OXFORD AQA
INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

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

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Forename(s) _____

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I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 4 Control

Monday 13 January 2025 07:00 GMT Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
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6	
7	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

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0 1 Sensory receptors detect changes in an organism's environment.

0 1 . 1 Pacinian corpuscles are sensory receptors in the skin.

Describe the structure of a Pacinian corpuscle.

[2 marks]

0 1 . 2 Pacinian corpuscles detect when pressure is applied to the skin.

Describe how.

[3 marks]

Question 1 continues on the next page

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Sound waves cause changes in pressure.
Elephants make low frequency sounds called rumbles that can travel through the ground.
Rumbles may help elephants communicate over long distances.

Scientists investigate if elephants use Pacinian corpuscles (PC) in their feet to detect the pressure changes in the ground caused by rumbles.

First, the scientists:

- take samples from the front left foot of three different elephants
- count the number of PC in three different parts of each foot as shown in **Figure 1**
- calculate the percentage of PC in each part of the foot using the formula:

$$\text{percentage} = \frac{\text{number of PC in each part of foot}}{\text{total number of PC in whole foot}} \times 100$$

Figure 1 shows the different parts of an elephant's foot.

Figure 1

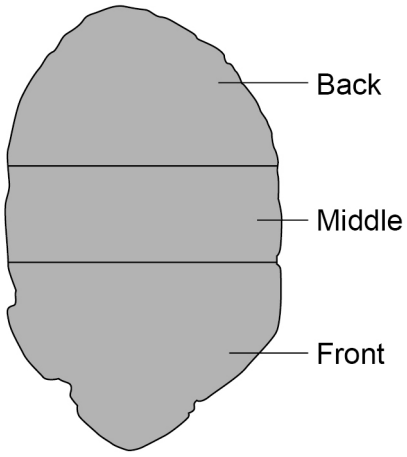

Table 1 shows the mean percentage of PC in each part of the foot.

Table 1

Part of foot	Mean percentage of PC
Back	43
Middle	5
Front	52

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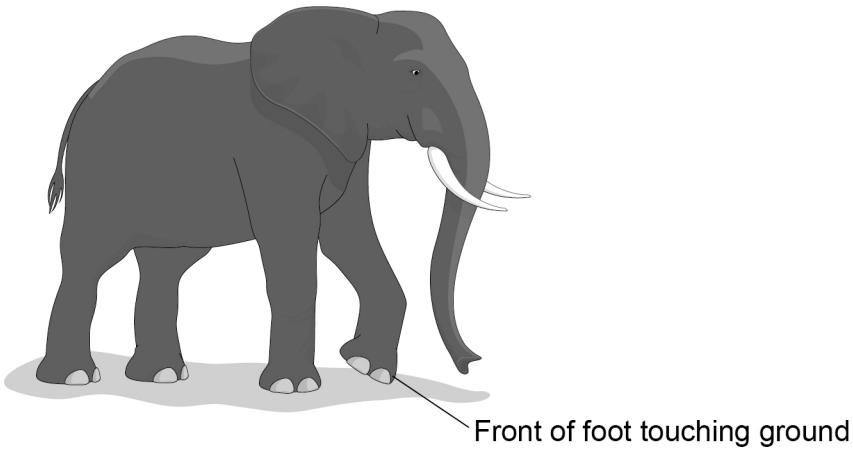
Then, the scientists:

- play recordings of elephant rumbles
- observe how the elephants stand.

Figure 2 shows the way that elephants stand when rumbles are played.

Figure 2



0 1 . 3 Using information from **Table 1** and **Figure 2**, the scientists conclude that elephants **do** use Pacinian corpuscles to detect rumbles.

Evaluate this conclusion.

[3 marks]

_____

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8

Turn over for the next question

Do not write outside the box

0 2 Stress can cause the release of the hormone adrenaline.

0 2 . 1 Adrenaline can increase blood glucose concentration.

Describe how.

[4 marks]

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A dentist sometimes has to remove a patient's tooth. A patient needing to have a tooth removed may experience stress and adrenaline will be released.

When dentists remove teeth, they use a drug called lignocaine to block pain.

Dentists often give adrenaline at the same time as lignocaine. Adding adrenaline blocks the pain for longer than lignocaine alone.

Since adrenaline can increase blood glucose levels, dentists want to know if giving additional adrenaline could be dangerous for patients with diabetes.

Some dentists investigate the blood glucose levels of their patients.
The dentists use 10 patients **without** diabetes that need dental treatment.

All the patients:

- visit the same dentist for two separate appointments
- have one tooth removed at each appointment
- are given only lignocaine (**L**) at the first appointment
- are given lignocaine **and** adrenaline (**L+A**) at the second appointment.

The dentists measure each patient's blood glucose concentration before, during and after the removal of each tooth.

0 2 . 2 Suggest **two** improvements that could be made to the method.

Give the reason each improvement would make the investigation more valid.

