AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

A-level BIOLOGY

Unit 5 Control in cells and in organisms

Tuesday 20 June 2017 Morning Time allowed: 2 hours 15 minutes

Materials

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

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

Do not write outside the box

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

1 (a) Complete **Table 1** to show the differences between DNA, mRNA and tRNA.

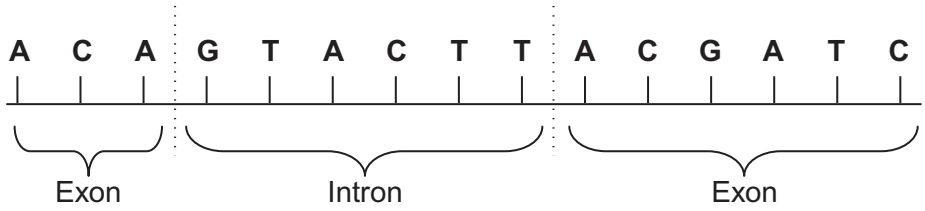
[2 marks]

Table 1

Type of nucleic acid	Hydrogen bonds present (✓) or not present (✗)	Number of polynucleotide strands in molecule
DNA		
mRNA		
tRNA		

1 (b) **Figure 1** shows the bases on one strand of a piece of DNA.

Figure 1



In the space below, give the sequence of bases on the mRNA produced using this DNA.

[2 marks]

1 (c) What is a codon?

[1 mark]

Do not write outside the box

1 (d) Which of these is the type of gene that **slows** cell division?
Tick (✓) **one** box.

[1 mark]

Mutated tumour suppressor gene ☐

Tumour suppressor gene ☐

Proto-oncogene ☐

Mutated proto-oncogene ☐

6

Turn over for the next question

Do not write outside the box

2 (a) The structure of a synapse ensures that the transmission of information across the synapse is unidirectional.

Explain how.

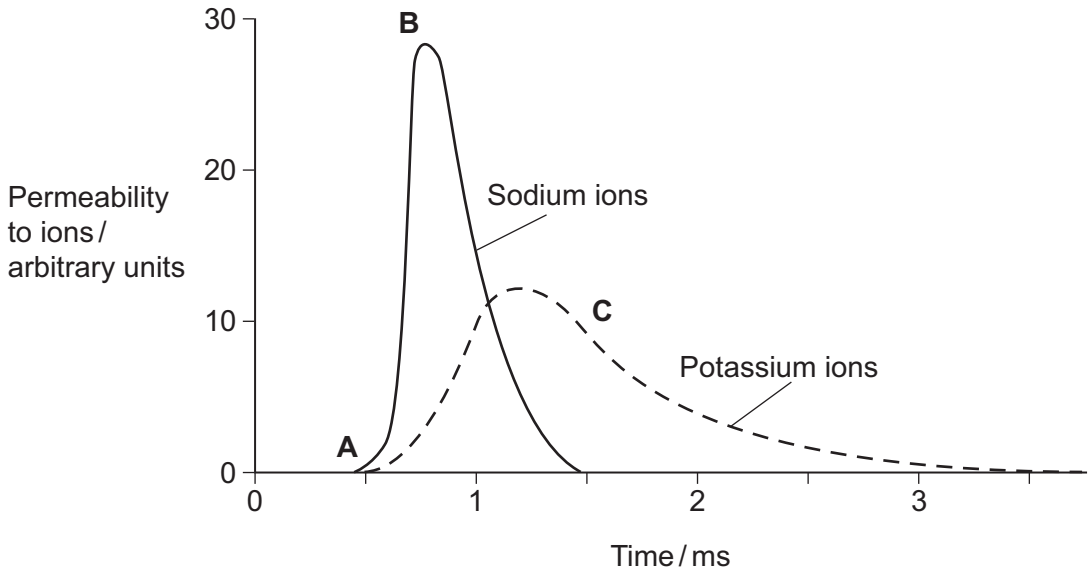
[2 marks]

[Extra space]

During an action potential, the permeability of the cell-surface membrane of an axon changes.

Figure 2 shows changes in permeability of the membrane to sodium ions (Na^+) and to potassium ions (K^+) during a single action potential.

