Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
January 2005
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

HUMAN BIOLOGY (SPECIFICATION A) BYA9/W
Unit 9 (Written Synoptic)

Thursday 27 January 2005 Morning Session

No additional materials are required.
You may use a calculator.

Time allowed: 1 hour 45 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 but note that **Question 3** offers a choice of essays.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.
- This unit assesses your understanding of the relationship between the different aspects of biology.
- 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			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 **Figure 1** shows a molecule of human haemoglobin.

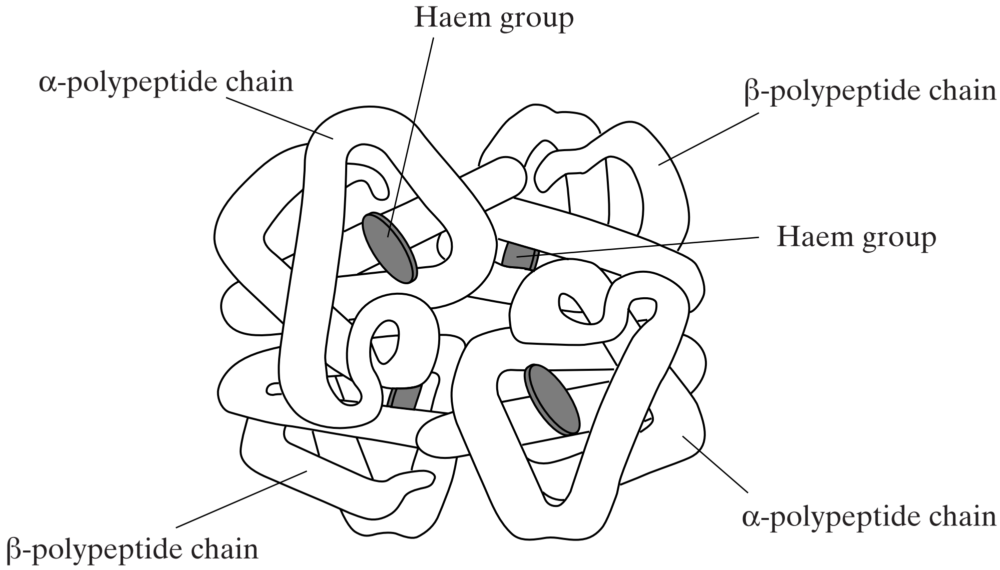

Figure 1

(a) (i) Explain why the β-chains always have the same tertiary structure.

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(2 marks)

(ii) Give the evidence from the diagram that a human haemoglobin molecule has a quaternary structure.

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(1 mark)

(b) The relative molecular mass of human haemoglobin is 68 000 and the molecules are contained in red blood cells. The relative molecular mass of the haemoglobin of a species of worm is 2.85 million and the molecules are found in the plasma. Suggest **one** advantage of haemoglobin being this size when it is in the plasma.

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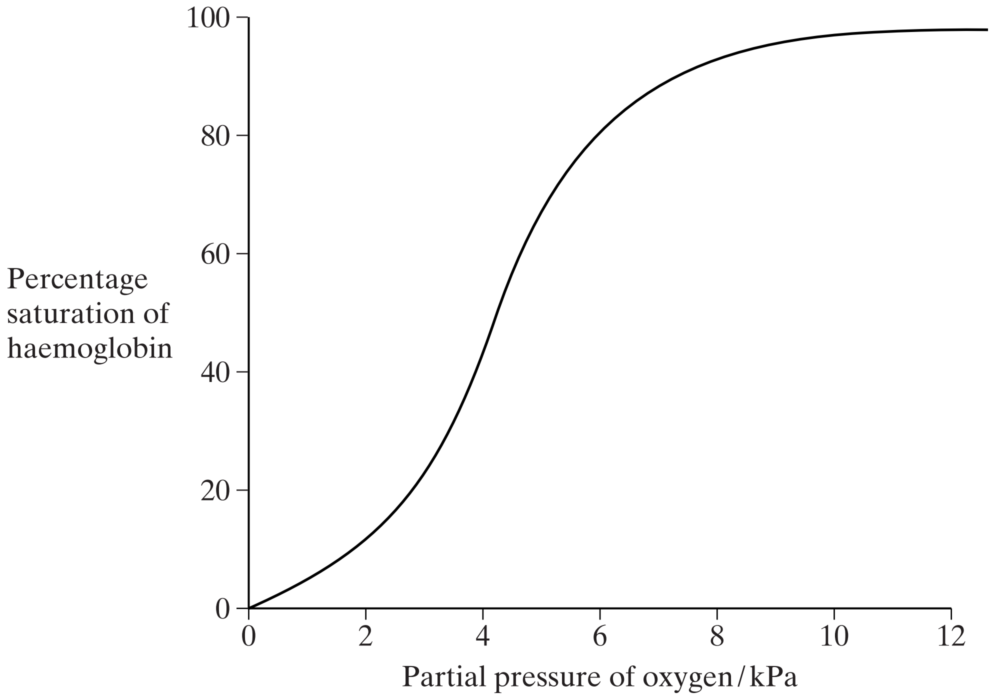
(1 mark)

The graph shows the dissociation curve for human oxyhaemoglobin.



(c) (i) Use the graph to explain how haemoglobin transports oxygen from the lungs to respiring muscles.

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(3 marks)

(ii) When mountain climbers go from lower areas to high altitudes, the supply of oxygen to their cells is affected. Use the graph to explain how.

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(3 marks)

QUESTION 1 CONTINUES ON THE NEXT PAGE

Turn over ▶

(d) The P_{50} of haemoglobin is the partial pressure at which haemoglobin is 50% saturated with oxygen. In mammals, the P_{50} increases by approximately 0.1 kPa for each degree Celsius rise in temperature. Explain how this has a beneficial effect during exercise.

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(3 marks)

β-thalassaemia is a genetic condition in which abnormal haemoglobin is produced. In one form, the recessive allele for β-thalassaemia, **t**, differs from the normal allele, **T**, by a single base-pair. A radioactive DNA probe was used to investigate the genotypes of four members of one family. The flowchart summarises the technique involved.

DNA samples extracted and cut into fragments using a restriction enzyme

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Fragments separated from each other by electrophoresis

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One region of the resulting gel was blotted with two pieces of filter paper. The first was soaked in a solution containing a radioactive DNA probe for the normal allele. The second was soaked in a solution containing a radioactive DNA probe for the β-thalassaemia allele.

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Surplus probe washed off

Figure 2 shows the appearance of the two pieces of filter paper which resulted from the investigation.

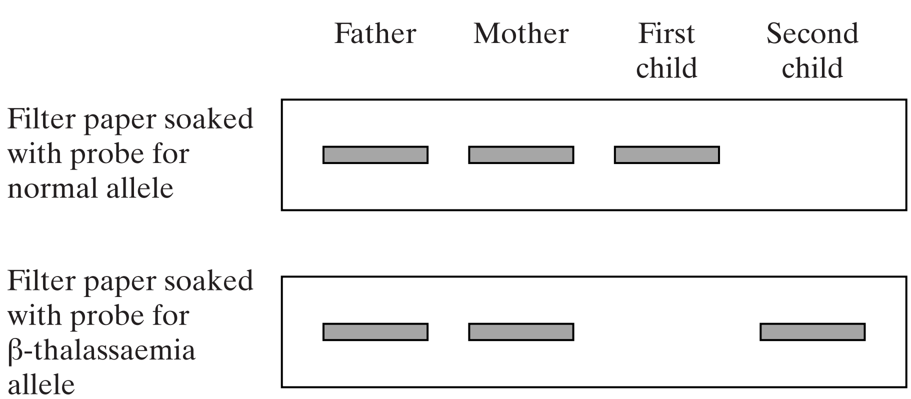

Figure 2

LEAVE MARGIN BLANK

(e) What is the probability that the next child that this couple have is a girl who has β-thalassaemia? Explain your answer.

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(3 marks)

(f) (i) The fragment of DNA containing the normal allele and the fragment with the β-thalassaemia allele moved the same distance on the gel. Explain why.

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(2 marks)

(ii) The allele for β-thalassaemia differs from the normal allele by only one base-pair. Explain why the probe used to identify these alleles consists of a piece of DNA twenty bases in length and not just one base.

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(2 marks)

20

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

2 Read the following passage.

The plasma membrane plays a vital role in microorganisms. It forms a barrier between the cell and its environment, controlling the entry and exit of solutes. This makes bacteria vulnerable to a range of antiseptics and antibiotics.

When bacteria are treated with antiseptics, the antiseptics bind to the proteins in the membrane and create tiny holes. Bacteria contain potassium ions at a concentration many times that outside the cell. Because of the small size of these ions and their concentration in the cell, the first observable sign of antiseptic damage to the plasma membrane is the leaking of potassium ions from the cell. Some antibiotics damage the plasma membrane in a similar way. One of these is tyrocidin. This is a cyclic polypeptide consisting of a ring of ten amino acids. Tyrocidin and other polypeptide antibiotics are of little use in medicine.

Other antibiotics also increase the rate of potassium movement from cells. It is thought that potassium ions are very important in energy release and protein synthesis, and a loss of potassium ions would lead to cell death. Gramicidin A coils to form a permanent pore passing through the plasma membrane. This pore enables potassium ions to be conducted from the inside of the cell into the surrounding medium. Vanilomycin also facilitates the passage of potassium ions from the cell. A molecule of vanilomycin forms a complex with a potassium ion and transports it across the membrane. The potassium ion is released on the outside and the vanilomycin is free to return and pick up another potassium ion. Vanilomycin depends on the fluid nature of the plasma membrane in order to function.

Polyene antibiotics have flattened, ring-shaped molecules. The two sides of the ring differ from each other. One side consists of an unsaturated carbon chain. This part is strongly hydrophobic and rigid. The opposite side is a flexible, strongly hydrophilic region. It has been shown that polyene antibiotics bind only to sterols. Sterols are lipids found in the membranes of eukaryotes but not in the membranes of prokaryotic organisms. It is thought that several sterol-polyene complexes come together. The plasma membranes of eukaryotic cells treated with these polyene antibiotics lose the ability to act as selective barriers and small ions and molecules rapidly leak out.

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

(a) (i) By what process do potassium ions normally enter a bacterial cell? Explain the evidence for your answer.

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(2 marks)

(ii) Use Fick's law to explain why leakage of potassium ions occurs following antiseptic damage to the plasma membrane (lines 7 - 8).

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(2 marks)

(b) (i) Draw a peptide bond showing how the COOH group of one amino acid joins to the NH_2 group of another.

(1 mark)

(ii) How many peptide bonds are there in a molecule of tyrocidin (lines 9 - 10)?

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(1 mark)

(c) Suggest why tyrocidin and other polypeptide antibiotics are of little use in medicine (line 10).

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(2 marks)

(d) Experiments have shown that vanilomycin is unable to transport potassium ions across a membrane when it is cooled. Gramicidin A continues to facilitate the movement of potassium ions at these low temperatures. Explain these results.

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(3 marks)

QUESTION 2 CONTINUES ON THE NEXT PAGE

Turn over ▶

(e) Explain why polyene antibiotics kill fungi but not bacteria.

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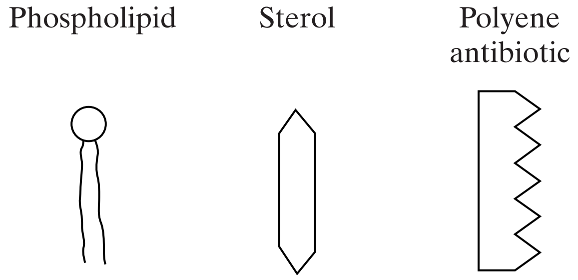
(2 marks)

(f) Draw a simple diagram of one of the phospholipid layers to show how polyene antibiotics allow small ions and molecules to leak rapidly through a plasma membrane. Use the following symbols to represent the different molecules.

Note that the zigzag line on the symbol for the polyene antibiotic represents its hydrophobic region.



These symbols have been drawn to the same scale

(2 marks)

15

3 Write an essay on **one** of the following topics. You should select and use information from different parts of the specification. Credit will be given not only for the biological content, but also for the selection and use of relevant information, and for the organisation and presentation of the essay.

EITHER A Negative feedback and its importance in biology *(25 marks)*

OR B Condensation and hydrolysis and their importance in biology *(25 marks)*

END OF QUESTIONS

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For Examiner's use only

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