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

HUMAN BIOLOGY (SPECIFICATION A) **BYA7**
Unit 7 The Human Life-span

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.

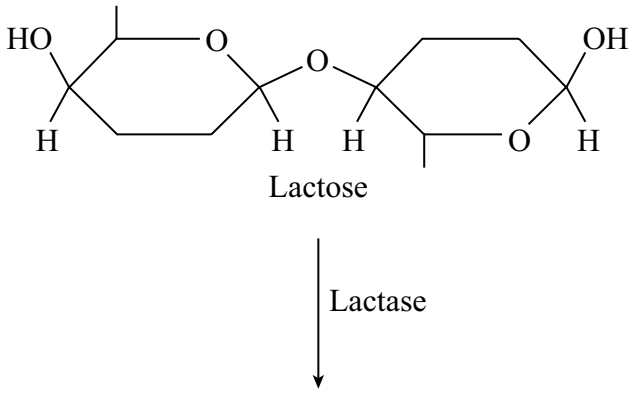
For Examiner's Use			
Number	Mark	Number	Mark
1		9	
2			
3			
4			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

There are no questions printed on this page

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

1 Lactose is a disaccharide found in milk. In the human small intestine, the enzyme lactase catalyses the hydrolysis of lactose to the monosaccharides, galactose and glucose. These monosaccharides are then absorbed into the blood.

S (a) Complete the diagram to show the hydrolysis of lactose to galactose and glucose.



(2 marks)

S (b) Some people are lactose intolerant because they do not produce enough lactase enzyme in the small intestine. Lactose accumulates in the intestines and either remains unhydrolysed or is converted to other soluble substances by bacteria in the intestine. Explain how this could lead to diarrhoea in a lactose-intolerant individual.

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(2 marks)

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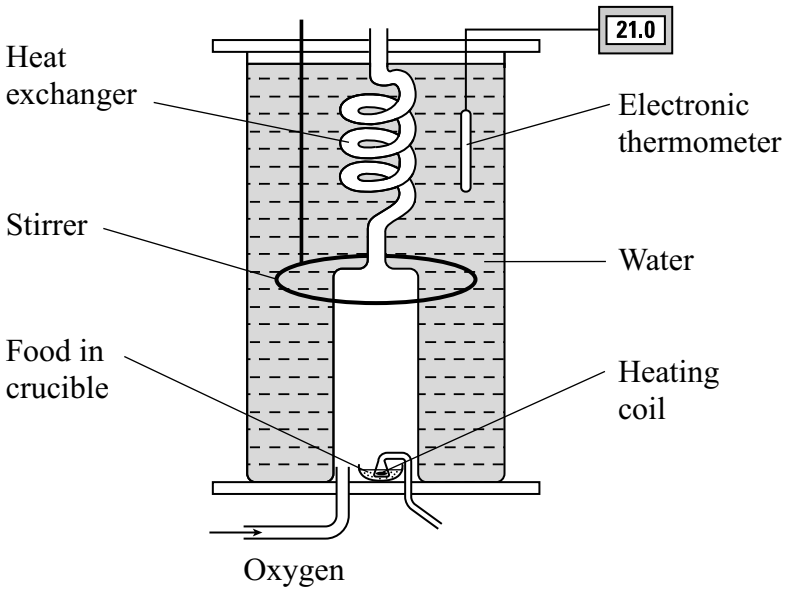
2 The diagram shows the apparatus used to determine the energy content of samples of food. The food is burned in oxygen and the heat released warms the water in the apparatus.



(a) Why is the food burned in oxygen rather than in air?

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(1 mark)

(b) In an investigation, some peanuts were ground up and 0.5 g of the ground peanut was burned in the apparatus. The volume of water in the apparatus was 1000 cm^3. The starting temperature of the water was 20.1 °C and the highest temperature reached was 22.1 °C.
The energy needed to raise the temperature of 1 cm^3 water by 1 °C is 4.18 Joules.

