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H

Monday 15 November 2021 – Morning

GCSE (9–1) Biology A (Gateway Science)

J247/03 Paper 3 (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)

You can use:
- a scientific or graphical calculator
- an HB pencil

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

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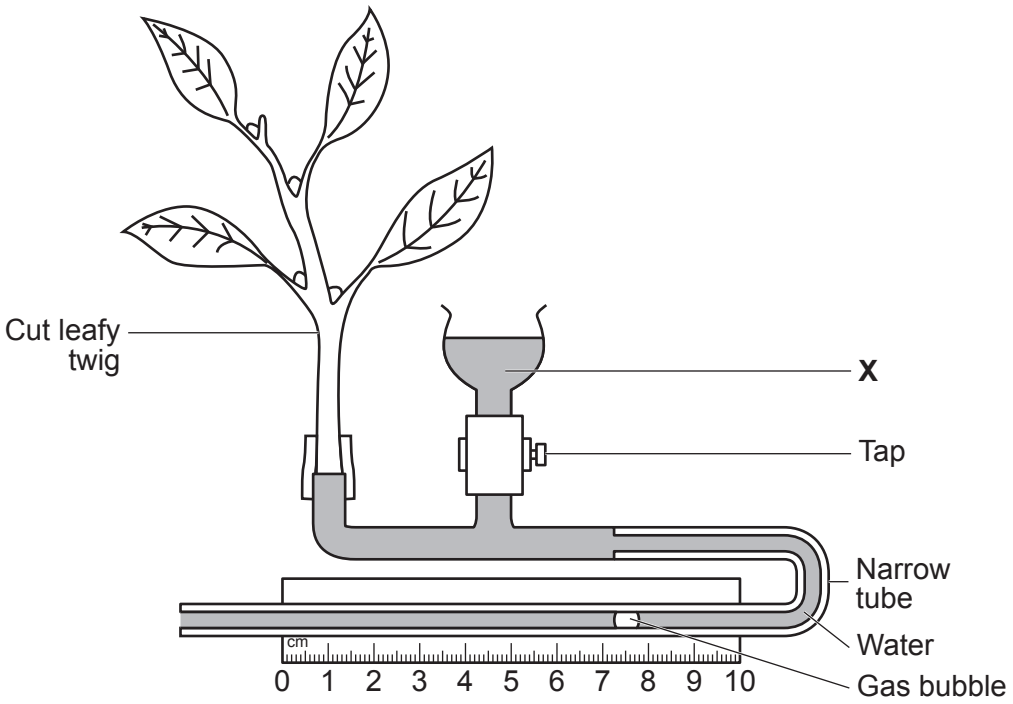
SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

Write your answer to each question in the box provided.

1 The diagram shows a potometer.



What is the purpose of the water in **X**?

A To provide water for the leafy twig.

B To reset the gas bubble to the start of the scale.

C To remove the gas bubble from the narrow tube.

D To measure the volume of water lost in transpiration.

Your answer ☐ **[1]**

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2 Q_{10} is a measure of the rate of change of a reaction when temperature is increased by 10 °C.

Q_{10} is calculated using this formula:

Q_{10} = rate at higher temperature ÷ rate at lower temperature

An enzyme reaction has a rate of 36 units / min at 30 °C and 16 units / min at 20 °C.

What is the Q_{10} for this enzyme?

A 0.44

B 2.25

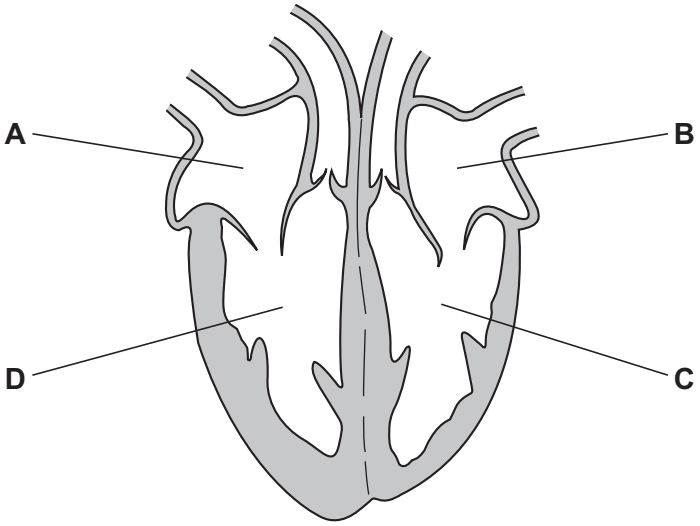
C 20

D 576

Your answer ☐ **[1]**

3 People with situs inversus have their organs reversed so they are a 'mirror image' of the usual arrangement.

The diagram shows the heart from someone with situs inversus, viewed from the front.



Which chamber pumps blood to the lungs in someone with situs inversus?

Your answer ☐ **[1]**

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4 Which statement explains why mitochondria are important in respiration?

A They contain mitochondrial DNA.

B They have a larger surface area to volume ratio than other organelles.

C They contain enzymes used in an exothermic reaction.

D They are at a lower temperature than the rest of the cell contents.

Your answer ☐ **[1]**

5 Which statement describes why iodine solution is added to onion epidermis cells before viewing under a microscope?

A To colour any protein in the cell.

B To kill the cells.

C To prevent osmosis.

D To stain starch.

Your answer ☐ **[1]**

6 Which feature of electron microscopy has allowed scientists to increase their understanding of sub-cellular structures?

