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)

Turn over for the next question

7

Turn over ▶

Question 2: N/A

Question 2: N/A

Question 2: N/A

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.
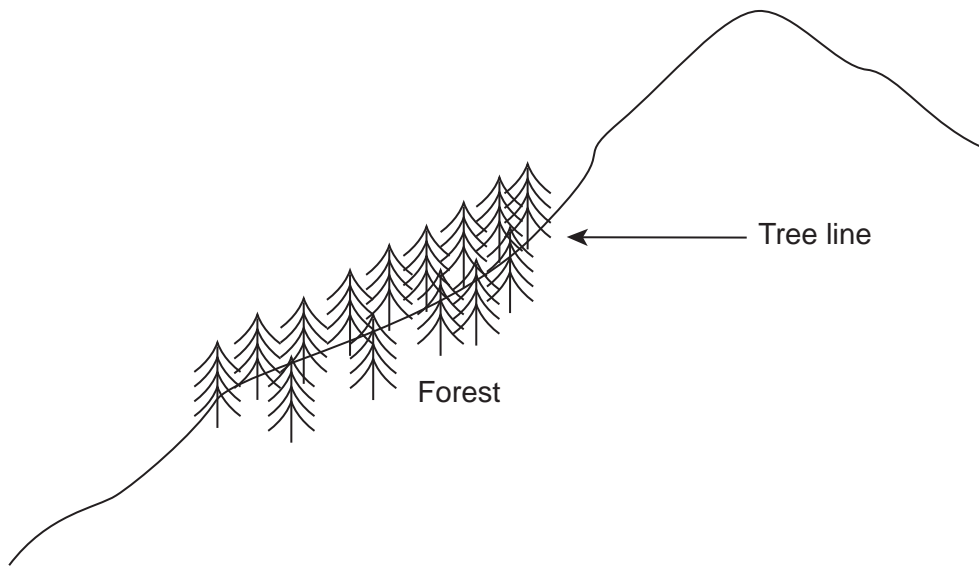
Use your knowledge of succession to explain how.

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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

Turn over ▶

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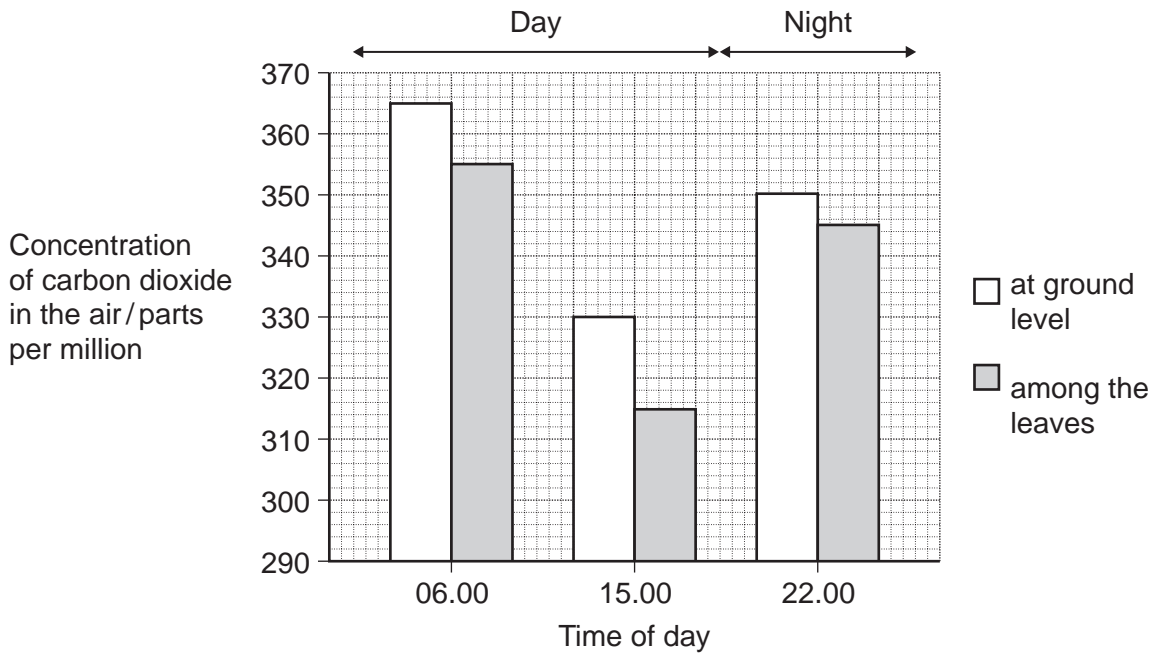
Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

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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

Turn over ▶

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.

Key

☐ Hairless male

⬤ Hairless female

□ Male with hair

○ Female with hair
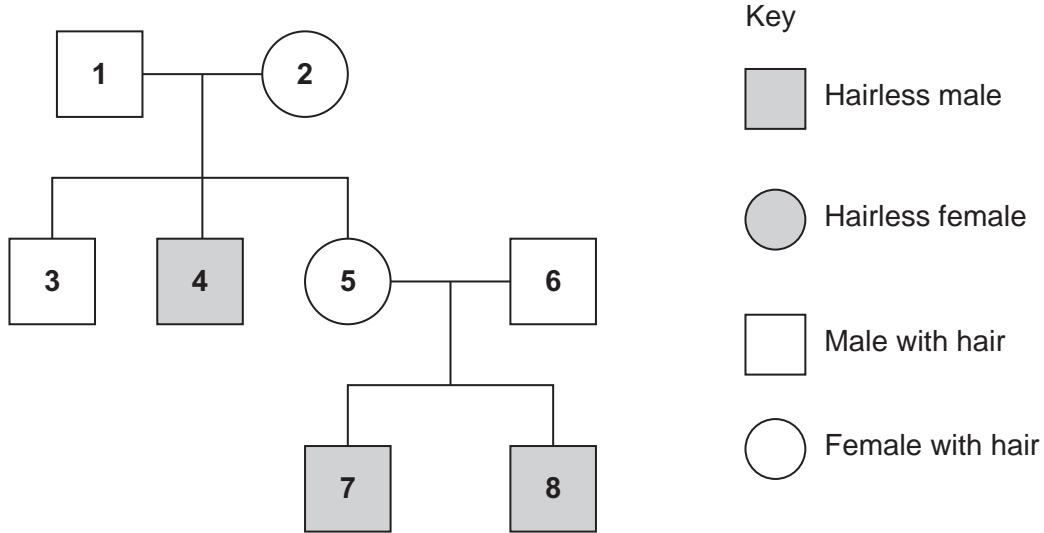
5 (a) Use evidence from the diagram to explain

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)

9

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

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

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

Answer .... %

(2 marks)

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

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(1 mark)

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

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

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

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(2 marks)

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

Type of selection ....

Explanation ....

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(2 marks)

7

Turn over ▶

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

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

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

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

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(2 marks)

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

For each nest they recorded

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

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

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(2 marks)

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

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

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

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

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(3 marks)

(*Extra Space*) ....

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Turn over ▶

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

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

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(1 mark)

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

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(1 mark)

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

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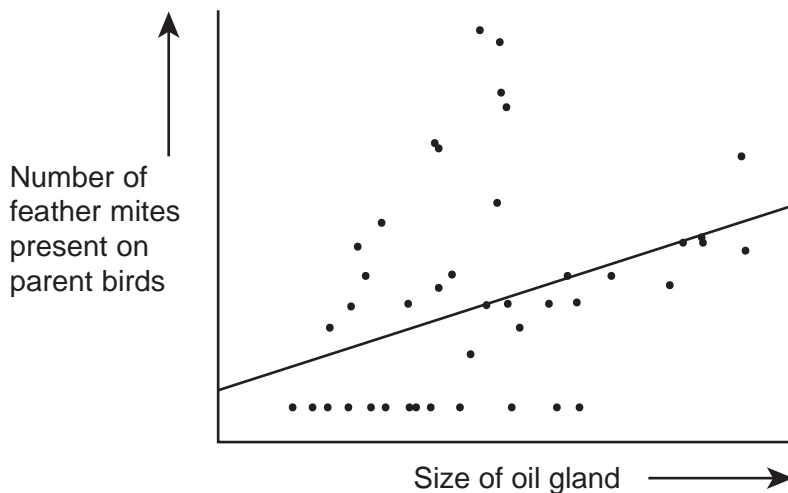
7 (d) (i) Describe the relationship between the number of feather mites present on each great tit and the size of the oil gland.

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(2 marks)

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

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(2 marks)

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

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(2 marks)

15

Turn over ▶

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

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

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(5 marks)

(Extra space) ....

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

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(4 marks)

(Extra space) ....

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Question 8 continues on the next page

Turn over ▶

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

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(6 marks)

(Extra space) ....

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

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

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(1 mark)

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

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(1 mark)

(b)   The gene controlling coat colour has three alleles. The allele **B** gives black fur,
the allele **b** gives chocolate fur and the allele **b^i** gives cinnamon fur.
  •   Allele **B** is dominant to both allele **b** and **b^i**.
  •   Allele **b** is dominant to allele **b^i**.

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

(1 mark)

9   A chocolate male was crossed several times with a black female.
They produced
- 11 black kittens
- 2 chocolate kittens
- 5 cinnamon kittens.

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

Parental phenotypes   Chocolate male   Black female

Parental genotypes   …………………   ………………

Gametes   …………………   ……………………

Offspring genotypes   ………………   ………………   ………………

Offspring phenotypes   Black   Chocolate   Cinnamon

(3 marks)

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

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(1 mark)

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

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(2 marks)

9

Turn over ▶

Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) Using DNA in science and technology

(25 marks)

OR

10 (b) A cycle is a biological pathway or process in which the end product of one cycle becomes the starting point for the next cycle. Write an essay about cycles in biology.

(25 marks)

If you want to make a plan write it here.

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