Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2002
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Monday 17 June 2002 Morning Session

No additional materials are required.
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			
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Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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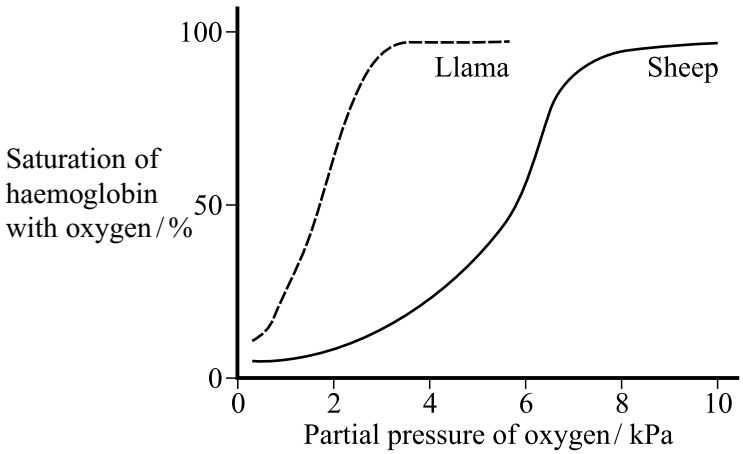
Answer **all** questions in the spaces provided.

1 The llama is a mammal which lives at high altitude. Sheep live at low altitude. The graph shows dissociation curves for llama and sheep haemoglobin.



(a) Explain the advantage of the shape and position of the llama's dissociation curve.

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(2 marks)

(b) Haemoglobin acts as a buffer, preventing changes in blood pH. Such changes could lead to a decrease in the rate of enzyme-controlled reactions in the body.

(i) Explain how haemoglobin is able to act as a buffer.

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(1 mark)

S (ii) Suggest how changes in pH could lead to a decrease in the rate of enzyme-controlled reactions.

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(2 marks)

5

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2 The table shows the concentrations of glucose and insulin in the blood plasma before and after a meal.

Time after eating meal / minutes	Concentration of glucose in blood plasma / mg 100 cm^{-3}	Concentration of insulin in blood plasma / arbitrary units
0	82	19
5	88	19
10	96	28
15	106	35
20	110	44
25	108	49
30	101	52
35	93	46
40	87	41
45	82	33

(a) Use information in the table to explain how insulin controls the concentration of blood glucose by negative feedback.

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(2 marks)

(b) Diabetes can occur when the pancreas cells are unable to secrete insulin. In a test, a person who is suspected of suffering from diabetes is given a solution of glucose to drink. Then blood samples are taken at regular intervals and the concentration of blood glucose is measured. If the person is diabetic, the blood glucose concentration rapidly peaks before slowly returning to its original level.

S (i) The test is carried out on the same person a second time. Apart from drinking the same volume and same concentration of glucose solution, suggest **two** ways in which the test should be carried out to produce reliable results.

1. .....

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2. .....

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(2 marks)

(ii) The blood plasma glucose concentration falls in diabetics even when there is no insulin present in the blood plasma. Explain why.

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(1 mark)

Turn over ▶

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3 (a) The blood vessels in the skin play an important part in allowing a mammal to conserve heat. Describe how.

