Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

Leave blank

General Certificate of Education
June 2004
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Tuesday 8 June 2004 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** the 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 (a) Describe how you would use a biochemical test to show that a solution contained protein.

.....

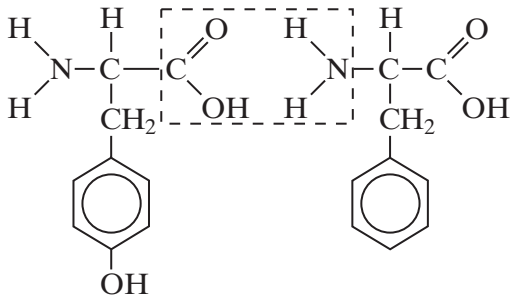
.....

.....

.....

(2 marks)

The diagram shows the structure of two amino acid molecules, tyrosine and phenylalanine.



Tyrosine Phenylalanine

(b) Copy from the diagram the R group in the phenylalanine molecule.

(1 mark)

(c) (i) In the space below, draw the chemical bond formed when these two amino acids are joined by condensation. You need only draw the parts of the molecules shown in the box.

(2 marks)

(ii) Name this bond.

.....

(1 mark)

(d) Tyrosine can be made in the body by hydroxylating phenylalanine. Use the diagram to explain the meaning of *hydroxylating*.

.....

.....

(1 mark)

7

TURN OVER FOR THE NEXT QUESTION

2 (a) Describe the part played by the diaphragm in causing air to enter the lungs during breathing.

.....

.....

.....

.....

.....

.....

(3 marks)

Seals are mammals. They have lungs and must breathe air. They can dive and remain under water for a long time. The table shows the flow of blood to the lungs and to the diaphragm in a seal when it is on land and when it is under water.

Organ	**Blood flow/cm^3 min^{-1} g^{-1}**	
	On land	**Under water**
Lungs	0.88	0.52
Diaphragm	0.21	0.02

(b) Explain why the figures in the table are given per gram of tissue.

.....

.....

.....

.....

(2 marks)

(c) Calculate the percentage by which blood flow to the lungs is reduced when a seal is swimming under water. Show your working.

Answer .....

(2 marks)

(d) There is a greater percentage reduction in blood flow to the diaphragm than to the lungs during a dive. Explain the advantage to a diving seal of

(i) blood continuing to flow to the lungs;

.....

.....

(1 mark)

(ii) a large reduction in blood flow to the diaphragm.

.....

.....

.....

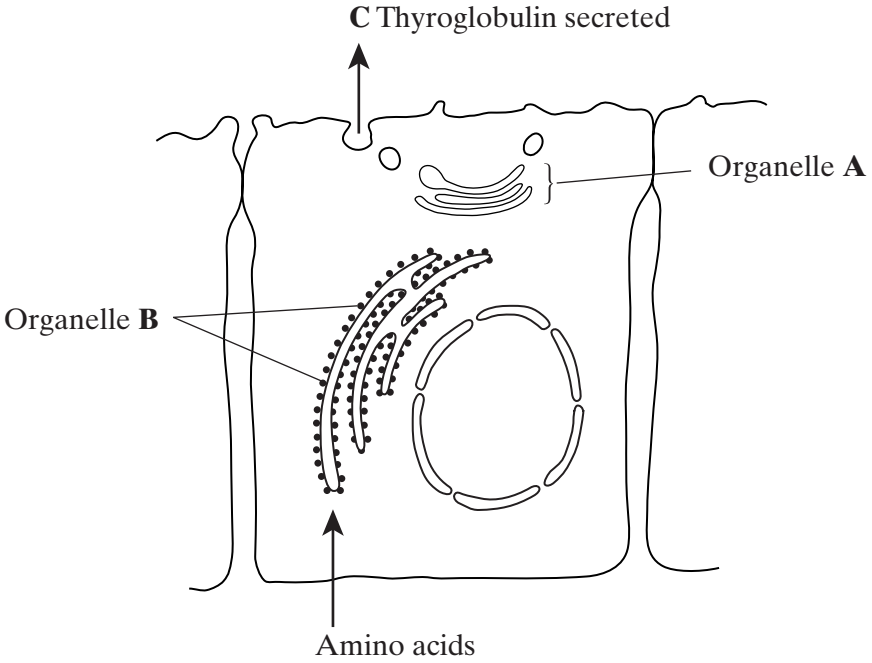
.....

(2 marks)

10

TURN OVER FOR THE NEXT QUESTION

3 The thyroid gland is an organ in the neck. The diagram shows the process in which epithelial cells from the thyroid gland make and secrete a protein called thyroglobulin.



(a) Name

(i) organelle **A**;

.....

(1 mark)

(ii) the process by which thyroglobulin is secreted from the cell at **C**.

.....

(1 mark)

(b) (i) Describe the part played by the organelles labelled **B**.

.....

.....

(1 mark)

(ii) Organelle **B** is very small. It cannot be seen when thyroid cells are examined with an optical microscope but it can be seen with an electron microscope. Explain why this organelle can be seen with an electron microscope.

.....

.....

.....

.....

(2 marks)

(c) The epithelial cells form a tissue. The thyroid gland is an organ. What is

(i) a tissue;

.....

.....

(1 mark)

(ii) an organ?

.....

.....

(1 mark)

7

TURN OVER FOR THE NEXT QUESTION

4 (a) Explain how the shape of a red blood cell allows it to take up a large amount of oxygen in a short time.

.....

.....

.....

.....

(2 marks)

Samples of blood were mixed with equal volumes of different liquids. A drop of each mixture was put on a slide and examined with an optical microscope. The table shows the appearance of each slide.

Slide	Liquid added	Appearance of slide
A	Distilled water	No cells seen. Slide appears a uniform pale red colour
B	Sucrose solution	Cells are smaller in diameter than in an untreated sample of blood
C	Detergent (dissolves lipids)	No cells seen. Slide appears a uniform pale red colour

(b) (i) What does the appearance of slide **B** tell you about the plasma membrane surrounding a red blood cell?

.....

.....

(1 mark)

(ii) Explain the appearance of slide **C**.

.....

.....

.....

.....

(2 marks)

(c) The blood from which these samples were taken also contained monocytes and granulocytes. How could you use the appearance of a nucleus to

(i) distinguish between a monocyte and a red blood cell;

.....

.....

(1 mark)

(ii) identify a granulocyte?

.....

.....

(1 mark)

5 (a) Complete **Table 1** to give **two** ways in which the structure of a plant cell differs from that of a prokaryotic cell.

Plant cell	Prokaryotic cell
1	....
2	....

Table 1 *(2 marks)*

Table 2 shows the amounts of three different substances in the seeds of various plants.

Plant	Percentage of total mass of all three substances		
	Proteins	**Polysaccharides**	**Lipids**
Buckwheat	15	84	1
Brazil nut	14	8	78
Mung bean	29	69	2
Sesame	25	16	59

Table 2

(b) Which plant has

(i) the greatest percentage of polymers in its seeds;

.....

(1 mark)

(ii) the smallest percentage of nitrogen-containing substances in its seeds?

.....

(1 mark)

(c) Describe how you could test a Brazil nut to show that it contained lipids.

.....

.....

.....

.....

.....

.....

(3 marks)

7

Turn over ▶

6 (a) Explain why the rate of diffusion is more rapid at higher temperatures.

.....

.....

.....

.....

(2 marks)

(b) Fick's law can be summarised as

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

Complete the table by adding the words maximum or minimum to show the values of the features in Fick's law which will ensure

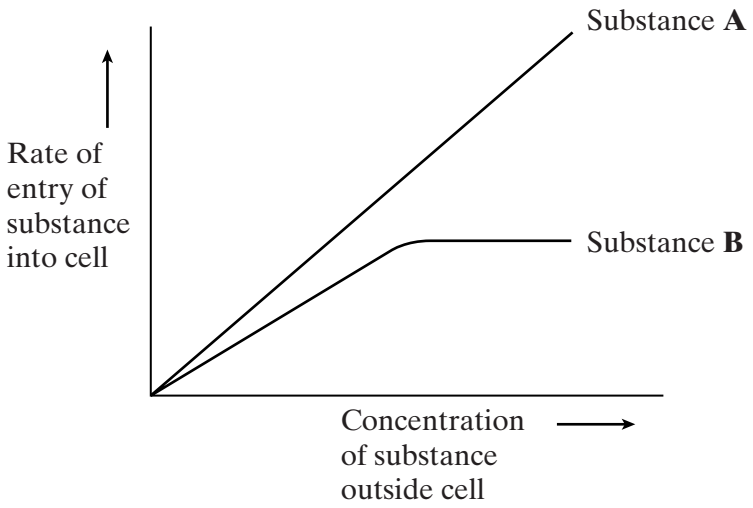
(i) efficient absorption of digested food from the small intestine;

(ii) reduction of water loss from a leaf.

Feature	**Efficient absorption of digested food from the small intestine**	**Reduction of water loss from a leaf**
Surface area		
Difference in concentration		
Thickness of exchange surface		

(2 marks)

(c) The graph shows how the concentration of a substance affects its rate of absorption into a cell.



(i) Substance **A** enters the cell by simple diffusion. Use Fick's law to explain the shape of the curve.

.....

.....

(1 mark)

(ii) Substance **B** enters the cell by facilitated diffusion. Explain the evidence from the graph which supports this.

.....

.....

.....

.....

(2 marks)

7

7 Read the following passage.

Job's Tears is a cereal plant which grows in the tropics. An unusual protein has been found in its grains. This protein is unusual because it has two functions. It acts as both an enzyme inhibitor and as an enzyme. As an inhibitor, the protein reduces the activity of starch-digesting enzymes. The protein acts as an enzyme by breaking down chitin, a polysaccharide found in the walls of many fungi, to its monomers. Because of the resulting more negative water potential in the cytoplasm of the fungus, this effectively leads to "death by osmosis" of any fungus attacking the grain.

Our knowledge of the relationship between protein structure and function has led to the development of the new technology of protein engineering. This involves changing the amino acid sequence of a protein and altering its tertiary structure. Altering the tertiary structure changes the protein's properties. So far, we have been unable to produce a protein with more than one function such as that found in Job's Tears. We have had success, though, in making some enzymes more stable and less prone to heat denaturation. We have done this by substituting amino acids and allowing the formation of additional chemical bonds.

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

(a) (i) The protein found in Job's Tears breaks down chitin (line 4). What type of chemical reaction is involved in breaking down chitin?

.....

(1 mark)

(ii) Breakdown of chitin leads to "death by osmosis" of fungi attacking the grain (lines 6 - 7). Explain how.

.....

.....

.....

.....

(2 marks)

(iii) This protein does not break down the cell walls of the Job's Tears plant. Explain why.

.....

.....

(1 mark)

(b) Explain what is meant by the tertiary structure of a protein (line 10).

.....

.....

(1 mark)

(c) (i) Explain how heating an enzyme leads to it being denatured.

.....

.....

.....

.....

(2 marks)

(ii) How can protein engineering make enzymes more stable and less prone to heat denaturation (line 13)?

.....

.....

.....

.....

(2 marks)

(d) Describe how the sequence of amino acids in part of the protein from Job's Tears could enable this protein to act as an enzyme inhibitor.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

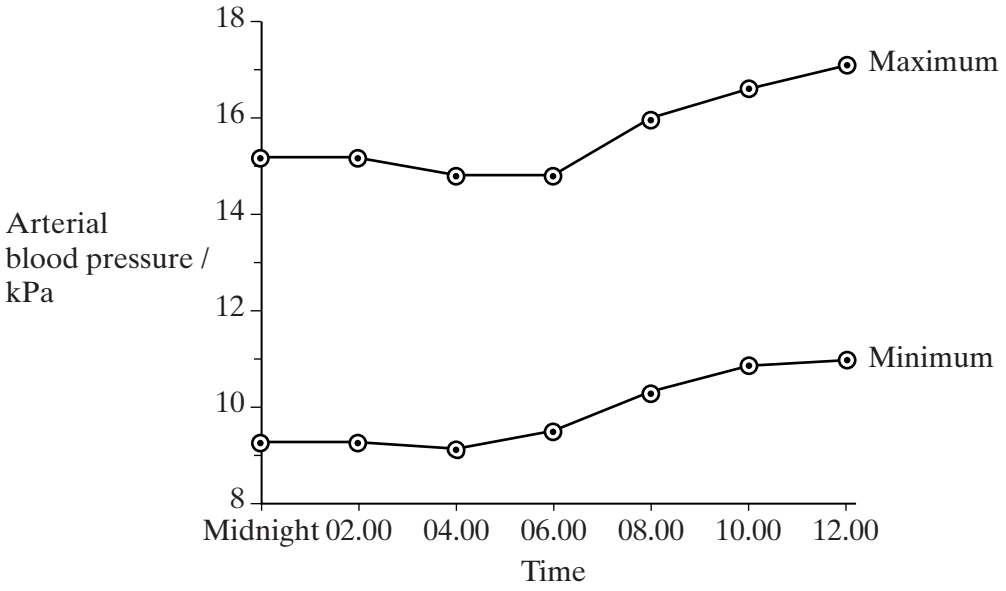
.....

(6 marks)

15

Turn over ▶

8 (a) The graph shows hourly blood pressure recordings from a group of 65 people.



(i) Describe how the mean maximum arterial blood pressure changes over the period shown in the graph.

.....

.....

(1 mark)

(ii) In each cardiac cycle, the arterial pressure has a maximum value. Explain the link between this maximum value and the events of the cardiac cycle.

.....

.....

(1 mark)

(iii) The recordings shown in this graph were taken from an artery. Describe **two** ways in which you would expect blood pressure in a vein to differ from that in an artery.

1 .....

.....

2 .....

.....

(2 marks)

(b) Molecules of different substances differ in size. The relative molecular mass of a substance gives an indication of the size of its molecules. The table shows the relative permeability of the wall of a capillary to different molecules.

Substance	Relative molecular mass	Relative permeability of capillary wall
Water	18	1.00
Urea	60	0.96
Glucose	180	0.60
Haemoglobin	68000	0.01
Albumin (plasma protein)	69000	0
Globulin (plasma protein)	140000	0

(i) Describe the relationship between molecule size and the permeability of the capillary wall.

.....

.....

.....

.....

(2 marks)

(ii) The water potential of the plasma at the venule end of the capillary is more negative than the water potential at the arteriole end. Use the table to explain why.

.....

.....

.....

.....

(2 marks)

(iii) Although the capillary walls are slightly permeable to haemoglobin molecules, there is no haemoglobin in the tissue fluid. Explain what causes the absence of haemoglobin in tissue fluid.

.....

.....

(1 mark)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(c) Describe the parts played by the sinoatrial node (SAN) and the atrioventricular node (AVN) in initiating and controlling the heart beat.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6 marks)

15

END OF QUESTIONS