Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

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2870919556

BIOLOGY **9700/21**

Paper 2 Structured Questions AS **October/November 2015**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
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Answer **all** the questions

1 Fig. 1.1 is an electron micrograph of a mitochondrion.

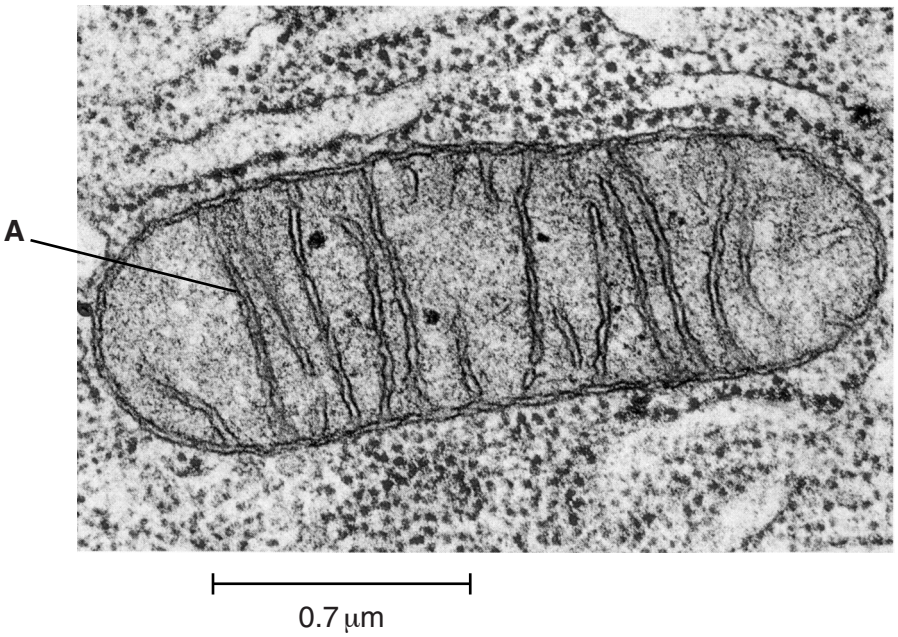


Fig. 1.1

(a) State the function of mitochondria.

..... [1]

(b) Name structure **A**.

..... [1]

(c) Calculate the magnification of the image in Fig. 1.1.

Show your working.

magnification × ..... [2]

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(d) Explain why the light microscope could **not** be used to produce the image in Fig. 1.1.

.....

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.....

.....

..... [2]

(e) Scientists think that mitochondria were once prokaryotes. The evidence for this is that mitochondria have features in common with prokaryotes.

State two features that mitochondria have in common with prokaryotes.

1. .....

2. .....

[2]

[Total: 8]

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2 Fig. 2.1 is a diagram of the structure of a protein channel for ions in a cell surface membrane.

Fig. 2.1a shows the channel when open and Fig. 2.1b shows the same channel when closed.

