

Paper Reference(s) 9BI0/01

Pearson Edexcel Level 3 GCE

Biology B

Advanced

Paper 1: Advanced Biochemistry, Microbiology and Genetics

Thursday 6 June 2019 – Morning

Time: 1 hour 45 minutes plus your additional time allowance

INSTRUCTIONS TO CANDIDATES

Write your centre number, candidate number, surname, other names and your signature in the boxes below. Check that you have the correct question paper.

| | | | | | |
|------------------------|---|---|---|---|-------|
| Centre No. | | | | | |
| Candidate No. | | | | | |
| Surname | | | | | |
| Other names | | | | | |
| Signature | | | | | |
| Paper Reference | 9 | B | I | 0 | / 0 1 |



- Use **BLACK** ink or ball-point pen.
- Answer **ALL** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided – there may be more space than you need.
- You may use a scientific calculator.
- In questions marked with an **ASTERISK (*)**, marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

MATERIALS REQUIRED FOR EXAMINATION

Calculator, HB pencil, ruler

ITEMS INCLUDED WITH QUESTION PAPERS

Nil

INFORMATION FOR CANDIDATES

- The total mark for this paper is 90.
- The marks for **EACH** question are shown in brackets – use this as a guide as to how much time to spend on each question.

ADVICE TO CANDIDATES

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

(Turn over)

Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The nucleic acids, DNA and mRNA, are polymers.

(a) The table shows some components that may be found in a molecule of these nucleic acids.

For each component, put ONE cross ☒ in the appropriate box, in each row, to show where these components can be found. (4 marks)

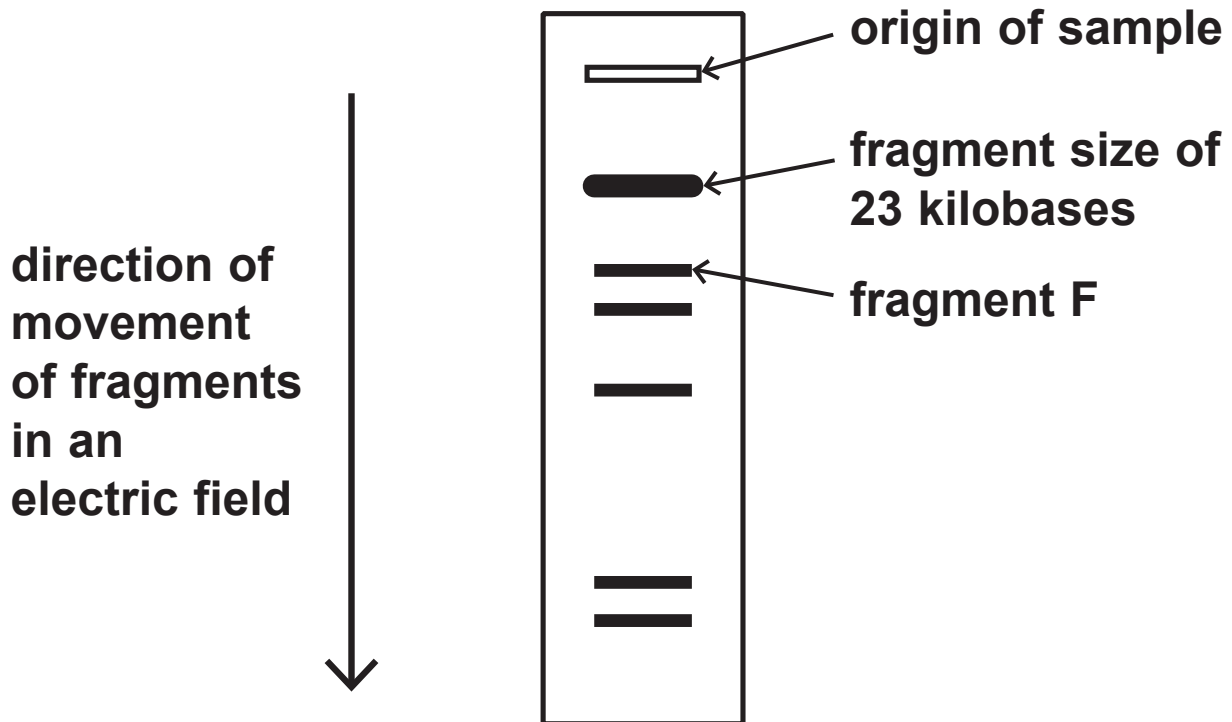
| Component | Component found in a molecule of | | | |
|----------------|----------------------------------|--------------------------|--------------------------|--------------------------|
| | both DNA and mRNA | DNA but NOT mRNA | mRNA but NOT DNA | neither DNA nor mRNA |
| Adenine | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Hydrogen bonds | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Pentose sugar | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Uracil | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

(Question continues on next page)

(Turn over)

- (b) Fragments of DNA can be separated by gel electrophoresis to produce a DNA profile.

The diagram shows an example of a DNA profile.

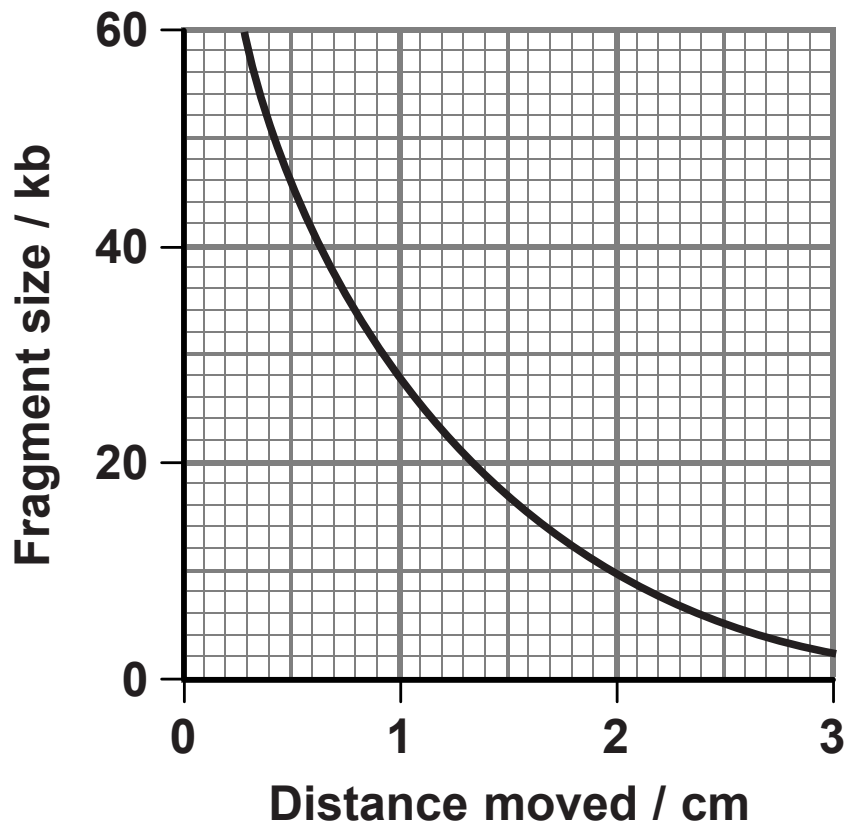


(Question continues on next page)

- (i) Explain why fragments of DNA can be separated by gel electrophoresis. (2 marks)

(Question continues on next page)

- (ii) The graph shows the relationship between the distance moved in a gel and the fragment size.