A The ability to increase magnification using an eyepiece and objective lens.

B The ability to magnify ×1500.

C The ability to view living cells.

D The ability to view and identify two structures 1 nm apart.

Your answer ☐ **[1]**

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7 Which statement describes DNA?

A A monomer of one strand that forms a single helix.

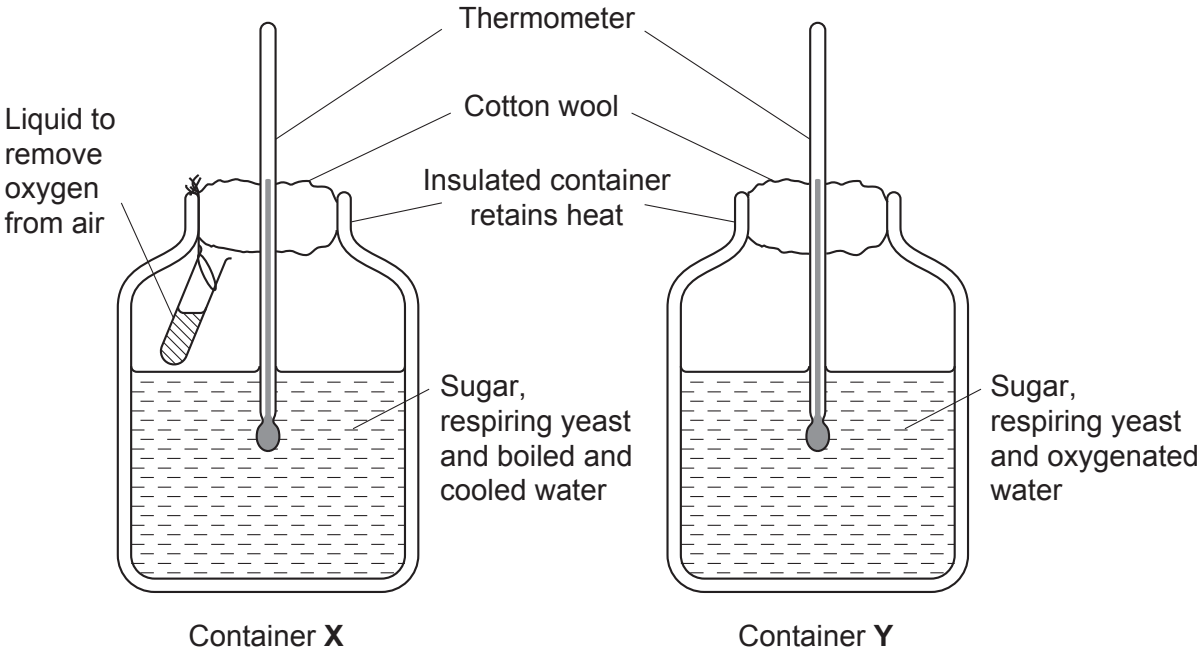
B A monomer of two strands that form a double helix.

C A polymer of two strands that form a double helix.

D A polymer of two strands that form a single helix.

Your answer ☐ **[1]**

8 The apparatus has been set up to compare aerobic and anaerobic respiration.



Which row in the table describes the type of respiration occurring in each container and the temperature rise at the end of the experiment?

	Type of respiration	Temperature rise in container
A	aerobic in **X**, anaerobic in **Y**	**X** is greater than **Y**
B	anaerobic in **X**, aerobic in **Y**	**X** is greater than **Y**
C	anaerobic in **X**, aerobic in **Y**	**Y** is greater than **X**
D	aerobic in **X**, anaerobic in **Y**	**Y** is greater than **X**

Your answer ☐ **[1]**

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9 Which description identifies the process of photosynthesis?

A It is endothermic because heat energy is absorbed.

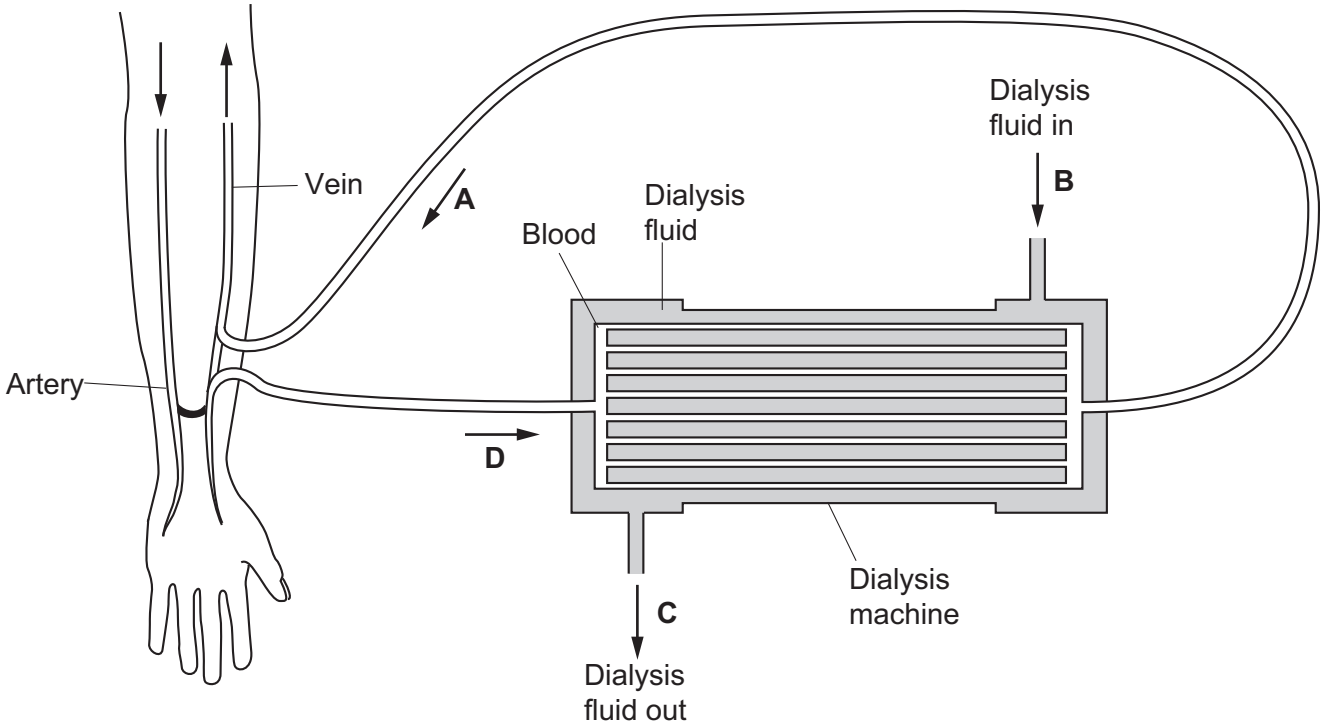
B It is endothermic because light energy is absorbed.

