OXFORD
INTERNATIONAL
AQA EXAMINATIONS

Please write clearly in block capitals.

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

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I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 4 Control

Monday 18 January 2021 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 **all** questions in the spaces provided.

0 1 Different types of stem cell exist at different stages of human development.

Stem cells can be totipotent or unipotent.

0 1 . 1 Give **two** differences between totipotent stem cells and unipotent stem cells.

[2 marks]

1 _____

_____

_____

2 _____

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Scientists are investigating the use of stem cells for treating some human disorders.

A new treatment for sight disorders involves taking blood cells from a patient and changing them into induced pluripotent stem cells (iPS cells). These iPS cells can be used to produce new cells in the retina, including rod cells and cone cells. These new cells could then be implanted into the same patient.

0 1 . 2 Explain how iPS cells are able to produce new cone cells.

[2 marks]

0 1 . 3 Explain **one** advantage of creating iPS cells from cells taken from the patient rather than from a donor.

[2 marks]

0 1 . 4 Explain how cone cells give higher visual acuity than rod cells.

[2 marks]

8

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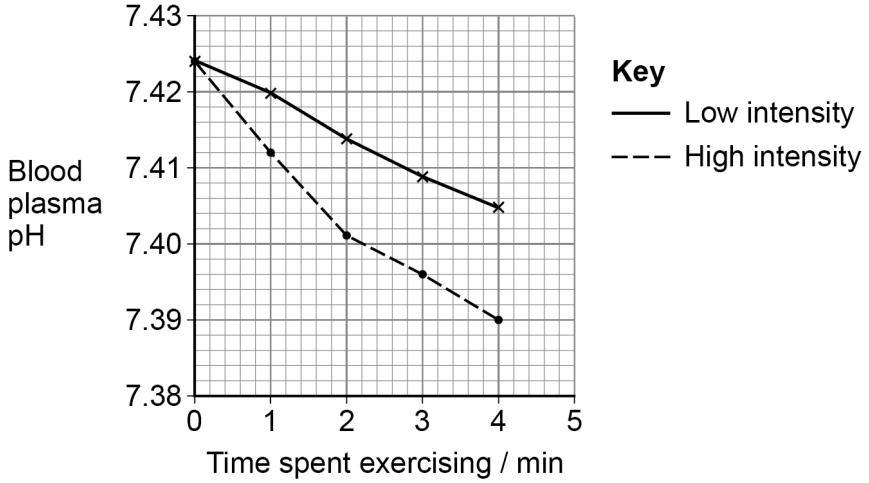
0 2 Scientists investigated the effect of exercise intensity on blood plasma pH.

Figure 1 shows the scientists' results.

Figure 1



0 2 . 1 Calculate the difference between the rate of blood plasma pH decrease at high intensity exercise and the rate of blood plasma pH decrease at low intensity exercise during the first 2 minutes.

[2 marks]

Answer _____ pH units min^{-1}

Do not write outside the box

0 2 . 2 **Figure 1** shows that high intensity exercise causes a larger decrease in blood plasma pH than low intensity exercise.

Explain the reason for this difference.

[2 marks]

0 2 . 3 Exercise causes an increase in heart rate.

Describe the role of receptors and of the nervous system in causing this increase.

[3 marks]

7

Turn over for the next question

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0 3 Scientists used genetic modification techniques to transform a crop plant to express a bacterial protein called PL1.

PL1 is produced naturally by non-pathogenic bacteria that live in soil. PL1 kills other competing species of bacteria.

The PL1 gene was injected into isolated cells of a crop plant. These genetically modified cells were then cloned, and new plants were grown from the cloned cells.

0 3 . 1 Describe how scientists could remove the PL1 gene from the DNA of bacteria.

[2 marks]

The scientists needed many copies of the PL1 gene.

0 3 . 2 Name the process used in a laboratory to produce many copies of DNA starting from a small amount of DNA.

[1 mark]

0 3 . 3 Explain the advantage of injecting the PL1 gene into isolated plant cells instead of injecting the PL1 gene directly into the cells of a mature plant.

[2 marks]

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Question 3 continues on the next page

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Pseudomonas syringae is a bacterial pathogen that causes damage to crop plants globally.

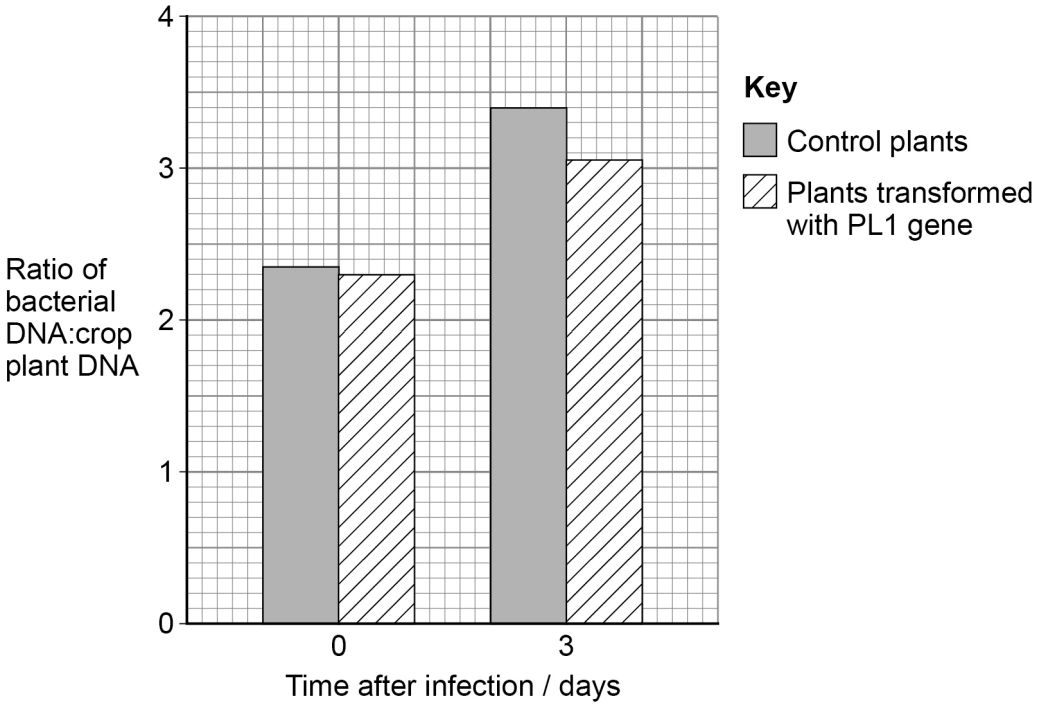
The scientists measure the response of the transformed crop plants (producing the PL1 protein) to *P. syringae*.

The scientists:

- create an experimental group using mature crop plants that can express the PL1 gene
- create a control group using mature crop plants of the same species that do **not** express the PL1 gene
- infect the crop plants in both groups with *P. syringae*
- measure the amount of bacterial DNA and the amount of plant DNA from infected leaves at the start and after 3 days.

Figure 2 shows the scientists' results.

Figure 2



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The work of these scientists has been reported in the media.

0 3 . 4 One journalist stated:

'Scientists successfully modify plants to fight off widespread crop disease.'

Evaluate this statement.

Use **Figure 2** and the information from the scientists' method.

[4 marks]

9

Turn over for the next question

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0 4 Scientists investigate how a drug called dobutamine affects the action of adrenaline.

The scientists:

- take liver cell samples from 10 healthy human volunteers
- culture the liver cell samples in the laboratory
- add different concentrations of adrenaline and dobutamine, both separately and combined, to the liver cell samples
- measure how much cyclic adenosine monophosphate (cAMP) the liver cells produce after 10 minutes.

0 4 . 1 The scientists only select volunteers who have not taken any medication for 30 days before the start of the investigation.

Explain why.

[2 marks]

Do not write outside the box

0 4 . 2 Describe the second messenger model of adrenaline action.

[4 marks]

Question 4 continues on the next page

Do not write outside the box

Figure 3 shows the mean rate of cAMP production from liver cells given adrenaline and dobutamine separately.

Error bars show ± 2 standard deviations.

Figure 3

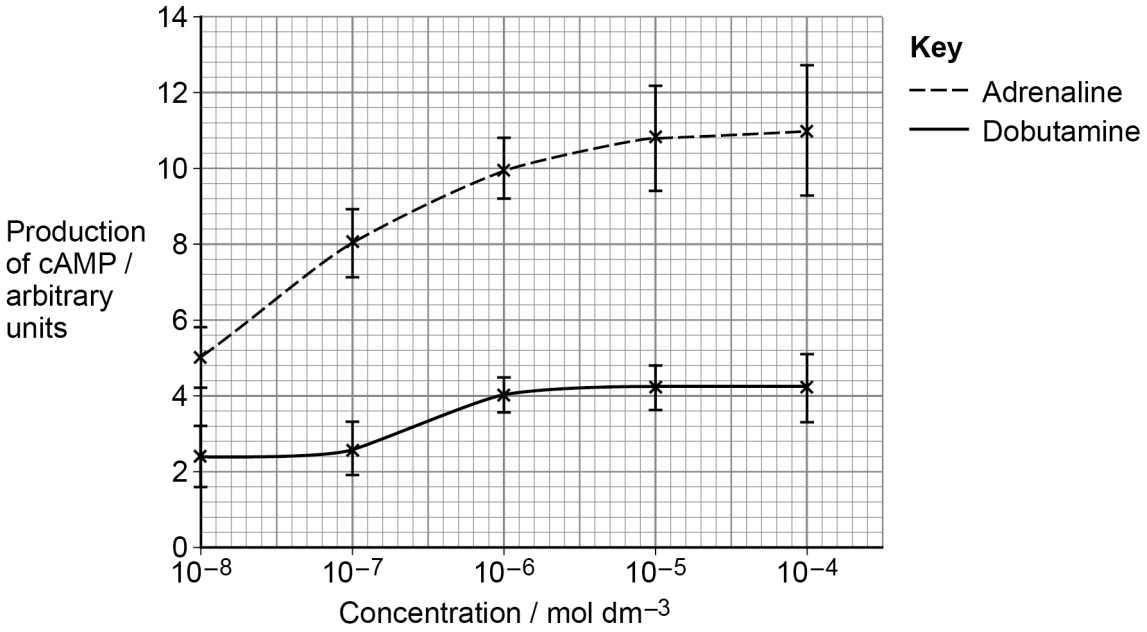
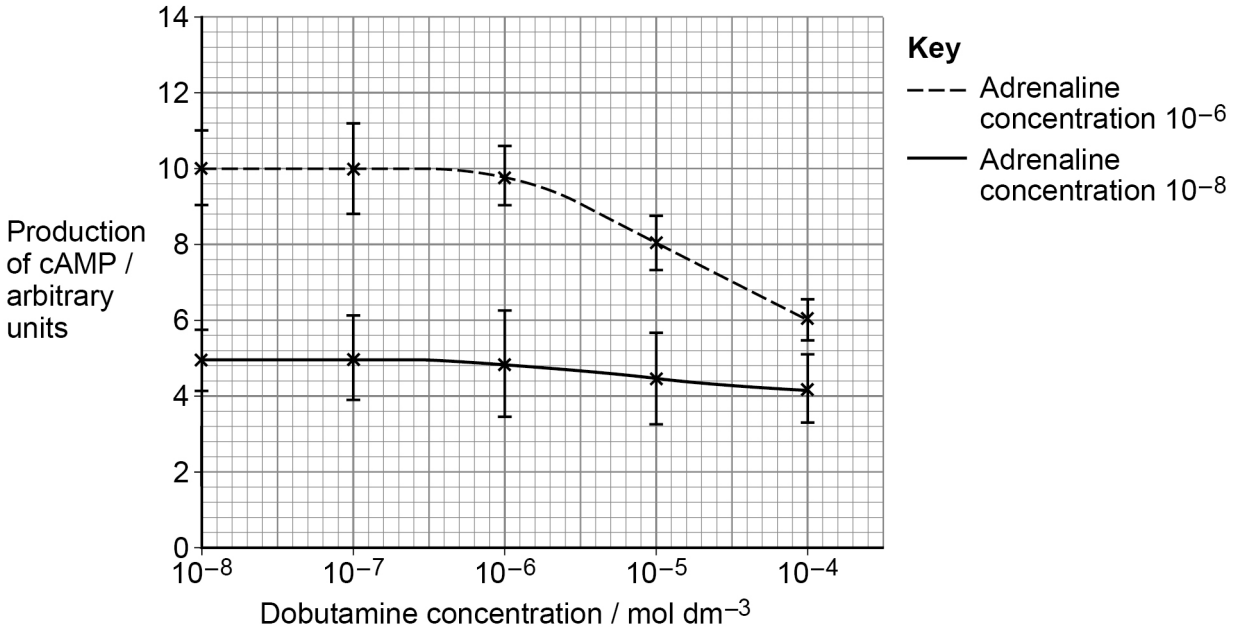


Figure 4 shows the mean rate of cAMP production from liver cells given different concentrations of adrenaline and dobutamine combined.

Error bars show ± 2 standard deviations.

Figure 4



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0 4 . 3 Describe the effect of dobutamine on the cAMP production caused by adrenaline.

Include information from **Figure 3** and **Figure 4** in your answer.

[3 marks]

Adrenaline concentration 10^{-8} mol dm^{-3} _____

_____

_____

_____

_____

Adrenaline concentration 10^{-6} mol dm^{-3} _____

_____

_____

_____

_____

0 4 . 4 The structures of adrenaline and dobutamine have some similarities.

Suggest how dobutamine could produce the effect shown in **Figure 3** and **Figure 4**.

[2 marks]

_____

_____

_____

_____

_____

_____

11

Turn over for the next question

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0 5 Scientists investigate the electrical activity of neurones placed in different solutions.

Table 1 shows the composition of solutions the scientists use.

Table 1

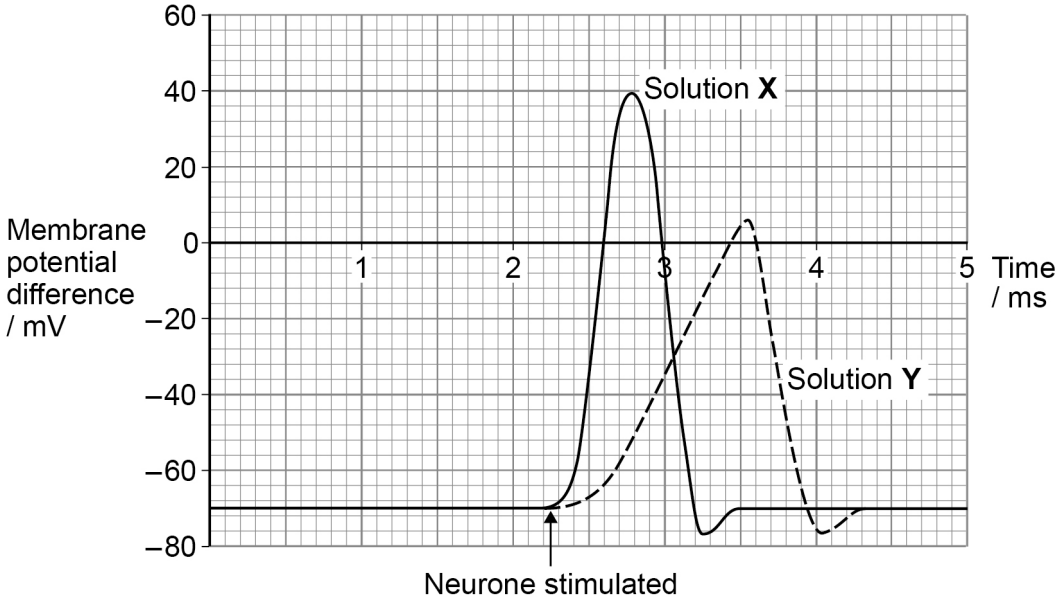
Solution	Ratio of concentration of sodium ions in solution to concentration of sodium ions in human tissue fluid
X	1:1
Y	0.35:1

The scientists:

- put a neurone into each solution
- stimulate the neurones
- measure the changes in potential difference across the axon membranes of the neurones in each solution.

Figure 5 shows the scientists' results.

Figure 5



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0 5 . 1 Explain how the neurones maintained a constant membrane potential before they were stimulated.

[2 marks]

0 5 . 2 Describe how the pattern of change in membrane potential in solution **Y** is different from the change in solution **X** after the neurones were stimulated.

[1 mark]

0 5 . 3 Explain what causes the differences you described in your answer to Question **05.2**.

[2 marks]

Question 5 continues on the next page

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Another group of scientists investigate the relationship between four neurones.

Figure 6 shows axons from three presynaptic neurones, **A**, **B** and **C**, and the synapses they form with postsynaptic neurone, **D**.

Figure 6

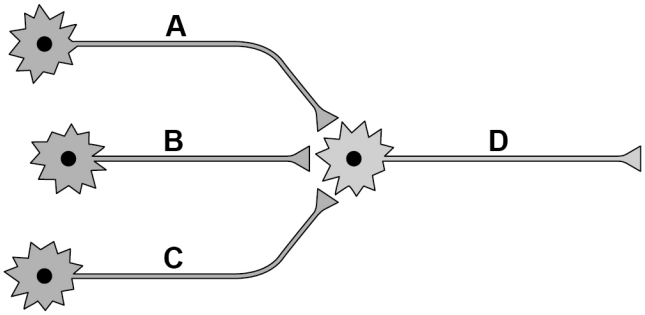
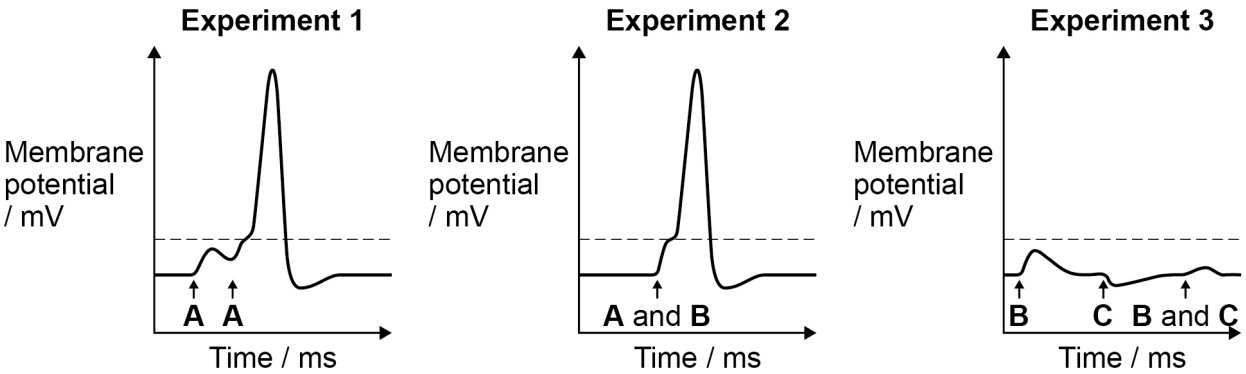


Figure 7 shows the results of three experiments to determine the effects of action potentials in neurones **A**, **B** and **C** on neurone **D**.

Figure 7



Key

↑ Arrival of action potential at end of neurone

--- Threshold value of neurone **D**

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Use **Figure 6** and **Figure 7** to answer Questions **05.4** and **05.5**.

0 5 . 4 Explain the results of experiments **1** and **2**.

[5 marks]

0 5 . 5 Explain what the result of experiment **3** shows about the relationship between neurone **C** and neurone **D**.

[3 marks]

13

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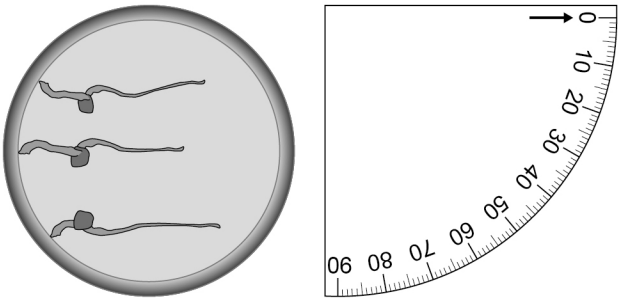
0 6 Students investigate geotropism in the roots of mustard seedlings.

The students:

- put 6 mustard seeds in a beaker of diluted bleach for 10 minutes
- wash the seeds in distilled water to remove any bleach solution
- take two agar plates
- put 3 seeds into each agar plate and wrap each plate in transparent plastic film
- position both plates so they are vertical and allow time for the seeds to germinate and become seedlings with roots at least 10 mm long
- then rotate both plates 90° so that the roots of the seedlings are horizontal as shown in **Figure 8**
- put one plate in a dark room and one plate in a light room
- measure the angle of root tip growth at regular intervals for 4 days.

Figure 8 shows one of the plates during the experiment and a section of a protractor to measure the angle of root tip growth.

Figure 8



0 6 . 1 Suggest **one** reason why the students:

[2 marks]

put the mustard seeds in a beaker of bleach for 10 minutes.

_____

_____

_____

wrapped each plate in transparent plastic film.

_____

_____

_____

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0 6 . 2 Give **two** variables that the students should control in this experiment.

[2 marks]

1 _____

_____

2 _____

_____

Table 2 shows the students' results.

Table 2

Time / days	Mean downward angle of root tip from horizontal / degrees	
	Light	Dark
0.0	7	6
0.5	11	8
1.0	26	15
1.5	65	39
2.0	72	54
2.5	86	63
3.0	91	78
3.5	92	83
4.0	92	91

0 6 . 3 The students conclude that light increases the geotropic response of mustard seedlings.

Describe how the data in **Table 2** support this conclusion.

[1 mark]

_____

_____

_____

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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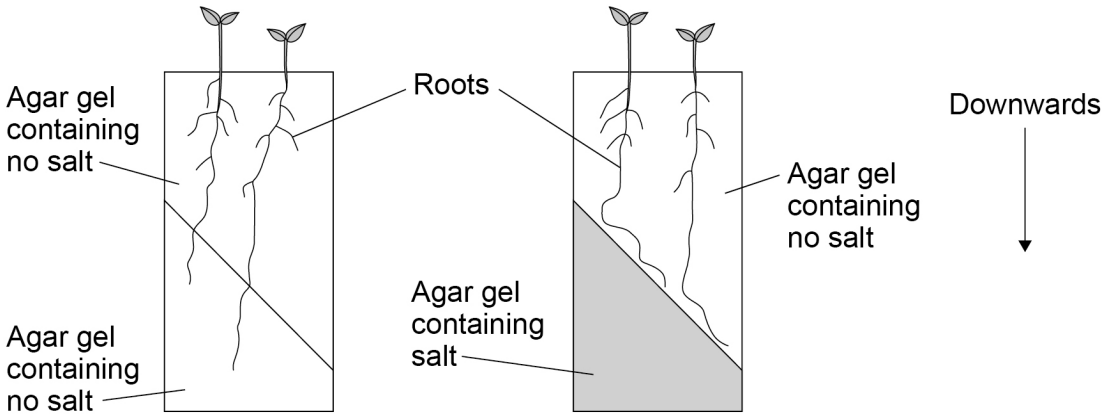
0 6 . 4 Suggest **one** reason why the students' conclusion may **not** be correct.

[1 mark]

Scientists investigate the tropic response of plant roots to salt.

The scientists first grow tomato plants from seeds on two vertical agar plates as shown in **Figure 9**.

Figure 9



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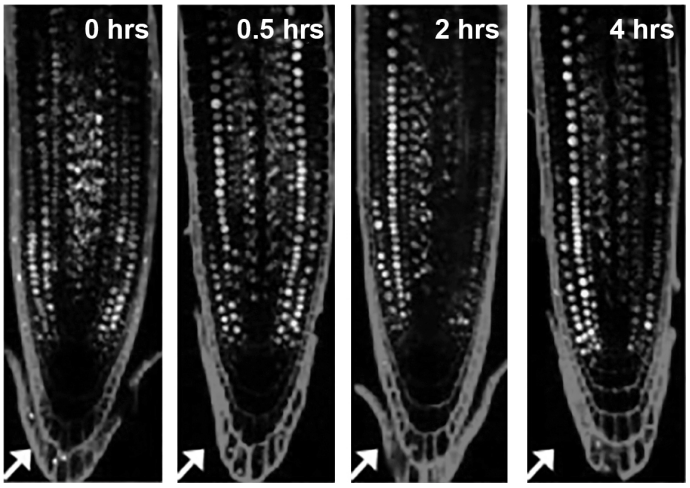
The scientists want to see if the distribution of auxin in the roots of tomato plants causes the growth response to salt shown in **Figure 9**.

The scientists use a chemical that fluoresces in cells that **do not** contain auxin.

Figure 10 shows images produced after the scientists used the fluorescent chemical. The arrow shows the direction of salt diffusion.

Figure 10

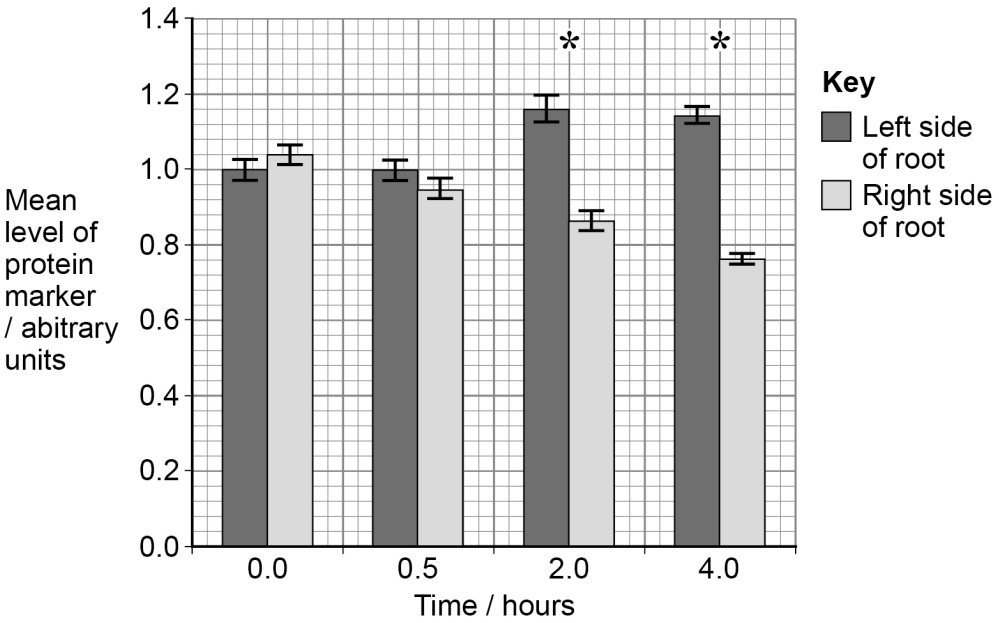


The scientists also use a protein marker to label carriers which transport auxin **out** of cells.

Figure 11 shows the mean level of protein marker on the left and right sides of the root. The bars show ± standard error.

*shows significance at P <0.01.

Figure 11



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0 6 . 5 The scientists used a statistical test to determine if there was a difference in the mean level of protein markers between the left and right sides of the root.

Name a suitable statistical test the scientists could have used.

[1 mark]

0 6 . 6 Explain what **Figure 11** shows about the results of the statistical test.

In your answer, use the words probability **and** chance.

[2 marks]

0 6 . 7 Explain the responses of the tomato plant roots to salt shown in **Figure 9** (on page 21).

Use evidence from **Figures 10** and **11** in your answer.

[3 marks]

12

Turn over for the next question

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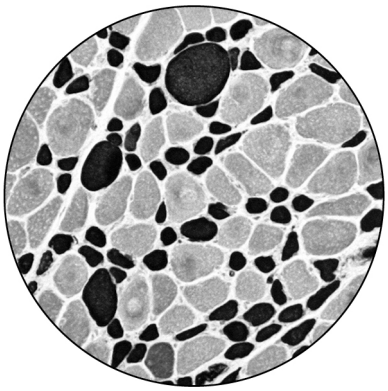
0 7 Scientists investigate the action of the enzyme ATPase in fast and slow skeletal muscles.

Fast and slow skeletal muscles both have fast and slow fibres but in different proportions.

The scientists use a chemical stain that reacts with ATPase. Fibres that contain a high concentration of ATPase produce a dark colour.

Figure 12 shows a muscle tissue sample that has reacted with this chemical stain.

Figure 12



The circular area of the image in **Figure 12** is 1.20 mm^2

The diameter of this area is equal to the diameter of 14 muscle fibres.

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0 7 . 1 Calculate the mean diameter of the muscle fibres shown in **Figure 12**.

Give your answer in micrometres.

The area of a circle is found using the formula:

Area = πr^2. Use 3.14 for the value of π

[3 marks]

Mean diameter of muscle fibres = _____ μm

0 7 . 2 Describe a more accurate method for measuring the diameter of a single muscle fibre using an optical microscope and a slide of stained muscle tissue as shown in **Figure 12**.

[2 marks]

_____

_____

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0 7 . 3 Describe how the chemical stain allows the scientists to determine the type of muscle fibre.

[1 mark]

_____

_____

_____

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The scientists test the effect of a drug called fenoterol on ATPase activity in fast and slow fibres.

The scientists:

- randomly put 20 rats, that are 16 months old, into either a control group or an experimental group
- repeat the previous step with 20 rats that are 28 months old
- measure the ATPase activity in muscle tissue samples from rats in all 4 groups at the start
- inject the rats in the experimental groups with fenoterol each day
- inject the rats in the control group with a saline solution containing no fenoterol each day
- measure the ATPase activity in muscle tissue samples from rats in all 4 groups at intervals during a 4-week period
- record the mean peak ATPase activity, calculated using the highest ATPase measurements recorded in each group during the 4-week period.

Table 3 shows the scientists' results.

Table 3

Types of muscle fibre		**Mean ATPase activity ± SE**			
		16-month-old rats		**28-month-old rats**	
		Control	Fenoterol	Control	Fenoterol
Slow	Start	38.3 (±3.7)	32.9 (±4.7)	31.5 (±3.0)	32.3 (±5.3)
	Peak	335.0 (±15)	438.0 (±15)	236.0 (±18)	358.0 (±21)
Fast	Start	72.8 (±8.0)	66.2 (±17)	67.3 (±9.6)	75.6 (±7.6)
	Peak	742.0 (±81)	1044.0 (±55)	688.0 (±74)	1066.0 (±57)

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0 7 . 4 Give **three** conclusions that can be made from the data in **Table 3** about the effect of fenoterol on ATPase activity in the two types of muscle fibres.

[3 marks]

1 _____

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3 _____

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Question 7 continues on the next page

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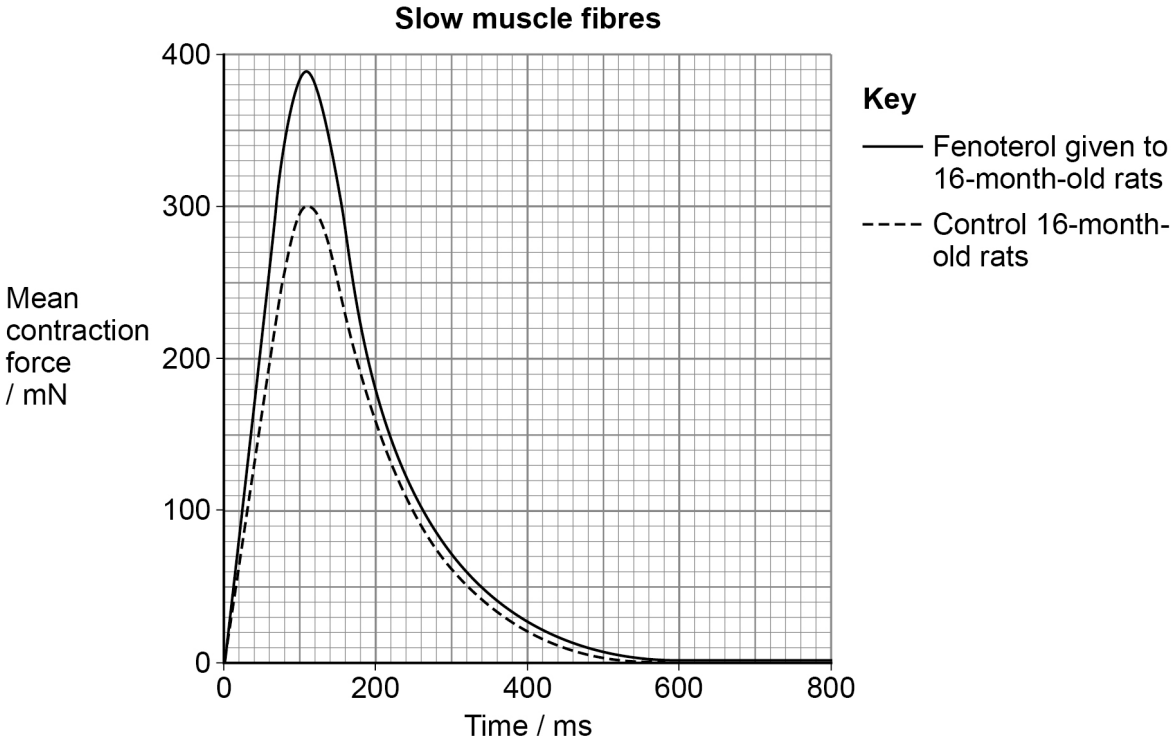
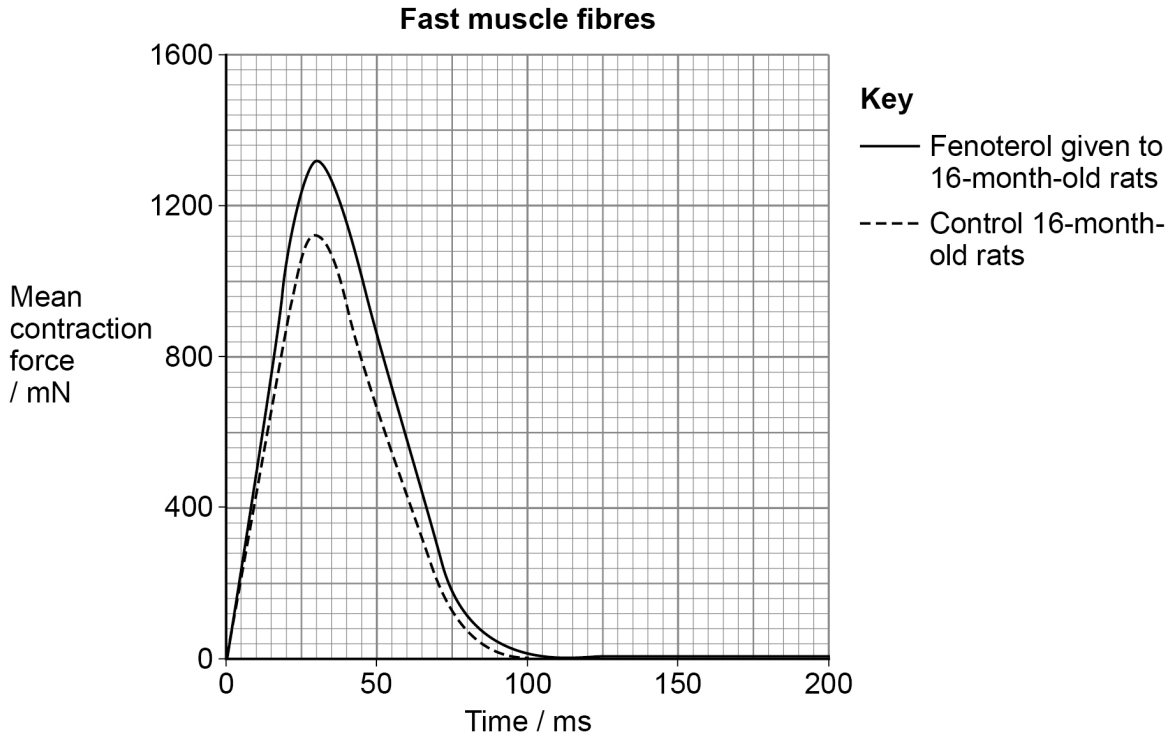
The scientists also measure the mean contraction force for fast and slow muscle fibres in the different groups of rats.

Figure 13 shows the scientists' results for the 16-month-old rats.

Figure 13





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0 7 . 5 Describe **two** differences between the contraction of fast and slow fibres shown in **Figure 13**.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 6 The sarcoplasmic reticulum of fast fibres contains a higher concentration of calcium ions than that found in slow fibres.

Suggest an explanation for the differences you described in your answer to Question **07.5**.

Use your knowledge of the mechanism of muscle contraction in your answer.

[2 marks]

_____

_____

_____

_____

_____

_____

0 7 . 7 What can you conclude about the effect of fenoterol on the contraction of fast and slow fibres in 16-month-old rats?

Use **only** information from **Figure 13**.

[2 marks]

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15

END OF QUESTIONS

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