Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2006
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Tuesday 20 June 2006 9.00 am to 10.30 am

For this paper you must have:
- 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.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.
- Use accurate scientific terminology in all your answers.

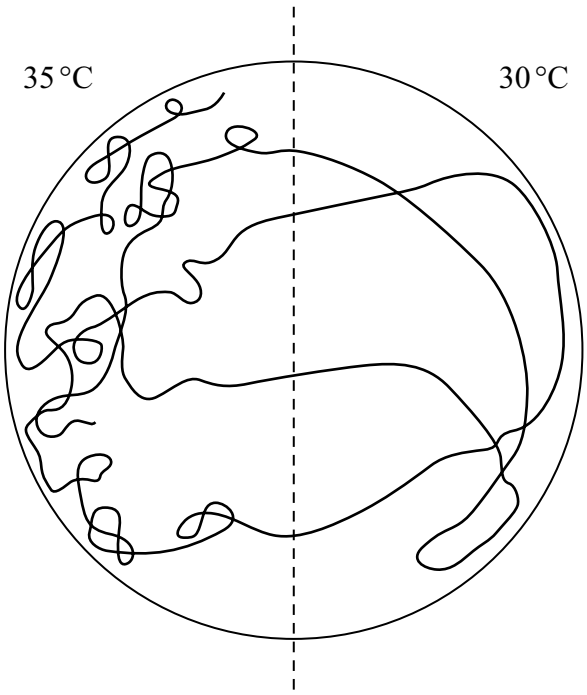
Information

- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

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

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

1 The human body-louse is an insect which lives and feeds on the surface of the skin. A louse was placed in a chamber, half of which was kept at 35 °C and half at 30 °C. The diagram shows the pattern of movement of the louse.



(a) Name the type of behavioural response shown by the body-louse in this investigation. Give evidence for your answer.

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(2 marks)

(b) Suggest and explain **one** advantage of this behaviour to the human body-louse.

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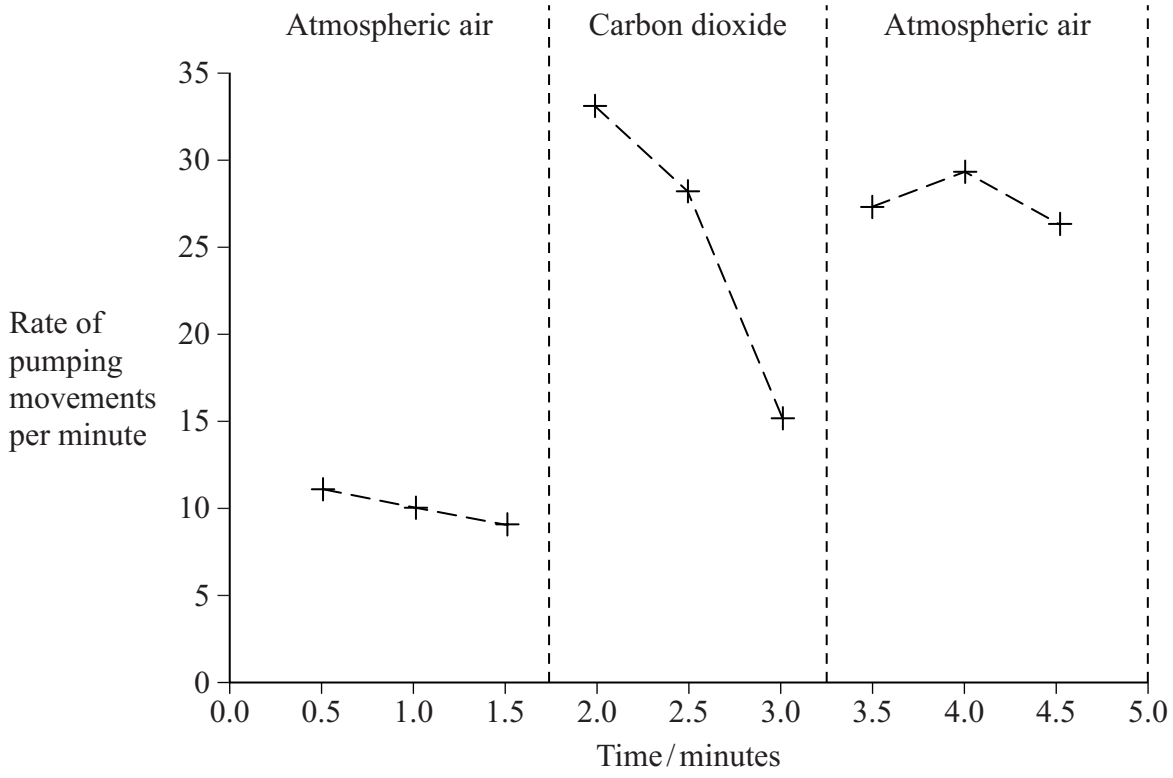
(2 marks)

4

2 In an investigation, a locust was given alternating supplies of atmospheric air and pure carbon dioxide. The rate of pumping movements of the insect's abdomen was measured. The graph shows the results.



(a) Explain what caused

(i) the rise in the rate of abdominal pumping movements between 1.5 and 2.0 minutes,

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(1 mark)

(ii) the fall in the rate of abdominal pumping movements between 2.0 and 3.0 minutes.

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(2 marks)

(b) The rate of abdominal pumping movements increases between 3.0 and 3.5 minutes. Suggest the advantage of this change to the locust.

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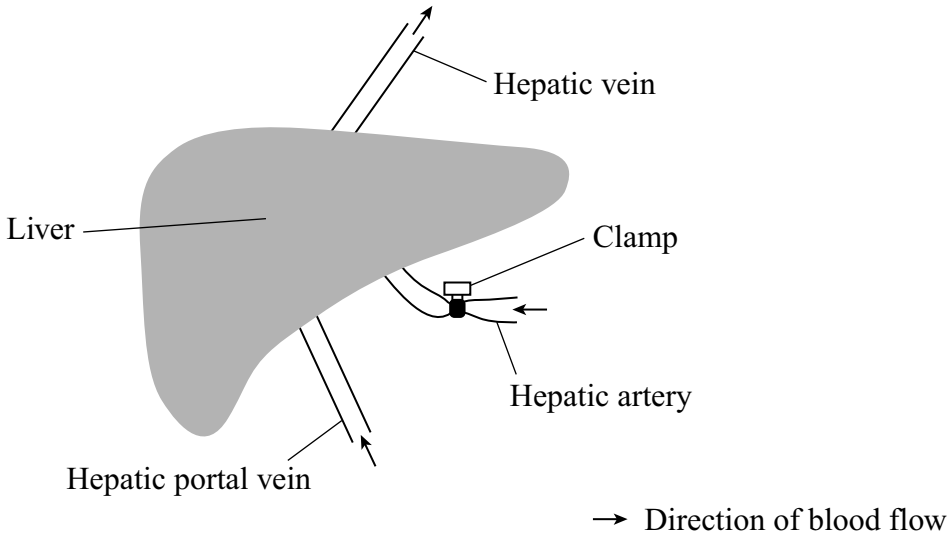
(1 mark)

3 In an investigation, the blood flow in the hepatic artery of a small mammal was prevented by clamping the artery, as shown in the diagram.



The rate of blood flow and the concentration of glucose in the blood of the hepatic portal vein and hepatic vein were then measured at 15-minute intervals. Insulin was injected into the blood at 35 minutes and adrenaline was injected into the blood at 65 minutes. The results are shown in the table.

Time / minutes	**Rate of flow / cm^3 min^{-1}**	**Glucose concentration / mg dm^{-3}**	
		Hepatic portal vein	**Hepatic vein**
0	154	1020	1060
15	151	1010	1040
30	148	1030	1070
Insulin injected			
45	145	940	720
60	144	970	780
Adrenaline injected			
75	74	1070	1270
90	82	1060	1190
105	126	1040	1110

S (a) Between 0 and 30 minutes, the concentration of glucose in the hepatic vein was slightly higher than that in the hepatic portal vein. Explain why.

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(2 marks)

S (b) Explain the effect of insulin on the concentration of glucose in the blood in the hepatic vein.

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(1 mark)

S (c) The effect of insulin on the glucose concentration in the hepatic vein was greater than its effect on the glucose concentration in the hepatic portal vein. Suggest **one** explanation for this.

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(1 mark)

S (d) Adrenaline has a similar effect to that of exercise on the redistribution of blood flow in the body. Explain how adrenaline caused a fall in blood flow in the hepatic portal vein between 60 and 75 minutes.

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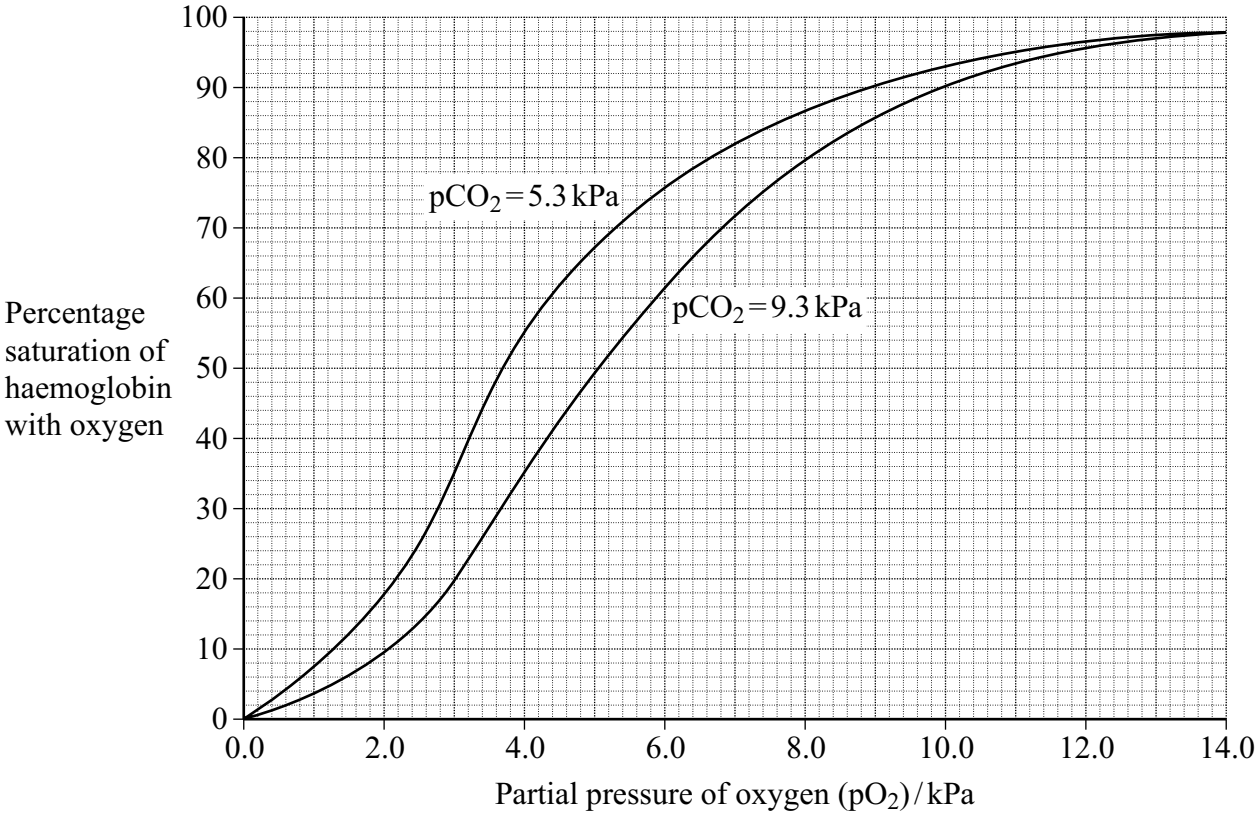
(2 marks)

6

4 The graph shows the oxyhaemoglobin dissociation curve at two different partial pressures of carbon dioxide (pCO_2).



(a) During vigorous exercise, the blood entering a leg muscle had a pO_2 of 4 kPa and a pCO_2 of 5.3 kPa. The blood leaving the muscle had a pO_2 of 2.8 kPa and a pCO_2 of 9.3 kPa. Each dm^3 of blood leaving the lungs contained 200 cm^3 oxygen and was 98 % saturated with oxygen.

Use this information and information from the graph to calculate the volume of oxygen released to the muscle from 1 dm^3 of blood. Show your working.

Answer ..... cm^3 oxygen *(2 marks)*

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S (b) The blood leaving a muscle has a lower pH than the blood entering it. During vigorous exercise, the fall in pH is even greater. Explain what causes this greater fall in pH.

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(3 marks)

5

Turn over for the next question

5 (a) Explain the *trichromatic theory* of colour vision.

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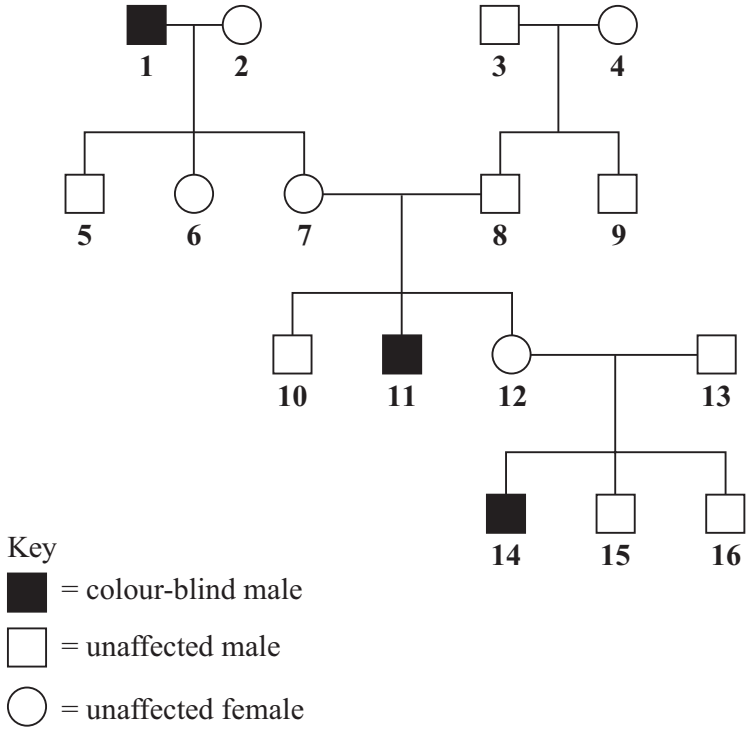
(2 marks)

S (b) Red-green colour blindness is caused by a mutation in the gene coding for one of the opsin proteins which are needed for colour vision. The diagram shows the inheritance of red-green colour blindness in one family.



Person **12** is pregnant with her fourth child. What is the probability that this child will be a male with red-green colour blindness? Explain your answer by drawing a genetic diagram. Use the following symbols

$\mathbf{X^R}$ = an X chromosome carrying an allele for normal colour vision
$\mathbf{X^r}$ = an X chromosome carrying an allele for red-green colour blindness
Y = a Y chromosome

Probability = ... *(4 marks)*

6

Turn over for the next question

6 S (a) Give **one** adaptation of sorghum which helps it to survive in dry conditions.

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(1 mark)

Transpiration in sorghum plants was measured under different conditions. The table shows the results.

Growing conditions	Transpiration rate / mmol m^{-2} s^{-1}	
	Low carbon dioxide concentration	High carbon dioxide concentration
Dry soil	12.68 ± 1.64	11.07 ± 1.52
Watered soil	18.29 ± 1.51	15.08 ± 1.38

(b) Changing the carbon dioxide concentration had a greater effect on the rate of transpiration when the plants were watered than when they were kept in dry conditions. Explain why.

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(2 marks)

S (c) (i) Giving a reason for your choice, suggest **one** factor which should be kept constant during this investigation.

Factor .....

Reason .....

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(1 mark)

(ii) The figures in the table are the mean values ± standard deviation. Suggest what the values of standard deviation given in the table indicate about the effects of carbon dioxide concentration and of watering on the variability of the results.

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(1 mark)

5

7 (a) The release of digestive secretions in a mammal is partly under nervous control and partly controlled by hormones.

Explain the benefit of

(i) the use of the nervous system to control the release of saliva,

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(2 marks)

(ii) the use of a hormone to control the release of digestive juices in the stomach.

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(1 mark)

(b) (i) Describe the effect of each of these hormones.

gastrin .....

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secretin .....

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cholecystokinin-pancreozymin (CCK-PZ) .....

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(3 marks)

(ii) Explain the importance of this sequence of hormone release.

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(1 mark)

Question 7 continues on the next page

(c) (i) Explain why the digestion of proteins is more efficient if they are exposed to endopeptidases before being acted on by exopeptidases.

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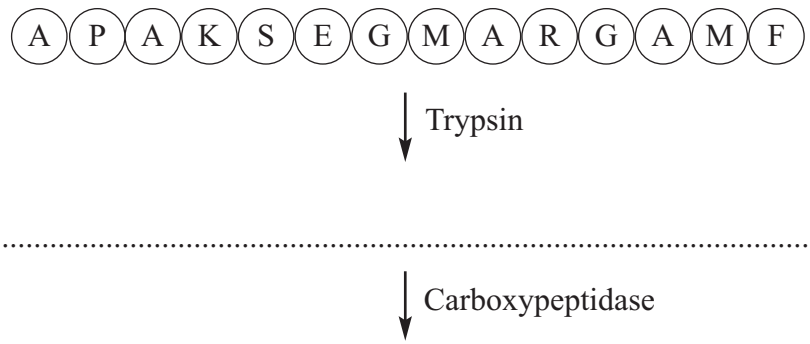
(2 marks)

(ii) **Figure 1** shows a peptide. Each circled letter represents a single amino acid.

Figure 1

This peptide was digested, first with trypsin and then with carboxypeptidase. Trypsin hydrolyses peptide bonds on the C-terminal side of each of the amino acids R and K. Carboxypeptidase hydrolyses one amino acid at a time from the C-terminal end of a peptide, but it will not hydrolyse a dipeptide.
Complete **Figure 2** to show digestion of this peptide as described above.

Figure 2



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(2 marks)

(d) Ruminants, such as cattle, have a diet which is poor in protein. Explain how the presence of mutualistic microorganisms in the rumen can increase the amounts of amino acids available for absorption from the digestive system.

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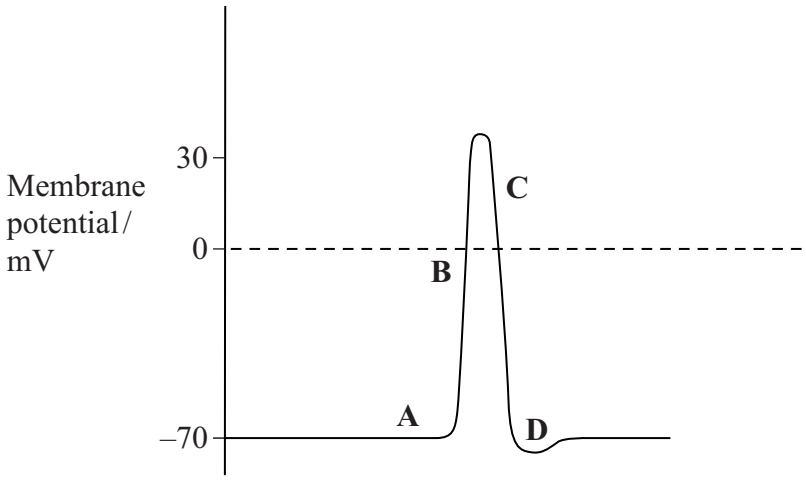
(4 marks)

15

Turn over for the next question

8 (a) **Figure 3** shows the changes in membrane potential at one point on an axon when an action potential is generated.

Figure 3



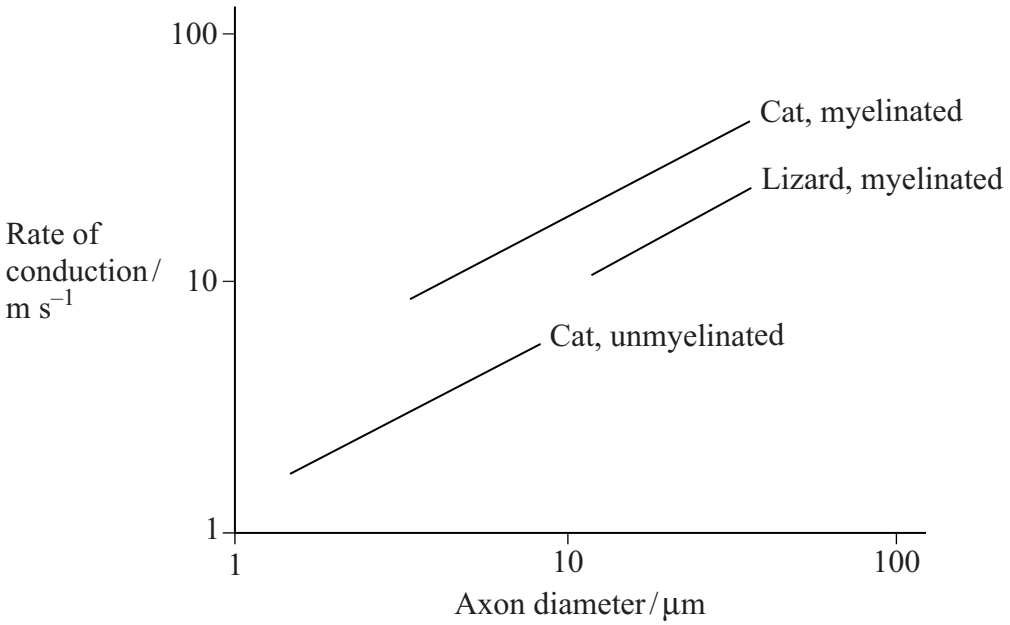
The changes shown in **Figure 3** are due to the movement of ions across the axon membrane. Complete the table by giving the letter (**A** to **D**) that shows where each process is occurring most rapidly.

Process	Letter
Active transport of sodium and potassium ions	
Diffusion of sodium ions	
Diffusion of potassium ions	

(2 marks)

(b) **Figure 4** shows the relationship between axon diameter, myelination and the rate of conduction of the nerve impulse in a cat (a mammal) and a lizard (a reptile).

Figure 4



(i) Explain the effect of myelination on the rate of nerve impulse conduction.

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(2 marks)

S (ii) For the same diameter of axon, the graph shows that the rate of conduction of the nerve impulse in myelinated neurones in the cat is faster than that in the lizard. Suggest an explanation for this.

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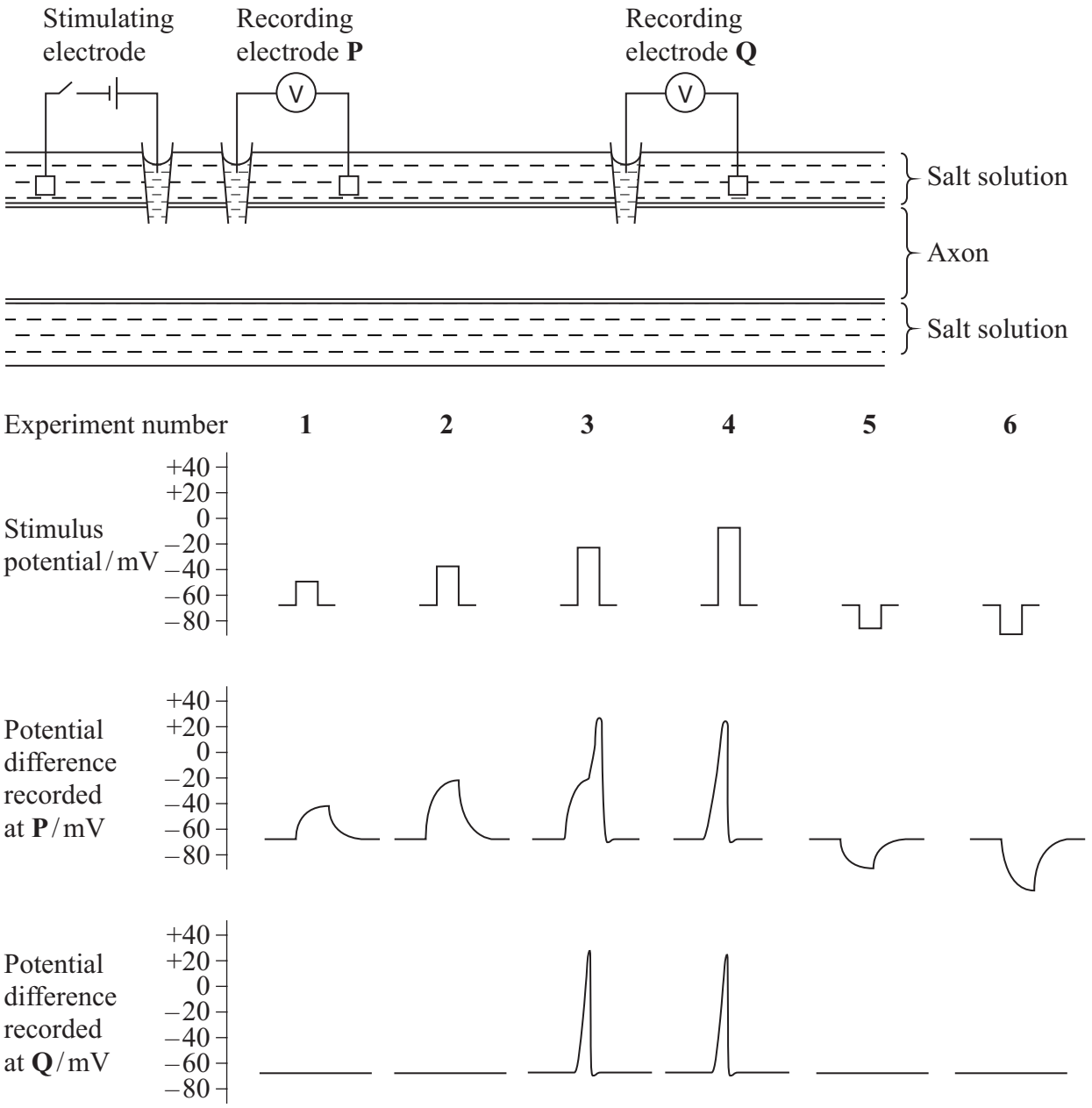
(2 marks)

Question 8 continues on the next page

Figure 5 shows how a stimulating electrode was used to change the potential difference across an axon membrane. Two other electrodes, **P** and **Q**, were used to record any potential difference produced after stimulation. The experiment was repeated six times, using a different stimulus potential each time.
In experiments **1** to **4**, the stimulating voltage made the inside of the axon less negative.
In experiments **5** and **6**, it made the inside of the axon more negative.

Figure 5



(c) Explain the results of experiments **1** to **4**.

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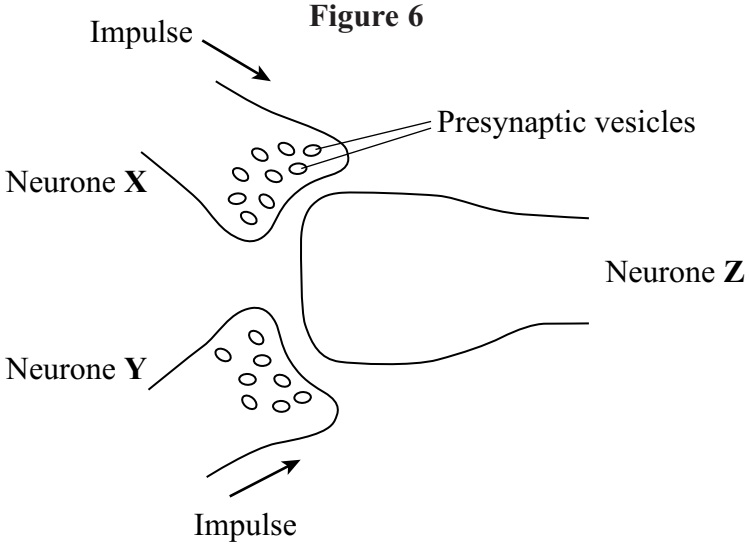
(5 marks)

(d) **Figure 6** shows two neurones, **X** and **Y**, which each have a synapse with neurone **Z**.

Figure 6



Neurone **X** releases acetylcholine from its presynaptic vesicles. Neurone **Y** releases a different neurotransmitter substance which allows chloride ions (Cl^-) to enter neurone **Z**. Use this information, and information from **Figure 5**, to explain how neurones **X** and **Y** have an antagonistic effect on neurone **Z**.

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(4 marks)

9 The kangaroo rat is a small desert mammal. It takes in very little water in its food and it rarely drinks. Its core body temperature is 38 °C.

S (a) The kangaroo rat takes in some water by feeding and drinking. Describe another method by which the kangaroo rat could obtain water.

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(2 marks)

(b) At an environmental temperature of 28 °C and 100 % saturation of the external air with water vapour, the temperature inside a kangaroo rat's nasal passages was 31 °C. At the same environmental temperature but 0 % saturation with water vapour, the temperature in the nasal passages was 26 °C. Explain the difference in temperature of the nasal passages and suggest how the lower nasal temperature helps the kangaroo rat to survive in hot, dry conditions.

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(4 marks)

S (c) The loops of Henle in the kangaroo rat's kidneys are very long and the animal produces highly concentrated urine in small quantities. Explain the part played by each of the following in the production of highly concentrated urine.

(i) The long loops of Henle,

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(6 marks)

(ii) Antidiuretic hormone.

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(3 marks)

END OF QUESTIONS

15

There are no questions printed on this page