Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

General Certificate of Education
Advanced Level Examination
June 2013

Biology BIOL5

Unit 5 Control in cells and in organisms

Monday 17 June 2013 1.30 pm to 3.45 pm

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

Time allowed
- 2 hours 15 minutes

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 boxes or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- 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 100.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Advice
- You are advised to spend no longer than 40 minutes on the essay.

Do not write outside the box

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

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

.....

.....

.....

(1 mark)

1 (b) What is a codon?

.....

.....

.....

.....

.....

(2 marks)

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

.....

.....

.....

(1 mark)

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

Name the enzyme used in this process.

.....

(1 mark)

Do not write outside the box

1 (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.

.....

.....

.....

(1 mark)

6

Turn over for the next question

Do not write outside the box

2 (a) Describe the part played by each of the following in myofibril contraction.

2 (a) (i) Tropomyosin

.....

.....

.....

.....

.....

(2 marks)

2 (a) (ii) Myosin

.....

.....

.....

.....

.....

(2 marks)

Do not write outside the box

2 (b) The table shows features of fast and slow muscle fibres.

Feature	Fast muscle fibre	Slow muscle fibre
Type of respiration	Mainly anaerobic	Mainly aerobic
Glycogen	High concentration	Low concentration
Capillaries	Few	Many

Use information from the table to suggest and explain **one** advantage of:

2 (b) (i) the high glycogen content of fast muscle fibres

.....

.....

.....

.....

.....

(2 marks)

2 (b) (ii) the number of capillaries supplying slow muscle fibres.

.....

.....

.....

.....

.....

(2 marks)

