Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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TOTAL	

General Certificate of Education
Advanced Level Examination
January 2011

Biology BIOL4

Unit 4 Populations and environment

Monday 24 January 2011 1.30 pm to 3.00 pm

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.

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

1 (a) Explain what is meant by the ecological term population.

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(1 mark)

1 (b) Four factors may affect the size of a human population. They are

- Birth rate (**B**)
- Death rate (**D**)
- Emigration rate (**E**)
- Immigration rate (**I**).

Use all the letters **B**, **D**, **E** and **I** to write a formula showing

1 (b) (i) a population that stays the same size

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(1 mark)

1 (b) (ii) a population that is increasing in size.

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(1 mark)

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1 (c) The table shows some features relating to the human population of Mexico in 2007.

Feature	
Total population / millions	107
Birth rate per 1000 population	20
Death rate per 1000 population	5
Life expectancy / years	76

1 (c) (i) In 1990 the life expectancy was 70 years. Suggest **one** reason for the change in life expectancy since 1990.

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(1 mark)

1 (c) (ii) Use the information in the table to calculate the size of the population of Mexico in 2008. Show your working.

Answer .....

(2 marks)

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Turn over for the next question

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2 (a) (i) Explain what is meant by a **recessive** allele.

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(1 mark)

2 (a) (ii) Explain what is meant by **codominant** alleles.

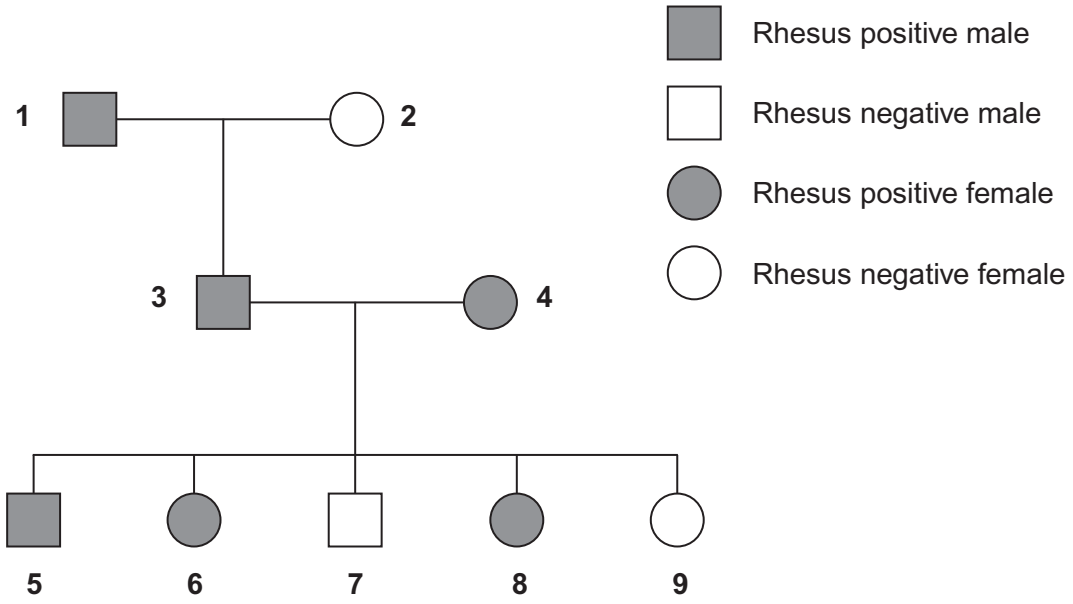
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(1 mark)

2 (b) The Rhesus blood group is genetically controlled. The gene for the Rhesus blood group has two alleles. The allele for Rhesus positive, **R**, is dominant to that for Rhesus negative, **r**. The diagram shows the inheritance of the Rhesus blood group in one family.



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2 (b) (i) Explain **one** piece of evidence from the diagram which shows that the allele for Rhesus positive is dominant.

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(2 marks)

2 (b) (ii) Explain **one** piece of evidence from the diagram which shows that the gene is **not** on the X chromosome.

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(2 marks)

2 (c) Sixteen percent of the population of Europe is Rhesus negative. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be heterozygous for the Rhesus gene.
Show your working.

Answer .....

(3 marks)

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3 Urea from animal waste can be used as a fertiliser. Some bacteria in the soil secrete the enzyme urease which hydrolyses urea into ammonia. Some of this ammonia is released into the atmosphere. NBPT is an inhibitor of urease and can be added to urea fertiliser to reduce the loss of ammonia to the atmosphere.

3 (a) A molecule of NBPT has a similar structure to a molecule of urea. Use this information to suggest how NBPT inhibits the enzyme urease.

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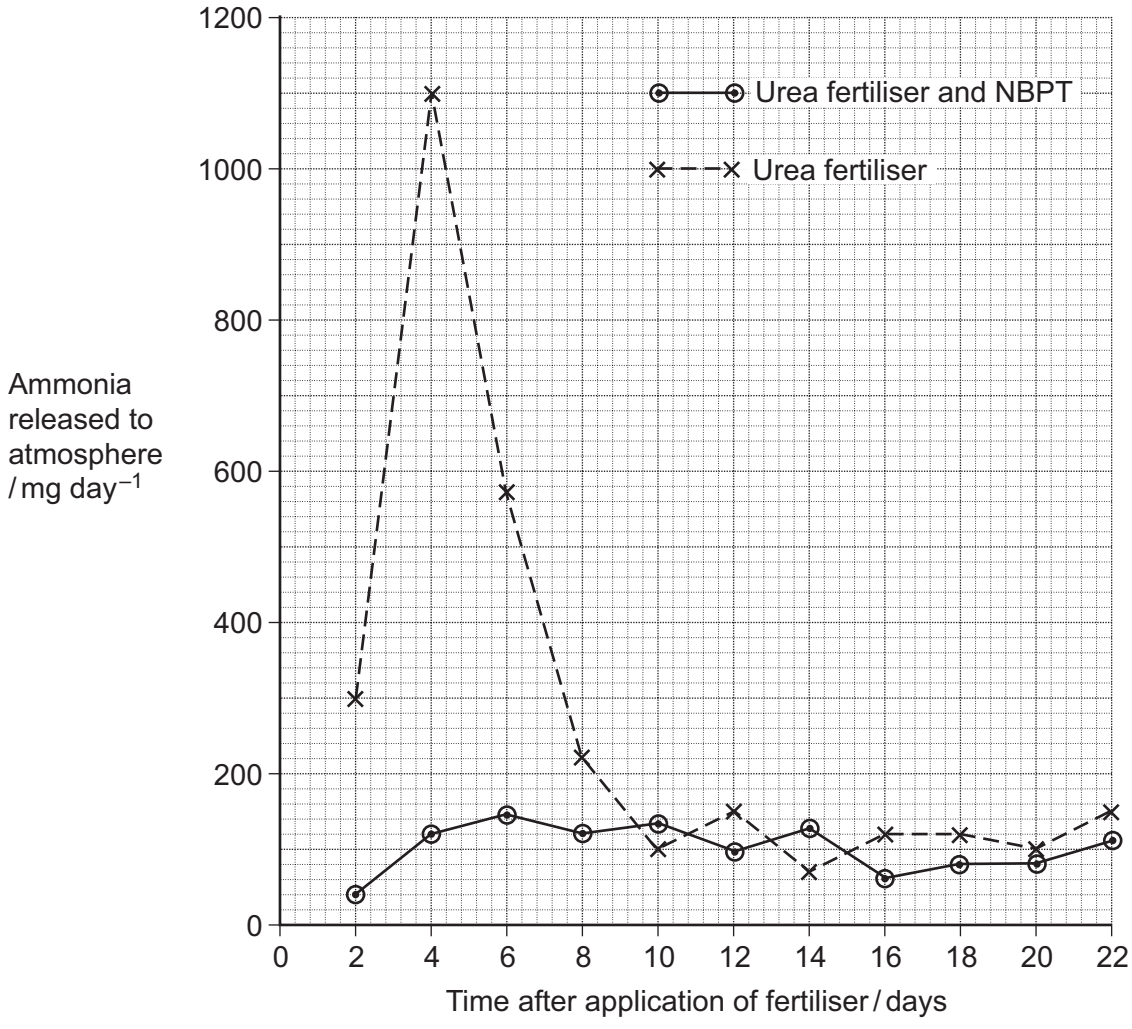
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(2 marks)

Scientists investigated the effect of NBPT on the release of ammonia from urea fertiliser added to the soil. A control experiment was carried out. This involved adding urea fertiliser only. The graph shows their results.



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3 (b) (i) Describe how NBPT affected the loss of ammonia from urea fertiliser.

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(1 mark)

3 (b) (ii) Suggest an explanation for the increase in mass of ammonia released over the first four days in the control experiment.

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(2 marks)

3 (c) Suggest how the addition of NBPT to urea fertiliser could result in increased growth of crop plants.

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(3 marks)

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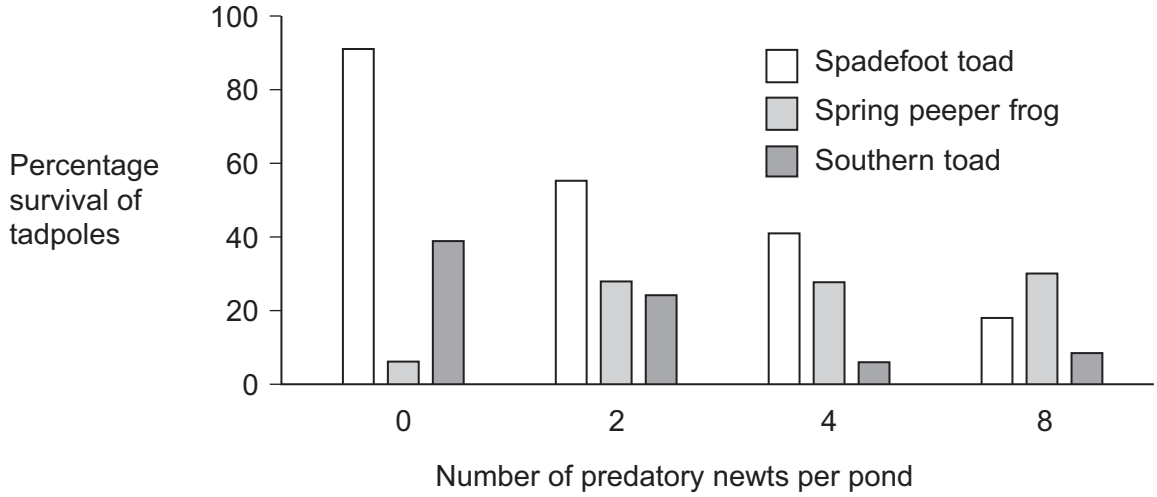
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4 The young of frogs and toads are called tadpoles. Ecologists investigated the effect of predation on three species of tadpole. They set up four artificial pond communities. Each community contained

- 200 spadefoot toad tadpoles
- 300 spring peeper frog tadpoles
- 300 southern toad tadpoles.

The ecologists then added a different number of newts to each pond. Newts are predators. **Figure 1** shows the effect of increasing the number of newts on the percentage survival of the tadpoles of each species.

Figure 1



4 (a) (i) Describe the effect of an increase in the number of newts on the percentage survival of the tadpoles of each of the **toad** species.

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(2 marks)

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4 (a) (ii) Suggest an explanation for the effect of an increase in the number of newts on the percentage survival of the tadpoles of spring peeper frogs.

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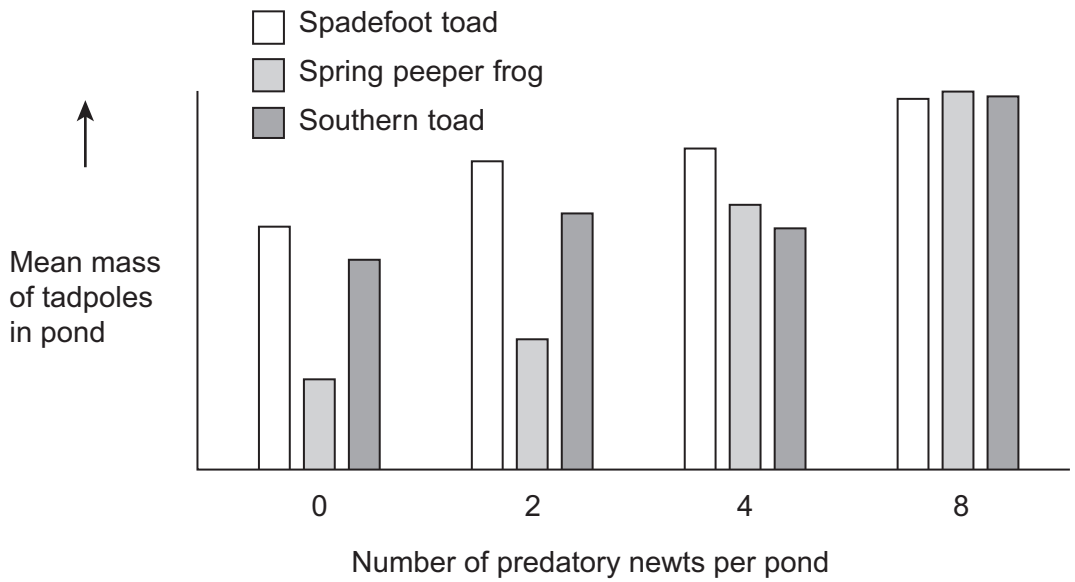
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Figure 2 shows how the masses of the tadpoles were affected in each pond during the investigation.

Figure 2



4 (b) Using the information provided in **Figure 1** explain the results obtained in **Figure 2**.

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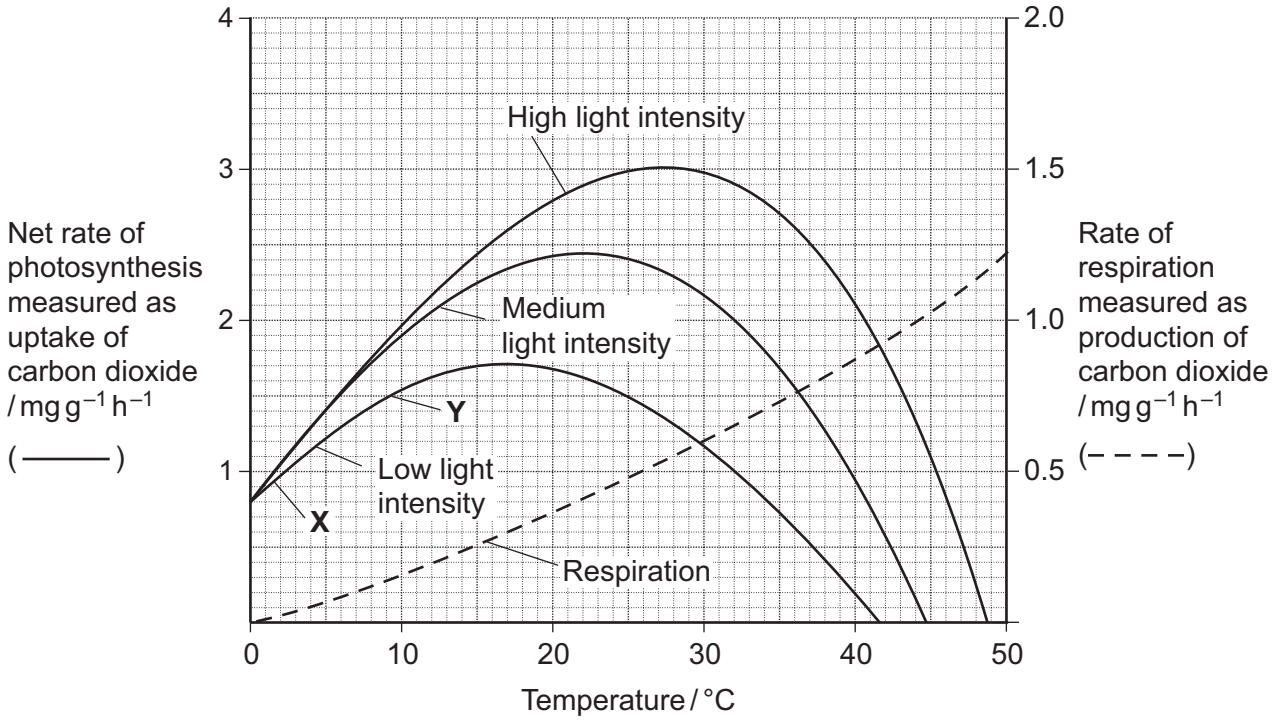
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5 Scientists investigated the effects of temperature and light intensity on the rate of photosynthesis in creeping azalea. They investigated the effect of temperature on the net rate of photosynthesis at three different light intensities. They also investigated the effect of temperature on the rate of respiration. The graph shows the results.



5 (a) (i) Name the factors that limited the rate of photosynthesis between **X** and **Y**.

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(1 mark)

5 (a) (ii) Use information from the graph to explain your answer.

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(2 marks)

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5 (b) Use information from the graph to find the gross rate of photosynthesis at 20°C and medium light intensity.

Answer .....

(1 mark)

5 (c) Creeping azalea is a plant which grows on mountains. Scientists predict that in the area where this plant grows the mean summer temperature is likely to rise from 20°C to 23°C. It is also likely to become much cloudier. Describe and explain how these changes are likely to affect the growth of creeping azalea.

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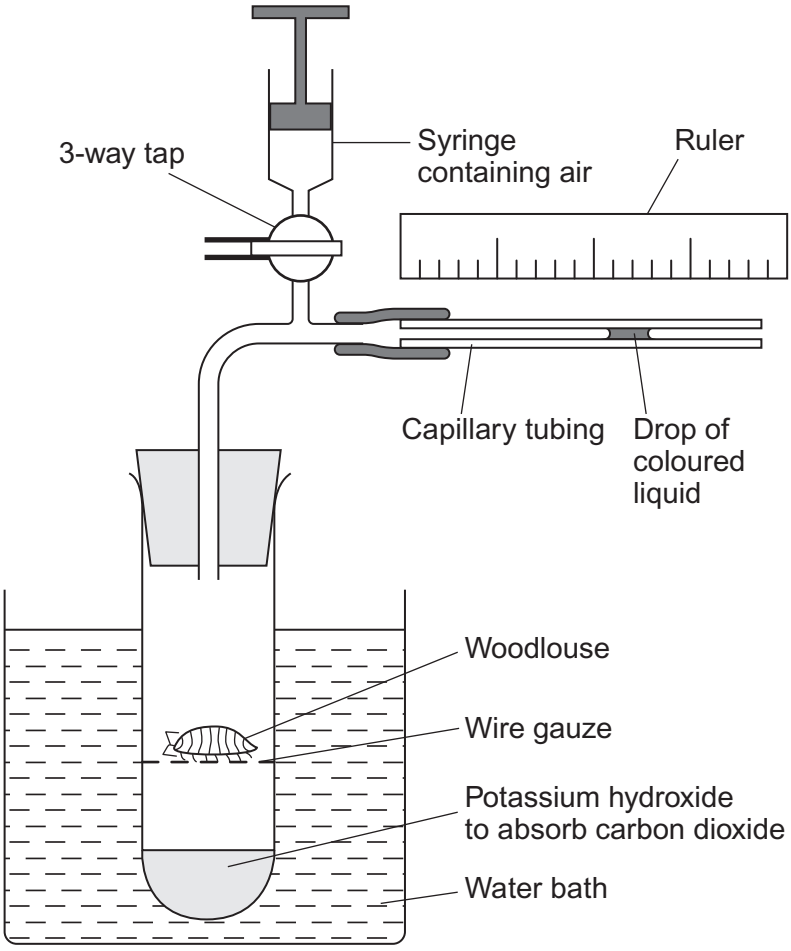
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6 (a) A student measured the rate of aerobic respiration of a woodlouse using the apparatus shown in the diagram.