[2 marks]

Change 1 _____

_____

Reason 1 _____

_____

Change 2 _____

_____

Reason 2 _____

_____

Question 2 continues on the next page

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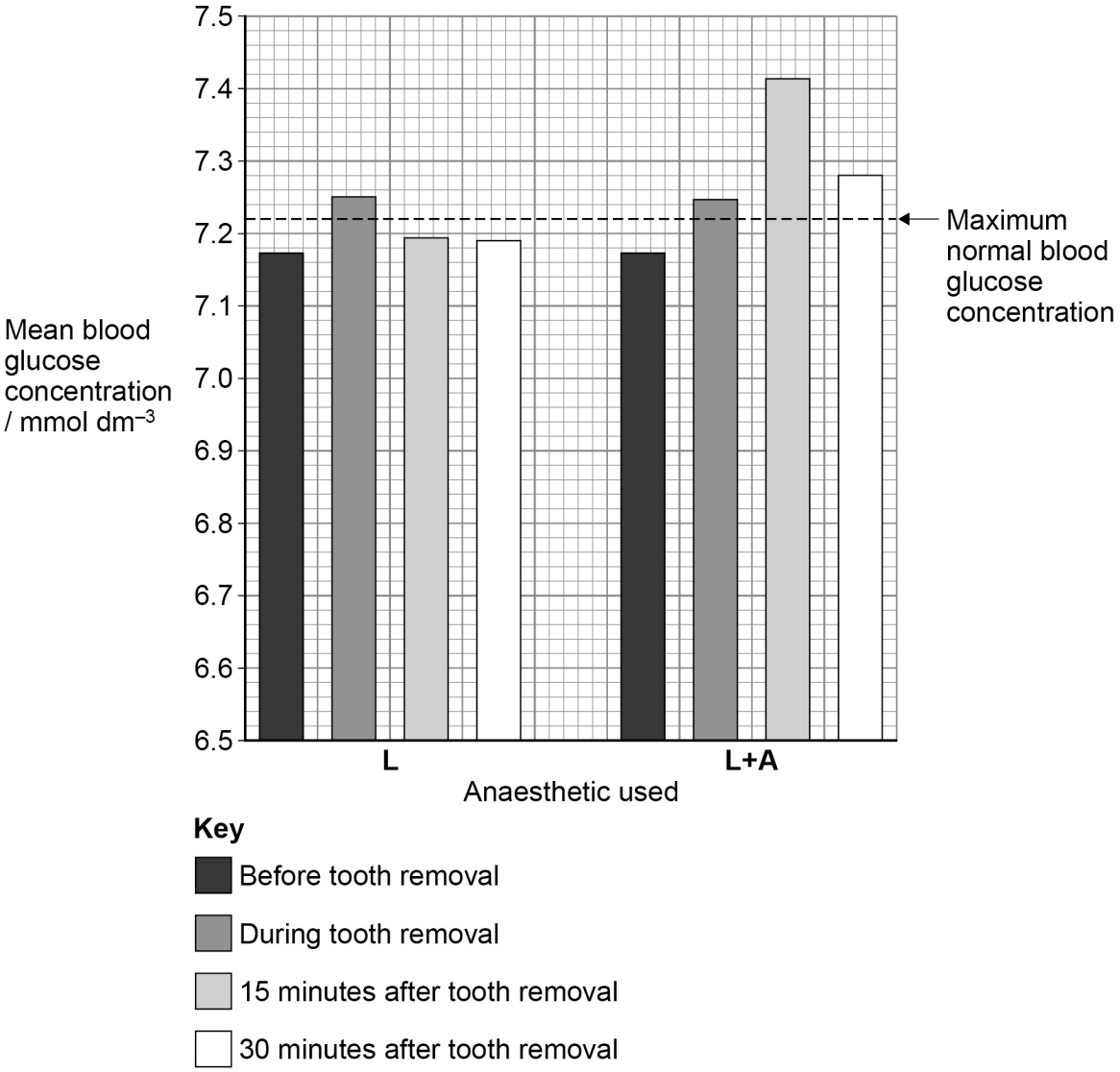
Figure 3 shows the results of the dentists' investigation.

Figure 3



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0 2 . 3 Compare the effects of **L** and **L+A** on mean blood glucose concentration.

Use information from **Figure 3**.

[3 marks]

0 2 . 4 Based on this investigation, the dentists suggest that it might be dangerous to give **L+A** to patients with diabetes due to water loss from their body cells.

Explain why.

[2 marks]

Question 2 continues on the next page

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0 2 . 5 Adrenaline also increases heart rate.

Suggest how.

A detailed description of the second messenger model of adrenaline is **not** required.

