OXFORD
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AQA EXAMINATIONS

Please write clearly in block capitals.

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I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 4 Control

Wednesday 11 January 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	

Do not write outside the box

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

0 1 Motile bacteria have a flagellum and are able to move. These bacteria can show chemotaxis.

0 1 . 1 Define the term **chemotaxis**.

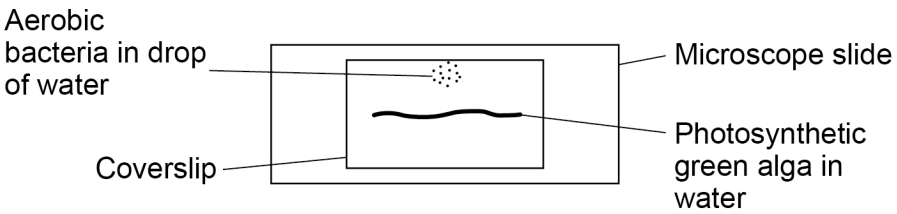
[2 marks]

Two students investigate chemotaxis in motile, aerobic bacteria. Each student prepares their own microscope slide.

The students:
- put a piece of photosynthetic green alga in water on a microscope slide
- put a coverslip over the alga
- add a drop of water containing the aerobic bacteria to the water under the coverslip
- leave the microscope slides in the light for 10 minutes.

The microscope slide is shown in **Figure 1**.

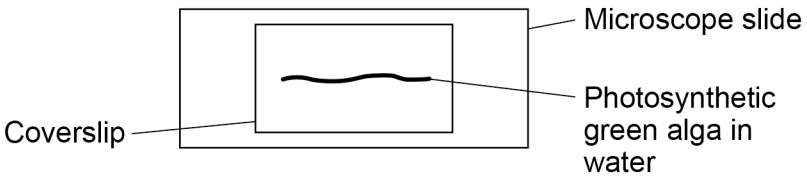
Figure 1



0 1 . 2 Complete **Figure 2** to show the position of the aerobic bacteria after the slide has been left in the light for 10 minutes.

[1 mark]

Figure 2



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0 1 . 3 Explain why the aerobic bacteria would be in the position you have drawn on **Figure 2**.

[3 marks]

0 1 . 4 When the students are waiting for 10 minutes, they keep their microscope slides in different places.

The first student keeps her slide on the work bench in the light.
The second student keeps her slide on the stage of the microscope with the lamp switched on.

Describe how an uncontrolled variable might affect the second student's results.

[1 mark]

0 1 . 5 Mammals can respond to a stimulus with a reflex.

Define **reflex**.

[1 mark]

Question 1 continues on the next page

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0 1 . 6 A reflex arc shows the pathway of a nerve impulse during a reflex.

Tick (✓) **one** box to show the correct pathway.

[1 mark]

Effector → motor neurone → relay neurone → sensory neurone → receptor ☐

Effector → motor neurone → sensory neurone → relay neurone → receptor ☐

Receptor → relay neurone → motor neurone → sensory neurone → effector ☐

Receptor → sensory neurone → relay neurone → motor neurone → effector ☐

9

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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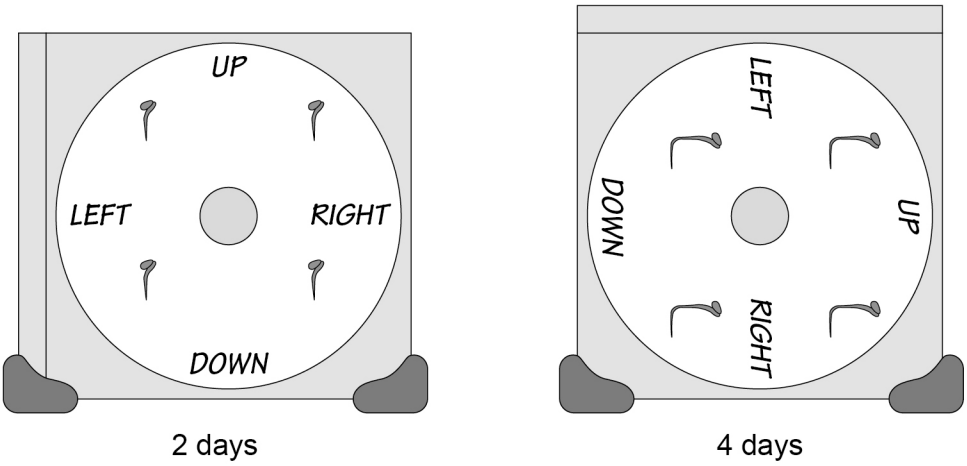
0 2 Two students want to investigate the growth of roots.

