Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
January 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Thursday 10 January 2002 Afternoon 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
1			
2			
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Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

NO QUESTIONS APPEAR ON THIS PAGE

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

1 Sucrase is an enzyme. It hydrolyses a molecule of sucrose to give a molecule of glucose and a molecule of fructose. This is shown in the equation.

$$\text{sucrose} + \text{water} \xrightarrow{\text{sucrase}} \text{glucose} + \text{fructose}$$

(a) The molecular formula of fructose is $C_6H_{12}O_6$. What is the molecular formula of sucrose?

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(2 marks)

A solution containing the enzyme sucrase was added to a sucrose solution. The mixture was incubated in a test tube at 40°C for 1 hour. Sample **A** was removed from the tube at the start. Sample **B** was removed after 1 hour.

(b) A biuret test was carried out on sample **A**. It gave a positive result.

(i) Describe what you would expect to see if the biuret test gave a positive result.

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(1 mark)

(ii) Explain why the biuret test gave a positive result with sample **A**.

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(1 mark)

(c) Describe how you would use a biochemical test to show that sample **B** contained reducing sugar.

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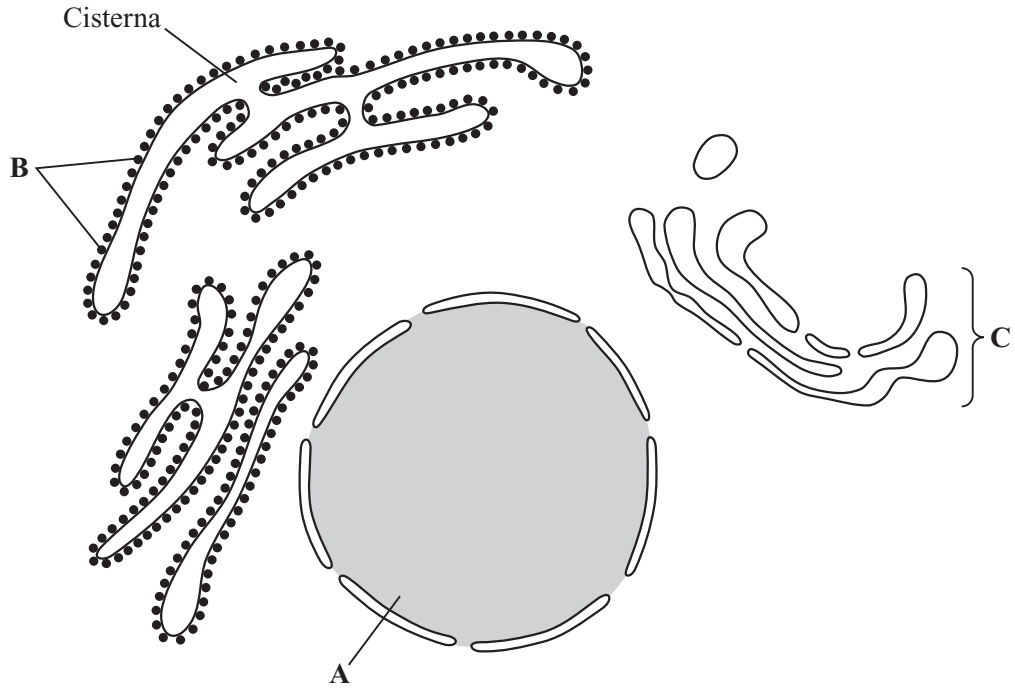
(2 marks)

6

2 The diagram shows a section through part of a cell as it would appear when seen with an electron microscope.



(a) This cell produces and secretes a protein. Describe the part played by organelles **A**, **B** and **C** in producing and secreting this protein.

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(3 marks)

(b) The table shows information about the different parts of this cell.

Part of cell	Percentage of total cell volume	Number in the cell
Cytoplasm surrounding cell organelles	54	1
Mitochondria	22	about 1700
Nucleus	6	1
Lysosomes	1	about 300
Cisternae of rough endoplasmic reticulum	9	1

(i) Which organelle is larger, a mitochondrion or a lysosome?
Use calculations based on figures from the table to support your answer.