[2 marks]

13

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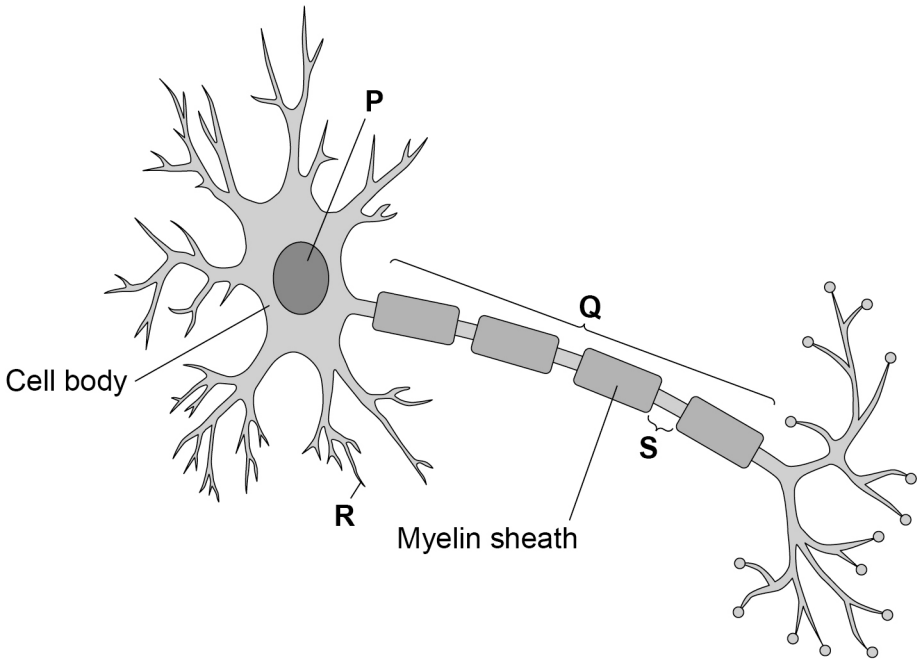
0 3 Some neurones are myelinated.

Figure 4 shows a myelinated motor neurone.

Figure 4



0 3 . 1 Name the structures **P**, **Q**, **R** and **S**.

[2 marks]

P _____

Q _____

R _____

S _____

Question 3 continues on the next page

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0 3 . 2 A neurone needs mitochondria to maintain its resting potential.

Explain why.

[2 marks]

Mitochondria are produced in the cell body of a neurone. Mitochondria can move along the length of the neurone.

Scientists investigate the movement of mitochondria in myelinated neurones in mice.

The scientists:

- stain the mitochondria
- stimulate different neurones at **low** frequency or at **high** frequency
- observe the movement of the mitochondria with a microscope
- count the number of moving mitochondria and calculate a median value
- measure how far the mitochondria move in a set time and calculate their mean speed.

0 3 . 3 Describe how the scientists calculate the **median** value for the number of mitochondria.

[1 mark]

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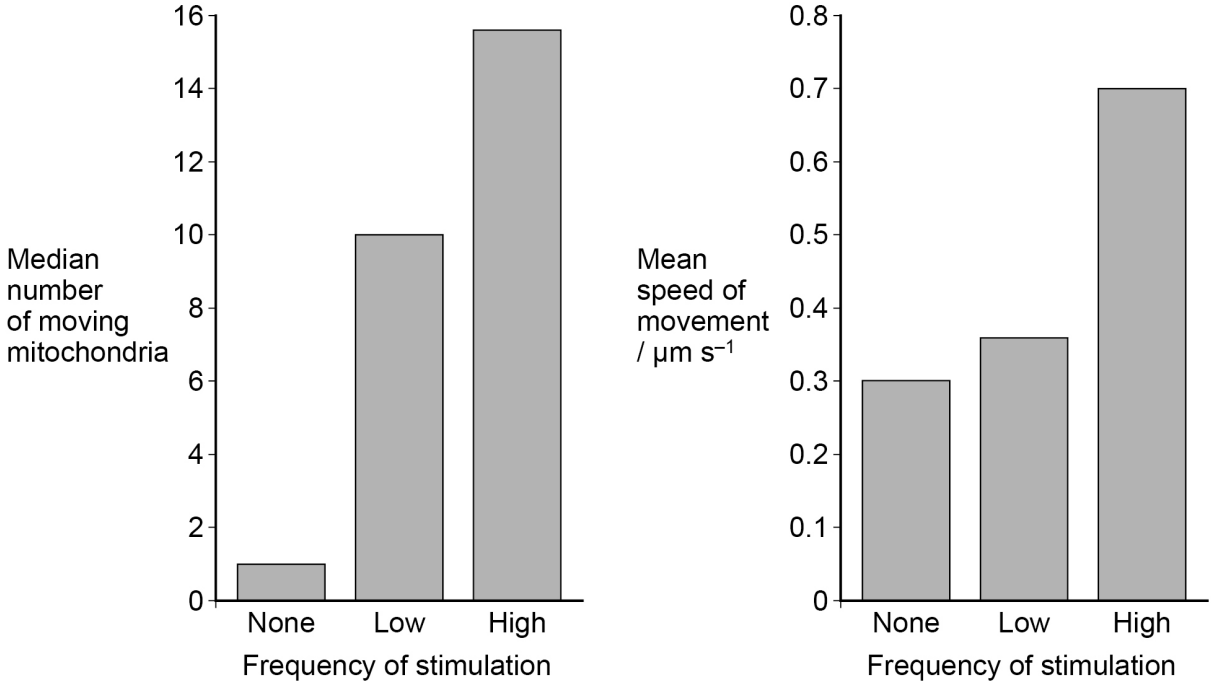
Figure 5 shows the median number of moving mitochondria and the mean speed of the moving mitochondria.

Figure 5



0 3 . 4 Describe how the different frequencies of stimulation affect the movement of mitochondria.

Use information from **Figure 5**.

[2 marks]

Question 3 continues on the next page

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0 3 . 5 Some of the scientists conclude that the investigation supports the idea that

'the higher the frequency of stimulation the more energy is needed by a neurone.'

Give **two** reasons why the investigation does **not** support this conclusion.

[2 marks]

Reason 1 _____

_____

_____

Reason 2 _____

_____

_____

9

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0 4 The polymerase chain reaction (PCR) is used to amplify fragments of DNA in biological samples.

0 4 . 1 Give the role of DNA polymerase in PCR.

[1 mark]

0 4 . 2 During PCR, the samples of DNA are heated to a temperature above 90 °C.

State why.

[1 mark]

0 4 . 3 After heating to above 90 °C, the DNA samples are cooled, then heated again to 72 °C.

Give the reason why the samples are heated to 72 °C.

[1 mark]

Question 4 continues on the next page

Do not write outside the box

PCR is often used to amplify DNA from body fluids.

Scientists obtain a sample of pure DNA.

The scientists investigate if the presence of red blood cells in a sample might affect how well the DNA polymerase amplifies the pure DNA.

The scientists test:

- three different types of DNA polymerase
- five different concentrations of red blood cells.

The scientists prepare the samples for PCR.

Each sample contains a fixed concentration of:

- the pure DNA
- primers
- **one** of the DNA polymerases.

0 4 . 4 Each sample needs **one** other type of substance to make the new DNA strands.

Name this other type of substance.

[1 mark]

_____

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Question 4 continues on the next page

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When all the samples have been prepared, the scientists put each sample into a machine called a thermal cycler.

The thermal cycler heats the samples to the required temperatures for a fixed time.

One cycle of PCR has three steps. Each step takes 40 seconds.

The scientists run the PCR for 30 cycles.

At the end of 30 cycles, the samples are left in the thermal cycler for an extra 7 minutes to ensure all reactions are complete.

0 4 . 5 Calculate the total time that the scientists need to leave the samples in the thermal cycler.

[2 marks]

Total time = _____ minutes

The scientists:

- use electrophoresis to observe the PCR product as bands on a gel
- give each band a score from 0–4, where 0 = no band and 4 = a very strong band.

Table 2 shows the scores for the bands the scientists observe on the gel.

Table 2

	Band score (0–4) for each percentage of red blood cells				
Type of DNA polymerase	20%	2%	0.2%	0.02%	0.002%
Taq	0	0	0	2	3
Pwo	3	4	4	4	4
HiF	0	1	2	3	3

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0 4 . 6 The scientists conclude that ***Pwo*** is the most suitable enzyme for use in PCR.

Evaluate this conclusion.

[3 marks]

0 4 . 7 The PCR process involves the use of primers.

Primers are short single-stranded pieces of DNA.

Give **two** reasons why primers are needed in PCR.

[2 marks]

Reason 1

Reason 2

Question 4 continues on the next page

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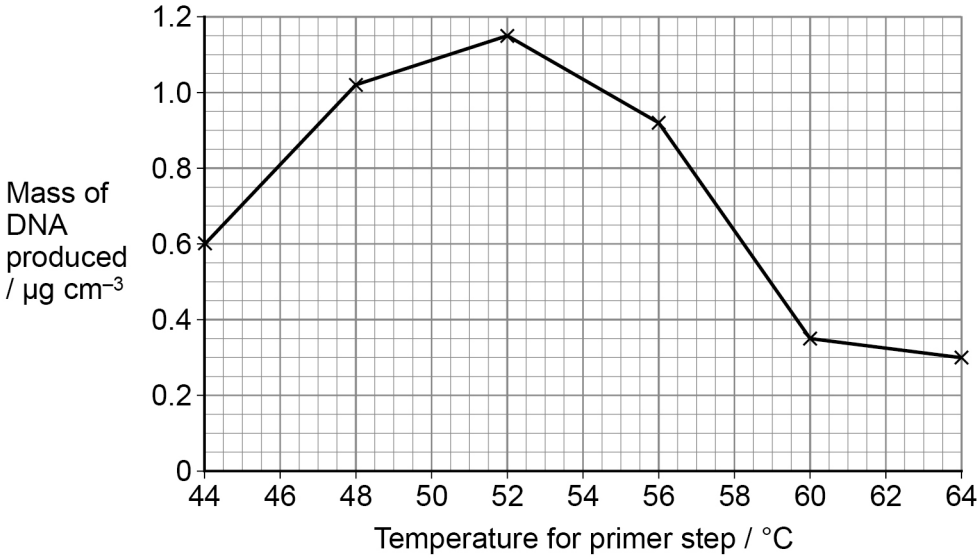
The scientists want to find the optimum temperature for the primer step of PCR. They measure the mass of DNA produced using different temperatures for the primer step.

Figure 6 shows their results.

Figure 6



0 4 . 8 The scientists conclude that the optimum temperature for the primer step is 52 °C.

Give evidence in support **and** evidence against this conclusion.

Use data from **Figure 6**.