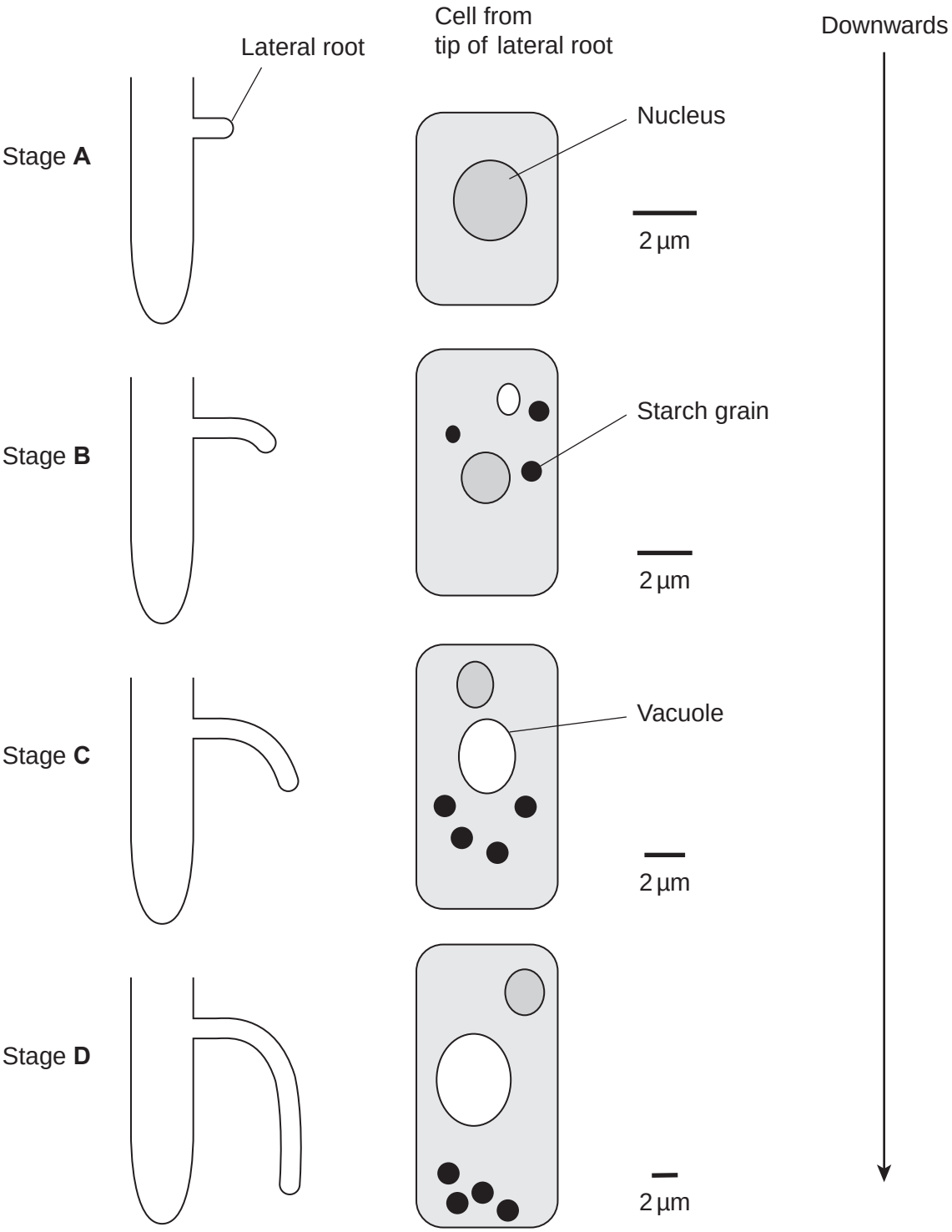
8

Turn over ▶

Do not write outside the box

3 Scientists investigated the response of lateral roots to gravity. Lateral roots grow from the side of main roots.

The diagrams show four stages, **A** to **D**, in the growth of a lateral root and typical cells from the tip of the lateral root in each stage. All of the cells are drawn with the bottom of the cell towards the bottom of the page.



Do not write outside the box

3 (a) Describe **three** changes in the root tip cells between stages **A** and **D**.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

3 (b) The scientists' hypothesis was that there was a relationship between the starch grains in the root tip cells and the bending and direction of growth of lateral roots.

Does the information in the diagram support this hypothesis? Give reasons for your answer.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

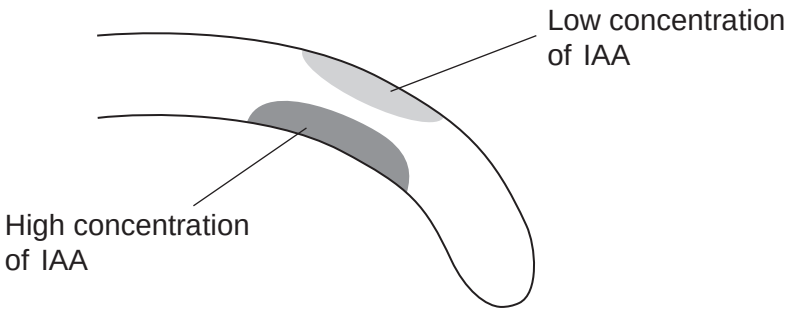
.....

.....

Question 3 continues on the next page

Do not write outside the box

3 (c) The diagram shows the distribution of indoleacetic acid (IAA) in the lateral root at Stage **B**.



Explain how this distribution of IAA causes the root to bend.

.....

.....

.....

.....

.....

(2 marks)

8

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

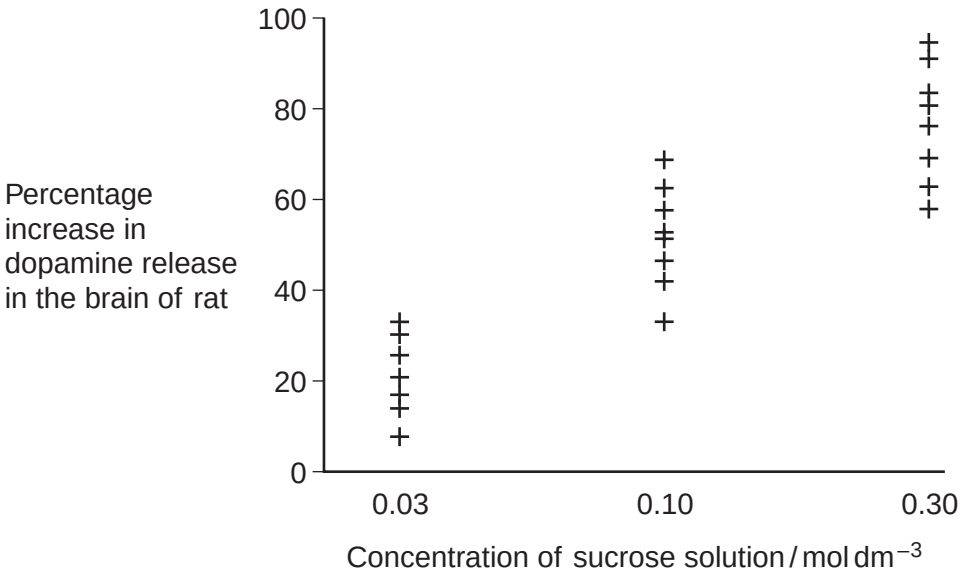
Do not write outside the box

4 The release of a substance called dopamine in some areas of the brain increases the desire to eat.

Scientists measured increases in the release of dopamine in the brains of rats given different concentrations of sucrose solution to drink.

Sucrose stimulates taste receptors on the tongue.

The graph shows their results. Each point is the result for one rat.



4 (a) The scientists concluded that drinking a sucrose solution had a positive feedback effect on the rats' desire to eat.

How do these data support this conclusion?

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

.....

.....

Do not write outside the box

4 (b) In this investigation, the higher the concentration of sucrose in a rat's mouth, the higher the frequency of nerve impulses from each taste receptor to the brain.

If rats are given very high concentrations of sucrose solution to drink, the refractory period makes it impossible for information about the differences in concentration to reach the brain.
Explain why.

.....

.....

.....

.....

.....

(2 marks)

4 (c) In humans, when the stomach starts to become full of food, receptors in the wall of the stomach are stimulated. This leads to negative feedback on the desire to eat.
Suggest why this negative feedback is important.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

.....

.....

8

Do not write outside the box

5 Hyperthermia is a condition in which a person's body temperature is above 37.5 ºC. This happens when a person's body produces or absorbs more heat than it loses to the environment.

Doctors recruited healthy volunteers. At a room temperature of 20 ºC, the doctors measured each volunteer's:

- body temperature
- rate of oxygen consumption
- rate of carbon dioxide production.

Each volunteer then put on a suit that covered the whole body. Water at 38 ºC was circulated through pipes in the suit. This caused the volunteer to develop hyperthermia.

The doctors' results are shown in the table.

	At 20 ºC	**In suit at 38 ºC**	**P value**
Mean body temperature / ºC	36.82	38.62	< 0.001
Mean rate of oxygen consumption / $cm^3\ kg^{-1}\ minute^{-1}$	3.31	4.16	< 0.05
Mean rate of carbon dioxide production / $cm^3\ kg^{-1}\ minute^{-1}$	2.68	3.03	> 0.05

The doctors carried out statistical tests to see whether or not the differences in the results were significant. The P values from these tests are shown in the table.

5 (a) Calculate the percentage increase in mean body temperature.
Show your working.

Percentage increase .....

(2 marks)

Do not write outside the box

5 (b) Explain **one** way in which a suit with water circulating in it at 38 ºC causes hyperthermia.

.....

.....

.....

.....

.....

(2 marks)

5 (c) Were the changes produced by hyperthermia significant? Give reasons for your answer. You should use the P values in your answer.

.....

.....

.....

.....

.....

(2 marks)

5 (d) Using information from the table, explain the increase in mean rate of oxygen consumption.

.....

.....

.....

.....

.....

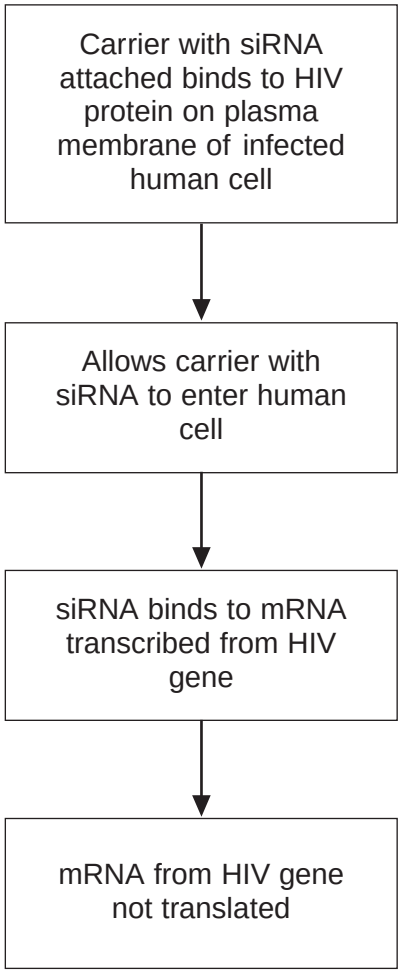
(2 marks)

8

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 .....

.....

.....

.....

2 .....

.....

.....

.....

(4 marks)

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

Explain how.

.....

.....

.....

.....

.....

(2 marks)

7

Do not write outside the box

7 Serotonin is a neurotransmitter released in some synapses in the brain. It is transported back out of the synaptic gap by a transport protein in the pre-synaptic membrane.

7 (a) Serotonin diffuses across the synaptic gap and binds to a receptor on the post-synaptic membrane.

Describe how this causes depolarisation of the post-synaptic membrane.

.....

.....

.....

.....

.....

(2 marks)

7 (b) It is important that a neurotransmitter such as serotonin is transported back out of synapses. Explain why.

.....

.....

.....

.....

.....

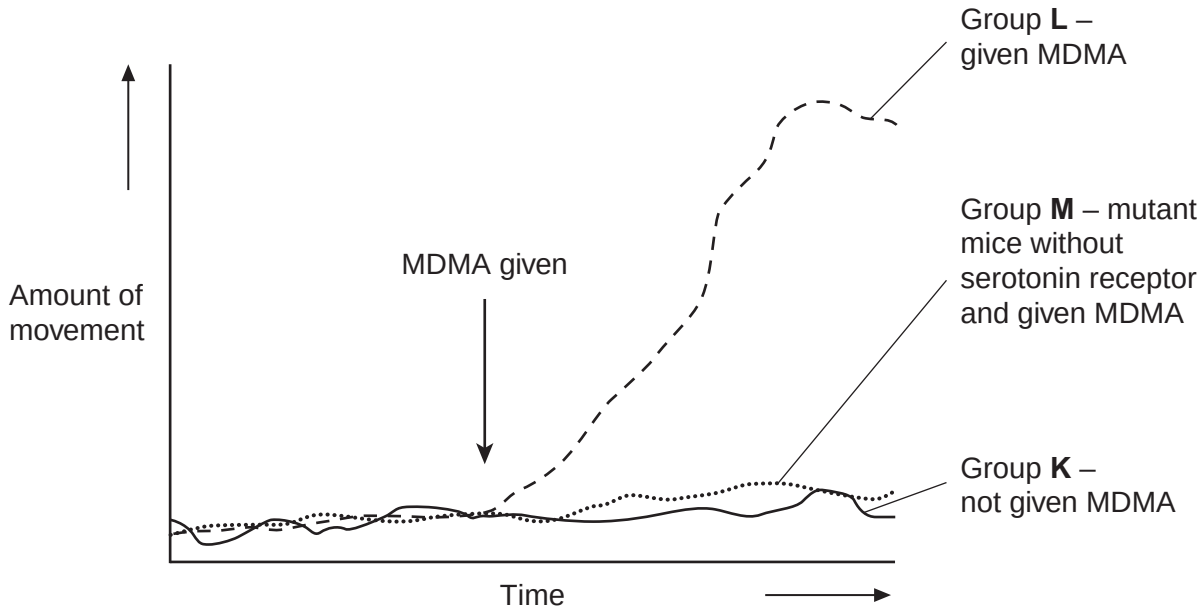
(2 marks)

Do not write outside the box

7 (c) Scientists investigated the effect of a drug called MDMA on movement of mice. They measured the amount of movement of three groups of mice, **K**, **L** and **M**.

- Group **K**, mice not given MDMA.
- Group **L**, mice given MDMA.
- Group **M**, mutant mice that did not produce a serotonin receptor on their post-synaptic membranes and were given MDMA.

The graph shows their results.



The scientists concluded that MDMA affects movement by binding to serotonin receptors.

How do these results support this conclusion?

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

.....

.....

7

Turn over ▶

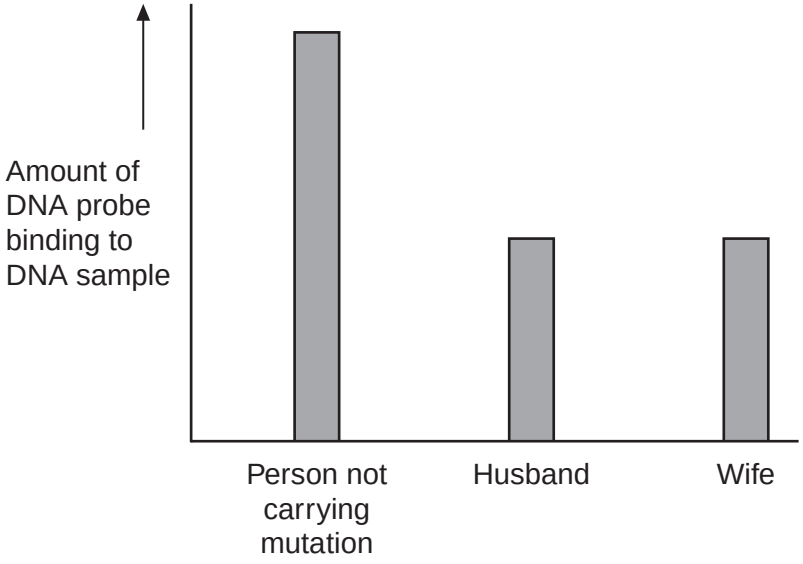
Do not write outside the box

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.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

.....

.....

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.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

.....

.....

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?

.....

.....

.....

.....

.....

(2 marks)

8

Do not write outside the box

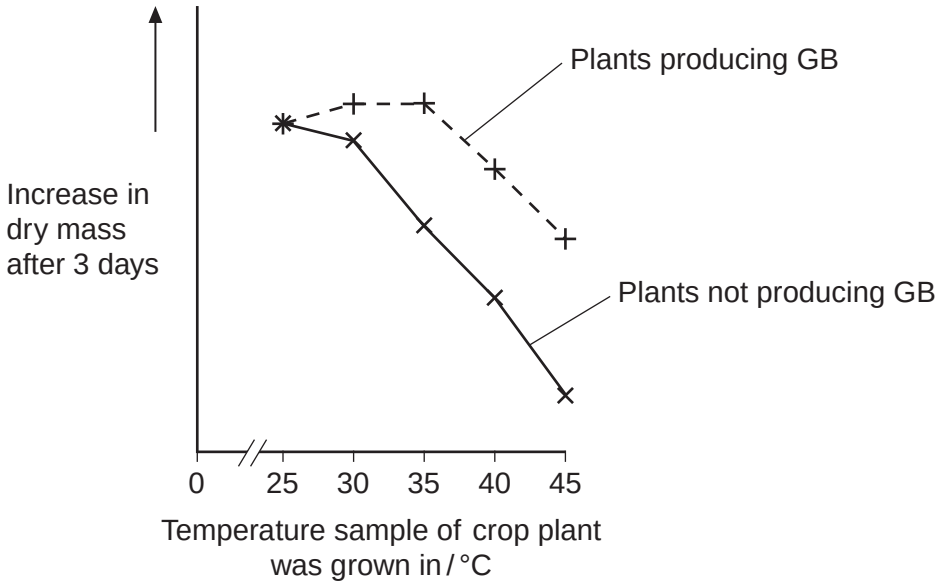
9 Some species of crop plant produce a substance called glycinebetaine (GB).

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.

.....

.....

.....

.....

