Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level BIOLOGY

Paper 1

Thursday 5 June 2025 Afternoon Time allowed: 2 hours

Materials

For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

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).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 91.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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

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0 1 . 1 The digestion and absorption of lipids involves:

- emulsification by bile salts
- micelles.

Explain each of the following.

[4 marks]

The importance of emulsification in the digestion of lipids

The role of micelles in the absorption of lipids

0 1 . 2 Describe and explain the arrangement of phospholipid molecules in the cell-surface membrane.

[2 marks]

6

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0 2 . 1 Describe how mRNA is obtained from pre-mRNA.

[1 mark]

0 2 . 2 Describe how RNA polymerase joins RNA nucleotides.

[2 marks]

Question 2 continues on the next page

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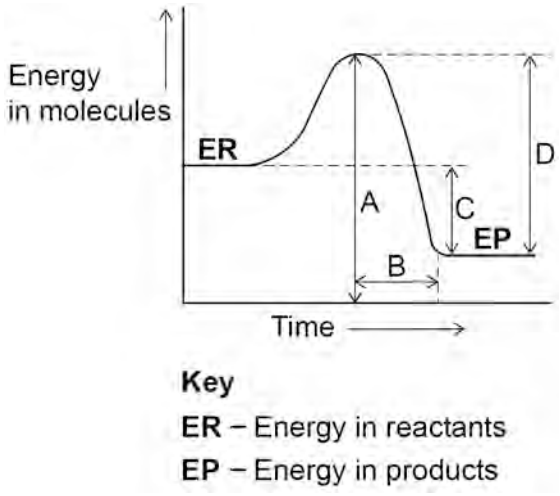
0 2 . 3 **Figure 1** shows the energy contained in molecules during an enzyme-controlled reaction.

Figure 1



Which expression represents the activation energy (E_a) of this reaction?

Tick (✓) **one** box.

[1 mark]

A – C ☐

D – C ☐

$\frac{D - C}{B}$ ☐

D ☐

Do not write outside the box

0 2 . 4 In 1914, a group of scientists investigated enzyme action.

After studying their results, the scientists reached the following conclusions:

> An enzyme is a substance which causes a reaction to occur at "ordinary" temperatures by being present, but **not** by its ability to combine with another substance. An enzyme changes the rate of a reaction without itself being changed by that reaction.

Our current understanding of enzyme action is based on the induced-fit model.

Describe similarities **and** differences between the conclusions from 1914 and our current understanding of enzyme action.

[4 marks]

Similarities

Differences

8

Turn over for the next question

Do not write outside the box

0 3 . 1 Complete **Table 1** by adding a tick (✓) if the feature is present in the biological molecules.

Table 1

	Biological molecule		
Feature	**Glycogen**	**Sucrose**	**DNA**
Contains glucose			
Contains galactose			
Contains fructose			
Contains phosphate			
Formed by condensation reaction(s)			
Is a polymer			

[3 marks]

0 3 . 2 Lactase catalyses the hydrolysis of lactose.

A student investigated the effect of galactose on lactase activity.

The student used the following method.

1. Mix together (in tube **X**) solutions of lactose, galactose and lactase in a 15 : 3 : 1 volume ratio so that the total volume is 90 cm^3
2. Leave the mixture at 30 °C for 10 minutes.
3. Measure the glucose concentration in the mixture.
4. Repeat steps 1 to 3 with two different mixtures.

Calculate the volume of **galactose** solution used in tube **X**.

[1 mark]

Volume of galactose = _____ cm^3

Do not write outside the box

Table 2 shows the student's results.

Table 2

Tube	Mixture	Glucose concentration after 10 minutes / mg dm^{-3}
X	Lactose, galactose, lactase	100
Y	Lactose, water, lactase	180
Z	Galactose, water, lactase	0

0 3 . 3 Galactose is a competitive inhibitor of lactase.

Use this information and your knowledge of enzymes to explain the results obtained in **Table 2**.

[4 marks]

Tube **X** _____

_____

_____

_____

Tube **Y** _____

_____

_____

_____

Tube **Z** _____

_____

_____

_____

Question 3 continues on the next page

Do not write outside the box

0 3 . 4 Give:

- **one** change the student could make in tube **X** to confirm that galactose is a **competitive** inhibitor
- the result you would expect.

[2 marks]

Change _____

_____

_____

Result _____

_____

_____

10

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 4 . 1 Name **three** structures that are found in **some** prokaryotic cells but are **not** found in **all** prokaryotic cells.

[2 marks]

1 _____

2 _____

3 _____

0 4 . 2 **Table 3** shows the resolution of three types of microscope.

Table 3

Microscope	**Resolution / μm**
Optical	0.25
Scanning electron (SEM)	0.02
Transmission electron (TEM)	0.0002

Table 4 shows information about yeast cells and mitochondria.

Table 4

	Mean diameter / μm
Yeast cells	3.0
Mitochondria	0.22

Do not write outside the box

Identify the correct microscope to use in each of the following investigations.

Use your knowledge of microscopes and information in **Table 3** and **Table 4**.

Give **two** reasons for each choice of microscope.

[4 marks]

Investigation 1 – to study the living cells in a yeast culture that contains both living cells and dead cells. The living cells remain colourless and the dead cells are stained blue when a dye is added.

Type of microscope _____

Reason 1 _____

_____

_____

Reason 2 _____

_____

_____

Investigation 2 – to observe the three-dimensional structure of mitochondria.

Type of microscope _____

Reason 1 _____

_____

_____

Reason 2 _____

_____

_____

6

Turn over for the next question

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0 5 . 1 Pears are a type of fruit.

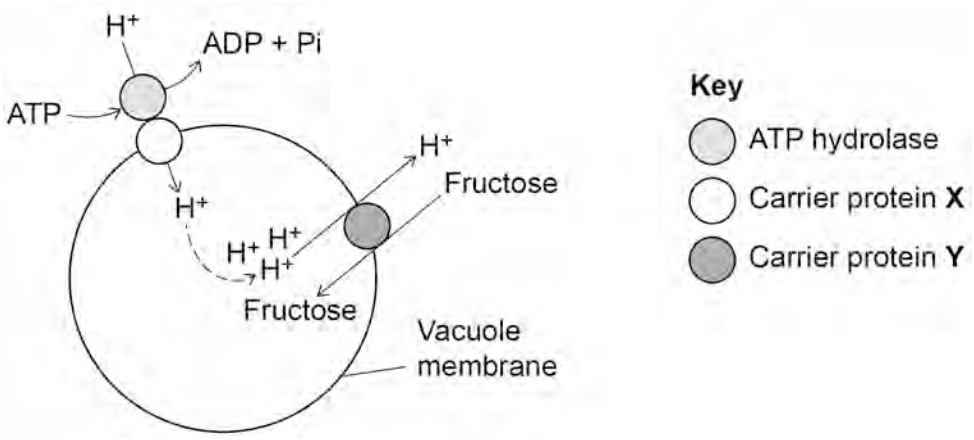
When pears ripen, the:

- fructose concentration increases in cell vacuoles
- volume of cell vacuoles increases.

Figure 2 shows information about a pear cell's vacuole membrane.

- Carrier protein **X** is linked to an ATP hydrolase enzyme.
- Carrier protein **Y** co-transports H^+ ions and fructose molecules in opposite directions.

Figure 2



Explain why the volume of the vacuoles in pear cells increases when pears ripen.

Your answer should refer to the role of:

- ATP hydrolase
- carrier protein **X** and carrier protein **Y**.

[4 marks]

Do not write outside the box

0 5 . 2 A respiratory inhibitor caused a change in pH of the solution within the vacuole.

Use information in **Figure 2** to explain how.

[3 marks]

0 5 . 3 Explain how a change in the expression of the genes coding for the carrier proteins can increase the rate of ripening of pears.