(i) Calculate the amount of energy released by 100 g of peanuts.
Give your answer in kilojoules and show your working.

Answer ..... kJ per 100 g *(2 marks)*

(ii) The published value for the energy content of 100 g of peanuts is 2428 kJ.
Suggest **one** reason why the value determined in the above investigation was less than the published value.

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(1 mark)

3 (a) Explain what is meant by *basal metabolic rate (BMR)*.

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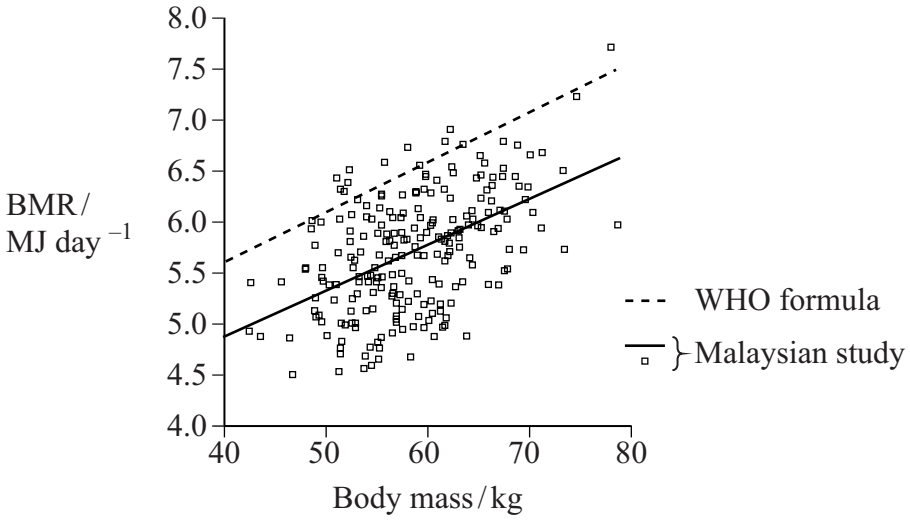
(2 marks)

(b) In 1985, the World Health Organisation (WHO) published a formula relating BMR to body mass. A more recent investigation of this relationship has been carried out in Malaysia, a tropical country. The results of the Malaysian investigation are plotted on the graph together with a line of best fit for these results. A line derived from the WHO formula is also shown on the graph.



(i) Suggest an explanation for the difference in results between the Malaysian investigation and those predicted from the WHO formula.

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(2 marks)

(ii) The Malaysian investigators expressed concern that the Malaysian population might be at risk of developing obesity. Use information from the graph to explain this concern.

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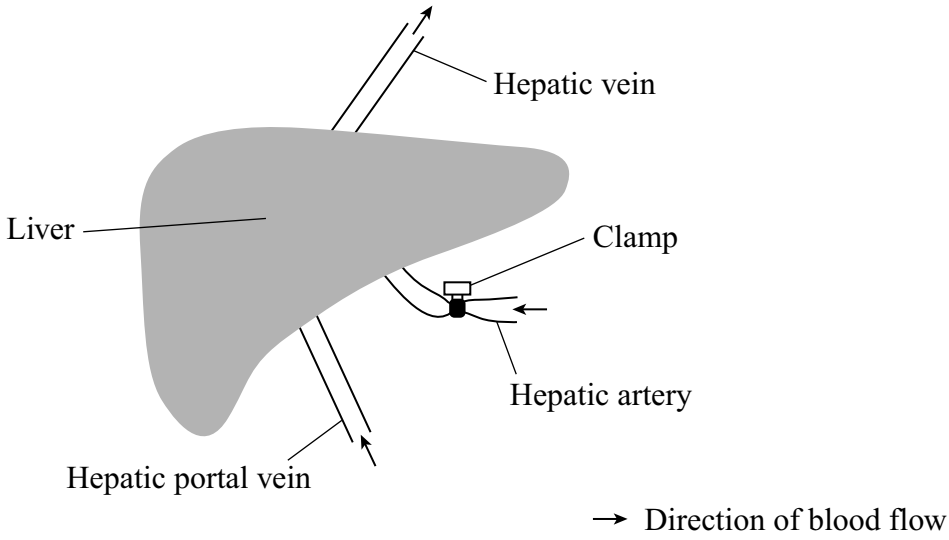
(1 mark)