The students:

- mark a disc of filter paper with the words up, down, left and right
- wet the disc of filter paper with water
- put the disc into a thin, transparent plastic case
- put 4 mustard seeds equally spaced on the filter paper
- put the case in the dark for 2 days
- rotate the case through 90° clockwise and leave for another 2 days.

Figure 3 shows the case after 2 days and after 4 days.

Figure 3



0 2 . 1 Suggest why the case is put in the dark during the investigation.

[1 mark]

_____

_____

_____

0 2 . 2 Name the growth response shown by the roots.

[1 mark]

_____

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0 2 . 3 Explain how the roots are able to bend between day 2 and day 4 as shown in **Figure 3**.

[3 marks]

Question 2 continues on the next page

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The students think that the availability of water will affect the growth of roots.

They investigate this using a glass tank filled with sand as shown in **Figure 4**.

Figure 4

Figure 4 not produced here due to third-party copyright restrictions

The students:

- fill a porous pot with water (the water will move out of the pot slowly)
- put the pot of water in the bottom of a glass tank
- fill the tank with sand
- put a mustard seed just below the surface of the sand, against the side of the glass tank
- put the tank in the dark for 4 days.

After 4 days the root has grown straight downwards.

One student concludes that all plant roots grow downwards because of water.

The other student concludes that all plant roots grow downwards because of the force of gravity.

0 2 . 4 The method used by the students does not justify their conclusions.

Give **three** reasons why.

[3 marks]

1 _____

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2 _____

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3 _____

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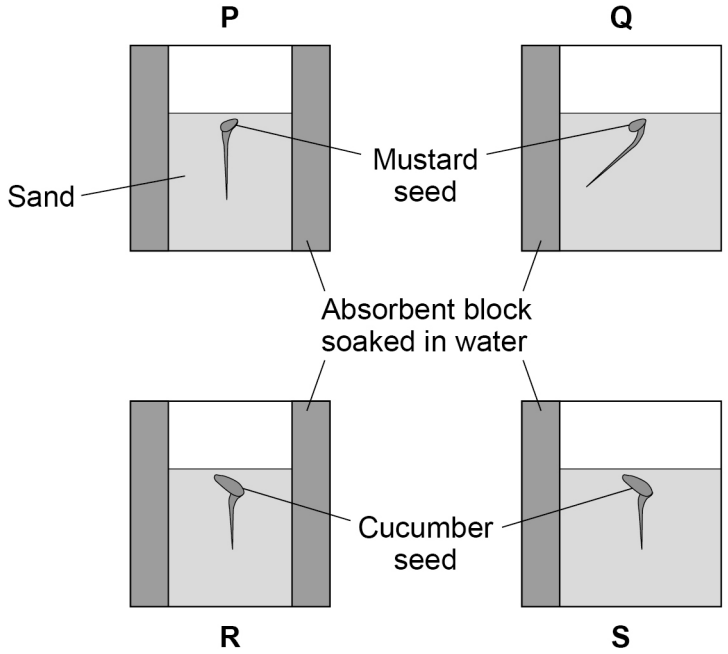
Do not write outside the box

The students' teacher suggests a different method to investigate if the availability of water affects the growth of roots.

The students:
- soak six absorbent blocks in water overnight
- put one or two of the absorbent blocks in the glass tanks
- fill the tanks with sand
- put a mustard seed (**P** and **Q**) or a cucumber seed (**R** and **S**) under the surface of the sand in each tank
- leave the tanks in the dark
- record root growth after 7 days.

Figure 5 shows the results after 7 days.

Figure 5



0 2 . 5 After 7 days, the roots in tanks **P**, **R** and **S** have grown straight down. The root in tank **Q** has grown downwards but has also grown towards the left.

Suggest **three** conclusions from the results shown in **Figure 5**.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

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11

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0 3 People with Type 1 diabetes can become hypoglycaemic.

Hypoglycaemia occurs when the blood glucose concentration decreases below the normal range.

0 3 . 1 The blood glucose concentration of a man with Type 1 diabetes has decreased below the normal range.

Suggest **two** causes for this decrease.

[2 marks]

1 _____

_____

2 _____

_____

Mild hypoglycaemia can be treated with glucose tablets.

Table 1 shows the increase in blood glucose concentration after taking 1 g of glucose. The increase is different depending on body mass.

Table 1

Body mass / kg	The increase in blood glucose concentration after taking 1 g of glucose / mmol dm^{-3}
48	0.39
64	0.28
80	0.22
96	0.18
112	0.17
128	0.14

Each glucose tablet contains 4 g of glucose.

The man with Type 1 diabetes weighs 80 kg

He measures his blood glucose level as 3.6 mmol dm^{-3}

The normal range for blood glucose is 4.7–6.7 mmol dm^{-3}

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0 3 . 2 Calculate the **minimum** number of glucose tablets needed to increase the man's blood glucose concentration to within the normal range.

Use the data from **Table 1**.

[3 marks]

Minimum number of glucose tablets = _____

0 3 . 3 Severe hypoglycaemia can cause unconsciousness so cannot be treated with glucose tablets. Instead the hormone glucagon can be injected to increase the blood glucose concentration.

Explain how glucagon increases blood glucose concentration.

[4 marks]

_____

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0 3 . 4 Too much glucagon could increase blood glucose concentration to dangerous levels. Homeostatic mechanisms in the body usually regulate glucagon secretion.

Name the type of homeostatic mechanism that regulates glucagon secretion.

[1 mark]

_____

10

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0 4 The polymerase chain reaction (PCR) is a method for making more copies of DNA fragments.

A scientist puts the following into a test tube:

- DNA fragments
- DNA polymerase
- primers
- DNA nucleotides.

The scientist puts the tube into a PCR machine. The machine changes the temperature as shown in **Table 2**.

Table 2

Temperature / °C	Time at each temperature / s	Reason why this temperature is needed
95	30	
55	45	
72	90	

0 4 . 1 Complete **Table 2** giving a reason why each different temperature is needed.

[3 marks]

0 4 . 2 Calculate the time taken to produce over a million copies of a single DNA fragment.

Use the times for each stage given in **Table 2**.

Give your answer in minutes.

[2 marks]

Time taken = _____ minutes

Do not write outside the box

0 4 . 3 In DNA, base pairs involving adenine have two hydrogen bonds and base pairs involving guanine have three hydrogen bonds.

When a DNA fragment contains a high percentage of cytosine bases, the timing of the temperature changes produced by the machine needs to be changed.

Explain why.

[2 marks]

0 4 . 4 Tiny blood samples collected at a crime scene contain DNA. These DNA samples can be amplified using PCR.

Scientists handling these samples wear gloves.

Suggest why.

[1 mark]

8

Turn over for the next question

Do not write outside the box

0 5 The human retina contains light sensitive cells called rod cells and cone cells. Scientists want to compare the retinas of fish with the retinas of humans.

The scientists count the numbers of rod cells and cone cells in the retinas of six species of fish found off the coast of Australia. **Table 3** shows their results.

Table 3

Species of fish	Mean number of rod cells per 0.01 mm^2	Mean number of cone cells per 0.01 mm^2	Ratio of rod cells:cone cells
U	29720	98	303:1
V	40010	41	976:1
W	45410	235	193:1
X	52020	40	1301:1
Y	64400	38	1695:1
Z		60	1280:1

0 5 . 1 The number of cells are shown per 0.01 mm^2.

Suggest why the scientists expressed the numbers per unit area.

[2 marks]

_____

_____

_____

_____

0 5 . 2 Calculate the mean number of rod cells per 0.01 mm^2 of retina in species **Z**.

[1 mark]

Mean number of rod cells per 0.01 mm^2 = _____

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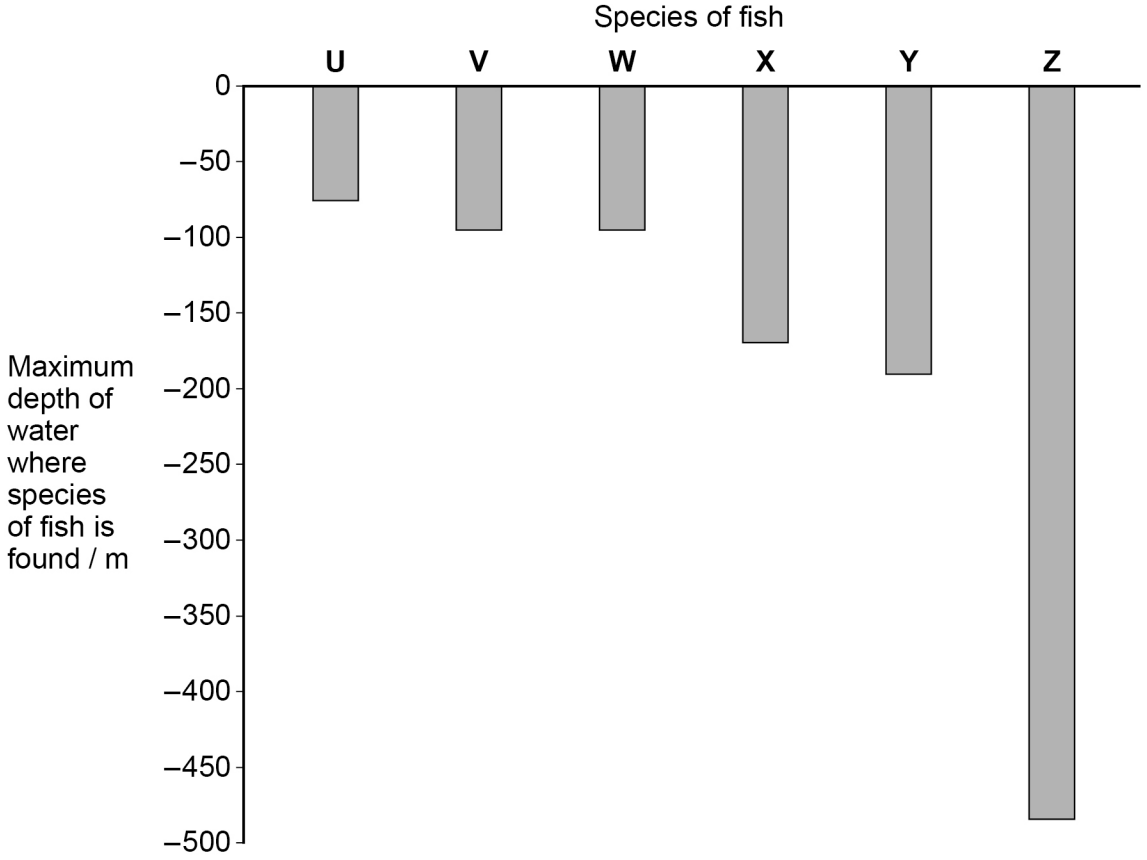
Figure 6 shows the maximum depth of water where the species of fish in **Table 3** are found.

Figure 6



0 5 . 3 Suggest a relationship between the maximum depth of water and the mean number of rod cells in the retina in these fish.

Use information from **Table 3** and **Figure 6**.

[1 mark]

_____

_____

_____

Question 5 continues on the next page

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0 5 . 4 The scientists carry out statistical analyses to test the relationship between maximum depth of water and the mean number of rod cells in the retina of the fish.

The scientists use the Spearman rank test.

The calculated statistic is 0.986, with a P value of 0.00031

Explain what this information tells the scientists.

[2 marks]

0 5 . 5 The retinas of the fish contain different types of cone cells. Different types of cone cells are able to respond differently to the same wavelength of light.

Explain why.

[2 marks]

0 5 . 6 Humans have good colour vision.

In humans, the mean rod cell:cone cell ratio is approximately 20:1

All the species of fish in **Table 3** have a lower proportion of cone cells than humans.

Suggest why.

[2 marks]

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0 5 . 7 The scientists conclude that all the data and the statistical analysis support the hypothesis that all fish see only in shades of black and white.

Evaluate this conclusion.

[4 marks]

0 5 . 8 Species **U** and **X** in **Table 3** are eaten by humans. The fish can be caught by attracting them with bait.

Species **U** is more likely to be attracted by colourful bait than **X**.

Suggest why.

[1 mark]

15

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0 6 During some forms of surgery, doctors give patients a muscle relaxant drug to ensure that the patient does not move.

Many muscle relaxant drugs work at neuromuscular junctions.

0 6 . 1 What is a neuromuscular junction?

[1 mark]

0 6 . 2 Some muscle relaxant drugs block the action of the neurotransmitter, acetylcholine.

Describe the normal action of acetylcholine at a neuromuscular junction.

[3 marks]

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Question 6 continues on the next page

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Succinylcholine is one muscle relaxant drug used during surgery.

Figure 7 shows the structure of succinylcholine compared with the structure of acetylcholine.

Figure 7

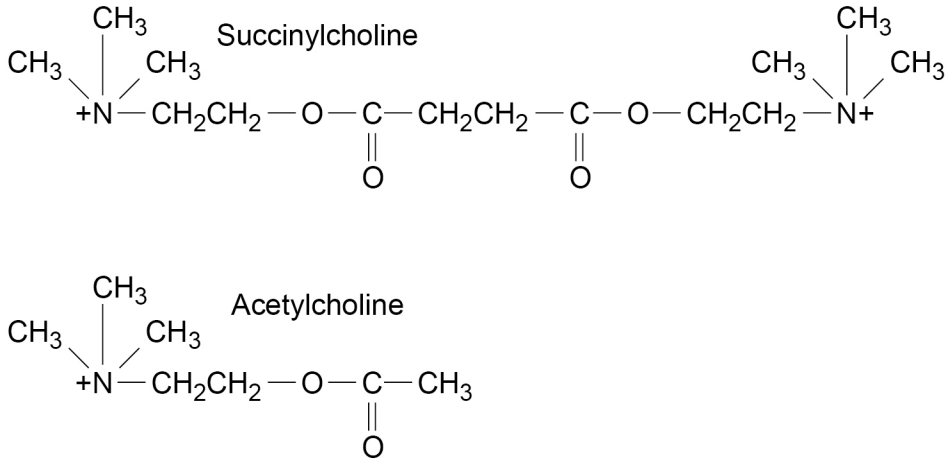
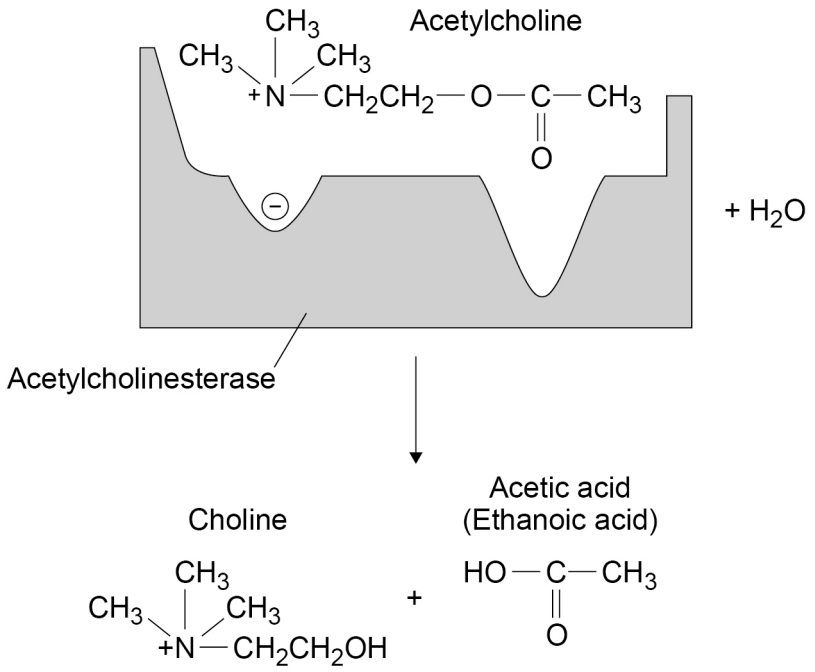


Figure 8 shows the hydrolysis of acetylcholine by the enzyme, acetylcholinesterase.

Figure 8



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0 6 . 3 At first succinylcholine causes muscle contraction. However, after a few minutes, succinylcholine causes muscle relaxation.

Suggest how.

Use information from **Figure 7** and **Figure 8**.

[3 marks]

7

Turn over for the next question

Do not write outside the box

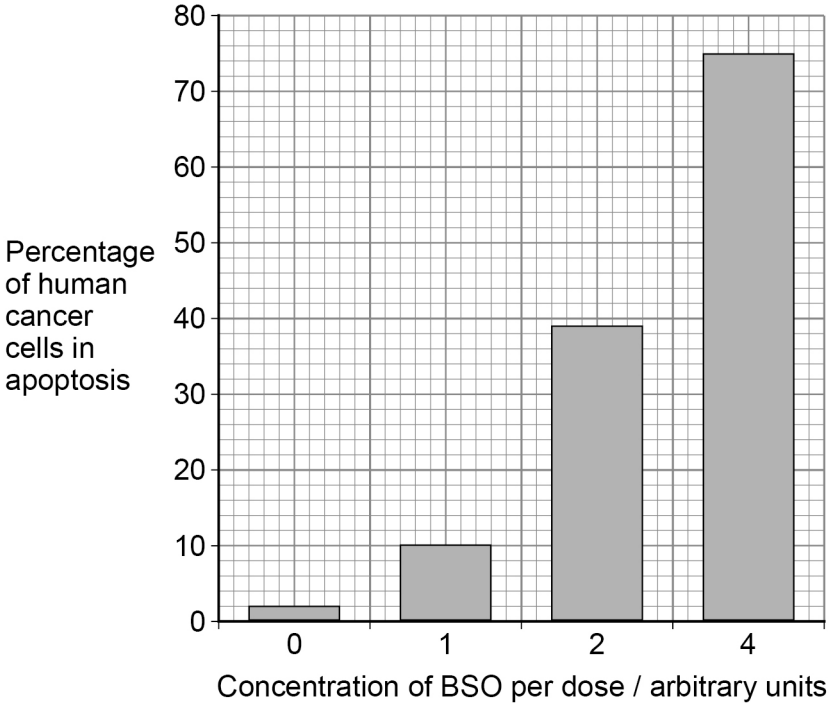
0 7 Black seed oil (BSO) has been used for thousands of years in traditional medicine to treat a variety of conditions.

Scientists want to know if BSO might be useful in treating cancer.

The scientists use a cell culture of human breast cancer cells. They measure the percentage of cancer cells in apoptosis (programmed cell death) when treated with different doses of BSO.

Figure 9 shows the results.

Figure 9



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0 7 . 1 The scientists suggest that BSO could be used to develop a new drug to treat cancer in humans.

Give **two** reasons in support of this suggestion and **two** reasons against this suggestion.

[4 marks]

Reasons in support

1 _____

_____

_____

2 _____

_____

_____

Reasons against

1 _____

_____

_____

2 _____

_____

_____

Question 7 continues on the next page

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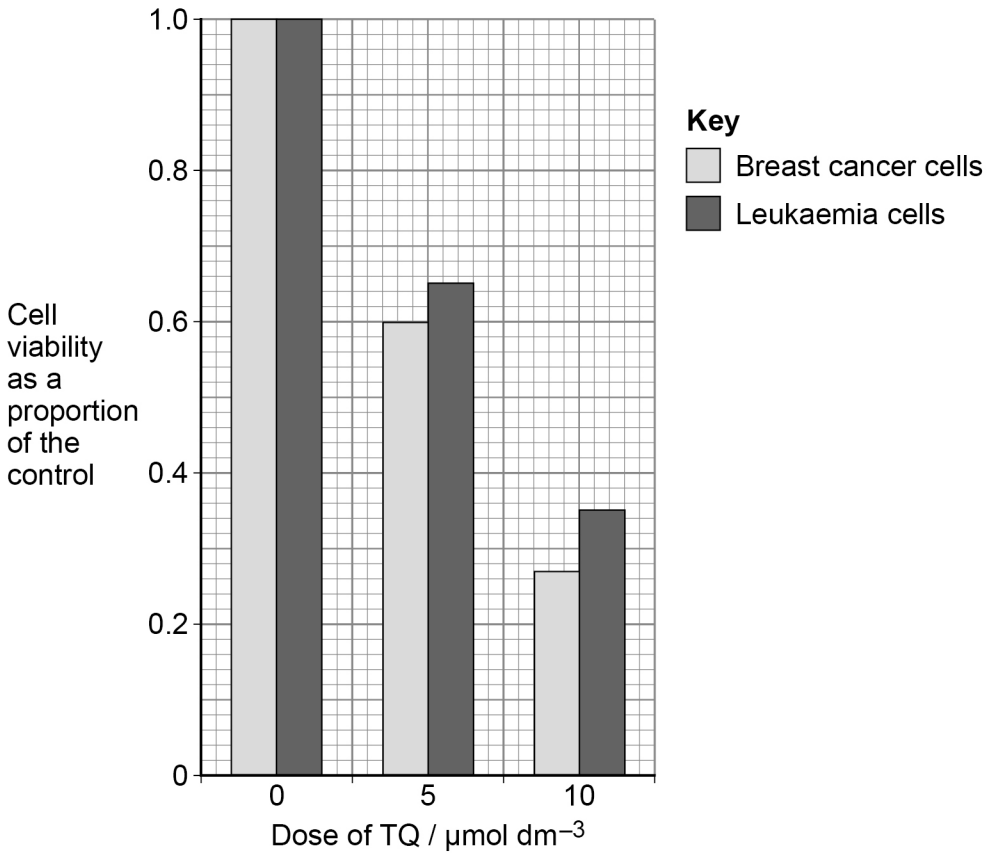
The scientists identify and isolate an ingredient called thymoquinone (TQ) from the BSO.

They measure the viability of human breast cancer cells and human leukaemia cells in cultures when treated with varying doses of TQ.

Viability is the proportion of live cells within a population.

Their results are shown in **Figure 10.**

Figure 10



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0 7 . 2 The scientists suggest that TQ is the active ingredient of BSO.

Give **one** way that the data support this suggestion.

Use information from **Figure 10** in your answer.

[2 marks]

0 7 . 3 The scientists want to know how TQ works.

They measure the effect of TQ on mRNA production by several known oncogenes.

Suggest why the scientists measure mRNA production.

[1 mark]

Question 7 continues on the next page

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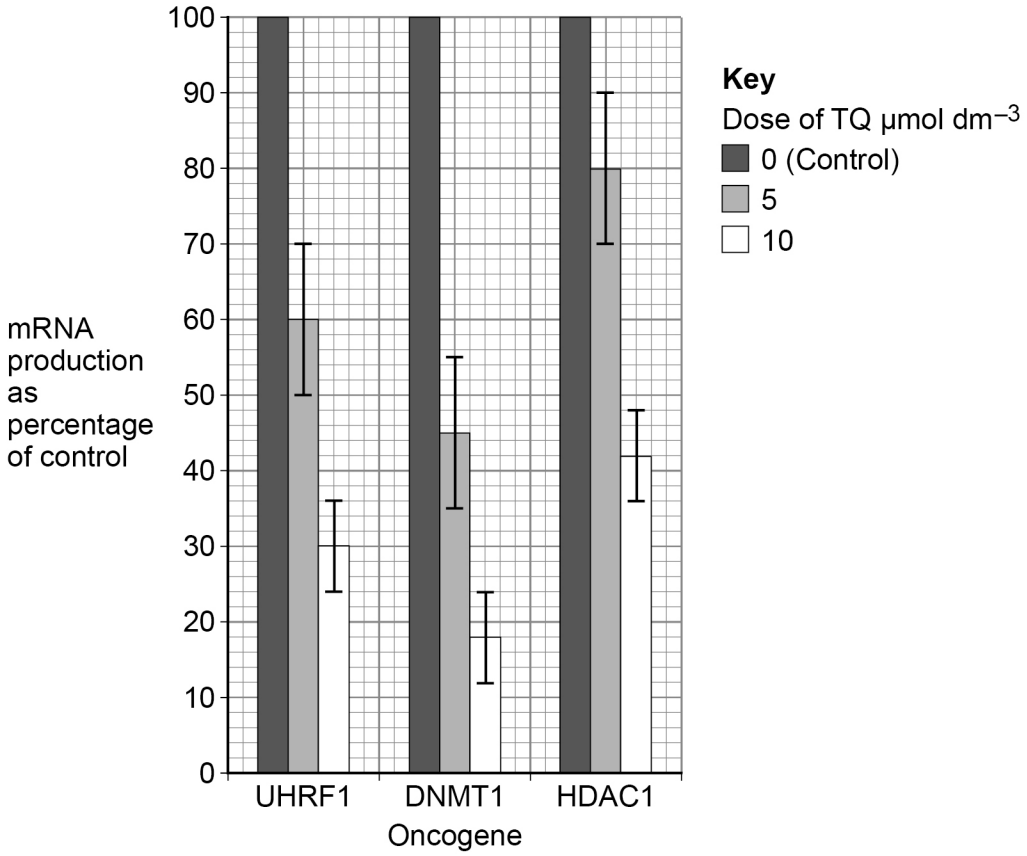
UHRF1, DNMT1 and HDAC1 are three different oncogenes that cause increased mitosis in human breast cancer cells.