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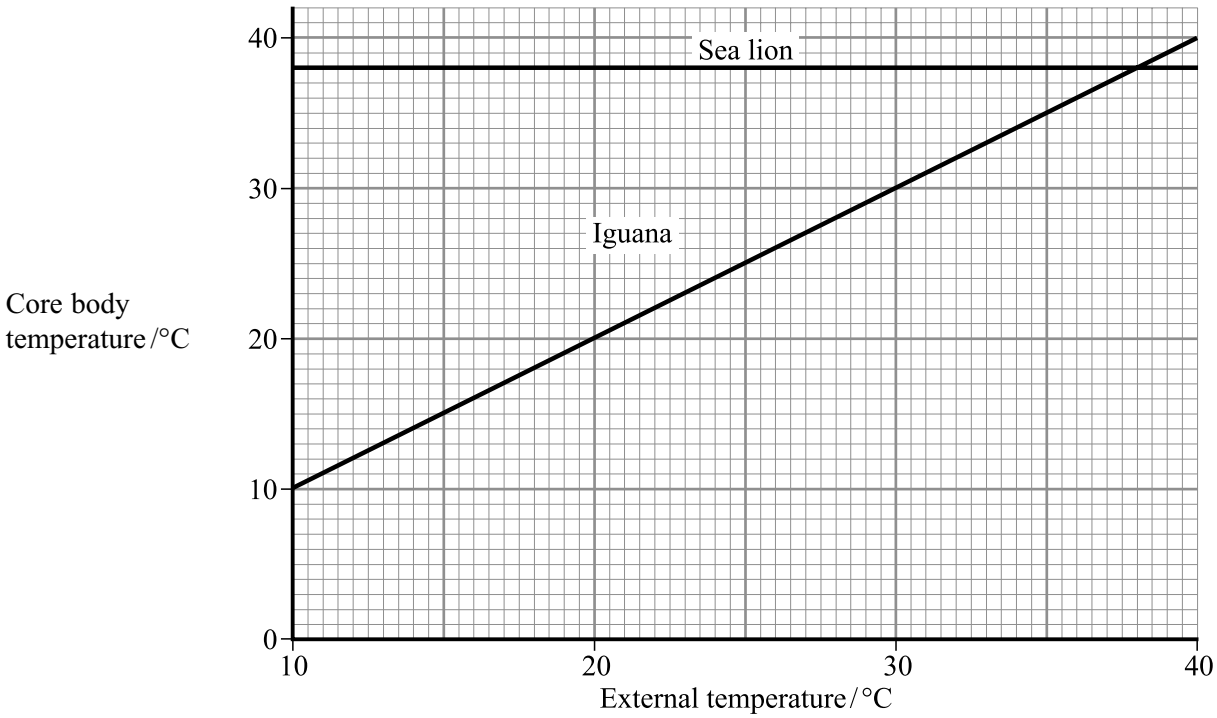
(2 marks)

(b) Sea lions and iguanas feed in the sea around the tropical Galapagos Islands. Sea lions are mammals and iguanas are reptiles. Both species spend some time on land. The graphs show the core body temperature and the oxygen consumption of an iguana and a sea lion at different external temperatures.



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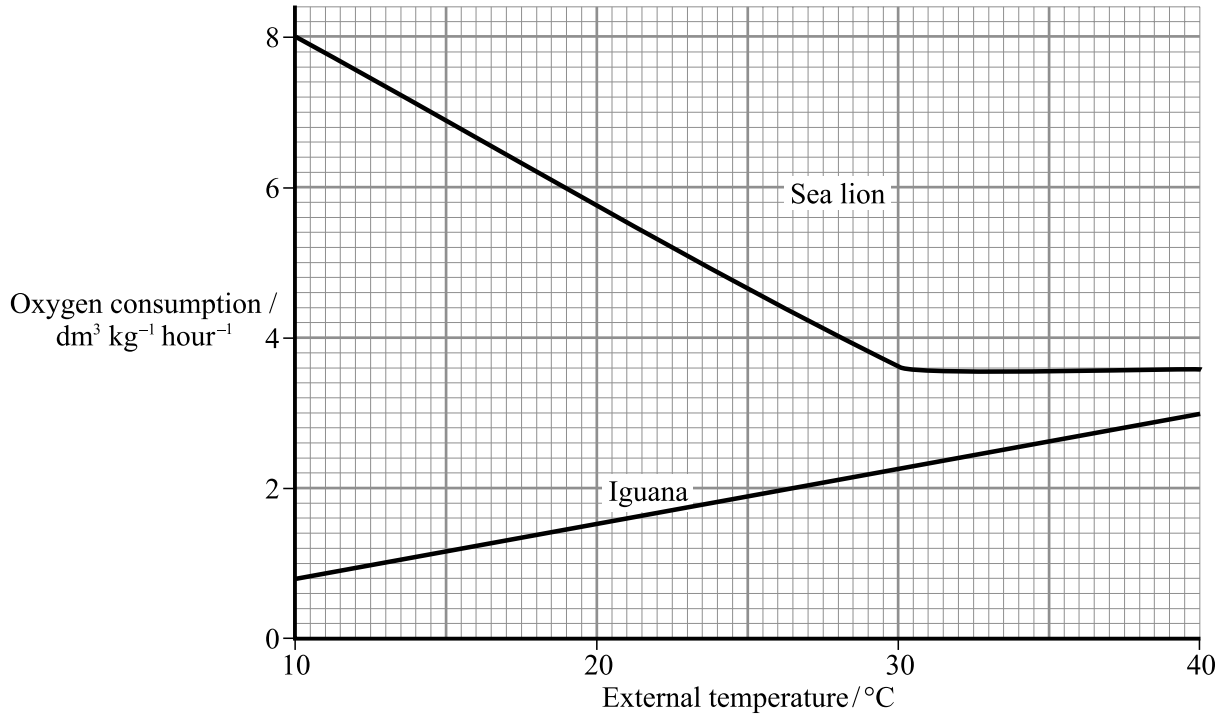

