

Please write clearly in block capitals.

Centre number

Candidate number

Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

Candidate signature \_\_\_\_\_

I declare this is my own work.

# INTERNATIONAL A-LEVEL BIOLOGY (9610)

## Unit 5 Synoptic paper

Tuesday 13 June 2023      07:00 GMT      Time allowed: 1 hour 30 minutes

### Materials

For this paper you must have:

- a pencil
- 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.
- In Question 6, 2 marks will be awarded for the quality of your written communication. You will be marked on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
<b>TOTAL</b>	

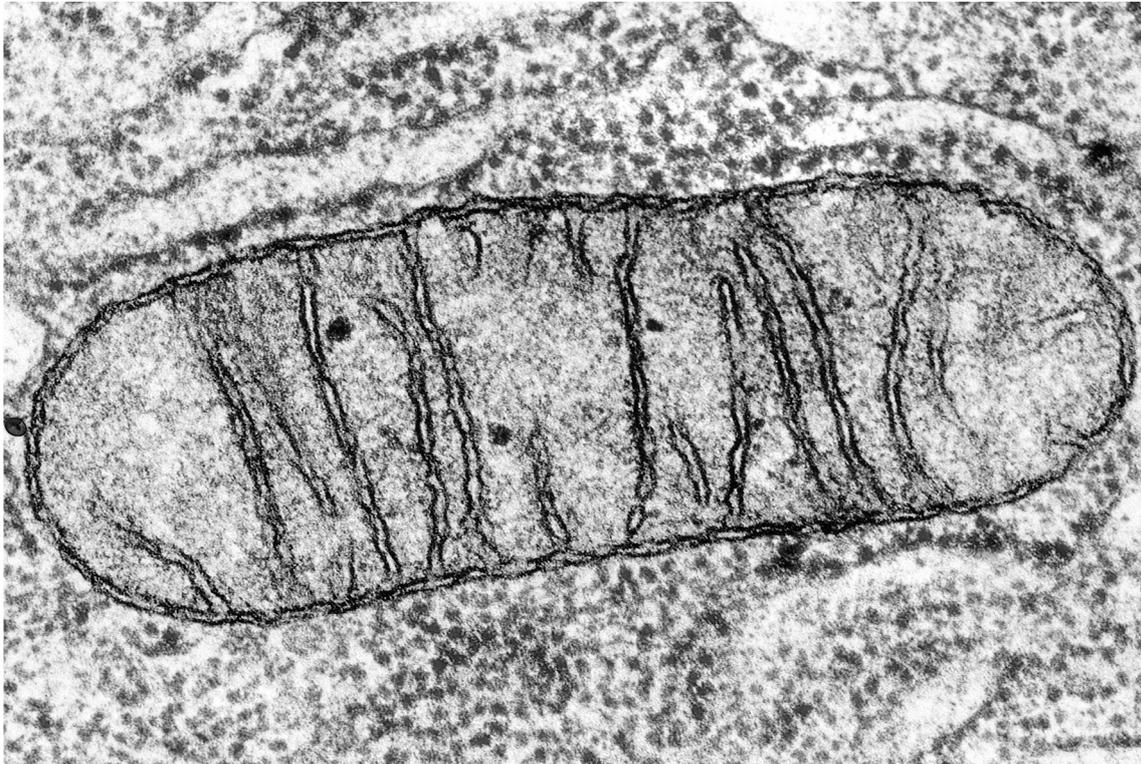


Answer **all** questions in the spaces provided.

0 1

**Figure 1** shows a mitochondrion in a liver cell.

**Figure 1**



× 60 000

0 1 . 1

Name the type of microscope used for producing **Figure 1**.

[1 mark]

---



**0 1 . 2** Draw a large, clear diagram of the mitochondrion in **Figure 1**.

**[2 marks]**

**0 1 . 3** The magnification of **Figure 1** is  $\times 60\,000$ .

Calculate the actual volume of the mitochondrion shown in **Figure 1**.

Assume that the mitochondrion is a cylinder.

Give your answer in  $\mu\text{m}^3$  to 3 significant figures.