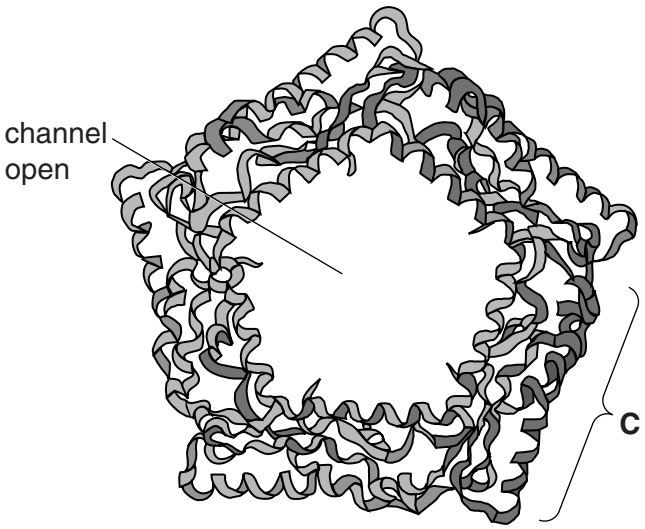


Fig. 2.1a

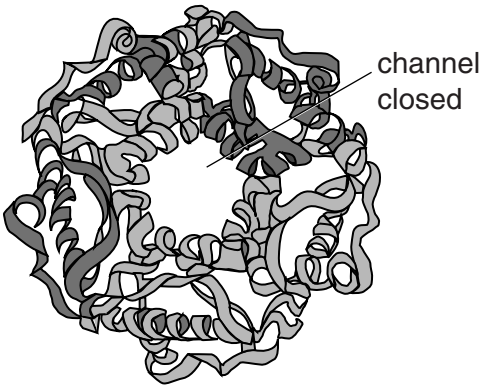


Fig. 2.1 b

(a) (i) Name the process by which ions pass across the membrane using channel proteins.

..... [1]

(ii) Explain why a channel protein is needed for ions to pass across a cell membrane.

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..... [2]

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(b) The channel protein in Fig. 2.1 is made from five identical polypeptide chains.

(i) Name the level of protein structure which is present when five polypeptide chains form the protein.

..... [1]

(ii) The part labelled **C** in Fig. 2.1 is another level of protein structure.

Name this level.

..... [1]

(c) Channel proteins are examples of transmembrane proteins. The polypeptides are held together and also interact with phospholipids in the membrane.

Suggest how the polypeptides are held together **and** suggest how they interact with phospholipids.

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..... [3]

[Total: 8]

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3 Fig. 3.1 is a light micrograph of cells in the root tip of the garlic plant *Allium sativum*. It has a diploid number (2n) of 16.

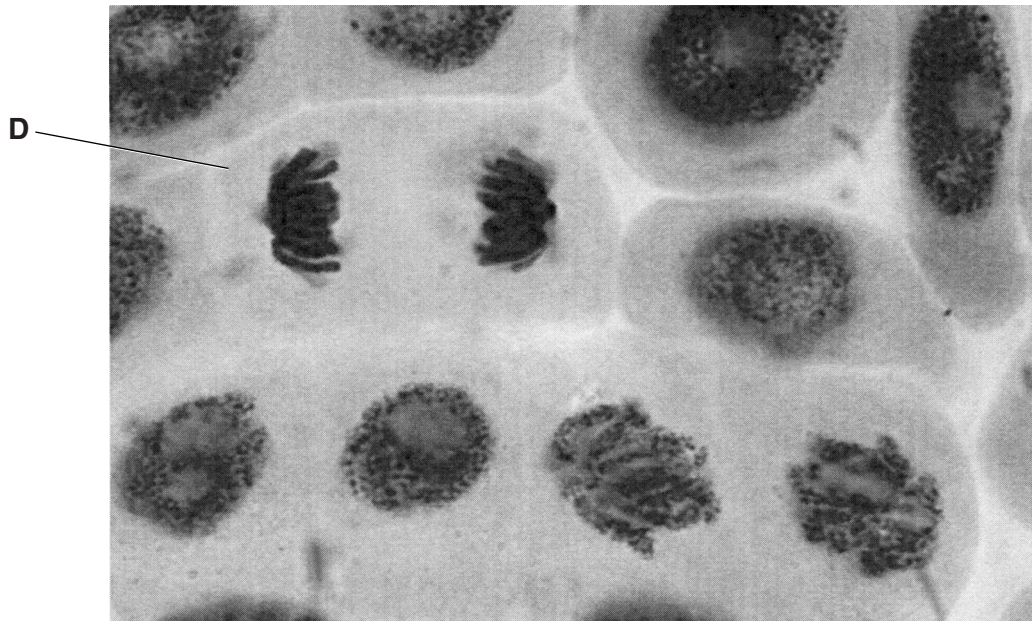


Fig. 3.1

(a) Name the stage of mitosis shown in cell **D**.

..... [1]

(b) Explain why mitosis occurs in a plant such as *A. sativum*.

.....

.....

.....

.....

..... [2]

(c) **(i)** State the haploid number of *A. sativum*.

..... [1]

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(ii) Explain why a plant such as *A. sativum* produces haploid cells.

.....

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..... [3]

(d) DNA replication must occur before cell division.

