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
January 2012

Biology BIOL4

Unit 4 Populations and environment

Wednesday 25 January 2012 9.00 am to 10.30 am

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.

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

1 Ecologists studied a community of fish in a lake.

1 (a) Explain what is meant by a community.

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(1 mark)

1 (b) (i) The ecologists could have used the mark-release-recapture method to estimate the number of one species of fish in the lake. Describe how.

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(3 marks)

(Extra space) .....

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1 (b) (ii) This species of fish breeds at a certain time of the year. During this fish-breeding season, the mark-release-recapture technique might **not** give a reliable estimate. Suggest **one** reason why.

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(1 mark)

1 (c) The ecologists found that each species of fish had adaptations to its niche. One of these adaptations was the shape of its mouth.

Suggest how the shape of mouth is an adaptation to its niche.

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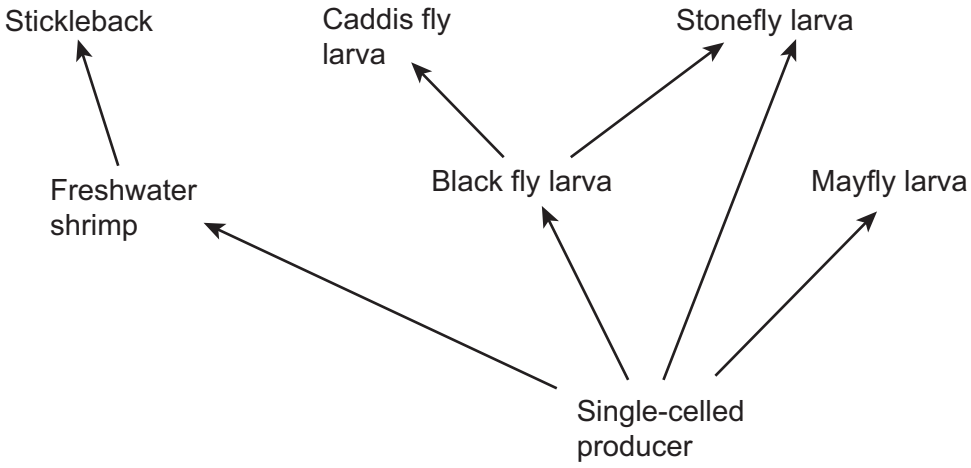
(2 marks)

7

Turn over for the next question

2 The diagram shows organisms in a food web.



2 (a) (i) Name **all** the secondary consumers in this food web.

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(1 mark)

2 (a) (ii) Use the diagram to explain the likely effect of a sudden decrease in the stickleback population on the population of mayfly larvae.

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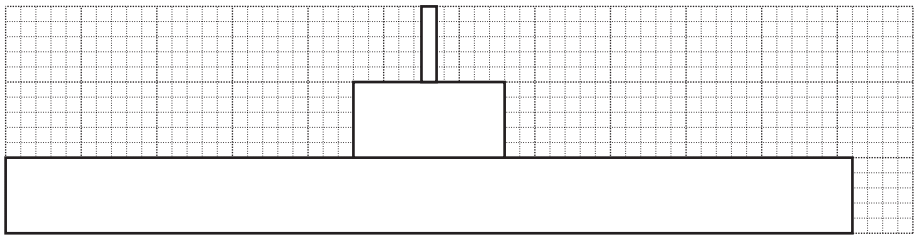
(2 marks)

2 (b) A pyramid of energy for this food web is shown below. The bars are drawn to the same scale.



2 (b) (i) Use the pyramid of energy to calculate the percentage efficiency of energy transfer between producers and primary consumers. Show your working.

efficiency = ... %

(2 marks)

2 (b) (ii) The average efficiency of energy transfer between producers and primary consumers in pyramids of energy is around 10 %.

Suggest why the efficiency of energy transfer from producers to primary consumers in this food web is higher than 10 %.

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(2 marks)

2 (c) Energy from the sun may ultimately end up in dead plant matter. Describe how.

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(2 marks)

9

3 The photograph shows marram grass growing on a sand dune.

3 (a) Describe how you would investigate the distribution of marram grass from one side of the dune to the other.

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(3 marks)

(Extra space) .....

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3 (b) Marram grass is a pioneer species that grows on sand dunes. It has long roots and a vertically growing stem that grows up through the sand.
Sand dunes are easily damaged by visitors and are blown by the wind. Planting marram grass is useful in helping sand dune ecosystems to recover from damage.

Use your knowledge of succession to explain how.

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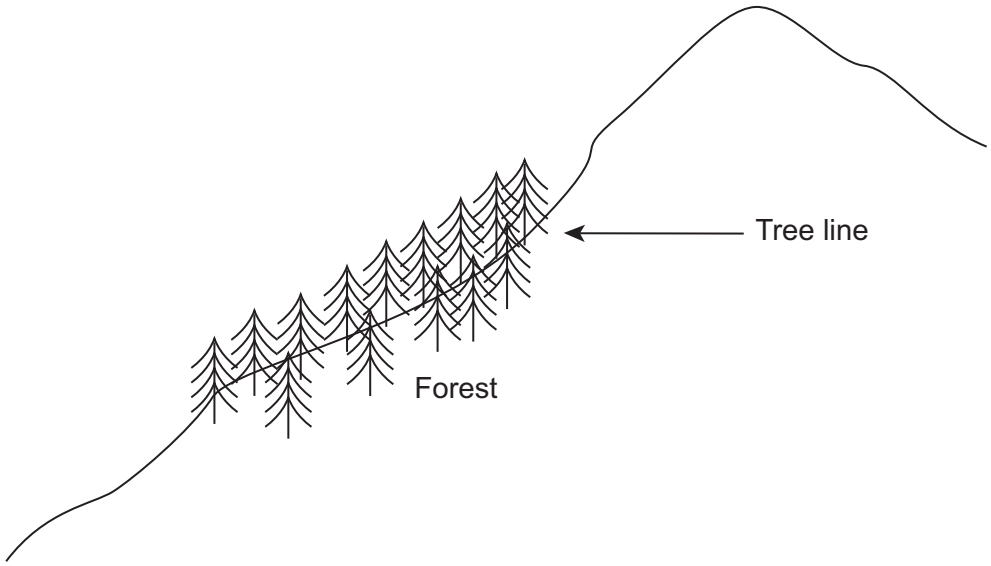
(2 marks)

5

4 Mountains are harsh environments. The higher up the mountain, the lower the temperature becomes. The diagram shows a forest growing on the side of a mountain. The upper boundary of the forest is called the tree line. Trees do not grow above the tree line.



4 (a) (i) The position of the tree line is determined by abiotic factors.
What is meant by an abiotic factor?

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(1 mark)

4 (a) (ii) Other than temperature, suggest **one** abiotic factor that is likely to affect the position of the tree line on the mountain.

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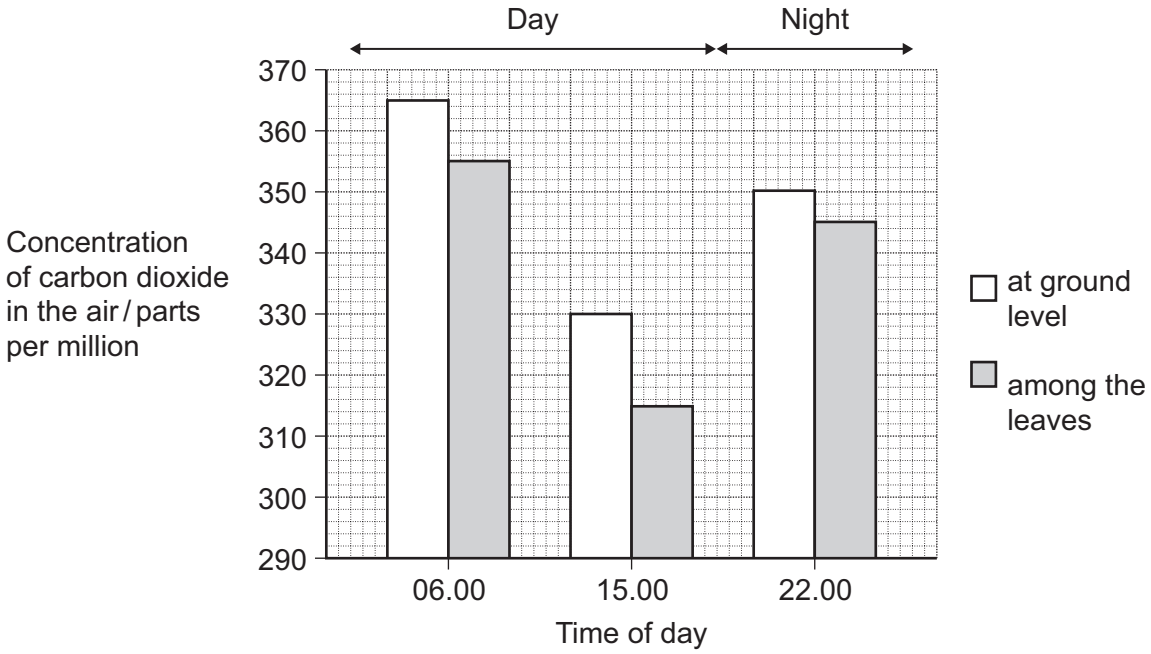
(1 mark)

Question 4 continues on the next page

4 (b) Scientists measured the concentration of carbon dioxide in the air in one part of the forest. They took measurements at different times of day and at two different heights above the ground. Their results are shown in the bar chart.



Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

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(4 marks)

(Extra space) .....

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4 (c) The population of trees in the forest evolved adaptations to the mountain environment. Use your knowledge of selection to explain how.

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(3 marks)

(Extra space) .....

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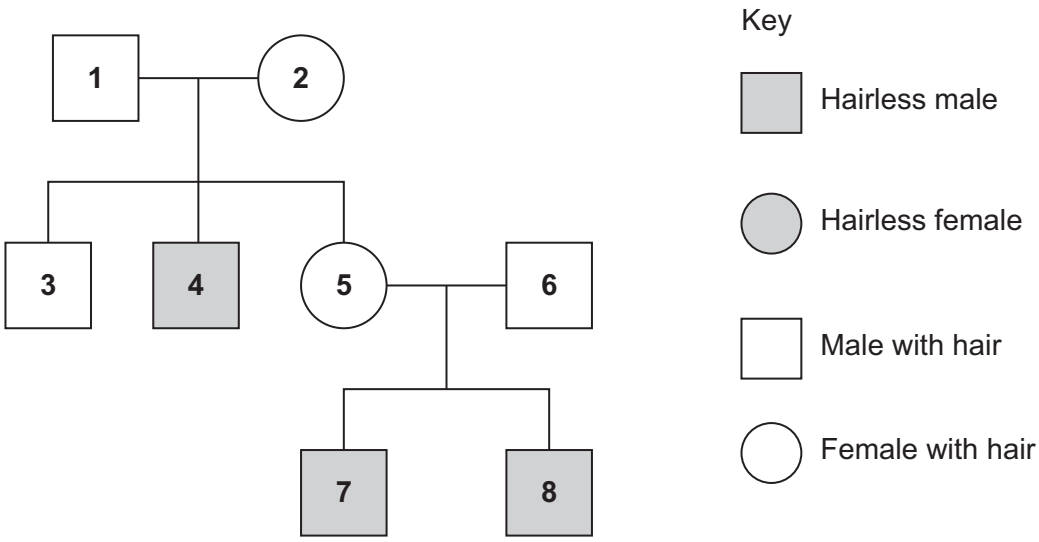
9

Turn over for the next question

5 A single gene controls the presence of hair on the skin of cattle. The gene is carried on the X chromosome. Its dominant allele causes hair to be present on the skin and its recessive allele causes hairlessness.

The diagram shows the pattern of inheritance of these alleles in a group of cattle.



5 (a) Use evidence from the diagram to explain

5 (a) (i) that hairlessness is caused by a recessive allele

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(2 marks)

5 (a) (ii) that hairlessness is caused by a gene on the X chromosome.

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(1 mark)

5 (b) What is the probability of the next calf born to animals **5** and **6** being hairless? Complete the genetic diagram to show how you arrived at your answer.

Phenotypes of parents	Female with hair	Male with hair
Genotypes of parents	.....	.....
Gametes	.....	.....

Genotypes of offspring .....

Phenotypes of offspring .....

Probability of next calf being hairless .....

(4 marks)

7

Turn over for the next question

6 (a) Name the process by which some bacteria oxidise ammonia to nitrate.

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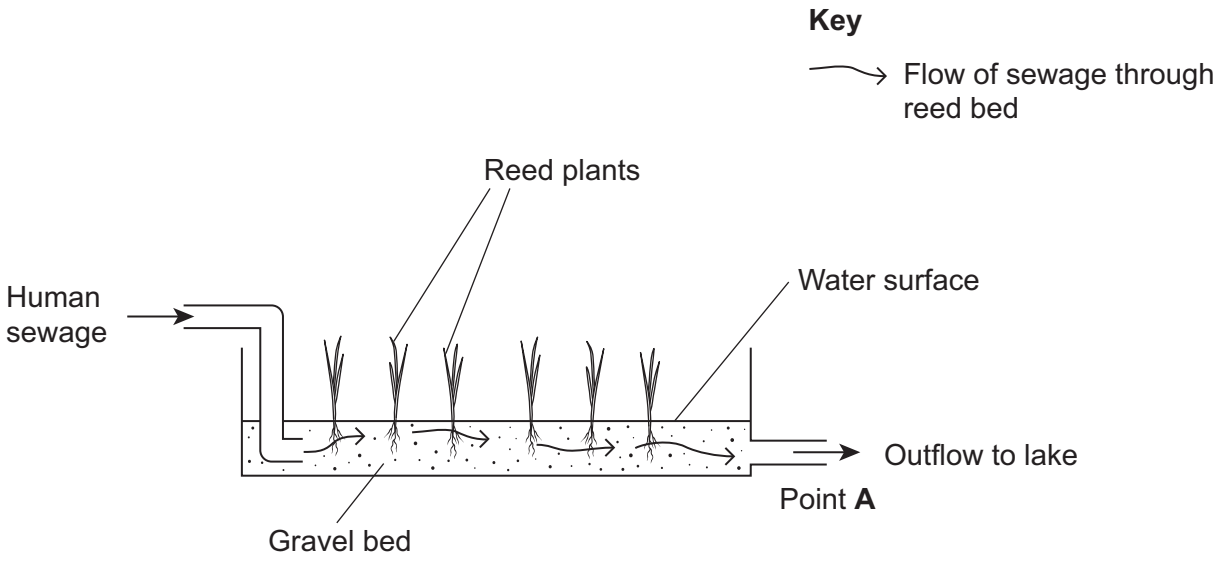
(1 mark)

Reeds are plants that grow with their roots under water. A reed bed contains a large number of growing reeds. Reed beds may be used to absorb nitrates produced when bacteria break down human sewage. The diagram shows a reed bed.



6 (b) Reeds have hollow, air-filled tissue in their stems which supplies oxygen to their roots. Explain how this enables the roots to take up nitrogen-containing substances.

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(2 marks)

6 (c) (i) There is an optimum rate at which human sewage should flow through the reed bed. If the flow of human sewage is too fast, the nitrate concentration at point **A** falls. Explain why.

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(2 marks)

6 (c) (ii) An increase in nitrate concentration in the water entering the lake could affect algae and fish in the lake. Explain how.

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(3 marks)

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8

7 In some countries, pigs are reared in intensive units in which the temperature is controlled. Agricultural scientists investigated the effect of temperature on pig growth and on the efficiency with which the pigs converted food to biomass.

7 (a) (i) In the investigation, the scientists used pigs of the same breed, with similar genotypes. Explain why.

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(2 marks)

7 (a) (ii) The pigs were allowed to eat as much food as they wanted.
How could this have decreased the reliability of any conclusions drawn from the investigation?

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(2 marks)

The table shows the results of this investigation.

Temperature / °C	Mean growth rate / kg per day	Efficiency of conversion of food to biomass / %
0	0.54	19
10	0.80	42
20	0.85	48
30	0.45	37
35	0.31	37

7 (b) (i) Describe the effect of temperature on mean growth rate.

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(1 mark)

7 (b) (ii) A student concluded from these data that the mean growth rate of the pigs was fastest at 20 °C. Do you agree with this conclusion? Explain your answer.

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(2 marks)

7 (c) (i) Pigs can survive at temperatures above 35 °C. Use the data to suggest why scientists did **not** carry out any investigations at temperatures higher than 35 °C.

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(2 marks)

7 (c) (ii) The efficiency of conversion of food to biomass is lower at 0 °C than it is at 20 °C. Suggest an explanation for the lower efficiency.

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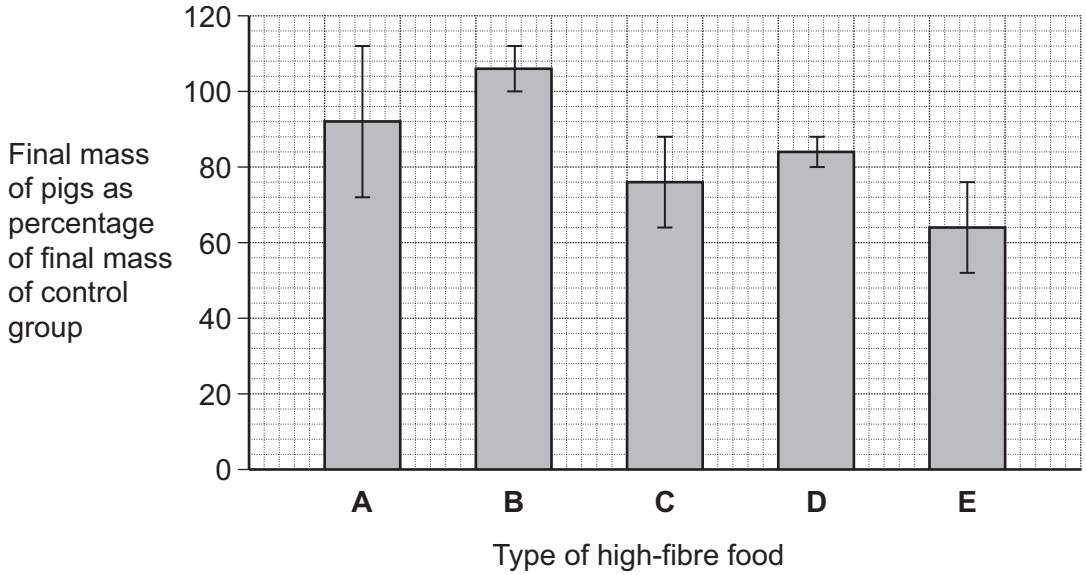
(2 marks)

Question 7 continues on the next page

7 (d) Pigs require a mixture of fibre and protein in their food. The greater the ratio of fibre to protein, the less the food costs.

Scientists took five large groups of pigs. They fed each group a different high-fibre food. Each of the foods contained fibre from different plant species, but they all had the same energy content. The scientists fed a control group of pigs a low-fibre food with the same energy content. After 10 days, the scientists compared the masses of the pigs fed on high-fibre food to those fed on low-fibre food.

The graph shows the results of the investigation. The bars represent ±2 standard errors of the mean.



A farmer saw these results and concluded that he should replace his pigs' usual food with food **B**. Evaluate this conclusion.

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(4 marks)

(Extra space) .....

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15

8 (a) ATP is useful in many biological processes. Explain why.

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(4 marks)

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Question 8 continues on the next page

8 (b) Describe how ATP is made in mitochondria.

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(6 marks)

(Extra space) .....

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8 (c) Plants produce ATP in their chloroplasts during photosynthesis. They also produce ATP during respiration. Explain why it is important for plants to produce ATP during respiration in addition to during photosynthesis.

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(5 marks)

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15

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

ACKNOWLEDGEMENTS

Question 3 Photograph, Thinkstock.