Volume of cylinder =  $\pi r^2 h$

$\pi = 3.14$

**[3 marks]**

Volume of mitochondrion = \_\_\_\_\_  $\mu\text{m}^3$

**Question 1 continues on the next page**

**Turn over ►**

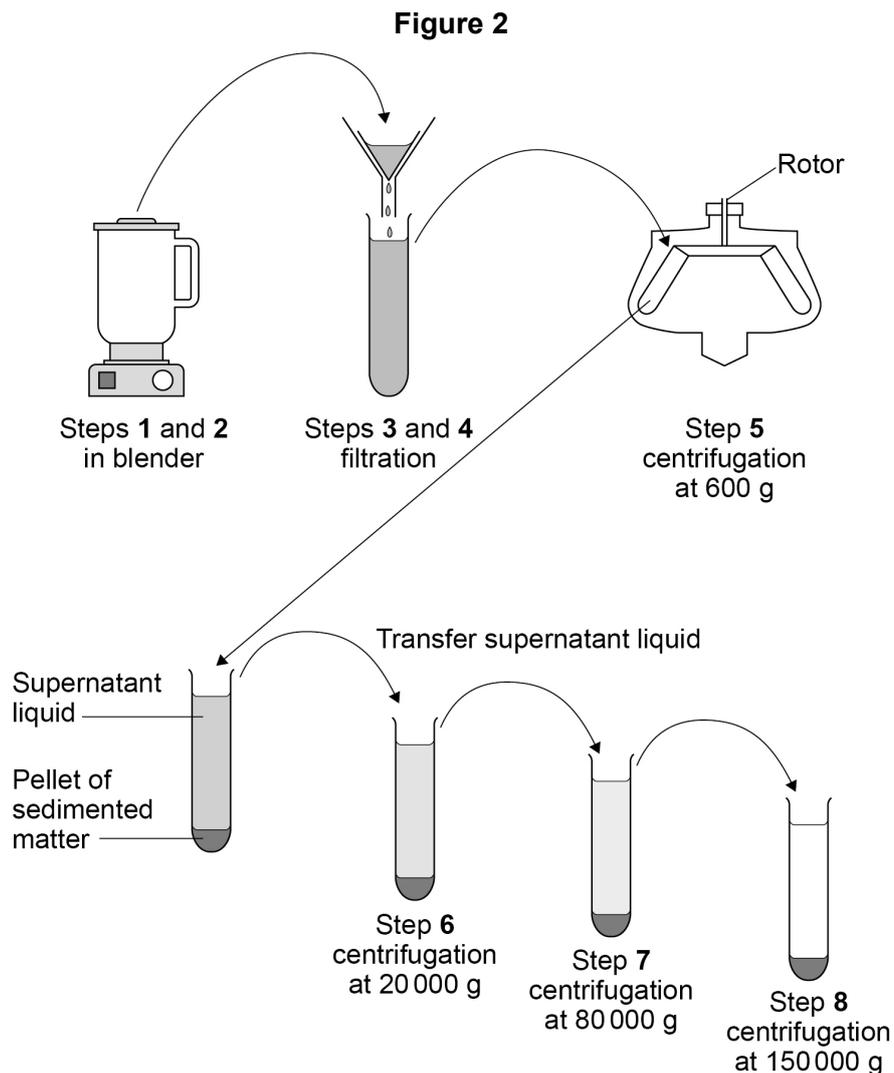


Scientists can separate mitochondria from other organelles in liver cells using the techniques of cell fractionation and ultracentrifugation.

The scientists:

1. put some liver tissue in  $0.25 \text{ mol dm}^{-3}$  sucrose solution at pH 7.4 and a temperature of  $4 \text{ }^\circ\text{C}$
2. gently break open the liver cells in a blender
3. filter the material from the blender to remove larger pieces of cell debris
4. put the filtrate in a centrifuge tube
5. spin the centrifuge at  $600 \text{ g}$  ( $600 \times$  the force of gravity) for 10 minutes
6. transfer the supernatant liquid from Step 5 to another centrifuge tube and spin at  $20\,000 \text{ g}$  for 20 minutes
7. transfer the supernatant liquid from Step 6 to another centrifuge tube and spin at  $80\,000 \text{ g}$  for 60 minutes
8. transfer the supernatant liquid from Step 7 to another centrifuge tube and spin at  $150\,000 \text{ g}$  for 3 hours.

Figure 2 gives a summary of the scientists' method.



0 1 . 4

During the whole investigation, the scientists keep the material from the liver:

- in 0.25 mol dm<sup>-3</sup> sucrose solution
- at pH 7.4
- at a temperature of 4 °C.