Determine the size of fragment F. (1 mark)

Answer _____ kb

(TOTAL FOR QUESTION 1 = 7 MARKS)

(Questions continue on next page)

(Turn over)

- 2 Bacteria were cultured in two different types of medium.**

One medium contained glucose as the energy source and the other contained sucrose.

The same molar concentrations of glucose and sucrose were used.

- (a) Which row of the table identifies these sugars?
(1 mark)**

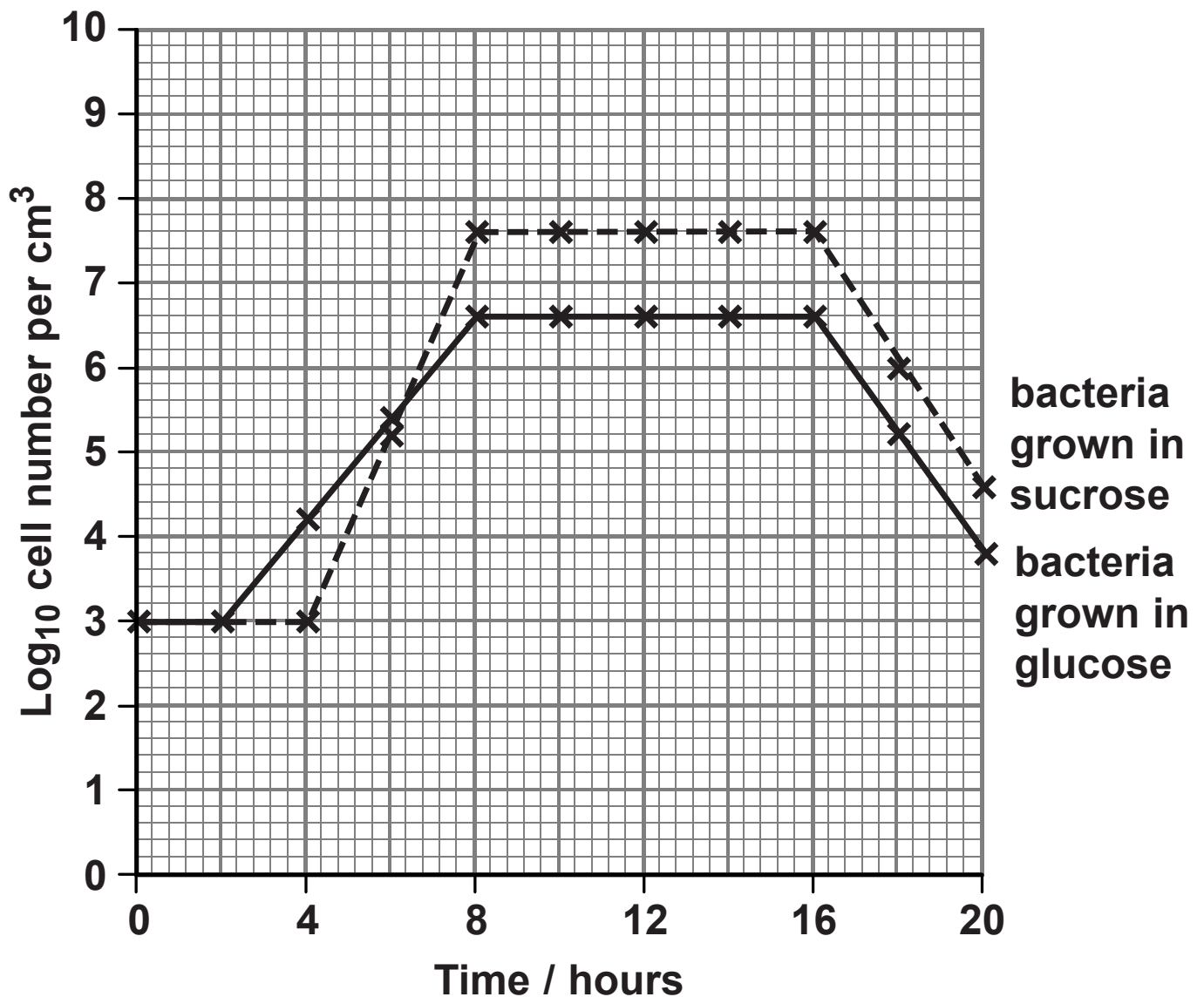
| | Glucose | Sucrose |
|-----------------------------------|-----------------------|-----------------------|
| <input type="checkbox"/> A | monosaccharide | monosaccharide |
| <input type="checkbox"/> B | monosaccharide | disaccharide |
| <input type="checkbox"/> C | disaccharide | disaccharide |
| <input type="checkbox"/> D | disaccharide | monosaccharide |

(Question continues on next page)

(b) Bacteria were grown in each medium for 20 hours.

Every two hours, the numbers of bacteria were determined using dilution plating and an optical method (turbidity).

The graph shows the results from the dilution plating.