Using information from the graphs, answer the following questions.

(i) The mean temperature of the sea surrounding the Galapagos Islands is 21 °C while the mean air temperature during the day is higher than this. Suggest why the iguana feeds for only short periods of time in the water before returning to the land.

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(2 marks)

S (ii) Explain the link between core body temperature and rate of oxygen consumption in the sea lion between the external temperatures of 10 °C and 30 °C.

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(2 marks)

6

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4 The African lungfish lives in water but is able to survive for periods of time in the mud of dried up rivers. In water, the lungfish excretes most of its nitrogenous waste in the form of ammonia.

When the river dries up, the lungfish burrows deep into the mud and curls up into a ball. In this state, the lungfish excretes only small amounts of ammonia. Instead it produces urea which accumulates in its tissues.

When rain refills the river, the lungfish excretes the accumulated urea and then returns to excreting large amounts of ammonia.

S (a) (i) Suggest how curling up into a ball increases the lungfish's chance of survival.

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(1 mark)

(ii) Explain the advantage of changing the method of excreting nitrogenous waste when the river dries up.

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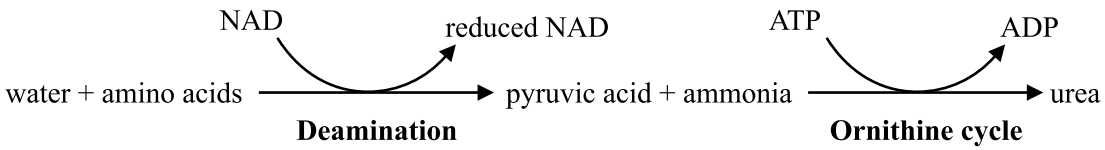
(2 marks)

S (b) The diagram shows some of the steps in the production of nitrogenous excretory products by the liver cells of the lungfish.



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(i) Use the equation to suggest **one** disadvantage of excreting urea rather than ammonia.

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(1 mark)

(ii) The lungfish requires water for the deamination of amino acids. Name **one** metabolic process that replaces water used for deamination.

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(1 mark)

5

TURN OVER FOR THE NEXT QUESTION

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5 (a) A diffusion gradient is essential for gas exchange. Describe **two** ways in which a diffusion gradient for oxygen is maintained at the gas exchange surface of a fish.

1. .....

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2. .....

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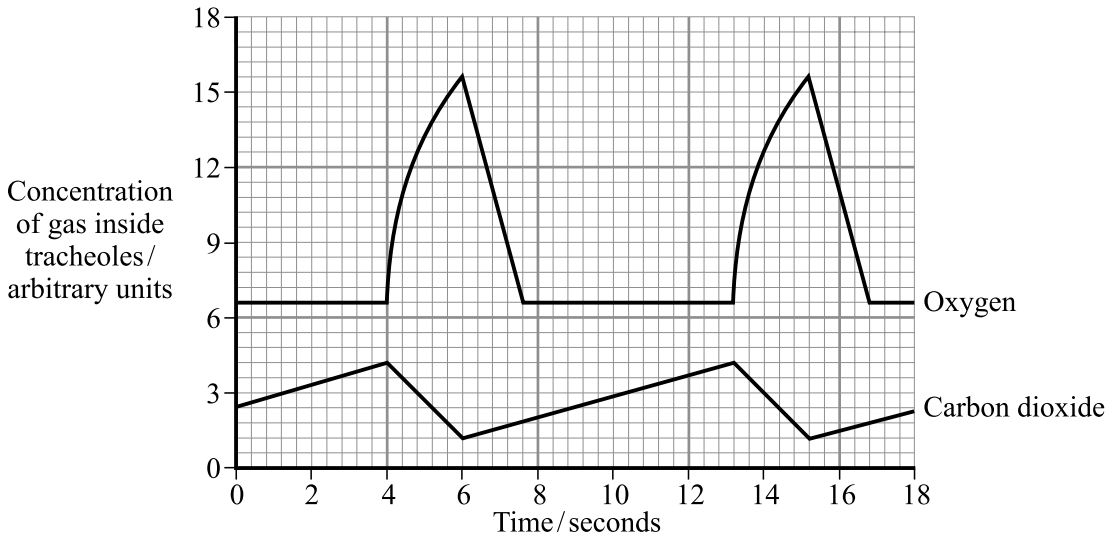
(2 marks)