Turn over ▶

4 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

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

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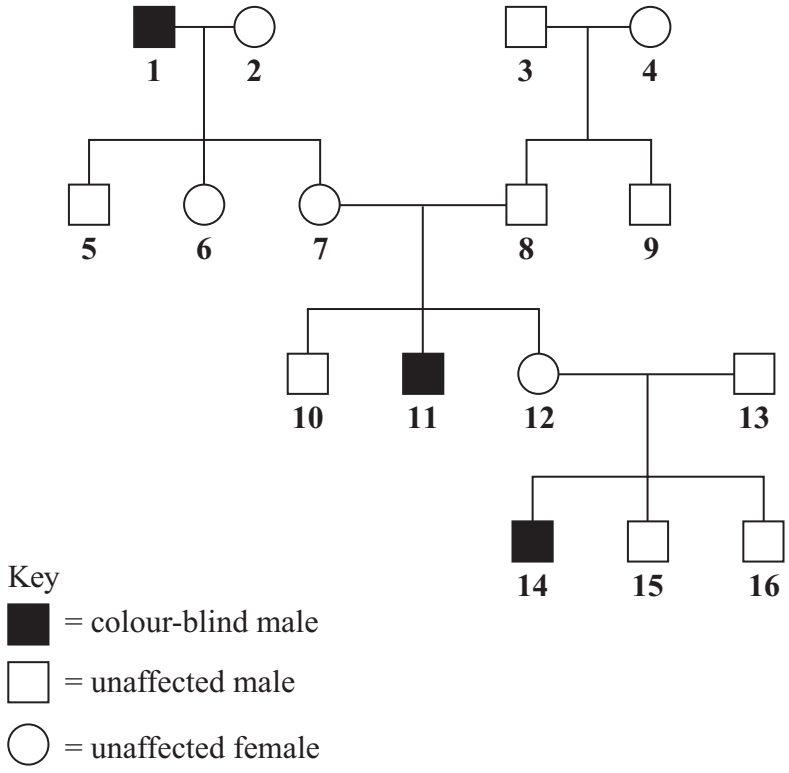
(2 marks)

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.



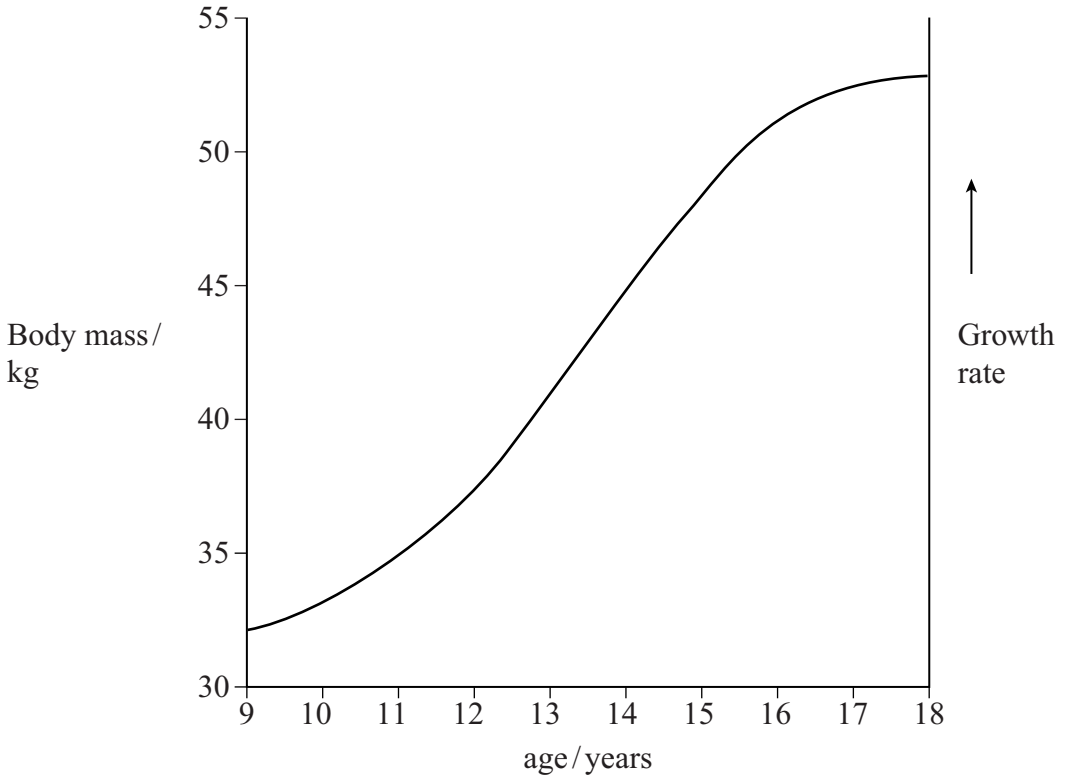
Person **12** is pregnant with her fourth child. What is the probability that this child will be a male with red-green colour blindness? Explain your answer by drawing a genetic diagram. Use the following symbols

$\mathbf{X^R}$ = 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

6 (a) The graph shows the increase in body mass of a human female between the ages of 9 and 18 years.



On the graph, sketch a curve to show the growth rate of this person between the ages of 9 and 18 years.

(2 marks)

S (b) Growth hormone (GH) stimulates growth during adolescence. It is also thought to slow the effects of senescence. In an investigation of the effects of growth hormone on senescence, men aged between 61 and 81, who had a low level of GH secretion, were divided into two groups. **Group 1** received regular injections of GH for six months, but **Group 2** did not. The table compares the values of some variables for each group at the start and at the end of the six-month period.

Variable	**Group**	**Mean value of variable**		**Probability of null hypothesis being accepted**
		at start	**after 6 months**	
Lean body mass / kg	1	53.00	57.70	0.0005
	2	54.20	55.20	0.17
Adipose tissue mass / kg	1	24.10	20.60	0.05
	2	29.00	28.00	0.43
Sum of skin thickness at four sites / mm	1	9.90	10.60	0.07
	2	9.30	9.20	0.69
Bone density in lumbar vertebrae / g cm^{-3}	1	1.23	1.25	0.04
	2	1.29	1.29	0.64

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(i) Suggest **one** factor that would need to be kept constant during this investigation. Explain your answer.

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(1 mark)

(ii) Upon which of the variables did injection of GH have a statistically significant effect? Give evidence from the table for your answer.

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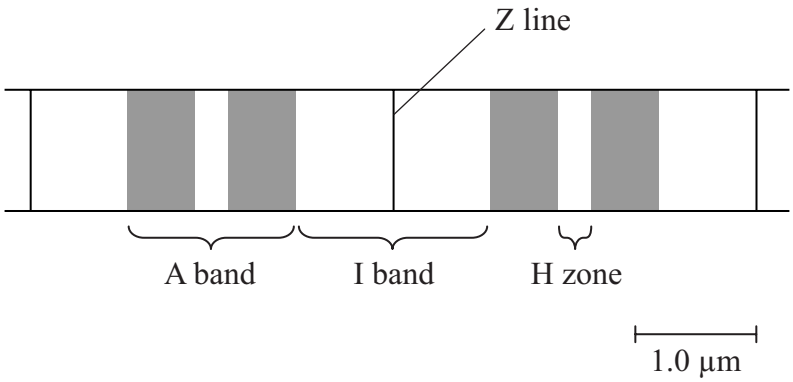
(2 marks)

5

Turn over for the next question

7 The diagram shows part of a myofibril from a relaxed muscle fibre.



(a) When the muscle fibre contracts, which of the A band, I band and H zone

(i) remain unchanged in length, ...
(1 mark)

(ii) decrease in length? .....
(1 mark)

(b) Explain what caused the decrease in length in part (a)(ii).

