Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
January 2005
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

BIOLOGY (SPECIFICATION A) BYA6
Unit 6 Physiology and the Environment

Monday 24 January 2005 Morning Session

In addition to this paper you will require:
- a ruler with millimetre measurements.

You may use a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.
- You are reminded that this test requires you to use your knowledge of Modules 1, 2, 4 and 5 as well as Module 6 in answering synoptic questions. These questions are indicated by the letter **S**.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
8			
9			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 A diabetic person did not produce sufficient insulin. This caused the blood glucose concentration to be highly variable.

(a) (i) Name **one** target organ for the action of insulin in controlling blood glucose concentration.

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(1 mark)

(ii) Give **one** effect of insulin on the cells of this target organ.

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(1 mark)

S (b) The concentration of glucose in a diabetic person's blood can be measured using an instrument which contains the enzyme glucose oxidase. Explain why the instrument measures the concentration of glucose only.

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(2 marks)

4

2 The electron micrograph shows a section through a fish gill. The directions of flow of water and of blood are indicated by arrows.

The figure is not reproduced here due to third-party restrictions.

(a) Calculate the minimum distance that a molecule of oxygen would have to travel from the water to a red blood cell. Give your answer in micrometres and show your working.

Answer ..... µm

(2 marks)

(b) Explain how the relationship between the direction of flow of water and of blood shown in the micrograph is useful to a fish.

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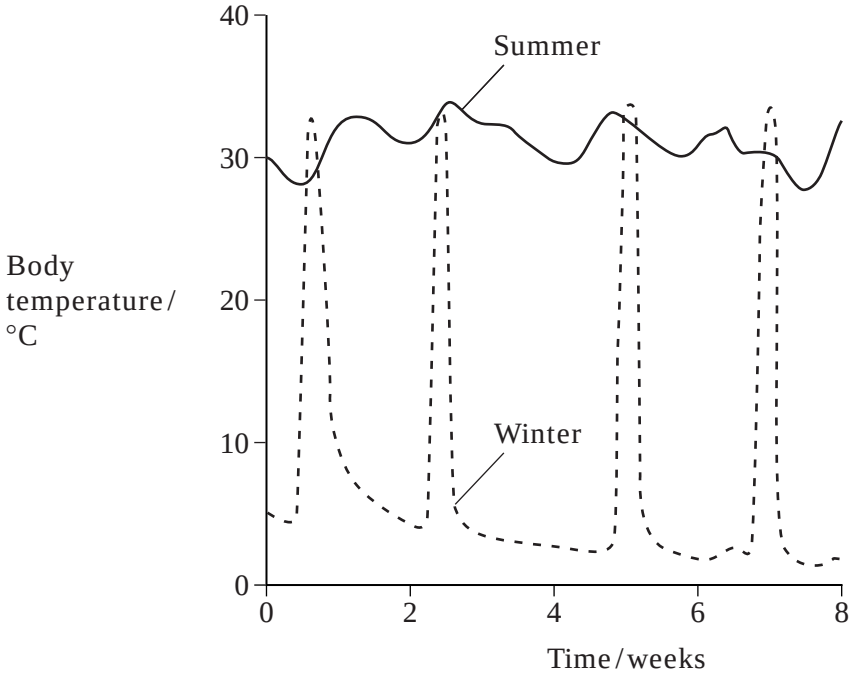
(3 marks)

5

3 The echidna is an Australian mammal. In winter, its body temperature falls to a temperature similar to that of its environment and it hibernates. However, during the period of hibernation, it becomes active every few weeks and at these times its temperature rises to a level similar to its summer temperature. The graph shows how the echidna's temperature varies in the summer and in the winter.



(a) Explain how the fall in body temperature to that of the environment helps the echidna to survive the winter.

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(2 marks)

S (b) Explain how a higher body temperature is of benefit to an active echidna.

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(2 marks)

4

4 (a) The table shows the concentrations of dissolved substances in different regions of a nephron in a kidney in the presence and in the absence of antidiuretic hormone (ADH).