The graph shows the concentration of gases inside the tracheoles of an insect.



(b) For how long were the insect's spiracles open during the period shown in the graph? Explain how you arrived at your answer.

Length of time: .....

Explanation: .....

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(2 marks)

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6 Anti-diuretic hormone (ADH) is released into the blood in response to a shortage of water in the body. ADH enters the collecting duct cells in nephrons and causes the increased synthesis of one type of protein molecule. These protein molecules are inserted into the plasma membranes of the collecting duct cells where they act as channels. Only water molecules can pass through these channels, increasing the reabsorption of water from the kidney filtrate.

(a) Name the gland which releases ADH.

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(1 mark)

S (b) (i) Explain how the structure of protein molecules allows them to form channels through which only water molecules can pass.

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(2 marks)

(ii) Explain how the cells of the collecting duct are able to absorb water from the filtrate through the protein channels in their plasma membranes.

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(2 marks)

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TURN OVER FOR THE NEXT QUESTION

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7 **Figure 1** shows a Pacinian corpuscle and its sensory neurone which are present in the skin of a fingertip.

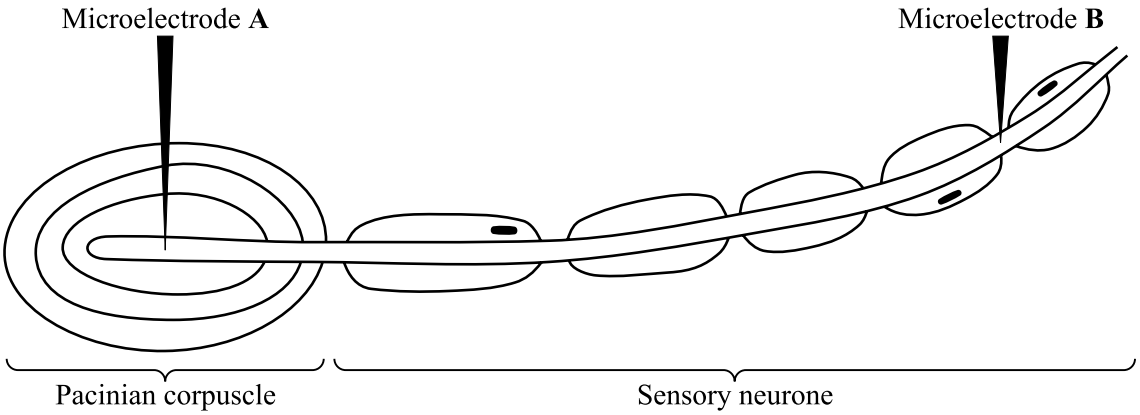

Figure 1

Figure 2 shows the electrical activity simultaneously recorded from the Pacinian corpuscle and its sensory neurone when increasing pressure was applied to a fingertip.

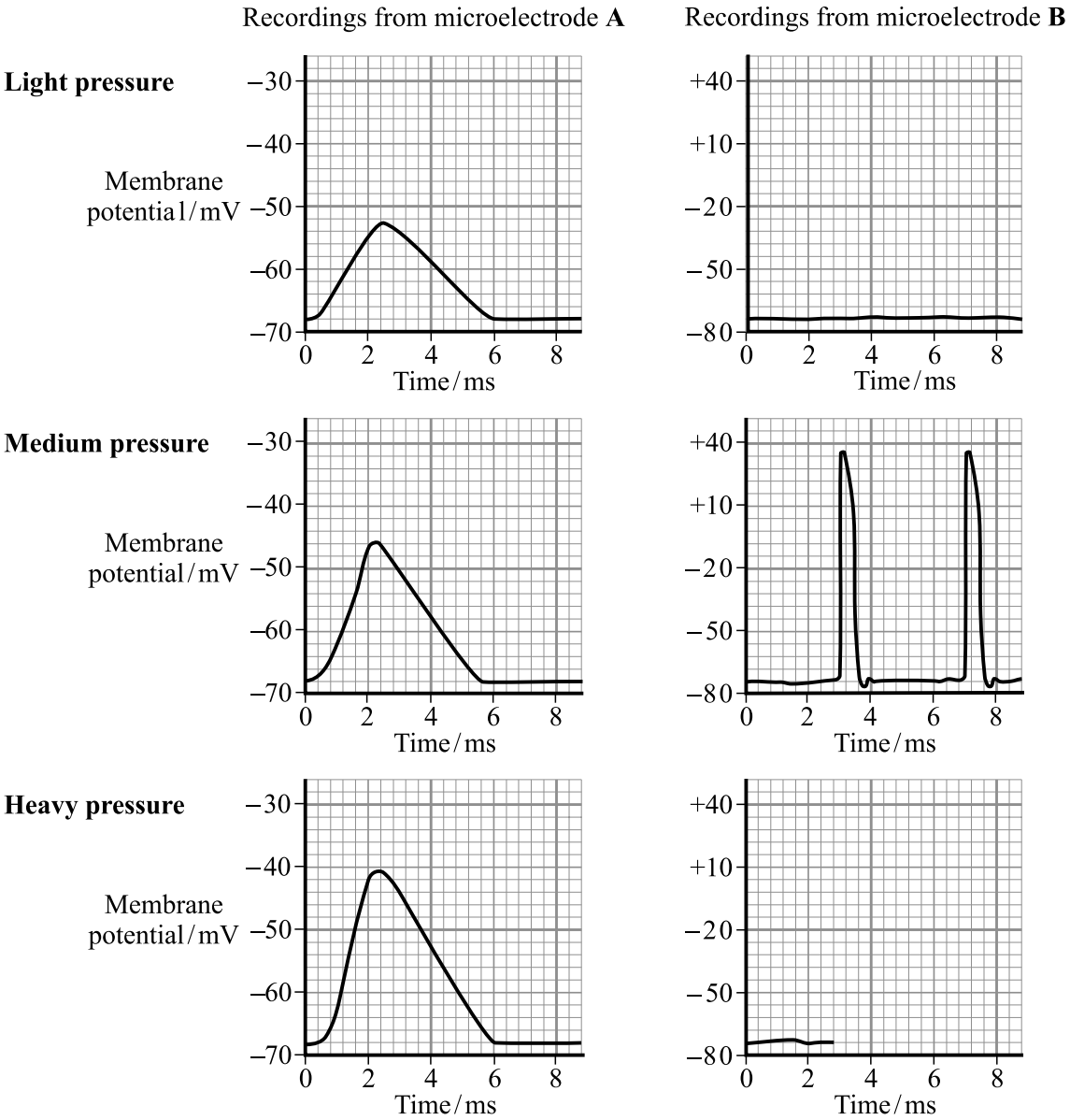

Figure 2

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(a) Explain how pressure on the Pacinian corpuscle produces the changes in membrane potential recorded by microelectrode **A**.

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(2 marks)

(b) (i) Draw an arrow on **Figure 1** to show the direction of net movement of potassium ions during repolarisation of the sensory neurone. Label this arrow with the letter **K**.

(1 mark)

(ii) Complete **Figure 2** to show the expected electrical activity recorded by microelectrode **B** when high pressure was applied to the fingertip.

(1 mark)

(c) (i) What is the delay between the maximum depolarisation recorded by microelectrode **A** and the first depolarisation recorded by microelectrode **B** when medium pressure was applied to the fingertip?

Answer ..... ms

(1 mark)

(ii) The distance between microelectrodes **A** and **B** is 8 cm. Use this information together with your answer to (c) (i) to calculate the speed of conductance of an impulse along the sensory neurone, in metres per second. Show your working.

Answer ..... $m\,s^{-1}$

(1 mark)

QUESTION 7 CONTINUES ON THE NEXT PAGE

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(d) Most of the sensory neurone in **Figure 1** is covered by a myelin sheath. This prevents the movement of ions across the axon membrane except at the small gaps in the sheath, called the nodes of Ranvier. Multiple sclerosis is a disease in which the myelin sheaths surrounding the neurones are destroyed so the neurones become de-myelinated.

