

Surname						Other Names					
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General Certificate of Education
 January 2003
 Advanced Subsidiary Examination



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

Thursday 9 January 2003 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.

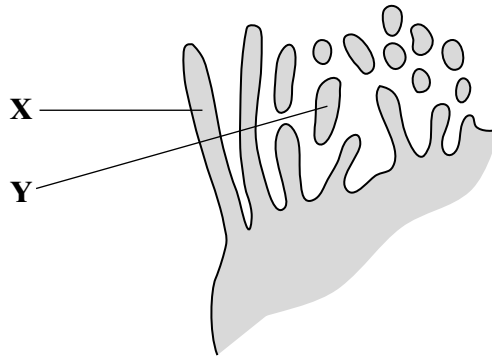
Information

- 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.

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

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

- 1 (a) The drawing was made from an electron micrograph. It shows some microvilli on an epithelial cell from the small intestine.



- (i) A transmission electron microscope uses a beam of electrons. Explain how a beam of electrons allows the microvilli to be seen in detail.

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(2 marks)

- (ii) Explain why the microvilli labelled **X** and **Y** differ in appearance.

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(1 mark)

- (b) Different cells contain different numbers of mitochondria. Suggest the advantage of large numbers of mitochondria in

- (i) a cell from a plant root which absorbs mineral ions from the soil;

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- (ii) a muscle cell.

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(3 marks)

2 Lactose is a sugar which is found in milk. It can spoil milk products such as ice cream by producing an unpleasant sandy texture. Lactase is an enzyme which is used in making ice cream. It breaks down lactose to glucose and galactose. When ice cream is made, lactase is added to milk and left for about a day at 5°C. The reaction is very slow.

(a) Use your knowledge of enzymes to explain why the rate of this reaction is very slow at 5°C.

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(3 marks)

(b) Adult cats are unable to digest lactose. Lactase is used to reduce the amount of lactose in milk for cats. The milk is heated to sterilise it. It is then cooled and the lactase added before packaging. Explain why lactase is added after cooling the milk rather than before heating it.

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(2 marks)



TURN OVER FOR THE NEXT QUESTION

Turn over

3 The table shows some information about blood vessels in a dog.

Blood vessels	Mean diameter/cm	Total number	Mean length/cm	Total cross-sectional area/cm ²	Total volume/cm ³
Main arteries	0.1	600	10.0	5	50
Arterioles	0.002	4×10^7	0.2	125	25
Capillaries	0.0008	1.2×10^9	0.1	600	60
Main veins	0.24	600	10.0	27	270
Other blood vessels					525

(a) Use your knowledge of the pattern of blood circulation in a mammal to explain why

(i) the total number of arterioles is more than the total number of main arteries;

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 (1 mark)

(ii) the total number of main arteries is the same as the total number of main veins.

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 (1 mark)

(b) (i) Explain how the total volume of blood in the arterioles was calculated.

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 (1 mark)

(ii) Calculate the percentage of blood in the blood vessels which is in the capillaries. Show your working.

Answer %
 (2 marks)

- (c) (i) Name **one** tissue or organ in which the volume of blood in the capillaries increases during exercise.

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(1 mark)

- (ii) Describe the part played by the arteriole walls in reducing blood flow to the capillaries in the intestines during exercise.

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(3 marks)

9

TURN OVER FOR THE NEXT QUESTION

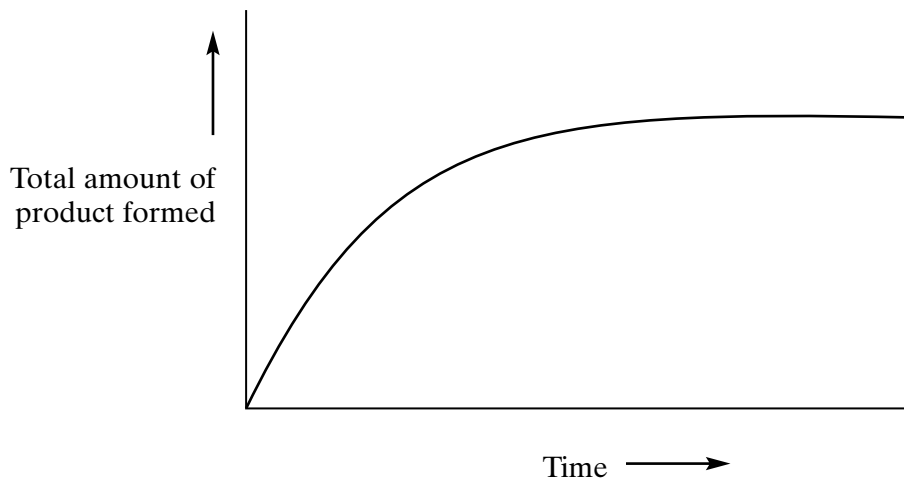
Turn over ►

- 4 (a) An enzyme was dissolved in water. A biuret test was carried out on the solution. Describe and explain the result you would expect.

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(2 marks)

- (b) The graph shows the total amount of product formed during an enzyme-controlled reaction.



- (i) Describe and explain what happened to the total amount of substrate present as the reaction progressed.

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(1 mark)

- (ii) Use your knowledge of how an enzyme works to explain why the rate of reaction decreased with time.

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(2 marks)

(iii) This reaction was carried out at a temperature of 30 °C. Sketch a curve on the graph to show the total amount of product formed at 20 °C. (2 marks)

(c) Catalase is an enzyme which breaks down hydrogen peroxide to produce water and oxygen. The effect of substrate concentration on the rate of this reaction was investigated. Explain why the *initial* rate of reaction was measured at each substrate concentration.

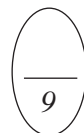
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(2 marks)



TURN OVER FOR THE NEXT QUESTION

Turn over

5 (a) Fick's law describes the effects of various factors on the rate of diffusion. These factors are:

- A** = surface area
- (C₁ - C₂)** = difference in concentration
- t** = thickness of exchange surface

Use **A**, **(C₁ - C₂)** and **t** to complete the equation representing Fick's law.

Rate of diffusion is proportional to _____ (1 mark)

(b) (i) There are about 150 000 000 alveoli in a human lung. Explain how this makes gas exchange very efficient.

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(1 mark)

(ii) The capillaries in the lungs are very small in diameter. As a result, blood travels through them slowly. Explain **two** ways in which the small diameter of the capillaries results in the efficient transfer of oxygen from the alveoli to the red blood cells.

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(3 marks)

(c) During a breath, little of the air contained in alveoli at the top of the lungs is replaced. Explain how this makes gas exchange inefficient in these alveoli.

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(2 marks)

- 6 (a) (i) How many molecules are produced when a triglyceride molecule is completely hydrolysed?

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(1 mark)

- (ii) Many large biological molecules are polymers. Explain why triglycerides are **not** polymers.

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(1 mark)

- (b) Molecules can be represented in different ways. **Figure 1** shows a model of a fatty acid. It shows the different atoms that make up the molecule.

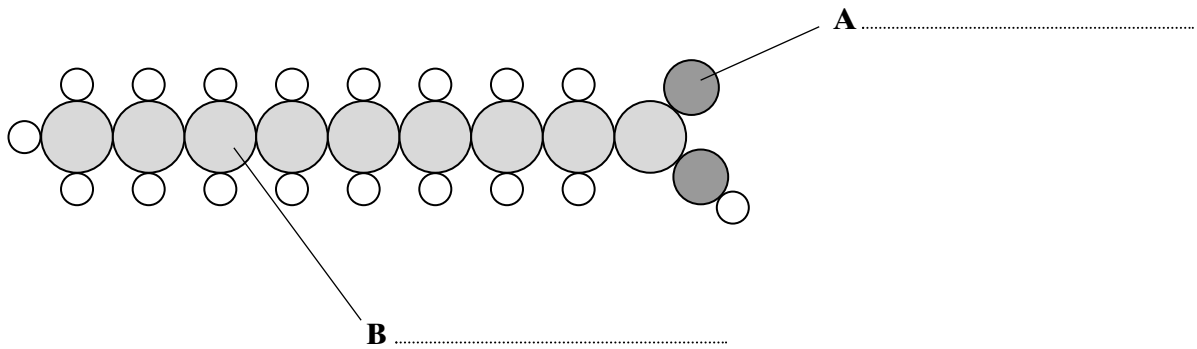


Figure 1

- (i) Complete the diagram by naming the atoms labelled **A** and **B**. (2 marks)
- (ii) This molecule is a saturated fatty acid. Explain the meaning of *saturated*.

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(1 mark)

- (c) A drop of phospholipid was put into a large dish of water. The drop had a volume of 1 mm^3 . It spread out to form a film on the surface of the water which covered an area of $400\,000 \text{ mm}^2$. **Figure 2** shows the appearance of the surface film formed by the phospholipid molecules.

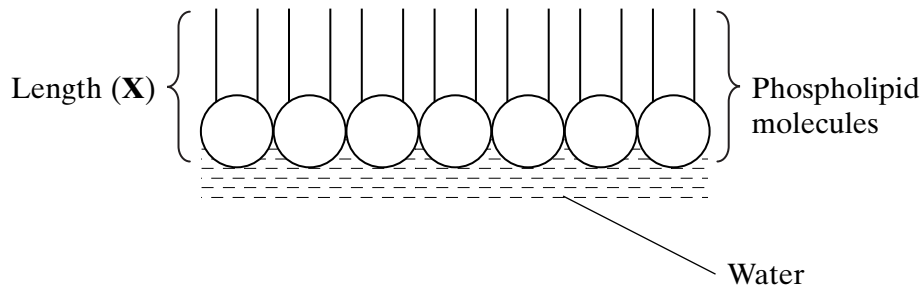


Figure 2

- (i) Calculate the length (**X**) of a single phospholipid molecule. Show your working.

Answer
(2 marks)

- (ii) Explain what causes the phospholipid molecules to be arranged in the way shown in **Figure 2**.

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(2 marks)

7 Read the following passage.

A red blood cell is packed full of haemoglobin. When mature, it contains none of the organelles usually found in an animal cell. The nucleus, endoplasmic reticulum, mitochondria and ribosomes are all absent.

5 More is known about the plasma membrane of a human red blood cell than about any other eukaryotic cell membrane. One reason for this is that the plasma membrane surrounding a red blood cell can be isolated without being contaminated by internal cell membranes. Red blood cell plasma membranes or “ghosts” can be prepared by putting the cells in a dilute salt solution. This causes the cells to swell and burst, leaving only the plasma membrane.

10 Red blood cell ghosts have been investigated and found to contain several different proteins. One of these proteins is spectrin. It is made up of long polypeptide chains which form a network on the inside of the membrane. Spectrin strengthens the membrane and is involved in maintaining the three-dimensional shape of the red blood cell.

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

(a) Complete the table by giving **two** ways in which the structure of a red blood cell differs from the structure of a bacterial cell.

Red blood cell	Bacterial cell
Contains haemoglobin	Does not contain haemoglobin
Contains spectrin	Does not contain spectrin

(2 marks)

(b) Haemoglobin is a protein. Explain why a mature red blood cell cannot make haemoglobin.

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(2 marks)

- (c) (i) Plasma membranes that have been isolated from red blood cells are not contaminated by internal cell membranes (lines 6 - 7). Explain why.

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(1 mark)

- (ii) When red blood cells are put in a dilute salt solution they swell (line 8). Use your knowledge of water potential to explain why.

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(2 marks)

- (d) Some people have red blood cells that do not contain spectrin. These red blood cells are spherical in shape. They also burst more quickly when put in distilled water.

- (i) Explain why more oxygen is taken up by normal red blood cells than by these spherical cells.

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(1 mark)

- (ii) Explain why red blood cells that do not contain spectrin burst more quickly when put into distilled water.

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(1 mark)

QUESTION 7 CONTINUES ON THE NEXT PAGE

Turn over ►

(e) Polypeptides such as spectrin are formed from amino acids. Describe the structure of an amino acid molecule and explain how amino acids link together.

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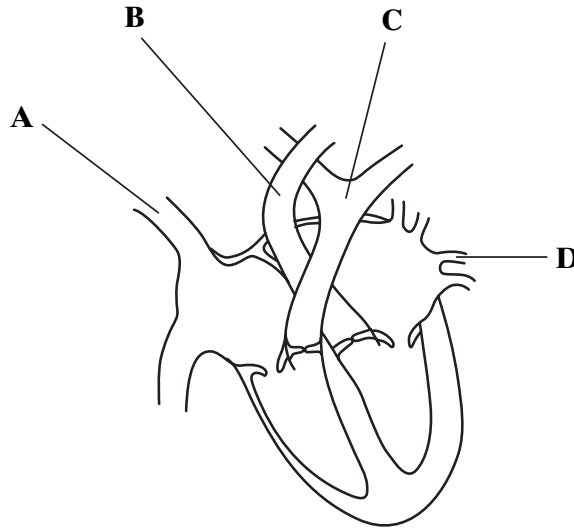
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(6 marks)

8 The diagram shows a section through a human heart.



(a) Which of the blood vessels labelled **A** to **D**

(i) takes blood from the heart to the muscles of the arms and legs;

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(1 mark)

(ii) is a vein which contains oxygenated blood?

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(1 mark)

(b) Is the right ventricle filling with blood or emptying? Give **two** pieces of evidence from the diagram to support your answer.

Filling or emptying?

Evidence

1

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2

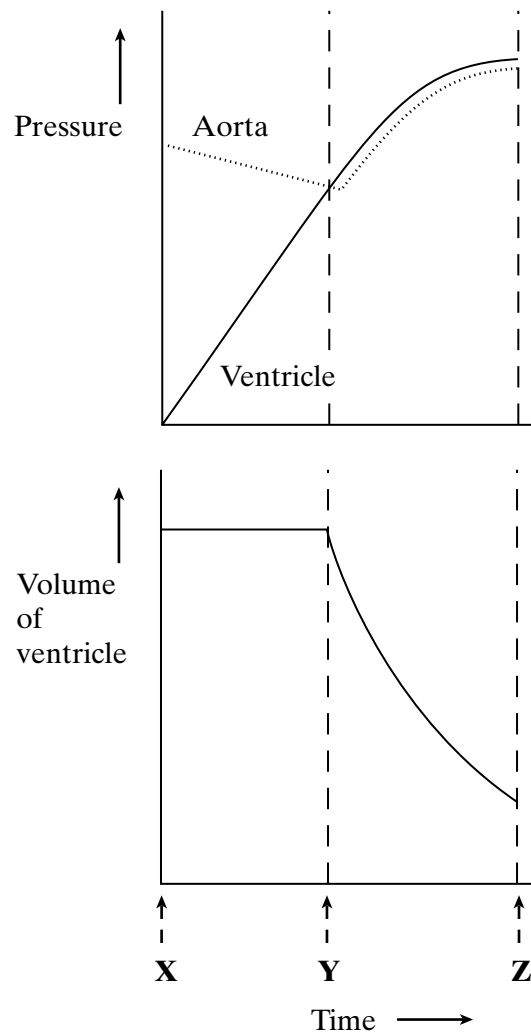
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(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

Turn over ►

The graphs show some changes in pressure and volume during part of a cardiac cycle.



- (c) Describe what the graphs show about the pressure and volume in the ventricle between times **X** and **Y**.

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 (1 mark)

- (d) At point **Y**, the valve between the aorta and the ventricle opens. Use the information about pressure on the graph to explain why.

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 (1 mark)

(e) Explain the changes in the volume of the ventricle between times **X** and **Z**.

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(3 marks)

(f) Describe the structure of a capillary and explain how capillaries are important in the formation of tissue fluid.

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(6 marks)

END OF QUESTIONS