6 (a) (i) The student closed the tap. After thirty minutes the drop of coloured liquid had moved to the left. Explain why the drop of coloured liquid moved to the left.

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6 (a) (ii) What measurements should the student have taken to calculate the rate of aerobic respiration in mm^3 of oxygen g^{-1} h^{-1}?

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(3 marks)

(Extra space) .....

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6 (b) DNP inhibits respiration by preventing a proton gradient being maintained across membranes. When DNP was added to isolated mitochondria the following changes were observed

- less ATP was produced
- more heat was produced
- the uptake of oxygen remained constant.

Explain how DNP caused these changes.

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7 Residual food intake (RFI) is the difference between the amount of food an animal actually eats and its expected food intake based on its size and growth rate. Scientists have selectively bred cattle for low RFI.

7 (a) (i) Explain the advantage to farmers of having cattle with a low RFI.

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(2 marks)

7 (a) (ii) When RFI is calculated, low values are negative. Explain why they are negative.

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(1 mark)

7 (b) Scientists have developed a standard procedure for comparing RFI in cattle. They control **two** factors. These are type of food and environmental temperature. Explain why each of these factors needs to be controlled.

Type of food

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Environmental temperature

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(4 marks)

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7 (c) Bacteria in the digestive systems of cattle break down food and produce methane. Scientists investigated the relationship between RFI and methane production. They measured the rate of methane production of 76 cattle over a fifteen-day period. Some of the results are shown in **Figure 3**.

Figure 3

	Low RFI	High RFI
Mean rate of methane production / g day^{-1}	142.3	190.2

7 (c) (i) Suggest a null hypothesis for this investigation.

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(1 mark)

7 (c) (ii) Selectively breeding cattle with a low RFI may help to limit global warming. Use the information in **Figure 3** to explain how.

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(2 marks)

Question 7 continues on the next page

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7 (d) Other scientists investigated the release of methane from rice fields. They investigated the effect of adding organic material (straw) and inorganic substances on the release of methane from rice fields. The results are shown in **Figure 4**.

Figure 4

Inorganic substance added to soil	Total methane released over 30 days / μmol kg^{-1} soil	
	Without straw	With straw
None	1179	25 492
Nitrate	63	764
Sulfate	19	144
Iron oxide	39	313
Manganese oxide	53	475

7 (d) (i) Which treatment is most effective in reducing release of methane from rice fields?

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(1 mark)

7 (d) (ii) Research findings are not always of direct use to farmers. What else would rice farmers need to know before acting on the results of this investigation?

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(2 marks)

7 (d) (iii) Methane is produced by anaerobic microorganisms in the soil. The scientists found that rice fields that are not flooded do not produce large amounts of methane. Suggest why.

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(2 marks)

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8 (a) Succession occurs in natural ecosystems. Describe and explain how succession occurs.

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8 (b) Managed ecosystems such as wheat fields are prone to pest infestations. Describe the advantages and disadvantages of using biological agents to control pests.

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8 (c) Changes in ecosystems can lead to speciation. In Southern California 10 000 years ago a number of interconnecting lakes contained a single species of pupfish. Increasing temperatures caused evaporation and the formation of separate, smaller lakes and streams. This led to the formation of a number of different species of pupfish. Explain how these different species evolved.

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END OF QUESTIONS

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