Explain how each of these conditions prevents damage to the mitochondria.

[4 marks]

0.25 mol dm<sup>-3</sup> sucrose solution \_\_\_\_\_

---



---



---

pH 7.4 \_\_\_\_\_

---



---

Temperature of 4 °C \_\_\_\_\_

---

0 1 . 5

Centrifugation at 80 000 g (step 7) causes sedimentation of lysosomes and pieces of membrane.

Complete **Table 1** to show which centrifugation step causes sedimentation of:

- mitochondria
- nuclei
- ribosomes.

[1 mark]

Table 1

Step	Centrifugal g-force	Organelle sedimented
5	600	
6	20 000	
7	80 000	Lysosomes
8	150 000	

Question 1 continues on the next page

Turn over ►



0 1 . 6

Give the reason for your answer to Question 01.5.

[1 mark]

---



---



---

The scientists investigate oxygen uptake by their preparation of mitochondria.

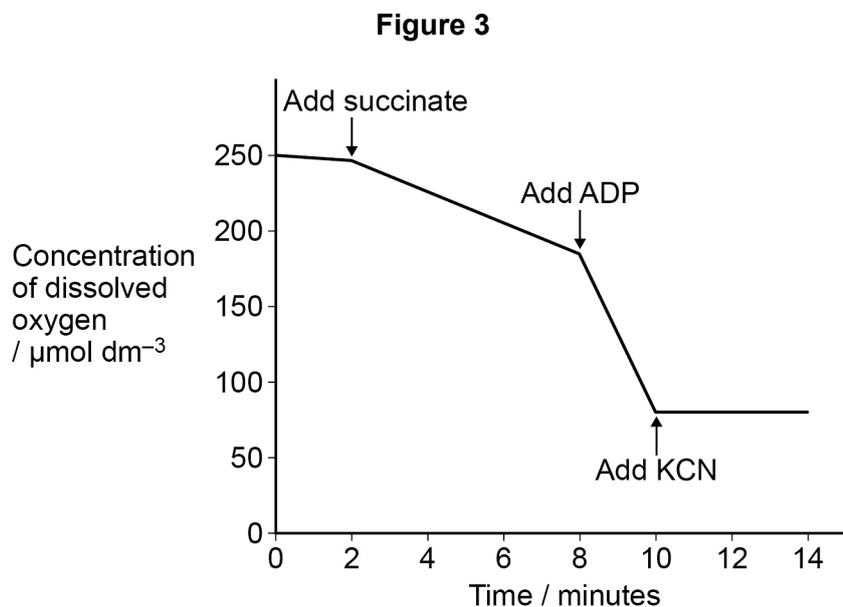
The scientists:

- suspend the mitochondria in  $0.25 \text{ mol dm}^{-3}$  sucrose solution at pH 7.4
- measure the concentration of dissolved oxygen in the suspension using an oxygen electrode.

The scientists test the effect of adding three substances, in sequence, to the suspension of mitochondria:

1. succinate – a substrate of the Krebs cycle
2. ADP
3. potassium cyanide (KCN) – binds to cytochrome oxidase and inhibits the final step in the electron transfer chain.

Figure 3 shows the scientists' results.



0 1 . 7

Explain why adding succinate causes a decrease in the concentration of dissolved oxygen.

[2 marks]

---

---

---

---

---

---

---

0 1 . 8

Explain why adding ADP causes a decrease in the concentration of dissolved oxygen.

[2 marks]

---

---

---

---

---

---

---

0 1 . 9

Potassium cyanide (KCN) is poisonous.

Use information from **Figure 3** to explain why.