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(2 marks)

(c) The whole muscle fibre is 30 mm long when relaxed. Each sarcomere is 2.25 µm long when contracted. Use the scale given on the diagram to calculate the length of the contracted muscle fibre in millimetres.

Length of contracted fibre = ... mm *(2 marks)*

(d) The table gives some properties of the two different types of muscle fibre found in skeletal muscle.

(i) Complete the table by writing the words 'high' or 'low' for the remaining three properties of each type of muscle fibre.

	Type of muscle fibre	
	Type 1	**Type 2**
Speed of contraction	high	low
Force generated	high	low
Activity of the enzymes of glycolysis	high	low
Number of mitochondria		
Activity of Krebs cycle enzymes		
Rate of fatigue		

(3 marks)

(ii) The myosin-ATPase of **type 1** muscle fibres has a faster rate of reaction than that in **type 2** fibres. Use your knowledge of the mechanism of muscle contraction to explain how this will help **type 1** muscle fibres to contract faster than **type 2**.

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(4 marks)

S (iii) The blood leaving an active muscle with a high percentage of **type 1** muscle fibres contained a higher concentration of lactate than that leaving a muscle with a high percentage of **type 2** muscle fibres. Explain why.

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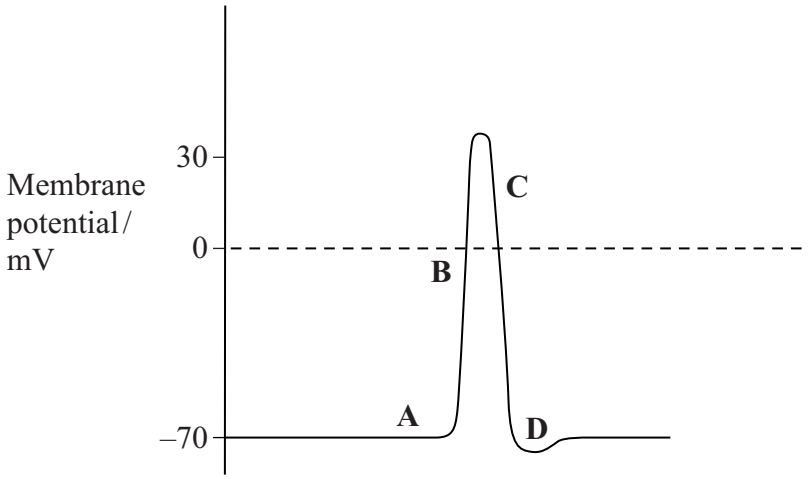
(2 marks)

8 (a) **Figure 1** shows the changes in membrane potential at one point on an axon when an action potential is generated.

Figure 1



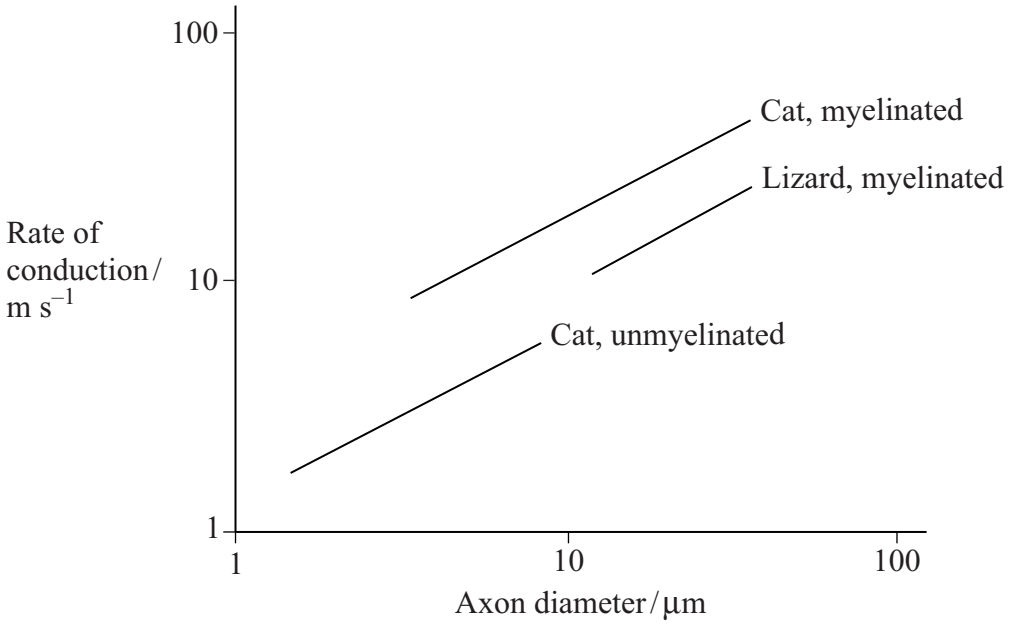
The changes shown in **Figure 1** are due to the movement of ions across the axon membrane. Complete the table by giving the letter (**A** to **D**) that shows where each process is occurring most rapidly.

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

(2 marks)

(b) **Figure 2** 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 2



(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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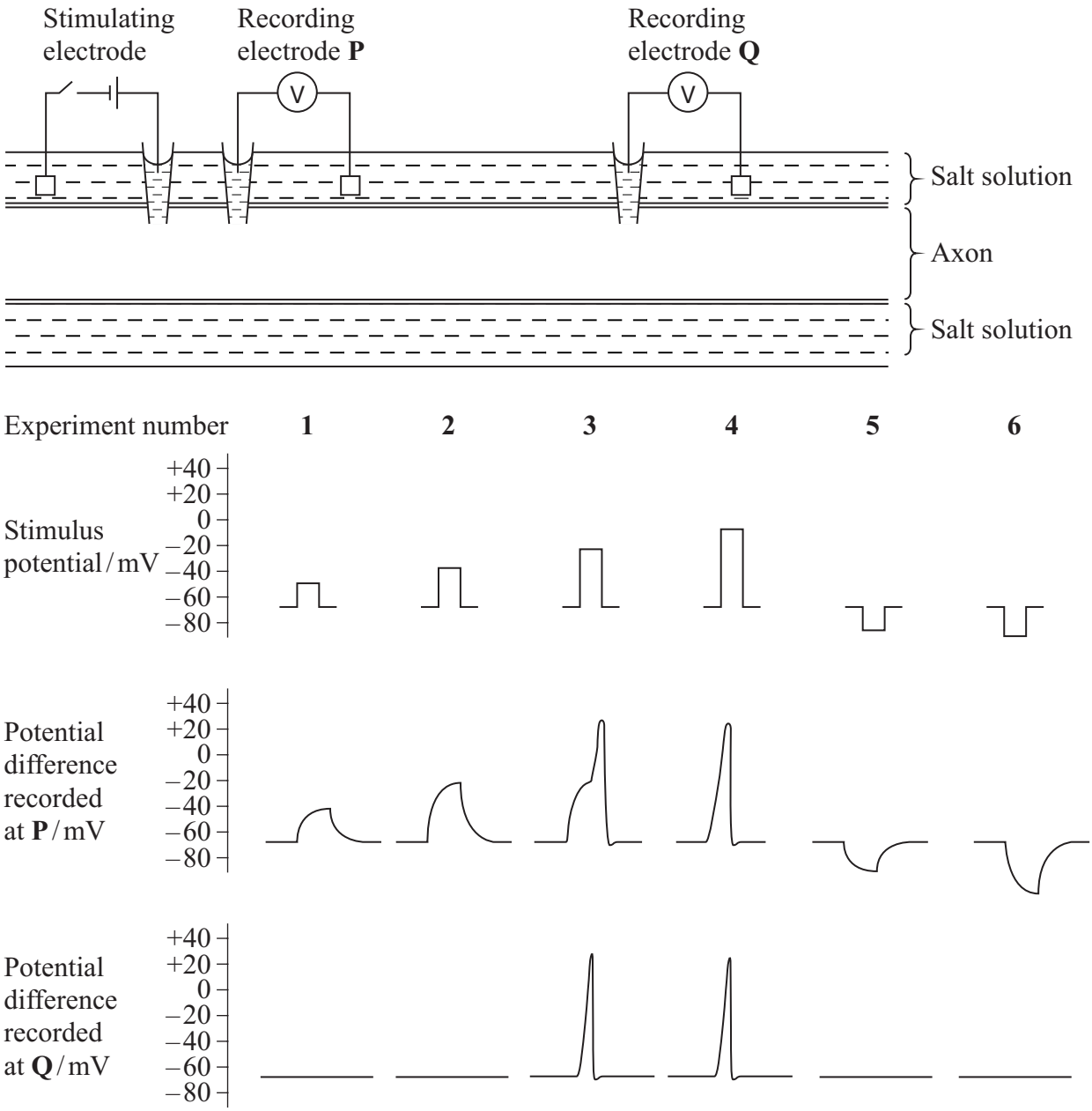
(2 marks)

Question 8 continues on the next page

Figure 3 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 3



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

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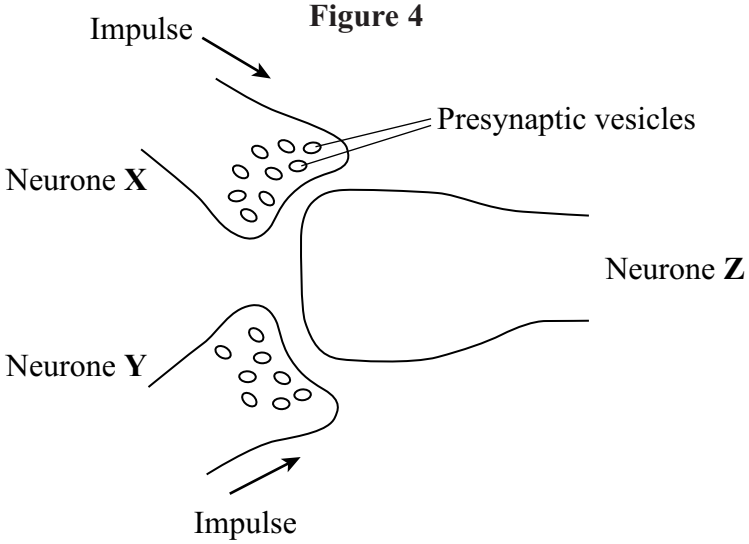
(5 marks)

(d) **Figure 4** shows two neurones, **X** and **Y**, which each have a synapse with neurone **Z**.

Figure 4



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 3**, to explain how neurones **X** and **Y** have an antagonistic effect on neurone **Z**.

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(4 marks)

9 (a) Describe the similarities and differences in gamete production in the human male and the human female.

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(6 marks)

S (b) Use Fick's law to explain how the placenta is adapted for efficient exchange of materials between mother and fetus.

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(5 marks)

(c) Describe the locations and explain the functions of the *ductus arteriosus* and the *foramen ovale* in the fetus.

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(4 marks)

15

END OF QUESTIONS

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