Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
January 2005
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Monday 10 January 2005 Morning Session

In addition to this paper you will require:
- 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 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
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 In the lungs, the alveoli are the site of gas exchange.

(a) A large number of small alveoli is more efficient in gas exchange than a smaller number of larger alveoli. Explain why.

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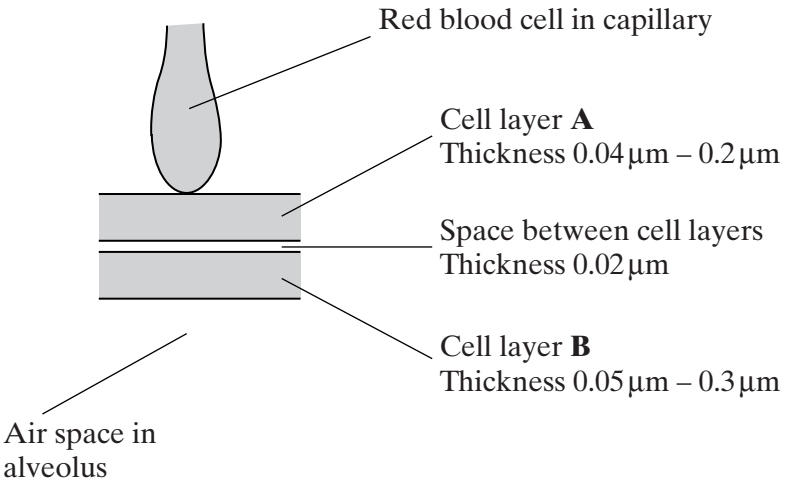
(2 marks)

(b) The diagram shows part of an alveolus and a capillary.



(i) Name the type of cells in layer **B**.

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(1 mark)

(ii) What is the minimum distance a molecule of carbon dioxide diffuses from the blood plasma to the air space in the alveolus?

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(1 mark)

(c) Just before a person starts to exhale, the composition of the air in an alveolus differs from the composition of the air in the trachea.

(i) Give **two** ways in which the composition would differ.

1 .....

2 .....

(1 mark)

(ii) Explain what causes this difference in composition between the air in the alveolus and the air in the trachea.

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(1 mark)

(d) The partial pressure of a gas is a measure of the amount of gas that is present. The partial pressure of carbon dioxide in blood going to the lungs is 6.3 kPa. The partial pressure of carbon dioxide in an alveolus is 5.3 kPa.

(i) Through which vessel does blood leave the heart to go to the lungs?

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(1 mark)

(ii) Suggest why blood returning to the heart from the lungs contains some carbon dioxide.

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(2 marks)

9

2 Catalase is an enzyme. It catalyses the breakdown of hydrogen peroxide in the reaction:

$$\underset{\text{hydrogen peroxide}}{2H_2O_2} \rightarrow \underset{\text{water}}{2H_2O} + \underset{\text{oxygen}}{O_2}$$

In an investigation, samples of different substances were added to hydrogen peroxide in a series of test tubes. The rate of reaction was measured by recording the rate at which bubbles of oxygen were produced. A scale going from 0 for no bubbles to 5 for the maximum rate of bubbling was used to measure this. The results are shown in the table.

Tube	Substance added	Rate at which bubbles of oxygen were produced
A	Piece of liver	4
B	Ground liver and sand	5
C	Sand	0
D	Piece of cooled, boiled liver	0

(a) Explain the difference between the rate at which bubbles were produced in

(i) tubes **A** and **B**;

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(2 marks)

(ii) tubes **A** and **D**.

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(3 marks)

(b) Explain the purpose of tube **C**.

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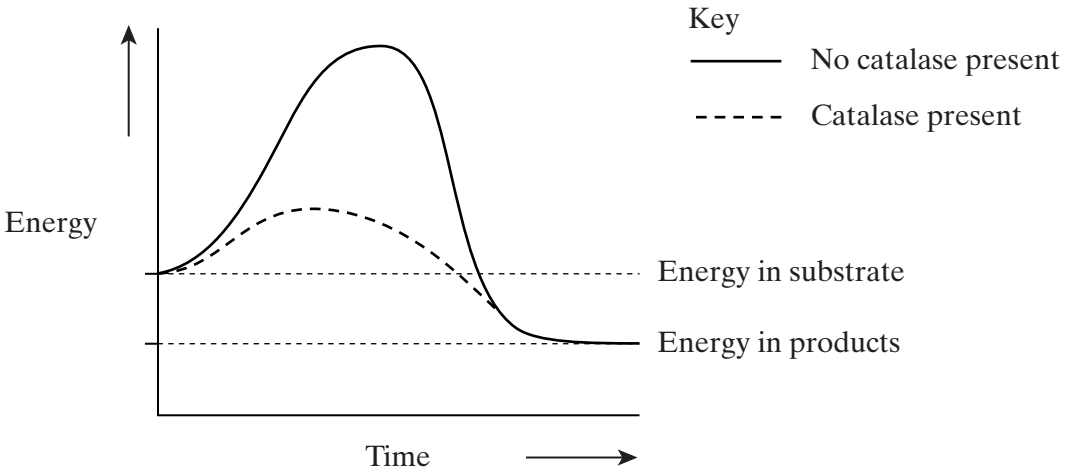
(1 mark)

(c) The graph shows the energy changes which take place during the reaction in which hydrogen peroxide is converted to water and oxygen.



Use the graph to explain why

(i) hydrogen peroxide breaks down at a lower temperature when catalase is present than when it is not present;

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(1 mark)

(ii) test tubes **A** and **B** became warmer when the reaction was taking place.

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(2 marks)

9

3 (a) Starch and protein are biologically important polymers.

(i) Explain what is meant by a polymer.

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(1 mark)

(ii) Give **one** example of a biologically important polymer other than starch or protein.

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(1 mark)

(b) In an investigation, the enzyme amylase was mixed in a test tube with a buffer solution and a suspension of starch. The amylase broke down the starch to maltose. When all the starch had been broken down, a sample was removed from the test tube and tested with biuret reagent.

(i) Explain why a buffer solution was added to the amylase-starch mixture.

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(2 marks)

(ii) What colour would you expect the sample to go when tested with biuret reagent?

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(1 mark)

(iii) Give an explanation for your answer to part (ii).

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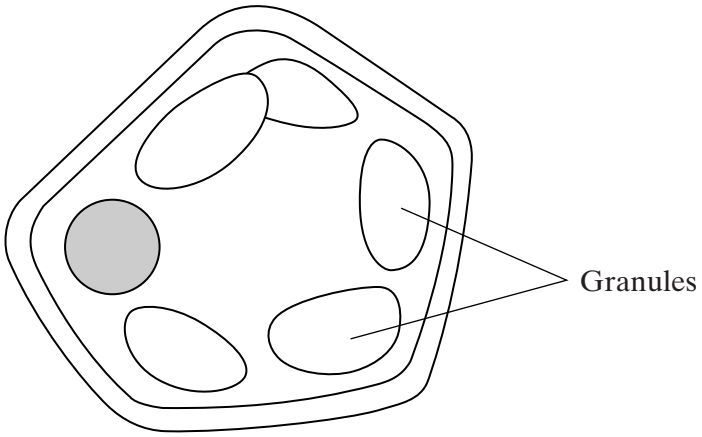
(2 marks)

7

4 The diagram shows a cell from a potato.



(a) Give **two** features which may be found in a prokaryotic cell which would not be found in this cell.

1 .....

2 .....

(2 marks)

(b) (i) Describe how you could confirm that the granules contained starch.

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(1 mark)

(ii) Name **one** polysaccharide other than starch that would be found in this cell.

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(1 mark)

(c) Explain **one** advantage of storing starch rather than glucose in potato cells.

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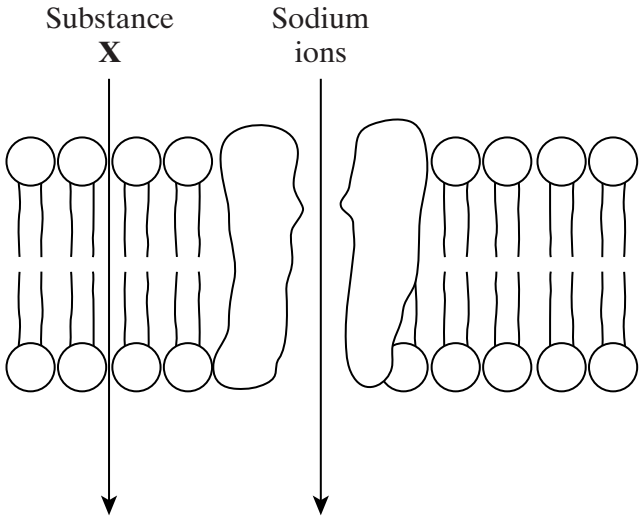
(2 marks)

6

5 The diagram shows part of a plasma membrane. The arrows show the path taken by sodium ions and by substance **X** when they diffuse through the membrane into a cell.



(a) An optical microscope cannot be used to see a plasma membrane. Explain why.

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(2 marks)

(b) Give **one** property of the molecules of substance **X** which allows them to diffuse through the membrane at the position shown.

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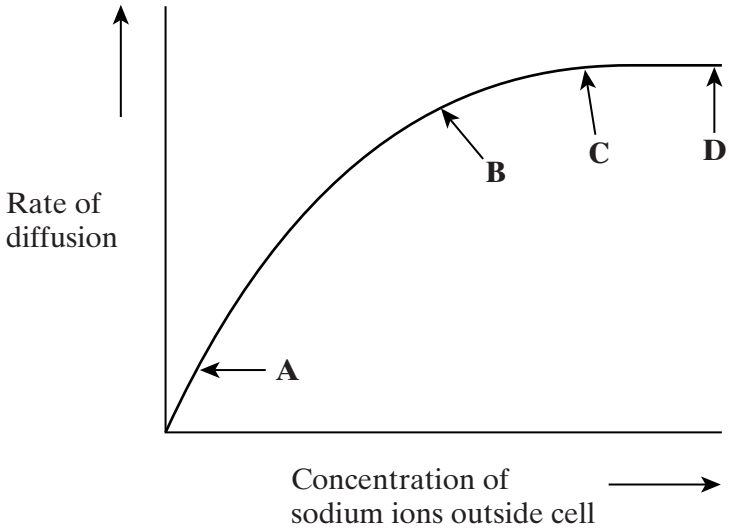
(1 mark)

(c) The effect of the concentration of sodium ions in the surrounding solution on their rate of diffusion across the membrane was investigated. The graph shows the results.



(i) What limits the diffusion of sodium ions across the membrane between **A** and **B** on the graph? Give the evidence for your answer.

Limiting factor .....

Evidence .....

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(2 marks)

(ii) Explain the shape of the curve between **C** and **D**.

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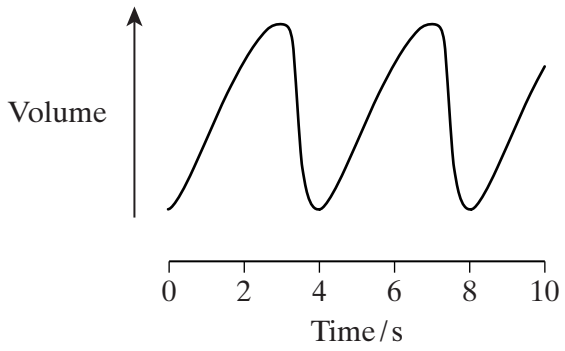
(2 marks)

7

6 A person was sitting at rest and breathing normally. A recording was made of the changes in the volume of air in his lungs over a ten-second period. The diagram shows this recording.



(a) Describe the part played by

(i) the phrenic nerve in bringing about the change in lung volume which takes place between 0 and 3 seconds;

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(2 marks)

(ii) muscles in bringing about the change between 3 and 4 seconds.

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(1 mark)

(b) Describe how an increase in lung volume leads to air entering the lungs.

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(1 mark)

(c) (i) Give the equation which represents Fick's law.

(1 mark)

(ii) Use Fick's law to explain how breathing helps to ensure efficient gas exchange.

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(2 marks)

7

TURN OVER FOR THE NEXT QUESTION

7 Read the following passage.

In a human, there are over 200 different types of cell clearly distinguishable from each other. What is more, many of these types include a number of different varieties. White blood cells, for example, include lymphocytes and granulocytes.

Although different animal cells have many features in common, each type has adaptations associated with its function in the organism. As an example, most cells contain the same organelles, but the number may differ from one type of cell to another. Muscle cells contain many mitochondria, while enzyme-secreting cells from salivary glands have particularly large amounts of rough endoplasmic reticulum.

The number of a particular kind of organelle may change during the life of the cell. An example of this change is provided by cells in the tail of a tadpole. As a tadpole matures into a frog, its tail is gradually absorbed until it disappears completely. Absorption is associated with an increase in the number of lysosomes in the cells of the tail.

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

(a) Lymphocytes and granulocytes are similar to each other as they are both varieties of white blood cell. One way in which they can be distinguished is by looking at their nuclei. Describe how the nuclei of lymphocytes and granulocytes differ from each other.

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(2 marks)

(b) Explain the link between

(i) mitochondria and muscle cells (lines 6 - 7);

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(3 marks)

(ii) rough endoplasmic reticulum and enzyme-secreting cells from salivary glands (lines 7 - 8).

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(2 marks)

(c) Use information in the passage to explain how a tadpole's tail is absorbed as a tadpole changes into a frog.

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(2 marks)

(d) Starting with some lettuce leaves, describe how you would obtain a sample of undamaged chloroplasts. Use your knowledge of cell fractionation and ultracentrifugation to answer this question.

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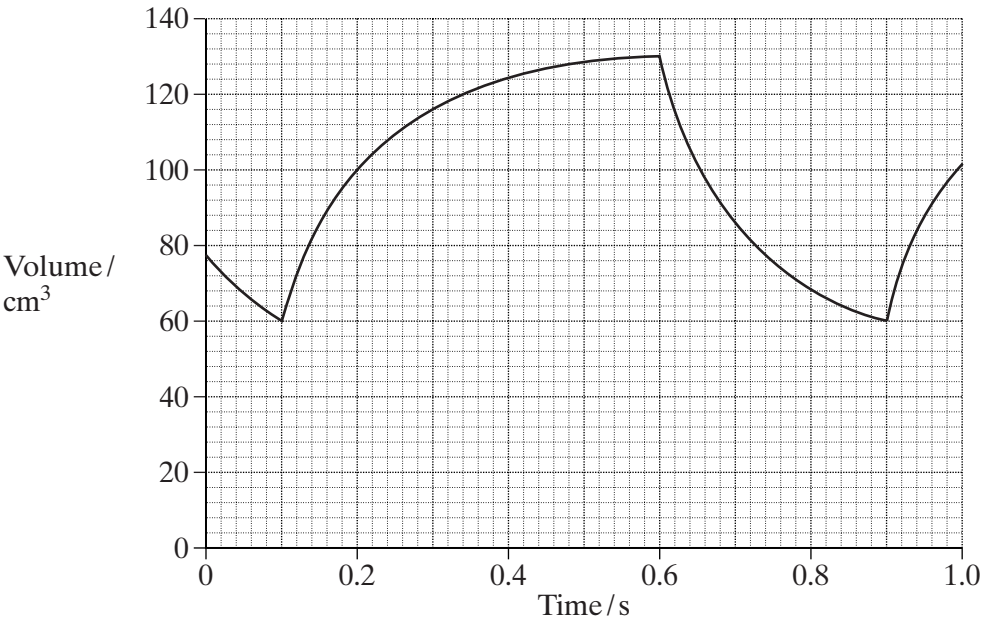
(6 marks)

15

8 The graph shows changes in the volume of blood in the left ventricle.



(a) Between which times is the left *atrium* contracting? Give the evidence from the graph that supports your answer.

Times .....

Evidence .....

.....

(2 marks)

(b) Use the graph to calculate

(i) the heart rate;

Answer .....

(2 marks)

(ii) stroke volume.

Answer .....

(1 mark)

(c) Describe how you would calculate cardiac output from heart rate and stroke volume.

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(1 mark)

The table shows the rate of blood flow to some organs when a person is at rest and during a period of vigorous exercise.

Organ	Rate of blood flow/cm^3 $minute^{-1}$	
	at rest	**during exercise**
Skeletal muscles	1 000	16 000
Kidney	1 200	1 200
Brain	750	
Heart muscle	300	1 200

(d) Suggest a value for the rate of blood flow to the brain during exercise.

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(1 mark)

(e) (i) The coronary arteries take blood to the muscles in the wall of the heart. Calculate the ratio of the rate of blood flow into the coronary arteries during exercise to the rate flowing into these arteries at rest.

Answer.....

(1 mark)

(ii) At rest the rate of flow of blood to the heart muscle is 0.9 cm^3 g^{-1} per minute. Calculate the volume of blood 1g of heart muscle would receive in 5 minutes of vigorous exercise.

Answer.....

(1 mark)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(f) Describe the structure of an artery and a vein. Explain how the features you have described help these blood vessels to carry out their functions.

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(6 marks)

15

END OF QUESTIONS