C It is exothermic because heat energy is absorbed.

D It is exothermic because light energy is absorbed.

Your answer ☐ **[1]**

10 A dialysis machine is shown in the diagram. The dialysis machine functions in a similar way to the kidney tubule (nephron).



Which letter shows the part of the dialysis machine that represents the collecting duct of the kidney tubule?

Your answer ☐ **[1]**

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11 Which description identifies the effect of ADH on the collecting duct of the kidney tubule?

A ADH decreases permeability to water, decreasing reabsorption.

B ADH decreases permeability to water, increasing reabsorption.

C ADH increases permeability to water, decreasing reabsorption.

D ADH increases permeability to water, increasing reabsorption.

Your answer ☐ **[1]**

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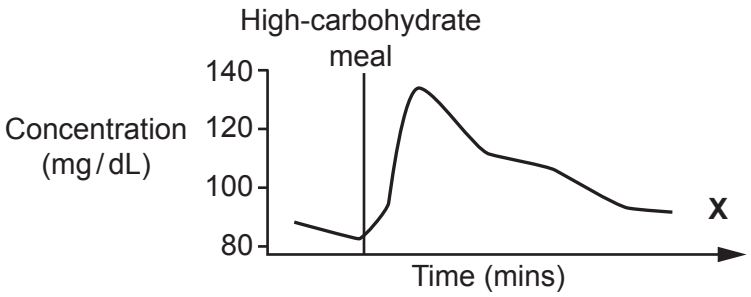
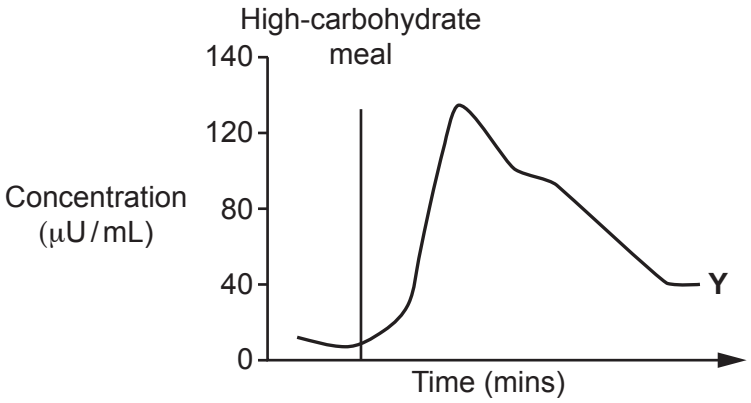
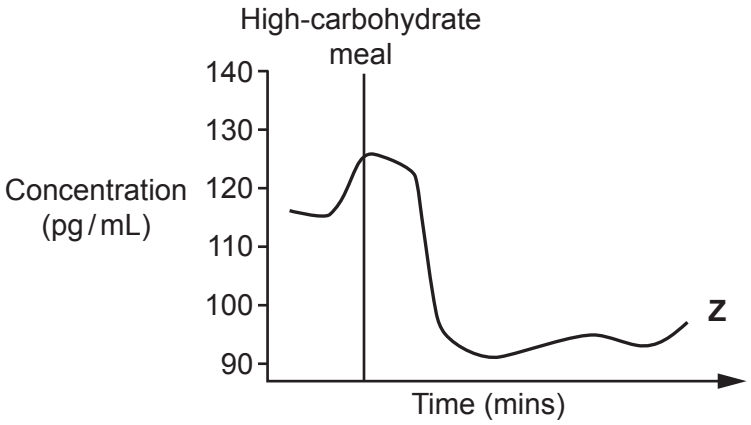
12 The graphs show the concentrations of three substances **X**, **Y** and **Z** in the blood after a high carbohydrate meal. One of the substances is glucose and the other two are hormones.







Which row of the table identifies substances **X**, **Y** and **Z**?

	Substance X	**Substance Y**	**Substance Z**
A	glucagon	insulin	glucose
B	glucose	glucagon	insulin
C	insulin	glucose	glucagon
D	glucose	insulin	glucagon

Your answer ☐ **[1]**

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13 Which description is **not** a use of plant hormones by people?

