a grid where six different coloured pins can be placed as shown in the diagram.



This is the student's method.

- place one pin into the lines of each column and row so that each pin is a different distance from the front of the grid
- ask a volunteer to close one eye
- hold the grid in front of the volunteer so they can see the coloured pins but not the grid
- ask the volunteer to call out the colour of the pins in order of distance, from nearest to furthest
- record the number of pins that the volunteer identifies correctly
- repeat eight more times, each time moving the pins to different positions in the grid

The student does the experiment again with both eyes open.

(i) Give the independent variable for the student's investigation.

(1)

.....

.....

(ii) Give one variable that the student should control.

(1)

.....

(iii) Table 1 shows the student's results.

Complete Table 2 by determining the mode and the median for the data shown in Table 1.

(2)

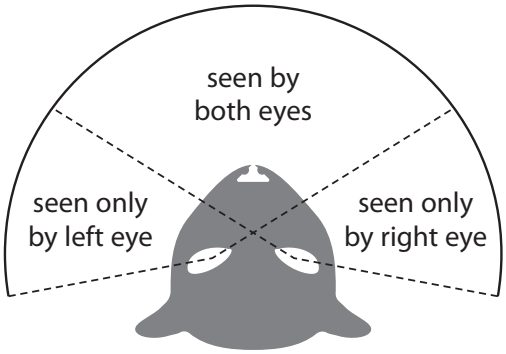
Trial number	Number of correctly identified pins	
	Using one eye	Using both eyes
1	1	6
2	1	6
3	3	4
4	0	6
5	2	6
6	2	6
7	3	3
8	3	4
9	0	6

Table 1

	Number of correctly identified pins	
	Using one eye	Using both eyes
Mode		
Median		

Table 2

(iv) The field of view is the area that an animal can see with their eyes.
The diagram shows the field of view for a cat.



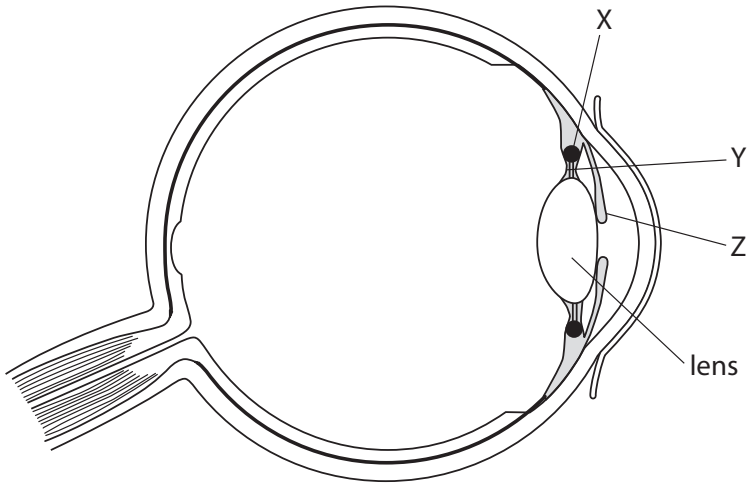
Explain why predators, such as cats, have two forward facing eyes.

Use the information in the diagram and Table 2 to support your answer.

(3)

(Total for Question 2 = 10 marks)

10 The diagram shows the structure of a human eye.



(a) (i) Give the name of structure Z.

(1)

.....

(ii) Describe how structures X and Y control the shape of a lens when focusing on a near object.

(3)

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(b) A cataract occurs when the lens becomes cloudy.

Severe cataracts are the main cause of blindness around the world.

(i) Explain why people with cataracts are unable to see clearly.

(2)

.....

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(ii) Exposure to ultraviolet light is thought to be a risk factor for the development of cataracts.

The table shows the results of a 25-year investigation into the effect of different mean hours of sunlight on agricultural workers in one south Asian country.

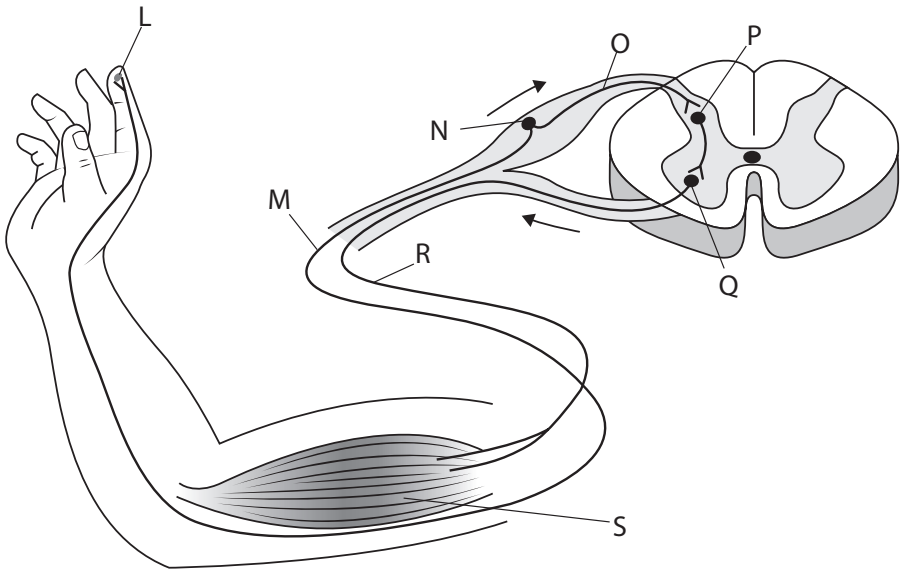
Mean daily hours of exposure to sunlight	Number of people in group	Number of people who develop cataracts
7	100	2
8	270	5
9	350	7
10	580	9
11	440	14
12	540	35

Comment on the results of the investigation.

(4)

(Total for Question 10 = 10 marks)

6 The diagram shows a human reflex arc with some structures labelled. It is the withdrawal reflex, which allows a person to remove their hand from a hot object quickly.



(a) (i) Which structure is the sensory receptor?

(1)

- ☒ **A** L
- ☒ **B** P
- ☒ **C** Q
- ☒ **D** S

(ii) Which structure is the cell body of the relay neurone?

(1)

- ☒ **A** L
- ☒ **B** N
- ☒ **C** M
- ☒ **D** P

(iii) Which structure is the motor neurone?

(1)

- ☒ **A** L
- ☒ **B** M
- ☒ **C** R
- ☒ **D** S

(iv) Which structure is the effector?

(1)

- ☒ **A** L
- ☒ **B** M
- ☒ **C** Q
- ☒ **D** S

(b) A nerve impulse travels at 50 metres per second.

(i) Calculate the time taken for an impulse to travel 180 cm.

(2)

time = ... seconds

(ii) The length of the nerve pathway in the withdrawal reflex arc is 180 cm.

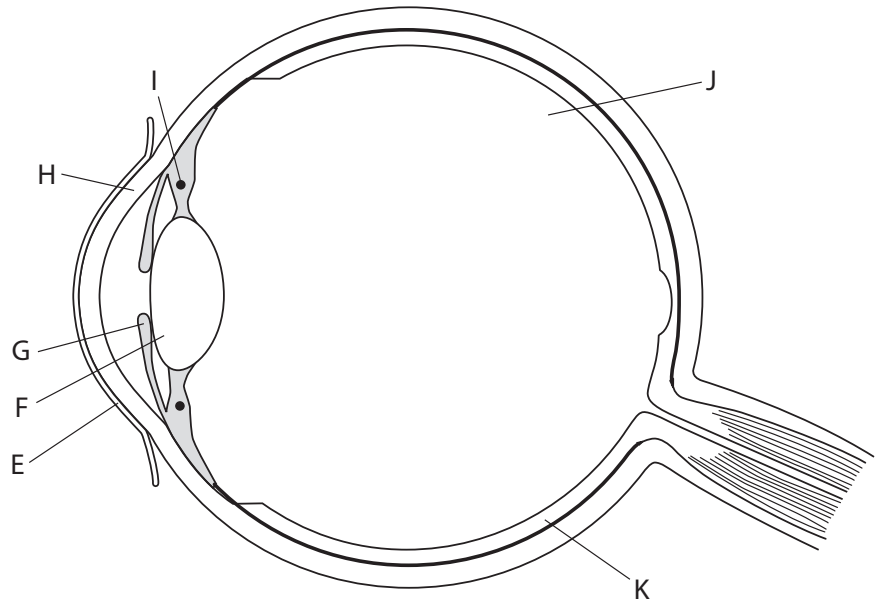
The time a person takes to remove their hand away from a hot object is called the response time.

Explain why the actual response time is different from the time taken for a nerve impulse to travel 180 cm.

(4)

(Total for Question 6 = 10 marks)

4 The diagram shows a section through a human eye with some structures labelled.



(a) (i) Which structures refract light onto the retina?

(1)

- ☒ **A** E and J
- ☒ **B** F and H
- ☒ **C** G and K
- ☒ **D** I and J

(ii) Which structure controls the amount of light reaching the retina?

(1)

- ☒ **A** E
- ☒ **B** F
- ☒ **C** G
- ☒ **D** H

(iii) Which structure contains light sensitive cells?

(1)

- ☒ **A** H
- ☒ **B** I
- ☒ **C** J
- ☒ **D** K

(b) The eye can focus on near objects and distant objects.

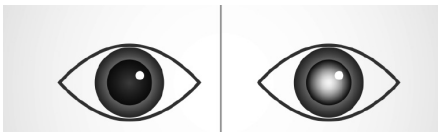
Describe the changes that take place in the eye when it focuses on a near object.

(4)

(c) Some people develop cataracts in their lenses as they get older.

The diagram shows how a cataract changes the appearance of a person's eye.

CATARACTS



Normal

Eye with Cataract

(Source: © iLoveCoffeeDesign / Shutterstock)

(i) Explain how cataracts affect a person's vision.

(2)

.....

.....

.....

.....

.....

.....

(ii) The treatment for a person with cataracts is to remove the affected lenses.

Suggest what additional treatment is needed for the person.

(1)

.....

.....

.....

(Total for Question 4 = 10 marks)

8 The body has a hormonal control system that coordinates some of the body's responses.

(a) The table shows the effects of some of the hormones and the gland that produces each hormone.

Complete the table by giving the missing information.

(4)

Effect	Name of hormone	Name of gland
converts blood glucose into glycogen		pancreas
stimulates the development of male secondary sexual characteristics		
increases heart rate	adrenaline	
maintains the uterus lining		

(b) Plants also respond to changes in their environment.

(i) Explain how plants benefit from the responses of their roots and stems to the direction of light they receive.

(4)

(ii) In many plants, flowering is stimulated by the number of hours of daylight.

Suggest why flowering in many plants is stimulated by the number of hours of daylight rather than by temperature.

(2)

(Total for Question 8 = 10 marks)

10 (a) Animals produce hormones to communicate between cells.

(i) Which hormone causes the development of secondary sexual characteristics in girls?

(1)

- ☒ **A** adrenaline
- ☒ **B** oestrogen
- ☒ **C** progesterone
- ☒ **D** testosterone

(ii) Which hormone causes an increased blood flow to the muscles during exercise?

(1)

- ☒ **A** adrenaline
- ☒ **B** insulin
- ☒ **C** progesterone
- ☒ **D** testosterone

(iii) Which of these is a correct statement about hormones?

(1)

- ☒ **A** they always produce short-term changes
- ☒ **B** they are carried by neurones
- ☒ **C** they are transported in the plasma
- ☒ **D** they always produce a rapid response

(b) Plants produce plant growth substances such as auxin.

Suggest why some biologists do not consider auxin to be a hormone.

(2)

.....

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.....

(c) Plant growth substances stimulate root growth from a cut stem.

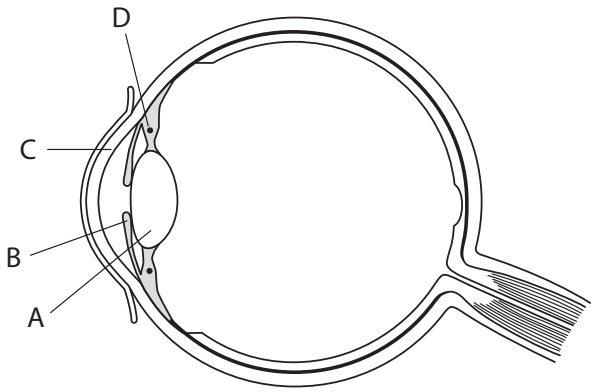
Describe an investigation to find the best concentration of plant growth substance to stimulate root growth.

You should include experimental details in your answer and write in full sentences.

(6)

(Total for Question 10 = 11 marks)

11 The diagram shows a section through the human eye.



(a) (i) Describe the role of structures A, C and D in focusing light from a near object onto the retina.

(4)

(ii) Bright light can damage the retina.

Explain how a reflex involving structure B protects the retina from this damage.

(3)

(b) There are tear glands that release liquid into the eye.

This liquid contains an enzyme called lysozyme that breaks down cell walls.

(i) Suggest why the liquid contains lysozyme.

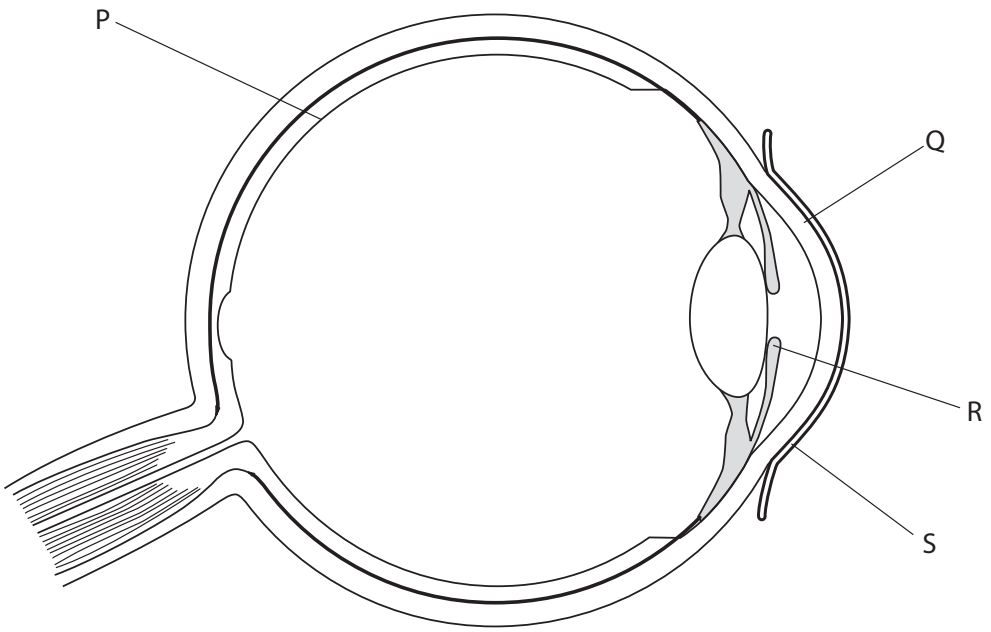
(2)

(ii) Suggest why the liquid is maintained at pH 7

(2)

(Total for Question 11 = 11 marks)

3 The diagram shows a human eye with some structures labelled.



(a) Which structure is the retina?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(b) A teacher investigates the effect of light intensity on pupil diameter.

This is the teacher's method.

- cover a student's eyes with a mask
- set the light intensity in the room to a low level
- remove the mask and wait 20 seconds
- record an image of the student's pupil and iris with a camera
- measure the diameter of the pupil on the image using a ruler
- repeat two more times at the same light intensity

The teacher repeats the experiment at different light intensities.

The table shows the teacher's results.

Light intensity in arbitrary units	Diameter of pupil in mm			
	test 1	test 2	test 3	mean
1	8.1	8.4	8.2	
2	7.8	7.5	7.4	7.6
3	3.5	3.2	3.6	3.4
4	2.1	2.2	2.2	2.2
5	2.2	2.1	1.9	2.0

(i) Calculate the mean pupil diameter for the light intensity of 1 arbitrary unit.

Give your answer to two significant figures.

(2)

mean pupil diameter ..... mm

(ii) With reference to data in the table, **describe** the effect of increasing light intensity on the diameter of the pupil.

(2)

(iii) **Explain** the effect of increasing light intensity on the diameter of the pupil.

(3)

(iv) State one variable that the teacher should control.

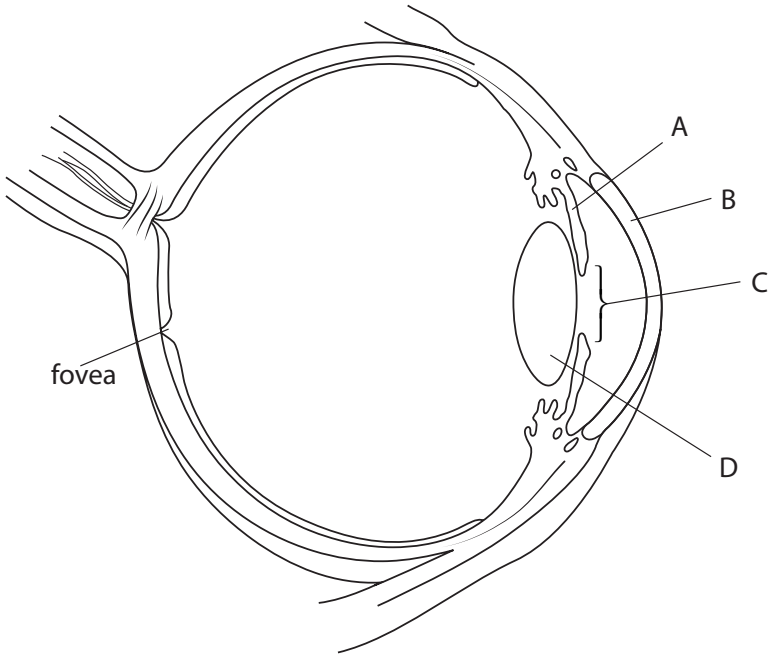
(1)

(v) Explain how the teacher's method ensures that the measurement of the pupil diameters are accurate.

(2)

(Total for Question 3 = 11 marks)

8 The diagram shows a section through the human eye.



(a) Name the structures labelled A, B, C and D.

(4)

A .....

B .....

C .....

D .....

(b) When a person looks directly at an object, light is focused on the fovea of the retina.

(i) A person is reading a book and then looks at a distant object.

Explain the changes that occur in the structures of the eye that allow light from the distant object to be focused on the fovea.

(4)

(ii) Some people develop a condition called age-related macular degeneration (AMD).

This occurs when cells in the fovea of the retina are damaged.

Suggest how AMD affects vision.

(2)

(iii) Scientists are developing a new treatment for AMD. The treatment involves an operation to replace the damaged cells in the fovea with new cells.

Early results show an improvement in the condition. However, the treatment has only been tested on two patients.

Suggest what else scientists need to do before the treatment is allowed to be used for all patients with AMD.

(2)

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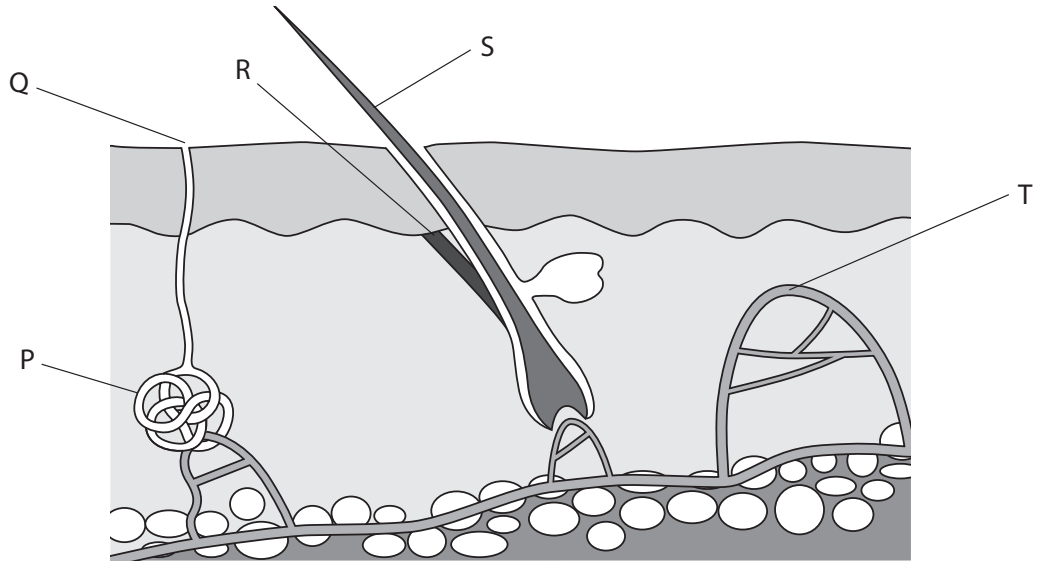
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(Total for Question 8 = 12 marks)

4 (a) The diagram shows a section through the skin with some structures labelled.



(i) Which structure is the sweat gland?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** S
- ☒ **D** T

(ii) Which structure is a capillary?

(1)

- ☒ **A** Q
- ☒ **B** R
- ☒ **C** S
- ☒ **D** T

(iii) Describe the changes that take place in the blood vessels in the skin if a person moves to a hot environment.

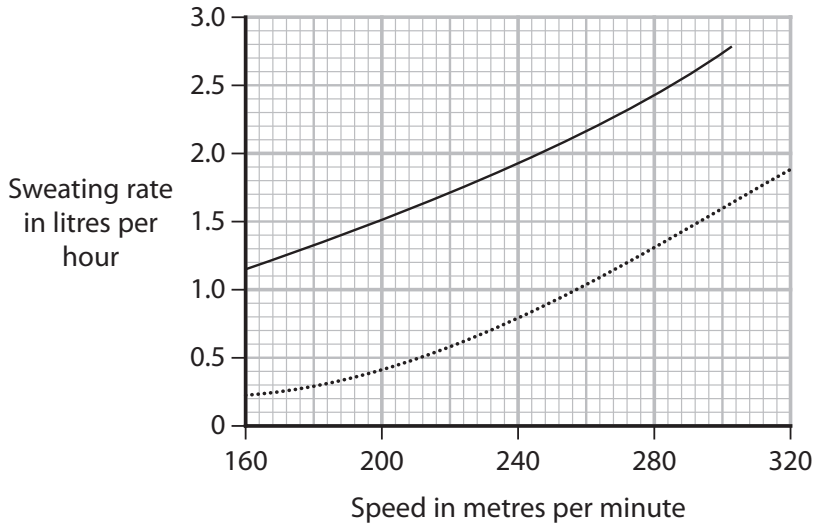
(3)

(b) Scientists investigate the release of sweat from human skin when a person runs at different speeds.

They measure the rate of sweating in litres per hour.

They take measurements in two environments. The first environment is hot and humid, and the second environment is cool and dry.

The graph shows the scientists' results.



(i) Give the dependent variable in this investigation.

(1)

.....

(ii) A person runs at a speed of 220 metres per minute in hot and humid conditions.

Calculate the volume of sweat the person releases in 15 minutes.

(3)

volume = ... litres

(iii) Using information from the graph, discuss the effect of increased running speed on sweating in the two environments.

(4)

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(Total for Question 4 = 13 marks)

10 Humans can control their internal environment.

(a) State the term used to describe the control of an organism's internal environment.

(1)

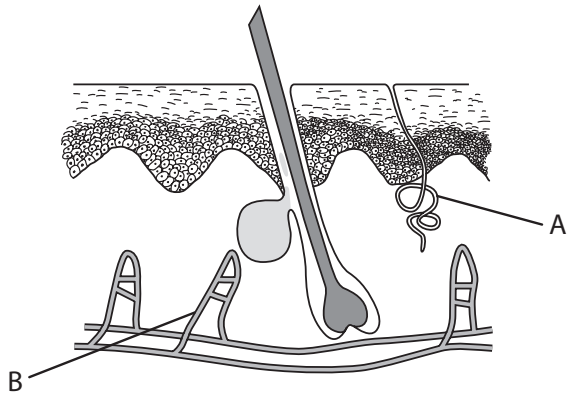
(b) Coordination uses hormones and nerves.

Some responses are simple reflex arcs.

Describe the structure and functioning of the withdrawal reflex of a finger from a hot object.

(4)

(c) Humans use their skin to regulate their body temperature. The diagram shows a section through the skin with two structures labelled A and B.



Changes take place in the skin when a person moves from a warm environment to a cold environment.

(i) Explain the changes that take place in structure A as a person enters a cold environment.

(2)

(ii) Explain the changes that take place in structure B as the person enters a cold environment.

(3)

(d) Modern humans have less body hair than their ancestors.

Explain how this evolutionary change was brought about by natural selection.

(4)

(Total for Question 10 = 14 marks)

8 Reflexes are responses that protect the body and involve the central nervous system (CNS).

(a) (i) Give the name of one part of the CNS.

(1)

.....

(ii) If an animal steps on a sharp object, a reflex arc occurs so that it picks up its foot to prevent further damage.

Describe how named neurones bring about a withdrawal reflex to protect the animal from damage.

(4)

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(b) The photograph shows a breed of dog called a border collie.



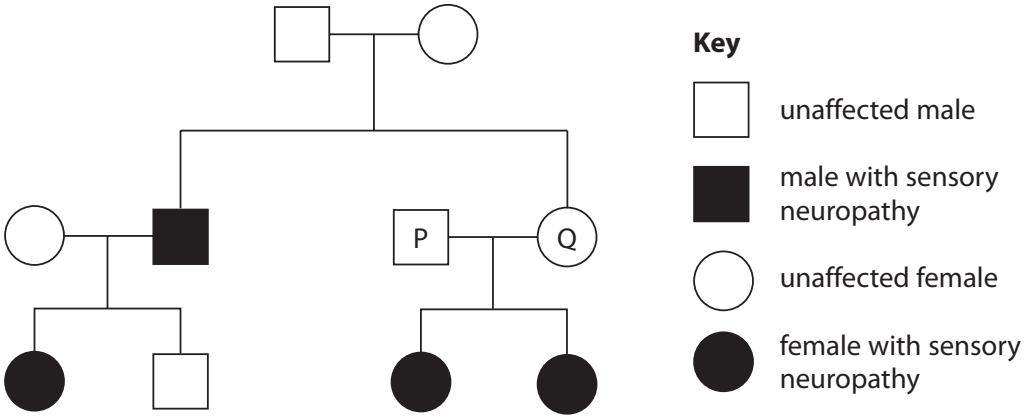
(Source: © PAL)

Some border collies have a genetic condition called sensory neuropathy.

Border collies with sensory neuropathy may be injured as their reflexes do not work well.

Sensory neuropathy is caused by a recessive allele, n. The dominant allele for not having sensory neuropathy is N.

The diagram shows a family pedigree for some border collies.



(i) Sex determination in dogs is controlled in the same way as in humans.

Which combination of sex chromosomes is present in the body cells of a male dog?

(1)

- ☒ **A** XX
- ☒ **B** XY
- ☒ **C** Y
- ☒ **D** YY

(ii) How many individuals in this family have the genotype Nn?

(1)

- ☒ **A** 2
- ☒ **B** 4
- ☒ **C** 5
- ☒ **D** 6

(iii) Determine the probability that the next offspring produced by individuals P and Q is a male with sensory neuropathy.

Include a genetic diagram in your answer.

(4)

probability = ...

(iv) Dog breeders use selective breeding to try to remove harmful alleles from dog breeds.

Explain how selective breeding could be used to remove the allele for sensory neuropathy from a population of border collies.

(3)

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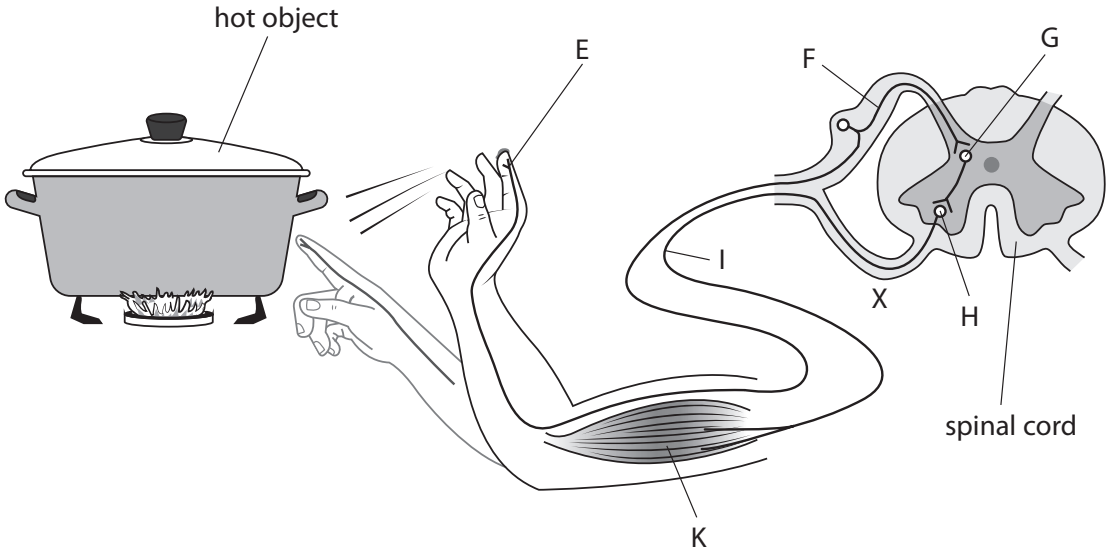
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(Total for Question 8 = 14 marks)

4 The diagram shows a human reflex response to touching a hot object.

Some of the structures in the reflex arc are labelled.



(a) (i) Give the name of this reflex response.

(1)

.....

(ii) Draw an arrow on the diagram to show the direction of the nerve impulse at point X.

(1)

(iii) Which structure detects the stimulus?

(1)

- ☒ **A** E
- ☒ **B** F
- ☒ **C** H
- ☒ **D** K

(iv) Which structure is the motor neurone?

(1)

- ☒ **A** F
- ☒ **B** G
- ☒ **C** I
- ☒ **D** K

(b) (i) A neurone is 1.10 m in length.

The speed of the nerve impulse in this neurone is 120 metres per second.

Calculate the time, in seconds, for the impulse to pass along the neurone.

Give your answer in standard form.

(2)

time ..... s

(ii) Describe how the impulse passes from neurone to neurone in the reflex arc.

(2)

.....

.....

.....

.....

.....

(c) Pain has a survival function.

If a person damages their ankle, they sense pain.

(i) Explain how sensing pain benefits an organism.

(2)

(ii) Some medicines are used to reduce pain.

These medicines work by preventing communication between the injured ankle and the brain.

Explain which components of the nervous system may be affected by these medicines.

(4)

(Total for Question 4 = 14 marks)

MARK SCHEMES

official Pearson Edexcel mark schemes

Question Number	Answer	Additional guidance	Mark
7(a)	An explanation that makes reference to two of the following points: • (unspecialised cells) develop into specialised cells / cells with specific functions (1) • to produce tissues / organs / example of tissue or organ (1)	**Allow** examples of specific cell types e.g. muscle cells / bone cells	**2**

Question Number	Answer	Mark
7(b) (i)	The only correct answer is D are found in some tissues and organs A is not correct as they can divide B is not correct as do not divide my meiosis C is not correct as cannot become all cell types	**1**

Question Number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that makes reference to two of the following points: • cells from embryos can make any cell type / many more cell types / adult stem cells can become fewer cell types (1) • ethical issues about the use of embryonic cells / eq (1)	**Allow** converse for adult cells for both MPs **Allow** only stem cells that come from embryos are totipotent / eq **Allow** people object to killing embryos / embryos are potential human lives / eq **Allow** embryo cells can become tumours	**2**

Total 5 marks

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>Value</th><th>Apparatus</th></tr>
<tr><td>magnification of a red blood cell</td><td>microscope</td></tr>
<tr><td>heat produced by germinating seeds</td><td>thermometer / temperature probe / data logger/eq (1)</td></tr>
<tr><td>surface area to volume ratio of a potato chip</td><td>ruler /eq (1)</td></tr>
<tr><td>breathing rate of a human</td><td>clock / watch / timer / spirometer /eq (1)</td></tr>
<tr><td>volume of gas produced by yeast in anaerobic respiration</td><td>syringe / measuring cylinder / respirometer/ eq (1)</td></tr>
</table>
</td><td>4</td></tr>
</table>

Question Number	Answer	additional guidance	Mark
1(b)	• width of cell = 5.3 cm • width of cell = in 53 000 µm ÷ 8 = 6625 6250 to 6750	**5.0 – 5.4 cm** **allow full marks for answer alone** allow 1 mark for dividing by 8	**2**

Total 6 marks

Question Number	Answer	Mark
3(a)	• nucleus	**1 cler**

Question Number	Answer	Additional guidance	Mark
3(b)	convert length into µm 60 mm = 60 000 µm (1) division 60 000 ÷ 6 = ×10 000 (1)	award full marks for correct numerical answer without working 1 mark for 60 000 or dividing by 6	**2 exp**

Question Number	Answer	Mark
3(c)(i)	A 0.33 *B is not correct as 3 is not the mean* *C is not correct as 10 000 is not the mean* *D is not correct as 75 000 000 is not the mean*	**1 comp**

Question Number	Answer	additional guidance	Mark
3(c)(ii)	An answer that makes reference to the following: • sperm smaller / sperm is small cell / eq (1) • fewer (total) mitochondria (per cell) (1) • more mitochondria per volume / per μm^3 (1) • uses <u>energy</u> to swim / move / get to /eq (1) • fertilise egg (1)	**allow converse for egg** larger more fewer does not move egg is fertilised	**3 exp**

Total 7 marks

Question Number	Answer	additional guidance	Mark
6(a)	A description that makes reference to two of the following points: • undifferentiated / unspecialised / can differentiate / can become specialised cells / eq (1) • and can become different <u>cell types</u> / eq (1) • can continue to divide / continue to multiply / can divide several times / eq (1)	**Accept** can divide whilst remaining undifferentiated = 2 marks	**2**

Question Number	Answer	Additional guidance	Mark
6(b)	An explanation that makes reference to three of the following points: • can make different (blood) cells / red cells and white cells / red cells and platelets / white cells and platelets (1) *Max two from:* • red blood cells to treat anaemia / ensure oxygen transport around body / eq (1) • white blood cells to kill infections / kill bacteria / remove viruses / improve immunity / increase antibodies / eq (1) • platelets to treat blood clotting problems / eq (1) • any one blood cell type to treat bone marrow cancer / treat leukaemia / treat lymphoma / treat myeloma / recover from chemotherapy / eq	**Accept** any two types of blood cell, e.g. phagocytes and lymphocytes **Accept** to treat sickle cell anaemia / thalassemia / eq	**3**

Question Number	Answer	Mark
6(c)	An explanation that makes reference to two of the following points: • have same proteins / antigens / eq (1) • genetically identical / same genes / eq (1) • no rejection / immune response / no need for immunosuppressant drugs / cells are accepted by body / cells are compatible / cells have same blood group / eq (1) • no transfer of other disease / infections / viruses (1)	**2**

Total 7 marks

Question Number	Answer	Mark
1(a)(i)	**B** cell wall *A is incorrect because it is not the cell membrane* *C is incorrect because it is not mitochondria* *D is incorrect because it is not the nucleus*	**1 comp**

Question Number	Answer	Mark
1(a)(ii)	**D** starch *A is incorrect because it is not chlorophyll* *B is incorrect because it is not glucose* *C is incorrect because it is not glycogen*	**1 comp**

Question Number	Answer	Additional guidance	Mark
1 (b) (i)	An answer that makes reference to the following points: • A: (chloroplasts absorb light) for photosynthesis / absorb light energy to make carbohydrate / eq (1) • B: (nucleus) controls protein synthesis / contains DNA / contains genes / controls cell / eq (1) • C: (vacuole) contains cell sap eq (1) • D: (cytoplasm) were chemical reactions occur (1)	**Allow** starch / glucose /sugar **Allow** maintains turgor / stores water / salts / pigments / toxins **Allow** where protein synthesis occurs / respiration occurs / medium for reactions	**4 grad**

Question Number	Answer	Mark
1 (b) (ii)	An answer that makes reference to the following points: • contains chloroplasts to absorb light / for photosynthesis eq (1) • long / arranged in a vertical plane / large surface area / rectangular shape, to absorb most light / eq (1) • large vacuole to store water (1)	**2 grad**

Total 8 marks

Question Number	Answer	Mark
1(a)	<table><tr><th>Letter</th><th>Name</th></tr><tr><td>A</td><td>vacuole (1)</td></tr><tr><td>B</td><td>nucleus (1)</td></tr><tr><td>C</td><td>cell wall (1)</td></tr><tr><td>D</td><td>cell membrane (1)</td></tr></table>	**4**

Question Number	Answer	Additional guidance	Mark
1(b) (i)	C / A	C A C and A A and C	**1**

Question Number	Answer	Additional guidance	Mark
1 (b)(ii)	An explanation that makes reference to three of the following: • photosynthesis (1) • (sun)light (1) • many in palisade (1) • few in spongy / few in guard (cells) (1) • none in upper epidermis / root (cells) (1)		**3**

Question Number	Answer	Additional guidance	Mark
1 (c)	An answer that makes reference to one of the following: • protein synthesis (1) • translation (1)	Ignore makes protein / produces protein	**1**

Total 9 marks

Question Number	Answer	Mark
2(a)(i)	**The only correct answer is D (I is the vacuole)** A is not correct as F is the cell wall B is not correct as G is the nucleus C is not correct as H is the cytoplasm	**1**

Question Number	Answer	Mark
2(a)(ii)	**The only correct answer is B (G is the nucleus)** A is not correct as F is the cell wall C is not correct as H is the cytoplasm D is not correct as J is a mitochondrion	**1**

Question Number	Answer	additional guidance	Mark
2(b)	correct measurement of P to Q conversion to μm division of PQ ÷ actual length correct answer = 475 (3) allow 450-500 for 3 marks allow in standard form (4.75×10^2)	allow 36-40 **mm** or 3.6 to 4.0 **cm** for correct measurement with units 1 mark and 1 mark for ÷ 80	**3**

Question Number	Answer	additional guidance	Mark
2(c)	An explanation that makes reference to four of the following points: • long (root hair) / reaches into soil / penetrates / branches / eq (1) • increases surface area (1) • to absorb water / eq (1) • by osmosis (1) • to absorb minerals / ions / eq • by diffusion (1) • active transport (1)	protuberance	**4**

Total = 8 marks

Question Number	Answer	Mark
3(a)(i)	**D (ribosome)** *A is incorrect as cell membrane does not synthesise protein* *B is incorrect as mitochondrion does not synthesise protein* *C is incorrect as the nucleus does not synthesise protein*	**1**

Question Number	Answer	Mark
3(a)(ii)	**C (mitochondrion, nucleus and ribosome)** *A is incorrect as ribosomes are also present in both* *B is incorrect as nuclei are also present in both* *D is incorrect as mitochondrion is also present in both*	**1**

Question Number	Answer	Additional guidance	Mark
3(b)(i)	An explanation that makes reference to three of the following: **40 (: 1) (3)** 62.5 for **two marks** **OR** 400(:1) for **two marks** **OR** 4(:1) for **two marks** ÷1.2 for **one mark** **OR** ÷12 for **one mark** **OR** ÷0.12 for **one mark** **OR** 6.25 for **one mark**	Example calculation: 75 / 1.2 = 62.5 2400 / 62.5 = 40 **Correct answer gains all three marks**	**3**

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	An answer that makes reference to four of the following: 1. villus has high(est) number of mitochondria (per cell) / sperm has low(est) number of mitochondria (per cell) / eq (1) 2. sperm has high(est) number of mitochondria per 10 μm^3/ skin has low(est) number 10 μm^3/ eq (1) 3. mitochondria perform (aerobic) respiration / make ATP / release energy / eq (1) 4. villus (cells) do active transport (so need lot of energy) / eq (1) 5. sperm cells move / swim (so need lot of energy) / eq (1) 6. skin cells have few active processes / use little energy / eq (1)	**Accept** villus has many mitochondria (per cell) **Accept** sperm have few mitochondria (per cell) **Accept** sperm has many mitochondria per 10 μm^3/ skin has few mitochondria per 10 μm^3/ eq (1) **Accept** volume or μm^3 for 10 μm^3 **Accept** sperm has highest concentration / density of mitochondria / skin has lowest concentration / density of mitochondria **Ignore** produce energy	**4**

(Total for Question 3= 9 marks)

Question Number	Answer	Mark
3(a)(i)	The only correct answer is D T is the vacuole A is not the answer as P is not the vacuole B is not the answer as R is not the vacuole C is not the answer as S is not the vacuole	**1**

Question Number	Answer	Mark
3(a)(ii)	The only correct answer is A P is the site of photosynthesis B is not the answer as Q is not the site of photosynthesis C is not the answer as R is not the site of photosynthesis D is not the answer as T is not the site of photosynthesis	**1**

Question Number	Answer	Mark
3(a)(iii)	The only correct answer is C S is the cell wall A is not the answer as P is not the cell wall B is not the answer as Q is not the cell wall D is not the answer as T is not the cell wall	**1**

Question Number	Answer	Mark
3(a)(iv)	The only correct answer is C U is the ribosome is the site of protein synthesis A chloroplast is not the site of protein synthesis B mitochondrion not the site of protein synthesis D starch granule is not the site of protein synthesis	**1**

Question Number	Answer	Additional guidance	Mark
3(b)	Volume = 0.053 × 0.053 × 0.053 = 0.000 148 877 or 0.00015 SA = 6 × 0.053 × 0.053 = 0.016 854 or 0.017 SA to volume = 0.016 854/ 0.000 148 877 113.21 or 113.2 or 113.33 or 113.3 (to 1)	**allow full marks for correct answer no working** **allow 1 mark for SA** 0.016 854 or 0.017 or other dec places in std form such as 1.7×10^{-2} **allow 1 mark for Vol** 0.000 148 877 or 0.00015 or other dec places or in std form such as 1.5×10^{-4} Accept 113 (to 1) 110 (to 1) as 110 is 2 sig figs same as data	**3**

Question Number	Answer	Additional guidance	Mark
3(c)(i)	An explanation that makes reference to three of the following • water enters cell due to <u>osmosis</u> / eq (1) • correct ref to water potential (high to low water potential (gradient) /low (solute) concentration to higher (solute) concentration / low water potential in cell / high water potential outside / eq (1) • as cannot prevent expansion / (keeps) expanding / expands / swells /eq (1) • animal cells / blood cells burst / eq (1)	allow from high concentration of water to lower concentration	**3**

Question Number	Answer	Additional guidance	Mark
3(c)(ii)	An explanation that makes reference to two of the following • water leaves cell due to <u>osmosis</u> / eq (1) • correct ref to water potential (high to low water potential (gradient) /low (solute) concentration to higher (solute) concentration / low water potential outside cell / high water potential inside / eq(1)	allow from high concentration of water to lower concentration **ignore flaccid**	**2**

	• animal cells / blood cells crenate / collapse / shrivel / eq (1)	**reject plasmolysed**	

Total 12 marks

Question Number	Answer	additional guidance	Mark
1(a)	A description that makes reference to the following points: • iodine (1) • blue black / blue / black /eq (1)	 allow purple	**2**

Question Number	Answer	Mark
1(b)(i)	The only correct answer is B fungus A is not correct because it is not a bacterium C is not correct because it is not a protoctist D is not correct because it is not a virus	**1**

Question Number	Answer	Mark
1(b)(ii)	The only correct answer is A amylase B is not correct because it is not digested by ligase C is not correct because it is not digested by lipase D is not correct because it is not digested by protease	**1**

Total 4 marks

Question Number	Answer	Mark
11	An answer that makes reference to six of the following points: • C shampoo with oil and without oil / shampoo with oil and no shampoo (1) • O hair from same person / same hair length / width / age / sex/ same hair type / dry hair same way (1) • R test many different hairs / repeat (1) • M1 add weights / masses to hairs (1) • M2 measure mass / g / pressure / weight / force /N that causes hair to break (1) • S1 same volume / concentration of shampoo / same type of shampoo with and without oil (1) • S2 wash for same time / frequency / same temperature of water (1)	**6** **exp** ignore amount

Total 6 marks

Question Number	Answer	Mark
2(a)(i)	• temperature/ 70°C / time / 5 mins / 5cm^3 / volume of water / 5cm^3 / volume of Benedict's / 5cm^3 /volume of solution (1)	**1**

Question Number	Answer	Mark
2(a)(ii)	• use water bath / beaker of water and Bunsen / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
2(b)	An explanation that makes reference to four of the following 1. B (1) 2. (B) as has turned (brick) red (1) 3. (B) has <u>most</u> glucose / eq (1) 4. for respiration / eq (1) 5. provides / releases energy / for energy / ATP /eq (1) 6. for muscle <u>contraction</u> / eq (1) 7. can run faster / longer / eq(1)	If answers A C D can still score mp 4 5 6 NOT 2 3 7	**4**

Question Number	Answer	additional guidance	Mark
2(c)	An explanation that makes reference to two of the following • fewer calories / kilojoules / less energy / eq (1) • so less mass gain / may wish to lose weight / prevent obesity / heart disease / eq (1) • less tooth decay / diabetes / eq(1)	allow • some people may be diabetic (1) • increase blood glucose/ blood sugar / cannot release (enough) insulin / eq (1)	**2**

Question Number	Answer	Mark
7(a)	An explanation that makes reference to the following points: • produces maltose / glucose (1) • turns red / green /yellow/orange /eq (with Benedict's test) (1)	**2 exp**

Question Number	Answer	Additional guidance	Mark
7(b)	An explanation that makes reference to four of the following points:		**4 exp**
	• same/stated volume / concentration of amylase (1)	**Ignore** amount for all	
	• same/stated mass of bread (1)	**Allow** same size /volume / piece of bread /same type of bread	
	• same/stated time (before pouring water) (1)		
	• same/stated volume of water (1)		
	• same/stated volume / concentration of Benedict's (1)	**Allow** same number of drops	
	• same time of heating / same temp for Benedict's test (1)		
	• stated range of temperatures (1)	at least two stated temperatures	
	• repeat each temperature / calculate mean time (1)		

Question Number	Answer	Mark
7(c)	An answer that makes reference to four of the following points: (increased temperature increases rate) • (due to increased) kinetic energy (1) • (more) movement of molecules / collisions (1) • until optimum temperature (1) • rate decreases at high temperature / digestion stops at high temperature (1) • (because) enzyme denatured / change to active site / no longer binds (1)	**4** **exp**

Total 10 marks

Question Number	Answer	Additional guidance	Mark
7 (a) (i)	An answer that makes reference to two of the following: • volume / 5cm^3 of fruit juice (1) • volume / 5cm^3 of Benedict's (1) • temperature / use 70°C (1) • time / for 3 minutes (1)	Ignore amount / concentration / mass	**2**

Question Number	Answer	Additional guidance	Mark
7 (a) (ii)	B C D A (2)	B D C A = 1	**2**

Question Number	Answer	Additional guidance	Mark
7 (a)(iii)	An explanation that makes reference to three of the following: • use 5cm^3 / same volume of each (sugar) solution **and** use 5cm^3 / same volume of Benedict's (1) • heat at same temperature **and** for 3 minutes / heat at 70ºC **and** for 3 minutes (1) • match / compare <u>colour</u> of sugar solutions with fruit juices / eq (1)	use the original/ same method alone = 1 only if mp1 or mp2 are not awarded	**3**

Question Number	Answer	Additional guidance	Mark
7 (b) (i)	An answer that makes reference to two of the following: • (sugar) provides energy (1) • respiration (in bacteria) (1) • produce acid / low(ers) pH (1)	Mp1 Ignore food	**2**

Question Number	Answer	Additional guidance	Mark
7 (b) (ii)	An explanation that makes reference to two of the following: • develop obesity / overweight (1) • sugar provides energy / joules / calories (1) or • (type 2) diabetes (1) • increase in <u>blood</u> glucose/sugar / insulin no longer works (1) or • CVD / heart disease / stroke (1) • sugar converted to fat / fat deposits in arteries (1)	Only credit 1 health risk Can only earn 2 marks if risk and explanation are linked (from same pair) Mp4 Ignore not enough insulin	**2**

Total 11 marks

Question Number	Answer		Mark
6(a)	An answer that makes reference to two of the following points: • increasing enzyme concentration increases the rate of oxygen production / eq (2) **one mark** for naming the enzyme concentration / number of potato discs as independent variable and the oxygen production as the dependent variable (1)	**Allow** increasing catalase concentration / number of potato discs increases the amount of oxygen produced / eq (2) **Max one** for correct relationship but variables named wrongly e.g. increasing potato disc number (dependent variable) increases the volume of oxygen produced (independent variable)	**2**

Question Number	Answer	Mark
6(b)	An answer that makes reference to two of the following points: • pH / volume of buffer (1) • volume of hydrogen peroxide / substrate (1) • time / duration of reaction (1) • size / volume / mass / shape / surface area of each disc (1) • temperature (1)	**2**

Question Number	Answer	Additional guidance	Mark
6(c) (i)	• 4.2 ÷ 3 • 1.4 (2)	Allow **one mark** for mean using all values e.g. 4.2 ÷ 4 = 1.05 or 1.1 or 1.0	**2**

Question Number	Answer	Additional guidance	Mark
6(c) (ii)	• 8.3 - 7.3 ÷ 7.3 x 100 • = 13.7 (2)	**Allow one mark** for 1(.0) or (8.3 – 7.3) **Allow one mark** for ÷ by 7.3 **Allow one mark** for 0.137 **Allow** 13.6986 / 14 for 2 marks **Allow one mark** for 13.69	**2**

Question Number	Answer	Additional guidance	Mark
6(c) (iii)	An explanation that makes reference to two of the following points: • increasing enzyme concentration /number of discs increases volume of oxygen produced (1) • more active sites (1) • (increase in enzyme concentration) means more collisions / more enzyme substrate complexes / more enzymes combine with substrates / eq (1)		**2**

Question Number	Answer	Additional guidance	Mark
6(d)	An explanation that makes reference to the following two points • to measure initial / fastest rate (1) • (as time increases) hydrogen peroxide / substrate concentration falls / hydrogen peroxide breaks down / is used up (1) • valid (comparison) (1)	**Allow** converse for mp1 and mp2 **Allow** reaction will slow down **Allow** the rate of oxygen production / bubbles produced will slow **Allow** reaction is not limited by substrate concentration **Allow** reaction may have finished by 10 min	**2**

Total 12 marks

Question Number	Answer	Mark
2(a)	An answer that makes reference to: • (biological) catalyst / substance that speeds up reactions / protein that speeds up reactions / eq (1)	**1**

Question Number	Answer	Mark
2(b)	An answer that makes reference to: • increased surface area / so more catalase exposed to the H_2O_2 / speeds up reaction / eq (1)	**1**

Question Number	Answer	Additional guidance	Mark
2(c)(i)	An answer that makes reference to: • volume of gas (released in 5 minutes) / eq (1)	**Ignore** amount	**1**

Question Number	Answer	Mark
2(c)(ii)	An answer that refers to two of the following: • concentration of peroxide / eq (1) • temperature (1) • volume of (pH) buffer / eq (1)	**2**

Question Number	Answer	additional guidance	Mark
2(d)(i)	2.4- 0.8 = 1.6 ÷ 0.8 × 100 = **200% (2)**	allow full marks for correct answer no working **Accept** 1 mark for 1.6 **OR** (2.4 – 0.8)	**2**

Question Number	Answer	Additional guidance	Mark
2(d)(ii)	An explanation that makes reference to two of the following points: • substrate / H_2O_2 is being used up / reaction complete / concentration of H_2O_2 decreases / eq (1) • so fewer enzyme substrate-complexes / fewer collisions / eq (1) • water formed dilutes H_2O_2 / eq (1)	**Accept** peroxide has been broken down / converted to products **Accept** fewer collisions between particles	**2**

Question Number	Answer	Mark
2(d)(iii)	An explanation that makes reference to the following points: • pH changes from <u>optimum pH</u> / enzymes have <u>optimum pH</u> / eq (1) • pH denatures enzyme / alters the bonding / alters shape of active site / eq (1) • substrate and enzyme no longer fit / ES complexes cannot form / substrate cannot bind / enzyme and substrate are no longer complementary / eq (1)	**3**

Total 12 marks

Question Number	Answer	Additional guidance	Mark
7(a)	• so that enzyme / substrate / test tube / beaker / solutions are at / reach correct temperature / same temperature / 20°C / eq (1)	ignore reach optimum temperature / keep temperature constant	**1**

Question Number	Answer	Mark
7(b)(i)	• time taken (to lose pink colour / change colour for milk / lipid to be digested) / rate of reaction / digestion / eq (1)	**1**

Question Number	Answer	Mark
7(b)(ii)	• volume of lipase / volume of milk / volume of sodium carbonate / time left in water bath (in stages 6 and 7) / volume / number of drops of phenolphthalein / eq (1)	**1**

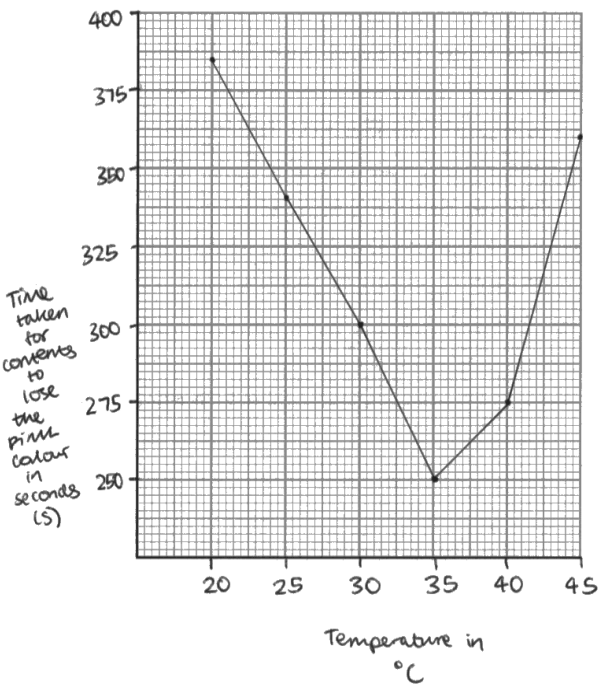
Question Number	Answer	Mark
7(c)	• to show all lipid digested / milk digested/ show fatty acids produced/ to show end (point) of reaction / show (changes in) pH / eq (1)	**1**

Question Number	Answer	Additional guidance	Mark
7 (d)	An answer that includes • graph plot covering at least 2.5 large squares for height and scale linear (1) • Lines straight and through all points (1) • Axes correct way round (temp x and time y) (1) • Units labelled with temperature in °C and time in seconds / s (1) • Points correctly plotted within half a small square (1)	allow full or truncated axis No L if extrapolated No L if bar chart even if unlabelled	**5**

Plot a line graph to show the effect of temperature on the time taken for the contents of the test tube to lose the pink colour.

Use a ruler to join your points with straight lines.

(5)



Question Number	Answer	Additional guidance	Mark
7(e)	An explanation that makes reference to four of the following • increased (kinetic) energy / molecules move faster/ more collisions / more enzyme substrate complexes formed / eq (1) • so time (to lose pink colour) decreases (1) • (up to/ till) <u>optimum temperature</u> / eq (1) • (time increases as) bonds in active site break / enzymes denature / eq (1) • (enzyme) active site changes shape / substrate can no longer fit / bind with enzyme / active site / eq (1)	allow low energy at low temp allow rate increases / reaction quicker / allow slow rate at lower temp / lipase digests lipid quicker allow enzyme and substrate no longer complementary	**4**

Total 13 marks

Question Number	Answer	Additional guidance	Mark
6(a)(i)	• 1400 (%) (2) **One mark** for 75-5 **OR** 70 **OR** ÷ 5		**2**

Question Number	Answer	Additional guidance	Mark
6(a)(ii)	An explanation that makes reference to three of the following points: 1. optimum pH is 7 (1) 2. (pH causes) enzyme to denature (1) 3. shape of enzyme changes / shape of active site changes / eq (1) 4. substrate does not fit active site / enzyme no longer complementary / cannot form E/S complexes / eq (1)	**Accept** optimal pH is 7 **Reject** optimum <u>temperature</u> **Accept** at optimum pH (many) E/S complexes form / eq	**3**

Question Number	Answer	Additional guidance	Mark
6(a)(iii)	An explanation that makes reference to two of the following points: 1. use a colour matching chart / light sensor / colorimeter / eq (1) 2. (because) colour change is subjective / to standardise the end colour / so colour is always same / eq (1) 3. use intervals of shorter than 5 minutes / shorter intervals / check more often check colour constantly / eq (1)	**Accept** use a reference colour / eq **Accept** depends on person viewing / eq	**2**

Question Number	Answer	Additional guidance	Mark
6(b)(i)	An answer that makes reference to three of the following points: 1. DNA is double stranded / RNA is single stranded (1) 2. DNA has T / RNA has U (1) 3. DNA is a helix / RNA is not a helix (1) 4. DNA has deoxyribose / RNA has ribose (1)	**Accept** DNA is a double helix = mp1 and mp3	**2**

	Answer	Additional guidance	Mark
6(b)(ii)	An explanation that makes reference to four of the following points: 1. (complementary) RNA binds to the phenol oxidase RNA / eq (1) 2. translation **cannot** occur (1) 3. so enzyme / phenol oxidase **not made** (1) **AND** **max three from:** 4. transcription makes (m)RNA (1) 5. RNA leaves nucleus and enters cytoplasm / RNA moves to ribosome / eq (1) 6. tRNA brings / carries / transports amino acids / eq (1) 7. (during translation) tRNA binds mRNA / anticodons bind codons (1) 8. amino acids join / amino acid chain / makes polypeptide / peptide bonds form / eq (1)	**Accept** DNA unzips and (m)RNA is made **Accept** polymerase makes (m)RNA **Accept** anticodons and codons cannot bind (if complementary RNA present) (1) **Accept** different amino <u>sequence</u> made / amino acids are not joined together **Ignore** wrong amino acid made	**4**

(Total for Question 6 = 13 marks)

Question Number	Answer	Additional guidance	Mark
4(a) (i)	• (substance that) speeds up (chemical) reactions (1)	**Allow** correct reference to activation energy **Ignore** catalyses	**1**

Question Number	Answer	Mark
4(a) (ii)	• (chemical) reactions / processes in cells / cytoplasm / body /organisms (1)	**1**

Question Number	Answer	additional guidance	Mark
4(b) (i)	An answer that includes: • scale linear and half of grid (1) • lines drawn neatly between points (1) • axis correct way around (1) • points correctly plotted (1) • axes labelled with (concentration in) **number of discs** (of potato) **and oxygen (production) in cm^3 min^{-1}** or **cm^3 per min** (1)	lose L if extrapolated bar charts lose L	**5**

Question Number	Answer	Additional guidance	Mark
4(b) (ii)	An explanation that makes reference to the following points: • as enzyme concentration increases so does oxygen production / rate / it increases / eq (1) • up to 8 (discs) / 8.2 (cm^3 min^{-1}) / levels off after / from 8 (discs) / 8.2 (cm^3 min^{-1}) / eq (1) • more enzyme (molecules) available to react with / break down hydrogen peroxide / substrate / form enzyme substrate complexes / more collisions / eq (1) • until all substrate molecules / hydrogen peroxide are combined with enzyme molecules / substrate limiting (1)	must give value for discs or rate **Ignore** faster collisions	**3**

Question Number	Answer	Mark
4(b) (iii)	• use (gas) syringe / (inverted) measuring cylinder / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
4(b) (iv)	An explanation that makes reference to the following points: • only one variable is changed / one independent variable / control variable / carry out valid experiment / produce accurate results / eq (1) • these (also) affect / change the rate (1)	**allow** make it a fair test **allow** so that they are controlled	**2**

Question Number	Answer	additional guidance	Mark
4(b) (v)	• temperature / pH / type / eq of potato / eq (1)	**ignore** time	**1**

Total = 14 marks

Question Number	Answer	Additional guidance	Mark
4(a)	An explanation that makes reference to the following points: • moves up / increases (1) • water enters / water passes through membrane (1) • sucrose is a concentrated solution / sucrose has a low(er) water potential / high water potential to low water potential / down a water potential gradient / dilute to concentrated (1)	Mp3 Allow high conc. to low conc. of <u>water</u> / down water conc gradient	**3**

Question Number	Answer	Mark
4(b)	An explanation that makes reference to the following points: • use water bath / use Bunsen (1) • use scale / measurements (on tube)/ ruler / (use pen to) mark tube (1) • use clock / timer / stopwatch (1)	**3**

Total 6 marks

Question Number	Answer	additional guidance	Mark
6 (a)	• salt <u>concentration</u> / <u>concentration</u> of salt (solution) /sodium chloride <u>concentration</u> / <u>percentage</u> sodium chloride / <u>percentage</u> salt solution / <u>water potential</u> of solution / eq (1)	must have concentration , percentage or water potential not just salt solution	**1**

Question Number	Answer	additional guidance	Mark
6(b)	• volume of (diluted) blood / volume of solution / time solution left for / concentration of (diluted) blood sample / concentration of blood plasma / eq	not volume of water ignore amount	**1**

Question Number	Answer	Mark
6(c)(i)	An explanation that makes reference to two of the following : • no cells in distilled water / A / cells burst / explode / eq (1) • haemoglobin dissolves / eq (1) • cells in present / cells unchanged in other B / 1% / c? 3% /eq(1)	**2**

Question Number	Answer	Mark
6(c)(ii)	An explanation that makes reference to two the following: • water enters red cells in A distilled water / eq (1) • water enters and leaves / no movement in B 1% / eq (1) • water leaves red cells in C 3% / eq (1) • (due to) osmosis (1)	**2**

Question Number	Answer	additional guidance	Mark
6(d)	An description that makes reference to the following: • Tube A no red cells (layer) / no bottom layer / red colour throughout tube / more 'plasma' / no platelets / no separation into layers / no layers / no cell layers / eq (1) • Tube B / C normal cell layers / normal (layer) of red cells / eq (1)	allow slightly fewer red cells / smaller layer in C than normal	**2**

total 8 marks

Question Number	Answer	Additional guidance	Mark
10(a)	An explanation answer that makes reference to five of the following points • temperature increases (kinetic) energy / particle movement / more collisions / eq (1) • difference in concentration / concentration gradient increases rate of movement (1) • short(er) distance increases diffusion /eq (1) • surface area to (volume ratio) increases diffusion (1) • mass / size of particle smaller particles move faster (1) • larger particles / charged particles cannot pass through cell membrane (1) • (increased) oxygen / ATP / respiration / energy for active transport (1)	allow converse thin walls villi / microvilli / eq	**5**

Question Number	Answer	Additional guidance	Mark
10(b)	An answer that makes reference to the four of the following points • diffusion <u>passive</u> (1) • diffusion from high concentration to low / requires concentration gradient (1) • active transport requires ATP / energy/ oxygen / respiration (1) • active transport requires membrane / carrier proteins (1) • diffusion can take place in non-living systems (1)	appropriate converse mp2-5	**4**

Total 9 marks

Question Number	Answer	Mark
2(a)	4 (1)	**1**

Question Number	Answer	additional guidance	Mark
2(b)	An explanation that makes reference to two of the following • remove surface moisture / liquid /eq (1) • that would add / alter / affect mass /affect results / eq (1) • so valid comparison can be made between with pre-solution dried cylinder / eq(1)	 Ignore water Ignore reliable /accurate	**2**

Question Number	Answer	additional guidance	Mark
2(c)(i)	change in mass 2.3-2.2 = 0.1g % = 0.1÷2.2 ×100 = 4.5 (2)	allow 1 mark for 0.1 full marks for correct answer no working allow 4.55 or 4.545 allow 4.54 dot / recurring etc	**2**

Question Number	Answer	additional guidance	Mark
2(c)(ii)	An answer that makes reference to five of the following 1. loses mass in high(er) (sucrose) concentration / 1.0 / 0.8 / eq (1) 2. gains mass in low(er) (sucrose) concentration/ 0.0 / 0.2 / 0.4/ eq (1) 3. as water exits / enters / eq (1) 4. by osmosis / eq (1) 5. from higher water potential / to low water potential / eq (1) 6. no change in mass / no (net) movement of water in 0.6 / eq (1) 7. potato has same water potential / same concentration / isosmotic / eq (1)	allow weight As conc increases mass decreases As conc decreases mass of potato increases Allow dilute to more concentrated / from higher water conc to lower /eq	**5**

Total 10 marks

Question Number	Answer	Additional guidance	Mark
6(a)(i)	A description that makes reference to the following • diffusion / movement of solvent / water through partially permeable membrane / eq (1) • from dilute to concentrated solution / high to low water potential / eq (1)	allow semi-permeable/ selectively permeable allow from high concentration (of water)to low(er) concentration (of water) **allow** movement of water from high to low concentration across partially permeable membrane for mp 1 and mp 2	**2**

Question Number	Answer	Mark
6(a)(ii)	• tube contents / the liquid / the solution / the concentration / what is in the tube / eq (1)	**1**

Question Number	Answer	Additional guidance	Mark
6(b)(i)	calculation = (2 × 3.14 x 0.25 x 5) + (2 × 3.14 × $(0.25)^2$) = 7.85 + 0.3925 = 8.2425 = **8.2 (cm^2) to 8.25** (2)	allow 1 mark for 7.85 7.855 7.86 Or 0.39 0.393 0.3925 or 0.39275	**2**

		full marks for correct answer with no working	

Question Number	Answer	Mark
6(b)(ii)	An explanation that makes reference to the following • increases rate of osmosis / eq (1) • as more contact (between potato and water / solution) / more space / eq (1)	**2**

Question Number	Answer	Additional guidance	Mark
6(b)(iii)	• temperature / type of potato / eq (1)	ignore time / volume of solution mass of potato	**1**

Question Number	Answer	Mark
6(c)(i)	An explanation that makes reference to three of the following • **distilled water** (increases in mass) water enters potato from distilled water (1) • **air** (little change in mass) no movement of water / no osmosis / water evaporates / eq (1) • **sucrose solution** (decrease in mass) water leaves potato into sucrose solution / eq (1) • Correct ref to water potential gradient or from dilute solution to concentrated solution / down water potential	**3**

	gradient / from higher concentration of water to lower concentration of water / eq (1)	

Question Number	Answer	Additional guidance	Mark
6(c)(ii)	calculation percentage change in mass in sucrose solution = (1.8- 2.1)÷ 2.1 = -0.3 -0.3 ÷2.1 = -0.143 × 100 = - 14.3 % 14.3 % of 5.0 cm = 0.143 ×5 = -0.71cm 5-0.71 = 4.3(4.29) allow **4.28 to 4.3** cm (3)	full marks for correct answer with no working allow 1 mark for 14.3 or 14.29 or 14.286 or 0.143 or 0.14286 etc **and** allow 1 mark for 0.71 to 0.72 etc	**3**

Total 14 marks

Question Number	Answer	Additional guidance	Mark
6(a)(i)	• (S) linear scale for both axes with at (1) • (L) straight lines between points (1) • (A) axes with time on horizontal and mass on vertical (1) • (P) plots correct (+/- half square) (1) • (U) axes labelled and with units (minimum: mass / g **and** time / min) (1)	at least two large squares on y axis and at least half of x axis **No Line mark if bar chart** **Time in minutes** / **Mass of bag in g** 0 / 15 5 / 17 10 / 20 15 / 23 20 / 26 25 / 27 30 / 27	**5**

Question Number	Answer	Additional guidance	Mark
6(a)(ii)	A description that makes reference to the following: • mass increases (1) • levels off after 25 minutes / at 27 g / eq (1)	**Accept** increase until it reaches 25 (min) / 27 (g) = **2 marks**	**2**

Question Number	Answer	Additional guidance	Mark
6(a)(iii)	An explanation that makes reference to two of the following: • water moved into bag (by osmosis / diffusion) / eq (1) • (water moves) from a high water potential to a low water potential / from high concentration (of water) to low concentration (of water) / from dilute to concentrated / eq (1) • until pressure prevented more water entering / bag was full / bag was turgid / eq (1)	**Accept** water moves in / eq **Accept** down a water potential gradient **Accept** from low sugar concentration to high sugar concentration **Ignore** refs to equal concentrations of water inside and outside bag	**2**

Question Number	Answer	Additional guidance	Mark
6(b)(i)	A description that makes reference to two of the following: • use a <u>water bath</u> (1) • with a thermostat / use a (Bunsen) burner **<u>and</u>** thermometer / eq (1) • eye protection / eq / use tongs / gloves / eq (1)	**Accept** temperature regulated (water bath) / eq **Accept** spirit burner / hot plate / kettle / eq for Bunsen burner **Accept** thermostatically controlled water bath for **mp1 and mp2** **Accept** tie hair back **Accept** lab coat / apron **Accept** put Bunsen onto safety flame (when not being used)	**2**

Question Number	Answer	Additional guidance	Mark
6(b)(ii)	An explanation that makes reference to three of the following: • osmosis is faster / eq (1) • tubing fills faster / mass increases faster / so increase in mass will be steeper / will level off earlier / eq (1) • more (kinetic) energy (1) • so particles / water, will move faster / eq (1)	**Accept** K.E. increases **Accept** more (frequent) collisions / eq **Ignore** refs to enzymes / denaturing	**3**

(Total for Question 6 = 14 marks)

Question Number	Answer	Mark
1(a)	liver	**1**

Question Number	Answer	Mark
1(b)	B ovary (1) *A is incorrect because the brain does not produce progesterone* *C is incorrect because the pituitary does not produce progesterone* *D is incorrect because the testis does not produce progesterone*	**1**

Question Number	Answer	Mark
1(c)	D yes yes (1) *A is incorrect because both organs excrete* *B is incorrect because the kidney excretes* *C is incorrect because the skin excretes*	**1**

Question Number	Answer	Additional guidance	Mark
1(d)	A description that makes reference to three of the following points: • protease / pepsin / peptidase (1) • digest / breaks down <u>protein</u> (1) • hydrochloric acid (1) • kill pathogens / eq / optimum pH ignore germs (1) • churning/ mechanical digestion (1)	**Allow** lipase digest lipid as alternative to mp1 and 2	**3**

Total = 6 marks

Question Number	Answer	Additional guidance	Mark
5	A description that makes reference to six of the following points: • weigh each crisp / use same mass of crisp (1) • stated volume / mass of water in tube / beaker / calorimeter (1) • ignite / light crisp (1) • heat water using burning crisp / place burning crisp under tube / eq (1) • burn until it has completely burnt / no longer relights / eq (1) • measure temperature of water before and after burning / measure change in temperature (1) • energy content (per g) = 4.2 x mass of water × temp rise ÷ (mass of crisp) (1) • repeat (to obtain reliable data) (1) • insulate / move crisp under tube quickly (1)	**Allow** shc for 4.2 mass of crisps / mass of water / temperature rise, may be awarded here	**6**

Total 6 marks

Question Number	Answer	Additional guidance	Mark
10	C use light bulbs / lamps different colours / wavelengths / eq (1) O of same species (of water) plant / age / size / condition / eq (1) R repeat / (calculate mean for each different colour) / eq (1) M1 measure volume of oxygen evolved / count bubbles /eq M2 in stated time period / minutes / eq (1) S1 at same temperature / same distance /same light intensity / same bulb / eq S2 same carbon dioxide concentration / same mineral ions / same pH /eq (1)	allow change in suitable indicator / allow testing leaves for starch	**6**

Total 6 marks

Question Number	Answer	Mark
1(a)(i)	The only correct answer is D S A is not correct as P does not contain chlorophyll B is not correct as Q does not contain chlorophyll C is not correct as R does not contain chlorophyll	**1**

Question Number	Answer	Mark
1(a)(ii)	The only correct answer is C magnesium A is not correct as chlorophyll does not contain calcium B is not correct as chlorophyll does not contain iron D is not correct as chlorophyll does not contain water	**1**

Question Number	Answer	Mark
1(a)(iii)	A description that makes reference to two of the following points: • absorb / trap / captures / eq, light (1) • photosynthesis (1) • make carbohydrate / make starch / make glucose / eq (1)	**2**

Question Number	Answer	Mark
1(b)	The only correct answer is C a plant stem growing towards light A a plant root growing away from light is not correct B a plant root growing downwards due to gravity is not correct D a plant stem growing upwards due to gravity is not correct	**1**

Question Number	Answer	Mark
1(c)		**3**

Role of substance	Name of substance
cause positive phototropism	**auxin**
digest fat	lipase (1)
diffuse across a synapse	neurotransmitter / acetylcholine / noradrenaline / correct named neurotransmitter (1)
prevent scurvy	vitamin C /ascorbic acid (1)

Total = 8 marks

Question Number	Answer	additional guidance	Mark
3(a)	P is the ileum / small intestine (1) Q is the <u>oesophagus</u> (1)	allow intestine reject large intestine	**2**

Question Number	Answer	additional guidance	Mark
3(b)	An explanation that makes reference to two of the following points: • <u>cellulose</u> (1) • (produces / release) glucose / energy (1) • respiration (1)	allow produce <u>cellulase</u> no credit for microorganisms being digested for glucose	**2**

Question Number	Answer	additional guidance	Mark
3(c)	An explanation that makes reference to two of the following points: • fewer cows means less methane (into atmosphere) (1) • greenhouse gas (1) • (less) heat trapped / (less) radiation reflected (1) • (less) global warming (1) • farmers may choose to keep same number / more cows (1) • some cows kept for beef / eq (1) • other sources of greenhouse gas / cars / fossil fuels / eq	allow converse ignore climate change	**4**

Total 8 marks

Question Number	Answer	Additional guidance	Mark
9(a)	$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$ (2)	Award no marks for word equation One mark for correct equation but not balanced Respiration equation = 0 Ignore light / chlorophyll	**2**

Question Number	Answer	Additional guidance	Mark
9(b)(i)	An explanation that makes reference to two of the following points: • (no) photosynthesis (1) • remove starch / destarch / cannot make starch (1) • respiration (1)	Mp1 less = 0	**2**

Question Number	Answer	Mark
9(b)(ii)	remove carbon dioxide / remove CO_2	**1**

Question Number	Answer	Mark
9(c)(i)	B orange *A is incorrect because iodine is not white in colour* *C is incorrect because starch is not present* *D is incorrect because iodine is not brick-red in colour*	**1**

Question Number	Answer	Mark
9(c)(ii)	C blue-black *A is incorrect because starch is not white when iodine is added* *B is incorrect because starch is not orange when iodine is added* *D is incorrect because starch is not brick-red when iodine is added*	**1**

Question Number	Answer	Mark
9(d)	An explanation that makes reference to the following points: • control (1) • carbon dioxide not absorbed / plant has carbon dioxide / CO_2 in bell jar / carbon dioxide needed for photosynthesis show bell jar allows photosynthesis / bell jar allows starch production (1)	**2**

Total 9 marks

Question Number	Answer	additional guidance	Mark
9(a)	$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$ (2)	allow 1 mark for correct formula but incorrect balance no credit for word equation	**2**

Question Number	Answer	additional guidance	Mark
9(b)(i)	Calculation 78 bubbles per minute gives $1 \div d^2$ value from x axis of 0.16 therefore $1 \div d^2 = 0.16$ $d^2 = 6.25$ distance d = 2.5 (cm) (2)	Graph clearly 0.16 allow 1 mark for 0.16 or 6.25	**2**

Question Number	Answer	Mark
9(b)(ii)	A description that makes reference to the following • more bubbles released / rate of photosynthesis increases / eq (1) • very steeply at low light intensities / at first / eq (1) • number of bubbles levels off / becomes constant / stays same / reaches maximum / rate of increase slows down / eq (1)	**3**

Question Number	Answer	Additional guidance	Mark
9(b)(iii)	An explanation that makes reference to two of the following • rate doesn't change / no change / increasing / changing light / light intensity / has no effect / / eq (1) • as light **no** longer / **not** limiting factor / other factor limiting / eq (1) • need more carbon dioxide / need higher temperature to increase photosynthesis rate / eq (1)	No credit for light is limiting factor carbon dioxide / chlorophyll is limiting factor / temperature limiting factor **scores mp 2 and mp 3**	**2**

Total 9 marks

Question Number	Answer	Additional guidance	Mark
2(a)	A description that makes reference to the following points: • use warm/hot ethanol/alcohol / use ethanol in water bath (1) • use iodine (1) • blue black / blue / black (1)	Add Benedict's and blue black = 1	**3**

Question Number	Answer	Additional guidance	Mark
2(b)	An explanation that makes reference to four of the following points: • (position) palisade at top / (just) beneath upper epidermis OR spongy in middle/near(er) lower surface (1) • (structure) palisade closely packed / long / rectangular / elongated / column / packed together / dense / fixed together / no air spaces / no gaps OR spongy have air spaces / gaps / rounded (1) • (chloroplasts) palisade have <u>more/many</u> chloroplasts / chlorophyll OR spongy have <u>fewer</u> chloroplasts / <u>less</u> chlorophyll (1) • (palisade cells) absorb (sun)light (1) • spongy allow diffusion / gas exchange / gases to move / movement of water <u>vapour</u> / movement of carbon dioxide / movement of oxygen / transpiration (1)	Mp1 Ignore palisade closer to surface Mp3 palisade have more and spongy have none = 0	**4**

Question Number	Answer	Additional guidance	Mark
2(c)	An answer that makes reference to three of the following points: • mass is lost from lower surface / mass is lost when upper surface covered / OR little/least mass lost from upper surface / little/least mass lost when lower surface is covered (1) • stomata in lower surface / few/no stomata on upper surface (1) • disagrees with conclusion (1)	Mp1 Ignore change in mass	**3**

Total 10 marks

Question Number	Answer	additional guidance	Mark
6(a)	An explanation that makes reference to four of the following points: • <u>neutralise</u> acid (from stomach) (1) • optimum pH for enzymes (1) • emulsify fat / lipid (1) • small droplets / eq (1) • increase surface area (1)	**ignore** makes alakaline / increases pH	**4**

Question Number	Answer	Mark
6(b)	Only B is correct as there is 1 blood vessel that transports deoxygenated blood from the liver *A is incorrect as there are not 0 blood vessels that transports deoxygenated blood from the liver* *C is incorrect as there are not 2 blood vessels that transports deoxygenated blood from the liver* *D is incorrect as there are not 3 blood vessels that transports deoxygenated blood from the liver*	**1**

Question Number	Answer	Mark
6(c)(i)	An explanation that makes reference three of the following points: • glucose absorbed / taken in / stored / removed from blood (1) • insulin (1) • (glucose to) glycogen (1) • lowers blood glucose in hepatic vein / leaving liver (1)	**3**

Question Number	Answer	Additional Guidance	Mark
6(c)(ii)	An explanation that makes reference two of the following points: • less food in gut / not eaten in a while / less absorption of glucose by gut / less glucose coming from small intestine / eq (1) • no insulin (released) (1) • glycogen to glucose (1) • glucose released from liver/eq (1)	**Allow** glucagon released	**2**

Total = 10 marks

Question Number	Answer	Additional guidance	Mark
10 (a)(i)	60 ÷ (1.65 X 1.65) 60 ÷ 2.7225 = 22.0 (2)	award full marks for correct numerical answer without working one mark for 1.65 **Allow** 20	**2**

