Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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10	
TOTAL	

AQA

General Certificate of Education
Advanced Level Examination
June 2014

Biology BIOL5

Unit 5 Control in cells and in organisms

Friday 20 June 2014 9.00 am to 11.15 am

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) (i) Why is the genetic code described as being universal?

[1 mark]

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1 (a) (ii) The genetic code uses four different DNA bases. What is the maximum number of different DNA triplets that can be made using these four bases?

[1 mark]

Transcription of a gene produces pre-mRNA.

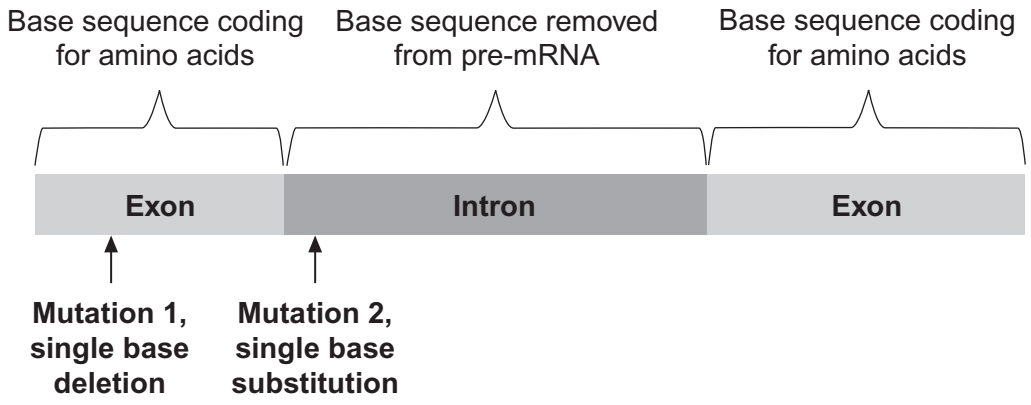
1 (b) Name the process that removes base sequences from pre-mRNA to form mRNA.

[1 mark]

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1 (c) **Figure 1** shows part of a pre-mRNA molecule. Geneticists identified two mutations that can affect this pre-mRNA, as shown in **Figure 1**.

Figure 1



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1 (c) (i) **Mutation 1** leads to the production of a non-functional protein.

Explain why.

[3 marks]

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1 (c) (ii) What effect might **mutation 2** have on the protein produced?

Explain your answer.

[2 marks]

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Turn over ▶

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2 A biologist investigated the behaviour of a species of worm that lives in soil.

He cultured three samples of worms in three separate trays of soil for many days. Each culture:

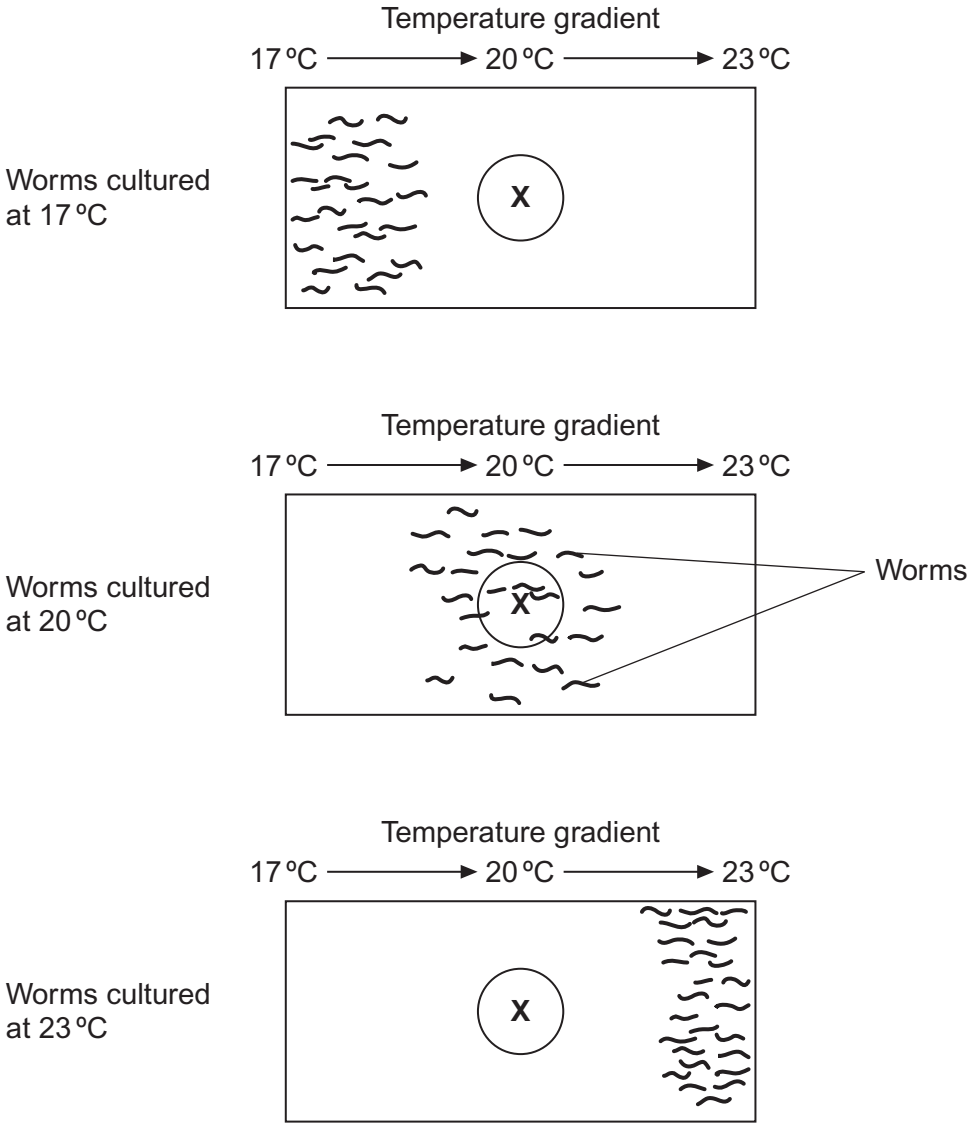
- contained a food supply
- was kept at a different temperature.

The temperatures of the cultures were 17 ºC, 20 ºC and 23 ºC.

The biologist then removed food from the trays for several hours. Then he transferred each sample of worms onto a glass surface where there was **no food**. Each surface had a temperature gradient across it. After 1 hour, the biologist recorded the position of each worm.

Figure 2 shows his results. On each diagram, (X) marks where he released the worms onto the glass surface.

Figure 2



Do not write outside the box

2 (a) The biologist concluded that the worms' behaviour demonstrated taxis.
How do these results support this conclusion?

[2 marks]

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2 (b) Using the information provided, suggest an explanation for the worms' behaviour on the glass surfaces in the absence of food.

[3 marks]

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2 (c) In each experiment, the biologist exposed the surfaces to light that was dim and even, so he could see where the worms went.

Apart from seeing where the worms went, suggest **two** reasons why it was important that the light was dim and even.

[2 marks]

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3 (a) A myelinated axon conducts impulses faster than a non-myelinated axon. Explain this difference.

[3 marks]