Region of nephron	Concentration of dissolved substances / arbitrary units	
	ADH present	ADH absent
First convoluted tubule	300	300
Bend of loop of Henle	1000	1000
Start of second convoluted tubule	150	150
Middle of second convoluted tubule	250	90
Start of collecting duct	300	50
End of collecting duct	1000	50

Describe and explain the effect of ADH on the volume and concentration of urine produced by the kidney. Give evidence from the table to support your answer.

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(3 marks)

(b) Glomerulosclerosis is a disease in which the glomeruli of the kidney are damaged. Explain why protein is not normally present in the urine of a healthy person but may be present in the urine of a person with glomerulosclerosis.

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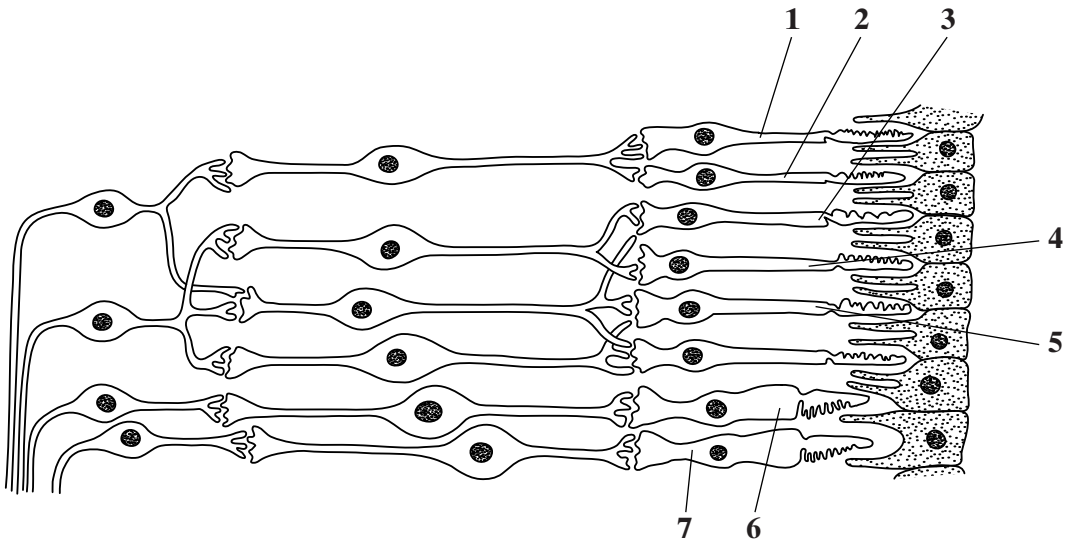
(2 marks)

5

5 The diagram shows part of the retina in a human eye.



(a) Explain each of the following observations.

(i) When light falls on cells **1** and **2**, only one spot of light is seen. But, when light falls on cells **2** and **3**, two spots of light are seen.

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(1 mark)

(ii) When one unit of light energy falls on cell **3**, no light is seen. But, when one unit of light energy falls on cell **3**, one unit falls on cell **4** and one unit falls on cell **5**, light is seen.

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(3 marks)

(b) Cells of the same type as cells **6** and **7** are found in large numbers at the fovea. This results in colour vision with high visual acuity.

Explain what causes vision using the fovea

(i) to be in colour;

.....

.....

(1 mark)

(ii) to have high visual acuity.