Question Number	Answer	Additional guidance	Mark
10(a)(ii)	healthy or whatever indicated in 10(a) (i)	**Allow** TE from 10 ai	**1**

Question Number	Answer	Mark
10(b)	A increase your BMI *B is incorrect because fat does not decrease BMI* *C is incorrect because fat does affect BMI* *D is incorrect because cannot have a negative BMI*	**1**

Question Number	Answer	Mark
10(c) (i)	An explanation that makes reference to the following points: • (carbohydrate and lipid) are (high) energy molecules (1) • energy intake is less than energy use (1) • stored fat / glycogen / carbohydrate is <u>respired</u> / eq (1)	**3**

Question Number	Answer	Mark
10(c) (ii)	An explanation that makes reference to the following points: • muscle (contraction) (1) • exercise requires / uses energy (1) • from respiration (1)	**3**

Total 10 marks

Question Number	Answer	additional guidance	Mark
8(a)	• Fat more in cow's / eq (1) • Fat could lead to obesity / too many kJ calories / eq (1) • Protein more in in cow's / eq (1) • Minerals more in cow's / eq (1) • Carbohydrate less in cow's / eq (1) • (too little carbohydrate in cow's) so not enough (quick) energy (1) • Vitamins similar / same (1) • Water the similar / same (1) • Antibodies no (human antibodies) in cow's (1) • Antibiotics in cow's (1)	allow converse for mp 1,3,4, 5, 9 and 10 allow 'too much' allow 'too much' allow 'too much' allow 'too little in cows '	**6**

Question Number	Answer	additional guidance	Mark
8(b)	An answer that makes reference to two of the following points: • (exposure to) sun(light) (1) • named source of vitamin D such as cod-liver oil / oily fish – such as salmon, sardines, herring and mackerel / red meat /liver /eggs / fortified foods – such as most fat spreads and some breakfast cereals (1) • add drops / use supplement / eq (1)	give cod-liver oil (tablets) = mp 2 and 3	**2**

Question Number	Answer	additional guidance	Mark
8(c)	An answer that makes reference to the following points: • Add biuret (1) • If protein present turns purple / lilac (1)	allow / uristix / clinistix /protein test sticks mp 1 and stated colour change mp 2	**2**

Total = 10

Question Number	Answer	additional guidance	Mark
10(a) (i)	A description that makes reference to the following points: • keep plant in dark / eq (1) • for 12 hours plus (1)	in cupboard / cover with black paper	**2**

Question Number	Answer	Mark
10(a)(ii)	• starch only made during experiment / produced during experiment / produced in the light / prevent false positive / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
10(b)	• (heat ethanol) using water bath / eq (1)	extinguish Bunsen flame	**1**

Question Number	Answer	Mark
10(c)	• keep leaf in dark / mask leaf / cover with foil / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
10(d)	An explanation that makes reference to five of the following points: • leaf flat / wide / large SA for diffusion / gas exchange / light absorption (1) • leaf thin so no cells far from surface to absorb light / short diffusion distance (1) • upper epidermis transparent to allow light through (1) • palisade (mesophyll) cells contain many chloroplasts / much chlorophyll (near surface) to absorb light (1) • spongy (mesophyll) / cells have air spaces / not tightly packed / for gas exchange / diffusion (1) • (lower surface) has <u>stomata</u> to absorb carbon dioxide (1) • xylem / vascular bundle bring water for photosynthesis (1)	for each mp must have structure and description of how adapted allow spongy for gas exchange	**5**

Total = 10 marks

Question Number	Answer	Mark
6 (a)	A oesophagus / gullet (1) B stomach (1) C small intestine / ileum / duodenum / jejunum (1) D large intestine / colon / eq (1)	**4**

Question Number	Answer	additional guidance	Mark
6 (b)	An explanation that makes reference to three of the following: • (plants contain) cellulose (1) • digested by cellulase / enzyme (1) • into <u>glucose</u> (1) • energy released / respiration / eq (1)	 allow broken down by cellulase converse for no cellulase energy not released / energy lost in feaces / eq	**3**

Question Number	Answer	Mark
6 (c)(i)	• humans do not digest cellulose / do not eat only plant material / omnivores / eat fewer / less plants / vegetables / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
6 (c)(ii)	An answer that makes reference to two the following: • removes <u>useful</u> bacteria / fewer / no useful bacteria / eq (1) • reduces competition / eq (1) • pathogenic bacteria increase / survive / multiply / grow / more harmful bacteria / eq (1)	not just appendix contains useful bacteria as this is in stem allow toxic / bad / eq to harmful bacteria	**2**

total 10 marks

10 (a)

Substrate	Enzyme	Products of digestion
starch	***amylase (1)***	maltose
maltose	maltase	***glucose(1)***
proteins / peptides / polypeptides (1)	protease	amino acids
lipids	lipase	***fatty acids /glycerol (1)***

4

Question number		Additional guidance	
10 (b)	C use different concentrations of vinegar / vinegar and no vinegar / range of pH acids / eq (1) O of same mass of starch / flour / bread /potato / rice / eq (1) R repeat (for each concentration (of vinegar) / eq (1) M1 use iodine to test for (digestion of) starch (1) M2 measure time it takes for all starch to be digested / iodine test to be negative / orange / yellow / or description of negative positive result / eq (1) S1 same temperature / use water bath / eq (1) S2 same time to react / same volume of amylase / same concentration of amylase / same mass of amylase / same volume of vinegar / same volume of iodine / same volume Benedic'ts /eq (1)	allow amount / more or less for C ignore amount Benedict's if starch still present will be blue black allow same volume of vinegar if vary conc in C	**6**

total 10 marks

Question Number	Answer	Mark
4 (a)(i)	The only correct answer is B (carbon, hydrogen, and oxygen only) A is incorrect because carbohydrates also contain oxygen C is incorrect because carbohydrates do not contain nitrogen D is incorrect because carbohydrates do not contain nitrogen	**1**

Question Number	Answer	Additional guidance	Mark
4 (a)(ii)	A description that makes reference to two of: • add biuret solution (1) • lilac / purple / pink colour (1)	**Allow** potassium / sodium hydroxide and copper sulfate other tests for protein **Allow** correct use of clinistix /uristix xanthoproteic test / ninhydrin with correct answer for two marks	**2**

Question Number	Answer	Additional guidance	Mark
4(b)(i)	• 1254(.4) / 1250 / 1300 (g) (2)	One mark for 5.6 **or** × 224 **or** 1400 ÷ 250 Correct answer with no working gains full marks	**2**

Question Number	Answer	Additional guidance	Mark
4 (b)(ii)	An answer that makes reference to five of the following points:		**5**
	• rice has less **protein** (than cow's milk) (1)	**Allow** soy has more protein / same protein (as cow's milk) / eq	
	• lack of protein / rice, could lead to less growth / repair / eq (1)	**Allow** converse for soy **Allow** rice could cause kwashiorkor / marasmus	
	• soy / rice has **less fat** than cow's milk / soy has more fat than rice / eq (1)	**Allow** soy / rice does not have enough fat	
	• soy / rice has **less energy** (than cow's milk) / rice has more energy than soy / soy has less energy than rice / eq (1)	**Allow** soy / rice do not have enough energy	
	• soy has **less carbohydrate** (than cow's milk) / rice has more carbohydrate than soy / rice has more carbohydrate (than cow's milk) / eq (1)	**Allow** rice has too much carbohydrate	
	• (less energy means) children may be less active / respire less / get tired easily / eq (1)		
	• rice has very little / less / not enough calcium (1)	**Allow** converse for soy	
	• lack of calcium / rice, could lead to rickets / weak bones teeth / eq (1)	**Allow** converse for soy	
	• (overall) soy is closer to cow's milk compared with rice / soy is a better substitute than rice / eq (1)	**Allow** soy is a suitable replacement	

(Total for Question 4 = 10 marks)

Question Number	Answer	Mark
2 (a)	A description that makes reference to two of the following. • peristalsis (1) • muscle contraction (1) • along oesophagus (1)	**2**

Question Number	Answer		Mark
2 (b)(i)	An answer that makes reference to one of the following. • fibre (1) • water (1) • other named vitamin / mineral (1)	e.g. vitamin A / iron **Ignore** vitamin C and calcium	**1**

Question Number	Answer		Mark
2(b)(ii)	An answer that makes reference to the following. • (vitamin C) scurvy / skin does not heal / blood vessels are weak / cartilage is weak / wounds do not heal / eq (1) • (calcium) rickets / weak bones / osteoporosis / eq (1)	**Allow** vitamin C needed for healthy skin / cartilage / connective tissue / eq **Allow** calcium needed for strong teeth / bones / eq	**2**

Question Number	Answer		Mark
2(b)(iii)	• RDA = 230 (g) (2)	**One mark** for 227.2727 **OR** 227 **OR** 2.3 **OR** other answer to correct decimal places with correct rounding	**2**

Question Number	Answer	Additional guidance	Mark
2(b)(iv)	A description that makes reference to three of the following. • protease / peptidase (1) • pepsin (in stomach) (1) • (digestion) in small intestine / duodenum / stomach / (protease) released by pancreas / stomach (1) • (produces) amino acids / (di)peptides (1)	**Allow** trypsin (in duodenum / from pancreas) **Ignore** absorbed in small intestine	**3**

(Total for Question 2 = 10 marks)

Question Number	Answer	Additional guidance	Mark
7(a)	• $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$ (2)	award one mark for correct but unbalanced equation no credit for word equation	**2**

Question Number	Answer	Mark
7(b)(i)	An explanation that makes reference to four of the following points: • place plant in dark (for 24 hours) (1) • to remove starch / destarch (1) • place plant in light (1) • test leaf no CO_2 / from flask and normal / control leaf (1) • sodium hydroxide removes CO_2 • using iodine solution / iodine test (1) • to show presence of starch (1)	**4**

Question Number	Answer	Mark
7(b)(ii)	An answer that makes reference to two of the following points: • fewer plants needed (1) • more students can do test / repeats / identify anomalies (1) • different shapes can be used to distinguish no CO_2 from control (1)	**2**

Question Number	Answer	Mark
7(c)	An explanation that makes reference to three of the following points: • keep all leaves in normal atmosphere / no NaOH (1) • use variegated leaf / eq / use a leaf with chlorophyll and one without (1) • compare blue black / starch areas with green areas / areas with chlorophyll / eq (1)	**3**

Total 11 marks

Question Number	Answer	Mark
3(a)	A description that makes reference to four of the following points: • boil leaf in water / eq (1) • boil in <u>ethanol</u> (to remove chlorophyll) (1) • hot water bath / kettle / turn off Bunsen / eq (1) • soak in water (to rehydrate / allow diffusion) (1) • add iodine solution (1) • <u>blue black</u> / eq (leaf uncovered) <u>starch present</u> / <u>yellow / eq</u> <u>no starch</u> (leaf covered) (1)	**4**

Question Number	Answer	additional guidance	Mark
3(b)(i)	An answer that makes reference to four of the following points: • increasing carbon dioxide increases rate /eq (1) • CO_2 required / substrate (for photosynthesis)/ eq (1) • greater higher (in rate) at high light intensity / eq (1) • light required / provides energy for photosynthesis/ eq (1) • increase is same from 0.00 to 0.02 / first two readings / eq (in both light intensities) (1) • levelling at (high light intensity) due to temperature / number of chloroplasts / amount of chlorophyll/ eq (1)	correct ref to CO_2 limiting factor allow converse light limiting/ eq factor ref to temperature limiting factor	**4**

Question Number	Answer	Mark
3(b)(ii)	An answer that makes reference to one of the following points: • use more bulbs / change bulb / wattage / use dimmer / filters / eq (1) • change distance (1)	**1**

Question Number	Answer	Mark
3(b)(iii)	• (number of) bubbles (per minute) / rate of photosynthesis / rate of oxygen production / eq	**1**

Question Number	Answer	Mark
3(b)(iv)	• same type / species / mass / number of leaves / length / size same piece of plant / eq	**1** **Grad**

Total = 11 marks

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>4(a)</td><td>
<table>
<tr><th>Function of vitamin</th><th>Vitamin</th></tr>
<tr><td>prevent scurvy</td><td>C</td></tr>
<tr><td>improve vision</td><td>(vitamin) A (1)</td></tr>
<tr><td>help bone growth</td><td>(vitamin) D (1)</td></tr>
</table>
</td><td>allow retinoid / carotene

allow calciferol</td><td>2</td></tr>
</table>

Question Number	Answer	Additional guidance	Mark
4(b)(i)	rate without vitamin C: 6.5 – 0.5 = 6.0 ÷ 30 = 0.20 (2)	award full marks for correct numerical answer without working allow 1 mark for 6.0 or ÷ 30	**2**

Question Number	Answer	Additional guidance	Mark
4(b)(ii)	An answer that makes reference to two of the following points: • pour contents onto filter paper (in funnel) (1) • heat / warm in oven (1) • weigh the residue /eq (using balance) (1)	 allow filter ignore sieve allow to dry/ evaporate	**2**

Question Number	Answer	Mark
4(b)(iii)	(dry) mass of yeast	**1**

Question Number	Answer	Additional guidance	Mark
4(b)(iv)	An explanation that makes reference to four of the following points: • temperature (1) • because it affects enzymes / enzymes have optimum temperature / rate of reaction / kinetic energy of molecules /eq (1) Or • pH (1) • because it affects / denatures enzymes /eq (1) Or • oxygen / aerobic /anaerobic conditions /eq(1) • because it affects respiration (1) Or • species / strain / type of yeast (1) • because they may grow at different rates / eq (1) Or • <u>concentration</u> of glucose solution (1) • used in respiration by yeast (1)	ignore volume of glucose ignore mass of yeast ignore time ignore mass / conc of Vitamin C	**4**

Total 11 marks

Question Number	Answer	Additional guidance	Mark
8(a)	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (2)	one mark for incorrectly balanced equation	**2**

Question Number	Answer	Mark
8 (b)(i)	• repeats / find means / eq (1)	**1**

Question Number	Answer	Mark
8 (b)(ii)	• time taken (for leaf to rise) (1)	**1**

Question Number	Answer	Additional guidance	Mark
8 (c)	An explanation that makes reference to four of the following: • as distance increases, light intensity / energy decreases (1) • (as distance increases / as light intensity decreases) rate of photosynthesis decreases / is slower / eq (1) • so less oxygen is produced / eq (1) • oxygen is trapped in leaf and causes leaf discs to rise / eq (1) • when close to lamp another factor is limiting / light intensity is not limiting / eq (1) • limiting factor could be temperature / carbon dioxide concentration (1)	**Accept** converse for decreasing distance	**4**

Question Number	Answer	Mark
8 (d)	An explanation that makes reference to three of the following: • place leaf disc in boiling water (1) • heat / boil leaf in ethanol (1) • stain with iodine (1) • iodine stain will turn blue black with starch (1)	**3**

Total for Question 8 = 11 marks

Question Number	Answer	additional guidance	Mark
3(a)(i)	An answer that makes reference to five of the following 1. oat milk provides more energy kJ / calories / (per 225 g) / eq (1) 2. more energy less weight loss / idea of carbohydrate / fats not used so stored / so more weight gain/ eq (1) 3. oat provides more (saturated) fat / eq (1) 4. oat provides more carbohydrate / eq (1) 5. oat provides similar sugar / same sugar/eq (1) 6. oat provides more protein (required for growth) / eq (1) 7. oat milk provides more fibre (1) 8. for peristalsis /prevent constipation / eq 9. but balance diet required / depends upon other foods consumed / eq (1) 10. weight loss depends upon activity age / eq (1)	allow converse Idea of energy balance more consumed than used	**5**

Question Number	Answer	Mark
3(a)(ii)	An answer that makes reference to the following • allergy / allergic / lacks enzyme / lactase / lactose intolerant / wants reduced (saturated) fat diet / cow's milk contains more fat / are vegan / wants to avoid constipation as cow's milk has no fibre / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
3(b)	A description that makes reference to two of the following • Benedict's added / eq (1) • heated / eq (1) • red / green / yellow / orange / eq (1)	allow alternative test Fehlings or $CuSO_4$ and Na_2CO_3 allow Benedict's test for mp 1 allow clinistix / ursitix / glucose testing strip for mp 1 and correct colour change for mp 3 / brown	**2**

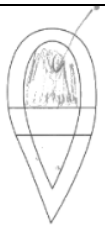
Question Number	Answer	Mark
3(c)	An explanation that makes reference to three of the following • <u>antibodies</u> (1) • (specific to / against / for) antigen / virus / bacterium / pathogen / eq (1) • <u>stick / clump / burst / label</u> bacteria / virus/ pathogen /eq (1) • <u>destroy / kill</u> bacteria / virus / pathogen / eq (1)	**3**

Total 11 marks

Question Number	Answer	Mark
6 (a)	An answer that makes reference to the following. $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (2) **one mark** if correct equation but incorrectly balanced	**2**

Question Number	Answer		Mark
6(b)(i)	An answer that makes reference to the following. • destarch the leaves / remove starch eq (1)	**Allow** so no starch present (in leaves) / so starch is used up / starch respired	**1**

Question Number	Answer		Mark
6 (b)(ii)	An answer that makes reference to the following. • **both** green areas shaded **and** area with no green with no shading / eq (1) • no shading in strip under paper / eq (1)	**Allow** labelled areas if not shaded (black / orange / starch / no starch) **No mp2 if rest of leaf is blank**	**2**

	**2 marks**
	**1 mark**
	**1 mark**
	**1 mark**
 Diagram 2	**0 marks**

Question Number	Answer		Mark
6 (c)	An answer that makes reference to six of the following. • C – (plant ivy in) shaded and unshaded area / different exposure to light / eq (1) • O – same species / type / age / starting size of leaf / same plant / eq (1) • R – repeat with multiple leaves / repeat / eq (1) • M1 – measure length / width / height / surface area / eq (of leaves) (1) • M2 – grow ivy for same <u>stated</u> time (1) • S1 - temperature / pests / humidity / plant density / carbon dioxide / weather / time of year / wind / eq (1) • S2 – same water / minerals / soil / nutrients / fertiliser / pH / eq (1)	**Allow** different light intensities / distances of lamp **Allow** groups **Ignore** size of leaves **Allow** measure size with a ruler / in mm / eq **Allow** volume Minimum time of one day	**6**

(Total for Question 6 = 11 marks)

Question Number	Answer	Additional guidance	Mark
4(a)(i)	• water / protein (1)	**Accept** amino acids	**1**

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	26 **(2)** **One mark** for correct answer to any number of decimal places e.g. 26.28571… **OR** **One mark** for 9.2÷35 **OR** **One mark** for 0.26(28571)	Example calculation: 9.2/35 x 100 = 26.28571 **Correct answer gains both marks**	**2**

Question Number	Answer	Additional guidance	Mark
4(a)(iii)	An answer that makes reference to one of the following: • helps peristalsis / eq (1) • prevents constipation / eq (1) • helps intestines push food / eq (1) • helps release faeces / eq (1) • helps egestion / eq (1) • helps in movement of food / eq (1)	**Reject** excrete faeces	**1**

Question Number	Answer	Additional guidance	Mark
4(b)	An answer that makes reference to three of the following: • amylase (1) • from salivary glands / from pancreas / eq (1) • starch / it, is digested into maltose (1) • maltase digests maltose (into glucose) (1)	**Accept** (released into / digested in) mouth **Accept** (released into / digested in) small intestine / duodenum / ileum **Accept** broken down / hydrolysed / turned into for digested	**3**

Question Number	Answer	Additional guidance	Mark
4(c)(i)	An answer that makes reference to the following: • 38 (mg per cm^3) (1)		**1**

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	An answer that makes reference to the following order: • orange lemon (lime) apple grape (1)	**Accept** numbers from table i.e. 3 4 (lime = 7) 18 22	**1**

Question Number	Answer	Additional guidance	Mark
4(c)(iii)	An answer that makes reference to two of the following: • use a syringe / graduated pipette / measuring cylinder / burette / eq (1) • to measure volume / ml / cm^3 / dm^3 / mm^3 / eq (1) • as drop sizes vary / masses of drops vary / volumes of drops vary / eq (1) • mix / swirl / stir (solution after adding drops) / eq (1)	**Ignore** references to repeats / replicates **Ignore** pipette alone **Accept** Automatic pipette **Accept** volumetric pipette **Accept** balance / scale **Accept** use titration **Accept** mass / weight (of juice) **Accept** idea that method does not control drop size	**2**

(Total for Question 4 = 11 marks)

Question Number	Answer	Mark
8(a) (i)	Only B is correct as this transports amino acids *A is incorrect as this does not transport amino acids* *C is incorrect as this does not transport amino acids* *D is incorrect as this does not transport amino acids*	**1**

Question Number	Answer	Mark
8(a) (ii)	Only C is correct as this absorbs most sunlight *A is incorrect as this does not absorb most sunlight* *B is incorrect as this does not absorb most sunlight* *D is incorrect as this does not absorb most sunlight*	**1**

Question Number	Answer	Mark
8(a) (iii)	Only C is correct as this transports the products of photosynthesis *A is incorrect as it does not transport the products of photosynthesis* *B is incorrect as it does not transport the products of photosynthesis* *D is incorrect as it does not transport the products of photosynthesis*	**1**

Question Number	Answer	Mark
8(a)(iv)	Only A is correct as it reduces water loss *B is incorrect as it does not reduce water loss* *C is incorrect as it does not reduce water loss* *D is incorrect as it does not reduce water loss*	**1**

Question Number	Answer	Additional guidance	Mark
8(b)	An explanation that makes reference to four of the following points: • R / palisade are near top / surface **to** absorb as much light as possible / eq (1) • R / palisade contain <u>many</u> / eq chloroplasts / lots of chlorophyll **to** absorb as much light as possible / eq (1) • R / palisade / are densely packed/ rectangular / long / arranged vertically **to** absorb as much light as possible / eq (1) • T / spongy are near bottom of leaf / stomata **for** absorption of CO_2 (1) • T / spongy are less densely packed / have air spaces/ gaps **for** diffusion / gas exchange / gas movement /eq (1)	Adaptation and reason needed for each mark Need only mention absorb light once must indicate many / eq	**4**

Question Number	Answer	Additional guidance	Mark
8(c)	• measure leaf = 29 (mm) / 2.9 (cm) • 29 ÷ 100 = 0.29 mm	**Allow** 1 mark for 29-33 (mm) or 2.9 (cm) to 3.3 (cm) **Allow** 1 mark for dividing by 100 **Allow** two marks for correct answer **Allow** range from 0.29 mm to 0.33 mm	**2**

Question Number	Answer	Mark
8(d)	An answer that makes reference to two the following points: • lower surface in water / upper in air / stomata would be in water / eq (1) • (stomata) able to absorb CO_2 / gases (by diffusion) / allows gas exchange (1) • (stomata) able to lose water (by transpiration / evaporation) / to allow transpiration (1)	**2**

Total = 12 marks

Question Number	Answer	Additional guidance	Mark
10 (a)	• $6CO_2 + 6H_2O$ (1) • $C_6H_{12}O_6$ (1)	**Allow** in either order	**2**

Question Number	Answer	Additional guidance	Mark
10 (b)(i)	An answer that makes reference to two of the following points: (mark in pairs) • temperature (1) • use a water bath / eq (1) OR • pH (1) • use a buffer (1)		**2**

Question Number	Answer	Additional guidance	Mark
10 (b)(ii)	An explanation that makes reference to the following points: • as distance (of lamp) increases, light (intensity) decreases / eq (1) • decreasing light intensity / increasing distance (at either concentration), decreases (rate of) photosynthesis / number of bubbles / eq (1) • as less energy (is absorbed) / eq (1) • with 5% solution there is no change in bubble production (from 5 cm) up to 15 cm / rate levels off between 15 cm and 5 cm / eq (1) • with 5% solution carbon dioxide is the limiting factor (between 5 cm and 15 cm) / carbon dioxide does not limit the rate of photosynthesis in the 10 % solution / eq (1) • light is a limiting factor (at both concentrations) for distances at / over 15 cm (1)	**Allow** converse **Allow** converse **Allow** converse **Allow** rate is constant until 20 cm / rate decreases after 15 cm **Allow** reducing carbon dioxide concentration reduces the rate as carbon dioxide is a limiting factor **Allow** light is the limiting factor for the 10 % solution **Allow** light is not the limiting factor up to 15 cm in the 5 % solution	**4**

Question Number	Answer	Additional guidance	Mark
10 (b)(iii)	An answer that makes reference to the following points: • (collect / measure) volume (1) • using a measuring cylinder / syringe / burette / eq (1)	**Allow** measure in cm^3 / eq **Allow** graduated test tube / test tube with scale / height of bubble in test tube	**2**

Question Number	Answer	Additional guidance	Mark
10 (b)(iv)	A description that makes reference to two of the following points: • repeat (1) • calculate means / averages (1) • identify / remove anomalies / check that results are concordant / eq (1)		**2**

(Total for Question 10 = 12 marks)

Question Number	Answer		Mark
3(a)	mass of starch ÷ mass of carbohydrate × 100 98% (2)	allow 1 mark for ÷ 68 allow 97.8 / 97.79 / 97.794 etc for 2 marks	**2**

Question Number	Answer	additional guidance	Mark
3(b)	An answer that that makes reference to four of the following points: biscuit B , difference and explanation 1. less energy/ kJ so less stored as fat / less weight gain / stored fat used for energy / eq (1) 2. less lipid / so less (energy) stored as fat / less weight gain / less blood cholesterol / less risk of CHD / eq (1) 3. less sugar / so less (energy) stored as fat / less weight gain / less risk of diabetes / eq (1) 4. more starch so energy released (more) slowly / eq (1) 5. less salt so less effect on blood pressure / less risk of CHD/ eq (1) 6. more protein for repair / growth / eq(1)	allow converse for biscuit A **if no reason and explanation** allow one max for biscuit B and correct difference(s) not just to lose weight	**4**

Question Number	Answer	additional guidance	Mark
3(c)(i)	A description that makes reference to four of the following points: 1. measure out cm^3 / same volume / measure mass of water / eq (1) 2. use sample of biscuits of same mass / known mass / eq (1) 3. hold under boiling tube of water /eq (1) 4. relight if goes out / continue until completely burnt / eq (1) 5. (use thermometer to) measure increase in water temperature / measure initial and final temperature of water/ eq (1) 6. highest temperature rise / ref to equation has most energy / eq (1)	allow mp 1 2 5 6 from equation energy = (mass of water x temp rise x 4.2) ÷ mass of biscuit	**4**

Question Number	Answer	Mark
3(c)(ii)	An answer that includes two of the following • some energy lost / some heat escapes / (to surroundings) / not all energy reaches tube / some released as light /eq (1) • not completely burnt / not all energy released / not burnt in oxygen / eq (1) • temperature of water uneven / eq (1)	**2**

Total = 12 marks

Question Number	Answer	Mark
3(a)(i)	The only correct answer is B A is not correct as it does not produce hydrochloric acid C is not correct as it does not produce hydrochloric acid D is not correct as it does not produce hydrochloric acid	**1**

Question Number	Answer	Mark
3(a)(ii)	The only correct answer is D A is not correct as it does not store faeces B is not correct as it does not store faeces C is not correct as it does not store faeces	**1**

	Answer	Mark
3(b)	An explanation that makes reference to two of the following points: • neutralises acid / eq (1) • optimal pH for enzymes / lipase eq (1) • emulsifies lipid / eq (1) • breaks down (large droplets) into small droplets / eq (1) • increases surface area for enzyme action /eq (1)	**3**

Question Number	Answer	Mark
3(c)(i)	An explanation that makes reference to four of the following points: • large surface area (1) • microvilli (1) • capillaries / blood supply to maintain concentration gradient / diffusion gradient (1) • absorb digested food / molecules / vitamins / minerals / correct named molecule / eq (1) • lacteal to absorb fats / correct vitamin / transport fats / eq (1) • thin wall / one cell thick / capillaries close to surface (1) • so short diffusion path / rapid diffusion / rapid active transport (1)	**4**

Question Number	Answer		Mark
3(c)(ii)	An answer that makes reference to four of the following points: • shorter / few / no villi / microvilli (1) • reduced surface area (1) • less absorption of digested food / molecules / vitamins / minerals / correct example / eq (1) • less glucose / lipid / eq, for energy / respiration / ATP (1) • fewer amino acids for growth / protein synthesis (1) • less vitamins / minerals / named vitamin or mineral for correct function of named vitamin or mineral (1)	Allow sugar for glucose e.g. iron for haemoglobin	**4**

Total = 13 marks

Question Number	Answer	Mark
4(a)(i)	An explanation that makes reference to two of the following points: • no photosynthesis (1) • remove all starch / destarch / eq (1) • by respiration (1) • so any starch present is due to photosynthesis (in the experiment) (1)	**2**

Question Number	Answer	Mark
4(a)(ii)	An explanation that makes reference to the following points: • act as a control / for a comparison (1) • show photosynthesis can occur with CO_2 present / show difference between X and Y is due to CO_2 (1) • show that when CO_2 is present light is required for photosynthesis / eq (1)	**2**

Question Number	Answer	Mark
4(a)(iii)	An answer that makes reference to four of the following points: • place leaf in boiling water (1) • boil / heat in ethanol (1) • use water bath / switch off Bunsen / keep away from Bunsen / eq (1) • wear safety glasses / use tongs / forceps / eq (1) • add iodine solution (1) • if starch present goes blue/black / see if it goes blue / black (1)	**4**

Question Number	Answer	Additional guidance	Mark
4(b)	An explanation that makes reference to the following points • on leaf Y (1) • no starch present under black paper strip (1) • so this part will be yellow/ orange / not blue black / eq (1)	Allow converse for rest of leaf	**3**

Question Number	Answer		Mark
4(c)	An explanation that makes reference the following points: • starch is insoluble / eq (1) • does not have osmotic effect on plant cell does not diffuse / pass out of cells / eq (1)	Allow converse for glucose for both MPs	**2**

Total = 13 marks

Question Number	Answer	additional guidance	Mark
8 (a)	0.04% = 0.04 in 100 1000000 ÷100 = 10000 10000 x 0.04 = 400 (ppm) (2)	allow 2 marks for correct answer no working allow 1 mark for 10000	**2**

Question Number	Answer	Mark
8 (b)(i)	An answer that makes reference to the following: • (increasing CO_2) increases (relative)(rate of photosynthesis) (1) • (begins to) level off / reaches maximum (at 0.10 % at 1.12) / rate of increase steepest up to 0.06 %/ eq (1)	**2**

Question Number	Answer	additional guidance	Mark
8 (b)(ii)	An answer that makes reference to two the following: • steepest increase / most effect at 35°C / higher temperatures / eq (1) • increasing CO_2 increases (relative) rate of photosynthesis at all temperatures (1) • at CO_2 of 0.03 %, temperature is not the limiting factor / CO_2 is limiting factor so increasing the temperature has little effect.(1)	allow converse	**2**

Question Number	Answer	Mark
8 (b)(iii)	An explanation that makes reference to three the following: • increasing temperature increases (relative) rate of photosynthesis (1) • as more (kinetic) energy (supplied to molecules) /eq (1) • more (frequent) collisions / faster collisions (between substrate and enzyme molecules) / more enzyme substrate complexes formed/ eq (1) • temperature becomes limiting factor at 5°C / increasing CO_2 has less effect on rate/eq (1)	**3**

Question Number	Answer	additional guidance	Mark
8 (c)(i)	An explanation that makes reference to one pair of the following: • nitrate (1) • for / amino acids/ proteins /stunted growth/	 allow	**2**

	yellow leaves / eq OR • magnesium (1) • for chlorophyll / yellow leaves chlorosis /eq (1) OR • other correct mineral (1) • correct effect (1)	chloroplasts allow chloroplasts must have named mineral to get effect	

Question Number	Answer	additional guidance	Mark
8 (c)(ii)	An explanation that makes reference to two of the following: • (increasing) light (intensity) (1) • provides energy for / required for photosynthesis / absorbed / trapped / used by chloroplasts /chlorophyll / stomata open more / eq (1) OR • changing wavelength / colour of light (1) • some not absorbed / affect photosynthesis (1) OR • (availability of) water (1) • as reactant / substrate / used in photosynthesis (1)	allow no light no photosynthesis= required for	**2**

total 13 marks

Question Number	Answer	Mark
3(a)(i)	**A (P)** B is not the answer as Q is not the oesophagus C is not the answer as R is not the oesophagus D is not the answer as U is not the oesophagus	**1**

Question Number	Answer	Mark
3(a)(ii)	**D (T)** A is not the answer as P is not part of the large intestine B is not the answer as Q is not part of the large intestine C is not the answer as R is not part of the large intestine	**1**

Question Number	Answer	Mark
3(a)(iii)	**C (S)** A is not the answer as Q does not contain villi B is not the answer as R does not contain villi D is not the answer as V does not contain villi	**1**

Question Number	Answer	Mark
3(a)(iv)	**A (Q)** B is not the answer as S is not the stomach C is not the answer as T is not the stomach D is not the answer as V is not the stomach	**1**

Question Number	Answer	additional guidance	Mark
3(b)	A description that makes reference to the following: • peristalsis (1) • muscles contract (behind food) / muscles push (food along) / muscles squeeze / eq (1)	ignore muscles move	**2**

	Answer	additional guidance	Mark
3(c)(i)	An answer that makes reference to four of the following: 1. more protein in young dog food as they are growing more / for growth / eq (1) 2. amino acids for protein synthesis / eq (1) 3. more fat in young dog food as more active / for growth / eq (1) 4. more fat for energy / for respiration / eq (1) 5. more calcium in young dog food as more bone and teeth growth / eq (1) 6. more phosphate for bones / ATP / DNA /eq (1) 7. **all** components higher in young dog food / total percentage higher / eq (1)	allow converse for adult stated not cumulative if mp 1-6 not credited **allow one mark max** for one correct difference eg more protein in	**4**

		young dog food	

	Answer	additional guidance	Mark
3(c)(ii)	An answer that makes reference to three of the following: 1. excess carbohydrates / starch / glucose / energy converted to fat / eq (1) 2. may gain (too much) mass / become obese / overweight / eq (1) 3. may become diabetic / have heart disease / CHD / eq (1) 4. may fail to thrive / grow / eq (1) 5. as lack protein / eq (1)	ignore become fat	**3**

total 13 marks

Question Number	Answer	additional guidance	Mark
2(a)	An explanation that makes reference to the following: • final temp minus start temperature / calculate change in temperature / calculate difference in temperatures (1) • multiply by 4.2 / specific heat capacity (of water) (1) • multiply by mass (of water) / 20 (1) mc Δθ = 3 marks mc ΔT = 3 marks	**Ignore** division by mass **Accept** volume of water **Allow** all marks from equation	**3**

Question Number	Answer		Mark
2(b)	An answer that refers to: • repeat / calculate means / eq (1)	**Ignore** repeat with **different** types of grain **Accept** repeat with each grain	**1**

Question Number	Answer	Mark
2(c)(i)	An explanation that makes refence to the following: • large surface area / more contact of tube with water / eq (1) • more energy transferred / more heat transferred / better heat transfer / eq (1)	**2**

Question Number	Answer	Mark
2(c)(ii)	An answer that refers to : • completely burns grain / complete combustion / complete oxidation / eq (1)	**1**

Question Number	Answer	Additional guidance	Mark
2(d)(i)	5 (g) **OR** 4.6 (g) **OR** 4.55 (g) **OR** 4.5 (g) (2)	**Allow** 1 mark for 0.07 **OR** x 65 **Allow** full marks for correct answer no working	**2**

Question Number	Answer	additional guidance	Mark
2(d)(ii)	An answer that makes reference to four of the following points: **one from:** • **oats** have high fat / high carbohydrate **AND** for running / for respiration / for energy / eq (1) • **oats** have high protein **AND** for muscles / repair / eq (1) • **oats** have high fat **AND** could cause heart disease / CHD / eq (1) **one from:** • **rye** has low fat / energy **AND** so cannot run as well / eq (1) • **rye** has low protein **AND** so not good muscle growth / cannot repair cells / eq (1) • **rye** has low fat **AND** so less risk of heart disease / eq (1) • **rye** has high fibre **AND** so athlete will not have constipation / good peristalsis / eq (1) **one from:** • **rice** has high carbohydrate **AND** so run well / for respiration / provides high energy / eq (1) • **rice** has low protein **AND** so not good muscle / repair / eq (1) • **rice** has low fat **AND** so less risk of heart disease / may lack energy / eq (1) • **rice** has low fibre **AND** so risk of constipation / poor peristalsis / eq (1) **one from:** • **wheat** has low carbohydrate **AND** so will lack endurance / will lack energy / eq (1) • **wheat** has high protein **AND** so helps to build muscle / repair tissues / eq (1) • **wheat** has high fat **AND** so more risk of heart disease / has (long term) energy / eq (1) • **wheat** has high fibre **AND** so reduces risk of constipation / good peristalsis / eq (1)	**Accept oats** have high / most energy **AND** for running / eq **Accept rye** has low fat **AND** so less energy **Accept rice** has high energy **AND** so can run well / eq **Accept wheat** has low (overall) energy **AND** so cannot run well / eq	**4**

Total 13 marks

Question Number	Answer	Mark
3(a)	• light / sunlight / solar (1) • chemical (1)	**2**

Question Number	Answer	additional guidance	Mark
3(b)(i)	An explanation that makes reference to two of the following • keep in dark for 12/ 24 /48 hours /eq (1) • so all starch used up / eq (1) • in respiration (1)	Not just a while /some time No credit for no photosynthesis	**2**

Question Number	Answer	additional guidance	Mark
3(b)(ii)	• LHS outside flask black / blue / starch present / eq (1) • RHS inside flask yellow / orange / brown / no starch / eq (1)	If unlabelled allow LHS if shaded for one mark If starch and colour don't match no credit	**2**

Question Number	Answer	Additional guidance	Mark
3(c)	A description that includes • mineral 1 / eq (1) • function 1 / eq (1) • mineral 2 /eq (1) • function 2 / eq (1)	Can gain two for two correct mineral **ions** mineral with correct function not just for growth nitrate amino acids / proteins / enzymes / DNA magnesium chlorophyll / chloroplasts / photosynthesis iron chlorophyll / chloroplasts / photosynthesis /respiration phosphate DNA / ATP /cell membranes calcium cell walls/cell membranes potassium water balance / enzymes /photosynthesis /respiration Ignore phosphorous nitrogen but allow function So phosphorus for DNA scores one mark nitrogen for amino acids scores one mark	**4**

Question Number	Answer	Additional guidance	Mark
3(d)	An explanation makes reference to three of the following 1. active transport / eq (1) 2. no / less oxygen (in waterlogged / flooded soil) / eq (1) 3. no / less respiration / eq (1) 4. no / less energy / ATP / eq (1)	No credit for no air	**3**

Question Number	Answer	Additional guidance	Mark
10(a)	A description that makes reference to the following points: • carbohydrate for energy / respiration (1) • lipid / fat for energy / storage / insulation / myelin / hormones / protecting organs (1) • protein for growth / repair / (named) enzyme / hormones / antibodies / neurotransmitter (1) • water as solvent / transport / reactions / temperature regulation / prevent constipation / help egestion (1) • fibre / roughage for peristalsis / move food / prevent constipation / help egestion (1)	Allow correct named hormone for Mp2 and Mp3 Mp3 Ignore skin / nails / hair / bones Ignore prevents cancer	**5**

Question Number	Answer	Additional guidance	Mark
10(b)	An explanation that makes reference to four of the following points: • vitamin A for (foetus) eyes / vision / sight (1) • vitamin C for (foetus) skin / (connective) tissue (1) • vitamin D for (foetus) bones / teeth / calcium absorption (1) • calcium for (foetus) bones / teeth / milk (1) • iron for (foetus) haemoglobin / Hb / red blood cells (1) • phosphate for (foetus) ATP / bones / DNA / RNA (1)	Answer makes no mention of foetus / embryo / baby = max 3 Mp2 Ignore scurvy Mp3 Ignore rickets Allow other vitamins and minerals eg. vitamin B for nerve development	**4**

Question Number	Answer	Mark
10(c)(i)	(70 × 126 =) 8820	**1**

Question Number	Answer	Additional guidance	Mark
10(c)(ii)	• determine difference in energy requirement • multiplication to get percentage 98.8 / 98.81 / 99 (2)	Award full marks for correct numerical answer without working overweight 84 and underweight 167 167 – 84 = 83 ÷ 84 percentage increase = 83 ÷ 84 × 100 or 167 × 80 = 13360 84 × 80 = 6720 6640 ÷ 6720 = 0.98809 × 100 Allow one mark for 83 **and** 84 or 13360 **and** 6720	**2**

Question Number	Answer	Additional guidance	Mark
10(c)(iii)	An explanation that makes reference to two of the following points: • use lipid / fat / glycogen / protein (1) • <u>respiration</u> (1)	Mp1 Ignore idea of not having enough lipid / protein = 0	**2**

Total 14 marks

Question Number	Answer	additional guidance	Mark
3(a)	A description that makes reference to three of the following points: • crush / grind nut /eq (1) • ethanol / Sudan III (1) • add water (1) • white / emulsion / red (layer) (1)	if add oil -1 to score	**3**

Question Number	Answer	Additional guidance	Mark
3(b)(i)	An explanation that makes reference to two of the following points: • peristalsis (1) • move food along intestine / prevent constipation / helps bowel movement / eq (1) • undigested material / indigestible / cellulose (1)	**ignore** ref to prevent cancer **ignore** helps digestion	**2**

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	An explanation that makes reference the following points: • (nut A) has <u>more</u> iron/protein (1) • (more) haemoglobin (1)	iron for haemoglobin scores 1	**2**

Question Number	Answer	Additional guidance	Mark
3(b)(iii)	• $16.7 \times 10^{-2} = 0.167$ • x 28 = 4.68 allow 4.676 allow 4.7	award full marks for correct numerical answer without working should be 3 sig figs allow one mark for 0.167 **or** one mark for x 28 one mark for any version 4676 or 47 or 468	**2**

Question Number	Answer	Mark
3(c)	An explanation that makes reference to five of the following points: • more foxes (to eat squirrels) / increased predation (1) • foxes eat nuts (so less food) (1) • fewer trees (1) • other species enter woods and feed on nuts /eq (1) • <u>other</u> predators entered woodland (1) • disease / infection (1) • migration / eq (1) • time of year when numbers counted (1) • cold weather / lower temperature (1) • fox increase <u>is more than</u> tree decrease (1) • human impact / hunting (by humans) / eq (1)	**5**

Total = 14 marks

Question Number	Answer	Additional guidance	Mark
4(a)	An answer that makes reference to the following points: $6CO_2 + 6H_20 \longrightarrow C_6H_{12}O_6 + 6O_2$ (2)	**Allow** 1 mark for unbalanced but correct formula No marks for word equation	**2 grad**

Question Number	Answer	Additional guidance	Mark
4(b)(i)	• 84 + 80 ÷ 2 • 82 (2)	**Allow** 1 mark for 70 or 70.3 or 70.33 etc **Allow** one mark for 164 or 80 + 84 Award full marks for correct answer	**2 grad**

Question Number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation that makes reference to four of the following points: • no filter has highest rate of photosynthesis / bubbling / oxygen (1) • (because) all light colours / wavelengths are present / has more light energy / most amount of light that can be absorbed / eq (1) • green has low(est) rate of photosynthesis, **because** green light is not absorbed / eq (1) • blue / red has a medium rate of photosynthesis **because** light is, absorbed / not reflected / eq (1) • chlorophyll / chloroplast absorbs red / blue light / does not absorb green light / eq (1)	**Allow** no bubbling / 8 bubbles / no oxygen production **because** green light is reflected / passes through **Allow** causes photosynthesis / produces bubbles **because** light is, absorbed / not reflected / eq	**4 exp**

Question Number	Answer	Additional guidance	Mark
4(b)(iii)	An answer that makes reference to two of the following points: • temperature (1) • carbon dioxide (1) • light <u>intensity</u> (1)	**Allow** volume / amount / concentration of hydrogen carbonate **Allow** brightness of lamp/ thickness of filter / eq	**2 grad**

Question Number	Answer	Additional guidance	Mark
4(c)(i)	An explanation that makes reference to two the following points: • bubbles are different volumes / sizes (1) • O_2 may dissolve in water (1) • bubbles may be CO_2 not oxygen / may not be due to photosynthesis /other gases may be present (1) • easy to miscount / miss bubbles (1) • bubbles get trapped / stuck (1)	**Allow** bubbles may be due to respiration **Ignore** 'make error' unqualified	**2 exp**

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	An answer that makes reference to two the following points: • use measuring cylinder / (gas) syringe / burette / graduated test tube (1) • (to measure) volume (1) OR • use hydrogen carbonate <u>indicator</u> (1) • change colour (of hydrogen carbonate indicator) (1)		**2 exp**

Total 14 marks

Question Number	Answer	Mark
2(a)	The only correct answer is A it is digested into amino acids *B is not correct as its surface area is not increased by bile* *C is not correct as its pH is not raised by hydrochloric acid* *D is not correct as it is not absorbed by villi*	**1**

Question Number	Answer	Additional guidance	Mark
2(b)	<table><tr><th>Component</th><th>Function</th></tr><tr><td>lipid</td><td>store of energy</td></tr><tr><td>vitamin D</td><td>bone / teeth / calcium absorption / prevent rickets (1)</td></tr><tr><td>iron</td><td>haemoglobin / red blood cells (1)</td></tr><tr><td>fibre</td><td>peristalsis / move food / prevent constipation (1)</td></tr></table>	Ignore egestion Helps digestion and prevents constipation = 1	**3**

Question Number	Answer	Additional guidance	Mark
2(c)(i)	20% of 1250 = 250 250 ÷ 50 = 5 (2)	Award full marks for correct numerical answer without working Allow one mark for 250 in working	**2**

Question Number	Answer	Mark
2(c)(ii)	An answer that makes reference to six of the following points: • GM salmon grow more / heavier / longer / larger / more mass / grow faster / eq (1) • (more) protein provided (1) • only need protein in correct amount / only need sufficient protein / only need 50g / too much protein / excess protein / eq (1) • balanced diet also needs vitamins / carbohydrate / lipid / minerals / fibre / no idea of other **named** component in salmon (1) • one salmon used / not repeated/ should use several fish (1) • (data) not reliable / result may be anomalous (1) • no information on food supply to salmon / temperature / oxygen / pollution (1) • protein need depends on age / sex / activity / eq (1)	**6** **Mp1 Allow converse**

Question Number	Answer	Additional guidance	Mark
2(d)	An answer that makes reference to the following points: • gene / allele (1) • restriction / endonuclease (1) • ligase (1)	Allow restrictive	**3**

Total 15 marks

Question Number	Answer	Mark
4(a)(i)	An explanation that makes reference to the following: • peristalsis (1) • (waves of) muscular <u>contractions</u> (1)	**2**

Question Number	Answer	Mark
4 (a)(ii)	C liver A is incorrect because bile is not made in the stomach B is incorrect because bile is not made in the pancreas D is incorrect because bile is not made in the gall bladder	**1**

Question Number	Answer	Mark
4 (a)(iii)	An explanation that makes reference to three of the following: • bile neutralises stomach acid / food / chyme / eq (1) • to set the optimum pH for <u>enzymes</u> (1) • bile emulsifies fats / breaks up fats into smaller droplets / eq (1) • to increase the surface area (for digestion) (1)	**3**

Question Number	Answer	Additional guidance	Mark
4 (b)(i)	0.11 (2)	One mark for 2.2 or 8 - 5.8 One mark for dividing by 20 **Award full marks for correct answer**	**2**

Question Number	Answer	Additional guidance	Mark
4 (b)(ii)	An explanation that makes reference to two of the following: • (without inhibitor) pH falls faster / falls more / becomes more acidic (without inhibitor) / bigger change in pH / eq (1) • because fats are broken down into fatty acids (and glycerol) (1) • inhibitor causes less acid to be produced (1)	**Accept** converse **Accept** converse	**2**

Question Number	Answer	Additional guidance	Mark
4 (b) (iii)	A discussion that makes reference to five of the following: 1. lower blood lipid / fat when taking inhibitor / eq (1) 2. (because) less fat is absorbed (when taking inhibitor) (1) 3. fat needs to be broken down into fatty acids (to be absorbed) (1) 4. less fat would be stored / deposited around the body (1) 5. one person who did not take inhibitor did not have increase in lipid / fat in blood / eq (1) 6. two / more / some suffered side effects when taking the drug / eq (1) 7. side effects may be due to the olive oil / may not be caused by the drug (1) 8. sample size is only very small / eq (1) 9. there is no information about diet / other food / activity / eq (1) 10. no information on age / sex / health / diabetes / eq (1) 11. no information on change of mass of people / experiment does not actually assess obesity / / eq (1) 12. starting levels of blood lipid were equal (so were controlled) (1)	**Accept** drug causes side effects / abdominal pains **Accept** one person had side effects without drug **Accept** other factors may affect obesity	**5**

Total for Question 4 = 15 marks

Question Number	Answer	Additional guidance	Mark
6(a)(i)	calculation method not marking points 82 ÷ 120 = 0.683 0.683 × 100 = 68 or 68.3 or less 68.33 (2)	Full marks for correct answer If answer incorrect allow one mark for ÷ 120 Allow any number of significant figures that round to 68	**2**

Question Number	Answer	Additional guidance	Mark
6(a)(ii)	An explanation that makes reference to • (temperature) changes during the day / changes at night / eq (1) • is more realistic / natural / outside / simulates / mirrors / eq (1)	Ignore changes in seasons	**2**

Question Number	Answer	Mark
6(a)(iii)	• leaf area / growth of maize / leaf size / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
6(b)(i)	An answer that includes • scales linear and at least 3.5 big squares on y axis and 3 on x axis (1) • lines straight and through all points (1) • axis right way round (days on x and leaf area y) with Units days and cm^2 / eq (1) • points correctly plotted within a small square (1) • key / labelled A and B	allow 2 different graphs for A and B ignore extrapolation Bar chart max 4 no L	**5**

Question Number	Answer	Additional guidance	Mark
6(b)(ii)	calculation method not marking points (6800 – 10) ÷ 100 67.9 or 68 (2)	Full marks for correct answer If answer incorrect allow one mark for 6790 or ÷ 100 Allow 70 (2)	**2**

Question Number	Answer	Additional guidance	Mark
6(b)(iii)	An explanation that makes reference to two of 1. no temperature difference up to 80 /82 days / increased temperature decrease growth /growth decreases in B / grows more in A after 80 / 82 days/ eq (1) 2. difference in growth in (first 80 / 82 days) due to other factors / light / eq (1) 3. enzyme denatures at higher temperature (B) / optimum is below 30 / eq (1) 4. enzyme and substrate no longer bind /change in active site /eq (1)	If no mp 1 to mp 4 marks awarded allow one alternative mark for link between temperature and kinetic energy or temperature and collisions /eq	**2**

Question Number	Answer	Additional guidance	Mark
6(b)(iv)	A description that makes reference to two of • draw around outline of / put on squared paper / grid / use transparent squared grid eq (1) • count squares / sum squares / eq (1) • multiply by 2 / for each side /eq (1)	measure width and length and multiply together	**2**

Question Number	Answer	Mark
5(a)	The only correct answer is D starch *A is not correct as glucose is not the large insoluble molecule* *B is not correct as lipid is not the large insoluble molecule* *C is not correct as protein is not the large insoluble molecule*	**1**

Question Number	Answer	Mark
5(b)(i)	An answer that makes reference to two of the following points: • reset (the coloured water) / eq (1) • repeat readings / reliable results / more results (1) • allow oxygen in / (aerobic) respiration / prevent anaerobic respiration (1)	**2**

Question Number	Answer	Mark
5(b)(ii)	The only correct answer is A absorbs carbon dioxide *B is not correct as it does not absorb oxygen* *C is not correct as it does not release carbon dioxide* *D is not correct as it does not release oxygen*	**1**

Question Number	Answer	Additional guidance	Mark
5(b)(iii)	• multiply by length • determine volume • correct answer 0.0047(13) / 4.7(13) × 10^{-3} (3)	Award full marks for correct numerical answer without working 3.142 x 0.05 x 0.05 = 0.007855 × 0.6 = 0.0047(13) / 4.7(13) × 10^{-3} Allow one mark for × 6.0 / × 0.6 in working Allow two marks for 4.7 / 47 / 0.47 in working Allow three marks for 4.7 $\underline{mm}^3$	**3**

Question Number	Answer	Additional guidance	Mark
5(c)(i)	• oxygen absorbed at 22 and 12 • calculation of percentage increase 100 (2)	Award full marks for correct numerical answer without working rate at 22 = 1.6 ÷ 20 = 0.08 and rate at 12 = 0.8 ÷ 20 = 0.04 percentage increase = (0.08 - 0.04) ÷ 0.04 × 100 = 100(%) Or 1.6 – 0.8 ÷ 0.8 × 100 = 100(%) One mark for 0.08 **and** 0.04 or 1.6 **and** 0.8 in working	**2**

Question Number	Answer	Additional guidance	Mark
5(c)(ii)	An answer that makes reference to two of the following points: • (more) respiration (1) • enzymes (1) • (more)(kinetic) energy / collisions / enzyme substrate complexes / move faster / eq (1)	Allow converse	**2**

Total 11 marks

Question Number	Answer	Mark
5(a)(i)	respiration / fermentation	**1**

Question Number	Answer	Mark
5(a)(ii)	A carbon dioxide *B is incorrect because the gas is not nitrogen* *C is incorrect because the gas is not oxygen* *D is incorrect because the gas is not water vapour*	**1**

Question Number	Answer	additional guidance	Mark
5(b)(i)	An answer that makes reference to the following points: S scale linear and half the axes (1) L lines straight and through each point (1) A1 axes correct way (1) A2 axes labelled <u>temperature in ^{0}C</u> **and** <u>bubbles per min(ute)</u> (1) P points plotted accurately (1)	 bar charts / extrapolations: no L mark no P mark if data plotted for 50	**5**

Question Number	Answer	Mark
5(b)(ii)	An explanation that makes reference to two of the following points: • enzymes denatured (1) • changes shape of active site (1) • substrate can no longer fit / E/S complexes do not form / eq (1)	**2**

Question Number	Answer	Mark
5(c)	A description that makes reference to two of the following points: • measure / collect volume / cm^3 / eq (1) • readings at smaller intervals (of temperature) / (1) • between **40** and **55** (1)	**2**

Total = 11 marks

Question Number	Answer	Mark
4(a)(i)	**The only correct answer is C chitin glycogen** A is not correct as it is not cellulose and glycogen B is not correct as it is not cellulose and starch D is not correct as it is not chitin and starch	**1**

Question Number	Answer	Mark
4(a)(ii)	**The only correct answer is B fungus** A is not correct as it is not a bacterium C is not correct as it is not a plant D is not correct as it is not a protoctist	**1**

Question Number	Answer	Mark
4(b)(i)	**Only correct answer is B glucose → ethanol + carbon dioxide** A is not correct as it is not the correct equation C is not correct as it is not the correct equation D is not correct as it is not the correct equation	**1**

Question Number	Answer	additional guidance	Mark
4(b)(ii)	• restriction / endonuclease / ligase (1)	allow correctly named endonuclease	**1**

Question Number	Answer	Mark
4(b)(iii)	• contains new DNA / new gene / foreign DNA / foreign gene / altered genes / DNA from other organism/ DNA from other species / gene from other organism / gene form other species / contains gene for digesting cell walls / contains gene for digesting cellulose / gene for cellulase / eq /	**1**

Question Number	Answer		Mark
4(b)(iv)	An answer that makes reference to two of the following points: • less burning of fossil fuels / eq (1) • less carbon dioxide in air / carbon neutral / plants use CO_2 (in photosynthesis) / eq (1) • less trapping of heat / less greenhouse effect / eq (1) • uses renewable resource (1)	allow named fossil fuel	**2**

Question Number	Answer	Additional guidance	Mark
4(c)(i)	• 2.2 – 1.25 = • 0.95 ÷ 1.25 = 0.76 • × 100 = 76% (2)	award full marks for correct numerical answer without working allow 2.2 -1.3 =0.9 0.9÷1.3 = 0.69 ×100 = 69% allow 2.2 – 1.2 =1 1÷ 1.2= 0.8 0.8×100 = 80% allow 1 mark for dividing by mass of normal yeast / 1.2 to 1.3 percentage between 69 and 80 (2)	**2**

Question Number	Answer	additional guidance	Mark
4(c)(ii)	An answer that makes reference to two of the following points: • running out of glucose / food / eq (1) • (build-up of) ethanol (1) • yeast cells die (1)	allow one mark for oxygen becomes available ethanol kills the yeast = mp2 and mp3	**2**

Total 11 marks

Question Number	Answer	Additional guidance	Mark
9(a)	An answer that makes reference to the following points: • glucose • carbon dioxide • water all 3 correct scores 2 marks 2 or 1 correct scores 1 mark	Allow correct formulae	**2**

Question Number	Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to three of the following points: • mouse is smaller / less body mass (1) • larger surface area to volume ratio (1) • heat loss / eq (1) • maintain body temperature (1) • (more) respiration / higher metabolic rate (1)	Allow converse for human	**3 exp**

Question Number	Answer	Mark
9(c)(i)	The only correct answer is C pulmonary vein A is not correct as X it is not the aorta B is not correct as X is not the pulmonary artery D is not correct as X is not the vena cava	**1**

Question Number	Answer	Additional guidance	Mark
9(c)(ii)	An explanation that makes reference to one of the following points: • human heart has 4 chambers / frog heart has 3 chambers (1) • frog heart has one ventricle / human heart has two ventricles (1) • no septum / no division between ventricles / human has septum (1) • frog artery splits into two / frog only has one artery leaving the heart (1) • frog heart has no semi lunar valves (1)		**1**

Question Number	Answer	Mark
9(c)(iii)	An answer that makes reference to five of the following points: • one ventricle (1) • oxygenated and deoxygenated blood mixes / blood from body mixes with blood from lung / eq (1) • less deoxygenated blood goes to lungs / some oxygenated blood to lungs / eq (1) • less efficient gas exchange in lungs / eq (1) • no semi-lunar valves (1) • backflow of blood into ventricle (1) • less oxygenated blood to body / some deoxygenated blood to body / less oxygen (to body) / eq (1) • less respiration / more anaerobic respiration (1) • lactic acid accumulation / less ATP made / less energy released (1)	**5**

Total 12 marks

Question Number	Answer	Mark
8(a)(i)	The only correct answer is **B** fungi A is not correct as yeast is not a bacterium C is not correct as yeast is not a plant D is not correct as yeast is not a protoctist	**1**

Question Number	Answer	Mark
8(a)(ii)	The only correct answer is **B** chitin A is not correct as wall is not made of cellulose C is not correct as wall is not made of sucrose D is not correct as wall is not made of starch	**1**

Question Number	Answer	Mark
8(b)(i)	An explanation that makes reference to the following • water bath / Bunsen / thermostat to vary temperature to heat up water / eq (1) • thermometer to measure temperature / eq (1) • clock watch / timer to measure time period / how long / rate per minute / eq (1)	**2**

Question Number	Answer	Mark
8(b)(ii)	• prevent entry of oxygen / makes conditions anaerobic / eq (1)	**1**

Question Number	Answer	Mark
8(b)(iii)	• limewater / calcium hydroxide solution / hydrogen carbonate indicator / sodium hydrogencarbonate / bicarbonate indicator / sodium bicarbonate (1)	**1**

Question Number	Answer	Additional guidance	Mark
8(b)(iv)	An explanation that makes reference to two the following • originally blue as oxygen present so yeast is respiring (aerobically) / eq (1) • (changes to pink)(all) oxygen **used** up / **taken in** / **consumed in** (aerobic) respiration / eq (1) • (when pink / when no oxygen present) now respiring <u>anaerobically</u> /eq (1)	oxygen used in respiration	**2**

Question Number	Answer	Additional guidance	Mark
8(c)	An explanation that makes reference to four of the following • enzyme / substrate / particles / molecules move faster / increased (kinetic) energy / eq (1) • collide more frequently / form more enzyme substrate complexes / eq (1) • (until) <u>optimum</u> temperature / eq (1) • then <u>active site</u> changes shape / eq (1) • substrate no longer fits / binds with enzyme / enzyme denatures / eq (1)	more kinetic energy not yeast denatures	**4**

Total 12 marks

Question Number	Answer	Additional guidance	Mark
8(a)	• Keep constant temperature / maintain temperature / control temperature / eq (1)	ignore heat / cool	**1**

Question Number	Answer	Additional guidance	Mark
8(b)	An explanation that includes the following either • lime water (1) • turns cloudy (with carbon dioxide) (1) or • hydrogen carbonate / bicarbonate / sodium hydrogencarbonate / eq (1) • turns yellow / orange (with carbon dioxide) /eq (1)	Can only get change if correct indicator given	**2**

Question Number	Answer	Mark
8(c)	an answer that refers to one of the following • stopwatch / stopclock / timer /eq (1) • syringe / measuring cylinder / burette / eq (1)	**1**

Question Number	Answer	Additional guidance	Mark
8(d)(i)	An explanation that makes reference to four of the following • provide **oxygen** (for respiration) / eq (1) • aerator / sparger / air inlet (1) • maintain optimum **temperature** / suitable temperature / prevent overheating / cool fermenter / eq (1) • temperature monitor / temperature probe (cold)-water jacket / eq (1) • maintain optimum **/** suitable **pH** / eq (1) • pH probe / pH monitor / control of inlet to acid / alkali / eq (1) • prevent **contamination**/ keep aseptic /growth of other bacteria / microorganisms/ eq (1) • air filter to remove dust / bacteria / sterilised / steam cleaned (before use)/ eq (1) • to **mix contents** / evenly distribute contents / nutrients / fungi / organisms / oxygen / heat /eq (1) • stirrer / paddles / eq(1)	idea is pairs of **named condition** and method **can only score method if condition named.** allow to exclude oxygen if anaerobic oxygen replaced with N_2 or CO_2 / eq ignore maintain high temp	**4**

Question Number	Answer	Additional guidance	Mark
8(d)(ii)	An explanation that makes reference to four of the following points • a mutation in bacteria / eq (1) • (can confer) <u>resistance</u> to antibiotic / (makes these) bacteria <u>resistant</u> / eq (1) • (only) resistant bacteria survive / no / less competition with other non-resistant bacteria (1) • resistant bacteria reproduce / multiply /eq (1) • passing on alleles / genes (for resistance) (1) • increase in frequency / population / increase in numbers of resistant bacteria / most illness disease caused by resistant strains / eq (1)	ignore immune non-resistant die non-resistant do not reproduce non-resistant do not pass on alleles	**4**

Total 12 marks

Question Number	Answer	Mark
6(a)	D $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ *A is not the correct equation for aerobic respiration* *B is not the correct equation for aerobic respiration* *C is not the correct equation for aerobic respiration*	**1 comp**

Question Number	Answer	additional guidance	Mark
6(b)(i)	An explanation that makes reference to two of the following points: • moves left / towards locust (1) • carbon dioxide produced by insect absorbed by KOH / filter paper (1) • oxygen (used by insect) (1) • in respiration (1)	ignore air ignore breathing /inhaling/eq	**2 Expert**

Question Number	Answer	additional guidance	Mark
6(b)(ii)	An answer that makes reference to six of the following points: • size / mass /(of locusts)/eq (1) • (more cells) (more) respiration (1) or • movement / size of flask /eq (1) • more room for movement means more respiration (1) or • volume / concentration of KOH / size of filter paper (1) • affects carbon dioxide absorption /eq (1) or • temperature (1) • affects enzymes / increase kinetic energy / particle movement /eq (1) or • time / duration (1) • more time to respire / more oxygen absorbed (1)	mark 3 variables to maximise score ignore amount but allow stated volume ignore time of day / light / oxygen / humidity etc	**6 exp**

Question Number	Answer	Mark
6(c)(i)	• 5.3 or 5.27 or 5.267 or 5.26 recurring	**1 grad**

Question Number	Answer	Mark
6(c)(ii)	An answer that makes reference to the following points: • not reliable / reliability can be increased /eq (1) • not enough repeats / only three results / needs to be repeated (1) • one result is <u>anomalous</u> / male 3 result is <u>anomalous</u> (1) • more variation within sex than between sexes / eq (1)	**3 exp** ignore not repeated

Total 13 marks

Question Number	Answer	Mark
4 (a)(i)	**The only correct answer is B (chitin)** *A is incorrect as fungal cell walls do not contain cellulose* *C is incorrect as fungal cell walls do not contain glycogen* *D is incorrect as fungal cell walls do not contain starch*	**1**

Question Number	Answer	Mark
4 (a)(ii)	**The only correct answer is A (ethanol and carbon dioxide)** *B is incorrect as yeast anaerobic respiration also produces carbon dioxide* *C is incorrect as yeast anaerobic respiration does not produce lactic acid* *D is incorrect as yeast anaerobic respiration does not produce lactic acid*	**1**

Question Number	Answer	Additional guidance	Mark
4 (b)(i)	An answer that makes reference to the following. • stops oxygen getting in / prevents <u>aerobic</u> respiration / eq (1)	**Ignore** ensures anaerobic respiration	**1**

Question Number	Answer		Mark
4 (b)(ii)	A description that makes reference to the following. • water bath (1) • (monitor with) thermometer / (use of) thermostat / eq (1)		**2**

Question Number	Answer	Additional guidance	Mark
4 (b)(iii)	• 4 (2)	**one mark** for 32 **OR** ÷ 8 **Correct answer gains both marks**	**2**

Question Number	Answer		Mark
4 (b)(iv)	An explanation that makes reference to two of the following. • increases up to 16 (min) / 17 (min) / 18 (min) and then levels off / slows / (bubble production) stops / eq • (when bubbles increase / initially) glucose is not limiting / eq (1) • (levels off because) glucose runs out / is limiting / yeast is poisoned by ethanol / eq (1)	**Allow** times between 16 and 18 for turning point **Allow** constant rate (or respiration) until 16 /18 then (respiration) stops / levels off / slows **Allow** glucose is not limiting when bubbles are increasing **Allow** substrate for glucose throughout	**2**

Question Number	Answer		Mark
4 (b)(v)	An explanation that makes reference to three of the following. • faster / more, respiration (1) • (at 37 °C) more (kinetic) energy / faster (particle) movement /eq (1) • more / faster, collisions / more E/S complexes / eq (1) • at 37°C glucose runs out (sooner) / glucose starts to limit / eq (1)	**Allow** 37^0C / it, is (closer to) optimum	**3**

Question Number	Answer	Mark
4 (b)(vi)	A description that makes reference to the following. • collect <u>volume</u> (of gas) (1) • using a measuring cylinder / syringe / burette / eq (1)	**2**

(Total for Question 4 = 14 marks)

2	1. trachea / windpipe (1) 2. bronchi / bronchus (1) 3. bronchiole(s) (1) 4. alveoli / alveolus (1) 5. diaphragm (1) 6. intercostal (1)	ignore internal / external	**6**

total 6 marks

Question Number	Answer	Mark
10 (a)(i)	The correct answer is: D trachea bronchus A is incorrect as Q is not a bronchiole B is incorrect as Q is not a bronchus C is incorrect as R is not a bronchiole	**1**

Question Number	Answer	Mark
10 (a)(ii)	An explanation that makes reference to three of the following: • S / diaphragm / it / muscle relaxes (1) • S / diaphragm moves up / becomes dome shaped (1) • volume decreases (1) • pressure increases (1)	**3**

Question Number	Answer	Additional guidance	Mark
10 (b)	An answer that makes reference to four of the following: • the (maximum) lung volume of people with lung disease is lower / less volume can be exhaled / less air exhaled (1) • people with lung disease cannot exhale as rapidly / eq (1) • less carbon dioxide removed / less oxygen taken in (1) • diffusion gradient (into blood) is less steep / eq (1) • less respiration (in cells) / more anaerobic respiration / more lactic acid accumulation / eq (1)	**Accept** converse for healthy lungs	**3**

Total for Question 10 = 7 marks

Question Number	Answer	Additional guidance	Mark
1(a)(i)	The only correct answer is B (bronchiole) A is incorrect as X is not an alveolus C is incorrect as X is not a bronchus D is incorrect as X is not the trachea		**1**

Question Number	Answer	Additional guidance	Mark
1 (a)(ii)	The only correct answer is A (diaphragm contracts and moves downwards) B is incorrect because the diaphragm does not move upwards C is incorrect because the diaphragm contracts D is incorrect because the diaphragm contracts		**1**

Question Number	Answer	Additional guidance	Mark
1 (b)(i)	An explanation that makes reference to three of the following: • inhaled air contains more oxygen (than exhaled air) / inhaled air contains less carbon dioxide than exhaled air / eq (1) • oxygen has diffused into the blood / carbon dioxide has diffused out of the blood (1) • oxygen is used by respiration / eq (1) • carbon dioxide is produced by respiration / eq (1) • nitrogen is not used / released (by respiration) / eq (1)	**Allow** oxygen has diffused into red blood cells **Allow** used in metabolic processes **Allow** produced by metabolic processes **Allow** not needed	**3**

Question Number	Answer	Additional guidance	Mark
1 (b)(ii)	An explanation that makes reference to two of the following: • exhaled air is a mixture of inhaled air and alveolar air / eq (1) • no gas exchange occurs in the trachea / bronchi / bronchioles / eq (1) • gas exchange (only) occurs at the alveoli (1)	**Allow** some air is breathed straight out / some air does not reach the alveoli / some air remains in bronchi / some air remains in trachea **Allow** diffusion of oxygen / carbon dioxide occurs in alveoli **Allow** movement of oxygen into blood / movement of carbon dioxide out of blood (only) occurs in the alveoli	**2**

(Total for Question 1 = 7 marks)

Question Number	**Answer**	**Mark 2**

6(a)(i)

Cube side in cm	Surface area of one cube in cm^2	Total Surface area in cm^2	Volume of one cube in cm^3	Total volume in cm^3
20	2400	2400	8000	8000
1	**6**	**48 000**	1	8000

- 6 (1)
- (6 x 8000 =) 48 000 (1) Allow if not in table but in working

Question Number	Answer	Additional guidance	**Mark**
6(a)(ii)	20 : 1	award the mark for error carried forward from table Allow their number for total surface area : 2400 eg: 48 000 : 2400 / 6 : 2400 / 1 : 400	**1**

Question Number	Answer	Additional guidance	**Mark**
6(b)	An answer that makes reference to two of the following points: **One from:** • (number) reference to many cubes / many alveoli / (alveoli) not one large cube • (surface) reference to SA:Vol / surface area (1) **One from:** • (shape) <u>alveoli</u> are not cubes / <u>alveoli</u> are round/spherical / <u>alveoli</u> have different shape / <u>lungs</u> are not cubes / eq (1) • <u>alveoli</u> surfaces touch / not all surfaces of <u>alveoli</u> are exposed (1) • reference to <u>bronchioles</u> (1)	Eg: alveoli have large SA:Vol / alveoli have large SA	**2**

Question Number	Answer	Additional guidance	Mark
6(c)	An explanation that makes reference to the following points: • thin (walls) / one cell thick / close to <u>capillaries</u> **and** short <u>diffusion</u> distance / not far to <u>diffuse</u> (1) • wet / water / moist **and** gases <u>dissolve</u> / <u>in solution</u> (1) • capillaries / blood supply / blood flow **and** concentration/diffusion gradient (1)	Mp1 Ignore faster diffusion Mp2 Ignore liquid	**3**

Total 8 marks

Question Number	Answer	additional guidance	Mark
7(a)	An answer that makes reference to the following points: • carbohydrate / named carbohydrate (1) • oxygen (1) • higher / greater / more (1) • carbon dioxide (1) • equal / the same / balanced (1)	**allow** carbohydrate / named carbohydrate	**5 grad**

Question Number	Answer	additional guidance	Mark
7(b)	A description that makes reference to three of the following points: • (how light intensity is varied)foil / muslin / move lamp / eq (1) • leaf in test tube with bung / use flask with delivery tube/eq (1) • (look for colour change after) same/ stated time (1) • same size / species / type / surface area /eq (1) • same temperature / same <u>volume</u> of indicator (1) • correct colour change so goes yellow with increased CO_2 in dark / goes dark red/ red/ purple with reduced CO_2 in light /eq (1)	allow light and dark	**3 exp**

Total 8 marks

Question Number	Answer	Mark
3(a)(i)	**D** trachea *A is incorrect because it is not the bronchiole* *B is incorrect because it is not the bronchus* *C is incorrect because it is not the oesophagus*	**1 comp**

Question Number	Answer	Mark
3(a)(ii)	**B** pulmonary artery *A is incorrect because it is not the aorta* *C is incorrect because it is not the pulmonary vein* *D is incorrect because it is not the vena cava*	**1 comp**

Question Number	Answer	Mark
3(a)(iii)	**A** contract contract *B is incorrect because the external intercostals do not relax* *C is incorrect because the diaphragm does not relax* *D is incorrect because the diaphragm and the intercostals do not relax*	**1 comp**

Question Number	Answer		Mark
3(b)	An answer that makes reference to four of the following points: • more blood to muscles / less blood to intestine (during exercise) / eq (1) • supply oxygen / oxygenated blood / glucose (1) • respiration (1) • energy / ATP (1) • muscle contraction (1) • less absorption of food / eq, in intestine when running / (1)	**Allow** converse for at rest **Allow** blood is diverted to the muscles from the intestine **Allow** prevent anaerobic respiration / enable aerobic respiration for two marks **Allow** high blood flow at rest to intestine to absorb food / maintain concentration gradient	**4 exp**

Question Number	Answer	Mark
3(c)	An explanation that makes reference to two of the following points: • (supply (more)) oxygen / there was a shortage of oxygen (1) • breakdown / remove lactic acid (1) • repay oxygen debt (1) • anaerobic respiration had occurred (1)	**2 exp**

Total 9 mark

Question Number	Answer	Additional guidance	Mark
1 (a) (i)	An explanation that makes reference to two of the following: • (Flask B) as (mouthpiece) connected to long tube in flask B / (mouthpiece) connected to flask A is shorter / eq (1) • (Flask B) tube (from mouthpiece) in limewater / tube in liquid in flask B / causes bubbles (in limewater) in B / not in liquid / draws air in flask A / eq (1) • cannot inhale in flask B as limewater would be sucked in / would get mouthful of liquid / Flask A for inhalation as no liquid drawn up eq (1)	No credit if identify flask A air into limewater limewater not breathable	**2**

Question Number	Answer	additional guidance	Mark
1 (a) (ii)	An explanation that makes reference to two of the following: • (Limewater) in flask A stays clear / no change / <u>less</u> cloudy / goes cloudy slowly / eq (1) • (Limewater in) flask B goes (more) cloudy / milky / cloudy quicker / (1) • as less carbon dioxide in inhaled / atmospheric air / (more) carbon dioxide in exhaled / eq (1) • due to respiration (1)	allow stays clear cloudy in both flasks scores 1 no credit for changes colour or cloudy (in both) as contains CO_2 also scores 1	**2**

		ignore no CO_2 in inhaled	

Question Number	Answer	Mark
1 (a) (iii)	• Sodium hydrogen-carbonate / sodium bicarbonate (solution)/ hydrogen-carbonate / bicarbonate indicator (1)	**1**

Question Number	Answer	Additional guidance	Mark
1 (b)	An answer that makes reference to four of the following: • diaphragm contracts (1) • diaphragm flattens / moves down /eq (1) • (external) intercostal muscles contract (1) • rib cage raised / moves out (1) • volume (of chest cavity / thorax) increases (1) • pressure in (chest cavity / thorax) decreases / reduces (1) • air drawn into lungs / lungs inflate /eq (1)	ignore volume of lungs	**4**

total 9 marks

Question Number	Answer	additional guidance	Mark
4(a)(i)	356 / (356+1331) 356 /1687 x 100 = 21.1% (2)	allow 1 mark for 356 / 1687 or 356 / (356+1331) allow full marks for correct answer allow 21	**2**

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	85147 and 7206 ratio = 11.82:1 12:1 (2)	allow full marks for correct answer allow 1 mark for 85147 **and** 7206	**2**

Question Number	Answer	Additional guidance	Mark
4(b)	An answer that that makes reference to six the following points: yes smoking important • higher % of low birth mass (at every age) / smokers have more low mass babies/ eq (1) • large numbers in study (1) No because • big age effect / more with low birth mass at under 19 • more with low birth mass over 35 (1) • greater effect of smoking at older ages above 35 (1) • as older mothers may have smoked for many years / no information on number of years mothers have smoked for (1) • no information on mothers' mass / weight (1) • no information on mothers' health care / medical condition / alcohol / diet / drugs / eq (1) • no information on premature birth /eq (1) • no information on frequency of smoking or	allow correlation between smoking and low birth mass ignore lifestyle	**6**

	when during pregnancy (1) own knowledge • smoking reduces oxygen / eq (1) • less respiration / eq (1)		

total 9 marks

Question Number	Answer	Additional guidance	Mark
2(a)(i)	**B (bronchiole)** *A is incorrect as it is not an alveolus* *C is incorrect as it is not a bronchus* *D is incorrect as it is not a trachea*		**1**

Question Number	Answer	Mark
2(a)(ii)	An answer that makes reference to the following: • it has more than one tissue / is a group of tissues / is a collection of tissues / made of multiple tissues / eq (1)	**1**

Question Number	Answer	Additional guidance	Mark
2(a)(iii)	An explanation that makes reference to the following: • diaphragm moves down / flattens / eq (1) • (chest / thorax) volume increases (1) • (chest / thorax) pressure decreases / air flows from high pressure to low pressure / down a pressure gradient / eq (1)	**Ignore** contracts as in q stem **Ignore** refs to ribs / other muscles / lungs	**3**

Question Number	Answer	Additional guidance	Mark
2(b)(i)	• 35 x 70 x 30 = 73 500 (cm^3) **(2)** **One mark** for x 35 **or** x 70 or x 30 **or** 2450 **or** 1050 **or** 2100	**Accept** 74 000 **or** 73 000 for **two marks** **Correct answer gains both marks**	**2**

Question Number	Answer	Additional guidance	Mark
2(b)(ii)	An explanation that makes reference to three of the following: 1. oxygen use lower in smokers / lower rate of oxygen use / eq (1) 2. tar (in cigarettes) (1) 3. causes emphysema / mucus builds up / mucus not removed / cilia damaged / eq (1) 4. less <u>surface area</u> (of alveoli) / eq (1) 5. less <u>diffusion</u> of oxygen (into blood) (1) 6. carbon monoxide binds to haemoglobin (reducing oxygen) /eq (1) 7. causes narrowing of arteries / blocks blood vessels (reducing flow of oxygenated blood) / eq (1)	**Accept** less oxygen uptake / eq **Accept** converse **Accept** alveoli walls break down / deform / are damaged **Ignore** gas exchange **Ignore** veins	**3**

(Total for Question 2 = 10 marks)

Question Number	Answer	additional guidance	Mark
6(a)	number at 2009 = 462 000 number at 2019 = 506 000 change = 506-462 = 44 % change = (44 ÷ 462) × 100 = **9.52 % / 9.5%/ 9.524% / 9.5238 %** / etc (2)	**allow 1 for 44** allow full marks for 9.52 / 9.524 / 9.5238 with no working	**2**

Question Number	Answer	additional guidance	Mark
6(b)	An answer that makes reference to four of the following points: 1. number of admissions due to smoking increased (2009 to 2019) /eq (1) 2. number of admissions due to smoking level / little change from 2009 to 2012 / eq (1) 3. number of admissions due to smoking decreased from 2012 to 2013 / least in 2013. (1) 4. but % / proportion of all admissions due to smoking declined / lowest in 2019 / eq (1) 5. as other admissions increased / other illnesses / diseases becoming more frequent / eq (1) 6. smaller percentage of people (started) smoking / greater percentage people stopped / eq (1) 7. population size increases / eq (1) 8. reliable / valid data / covers large numbers / all admissions / long period of time / eq (1)	From Graph 1 must have date ref From Graph 2 fewer people smoking / smoking habits change people using alternatives e cigarettes	**4**

Question Number	Answer	Mark
6(c)	A description that makes reference to five of the following points: 1. destroys cilia in trachea / cilia no longer function / eq (1) 2. mucus builds up / cannot be removed /eq (1) 3. leads to (bacterial) infection (of alveoli) /pneumonia / eq (1) 4. loss of surface area / loss of / damage to alveoli /emphysema / eq (1) 5. airways inflamed or narrowed / bronchitis / eq (1) 6. can lead to COPD (1) 7. (lung) cancer (1)	**5**

Total = 11 marks

Question Number	Answer	Additional guidance	Mark
8(a) (i)	pull (rubber) sheet <u>down</u> / pull ring <u>down</u>	Blowing into tube and pulling sheet down = 0 Pull up and down = 0	**1**

Question Number	Answer	Additional guidance	Mark
8(a)(ii)	An explanation that makes reference to three of the following points: • increase in <u>volume</u> (1) • decrease in pressure (1) • pressure (inside) lower than atmospheric (outside) (1) • air in (1)	Mp1 Ignore balloons Mp4 Ignore inflate / blown in	**3**

Question Number	Answer	Mark
8(b)	An answer that makes reference to four of the following points: • reference to diaphragm (1) • balloons represent lungs (1) • reference to trachea / windpipe / bronchus (1) • reference to ribs / ribcage / movement of chest / ribcage / bell jar does not move (1) • reference to intercostal muscles (1)	**4**

Question Number	Answer	Additional guidance	Mark
8(c)(i)	An answer on that makes reference to the following points: • increase diameter / width / expands the airways / bronchi / bronchioles (1) • air / oxygen into lungs / alveoli	Mp1 Ignore dilate Mp1 Allow trachea	**2**

Question Number	Answer	Mark
8(c)(ii)	An explanation that makes reference to two of the following points: • need oxygen / getting less oxygen / short of oxygen / eq (1) • respiration (1) • (removal of) carbon dioxide (1)	**2**

Total 12 marks

Question Number	Answer	Mark
3(a)	• lung(s) (1)	**1**

Question Number	Answer	Mark
3(b)	• 5.0×10^6 or 5×10^6	**1**

Question Number	Answer	additional guidance	Mark
3(c)	An explanation that makes reference to three of the following points: • (concentration) gradient (1) • more oxygen in alveoli than in blood / more carbon dioxide in blood than in alveoli (1) • diffusion (into / out of blood) (1) • thin wall / one cell thick / moist (1) • blood moves / flow (1)	**Ignore** references to high surface area as question refers to one alveolus	**3**

Question Number	Answer	Additional guidance	Mark
3(d)(i)	An answer that makes reference to two of the following points: • as surface area increases respiration rate increase (1) • bigger animals respire more (1) • bigger animals have more surface area of alveoli (1)	**Allow** converse for all	**2**

Question Number	Answer	Additional guidance	Mark
3(d)(ii)	An explanation that makes reference to two of the following points: • humans have a <u>small(er)</u> surface area to volume ratio (1) • less heat loss (1) • (less respiration is required) to maintain body temperature / eq (1)	**Allow** converse for mice mice have a larger surface to volume area mice have more heat loss in mice, (more) respiration is required to maintain body temperature	**2**

Question Number	Answer	Additional guidance	Mark
3(e)	An explanation that makes reference to three of the following points: • measure / record distance moved by coloured liquid / record starting position and final position of liquid on scale / eq (1) • ref to time (1) • use syringe to reset liquid / eq (1) • repeat (1)	**Allow** bubble for liquid	**3**

Total 12 marks

Question Number	Answer	Additional guidance	Mark
4(a)	An explanation that makes reference to two of the following points: • few / no chloroplasts / thin layer / thin cells / one cell thick (1) • transparent / lets light through / allows light to reach palisade layer (1) • (waxy cuticle) reduces water loss / evaporation / waterproof layer / barrier to water / eq (1) • protects against infection / eq (1)	**Allow** light to reach layer B / **Allows** cells underneath to photosynthesise	**2**

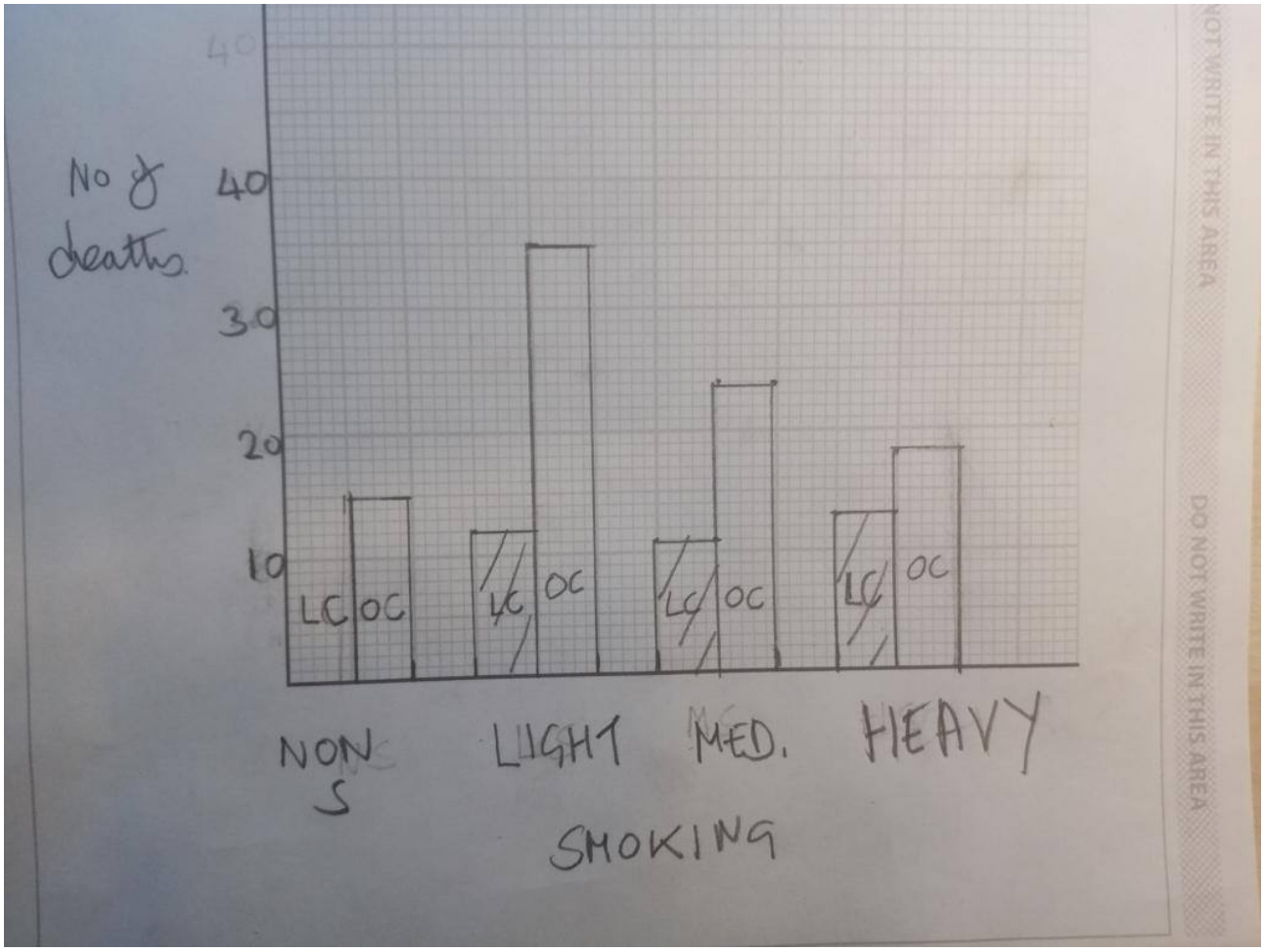
Question Number	Answer	Additional guidance	Mark
4(b)	An answer that makes reference to two of the following points: **two from:** *(Layer B)* • vertical cells / rectangular / tightly packed / many chloroplasts (1) • large surface area (1) • absorb / capture / harvest / trap light / eq (1) **and two from** *(Layer C)* • air spaces / gaps between cells / loosely packed / eq (1) • for gas exchange (1) • diffusion of CO_2 / diffusion of O_2 (1)	**Allow** for one mark gases diffuse if not mp5 / 6	**4**

Question Number	Answer	Additional Guidance	Mark
4(c)	An explanation that makes reference to the following points: • guard cells (1) • open / close stomata (1) • let carbon dioxide in during day / when light (1)	**Allow** oxygen out during day / when light	**2**

Question Number	Answer	Mark
4(d)	An explanation that makes reference to four of the following points: • reduce / stop transpiration / water loss (from plant) (1) • so plant does not wilt / go flaccid (1) • (but) allows absorption of carbon dioxide / CO_2 can still get in / can still pass through (1) • photosynthesis can occur **/** can (still) make glucose / carbohydrates / starch (1) • but less absorption / transport of mineral ions / named mineral ions (1) • less cooling / plant may overheat / eq (1)	**4**

Total 12 marks

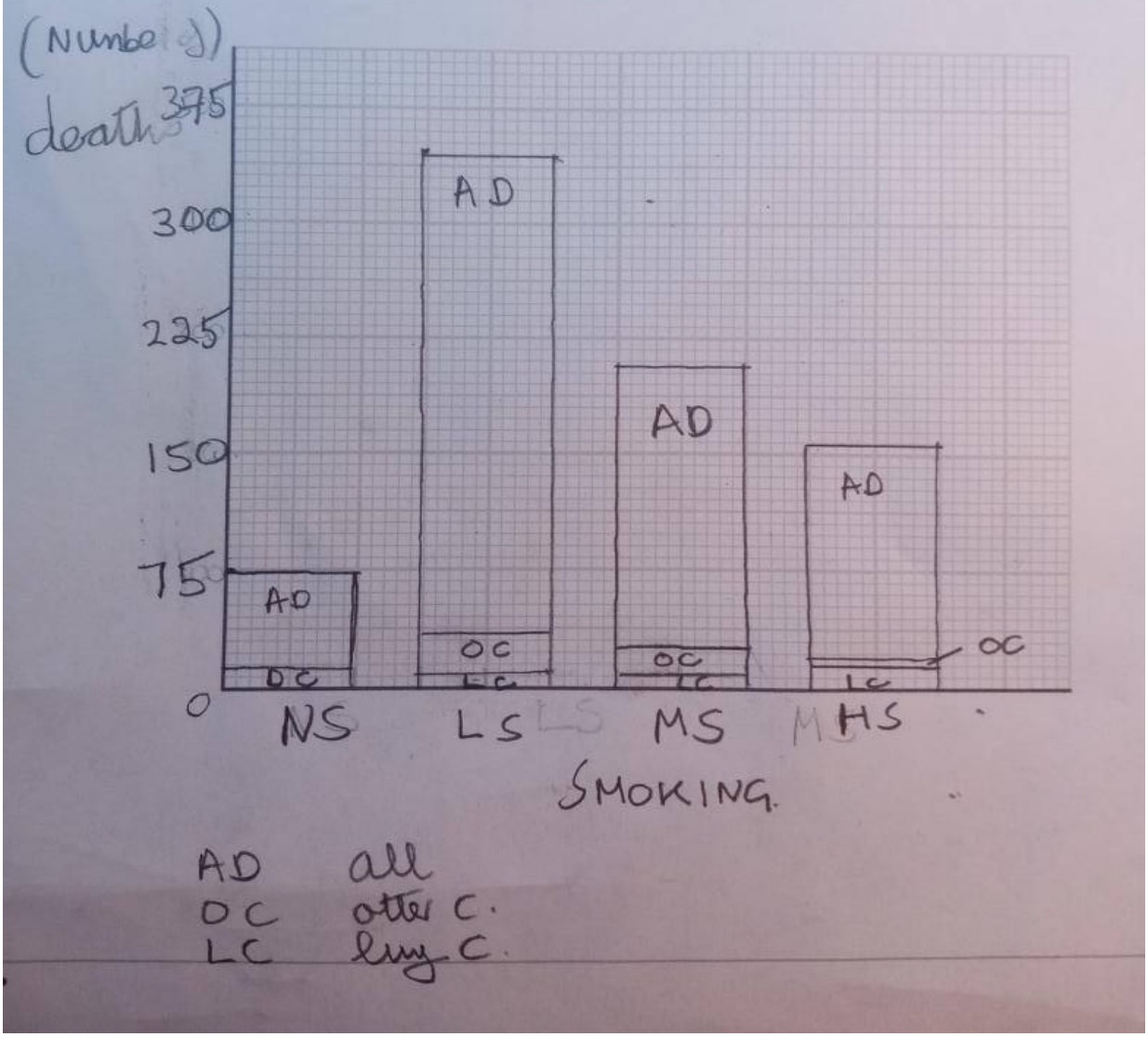
Question Number	Answer	Additional guidance	Mark
9(a)(i)	An answer that makes reference to 5 of the following points: • S y axis scale linear and half the grid (1) • A 2 y axis labelled (number of) deaths (1) • P bars plotted correctly within one (1) • K 1 non- smoker / light/ medium /heavy labelled key shown (1) • K2 labelled lung / other cancer (1)	allow stacked bar chart for LC and OC or LC OC and All line graph scores 4 max	**5**



lung cancer	0	12	11	13	36
other cancers	15	35	24	18	92
all deaths	82	345	206	157	790

(a) (i) Plot a bar chart to show the number of deaths from lung cancer and from other cancers for each of the four groups.

(5)



Question Number	Answer	Additional guidance	Mark
9(a)(ii)	• percentage of deaths due to lung cancer in heavy = 13/157 x 100 = 8.3% • percentage of deaths caused by lung cancer in light smokers = 12/345 x 100 =3.5% • difference = 4.8% (3)	Allow 1 mark for 8.3 or 8.28/etc Allow 1 mark for 3.5 or 3.48/etc Allow full marks for 4.8%/ 4.802 etc	**3**

Question Number	Answer	additional guidance	Mark
9(b)	An explanation that makes reference to two of the following • as age increase higher incidence of cancers /eq (1) • as cells more likely to mutate /eq (1) • smoked for longer period / eq (1) • weak immune system / eq(1)	eg 'old people get more cancer'	**2**

Question Number	Answer	additional guidance	Mark
9(c)	An explanation that makes reference to one pair of the following • causing CHD / heart disease / heart attack / blood clots /eq (1) • due to narrowing / blocking of arteries / blood vessels / damage to artery lining /blood vessels lining/ eq (1) OR • bronchitis / pneumonia/ emphysema / lung infection / shortness of breath / eq(1) • due to damage to alveoli / reduces SA / damages cilia / build-up of mucus / prevents removal of mucus (1) OR • affects oxygen transport / shortness of breath / eq (1) • due to carbon monoxide binding to Hb /eq (1)	ignore veins second point must match first to score 2 ignore 'cough(ing)' can get second point without first eg smoking causes build-up of mucus	**2**

Total = 12 marks

Question Number	Answer	Additional guidance	Mark
3(a)(i)	**B is the correct answer** A is incorrect as there are no palisade cells present C is incorrect as there are no palisade cells present D is incorrect as there are no palisade cells present		**1**

Question Number	Answer	Additional guidance	Mark
3 (a)(ii)	**C is the correct answer (low humidity high temperature)** A is incorrect because high humidity would reduce transpiration B is incorrect because high humidity would reduce transpiration D is incorrect because low temperature would reduce transpiration		**1**

Question Number	Answer	Additional guidance	Mark
3 (b)(i)	(concentration of) carbon dioxide (1)		**1**

Question Number	Answer	Additional guidance	Mark
3 (b)(ii)	An answer that makes reference to two of: • temperature (1) • light (1) • mineral ions / pH / soil / eq (1) • water / humidity (1)	**Accept** light intensity / wavelength / colour	**2**

Question Number	Answer	Additional guidance	Mark
3 (b)(iii)	140 (3)	**Accept** answers between 139 and 140 for 3 marks **one mark** for 70 **AND** **one mark** for area between 0.50 and 0.503 **Correct answer gains all marks**	**3**

Question Number	Answer	Additional guidance	Mark
3 (b)(iv)	A discussion that makes reference to four of the following: 1. carbon dioxide is needed in photosynthesis / eq (1) 2. fewer stomata may reduce uptake of carbon dioxide / less gas exchange (1) 3. fewer stomata needed if carbon dioxide is high / higher diffusion gradient of carbon dioxide (1) 4. (fewer stomata) reduces water loss / transpiration / evaporation / eq (1) 5. (less transpiration) prevents wilting (1) 6. (less transpiration) reduces mineral transport (to leaves) / reduces mineral absorption / eq (1) 7. less magnesium for chlorophyll / less nitrate for amino acids / eq (1) 8. (less transpiration) reduces cooling / eq (1)	**Accept** high carbon dioxide generates high diffusion gradient **Ignore** nutrients **Accept** named minerals **Accept** other correct minerals and functions less uptake of magnesium to make chlorophyll = 2 marks	**4**

Total: 12 marks

Question Number	Answer	Additional guidance	Mark
3(a)(i)	• limewater / hydrogen carbonate indicator/ sodium hydrogen carbonate / sodium bicarbonate / bicarbonate indicator /eq	allow calcium hydroxide for limewater	**1**

Question Number	Answer	Additional Guidance	Mark
3(a)(ii)	An explanation that makes reference to three of the following: • tube A (stays) clear / (stays) red / (stays) orange / no change /eq (1) • tube B goes cloudy / milky / yellow /eq (1) • (more) carbon dioxide in exhaled air / in tube B /eq (1)	Mp 1-2 Must be true for answer in (a)(i) If (a)(i) blank can only score mp 1 if write no change and mp 3 allow tube A changes slowly/ eq	**3**

Question Number	Answer	Additional guidance	Mark
3(a)(iii)	• warmer / less oxygen / more water (vapour) /eq (1)	allow converse	**1**

Question Number	Answer	Mark
3(b)(i)	• duration (of exercise)/ time / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
3(b)(ii)	An answer that includes • Scales linear and at least 2 big squares on y and 3 on x (1) • Lines straight and through all points (1) • Axis correct way round (duration on x and breathing rate y)(1) • Units labelled with duration/ exercise in seconds/s and breathing rate in breaths per minute / breathing rate/min eq (1) • Points correctly plotted within a small square (1)	allow truncated y even if unlabelled Bar chart max 3 no S no L	**5**

Question Number	Answer	Additional guidance	Mark
3(b)(iii)	A description that includes two of the following points: • breathing rate increases until 180 seconds / up to 42 (breathes)/ eq (1) • decreases slightly (between 180 -210) / eq (1) • (then) levels out / becomes constant / eq (1)	Need number ref for mp 1 but not for mp 2 mp3 Increases decreases then constant scores =2	**2**

Question Number	Answer	Mark
3(b)(iv)	• repeat / use more students / people / eq (1)	**1**

Total 14 marks

Question Number	Answer	additional guidance	Mark
5(a)(i)	calculation method not marking points change in rate 50-20 = 30 % = 30 ÷20 ×100 = 150% (2)	full marks for correct answer no working allow 1 mark for 30 or 50÷20 or (50-20)÷20	**2**

Question Number	Answer	Additional guidance	Mark
5(a)(ii)	An answer that includes • Scale half grid (at least 2.5 big squares) and linear (1) • Lines straight and through all points (1) • Axis correct way round (time on x and breathing rate y)(1) • Units labelled on each axis breaths per minute or breathes /minute and minutes / eq (1) • Points correctly plotted within half a small square (1)	allow // truncated if start at 0 or y can start at 10/20 Bar chart does not score L If non-linear scale **between points** No P No L if extrapolated even if unlabelled	**5**

Question Number	Answer	Additional guidance	Mark
5(a)(iii)	An explanation makes reference to three of the following points: 1. (intake of) (more) oxygen /eq (1) 2. releases (more) carbon dioxide eq (1) 3. (provides more oxygen) to red cells / for muscles / for respiration / eq (1) 4. reaches maximum / stops increasing / no change / eq (1) 5. chest cannot inflate and deflate any quicker / eq (1)	ignore slows down	**3**

Question Number	Answer	additional guidance	Mark
5(b)	An explanation makes reference to two of the following points: • (build-up of) lactic acid / lactate (in muscle) / eq (1) • due to anaerobic respiration/ eq (1) • <u>oxygen</u> debt / EPOC / eq (1)	break down lactic acid =MP 1 only <u>oxygen</u> required to break down lactic acid = MP 1 and MP 3 to oxidise lactate = MP 1 and MP 3	**2**

Question Number	Answer	Additional guidance	Mark
5(c)	An answer that includes : • mouth / nose / face not covered / does not interfere with airflow / breathing / breathe normally / easier to breathe / breathe freely / eq (1) • muscle movement may not be breathing / other movements may be recorded / indirect measurement / shirt may be heavy / uncomfortable / affect performance / sweat may affect sensors / eq (1)	ignore no mask / affect breathing allow movement due to exercise (not breathing)	**2**

Total 14 marks

Question Number	Answer	Additional guidance	Mark
8(a)(i)	A graph that makes reference to the following points: • S scales linear and at least half page (1) • L straight lines joining points (1) • A1 axes the correct way around (time on x axis) (1) • A2 axis labelled 'minutes' and 'breaths per minute' / 'BPM' (1) • P points plotted correctly within one square (1) • K indicates (person) P and (person) Q (1)	Allow truncated y axis Bar graph loses S and L	**6**

Question Number	Answer	Mark
8(a)(ii)	An explanation that makes reference to three of the following points: • increases (1) • oxygen for respiration / <u>aerobic</u> respiration (1) • <u>muscle</u> (1) • remove carbon dioxide (1)	**3**

Question Number	Answer	Mark
8(a)(iii)	An explanation that makes reference to two of the following points: • (remove) lactic acid (1) • anaerobic respiration (1) • <u>oxygen debt</u> / <u>EPOC</u> / <u>excess post-exercise oxygen consumption</u> (1)	**2**

Question Number	Answer	Mark
8(b)	An answer that makes reference to four of the following points: (P may be fitter): • P has lower breathing rate at rest / Q has higher breathing rate at rest (1) • P drops more (after exercise) / Q drops less (after exercise)/ P recovers faster (after exercise)/ Q recovers slower (after exercise) (1) (P may not be fitter): • both return to normal in same time / both return to normal by 30 minutes (1) • P breathing rate higher /Q breathing rate lower/ P increase more than Q /Q increase less than P (1) (Design): • no data on age / sex / mass / lung size (1) • may have lung disease / asthma / smoke / drugs / medication / altitude training / nervousness / adrenaline / eq (1) • no data on exercise intensity /type/amount/hardness/ only one measure of fitness / no information on heart rate (1) • not repeated / only tested once / eq (1)	**4**

Total 15 marks

Question Number	Answer	Mark
4(a)(i)	**The only correct answer is B (guard)** *A is incorrect as it is the cuticle* *C is incorrect as it is a palisade cell* *D is incorrect as it is a stoma*	**1**

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation that makes reference to three of the following. • spongy mesophyll / spongy cells / spongy tissue / spongy layer (1) • has air spaces / gaps between cells / spaces / eq (1) • (for) diffusion / gas exchange (1) • carbon dioxide moves in (to palisade cells) / oxygen out (from palisade cells) / eq (1) • xylem to transport water (1)	**Ignore** chloroplasts / chlorophyll **Reject** palisade **Allow** pockets (of air) **Ignore** phloem	**3**

Question Number	Answer	Additional guidance	Mark
4(b)(i)	An answer that makes reference to the following. • temperature (of water bath) (1)	**Ignore** heat	**1**

Question Number	Answer	Additional guidance	Mark
4(b)(ii)	An answer that makes reference to two of the following. • light (1) • changes stomatal opening / (affects) photosynthesis / eq (1) **OR** • volume / concentration of (hydrogen carbonate) indicator (1) • different volumes / concentrations would release / absorb different amounts of carbon dioxide /eq (1) **OR** • size of tube (1) • would affect concentration of carbon dioxide / eq (1) **OR** • pH (1) • affects enzymes / photosynthesis / eq (1) **OR** • age of leaf (1) • may affect chloroplast number / amount of photosynthesis / eq (1) **OR** • **<u>starting</u>** concentration of carbon dioxide (1) • (carbon dioxide) is needed for photosynthesis/ is a limiting factor (1)	**max one for factors** **Mark in pairs reason can only be awarded if factor is correct except for carbon dioxide** **Allow** to prevent light being a limiting factor **Ignore** amount of indicator **Allow** different volumes would affect time to change colour / different volumes would result in different colour change / eq **Allow for this one case only** correct reason if just says carbon dioxide as factor	**2**

Question Number	Answer	Additional guidance	Mark
4(b)(iii)	An answer that makes reference to the following. • control (experiment) / to compare / show effect of temperature on indicator / show that leaf is required to affect the colour / eq (1)	**Ignore** control **variable** **Allow** shows changes are due to leaf / photosynthesis	**1**

Question Number	Answer	Additional guidance	Mark
4(c)(i)	• 27 (2)	**One mark** for 26.7 **or** 26.67 **or** 26.667 **or** 26.6667 **or** 26.66667 **or** other correct decimal places **or** 26.6 recurring **or** 27.0 **Ignore** 26.6 **Answer on answer line takes precedence over answer in table** **Correct answer gains all marks**	**2**

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	An explanation that makes reference to three of the following. • faster photosynthesis / eq (1) • (more) carbon dioxide is removed / taken in / absorbed / eq (1) • increased collisions / more (kinetic) energy / faster movement of molecules / eq (1) • (levels off as) another factor limits / light intensity limits the rate / temp no longer limiting / eq (1)	**Ignore** references to respiration **Allow** less carbon dioxide (in solution / tube) **Allow** more E/S complexes / optimum temperature for <u>enzymes</u>	**3**

Question Number	Answer	Additional guidance	Mark
4(d)	An explanation that makes reference to two of the following. • respiration is faster than photosynthesis / more respiration than photosynthesis / eq (1) • so carbon dioxide is released / increases (in indicator / tube) / eq (1)	**Allow** respiration but no photosynthesis **Reject** if candidate suggests that respiration **ONLY** starts after photosynthesis stops e.g. respires **instead of** photosynthesising	**2**

(Total for Question 4 = 15 marks)

Question Number	Answer	Additional guidance	Mark
8(a)	An answer that makes reference to the following points: • S scales linear and at least half axis (1) • A1 Axes 'correct way round' (1) • L lines straight and joining each point (1) • A2 labelled 'year' and 'percentage of students' (1) • P points accurately plotted (1) • K key or lines labelled for cigarettes and vaping (1)	bar chart lose L only **Do not allow** L if extrapolated Points plotted within one small square	**6 exp**

Question Number	Answer	Mark
8(b)	A description that makes reference to two from the following points: • e-cigarette use increased (from 2011) **up to 2015** then decreased / decreased in 2016 (1) • smoking normal cigarettes decreases (from 2011 to 2016) (1) • at start e-cigarettes lower than smoking / significantly low / at end e-cigarette use higher than smoking / significantly high (1)	**2 grad**

Question Number	Answer	Additional guidance	Mark
8(c)	• 15.8 - 8 = 7.8 • 7.8 ÷ 100 × 60 000 = 4680 OR • 15.8 / 100 x 60 000 = 9480 • 8.0 /100 x 60 000 = 4800 • 9480 – 4800 = 4680	**Allow** 1 mark for 7.8 or 0.078 Award full marks for correct numerical answer without working	**2 grad**

Question Number	Answer	Additional guidance	Mark
8(d)(i)	An explanation that makes reference to four of the following points • less tar (1) • fewer carcinogens / less risk of cancer (1) • less risk of emphysema / lung disease / damage to alveoli / chronic bronchitis / damage to cilia / eq (1) • less carbon monoxide (1) • less risk of heart disease / strokes (1) • less risk of addiction / can control nicotine levels (1)	**Allow** converse for normal cigarettes for all MPs	**4 exp**

Question Number	Answer	Mark
8(d)(ii)	An answer that makes reference to two of the following points: • non-smokers may start using e-cigarettes (1) • e-cigarettes may lead to taking up smoking (1) • e-cigarettes are addictive as they contain nicotine (1) • nicotine can increase risk of blood clots / increase blood pressure (1) • e-cigarettes may also be harmful / damage lungs / risks not yet known (1)	**2 exp**

Total 16 marks

Question Number	Answer	Mark
3(a)	The only correct answer is **D** osmosis *A is not correct as it is not how plants absorb water* *B is not correct as it is not how plants absorb water* *C is not correct as it is not how plants absorb water*	**1 comp**

Question Number	Answer	Mark
3(b)	• xylem / xylem vessels	**1 cler**

Question Number	Answer	Mark
3(c)	• transpiration / evaporation / diffusion / evapotranspiration	**1 cler**

Question Number	Answer	Mark
3(d)	**C** low air temperature *A is not correct as it does not reduce the movement of water from the leaves into the air* *B is not correct as it does not reduce the movement of water from the leaves into the air* *D is not correct as it does not reduce the movement of water from the leaves into the air*	**1 comp**

Question Number	Answer	additional guidance	Mark
3(e)	An answer that makes reference to two of the following points: • support / turgor / eq (1) • photosynthesis / eq (1) • cooling (1) • reactions / solvent / transport of mineral ions /named/mineral ion /eq (1)	**ignore** transpiration for enzymes to work eq reactions	**2 grad**

Total 6 marks

Question Number	Answer	Mark
2(a)(i)	$\underline{6.0 \times 10^3}$	**1**

Question Number	Answer	Mark
2(a)(ii)	The only correct answer is D 5.0×10^{12} A is not correct as it is not 5.0×10^6 B is not correct as it is not 5.0×10^9 C is not correct as it is not 5.0×10^{11}	**1**

Question Number	Answer	additional guidance	Mark
2(b)(i)	An explanation that makes reference to two of the following points: • (less) oxygen (transported) (1) • (less) respiration (1) • (less) energy / less ATP (1)	idea of less once no credit for fewer red cells	**2**

Question Number	Answer	additional guidance	Mark
2(b)(ii)	An explanation that makes reference to two of the following points: • (fewer) phagocytes / (fewer) lymphocytes (1) • (so less) ingestion / phagocytosis / digestion / engulfing /eq (1) • (so fewer) antibodies (1)	must have idea of fewer cells / less response no credit for fewer white cells allow fewer anti-toxins	**2**

Total 6 marks

Question Number	Answer	Mark
2(a)	An answer that makes reference to two of the following points: • cytoplasm (1) • ribosomes (1) • cell membrane (1) • DNA (1)	**2**

Question Number	Answer	Mark
2(b)(i)	The only correct answer is B bacteria are pathogens *A is not correct because it is not possible to conclude that the bacteria are decomposers* *C is not correct because it is not possible to conclude that the bacteria are microscopic* *D is not correct because it is not possible to conclude that the bacteria are non-living*	**1**

Question Number	Answer	Mark
1(b)(ii)	An answer that makes reference to two of the following points: • vaccination / inoculated (1) • (same) antigens / (same) protein (on bacteria) (1) • secondary immune response (1) • memory cells (1) • (make) large numbers antibodies / (make) antibodies produced fast / soon / eq (1)	**4**

Total = 7 marks

Question Number	Answer	Mark
3(a)	A the left ventricle is thick to pump blood to the body *B is not correct because the left ventricle wall is not thin* *C is not correct because the right ventricle pumps to the lungs* *D is not correct because the right ventricle wall is not thick*	**1**

Question Number	Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to three of the following points: • ventricle (wall) is thinner / ventricle (wall) has less muscle (1) • <u>coronary artery</u> is blocked / coronary artery has less blood passing through / eq (1) • less oxygen / glucose (1) • less (aerobic) respiration / anaerobic respiration occurs / not enough energy / less ATP (1) • cell / muscle / tissue death (1)	**Ignore** heart dies	**3**

Question Number	Answer	Additional guidance	Mark
3(c)(i)	An explanation that makes reference to three of the following points: • (stem cells can) differentiate / can become muscle cells / can make any cell types / stem cells are undifferentiated / unspecialised cells / eq (1) • stem cells divide / (carry out) mitosis / cell division (1)	**Allow** stems cells are pluripotent / totipotent / multipotent	**2**

Question Number	Answer	Additional guidance	Mark
3(c)(ii)	An explanation that makes reference to two of the following points: • cells have same DNA / genes / alleles / eq (1) • same antigens / tissue type / blood group (1) • less risk of rejection / not rejected (1) • no immune response / by immune system / no need to take immunosuppressants (1) • no risk of infection / disease spread (1)	No immune rejection = two marks	**2**

Total = 8 marks

Question Number	Answer	additional guidance	Mark
6(a)	1950 =400 - 420 1965 = 510 - 520 percentage change ((520-400)÷400) ×100 = + 30% 520-420 ÷420 x 100 = + 24% **range for 1950 to 1965 = 21 to 30** 1968 = 480-490 1983=120-130 percentage change ((120-490)÷490) ×100 = -75.5% ((130-480))÷480) X 100 = -72.9% **range for 1968 to 1983 = -73 to - 76** subtraction -75.5% – 30% = 105.5 max 30 + 76 min 21 + 73 **allow range 94 to 106 (3)**	**allow 1 for 21 to 30** and **1 for 73 to 76** if one of these figs is wrong allow one for subtraction of (-74 to + 30) being correct eq even if using incorrect values **so if incorrect final answer can get up to 2 for working** allow full marks for **94 to 106** with no working	**3**

Question Number	Answer	additional guidance	Mark
6(b)	An explanation that makes reference to four of the following points: 1. cases higher before vaccine introduced / lower after vaccination introduced/ eq (1) 2. cases more variable before vaccine introduced/ less variable after vaccine introduced / eq (1) 3. as no immunity / antibodies to measles / takes time to produce antibodies / eq (1) 4. as percentage / more of population vaccinated cases decrease/ eq (1) 5. as virus no longer reproducing in children / virus destroyed in children / no longer spreading / can no longer find a suitable host / eq (1) 6. as vaccinated children have antibodies / memory cells /eq (1) 7. quoting early data (eg up to 1974) (**cases and percent vaccinated**) 125 cases 52% vaccinated /eq (1) 8. quoting later data: (**cases and percent vaccinated**) (eg 1990 onwards) later data eg 80% vaccinated 20 cases / no cases (by 1998) when 90% vaccinated / eq (1)	herd immunity reject antibiotics mp 7 mp 8 allow range / leeway on cases and percentage	**4**

Question Number	Answer	Mark
6(c)	An explanation that makes reference to two of the following points: • cannot produce antibodies /fewer antibodies produced / eq (1) • no / fewer memory cells produced / no / less secondary immune response / eq (1) • could develop disease / give child disease / give child illness / give child measles / eq (1)	**2**

Total = 9 marks

Question Number	Answer	Mark
2(a)(i)	B P and S *A is incorrect because Q contains oxygenated blood* *C is incorrect because R contains oxygenated blood* *D is incorrect because Q and R contain oxygenated blood* /	**1**

Question Number	Answer	Mark
2(a)(ii)	An explanation that makes reference to two of the following points: • prevent backflow / blood returning (1) • to heart / ventricles (1) • blood transported to lungs / body (1) • pressure in ventricles drop / artery pressure is greater than ventricle pressure (1)	**2**

Question Number	Answer	Additional guidance	Mark
2(b)(i)	An answer that makes reference to the following points: • heart disease increases with age / older people more likely to have heart disease / more over 75 /eq (1) • males more at risk than females / men more at risk than women (1)	**Allow** converse	**2**

Question Number	Answer	Additional guidance	Mark
2(b)(ii)	• 32 500 000 ÷ 1000 = 32 500 • 32 500 × 5 = 162 500 (2)	Award full marks for correct numerical answer without working one mark for x 5 or 32 500 000 or 32 500	**2**

Question Number	Answer	Additional Guidance	Mark
2(c)	An explanation that makes reference to three of the following points: • blockage of (coronary) artery / less blood to heart (1) • cholesterol / fatty deposits (1) • less oxygen / out of breath / breathless /eq (1) • less (aerobic) respiration / less energy /unable to exercise / eq (1) • heart stops beating / heart contracts less / heart attack / death (1)	**Ignore** causes heart disease	**3**

Total = 10 marks

Question Number	Answer	Additional guidance	Mark
6(a)(i)	A description that makes reference to two of the following points: • elongated / pointed / projections / extensions /eq (1) • increase surface area (1) • thin wall for short diffusion path / eq (1) • concentrated cell sap for osmosis / eq (1)	**Allow** low water potential to increase gradient for osmosis / increase water potential gradient /eq	**2 grad**

Question Number	Answer	Additional guidance	Mark
6(a)(ii)	An explanation that makes reference to four of the following points: • water enters (root) by osmosis (1) • from dilute solution to more concentrated solution / eq (1) • (water) enters / moves up xylem (1) • water pulled up to leaf due to transpiration / pulled along transpiration stream / eq (1) • (water vapour) exits through stomata (1)	**Allow** from higher water potential to lower water potential **Allow** from high concentration of water to low concentration of water **Allow** water pulled due to evaporation from leaf / eq	**4 exp**

Question Number	Answer	Additional guidance	Mark
6(b)	A description that makes reference to four of the following points: • use (bubble) / (weight) <u>potometer</u> (1) • cut shoot underwater / dry leaves / place mineral oil on surface of water / eq (1) • measure distance moved by bubble (in cm) / mass lost / change in volume of water (1) • (in set) time (1) • repeat / calculate mean rate (1)	**Allow** polythene bag around soil (if shoot placed in soil) **Allow** stated time **Allow** time mark ref and mass mark for two marks if given as units e.g. cm per min g per min	**4 exp**

Total 10 marks

Question Number	Answer	Mark
10(a)	An explanation that makes reference to four of the following points: • glucose (transported) from intestine / ileum / liver / glucose (transported) to body cells / to liver (1) • amino acids (transported) from ileum / liver / amino acids (transported) to body cells / liver (1) • fatty acids / vitamins / minerals / eq (transported) from intestine / fatty acids / vitamins / minerals / eq (transported) to cells (1) • hormones (transported) from (endocrine) glands / hormones (transported) to organs / tissues (1) • urea (transported) from liver / urea (transported) to kidney (1) • carbon dioxide (transported) from cells / carbon dioxide (transported) to lungs (1) • antibodies (transported) to site of infection / eq (1) • fibrinogen / clotting proteins (transported) to wound / eq (1)	**4**

Question Number	Answer	Additional guidance	Mark
10(b)(i)	• measurement of diagram = 58 mm / 5.8 cm • divide diagram measurement in mm by 0.013 • answer 4462 (2)	Award full marks for correct numerical answer without working Accept answers between 4307 to 4616 Award one mark for 56 mm up to 60 mm or 5.6 cm up to 6.0 cm or award one mark for a division by 0.013	**2**

Question Number	Answer	Mark
10(b)(ii)	• nucleus (1)	**1**

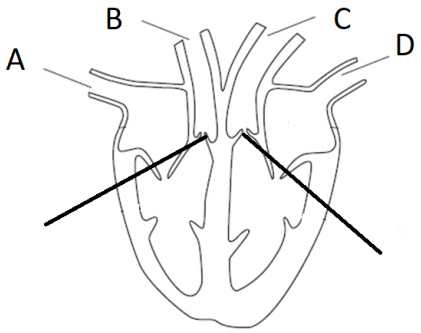
Question Number	Answer	Mark
10(b)(iii)	An answer that makes reference to • engulf / ingest / eq bacteria / pathogen / microbe / eq (1) • digest / break down (1) • enzymes (1)	**2**

Question Number	Answer	Mark
10(c)	An answer that makes reference to Biuret / add NaOH and CuSO4 **/** albustix /eq (1)	**1**

Total 10 marks

Question Number	Answer	Mark
2(a) (i)	**The only correct answer is D** A is not correct as it does not bring oxygenated blood to heart B is not correct as it does not bring oxygenated blood to heart C is not correct as it does not bring oxygenated blood to heart	**1**

Question Number	Answer	Mark
2(a) (ii)	**The only correct answer is C** A is not correct as it does not contain blood with the highest pressure B is not correct as it does not contain blood with the highest pressure D is not correct as it does not contain blood with the highest pressure	**1**

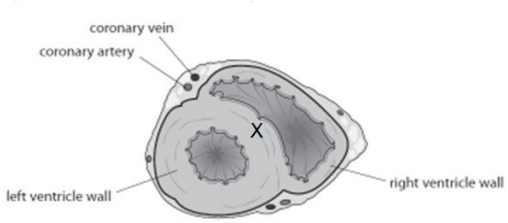
Question Number	Answer	additional guidance	Mark
2(b) (i)		allow other forms of indication of location	**1**

Question Number	Answer	additional guidance	Mark
2(b)(ii)	A description that makes reference to the following points: • prevent backflow of blood /one way flow /eq (1) • (from arteries) into <u>ventricle/ ventricles</u> (1)	back into heart =mp1	**2**

Question Number	Answer	Mark
2(c)(i)	An explanation that makes reference to the following points: • so that oxygenated and deoxygenated blood do not mix / as left hand side now contains oxygenated blood from lungs / eq (1) • so that oxygenated blood can be pumped around body / so deoxygenated blood does not go round body / so oxygenated blood does not go to lungs / eq (1)	**2**

Question Number	Answer	Mark
2(c)(ii)	An explanation that makes reference to three of the following points: • may appear blue / lack colour / not survive / shortness of breath/ eq (1) • as less oxygen (transported from heart to body) / deoxygenated blood goes to body / eq (1) • less (aerobic) respiration (1) • less energy / less ATP/ eq (1)	**3**

Total = 10 marks

Question Number	Answer	Mark
2(a)(i)		**1**

Question Number	Answer	additional guidance	Mark
2(a)(ii)	An answer that makes reference to the following • coronary artery contains (more) oxygen / oxygenated (1) • coronary artery contains less carbon dioxide / no carbon dioxide (1)	No credit for pressure vein no / less oxygen / deoxygenated vein (more) CO_2	**2**

Question Number	Answer	additional guidance	Mark
2(a)(iii)	An explanation that makes reference to three of the following • (left wall) much thicker / eq (1) • more muscle / muscular (tissue) / eq (1) • (generates) more pressure / more force / eq (1) • pumps blood (all) around body / eq (1)	allow converse for each mp thinner less muscle less pressure /force ignore withstands pressure to lungs thicker muscle = mp1 and mp 2	**3**

Question Number	Answer	additional guidance	Mark
2(b)	An explanation that makes reference to four of the following 1. genetics / inheritance / some people inherit increased risk from parents eq (1) 2. high blood pressure (puts more strain on heart) / eq (1) 3. high fat diet / lipid / cholesterol / (blocks coronary artery walls) / eq (1) 4. smoking (raises blood pressure and increase chances of clots) / eq (1) 5. stress (raises blood pressure) / eq (1) 6. lack of exercise , (exercise reduces blood pressure and strengthens heart) / eq (1) 7. obesity / being overweight / diabetes (increase strain on heart) / eq (1)	allow converse for each mp Ign bad diet unqalified	**4**

Total 10 marks

Question Number	Answer	Additional guidance	Mark
9 (a)(i)	• hepatic portal vein (1)		**1**

Question Number	Answer	Mark
9 (a)(ii)	The only correct answer is B (X) A is incorrect because W is the pulmonary artery C is incorrect because Y is the aorta D is incorrect because Z is the hepatic portal vein	**1**

Question Number	Answer	Additional guidance	Mark
9 (b)	An answer that makes reference to two of the following points: • (V / vein has) thin(ner) wall (1) • (V / vein has) less / thin muscle (1) • (V / vein has) fewer elastic fibres / less elastic (1) • (V / vein has) valves (present) (1) • (V / vein has) wide(r) lumen / space / hole / eq (1)	**Allow** vena cava for V and aorta for Y **Allow** converse for aorta (Y) Y has thicker wall Y has more muscle Y has more elastic Y does not have valves Y has a narrow lumen	**2**

Question Number	Answer	Additional guidance	Mark
9 (c)(i)	An answer that makes reference to two of the following points: • obesity / eq (1) • diabetes (1) • high (saturated) fat diet / high cholesterol / eq (1) • high salt diet / eq (1) • low exercise / eq (1) • smoking / alcohol (1) • stress / eq (1) • age (1)		**2**

Question Number	Answer	Additional guidance	Mark
9 (c)(ii)	An answer that makes reference to four of the following points: • increasing blood pressure increases deaths / eq (1) • Northern / Eastern Europe have a steep / big increase (as blood pressure increases) / Japan has less / low increase / steady increase (as blood pressure increases) / eq (1) • Japan has lowest number of deaths (at all blood pressures) / Northern / Eastern Europe has highest / Japan has lower death rate / eq (1) • (Northern / Eastern) Europe has more deaths (compared with Japan) when blood pressure is healthy / below 130 / eq (1) • decrease in number of deaths in Eastern Europe from 120 to 130 a.u. / at 130 / eq (1) • Japan may have lower death rates due to genetics / heredity / eq (1) • people in Japan may have better diet / healthy lifestyle / more exercise / less stress / less smoking / less obesity (so reduces deaths or heart disease) / eq (1) • no idea of sample sizes / no record of other factors / age / sex / lifestyle / diet / exercise / smoking / data / eq (1)	**Allow** increased blood pressure has less effect in Japan **Allow** converse for Japan **Allow** anomaly at 130 a.u. **Allow** converse for Europe **Allow** different regions may have different genetic factors **Allow** converse for Europe **Allow** different regions may have different diets / stress / smoking / eq **Allow** data not at same blood pressures for each country	**4**

(Total for Question 9 = 10 marks)

Question Number	Answer	Additional guidance	Mark
2(a)	An answer that makes reference to the following. • prevent evaporation (from surface of water) / eq (1)	**Allow** ensure water loss is from plant / eq **Ignore** stops water loss unqualified	**1**

Question Number	Answer	Additional guidance	Mark
2(b)(i)	• 4.4 **or** 4.38 **or** 4.375 (2)	**Allow** 4.37 **One mark** 35 **or** ÷ 8 **Ignore** 4.3 but credit any correct working **Correct answer gains all marks**	**2**

Question Number	Answer	Additional guidance	Mark
2(b)(ii)	An answer that makes reference to four of the following. • both / volume **and** mass, decrease / eq (1) • volume changes more than mass / more water is taken up than lost (up to 4 or 8 days) / eq (1) • water loss and uptake are same between 4 and 8 days / after 4 days / eq (1) • correct numerical manipulation (1) • transpiration occurs / water evaporates (from leaves) / water lost through stomata (1) • (some) water is retained / stored in cells / (used for) turgor (1) • used in photosynthesis (1)	Need not be stated in same sentence **Allow** volume decreases more than mass = 2 marks e.g. 35 (cm^3) lost / 10 (g) lost after 4 days **Ignore** quoting data	**4**

Question Number	Answer	Additional guidance	Mark
2(c)	An explanation that makes reference to three of the following. • more transpiration / more evaporation / higher (water loss) / faster (water loss) / eq (1) • (wind) blows /moves, the water away / removes still air / removes humid air / eq (1) • increases / maintains / steeper diffusion gradient / concentration gradient / eq (1)	**Allow** converse for all mark points **Allow** more water (moves) into air **Allow** keeps air dry **Allow** water potential gradient **Allow** maintains a difference in concentration	**3**

(Total for Question 2 = 10 marks)

Question Number	Answer	additional guidance	Mark
4(a)	An answer that makes reference to two of the following • more red cells / erythrocytes / eq (1) • fewer lymphocytes / eq (1) • fewer monocytes / eq (1) • fewer neutrophils / eq (1)	**Allow converse for condition** fewer (in condition) more lymphocytes more monoctyes more neutrophils if no ref to named wbc allow fewer wbc for 1	**2**

	Answer	additional guidance	Mark
4(b)	line length = 14 (mm) 14 mm = 14 × 1000 magnification = 14 000 ÷ 25 = x 560 (2) Allow range 520 - 600	1 mark for correct length and units 13-15mm or 1.3-1.5cm OR ÷ 25	**2**

	Answer	additional guidance	Mark
4(c)	$5.0 \times 10^9 \times 1000$ 5.0×10^{12} $5.0 \times 5.0 \times 10^{12}$ $= 2.5 \times 10^{13}$ (2)	allow 1 mark for 25 etc in answer	**2**

Question Number	Answer	additional guidance	Mark
4(d)	An answer that makes reference to four of the following 1. less haemoglobin (1) 2. less (transport of) oxygen /eq(1) 3. less energy / less ATP / respiration / eq (1) 4. tired / out of breath / lactic acid build up / eq (1) 5. more immune response / greater immunity / more memory cells/ eq (1) 6. more antibodies / eq (1) 7. more phagocytosis / eq (1) 8. less infection / may be infected / eq (1)	allow more anaerobic respiration allow pathogens present	**4**

Total 10 marks

Question Number	Answer	Additional guidance	Mark
2(a)	An explanation that makes reference to the following points: • draws water up (to leaves) / enables water to be taken up (by roots) (1) • cooling (1) • (transport) minerals / named mineral (1) • prevent wilting / eq (1) • (water for) photosynthesis (1)	**Allow** maintain turgidity	**2**

Question Number	Answer	Additional guidance	Mark
2(b)(i)	• reading from graph multiplied = 21. 5 x 10^{-4} = 0.00215 • multiply by 250 Answer: 0.5375 or 0.538 or 0.537 or 0.54 scores two (2)	award full marks for correct numerical answer without working one mark for x 250 one mark for 0.00215 one mark for 5400 or 5375 or 5380 or 5370	**2**

Question Number	Answer	Additional guidance	Mark
2(b)(ii)	An explanation that makes reference to the following points: • wind moves water (away from plant surface) / blows water away (1) • creates / maintains / increases (concentration) gradient (1) • (more) (water moves out of plant by) diffusion / evaporation (1)	**Allow** converse for still air for all marking points Maintains diffusion gradient = two marks	**3**

Question Number	Answer	Additional guidance	Mark
2(c)	An answer that makes reference to the following points: • (same) light (intensity) (1) • as it affects stomata opening / eq (1) OR • (same) temperature (1) • as it affects diffusion / speed of molecules / (kinetic) energy / evaporation (1) OR • humidity (1) • reduces / affects concentration / diffusion gradient (1) OR • (same) species / age / size / mass / leaf area of plant (1) • as this affects number of stomata / thickness of leaves / eq (1) OR • same CO_2 concentration (1) • as it affects stomata opening (1)	Mark in pairs **Ignore** transpiration	**4**

Total = 11 mark

Question Number	Answer	additional guidance	Mark
2(a)(i)	An explanation that makes reference to two of the following points: • higher when temperature increases / lower when temp decreases (1) • more (kinetic) energy of water molecules / particles / eq (1) • increased diffusion / more liquid become gas / eq (1)	allow converse	**2**

Question Number	Answer	additional guidance	Mark
2(a)(ii)	An answer that makes reference to three of the following points: • use scale on beaker / tube / ruler / eq (1) • volume / mass of water lost from beaker / level of water in beaker / distance moved by bubble/eq (1) • use clock / measure time /stated time /eq (1) • divide volume / distance by time (1)	ign weigh clay pot	**3**

Question Number	Answer	Mark
2(b)(i)	An explanation that makes reference to two of the following points: • light (intensity) / carbon dioxide / turgor (1) • affects stomata opening / guard cells / eq (1)	**2**

Question Number	Answer	additional guidance	Mark
2(b)(ii)	An answer that makes includes **labelled** drawings of: **<u>bubble potometer</u>** • plant (1) • capillary tube (1) • with bubble / drop of liquid /meniscus (1) • seal / petroleum jelly / /cork /bung/eq (1) • scale / ruler /eq (1) OR **<u>mass potometer</u>** • plant (1) • pot with soil / glass container with water (1) • method to avoid soil water loss eg. polythene / bung / (1) • weighing scales (1)	**no label no mark**	**4**

Total 11 marks

Question Number	Answer	Mark
5(a)	The only correct answer is C **Y** A **W** is not the answer as it does not contain xylem B **X** is not the answer as it does not contain xylem D **Z** is not the answer as it does not contain xylem	**1**

Question Number	**Answer**	**Additional guidance**	**Mark**
5(b)(i)	• 8.16(4) (2) **One mark for:** ÷ by 5 **OR** X 52 **OR** X 0.25 **OR** 0.8(164) **OR** 40.82 (allow between 40.82 and 40.85)	**Allow** answers between 8.16 and 8.2 **Allow** answers between 0.816 and 0.82 for 1 mark **Correct answer gains both marks**	**2**

Question Number	Answer	Additional guidance	Mark
5(b)(ii)	A description that makes reference to four of the following points: 1. set up potometer underwater / cut stem underwater / dry leaves / eq (1) 2. use a fan at different distances / with and without fans / different fan speeds / eq (1) 3. leave for set time / stated time (1) 4. measure distance bubble moves / distance water moves (on scale) / eq (1) 5. keep other factors constant (1) 6. repeat / reset bubble with reservoir / eq (1)	**Accept** wafting with card / hairdryer **Accept** time taken to move set distance for mp3 and mp4 **Accept** named factors e.g. temperature / humidity / light intensity / CO_2	**4**

Question Number	Answer	Additional guidance	Mark
5(c)	An answer that makes reference to four of the following points: 1. at start / for first two days, ABA is low / is 0.5 **OR** at start / for first two days water loss is high / is 100 (1) 2. after two days / from three days ABA increases **OR** after two days / from three days percentage water loss decreases / eq (1) 3. after five days / after watering / ABA decreases **OR** after five days / after watering water loss increases / eq (1) 4. as ABA increases water loss decreases / inverse relationship / negative correlation / eq (1) 5. ABA closes stomata / stomata open when ABA low / eq (1) 6. stomata close from two days / stomata close from three days / eq 7. stomata closing reduces transpiration / water loss / evaporation / stomata closing prevents wilting / stomata closing prevents loss of turgidity / ABA reduces transpiration / eq (1) 8. light intensity may change / humidity may change / wind may change / eq (1)	**Accept** when ABA is high, water loss is low **Accept** stomata open for first two days / stomata open after 5/6/7 days / after watering **Accept** converse for open stomata / low ABA **Accept** other correct named factors	**4**

(Total for Question 5 = 11 marks)

Question Number	Answer	Mark
5(a)	D arteries have thicker walls *A is incorrect because veins transport blood to the heart* *B is incorrect because veins have a larger lumen* *C is incorrect because veins contain valves*	**1**

Question Number	Answer	Additional guidance	Mark
5(b)(i)	• correct measurement of lengths • divide decrease in diameter by diameter of lumen • multiplication to get percentage 42 / 41.7 / 41.67 / 41.667 / 41.6 recurring (3)	Award full marks for correct numerical answer without working 36 and 15 or 36 and 21 36 – 21 = 15 15 ÷ 36 = 0.42 x 100 = 42 One mark for 36 **and** 15 or 36 **and** 21 or 3.6 **and** 1.5 or 3.6 **and** 2.1 One mark for ÷ 36 or 3.6 or their measured diameter within range 35 to 45 or 3.5 to 4.5	**3**

Question Number	Answer	Mark
5(b)(ii)	An explanation that makes reference to the following points: • becomes anaerobic (1) • (less) oxygen (1)	**2**

Question Number	Answer	Additional guidance	Mark
5(c)	An answer that makes reference to two the following points: • smoking / nicotine (1) • lack of exercise / sedentary lifestyle (1) • salt (1) • stress (1) • alcohol (1) • sex (1) • age (1) • high blood pressure (1) • obesity (1) • high carbohydrate diet / eq (1) • diabetes (1) • genes / genetics / eq (1)	Allow family history / inheritance	**2**

Question Number	Answer	Additional guidance	Mark
5(d)	An explanation that makes reference to four of the following points: • vasodilation (1) • (more) blood to surface / skin (1) • heat loss / cooling / prevents overheating (1) • radiation / convection (1) • affect enzymes (1)	Allow converse Mp2 blood vessel moves close to surface = 0	**4**

Total 12 marks

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>3(a)(i)</td><td>
<table>
<tr><th>statement</th><th>letter</th></tr>
<tr><td>contains the least carbon dioxide</td><td>A</td></tr>
<tr><td>contains the most glucose after a meal</td><td>G</td></tr>
<tr><td>contains the least oxygen</td><td>J</td></tr>
<tr><td>contains the least urea</td><td>F</td></tr>
<tr><td>contains blood at the highest pressure</td><td>B</td></tr>
</table>
</td><td>5</td></tr>
</table>

Question Number	Answer	additional guidance	Mark
3(a)(ii)	An answer that makes reference to two of the following points: A / pV has • thin(ner) wall (1) • less muscle (1) • less elastic tissue (1) • wide(r) / big(er) / lumen (1)	allow converse for J allow thin allow wide ignore ref to valves	**2**

Question Number	Answer	Mark
3(b)	An answer that makes reference to five of the following points: • more (capillaries to transport) oxygen / glucose (1) • more (aerobic) respiration / less anaerobic respiration (1) • more ATP/ more energy (1) • (more) muscle contraction (1) • less lactic acid (1) • effective for long distance events / ineffective for power events / type of performance not specified /only leg muscle sampled / eq(1) • other factor(s) / age / lung (capacity) / heart (rate) named other factors affect performance (1) • need to test more than one person / not repeated / eq (1)	**5**

Total 12 marks

Question Number	Answer	additional guidance	Mark
3(a)(i)	An answer that makes reference to the following points: • extension / pointed / elongated / eq (1) • increased surface area / increased surface area to volume ratio (1)	**Allow** from labelled diagram	**2**

Question Number	Answer	additional guidance	Mark
3(a)(ii)	An answer that makes reference to one of the following points: • involve (movement of) water (only) (1) • must pass through cell membrane (1)	**Allow** converse **Allow** converse	**1**

Question Number	Answer	additional guidance	Mark
3(b)(i)	An explanation that makes reference to three of the following points: • more water taken up in light (1) • more water lost in light (1) • evaporation from leaves creates a transpiration stream / transpiration pull / sets up water potential gradient / eq (1) • stomata open in light (1) • (more water is taken up than lost because) water used to fill cells / growth / turgor/ photosynthesis (1)	**Allow** converse **Allow** converse **Allow** converse Ignore refs to temp	**3**

Question Number	Answer	additional guidance	Mark
3(b)(ii)	An answer that makes reference to two of the following points: • humidity / moisture (1) • temperature (1) • wind / air flow / eq (1) • time (1)	Ignore CO_2	**2**

Question Number	Answer	Mark
3(c)(i)	potometer / bubble potometer / volume potometer (1)	**1**

Question Number	Answer	Additional guidance	Mark
3(c)(ii)	An answer that makes reference to three of the following points: • measure distance bubble moves (1) • calibrate (scale) / calculate volume by multiplying distance by (cross sectional) area / eq (1) • use reservoir to reset / eq (1) • repeats (to calculate mean) (1) • ref to measuring / stated time (1)	• measure volume lost from beaker (1) • use scale on beaker / note volume before and after time period (1)	**3**

Total = 12 marks

Question Number	Answer	Mark
3(a)	W nucleus / eq (1) X cell sap / vacuole / eq (1) Y cellulose cell wall / cell wall / eq (1) Z cytoplasm (1)	**4**

Question Number	Answer	Additional guidance	Mark
3(b)	An answer that makes reference to two the following: measure distance A-B 80 **mm** 8.0 **cm** = 80 000 μm magn = 80 000 ÷ 1000 80 or 79 or 81 or 82 (2) or A-B 8 cm = 8 × 10000	allow full marks for correct answer alone allow 1 mark for ×1000÷1000 if mm or ×10000÷1000 if cm or for correct length of AB from diagram **with units** range 79-82 mm 7.9-8.2 cm	**2**

Question Number	Answer	Mark
3(c) (i)	An explanation that makes reference to three of the following: • increases surface area (1) • osmosis (1) • (water in) root hair cell has lower water potential (than water in soil) / from high to low water potential from dilute to more concentrated solution / eq (1) • as water is lost from leaves/ stomata reducing / setting up osmotic gradient/ water potential gradient in plant /eq (1) • for photosynthesis / turgor/ eq (1) • to transport / absorb mineral ions / eq (1)	**3** allow correctly expressed idea of conc gradient

Question Number	Answer	Mark
3(c) (ii)	An explanation that makes reference to three of the following: • (no / less) oxygen / eq (1) • (no / less) respiration / eq (1) • (no / less) active transport / eq (1) • (no / less) absorption of minerals /named mineral /eq (1) • (no / less) nitrates for amino acids / for protein synthesis / no magnesium for chlorophyll synthesis / eq (1)	**3**

total 12 marks

Question Number	Answer	Additional guidance	Mark
6 (a)	B (bacteria, fungi, and protoctists) is the only correct answer *A is incorrect because protoctists also has pathogens* *C is incorrect because fungi also has pathogens* *D is incorrect because bacteria also has pathogens*		**1**

Question Number	Answer	Additional guidance	Mark
6(b)(i)	An explanation that makes reference to three of the following: • weak(er) / inactivated virus / inactive pathogen / microbe / eq (1) • antigens (in vaccine) (1) • lymphocytes (recognise antigens) (1) • memory cells (1) • faster / sooner / larger number of antibodies made (when virus encountered again) / secondary immune response occurs (if virus encountered again) (1)	**Ignore** small amount / dead virus **Allow** wbc **Ignore** phagocyte	**3**

Question Number	Answer	Additional guidance	Mark
6 (b)(ii)	An answer that makes reference to four of the following: • rabies cases are high <u>before vaccination</u> / before 1947 / eq (1) • (continuous) fall in cases <u>after vaccination</u> / after 1940s / after 1950s (1) • cases of rabies, plateau / level off (from 1950s / 1960s) (1) • correlation between rabies cases in dogs and humans / rabies cases in dogs and humans fall at same times / eq (1) • human rabies cases fluctuate / there are still some cases of human rabies / human rabies has not been eradicated / eq (1) • (most) human rabies must have been from dogs / vaccinated dogs do not pass rabies on to humans / eq (1) • some human rabies cases from other animal species / wild dogs / wild animals / eq (1) • data is reliable as it is for a long time / large area / whole country / eq (1)	**Allow** for human or dog **Allow** for human or dog **Allow** for human or dog **Allow** cases in dogs and humans both fall <u>after vaccination</u> **= 2 marks** **Allow** fewer dogs can pass on rabies to humans / vaccination means fewer hosts for virus / virus can't reproduce in vaccinated dogs	**4**

Question Number	Answer	Additional guidance	Mark
6 (b)(iii)	A description that makes reference to four of the following points: • ribosomes (bind to RNA) (1) • translation occurs (1) • triplet / codon on RNA codes for an amino acid / eq (1) • tRNA binds to RNA / anticodon binds to codon / eq (1) • tRNA brings amino acids / eq (1) • amino acids are joined together (to make protein) / forms a chain of amino acids / peptide bonds form / polypeptide forms / eq (1)	**Allow** mRNA for the vaccine RNA **Ignore** to make protein unqualified	**4**

Total 12 marks

Question Number	Answer	additional guidance	Mark
3(a)	A description that makes reference to two of the following: • (stem cells) are unspecialised / are undifferentiated (1) • (stem cells) can divide / undergo mitosis (1) • (stem cells can differentiate) into other cell types / can form other cell types / can form specialised cells (1)	**Accept** converse for normal body cells	**2**

Question Number	Answer	Additional guidance	Mark
3(b)	A description that makes reference to the following: • help blood to clot / eq (1) • prevent (further) blood loss / stop bleeding / eq (1) • prevent entry of pathogens / bacteria / viruses / fungi / microorganisms / stop infection / eq (1)	**Accept** convert fibrinogen to fibrin / eq	**3**

Question Number	Answer	Mark
3(c)	An explanation that makes reference to four of the following: • dead bacteria / dead pathogen / weaker virus / weaker pathogen / attenuated virus / inactive pathogen / eq (1) • antigens (present in vaccine) (1) • lymphocytes respond (1) • memory cells produced / eq (1) • secondary (immune) response (1) • **more** antibodies / antibodies produced **faster** / antibodies produced **sooner** / eq (1)	**4**

Question Number	Answer		Mark
3(d)	An explanation that makes reference to three of the following: • (blood stem cells) can differentiate / specialise (1) • into different blood cells / various blood cells / any type of blood cell / eq (1) • can make red blood cells **AND** to transport oxygen / eq (1) • can make white blood cells / phagocytes / lymphocytes **AND** to destroy pathogens / release antibodies / produce immunity / eq (1) • can make platelets **AND** to help blood clotting / prevent blood loss / eq (1)	**Allow** any **two** named blood cells for one mark **Ignore** to treat anaemia **Ignore** to treat leukaemia	**3**

Total 12 marks

Question Number	Answer	Mark
3(a)	**D (weight potometer)** A is not the answer as it is not a bubble potometer B is not the answer as it is not a hydrometer C is not the answer as it is not an osmometer	**1**

Question Number	Answer	Additional guidance	Mark
3(b)	Calculation steps not marking points (207.25- 204.5) ÷48 = 0.05729 = 0.057 (2)	Allow **one mark** for 0.0573 or 0.05729 etc or 0.06 or 0.1 Not incorrect rounding so 0.572 no credit 5.7×10^{-2} scores 2 marks	**2**

Question Number	Answer	Additional guidance	Mark
3(c)	An explanation that makes reference to two of the following • can calculate mean /average / eq (1) • increases reliability / eq (1) • allows detection / exclusion of anomalous results / ensure results are concordant/ eq (1) • change in conditions could affect water loss/ results / eq (1)	Ignore accuracy / validity	**2**

Question Number	Answer	Mark
3(d)(i)	A description that makes reference to the following • use fan / hairdryer / eq (1) • control other / named environmental condition / temp / light /eq (1)	**2**

Question Number	Answer	Mark
3(d)(ii)	An explanation that makes reference to three of the following • moves moist air / water molecules away from leaf (surface) / stomata / reduces humidity / eq (1) • increases / restores (concentration) gradient / eq (1) • increases transpiration / evaporation / diffusion / eq (1) • more mass lost / mass changes more / eq (1)	**3**

Question Number	Answer	Mark
3(e)	A description that makes reference to two of the following • have two plants of same species / same type / same size / same leaf area / use same plant / eq (1) • remove roots / eq (1) • control named environmental condition / temperature / light / moving air / eq (1)	**2**

Question Number	Answer	Mark
9(a)	An explanation that makes reference to three of the following points: • antibodies (1) • specific (1) • antigens / foreign / invading cells/ bacteria / virus /pathogen / eq (1) • attach to / clump / kill / destroy pathogens / make memory cells (1)	**3**

Question Number	Answer	Mark
9(b)	An explanation that makes reference to the following points: • killed / destroyed (1) • digested / broken down (1) • by enzymes / named enzyme (1) • products absorbed (by phagocyte) (1)	**3**

Question Number	Answer	Mark
9(c)(i)	Only A is correct as 85 per hour is the rate of ingestion of bacteria in the control *B is incorrect as the rate is not this per hour* *C is incorrect as the rate is not this per hour* *D is incorrect as the rate is not this per hour*	**1**

Question Number	Answer	Mark
9(c)(ii)	• concentration of vitamin C	**1**

Question Number	Answer	Additional guidance	Mark
9(c)(iii)	An answer that makes reference to two of the following points: • number / amount / concentration / volume / type of / size of phagocytes (1) • number / amount / concentration of bacteria (1) • species of bacteria / type / culture of bacteria / no other bacteria / aseptic environment / sterilise test tubes / eq (1)	**mark as list** **Allow** same phagocytes **Ignore** number of bacteria ingested	**2**

Question Number	Answer	Additional Guidance	Mark
9(c)(iv)	An explanation that makes reference to the following points: • vitamin C increases ingestion (by phagocytes) / digested / killed / removed (1) • only done once / not reliable / not repeated (1) • done in vitro / in test tube / not in human / body (1) • need to test with other bacteria / bacteria that are pathogenic / may not work with other bacteria / species (1) • not all pathogens are bacteria / some pathogens are virus /eq (1) • not done at 37°C / not done at body temp / eq (1)	**Ignore** done at 35 °C	**4**

Total = 14 marks

Question Number	Answer	Additional guidance	Mark
5(a)	An answer that makes reference to the following • plasma (1) • platelets (1)	Mark first two answers only	**2**

Question Number	Answer	Additional guidance	Mark
5(b)	A description that makes reference to four of the following points (Stage 1 and Stage 2) • phagocyte / phagocytosis (1) • engulf / pseudopodia / surround /eq (1) • bacterium / pathogen inside white cell / inside vesicle / inside phagosome / eq (1) (Stage 3) • vesicles fuse with bacterium / vesicle fuses with phagosome eq (1) • enzymes digest (bacterium / pathogen) / enzymes break down (bacterium / pathogen) /eq (1) (Stage 4) • products (of digestion) expelled (from white cell) / (from the phagosome/ from the vesicle) eq (1)	allow marking points (in order) even if no reference to stages this can be gained in any stage allow enclosed completely engulfed allow lysosome allow digestive enzymes (waste) products / remains of bacterium / (broken down) bacterium pathogen secreted / excreted / released / exocytosis	**4**

Question Number	Answer	Additional guidance	Mark
5(c)(i)	measurement of diagram 5.7 (5.5-5.9) cm or 55 -59 mm conversion of units cm × 10,000 or mm × 1,000 magnification = 57000 (55000- 59000) ÷8.1 = 7037 (6790 – 7284) (3)	allow 1 mark for measurement with units 1 mark for 5.7 ×10,000 or 57 × 1000 or allow 8.1 ÷10,000 or ÷ 1000 allow full marks for correct answer alone allow **6800-7300** given to 2 sig figs for 3 marks	**3**

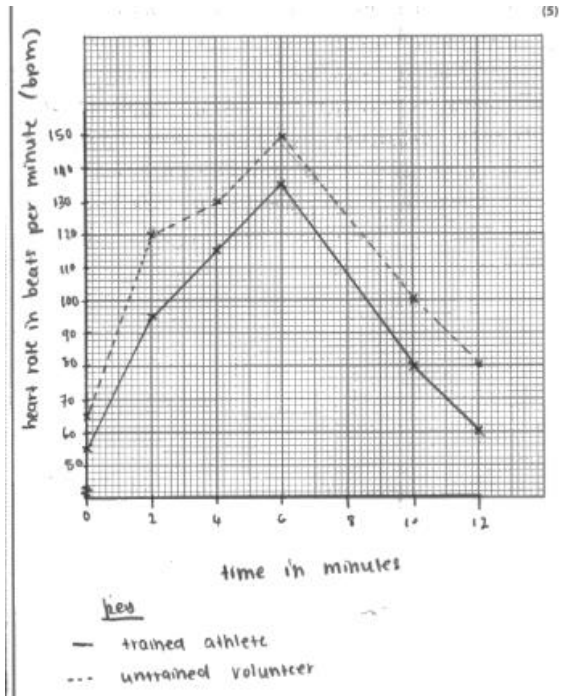
Question Number	Answer	Additional guidance	Mark
5(c)(ii)	An answer that makes reference to five of the following	no credit for quoting figures alone unless ref to only higher etc	**5**
	1. **normal blood flow % oxygen /saturation** is higher (than slow) / (in non-anaemic / anaemic patients) eq (1)	lower in slow	
	2. **normal blood flow rate of deoxygenation** higher (in non-anaemic / anaemic patients) / eq (1)	lower in slow flow	
	3. **% oxygen /saturation lower in anaemic** (in normal and slow blood flow) / eq (1)	higher in non-anaemic	
	4. greater difference in **% oxygen/ saturation** between non-anaemic and anaemic in slow blood flow than normal blood flow/ eq (1)		
	5. fewer red blood cells / less haemoglobin in anaemic patients / eq (1)	more in non-anaemic	
	6. (fewer red cells)to carry oxygen (1)		
	7. anaemic patients tissues deoxygenate faster / eq (1)	non-anaemic deoxgenate slower	
	8. little difference in deoxygenation (between normal and slow blood flow patients) / eq (1)		
	9. reference to high numbers of non-anaemic / lower numbers especially of anaemic slow blood flow (so data less reliable)		
	10. factors such as smoking/ mass / sex / diet / blood pressure / activity / genetics / eq (1)		

Total 14 marks

Question Number	Answer	Mark
5 (a)(i)	**The only correct answer is C** *A is incorrect as W is not the left atrium* *B is incorrect as W is not a ventricle* *D is incorrect as W is not a ventricle*	**1**

Question Number	Answer		Mark
5 (a)(ii)	A description that makes reference to the following. • X / pulmonary artery, has lower oxygen / is deoxygenated / eq (1) • X / pulmonary artery has higher carbon dioxide / eq (1)	**Allow** Y / aorta, has higher oxygen / is oxygenated **Allow** Y / aorta, has lower carbon dioxide	**2**

Question Number	Answer	Additional guidance	Mark
5(b)(i)	• 89 (2)	**Allow** any number of correct decimal places e.g. 89.0909, 89.1 **Allow** 90 **One mark** for 55 **OR** **One mark** for 75, 75.4, 75.38 etc. **Correct answer gains both marks**	**2**

Question Number	Answer	Additional guidance	Mark
5 (b)(ii)	An answer that makes reference to the following. S – linear scales for both axes and at least half grid (1) L – ruled, straight lines (1) A – both axes fully labelled (1) P – correct plots (1) K – key / eq (1)  	time must be on x axis Minimum label: heart rate / bpm **and** time / min **Allow** plots if non-linear scales Plots +/- half square Bar chart: S, A, P, K (max 4) One data set plotted: S, L, A **Time in minutes** / **Heart rate in beats per minute (bpm)**: **untrained volunteer** / **trained athlete** 0 (rest): 65 / 55 2: 120 / 95 4: 130 / 115 6: 150 / 135 10: 100 / 80 12: 80 / 60	**5**

Question Number	Answer		Mark
5 (b)(iii)	An explanation that makes reference to four of the following. • (trained athlete) has lower heart rate / heart rate returns to normal quicker / eq (1) • (trained athlete) has larger heart / larger stroke volume / pumps more blood / eq (1) • more / faster transport of, oxygen / glucose pumped / more removal of carbon dioxide / heat / eq (1) • (more) (aerobic) respiration / ATP production / energy / eq (1) • (more) muscle <u>contraction</u> (1) • less anaerobic respiration / lactic acid / less <u>oxygen debt</u> / eq (1)	**Allow** converse for untrained **Allow** stronger heart **Allow** untrained has to pump faster to move same amount of blood / eq **Allow** untrained has to pump faster to move same amount of oxygen / eq	**4**

(Total for Question 5 = 14 marks)

Question Number	Answer	additional guidance	Mark
4(a)	An explanation that makes reference to four of the following points: • cut plant under water / set up under water (1) • seal connection / check for leaks / dry leaf / no air gaps / airtight /eq (1) • (observe/ introduce) air bubble (1) • measure distance / movement / record position (1) • use reservoir/ tap to reset bubble / move bubble on to scale / use reservoir to measure volume/ eq (1) • convert answer into volume by $\pi r^2 h$ distance times πr^2 (1)	**ignore count bubbles** measure distance moved by bubble = 2	**4**

Question Number	Answer	Mark
4(b)	An answer that makes reference to two of the following points: • light (1) • temperature (1) • humidity (1) • carbon dioxide / CO_2 (1)	**2**

Question Number	Answer	Additional guidance	Mark
4(c)	water loss per cm^2 in 30 minutes is $10.5 \times 10^{-4} = 0.00105$ water loss with area of 200 cm^2 is $0.00105 \times 200 = 0.21$ $0.21 \div 30 = 0.007$ cm^3 per min $1 \div 0.007 =$ 143 / 142.9 / 142.86 / 142.857 etc (3 marks)	award full marks for correct numerical answer without working one mark for $\times 200$ one mark for $\div 30$ allow 2 marks for 1.43or 1430 or 14.3 etc and for other versions eg 1.429 eq allow 140 for 3 marks	**3**

Question Number	Answer	additional guidance	Mark
4(d)	An answer that makes reference to the following points: • more transpiration (stream) / water loss / evaporation in wind (1) • cools plant / prevents overheating /eq (1) • more mineral ions / named mineral transported (1) • **(function of named mineral ion)** nitrate for amino acids / magnesium for chlorophyll / phosphate for DNA / ATP (1) • plant wilts / cells not turgid/eq(1) • wind may snap stems /eq (1) • wind may dry the soil (1) • plants may close stomata so reducing photosynthesis (1) • no information on /plant growth affected by light/ temperature / CO_2 / other named abiotic factor(s) (1) • investigation not repeated / eq (1) • no information about / species other species / plants may respond differently than experimental plant (1) • field trials needed / only done in lab/eq(1)	at least one from not just take up more water max 5 from	**6**

Total = 15 marks

Question Number	Answer	Additional guidance	Mark
6(a)	control the movement (of substances) in /out of cell / eq	control what comes into out of cell only allows certain substances to enter cell	**1**

Question Number	Answer	Additional guidance	Mark
6(b)	original area = 3.14 × 4 = 12.56 0.55 × 12.56 = 6.9 / 6.91 / 6.908 mm^2 (2)	award full marks for correct numerical answer without working allow 1 mark for 12.56 or allow 1 mark for x 0.55	**2**

Question Number	Answer		Mark
6(c)(i)	An answer that makes reference to the following points: • S y axis linear and half the grid (1) • L labelled bars drawn for each range (1) • A1 axes labelled number (of men) (1) • A2 axes labelled 'cholesterol concentration in mg /cm^3 or mg per cm^3 or mg cm^{-3}' • P bar heights correct (within half small square) (1)	line graph no L mark	**5**

Question Number	Answer	Mark
6(c)(ii)	The only correct answer is C 160 to 199 A is not correct as the mode is not 80 to 119 B is not correct as the mode is not 80 to 379 D is not correct as the mode is not 360 to 399	**1**

Question Number	Answer	Additional guidance	Mark
6(c)(iii)	115 + 34 + 9 + 5 = 163 total men in sample = 1067 163 ÷ 1067 × 100 15.276 / 15 .28 /15.3 / 15 (2)	award full marks for correct numerical answer without working allow 1 mark for 163 or 1 mark for dividing by 1067 **and** x 100	**2**

Question Number	Answer	additional guidance	Mark
6(d)	An answer that makes reference to four of the following points: • statin shows less percentage of / fewer heart attacks (1) • only one statin tested (1) • only tested for four years (1) • difference could be due to chance (1) • groups may have small size / no information on group size /eq (1) • some may have pre-existing heart condition / blood pressure / eq (1) • groups may not have same diet / exercise / stress / smoking / eq (1) • groups may be different ages / masses / obesity / have different genes / family history / sex / ethnicity / eq (1)	converse ignore ref to repeated ignore healthier ignore lifestyle	**4**

Total 15 marks

Question Number	Answer	Additional guidance	Mark
1(a)	An explanation that makes reference to two of the following points: • (damage to) alveoli (1) • reduces / less / small surface area (1) • (less) diffusion / (less) oxygen in / (less) carbon dioxide out (1)	Less surface area of alveoli = two marks	**2**

Question Number	Answer	Additional guidance	Mark
1(b)	An explanation that makes reference to the following points: • bacteria / microorganisms / pathogens are killed / destroyed / removed / eq (1) • no / less chance of infection (with TB) / disease / catching *Mycobacterium* / *Mycobacterium bovis* / catching TB / eq (1)	**Allow** converse **Ignore** get sick / ill	**2**

Question Number	Answer	Additional guidance	Mark
1(c)	An answer that makes reference to two of the following points: • fewer cattle (to be infected) (1) • fewer people in Europe (than in rest of world) (1) • cattle are screened / if infected are killed (1) • cattle are given antibiotics (1) • vaccination (of cattle / people / badgers in Europe) (1) • more pasteurised milk drunk / milk pasteurised (1) • fewer badgers (in Europe to transmit TB) / fewer other animals (in Europe to transmit TB) / badgers culled (in Europe) (1)	**Allow** converse	**2**

Question Number	Answer	Additional guidance	Mark
1(d)	• 149 000 – 1290 = 147 710 and 13 400 – 103 = 13 297 (1) • 147 710 ÷ 13 297 = 11.1 : 1 (2)	award full marks for correct numerical answer without working **Allow** 11.11, 11.108 etc **Allow** full marks for 11.1 to 1 one mark for 13297 **and** 147710 or one mark for 1:11.1 or one mark for 11.1 alone	**2**

Question Number	Answer	Mark
1(e)	An answer that makes reference to two of the following points: • (find / protect / less competition for) mates / females (1) • (protect) food / less competition for food / resources / obtain more food (1) • protect young (1)	**2**

Question Number	Answer	Additional guidance	Mark
1(f)	An explanation that makes reference to three of the following points: • use attenuated / dead / weak / inactive pathogen / bacterium / eq (1) • antigens (1) • memory cells (1) • secondary immune (response) (1) • antibody production fast(er) / soon(er) / more / large amounts (1)	**Ignore** disease / virus no credit for antibody production alone	**3**

Question Number	Answer	Mark
1(g)	An answer that makes reference to three of the following points: • vaccinate badgers in one area and not in another / eq (1) • (count) number of cattle with TB / see if there are fewer / more cases of TB (1) • same number / control number of badgers in each area (1) • same field size / area (1) • same number of cattle (1)	**3**

Total = 16 marks

Question Number	Answer	Mark
7(a)(i)	**C (S)** A is not the answer as P is a platelet B is not the answer as Q is a white blood cell D is not the answer as T is a monocyte	**1**

Question Number	Answer	Mark
7(a)(ii)	**A (P)** B is not the answer as Q is a white blood cell C is not the answer as R is a lymphocyte D is not the answer as T is a monocyte	**1**

Question Number	Answer	Mark
7(a)(iii)	**C (R)** A is not the answer as P is a platelet B is not the answer as Q is a white blood cell D is not the answer as S is red blood cell	**1**

Question Number	Answer	Mark
7(a)(iv)	**B (iron)** A is not the answer as calcium is not found C is not the answer as magnesium is not found D is not the answer as sodium is not found	**1**

Question Number	Answer	additional guidance	Mark
7(b)	A description that makes reference to four of the following 1. phagocytes / white blood cells engulf pathogens / bacteria /eq (1) 2. phagocytes / white blood cells digest / break down / pathogens / bacteria /eq (1) 3. lymphocytes / white blood cells produce antibodies / eq (1) 4. antibodies are specific to pathogen / antigens / complementary to pathogen / antigens / eq (1) 5. antibodies attach to pathogens / bacteria / antigens / eq (1) 6. (antibodies) cause agglutination / sticking together / bursting / eq (1)	No credit for phagocytes release antibodies / lymphocytes engulf allow ref to memory cells as alternative to mp 6	**4**

Question Number	Answer	additional guidance	Mark

7(c)(i)	calculation method not marking points 5.0×10^{12} in one litre / dm^3 $(5.0 \times 10^{12}) \div (1 \times 10^6\ mm^3)$ So 5×10^6 in $1mm^3$ and 2 x in $2mm^3$ $= 1.0 \times 10^7$ or 1×10^7 (3)	Full marks for correct answer If answer incorrect allow one mark for $\div 1.0 \times 10^6$ ÷1000000 or 5.0×10^6 Allow 2 marks for 10×10^6 or 0.1×10^8 or 0.01×10^9 10 million Or 10 000 000	**3**

Question Number	Answer	additional guidance	Mark
7(c)(ii)	An answer that makes reference to five of the following 1. no difference in platelets (1) 2. no difference in clotting / scab formation / eq (1) 3. more phagocytes that engulf / digest pathogens / bacteria /eq (1) 4. more lymphocytes that produce antibodies / eq (1) 5. can fight infection / prevent disease / more effective immune system / can become immune /eq (1) 6. has an infection / bacteria / virus /sepsis / eq (1) 7. too much cell division / mutation / cancer / eq (1) 8. no difference in rbc / eq (1) 9. no difference in oxygen transport / no difference in respiration / not anaemic / eq (1)	allow converse for mp 3-mp7 for without condition	**5**

Question Number	Answer	Mark
1(a)	C ultrafiltration *A is incorrect because digestion is not a process in the kidneys* *B is incorrect because mutation is not a process in the kidneys* *D is incorrect because vaccination is not a process in the kidneys*	**1 comp**

Question Number	Answer	Additional guidance	Mark
1(b)	An answer that makes reference to three of the following points: • stay out of water / wear waterproof clothes / eq (1) • treat drinking water / boil water (before drinking) / do not drink water / drink bottled water / eq (1) • sanitation / no faeces in water / no urine in water /eq (1) • remove snails /eq (1) • vaccination (1)	**Allow** do not go in infected rivers or lakes / cover skin when in water / avoid contact with affected water / only wash in clean water **Allow** filter water / do not drink river water / lake water **Allow** use sewage treatment system / use toilet with septic tank **Allow** don't touch snails	**3 exp**

Question Number	Answer	Mark
1(c)	An answer that makes reference to two of the following points: • red blood cells / rbc (1) • white blood cells / wbc (1) • lymphocytes (1) • phagocytes / macrophages (1)	**2 grad**

Question Number	Answer	Mark
1(d)	D 4 800 *A is incorrect because it is the wrong value* *B is incorrect because it is the wrong value* *C is incorrect because it is the wrong value*	**1 comp**

Question Number	Answer	Additional guidance	Mark
1(e)	• $8 \times 10^{-4} = 0.0008$ • x 240 million = 192 000 ÷ 100 = 1920 (2)	**Allow** 1 mark for: 19200000 / 1920000 / 192000 / 19200 / 192 / 19.2 / 1.92 / 0.192 / 0.0192 Award full marks for correct numerical answer without working	**2 grad**

Question Number	Answer	Mark
1(f)	A a circle of DNA *B is incorrect because it is not RNA* *C is incorrect because it is not a protein* *D is incorrect because it is not RNA*	**1 comp**

Question Number	Answer	Mark
1(g)	An explanation that makes reference to three of the following points: • antigen (1) • memory cells / lymphocytes (1) • (secondary) immune response (1) • more antibodies / antibodies made sooner / faster / faster immune response / eq (1)	**3 exp**

Question Number	Answer		Mark
1(h)(i)	• (a treatment with) no plasmid / no protein / only water / saline / eq (1)	**Allow** placebo vaccine / a placebo / plasmid with no gene / plasmid with no DNA / different DNA	**1 exp**

Question Number	Answer	Additional Guidance	Mark
1(h)(ii)	An answer that makes reference to three of the following points: • reduced numbers / eq (1) • by 19 or by 47% / about 50% • schistosomes / worms, still present in body (1) • no idea of group size / needs to be repeated (1) • no idea of age / sex / health (1)	**Allow** reduces numbers of worms / worms decrease / lower number of worms after vaccine **Allow** more worms in control group **Allow** does not completely get rid of them **Allow** more testing / more people tested	**3 exp**

Total = 17 marks

Question Number	Answer	Additional guidance	Mark
1(a)	lymphocytes / eq	**Ignore** white blood cells **Reject** phagocytes	**1**

Question Number	Answer	Additional guidance	Mark
1 (b)(i)	An answer that makes reference to one of the following: • both alleles expressed (1) • both alleles affect the phenotype (1) • both alleles show their characteristics / traits (1)	**Accept** both alleles work together / both alleles work together to form a third phenotype / phenotype depends upon both alleles	**1**

Question Number	Answer	Additional guidance	Mark
1 (b)(ii)	**The correct answer is D (A, B, AB and O)** A is incorrect as the cross could also produce AB and O B is incorrect as the cross could produce also AB and O C is incorrect as the cross could also produce A, and B		**1**

Question Number	Answer	Additional guidance	Mark
1 (c)	$4.7(4) \times 10^7$ (2)	**one mark** for 47400000 **or** 47.4 million **or** 47 million **or** other incorrect standard forms using 47(4) **Correct answer gains all marks**	**2**

Question Number	Answer	Additional guidance	Mark
1(d)	An explanation that makes reference to the following: • artificial cells are not (bi)concave / red blood cells are (bi)concave (1) • artificial cells have smaller SA(:vol ratio) / red blood cells have larger SA (:vol ratio) (1) • artificial cells absorb / bind / release less oxygen / red blood cells absorb bind more oxygen / release more oxygen / eq (1) • artificial cells do not pass through capillaries easily / eq / red blood cells pass through capillaries more easily / eq (1)	**Accept** artificial cells carry less oxygen / red blood cells carry **more** oxygen **Accept** artificial cells have slower diffusion (of oxygen) / red blood cells have faster diffusion (of oxygen)	**3**

Question Number	Answer	Additional guidance	Mark
1 (e)	An explanation that makes reference to the following: • no platelets (1)	**Allow** no fibrinogen	**1**

Question Number	Answer	Additional guidance	Mark
1 (f)	An explanation that makes reference to two of the following: • no / less water uptake / eq (1) • by osmosis / due to osmotic effects (1) • so cells do not burst / eq (1)	**Accept** converse **Accept** equal water movement in and out **Accept** correct ref to water potential	**2**

Question Number	Answer	Additional guidance	Mark
1 (g)(i)	An explanation that makes reference to two of the following: • stem cells can divide / perform mitosis (1) • stem cells can differentiate / specialise / stem cells can become any cell / other cell types (1)	**Accept** stem cells are undifferentiated / unspecialised	**2**

Question Number	Answer	Additional guidance	Mark
1 (g)(ii)	An answer that makes reference to two of the following: • (there are) no antigens (present) / eq (1) • so antibodies will not be produced / no rejection / no immune response / eq (1) • any recipient / more people can receive blood group O (1)	**Accept** no surface proteins **Accept** blood group A/ B / AB can receive the blood / O is the universal donor	**2**

Question Number	Answer	Additional guidance	Mark
1 (h)	An answer that makes reference to two of the following: • urea (1) • digested food / named example (1) • carbon dioxide (1) • hormone / named hormone (1) • mineral / ion / (not sodium / sodium chloride / salt) / vitamins (1) • protein / clotting factors / fibrinogen / antibodies / eq (1)	e.g amino acids / glucose / fatty acids / LDLs **Accept** named minerals / vitamins	**2**

Total: 17 marks

Question Number	Answer	additional guidance	Mark
1(a)	An explanation that makes reference to the following points: • roots (hair cells) damaged / roots not in soil / roots exposed / eq (1) • water not absorbed / taken up /eq (1) • water lost by transpiration / evaporation / eq (1)	don't get water mp 2 from soil mp1	**2**

Question Number	Answer	additional guidance	Mark
1(b)	number of stomata in photo=3 area of photo = 100 µm x 100 µm conversion of µm to mm = 0.1 x 0.1 mm = 0.01mm^2 3 stomata in 0.01 mm^2 answer in stomata per mm^2 = 3 × 1/0.01 = **300** (3)	allow 1 mark for 3 allow 1 mark for 1 ÷ 0.01 or 3 ÷0.01 or number of stomata ÷0.01 or number of stomata×100 allow full marks for 300 with no working	**3**

Question Number	Answer	Mark
1(c)	An explanation that makes reference to two of the following points: • stomata closed / shut / less open / smaller / eq (1) • less carbon dioxide absorbed / eq (1)	**2**

Question Number	Answer	Additional guidance	Mark
1(d)(i)	An explanation that makes reference to two of the following points: • stomata mainly / only on lower surface / upper surface has no/ fewer stomata / eq (1) • so stomata not blocked / stomata not covered by reflective compound / eq (1) • carbon dioxide can still be absorbed / gas exchange can still take place / eq (1) • more /most light falls on upper surface / eq (1)	allow converse for if covered	**2**

Question Number	Answer	Mark
1(d)(ii)	An explanation that makes reference to two of the following points: • lower temperature reduces (kinetic) energy (1) • water molecules move less / eq (1) • less diffusion / evaporation / eq (1)	**2**

Question Number	Answer	additional guidance	Mark
1(e)	A description that makes reference to two of the following points: • named mineral ion (1) • correct matched function (1)	must be ions eg nitrate (1) ignore nitrogen for amino acids / protein (1) ignore growth magnesium for chlorophyll / chloroplasts (1) allow other correct mineral ions and correct function	**2**

Question Number	Answer	additional guidance	Mark
1(f)	A description that makes reference to four of the following points: • root hair cells (1) • (absorb water by) osmosis / eq (1) • from dilute solution to more concentrated / eq (1) • water moves up xylem / xylem carries water to leaves /eq (1) • transpiration pull /stream /eq (1) • due to water loss from stomata / transpiration from stomata / evaporation from stomata /eq (1)		**4**

Total = 17 marks

Question Number	Answer	Additional guidance	Mark
1(a)	• Less able to contract / pump / beat / eq (1)	**Allow** heart has to work harder to push blood	**1**

Question Number	Answer	Additional guidance	Mark
1(b)	An answer that refers to three of the following points • pump / push blood into ventricles (1) • receive deoxygenated blood / blood from body / blood from vena cava (1) • receive oxygenated blood / blood from lungs / blood from pulmonary vein (1)	**Ignore** blood passes from atria ventricles without idea of actively being moved **Allow** one mark for receive blood if no MP2 or MP3	**3**

Question Number	Answer	Additional guidance	Mark
1(c)	An answer that refers to two of the following points • low(er) pressure (1) • low(er) oxygen / less oxygenated / deoxygenated (1) • high(er) carbon dioxide (1)	**Allow** converse for all mark points	**2**

Question Number	Answer	Additional guidance	Mark
1(d)	An explanation that refers to three of the following points **LUNG FUNCTION** • oxygenates blood (1) • removes carbon dioxide (1) **HEART FUNCTION** • transport / pump, blood around body (1) • (enable tissues / cells to) respire (1) • allows surgeon to operate on heart / connect new heart (1)	**Allow** aerates blood **Allow** transport glucose / nutrients, around body / to cells	**3**

Question Number	Answer	Additional guidance	Mark
1(e)	An explanation that refers to two of the following points • prevents rejection (1) • because antigens / eq, are recognised / are different (1) • stops action of immune system / reduces immune response / reduces lymphocyte action / stops antibody production /prevents white blood cells activity / eq (1)	**Ignore** attack stops immune system rejecting heart = 2 marks **Ignore** suppress **Allow** reduced phagocytosis	**2**

Question Number	Answer	Additional guidance	Mark
1(f)	An explanation that refers to two of the following points • less oxygen in blood / less efficient gas exchange (1) • narrows arteries / damages artery walls / increased risk of fat in artery walls / atheroma / increased risk of heart disease / eq (1) • carbon monoxide binds with haemoglobin / red blood cells (1) • (increased risk of) blood clotting / strokes (1) • (increases risk of) higher blood pressure (1)		**2**

Question Number	Answer	Additional guidance	Mark
1(g)	• contains **all** required nutrients /food groups in the correct proportion / amounts (1)	**Allow** all the food groups in correct amounts / eq **Allow** has carbohydrates, protein, fats, vitamins minerals, fibre and (water) in right amounts **Ignore** balance must contain **all** or complete list (except water) and correct proportion	**1**

Question Number	Answer	Additional guidance	Mark
1(h)	150 (2)	75 x 200 /100 75/100 x 200 0.75 x 200 **Allow** 2 marks for 150 **one mark** for use of 75 and 200	**2**

Question Number	Answer	Additional guidance	Mark
1(i)	• puts more pressure on heart / (increased risk of) heart attack / causes heart rate to increase / makes heart beat harder / increases blood pressure / eq (1)	**Allow to** not strain the heart / too stressful on heart	**1**

Question Number	Answer	Additional guidance	Mark
1(j)	• immune system is weaker / less able to produce antibodies / less immune response / eq	**Allow** because they are taking immunosuppressants	**1**

Total 18 marks

Question Number	Answer	Mark
3(a)	The only correct answer is A cortex *B is not correct as it is not in the collecting duct* *C is not correct as it is not in the loop of Henle* *D is not correct as it is not in the medulla*	**1**

Question Number	Answer	Additional guidance	Mark
3(b)	64 to 66 (1)	Allow mark if seen on graph	**1**

Question Number	Answer	Mark
3©	An explanation that makes reference to four of the following points: • protein large (molecule) (1) • cannot enter Bowman's capsule / cannot leave blood / cannot pass through glomerulus / basement membrane / capillaries (1) • glucose (re)absorbed / glucose into blood / glucose into capillaries (1) • proximal convoluted tubule / by active transport / diffusion (1) • urea concentration higher / increased (1) • because water (re)absorbed / water into blood / water into capillaries / urea secreted / urea added to urine (1)	**4**

Total 6 marks

Question Number	Answer	Mark
3(a)	**The only correct answer is A (proximal convoluted tubule)** *B is incorrect as it is the distal convoluted tubule* *C is incorrect as it is the collecting duct* *D is incorrect as it is the loop of Henle*	**1**

Question Number	Answer	Additional guidance	Mark
3(b)(i)	0.03 (2)	**Allow** 0.031 **or** 0.0314 **or** other correct significant figures **Allow** 3.14×10^{-2}, 3×10^{-2} **One mark** for 0.1 **or** 100/1000 **or** 31400 **Correct answer gains all marks**	**2**

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	An explanation that makes reference to two of the following. • increases the pressure / creates high pressure / eq (1) • (for) ultrafiltration (1) • so that plasma / small molecules / fluid / filtrate, leave glomerulus / enter Bowman's capsule / eq (1)	**Allow** generates pressure **Allow** renal capsule **Allow** correct named small molecule e.g. urea **Allow** small particles **Ignore** blood	**2**

Question Number	Answer	Additional guidance	Mark
3(c)	A description that makes reference to the following. • biuret (reagent) (1) • lilac / purple / pink / mauve / eq (1)	**Allow** ninhydrin **Allow** uristix / clinistix **Allow** ninhydrin goes pink / red **Allow** uristix / clinistix go brown / green	**2**

(Total for Question 3 = 7 marks)

Question Number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation that makes reference to three of the following points: 1. <u>volume</u> increases / inhalation occurs / air drawn in / eq (1) 2. diaphragm / intercostal muscles contract (1) 3. diaphragm moves down / flattens / eq (1) 4. ribcage expands / eq (1) 5. pressure decreases (inside thorax / lungs) / eq (1)	 **Accept** internal intercostal muscles relax **Accept** ribs move up / move out / eq **Accept** thorax / chest expands / eq **Accept** pressure higher outside / eq	**3**

Question Number	Answer	Additional guidance	Mark
2(b)	An explanation that makes reference to three of the following points: 1. glucose in urine / eq (1) 2. glucose released by <u>ultrafiltration</u> (into filtrate) / eq (1) 3. glucose not <u>re</u>absorbed / too much glucose (in filtrate) to <u>re</u>absorb / eq (1) 4. in the proximal convoluted tubule / PCT / first convoluted tubule / eq (1) 5. by active transport / eq (1)	 **Accept** glucose not absorbed into blood **Accept** some glucose not reabsorbed **Reject** if active transport pumping glucose into filtrate	**3**

(Total for Question 2 = 7 marks)

Question Number	Answer	additional guidance	Mark
7(a)	• 600 / 1400 • 0.43 dm^3 = • 430	one mark for 600 /1400 or one mark for 0.43/ eq **full marks for correct answer with no working** allow 429 / 428.57 or 428.6 / eq	**2**

Question Number	Answer	additional guidance	Mark
7(b)	• lungs / skin (1)	allow liver if two answers and one incorrect = 0 skin anus =0	**1**

Question Number	Answer	additional guidance	Mark
7(c)	An answer that makes reference to five of the following points • as blood concentration increases osmoreceptors / hypothalamus detects change (1) • pituitary gland release ADH (1) • increase permeability of collecting duct (1) • reabsorbed from collecting duct / into blood (1) • less urine /more concentrated urine (1) • increases water level / reduces blood concentration (1) • (so that) hypothalamus not stimulated / pituitary releases less ADH / negative feedback idea (1)	**allow converse if blood water content increases**	**5**

Total 8 marks

Question Number	Answer	Mark
4(a)(i)	The only correct answer is A *B is incorrect because ultrafiltration does not take place at the proximal convoluted tubule* *C is incorrect because ultrafiltration does not take place at the loop of Henle* *D is incorrect because ultrafiltration does not take place at the collecting duct*	**1**

Question Number	Answer	Mark
4(a)(ii)	The only correct answer is B *A is incorrect because reabsorption of glucose does not take place at the glomerulus* *C is incorrect because reabsorption of glucose does not take place at the loop of Henle* *D is incorrect because reabsorption of glucose does not take place at the collecting duct*	**1**

Question Number	Answer	Mark
4(a)(iii)	The only correct answer is D *A is incorrect because the proximal convoluted tubule does not respond to ADH* *B is incorrect because ultrafiltration does not respond to ADH* *C is incorrect because ultrafiltration does not respond to ADH*	**1**

Question Number	Answer	Mark
4(b)(i)	An explanation that makes reference to the three of following points: • water reabsorbed / water into blood (1) • osmosis (1) • concentrated urine / less water in urine / less urine (1)	**3**

Question Number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation that makes reference to the following points: • hot/higher temperature during day / cool(er)/lower temperature at night / cool(er)/lower temperature underground (1) • less water loss / less dehydration (1) • hide from predators / less visible to predators / less chance of being hunted (1)	Mp2 Allow less sweating Allow converse for Mps 2 and 3	**2**

Question Number	Answer	Additional guidance	Mark
4(b)(iii)	An answer that makes reference to one of the following: • respiration (1) • food / cacti / plants / seeds (1) • condensation (1)	Ignore rain / other water source	**1**

Total 9 marks

Question Number	Answer	Mark
2(a)	The only correct answer is A *B is not correct because it does not contain nephrons* *C is not correct because it does not contain nephrons* *D is not correct because it does not contain nephrons*	**1**

Question Number	Answer	Mark
2(b)	An answer that makes reference to one of the following points: • water (1) • urea (1) • ions / named ion / salts (1)	**1**

Question Number	Answer	Additional Guidance	Mark
2(c)(i)	An explanation that makes reference to five of the following points: • more urine produced when drinking water / less urine when drinking salt solution (1) • lower blood concentration (when drinking water) / higher blood concentration (when drinking salt solution) (1) • detected by hypothalamus / osmoreceptors (1) • less / no ADH released by (pituitary) (with water) / (more) ADH released (with salt) (1) • collecting ducts are less permeable (with water) / collecting ducts are more permeable (with salt) (1) • less water reabsorbed / absorbed into blood (with water) / (more) water reabsorbed / absorbed into blood (with salt) (1)	**Allow** converse for salt **Allow** correct water potentials **Allow** blood is more dilute / higher water levels	**5**

Question Number	Answer	Mark
2(c)(ii)	An answer that makes reference to two of the following points: • exercise / sweating / activity (1) • volume of fluid consumed before investigation / what they drank (1) • temperature / eq (1) • food eaten / diet (1)	**2**

Total 9 marks

Question Number	Answer	Mark
6(a)	D organ S *A is incorrect as P does not store urine* *B is incorrect as Q does not store urine* *C is incorrect as R does not store urine*	**1**

Question Number	Answer	Mark
6(b)	B organ Q *A is not correct as organ P does not produce adrenaline* *C is not correct as organ R does not produce adrenaline* *D is not correct as organ S does not produce adrenaline*	**1**

Question Number	Answer	additional guidance	Mark
6(c)(i)	An answer that includes two of the following: • urea (1) • water (1) • ions / salt / named ion / named salt (1)	ignore urine	**2**

Question Number	Answer	additional guidance	Mark
6(c)(ii)	An explanation that makes reference to the following points: • female only transports urine / urination / no gametes (1) • separate reproductive passage / vagina / birth canal /eq (1)	not just used for excretion	**2**

Question Number	Answer	Mark
6(d)	An explanation that makes reference to four of the following points : • (increased) sweat (1) • blood concentration increases / blood water potential decreases (1) • (more) ADH (1) • from pituitary glands (1) • more water reabsorbed from collecting duct (1) • lower volume / less urine / more concentrated urine produced (1)	**4**

Total = 10 marks

Question Number	Answer	Mark
2(a) (i)	**The only correct answer is B nephron** A is not correct as it is not the bladder C is not correct as it is not the ureter D is not correct as it is not the urethra	**1**

Question Number	Answer	Mark
2(a) (ii)	**The only correct answer is B blood** A is not correct as it not bile C is not correct as it not filtrate D is not correct as it not urine	**1**

Question Number	Answer	Mark
2(a) (iii)	**The only correct answer is C ureter** A is not correct as it not the renal artery C is not correct as it not the renal vein D is not correct as it not the urethra	**1**

Question Number	Answer	additional guidance	Mark
2(b)(i)	An answer that makes reference to five of the following points: 1. **Process** W (ultra) filtration (1) 2. **Location** from glomerulus / into Bowman's capsule (1) 3. **Effect** protein passes (through basement membrane) out of blood / into nephron / eq (1) 4. **Process** X (selective) reabsorption (1) 5. **Location** in convoluted tubule (1) 6. **Effect** glucose not taken back into blood / stays in tubule / eq (1) 7. **Process** Y reabsorption of water / ADH release / osmoregulation/ eq (1) 8. **Location** in collecting duct (1) 9. **Effect** stays impermeable / less permeable / doesn't allow water (back) into blood / eq (1)	glomerular filtration = mp 1 and mp 2	**5**

Question Number	Answer	additional guidance	Mark
2(b)(ii)	A description that makes reference to two of the following • Benedict's added / eq (1) • heated / eq (1)	allow alternative test Fehlings or $CuSO_4$ and Na_2CO_3 allow Benedict's	**2**

	• red / green / yellow / orange / eq (1)	test for mp 1 allow clinistix / ursitix / glucose testing strip for mp 1 and correct colour change for mp 3 / brown	

Total = 10 marks

Question Number	Answer	Mark
3(a)(i)	The only correct answer is **C (S)** A is not the answer as P is not the Bowman's capsule B is not the answer as R is not the Bowman's capsule D is not the answer as T is not the Bowman's capsule	**1**

Question Number	Answer	Mark
3(a)(ii)	The only correct answer is **B (Q)** A is not the answer as P is not the Loop of Henle C is not the answer as S is not the Loop of Henle D is not the answer as U is not the Loop of Henle	**1**

Question Number	Answer	Mark
3(a)(iii)	The only correct answer is **A (P)** B is not the answer as Q is not affected C is not the answer as S is not affected D is not the answer as T is not affected	**1**

Question Number	Answer	Additional guidance	Mark
3(b)(i)	An explanation that makes reference to three of the following points: • glucose passes from glomerulus / glucose passes into renal / Bowman's capsule / eq (1) • reabsorbed / absorbed back into blood / eq (1) • by active transport / eq (1) • (reabsorbed) in the proximal convoluted tubule / PCT / first convoluted tubule / eq (1)	**Accept** glucose passes out from R / passes into S **Accept** in T	**3**

Question Number	Answer	**Additional guidance**	**Mark**
3(b)(ii)	A description that makes reference to two of the following points: • add Benedict's solution (and heat) / eq (1) • red / orange / yellow / green colour show positive result / eq (1)	**Accept** Clinistix / eq **Accept** Fehling's **Accept** Clinistix go brown / eq	**2**

Question Number	Answer	Mark
3(c)	A description that makes reference to the following points: • less urine / lower volume / less water / eq (1) • more concentrated / more urea / darker / eq (1)	2

Total 10 marks

Question Number	Answer	Mark
6(a)(i)	**D (proximal convoluted tubule)** **A** is not correct as U is not the Bowman's capsule **B** is not correct as U is not the collecting duct **C** is not correct as U is not the loop of Henle	**1**

Question Number	Answer	Mark
6(a)(ii)	**D (ultrafiltration)** **A** is not correct as it is not ADH production **B** is not correct as it is not selective reabsorption **C** is not correct as it is not transpiration	**1**

Question Number	Answer	Mark
6(a)(iii)	**B (Q)** **A** is not correct as P is the distal convoluted tubule **C** is not correct as S is the glomerulus **D** is not correct as T is the Bowman's capsule	**1**

Question Number	Answer	Additional guidance	Mark
6(b)(i)	Calculation steps not mark points Full marks for correct answer 0.1x 5 x 1000/100 = 5 (2)	Allow one mark for × 10 or x (1000/100) or ×5 or 5 in answer eg 0.05 0.5 etc	**2**

Question Number	Answer	Mark
6(b)(ii)	An explanation that makes reference to two of the following • protein molecules too large / large mass / too heavy / eq (1) • cannot pass out of glomerulus / into Bowman's capsule / into nephron / into tubules / through basement membrane / eq (1) • so stay in blood / not in filtrate / eq (1)	**2**

Question Number	Answer	Mark
6(b)(iii)	An explanation that makes reference to two of the following • glucose passes out of glomerulus / into Bowman's capsule / into nephron / into tubules / through basement membrane / eq (1) • (then) reabsorbed / back into blood / eq (1) • by active transport / eq/ (1) • in proximal convoluted tubule / PCT/ eq (1)	**3**

Question Number	Answer	Mark
6(a)(i)	The only correct answer is C *A is not correct as ultrafiltration does not take place in A* *B is not correct as ultrafiltration does not take place in B* *D is not correct as ultrafiltration does not take place in D*	**1**

Question Number	Answer	Mark
6(a)(ii)	The only correct answer is D *A is not correct as reabsorption does not take place in A* *B is not correct as reabsorption does not take place in B* *C is not correct as reabsorption does not take place in C*	**1**

Question Number	Answer	Mark
6(b)(i)	• osmoregulation (1)	**1**

Question Number	Answer	additional guidance	Mark
6(b)(ii)	• removal of metabolic waste / waste from chemical reactions (from cells) (1)	Ignore waste removal	**1**

Question Number	Answer	Mark
6(c)	An explanation that makes reference to the following points: • collecting duct (1) • impermeable / less permeable / no change in permeability / eq (1) • less water reabsorbed / water is not reabsorbed / less water back into blood / eq (1) • more urine produced / dilute urine produced / more water lost / dehydration / eq (1) • blood concentration increases / eq (1)	**4**

Question Number	Answer	Mark
6(d)(i)	• increases permeability of collecting duct (wall) / becomes permeable / will now be permeable / eq (1)	**1**

Question Number	Answer	Mark
6(d)(ii)	An answer that makes reference to the following points: • decrease (volume) / less urine / eq (1) • increase concentration / eq (1)	**2**

Total = 11 marks

Question Number	Answer	Mark
3(a)	The only correct answer is A B is not correct as B is not the Bowman's capsule C is not correct as C is not the Bowman's capsule D is not correct as D is not the Bowman's capsule	**1**

Question Number	Answer	Additional guidance	Mark
3(b)(i)	An explanation that makes reference to three of the following points: • (selective) (re)absorption (1) • into blood / from / out of filtrate (1) • proximal convoluted tubule / B (1) • active transport (1)	**Allow** PCT / first coiled tubule	**3**

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	• 99 / 99.2 / 99.17 / 99.16 (recurring) **(2)**	180 000 - 1500 = 178 500 178 500 ÷ 180 000 × 100 = 99.2 **One mark** for 178 500 / (180000-1500 ÷ 180000) / 0.99 / 99.1 / 99.16 award full marks for correct numerical answer without working	**2**

Question Number	Answer	Mark
3(b)(iii)	the only correct answer is C protein A is not correct as is fat not used to produce urea B is not correct as is glucose not used to produce urea D is not correct as is water not used to produce urea	**1**

Question Number	Answer	Mark
3(c)	An explanation that makes reference to four of the following points: • less urine / decreases urine production / urine more concentrated (1) • collecting duct (1) • more permeable (1) • water (absorbed) into blood / water reabsorbed (1) • by osmosis (1)	**4**

Total 11 marks

Question Number	Answer	Additional guidance	Mark
5 (a)	An explanation that makes reference to three of the following: • (selective) reabsorption (1) • in proximal convoluted tubule (1) • by active transport (1) • using energy / ATP (1)	**Accept** absorbed into blood **Accept** pct / first convoluted tubule	**3**

Question Number	Answer	Additional guidance	Mark
5 (b)(i)	3.9 (2)	**one mark** for 3.86… **OR** for 1700 ÷ 440 **Correct answer gains all marks**	**2**

Question Number	Answer	Additional guidance	Mark
5 (b)(ii)	An explanation that makes reference to two of the following: • water is absorbed (1) • in collecting duct (1) • by osmosis (1) • ADH was present (1)	**Accept** urea is not absorbed **Accept** (water absorbed) in loop of Henlé / distal convoluted tubule	**2**

Question Number	Answer	Additional guidance	Mark
5 (c)(i)	A description that makes reference to two of the following: • biuret (reagent) / sodium hydroxide + copper sulfate (1) • lilac / purple / pink (1)	**Accept** uristicks / eq (1) colour change to blue or green (1)	**2**

Question Number	Answer	Additional guidance	Mark
5 (c)(ii)	An answer that makes reference to two of the following • protein is a large molecule (1) • high pressure forces protein / eq (1) • out of glomerulus / out of capillaries / through membranes / into (Bowman's) capsule / into glomerular filtrate (1) • the protein is not (re)absorbed (by nephron) (1)	**Accept** pushes / squeezes	**2**

Total: 11 marks

Question Number	Answer	Additional guidance	Mark
4(a)(i)	An answer that makes reference to two the following points: • more poisonous / toxic / dangerous to a cat / cats are more susceptible / cats more easily poisoned / smaller amount needed to poison cat / less required to poison cats / eq (1) • by 6 times / 600% / over 1000 / 1065 mg more (1)	Ignore just quoting figures alone Ignore immunity Allow converse	**2**

Question Number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation that makes reference to the following points: • they would need to eat 350 bars (2) OR • (for a 70 kg person) each bar provides only 2.86 (mg per kg) (2)	Allow full marks for correct answer without working calculation 1000 x 70 = 70 000 70000÷ 200 = 350 OR 200 ÷ 70 = 2.86 1 mark for **200** (mg) (less than) **70 000**	**2**

Question Number	Answer	Additional guidance	Mark
4(b)	An explanation that makes reference to four of the following points: • osmoregulation / homeostasis (1) • collecting duct (1) • less / not permeable (1) • less water (re)absorbed / less water in <u>blood</u> / blood more concentrated / dehydration (1) • more urine / more water in urine / dilute urine / urine not concentrated (1)		**4**

Question Number	Answer	Additional guidance	Mark
4(c)	An explanation that makes reference to the following points: • (same) volume / cm^3 / mass / g of water (1) • temperature change / rise / before and after (burning) (1) • (same) mass of chocolate / food (1) • mass **<u>of water</u>** (g/cm^3) × temperature rise (°C) (× 4.2) ÷ mass of chocolate (g)	Allow Mps 1 2 and 3 in formula Mp 1 Ignore amount Reject unexplained symbols Mp 4 mass of chocolate not needed if same mass of chocolate	**4**

Total 12 marks

Question Number	Answer	Mark
5(a)(i)	A collecting duct *B is not correct because it is not the collecting duct* *C is not correct because it is not the collecting duct* *D is not correct because it is not the collecting duct*	**1**

Question Number	Answer	Mark
5(a)(ii)	D T *A is not correct because ultrafiltration does not occur here* *B is not correct because ultrafiltration does not occur here* *C is not correct because ultrafiltration does not occur here*	**1**

Question Number	Answer	Mark
5(a)(iii)	A P *B is not correct because not affected by ADH* *C is not correct because not affected by ADH* *D is not correct because not affected by ADH*	**1**

Question Number	Answer	Mark
5(a)(iv)	B R *A is not correct because glucose not absorbed* *C is not correct because glucose not absorbed* *D is not correct because glucose not absorbed*	**1**

Question Number	Answer	Mark
5 (b)(i)	An answer that makes reference to the following points: • increasing birth mass associated with more nephrons / eq (1) • a positive correlation / linear / straight line / (directly) proportional (1)	**2**

Question Number	Answer	Mark
5 (b)(ii)	An explanation that makes reference to four of the following points: • proteins are big / large / only small molecules (1) • normally will not pass out of glomerulus / through basement membrane / into Bowman's capsule / not present in glomerular filtrate (1) • (high blood pressure) forces / squeezes / pushes protein molecules out (1) • damage to glomerulus / Bowman's capsule / basement membrane / nephron (1)	**4**

Question Number	Answer	Additional guidance	Mark
5 (b)(iii)	An answer that makes reference to the following points: • add Biuret (1) • (changes to) purple/ lilac / mauve (1)	**Allow** NaOH and $CuSO_4$ / use urine testing strips e.g uristix / eq **Allow** green colour for urine testing strip	**2**

Total = 12 marks

Question Number	Answer	Mark
2(a)(i)	The only correct answer is **D** S glomerulus **A** is not the answer as P is the distil convoluted tubule **B** is not the answer as Q is the collecting duct **C** is not the answer as R is the loop of Henle	**1**

Question Number	Answer	Mark
2(a)(ii)	The only correct answer is **D U** the PCT **A** as Q is the collecting duct **B** is not the answer as R is the loop of Henle **C** is not the answer as S is the glomerulus	**1**

Question Number	Answer	Mark
2(a)(iii)	The only correct answer is **B** structure R is the loop of Henle **A** is not the answer as P is the distil convoluted tubule **C** is not the answer as S is the glomerulus **D** is not the answer as U is the proximal convolute tubule	**1**

Question Number	Answer	additional guidance	Mark
2(b)(i)	An answer that makes reference to the following: • substances / chemicals present / in solution/ dissolved / carried in the liquid part of the blood / substances / chemicals / present / in solution/ dissolved / carried in the plasma / eq (1)	no credit for components	**1**

Question Number	Answer	additional guidance	Mark
2(b)(ii)	56 / 100 x 54 = 30 (2)	allow 30.2 / 30.24 (2) allow full marks for correct answer alone allow 1 mark for 56 or 1 mark for 54 – (54 x 44 / 100)	**2**

Question Number	Answer	Mark
2(b)(iii)	An explanation that makes reference to two the following: • (so that) glucose not excreted / lost from body / eq (1) • maintain blood glucose / eq (1) • (required for) respiration / (release of) energy / eq (1)	**2**

Question Number	Answer	Mark
2(b)(iv)	An answer that makes reference to five of the following: • 1 as water potential of blood decreases / (solute / solution) concentration increases /eq(1) • 2 osmoreceptors / hypothalamus /pituitary glands (1) • 3 (more) ADH secreted (1) • 4 increase permeability of collecting duct / eq (1) • 5 more water (re)absorbed / less excreted / less urine /more concentrated urine / eq(1) • 6 more urea produced / concentration increases /eq (1) • 7 less urea reabsorbed / more urea excreted / more in urine / eq (1) • 8 more sodium / salts in plasma /eq (1) • 9 so more salt / sodium excreted / less reabsorbed / more in urine / eq(1) • 10 more glucose in blood/ filtered but no change as all reabsorbed / none excreted / eq (1)	**5**

total 13 marks

Question Number	Answer	Additional guidance	Mark
1(a)	9.5 $\times 10^8$ (2)	**Allow** 9.48 $\times 10^8$ **Allow** 950 000 000 **or** 948 000 000 **or** 9.50 / 9.48 with wrong power for standard form for **one mark** e.g. 95 x 10^7 correct answer gains full credit	**2**

Question Number	Answer	Additional guidance	Mark
1 (b)	carbon dioxide / CO_2 / water (vapour) / H_2O (1)		**1**

Question Number	Answer	Additional guidance	Mark
1 (c)	An explanation that makes reference to four from: • 40 °C (temperature) (1) • more particle movement / more (kinetic) energy / faster diffusion / eq (1) **OR** • long tubing / coiled tubing / eq (1) • to increase / large surface area / eq (1) **OR** • thin wall / thin membrane / eq (1) • to decrease diffusion path / short diffusion distance / eq (1) **OR** • circulating / moving dialysis fluid / eq (1) • to maintain diffusion gradient / concentration gradient / eq (1) **OR** • no urea (in dialysis fluid) (1) • (so there is a) concentration / diffusion gradient / eq (1)	**mark in pairs** **Allow** warm / body temperature **Allow** large surface area (1) for (fast) diffusion (1) **Allow** short distance through membrane for diffusion = two marks **Allow** fluid is pumped **Allow** high to low concentration	**4**

Question Number	Answer	Additional guidance	Mark
1 (d)(i)	A (Bowman's capsule) is the only correct answer *B is incorrect as ultrafiltration does not occur at the collecting duct* *C is incorrect as ultrafiltration does not occur at the distal convoluted tubule* *D is incorrect as ultrafiltration does not occur at the loop of Henle*		**1**

Question Number	Answer	Additional guidance	Mark
1(d)(ii)	A description that makes reference to two of the following: • selective reabsorption (1) • in proximal (convoluted) tubule / PCT (1) • active transport / uses energy / uses ATP (1) • against (concentration) gradient (1)		**2**

Question Number	Answer	Additional guidance	Mark
1(d) (iii)	A (renal artery / ureter) is the only correct answer *B is incorrect because the urethra does not exit the kidney* *C is incorrect because the renal vein does not bring blood into the kidney* *D is incorrect because the renal vein does not bring blood into the kidney*		**1**

Question Number	Answer	Additional guidance	Mark
1 (e)	An explanation that makes reference to three of the following: • osmoreceptors / hypothalamus, detects high salt concentration in blood / lower water potential in blood / eq (1) • (pituitary) releases (more) ADH (1) • (nephron) cells / collecting duct more permeable (1) • (more) water is reabsorbed / (more) water absorbed into blood /eq (1) • urine becomes more concentrated / lower volume of urine / eq (1)	**Allow** lower water concentration	**3**

Total 14 marks

Question Number	Answer		Mark
1(a)	An answer that makes reference to two of the following: • urea (1) • water (1) • salts / named salt / ions / minerals / named ions / eq (1)	**Accept** uric acid / creatinine **Accept** ammonia / ammonium Mark first two e.g. glucose, urea, water would be one mark ; urea, uric acid, water is two (for urea /uric acid and water as urea / uric acid are both mp1)	**2**

Question Number	Answer	Additional guidance	Mark
1(b)	An answer that makes reference to two of the following points: • permanent / does not need replacing / long term treatment / eq (1) • can lead normal life / have normal diet / more independent / better quality of life / eq (1) • doesn't require (repeated) visits to a hospital / no need to repeat every week / eq (1) • kidney can perform other functions / eq (1)	**Accept** converse for dialysis machines for all mps **Ignore** dialysis takes a long time / inconvenient **Ignore** cost effective over long term **Accept** can live longer / longer lifespan / no need to monitor diet **Accept** kidney works all the time / continuous filtration / eq	**2**

Question Number	Answer		Mark
1(c)	A description that makes reference to three of the following points: • white blood cells / lymphocytes / phagocytes / eq (1) • (phagocytes / white blood cells) engulf / phagocytosis / eq (1) • (lymphocytes / white blood cells / memory cells) produce antibodies / eq (1) • (kill / remove) bacteria / viruses / microorganisms / pathogens / antigens / eq (1) • make memory cells (1)	**Allow** phagocytes engulf for 2 marks for mp1 and mp2 **Reject** lymphocytes engulf **Allow** lymphocytes produce antibodies for 2 marks for mp1 and mp2 **Reject** phagocytes produce antibodies	**3**

Question Number	Answer		Mark
1(d)	An explanation that makes reference to two of the following points: • genetically similar / eq (1) • same / similar proteins / antigens / eq (1) • no / less immune response / less response by white blood cells / fewer antibodies made / eq (1)	**Accept** same genes / identical genes / same DNA **Accept** same blood type / same tissue type **Accept** recognises kidney / cells as own body **Accept** recognises kidney as not foreign	**2**

Question Number	Answer	additional guidance	Mark
1(e)(i)	39.17 (3) If incorrect final answer, then: 58.75 **OR** 58.8 **OR** [(1040-429) / 1040] x 100 **for one mark** **and** 19.6 **OR** 19.58 **OR** 19.579(5….) **OR** [(2283-1836 / 2283)] x 100 **for one mark**	**Accept** answer between 39.15 to 39.2 for **3 marks** **Allow** full marks for correct answer no working	**3**

Question Number	Answer	Mark
1(e)(ii)	An answer that makes reference to one of the following points: • more deceased donor kidneys available / two kidneys per deceased donor / living can only donate one kidney / deceased do not need kidneys / living people may need both kidneys to live / both kidneys can be harvested when dead / eq (1) • living people reluctant to donate / people reluctant to have surgery / only (close) family will volunteer to be living donors / few living people agree to donate / surgery may cause harm / people might be harmed by removal / eq (1)	**1**

Question Number	Answer	Mark
1(f)	An answer that makes reference to the following point: • same tissue type / same tissue match / same blood type / similar genes / similar antigens / one that won't be rejected / a healthy kidney / a functioning kidney / not diseased / eq (1)	**1**

Question Number	Answer		Mark
1(g)	An explanation that makes reference to two of the following points: • more susceptible to kidney failure / get more kidney disease / eq (1) • few(er) donors / eq (1) • may not be able to receive from different group / may reject transplant from different group / less likely to reject from similar group / kidney will be a better match / eq (1)	**Accept** people in these countries have more kidney disease **Accept** there is more kidney disease in the countries **Accept** many donors are from different ethnic backgrounds **Ignore** more donors needed unqualified	**2**

Total 16 marks

Question Number	Answer	Additional guidance	Mark
3	An answer that makes reference to the following points: • tropism(s) / tropic (responses) (1) • to / toward(s) / (move) towards (1) • phototropic / phototropism (1) • auxin / IAA (1) • gravity (1) • negative (1)	Trophism = 0 Phototropism = 0 Mp3 allow phototrophic	**6**

Total 6 marks

Question Number	Answer	Additional guidance	Mark
11	An answer that makes reference to the following points: • C venom and no venom / different concentration / different volumes / different amounts of venom (1) • O same species / sex / age / size of wasp (1) • R repeat / group / eq (1) • M1 number of wasps / count wasps (1) • M2 in stated time period (1) • S1 + S2 same volume of solutions / venom from same source / venom same distance from wasps / same size of container / same size dish / same temperature / light / time of day / time of year / weather / wind / other scents / eq (2)	S2 Ignore carbon dioxide / oxygen / prey	**6**

Total 6 marks

Question Number	Answer	Additional guidance	Mark
11	An answer that makes reference to six of the following: C: range of different light intensities / dark and light (1) O: same species / age of wood lice / eq (1) R: repeats / groups of woodlice (1) M1: measure distance moved (1) M2: over a set / stated time (1) S1 and S2: same humidity / temperature / oxygen / carbon dioxide / food / size of container / wood types / eq (2)	**Accept** for M1 and M2, time how long takes to move set distance	**6**

Total for Question 11 = 6 marks

Question Number	Answer	Additional guidance	Mark
10	An answer that makes reference to the following: • C - change colour of light / wavelength of light / use different filters / eq (1) • O – same species / type / age / size / food / eq (1) • R – use several larvae with each light colour / repeat / eq (1) • M1 – measure distance larvae move / measure arc of dish / number of circuits / eq (1) • M2 - time / stated time / eq (1) • S1 & S2 **(two from)** – same humidity / food / light intensity / temperature / of dish / surface of Petri / same dish / eq (2)	**Ignore** same larva unqualified **Ignore** repeat with different colours **Accept** measure how long it takes to move set distance for M1 and M2 **Accept** time taken to do a number of laps / eq for two marks (M1 and M2) **Accept** speed = distance / time for M1 and M2 **Accept** clean dish between tests **Accept** alternatives for light intensity e.g. same lamp distance / same bulb / eq	**6**

(Total for Question 10 = 6 marks)

Question Number	Answer	Mark
2(a)	• W = lens (1) • X = cornea (1) • Y = retina (1)	**3**

Question Number	Answer	Mark
2(b)	A description that makes reference to the following • circular muscles relax (1) • radial muscles contract (1) • pupil dilates / gets wider /eq (1)	**3**

Question Number	Answer	Mark
2(a)	The only correct answer is C Y A is not correct as W is not adrenal gland B is not correct as X is not adrenal gland D is not correct as Z is not adrenal gland	**1**

Question Number	Answer	Mark
2(b)	• several / different tissues carrying out a / one / particular, function / purpose / eq (1)	**1**

Question Number	Answer	Mark
2(c)	An answer that makes reference to five of the following points: • (more) light into eye / retina (1) • to see danger / be more aware of surroundings / eq (1) • more blood to lungs (1) • more blood to (leg) muscles / blood diverted to (leg) muscles (1) • more oxygen (to muscles) (1) • more glucose (to muscles / in blood) (1) • more respiration / less anaerobic respiration / less lactic acid produced (1) • more ATP / energy (1) • run faster / escape / contract muscles more / eq (1)	**5**

Total 7 marks

Question Number	Answer	Additional guidance	Mark
6	• plasma (1) • insulin (1) • pancreas (1) • liver / muscles (1) • glycogen (1) • (positive) phototropism (1) • Auxin/ I.A.A (1)	**Allow** islets of Langerhans / beta cells **Allow** named muscles **Reject** glucagon	**7**

(Total for Question 6 = 7 marks)

Question Number	Answer	Mark
6(a)(i)	Circle around axon terminals	**1**

Question Number	Answer	Mark
6(a)(ii)	The only correct answer is B motor A is not correct as it is not an association neurone C is not correct as it is not a relay neurone D is not correct as it is not a sensory neurone	**1**

Question Number	Answer	Mark
6(a)(iii)	An explanation that makes reference to two of the following points: • fast (1) • no brain involvement / no thought / automatic /involuntary / eq (1) • less damage / harm / eq (1)	**2**

Question Number	Answer	Mark
6(b)(i)	The only correct answer is D wider neurones have faster impulses A is not correct as it is not supported by the graph B is not correct as it is not supported by the graph C is not correct as it is not supported by the graph	**1**

Question	Answer	Mark

Number		
6(b)(ii)	4.4 (m per s)	**1**

Question Number	Answer	Additional guidance	Mark
6(b)(iii)	• 90cm = 0.9m • 90 ÷ (speed) 440 = 0.20s 0.9 ÷ (speed) 4.4 = 0.20 s = seconds • 2.0×10^{-1} (3)	award full marks for correct numerical answer without working regardless of speed used allow 1 mark for 0.9 (m) **or** speed expressed as x 100 cm/s (440 idea) allow 1 mark for 90 ÷ speed **or** 0.9 ÷ speed (if not 0.20455 etc) allow 2 marks for marks for correct numerical answer without working but not in standard form	**3**

Total 9 marks

Question Number	Answer	Mark
2(a)(i)	B – cornea *A is incorrect as X is not the conjunctive* *C is incorrect as X is not the lens* *D is incorrect as X is not the retina*	**1**

Question Number	Answer	Mark
2(a)(ii)	A – contracted loose B is incorrect as the ligaments would be loose C in incorrect as the muscles would be contracted D in incorrect as the muscles would be contracted	**1**

Question Number	Answer	Additional guidance	Mark
2(a)(iii)	An explanation that makes reference to 3 of the following: • pupil widens / dilates / gets bigger (1) • radial muscles contract (1) • circular muscles relax (1)	**Ignore** it / Y	**2**

Question Number	Answer	Additional guidance	Mark
2(b)(i)	27 m/s (3)	**One Mark:** 2.5 ÷ 0.005 or 25 ÷ 0.005 or 0.25 (m) or 5000 **Two marks:** 50 (m/s) **Award full marks for correct answer**	**3**

Question Number	Answer	Additional guidance	Mark
2(b)(ii)	An explanation that makes reference to two of the following: • (more) synapses are present / eq (1) • which transmit by (chemical) diffusion (1) • of neurotransmitters (1)	**A** gaps / clefts present	**2**

Total for Question 2 = 9 marks

Question Number	Answer	Mark
10 (a)(i)	• A sensory / afferent (1) • B relay / association (1) • C motor / efferent (1)	**3 grad**

Question Number	Answer		Mark
10(a)(ii)	An explanation that makes reference to the following points • neurone A / sensory / afferent (+ impulse) (from receptor) to CNS / spinal cord / relay neurone / neurone B (1) • (synapses with) neurone B / relay / association / (+ impulse) (from receptor neurone A) to motor / efferent / neurone C • neurone C / motor / efferent (+ impulse) to effector / muscle	must have impulse once to score 3 marks allow signal message for 2 max	**3 exp**

Question Number	Answer	additional guidance	Mark
10(b)(i)	An explanation that makes reference to two of the following points • measure the distance (from hand to spinal cord and or brain to other hand) (1) • for each student / all students in ring (1) • measure time taken (for student A to feel hand being squeezed / eq) (1) • divide distance by time (1)	ignore count number of students allow 'how long it took'	**2 exp**

Question Number	Answer	Mark
10(b)(ii)	An explanation that makes reference to two of the following points • may be underestimate / too slow / method adds time / delay / eq (1) • not a reflex so need to allow decision making / role of brain / reaction time /eq (1) • as delay occurs at each synapse (1)	**2 exp**

Total 10 marks

Question Number	Answer	Mark
4(a)	• no GH / water / saline / eq	**1 grad**

Question Number	Answer	Additional guidance	Mark
4(b)	increase in mass between 100 and 500 days divide by 400 = g per day 485-230 = 255 ÷ 400 = 0.6375 / 0.638 / 0.64 **allow any answer between 0.6375 and 0.65**	award full marks for correct numerical answer allow 1 mark for ÷ 400	**2 grad**

Question Number	Answer	Mark
4(c)	An answer that makes reference to two of the following points: • temperature (1) • (mass of) food / diet / type of food /eq (1) • water (1) • size of cage (1) • time (1) • volume of solution/eq (1)	**2 exp**

Question Number	Answer	Mark
4(d)	An explanation that makes reference to two of the following points: • avoids making wrong conclusion based on one / few result(s) / conclusion is valid / eq(1) • can calculate mean / average (1) • results are reliable / increase reliability (1) • anomalous results recognised / eq(1)	**2 exp**

Question Number	Answer	additional guidance	Mark
4(e)	An answer that makes reference to three of the following points: • (more) mRNA made (1) • (more) translation (1) • (more) proteins / polypeptides made (1) • enzymes / muscle / tissue (1)	**ignore more cells**	**3 exp**

Total 10 marks

Question Number	Answer	Additional guidance	Mark
2(a)(i)	C is the only correct answer *A is incorrect because it is the retina* *B is incorrect because it is the conjunctiva* *D is incorrect because it is the lens*		**1**

Question Number	Answer	Additional guidance	Mark
2 (a)(ii)	An explanation that makes reference to two of the following: • circular muscles <u>contract</u> (1) • radial muscles relax (1) • (so) pupil narrows / gets smaller / constricts / iris widens / eq (1)	**Ignore** ciliary	**2**

Question Number	Answer	Additional guidance	Mark
2 (b)(i)	• using one eye or both eyes / amount of eyes / number of eyes / eq (1)		**1**

Question Number	Answer	Additional guidance	Mark
2 (b)(ii)	An answer that makes reference one of: • light intensity / lighting / eq (1) • distance (from block) / eq (1) • size of pins / shape of pins / colour of pins / sideways distance between pins / number of pins / eq (1) • size of block / shape of block / angle of the block / size of grid / eq (1)		**1**

Question Number	Answer			Additional guidance	Mark
2 (b)(iii)		**Number of correctly identified pins**		**two marks** for all four correct **Allow one mark** for any **two** correct	**2**
		Using one eye	**Using both eyes**		
	Mode	3	6		
	Median	2	6		

Question Number	Answer	Additional guidance	Mark
2 (b)(iv)	An explanation that makes reference to three of: • better distance judgement (with two eyes) / better depth perception / poorer distance judgement with one eye / eq (1) • large area seen by <u>both eyes</u> / large overlapping visual field / eq (1) • to locate prey / catch prey / chase prey / see prey / eq (1) • do not need wide field of view as not preyed upon / do not need to see behind as not preyed on / eq (1)	**Allow** more pins were correct when using two eyes / higher mode / median when using two eyes / eq **Allow** converse for one eye **Ignore** larger field of view unqualified **Ignore** food **Allow** animal for prey	**3**

Total 10 marks

Question Number	Answer	Mark
10 (a)(i)	• iris (1)	**1**

Question Number	Answer		Mark
10 (a)(ii)	A description that makes reference to three of the following. • X / ciliary muscle, contracts (1) • Y / suspensory ligaments go slack / loosen / eq (1) • lens becomes thicker / more spherical / more convex / eq (1) • so (lens) refracts light more / bends light more / eq (1)	**Ignore** relax **Ignore** suspensory muscle **Allow** fatter / more rounded / bulges	**3**

Question Number	Answer		Mark
10 (b)(i)	A description that makes reference to two of the following. • less light can pass through / refraction affected / eq (1) • to retina / fovea / rods / cones / photoreceptors (1) • so fewer <u>impulses</u> (to brain) (1)	**Allow** cannot focus well / bend light **Allow** stops light getting into eye	**2**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>10 (b)(ii)</td><td>An answer that makes reference to four of the following.

• numbers increase as exposure to sunlight increases / eq (1)

• groups sizes are different / eq (1)

• credit calculation of proportions / percentages (1)

• the <u>proportion / percentage</u> of cases fluctuates / does not change (much) between 7 and 10 (hrs) / eq (1)

• <u>proportion / percentage</u>, rises after 10 (hrs) / 11 (hrs) / 12 (hrs) (1)

• the large number of people makes it reliable OR (less reliable as) only one country / no information on location / climate / eq (1)

• age / sex / health status / genetics / diet / clothing / sunglasses / could affect the results / eq (1)</td><td>Allow more sunlight increases chance of cataracts
Allow percentage of cases increases

Allow number of people vary / increase

<table><tr><th>Sunlight</th><th>Percentage</th></tr><tr><td>7</td><td>2.0</td></tr><tr><td>8</td><td>1.9</td></tr><tr><td>9</td><td>2.0</td></tr><tr><td>10</td><td>1.6</td></tr><tr><td>11</td><td>3.2</td></tr><tr><td>12</td><td>6.5</td></tr></table>
Allow no / little effect between 7 – 10 (hrs) / 10 (hrs) is lower than 7 / 8 / 9 (hrs)

Allow (proportion of) cases only increases after 10 / 11 (hrs)

Allow reliable / valid as it is a long survey / lasts 25 years
Allow other countries / regions should be investigated

Allow other correct, relevant factors</td><td>4</td></tr>
</table>

(Total for Question 10 = 10 marks)

Question Number	Answer	Mark
6(a)(i)	The only correct answer is A (L) B is not the answer as P is not the sensory receptor C is not the answer as Q is not the sensory receptor D is not the answer as S is not the sensory receptor	**1**

Question Number	Answer	Mark
6(a)(ii)	The only correct answer is D (P) A is not the answer as L is not the cell body of the relay neurone B is not the answer as N is not the cell body of the relay neurone motor neurone C is not the answer as M is not the cell body of the relay neurone	**1**

Question Number	Answer	Mark
6(a)(iii)	The only correct answer is C (R) A is not the answer as L is not the motor neurone B is not the answer as M is not the motor neurone D is not the answer as S is not the motor neurone	**1**

Question Number	Answer	Mark
6(a)(iv)	The only correct answer is D (S) A is not the answer as L is not the effector B is not the answer as M is not the effector C is not the answer as Q is not the effector	**1**

Question Number	Answer	additional guidance	Mark
6(b)(i)	180 cm = 1.8m time = 1.8 ÷ 50 = 0.036 or 3.6 x 10^{-2}(2)	allow 1 mark for ÷50 or ÷5000 allow full marks for correct answer alone	**2**

Question Number	Answer	additional guidance	Mark
6(b)(ii)	An explanation that makes reference to four of the following 1. response time slower / longer /delay / (more) time taken / eq (1) 2. (delay / transmission) between neurones / in between neurones / not just speed along neurones / eq (1) 3. (includes time) to generate impulse (in receptor) / (time) for muscle to contract / eq (1) 4. chemical coordination / diffusion / eq (1) 5. <u>synapse</u> (1) 6. <u>neurotransmitter</u> / named neurotransmitter (1)	ignore impulse travels faster synapses between neurones scores mp 2 and 5	**4**

Total 10 marks

Question Number	Answer	Mark
4(a)(i)	**B (F and H)** A is not the answer as E and J do not refract light C is not the answer as G and K do not refract light D is not the answer as I and J do not refract light	**1**

Question Number	Answer	Mark
4(a)(ii)	**C (G)** A is not the answer as E does not control the amount of light B is not the answer as F does not control the amount of light D is not the answer as H does not control the amount of light	**1**

Question Number	Answer	Mark
4(a)(iii)	**D (K)** A is not the answer as H does not contain light sensitive cells B is not the answer as I does not contain light sensitive cells C is not the answer as J does not contain light sensitive cells	**1**

Question Number	Answer	Additional guidance	Mark
4(b)	A description that makes reference to four of the following points: 1. the <u>ciliary</u> muscle(s) <u>contract</u> / structure I <u>contract(s)</u> / eq (1) 2. the tension in the <u>suspensory</u> <u>ligament(s)</u> is reduced / loosened / slackens / eq (1) 3. the lens becomes thick(er) / wide(r) / fat(ter) / round(er) / more convex / eq (1) 4. the light is refracted more / bent more / eq (1) 5. <u>accommodation</u> (1)	ignore relax	**4**

Question Number	Answer	Additional guidance	Mark
4(c)(i)	An explanation that makes reference to two of the following points: • lens becomes cloudy / opaque / misty / milky / eq (1) • less light enters eye / eq (1) • image dimmer / not formed / vision blurred / distorted / not clear / blindness / eq (1)	ignore poor vision	**2**

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	• glasses / contact lens / new lens inside eye / eye drops / eq (1)	ignore laser eye surgery	**1**

total 10 marks

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>8(a)</td><td>
<table>
<tr><th>Effect</th><th>Name of hormone</th><th>Name of gland</th></tr>
<tr><td>converts blood glucose into glycogen</td><td>insulin (1)</td><td>pancreas</td></tr>
<tr><td>stimulates the development of male secondary sexual characteristics</td><td>testosterone</td><td>testis / eq (1)</td></tr>
<tr><td>Increases heart rate</td><td>adrenaline</td><td>adrenal (1)</td></tr>
<tr><td>maintains the uterus lining</td><td>progesterone</td><td>ovary / corpus luteum/ placenta (1)</td></tr>
</table>
</td><td>4

one mark for each correct row</td></tr>
</table>

Question Number	Answer	additional guidance	Mark
8(b)(i)	An explanation makes reference to four of the following points: 1. stems (grow) towards light / positively phototropic / eq (1) 2. (increase) photosynthesis / eq (1) 3. away from competition / other plants / eq (1) 4. <u>roots</u> (grow) away from light / negatively phototropic /eq (1) 5. into soil / to absorb water / minerals / named mineral / for water / for minerals / for named mineral /eq (1) 6. to anchor plant / eq (1)	allow leaves (face sun) ignore plants	**4**

Question Number	Answer	additional guidance	Mark
8(b)(ii)	An explanation makes reference to two of the following points: 1. hours of daylight (better) indicator of season / time of year /eq (1) 2. daylight does not vary / temperature can vary (day to day) / eq (1) 3. (more hours of) daylight allow insects to see flowers / eq (1) 4. (more) insect pollination / insects pollinate in daylight / eq (1)	eg more hours/ daylight in summer	**2**

total 10 marks

Question Number	Answer	Mark
10(a)(i)	The only correct answer is B oestrogen *A is not correct as it is not adrenaline* *C is not correct as it is not progesterone* *D is not correct as it is not testosterone*	**1**

Question Number	Answer	Mark
10(a)(ii)	The only correct answer is A adrenaline *B is not correct as it is not insulin* *C is not correct as it is not progesterone* *D is not correct as it is not testosterone*	**1**

Question Number	Answer	Mark
10(a)(iii)	The only correct answer is C they are transported in the plasma *A is not correct as they do not always produce short term changes* *B is not correct as they are not carried by neurones* *D is not correct as they do not always produce a rapid response*	**1**

Question Number	Answer	Mark
10(b)	An answer that makes reference to two of the following points: • auxin transported in xylem / phloem / auxin not transported in blood / plasma (1) • auxin produced in tips / eq auxin not from endocrine / glands / organs (1) • auxin has different effect on roots and shoots / eq (1)	**2** **Allow converse for Mp1 and Mp2**

Question Number	Answer	Additional guidance	Mark
10(c)	A description that makes reference to six of the following points: • C change / different concentrations of growth substances (1) • O same species / same plant / same type of plant/ named plant / same age / same size / eq (1) • R repeat (1) • M1 count number of roots / length of roots / measure roots with ruler / eq (1) • M2 stated time period of one day plus (1) • S1 same (control) temperature / oxygen / light / carbon dioxide (1) • S2 same compost / water / humidity / soil / mineral ions / named mineral ion / same <u>volume</u> of plant growth substance (1)	Auxin and no auxin = 0 M1 Ignore mass S2 Ignore nutrients	**6**

Total 11 marks

Question Number	Answer	Mark
11(a)(i)	An answer that makes reference to the following points: • cornea / C bends / refracts light (1) • lens / A becomes (more) curved / rounder / convex / thicker / eq (1) • as ciliary muscles / D contract (1) • (ciliary muscles / D) cause suspensory ligaments to relax become less taut / slacken / loosen / eq (1)	**4** allow ciliary body

Question Number	Answer	Mark
11(a)(ii)	An explanation that makes reference to three of the following points: • circular muscles contract (1) • radial muscles relax (1) • pupil constricts / becomes smaller / eq (1) • less light enters eye (1)	**3**

Question Number	Answer	additional guidance	Mark
11(b)(i)	An answer that makes reference to the following points: • (breaks down / digests cell walls of / kill / prevent growth of / remove / protect from) <u>bacteria</u> / <u>fungi</u> / <u>pathogens / microorganisms</u> / eq (1) • prevent infection / disease (1)	prevent bacterial infection = 2 marks	**2**

Question Number	Answer	additional guidance	Mark
11(b)(ii)	An answer that makes reference to two of the following points: • optimum pH (for lysozyme) (1) • prevent enzyme being denatured / change in active site /eq (1) • break down cell walls / kill bacteria / work at fastest / fast rate / eq (1) • (too) acidic / (too) alkaline may damage eye / eq (1)	neutral won't damage eye	**2**

Total = 11 marks

Question Number	Answer	Mark
3(a)	The only correct answer is **A P** B is not the answer as **Q** is the cornea C is not the answer as **R** is the iris D is not the answer as **S** is the conjunctiva	**1**

Question Number	**Answer**	**Additional guidance**	**Mark**
3(b)(i)	8.2 (2) **Only one mark for:** 24.7 **OR** division by 3 **OR** 8.23….	**Accept** if written in table if nothing written on answer line **Correct answer gains all marks**	**2**

Question Number	**Answer**	**Additional guidance**	**Mark**
3(b)(ii)	A description that makes reference to two of the following points: • (diameter) decreases / pupil smaller / eq (1) • small decrease between 4(au) and 5(au) / starts to level off after 3(au) / starts to level off from 4(au) / large decrease between 2 and 3 (au) / calculated fall / eq (1)	**Accept** any calculated difference in diameter e.g. 6.2 between 1 and 5	**2**

Question Number	Answer	Additional guidance	Mark
3(b)(iii)	An explanation that makes reference to three of the following points: • less light enters (eye) / passes through pupil / eq (1) • to prevent damage to retina / eq (1) • (as pupil narrows) circular muscles (of iris) contract (1) • (as pupil narrows) radial muscles (of iris) relax (1)	**Accept** converse for all mark points for low light intensity **Accept** prevent overstimulation of retina **Accept** prevent damage to rods / cones / fovea **Accept** prevent risk of cataracts **Ignore** damage eye	**3**

Question Number	Answer	Mark
3(b)(iv)	An explanation that makes reference to one of the following points: • distance from camera (1) • same student / person / same eye / left or right eye (1) • food / drinks / caffeine consumed / eq (1) • recovery time / time spent with mask on (1) • noise in room (1) • other light sources / distance from light (1) • (type of) mask (1) • colour of light / wavelength of light (1)	1

Question Number	Answer	Additional guidance	Mark
3(b)(v)	An explanation that makes reference to two of the following points: 1. using a camera (to record) / takes a photograph / uses an image / eq (1) 2. waiting 20 s (each time) / waiting same time / eq (1) 3. pupil is not changing size / is stationary / eye has adjusted / eq (1)	**Accept** (image) measured on flat surface / ruler can be placed directly on image (rather than in front of eye) **Accept** can magnify (an image) / eq **Accept** iris has had time to change shape	2

(Total for Question 3 = 11 marks)

Question Number	Answer	Mark
8(a)	An answer that makes reference to the following points: • A iris (1) • B cornea (1) • C pupil (1) • D lens (1)	**4**

Question Number	Answer	Mark
8(b) (i)	An explanation that makes reference to four of the following points: • ciliary muscles relax (1) • suspensory ligaments taut increased tension / taut / tight /eq (1) • lens less curved / thinner (1) • light refracted / bent less (1) • pupil dilates / expands / widens (1)	**4**

Question Number	Answer	Mark
8(b) (ii)	An answer that make reference to two of the following points: • loss of vision / sight / go blind / can't see / eq (1) • in centre of visual field (1) • loss of detail / colour (1)	**2**

Question Number	Answer	Mark
8(b) (iii)	An answer that makes reference to two of the following points: • repeat with more patients / different patients / eq (1) • longer study / for a greater period / more years / monitor the progress of the patients / eq (1) • see if treatment causes damage / side effects	**2**

Total 12 marks

Question Number	Answer	Mark
4(a)(i)	The only correct answer is **A (P)** B is not the answer as Q is not the sweat gland C is not the answer as S is not the sweat gland D is not the answer as T is not the sweat gland	**1**

Question Number	Answer	Mark
4(a)(ii)	The only correct answer is **D (T)** A is not the answer as Q is not a capillary B is not the answer as R is not a capillary C is not the answer as S is not a capillary	**1**

Question Number	Answer	additional guidance	Mark
4(a)(iii)	A description that makes reference to three of the following points: • <u>vasodilation</u> / <u>vasodilate</u> (1) • as arterioles get wider /dilate / eq (1) • more blood flow near skin surface / more blood flow through the blood vessels / more blood flow through capillaries / eq (1) • so (more) heat lost / blood cools / eq (1)	**Accept** blood vessels get wider / dilate / **Reject** capillaries dilate **Reject** blood vessels move **Accept** (more) radiated heat	**3**

Question Number	Answer	Mark
4(b)(i)	• sweating rate / sweat loss (in litres per hour) / amount of sweat / volume of sweat / sweat release / eq (1)	**1**

Question Number	Answer	additional guidance	Mark
4(b)(ii)	0.43 **OR** 0.42 **OR** 0.425 (3) If final answer is not correct: **Accept** 1.7 for one mark **AND** **Accept** x0.25 or x¼ or ÷4 or x15/60 for one mark	**Accept** answers between 0.42 and 0.43 for three marks **Accept** reading between 1.7 and 1.72 **Accept** full marks for correct answer with no working	**3**

Question Number	Answer	additional guidance	Mark
4(b)(iii)	An answer that makes reference to four of the following: • increasing running speed increases sweating / eq (1) • sweating cools the body / sweating cools blood / sweating maintains body temperature / body heats up during running / eq (1) • increase in sweating is similar for both condition / effect of running speed has similar slope / eq (1) • more sweat produced in hot and humid condition / eq (1) • sweat / water <u>evaporates</u> more easily in dry / eq (1) • lower concentration gradient in humid conditions / lower diffusion gradient in humid conditions / eq (1) • no repeats / only one person / small sample size / no mention of water intake / no mention of diet / eq (1)	**Accept** same difference between the two conditions **Accept** same rate of increase **Accept** converse for dry **Accept** converse for humid **Accept** body heats up more in hot and humid so more sweat / eq (1) **Accept** converse for dry **Ignore** ref to different ages / body mass / sex etc	**4**

Total 13 marks

Question Number	Answer	Mark
10(a)	• homeostasis (1)	**1**

Question Number	Answer	additional guidance	Mark
10(b)	An answer that makes reference to 4 of the following points. • receptors in skin surface detect stimulus / are stimulated /(1) • impulse (1) (once) • sensory neurone to relay neurone / CNS / eq (1) • via diffusion of neurotransmitters / eq (1) (once) • synapse (1) (once) • motor neurone to muscle / effector (1) • effector/ muscle contracts eq (1)	allow action potential ignore message / signal eq	**4**

Question Number	Answer	Mark
10(c)(i)	An explanation that makes reference to the following points. • less sweat released /eq (1) • less (sweat) evaporates / less cooling / less heat loss /eq (1)	**2**

Question Number	Answer	additional guidance	Mark
10(c)(ii)	An explanation that makes reference to 3 of the following points. • B / blood vessels (to surface) constrict / vasoconstriction / eq (1) • less blood flows (to skin surface) / eq (1) • less heat loss / heat conserved /eq (1) • less convection / radiation (1)	allow converse ignore capillaries constrict more blood away from surface / eq	**3**

Question Number	Answer	Mark
10(d)	An explanation that makes reference to 4 of the following points. • variation in amount of body hair / eq (1) • caused by mutation (1) • less hair increased heat loss / can lose heat in sun / warm / hot climate / chase animals / started to wear clothes / eq (1) • survive and reproduce (1) • pass on alleles / genes to offspring (1)	**4**

Total = 14 marks

Question Number	Answer	Additional guidance	Mark
8 (a)(i)	brain / named part of brain/ spinal cord/ eq (1)	Ignore neurons	**1**

Question Number	Answer	Additional guidance	Mark
8(a)(ii)	A description that makes reference to four of the following points: • receptor receives / senses / detects (object) / eq (1) • impulse (1) • (impulse moves along) sensory neurone to CNS / spinal cord / relay neurone (1) • (chemical diffusion of) neurotransmitters across synapse (1) • motor neurone to effector / muscle (1) • (muscle) <u>contracts</u> (1)	**Ignore** signal / message	**4**

Question Number	Answer	Mark
8 (b)(i)	The only correct answer is B (XY) A is incorrect because XX is female C is incorrect because males have one X chromosome D is incorrect because males have one X chromosome	**1**

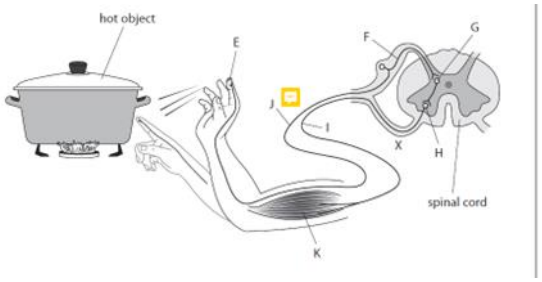
Question Number	Answer	Mark
8 (b)(ii)	The only correct answer is D (6) A is incorrect because 6 dogs must be heterozygous B is incorrect because 6 dogs must be heterozygous C is incorrect because 6 dogs must be heterozygous	**1**

Question Number	Answer	Additional guidance	Mark
8 (b)(iii)	An answer that makes reference to the following points: • both parents identified as Nn and Nn (1) • gametes as N or n (for both parents) (1) • offspring identified as NN, Nn, Nn, nn (1) • (probability determined as) 0.125 / 1/8 / 12.5 % (1)	**Allow** other letters **Allow** Punnet square ECF for mp2, 3, 4	**4**

Question Number	Answer	Additional guidance	Mark
8 (b)(iv)	An explanation that makes reference to three of the following points: • do a test cross to identify dogs that are NN / homozygous (dominant) / eq (1) • breed using dogs with no family history of sensory neuropathy / eq (1) • mate dogs that do not have sensory neuropathy / do not breed from dogs with sensory neuropathy / eq (1) • only allow homozygous dominant dogs to breed / breed with homozygous dominant dogs (1) • select / mate / breed from offspring that do not have sensory neuropathy / are homozygous dominant / eq (1) • repeat over several generations / eq (1)	**Allow** mate dogs that did not produce any offspring with sensory neuropathy	**3**

(Total for Question 8 = 14 marks)

Question Number	Answer	Mark
4(a)(i)	• withdrawal / somatic / simple / involuntary / automatic / unconscious (1)	**1**

Question Number	Answer	Additional guidance	Mark
4(a)(ii)		arrow at X away from spinal cord/ towards muscle	**1**

Question Number	Answer	Mark
4(a)(iii)	The only correct answer is A E is where the stimulus is detected B is not the answer as F is not where stimulus is detected C is not the answer as H is not where stimulus is detected D is not the answer as K is not where stimulus is detected	**1**

Question Number	Answer	Mark
4(a)(iv)	The only correct answer is C I is the motor neurone A is not the answer as F is not the motor neurone B is not the answer as G is not the motor neurone D is not the answer as K is not the motor neurone	**1**

Question Number	Answer	Additional guidance	Mark
4(b) (i)	1.10 ÷ 120 0.0092 9.2×10^{-3} (2)	allow 1 mark for correct answer but not in correct standard form 0.0092 or 0.00917 or 0.009167 etc or 92×10^{-4} allow full marks for correct answer alone allow 9.17×10^{-3} allow 9.167 etc $\times 10^{-3}$ 9.16 recurring x 10^{-3} full marks	**2**

Question Number	Answer	Mark
4(b)(ii)	A description that makes reference to two of the following • in a <u>synapse</u> (1) • <u>neurotransmitter</u> / named neurotransmitter (travels / moves) (1) • by diffusion / chemical coordination / eq (1)	**2**

Question Number	Answer	Additional guidance	Mark
4(c)(i)	An explanation that makes reference to two of the following • prevents / stops movement / walking / running / eq (1) • prevents further damage /injury /eq (1) • allows rest / recovery / healing / repair/ eq (1) • learn to avoid painful situations/ eq (1)	not putting weight / pressure (on ankle)	**2**

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	An answer that makes reference to four of the following : • prevent detection of pain / stimulus /eq (1) • by receptor / eq (1) • prevent transmission of <u>impulse</u> / prevent generation of <u>impulse</u> / fewer impulses passed / sent / generated/ eq (1) • in sensory neurone / eq (1) • in relay neurone / eq (1) • synapses / prevent synaptic transmission /eq (1)	allow stops feeling pain stop impulses being sent/ moving along ignore signal/ message ignore motor neurone allow one mark for neurones/ nerves unqualified	**4**

Total 14 marks