

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

**1 (a)** What information is required in order to calculate the growth rate of a population?

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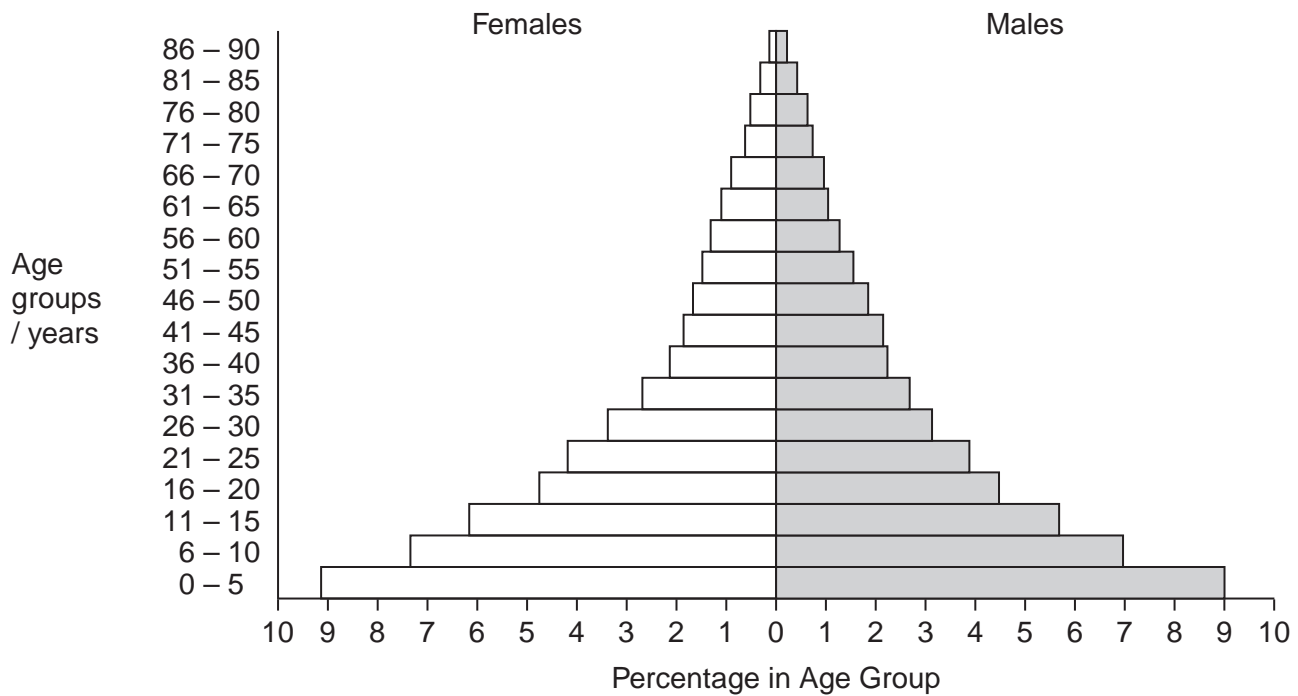
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(2 marks)

- 1 (b)** The diagram shows an age population pyramid for humans in a country.



This country is at an early stage of demographic transition. Describe the evidence for this.

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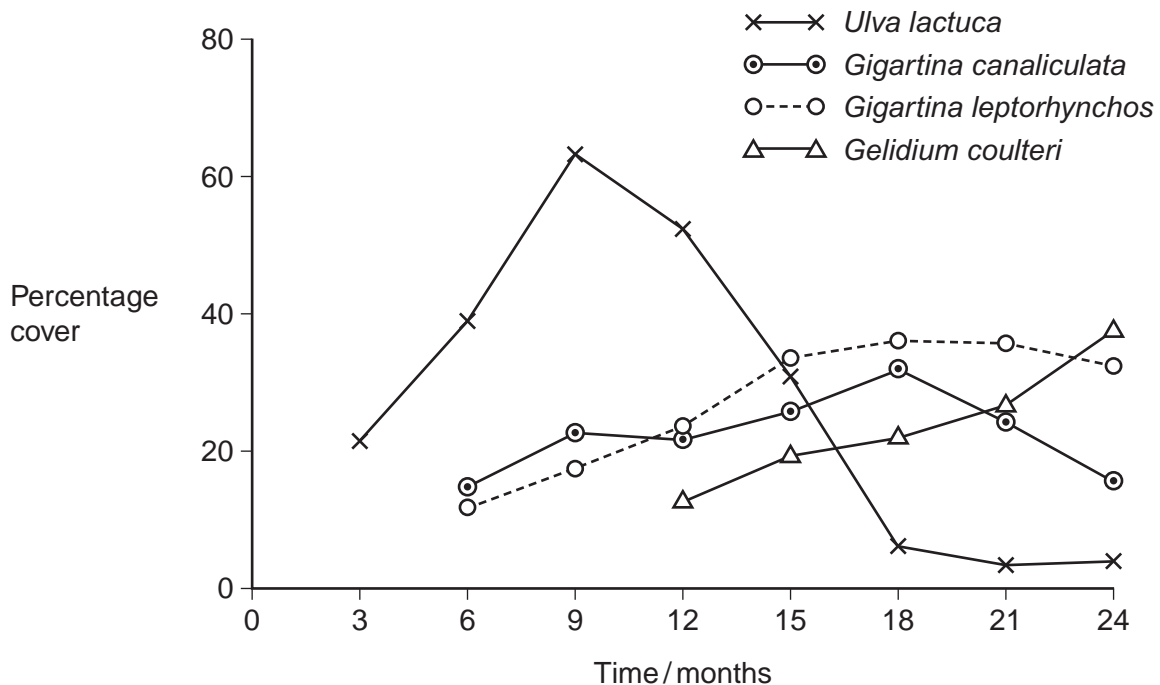
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(2 marks)

- 2** Algae are photosynthesising organisms. Some algae grow on rocky shores. A scientist investigated succession involving different species of algae. He placed concrete blocks on a rocky shore. At regular intervals over 2 years, he recorded the percentage cover of algal species on the blocks. His results are shown in the graph.



- 2 (a)** Name the pioneer species.

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(1 mark)

- 2 (b) (i)** The scientist used percentage cover rather than frequency to record the abundance of algae present. Suggest why.

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(1 mark)

- 2 (b) (ii)** Some scientists reviewing this investigation were concerned about the validity of the results because of the use of concrete blocks.  
Suggest **one** reason why these scientists were concerned about using concrete blocks for the growth of algae.

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(1 mark)

- 2 (c)** Use the results of this investigation to describe and explain the process of succession.

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(4 marks)

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Turn over ►

**3 (a)** Explain what is meant by the term phenotype.

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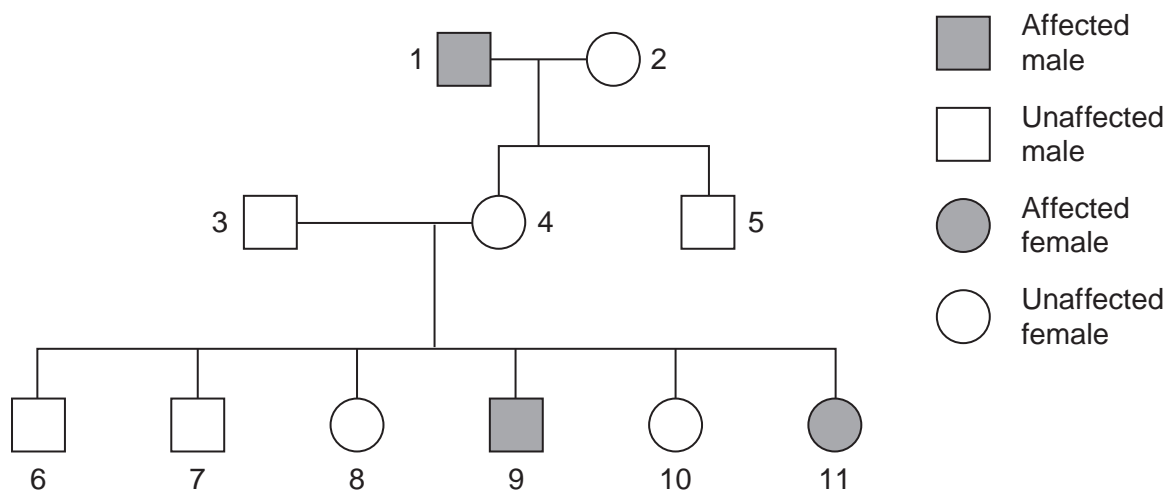
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(2 marks)

**3 (b)** Tay-Sachs disease is a human inherited disorder. Sufferers of this disease often die during childhood. The allele for Tay-Sachs disease **t**, is recessive to allele **T**, present in unaffected individuals. The diagram shows the inheritance of Tay-Sachs in one family.



**3 (b) (i)** Explain **one** piece of evidence from the diagram which proves that the allele for Tay-Sachs disease is recessive.

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(2 marks)

- 3 (b) (ii) Explain **one** piece of evidence from the diagram which proves that the allele for Tay-Sachs disease is **not** on the X chromosome.

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(2 marks)

- 3 (c) (i) In a human population, one in every 1000 children born had Tay-Sachs disease. Use the Hardy-Weinberg equation to calculate the percentage of this population you would expect to be heterozygous for this gene. Show your working.

Answer = ..... %  
(3 marks)

- 3 (c) (ii) The actual percentage of heterozygotes is likely to be lower in future generations than the answer to part (c)(i). Explain why.

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(1 mark)

10
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Turn over ►

- 4** Scientists constructed a mathematical model. They used this model to estimate the transfer of energy through consumers in a natural grassland ecosystem. The table shows their results.

	Energy transferred as percentage of energy in biomass of producers				
	Ingested food (F)	Absorbed from gut (A)	Egested (E)	Net production (P)	Respired (R)
<b>Primary consumers</b>					
Mammals	25.00	12.50	12.50	0.25	12.25
Insects	4.00	1.60	2.40	0.64	0.96
<b>Secondary consumers</b>					
Mammals	0.16	0.13	0.03	0.003	0.127
Insects	0.17	0.135	0.035	0.040	0.095

- 4 (a)** Complete the equation to show how net production is calculated from the energy in ingested food.

**P** =

(1 mark)

- 4 (b)** Describe and explain how intensive rearing of domestic livestock would affect

- 4 (b) (i)** the figure for **A** in the first row of the table

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(1 mark)

- 4 (b) (ii)** the figure for **R** in the first row of the table.

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(1 mark)

- 4 (c) (i)** Calculate the ratio of **R** : **A** for mammalian primary consumers.

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(1 mark)

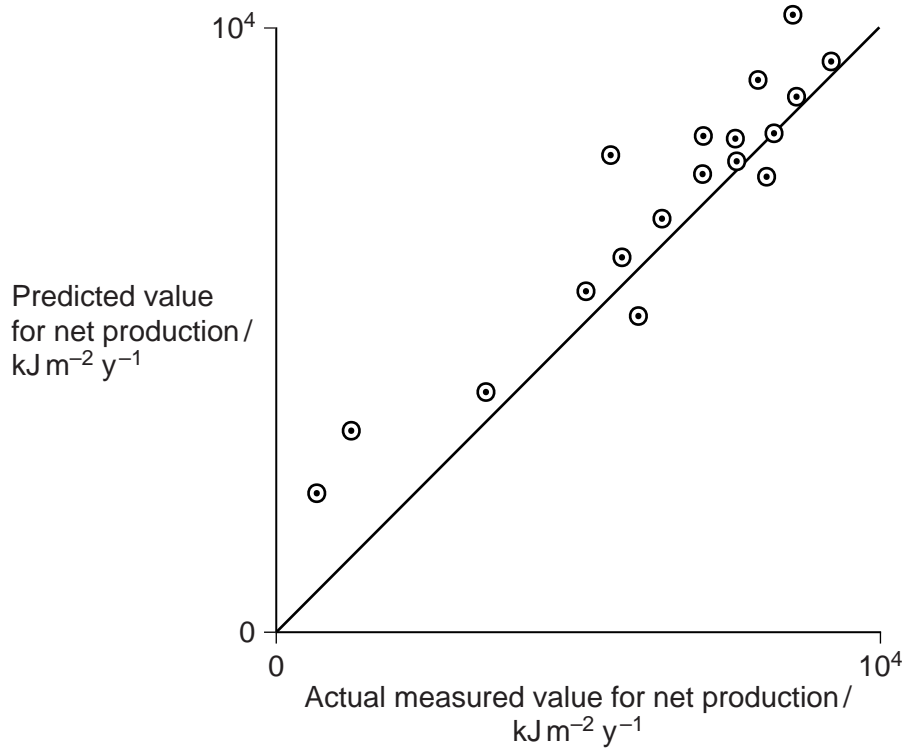
- 4 (c) (ii)** The **R** : **A** ratio is higher in mammalian primary consumers than in insect primary consumers. Suggest a reason for this higher value.

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(1 mark)

- 4 (d)** The scientists tested their model by comparing the values it predicted with actual measured values. The graph shows their results.



Are the values predicted by the model supported by the actual measured values?  
Evaluate the evidence in the graph.

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(3 marks)

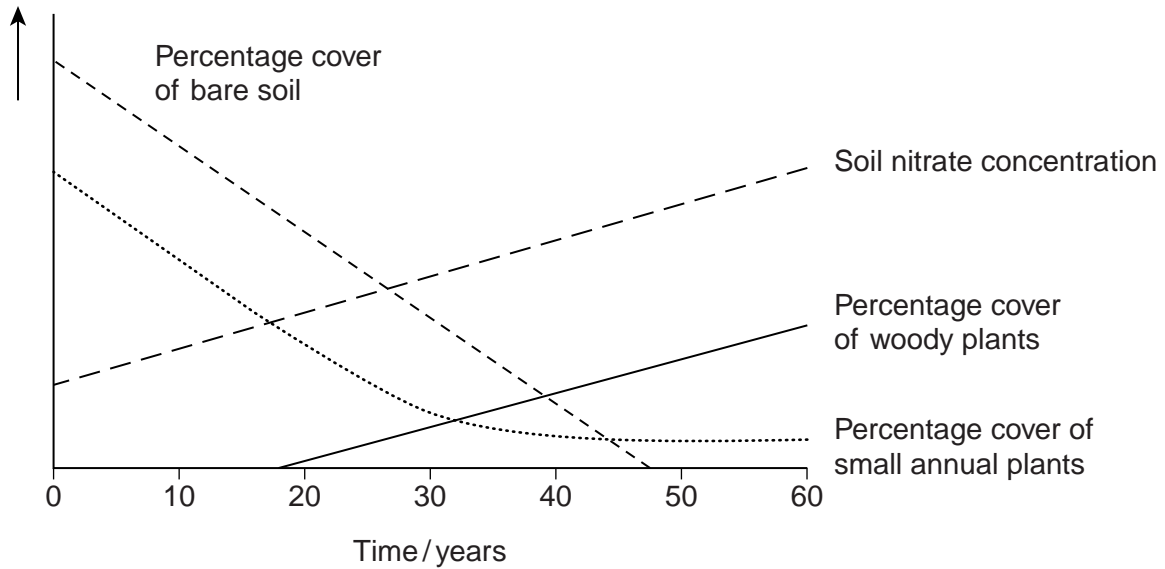
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- 5 Ecologists investigated succession in some abandoned crop fields. The data that they collected are shown in the graph. The curves show the trends that occurred over a period of 60 years.



- 5 (a) Explain the change in soil nitrate concentration shown on the graph.

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(2 marks)

**5 (b)** The pioneer plants had different characteristics from the plants that colonised the fields after 50 years.

**5 (b) (i)** The pioneer plants had seeds that germinate better when the temperature fluctuates. Explain the advantage of this to these pioneer plants.

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(2 marks)

**5 (b) (ii)** Explain the advantage to a plant that colonises after 50 years of having a high rate of photosynthesis at low light intensities.

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(1 mark)

**5 (c)** Conservation of grassland habitats involves management of succession. Use the data in the graph to explain why.

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(2 marks)

- Over the last 2 000 000 years, long periods of dry climate caused this forest to separate into a number of smaller forests.
- Different plant communities developed in each of these smaller forests.
- Each time the climate became wetter again, the smaller forests grew in size and merged to reform the Amazonian forest.

This image shows a single sheet of white paper with ten evenly spaced, horizontal dashed lines. The lines are black and extend across the full width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the paper.

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- 6 (b)** Speciation is far less frequent in the reformed Amazonian forest. Suggest **one** reason for this.

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(1 mark)

6

**Turn over for the next question**

**Turn over ►**

- 7 (a) Blue tits are small birds that live in woods. An ecologist estimated the size of the blue tit population visiting gardens near a wood in November.

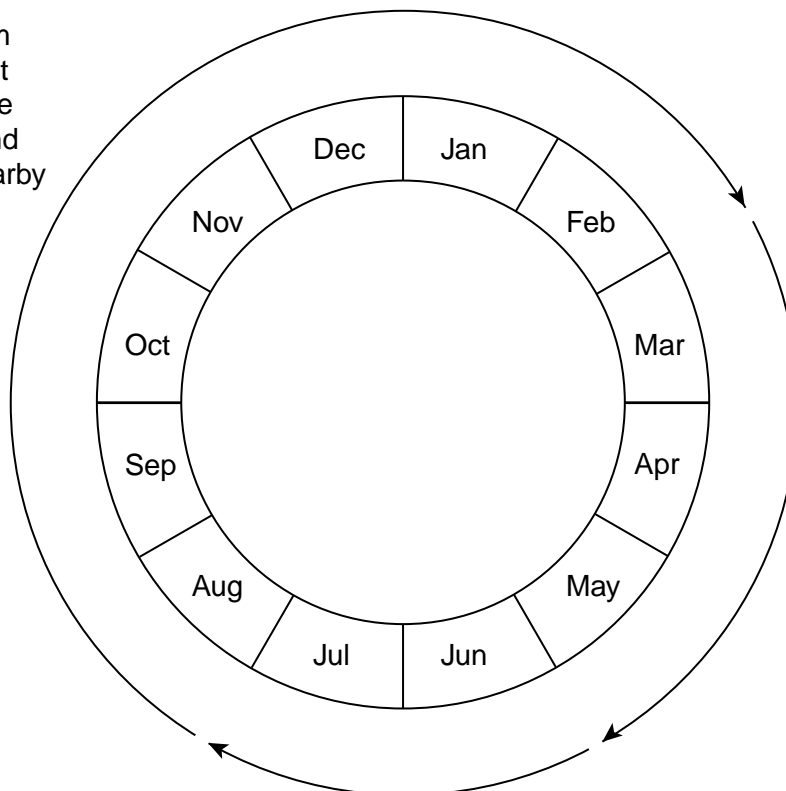
- She trapped 28 blue tits. She marked all of these birds with small metal rings on their legs.
- Two weeks later, she trapped another sample of blue tits. Of these birds, 18 were marked and 20 were not marked.

Use the data to estimate the size of the blue tit population. Show your working.

Size of population .....  
(2 marks)

- (b) The diagram shows some features of blue tit behaviour at different times of the year.

Birds form  
flocks that  
feed in the  
woods and  
in the nearby  
gardens



Each pair of  
adult birds forms  
a separate  
territory. The  
pair stays in  
this territory  
while breeding

Young birds leave  
their nests and join  
the adults

- 7 (b) (i) Using mark-release-recapture to estimate the size of a blue tit population in June would **not** give reliable results. Explain why.

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(2 marks)

- (b) (ii) Using mark-release-recapture to estimate the size of a blue tit population in March would **not** give reliable results. Explain why.

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(2 marks)

- (c) Whales spend most of their time deep in the sea but they come to the surface to breathe. When they are at the surface, scientists obtain small samples of their skin. The scientists find the base sequence in some of the DNA from these samples. The base sequence is different in each whale.

You could use the information about the base sequence to estimate the size of the whale population by using mark-release-recapture. Explain why.

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(2 marks)

- 8 (a) What does the Hardy–Weinberg principle predict?

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(3 marks)

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The table shows the frequencies of some alleles in the population of cats in three cities.

City	Frequency of allele			
	White	Non-agouti	Blotched	Long-haired
Athens	0.001	0.72	0.25	0.50
Paris	0.011	0.71	0.78	0.24
London	0.004	0.76	0.81	0.33

- (b) White cats are deaf. Would the Hardy–Weinberg principle hold true for white cats? Explain your answer.

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(2 marks)

- (c) What is the evidence from the table that non-agouti and blotched are alleles of different genes?

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(1 mark)

- (d) Hair length in cats is determined by a single gene with two alleles. The allele for long hair (h) is recessive. The allele for short hair (H) is dominant.

Use the information in the table and the Hardy–Weinberg equation to estimate the percentage of cats in London that are heterozygous for hair length. Show your working.

Answer .....

(2 marks)

8

**Turn over for the next question**

**Turn over ►**



- 9** Cows suffer from heat stress when the environmental temperature is too high. Heat stress occurs when their core body temperature rises above 39.4 °C. The table shows how environmental temperature affects the food intake, water intake and milk production of cows in a fixed period of time.

Environmental temperature / °C	Food intake / kg	Water intake / dm <sup>3</sup>	Milk production / dm <sup>3</sup>
20	18.2	81.8	27.0
25	17.7	88.6	25.0
30	17.0	95.0	22.9
35	16.7	144.1	18.0

- 9 (a)** Calculate the percentage decrease in milk production between the temperatures of 30 °C and 35 °C. Show your working.

Answer ..... %  
(2 marks)

- 9 (b)** Suggest how each of the following responses helps to maintain core body temperature.

- 9 (b) (i)** The change in water intake as environmental temperature increases.

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 (1 mark)

- 9 (b) (ii)** The change in food intake as environmental temperature decreases.

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 (2 marks)

- 9 (c)** Explain the change in milk production as environmental temperature increases.

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(1 mark)

- 9 (d)** The rectal temperatures of cows are recorded to monitor heat stress. This is a better measurement of core body temperature than measuring the temperature of the skin. Explain why.

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(2 marks)

- 9 (e)** Selective breeding can be used to produce cows with desirable features. This involves mating cows with bulls. Suggest how a bull is selected to increase the probability of producing cows with a high milk yield.

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(1 mark)

**Question 9 continues on the next page**

**Turn over ►**

Milk contains lactose. Human babies produce the enzyme lactase, which digests lactose. Many human adults do not produce lactase and are lactose intolerant.

People who are lactose intolerant can become very ill if they drink milk or eat dairy products, such as butter and cheese.

- 9 (f)** Scientists have recorded the percentage of adults who are lactose intolerant in different countries. Explain the advantage of using percentages in this type of study.

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(2 marks)

- 9 (g)** The scientists found that the percentage of people who can tolerate lactose is much higher in populations that drink a lot of milk and eat a lot of dairy products.

Use your knowledge of natural selection to explain this finding.

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(4 marks)

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**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)** The membranes of different types of cells are involved in many different functions.  
(25 marks)

**OR**

**10 (b)** There are many different types of relationships and interactions between organisms.  
(25 marks)

If you want to make a plan write it here.

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