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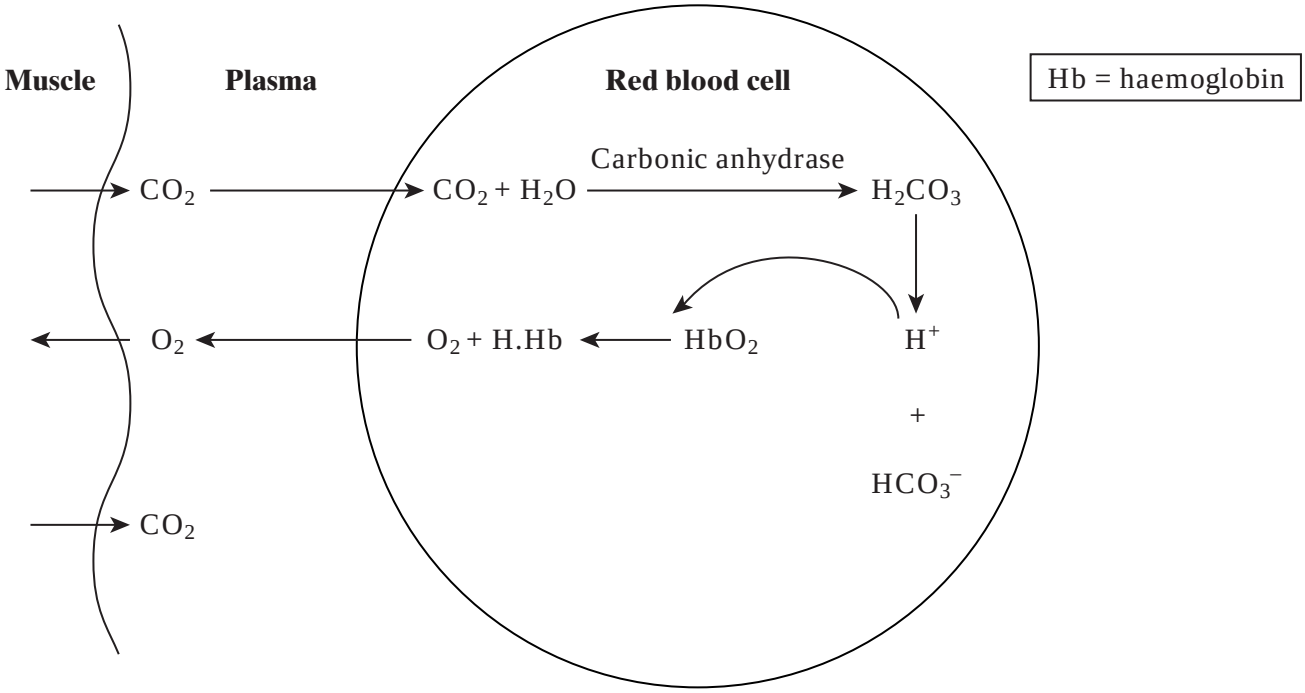
(1 mark)

6

TURN OVER FOR THE NEXT QUESTION

6 The diagram shows some aspects of the exchange of carbon dioxide and oxygen between a red blood cell and muscle tissue.



S (a) Increased muscle activity increases the amount of oxygen released from a red blood cell during exercise. Using information in the diagram, explain how.

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(3 marks)

(b) The blood in a vein leaving a muscle has a pH only slightly lower than that in the artery entering it. This is partly due to haemoglobin in the red cells acting as a buffer.

(i) Explain why the pH in the vein is lower than that in the artery.

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(2 marks)

(ii) Explain how haemoglobin acts as a buffer.

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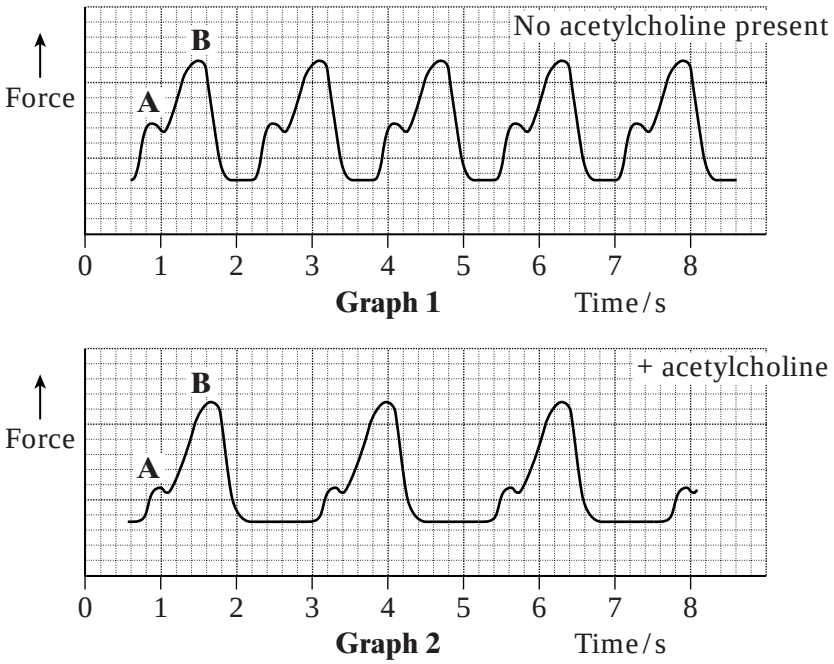
(1 mark)

