Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2011

Biology BIOL4

Unit 4 Populations and environment

Monday 13 June 2011 1.30pm to 3.00pm

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- 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 75.
- The marks for questions are shown in brackets.
- Quality of written communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

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

1 (a) The table contains statements about three biological processes.

Complete the table with a tick if the statement in the first column is true, for each process.

	Photosynthesis	**Anaerobic respiration**	**Aerobic respiration**
ATP produced			
Occurs in organelles			
Electron transport chain involved			

(3 marks)

1 (b) Write a simple equation to show how ATP is synthesised from ADP.

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(1 mark)

1 (c) Give **two** ways in which the properties of ATP make it a suitable source of energy in biological processes.

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(2 marks)

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1 (d) Humans synthesise more than their body mass of ATP each day. Explain why it is necessary for them to synthesise such a large amount of ATP.

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(2 marks)

8

Turn over for the next question

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2 Scientists measured the mean temperature in a field each month between March and October. The table shows their results.

Month	Mean temperature / °C
March	9
April	11
May	14
June	17
July	20
August	18
September	16
October	14

2 (a) The gross productivity of the plants in the field was highest in July. Use the data in the table to explain why.

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(2 marks)

2 (b) (i) Give the equation that links gross productivity and net productivity.

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(1 mark)

2 (b) (ii) The net productivity of the plants in the field was higher in August than in July. Use the equation in part **(b)(i)** and your knowledge of photosynthesis and respiration to suggest why.

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(2 marks)

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2 (c) A horse was kept in the field from March to October. During the summer months, the horse was able to eat more than it needed to meet its minimum daily requirements.

Suggest how the horse used the extra nutrients absorbed.

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(1 mark)

2 (d) The horse's mean energy expenditure was higher in March than it was in August. Use information in the table to suggest why.

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(2 marks)

8

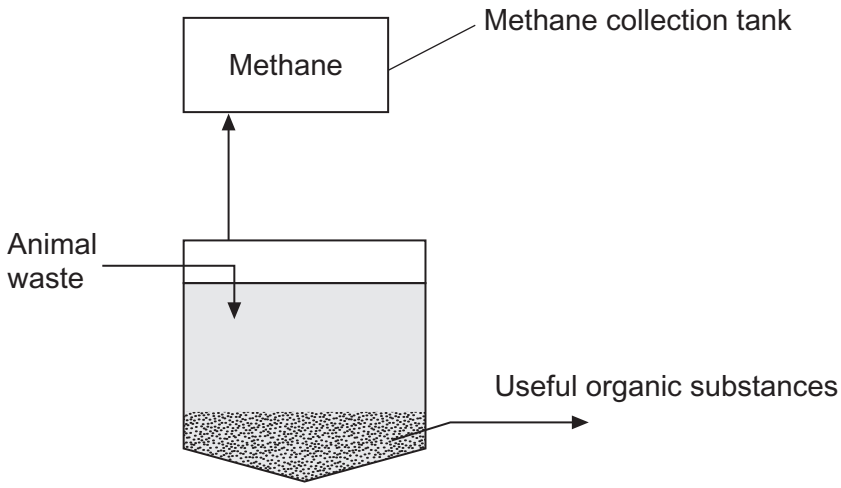
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3 Intensive rearing of livestock produces large quantities of waste. Some farmers use an anaerobic digester to get rid of the waste.

In an anaerobic digester, microorganisms break down the large, organic molecules in the waste. This produces methane, which is a useful fuel. It also produces organic substances that can be used as a natural fertiliser.

The diagram shows an anaerobic digester.



3 (a) (i) Suggest **two** advantages of processing waste in anaerobic digesters rather than in open ponds.

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(2 marks)

3 (a) (ii) The anaerobic digester has a cooling system, which is not shown in the diagram. Without this cooling system the digester would soon stop working. Explain why.

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(2 marks)

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3 (b) (i) The over-application of fertiliser increases the rate of leaching. Explain the consequences of leaching of fertiliser into ponds and lakes.

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(3 marks)

(*Extra Space)* .....

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3 (b) (ii) Give **one** advantage of using natural fertiliser produced in the digester rather than an artificial fertiliser.

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(1 mark)

8

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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4 (a) Explain what is meant by birth rate.

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(1 mark)

4 (b) The table shows life expectancies for babies born in the United Kingdom and in the Sudan in 2009.

	United Kingdom	**Sudan**
Life expectancy males / years	76.5	50.5
Life expectancy females / years	81.6	52.4

4 (b) (i) Describe the patterns shown by these data.

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(2 marks)

4 (b) (ii) Suggest reasons for the differences in the life expectancy shown by these data.

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(2 marks)

5

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5 A breeder crossed a black male cat with a black female cat on a number of occasions. The female cat produced 8 black kittens and 4 white kittens.

5 (a) (i) Explain the evidence that the allele for white fur is recessive.

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(1 mark)

5 (a) (ii) Predict the likely ratio of colours of kittens born to a cross between **this** black male and a white female.

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(1 mark)

5 (b) The gene controlling coat colour has three alleles. The allele **B** gives black fur, the allele **b** gives chocolate fur and the allele $\mathbf{b^i}$ gives cinnamon fur.

- Allele **B** is dominant to both allele **b** and $\mathbf{b^i}$.
- Allele **b** is dominant to allele $\mathbf{b^i}$.

5 (b) (i) Complete the table to show the phenotypes of cats with each of the genotypes shown.

Genotype	Phenotype
$\mathbf{Bb^i}$	
$\mathbf{bb^i}$	
Bb	

(1 mark)

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A chocolate male was crossed several times with a black female.
They produced

- 11 black kittens
- 2 chocolate kittens
- 5 cinnamon kittens.

5 (b) (ii) Using the symbols given on the previous page, complete the genetic diagram to show the results of this cross.

Parental phenotypes	Chocolate male		Black female
Parental genotypes	……		……
Gametes	……		……
Offspring genotypes	……	……	……
Offspring phenotypes	Black	Chocolate	Cinnamon

(3 marks)

5 (b) (iii) The breeder had expected equal numbers of chocolate and cinnamon kittens from the cross between the chocolate male and black female. Explain why the actual numbers were different from those expected.

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(1 mark)

5 (b) (iv) The breeder wanted to produce a population of cats that would all have chocolate fur. Is this possible? Explain your answer.

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(2 marks)

9

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6 Sea otters were close to extinction at the start of the 20th century. Following a ban on hunting sea otters, the sizes of their populations began to increase. Scientists studied the frequencies of two alleles of a gene in one population of sea otters. The dominant allele, **T**, codes for an enzyme. The other allele, **t**, is recessive and does not produce a functional enzyme.

In a population of sea otters, the allele frequency for the recessive allele, **t**, was found to be 0.2.

6 (a) (i) Use the Hardy-Weinberg equation to calculate the percentage of homozygous recessive sea otters in this population. Show your working.

Answer ..... %

(2 marks)

6 (a) (ii) What does the Hardy-Weinberg principle predict about the frequency of the **t** allele after another 10 generations?

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(1 mark)

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6 (b) Several years later, scientists repeated their study on this population. They found that the frequency of the recessive allele had decreased.

6 (b) (i) A statistical test showed that the difference between the two frequencies of the **t** allele was significant at the P = 0.05 level.

Use the terms **probability** and **chance** to help explain what this means.

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(2 marks)

6 (b) (ii) What type of natural selection appears to have occurred in this population of sea otters? Explain how this type of selection led to a decrease in the frequency of the recessive allele.

Type of selection .....

Explanation .....

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(2 marks)

7

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7 Parasites are organisms that live on or in host organisms. The populations of many organisms may be reduced by the effects of parasites.

Feather mites are small parasites found on the wing feathers of many birds. The mites feed on the oil that the birds produce. This oil keeps the feathers in good condition. Birds unable to oil their feathers properly use more energy in maintaining their body temperature. This results in less energy being available for other processes.

Scientists investigated the relationship between the numbers of feather mites and the breeding success of one species of bird, the great tit.

7 (a) Use the information above to suggest how feather mites could affect breeding in great tits.