[3 marks]

---

---

---

---

---

---

---

---

Turn over for the next question

Turn over ►

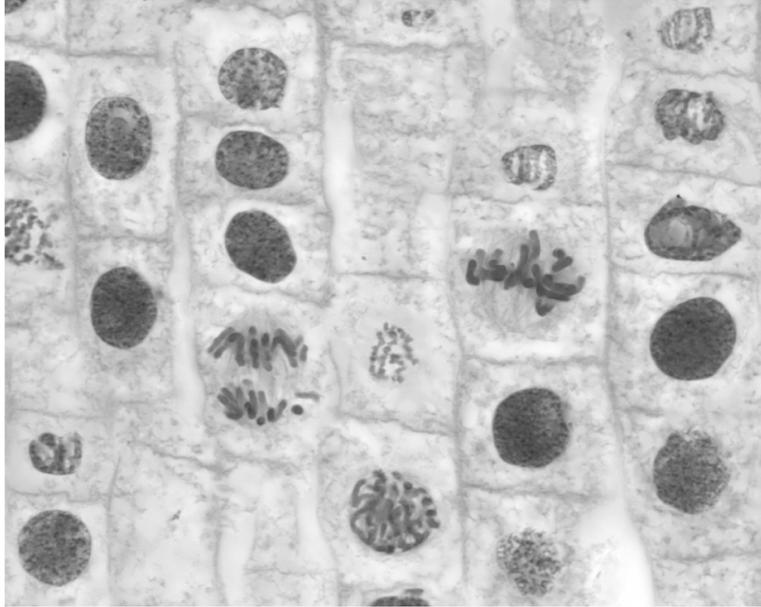


0 2

In eukaryotic organisms, cells divide by mitosis during growth.

**Figure 4** shows cells from the root of an onion plant.

**Figure 4**



0 2 . 1

Write each of the letters **A**, **M** and **P** on **Figure 4** to label the following:

- A** one cell in anaphase
- M** one cell in metaphase
- P** one cell in prophase.

**[3 marks]**





A class of 10 students prepares slides from onion roots.

The students count the number of cells in each of the different phases of mitosis.

**Table 2** shows the results.

**Table 2**

Phase	Students										Class total
	1	2	3	4	5	6	7	8	9	10	
<b>Interphase</b>	149	160	121	135	166	232	155	164	162	113	1557
<b>Prophase</b>	35	25	21	30	19	10	15	24	20	16	215
<b>Metaphase</b>	20	12	18	9	11	6	20	12	7	11	126
<b>Anaphase</b>	4	8	5	14	4	0	11	12	8	3	69
<b>Telophase</b>	9	6	14	11	8	4	7	8	12	12	91
<b>Total cells</b>	217	211	179	199	208	252	208	220	209	155	2058
<b>Cells in mitosis</b>	68	51	58	64	42	20	53	56	47	42	501
<b>Mitotic index</b>	0.31	0.24	0.32	0.32	0.20	0.08	0.25	0.25	0.22	0.27	<b>X</b>

**0 2 . 3** Calculate the mitotic index, **X**, for the results from the whole class.

Use data from the **Class total** column in **Table 2**.

Give your answer to an appropriate level of accuracy.

**[1 mark]**

Mitotic index for results from whole class = \_\_\_\_\_



The students calculate the standard deviation (SD) of the mitotic indices from their 10 sets of results:

$$SD = 0.07$$

The teacher states:

‘There is a significant error in the results from student **6**.’

0 2 . 4

Use data from **Table 2** and your answer to Question **02.3** to explain the teacher’s statement.

[2 marks]

---



---



---



---



---



---

0 2 . 5

Student **6** made a mistake while preparing his slide.

Suggest what mistake student **6** made.

Use information from **Table 2** to give the reason for your answer.

[2 marks]

Mistake \_\_\_\_\_

---

Reason \_\_\_\_\_

---



---

13

Turn over for the next question

Turn over ►



**0 3**

Genes often have several alleles.

An allele may be dominant, recessive or codominant.

**0 3****1**

Explain how a **codominant** allele is different from a **dominant** allele.

Use **all** the words from the box in your answer.

**genotype****heterozygous****homozygous****phenotype****[2 marks]**

---

---

---

---

---

---

---

---

---

---



The human **ABO** blood group system is an example of a characteristic controlled by multiple alleles. The alleles show a mixture of being dominant, codominant and recessive.

A person can have one of four possible blood groups:

group **A**

group **B**

group **AB**

group **O**

The blood group is determined by the inheritance of three different alleles:

$I^A$  = allele for blood group **A**

$I^B$  = allele for blood group **B**

$I^O$  = allele for blood group **O**

0 3 . 2

A man with blood group **A** and a woman with blood group **B** have two children:

a child with blood group **O**

a child with blood group **AB**

Complete the genetic diagram in **Figure 5** to explain how the children can inherit different blood groups.

You should include **all** possible offspring genotypes and phenotypes in your answer.