(Question continues on next page)

(Turn over)

- (i) Calculate how many times faster the bacteria in sucrose reproduce than the bacteria in glucose, during the log phase. (2 marks)

Answer _____

- (ii) Analyse the data to explain why the growth curve for sucrose is different from the growth curve for glucose. (2 marks)

(Continue your answer on next page)

(Turn over)

- (iii) On the graph on page 8, draw a curve to show the number of bacteria grown in glucose as determined by the optical method. (1 mark)

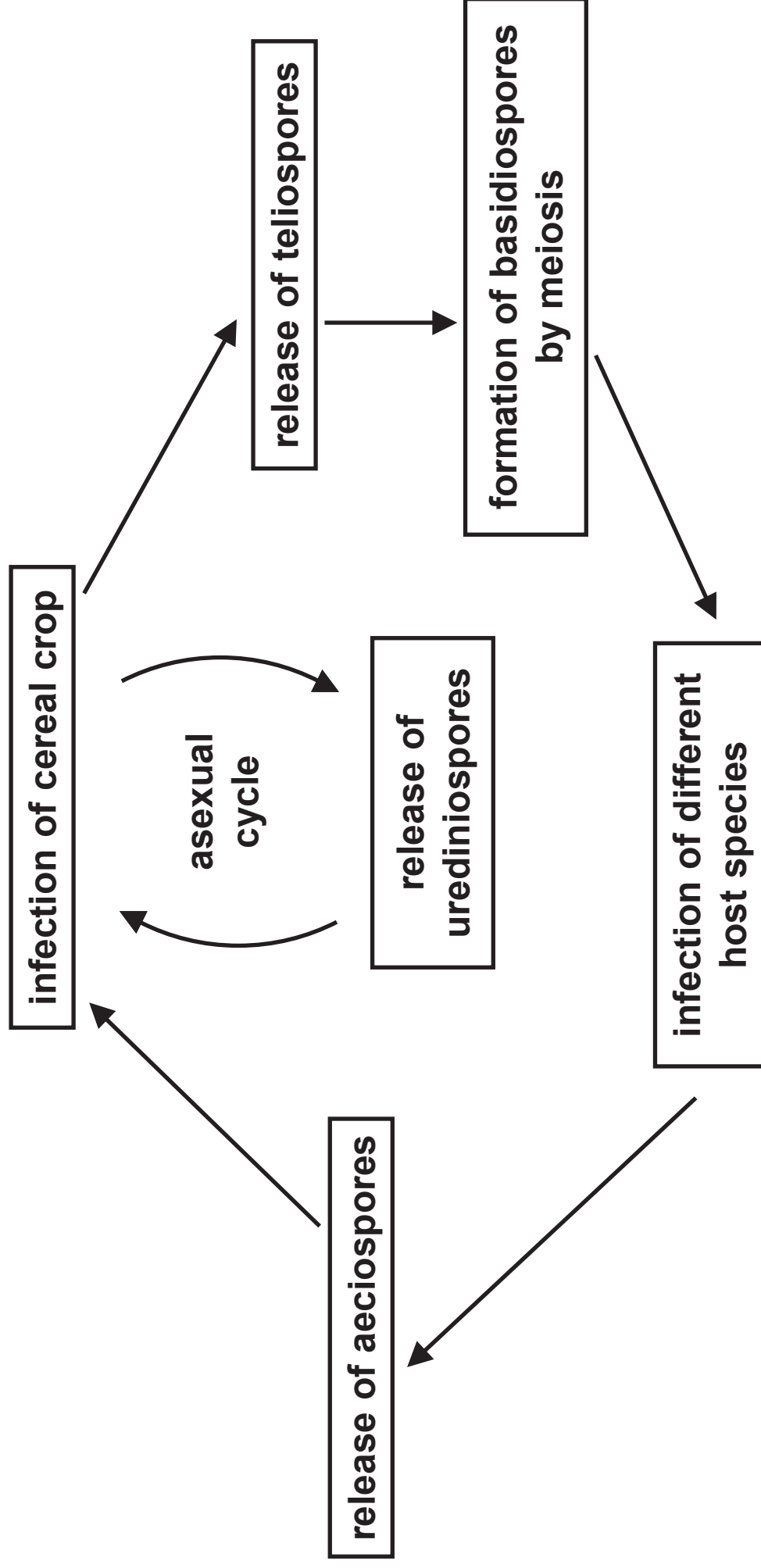
(TOTAL FOR QUESTION 2 = 6 MARKS)

(Questions continue on next page)

(Turn over)

- 3 The stem rust fungus is responsible for destroying cereal crops and reducing grain yield.

The diagram shows some stages in the life cycle of the stem rust fungus.



(Question continues on next page)

(Turn over)

**(a) Which genus does the stem rust fungus belong to?
(1 mark)**

- ☐ **A Plasmodium**
- ☐ **B Puccinia**
- ☐ **C Salmonella**
- ☐ **D Staphylococcus**

(b) Explain how stem rust fungus results in a reduction in grain yield. (3 marks)

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

- (c) Cereal crops have been genetically modified (GM) to produce plants that are resistant to stem rust fungus.

Analyse the diagram to deduce why the formation of basidiospores and urediniospores can produce a stem rust fungus to which these GM plants are no longer resistant. (3 marks)

(Continue your answer on next page)

(Turn over)

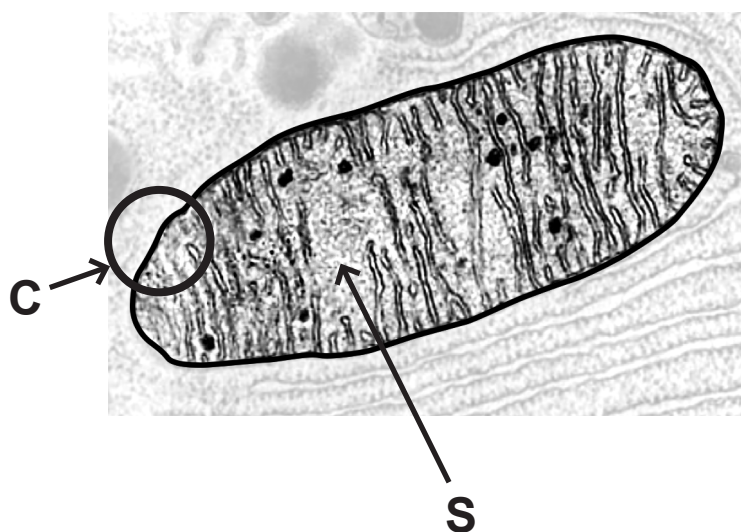
(TOTAL FOR QUESTION 3 = 7 MARKS)

(Questions continue on next page)

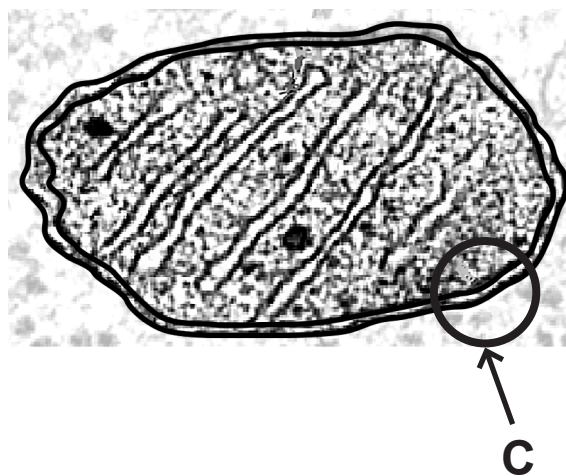
- 4 (a) Photographs P and Q are electron micrographs of mitochondria.

Each photograph was taken using a different electron microscope.

Photograph P



Photograph Q



Sourced from:
<http://book.bionumbers.org/how-big-are-mitochondria/>

Source: Cellupedia

- (i) What is the structure labelled S? (1 mark)

- ☐ A crista
- ☐ B matrix
- ☐ C stroma
- ☐ D thylakoid

(Question continues on next page)

(Turn over)

- (ii) Explain the difference in appearance of the parts labelled C using the two different electron microscopes. (2 marks)

(Question continues on next page)

***(b) The table shows the protein : lipid ratio of the inner and outer membrane of a mitochondrion.**

| Membrane of mitochondrion | Protein : lipid ratio |
|----------------------------------|------------------------------|
| inner | 3:2 |
| outer | 1:1 |

**Explain the difference in the protein : lipid ratio of the inner and outer membrane of a mitochondrion.
(6 marks)**

(Continue your answer on next page)

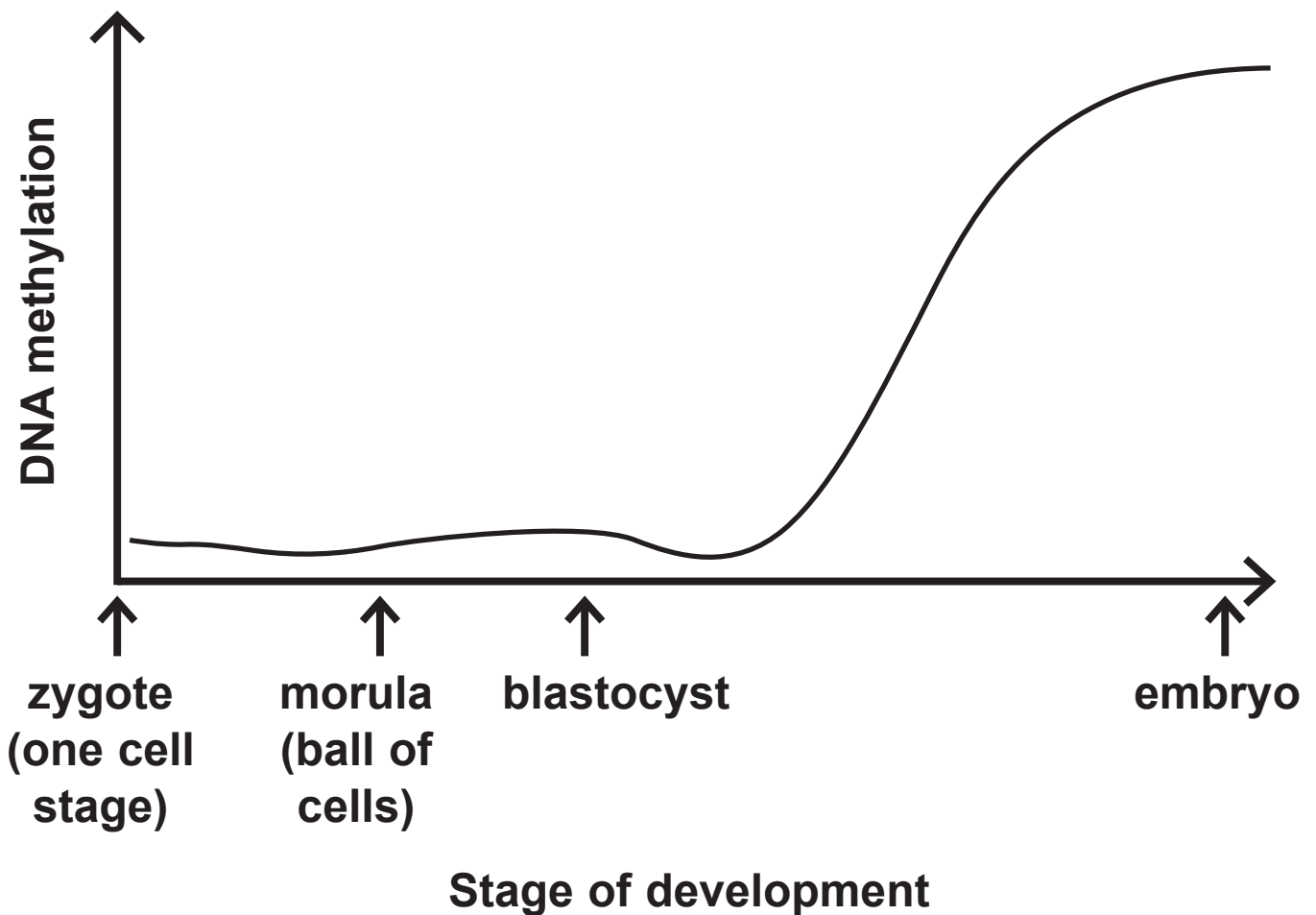
(Turn over)

(Questions continue on next page)

(Turn over)

- 5 (a) Epigenetic modifications are involved in the development of an embryo.

The graph shows the changes in DNA methylation during the development of an embryo from a zygote.



(Question continues on next page)

- (i) State the meaning of the term DNA methylation. (1 mark)

- (ii) Describe the differences between totipotent, pluripotent and multipotent stem cells during the development of an embryo. (3 marks)

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

(iii) Analyse the graph to explain why DNA methylation is involved in the development of an embryo. (2 marks)

[illegible]

(b) Explain why some cells are not able to become other cell types. (2 marks)

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(Continue your answer on next page)

(Turn over)

(TOTAL FOR QUESTION 5 = 8 MARKS)

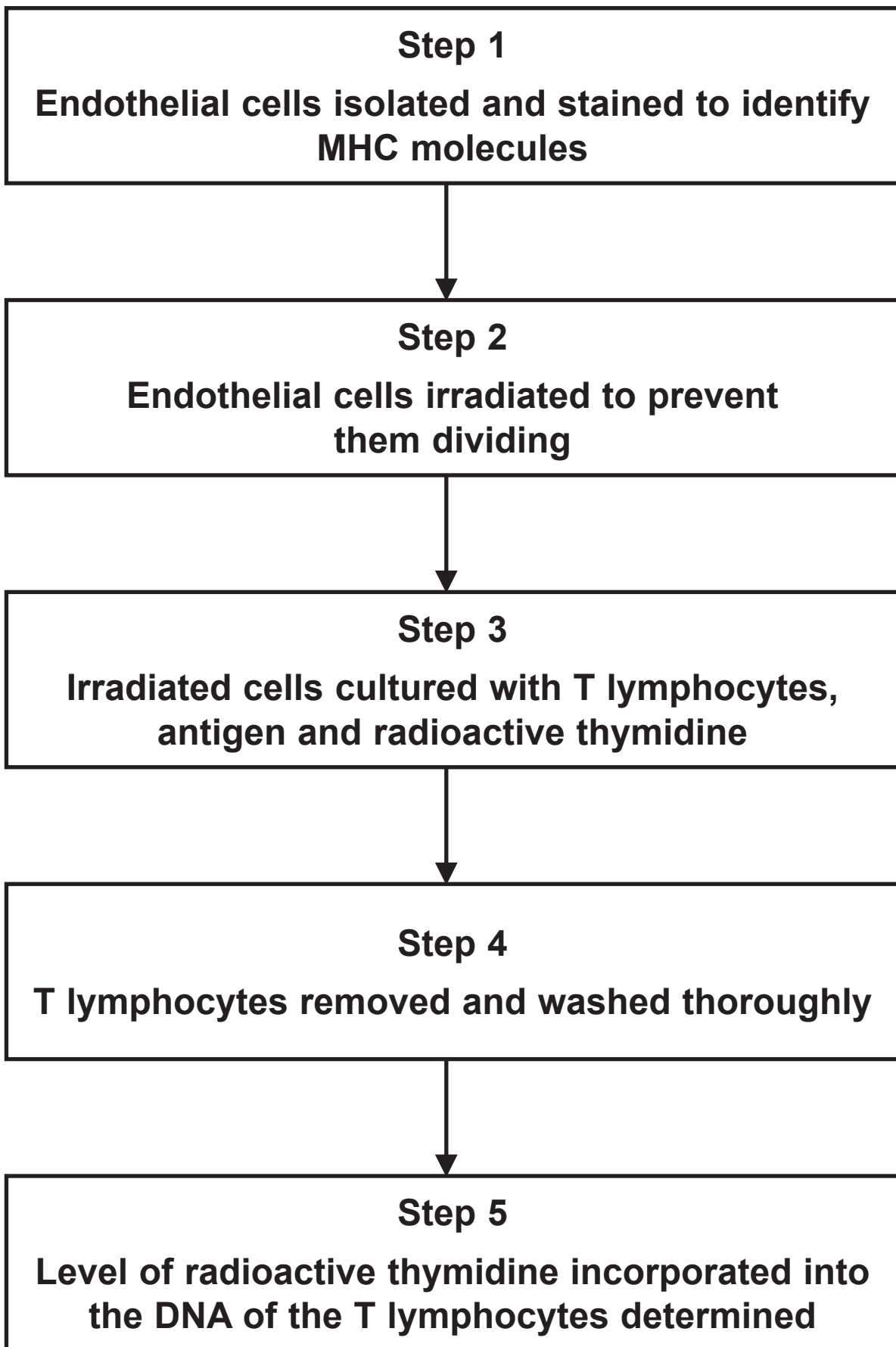
(Questions continue on next page)

- 6 Cell division can be measured using radioactive thymidine. This molecule is used in the synthesis of new DNA molecules.**

A scientist investigated the ability of endothelial cells to present antigens.

The flow chart on page 27 shows some of the steps involved in this investigation.

(Question continues on next page)



(Question continues on next page)

(Turn over)

- (a) Explain why the scientist looked for the presence of MHC molecules on the endothelial cells, in Step 1. (2 marks)

(Question continues on next page)

(Turn over)

(b) Irradiation prevents cells from dividing.

Explain why the endothelial cells were irradiated in Step 2, before they were cultured with T lymphocytes and antigen. (2 marks)

(Question continues on next page)

(Turn over)

(c) Explain why the T lymphocytes needed to be washed thoroughly in Step 4. (2 marks)

(Question continues on next page)

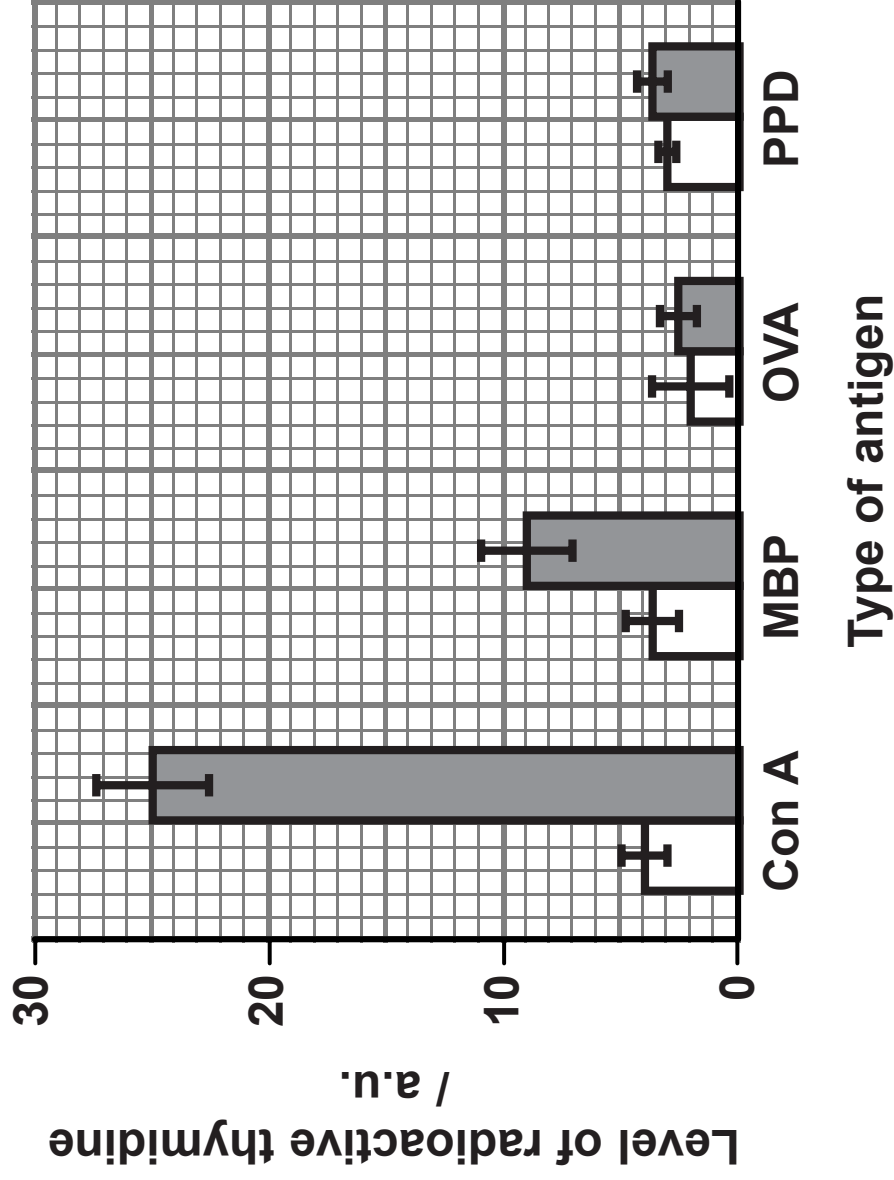
- (d) In this investigation, the ability of the endothelial cells to present four different types of antigen was assessed.

T lymphocytes were cultured with endothelial cells and antigen.

This was repeated using T lymphocytes cultured with endothelial cells and no antigen.

The graph on page 32 shows the results of this investigation.

(Question continues on next page)



(Question continues on next page)

- (i) Explain why T lymphocytes were cultured with and without the antigen. (2 marks)

- (ii) Analyse the data to explain the conclusions that can be drawn from this investigation. (3 marks)

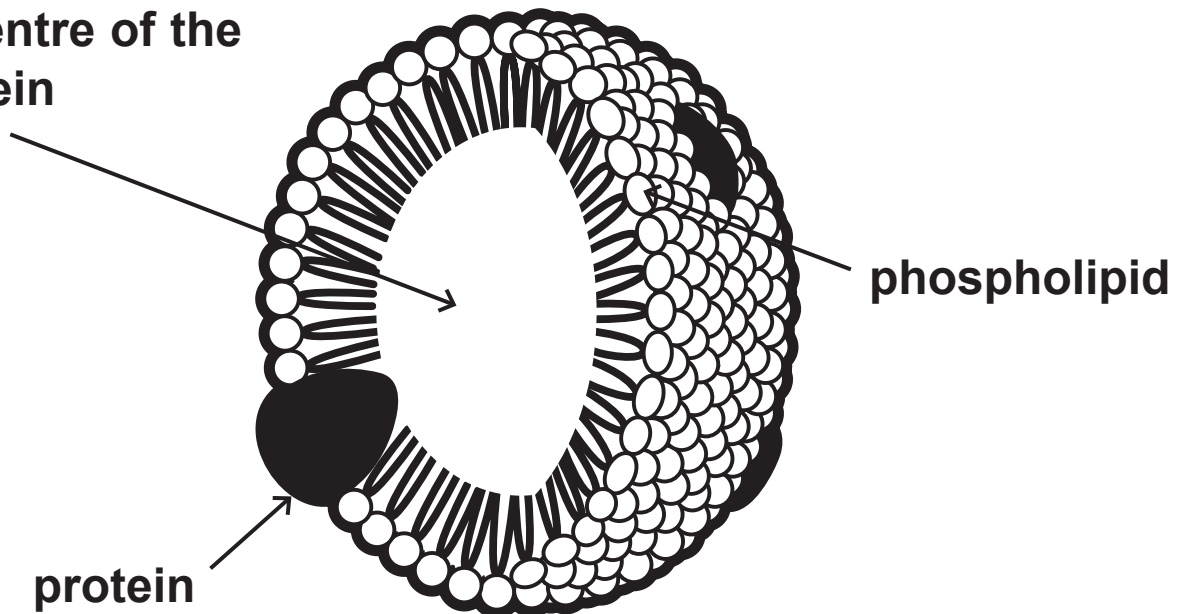
(Continue your answer on next page)

(Turn over)

- 7 High density and low density lipoproteins are spherical structures that transport cholesterol and fatty acids in the bloodstream.

The diagram shows a lipoprotein.

cholesterol and fatty acids transported in the centre of the lipoprotein



- (a) Explain why the properties of lipoproteins enable cholesterol and fatty acids to be transported in the bloodstream. (3 marks)

(Continue your answer on next page)

(Turn over)

(Turn over)

- (b) The table shows some information about two types of lipoprotein, high density lipoprotein (HDL) and low density lipoprotein (LDL).

| Information about lipoproteins | HDL | LDL |
|------------------------------------|----------------|----------------|
| density range / g cm ⁻³ | 1·063 to 1·210 | 1·019 to 1·063 |
| typical diameter / nm | 8 | 22 |
| typical volume / nm ³ | 268 | |
| percentage of protein (%) | 50 | 20 |

- (i) Complete the table to show the volume of a typical LDL using the formula:

$$\frac{4}{3} \pi r^3 \quad \text{where } \pi = 3\cdot14$$

(2 marks)

- (ii) Analyse the information to explain why LDLs have a lower density range than HDLs. (2 marks)

(Question continues on next page)

(iii) Explain why raised levels of LDLs may increase the risk of heart disease. (4 marks)

[illegible]

(Continue your answer on next page)

(Turn over)

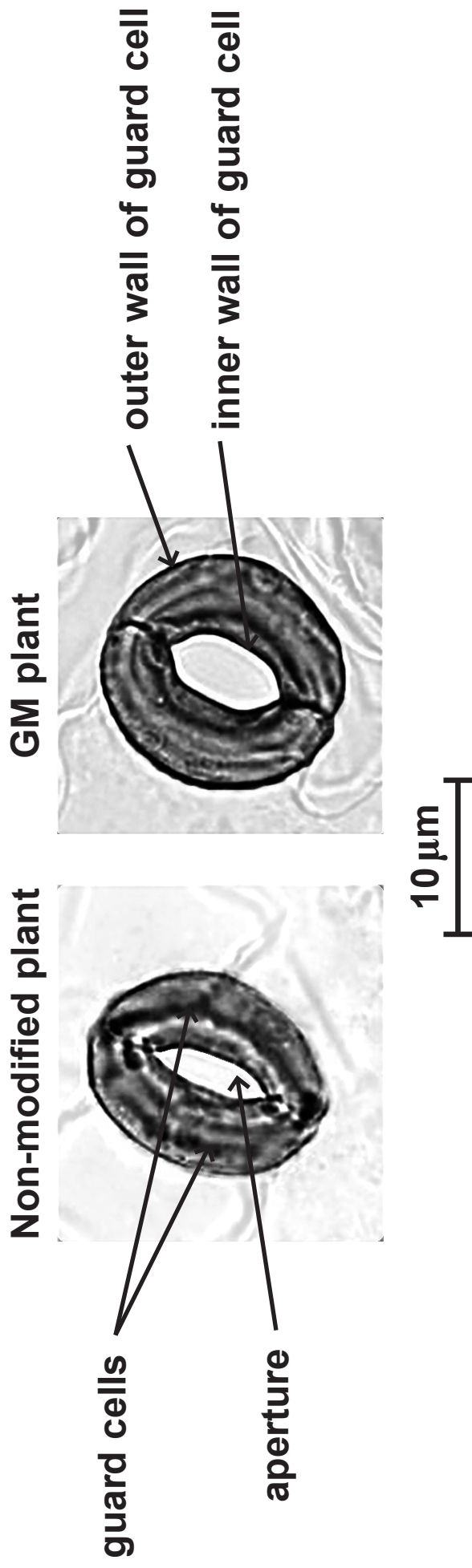
(TOTAL FOR QUESTION 7 = 11 MARKS)

(Questions continue on next page)

- 8 Genetically modified (GM) crop plants have been produced that have stomata with a wider aperture than non-modified crop plants.

This difference in the width of the aperture is only evident in daylight.

The photographs show the appearance of each type of stoma in daylight.



Sourced from: http://www.aip.nagoya-u.ac.jp/en/public/nu_research/images/Wang_f1.jpg

(Question continues on next page)

(Turn over)

- (a) (i) Calculate the magnification of the GM plant photograph using the scale bar.

Give the answer in standard form. (2 marks)

Answer _____

- (ii) Calculate how many times wider the aperture of the stoma of the GM plant is compared with the stoma of the non-modified plant. (1 mark)

Answer _____

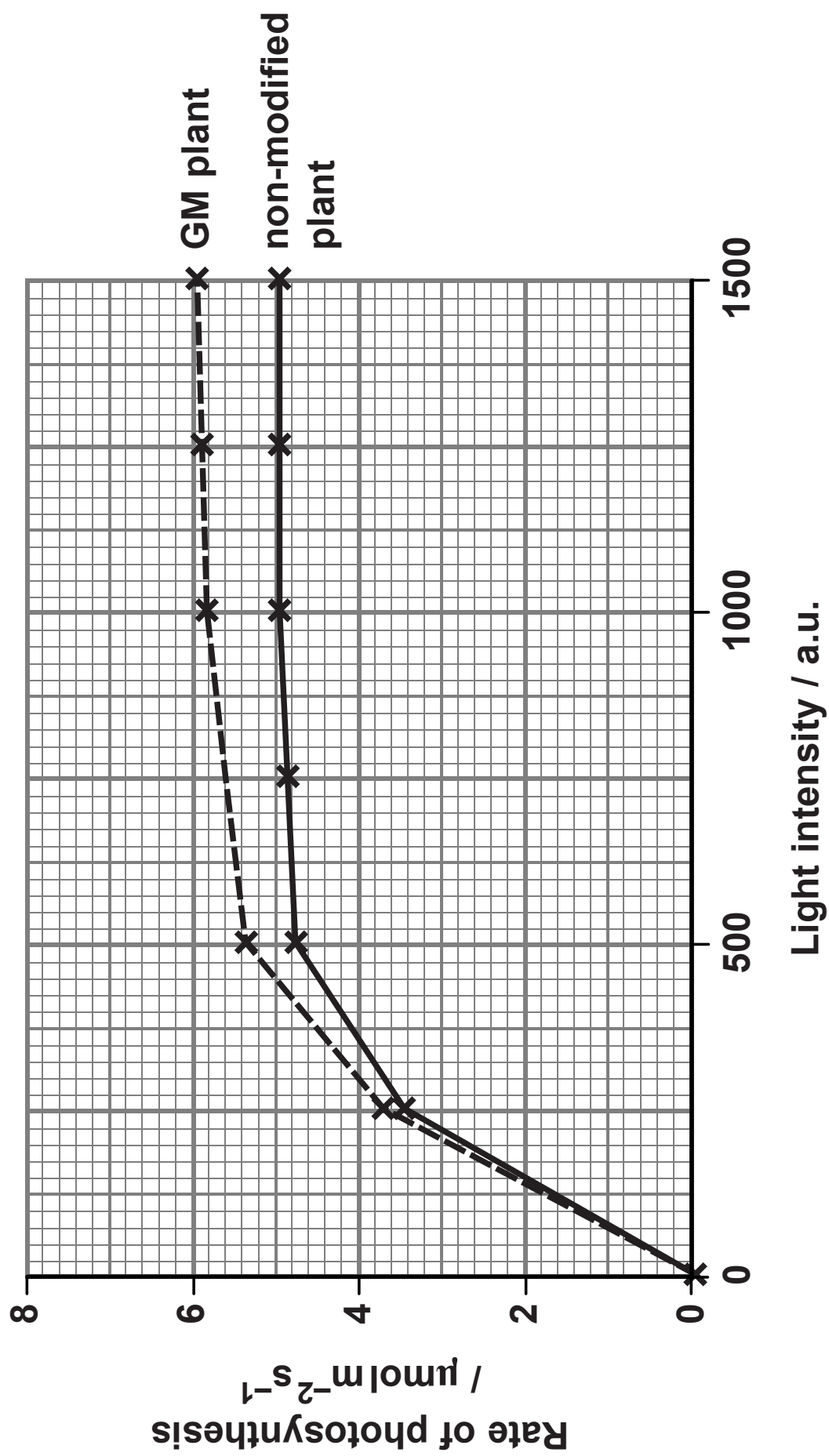
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(Turn over)

- (b) An investigation was carried out to compare the effect of light intensity on the rate of photosynthesis in GM plants with the effect in non-modified plants.**

The graph on page 44 shows the results of this investigation.

(Question continues on next page)



(Question continues on next page)

(Turn over)

- (i) The rate of photosynthesis is expressed as $\mu\text{mol m}^{-2} \text{s}^{-1}$.

Describe what was measured to find the rate of photosynthesis. (3 marks)

**(ii) Explain the results of this investigation.
(3 marks)**

[illegible]

(c) Explain why the wider stomata in GM crop plants could increase their yield. (3 marks)

[illegible]

- (d) The flow chart shows some of the steps involved in opening the aperture of a stoma.

Hydrogen ions actively transported out of the guard cells



Potassium ions diffuse into the guard cells



Starch broken down into malate



Water moves into the guard cells



Aperture of the stoma widens

(Question continues on next page)

(i) What happens when hydrogen ions are actively transported out of the guard cells? (1 mark)

- ☐ **A ADP and phosphate ions are converted into ATP by a hydrolysis reaction**
- ☐ **B ADP and phosphate ions are converted into ATP by a condensation reaction**
- ☐ **C ATP is broken down into ADP and phosphate ions by a condensation reaction**
- ☐ **D ATP is broken down into ADP and phosphate ions by a hydrolysis reaction**

(ii) Which of the following explains why water moves into the guard cells? (1 mark)

- ☐ **A malate lowers the water potential of the cytoplasm**
- ☐ **B malate raises the water potential of the cytoplasm**
- ☐ **C starch lowers the water potential of the cytoplasm**
- ☐ **D starch raises the water potential of the cytoplasm**

(Question continues on next page)

(Turn over)

(iii) Which of the following explains why the aperture of the stoma widens? (1 mark)

- ☐ A The guard cells become smaller and the inner wall of the guard cell is more flexible than the outer wall
- ☐ B The guard cells become smaller and the inner wall of the guard cell is less flexible than the outer wall
- ☐ C The guard cells become larger and the inner wall of the guard cell is more flexible than the outer wall
- ☐ D The guard cells become larger and the inner wall of the guard cell is less flexible than the outer wall

(TOTAL FOR QUESTION 8 = 15 MARKS)

(Questions continue on next page)

(Turn over)

9 Doxorubicin (Dox) is a drug used to treat cancer.

(a) Cancer is caused when cells divide uncontrollably.

This drug works in two ways:

- **it becomes inserted into the DNA and holds the two strands together.**
- **it binds to an enzyme that repairs DNA.**

Explain how Dox prevents cancer cells from dividing. (5 marks)

(Continue your answer on next page)

(Turn over)

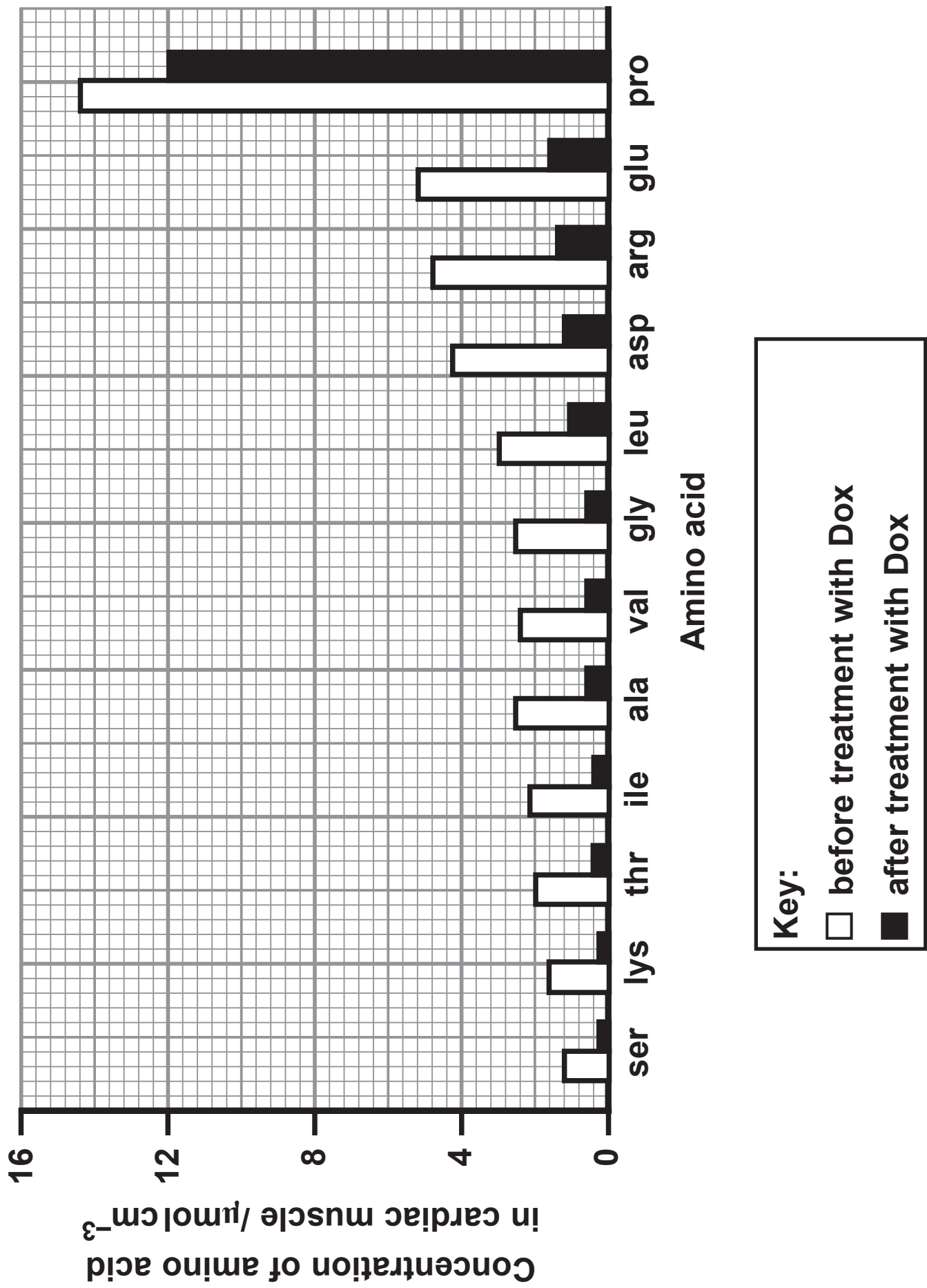
(Question continues on next page)

- (b) Weakening of the cardiac muscle is one side effect of using Dox.**

The effect of Dox on the concentration of several amino acids in cardiac muscle was investigated.

The graph on page 54 shows the results of this investigation.

(Question continues on next page)



(Question continues on next page)

(Turn over)

The table shows some non-polar and polar amino acids.

| Type | Amino acids |
|-----------|------------------------------|
| non-polar | ala, gly, ile, leu, pro, val |
| polar | arg, asp, glu, lys, ser, thr |

- * (i) Analyse the information to determine the effect of Dox on the concentration of these types of amino acid in cardiac muscle.
(6 marks)**

(Continue your answer on next page)

(Turn over)

(ii) Explain why a change in the concentration of amino acids results in the weakening of cardiac muscle. (2 marks)

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(iii) Explain how weakening of the cardiac muscle could affect a person. (3 marks)

[illegible]

(Continue your answer on next page)

(Turn over)

(TOTAL FOR QUESTION 9 = 16 MARKS)

TOTAL FOR PAPER = 90 MARKS
END