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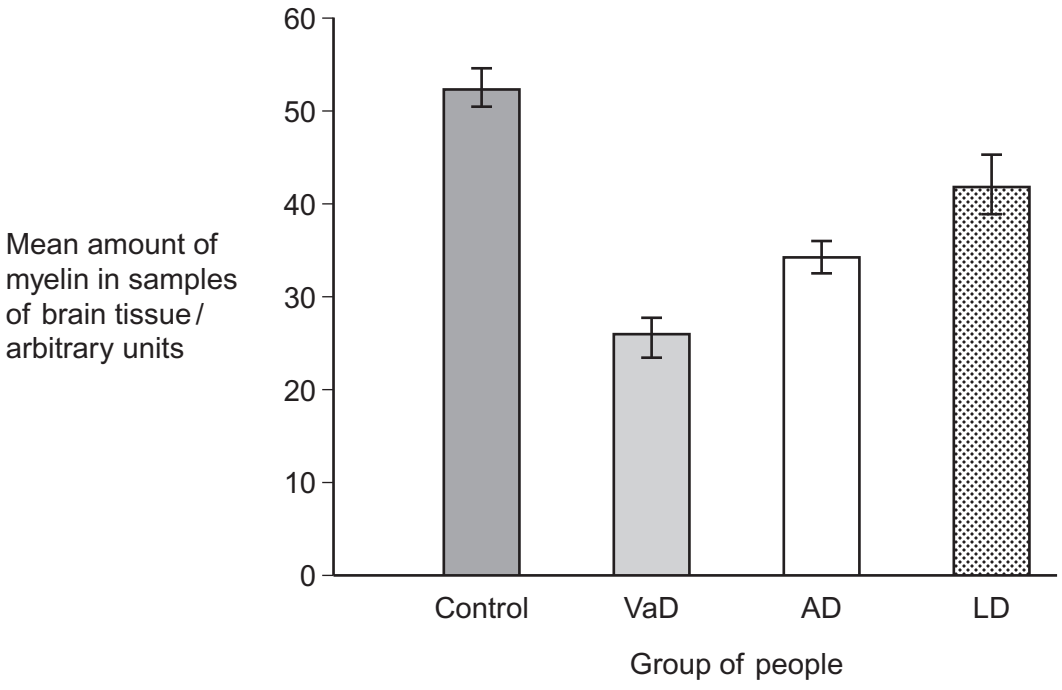
Doctors investigated the relationship between myelin in brain tissue and different types of dementia. All types of dementia involve loss of mental ability.

The doctors measured the mean amount of myelin in samples of brain tissue from:

- a control group of 12 people without dementia
- 20 people with vascular dementia (VaD)
- 19 people with Alzheimer's dementia (AD)
- 31 people with Lewy body dementia (LD).

The doctors' results are shown in **Figure 3**. The vertical bars show standard errors.

Figure 3



Do not write outside the box

3 (b) The doctors used a statistical test to compare the results for AD and LD. They obtained a value for P of 0.047.

What does this result show about the difference between the means for AD and LD?

Use the words **probability** and **chance** in your answer.

[2 marks]

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3 (c) A student who read this investigation concluded that there was a relationship between the amount of myelin in a person's brain and whether or not they had dementia.

Do these data support this conclusion? Give reasons for your answer.

[4 marks]

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4 (a) When insulin binds to receptors on liver cells, it leads to the formation of glycogen from glucose. This lowers the concentration of glucose in liver cells.

Explain how the formation of glycogen in liver cells leads to a lowering of blood glucose concentration.

[2 marks]

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People with type II diabetes have cells with low sensitivity to insulin. About 80% of people with type II diabetes are overweight or obese. Some people who are obese have gastric bypass surgery (GBS) to help them to lose weight.

Doctors investigated whether GBS affected sensitivity to insulin. They measured patients' sensitivity to insulin before and after GBS. About half of the patients had type II diabetes. The other half did not but were considered at high risk of developing the condition.

Table 1 shows the doctors' results. The higher the number, the greater the sensitivity to insulin.

Table 1

Patients	**Mean sensitivity to insulin/ arbitrary units (± SD)**	
	Before gastric bypass surgery	**1 month after gastric bypass surgery**
Did not have diabetes	0.55 (± 0.32)	1.30 (± 0.88)
Had type II diabetes	0.40 (± 0.24)	1.10 (± 0.87)

Do not write outside the box

4 (b) The doctors concluded that many of the patients who did not have type II diabetes were at high risk of developing the condition.

Use the data in **Table 1** to suggest why they reached this conclusion.

[2 marks]

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4 (c) The doctors also concluded that GBS cured many patients' diabetes but that some were not helped very much.

Do these data support this conclusion? Give reasons for your answer.

[3 marks]

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[Extra space] .....

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5 Hodgkin's lymphoma (HL) is a type of cancer. It is usually treated using chemotherapy.

In young female patients with HL, chemotherapy can reduce their ability to have children in later life. This is because some of the drugs used in chemotherapy destroy developing follicles in their ovaries.

5 (a) Destruction of developing follicles during chemotherapy can lead to a much higher concentration of FSH in the young female patients' bodies than normal.

Use your knowledge of hormonal interactions to explain why.

[2 marks]

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5 (b) Some young female patients with HL are given an artificial hormone during chemotherapy. This artifical hormone **reduces** the release of FSH.

5 (b) (i) Suggest how the artificial hormone helps to prevent a reduction in their ability to have children in later life.

[3 marks]

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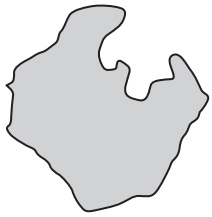
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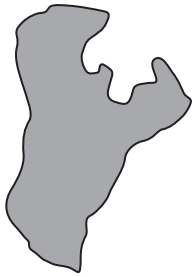
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5 (b) (ii) **Figure 4** shows the structures of the artificial hormone and the hormone that normally causes the release of FSH.

Figure 4



Artificial hormone



Hormone that normally causes the release of FSH

Suggest how the artificial hormone reduces the release of FSH.

[2 marks]

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Turn over for the next question

Do not write outside the box

6 (a) What is the role of phosphocreatine (PC) in providing energy during muscle contraction?

[2 marks]

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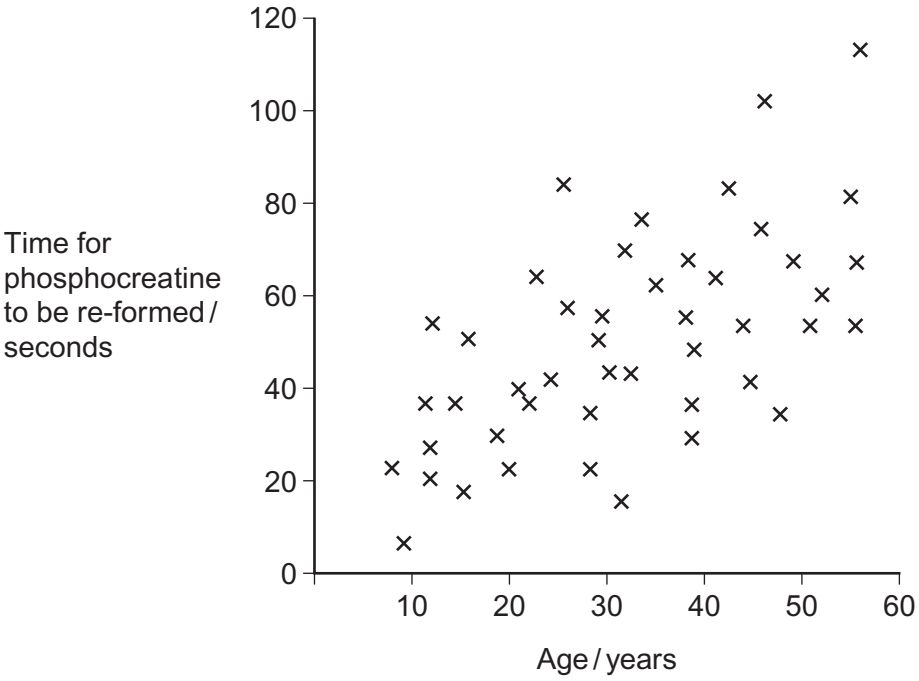
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Scientists investigated the time for phosphocreatine (PC) to be re-formed in arm muscles after the same exercise in healthy people of different ages. The exercise involved brief, rapid contractions of arm muscles.

Figure 5 shows the scientists' results. Each cross is the result for one person.

Figure 5



6 (b) There is a lot of variation in the time taken for PC to be re-formed in people of a very similar age.

Suggest **one** reason for this variation.

[1 mark]

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Do not write outside the box

6 (c) Use your knowledge of fast muscle fibres to explain the data in **Figure 5**.

[4 marks]

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Turn over for the next question

Do not write outside the box

7 CREB is a transcription factor in the mitochondria of neurones.

7 (a) What is a **transcription factor**?

[2 marks]

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7 (b) CREB leads to the formation of a protein that removes electrons and protons from reduced NAD in the mitochondrion.

Huntington's disease (HD) causes the death of neurones. People with HD produce a substance called huntingtin. Some scientists have suggested that binding of huntingtin to CREB may lead to the death of neurones.

Suggest how binding of huntingtin to CREB may lead to the death of neurones.

[3 marks]

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7 (c) CREB is a protein synthesised in the cytoplasm of neurones. Transport of CREB from the cytoplasm into the matrix of a mitochondrion requires two carrier proteins.

Use your knowledge of the structure of a mitochondrion to explain why transport of CREB requires **two** carrier proteins.

[2 marks]

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Turn over for the next question

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8 Scientists wanted to measure how much mRNA was transcribed from allele **A** of a gene in a sample of cells. This gene exists in two forms, **A** and **a**.

The scientists isolated mRNA from the cells. They added an enzyme to mRNA to produce cDNA.

8 (a) Name the type of enzyme used to produce the cDNA.

[1 mark]

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The scientists used the polymerase chain reaction (PCR) to produce copies of the cDNA. They added a DNA probe for allele **A** to the cDNA copies. This DNA probe had a dye attached to it. This dye glows with a green light **only** when the DNA probe is attached to its target cDNA.

8 (b) Explain why this DNA probe will only detect allele **A**.

[2 marks]

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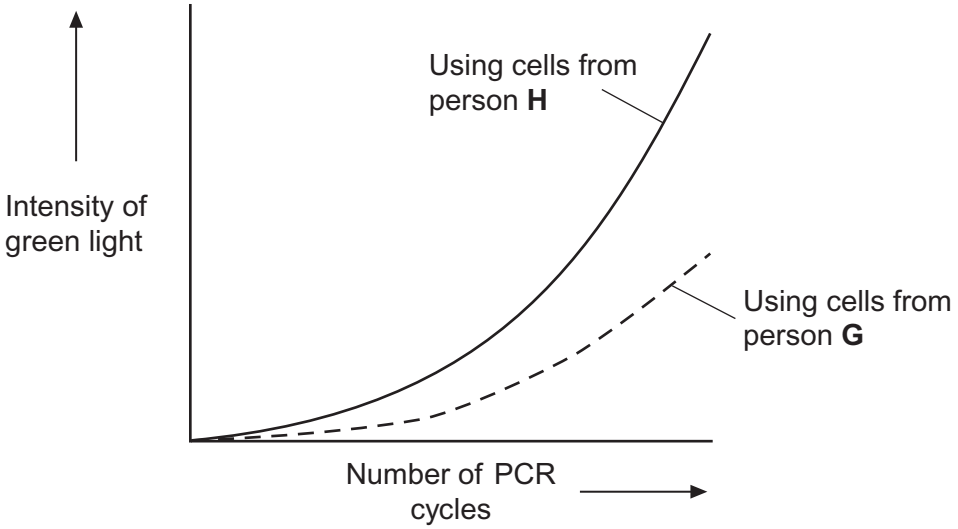
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8 (c) The scientists used this method with cells from two people, **H** and **G**.
One person was homozygous, **AA**, and the other was heterozygous, **Aa**.
The scientists used the PCR and the DNA probe specific for allele **A** on the cDNA from both people.

Figure 6 shows the scientists' results.

Figure 6



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8 (c) (i) Explain the curve for person **H**.

[3 marks]

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8 (c) (ii) Which person, **H** or **G**, was heterozygous, **Aa**? Explain your answer.

[2 marks]

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Turn over ▶

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9 Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

- leaves of plants
- stems and roots of plants
- non-photosynthetic soil organisms.

Table 2 shows the scientists' results for these three parts of the ecosystem.

Table 2

Part of ecosystem	**Mean rate of carbon dioxide production/ $cm^3\ m^{-2}\ s^{-1}$**	**Percentage of total carbon dioxide production measured by the scientists**
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	
Non-photosynthetic soil organisms	0.045	

9 (a) Complete **Table 2** to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

[2 marks]

Do not write outside the box

9 (b) A student who looked at the data in **Table 2** concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student's conclusion.

[2 marks]

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9 (c) What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

[2 marks]

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9 (d) The scientists calculated the mean rate of carbon dioxide production of the leaves using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

[2 marks]

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Question 9 continues on the next page

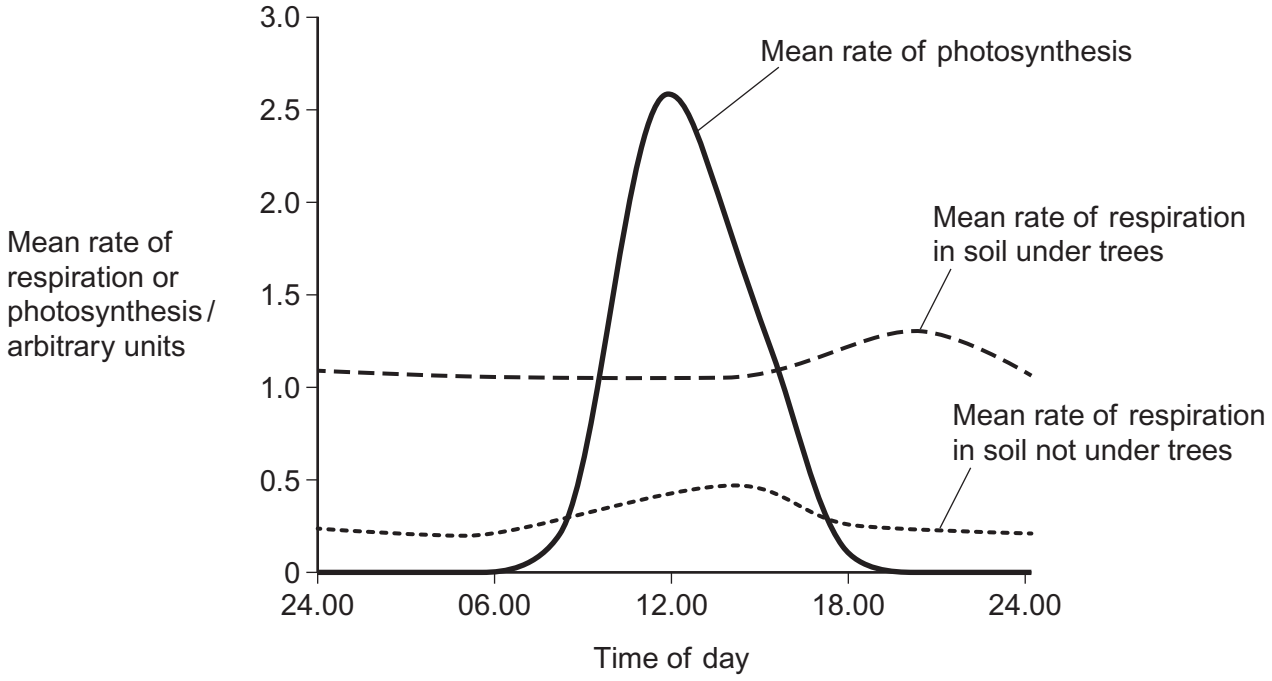
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Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

Figure 7 shows the scientists' results.

Figure 7



9 (e) (i) Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

[2 marks]

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9 (e) (ii) Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

[2 marks]

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9 (f) The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

9 (f) (i) Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

[2 marks]

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9 (f) (ii) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

[1 mark]

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Turn over for the next question

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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) How cells and organisms carry out exchanges with their external environment to maintain their internal environment.

[25 marks]

OR

10 (b) How energy is transferred within and between organisms.

[25 marks]

If you want to make a plan write it here.

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END OF QUESTIONS

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