Figure 2



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2 (b) Use information from **Figure 2** to explain what happens to the membrane potential between times **A** and **B**.

[3 marks]

[Extra space]

2 (c) Use information from **Figure 2** to explain what happens to the membrane potential between times **B** and **C**.

[3 marks]

[Extra space]

8

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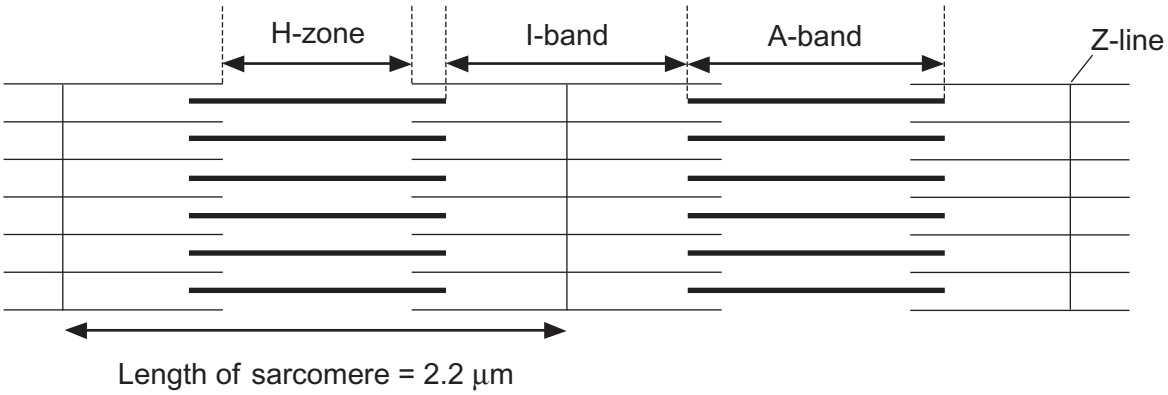
3 **Figure 3** shows two relaxed sarcomeres from skeletal muscle.

Figure 3



3 (a) When the sarcomeres contract, what happens to the length of

3 (a) (i) the H-zone

[1 mark]

_____

3 (a) (ii) the A-band?

[1 mark]

_____

3 (b) The length of each sarcomere in **Figure 3** is 2.2 μm.

Use this information to calculate the magnification of the diagram.
Show your working.

[2 marks]

Magnification _____

Do not write outside the box

3 (c) Explain how calcium ions **start** muscle contraction.

[3 marks]

[Extra space]

7

Turn over for the next question

Do not write outside the box

4 (a) Describe the difference between negative feedback and positive feedback.

[2 marks]

[Extra space]

Levonorgestrel is a drug used for emergency contraception for women who have had unprotected sexual intercourse.

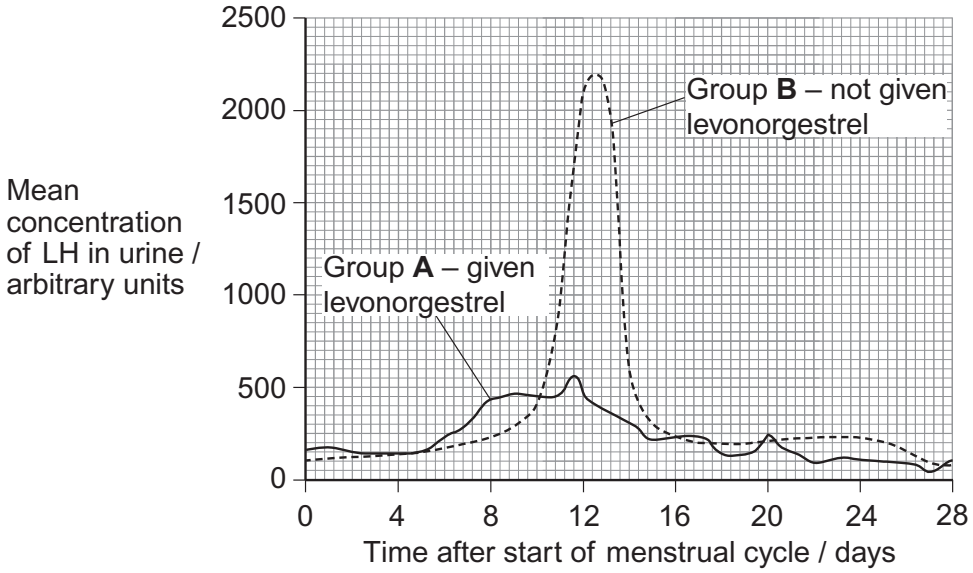
Doctors investigated the effect of levonorgestrel on two large groups of volunteers, Group **A** and Group **B**.