6

TURN OVER FOR THE NEXT QUESTION

7 A frog's heart was attached to an instrument which measured the force produced as the heart contracted. **Graph 1** shows the changes in force when the heart was bathed in a solution of salts at 20 °C. **Graph 2** shows the results when the heart was bathed in the same solution at the same temperature, but including acetylcholine.



Graph 1

Graph 2

S (a) Points **A** and **B** show when the atria and ventricle were contracting. Which point, **A** or **B**, shows contraction of the ventricle? Give **two** reasons for your answer.

Point .....

Reason 1 .....

.....

Reason 2 .....

.....

(2 marks)

(b) Calculate the frog's heart rate when acetylcholine was **not** present. Show your working.

Heart rate = ... beats per minute

(2 marks)

(c) (i) From the graphs, what can you conclude about the effect of acetylcholine on

heart rate; .....

stroke volume? .....

(2 marks)

S (ii) Use your answer to part (i) to explain the effect of acetylcholine on cardiac output.

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(1 mark)

(iii) Addition of acetylcholine in the experiment mimics the effect of one branch of the autonomic nervous system. Which branch is this?

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(1 mark)

S (d) (i) Explain how nervous control in a human can cause increased cardiac output during exercise.

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(4 marks)

(ii) Explain why increased cardiac output is an advantage during exercise.

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(3 marks)

15

Turn over ▶

8 (a) When dogs eat, food normally reaches the stomach within one minute. It then remains in the stomach for three to four hours.

The following observations were made in experiments performed on dogs in the early 1900s.

1 Secretion of gastric juice began within five minutes of food entering the mouth, even when food did not enter the stomach.

2 The result described in 1 also occurred after only seeing the food.

3 When food did not enter the stomach, as in 1, gastric secretion soon stopped.

4 When food did enter the stomach, gastric secretion continued for three to four hours.

5 When the vagus nerve from the brain to the stomach was cut, observations 1 and 2 no longer happened.

6 When partially digested meat was put directly into the stomach, gastric secretion started and continued for two to three hours, even when the vagus nerve was cut.

(i) Name the type of action shown in observation 2.

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(1 mark)

(ii) Use information from the experimental observations to support your answer to part (i).

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(2 marks)

(iii) Explain how **two** of the experimental observations suggest that a hormone may be involved in controlling gastric secretion.

1 .....

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2 .....

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(2 marks)

(b) Cells in the stomach wall secrete an endopeptidase called pepsin.

(i) What does an endopeptidase do?

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(1 mark)

(ii) Explain the advantage of secreting an endopeptidase onto the food before exposure to exopeptidases in the small intestine.

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(2 marks)

(iii) Pepsin is secreted in an inactive form, called pepsinogen. Explain the advantage of producing pepsin in an inactive form.