Larger organelle; .....

(2 marks)

(ii) In the drawing there appear to be a number of separate cisternae in the rough endoplasmic reticulum. The table gives the approximate number of cisternae as one. Suggest an explanation for the apparent difference.

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(2 marks)

(iii) This cell produces a large amount of protein. Explain how the number of mitochondria in the cell may be linked to this.

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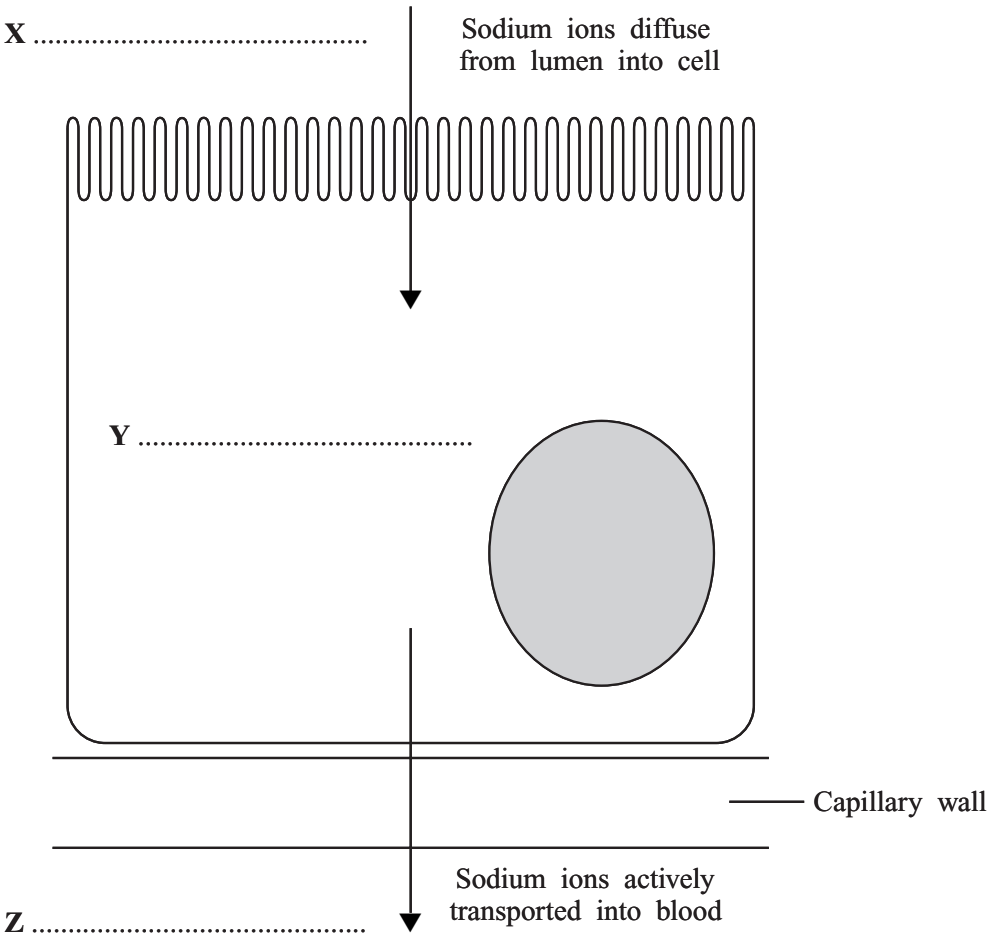
(3 marks)

10

3 The diagram shows a cell from the small intestine of a mammal.



(a) Sodium ions diffuse into the cell from the lumen of the intestine. They move out of the cell into the blood by active transport. Complete the diagram by using the words high or low to show the relative concentration of sodium ions at **X**, **Y** and **Z**.

(1 mark)

(b) A number of factors influence the rate of diffusion. They may be summarised by Fick's law.

Rate of diffusion is proportional to $\frac{\text{Surface area} \times \text{Difference in concentration}}{\text{Thickness of exchange surface}}$

Complete the table to show which factors are high and which are low when there is a rapid rate of diffusion.

Factor	**Value of factor which produces a rapid rate of diffusion (high or low)**
Surface area	
Difference in concentration	
Thickness of exchange surface	

(1 mark)

(c) There is a rapid rate of diffusion of sodium ions into the cell shown in the diagram.

(i) Explain how **one** structural feature shown on the diagram helps to ensure a rapid rate of diffusion.

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(1 mark)

(ii) Explain how active transport of sodium ions out of this cell helps to ensure a rapid rate of diffusion of sodium ions into the cell.

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(1 mark)

(d) Describe and explain the effect of an increase in temperature on the rate of diffusion.

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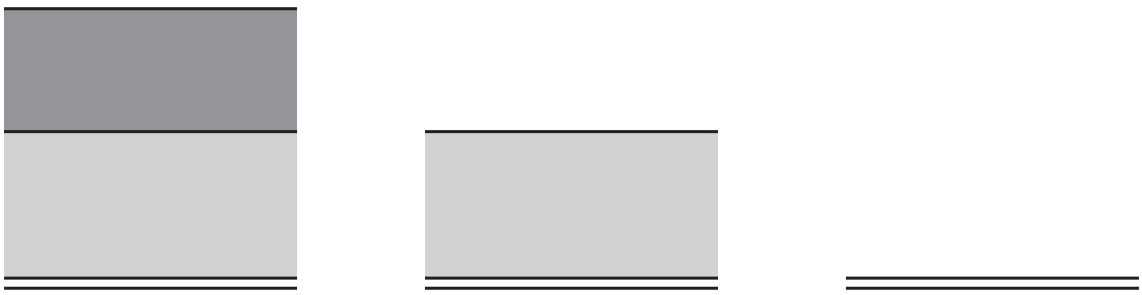
(2 marks)

4 The diagram shows the outer layers of a cell from each of three different organisms. One of the cells is a prokaryotic cell, one is an animal cell and one is a plant cell.



Cell **A** Cell **B** Cell **C**

These drawings are not to scale

(a) Which of the three cells, **A**, **B** or **C**, is the prokaryotic cell? Give a reason for your answer.

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(1 mark)

(b) Complete the table which shows some of the similarities and differences between the outer layers of these cells. Use a tick if the statement is true or a cross if it is not true.

Statement	Cell A	Cell B	Cell C
One of the layers surrounding this cell contains cellulose			
One of the layers surrounding this cell is partially permeable			

(2 marks)

(c) Penicillin is a substance which kills bacterial cells by damaging their cell walls. As a result, they burst when they take in water.

(i) The concentration of dissolved substances is higher in the cytoplasm of a bacterial cell than it is in the surrounding solution. Explain why water enters the bacterial cell.

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(2 marks)

(ii) Penicillin kills bacterial cells but has no effect on plant cells. Suggest why.

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(1 mark)

(d) Explain why a plasma membrane can be seen with an electron microscope but not with an optical microscope.

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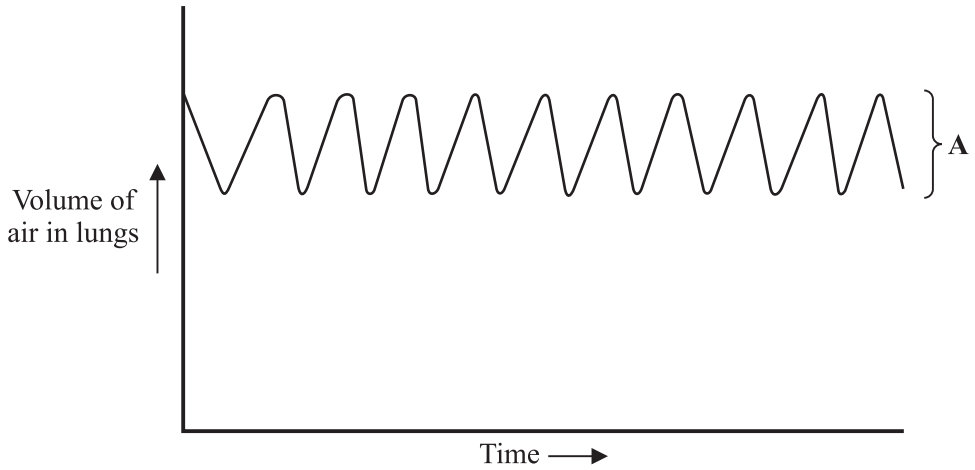
(2 marks)

8

TURN OVER FOR THE NEXT QUESTION

5 The graph shows the pattern of breathing in a person sitting at rest.



(a) (i) What is the name given to the volume of air labelled **A**?

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(1 mark)

(ii) Explain how you would calculate the volume of air taken into the lungs in one minute.

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(1 mark)

(b) During exercise the breathing rate and the cardiac output both increase.

(i) Describe how the medulla increases breathing rate.

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(ii) Describe how sympathetic nerves increase cardiac output.

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(4 marks)

One way in which hospitals test how well the lungs are working is to measure the gas transfer factor. This is done by measuring the uptake of carbon monoxide from a single breath of air containing 0.3% carbon monoxide.

(c) (i) By what process would carbon monoxide pass from the air in the alveoli to the blood in the lung capillaries?

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(1 mark)

(ii) Suggest why carbon monoxide is used for this test.

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(2 marks)

(d) Interstitial lung disease is a disease in which the alveolar walls become thicker. Explain why the gas transfer factor would be low in a person who had interstitial lung disease.

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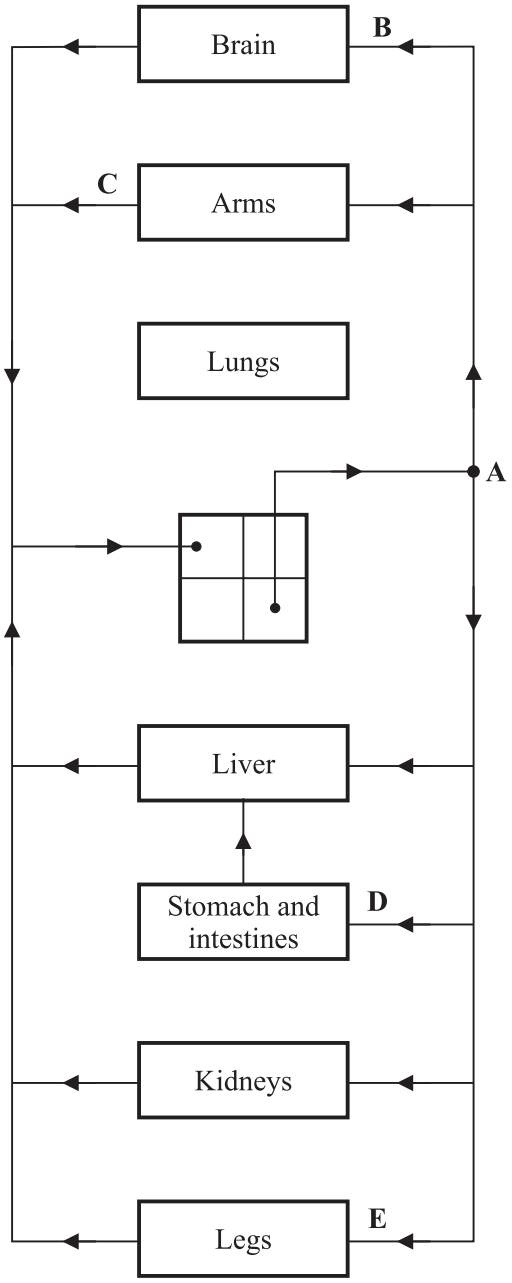
(1 mark)

10

TURN OVER FOR THE NEXT QUESTION

6 The diagram shows the blood system of a mammal.



(a) Draw lines on the diagram to represent the arteries and veins linking the heart and the lungs. Show by means of arrowheads drawn on these lines the direction of blood flow. *(2 marks)*

(b) (i) The concentration of carbon dioxide in the blood is monitored by receptors found in the walls of the blood vessel at point **A**. Explain what causes the concentration of carbon dioxide in the blood to increase during a period of exercise.

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(2 marks)

(ii) The rate of blood flow to various organs changes when a person starts to take vigorous exercise. In which of blood vessels **B**, **C**, **D** or **E** would you expect the smallest change in the rate of blood flow?

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(1 mark)

5

TURN OVER FOR THE NEXT QUESTION

7 Read the following passage.

Many different processes essential to life depend on proteins. These include enzyme-controlled reactions, transport across plasma membranes and the binding of hormones to receptor molecules on their target cells. Every protein molecule has a tertiary structure which gives it a precise three-dimensional shape. The function of the protein depends on this shape, and the shape depends on the pH of the surrounding solution.

Changes in pH affect different proteins in different ways. This is because the amino acid molecules from which they are built have different structures. Some of these amino acids have different charges at different pH values. Unless they have the correct charges, the protein molecule will not have its correct three-dimensional shape.

If hydrogen or hydroxyl ions are added to a solution, its pH will normally change. A buffer solution is one which maintains a constant pH when hydrogen or hydroxyl ions are added to it. Buffers also occur naturally and play an important role in keeping conditions inside living organisms constant.

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

(a) The receptor molecules to which hormones bind are proteins. Glucagon is a hormone.

(i) Use the information in the first paragraph to explain why glucagon will only bind to one particular type of receptor molecule.

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(2 marks)

(ii) Suggest why glucagon is able to bind to liver cells but not to cells in other parts of the body.

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(1 mark)

(b) Explain how the amino acids from which proteins are built (lines 6–7) differ in structure from each other.

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(1 mark)

(c) Amylase is an enzyme, found in saliva, which breaks down starch. It works best at a pH of 8. Explain why amylase does not function in the stomach where the pH is approximately 3.

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(3 marks)

(d) When a suspension of mitochondria is prepared from liver, the tissue is ground in a buffer solution, then centrifuged. Explain why a buffer solution is used.

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(2 marks)

QUESTION 7 CONTINUES ON THE NEXT PAGE

(e) Describe how proteins are arranged in a plasma membrane and the part they play in transporting substances into and out of cells.

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(6 marks)

15

8 **Table 1** shows the blood pressure in the left atrium, the left ventricle and the aorta at different stages in a cardiac cycle. These three parts of the circulatory system have been labelled **A**, **B** and **C**.

Time/s	Blood pressure/kPa		
	Part **A** (left atrium)	Part **B** (left ventricle)	Part **C** (aorta)
0	0.6	0.3	12.1
0.1	1.1	0.7	11.7
0.2	0.6	12.6	11.8
0.3	0.9	14.8	13.6
0.4	1.2	1.1	12.8
0.5	0.6	0.2	12.6
0.6	0.6	0.2	12.4

Table 1

(a) What is the evidence from the figures in **Table 1** that part **B** is the ventricle?

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(1 mark)

(b) (i) At 0.3 s, the atrioventricular valves are closed. Give the evidence from **Table 1** which supports this statement.

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(1 mark)

(ii) For approximately how long is the valve between the left ventricle and the aorta open? Give the reason for your answer.

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(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(c) The figures in the third column of **Table 1** show the changes in pressure in the left ventricle.

(i) Describe how the pressure in the left ventricle differs from that in the right ventricle.

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(1 mark)

(ii) Explain what causes this difference.

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(1 mark)

Table 2 compares some features of different blood vessels from a dog.

Property	**Blood vessel**		
	Artery	**Arteriole**	**Capillary**
Diameter of lumen	0.4 cm	30 µm	8 µm
Thickness of wall	1 mm	20 µm	1 µm
Tissues present in wall			
Endothelium	✔	✔	✔
Elastic tissue	✔	✔	✕
Muscle	✔	✔	✕

Table 2

Key ✔ Tissue present
✕ Tissue absent

(d) What is the thickness of one of the endothelial cells lining these blood vessels?

Answer: ..... µm

(1 mark)

(e) Explain why an arteriole may be described as an organ.

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(2 marks)

(f) Use the information in **Table 2** to explain how the structure of the walls of arteries, arterioles and capillaries is related to their function.

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(6 marks)

END OF QUESTIONS

15

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE