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Areas outside the box will not be scanned for marking

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

1 Snow geese fly north to the Arctic in the spring and form breeding colonies. Different colonies form at different latitudes. The greater the latitude, the further north is the colony. The further north a breeding colony forms, the colder the temperature and the greater the risk of snow.

1 (a) There is a positive correlation between the size of snow geese and how far north they breed. A large size results in snow geese being adapted for breeding in colder conditions. Explain how.

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(2 marks)

Snow geese are either white or blue in colour. The table shows the percentage of white snow geese in colonies at different latitudes at different times over a 40-year period. The blank cells in the table are years for which no figures are available.

Colony	**Latitude in degrees north**	**Percentage of white snow geese each year**			
		1930	**1950**	**1960**	**1970**
A	72	100		100	100
B	71		>99	>99	>99
C	66	95	85	76	
D	63	86	75	67	65
E	55		62		28

1 (b) (i) Describe how the percentage of white snow geese varies with distance north.

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(1 mark)

1 (b) (ii) The further north, the greater the risk of snow. Use this information to explain how natural selection might have accounted for the effect of latitude on the percentage of white snow geese.

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(3 marks)

(Extra space) .....

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1 (c) The percentage of white snow geese in these colonies changed over the period shown in the table. Use your knowledge of climate change to suggest an explanation.

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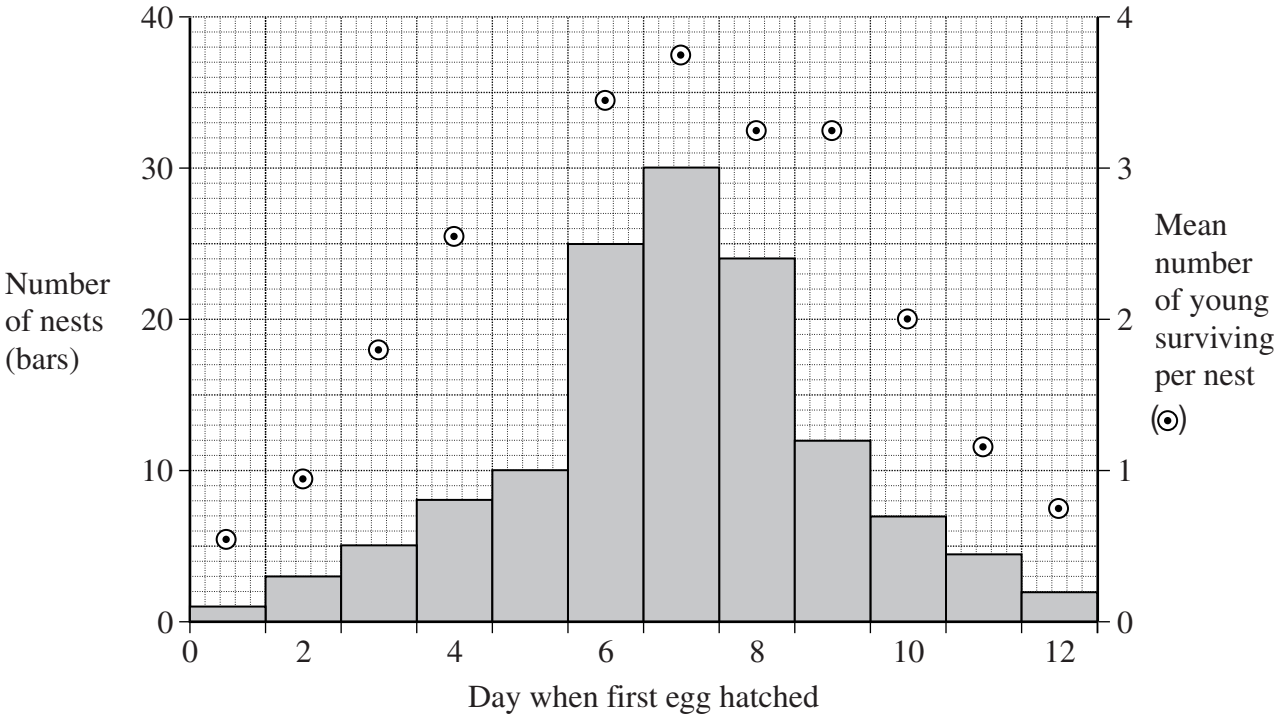
(2 marks)

Question 1 continues on the next page

1 (d) Snow geese breed in large colonies. Scientists studied the nests in one colony. For each nest, they recorded the day on which the first egg hatched. They also recorded the number of young that survived from the nest. They used the data to plot a graph.



1 (d) (i) What type of natural selection is shown in the graph?

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(1 mark)

1 (d) (ii) Describe the evidence for your answer.

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(1 mark)

10

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

2 (a) Dead leaves contain starch. Describe how microorganisms make carbon in starch available to plants.

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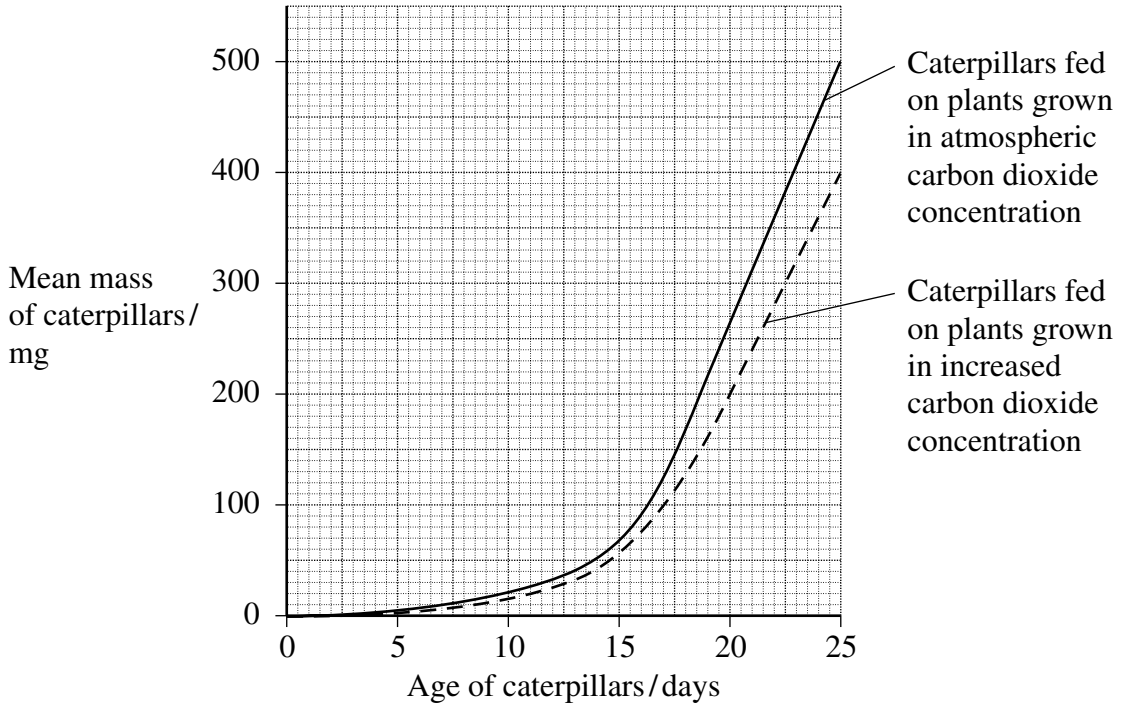
(2 marks)

Scientists grew groups of the same species of crop plant in a greenhouse in two different concentrations of carbon dioxide. They fed caterpillars on plants from each group and measured the growth of the caterpillars. The results of their investigation are shown in the graph.



2 (b) Calculate the maximum rate of growth of the caterpillars on the plants grown in the increased carbon dioxide concentration. Show your working.

Answer ..... mg day^{-1}

(2 marks)

2 (c) Other scientists showed that plants grown in an increased concentration of carbon dioxide have a higher carbon : nitrogen ratio than plants grown in atmospheric carbon dioxide concentration. What does this suggest about the protein concentration in the plants grown in the increased concentration of carbon dioxide? Explain your answer.

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(2 marks)

2 (d) It would not be valid to conclude from the investigations described in this question that an increase in carbon dioxide concentration would reduce crop losses due to caterpillars. Give **two** reasons why this conclusion might not be valid in field conditions.

1 .....

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2 .....

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(2 marks)

8

Turn over for the next question

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

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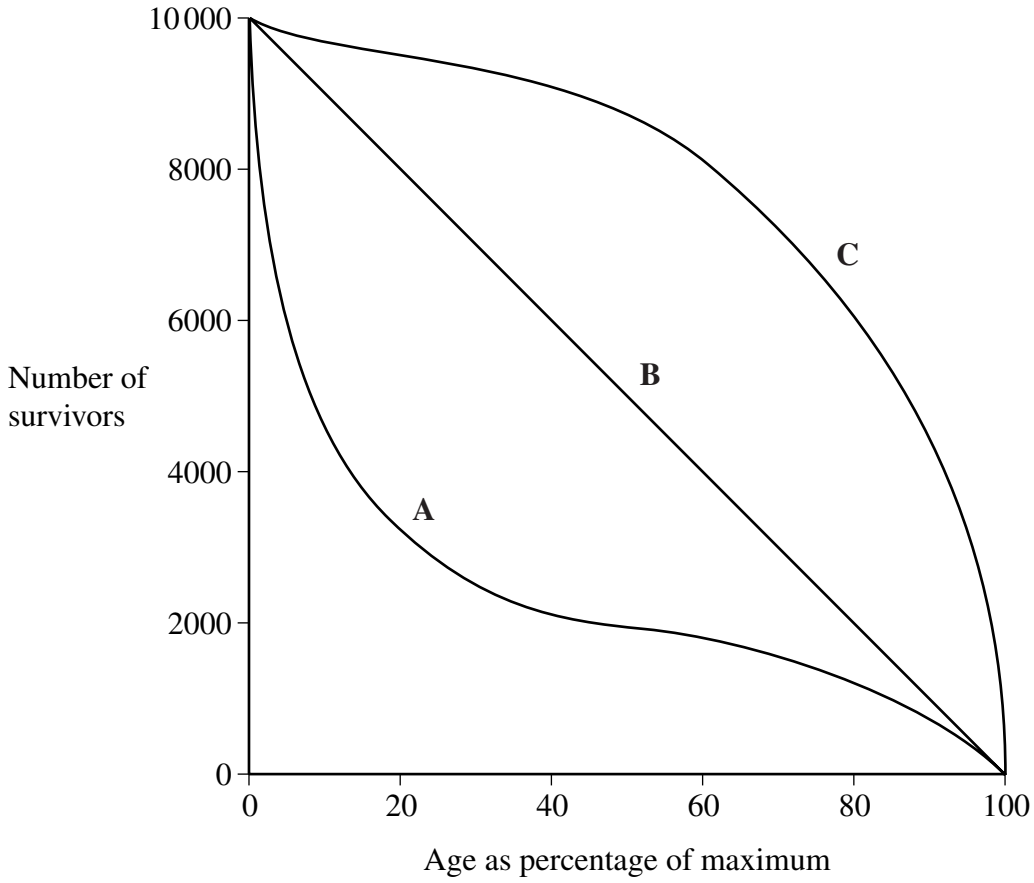
(1 mark)

3 (b) The diagram shows three survival curves, **A**, **B** and **C**.



3 (b) (i) Assume that the maximum age of a person living in a developed country is 95 years.

The diagram can be used to find the average life expectancy of people living in developed countries. Explain how.

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(3 marks)

(Extra space) .....

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3 (b) (ii) Curve **A** is a survival curve for people living in the UK in 1750. Explain why the curve is this shape.

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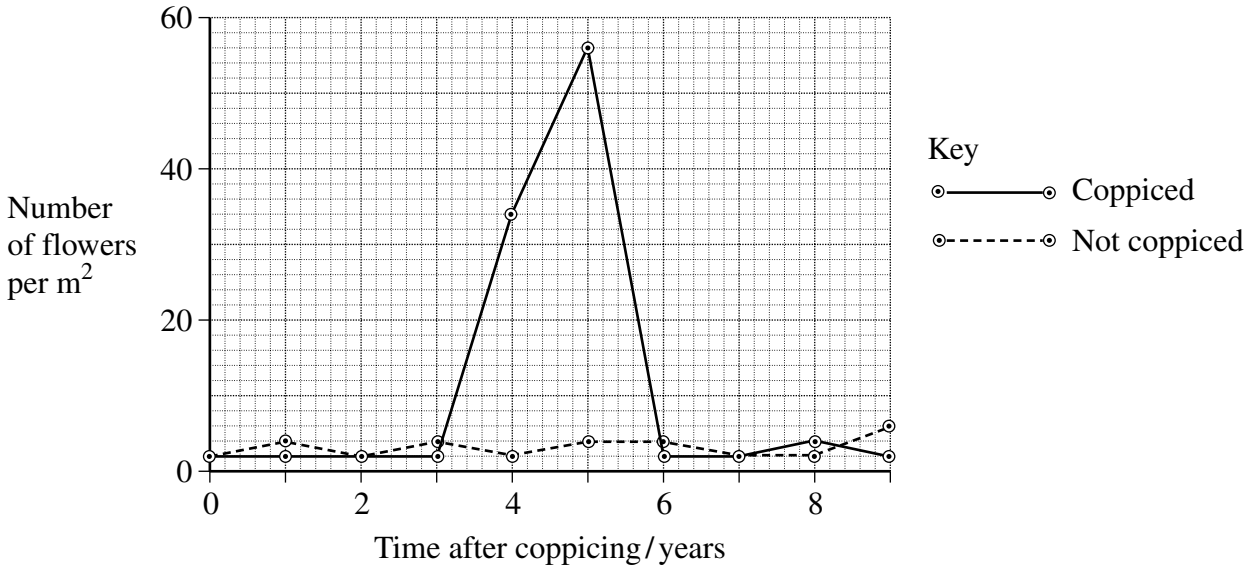
(2 marks)

6

4 Woods can be coppiced to provide a continuous supply of useful logs and poles. Coppicing involves cutting down some trees in a wood to leave stumps. New shoots grow from the stumps. After about 15 years, these trees can be coppiced again.

Because coppicing produces a wood with patches of light and shade, the diversity of plants and animals in a coppiced wood is high.

Ecologists investigated the effect of coppicing on the flowering of wild daffodils growing in a wood in Cumbria. Some areas of the wood were coppiced and some areas were not. The graph shows some results from this investigation.



4 (a) You could collect data for the coppiced plots by using quadrats.

4 (a) (i) Describe how you would place the quadrats at random.

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(2 marks)

4 (a) (ii) Describe how you would decide the number of quadrats to use in order to collect representative data.

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(2 marks)

4 (b) Members of the public visit this wood to see wild daffodils in flower. Explain how the information in the graph could help the owners to manage the wood so that there were many wild daffodils in flower every year.

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(2 marks)

4 (c) The ecologists analysed the relationship between the number of daffodils in flower in the whole wood and data collected from a nearby weather station for the previous year. They used the Spearman rank correlation test. The table shows their results.

Month	Climatic factor	Correlation coefficient	Statistical significance
July	Total rainfall	+0.65	significant
August	Total rainfall	+0.74	significant
July	Monthly mean temperature	−0.78	significant
August	Monthly mean temperature	−0.65	significant

The ecologists concluded that a wet, cool summer produces good flowering the following spring. Do you support this conclusion? Use the data in the table to explain your answer.

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(2 marks)

8

5 (a) The biochemical pathway of aerobic respiration involves a number of different steps. Name **one** step in which carbon dioxide is produced.

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(1 mark)

In an investigation, scientists transferred slices of apple from air to anaerobic conditions in pure nitrogen gas. They measured the rate of carbon dioxide production.

5 (b) The scientists kept the temperature constant throughout the investigation. Explain how a decrease in temperature would affect the rate of carbon dioxide production.

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(2 marks)

5 (c) When the apple slices were transferred to nitrogen, the following biochemical pathway took place.

Pyruvic acid Ethanol

Use this pathway to explain the part played by reduced NAD when the apple slices were transferred to nitrogen.

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(2 marks)

5 (d) The rate of carbon dioxide production was higher when the apple slices were in nitrogen than when they were in the air. Explain why.

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(3 marks)

(Extra space) .....

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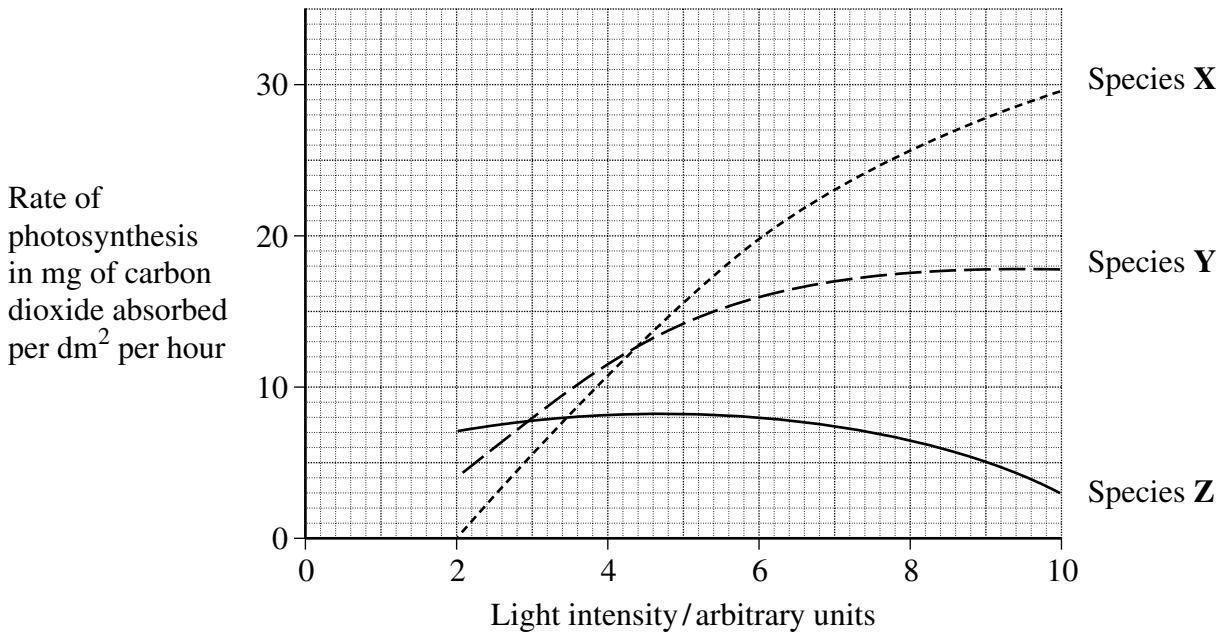
8

Turn over for the next question

6 The graph shows the effects of light intensity on the rate of photosynthesis of three species of tree, **X**, **Y** and **Z**. Each of these species occurs at a different stage in succession.



6 (a) Species **X** is the first tree to become established in the succession. Use the graph to explain why it is likely to become established earlier in the succession than **Y** or **Z**.

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(3 marks)

(Extra space) .....

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6 (b) Species **X** may change the environment so that it becomes more suitable for species **Z**. Use the graph to explain why.

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(2 marks)

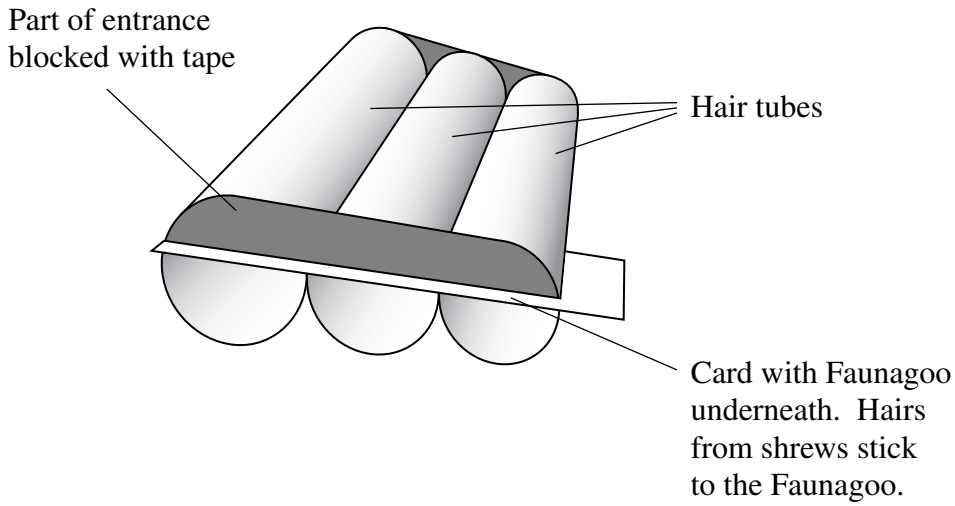
5

Turn over for the next question

7 Shrews are small mammals. Three species of shrew live in mainland Britain. The table shows some features of these shrews.

Species	Mean body mass / g	Mean length of head and body / mm	Food
Common shrew	10	79	Mainly insects and other small invertebrates
Pygmy shrew	5	58	
Water shrew	13	85	

A team of biologists investigated a method of estimating the abundance of shrews. They used plastic tubes, called hair tubes. Some of the hairs from a shrew that enters one of these tubes stick to glue in the tube. These hairs can be used to identify the species of shrew. The diagram shows a set of these hair tubes.



7 (a) (i) Faunagoo is a glue that remains sticky after wetting and drying. Explain the advantage of using Faunagoo in these hair tubes.

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(1 mark)

7 (a) (ii) The diagram shows that the biologists partly blocked the entrances to the tubes with tape. Suggest why they partly blocked the entrances.

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(1 mark)

7 (b) The biologists needed to find a way of distinguishing between the hairs of the three species of shrew. They collected hairs from shrews of each species. For each species, they selected hairs at random and made different measurements.

Explain why the biologists selected the hairs at random.

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(1 mark)

7 (c) Repeatable measurements are measurements of the same feature that are very similar. In this investigation, each measurement was made by two observers. This helped the team to check the repeatability of these measurements.

7 (c) (i) Explain why it was important to check the repeatability of the measurements.

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(2 marks)

7 (c) (ii) You could use a scatter diagram to check the repeatability of measurements made by two observers. Describe how.

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(2 marks)

Question 7 continues on page 19

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ANSWER IN THE SPACES PROVIDED

7 (d) The biologists used hair tubes to find the abundance of shrews along the edges of some fields. They also used traps that caught shrews without harming them. They selected areas where all three species of shrew were present.

- They put sets of hair tubes at 5 m intervals along the edges of the fields. They inspected the tubes one week later and recorded the number of sets of tubes that contained shrew hairs. They called this the hair tube index.
- At each site where they used hair tubes, they set traps immediately after using the hair tubes. They recorded the number of different shrews caught in these traps.

7 (d) (i) The research team found the hair tube index. Explain why they could not use the hair tubes to find the total number of shrews present.

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(1 mark)

7 (d) (ii) The research team set the traps immediately after using the hair tubes. Explain why setting the traps immediately after using the hair tubes would make comparisons between the two methods more reliable.

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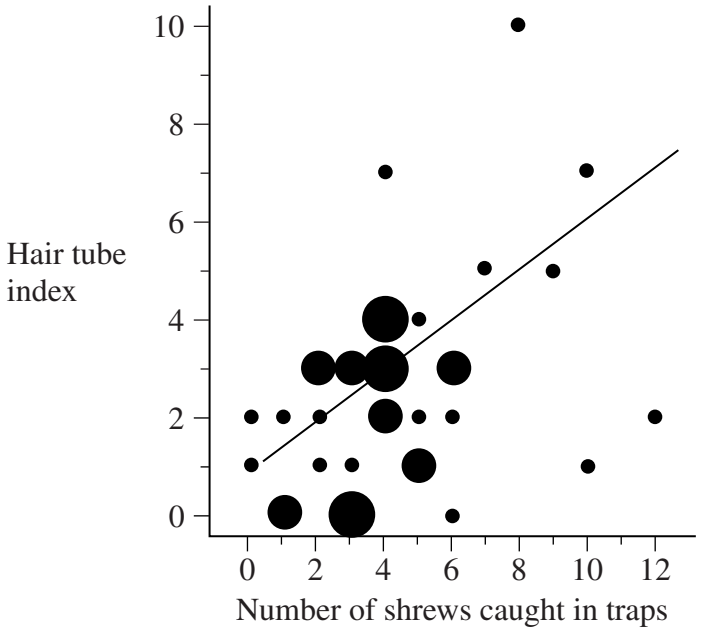
(2 marks)

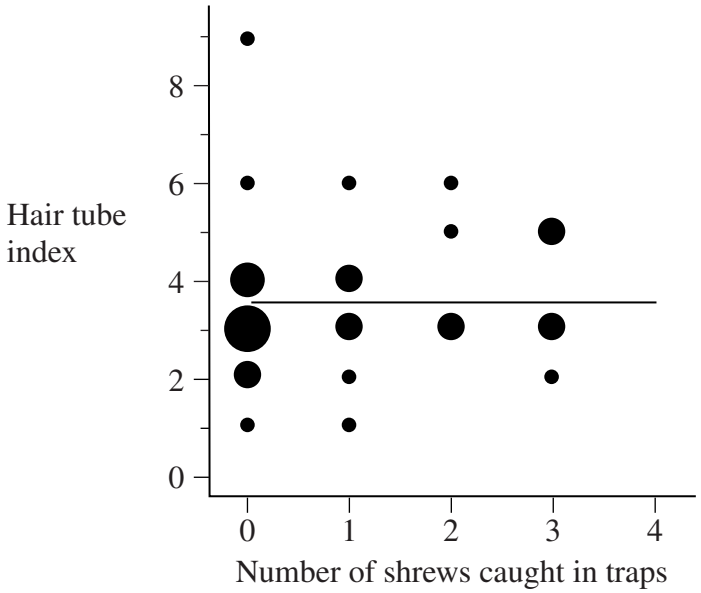
Question 7 continues on the next page

The graphs are types of scatter diagram called bubble plots. They show hair tube index plotted against the number of shrews caught in traps. The area of the bubble is proportional to the number of records plotted.

Common shrew



Pygmy shrew



7 (e) Explain why a statistical test was necessary in analysing the results for the common shrew. Use the terms chance and probability in your answer.

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(2 marks)

7 (f) (i) The biologists concluded that hair tubes were a reliable way of measuring the abundance of common shrews. Give evidence from the graph to support this conclusion.

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(1 mark)

7 (f) (ii) Use information in this question to evaluate the use of hair tubes as a way of measuring the abundance of pygmy shrews.

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(2 marks)

15

8 (a) In the light-dependent reaction of photosynthesis, light energy generates ATP. Describe how.

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(5 marks)

(Extra space) .....

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8 (b) Energy is transferred through an ecosystem.
Describe how and explain why the efficiency of energy transfer is different at different stages in the transfer.

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(6 marks)

(Extra space) .....

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Question 8 continues on the next page

8 (c) Explain how the intensive rearing of domestic livestock increases net productivity.

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(4 marks)

(Extra space).....

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15

END OF QUESTIONS

Practice 2

Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The process of photosynthesis has two main stages. The first of these involves the light-dependent reactions.

(a) The statements below describe important parts of the light-dependent reactions of photosynthesis. Place a cross ☒ in the box next to the term that completes each statement correctly.

(i) When light is absorbed by chlorophyll, it excites

(1)

☒ **A** electrons

☒ **B** neutrons

☒ **C** photons

☒ **D** protons

(ii) Oxygen is produced when water molecules are split in the process of

(1)

☒ **A** analysis

☒ **B** autolysis

☒ **C** hydrolysis

☒ **D** photolysis

(iii) The products of the light-dependent reactions that are used in the light-independent reactions are reduced NADP and

(1)

☒ **A** ATP

☒ **B** GALP

☒ **C** DNA

☒ **D** RuBP

(b) Describe the structures in a chloroplast that are involved in the light-dependent reactions of photosynthesis.

(3)

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(c) In an investigation, wheat plants were grown using artificial lighting. Three different types of lighting were used. When the wheat plants were mature, the total biomass of the plants and the mass of the grain (seeds) they produced were measured for each type of lighting.

The table below shows the results of this investigation.

Type of lighting	**Total biomass / kg**	**Mass of grain / kg**	**Grain yield as a percentage of total biomass (%)**
Low pressure sodium lamps	171	61.7	36.1
High pressure sodium lamps	159	58.8	37.0
Metal halide lamps	162	62.4	

(i) Calculate the grain yield, as a percentage of total biomass, for the wheat grown under metal halide lamps. Show your working.

(2)

Answer ..... %

(ii) With reference to the data in the table, suggest the conclusions the investigators may have made about the effect of using different types of lighting on grain yield.

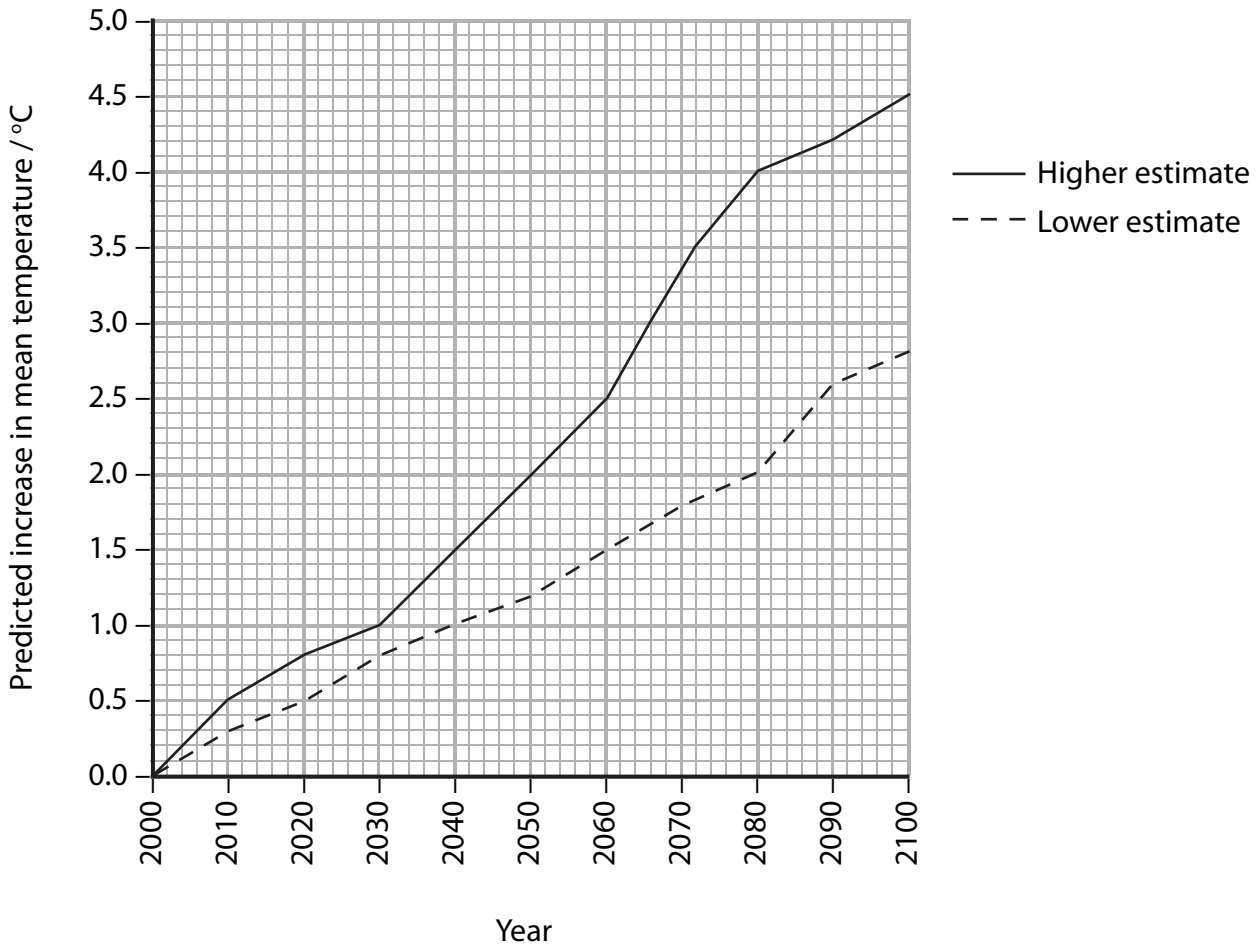
(3)

(iii) Suggest **two** advantages of growing crops of wheat in glasshouses with artificial lighting rather than growing them in open fields.

(2)

(Total for Question 1 = 13 marks)

2 The mean global temperature is expected to increase as a result of climate change. The graph below shows the predicted changes in mean temperature in New Zealand, during the 21st century. A higher and lower estimate of these changes have been made.



(a) (i) Explain how increases in carbon dioxide and methane, released into the atmosphere, may be contributing towards the estimated changes in mean temperature shown in the graph.

(3)

(ii) Suggest why a higher estimate and a lower estimate were made.

(1)

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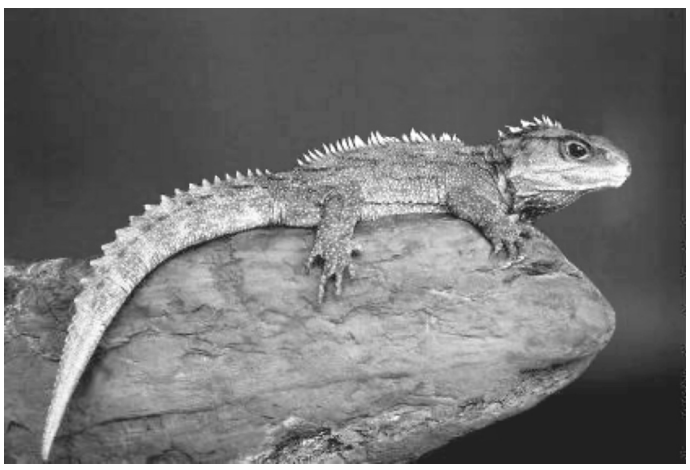
(b) Tuataras are reptiles found only on a group of small islands off the coast of mainland New Zealand. Adult tuataras grow to approximately 65 cm in length. They feed on small mammals, bird chicks and invertebrates such as insects and worms.



Tuataras build nests in which their eggs are laid. The gender (sex) of the tuatara, that hatches from an egg, is determined by the incubation temperature in the nest. A temperature of 22 °C or above will mean that a male tuatara will hatch. Female tuataras only hatch from eggs incubated below 22 °C.

During the breeding season in 2000, the temperature of the nests ranged between 18 °C and 24 °C.

(i) Suggest how the changes in the mean temperature, shown in the graph on page 6, might affect the tuataras on the islands off the coast of New Zealand.

(4)

(ii) Suggest how other animal populations on these islands might be affected by changes in the tuatara population.

(2)

(Total for Question 2 = 10 marks)

3 The distribution and abundance of an organism within its habitat can be influenced by both abiotic and biotic factors.

(a) Explain the difference between **abiotic** and **biotic** factors.

(1)

(b) Periwinkles are similar to snails and are one of the common invertebrates found on many seashores around Britain. A study of the distribution of two species of periwinkle, *Littorina littorea* and *Littorina obtusata*, was carried out.

Areas of a sloping seashore were selected at different heights above sea level. Within each of these areas, the mean density (individuals per m^2) of each of the periwinkle species was recorded.

(i) Place a cross ☒ in the box next to the name of the most suitable piece of apparatus for obtaining the data for the density of the periwinkles.

(1)

☒ **A** quadrant

☒ **B** quadrat

☒ **C** quadrille

☒ **D** quartile

*(ii) Explain how this piece of apparatus would be used to obtain the mean density of the two species of periwinkle in each area.

(3)

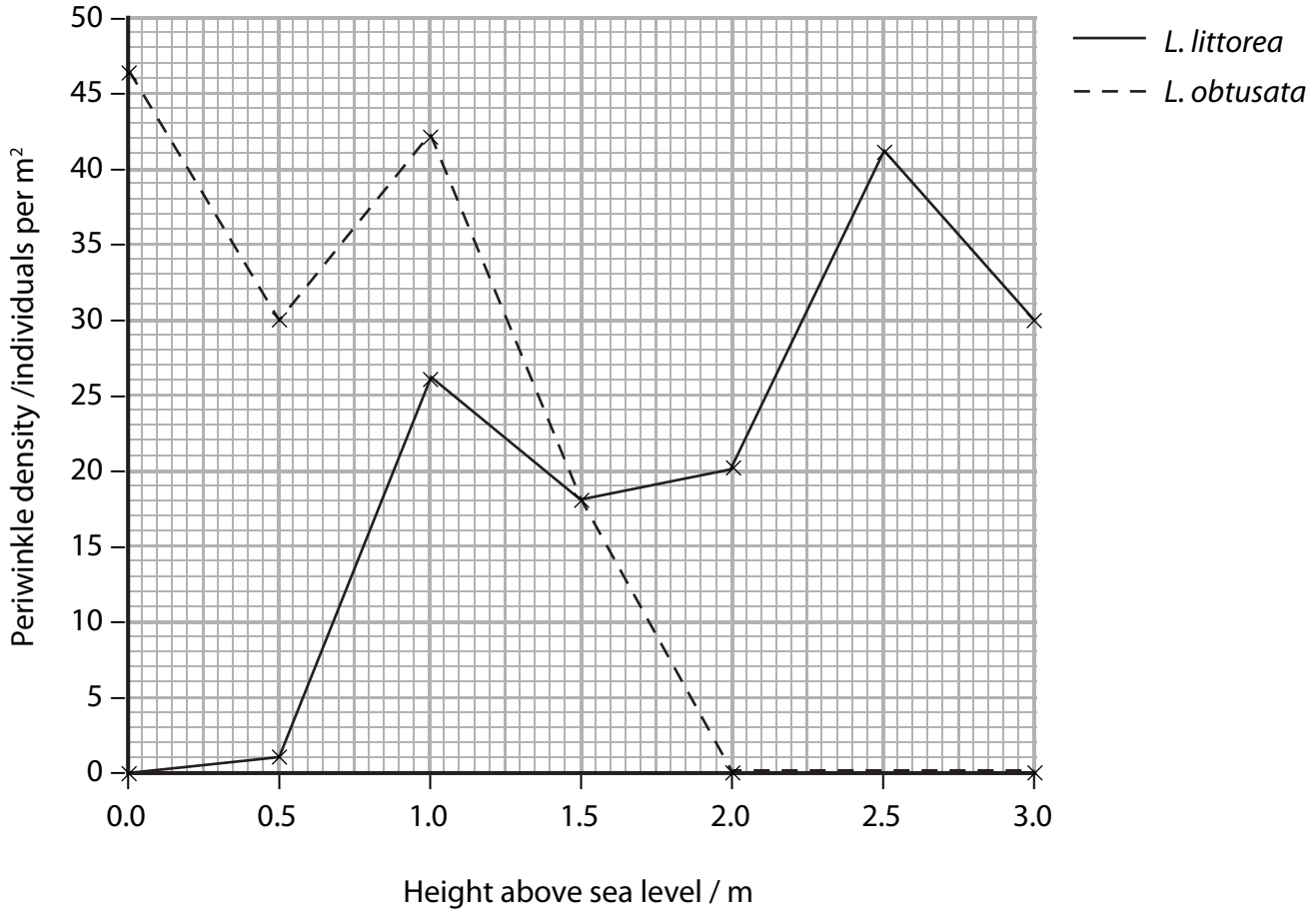
(iii) Suggest **one** abiotic factor and **one** biotic factor that may influence the distribution of the periwinkles on the seashore.

(2)

Abiotic .....

Biotic .....

(iv) The results of this study into periwinkle density are shown in the graph below.



The three statements below show the conclusions recorded by different students following the seashore study of periwinkles.
Place a cross ☒ in the box next to one statement that could form a valid conclusion using the information shown in the graph opposite.

(1)

☒ **A** All periwinkles are affected by the height above sea level

☒ **B** The height above sea level influences the distribution of different species of periwinkle

☒ **C** Neither of the species of periwinkle is affected by the height above sea level

(v) With reference to the data in the graph, discuss the validity of statements **A**, **B** and **C**.

(4)

(Total for Question 3 = 12 marks)

4 The bases in a gene code for the synthesis of a protein. Gene mutations can influence the metabolism of an organism.

(a) (i) The diagram below shows the bases on the template strand of DNA in the part of a gene that codes for a short sequence of amino acids in an enzyme.

A A C T A G T T G G C A A G T G G T C A C

Each of the following statements is about this sequence of bases. For each statement, place a cross ☒ in the appropriate box to show whether it is true or false.

(3)

Statement	True	False
This sequence of bases could be used as a template during translation	☒	☒
A strand of mRNA could be synthesised using this sequence	☒	☒
This sequence codes for 7 amino acids during protein synthesis	☒	☒

(ii) Name and describe the structures where the polypeptide chain of this enzyme would be synthesised.

(2)

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(b) *Chlamydomonas* is a single-celled photosynthetic organism that lives in well-illuminated ponds. In populations of *Chlamydomonas*, a gene mutation occasionally occurs. This mutation enables *Chlamydomonas* to take in organic compounds produced by other organisms and use them as a source of energy.

(i) Explain what is meant by the term **gene mutation**.

(2)

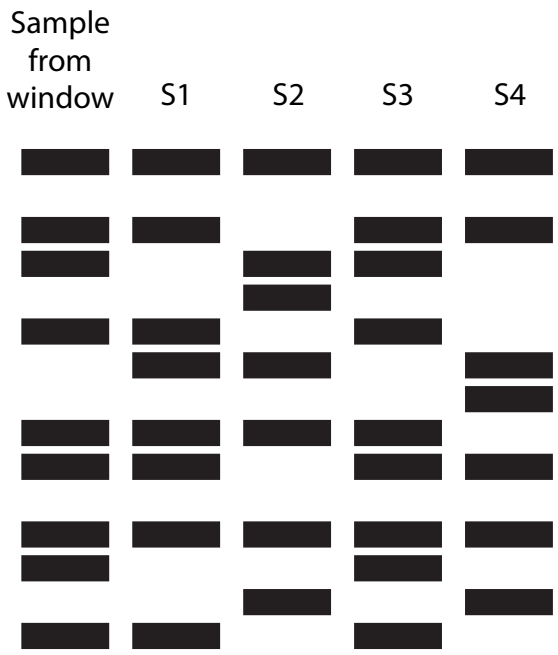
(ii) A population of *Chlamydomonas* was found in a pond in the centre of a developing forest of fast-growing trees. Suggest how the allele frequency for this mutation could change as the forest develops. Give reasons for your answer.

(4)

(Total for Question 4 = 11 marks)

Turn over ▶

5 Following a burglary, a DNA profile was created using a small sample of blood left behind on a broken window pane. This DNA profile was then compared with DNA profiles from four suspects, S1, S2, S3 and S4. These DNA profiles are shown in the diagram below.



(a) (i) Place a cross ☒ in the box next to the name of the enzyme used in the process used to amplify the DNA in the small sample of blood taken from the crime scene.

(1)

☒ **A** endonuclease

☒ **B** invertase

☒ **C** polymerase

☒ **D** transcriptase

(ii) Place a cross ☒ in the box next to the name of the process that could be used to separate DNA fragments to create the profiles shown in the diagram above.

(1)

☒ **A** amniocentesis

☒ **B** electrophoresis

☒ **C** endocytosis

☒ **D** chromatography

(iii) Suggest which of the suspects is most likely to have left the blood sample on the broken window pane. With reference to the theory used in DNA profiling, explain how you came to this conclusion.

(5)

Suspect .....

Explanation .....

(b) Explain why evidence from DNA profiles may not be absolutely conclusive.

(2)

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(c) Suggest how DNA profiling could be useful to scientists who examine fossils of animals and plants.

(2)

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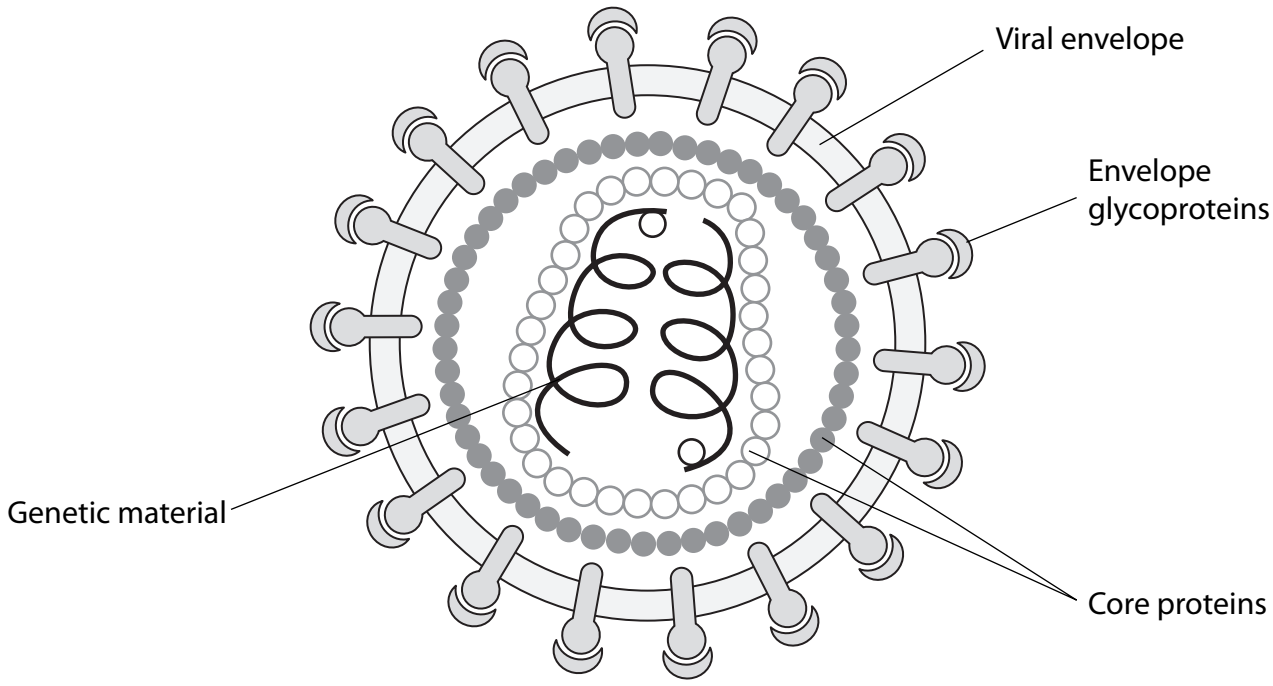
(Total for Question 5 = 11 marks)

6 The diagram below shows the structure of Human Immunodeficiency Virus (HIV).



(a) State how the genetic material in HIV differs from the genetic material in the bacterium *Mycobacterium tuberculosis* that causes TB.

(2)

Turn over ▶

(b) One of the ways in which HIV may enter the blood is through the use of infected needles. Explain why unbroken skin is an effective barrier against HIV infection.

(2)

(c) The table below shows the changes in the number of CD4 T-lymphocytes in the blood of a person infected with HIV, during the first 10 weeks after infection.

Time after infection / weeks	CD4 T-lymphocyte count / cells per mm^3 of blood
0	1050
1	980
2	810
3	600
4	520
5	490
6	480
7	500
8	530
9	580
10	600

(i) Describe the change in numbers of CD4 T-lymphocytes during the first 6 weeks after infection with HIV.

(2)

*(ii) Explain the change in numbers of CD4 T-lymphocytes during the first 6 weeks after infection with HIV.

(5)

(iii) Suggest **one** effect that this change would have on one other component of the infected person's blood.

(1)

(Total for Question 6 = 12 marks)

7 Cow pats, formed from the faeces dropped by cattle, are a familiar sight in any field where cattle have been grazing. Apart from water, a cow pat consists of a mixture of organic compounds left over from the digestive processes in the cow.

Cellulose and plant fibres are efficiently digested in cattle. Therefore, the texture of a cow pat is relatively soft in comparison to the faeces of some other herbivores.

(a) (i) Place a cross ☒ in the **two** boxes next to the types of bond that would need to be broken during the digestion of cellulose in cattle.

(2)

ester ☒

hydrogen ☒

glycosidic ☒

peptide ☒

(ii) Name **two** types of plant fibre that may be present in the material eaten by cattle.

(2)

1 .....

2 .....

(b) The first stage in the decomposition of a cow pat is known as putrefaction. Explain how carbon dioxide and ammonia are formed during this stage of decomposition.

(4)

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(c) The table below shows the mean time taken for a cow pat to decompose, at different times of the year, in a field in southern Britain.

Season	Decomposition time for cow pat / days
Early spring	140
Late spring	125
Early summer	110
Late summer	90
Early autumn	120
Late autumn	150

With reference to the data in the table, suggest why the time taken for a cow pat to decompose changes at different times of the year.

(3)

(Total for Question 7 = 11 marks)

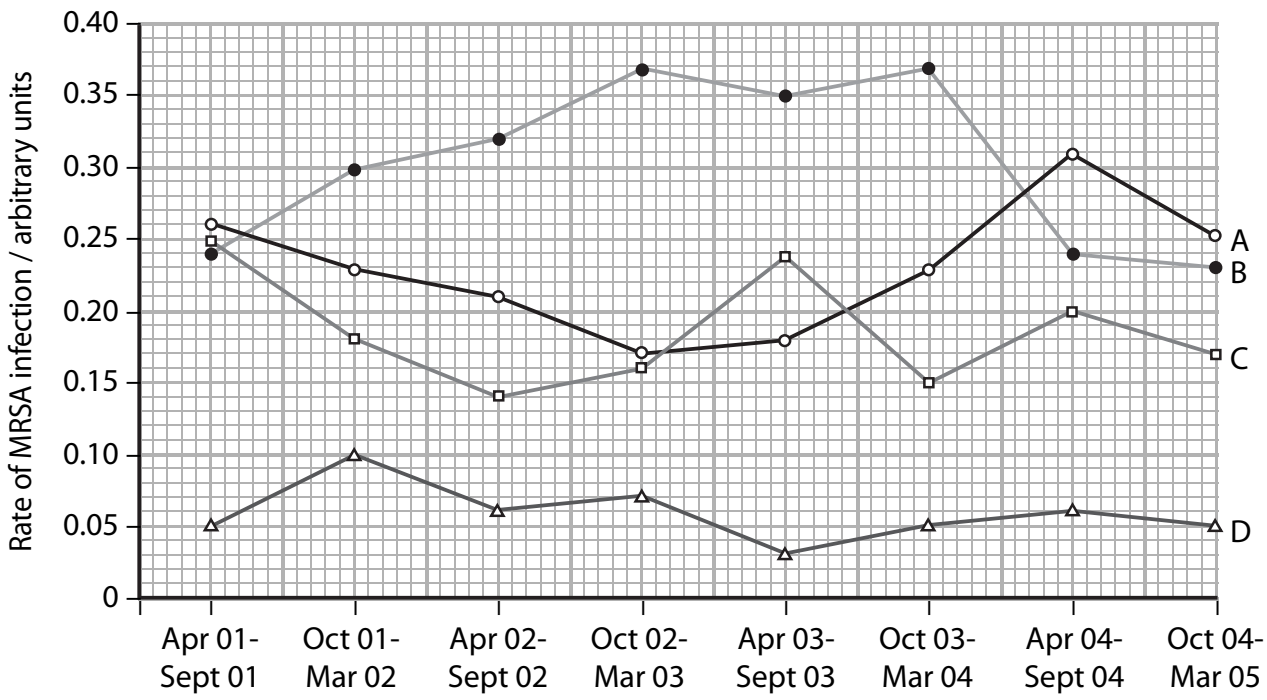
Turn over ▶

8 Blood infection caused by the bacterium, methicillin-resistant *Staphylococcus aureus* (MRSA), has become a major concern in hospitals. This infection can be difficult to treat due to increasing resistance of MRSA to bacteriostatic and bactericidal antibiotics.

(a) Explain what is meant by the terms **bacteriostatic antibiotic** and **bactericidal antibiotic**.

(3)

(b) The graph below shows the occurrence of MRSA infection in four hospitals, A, B, C, and D for the period from April 2001 to March 2005. The rate of MRSA infection in each hospital during each six-month period was recorded.



Compare the rates of MRSA infection in hospital A with those in hospital B.

(3)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(c) MRSA is present on the skin of approximately 1 in 3 of all patients entering hospitals for treatment.

(i) Describe the most significant difference between the rate of MRSA infection in hospital D compared with those of the other three hospitals.

(1)

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(ii) Suggest why the rate of MRSA infection in hospital D differs from the rates in the other hospitals.

(3)

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(Total for Question 8 = 10 marks)

TOTAL FOR PAPER = 90 MARKS

Do not write outside the box

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)

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)

6

Turn over for the next question

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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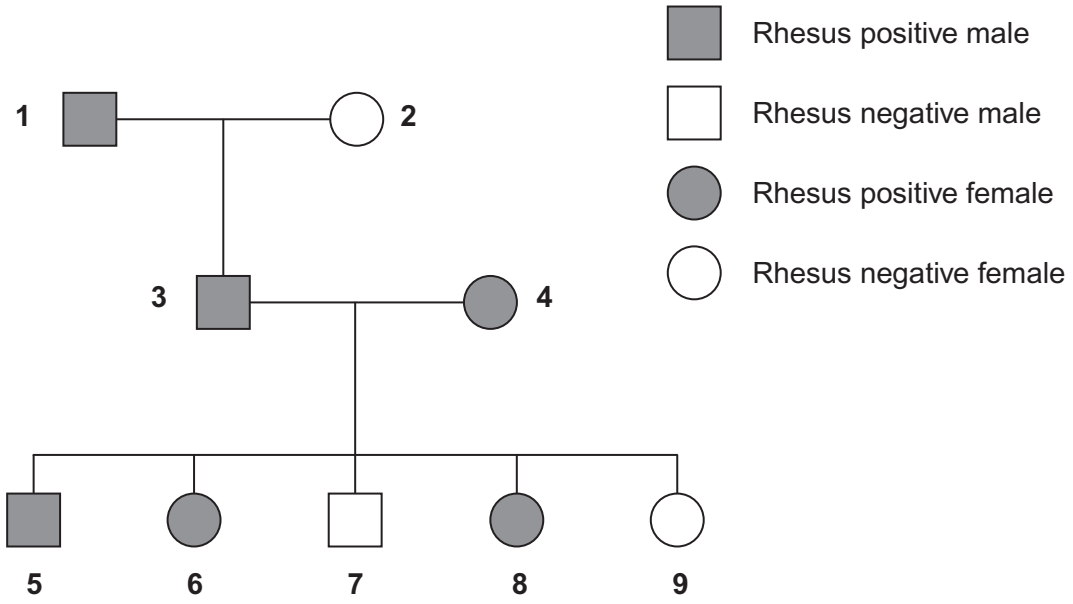
(1 mark)

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.



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)

9

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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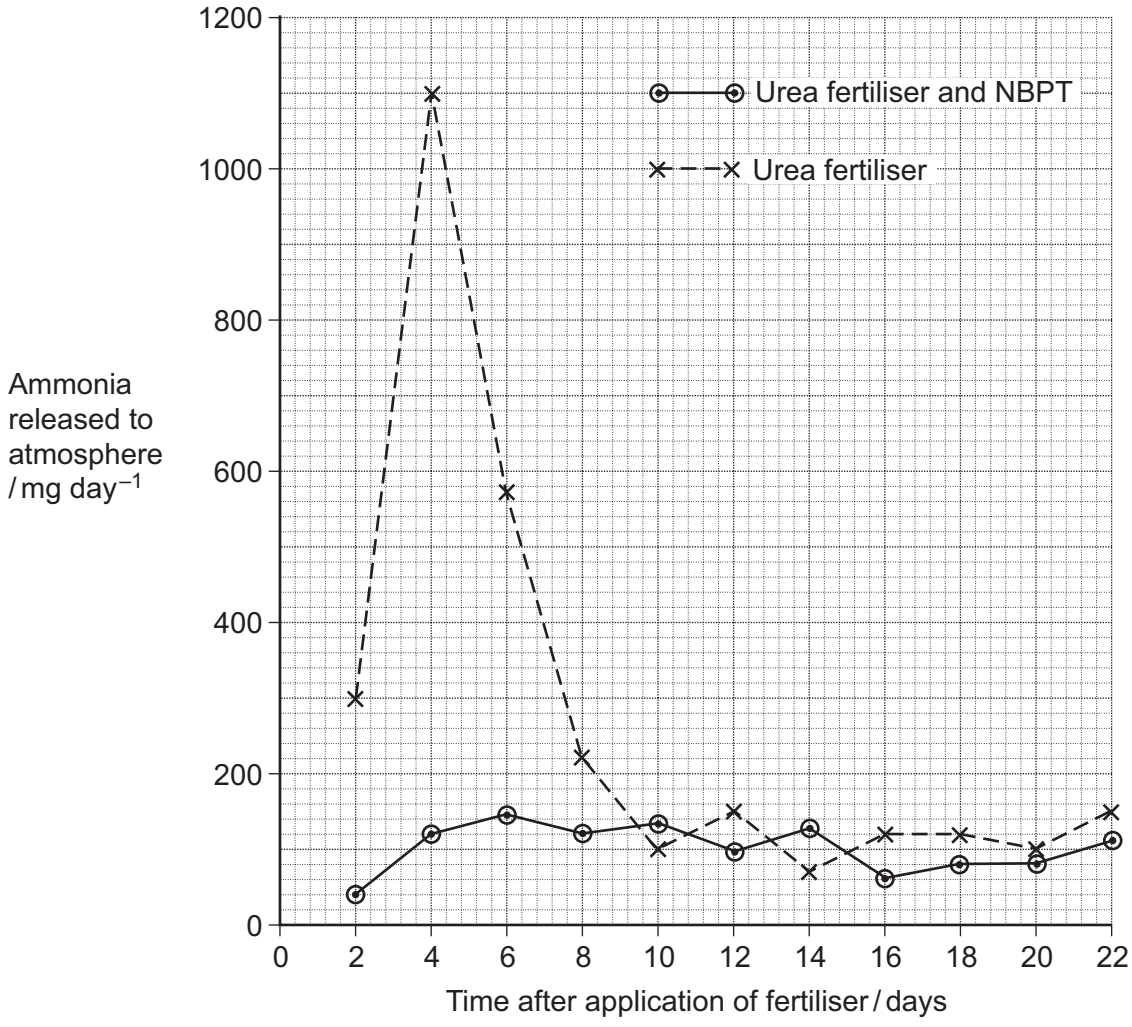
(2 marks)

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.



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)

(Extra space) .....

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8

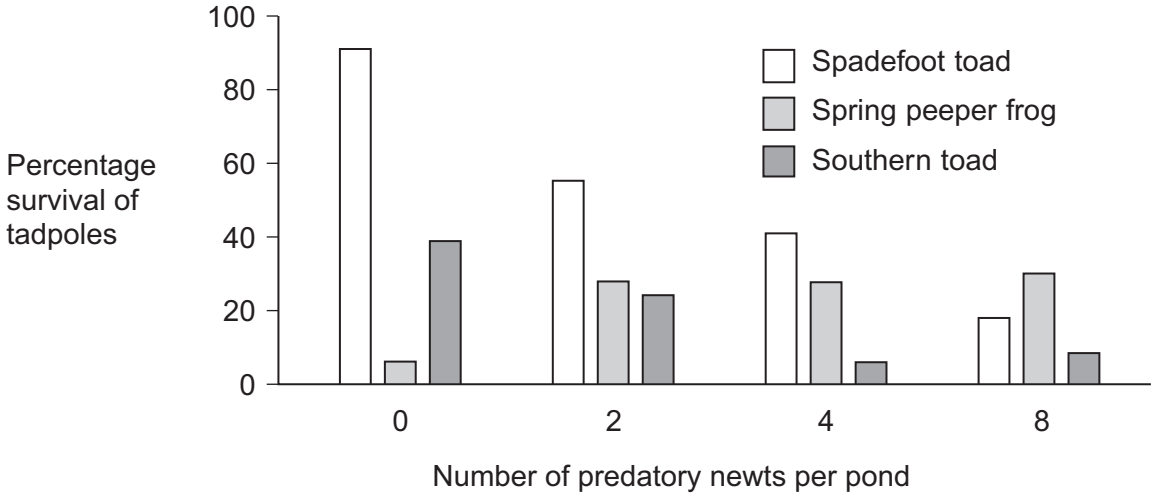
Do not write outside the box

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)

Do not write outside the box

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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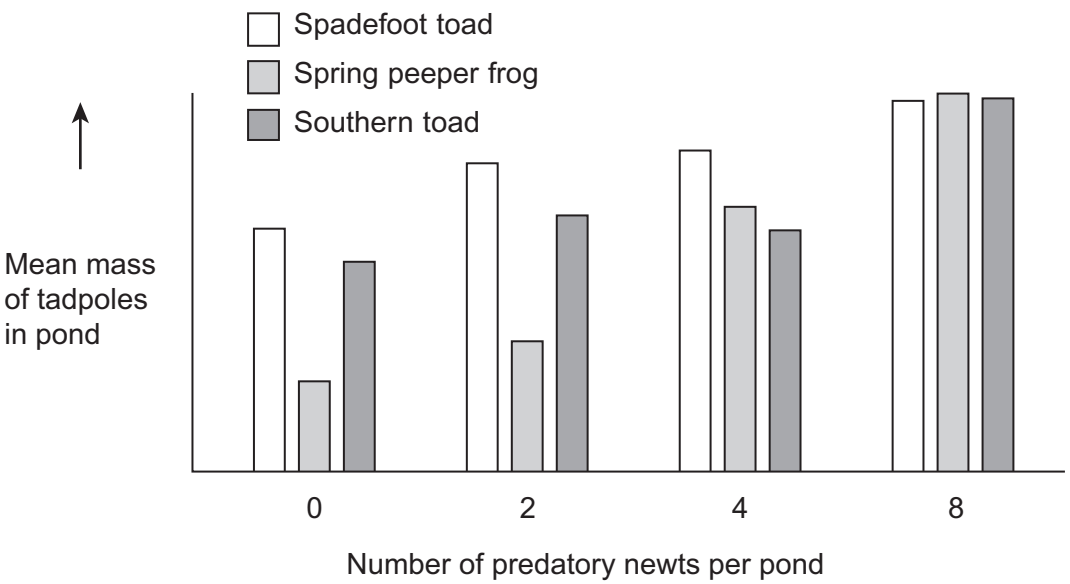
(2 marks)

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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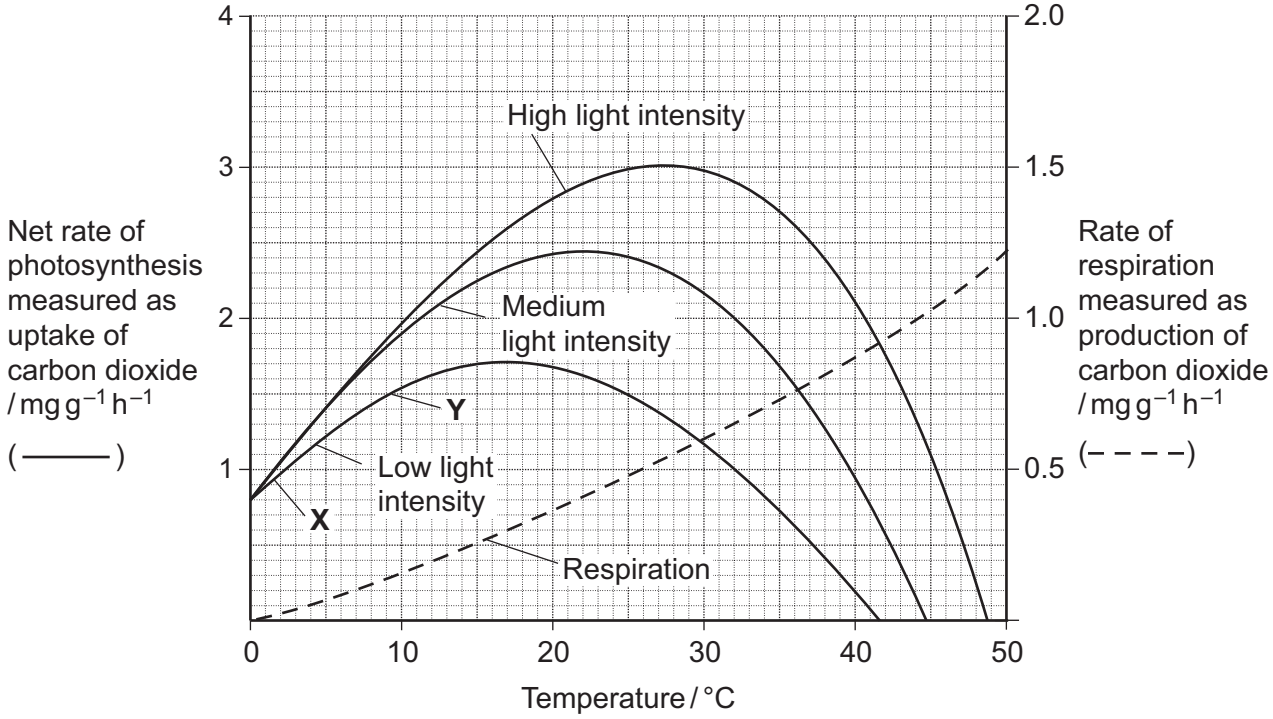
(2 marks)

6

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)

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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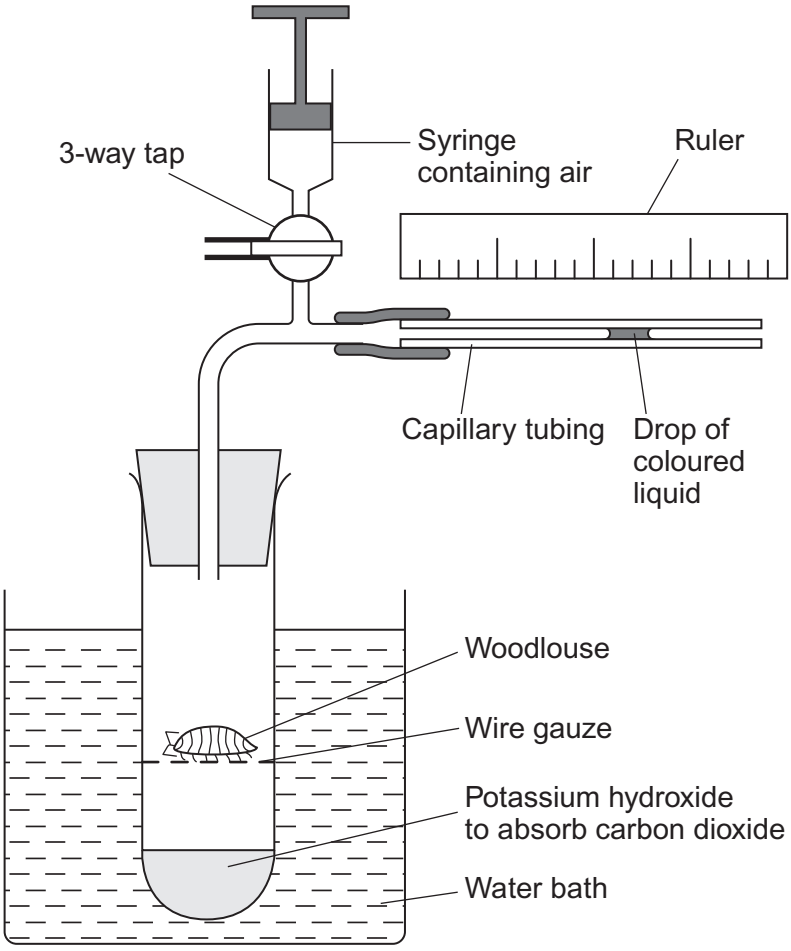
7

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)

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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)

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

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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Do not write outside the box

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

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Question 8 continues on the next page

Do not write outside the box

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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(5 marks)

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END OF QUESTIONS

Do not write outside the box

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)

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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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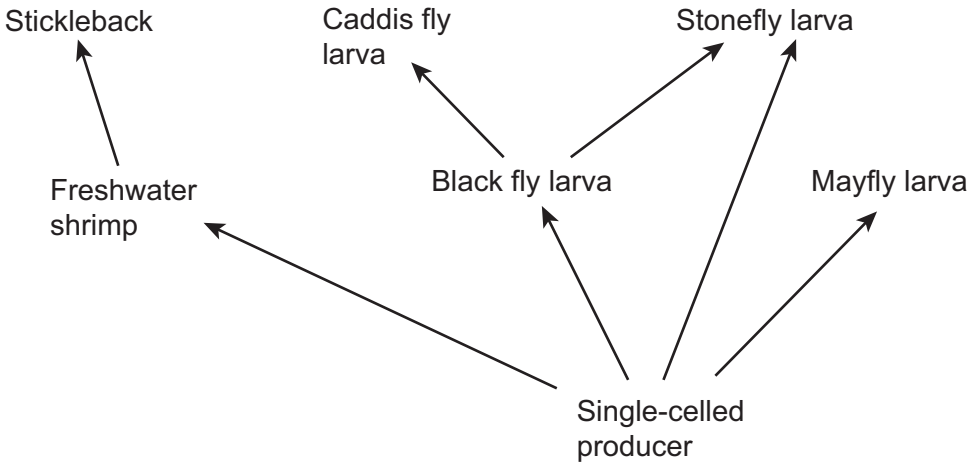
(2 marks)

7

Turn over for the next question

Do not write outside the box

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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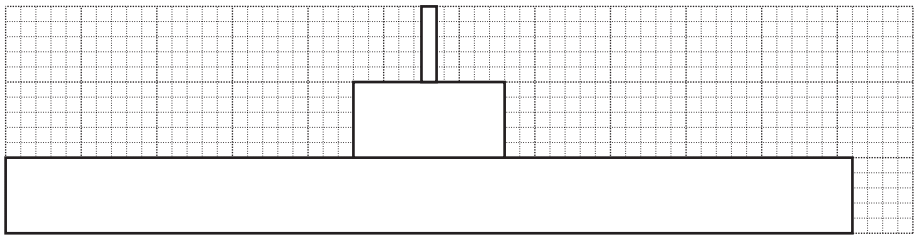
(2 marks)

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

Do not write outside the box

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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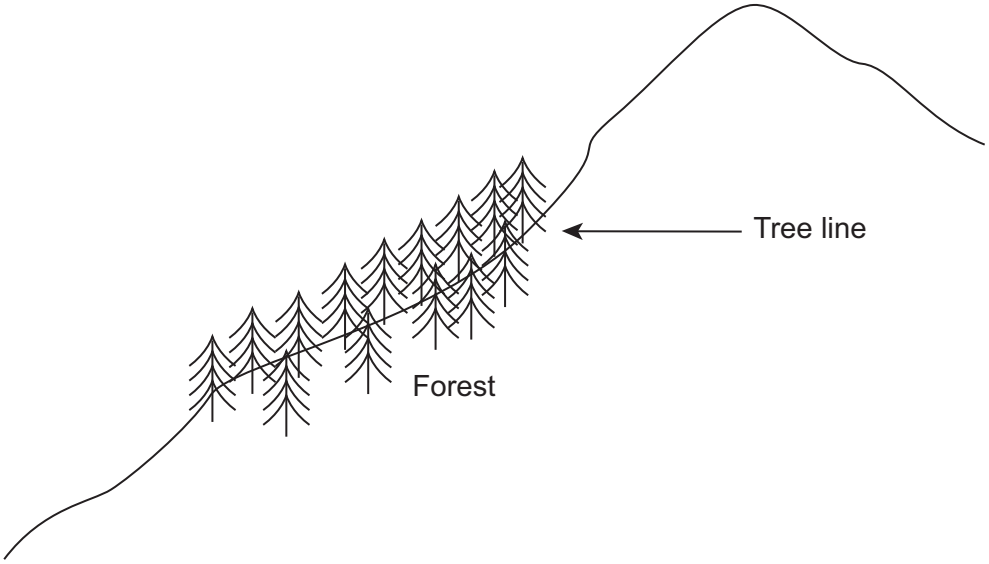
(2 marks)

5

Do not write outside the box

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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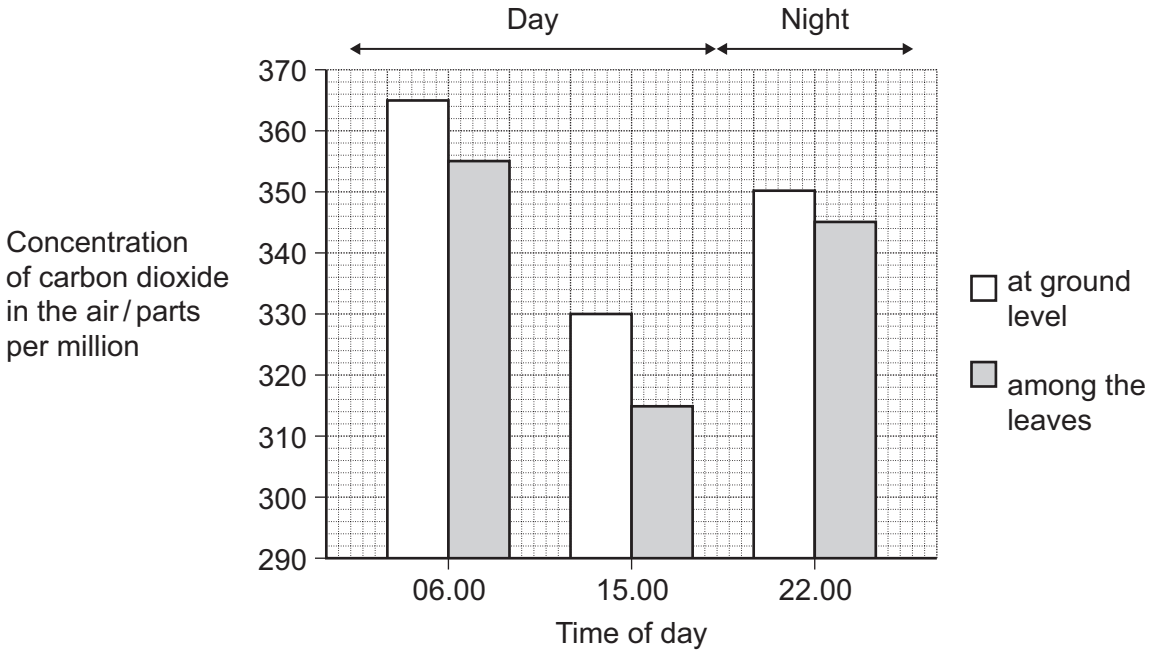
(1 mark)

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)

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Do not write outside the box

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)

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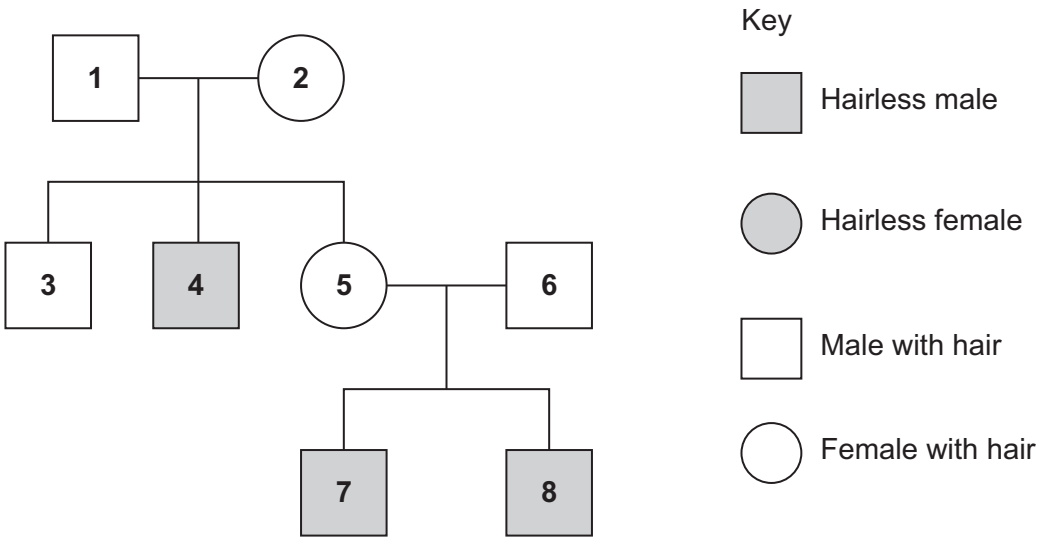
9

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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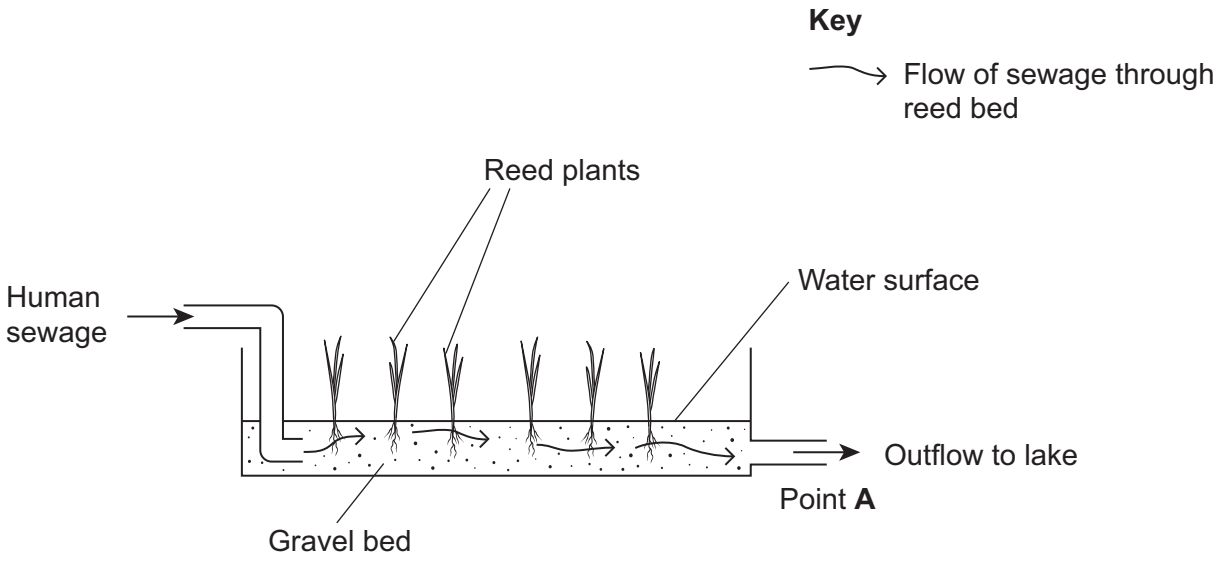
(1 mark)

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)

Do not write outside the box

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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Do not write outside the box

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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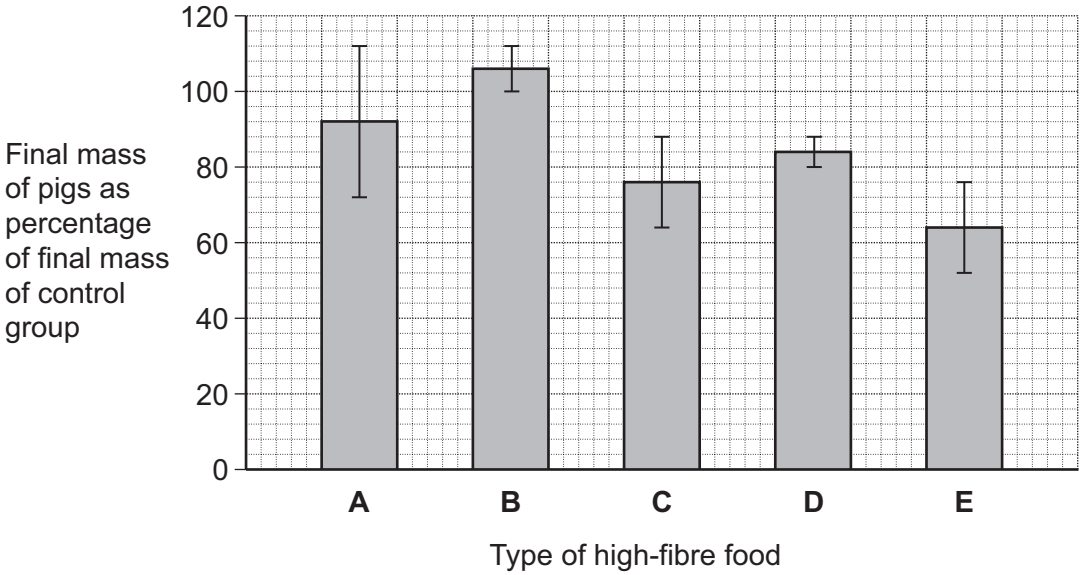
(2 marks)

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)

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Do not write outside the box

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

Do not write outside the box

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

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(6 marks)

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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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END OF QUESTIONS

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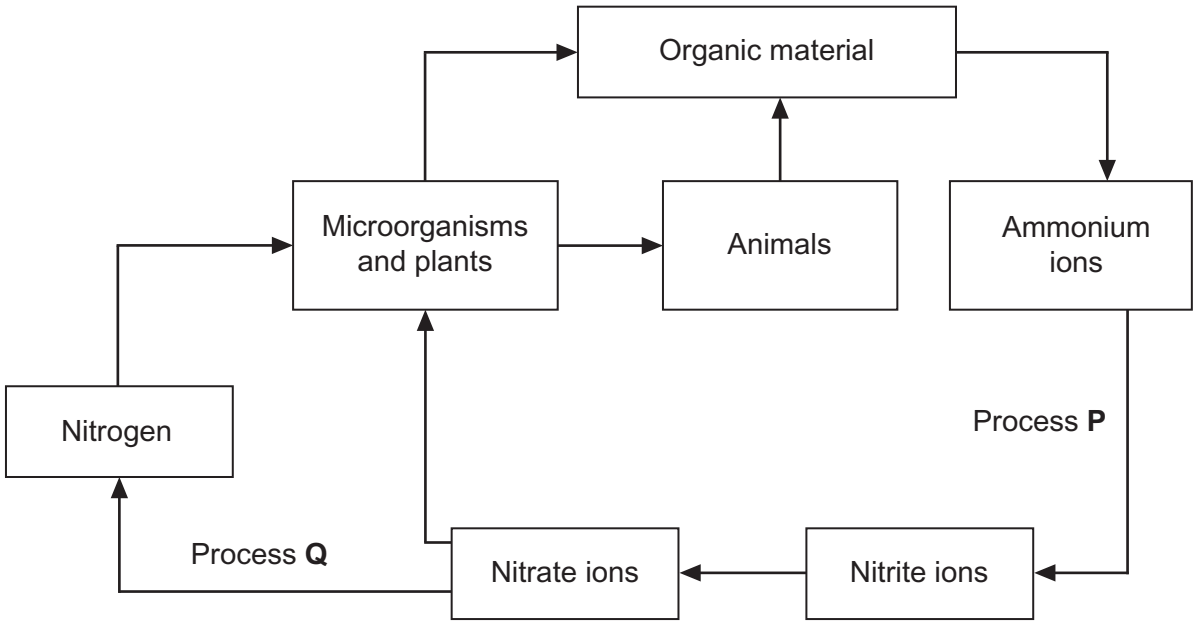
Answer **all** questions in the spaces provided.

1 The diagram shows the nitrogen cycle.



1 (a) (i) Name process **P**.

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(1 mark)

1 (a) (ii) Name process **Q**.

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(1 mark)

1 (b) Leguminous crop plants have nitrogen-fixing bacteria in nodules on their roots. On soils with a low concentration of nitrate ions, leguminous crops often grow better than other types of crop. Explain why.

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(2 marks)

1 (c) Applying very high concentrations of fertiliser to the soil can reduce plant growth. Use your knowledge of water potential to explain why.

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(2 marks)

6

Turn over for the next question

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

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(1 mark)

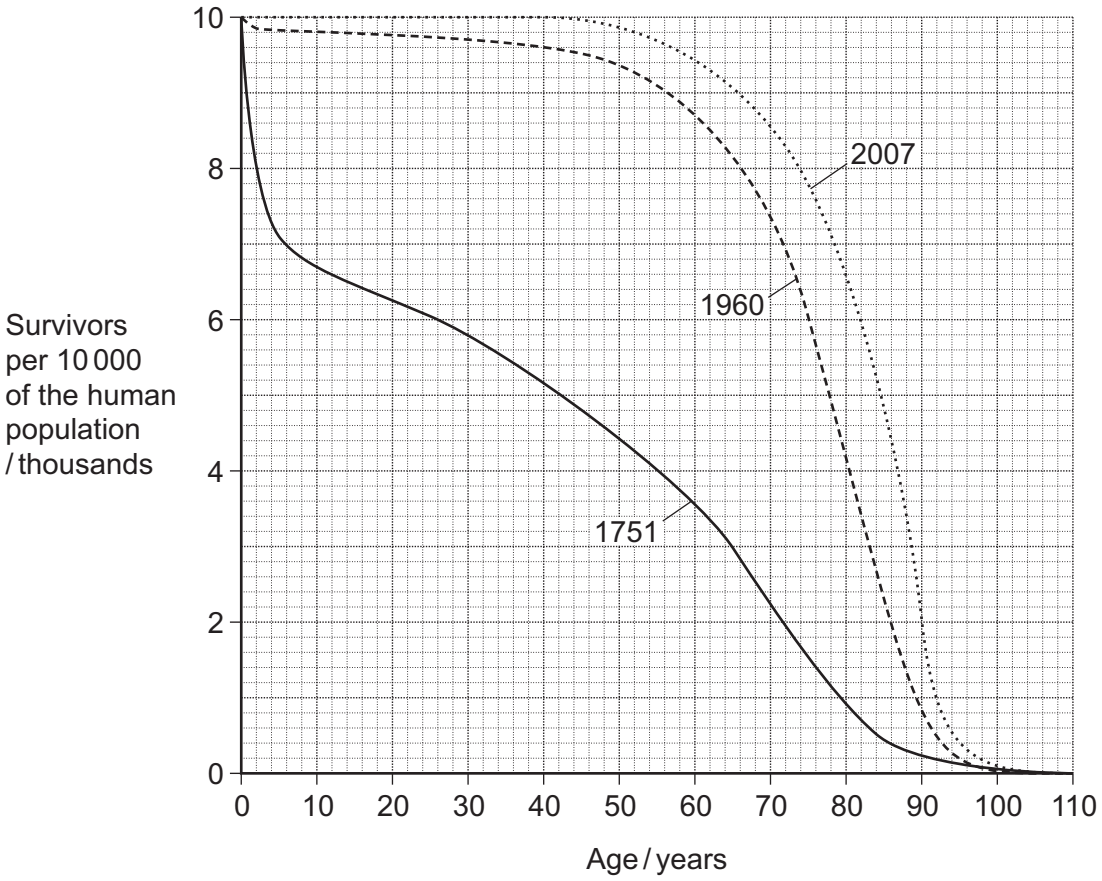
2 (b) Give **two** factors which could lead to a decrease in the death rate in a human population.

1 .....

2 .....

(1 mark)

The graph shows survival curves for human populations of the same country in different years.



2 (c) Calculate the percentage increase from 1751 to 2007 in the number of people who survived to 70 years of age. Show your working.

Answer = ... %

(2 marks)

2 (d) The changes in the survival curves between 1751 and 1960 show that a demographic transition has taken place in this country. Explain how the changes show this.

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(2 marks)

6

Turn over for the next question

Do not write outside the box

3 The fruit fly is a useful organism for studying genetic crosses. Female fruit flies are approximately 2.5 mm long. Males are smaller and possess a distinct black patch on their bodies. Females lay up to 400 eggs which develop into adults in 7 to 14 days. Fruit flies will survive and breed in small flasks containing a simple nutrient medium consisting mainly of sugars.

3 (a) Use this information to explain **two** reasons why the fruit fly is a useful organism for studying genetic crosses.

1 .....

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2 .....

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(2 marks)

3 (b) Male fruit flies have the sex chromosomes XY and the females have XX. In the fruit fly, a gene for eye colour is carried on the X chromosome. The allele for red eyes, **R**, is dominant to the allele for white eyes, **r**. The genetic diagram shows a cross between two fruit flies.

3 (b) (i) Complete the genetic diagram for this cross.

Phenotypes of parents	red-eyed female	×	white-eyed male
Genotype of parents	.....		.....
Gametes	..... and		..... and .....
Phenotypes of offspring	red-eyed females	and	red-eyed males
Genotype of offspring	.....		.....

(3 marks)

3 (b) (ii) The number of red-eyed females and red-eyed males in the offspring was counted. The observed ratio of red-eyed females to red-eyed males was similar to, but not the same as, the expected ratio. Suggest **one** reason why observed ratios are often **not** the same as expected ratios.

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(1 mark)

3 (c) Male fruit flies are more likely than female fruit flies to show a phenotype produced by a recessive allele carried on the X chromosome. Explain why.

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(2 marks)

8

Turn over for the next question

4 A student investigated an area of moorland where succession was occurring. She used quadrats to measure the percentage cover of plant species, bare ground and surface water every 10 metres along a transect. She also recorded the depth of soil at each quadrat. Her results are shown in the table.

	Percentage cover in each quadrat A to E				
	A	**B**	**C**	**D**	**E**
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

– Indicates zero percentage cover.

4 (a) Explain how these data suggest that succession has occurred from points **A** to **E** along the transect.

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(3 marks)

(Extra space) .....

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Do not write outside the box

4 (b) The diversity of animal species is higher at **E** than **A**. Explain why.

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(2 marks)

4 (c) The student used the mark-release-recapture technique to estimate the size of the population of sand lizards on an area of moorland. She collected 17 lizards and marked them before releasing them back into the same area. Later, she collected 20 lizards, 10 of which were marked.

4 (c) (i) Give **two** conditions for results from mark-release-recapture investigations to be valid.

1 .....

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2 .....

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(2 marks)

4 (c) (ii) Calculate the number of sand lizards on this area of moorland. Show your working.

Answer = ...

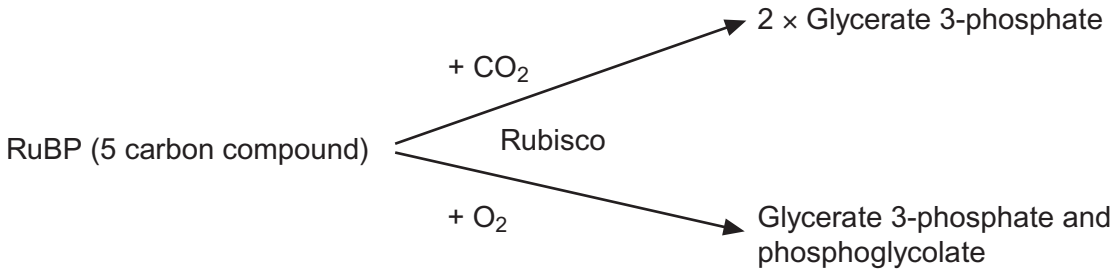
(2 marks)

9

Do not write outside the box

5 During photosynthesis, carbon dioxide reacts with ribulose bisphosphate (RuBP) to form two molecules of glycerate 3-phosphate (GP). This reaction is catalysed by the enzyme Rubisco. Rubisco can also catalyse a reaction between RuBP and oxygen to form one molecule of GP and one molecule of phosphoglycolate. Both the reactions catalysed by Rubisco are shown in **Figure 1**.

Figure 1



5 (a) (i) Where exactly in a cell is the enzyme Rubisco found?

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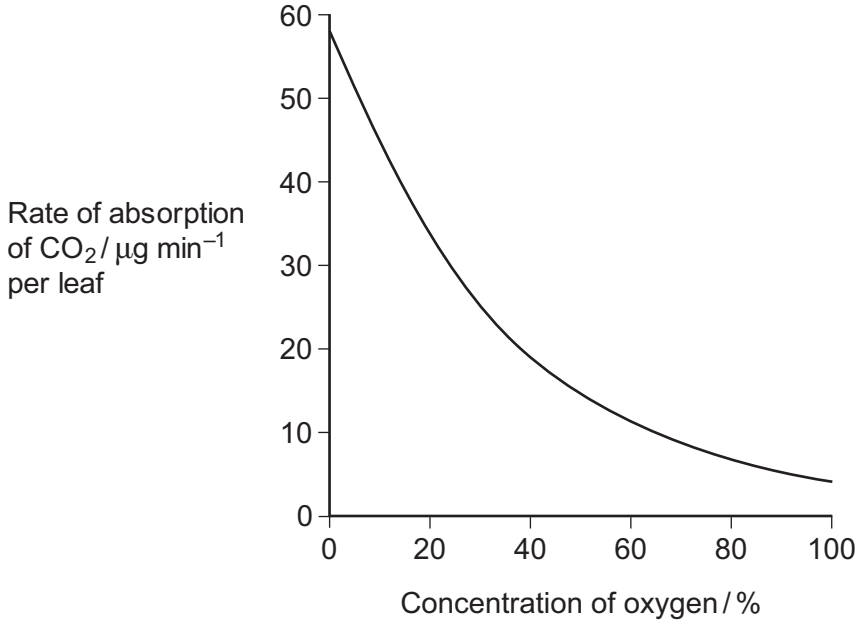
(1 mark)

5 (a) (ii) Use the information provided to give the number of carbon atoms in **one** molecule of phosphoglycolate.

(1 mark)

5 (b) Scientists investigated the effect of different concentrations of oxygen on the rate of absorption of carbon dioxide by leaves of soya bean plants. Their results are shown in **Figure 2**.

Figure 2



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Use **Figure 1** to explain the results obtained in **Figure 2**.

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(2 marks)

5 (c) Use the information provided and your knowledge of the light-independent reaction to explain why the yield from soya bean plants is decreased at higher concentrations of oxygen. Phosphoglycolate is not used in the light-independent reaction.

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(3 marks)

(Extra space) .....

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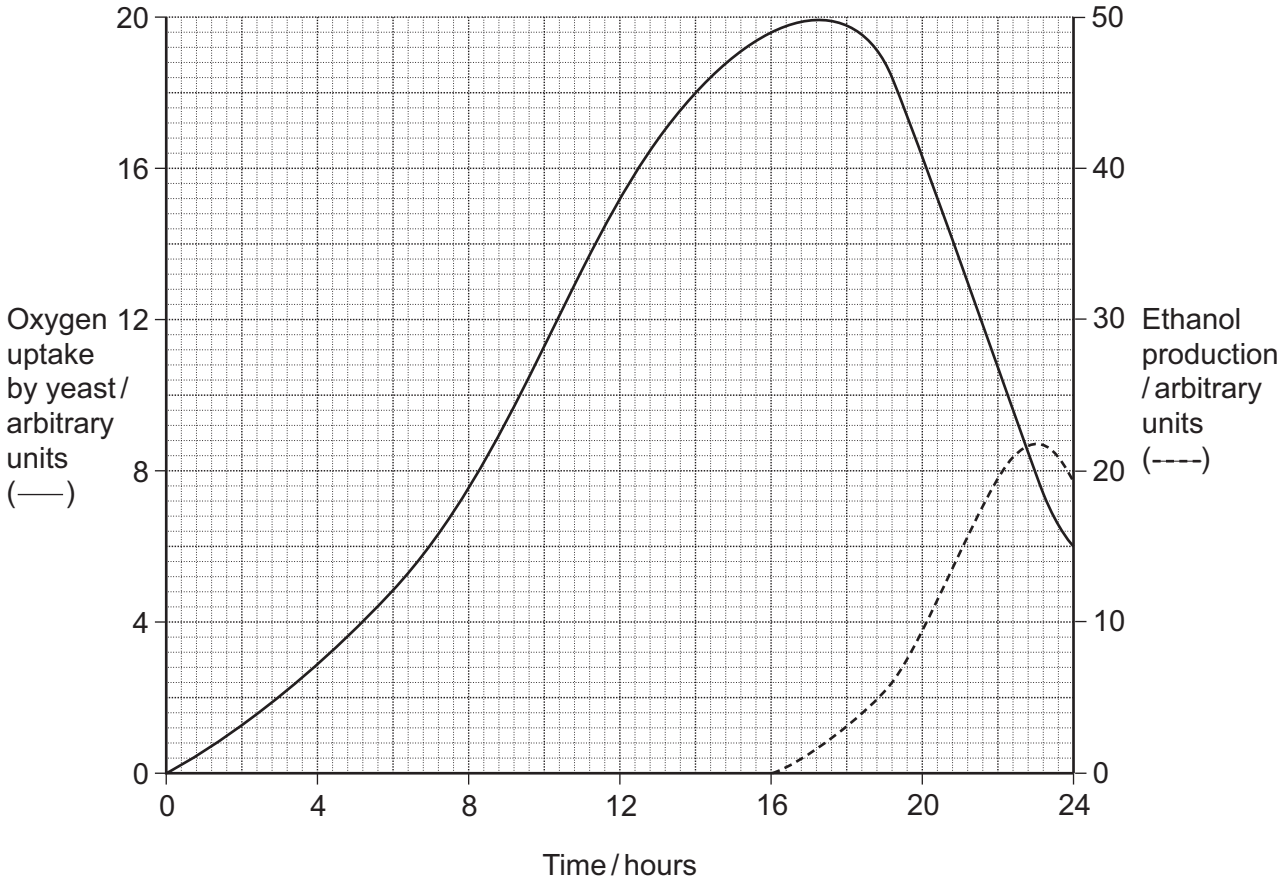
7

6 Yeast is a single-celled organism. A student investigated respiration in a population of yeast growing in a sealed container. His results are shown in the graph.



6 (a) Calculate the rate of oxygen uptake in arbitrary units per hour between 2 and 4 hours.

Answer ..... arbitrary units per hour
(1 mark)

6 (b) (i) Use the information provided to explain the changes in oxygen uptake during this investigation.

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(3 marks)

Do not write outside the box

(Extra space) .....

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6 (b) (ii) Use the information provided to explain the changes in production of ethanol during this investigation.

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(2 marks)

6 (c) Sodium azide is a substance that inhibits the electron transport chain in respiration.
The student repeated the investigation but added sodium azide after 4 hours.
Suggest and explain how the addition of sodium azide would affect oxygen uptake and the production of ethanol.

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(3 marks)

(Extra space) .....

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Do not write outside the box

7 Scientists investigated the effect of a pesticide called malathion on the survival of tadpoles of species of toads found in the USA. The scientists determined the LC50 for the tadpoles of each species over a 16-day period in an aquarium. The LC50 is the concentration of malathion that killed 50 percent of a population of tadpoles. The scientists also investigated whether the presence of a predator of tadpoles changed the effect of malathion.

7 (a) Suggest **two** advantages of using the LC50 to determine the effect of a pesticide.

1 .....

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2 .....

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(2 marks)

The scientists looked at previous studies on the effects of various pesticides on tadpoles.

They found that most of these studies:

- were carried out on tadpoles of the African clawed toad
- measured the LC50 of each pesticide over 1 to 4 days in the absence of any biotic factor.

7 (b) The scientists concluded that these previous studies were of limited use when trying to assess the effects of malathion on the tadpoles of toads found in the USA. Suggest why the scientists reached this conclusion.

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(3 marks)

(Extra space) .....

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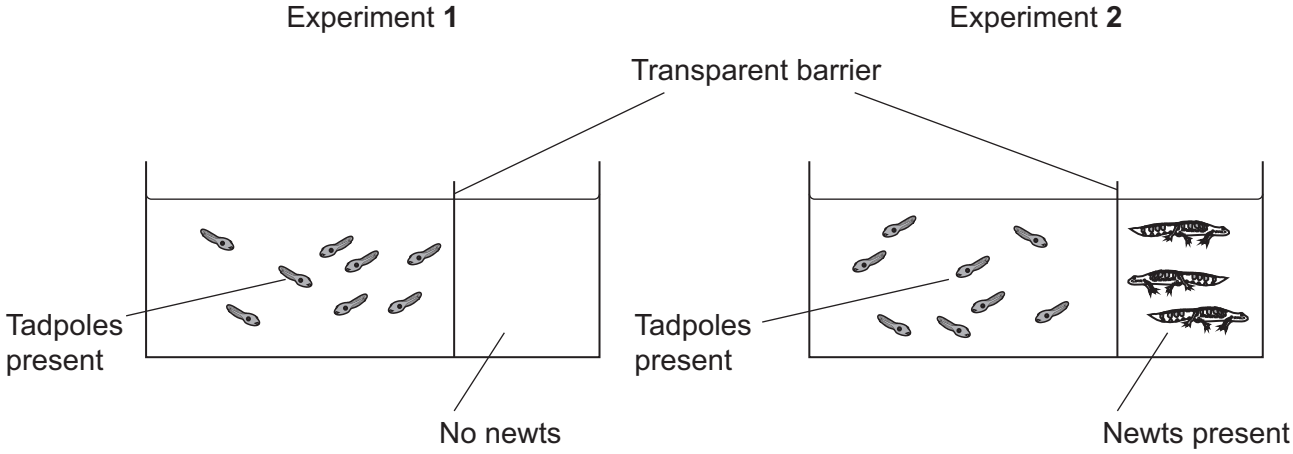
Do not write outside the box

7 (c) Malathion affects the nervous system of tadpoles. The scientists investigated whether the stress caused by the presence of a predator changed the effect of malathion on the tadpoles. The scientists used newts which are predators of tadpoles. They carried out two experiments, as shown in the diagram.



7 (c) (i) Explain why the scientists carried out experiment **1**.

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(2 marks)

7 (c) (ii) Explain why the scientists used a transparent barrier in experiment **2**.

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(2 marks)

Question 7 continues on the next page

Do not write outside the box

7 (d) Adult toads spend most of their time on land but lay their eggs in water. These eggs hatch into tadpoles, which live in water and develop into adults. The tadpoles are much smaller than adult toads. Use this information to explain why the tadpoles are affected more rapidly by pesticides in water than adult toads.

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(2 marks)

7 (e) When malathion is used as a pesticide, it is often sprayed onto aquatic habitats at concentrations of 0.1 to 1.6 mg dm^{-3}. The scientists tested the effect of malathion at concentrations of 0.001 to 10 mg dm^{-3}.
Suggest why.

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(2 marks)

7 (f) As a result of this investigation, the scientists concluded that more studies on pesticides should be carried out in natural habitats rather than under laboratory conditions. Suggest **two** advantages of carrying out such investigations in natural habitats.

1 .....

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2 .....

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(2 marks)

15

Do not write outside the box

8 (a) Energy enters most ecosystems through the light-dependent reaction of photosynthesis. Describe what happens during the light-dependent reaction.

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(5 marks)

(Extra space) .....

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Question 8 continues on the next page

Do not write outside the box

8 (b) Describe the reasons for the low efficiency of energy transfer through ecosystems.

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(5 marks)

(Extra space) .....

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8 (c) Changes in ecosystems can lead to speciation. A high concentration of copper in soil is toxic to most plants. In some areas where the soil is polluted with copper, populations of grasses are found to be growing. These populations of grass belong to a species also found growing on unpolluted soils.

It has been suggested that a new species of grass may evolve on soil that has been polluted with copper. Explain how this new species might evolve.

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(5 marks)

(Extra space) .....

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END OF QUESTIONS