Describe the process of DNA replication.

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..... [5]

[Total: 12]

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4 Marram grass, *Ammophila arenaria*, is a xerophyte adapted to grow in sandy soils in exposed locations.

Fig. 4.1 is a light micrograph of a section through a leaf of marram grass.

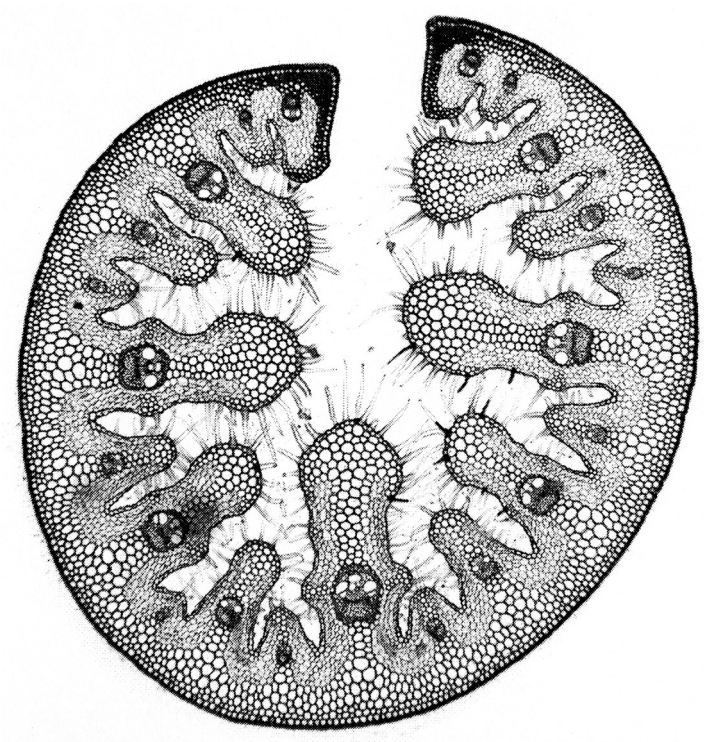


Fig. 4.1

(a) *A. arenaria* is adapted to reduce transpiration.

(i) State what is meant by the term *transpiration*.

.....

.....

.....

.....

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.....

..... [3]

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(ii) One adaptation of *A. arenaria* is the curled leaf.

Give **one** other adaptation, **visible in Fig. 4.1**, and explain how this reduces transpiration.

adaptation

.....

.....

explanation

.....

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.....

..... [3]

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(b) A student investigated the rates of transpiration and absorption of water by two species of plants, **P** and **Q**, over an 18 hour period between 0600 and 2400. The environmental conditions for the two species were the same.

The results are shown in Fig. 4.2.