[2 marks]

9

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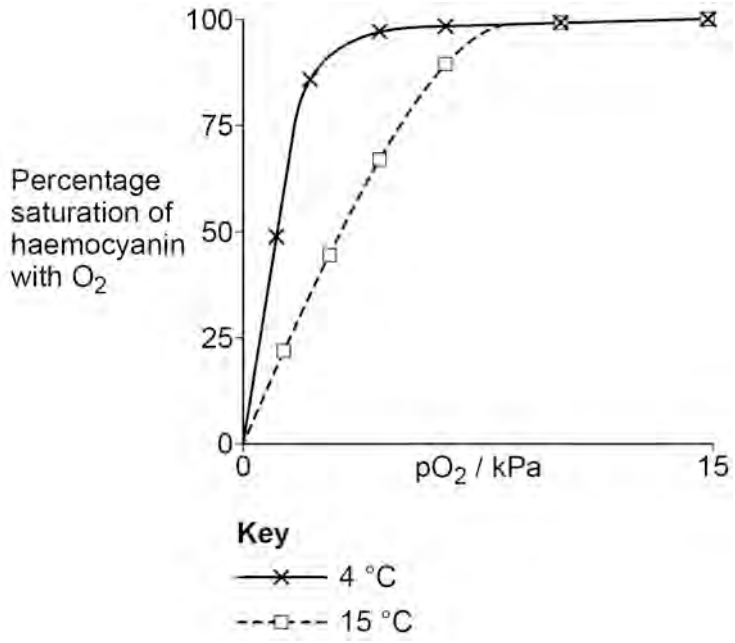
0 6 . 1 Crab blood contains the respiratory pigment haemocyanin.

Figure 3 shows the dissociation curve for oxyhaemocyanin in a species of crab at two temperatures.

Figure 3



Crabs use gills for gas exchange.

Use **Figure 3** to explain how the increase in temperature affects the ability of haemocyanin to load or unload oxygen at the gills **and** in tissues.

Refer to high pO_2 and low pO_2 in your answer.

[2 marks]

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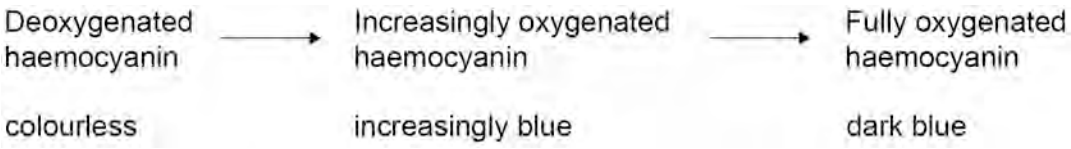
0 6 . 2 **Figure 4** shows the colour of haemocyanin with increasing concentrations of oxygen.

Figure 4



A calibration curve can be used to determine the percentage oxygen saturation of haemocyanin in a sample of crab blood.

You are given samples of crab blood in which the percentage oxygen saturation of haemocyanin is known.

Use all the information provided to:

- describe how you could produce a calibration curve for the percentage oxygen saturation of haemocyanin in crab blood
- identify **one** control variable used in the procedure to obtain data for the calibration curve.

[3 marks]

Description _____

_____

_____

_____

_____

_____

One control variable _____

_____

_____

Question 6 continues on the next page

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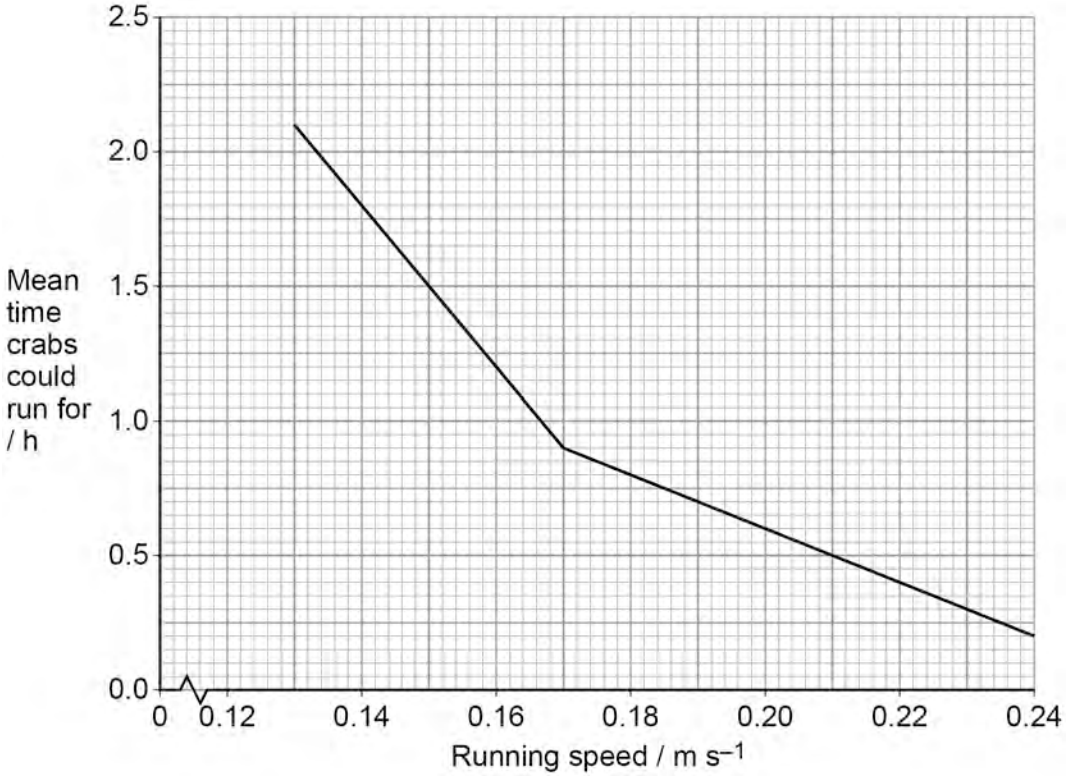
0 6 . 3 Ghost crabs live on sandy beaches.

Ghost crabs can run for a long time before they get tired and have to stop.

A scientist calculated the mean time ghost crabs could run for at different speeds before they stopped.

Figure 5 summarises the scientist's results.

Figure 5



A ghost crab running at 0.14 m s^{-1} covered a distance of 504 m in 1 hour.

Use **Figure 5** to calculate the extra distance this crab could cover if it continued running at 0.14 m s^{-1} before it stopped running.

Show your working.

[2 marks]

Extra distance _____ m

Do not write outside the box

0 6 . 4 **Figure 6** shows the data points from individual crabs that were used to plot the curve in **Figure 5**.

Figure 6

Figure 6 not reproduced here due to third-party copyright restrictions.

The figure is adapted from Figure 1 in https://journals.co.za/doi/pdf/10.10520/AJA00445096_586

The scientist selected the crabs at random from one sandy beach. Before the investigation, the crabs were equally rested and fed identical diets.

Use information in **Figure 6** to suggest why the line of best fit in **Figure 5** is **not** a good indicator of the time ghost crabs can run for.

[3 marks]

10

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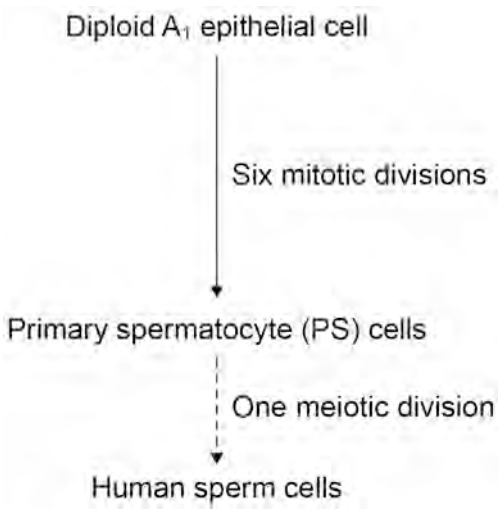
0 7 . 1 **Figure 7** shows how human sperm cells are produced in the testes from diploid A_1 epithelial cells.

Figure 7



Use **Figure 7** to calculate the minimum number of A_1 cells needed to produce 1.5×10^7 sperm cells.

Give your answer in standard form.

Show your working.

[2 marks]

Answer _____ A_1 cells

Do not write outside the box

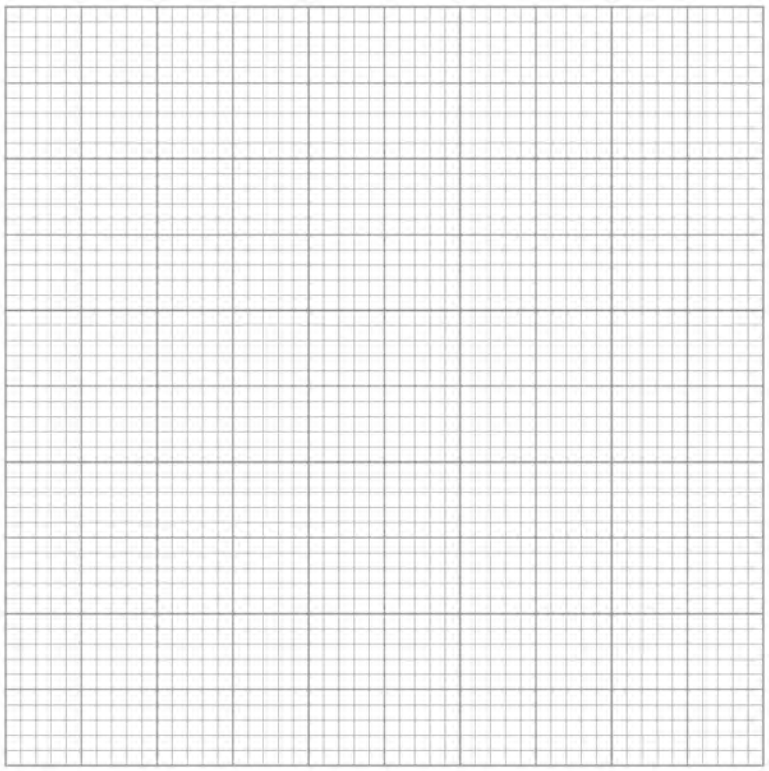
0 7 . 2 A PS cell goes through interphase before a meiotic division.

A scientist determined that the mass of DNA in **one** PS cell at the start of interphase is 8 arbitrary units.

Draw a bar chart in **Figure 8** showing the mass of DNA in **one** cell in each of these phases:

- at the start of interphase
- at the end of interphase
- at the end of the first meiotic division
- at the end of the second meiotic division.

Figure 8



[3 marks]

Question 7 continues on the next page

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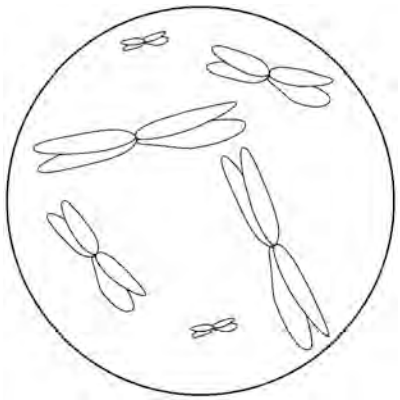
0 7 . 3 A PS cell contains 46 chromosomes.

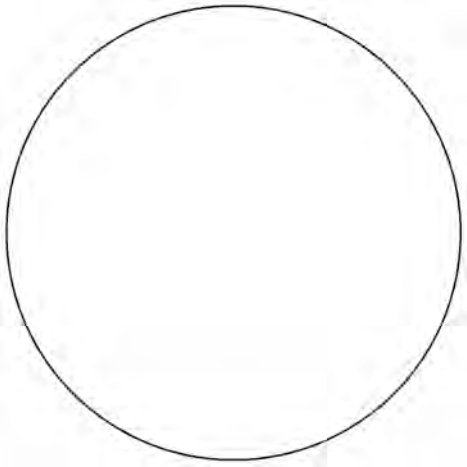
Figure 9 shows the appearance of six of those chromosomes just as a PS cell enters meiosis.

Figure 9



Using the information in **Figure 9**, draw chromosomes in **Figure 10** as they would appear in **one** cell at the end of the first meiotic division.

Figure 10



[1 mark]

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0 7 . 4 A mutation can produce a gamete with **one** extra chromosome.

Name the type of mutation that produces a gamete with one extra chromosome.

Explain how meiosis can produce a gamete with one extra chromosome.

[3 marks]

Type of mutation _____

Explanation _____

_____

_____

_____

_____

_____

9

Turn over for the next question

Do not write outside the box

0 8 . 1 Strains of bacteria with antibiotic resistance are common in hospitals.

Use your knowledge of selection to explain why.

[3 marks]

0 8 . 2 Antibiotic resistance alleles are located in plasmids.

There are 11 different types of plasmid inside cells of the bacterium *Bacillus thuringiensis*.

A scientist determined the:

- length of each type of plasmid in kilobase pairs (kbp)
- mean plasmid copy number (mean number of each type of plasmid per cell).

Do not write outside the box

Table 5 shows the scientist's results for 5 of these plasmids.

Table 5

Plasmid identity	Plasmid length / kbp	Mean plasmid copy number	Rank of plasmid length	Rank of mean plasmid copy number	Squared difference between ranks (d^2)
A	8	172	2	5	9
B	95	6	4	2	4
C	12	35	3	3	0
D	2	139	1	4	9
E	294	3	5	1	16

The Spearman rank correlation coefficient (r_s) between plasmid length and mean plasmid copy number is determined using this equation.

$$r_s = 1 - \frac{6 \sum d^2}{n (n^2 - 1)}$$

where

$\sum d^2$ = the sum of all d^2 figures

n = 5 (the highest rank number)

Use information in **Table 5** and the formula to calculate the r_s value for this set of data.

Show your working.

[2 marks]

r_s = _____

Turn over ►

Do not write outside the box

0 8 . 3 The scientist determined that the r_s value between plasmid length and mean plasmid copy number for all 11 types of plasmid is –0.94

What can you conclude from this r_s value?

[1 mark]

0 8 . 4 The length of the single circular (non-plasmid) DNA molecule in a *B. thuringiensis* cell is 5400 kbp

The total length of all plasmid DNA molecules in a *B. thuringiensis* cell is 65% greater than the length of the single circular DNA molecule.

Calculate the total number of kbp in all the plasmid molecules in a *B. thuringiensis* cell.

Show your working.

[2 marks]

Answer _____ kbp

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Question 8 continues on the next page

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ANSWER IN THE SPACES PROVIDED

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0 8 . 5 A growing population of *B*. *thuringiensis* cells includes a:

- germination phase
- growth phase
- dormant phase.

A scientist incubated a culture of *B. thuringiensis* cells at 20 °C

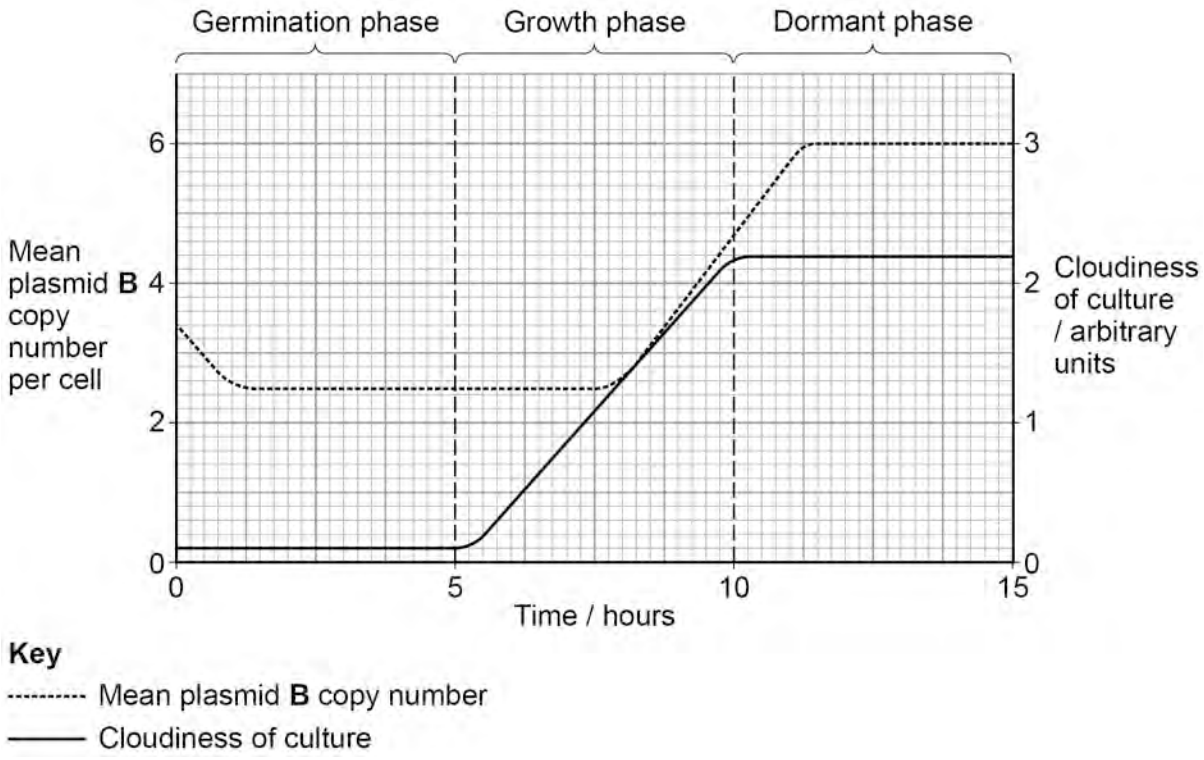
At intervals, the scientist:

- measured the cloudiness of the culture
- determined the mean plasmid **B** copy number per cell.

Cloudiness is a measure of the number of cells in a culture.

Figure 11 shows the scientist's results.

Figure 11



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Using information in **Figure 11**, what can you conclude about binary fission and the replication of plasmid **B** in the different phases of a growing population of *B. thuringiensis*?

[3 marks]

11

Turn over for the next question

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0 9 . 1 Scientists investigated chloroplasts taken from leaf cells of the species *Nicotiana tabacum*.

The scientists took chloroplasts from leaf cells of a healthy plant and from leaf cells of a mutant plant.

Chloroplasts are contained in several different types of specialised cells in *N. tabacum* leaves.

What terms are used to describe an organisation of specialised cells in an organism when:

- all the cells are of one type
- the cells are of more than one type?

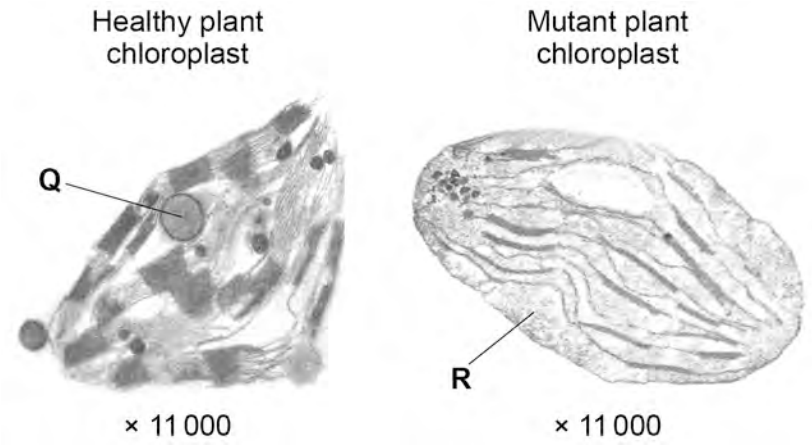
[1 mark]

Cells of one type _____

Cells of more than one type _____

0 9 . 2 **Figure 12** shows images of chloroplasts from *N. tabacum* cells observed with an electron microscope.

Figure 12



Identify the parts labelled **Q** and **R**.

[1 mark]

Q _____

R _____

Do not write outside the box

0 9 . 3 Use the images in **Figure 12** to predict how photosynthesis could be affected in the mutant plants.

Justify your answer.

[2 marks]

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 Scientists investigated the rate of photosynthesis in healthy plants and in mutant plants.

Table 6 shows the scientists' results.

Chlorophyll a and chlorophyll b are two types of chlorophyll molecules used in photosynthesis.

Table 6

	Chlorophyll concentration / µg cm^{-3}	**Chlorophyll a : chlorophyll b ratio**	**Rate of photosynthesis / arbitrary units**
Healthy plant	45	2 : 1	1
Mutant plant	9	6 : 1	5

The scientists' results did not support what they predicted from **Figure 12** (on page 28) would be the effect of the mutation on photosynthesis.

Use information in **Table 6** to describe **and** explain the effect of the mutation.

[3 marks]

7

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1 0 . 1 Describe the roles of ribosomes, tRNA and ATP in the process of translation.

[6 marks]

Question 10 continues on the next page

Do not write outside the box

1 0 . 2 Describe **and** explain the adaptations of leaves that maximise gas exchange.

Do **not** refer to organelles in your answer.

[4 marks]

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1 0 . 3 Describe the pathway taken by blood between a kidney and the coronary arteries.

Include names of the major blood vessels (arteries and veins) **and** heart valves involved.

[5 marks]

15

END OF QUESTIONS

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**
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