[3 marks]

14

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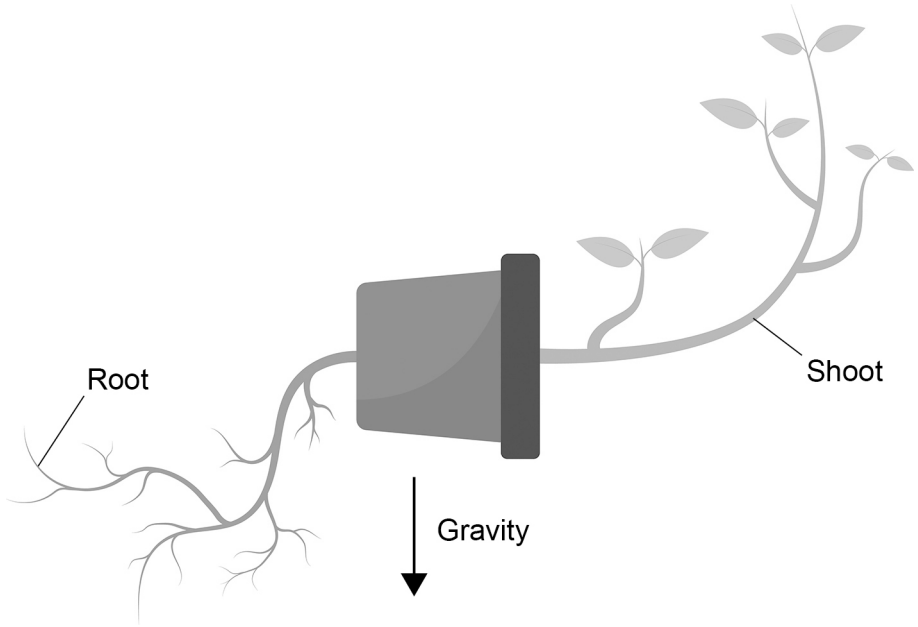
0 5 Some plants are growing in a classroom. One plant pot is knocked over.

Figure 7 shows how the plant is growing a few days later.

Figure 7



The root of the plant and the shoot of the plant respond differently to gravity.

0 5 . 1 Describe the mechanisms in the plant that cause the root and shoot to respond differently to gravity.

[4 marks]

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One student says:

"The plant in **Figure 7** could be responding to light."

0 5 . 2 Describe a simple investigation the student could do to test this hypothesis.

Include **one** controlled variable.

[3 marks]

7

Turn over for the next question

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0 6 In mammals, many physiological control systems involve homeostasis.

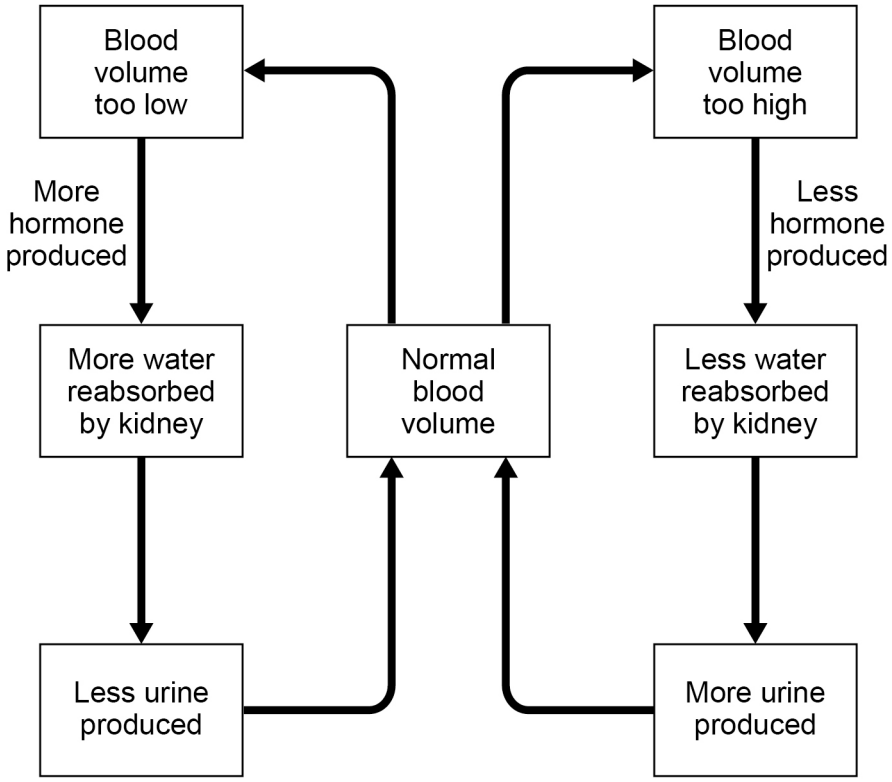
0 6 . 1 Define **homeostasis**.

[1 mark]

Total blood volume is an example of a factor that is maintained by homeostasis.

Figure 8 shows how normal total blood volume is maintained.

Figure 8



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0 6 . 2 Describe how blood volume is returned to normal after sweating during exercise.

Use **Figure 8**.

[3 marks]

Question 6 continues on the next page

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A serious injury can result in a sudden reduction in total blood volume.

In adults, a blood loss of 40% or more of total blood volume causes severe shock, often leading to death.