(i) Explain how de-myelination of neurones produces slow responses to stimuli in people with multiple sclerosis.

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(2 marks)

(ii) The rate of ATP consumption of a de-myelinated neurone is greater than that of a myelinated neurone when conducting impulses at the same frequency. Explain why.

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(2 marks)

(e) Hydra is a small animal which lives in water. It traps food particles by random movement of its tentacles. The rate of tentacle movement is usually slow but becomes faster as more tentacles touch food particles.

(i) Name the type of behaviour described above.

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(1 mark)

(ii) Give a reason for your answer.

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(1 mark)

LEAVE MARGIN BLANK

S (iii) All hydra show an increase in rate of tentacle movement in response to a greater concentration of food particles in the surrounding water. Explain how natural selection may account for this.

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(3 marks)

15

TURN OVER FOR THE NEXT QUESTION

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8 (a) Termites and peacock butterfly larvae are insects which require a large amount of protein in their diets. Both insects release enzymes from their gut tissues. These enzymes digest proteins to peptides and peptides to amino acids.

S (i) Name the chemical process responsible for the digestion of a peptide molecule into amino acid molecules.

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(1 mark)

(ii) Explain why a peacock butterfly larva requires a large amount of protein in its diet.

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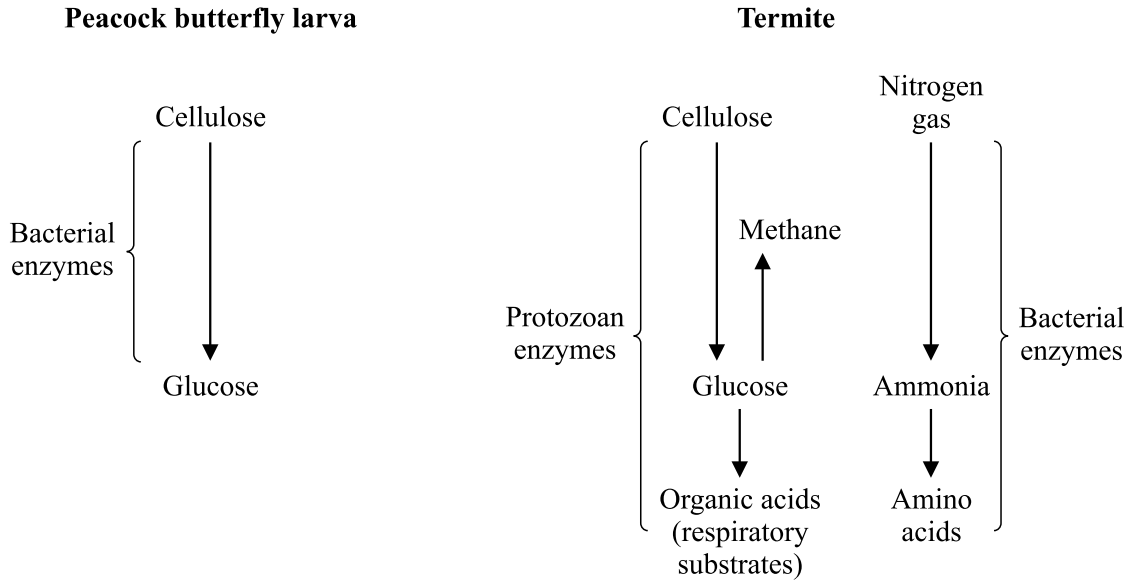
(1 mark)

(b) The peacock butterfly larva feeds on leaves, a diet rich in cellulose and protein. Termites feed on wood, a diet rich in cellulose but poor in protein. Peacock butterfly larvae and termites benefit from the presence of mutualistic microorganisms which live in their guts.

The diagram summarises the biochemical processes carried out by these different microorganisms.



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(i) Explain how it is possible for termites to survive on a diet poor in protein.

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(2 marks)

(ii) Peacock butterfly larvae obtain more energy from the same amount of cellulose than do termites. Explain why.

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(1 mark)

(iii) Nitrogen gas in the termite gut comes from swallowed air. However nitrogen fixation can only occur in anaerobic conditions, since the enzyme responsible for converting nitrogen gas to ammonia is inhibited by oxygen. Suggest how it is possible for nitrogen fixation to take place inside the termite gut.

