General Certificate of Education
June 2008
Advanced Extension Award

BIOLOGY **6811**

Friday 20 June 2008 9.00 am to 12 noon

For this paper you must have:
- a 16-page answer book.

You may use a calculator.

Time allowed: 3 hours

Instructions
- Use blue or black ink or ball-point pen.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is 6811.
- Answer **four** questions.
- This paper is divided into four Sections, A, B, C and D. Answer **all** parts of the questions in Sections A and B. Answer **one** question from each of Sections C and D.
- Do all rough work in the answer book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 100.
- There are 25 marks for each question.
- In Sections C and D you will be marked on your ability to use good English, to organise information clearly and to use specialist vocabulary, where appropriate.
- You may illustrate your answers with diagrams provided that the diagrams explain or add to the written information.
- Graph paper is available on request.
- You are expected to use a calculator where appropriate.

Advice
- You are advised to spend about 45 minutes on each question.
- You may answer the questions in any order.
- Read each question carefully in Sections C and D before making your choice. Before beginning your answers, plan out roughly what you intend to write.

SECTION A

Answer **all** parts of the question.

1 **Total for this question: *25 marks***

Read the following passage.

Whales and seals are marine mammals. Although they all show adaptations to a marine environment, they are taxonomically diverse. Approximately 120 living species of marine mammal are currently recognised, but specialists disagree over the exact number. This number changes as new genetic and morphological information throws more light on the situation.

The use of computers to compare DNA sequences from different species has added to our understanding of evolutionary relationships among marine mammals. DNA sequences evolve by gradual accumulation of mutations. Changes in DNA may give rise to changes in proteins and this sometimes results in functional or morphological changes. The more differences there are in nucleotide sequences, the longer the period since the species split apart from each other. The accumulation of nucleotide substitutions, however, eventually reaches a point that is no longer helpful in studying evolutionary relationships. The length of time that it takes to reach this point depends on the rate at which the locus in question is evolving. Mitochondrial DNA, for example, evolves faster than ribosomal RNA genes. Even before this point is reached, interpretation of data involving nucleotide sequences requires care. A cytosine, for example, at a particular position in a sequence might be assumed to be homologous with the cytosine at the same position in another species, whereas it might be the result of a series of substitutions.

Further evidence for the classification of marine mammals may be obtained from their ecology, but even information about the diets of these animals is difficult to obtain and often limited to their last meal. Lipids in marine mammals are characterised by their diversity and the high proportion of long-chain fatty acids they contain. These fatty acids pass into the circulation of the whale or the seal and are often deposited in the tissues without further modification. A new technique based on the fatty acid composition of tissues has been developed to investigate the food of marine mammals. Analysis of the fatty acid composition of blood provides information about diet on a different time scale from a similar analysis of blubber. In addition, the fatty acids in the milk of lactating fur seals provide short-term dietary information; those in the milk of lactating true seals provide longer-term information.

(a) Suggest **four** adaptations to a marine environment that you would expect all whales and seals to show. In each case give the reason for your answer. *(4 marks)*

(b) Explain what is meant by

(i) describing whales and seals as taxonomically diverse (line 2) *(1 mark)*

(ii) ribosomal RNA genes (line 16). *(2 marks)*

(c) Comparing nucleotide sequences is more likely to give useful evolutionary information than comparing amino acid sequences. Explain why. *(3 marks)*

(d) Suggest why changes in proteins may only sometimes give rise to functional or morphological changes (lines 9-10). *(2 marks)*

(e) (i) It should not be assumed that a cytosine base at a particular position in a nucleotide sequence is homologous with the cytosine at the same position in another species (lines 17-20). Explain why. *(2 marks)*

(ii) Suggest why substitutions limit the use of nucleotide sequence analysis for studying evolutionary relationships (lines 11-13). *(2 marks)*

(f) Suggest why information about the diet of marine mammals is often limited to their last meal (lines 22-23). *(1 mark)*

(g) The fatty acid composition of tissues can be used to investigate the food of marine mammals (lines 27-28). Explain why tissue proteins cannot be used for this purpose. *(3 marks)*

(h) (i) Analysis of the fatty acid composition of blood provides information about diet on a different time scale from a similar analysis of blubber (lines 28-30). Explain how. *(3 marks)*

(ii) Although seals are marine mammals, they breed and suckle their young on land. What does the information about lactating seals (lines 30-32) suggest about the feeding behaviour in fur seals and true seals during the breeding season? Explain your answer. *(2 marks)*

SECTION B

Answer **all** parts of the question.

2 **Total for this question: *25 marks***

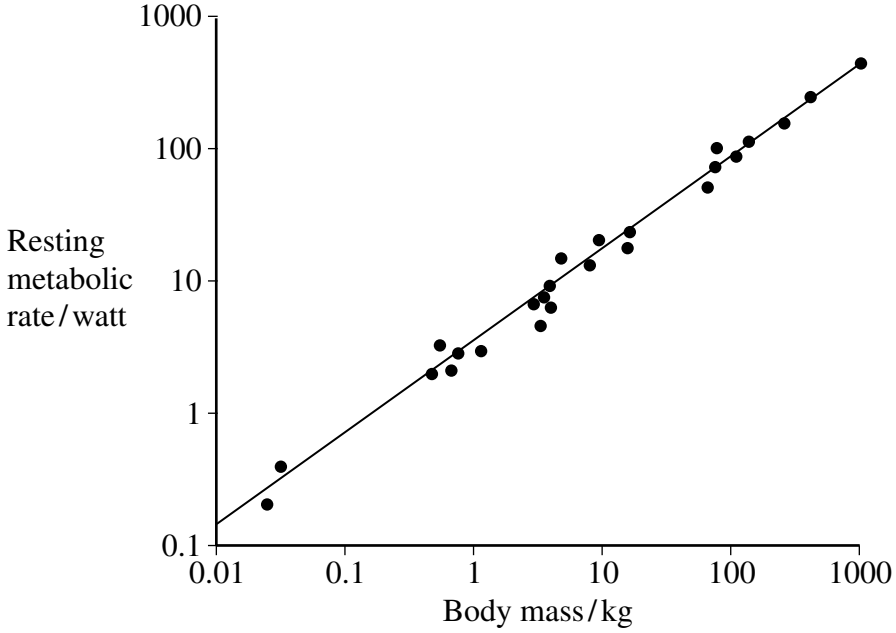
Resting metabolic rate is a measure of an animal's total use of chemical energy while it is at rest. There are several ways in which it can be measured. These include heat production and oxygen consumption.

(a) Explain why determining oxygen consumption provides only a reasonably accurate way of measuring resting metabolic rate. *(2 marks)*

(b) What are the main functions for which an animal requires chemical energy when it is at rest? *(3 marks)*

Figure 1 shows how the resting metabolic rate varies with the body mass of different mammals and birds.

Figure 1



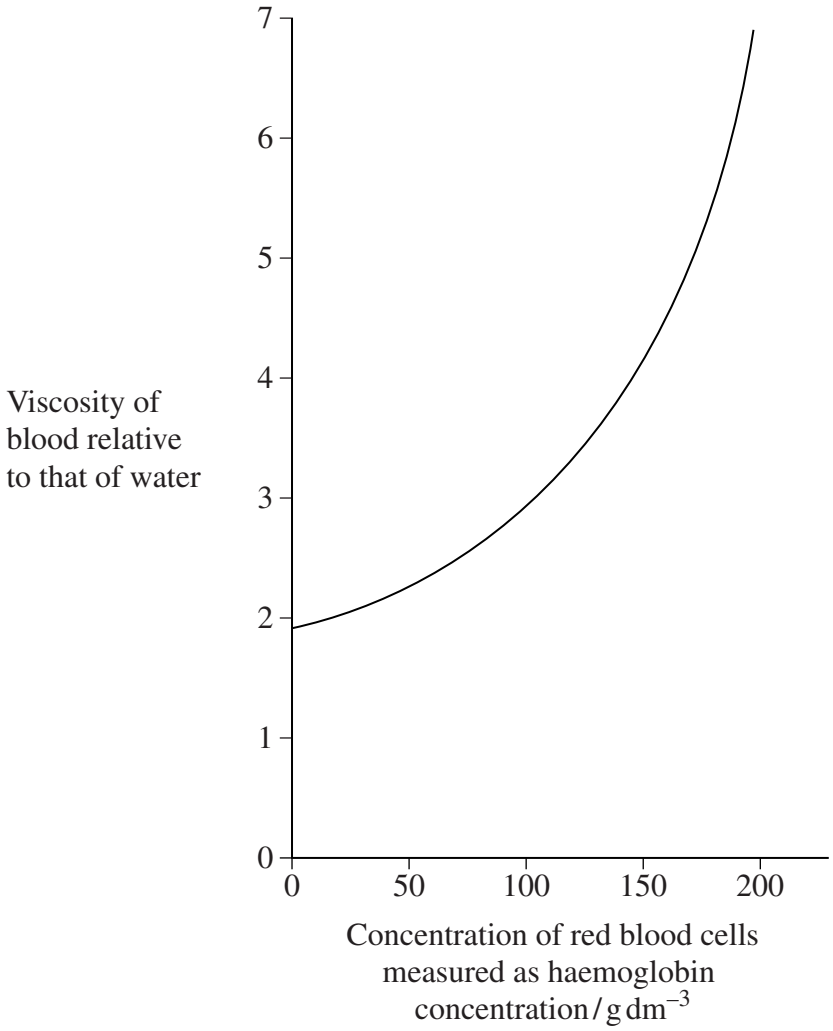
(c) Many desert-living mammals have resting metabolic rates lower than those predicted from the graph. Suggest and explain **one** advantage of this adaptation. *(2 marks)*

