Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
June 2007
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

BIOLOGY/HUMAN BIOLOGY (SPECIFICATION A) BYA1
Unit 1 Molecules, Cells and Systems

Monday 4 June 2007 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 to be marked.

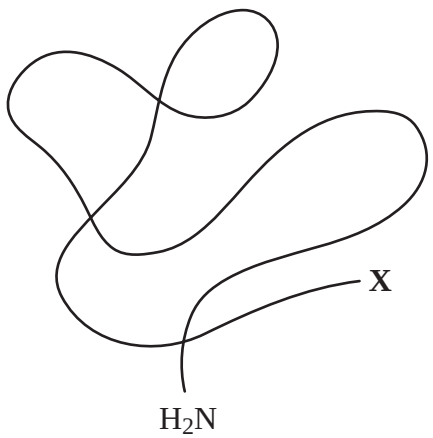
Information

- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- You will be marked on your ability to use good English, to organise information clearly and to use accurate scientific terminology where appropriate.

For Examiner's Use			
Question	Mark	Question	Mark
1			
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 (a) The diagram shows a protein molecule.



(i) Give the chemical formula of the group in position **X**.

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(1 mark)

(ii) Name the chemical bonds that link the amino acids in this molecule.

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(1 mark)

(b) Trypsin is a protein-digesting enzyme. It breaks the bonds between specific amino acids.

(i) Name the chemical reaction involved in breaking these bonds.

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(1 mark)

(ii) Use your knowledge of the way in which enzymes work to explain why trypsin only breaks the bonds between specific amino acids.

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(2 marks)

(c) The protein shown in the diagram was incubated with trypsin. The short polypeptides formed were separated from each other by two-way chromatography.

(i) Describe how two-way chromatography is carried out.

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(2 marks)

(ii) Explain the advantage of using two-way chromatography to separate the short polypeptides.

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(1 mark)

(d) Haemoglobin from people with sickle-cell anaemia is different from haemoglobin from people who do not have sickle-cell anaemia. The technique described in part (c) was used to compare these two types of haemoglobin. The chromatograms were different. Explain why.

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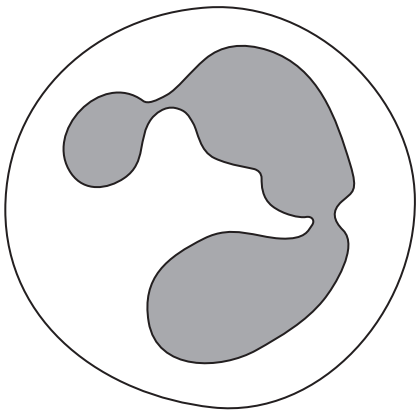
(2 marks)

10

Turn over for the next question

2 (a) The diagram shows a granulocyte.



The nucleus of a lymphocyte differs in appearance from that of a granulocyte. Describe the appearance of the nucleus of a lymphocyte.

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(1 mark)

(b) Granulocytes in a blood smear were examined with an optical microscope.

(i) Explain why it was necessary to stain the smear before looking at the granulocytes.

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(1 mark)

(ii) Describe how the diameter of a granulocyte could be estimated.

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(2 marks)

(c) The table shows the masses of some of the substances present in a granulocyte and in a bacterial cell. The figures are shown as percentages of the total cell mass.

Substance	**Percentage of total cell mass**	
	Granulocyte	Bacterial cell
Water	70	70
Inorganic ions	1	1
Monosaccharides and amino acids	2	2
Protein	17	15
Cell membrane phospholipids	4	2
Other lipids	2	0
Polysaccharides	2	2

(i) Which substance or substances in the table are polymers?

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(1 mark)

(ii) Explain the difference between the figures for cell membrane phospholipids in the two cells.

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(2 marks)

(iii) How would the percentage of the total cell mass that was polysaccharide differ in a plant cell and a granulocyte? Explain your answer.

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(2 marks)

9

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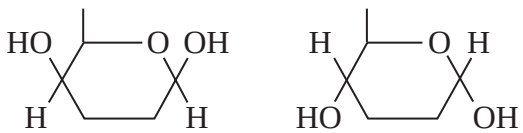
3 Lactose is a carbohydrate. It consists of a galactose molecule joined to an α-glucose molecule by a glycosidic bond.

(a) The diagram shows a galactose molecule and an α-glucose molecule.



galactose α-glucose

(i) Draw a box round the atoms that are removed when a glycosidic bond is formed between these two molecules.

(1 mark)

(ii) The formula for galactose is $C_6H_{12}O_6$. What is the formula for lactose?

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(2 marks)

(b) Describe how you would use a biochemical test to show that lactose is a reducing sugar.

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(2 marks)

(c) All lactose molecules have the same chemical structure. Starch molecules from different organisms may be different from each other. Give **one** way in which starch molecules may be different from each other.

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(1 mark)

6

4 (a) 'Induced fit' and the 'lock and key' are two models used to explain enzyme action. Describe how 'induced fit' is different from the 'lock and key' model.

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(2 marks)

(b) The effect of temperature on the rate of an enzyme-controlled reaction was investigated. Separate solutions of the enzyme and its substrate were raised to the required temperatures. They were then mixed and put in four test tubes, **A**, **B**, **C** and **D**. These four test tubes were placed in waterbaths and incubated at different temperatures and for different times. The amount of product in each test tube was then measured. The results of the investigation are shown in the table.

	Test tube			
	A	**B**	**C**	**D**
Incubation temperature / °C	30.0	30.0	45.0	45.0
Incubation time / minutes	0.5	10.0	0.5	10.0
Mass of product formed / µg	2.5	47.0	8.0	10.0
Rate of formation of product / µg minute^{-1}	5.0	4.7	16.0	1.0

(i) Explain the difference in the rate of formation of product between test tubes **B** and **A**.

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(1 mark)

(ii) Explain the difference in the rate of formation of product between test tubes **C** and **A**.

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(3 marks)

(iii) What causes the difference in the rate of formation of product between test tubes **D** and **C**?

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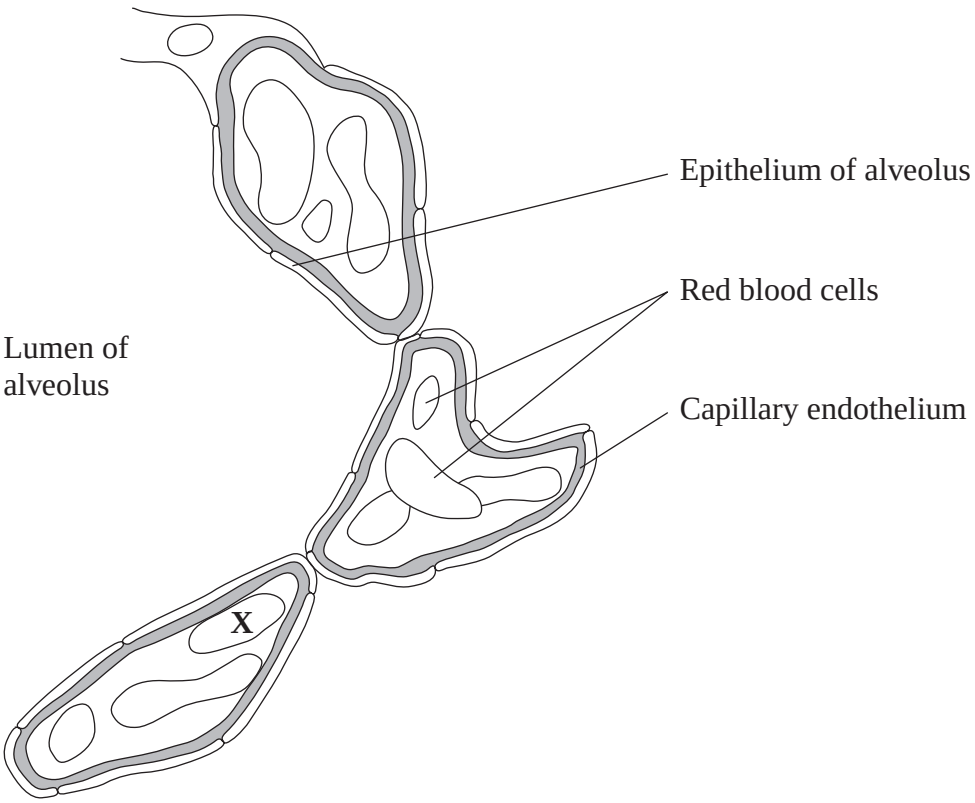
(1 mark)

7

Turn over for the next question

5 The drawing shows a section through part of an alveolus from a human lung. The drawing has been made from an electron micrograph. The magnification of this drawing is 3600 times.



(a) (i) Explain why the red blood cells in the drawing are different in shape.

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(2 marks)

(ii) A molecule of oxygen diffuses from the lumen of the alveolus to the plasma membrane around red blood cell **X**. Calculate the minimum distance the oxygen molecule would diffuse. Show your working and give your answer in micrometres.

Answer ..... µm *(2 marks)*

(b) The concentration of water vapour is higher in the alveolus than in the atmospheric air.

(i) Explain why the concentration of water vapour is higher in the alveolus.

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(2 marks)

(ii) Give **two** other ways in which the composition of the air in the alveolus differs from that of atmospheric air.

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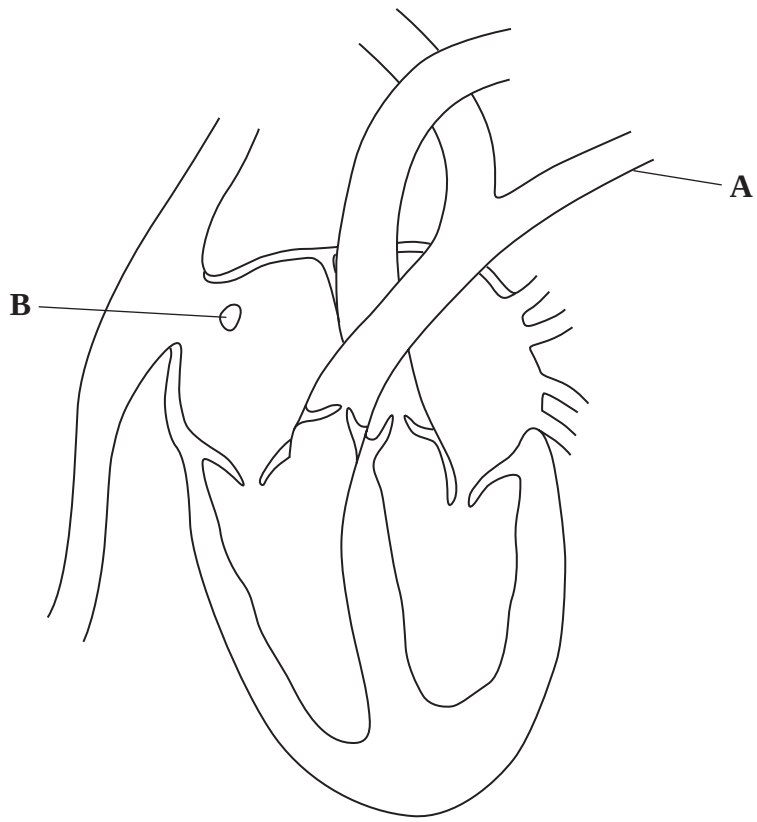
(1 mark)

7

Turn over for the next question

6 The diagram shows a section through the heart of a mammal.



(a) Draw arrows on the diagram to show the path taken by blood returning from the liver and going to the left lung.

(1 mark)

(b) There are elastic fibres in the wall of vessel **A**. These elastic fibres help to smooth out the pressure in blood vessel **A**. Describe how.

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(2 marks)

(c) The structure labelled **B** initiates the heart beat.

(i) Name structure **B**.

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(1 mark)

(ii) Nerves to structure **B** reduce the heart rate when a person is resting. Explain how.

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(2 marks)

6

Turn over for the next question

7 Read the following passage.

The skin of a fish is not very permeable to water. Surprisingly, this is true even for fish that can absorb oxygen through their skin. All fish, however, have a large amount of permeable epithelium and this tissue is in contact with the water in which they live.

Marine fish, such as cod, live in the sea. Their body fluids have a lower concentration of dissolved substances than sea water. Therefore their body fluids lose water and gain ions. Cod overcome water loss by drinking sea water. The ions that enter the body fluid are then actively transported out of the fish by chloride cells in the gills. Chloride cells are packed with large numbers of mitochondria.

Sharks are also marine fish. They have another strategy for living in the sea. They retain nitrogen-containing substances such as urea in their blood. This results in shark body fluids having the same water potential as sea water. When scientists discovered this they thought it was very unusual because urea denatures mammalian proteins such as enzymes and the transport proteins found in plasma membranes.

Use information from the passage and your own knowledge to answer the questions.

(a) (i) Explain why epithelium is described as a tissue (line 3).

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(1 mark)

(ii) Suggest **one** organ in a fish which would have permeable epithelium in contact with the water in which the fish lives (lines 2–4).

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(1 mark)

(b) Explain why the body fluids of cod tend to lose water and gain ions (lines 6–7).

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(3 marks)

(c) Evidence from the passage suggests that chloride cells actively transport ions out of fish (lines 7–9). Explain this evidence.

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(2 marks)

(d) The skin of fish is not very permeable to water but some fish can absorb oxygen through the skin (lines 1–2). Explain why this absorption of oxygen is surprising.

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(2 marks)

(e) Describe what happens when a protein is denatured. Explain how this affects enzymes and transport proteins in plasma membranes (lines 13–14).

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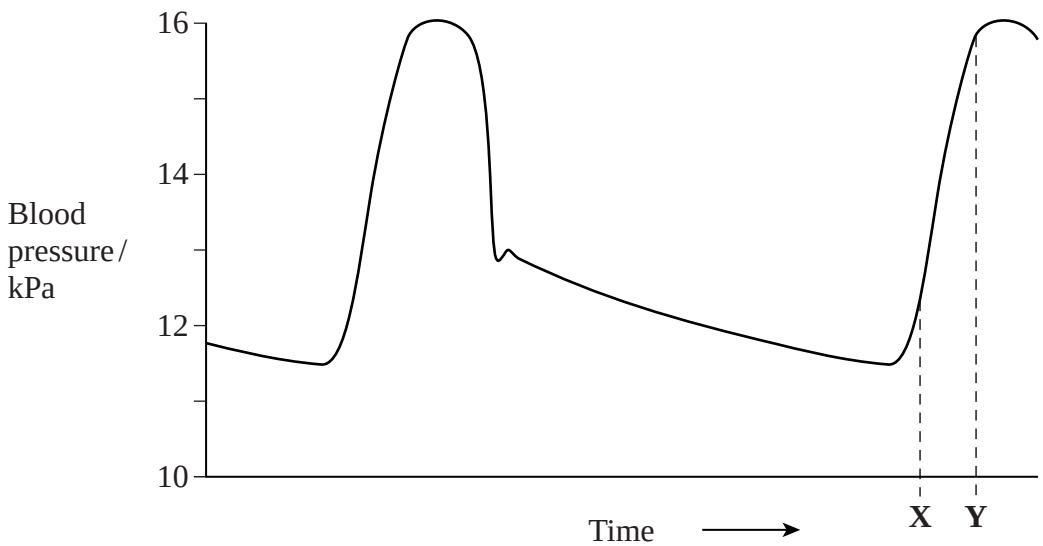
(6 marks)

8 The graph shows how pressure changes in the aorta when the heart beats.



(a) Explain what causes blood to enter the aorta and the pressure to change between times **X** and **Y**.

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(2 marks)

(b) (i) How would you expect the pressure at time **Y** to be different in the pulmonary artery?

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(1 mark)

(ii) Explain the cause of this difference in pressure.

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(1 mark)

The table shows the time it takes for the ventricles to fill and to empty at different heart rates.

Heart rate / beats per minute	Time taken for ventricles to fill / s	Time taken for ventricles to empty / s
40		0.37
50	0.81	0.39
60	0.62	0.38
70	0.48	0.38
80	0.37	0.38
90	0.28	0.39

(c) Calculate the time taken for the ventricles to fill at a heart rate of 40 beats per minute. Show your working.

Answer ..... s *(2 marks)*

(d) (i) Describe how the time taken for the ventricles to fill varies as the heart rate increases.

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(1 mark)

(ii) The table shows the time taken for the ventricles to fill, and the time taken for the ventricles to empty. These times help to increase the rate of blood flow during exercise. Explain how.

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(2 marks)

Question 8 continues on the next page

(e) Explain how red blood cells are adapted to their function of transporting oxygen. In your answer, write about both the shape and structure of the cells and their size in relation to that of capillaries.

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(6 marks)

15

END OF QUESTIONS

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