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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)

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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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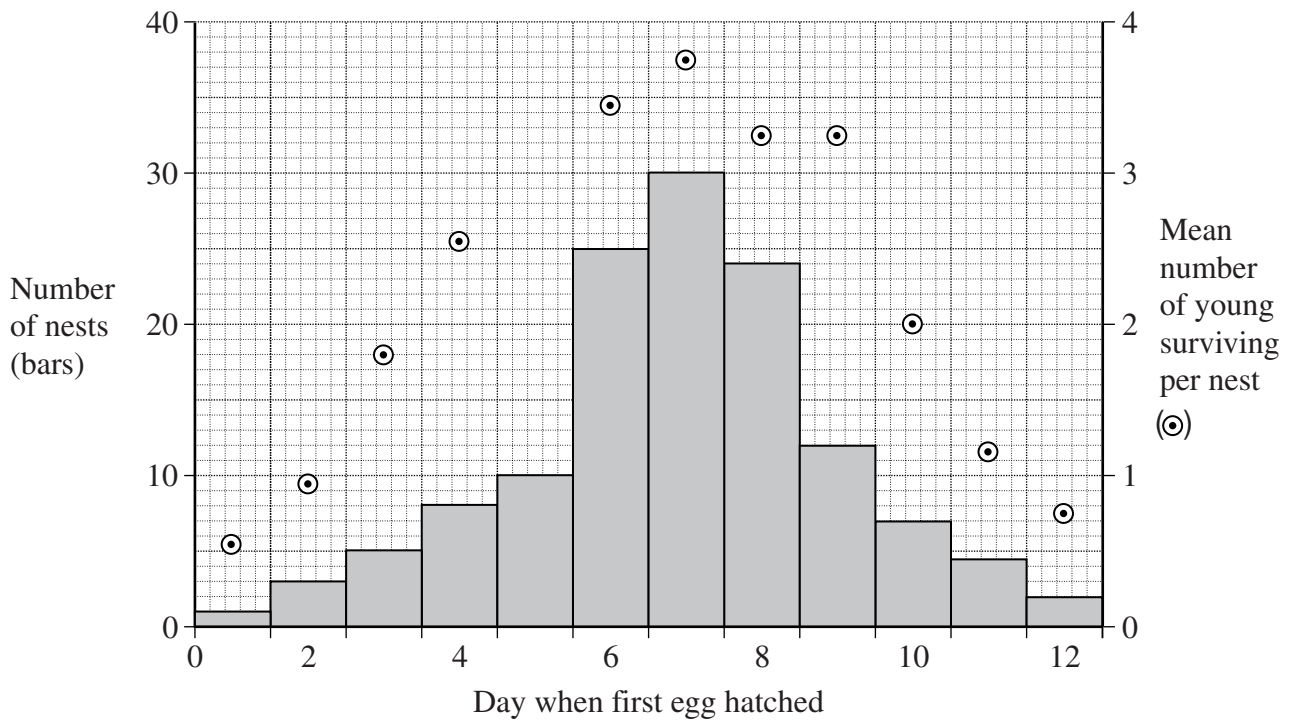
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(2 marks)

Question 1 continues on the next page

Turn over ►

- 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)

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

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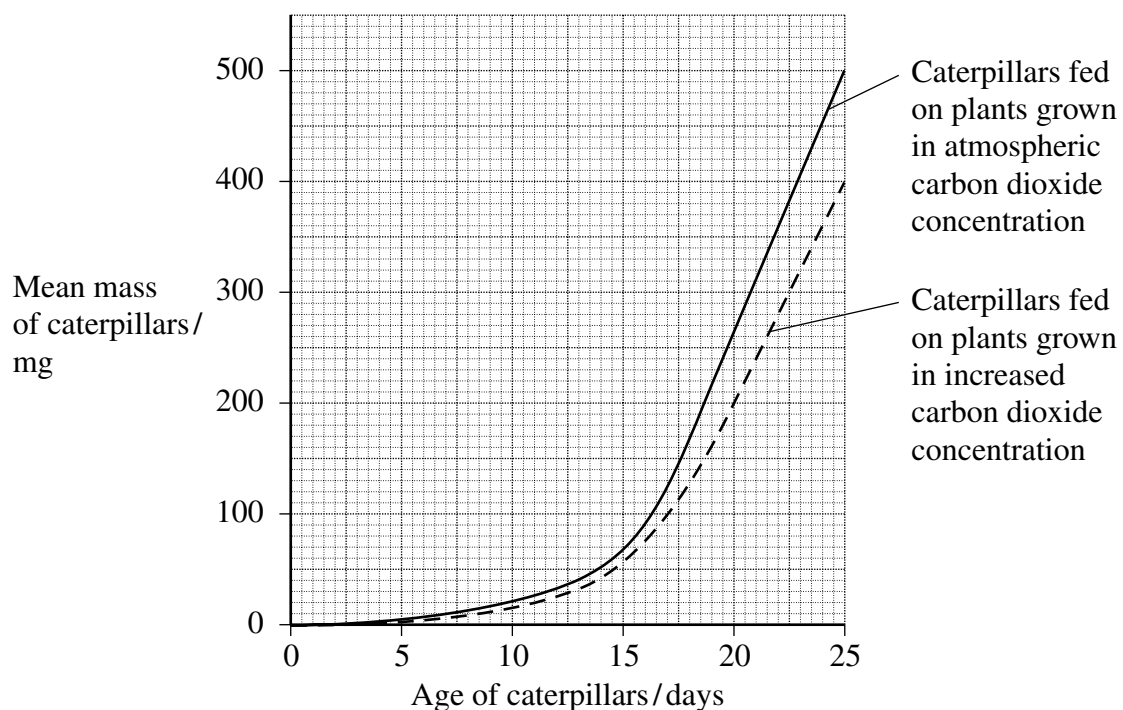
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Scientists grew groups of the same species of crop plant in a greenhouse in two different concentrations of carbon dioxide. They fed caterpillars on plants from each group and measured the growth of the caterpillars. The results of their investigation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

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(2 marks)