A As a selective herbicide.

B To control the translocation of sugars in phloem.

C To produce roots on plant cuttings.

D To stimulate parthenocarpy for fruit development.

Your answer ☐ **[1]**

14 In experiments on photosynthesis, it is often necessary to compare different light intensities.

A plant 20 cm from a light receives a light intensity of 25 arbitrary units of light.

What light intensity does a plant receive 10 cm from the light?

A 10

B 50

C 100

D 1000

Your answer ☐ **[1]**

15 A cheek cell is 70 μm and a red blood cell 7 μm.

What is the order of magnitude difference between a cheek cell and a red blood cell?

A 0

B 1

C 2

D 3

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

16 Polymenorrhea is a condition which affects the menstrual cycle.

Symptoms of the condition include the time between ovulation and the next period being shorter than usual.

(a) **(i)** What is the name of the hormone that could treat the symptoms of this condition?

Tick (✓) **one** box.

- FSH ☐
- Oestrogen ☐
- Progesterone ☐
- Testosterone ☐

[1]

(ii) Describe how the hormone chosen in part **(a)(i)** would help.

.....

..... **[1]**

(b) Stem cells can be obtained from embryos. Stem cells can also be extracted from menstrual blood. These two types of cells are different.

(i) Embryo stem cells can be used to treat a wider range of disorders than menstrual blood stem cells.

Explain why.

.....

.....

..... **[2]**

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(ii) The time it takes for a population to double in size is called the **doubling time**.
For menstrual blood stem cells, doubling time is 19.4 hours.

Starting with 1 stem cell, assuming a constant growth rate, it is possible to work out how long a population takes to grow.

Calculate the time it takes for the population to reach 16 cells.

Time to reach 16 cells = ... hours **[2]**

(iii) The doubling time for umbilical cord stem cells is 48 hours.

How many times faster is the growth of menstrual blood stem cells?

..... **[1]**

(iv) Discuss why scientists think menstrual blood stem cell extraction is a positive development.

.....

.....

.....

..... **[2]**

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17 Marimo moss balls are made up of green algae. They are found in lakes and are known to rise and fall during different times of the day. **Fig. 17.1** shows some moss balls in a beaker of water.

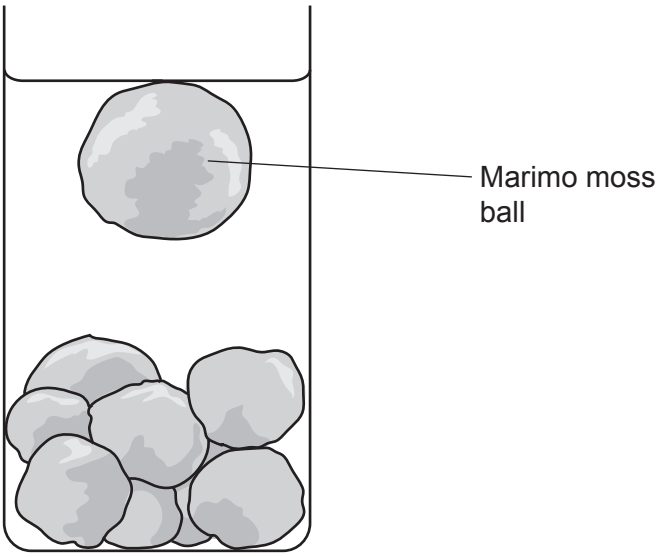

Fig. 17.1

Scientists predict that the moss balls rise because they are covered in tiny bubbles of oxygen.

(a) The scientists test their prediction by using a chemical that stops a biological process in the algae. When the chemical is added they found the moss balls did **not** rise.

(i) Which biological process is affected by the chemical?

Tick (✓) **one** box.

Diffusion ☐

Osmosis ☐

Photosynthesis ☐

Respiration ☐

[1]

(ii) Explain why the moss balls did **not** rise.

.....

..... **[1]**

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(b) The scientists then investigate how exposure to light affects a moss ball which had been in the dark.

- In **Experiment 1**, a moss ball is exposed to 12 hours of light then 12 hours of darkness.
- In **Experiment 2**, the moss ball is exposed to continuous light for 24 hours.

They measure the height of the moss ball in a column of water.

Fig. 17.2 shows their results.