(d) The gradient of the line drawn on this graph has been calculated to be +0.75. When the resting metabolic rate per unit of body mass is plotted against body mass on a similar graph, the gradient is −0.25. What does a gradient of −0.25 indicate about the relationship between the two measurements? *(1 mark)*

(e) Some of the largest dinosaurs had body masses over 10 000 kg. It was once thought that these dinosaurs could maintain a constant body temperature. Use **Figure 1** to suggest why this is unlikely. *(4 marks)*

The supply of oxygen to metabolising cells is important. One factor that could influence oxygen supply is the concentration of red blood cells in the plasma. **Figure 2** shows how the viscosity of the blood, relative to the viscosity of water, changes with the concentration of red blood cells.

Figure 2



(f) The viscosity of pure water is 1. There is a difference between the viscosity of blood and the viscosity of water when there are no red blood cells in the blood. Explain this difference. *(2 marks)*

(g) (i) The optimum concentration of red blood cells in the blood of most mammals has been calculated to correspond to a haemoglobin concentration of approximately 150 g dm^{-3}. What factors determine the optimum concentration of red blood cells? Explain your answer. *(3 marks)*

(ii) Humans who live at high altitudes in mountainous areas have a concentration of red blood cells higher than this optimum value. Explain the advantage of a high concentration of red blood cells to a human living at high altitude.

(2 marks)

Question 2 continues on the next page

The table shows some other factors associated with oxygen supply to the cells of different mammals. The mammals are listed in order of increasing body mass. The table is incomplete because the data have been collected from different sources.

Species	**Mean diameter of red blood cells / µm**	**Bohr effect relative to that in humans**	**Partial pressure of oxygen at which haemoglobin is 50 % saturated (P_{50}) / kPa**
Shrew	7.5	Higher	
Mouse	6.6		6.5
Rat	6.8	Higher	
Dog	7.1	Similar	4.1
Sheep	4.8		
Human	7.5		3.6
Cow	5.9	Similar	
Horse	5.5	Lower	3.3
Elephant	9.2	Lower	3.1
Humpback whale	8.2		

(h) (i) Describe how you could determine whether the correlation between red blood cell diameter and body mass in mammals was significant. *(2 marks)*

(ii) The P_{50} of mouse haemoglobin is just over twice that of elephant haemoglobin. Explain why an even higher P_{50} would not be an advantage to the mouse. *(1 mark)*

(iii) Using the data in the table, discuss how blood supplies sufficient oxygen to meet the respiratory requirements of small mammals. *(3 marks)*

SECTION C

Answer **one** question from this section.

There are 25 marks for this question.

In addition to the biological content of your answer, marks will be awarded for your ability to:
- select appropriate and relevant material from different areas of your biological knowledge and apply this to the topics concerned;
- organise and present information clearly and logically, using appropriate scientific terminology.

3 Discuss how the functions of proteins are related to the size and shape of their molecules.

4 What are the main features of ecological succession and how is it influenced by human activity?

5 How do genes work?

SECTION D

Answer **one** question from this section.

There are 25 marks for this question.

In addition to the biological content of your answer, marks will be awarded for your ability to:
- develop and support a general argument with appropriate biological information;
- organise and present information clearly and logically, using appropriate scientific terminology.

6 What are biofuels and do they offer a realistic alternative fuel supply to conventional energy sources such as coal and oil?

7 'Humans have had their opportunity to control infectious disease but they have lost this battle.' Explain whether or not you agree with this statement.

8 Can organic farming supply our needs for food? Evaluate the alternatives to chemical pesticides and inorganic fertilisers in growing food for human consumption.

END OF QUESTIONS

There are no questions printed on this page