Do not write outside the box

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

1 The diagram shows the dominant plants in communities formed during a succession from bare soil to pine forest.

Time in years	1	2 – 4	5 – 24	25 – 100
	Bare field	Grassland	Shrub	Forest

Key

1 (a) Name the pioneer species shown in the diagram.

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(1 mark)

1 (b) The species that are present change during succession. Explain why.

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(2 marks)

1 (c) The pine trees in the forest have leaves all year. Explain how this results in a low species diversity of plants in the forest.

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(1 mark)

4

Turn over ▶

Do not write outside the box

2 In a species of snail, shell colour is controlled by a gene with three alleles. The shell may be brown, pink or yellow. The allele for brown, $\mathbf{C^B}$, is dominant to the other two alleles. The allele for pink, $\mathbf{C^P}$, is dominant to the allele for yellow, $\mathbf{C^Y}$.

2 (a) Explain what is meant by a *dominant* allele.

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(1 mark)

2 (b) Give **all** the genotypes which would result in a brown-shelled snail.

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(1 mark)

2 (c) A cross between two pink-shelled snails produced only pink-shelled and yellow-shelled snails. Use a genetic diagram to explain why.

(3 marks)

Do not write outside the box

2 (d) The shells of this snail may be unbanded or banded. The absence or presence of bands is controlled by a single gene with two alleles. The allele for unbanded, **B**, is dominant to the allele for banded, **b**.

A population of snails contained 51 % unbanded snails. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be heterozygous for this gene. Show your working.

Answer .... %

(3 marks)

8

Turn over for the next question

Turn over ▶

Do not write outside the box

3 (a) Explain what is meant by the ecological term community.

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(1 mark)

3 (b) Scientists investigated the distribution of three species of fish in a lake. They recorded the range of depths where each species was found. The table shows their results.

Species of fish	Range of depths / m
White bass	0 to 8.4
Walleye	6.8 to 10.0
Sauger	7.2 to 14.6

3 (b) (i) Use information from the table to give the range of depths at which all three species of fish may be found living together.

Answer .... m

(1 mark)

3 (b) (ii) Suggest and explain **one** advantage to the fish of occupying different depths in the lake.

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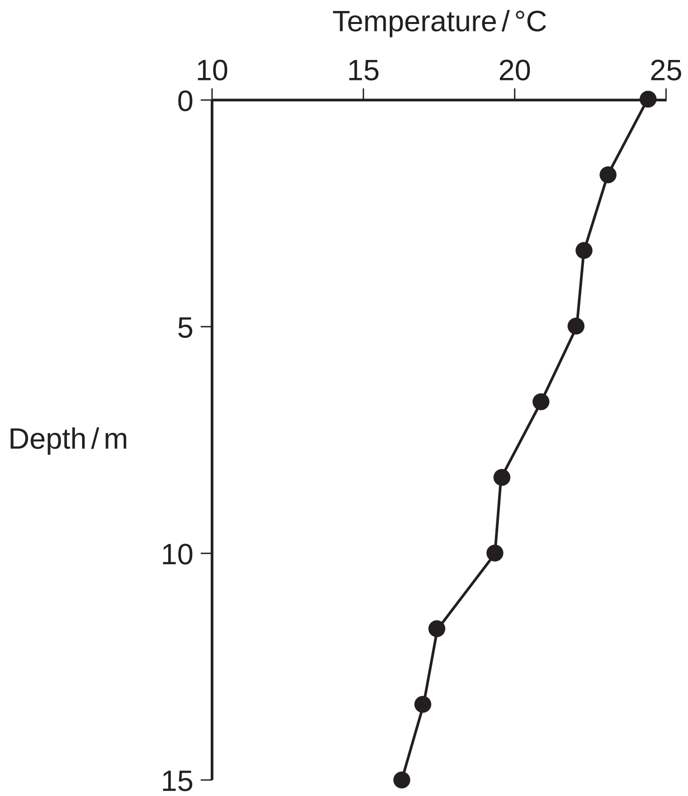
(2 marks)

Do not write outside the box

3 (c) The graph shows the relationship between the depth and the temperature of the water in the lake.



A student concluded that the temperature of the water in the lake determined the depth at which the species of fish were found. Use the table and the graph to evaluate this conclusion.

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(3 marks)

(Extra space) ....

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7

Turn over ▶

Do not write outside the box

4 **(a)** The genetic code is described as being degenerate. What does this mean?

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(1 mark)

(b) What is a codon?

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(2 marks)

(c) (i) What is the role of RNA polymerase during transcription?

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(1 mark)

(c) (ii) mRNA can be converted to cDNA.

Name the enzyme used in this process.

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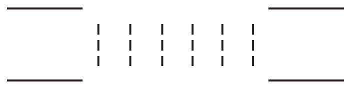
(1 mark)

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

Do not write outside the box

4 (d) The diagram shows the base sequence on DNA where a restriction endonuclease cuts DNA.



Use evidence from the diagram to explain what is meant by a palindromic recognition sequence on DNA.

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(1 mark)

Turn over for the next question

G G A T C C

C C T A G G

Do not write outside the box

5 (a) Insect pests of crop plants can be controlled by chemical pesticides or biological agents.
Give **two** advantages of using biological agents.

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2 ....

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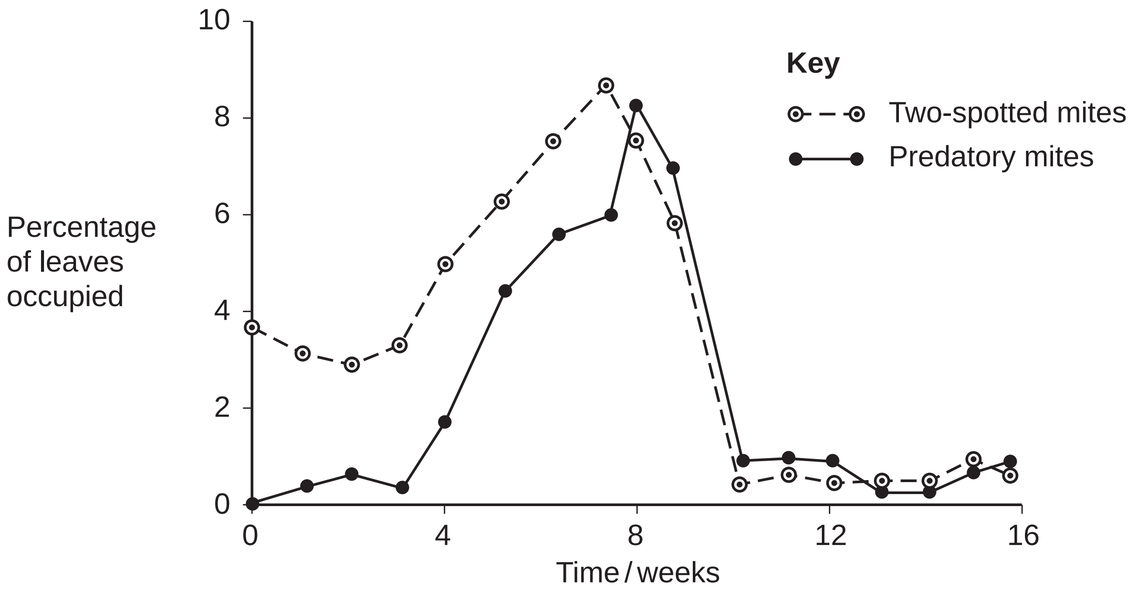
(2 marks)

Two-spotted mites are pests of strawberry plants. Ecologists investigated the use of predatory mites to control two-spotted mites. They released predatory mites on strawberry plants infested with two-spotted mites. They then recorded the percentage of strawberry leaves occupied by two-spotted mites and by predatory mites over a 16-week period. The results are shown on the graph.



5 (b) Describe how the percentage of leaves occupied by predatory mites changed during the period of this investigation.

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(2 marks)

Do not write outside the box

5 (c) The ecologists concluded that in this investigation control of the two-spotted mite by a biological agent was effective. Explain how the results support this conclusion.

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(2 marks)

5 (d) Farmers who grow strawberry plants and read about this investigation might decide **not** to use these predatory mites. Suggest **two** reasons why.

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2 ....

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(2 marks)

5 (e) The ecologists repeated the investigation but sprayed chemical pesticide on the strawberry plants after 10 weeks. After 16 weeks no predatory mites were found but the population of two-spotted mites had risen significantly. Suggest an explanation for the rise in the two-spotted mite population.

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(2 marks)

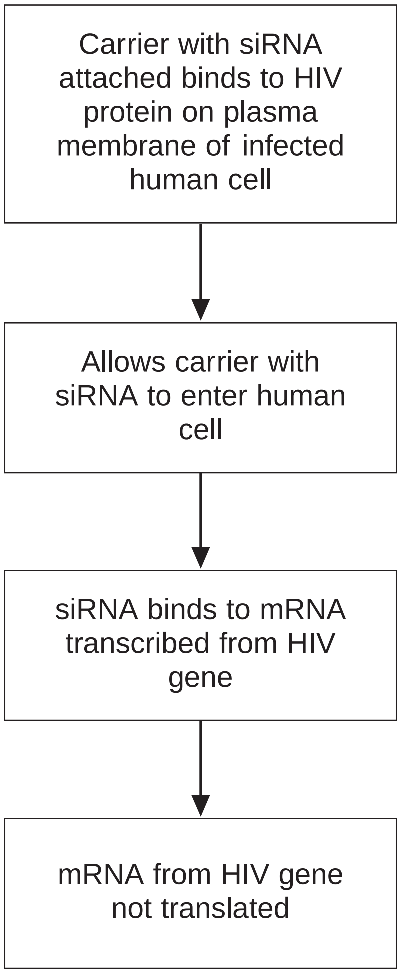
10

Turn over ▶

Do not write outside the box

6 Human immunodeficiency virus (HIV) particles have a specific protein on their surface. This protein binds to a receptor on the plasma membrane of a human cell and allows HIV to enter. This HIV protein is found on the surface of human cells after they have become infected with HIV.

Scientists made siRNA to inhibit expression of a specific HIV gene inside a human cell. They attached this siRNA to a carrier molecule. The flow chart shows what happens when this carrier molecule reaches a human cell infected with HIV



Do not write outside the box

6 (a) When siRNA binds to mRNA, name the complementary base pairs holding the siRNA and mRNA together. One of the bases is named for you.

.... with ....

.... **Adenine** .... with ....

(1 mark)

6 (b) This siRNA would **only** affect gene expression in cells infected with HIV.

Suggest **two** reasons why.

1 ....

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2 ....

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(4 marks)

6 (c) The carrier molecule on its own may be able to prevent the infection of cells by HIV.

Explain how.

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(2 marks)

Do not write outside the box

7 Biofuels are fuels which can be produced from plants. Scientists have developed a standard method called net life-cycle carbon dioxide production (NLP) to find the overall effect of producing and using particular biofuels on carbon dioxide production.

7 (a) Petroleum is used as a comparison when evaluating NLPs of biofuels. Suggest **two** reasons why.

1 ....

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2 ....

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(2 marks)

7 (b) Biofuels are produced by a variety of different companies. The scientists who developed the method of calculating NLPs are funded by the government's environmental agency.
Suggest **two** advantages of this method being developed by these scientists.

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2 ....

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(2 marks)

Scientists compared the percentage change in carbon dioxide production if different biofuels replaced petroleum. Their results are shown in the table.

Biofuel	Percentage change in carbon dioxide production if this fuel replaced petroleum
Corn ethanol	–18
Soy-based biodiesel	+4
Switch-grass ethanol	–124
Sugar-cane ethanol	–26

7 (c) (i) The scientists suggested that using biofuels would have a great effect on limiting climate change. Use the data in the table to evaluate this suggestion.

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(4 marks)

(*Extra space)* ....

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Question 7 continues on the next page

Do not write outside the box

7 (c) (ii) Producing and using biofuels from corn ethanol results in a negative percentage change in carbon dioxide production. Explain why.

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(2 marks)

7 (d) Ethanol can be produced from cellulose. It is produced by anaerobic respiration of cellulose-based biomass by microorganisms. The cellulose is pre-treated by adding cellulose-digesting enzymes before it is used in anaerobic respiration. Suggest why pre-treatment is necessary.

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(3 marks)

(Extra space) ....

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7 (e) Large areas of land have to be used to grow the plants to make biofuels. Ecologists have suggested that changes in land use could lead to a decrease in biodiversity. Suggest how changes in land use could lead to a decrease in biodiversity.

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(2 marks)

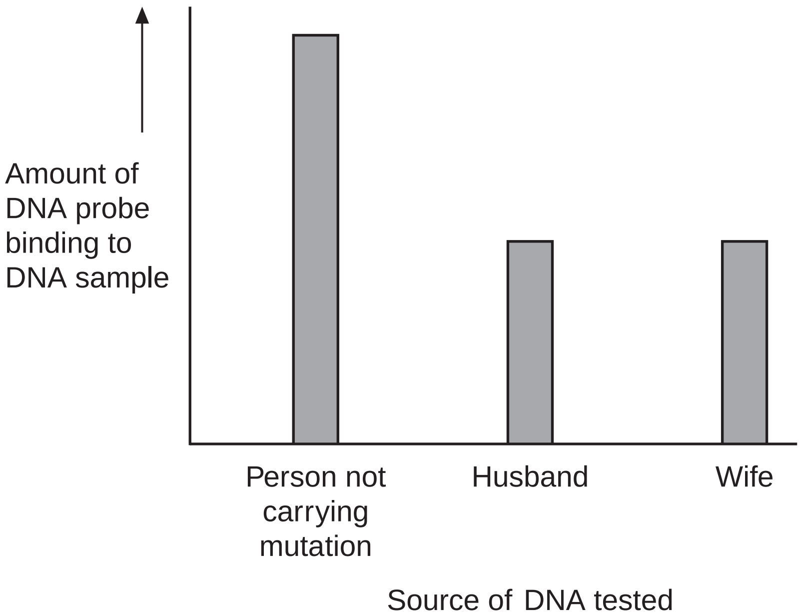
15

8 A husband and wife wanted to know whether they were carriers of the mutated form of a gene. This mutation is a deletion that causes a serious inherited genetic disorder in people who are homozygous.

A geneticist took samples of DNA from the husband and the wife. He used a DNA probe to look for the deletion mutation. The DNA probe was specific to a particular base sequence in an exon in the gene. Exons are the coding sequences in a gene.

The geneticist compared the couple's DNA with that of a person known not to carry this mutation.

The chart shows the geneticist's results.



8 (a) The geneticist told the couple they were both carriers of the mutated gene. Explain how he reached this conclusion.

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(3 marks)

(Extra space) ....

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Do not write outside the box

8 (b) The DNA probe the geneticist used was for an exon in the DNA, **not** an intron. Explain why.

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(3 marks)

(Extra space) ....

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8 (c) To make the DNA probe, the geneticist had to find the base sequence of the normal gene. Once he had copies of the gene, what methods would he use to find the base sequence of the gene?

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(2 marks)

Do not write outside the box

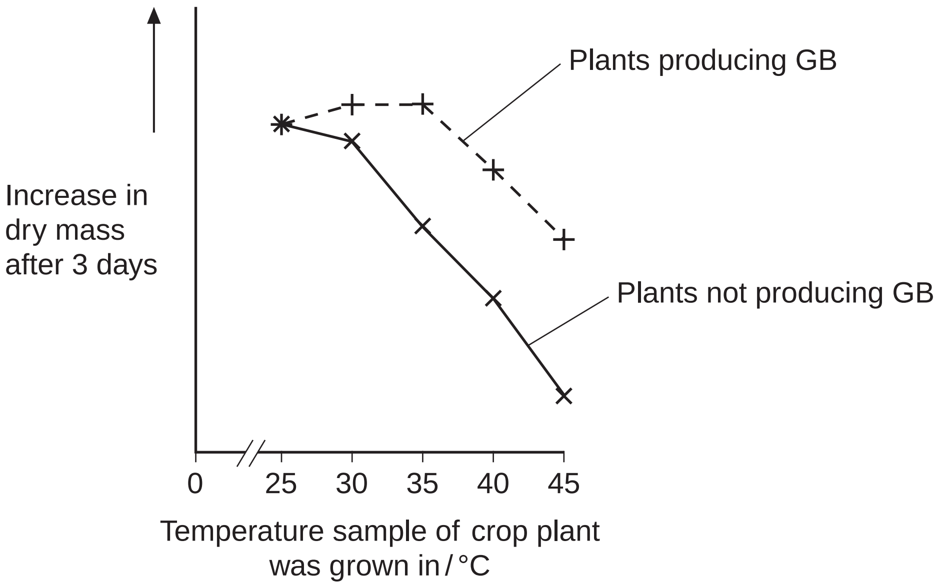
9 Some species of crop plant produce a substance called glycinebetaine (GB).

Scientists transferred the gene for GB into a species of crop plant that does not normally produce GB. These genetically modified plants then produced GB.

The scientists grew large numbers of the same crop plant with and without the gene at different temperatures. After 3 days, they found the increase in dry mass of the plants.

Figure 1 shows their results.

Figure 1



9 (a) Describe the effect on growth of transferring the gene for GB into this plant.

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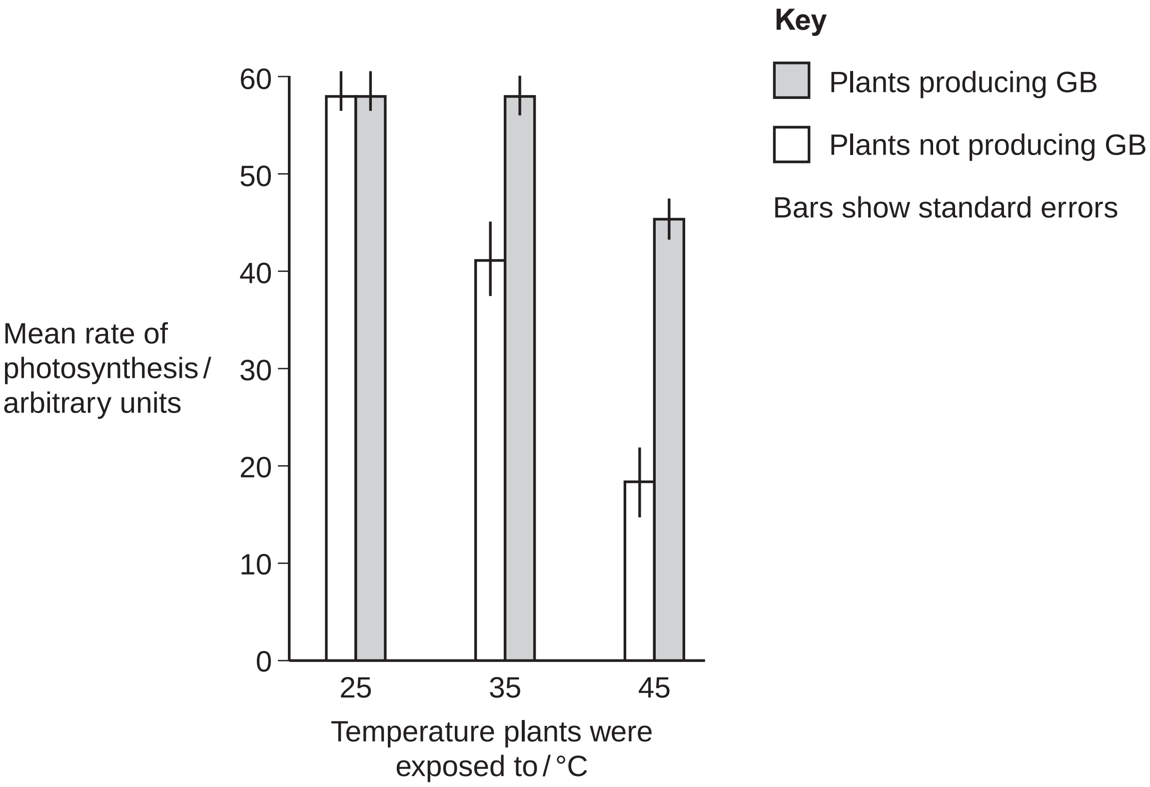
(2 marks)

Do not write outside the box

9 (b) The scientists measured the rate of photosynthesis in plants that produce GB and plants that do not produce GB at 25 ºC, 35 ºC and 45 ºC.

Figure 2 shows their results.

Figure 2



9 (b) (i) The scientists concluded that the production of GB protects photosynthesis from damage by high temperatures.

Use these data to support this conclusion.

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(1 mark)

Question 9 continues on the next page

Turn over ▶

Do not write outside the box

9 (b) (ii) Use the data from **Figure 2** for plants that do **not** produce GB to explain the effect of temperature on changes in dry mass of the plants shown in **Figure 1**.

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(4 marks)

(Extra space) ....

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Rubisco activase is an enzyme found in chloroplasts. It activates the light-independent reaction of photosynthesis.

The scientists discovered that, as temperature increased from 25 ºC to 45 ºC, rubisco activase began attaching to thylakoid membranes in chloroplasts and this stopped it working.

9 (c) Rubisco activase stops working when it attaches to a thylakoid.

Use your knowledge of protein structure to explain why.

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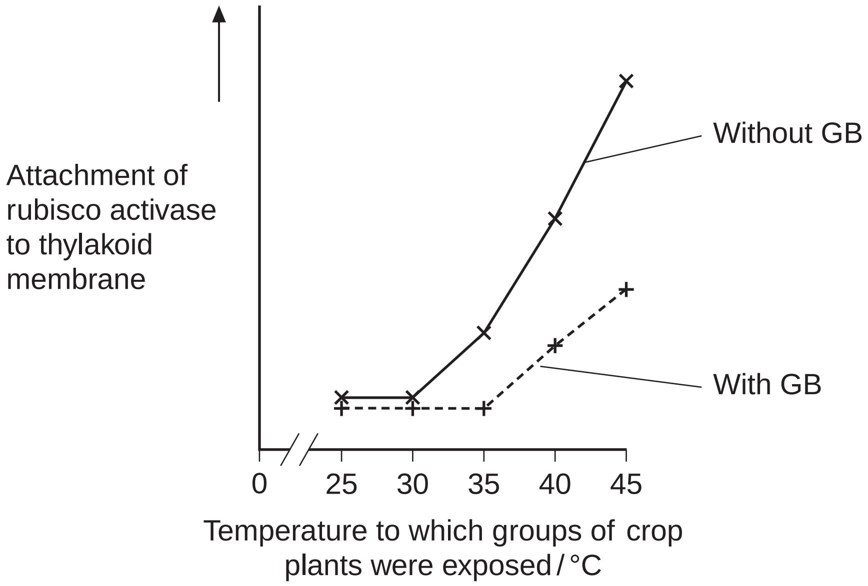
(2 marks)

Do not write outside the box

9 (d) The scientists investigated the effect of GB on attachment of rubisco activase to thylakoid membranes at different temperatures.

Figure 3 shows their results.

Figure 3



Use information from **Figure 2** and **Figure 3** to suggest how GB protects the crop plant from high temperatures.

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(4 marks)

(Extra space) ....

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Question 9 continues on the next page

Turn over ▶

Do not write outside the box

9 (e) The scientists' hypothesis at the start of the investigation was that crop plants genetically engineered to produce GB would become more resistant to high environmental temperatures.
The scientists developed this hypothesis on the basis of previous research on crops that are grown in hot climates.

Suggest how the scientists arrived at their hypothesis.

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(2 marks)

15

Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) The membranes of different types of cells are involved in many different functions.

(25 marks)

OR

10 (b) There are many different types of relationships and interactions between organisms.

(25 marks)

If you want to make a plan write it here.

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Turn over ▶