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(2 marks)

7 (b) The scientists located a large number of great tit nests. They sampled these at random.

For each nest they recorded

- the total number of eggs laid
- the number of chicks that hatched from the eggs
- the number of chicks that survived to leave the nest
- the total number of feather mites on the two parent birds.

7 (b) (i) Explain why the scientists sampled the nests at random.

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(2 marks)

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The scientists calculated the percentage of each pair's eggs from which chicks survived to leave the nest. They called this 'breeding success per pair'.

The table shows some of the data that the scientists obtained.

Total number of feather mites on both parent birds	Breeding success per pair
0	86
2	100
5	64
10	82
14	70
15	85
170	42

7 (b) (ii) Do these data support the hypothesis that the presence of feather mites reduces the ability of great tits to reproduce successfully? Give reasons for your answer.

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(3 marks)

(*Extra Space)* .....

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Question 7 continues on the next page

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7 (c) The scientists calculated a correlation coefficient for these data.

7 (c) (i) State a null hypothesis that would be appropriate for this investigation.

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(1 mark)

7 (c) (ii) The correlation coefficient that they obtained had a negative value. What does a negative value indicate about these data?

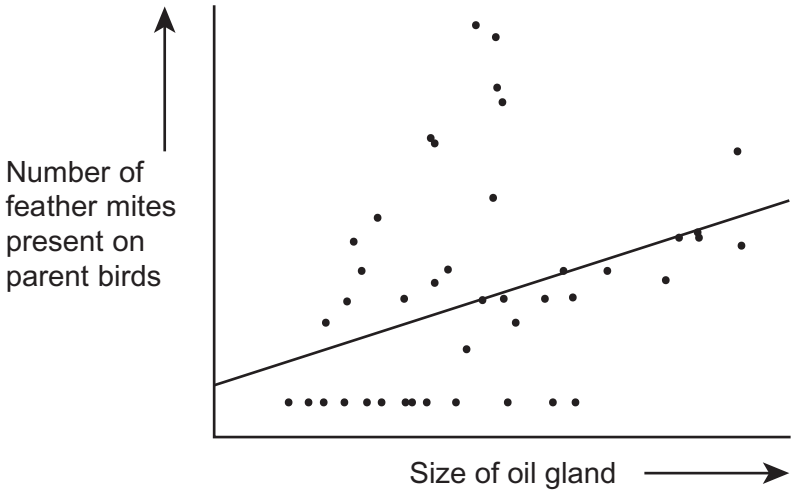
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(1 mark)

7 (d) The oil that a great tit puts on its feathers is made in an oil gland at the base of the tail. The bird uses its beak to spread the oil over its feathers. This is called preening. Preening takes place in early morning and evening and empties the oil gland each time. After preening, the oil gland is considerably smaller.

At the same time that the scientists recorded the number of feather mites on each great tit, they also measured the size of the oil gland. The graph shows their results and includes the scientist's line of best fit.



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7 (d) (i) Describe the relationship between the number of feather mites present on each great tit and the size of the oil gland.

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(2 marks)

7 (d) (ii) Explain how measuring the oil gland at the same time as counting the feather mites may have affected the reliability of the data.

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(2 marks)

7 (e) Feather mites eat pathogenic bacteria and fungi as well as oil. Explain how this may affect the breeding success of the birds.

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(2 marks)

15

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8 Much of Indonesia is covered with forest. Large areas of forest have been cleared and planted with oil-palm trees to be used in the production of fuel.

8 (a) In these forests, nitrogen in dead leaves is made available to growing plants by the action of bacteria. Describe the role of bacteria in making the nitrogen in dead leaves available to growing plants.

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(5 marks)

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8 (b) Clearing the forests and burning the vegetation affects the carbon dioxide concentration in the atmosphere.
Describe how and explain why.

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(4 marks)

(Extra space) .....

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Question 8 continues on the next page

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8 (c) During photosynthesis, oil-palm trees convert carbon dioxide into organic substances. Describe how.

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(6 marks)

(Extra space) .....

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15

END OF QUESTIONS

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