Figure 11 shows the effect of TQ on mRNA production by these three oncogenes. The bars represent standard error of the mean.

Figure 11



0 7 . 4 Describe what the data in **Figure 11** show about the effects of TQ.

[3 marks]

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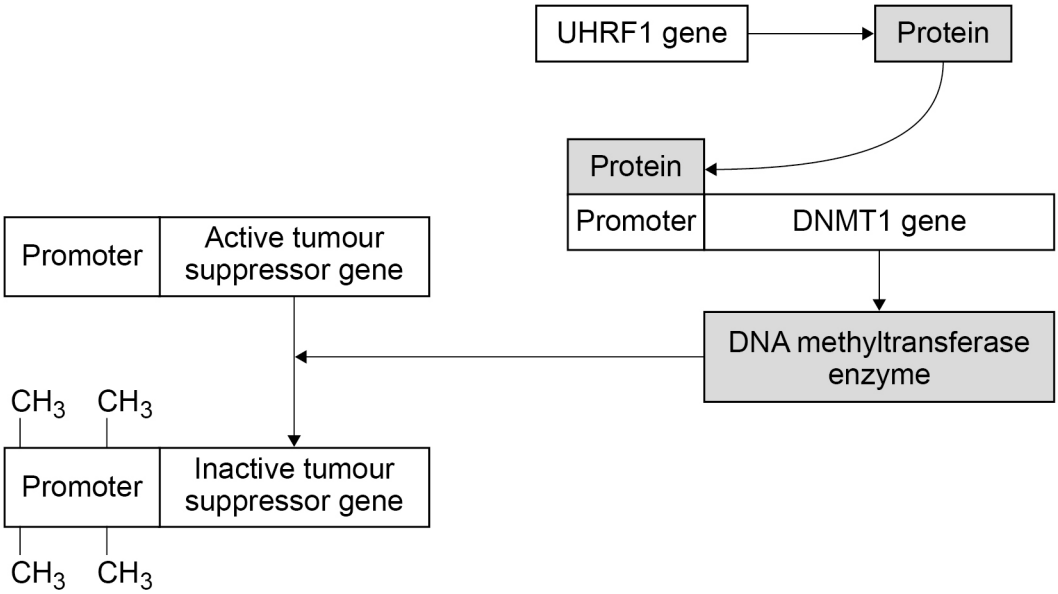
Two of the oncogenes, UHRF1 and DNMT1, are involved in the epigenetic control of a tumour suppressor gene. The scientists produce a simplified pathway, shown in **Figure 12**.

Figure 12



0 7 . 5 A reduction in mRNA production from the UHRF1 oncogene could prevent the growth of a tumour.

Describe how.

[3 marks]

Question 7 continues on the next page

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0 7 . 6 The HDAC1 oncogene is involved in a different epigenetic pathway to control the expression of a tumour suppressor gene.

The HDAC1 oncogene codes for a deacetylase enzyme that removes acetyl groups from other molecules. The deacetylase enzyme does not bind to the DNA base sequence.

Suggest how the enzyme coded for by the HDAC1 oncogene results in uncontrolled cell division.

[2 marks]

15

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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