A woman measuring 1.6 m tall with a mass of 63.2 kg suffers a serious injury resulting in blood loss.

0 6 . 3 Calculate the minimum volume of blood loss for her to go into severe shock.

Use **both** of the following equations.

[3 marks]

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

$$\text{Total blood volume in cm}^3 = \frac{\text{mass in kg} \times 70}{\sqrt{\frac{\text{BMI}}{22}}}$$

Minimum blood loss for severe shock = _____ cm^3

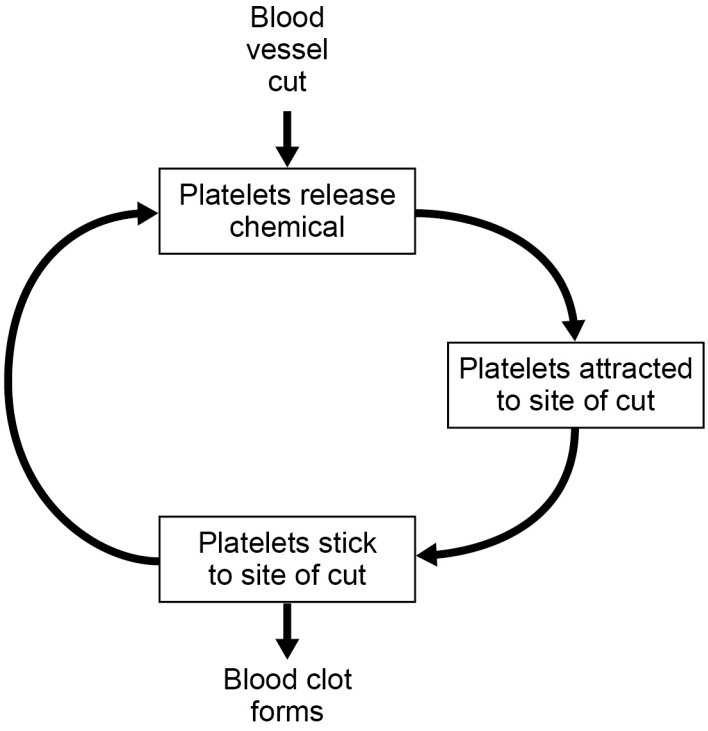
Do not write outside the box

With minor injuries, blood loss can be stopped when a blood clot is formed.

Cell fragments in the blood called platelets help to form the blood clot.

Figure 9 shows how blood clotting is controlled.

Figure 9



0 6 . 4 The system for the control of blood clotting shown in **Figure 9** is **different** from the system for the control of total blood volume shown in **Figure 8** (on page 24).

Describe how the two systems are different.

[2 marks]

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9

Turn over for the next question

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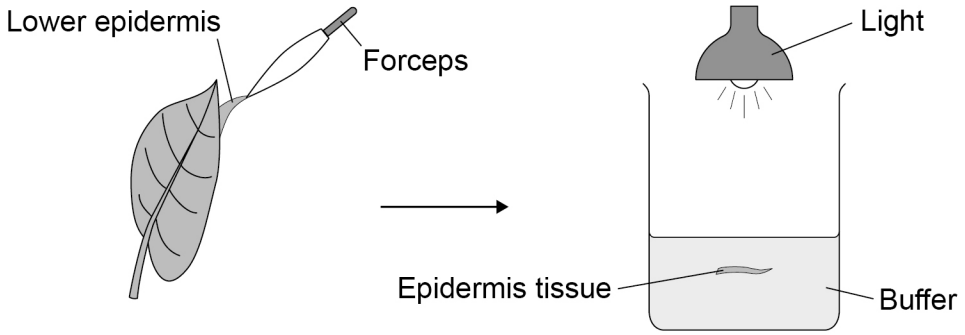
0 7 Plants can close their stomata.

Scientists complete four investigations to help understand how plants control the closing of their stomata.

The scientists start each investigation by preparing the epidermis tissue from the plants.

Figure 10 shows the scientists' method.

Figure 10



Step 1 Remove lower epidermis from plant leaf

Step 2 Keep the epidermis tissue in buffer in light for 2 hours

0 7 . 1 The scientists prepare the epidermis tissue before studying the stomata by completing step **1** and step **2** shown in **Figure 10**.

Suggest why the scientists complete step **1** and step **2**.

[2 marks]

Step 1 _____

_____

_____

Step 2 _____

_____

_____

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Abscisic acid (ABA) is a plant growth substance that causes stomata to close.

ABA uses a complex process to close the stomata.

The scientists investigate if ABA uses nitric oxide (NO) in this process.

Investigation 1

The scientists:

- keep the prepared epidermis tissue in buffer with the treatments shown in **Table 3** for 2 hours in the light
- view the stomata with a microscope and measure the stomatal openings.

Table 3 shows the scientists' results for **Investigation 1**.

Table 3

Treatment	Number of stomata measured	Mean size of stomatal opening / µm
None	60	5.0
ABA	60	1.5
ABA + Inhibitor of NO	60	4.6

0 7 . 2 The scientists conclude that NO is involved in the process used by ABA.

Give **two** ways that the results in **Table 3** support this conclusion.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

Question 7 continues on the next page

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Investigation 2

The scientists grow some plants with a mutation.