**[4 marks]**

**Figure 5**

	<b>Man</b>	<b>Woman</b>
Parental phenotypes	Group <b>A</b>	Group <b>B</b>
Parental genotypes	_____	_____
Genotypes of gametes	_____	_____
Offspring genotypes	_____	
Offspring phenotypes	_____	

6

Turn over ►



**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**



**0 4**

Farmers can spray crop plants with hormones to control the growth of the plants.

Scientists investigate the effect of a plant growth hormone called GA<sub>3</sub> on the growth of avocado fruits.

The scientists:

1. spray 10 avocado trees with a solution of GA<sub>3</sub>
2. spray 10 more avocado trees with water as a control
3. take two fruits from each tree at intervals for 135 days
4. remove a 10 g sample of flesh from each of the fruits
5. determine the dry mass of each sample
6. calculate the dry mass as a percentage of each sample.

**0 4 . 1**

Describe how the scientists could determine the dry mass of each sample (step 5).

**[2 marks]**

---

---

---

---

---

---

---

**Question 4 continues on the next page**

**Turn over ►**

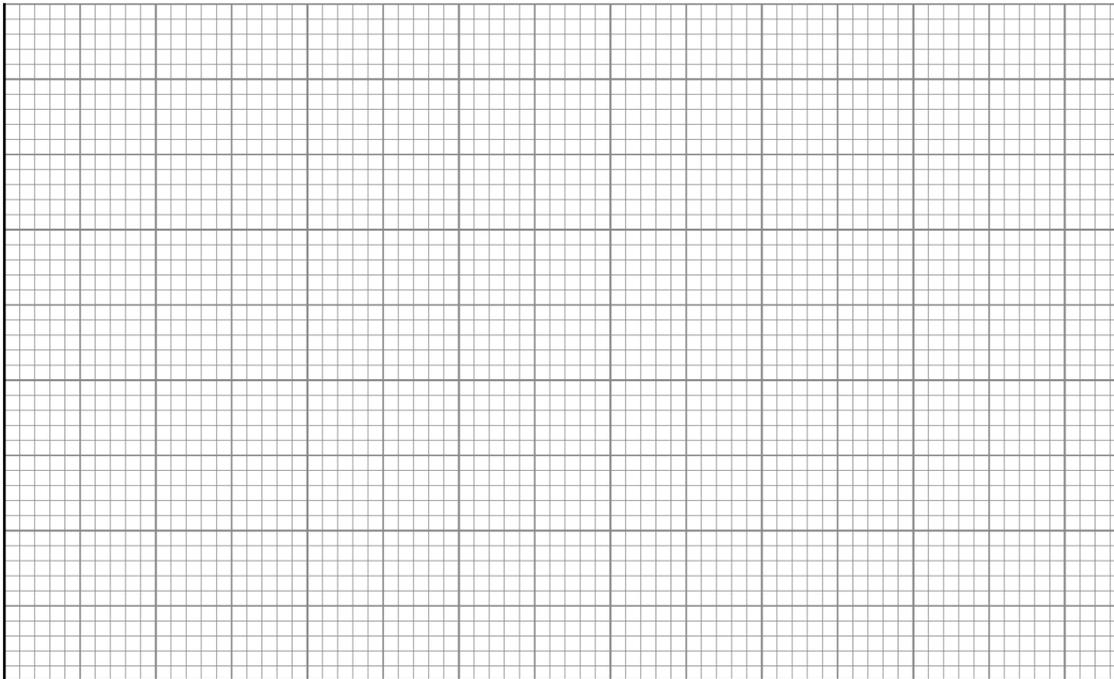
**Table 3** shows the scientists' results.

**Table 3**

Time / days	Mean percentage dry mass of avocado flesh	
	+GA <sub>3</sub>	Control
0	16.2	16.2
45	19.3	18.8
75	21.7	20.3
105	22.0	21.7
135	22.7	22.5

**0 4 . 2** Plot a graph of the data in **Table 3**.

**[4 marks]**



**0 4 . 3**

During the first 75 days, the avocado fruits grew faster on the GA<sub>3</sub>-sprayed trees than on the control trees.

Calculate the percentage increase in growth rate of the fruits sprayed with GA<sub>3</sub> compared with the growth rate of the control fruits during the first 75 days.

Give your answer to 3 significant figures.

**[2 marks]**

Percentage increase in growth rate = \_\_\_\_\_

**0 4 . 4**

Avocado fruits are mature when they contain at least 21.5% dry matter.

A farmer looked at the scientists' data.

Suggest why the farmer decides to spray some avocado trees with GA<sub>3</sub> and to leave some trees unsprayed.

Use data from your graph in Question **04.2** in your answer.

**[2 marks]**


---



---



---



---



---



---



---

**10**

**Turn over for the next question**

**Turn over ►**



**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**



**0 5**

Omega-3 and omega-6 are two types of unsaturated fatty acid.

Doctors think that a diet with a high ratio of omega-3 to omega-6 fatty acid is good for human health.

Scientists are investigating how to produce meat from sheep that contains a higher proportion of omega-3 fatty acids.

Three different methods are being used:

- selective breeding
- adding fish oils to the diet of the sheep
- genetic engineering.

**0 5 . 1**

Suggest how selective breeding could be used to increase the proportion of omega-3 in sheep.

**[2 marks]**

---

---

---

---

---

---

**0 5 . 2**

Suggest **one** reason why feeding sheep with fish oils containing a high omega-3 concentration may **not** affect the ratio of omega-3 to omega-6 fatty acids in meat from sheep.

**[1 mark]**

---

---

---

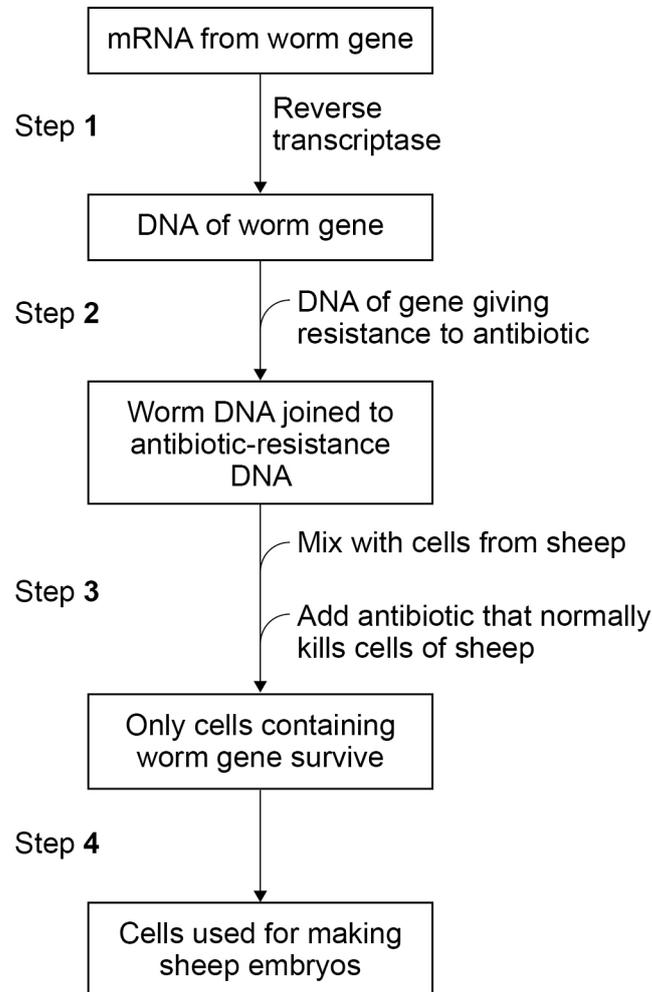
**Question 5 continues on the next page**

**Turn over ►**

Scientists have produced genetically-modified sheep containing a gene from a worm. This gene codes for an enzyme that changes omega-6 fatty acids into omega-3 fatty acids.

**Figure 6** shows the method used for producing the genetically-modified sheep.

**Figure 6**



0 5 . 3

Give **two** advantages of using mRNA to make the worm gene at step 1, instead of using a restriction enzyme to cut the gene from the worm's DNA.

**[2 marks]**1 \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_2 \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

0 5 . 4

Explain why a gene giving resistance to an antibiotic is attached to the DNA at step 2.

**[2 marks]**

---

---

---

---

---

---

---

---

7
---

**Turn over for the next question**

**Turn over ►**







**There are no questions printed on this page**

*Do not write  
outside the  
box*

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**