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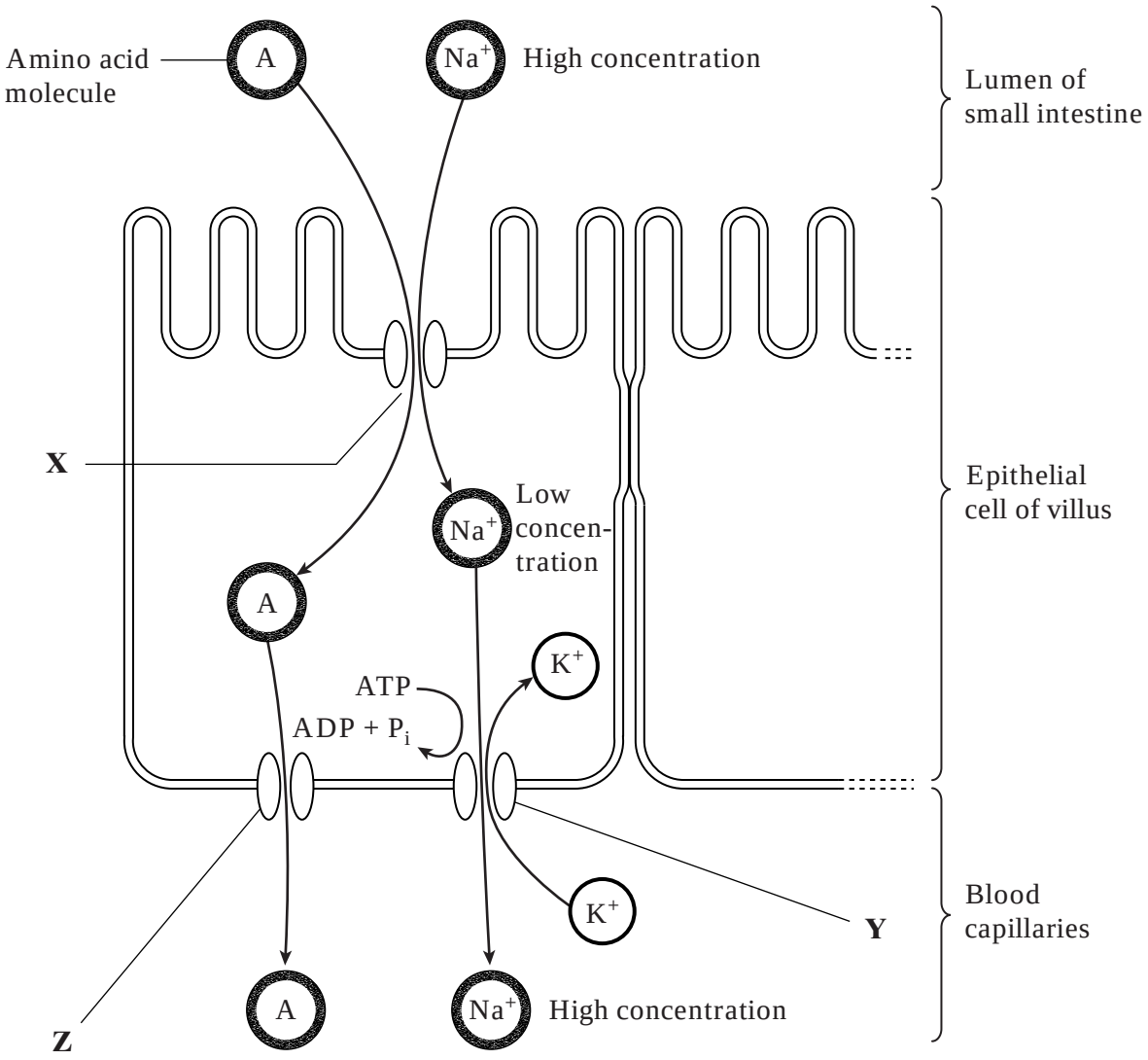
(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

S (c) The diagram shows one method by which amino acids are absorbed from the small intestine into the blood. They are co-transported into the epithelial cell with sodium ions (Na^+) at point **X** on the diagram. Normally, the concentration of sodium ions inside the epithelial cell is low.



Source: adapted from M. ROWLAND, *Biology (University of Bath Science 16-19)* (Nelson Thornes) 1992

Dinitrophenol (DNP) prevents oxidative phosphorylation. When treated with DNP, the sodium-potassium pump at **Y** no longer works. As a result, the concentration of sodium ions in the cell rises and amino acid absorption stops.

(i) Explain why pump **Y** will **not** work in the presence of DNP.

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(2 marks)

(ii) Explain why sodium ions and amino acids are **not** absorbed from the lumen of the small intestine in the presence of DNP.

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(2 marks)

(iii) By what mechanism would amino acids leave the epithelial cell at point **Z**?

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(1 mark)

15

9 (a) Describe and explain how water moves via the apoplastic and symplastic pathways from the soil to the xylem in a root.