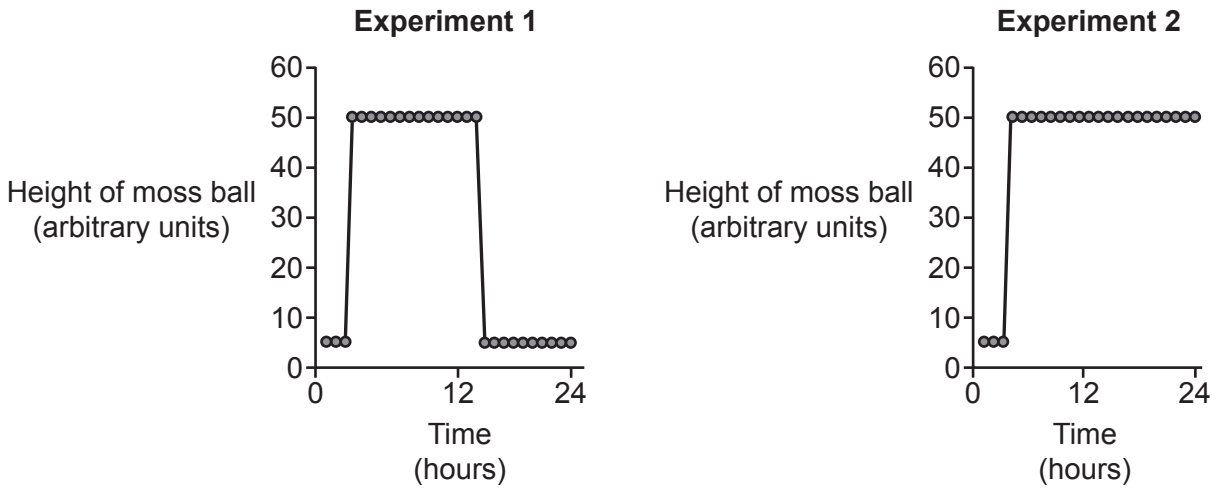

Fig. 17.2

(i) What conclusion can be made from **Experiment 1** about the effect of light on the position of the moss ball?

.....

.....

.....

..... **[2]**

(ii) Suggest an explanation for the differences between the two graphs.

.....

.....

.....

..... **[2]**

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(c) Light is one environmental factor that affects plants.

Explain how increasing the temperature from 15 °C to 40 °C can affect plants.

.....

.....

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.....

..... **[3]**

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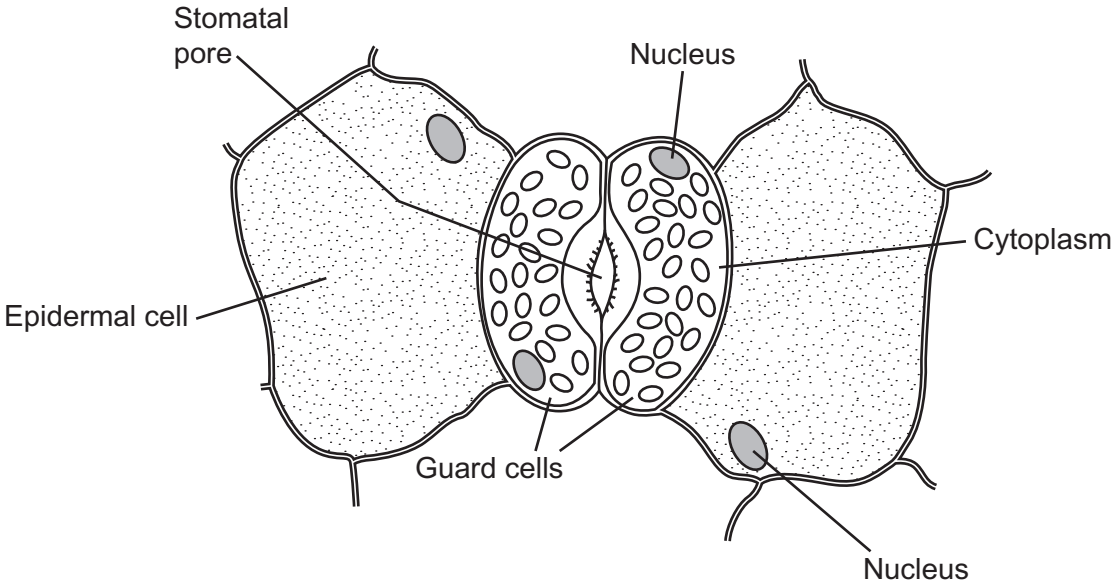
18 (a) The diagram shows the lower surface of a leaf.



Explain how guard cells change shape to open stomata.

.....

.....

.....

.....

.....

.....

..... **[4]**

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(b) A student looked at the surface of a leaf using a light microscope. **Fig. 18.1** shows a field of view from the leaf surface.

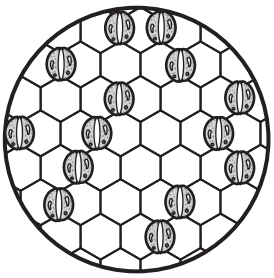

Fig. 18.1

The diameter of the field of view is 0.20 mm.

The student then looked at another two zones of the same leaf using the same magnification.

Table 18.1 shows their results.

Area of field of view (mm^2)	Number of stomata seen in the field of view			Mean number of stomata in field of view
	Zone 1	Zone 2	Zone 3	
.....	14	7	9	.....

Table 18.1

(i) Calculate the area of the field of view.
Use the equation: area = πr^2, where π = 3.14 and r = radius of the field of view

Write your answer in **Table 18.1**.

[1]

(ii) Calculate the mean number of stomata in one field of view.

Write your answer in **Table 18.1**.

[1]

(iii) Stomatal density is the number of stomata per mm^2.

Use the data in **Table 18.1** to calculate the mean stomatal density.

Give your answer to **3** significant figures.

Mean stomatal density = ... stomata / mm^2 **[2]**

(iv) Random errors can cause results to be above or below the true or accepted value.

How has the student tried to minimise the effect of random error?

..... **[1]**

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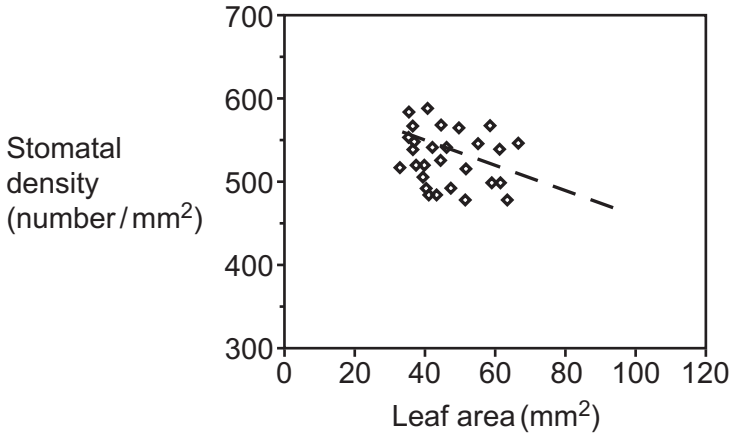
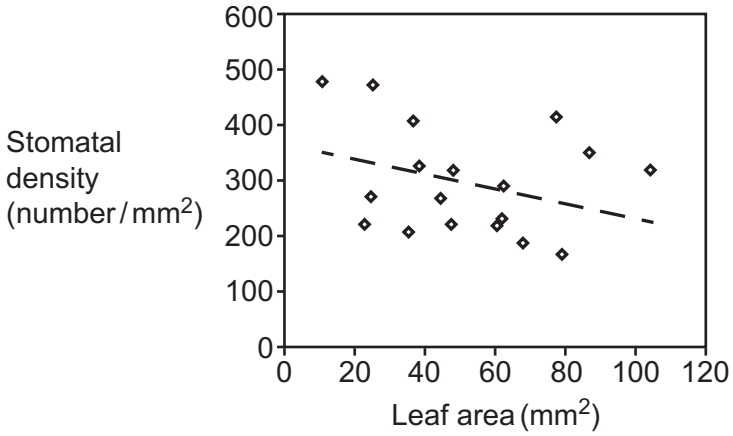
(c) **Fig. 18.2** shows the relationship between stomatal density and leaf area for leaves from two different plants, **A** and **B**.



Plant A



Plant B

Fig. 18.2

(i) What do the graphs show about the relationship between stomatal density and leaf area?

..... **[1]**

(ii) Give **two** differences in patterns of data shown in the two graphs.

1 .....

.....

2 .....

.....

[2]

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(d) **Fig. 18.3** shows the relationship between leaf age, stomatal density and cuticle thickness.

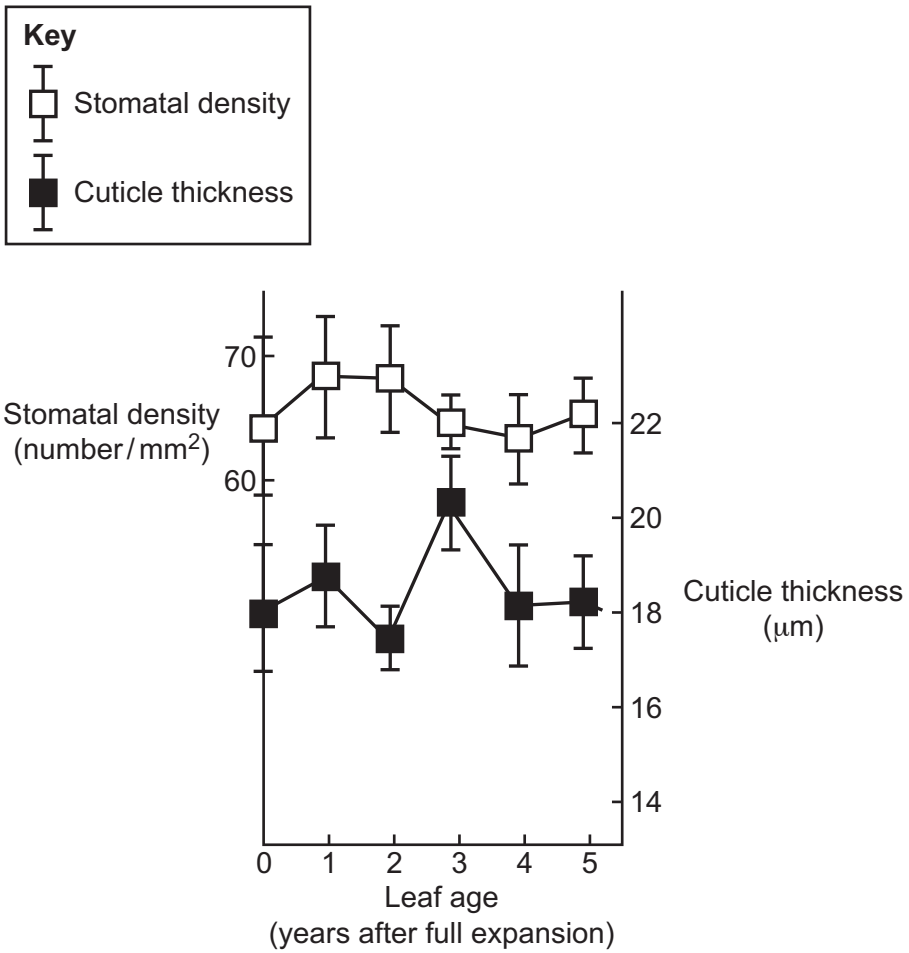

Fig. 18.3

(i) The graph has range bars drawn at each plotted point. These give the highest and lowest values at each point.

Give **one** reason why plotting range bars on the graph improves any interpretations made from the graph.

.....

..... **[1]**

(ii) What does the graph suggest about the relationship between stomatal density and cuticle thickness?

Tick (✓) **one** box.

As stomatal density decreases, cuticle thickness decreases. ☐

As stomatal density decreases, cuticle thickness increases. ☐

As stomatal density increases, cuticle thickness decreases. ☐

As stomatal density increases, cuticle thickness increases. ☐

Stomatal density and cuticle thickness do not have a relationship. ☐

[1]

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19 This question is about homeostasis.

(a) Explain why homeostasis is important for metabolism in humans.

.....

.....

.....

..... **[2]**

(b) **(i)** In humans, the skin is involved in homeostasis.

Changes of blood flow in the skin occur in colder environments.

Describe **two** other changes that occur in the skin in colder environments.

1 .....

.....

2 .....

.....
[2]

(ii) Give **one** way that the structure of blood vessels allows them to change blood flow in the skin.

.....

..... **[1]**

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(iii) Raynaud's disease produces a poor flow of blood to the skin.
The thermograph image shows changes in temperature at the skin surface.

Hand A **Hand B**

Explain which hand is from a person with Raynaud's disease.

.....

.....

..... **[2]**

(c) Thyroxine hormone levels in the body are maintained about a fixed point.

Explain how variables in the body are maintained about a fixed point.

.....

.....

.....

..... **[2]**

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20 **(a)** **(i)** Adrenaline is produced by the body and prepares it for vigorous exercise.

Complete the sentences about adrenaline.

Adrenaline is a hormone made by ..... glands.

Hormones are ..... messengers that travel in the blood.

[2]

(ii) Explain how **two** changes caused by adrenaline prepare muscles for exercise.

1 .....

.....

.....

2 .....

.....

.....

[2]

(iii) Explain how muscle cells get the energy needed to work during exercise.

.....

..... **[2]**

(b) The heart pumps blood through two systems:

- A pulmonary circuit that goes to and from the lungs.
- A systemic circuit that goes to the rest of the body and back to the heart.

(i) Which chamber of the heart receives blood from the pulmonary circuit?

..... **[1]**

(ii) Which structure in the heart controls the direction of blood flow between the left atrium and left ventricle?

..... **[1]**

(iii) Which tissue in the wall of the heart contracts to pump the blood?

..... **[1]**

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(c) Desert marathons take place in extreme heat. High external temperatures can cause dehydration.

Fig. 20.1 and **Fig. 20.2** show some of the effects of dehydration on the body during a race.

Key
—— Correctly hydrated
-------- Dehydrated

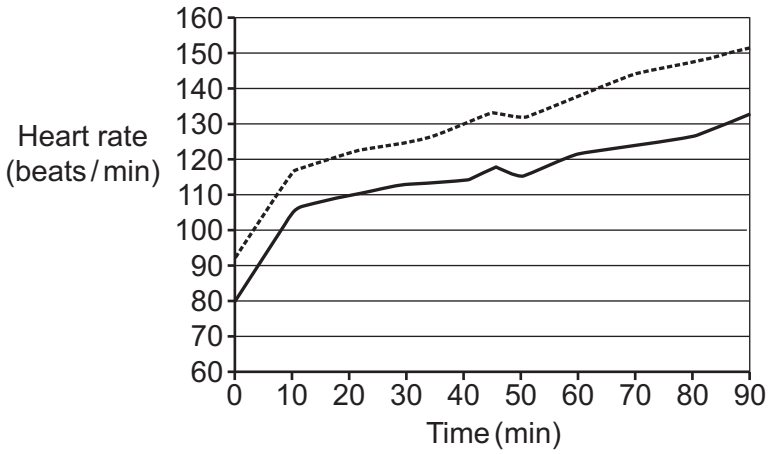

Fig. 20.1

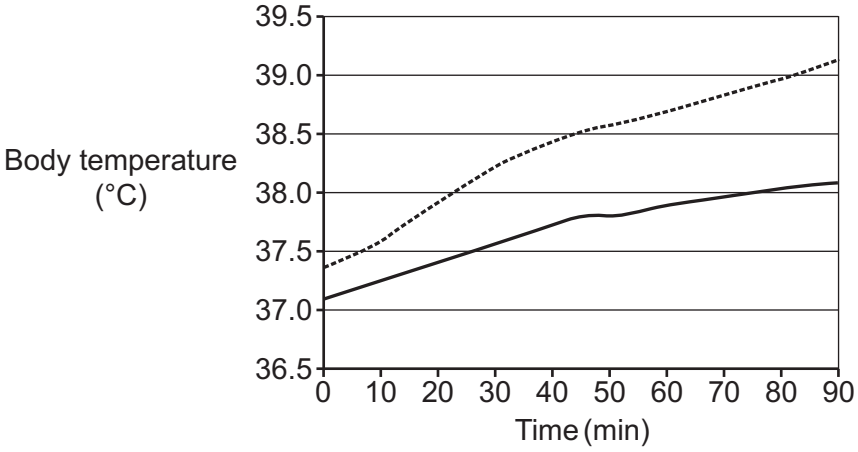

Fig. 20.2

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(i) Explain the changes shown by the graphs in **Fig. 20.1** and **Fig. 20.2**.

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.....

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.....

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.....

..... **[4]**

(ii) Suggest what an athlete could do in advance to minimise the effect of these challenges during a desert marathon.

.....

.....

.....

..... **[2]**

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21 **(a)** The sugar glucose is an important food molecule.

Which type of organisms can make their own glucose?

..... **[1]**

(b) Two students want to use the Benedict's solution test to estimate the glucose concentration of a food.

They notice that the colour change of the Benedict's solution depends on the concentration of glucose in the food. The colour changes are shown in **Table 21.1**.

Benedict's solution colour	**Glucose concentration**
blue colour	low ↓ intermediate ↓ high
green precipitate	
yellow precipitate	
orange precipitate	
brick red precipitate	

Table 21.1

(i) Identify **three** problems with using the information in **Table 21.1** to estimate the concentration of glucose in a food.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(ii) Suggest **two** ways to improve this method so that the colour change of Benedict's solution can give a more accurate estimate of glucose concentration.

1 .....

.....

2 .....

.....

[2]

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(c) Instead of measuring colour change, a precipitate can be collected.

The precipitate is dried and its mass is measured.

The concentration of glucose can then be read off a calibration curve as shown in **Fig. 21.1**.

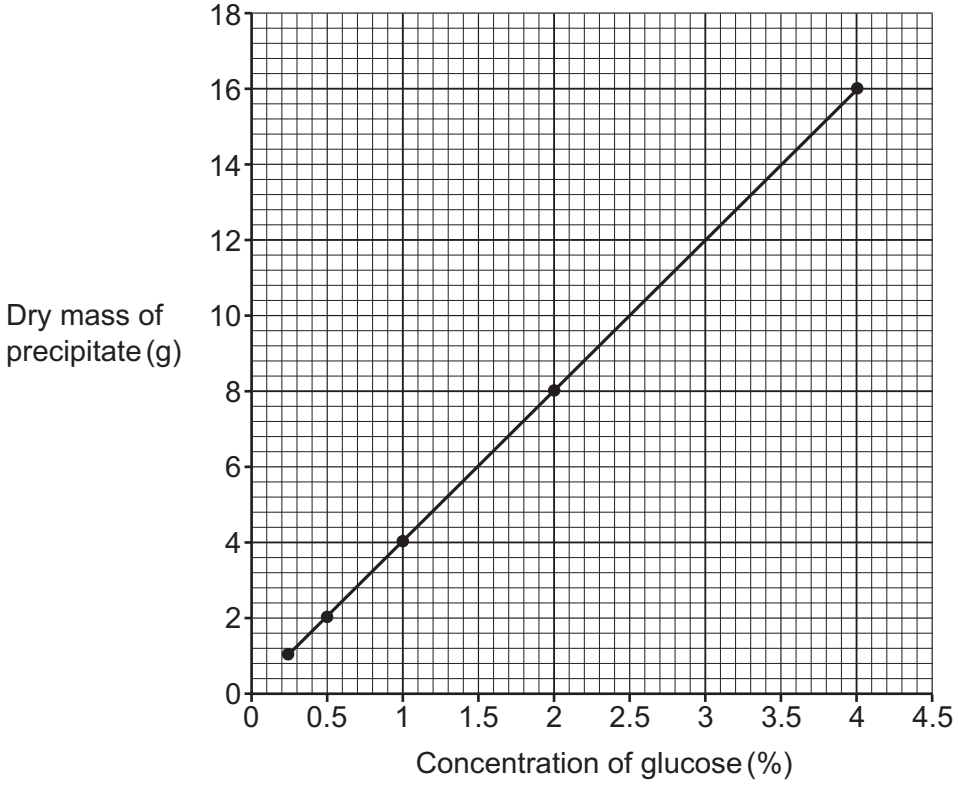

Fig. 21.1

The students collect the precipitate from the Benedict's test of a sample containing glucose.

The wet mass of the precipitate is 15 g, which is 80% water.

Calculate the concentration of glucose in the precipitate.

Use **Fig. 21.1** to support your answer.

Concentration of glucose = ... % **[2]**

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22 (a) (i) **Fig. 22.1** shows the cell cycle. The letters represent different stages.

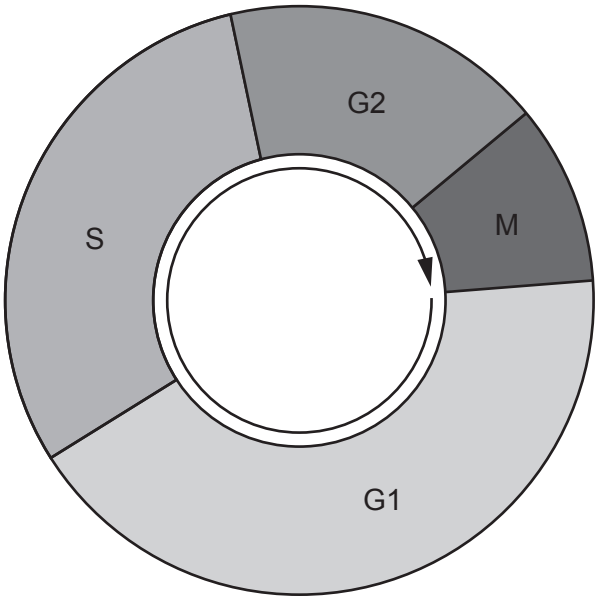

Fig. 22.1

Which processes happen during stage **S** and stage **M**?

Write your answers in the table.

Stage	Process
G1	Growth
S	.....
G2	Growth and preparation for cell division
M	.....

[2]

(ii) Cells can become specialised.

Give **one** reason why this is important for organisms.

.....

..... **[1]**

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(b)* Actinomycin D is a drug used in experiments investigating control of growth of malignant tumours. The drug inhibits one stage of protein synthesis.

The drug firmly binds to unzipped DNA. It does not bind to RNA already present in the cell.

Describe how cells make proteins for growth and explain why the drug Actinomycin D inhibits some but not all protein synthesis.

.....

.....

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.....

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..... **[6]**

(c) Explain how the structure of DNA determines the type of protein made.

.....

.....

.....

..... **[2]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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