The mutation means that the plants do **not** produce NO.

The scientists test how these plants react to different concentrations of ABA.

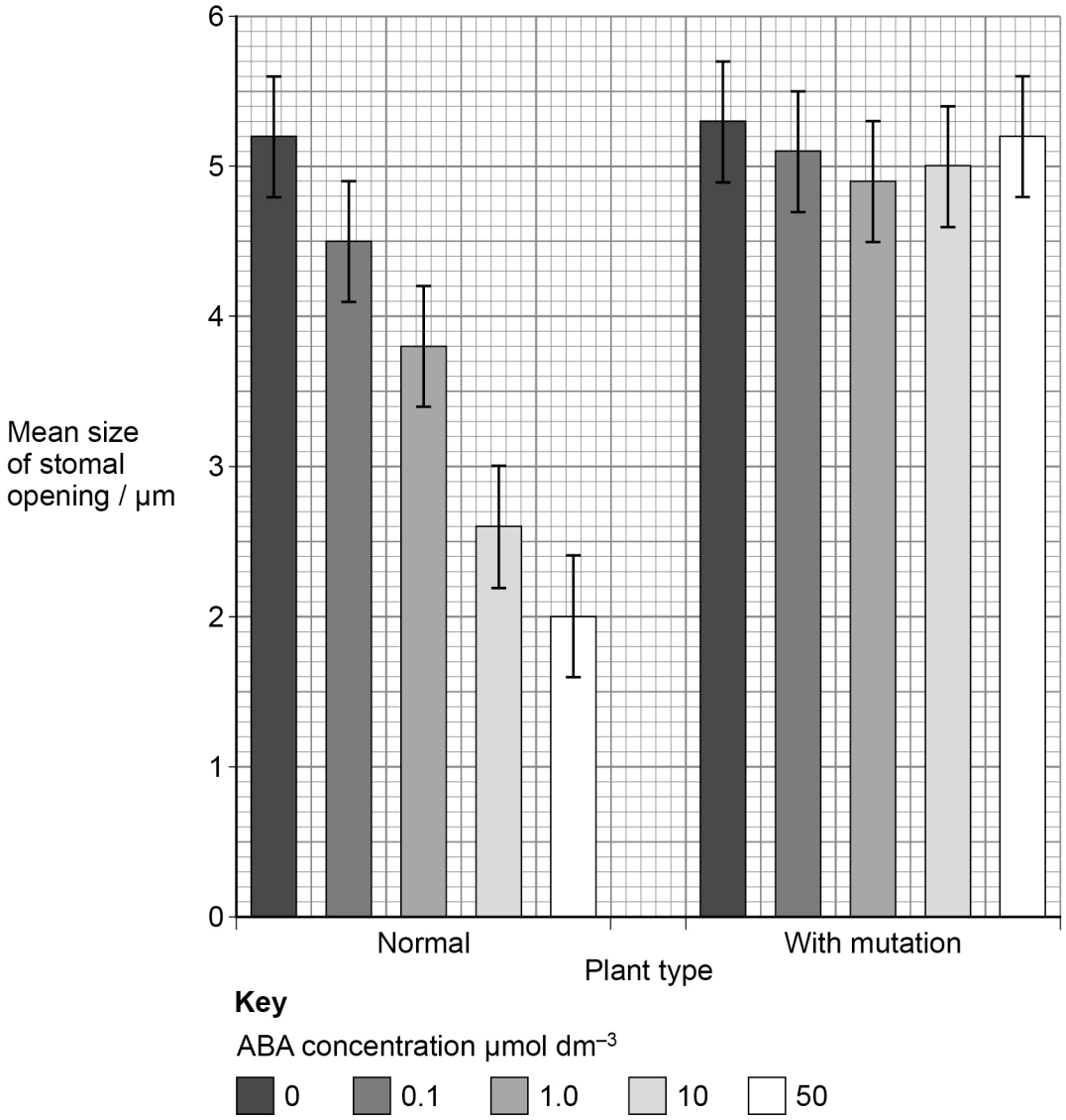
The scientists:

- keep the prepared epidermis tissue in buffer with increasing concentrations of ABA for 2 hours in the light
- view the stomata with a microscope and measure the stomatal openings.

Figure 11 shows the scientists' results for **Investigation 2**.

The error bars show ± standard error.

Figure 11



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0 7 . 3 Describe the effect of ABA on stomatal opening in normal plants and in plants with the mutation.

Use information from **Figure 11**.

[4 marks]

Question 7 continues on the next page

Do not write outside the box

Plants take in nitrates from the soil.

Plants could use these nitrates to produce NO. The process involves **two** different enzymes.

In **normal** plants

Nitrate $\xrightarrow{\text{Enzyme 1}}$ Nitrite $\xrightarrow{\text{Enzyme 2}}$ Nitric oxide (NO)

The scientists think that the plants with the mutation in **Investigation 2** cannot produce NO because they do **not** have enzyme **1**.