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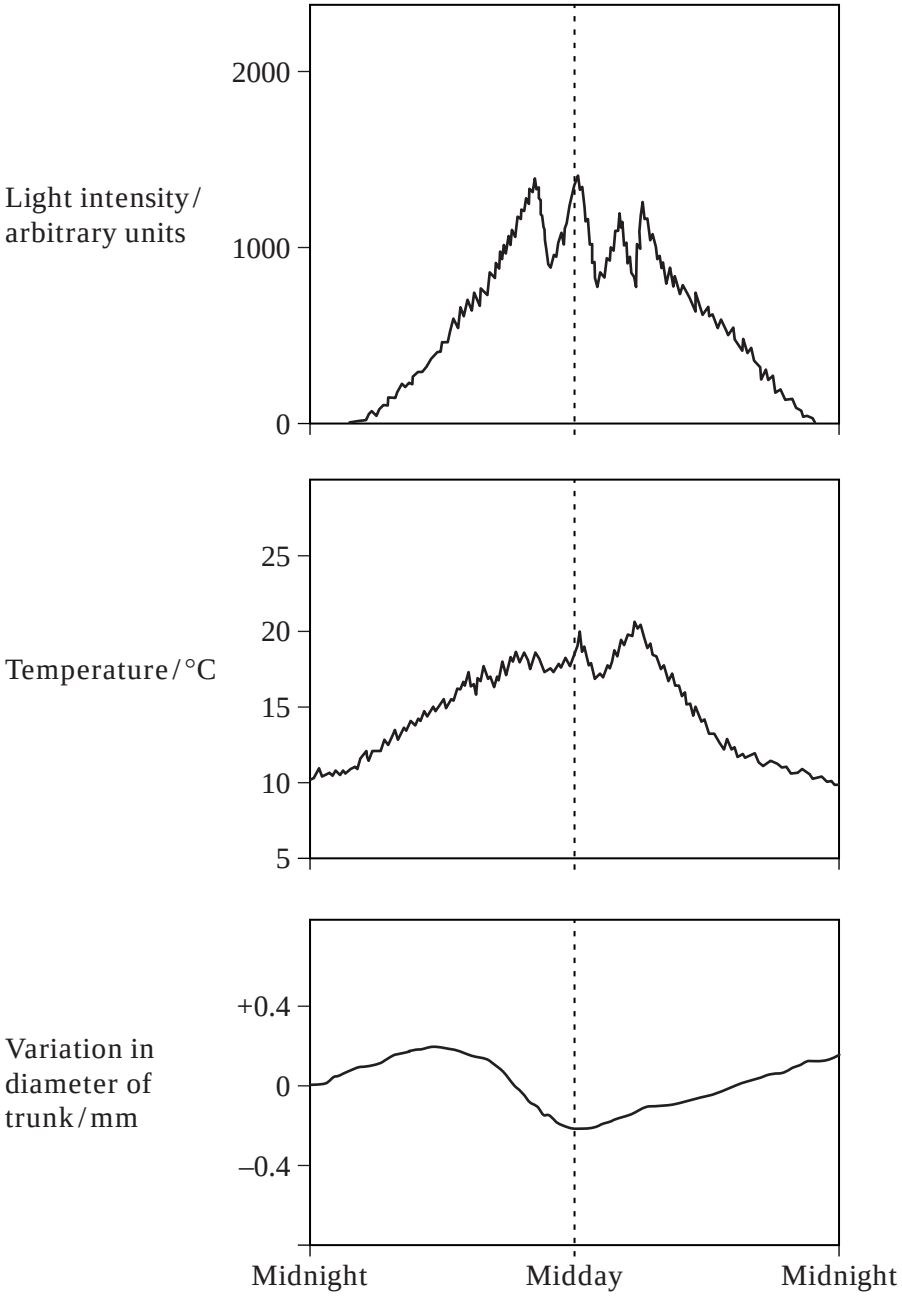
(6 marks)

QUESTION 9 CONTINUES ON THE NEXT PAGE

(b) The graphs show the daily changes in environmental temperature and light intensity, and changes in the diameter of the trunk of a pine tree.



Use information from the graphs, and your knowledge of the cohesion-tension theory of water movement through a plant, to explain why the diameter of the trunk is smallest at midday.

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(6 marks)

(c) Describe and explain **three** ways in which the leaves of xerophytic plants may be adapted to reduce water loss.

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(3 marks)

END OF QUESTIONS

15

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