- Women in Group **A** were given levonorgestrel two days before ovulation.
- Women in Group **B** were not given levonorgestrel.

The doctors measured the mean concentration of LH in the urine of the women in each group during their menstrual cycles.

Figure 4 shows their results.

Figure 4



Do not write outside the box

4 (b) At day 12, what is the percentage fall in the mean concentration of LH with levonorgestrel, compared to without levonorgestrel?

Show your working.

[2 marks]

_____%

4 (c) Use the information provided to explain how levonorgestrel prevents a woman becoming pregnant.

[3 marks]

[Extra space]

Question 4 continues on the next page

Do not write outside the box

4 (d) The combined contraceptive pill is used as a method of birth control. One effect of the combined contraceptive pill is to reduce the release of FSH.

The way in which the combined contraceptive pill works is different from the way levonorgestrel works.

Use the information given and your knowledge of the role of FSH in the oestrus cycle to explain how it is different.

[2 marks]

[Extra space]

9

Do not write outside the box

5 (a) Desert iguanas are lizards that live in hot, dry conditions. Scientists measured the rate of oxygen consumption of desert iguanas at different body temperatures.

Some of the scientists' results are shown in **Table 2**.

Table 2

Body temperature / °C	Mean rate of oxygen consumption at rest / $cm^3 g^{-1} h^{-1}$
25	0.4
30	0.7
35	1.2
40	1.5

5 (a) (i) Explain how an increase in the iguana's body temperature affects its oxygen consumption when it is at rest.

[3 marks]

[Extra space]

5 (a) (ii) The units in **Table 2** allowed the scientists to compare the oxygen consumptions of different iguanas.

Explain how.

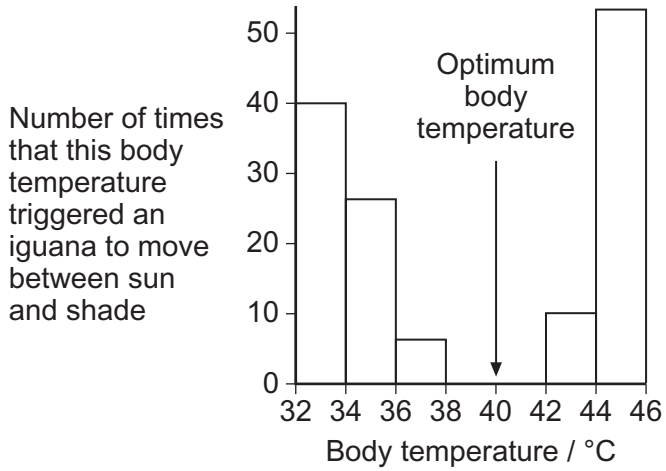
[1 mark]

Question 5 continues on the next page

Do not write outside the box

5 (b) The scientists then investigated how body temperature affected the behaviour of desert iguanas. They kept the iguanas in cages. Half of each cage was in the sun and half was covered to provide shade. The scientists continuously measured the body temperature of each iguana. They also recorded the body temperature when the iguana moved between sun and shade. Their results are shown in **Figure 5**.

Figure 5



5 (b) (i) Describe how the movements of the iguanas between sun and shade are related to body temperature.

[1 mark]

5 (b) (ii) The behaviour of the desert iguanas keeps their body temperatures within a narrow range.

Explain how.

[2 marks]

[Extra space]

Do not write outside the box

5 (c) At high temperatures, a desert iguana keeps its mouth wide open and breathes in and out rapidly. This is called panting.

Explain how panting helps to reduce the body temperature of an iguana.

[2 marks]

[Extra space]

9

Turn over for the next question

Do not write outside the box

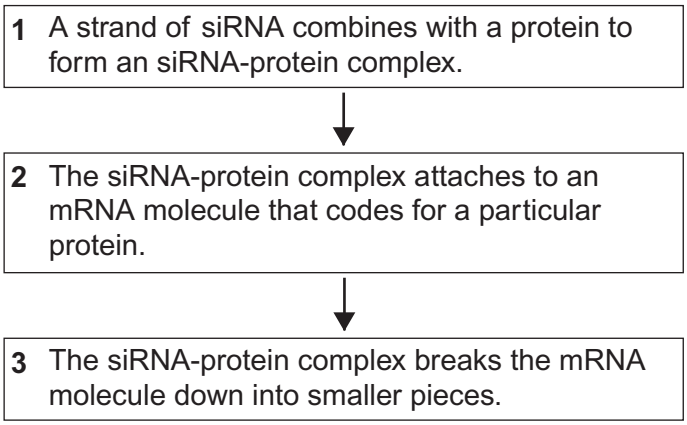
6 (a) Transcriptional factors are important in the synthesis of particular proteins.

Describe how.

[2 marks]

[Extra space]

6 (b) The flowchart shows how small interfering RNA (siRNA) affects the expression of a particular target gene.



6 (b) (i) The siRNA-protein complex attaches to an mRNA molecule coding for a particular protein (step **2**).

Explain what causes the siRNA to attach only to one sort of mRNA molecule.

[1 mark]

Do not write outside the box

6 (b) (ii) Describe and explain how expression of the target gene is affected by siRNA.

[2 marks]

[Extra space]

6 (b) (iii) Scientists have suggested that siRNA may be useful in treating some diseases.

Suggest why siRNA may be useful in treating disease.

[2 marks]

[Extra space]

7

Turn over for the next question

Do not write outside the box

7 (a) Cystic fibrosis (CF) is an inherited condition caused by a faulty allele of the CFTR gene. CF leads to damage to lung tissue.

Scientists are trialling a type of gene therapy to treat patients with CF. They obtained copies of healthy CFTR alleles and put them into plasmids. They then inserted the plasmids into liposomes. Liposomes are microscopic vesicles surrounded by a phospholipid bilayer. Patients inhale a spray containing these liposomes at regular intervals.

7 (a) (i) Outline a method the scientists could have used to put the healthy allele into plasmids.

[2 marks]

[Extra space]

7 (a) (ii) Suggest how the liposomes allow the healthy CFTR alleles to enter cells in a patient's lungs.

[2 marks]

[Extra space]

Do not write outside the box

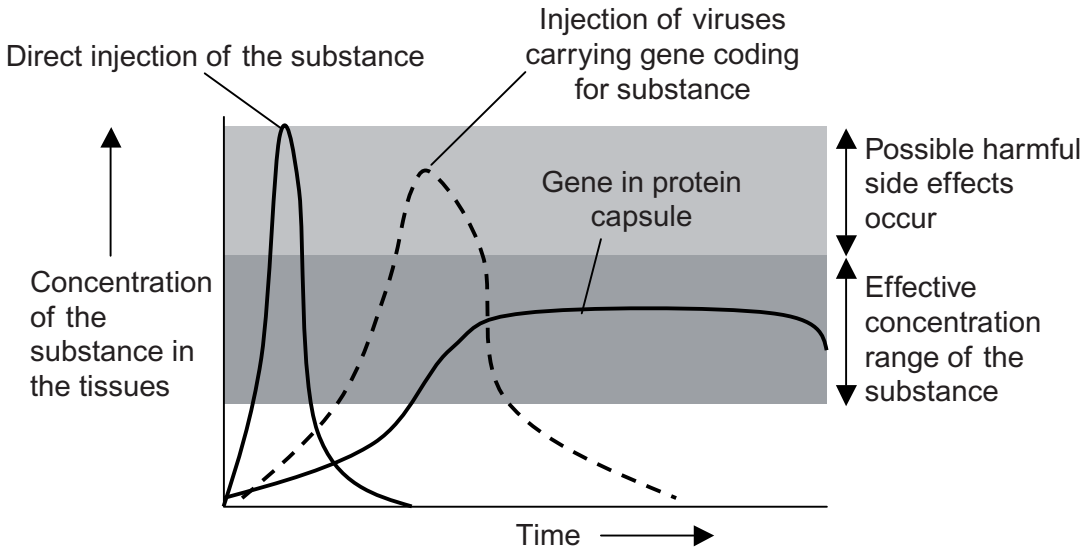
7 (b) Another group of scientists investigated three ways to introduce an important substance into people. These people were unable to make this substance because they had a defective gene.

The three methods the scientists used were as follows.

- The substance was injected directly into the person.
- Harmless viruses carrying the gene coding for the substance were injected into the person.
- Copies of the gene were put into protein capsules that were inserted into the person's tissues.

Figure 6 shows their results.

Figure 6



The scientists concluded that putting genes into protein capsules was a better method to use than the other two methods.

How does the information in **Figure 6** support their conclusion?

[3 marks]

7

Do not write outside the box

8 (a) Increased intensity of exercise leads to an increased heart rate. Describe how.

[3 marks]

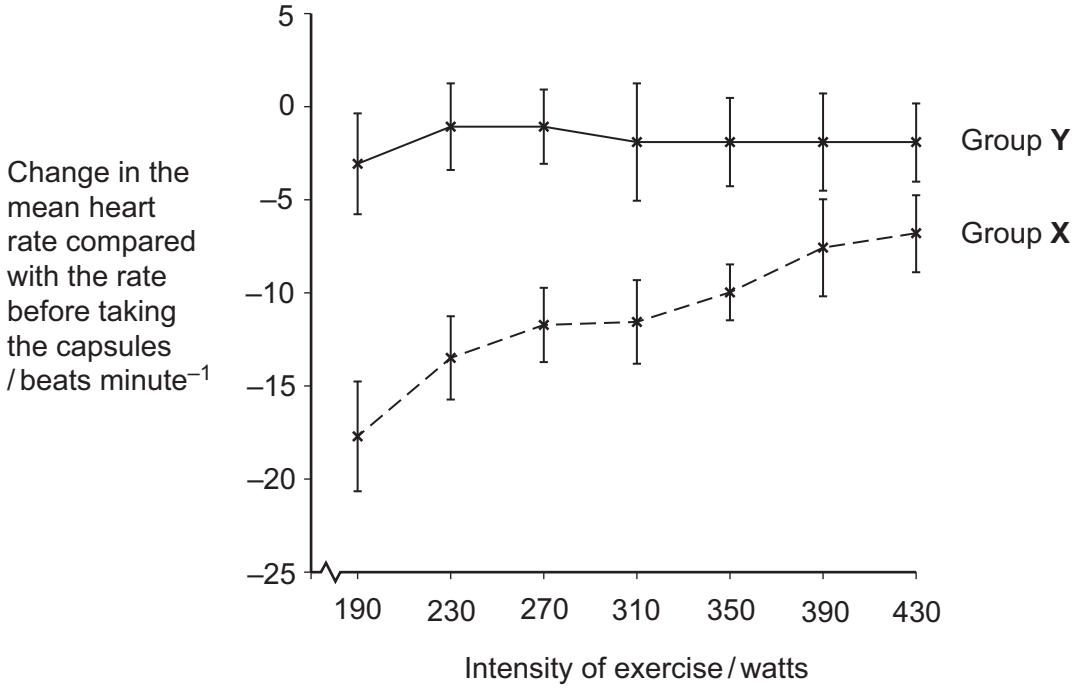
[Extra space]

8 (b) Scientists investigated the effect of taking omega-3 fatty acids in fish oil on heart rate during exercise. They recruited two large groups of volunteers, **X** and **Y**. For each group, they calculated the mean heart rates at different intensities of exercise. The volunteers were then given capsules to take for 8 weeks.

- The volunteers in Group **X** were given capsules containing omega-3 fatty acids in fish oil.
- The volunteers in Group **Y** were given capsules containing olive oil.

After 8 weeks, they repeated the measurements of mean heart rates at different intensities of exercise. **Figure 7** shows their results. The bars represent the standard deviations.

Figure 7



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8 (b) (i) The volunteers in Group **Y** were given capsules containing olive oil.

Explain why.

[1 mark]

8 (b) (ii) The scientists concluded that omega-3 fatty acids lower the heart rate during exercise.

Explain how the information in **Figure 7** supports this conclusion.

[3 marks]

[Extra space]

7

Turn over for the next question

Do not write outside the box

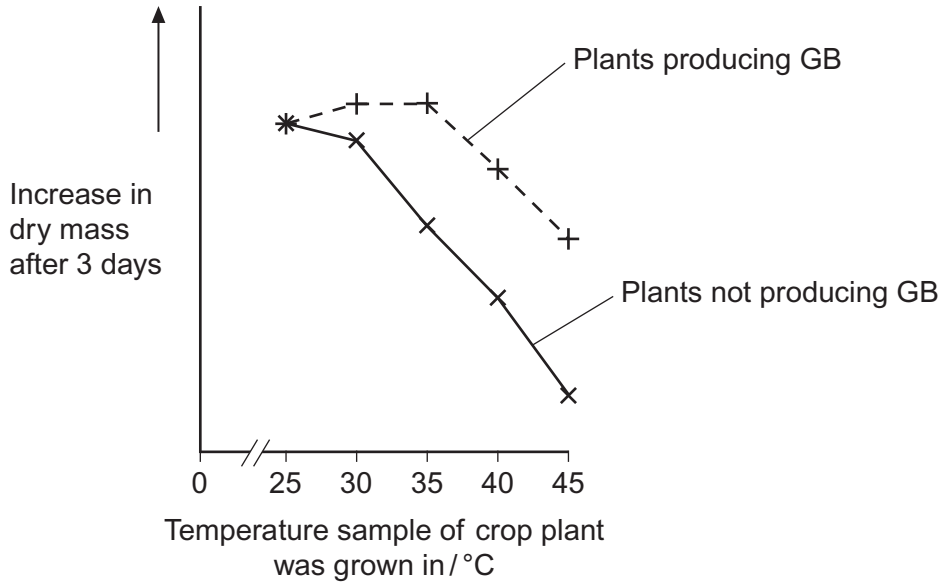
9 Some species of crop plant produce a substance called glycinebetaine (GB).

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 8 shows their results.

Figure 8



9 (a) All of the plants increased in dry mass during the investigation.

Describe the effect on growth of transferring the gene for GB into plants that did **not** previously produce GB.

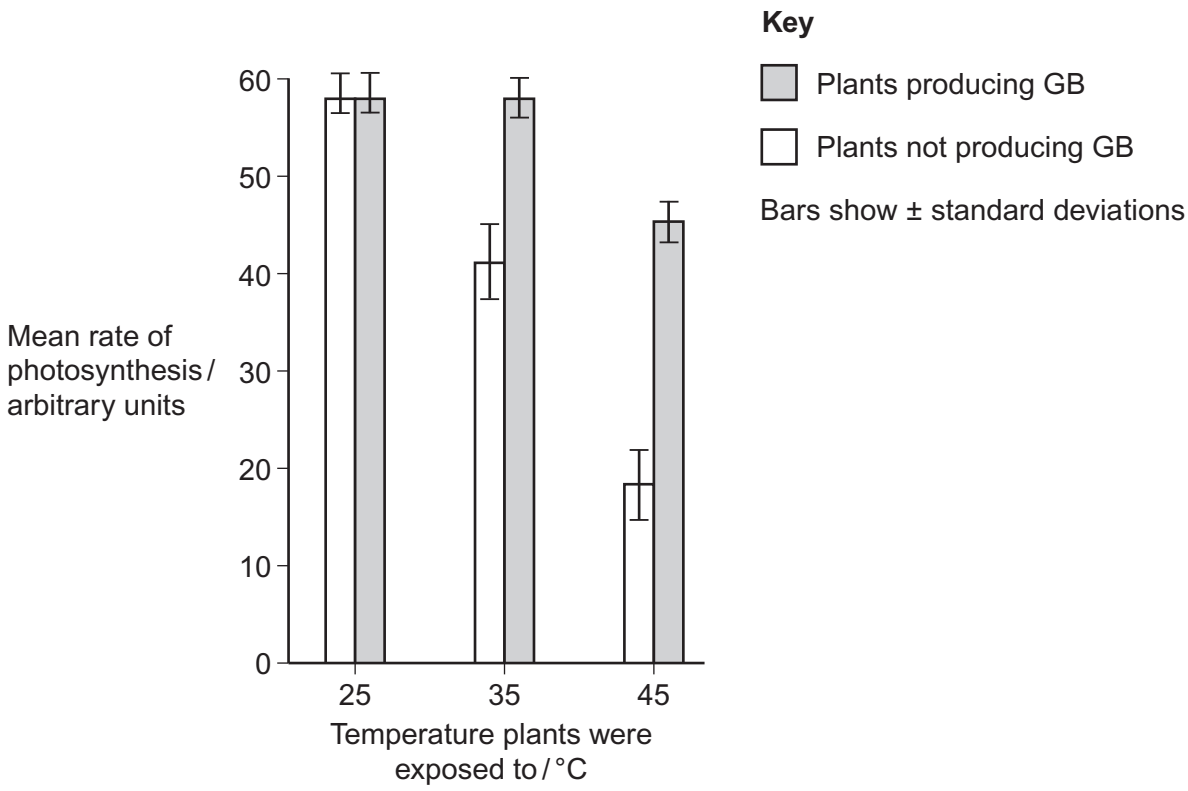
[2 marks]

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 9 shows their results.

Figure 9



9 (b) (i) The scientists concluded that the production of GB gives significant protection of 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 9** for plants that do **not** produce GB to explain the effect of temperature on changes in dry mass of the plants shown in **Figure 8**.

[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.

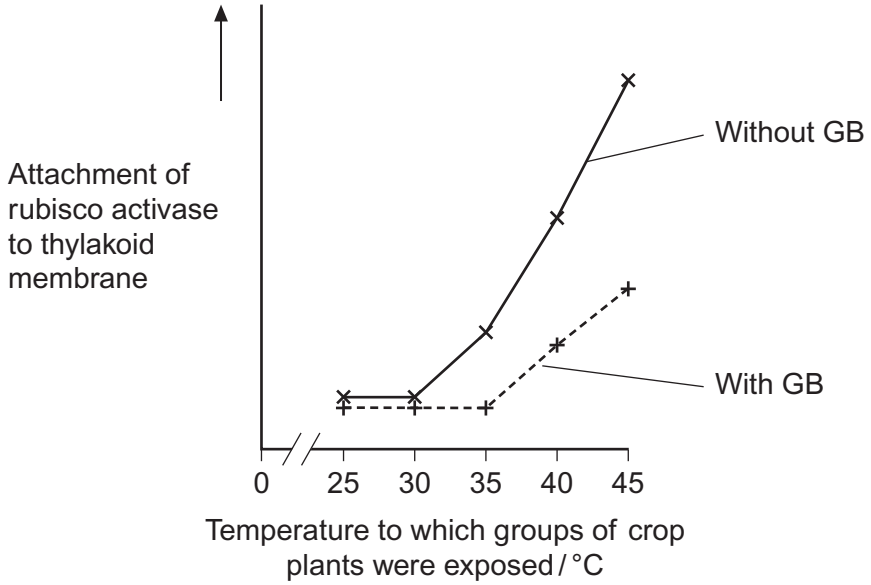
[2 marks]

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 10 shows their results.

Figure 10



Use information from **Figure 9** and **Figure 10** to suggest how GB protects the crop plant from high temperatures.

[4 marks]

[Extra space]

Question 9 continues on the next page

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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

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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 importance of the specific shapes of molecules in organisms.

[25 marks]

OR

10 (b) The importance of transfers of substances within organisms and between organisms and their environment.

[25 marks]

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END OF QUESTIONS

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