In plants with the **mutation**

Nitrate $\xrightarrow{\text{Enzyme 1}}$ Nitrite $\xrightarrow{\text{Enzyme 2}}$ Nitric oxide (NO)

Investigation 3

The scientists test the theory that the plants with the mutation do **not** have enzyme **1** but do have enzyme **2**.

The scientists use more of the plants used in **Investigation 2** to test this theory.

0 7 . 4 **Table 4** shows:

- the treatments the scientists use to test if the plants with the mutation do **not** have enzyme **1** but do have enzyme **2**
- the expected results if the plants with the mutation do **not** produce enzyme **1**.

Complete **Table 4**.

[2 marks]

Table 4

Plant type	**Treatment**	**Expected result**
With mutation	None	Stomata open
With mutation	ABA	
With mutation		Stomata closed

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Investigation 4

Plants also produce ethene.

Scientists use some plants with a **different** mutation. These plants produce much **more** ethene than normal plants.

The scientists:

- keep the prepared epidermis tissue in the light in buffer with:
  - ABA **only**
  - ABA **and** ethene
- view the stomata with a microscope and measure the stomatal openings at 0, 5, 15 and 30 minutes.

0 7 . 5 The scientists add ABA at a concentration of 10 μmol dm^{-3} to **all** the samples.

Give **one** reason for using this concentration of ABA.

Use information from **Figure 11** (on page 30).

[1 mark]

_____

_____

_____

Question 7 continues on the next page

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Table 5 shows the plant types and treatments used in **Investigation 4**.

The final column of **Table 5** shows the symbols used to represent each treatment.

Table 5

		Treatment		
Plant type	**Internal ethene production**	**ABA added**	**Ethene added**	**Symbol used**
With mutation	High	✓	×	**M**
Normal	Low	✓	✓	**N+E**
Normal	Low	✓	×	**N**

0 7 . 6 Give the reason why the scientists include normal plants treated with ABA only (**N**) in **Investigation 4**.

[1 mark]

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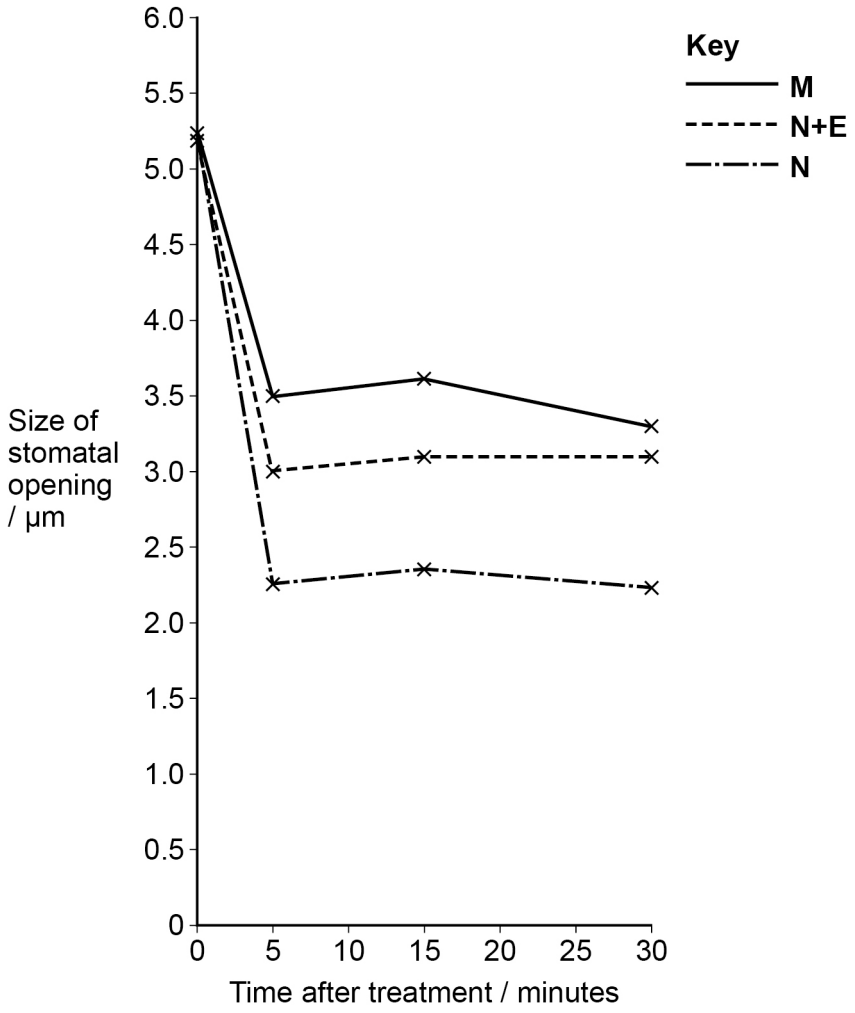
Figure 12 shows the scientists' results from **Investigation 4**.

Figure 12



0 7 . 7 Give **two** conclusions the scientists could make about the effect of ethene on plants.

Use information from **Figure 12**.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

Question 7 continues on the next page

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0 7 . 8 When water is limited, plants produce ABA to close their stomata.

The plants also produce some ethene.

Suggest how ethene production helps the plant.

[1 mark]

_____

_____

_____

15

END OF QUESTIONS

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