Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Education
June 2007
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Friday 22 June 2007 1.30 pm to 3.15 pm

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

Time allowed: 1 hour 45 minutes

For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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 to be marked.

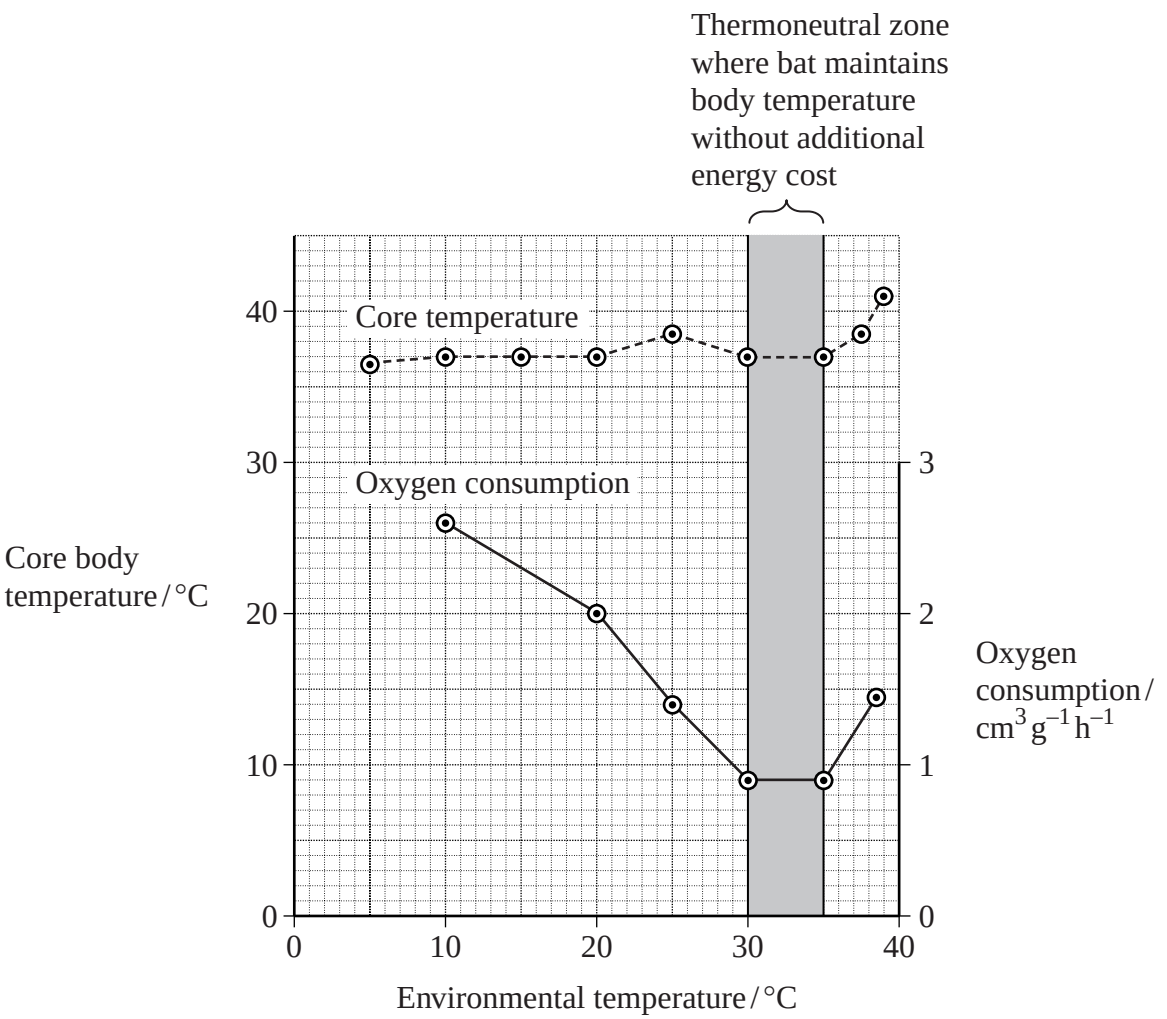
Information

- The maximum mark for this paper is 60.
- The marks for questions are shown in brackets.
- This unit assesses your understanding of the relationship between the different aspects of biology.
- You will be marked on your ability to use good English, to organise information clearly and to use accurate scientific terminology where appropriate.

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

1 Bats are the only mammals that can fly. They are very similar to other mammals but they have a number of adaptations associated with the high energy demands of flight.

The graph shows the effect of environmental temperature on a small bat's core body temperature and oxygen consumption. The bat had a body mass of 7 g.



(a) The fall in environmental temperature from 30 °C to 10 °C brings about the change in oxygen consumption shown in the graph. Explain how.

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(3 marks)

(b) Positive feedback occurs when a departure from a set level or norm sets in motion changes that bring about further departure.

(i) The change in core body temperature above an environmental temperature of 35 °C is an example of positive feedback. Explain why the continued rise in core body temperature occurs.

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(2 marks)

(ii) Positive feedback is important in other systems in the body. Describe **one** way in which positive feedback, other than the effect of temperature, is important in the transmission of a nerve impulse.

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(2 marks)

(c) A flying fox is a large bat with a body mass of approximately 1.2 kg. Its thermoneutral zone is between 25 °C and 35 °C.
The thermoneutral zone of a flying fox is different from the thermoneutral zone of the small bat shown in the graph. Explain why.

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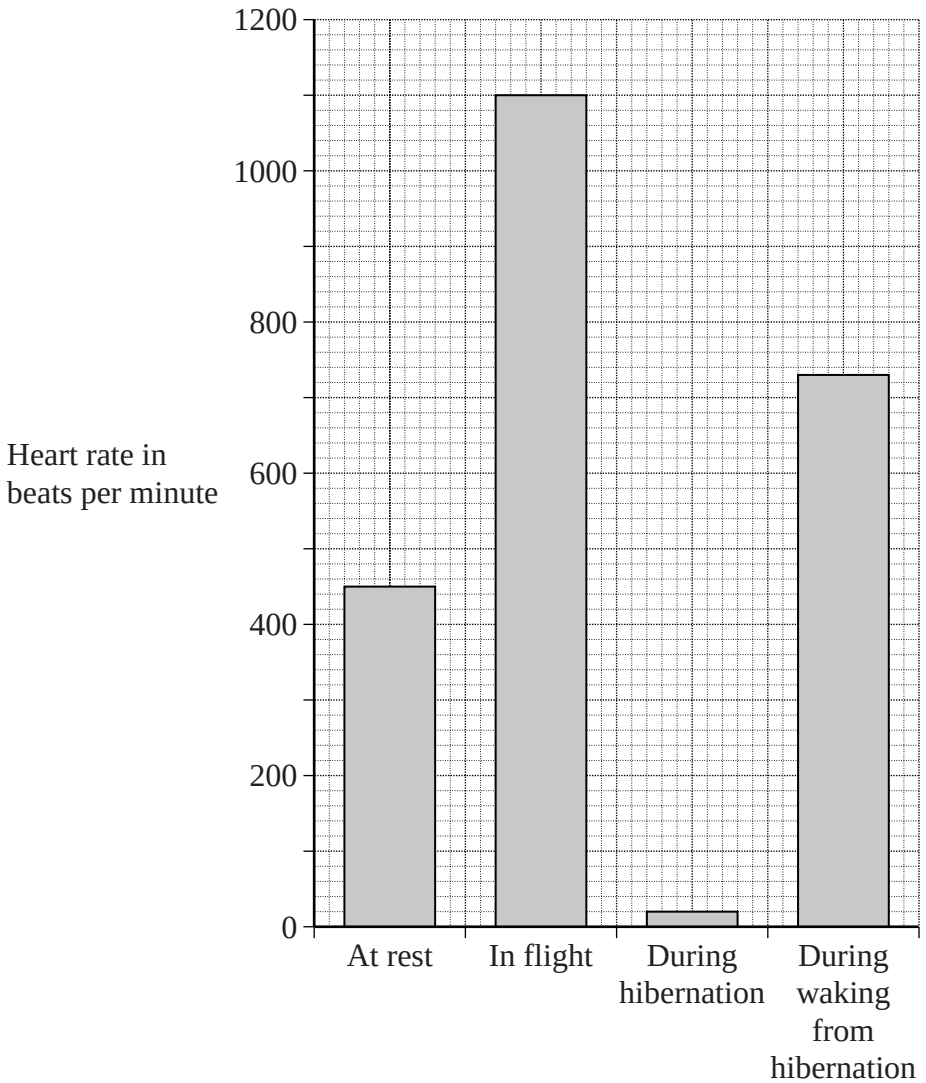
(2 marks)

Question 1 continues on the next page

The barchart shows how the heart rate of a bat changes with activity.



(d) The activity of the parasympathetic nervous system causes one of the changes shown in the barchart. Identify which and explain how.

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(2 marks)

(e) The cardiac output of this bat is 13.5 cm^3 $minute^{-1}$ at rest and 113 cm^3 $minute^{-1}$ during flight. Calculate the change in stroke volume between rest and flight. Show your working.

Answer ..... *(2 marks)*

The table shows some of the features of the blood of bats and of humans.

	Bat	**Human**
Haematocrit (The volume of cells in a blood sample expressed as a percentage of the sample volume)	59	45
Number of red blood cells per mm^3	12.5×10^6	5.2×10^6
Concentration of haemoglobin / g $100\,cm^{-3}$	17	17
P_{50} / kPa (Partial pressure of oxygen at which haemoglobin is 50 % saturated)	6.8	4.0

(f) (i) The red blood cells of bats are smaller than human red blood cells. Explain how the data in the table support this statement.

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(2 marks)

(ii) Suggest the advantage to the bat of very small red blood cells.

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(2 marks)

(g) The P_{50} of the bat's haemoglobin helps it to meet the high energy demands of flight. Explain how.

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(3 marks)

2 Read the following passage.

Trypanosomes are single-celled parasites that may be found in the blood of humans and other mammals. Trypanosomes are transmitted between hosts by the tsetse fly and cause the fatal disease, trypanosomiasis. This disease is present in those parts of Africa where the tsetse fly is found.

Another parasite that lives in the blood causes malaria. This parasite is successful because it avoids exposure to the immune response of its mammalian host. Trypanosomes also have a way of avoiding a mammal's immune response, even though they live in the blood plasma. They are able continually to change the antigen which makes up their surface coat. In 1910, Ross and Thomson found the first signs that the antigens might be changing. They noted that fluctuations in the temperature of patients with trypanosomiasis paralleled a rise and fall in the number of trypanosomes in the blood.

The antigens have since been isolated and are now called variable surface antigens (VSGs). Scientists have used gene technology to find out more about VSGs. They extracted all the mRNA from trypanosomes showing the same surface antigen and used this to make complementary DNA (cDNA). These different cDNA molecules were then introduced into bacteria. Eventually a copy of the antigen gene that the trypanosomes were expressing was isolated from the bacteria. From this piece of DNA it was possible to predict the amino acid sequence of the VSG for which the gene coded.

We now know that all VSGs are made up of approximately 500 amino acids. The first 20 form a signal peptide. This is removed before the VSG is implanted in the trypanosome's plasma membrane. The next 360 amino acids comprise the variable region, which is different in each antigenically different VSG. The trypanosome replaces the final 20 amino acids with a complex sugar. This sugar is known to be identical in all VSGs because, in laboratory conditions, antibodies produced against this complex sugar bind to all VSG molecules. The sugar is linked to a phospholipid. The phospholipid and the sugar to which it is linked penetrate into the plasma membrane of the trypanosome. They hold the rest of the tightly coiled VSG molecule in place on the surface of the trypanosome.

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

(a) Malarial parasites avoid exposure to the immune response when inside their human host (lines 5–6). Describe how.

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(2 marks)

(b) The periodical rises in temperature of a person with trypanosomiasis are due to substances released when trypanosomes are destroyed. Use this information to explain how the observations made by Ross and Thomson could be due to changing antigens (lines 9–12).

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(4 marks)

(c) (i) Name the enzyme which is used to produce cDNA from mRNA (lines 15–16).

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(1 mark)

(ii) The mRNA which the scientists extracted from the trypanosomes (lines 14–15) could not be used directly to predict the amino acid sequence of the VSG being produced. Suggest why.

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(1 mark)

(iii) It is possible to predict the amino acid sequence of a VSG molecule from the DNA that encodes it (lines 18–19). Explain why.

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(2 marks)

Question 2 continues on the next page

(d) Name the chemical reaction involved in the removal of the signal peptide before the VSG is implanted in the plasma membrane (lines 21–22).

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(1 mark)

(e) (i) In laboratory conditions, antibodies produced against the complex sugar will bind to all VSG molecules (lines 24–26). Explain why.

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(2 marks)

(ii) A vaccine which resulted in the production of antibodies to the complex sugar would not be effective in eradicating trypanosomes. Use information from lines 24–29 to explain why.

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(2 marks)

15

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Answer **Question 3** in continuous prose.
Quality of Written Communication will be assessed in the answer.

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** Carbon dioxide in organisms and ecosystems *(25 marks)*

OR **B** Why offspring produced by the same parents are different in appearance *(25 marks)*

END OF QUESTIONS

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