Turn over for the next question

Turn over ►

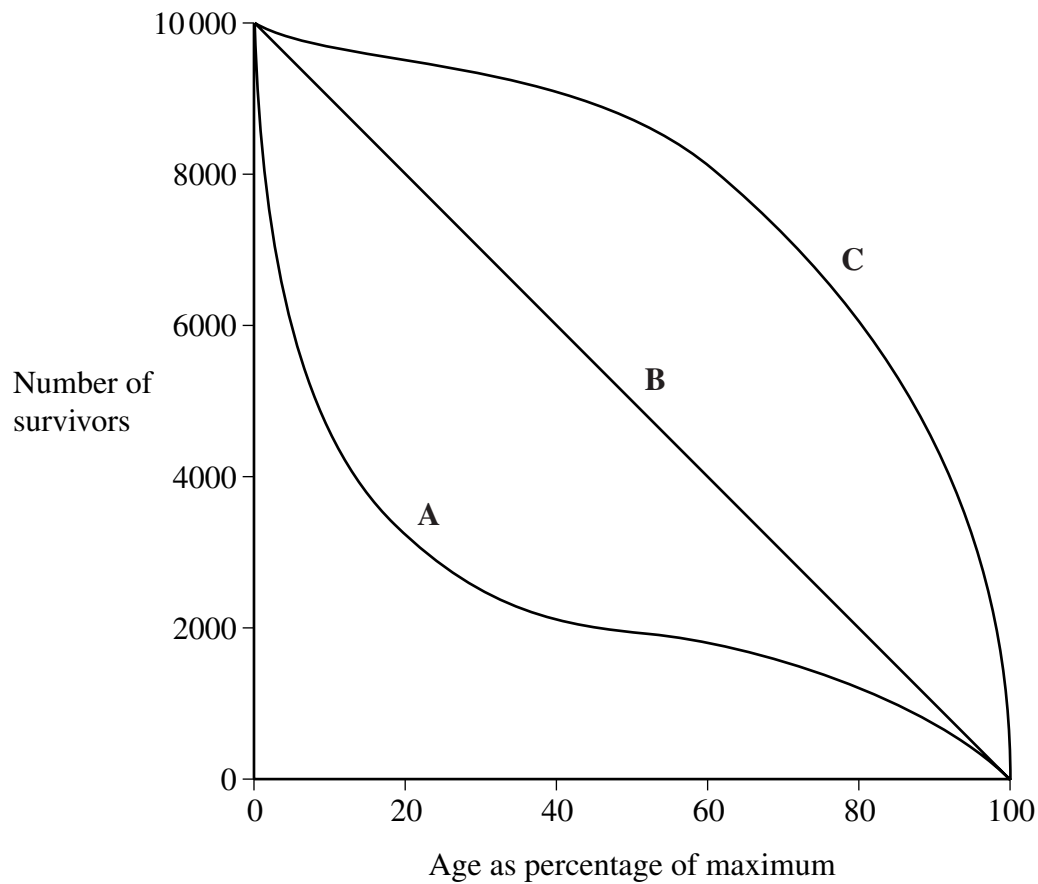
- 3 (a) Explain what is meant by the ecological term, population.

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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)

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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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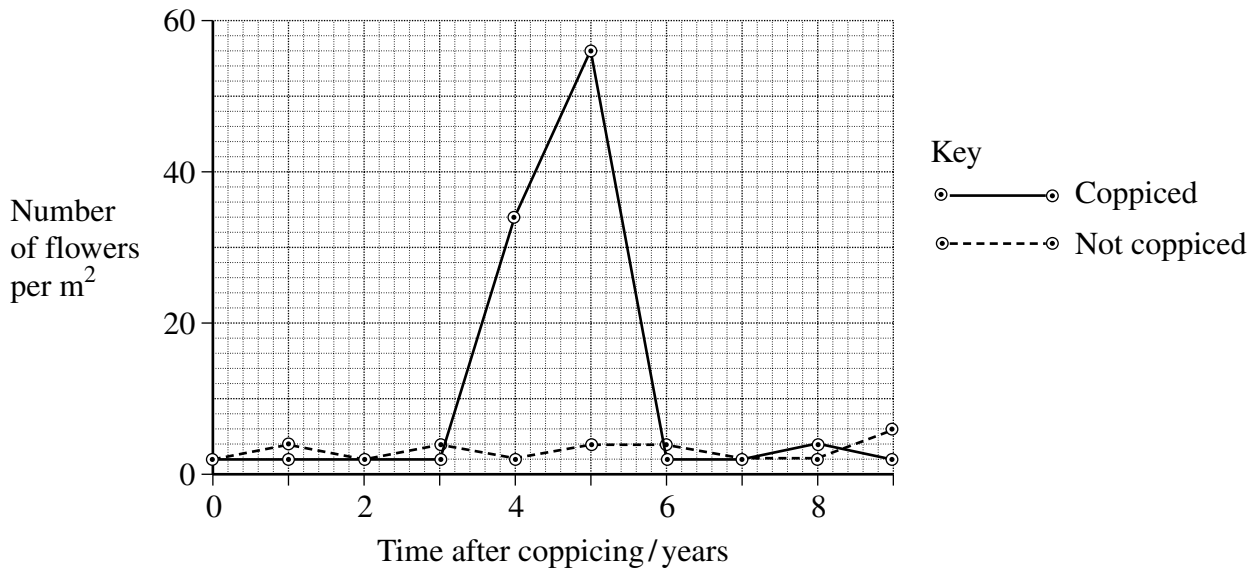
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(2 marks)

- 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)

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

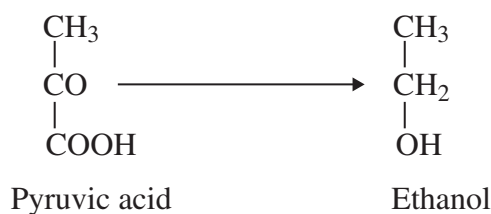
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(1 mark)

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.



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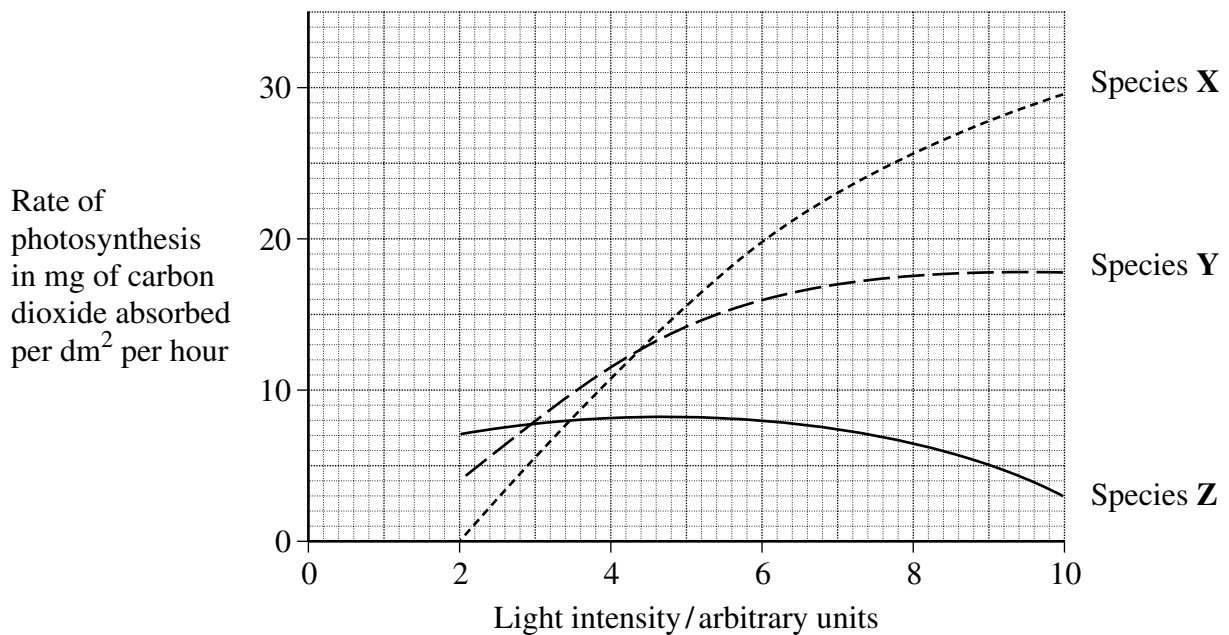
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- 6 The graph shows the effects of light intensity on the rate of photosynthesis of three species of tree, **X**, **Y** and **Z**. Each of these species occurs at a different stage in succession.



- 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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- 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)

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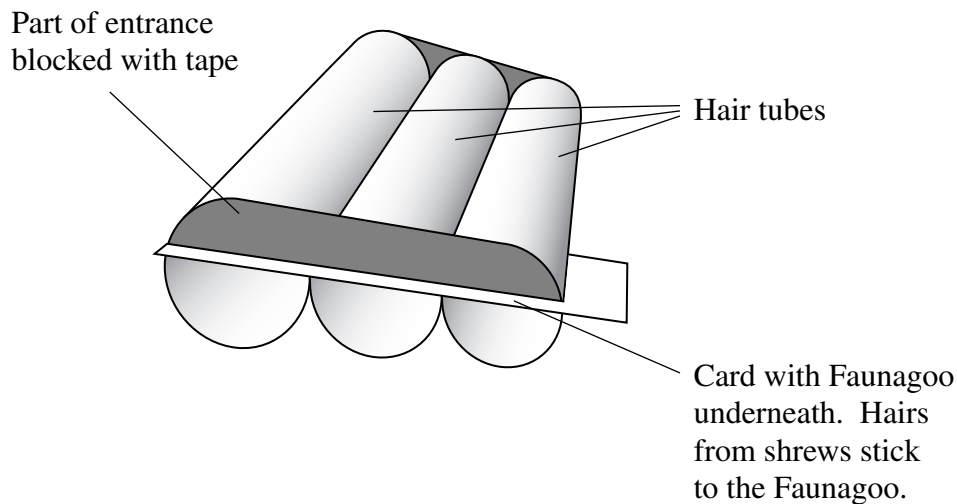
Turn over for the next question

Turn over ►

- 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)

Turn over ►

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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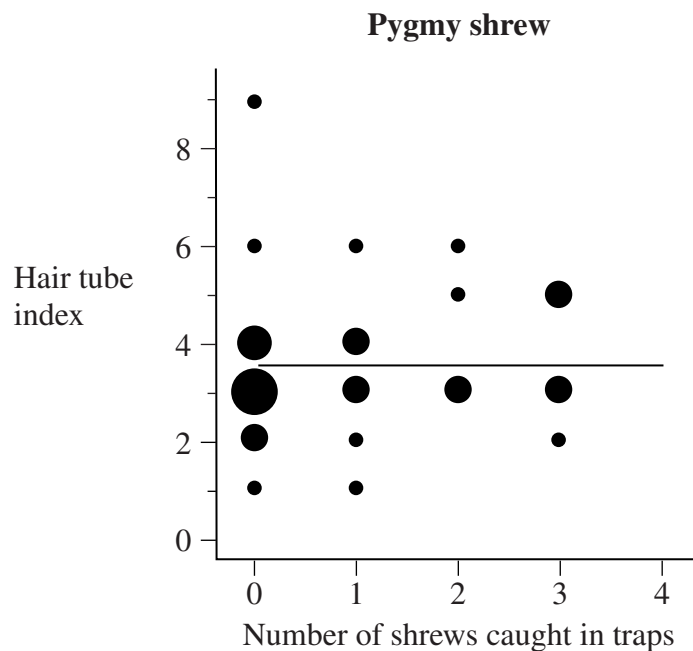
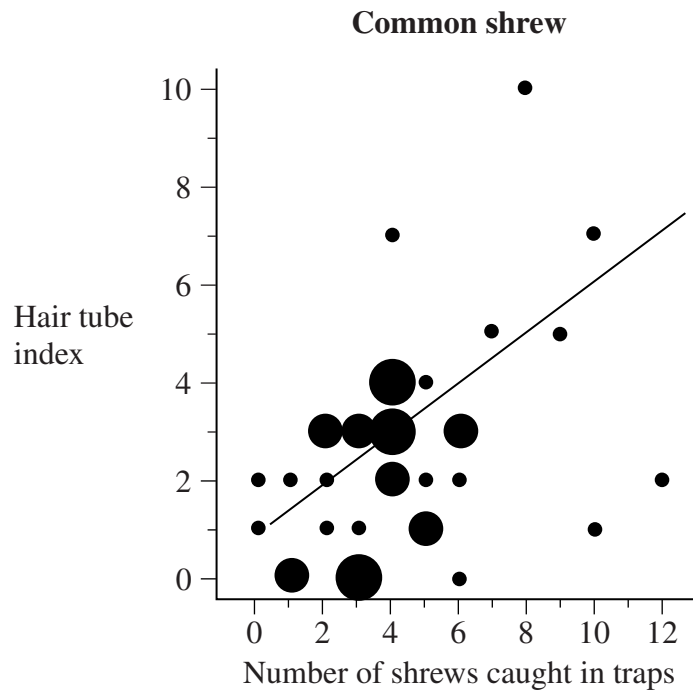
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Turn over ►

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.



- 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)

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

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END OF QUESTIONS

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 ►

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

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(1 mark)

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

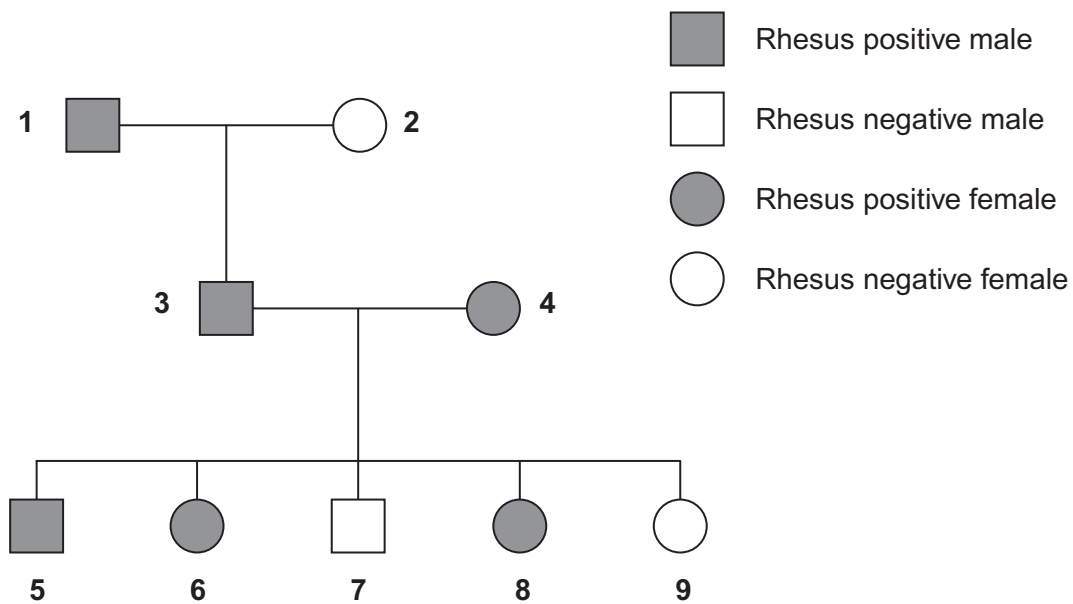
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(1 mark)

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



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Answer (3 marks)

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

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

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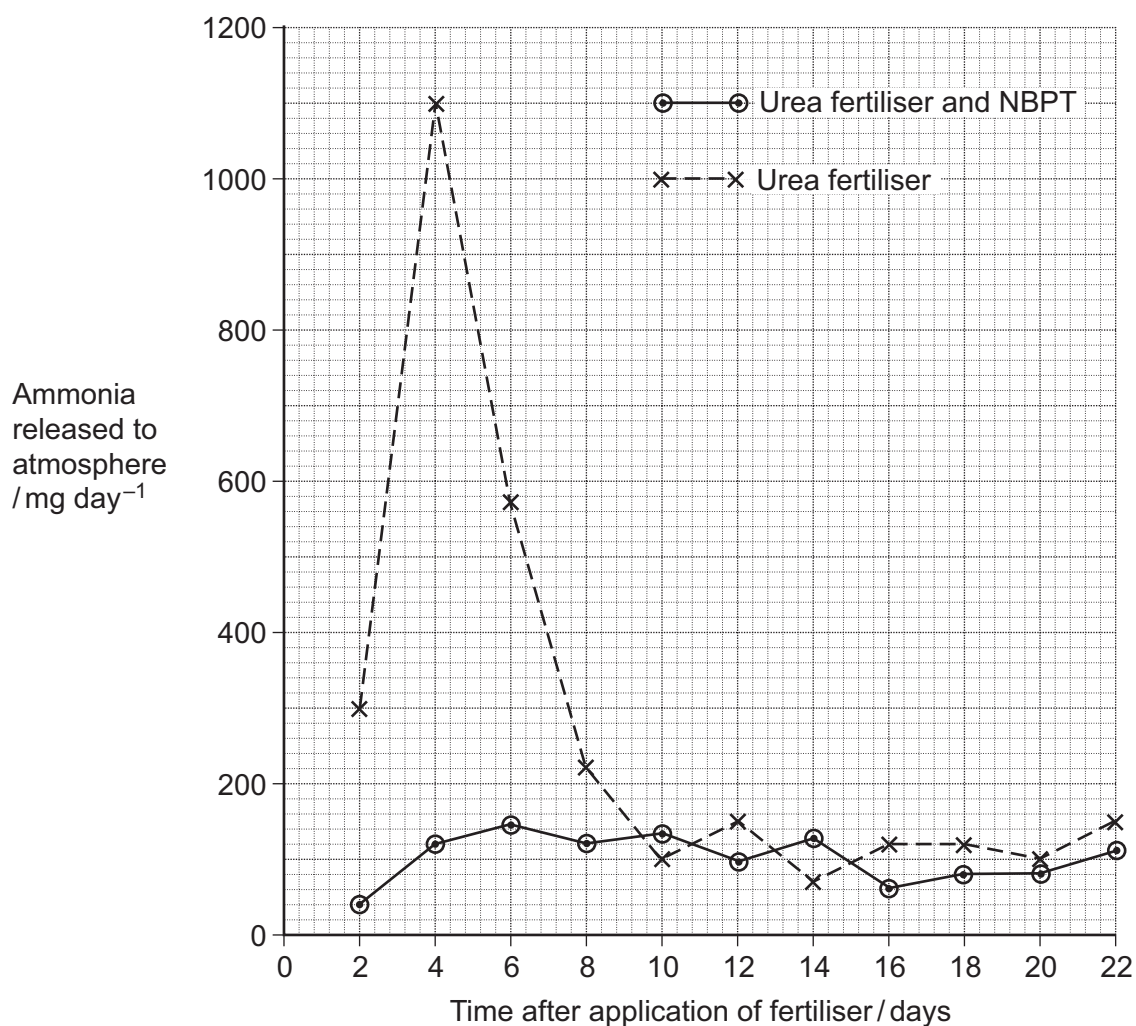
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(2 marks)

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



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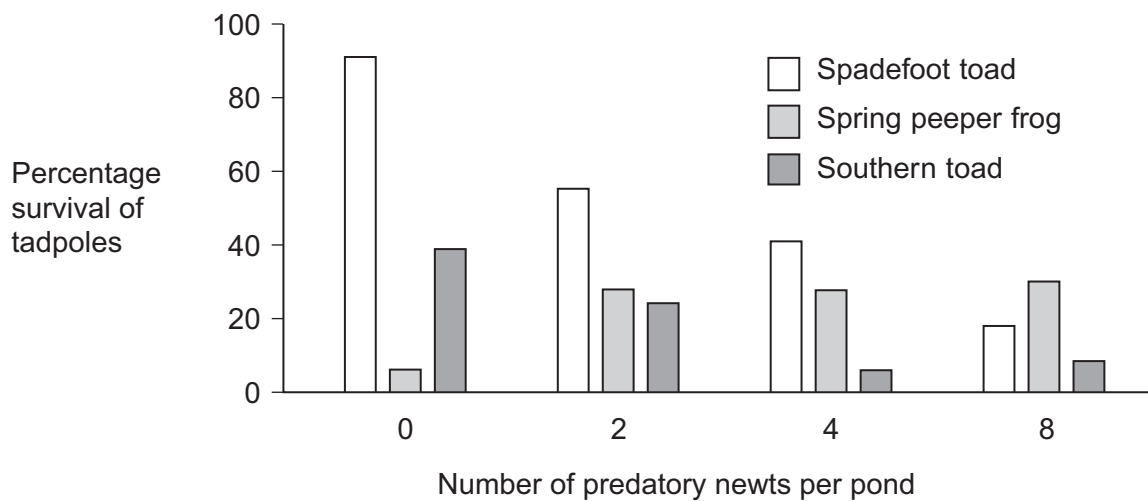
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- 4 The young of frogs and toads are called tadpoles. Ecologists investigated the effect of predation on three species of tadpole. They set up four artificial pond communities. Each community contained

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

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

Figure 1



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

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(2 marks)

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

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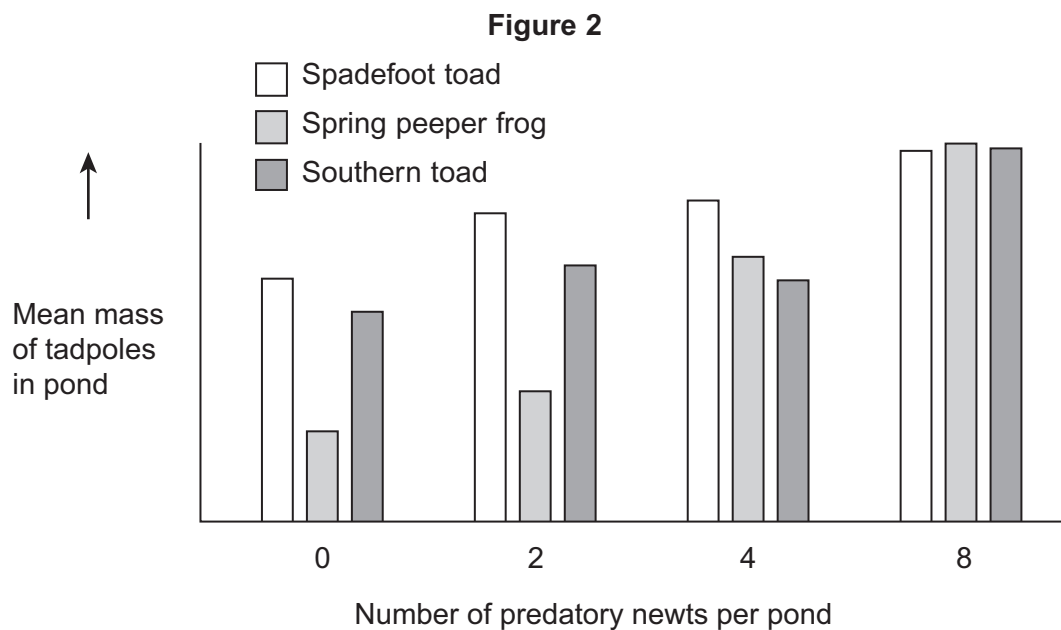
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(2 marks)

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



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

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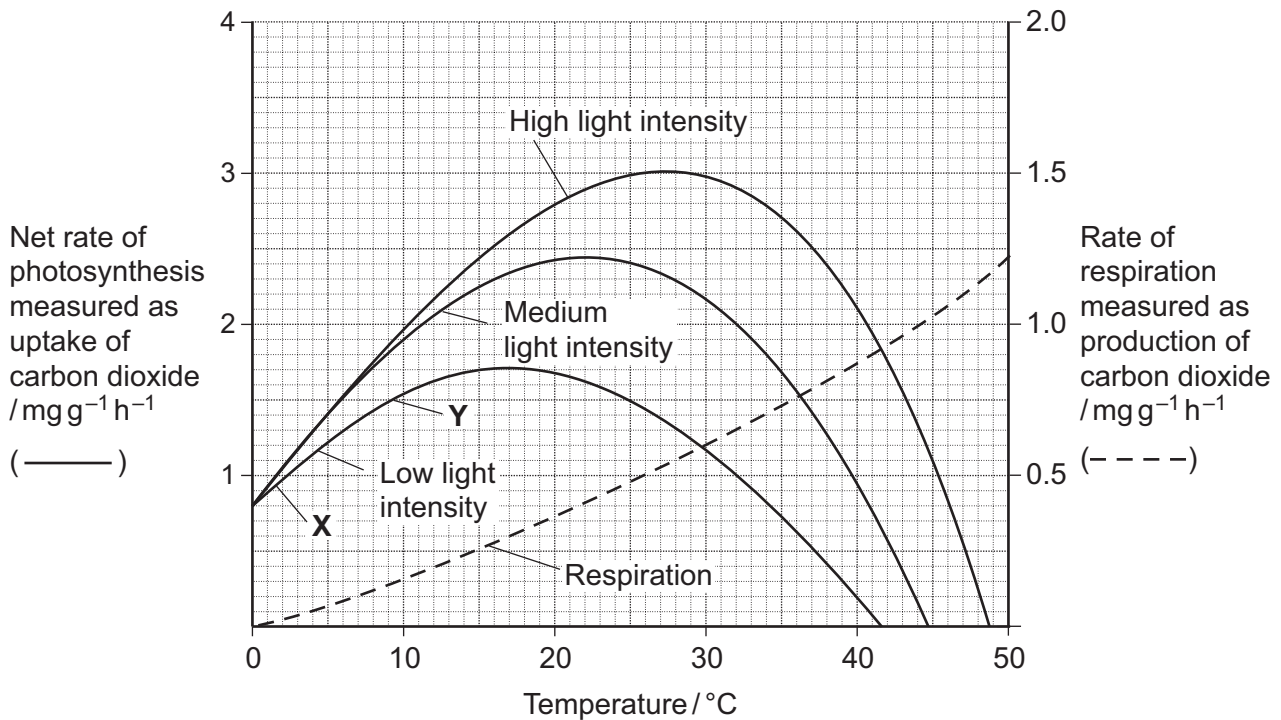
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- 5** Scientists investigated the effects of temperature and light intensity on the rate of photosynthesis in creeping azalea. They investigated the effect of temperature on the net rate of photosynthesis at three different light intensities. They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



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

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(1 mark)

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

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(2 marks)

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

Answer
(1 mark)

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

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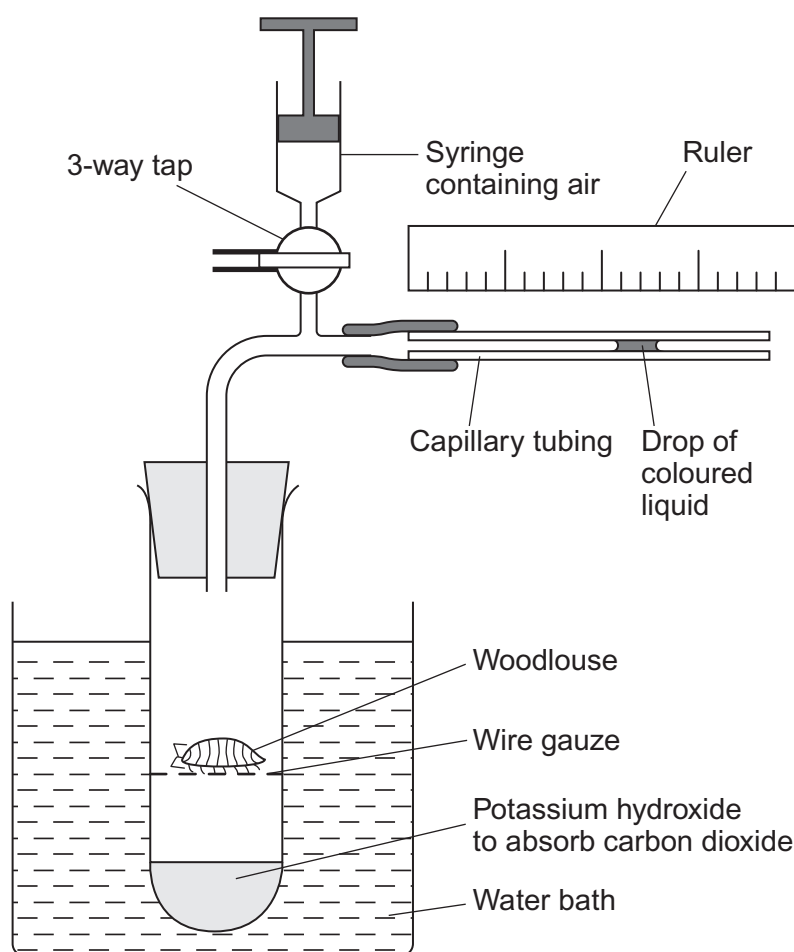
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- 6 (a)** A student measured the rate of aerobic respiration of a woodlouse using the apparatus shown in the diagram.



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

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

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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)

Turn over ►

- 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 / $\mu\text{mol kg}^{-1}$ 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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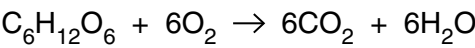
1 (a) Excretion and secretion are two processes that take place in the body of a mammal.

Complete the table below to compare the processes of excretion and secretion.

	excretion	secretion
one difference		
one example of a product		
one similarity		

[3]

(b) Aerobic respiration may be summarised by the following equation:



Although carbon dioxide and water are products of aerobic respiration, the equation is an over-simplification of the process.

State **and** explain **one** way in which this equation is an over-simplification.

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(c) Over 2.3 million people in the UK are known to have diabetes. It is also estimated that a further 0.5 million people have the condition but are unaware of it.

(i) Explain how **Type 1** diabetes is caused.

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(ii) Describe **three** factors that increase a person's risk of developing **Type 2** diabetes.

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[Total: 10]

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- 2 (a) Fig. 2.1 represents the first stage of respiration.

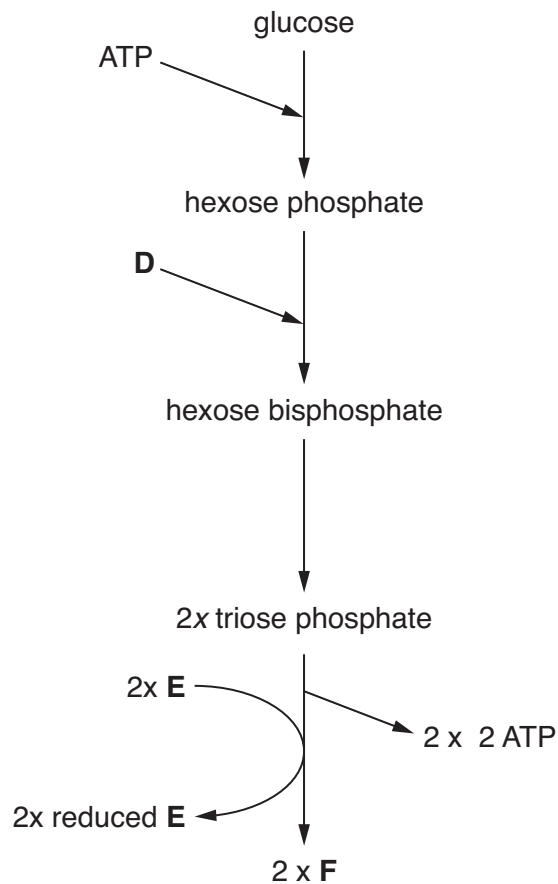


Fig. 2.1

- (i) Name the stage represented by Fig. 2.1.
..... [1]
- (ii) State precisely where in the cell this stage takes place.
..... [1]
- (iii) Identify the compounds **D**, **E** and **F**.
D
E
F [3]

- (b)** In **anaerobic** conditions, compound **F** does not proceed to the link reaction.

Describe the fate of compound **F** during anaerobic respiration in an animal cell **and** explain the importance of this reaction.

[5]

Turn over

(c) Fig. 2.2 is a drawing of a common seal, *Phoca vitulina*, an aquatic mammal.

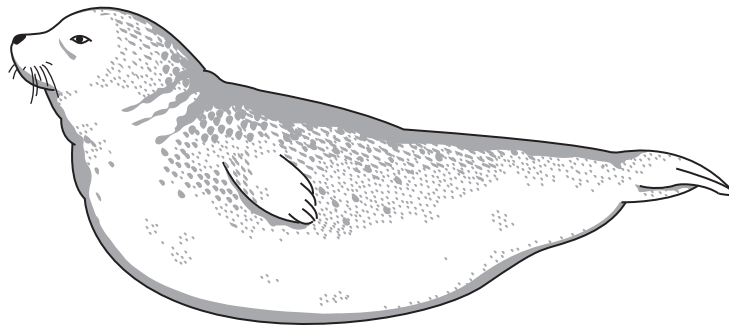


Fig. 2.2

The seal comes to the surface of the water to obtain air and it can then stay underwater for over 20 minutes.

Fig. 2.3 shows a seal at the surface of the water and Fig. 2.4 shows the same animal then submerging again.

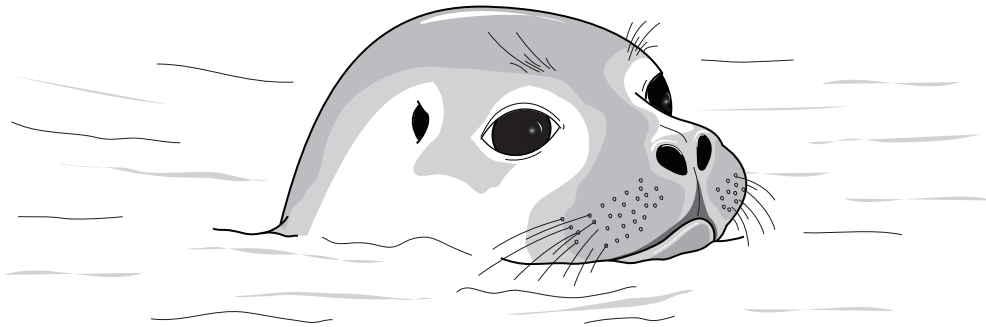


Fig. 2.3

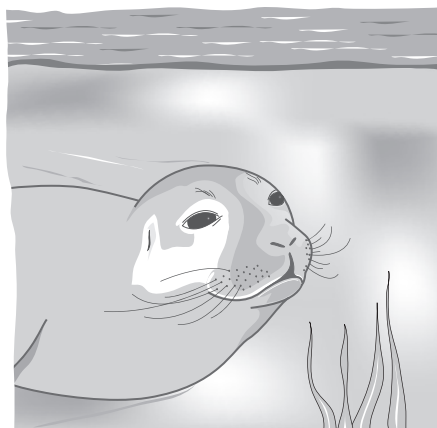


Fig. 2.4

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Suggest how the seal is adapted to respire for such a long time underwater.

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[Total: 13]

Turn over

3 (a) Fig. 3.1 represents part of the axon of a neurone.

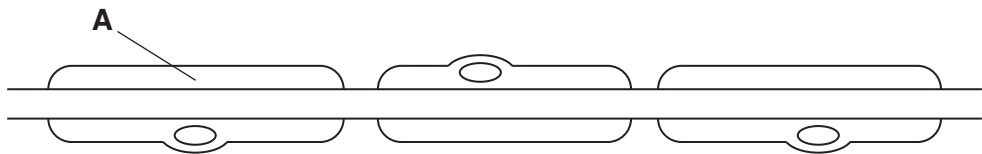


Fig. 3.1

Describe the **structure** of the feature labelled **A**.

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..... [2]

Table 3.1 shows details of the diameter and speed of conduction of impulse along the neurones of different animal taxa.

Table 3.1

type of neurone	axon diameter (µm)	speed of conduction (m s ⁻¹)	animal taxon
myelinated	4	25	mammal
myelinated	10	30	amphibian
myelinated	14	35	amphibian
unmyelinated	15	3	mammal
unmyelinated	1000	30	mollusc

(b) Using **only the data in Table 3.1**, describe the effect of each of the following on the speed of conduction:

(i) myelination,

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..... [2]

(ii) axon diameter.

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..... [2]

(c) The speed of conduction of a nerve impulse is also affected by temperature.

(i) Suggest why an increase in temperature results in an increase in the speed of conduction.

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..... [1]


(ii) As the temperature continues to increase, it reaches a point at which the conduction of the impulse ceases. Suggest why.

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..... [1]

(d) Outline the events following the arrival of an action potential at the synaptic knob until the acetylcholine has been released into the synapse.

 In your answer, you should use appropriate technical terms, spelt correctly.

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..... [4]

[Total: 12]

Turn over

- 4 (a) Blood enters the kidneys through the renal arteries and the human kidneys process 1200cm^3 of blood every minute. This 1200cm^3 of blood contains 700cm^3 of plasma. As this blood passes through a glomerulus, 125cm^3 of fluid passes into the renal tubule.

(i) Name the process by which the fluid passes from the glomerulus into the renal tubule.

..... [1]

(ii) Calculate the percentage of plasma that passes into the renal tubule.

Show your working and **give your answer to one decimal place.**

Answer = % [2]

- (b) Fig. 4.1, **on the insert**, is an electronmicrograph of a transverse section of part of a proximal convoluted tubule.

(i) Name the tissue that lines the proximal convoluted tubule.

..... [1]

(ii) Name the structures indicated by X.

..... [1]

- (iii) Table 4.1 shows the approximate concentration of some of the substances in the blood plasma, the glomerular filtrate and the urine leaving the collecting duct.

Table 4.1

substance	concentration in blood plasma (g dm ⁻³)	concentration in glomerular filtrate (g dm ⁻³)	concentration in urine leaving collecting duct (g dm ⁻³)
amino acids	0.50	0.50	0.00
glucose	1.00	1.00	0.00
inorganic ions	7.30	7.30	15.60
nitrogenous waste (not including urea)	0.03	0.03	0.28
protein	80.00	0.00	0.00
urea	0.30	0.30	21.00

Some of the changes observed between the glomerular filtrate and the urine are as a result of activity in the proximal convoluted tubule.

With reference to Table 4.1, explain how these observed changes in concentration are brought about by the **proximal convoluted tubule**.



In your answer, you should use appropriate technical terms, spelt correctly.

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..... [4]

Turn over

(c) When the kidneys cease functioning or fail to work effectively, renal dialysis may be necessary.

Fig. 4.2 outlines the procedure of haemodialysis, a type of renal dialysis.

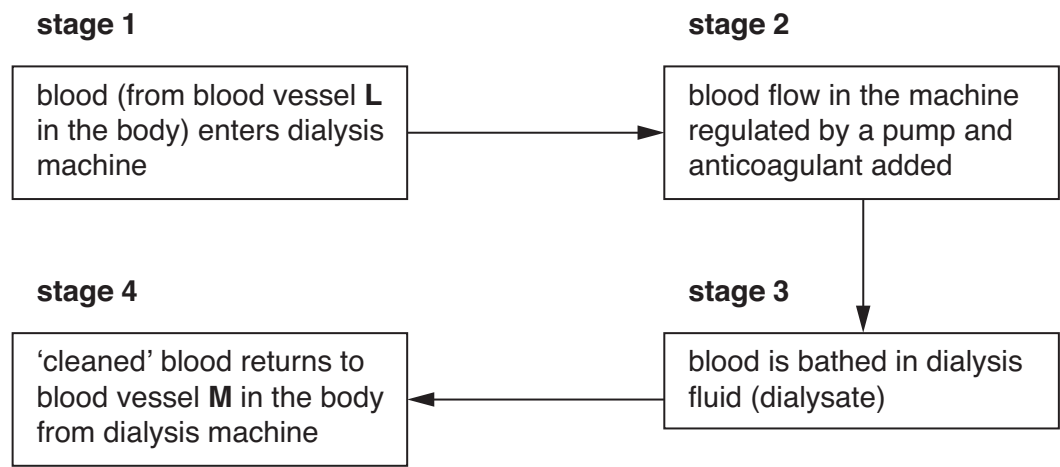


Fig. 4.2

Fig. 4.3 shows further detail of how **stage 3** is achieved.

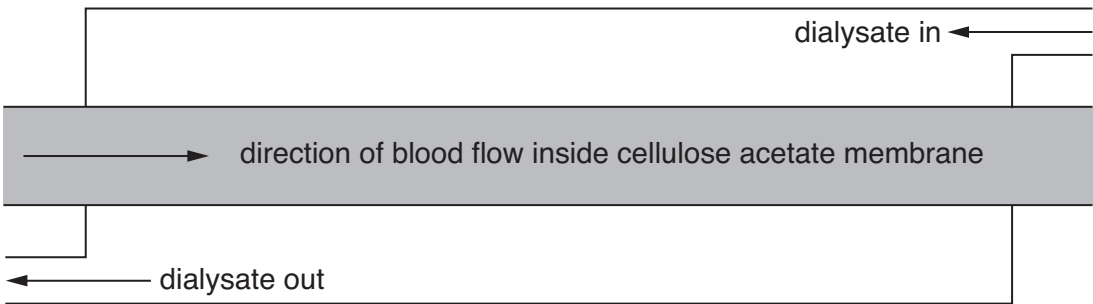


Fig. 4.3

- (i) State the **types** of blood vessel represented by **L** and **M** in Fig. 4.2.
- L**
- M** [1]
- (ii) Suggest why it is necessary to add an anticoagulant to the blood in **stage 2**.
-
- [1]
- (iii) Suggest why **no** anticoagulant is added to the blood towards the end of a dialysis session.
-
- [1]

12

- (iv) State the process by which molecules and ions, **other than water**, will move from the blood into the dialysate.

..... [1]

- (v) Suggest why the direction of flow of the blood and the dialysate is as shown in Fig. 4.3.

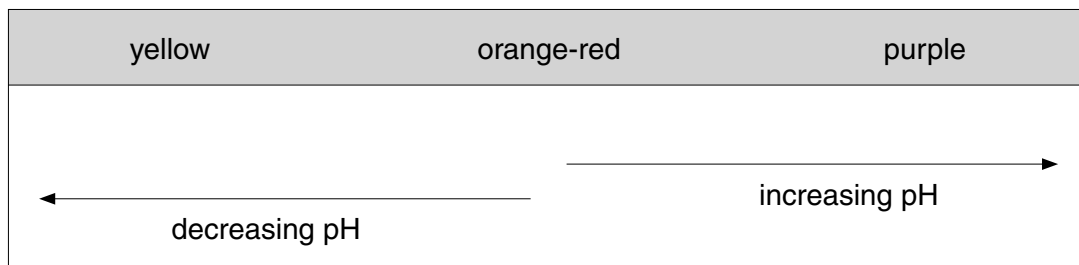
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..... [1]

[Total: 14]

Turn over

- 5 (a) An experiment was carried out into the effect of different wavelengths of light on the rate of photosynthesis.

Four sealed test-tubes were set up, each containing three leaf discs from the same plant suspended above hydrogencarbonate indicator solution. This solution changes colour at different pH values, as shown below.



At the start of the experiment, the contents of all four tubes were orange-red.

Each tube was illuminated by a lamp with a coloured filter in front of it. The tubes were illuminated for the same length of time. The colour changes were noted and the results are shown in Table 5.1.

Table 5.1

colour of filter	final colour of hydrogencarbonate indicator
colourless	purple
blue	purple
green	orange-yellow
red	red

A fifth tube was set up in the same way as the other tubes. This tube was then covered in black paper before being illuminated for the same length of time. The final colour of the hydrogencarbonate indicator in this tube was yellow.

- (i) State the purpose of the tube covered with black paper.

.....

..... [1]

- (ii) State **two** precautions that need to be taken when designing and carrying out this experiment in order to obtain results from which valid conclusions can be drawn. Explain the need for each precaution.

precaution 1

explanation

.....

precaution 2

explanation

..... [2]

- (iii) Name the pigment at the reaction centre of photosystems I and II.

..... [1]

- (iv) Explain the change observed in the tube exposed to green light.

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..... [3]

Turn over

(b) In order to maximise production, market gardeners often grow plants in glasshouses. Light conditions can be controlled along with a number of other factors.

How can factors **other than light conditions** be controlled to increase the rate of photosynthesis and maximise production?

In your answer you should explain why the rate of photosynthesis is affected by the controlled factors you have discussed.

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..... [4]

[Total: 11]

END OF QUESTION PAPER

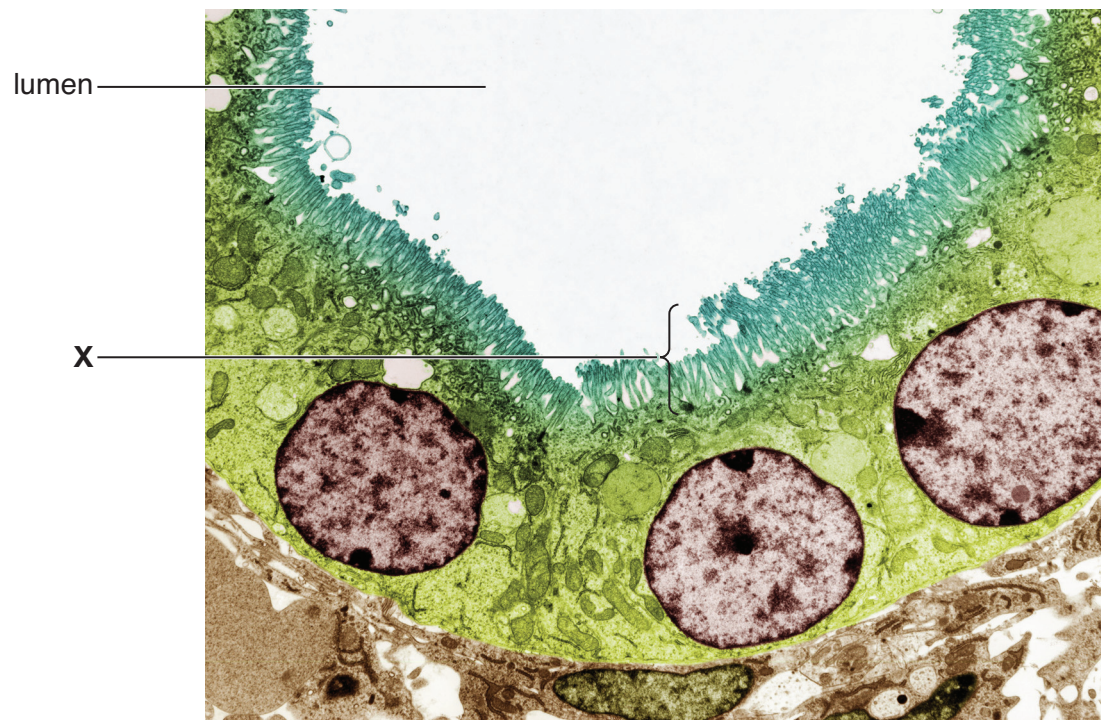


Fig. 4.1