**NOTICE TO CUSTOMER:**

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

**1 (a)** The table contains statements about three biological processes.

Complete the table with a tick if the statement in the first column is true, for each process.

| | **Photosynthesis** | **Anaerobic respiration** | **Aerobic respiration** |
|---|---|---|---|
| ATP produced | | | |
| Occurs in organelles | | | |
| Electron transport chain involved | | | |

*(3 marks)*

**1 (b)** Write a simple equation to show how ATP is synthesised from ADP.

.....

*(1 mark)*

**1 (c)** Give **two** ways in which the properties of ATP make it a suitable source of energy in biological processes.

1.....

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2.....

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*(2 marks)*

**1 (d)** Humans synthesise more than their body mass of ATP each day. Explain why it is necessary for them to synthesise such a large amount of ATP.

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*(2 marks)*

8

**Turn over for the next question**

**2** Scientists measured the mean temperature in a field each month between March and October. The table shows their results.

| Month | Mean temperature / °C |
|---|---|
| March | 9 |
| April | 11 |
| May | 14 |
| June | 17 |
| July | 20 |
| August | 18 |
| September | 16 |
| October | 14 |

**2 (a)** The gross productivity of the plants in the field was highest in July. Use the data in the table to explain why.

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*(2 marks)*

**2 (b) (i)** Give the equation that links gross productivity and net productivity.

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*(1 mark)*

**2 (b) (ii)** The net productivity of the plants in the field was higher in August than in July. Use the equation in part **(b)(i)** and your knowledge of photosynthesis and respiration to suggest why.

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*(2 marks)*

**2 (c)** A horse was kept in the field from March to October. During the summer months, the horse was able to eat more than it needed to meet its minimum daily requirements.

Suggest how the horse used the extra nutrients absorbed.

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*(1 mark)*

**2 (d)** The horse's mean energy expenditure was higher in March than it was in August. Use information in the table to suggest why.

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*(2 marks)*

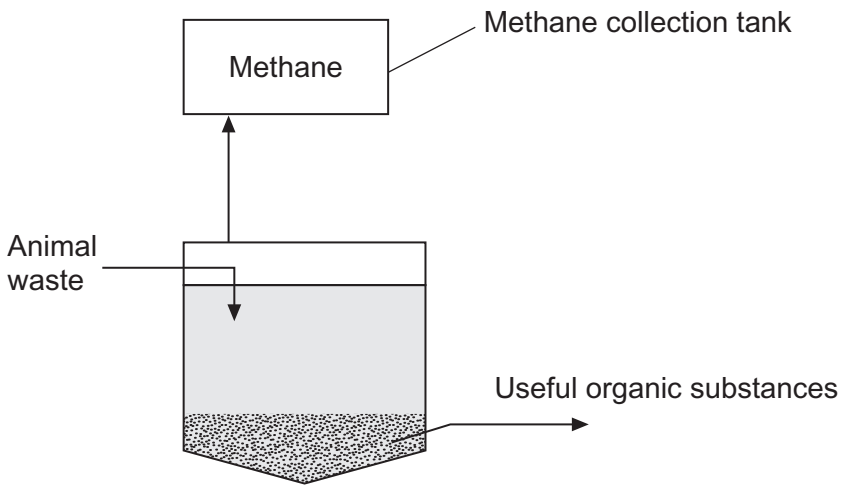
8

**Turn over for the next question**

**3** Intensive rearing of livestock produces large quantities of waste. Some farmers use an anaerobic digester to get rid of the waste.

In an anaerobic digester, microorganisms break down the large, organic molecules in the waste. This produces methane, which is a useful fuel. It also produces organic substances that can be used as a natural fertiliser.

The diagram shows an anaerobic digester.




**3 (a) (i)** Suggest **two** advantages of processing waste in anaerobic digesters rather than in open ponds.

1 .....

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2 .....

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*(2 marks)*

**3 (a) (ii)** The anaerobic digester has a cooling system, which is not shown in the diagram. Without this cooling system the digester would soon stop working. Explain why.

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*(2 marks)*

**3 (b) (i)** The over-application of fertiliser increases the rate of leaching. Explain the consequences of leaching of fertiliser into ponds and lakes.

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*(3 marks)*

(*Extra Space)* .....

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**3 (b) (ii)** Give **one** advantage of using natural fertiliser produced in the digester rather than an artificial fertiliser.

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*(1 mark)*

8

**Turn over for the next question**

**4 (a)** Explain what is meant by birth rate.

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*(1 mark)*

**4 (b)** The table shows life expectancies for babies born in the United Kingdom and in the Sudan in 2009.

| | **United Kingdom** | **Sudan** |
|---|---|---|
| Life expectancy males / years | 76.5 | 50.5 |
| Life expectancy females / years | 81.6 | 52.4 |

**4 (b) (i)** Describe the patterns shown by these data.

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*(2 marks)*

**4 (b) (ii)** Suggest reasons for the differences in the life expectancy shown by these data.

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*(2 marks)*

5

**5** 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.

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

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*(1 mark)*

**5 (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)*

**5 (b)** The gene controlling coat colour has three alleles. The allele **B** gives black fur, the allele **b** gives chocolate fur and the allele $\mathbf{b^i}$ gives cinnamon fur.

- Allele **B** is dominant to both allele **b** and $\mathbf{b^i}$.
- Allele **b** is dominant to allele $\mathbf{b^i}$.

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

| Genotype | Phenotype |
|---|---|
| $\mathbf{Bb^i}$ | |
| $\mathbf{bb^i}$ | |
| **Bb** | |

*(1 mark)*

A chocolate male was crossed several times with a black female.
They produced

- 11 black kittens
- 2 chocolate kittens
- 5 cinnamon kittens.

**5 (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)*

**5 (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)*

**5 (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

**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

**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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**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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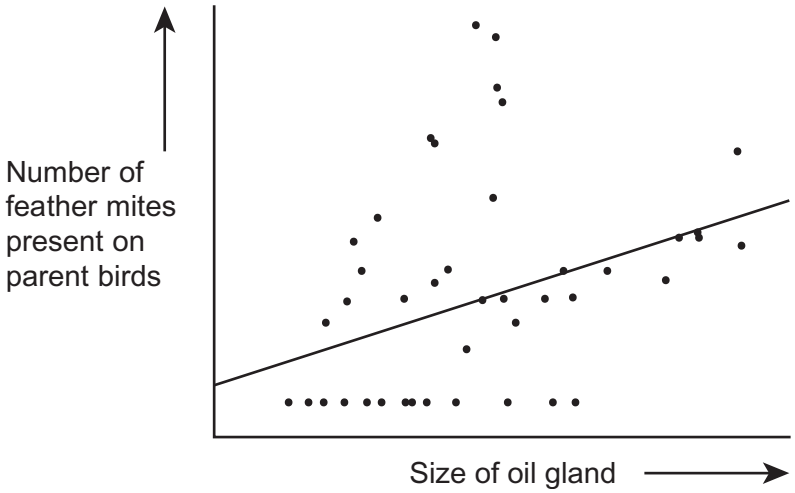
*(1 mark)*

**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

**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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**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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**END OF QUESTIONS**

15

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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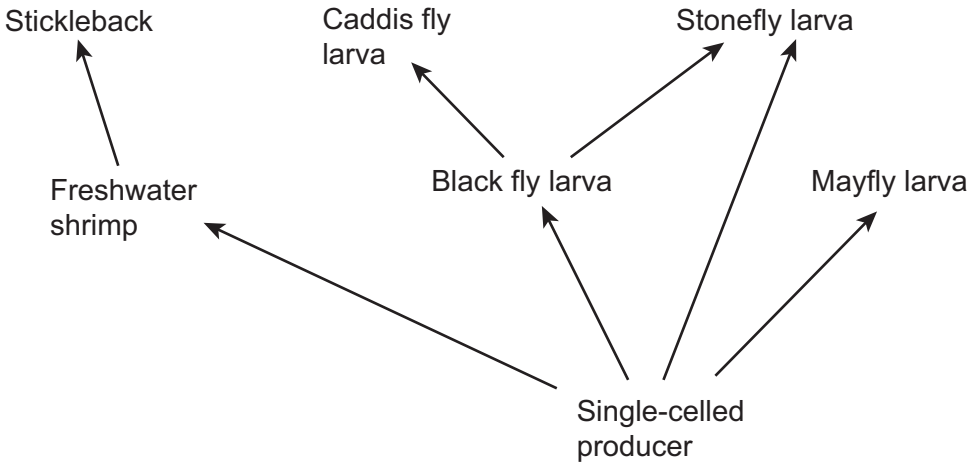
*(2 marks)*

7

**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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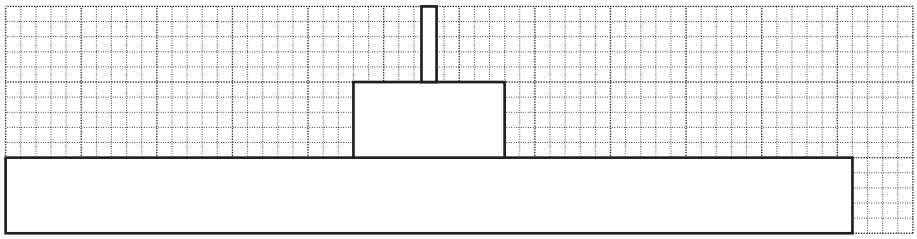
*(2 marks)*

**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

**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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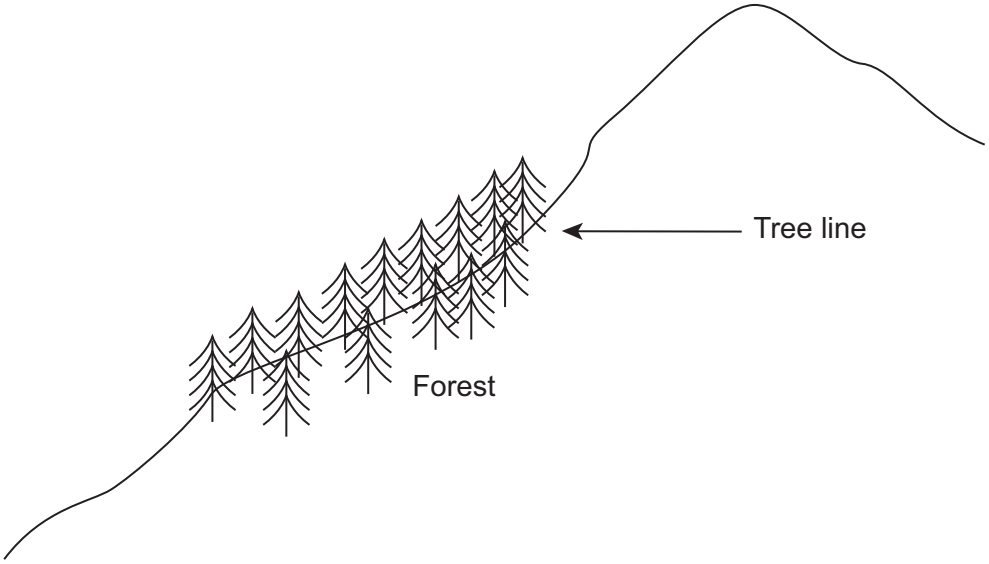
*(2 marks)*

**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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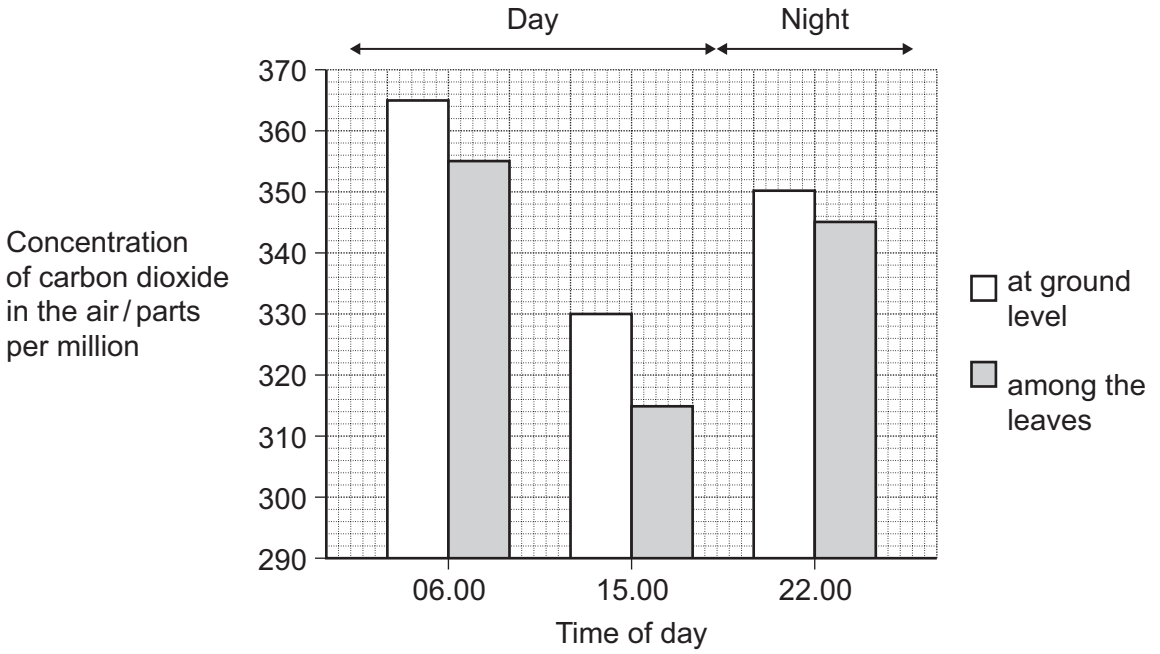
*(1 mark)*

**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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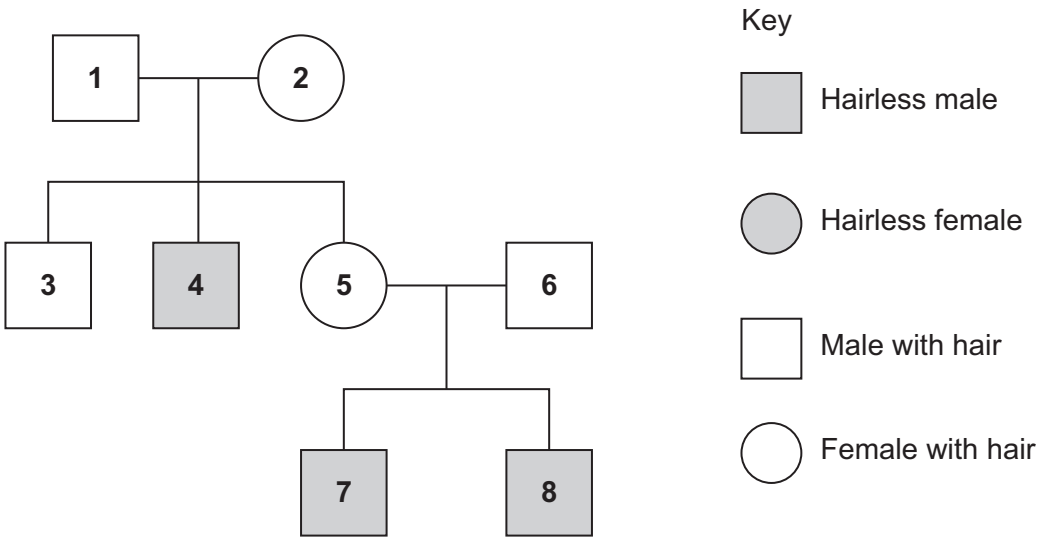
9

**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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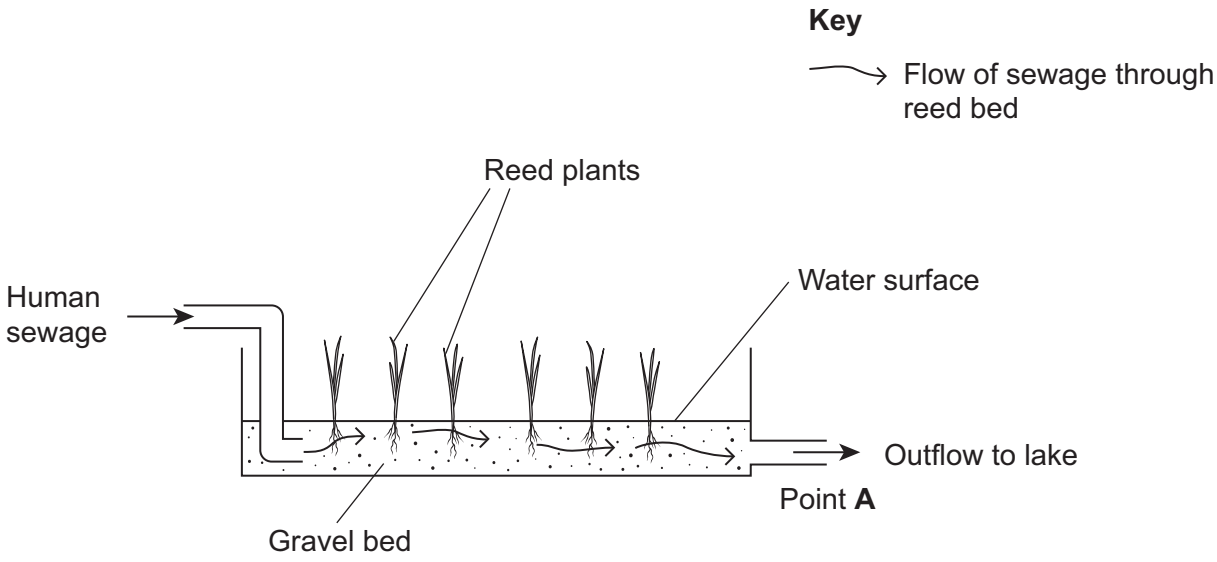
*(1 mark)*

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)*

**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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*(3 marks)*

*(Extra space)* .....

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8

**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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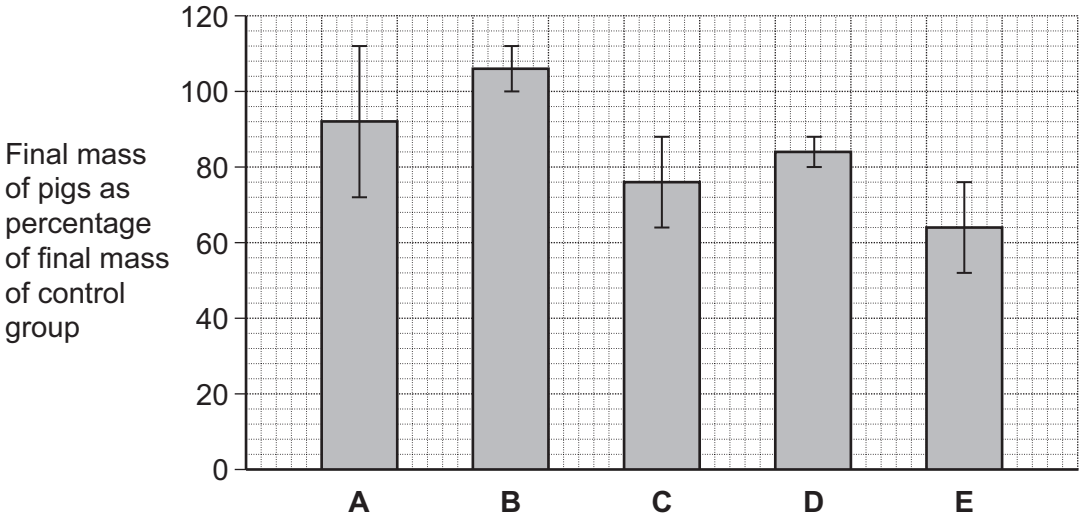
*(2 marks)*

**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)*

*(Extra space)* .....

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15

**8 (a)** ATP is useful in many biological processes. Explain why.

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*(4 marks)*

*(Extra space)* .....

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**Question 8 continues on the next page**

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

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*(6 marks)*

*(Extra space)* .....

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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)*

*(Extra space)* .....

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**END OF QUESTIONS**

Answer **all** the questions.

**1** **(a)** Fig. 1.1 represents a molecule of ATP.

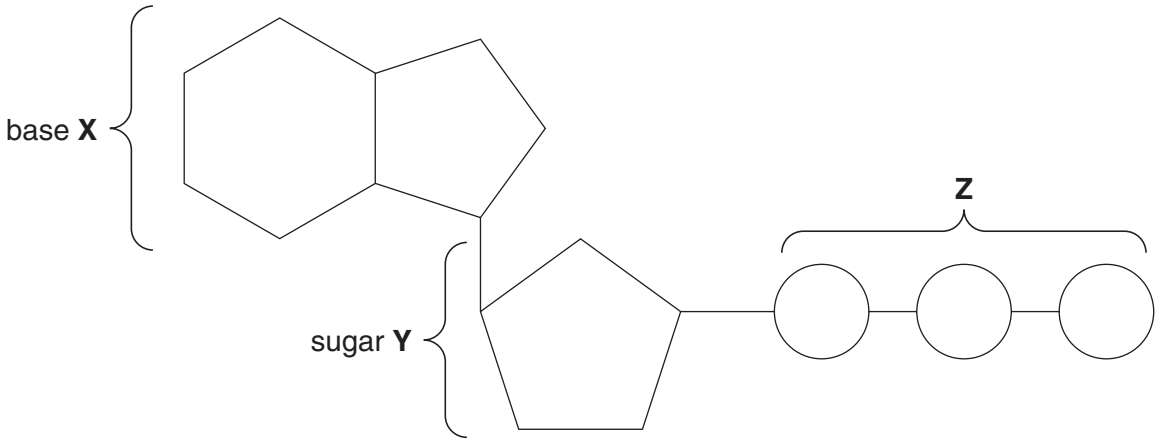


**Fig. 1.1**

**(i)** Name the parts of the ATP molecule labelled **X**, **Y** and **Z**.

**X** .....

**Y** .....

**Z** ..... **[3]**

**(ii)** With reference to Fig. 1.1, describe and explain the role of ATP in the cell.

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..... **[3]**

**(b)** Fig. 1.2 is an electron micrograph of a mitochondrion from an animal cell.

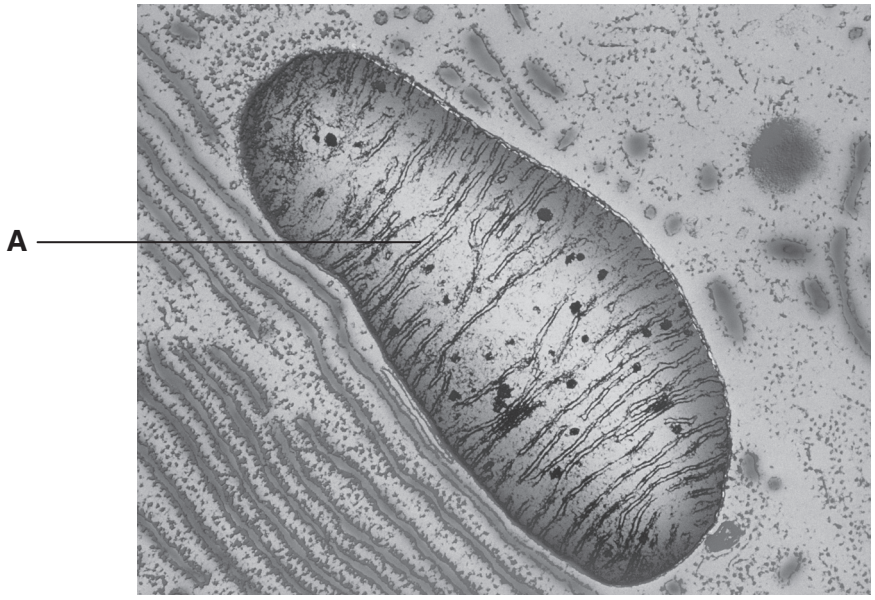


**Fig. 1.2**

**(i)** Name the structure labelled **A**.

..... **[1]**

**(ii)** Name the specific process that is carried out by structure **A** in the mitochondrion.

..... **[1]**

**(c)** Some animals conserve energy by entering a state of torpor (a short period of dormancy), in which they allow their body temperature to fall below normal for a number of hours.

In an investigation into torpor in the Siberian hamster, *Phodopus sungorus*, the animal's respiratory quotient (RQ) was measured before and during the period of torpor.

The respiratory quotient is determined by the following equation:

$$RQ = \frac{\text{volume of carbon dioxide produced}}{\text{volume of oxygen consumed in the same time}}$$

RQ values for different respiratory substrates have been determined and are shown in Table 1.1.

**Table 1.1**

| substrate | RQ |
|---|---|
| carbohydrate | 1.0 |
| lipid | 0.7 |
| protein | 0.9 |

**(i)** Initially, the RQ value determined for the hamster was 0.95, but as the period of torpor progressed, its RQ value decreased to 0.75.

What do these values suggest about the substrates being respired by the hamster during the period of the investigation?

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..... **[3]**

**(ii)** Describe the way in which an endothermic animal, such as a mammal, normally prevents its body temperature from decreasing when the external temperature decreases.

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

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..... **[5]**

**[Total: 16]**

**2** **(a)** Fig. 2.1 is a photomicrograph through the centre of a lobule of a mammalian liver.

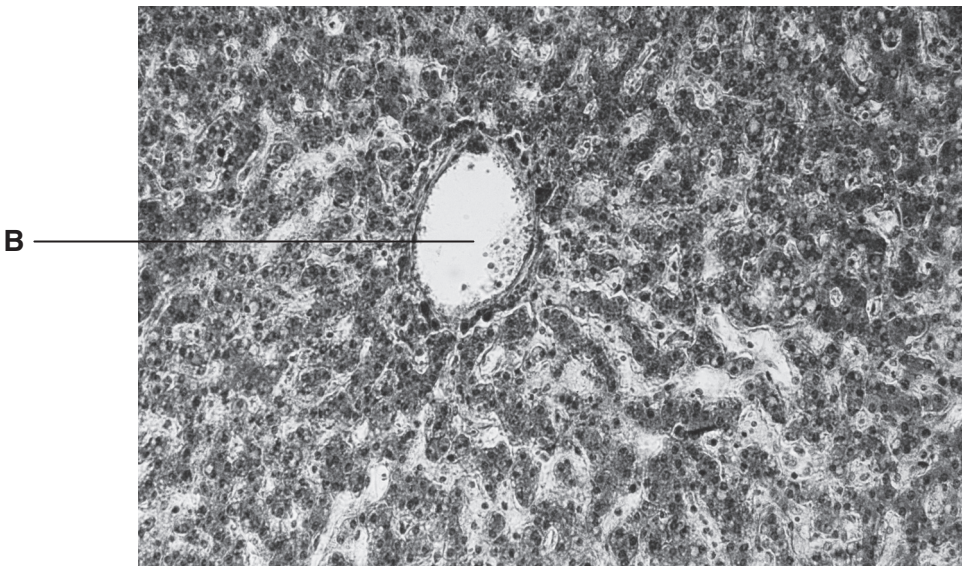


**Fig. 2.1**

**(i)** Name the type of vessel labelled **B**.

..... **[1]**

**(ii)** Name the cells that make up the lobule.

..... **[1]**

**(b)** Fig. 2.2 outlines the formation of urea in the liver.

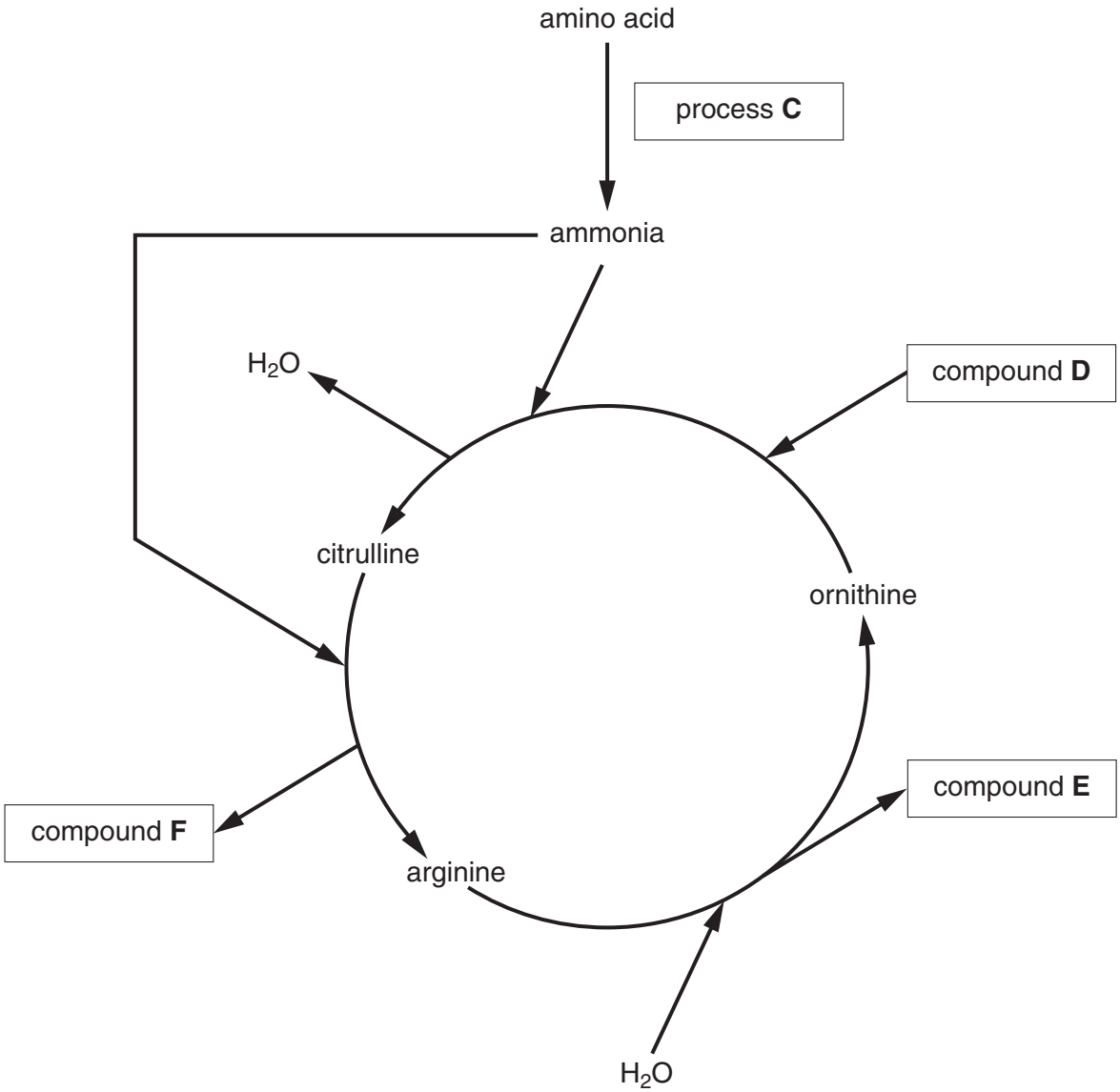


**Fig. 2.2**

Using Fig. 2.2, identify:

process **C** .....

compound **D** .....

compound **E** .....

compound **F** ..... **[4]**

**(c)** The urea formed in the ornithine cycle will be excreted from the body in urine. Urine also contains other chemicals.

Procedures have been developed to test for the presence of some of these chemicals, such as hormones.

**(i)** A pregnancy testing kit contains a testing 'stick' to detect a hormone in the urine.

Explain how the stick detects this pregnancy hormone.

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

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..... **[4]**

**(ii)** The urine of some high profile athletes has been tested and found to contain abnormally high levels of banned steroids or their metabolites.

The pressure on elite athletes to succeed in their sport leads some of them to resort to the use of these performance-enhancing steroids.

Comment on whether the use of steroids should be permitted in sport.

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..... **[3]**

**[Total: 13]**

**3** **(a)** The Calvin cycle is the stage of photosynthesis during which carbon dioxide is fixed. The Calvin cycle uses the products of the light dependent stage.

**(i)** Name the products of the light dependent stage that are used in the Calvin cycle.

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..... **[2]**

**(ii)** Discuss the fate of triose phosphate (TP) in the Calvin cycle.

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..... **[3]**

**(b)** A process known as **photorespiration** also takes place in photosynthetic cells. In this process, oxygen competes with carbon dioxide for the active site of the enzyme RuBP carboxylase (Rubisco).

Fig. 3.1 (a) and Fig. 3.1 (b) outline the processes of photosynthesis and photorespiration.

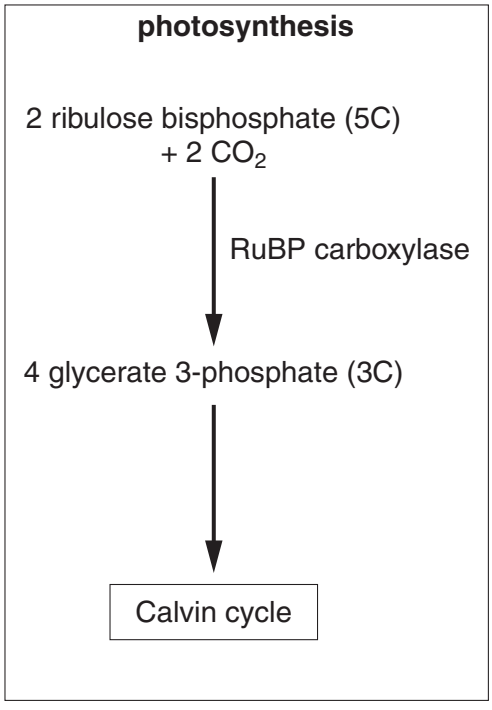


Fig. 3.1 (a)

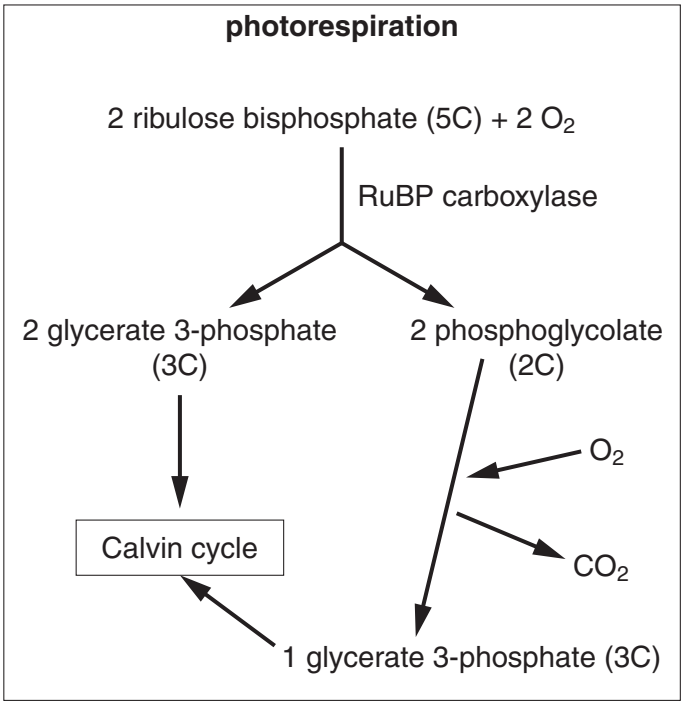


Fig. 3.1 (b)

**(i)** Suggest why the process outlined in Fig. 3.1 (b) is known as photorespiration.

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..... **[2]**

**(ii)** Using Fig. 3.1 (a) and Fig. 3.1 (b), describe and explain the likely effect on photosynthesis of an increase in the oxygen concentration.

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..... **[3]**

**(iii)** Some plants, known as $C_4$ plants, use an enzyme called PEP carboxylase, instead of Rubisco, to fix carbon dioxide.

Suggest why these plants do **not** show photorespiration.

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..... **[1]**

**[Total: 11]**

**4** As part of a study to control Type 2 diabetes by modification of the diet, an investigation was carried out into the effects of different food compounds on the blood glucose and blood insulin concentrations of patients with this type of diabetes.

The food compounds, their components and their effect on blood glucose and blood insulin concentrations are summarised in Table 4.1.

**Table 4.1**

| food compound | component(s) | effect on blood glucose concentration | effect on blood insulin concentration |
|---|---|---|---|
| sucrose | glucose and fructose | moderate increase | moderate increase |
| lactose | glucose and galactose | moderate increase | moderate increase |
| starch | glucose | substantial increase | substantial increase |
| cellulose | glucose | no effect | no effect |
| protein | amino acid | no effect | moderate increase |
| fat | fatty acid and glycerol | no effect | moderate increase |

**(a)** Suggest an explanation for the differences observed in **blood glucose concentration**:

**(i)** between starch and sucrose,

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..... **[2]**

**(ii)** between starch and cellulose.

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..... **[2]**

**(b)** With reference to the food compounds in Table 4.1, explain how a person with Type 2 diabetes could control the condition by modifying their diet.

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..... **[3]**

**(c)** Glycogen and glucagon are compounds that are involved in the control of blood glucose concentration.

Complete the table below to distinguish between these two compounds.

| | glycogen | glucagon |
|---|---|---|
| type of compound | | |
| role of compound | | |
| site of production | | |

**[3]**

**[Total: 10]**

**5** Fig. 5.1 is a trace that shows the changes that occur in the membrane potential of a neurone during the generation of an action potential.

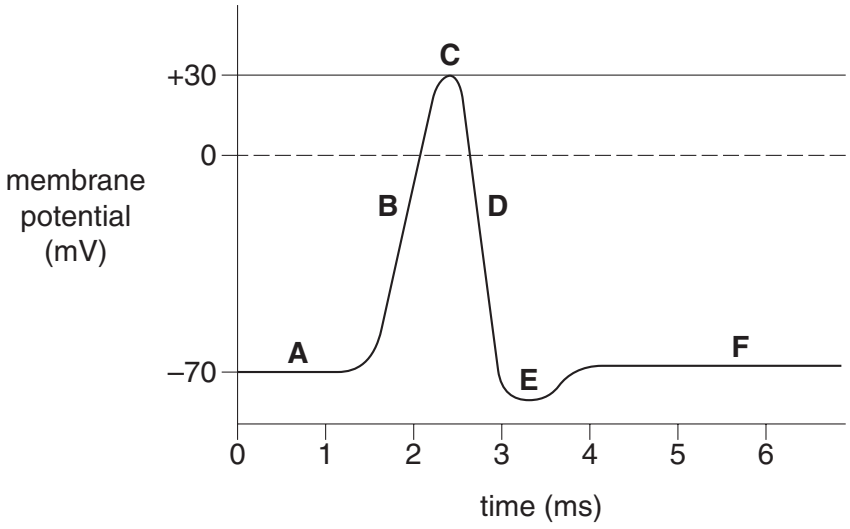


**Fig. 5.1**

**(a)** Using the letters **A** to **F**, indicate the point or points on the trace which correspond to the following:

**(i)** hyperpolarisation,

..... **[1]**

**(ii)** resting potential,

..... **[1]**

**(iii)** the membrane is most permeable to potassium ions,

..... **[1]**

**(iv)** depolarisation.

..... **[1]**

**(b)** Puffer fish, *Fugu spp.*, produce a powerful poison, tetradotoxin, and some species store it in high concentrations in their body tissues. Unless these fish are correctly prepared, eating them can be fatal.

Tetradotoxin is poisonous to humans because it blocks **gated** sodium channels in cell membranes, preventing action potentials. This does not happen in the fish themselves.

**(i)** With reference to Fig. 5.1, identify, using the appropriate letter, the part of the action potential trace that will be affected by tetradotoxin.

..... **[1]**

**(ii)** Suggest why tetradotoxin is **not** toxic to the puffer fish.

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..... **[1]**

**(c)** Multiple sclerosis (MS) is an auto-immune condition in which the nervous system is damaged. This damage leads to loss of sensation. One form of damage is shown in Fig. 5.2.

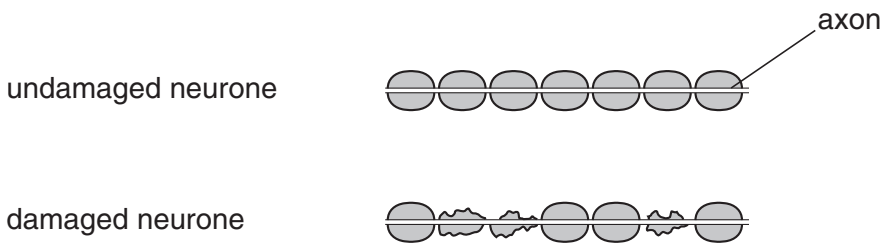


**Fig. 5.2**

**(i)** Suggest why MS is described as an auto-immune condition.

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..... **[2]**

**(ii)** Explain why this damage leads to a loss of sensation.

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..... **[2]**

**[Total: 10]**

**END OF QUESTION PAPER**

**1** **(a)** The nervous system is made up of a number of different types of neurone, which transmit electrical impulses.

Complete the table below by stating **three** differences in the structure of motor and sensory neurones.

| motor neurone | sensory neurone |
|---|---|
| | |
| | |
| | |

**[3]**

**(b)** Complete the following passage, using the most appropriate term(s) in each case.

When an impulse is not passing along a neurone, a resting potential of .....mV is established. When the neurone is stimulated, it causes ..... of the cell surface membrane. This will not generate an action potential unless it is large enough to exceed the ..... ..... .

A neurone will either conduct an action potential or not; this is described as the ..... - ..... - ..... law.

Action potentials all have the same ..... . The only way in which the intensity of a stimulus can be interpreted is by the ..... of the action potential. **[6]**

**[Total: 9]**

**2** A student carried out an experiment to investigate the effect of light intensity on the rate of photosynthesis in an aquatic plant, using the apparatus shown in Fig. 2.1.

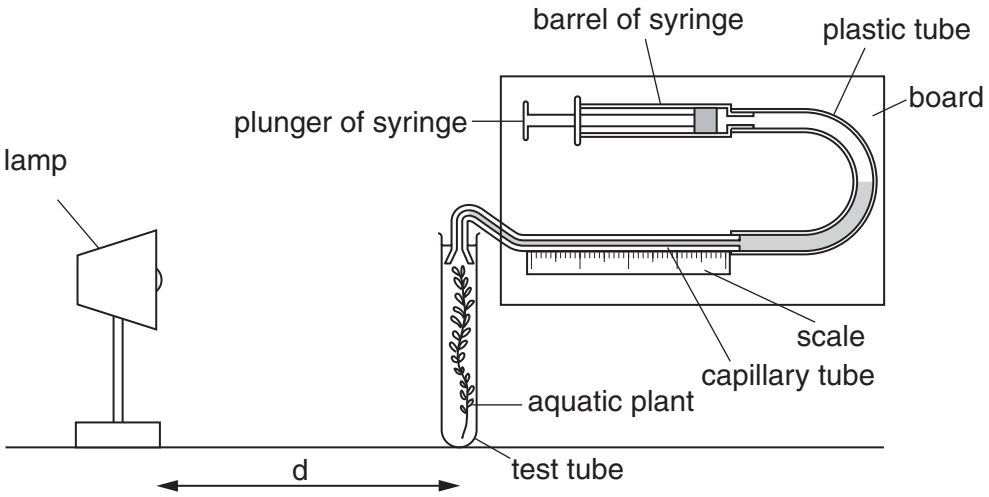


**Fig. 2.1**

The student decided to measure the rate of photosynthesis by measuring the gas produced over a five minute period. The gas collected in the capillary tube.

After five minutes, the length of the bubble was measured along the scale.

The light intensity was varied by altering the distance (d) between the lamp and the photosynthesising plant.

The student prepared Table 2.1 to calculate the light intensity.

**Table 2.1**

| distance (d) from lamp to plant (cm) | light intensity $\left(\frac{1}{d^2}\right)$ |
|---|---|
| 4 | 0.0625 |
| 8 | 0.0156 |
| 12 | 0.0069 |
| 16 | 0.0039 |
| 20 | 0.0025 |
| 24 | |
| 60 | 0.0003 |

**(a) (i)** Calculate the light intensity when the lamp was 24 cm from the plant.

Show your working.

Answer = ..... **[2]**

**(ii)** The length of the gas bubble was measured (in mm).

State what additional information would be required to calculate the **volume** of gas produced.

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..... **[1]**

**(iii)** Suggest how the student supplied the aquatic plant with a source of carbon dioxide.

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..... **[1]**

**(b)** Certain assumptions are made when using the apparatus shown in Fig. 2.1 to measure the rate of photosynthesis.

**(i)** One of these assumptions is that all of the oxygen produced by the plant during photosynthesis is collected.

Suggest why not all of the oxygen produced by the plant is collected.

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..... **[2]**

**(ii)** Another assumption is that all of the gas collected is oxygen.

Analysis of the gas collected reveals that it has the following composition:

- oxygen 50%
- nitrogen 44%
- carbon dioxide 6%

Suggest a reason for the presence of nitrogen in the gas collected.

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..... **[1]**

**(iii)** Comment on the percentage of carbon dioxide present in the gas collected and give reasons for this figure.

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..... **[3]**

**(c)** Some aquatic photosynthetic organisms, for example seaweeds, contain pigments such as fucoxanthin and phycoerythrin, in addition to chlorophyll. These pigments give seaweeds a brown or red colour and are produced in larger quantities in those seaweeds that live in deeper water.

Suggest why the presence of these pigments is an advantage to seaweeds that live in deeper water.

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..... **[2]**

**[Total: 12]**

**3** Fatigue is a symptom of some medical conditions. One feature of fatigue is extreme tiredness, due to a lack of energy.

Medical conditions that have fatigue as a characteristic symptom include Type 2 diabetes, certain heart conditions, chronic fatigue syndrome (CFS) and emphysema.

**(a)** Explain how emphysema could result in fatigue.

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..... **[2]**

**(b)** In Type 2 diabetes, the target cells do not respond correctly to the insulin produced when there is an increase in blood glucose concentration.

Suggest why fatigue may occur in a person with Type 2 diabetes who is **not** taking medication.

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..... **[2]**

**(c)** Certain heart conditions result in a weak and irregular heart beat.

Suggest how a weak and irregular heart beat could result in fatigue.

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..... **[2]**

**(d)** Chronic fatigue syndrome (CFS) is a condition in which symptoms vary from individual to individual.

It is thought that a number of different malfunctioning processes can contribute to this condition in an individual.

CFS can affect every system in the body and is identified by symptoms that include fatigue, muscle weakness and aching muscles.

**(i)** It has been suggested that, in the cells of people with CFS, pyruvate may not be transferred into the mitochondria efficiently.

Outline the consequences of an inefficient transfer of pyruvate into mitochondria and link this to the symptoms of CFS stated above.

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..... **[3]**

**(ii)** Some people with CFS overproduce T lymphocytes and associated cytokines. Despite this, the specific immune response is poor in these people, resulting in an increased susceptibility to infection.

Suggest a reason for the poor specific immune response in people with CFS.

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..... **[1]**

**[Total: 10]**

**4** **(a)** The pancreas is an unusual gland as it is both an endocrine and an exocrine gland.

Fig. 4.1, **on the insert**, shows a group of cells in the pancreas.

**(i)** State the name given to the group of cells labelled **X**.

..... **[1]**

**(ii)** Describe the different ways in which the pancreas acts as both an endocrine and an exocrine gland.

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

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..... **[5]**

**(b)** One particular type of cell in the pancreas is responsible for secreting insulin. The various events involved in the secretion of insulin are listed below.

| | |
|---|---|
| **A** | Glucose is phosphorylated and metabolised to produce ATP |
| **B** | Potassium channels open, allowing potassium ions to diffuse out of the cell |
| **C** | The change in voltage across the membrane causes calcium channels to open |
| **D** | Glucose enters the cell |
| **E** | The movement of ions results in a potential difference across the cell surface membrane of –70 mV |
| **F** | Calcium ions diffuse into the cell |
| **G** | The presence of extra ATP causes the potassium channels to close |
| **H** | The membrane potential changes to –30 mV |
| **J** | The calcium ions cause the vesicles to fuse with the membrane and release insulin |

Complete the following list by placing the events in the correct order.

**B** **E** ..... ..... ..... ..... ..... ..... **J** **[4]**

**(c)** **(i)** State **two** advantages of treating **Type 1** diabetes by using insulin that has been produced by genetically modified bacteria rather than insulin that has been extracted from pigs.

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..... **[2]**

**(ii)** A potential treatment for Type 1 diabetes is the use of stem cells.

State an advantage of this form of treatment compared to treatment using insulin.

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..... **[1]**

**[Total: 13]**

**5** **(a)** Fig. 5.1 is a drawing representing a vertical section through a mammalian kidney.

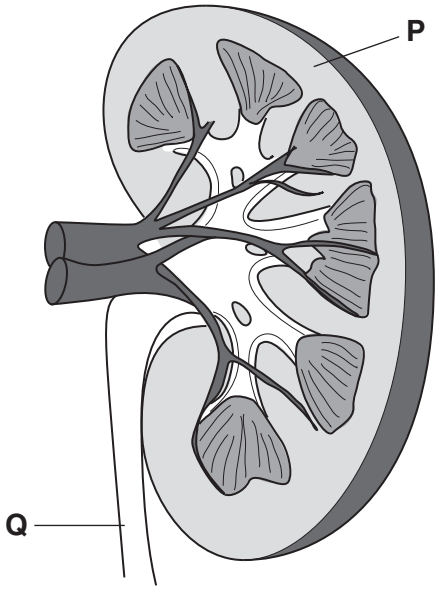


**Fig. 5.1**

Name the region **P** and the structure **Q**.

**P** .....

**Q** ..... **[2]**

**(b) (i)** Each kidney contains approximately one million nephrons. Each section of a kidney nephron is adapted to perform its function effectively.

Describe the features of the **glomerulus** and **Bowman's capsule** that allow them to perform their function effectively.

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

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..... **[4]**

**(ii)** Nephritis is a condition in which the tissue of the glomerulus and proximal convoluted tubule becomes inflamed and damaged.

Suggest **two** differences in the composition of the urine of a person with nephritis when compared to the urine of a person with healthy kidneys.

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..... **[2]**

**(c)** Caffeine is a mild diuretic. Caffeine prevents the introduction of additional aquaporins into the wall of the collecting duct of the nephron and therefore additional water is not removed from the urine.

Aquaporins are channels in the cell surface membrane that allow water molecules to pass through.

Fig. 5.2 represents an aquaporin.

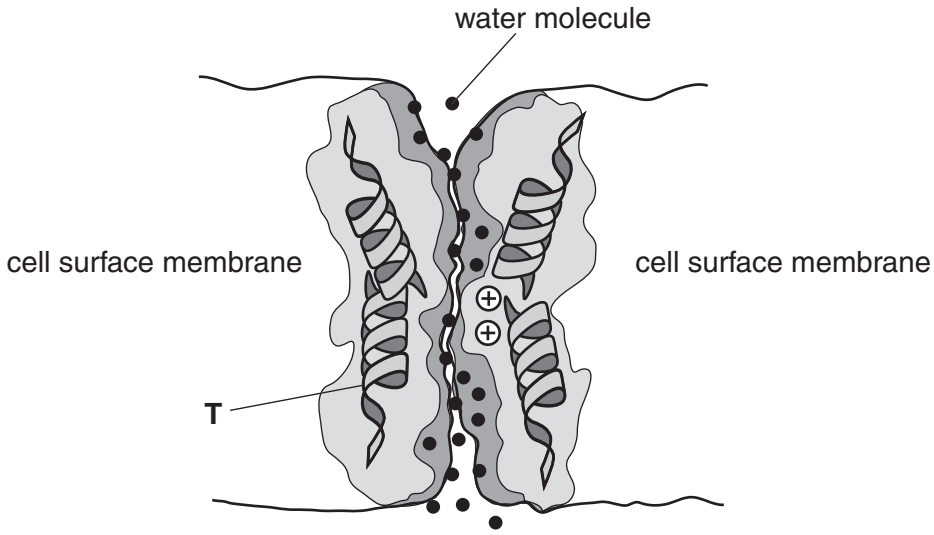


**Fig. 5.2**

**(i)** Identify the type of molecule labelled **T**.

..... **[1]**

**(ii)** The aquaporin allows water to travel from the collecting duct into the surrounding tissues but prevents the passage of ions such as sodium ions and potassium ions.

With reference to Fig.5.2, suggest **two** ways in which the structure of this aquaporin prevents the passage of ions.

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..... **[2]**

**[Total: 11]**

**6** **(a)** State the **precise** location where each of the following biochemical processes take place:

**(i)** the production of glucocorticoids in the body

..... **[1]**

**(ii)** chemiosmosis within an animal cell.

..... **[1]**

**(b)** Name the mechanism or process that is being described in each of the following statements.

**(i)** *A person breathes in air that is high in carbon dioxide. This produces a high concentration of carbon dioxide in the blood. This increased concentration is detected by receptors, resulting in the person breathing more rapidly. In turn, more carbon dioxide enters the blood causing the breathing to be even more rapid.*

The mechanism being described is:

..... **[1]**

**(ii)** *Light strikes a molecule of chlorophyll a in photosystem I, providing it with enough energy so that it loses an electron. This electron is passed along a series of electron carriers and then returns to a molecule of chlorophyll a in photosystem I. As the electron loses energy, ATP is formed.*

The process being described is:

..... **[1]**

**(iii)** *As an animal needs to respond to changes in the external and internal environment, communication between cells takes place within the body to coordinate the activities of different organs.*

The mechanism being described is:

..... **[1]**

**[Total: 5]**

**END OF QUESTION PAPER**

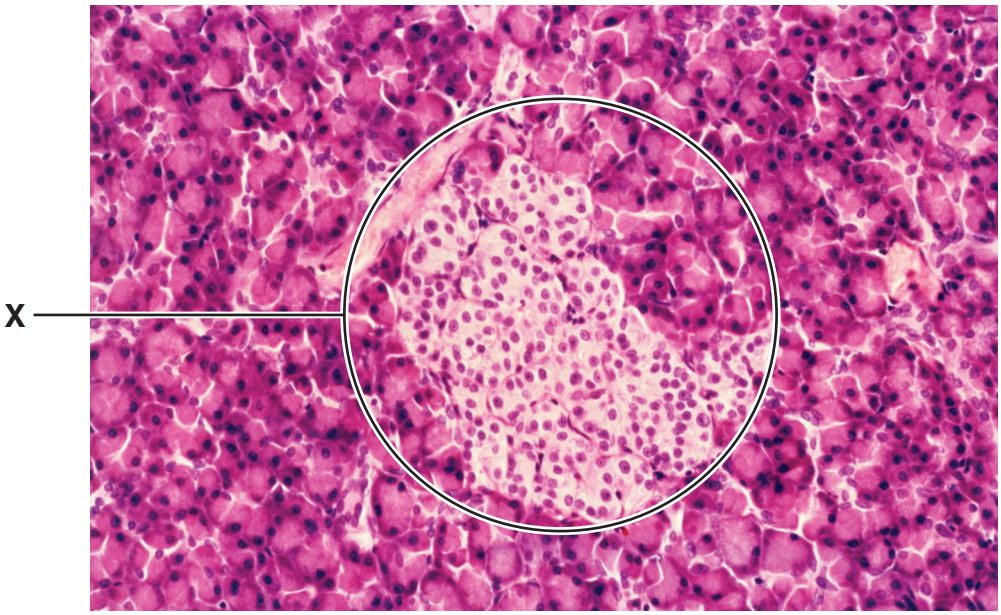


Fig. 4.1