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(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

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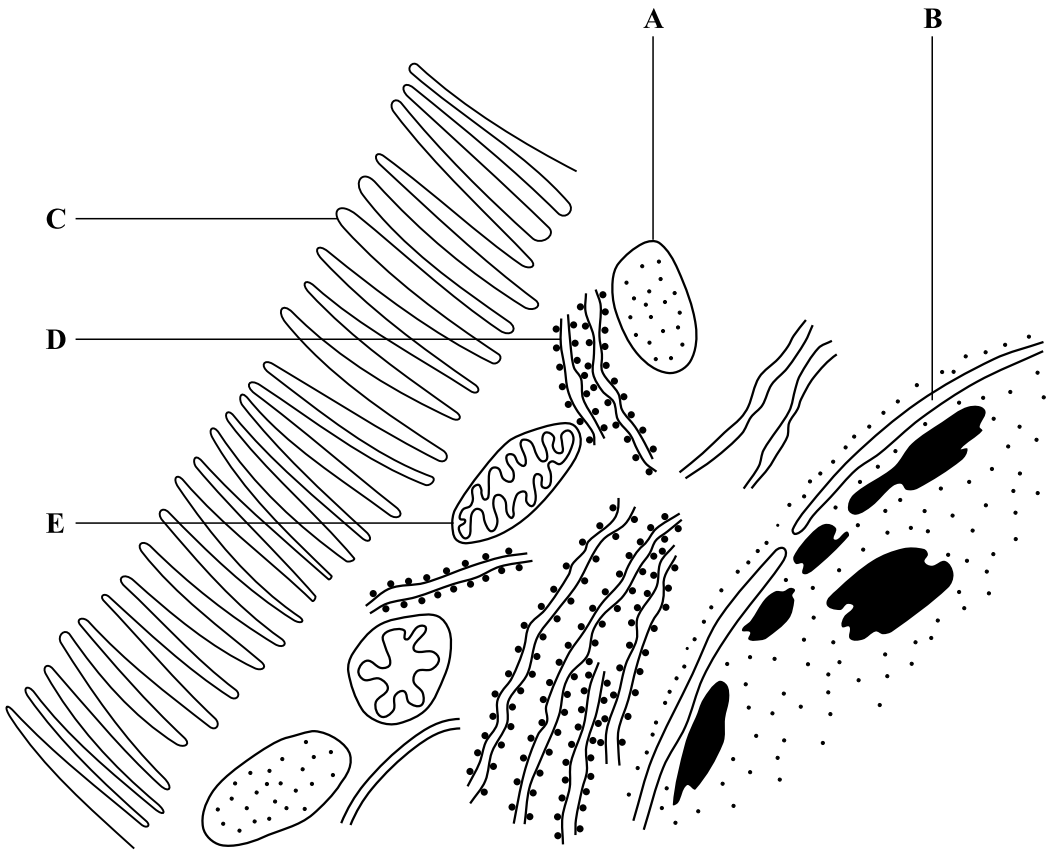
S (c) The diagram shows part of an epithelial cell from a termite gut as seen under the electron microscope.



Give the letter and name of **two** features shown on the diagram and explain how each is involved in the rapid uptake of amino acids from the gut.

Letter: .....

Name of feature: .....

Explanation: .....

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Letter: .....

Name of feature: .....

Explanation: .....

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(4 marks)

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(d) In mammals, secretion of digestive juices is controlled by hormones and nerves.

(i) Describe **two** ways in which hormonal control differs from nervous control.

1. .....

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2. .....

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(2 marks)

(ii) Secretin is a hormone. Explain its role in digestion.

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(2 marks)

15

TURN OVER FOR THE NEXT QUESTION

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9 (a) Explain how root pressure and cohesion–tension are responsible for the movement of water in xylem vessels.

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(7 marks)

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(b) Explain how the presence of "hairs" and rolled leaves reduce water loss in xerophytic plants.

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(4 marks)

S (c) Certain species of yambeans have no obvious xerophytic structural adaptations, yet are able to survive long periods of drought. Scientists have identified a gene which is responsible for the drought resistance of yambeans. They plan to transfer this gene into wheat plants. This might allow wheat to be grown in countries with a very dry climate. Explain how a vector could be genetically engineered to contain the gene for drought resistance.

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(4 marks)

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END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE