OXFORD
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I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 4 Control

Tuesday 6 June 2023 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	
5	
6	
7	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

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Answer **all** questions in the spaces provided.

0 1 Neurones are specialised cells adapted to conduct nerve impulses.

0 1 . 1 Complete **Table 1** by naming the part of the neurone that carries out the function described.

Table 1

Function	**Part of neurone**
Conducts nerve impulses towards the cell body	
Provides electrical insulation	

[2 marks]

Question 1 continues on the next page

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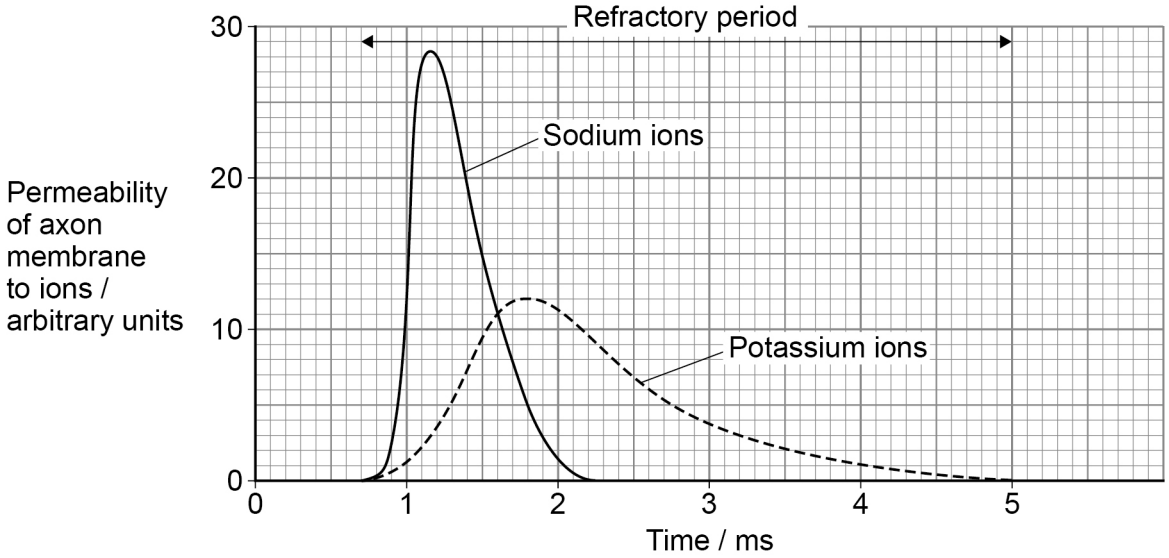
During an action potential, the permeability of the axon membrane to sodium ions and potassium ions changes.

Figure 1 shows how membrane permeability changes during the action potential.

Figure 1



During an action potential, the membrane potential rises to +40 mV and then falls.

0 1 . 2 Explain the rise and fall in membrane potential during an action potential.

[4 marks]

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0 1 . 3 Calculate the maximum number of action potentials per second along this axon.

Give your answer to the nearest whole number.

Use data from **Figure 1**.

[2 marks]

Answer = _____ action potentials s^{-1}

0 1 . 4 The refractory period causes action potentials to move in one direction only.

Explain why.

[2 marks]

_____

_____

_____

_____

_____

_____

10

Turn over for the next question

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0 2 Scientists have discovered a bacterium that produces an enzyme called PETase. This enzyme can break down a plastic called PET.

Using genetic engineering techniques, scientists used plasmids as a vector to transform yeast cells. The transformed yeast cells now produce the PETase enzyme.

0 2 . 1 Describe how vectors transform the yeast cells.

[1 mark]

0 2 . 2 Describe the role of restriction endonuclease **and** DNA ligase enzymes in the process of inserting the PETase gene into a plasmid.

[4 marks]

Restriction endonuclease

DNA ligase

0 2 . 3 Suggest **one** possible advantage of transforming yeast with the PETase gene for reducing plastic pollution.

[1 mark]

6

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Turn over for the next question

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0 3 Scientists investigate the effect of two different chemicals on the behaviour of a species of beetle (*Tribolium confusum*). This beetle is a pest that feeds on stored cereal products such as wheat flour.

The scientists:

1. divide a choice chamber (a clear plastic container) into two sections as shown in **Figure 2** (on page 9)
2. add a chemical called anethole to one section of the choice chamber and distilled water to the other section (control)
3. put the choice chamber into a temperature-controlled and light-controlled room
4. put one beetle into the choice chamber and wait five minutes
5. observe the behaviour of the beetle for 10 minutes and record the time that the beetle spends in each of the two sections
6. repeat steps 1 to 5 to collect results for a total of 30 individual beetles.

To complete the investigation, the scientists repeat steps 1 to 6, but in step 2 add a chemical called caryophyllene instead of anethole.

0 3 . 1 Name **one** factor, other than temperature or light, that the scientists should control.

[1 mark]

_____

0 3 . 2 Give **one** reason why the beetles are left for five minutes before their movement is recorded.

[1 mark]

_____

_____

_____

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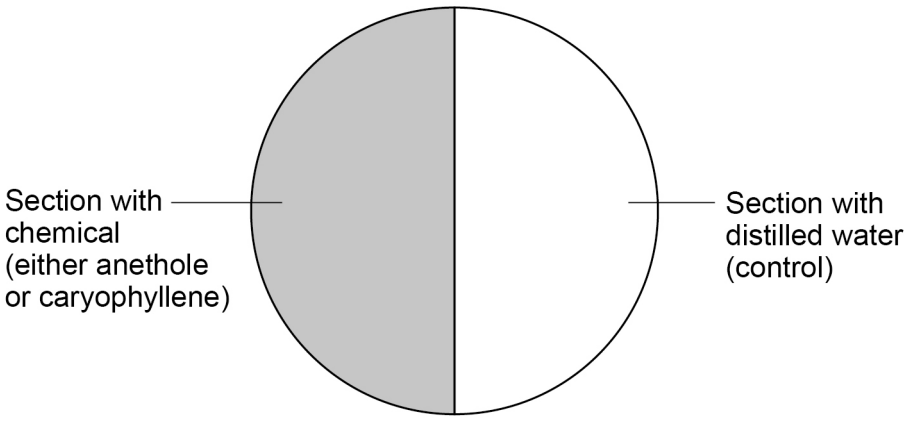
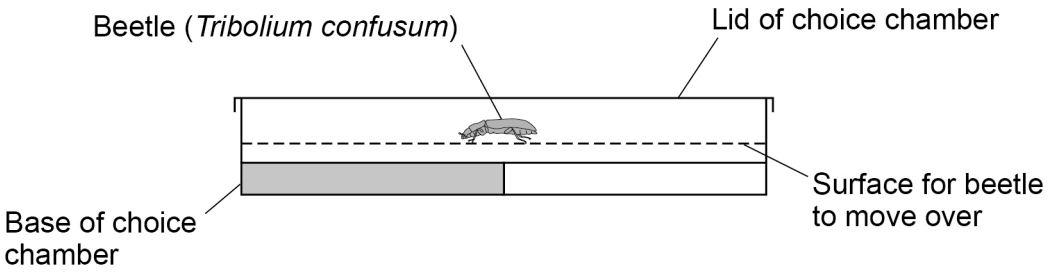
Figure 2 shows the choice chamber that the scientists use.

Figure 2

Top view



Side view



0 3 . 3 Each beetle usually spends more time in the control area.
The scientists conclude that the beetles are showing a kinesis response.

Describe what observations of the beetle's movements would support this conclusion.

[2 marks]

Question 3 continues on the next page

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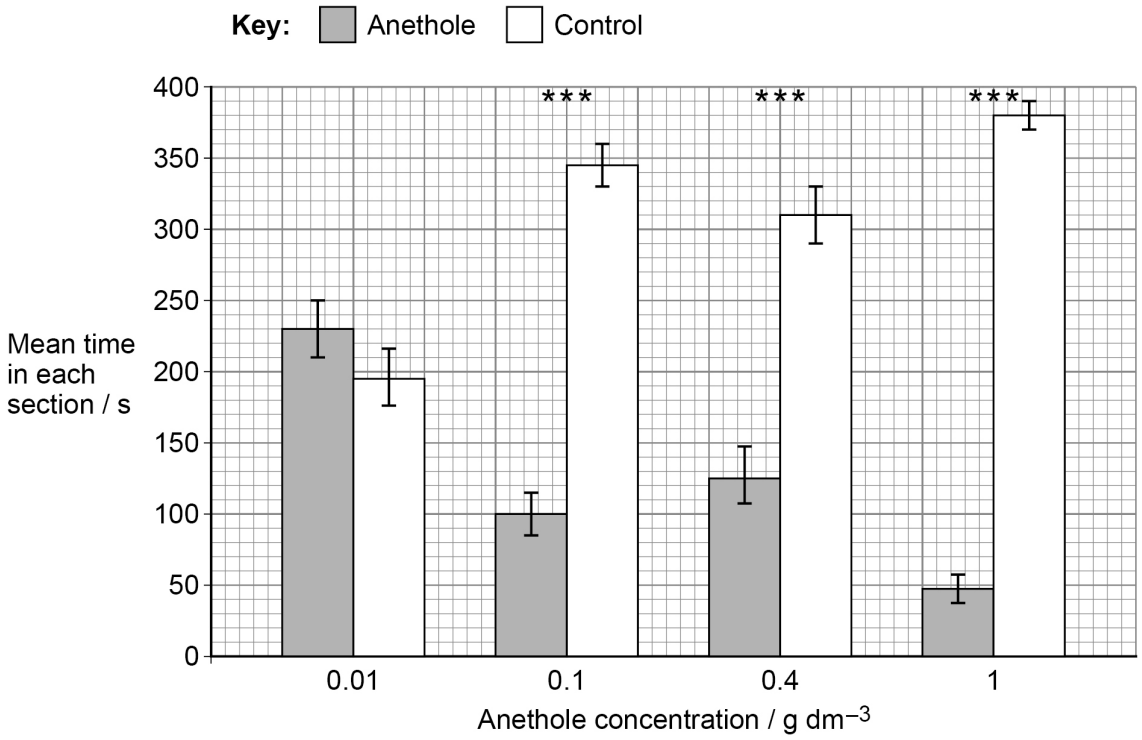
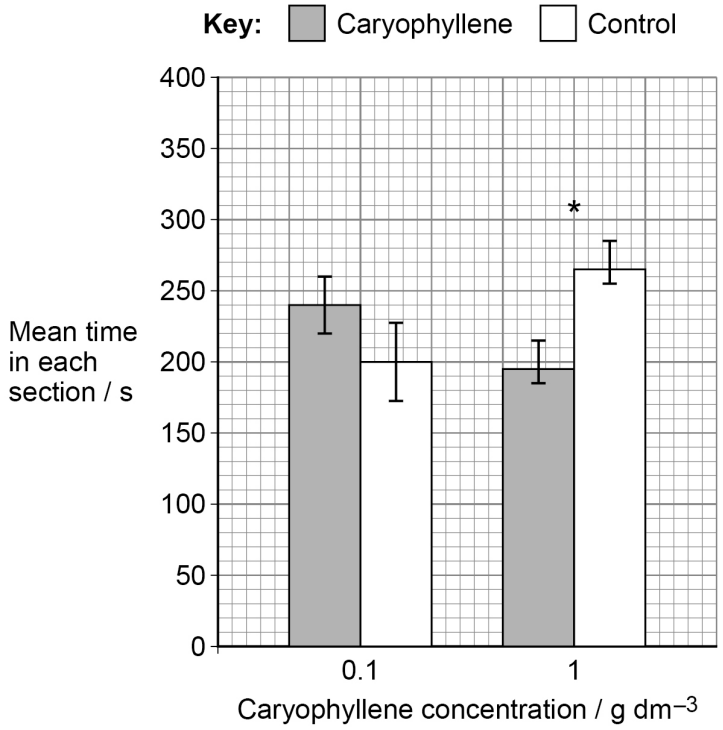
Figure 3 shows the mean time the beetles are in each section when different concentrations of anethole and caryophyllene are used.

Error bars show ± 2 standard deviations.
* shows significance at P < 0.05
*** shows significance at P < 0.001

Figure 3





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0 3 . 4 The scientists make two conclusions.

1. Anethole is more effective than caryophyllene at repelling the beetles.
2. Anethole could be used for protecting stored cereal products from insect pests such as *Tribolium confusum*.

Use the information in **Figure 3** to evaluate the scientists' conclusions.

[5 marks]

9

Turn over for the next question

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0 4 Students investigate the effects of indoleacetic acid (IAA) on the growth of *Arabidopsis thaliana* seedlings.

The students:

- remove 2 mm from the shoot tips of 30 seedlings of the same age
- cut the next 15 mm lengths from the shoots
- put 5 of the 15 mm lengths of shoot into each of 6 Petri dishes
- add 50 cm^3 of a different concentration of IAA solution to each Petri dish
- cover the Petri dishes in plastic film
- measure the length of each shoot after 4 days and calculate the mean change in the shoot length at each of the IAA concentrations.

0 4 . 1 The students grow the seedlings at the same temperature and light intensity before the start of the investigation.

Give **two** other environmental variables that the students should control.

[2 marks]

1 _____

2 _____

0 4 . 2 Explain why the students remove the shoot tips from each of the seedlings.

[2 marks]

_____

_____

_____

_____

_____

0 4 . 3 Explain why the students covered each Petri dish in plastic film.

[2 marks]

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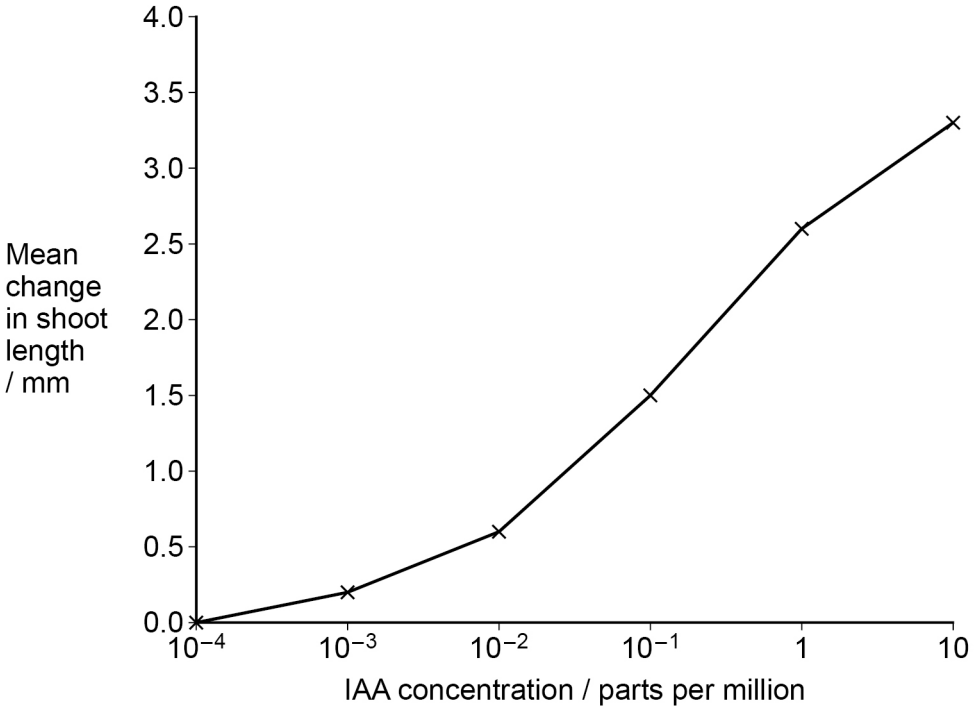
Figure 4 shows the students' results.

Figure 4



0 4 . 4 Give the reason why the students use a logarithmic scale for the IAA concentration.

[1 mark]

0 4 . 5 Explain the effect of IAA on shoot growth shown in **Figure 4**.

[2 marks]

9

Turn over for the next question

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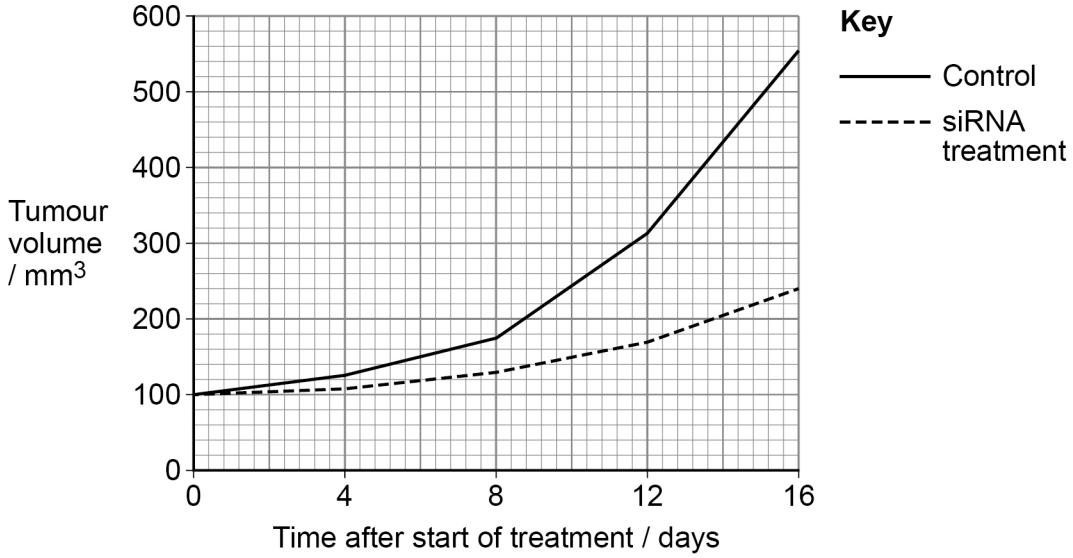
0 5 Small interfering RNA (siRNA) can be used for treating tumours. Scientists investigate the effect of siRNA on the growth of tumours.

Figure 5 shows the scientists' results.

Figure 5



0 5 . 1 Calculate the difference in rate of tumour growth between the control and siRNA treatment over the 16 days.

[2 marks]

Difference in rate = _____ $mm^3\ day^{-1}$

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0 5 . 2 One type of tumour cell that the scientists used divides every 8 hours.

Calculate the number of tumour cells that would be produced from a single tumour cell after 16 days.

Give your answer in standard form to 3 significant figures.

[2 marks]

Number of tumour cells = _____

In similar investigations, scientists have measured the area of a tumour as an indicator of tumour size.

0 5 . 3 Give **one** reason why measuring the volume of the tumour gives a better indication of tumour size.

[1 mark]

_____

_____

_____

Question 5 continues on the next page

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The siRNA used in the investigation inhibits the expression of a gene that blocks cell death (apoptosis).

0 5 . 4 Explain how this siRNA could inhibit the expression of the gene and how this could slow the onset of cancer.

Use the information given and the results in **Figure 5** (on page 14).

[3 marks]

Another cause of tumour development is abnormal methylation of DNA in tumour suppressor genes.

0 5 . 5 Explain how abnormal methylation of a tumour suppressor gene could cause the development of a tumour.

[3 marks]

11

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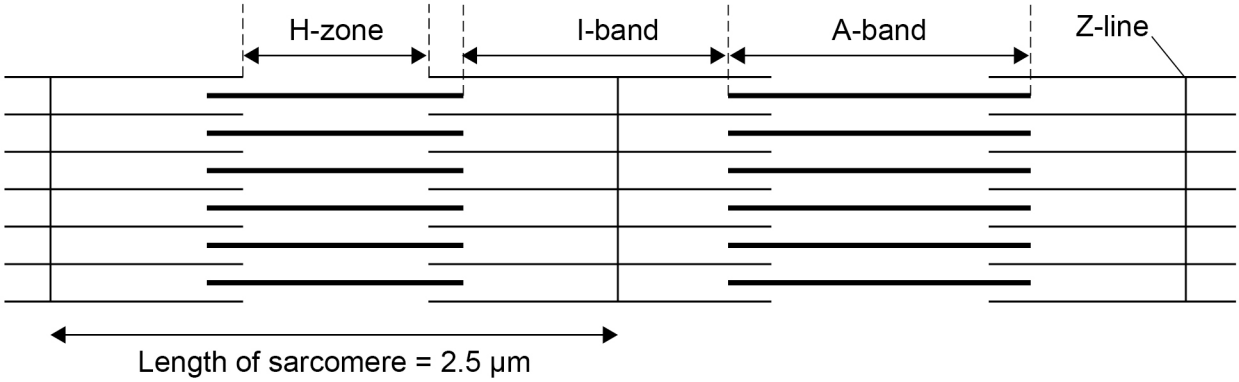
0 6 **Figure 6** shows part of a myofibril from a section of skeletal muscle. The sarcomeres are relaxed.

Figure 6



0 6 . 1 **Figure 6** shows that the length of each sarcomere is 2.5 μm

Use this information to calculate the magnification of the diagram.

[2 marks]

Magnification = _____

0 6 . 2 Describe **two** ways the appearance of the sarcomeres would change when the muscle fibre contracts.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

Question 6 continues on the next page

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0 6 . 3 When a muscle sarcomere contracts, a single actin filament moves 0.64 μm

This movement requires energy from the hydrolysis of 16 ATP molecules.

Calculate the distance that an actin filament would move with the energy from the hydrolysis of only one ATP molecule.

Give your answer in nm

[1 mark]

Distance = _____ nm

0 6 . 4 Describe the role of phosphocreatine during muscle contraction.

[2 marks]

_____

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Question 6 continues on the next page

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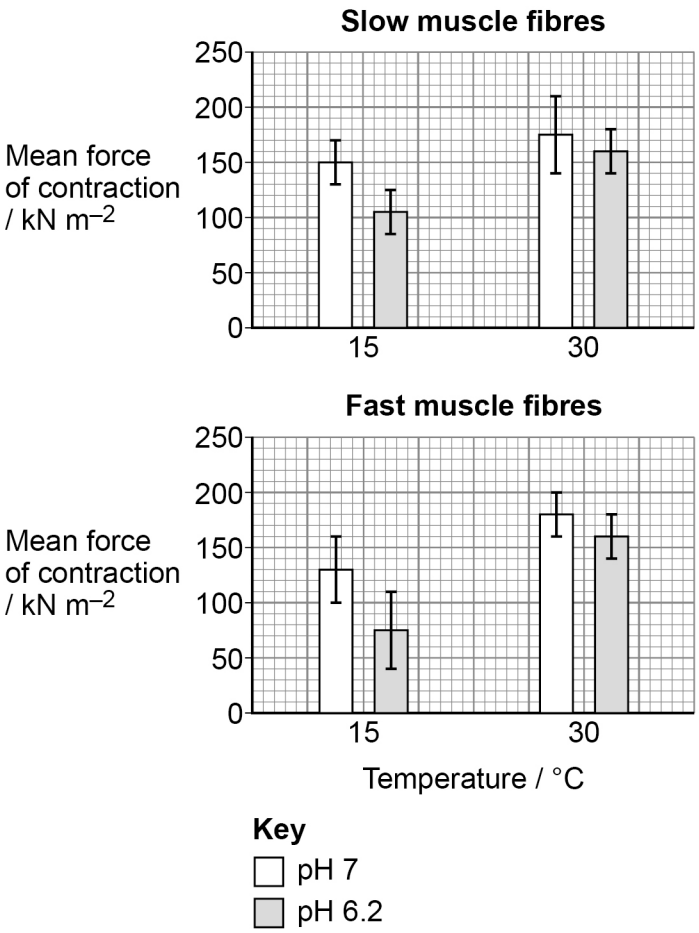
Scientists investigate the effect of pH and temperature on the force of skeletal muscle contraction.

The scientists:

- isolate fast and slow skeletal muscle fibres from the bodies of four rats
- put the isolated fast and slow muscle fibres into two different solutions:
  - pH 7 (typical pH of rat muscle tissue)
  - pH 6.2
- measure the force of muscle contraction of both fast and slow muscle fibres at 15 °C and 30 °C

Figure 7 shows the scientists' results. Error bars show ± 2 standard deviations.

Figure 7



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0 6 . 5 A student concludes that a decrease in pH always causes a decrease in the force of muscle contraction.

Use information from **Figure 7** to evaluate this conclusion.

[5 marks]

Question 6 continues on the next page

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0 6 . 6 The scientists suggest that the decrease in the force of muscle contraction is due to a reduction in the effect of calcium ions.

Explain how a reduction in the effect of calcium ions might lower the force of contraction.

Use your knowledge of muscle contraction.

[3 marks]

15

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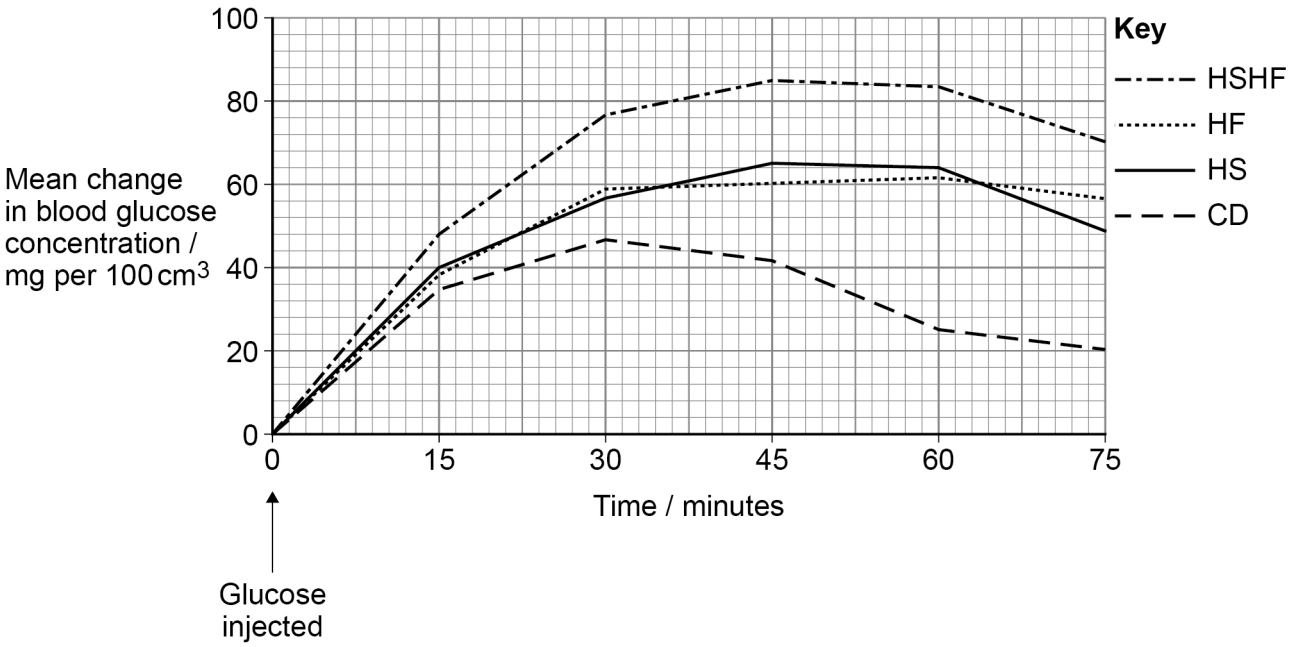
0 7 Scientists investigate the effect of diet on the blood glucose concentration of mice.

The scientists:

- put 24 mice into four groups of 6 mice
- feed each group of mice a different diet for eight weeks as follows:
  - high sugar and high fat diet (HSHF)
  - high fat diet (HF)
  - high sugar diet (HS)
  - control diet (CD)
- stop feeding the mice six hours before the start of the experiment
- inject each of the mice with a glucose solution
- measure the blood glucose concentration of the mice in each group at 15-minute intervals.

Figure 8 shows the scientists' results.

Figure 8



0 7 . 1 Suggest why the scientists stop feeding the mice six hours before the start of the experiment.

[1 mark]

_____

_____

_____

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0 7 . 2 Describe what **Figure 8** shows about the effect of diet on blood glucose concentration.

[3 marks]

0 7 . 3 Explain the change in blood glucose concentration in the control mice after 30 minutes.

[4 marks]

Question 7 continues on the next page

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Another group of scientists report the effect of a chemical called Cpd 1 on the action of glucagon. The structure of Cpd 1 allows it to bind to the same receptors as glucagon on the surface of liver cells.

The scientists:

1. isolate the livers from mice and put the livers into dilute salt solution
2. measure the glycogen content of the livers
3. add glucagon to one of the livers and measure the amount of glycogen in the liver at 10-minute intervals for 40 minutes
4. repeat step 3 by adding different concentrations of Cpd 1 in addition to glucagon to each of the other livers
5. calculate the amount of glycogen remaining in the livers as a percentage of the maximum content.

Figure 9 shows the scientists' results.

Figure 9

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0 7 . 4 Describe the scientists' results.

Use data from **Figure 9** in your answer.

[3 marks]

Question 7 continues on the next page

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People with diabetes can have high levels of glucagon linked to a high blood glucose concentration.

The scientists conclude that Cpd 1 is effective in blocking glucagon receptors on liver cells and could prevent high blood glucose in people with diabetes.

0 7 . 5 Explain the effects of Cpd 1 shown in **Figure 9** (on page 26).

Use your knowledge of the mechanism of glucagon action.

[4 marks]

15

END OF QUESTIONS

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