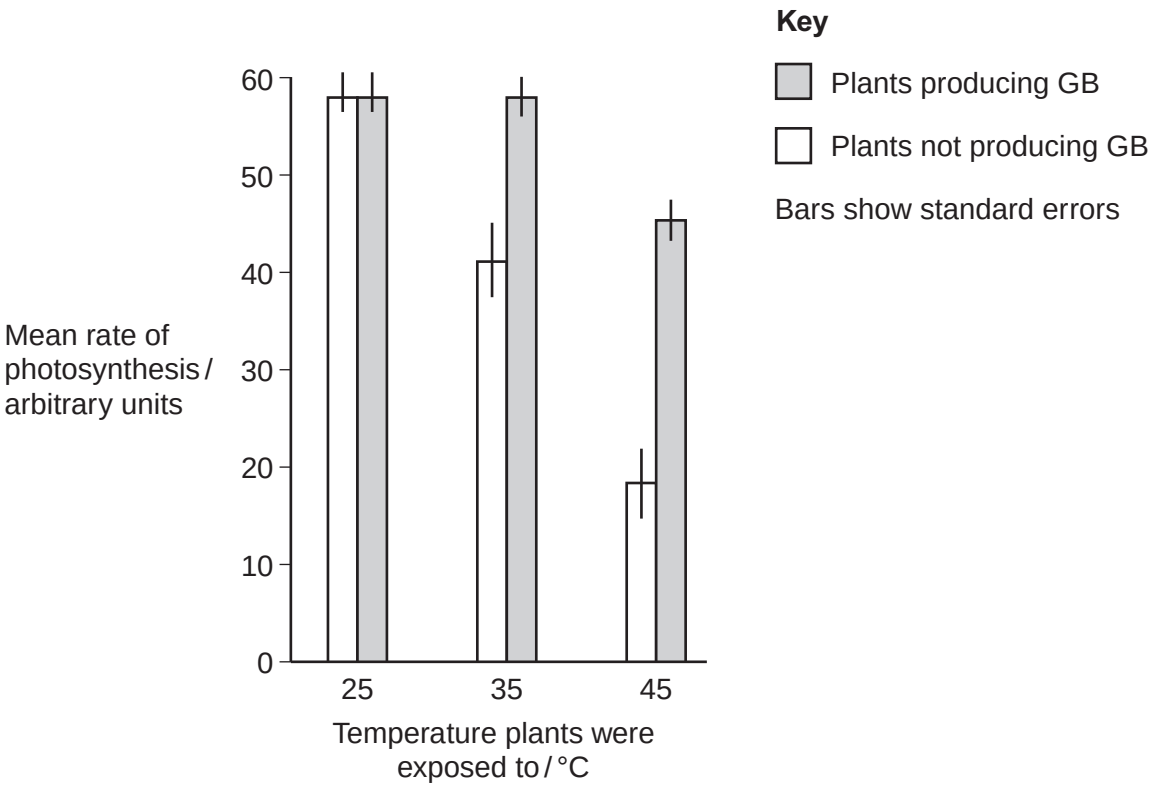
.....

(2 marks)

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.

.....

.....

.....

(1 mark)

Question 9 continues on the next page

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**.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

(Extra space) .....

.....

.....

.....

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.

.....

.....

.....

.....

.....

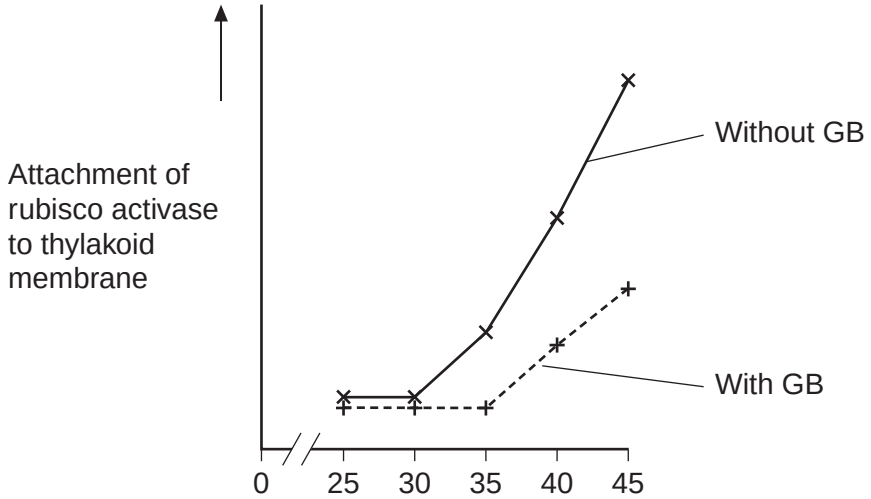
(2 marks)

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.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

(Extra space) .....

.....

.....

.....

Question 9 continues on the next page

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.

.....

.....

.....

.....

.....

(2 marks)

15

Do not write outside the box

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.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Do not write outside the box

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

END OF QUESTIONS

25