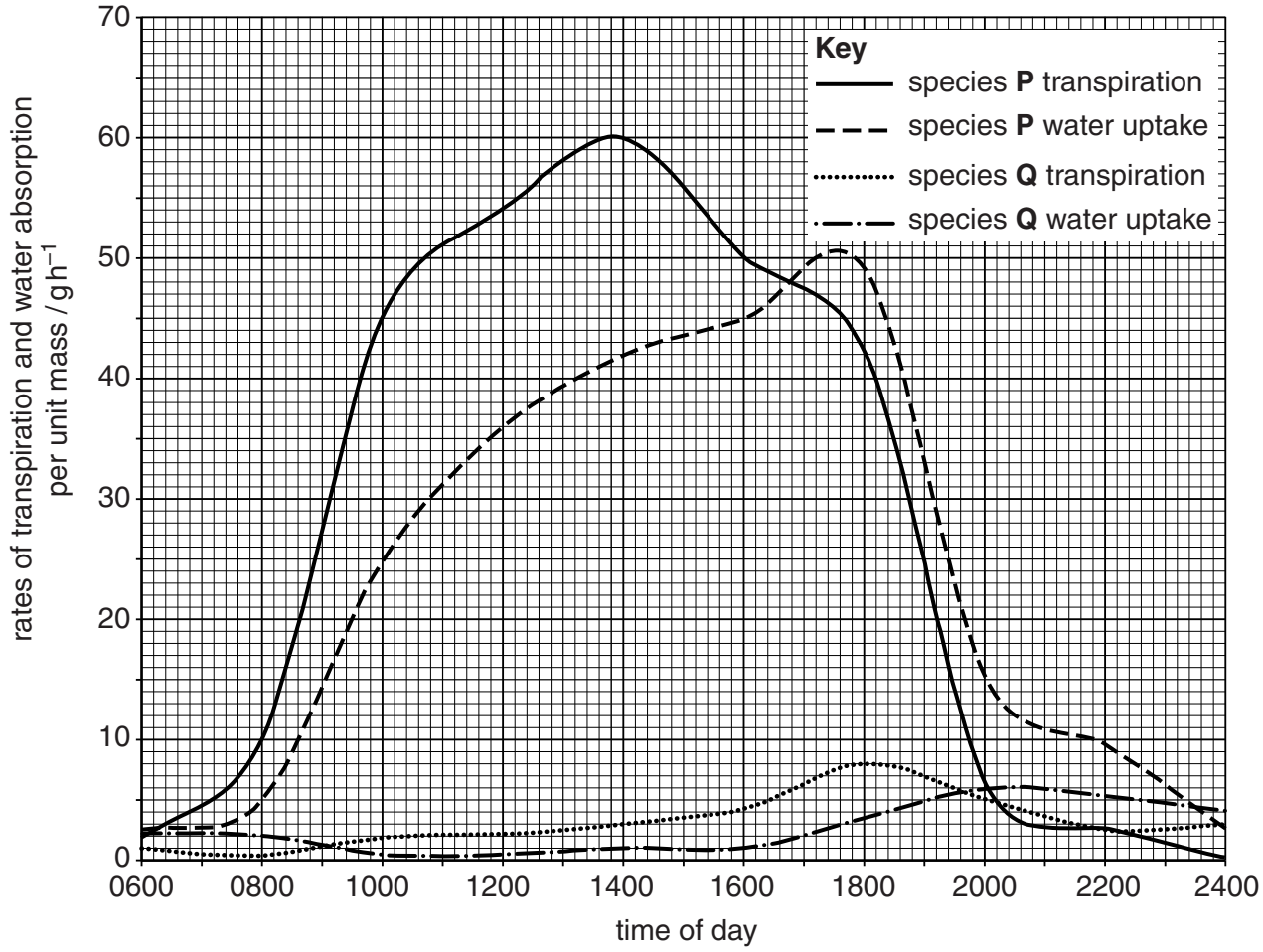


Fig. 4.2

(i) Use Fig. 4.2 to calculate the difference between the rates of transpiration and water absorption for species **P** at time 1400.

answer ..... [2]

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(ii) Describe **and** explain the patterns of transpiration **and** water absorption for species **P**.

.....

.....

.....

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.....

..... [4]

(iii) Suggest why the pattern of transpiration for species **Q** is not the same as for species **P**.

.....

.....

.....

.....

.....

.....

..... [2]

[Total: 14]

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5 **(a)** State the name of the causative organism (pathogen) of measles.

..... [1]

(b) Describe how the measles pathogen is transmitted.

.....

.....

.....

.....

..... [2]

(c) The measles pathogen contains a single stranded RNA molecule and no DNA.

The cells that the measles pathogen infects contain double stranded DNA molecules.

State two **other** ways in which the RNA in the measles pathogen differs from the DNA in the infected cells.

1. .....

.....

2. .....

.....
[2]

(d) The measles pathogen must carry out RNA replication to make new RNA molecules for the new pathogens. This happens inside the infected cell.

The pathogen carries its own enzyme for RNA replication, but no other enzymes.

Explain why the measles pathogen cannot use an enzyme from the cell to carry out RNA replication.

.....

.....

.....

.....

..... [2]

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(e) The outer part of the measles pathogen contains an antigen called the H-protein. This antigen appears on the surface of cells infected with the measles pathogen.

Describe the role played by T-lymphocytes in a primary immune response to an infection by the measles pathogen.

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..... [5]

[Total: 12]

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6 Fig. 6.1 is a food web.

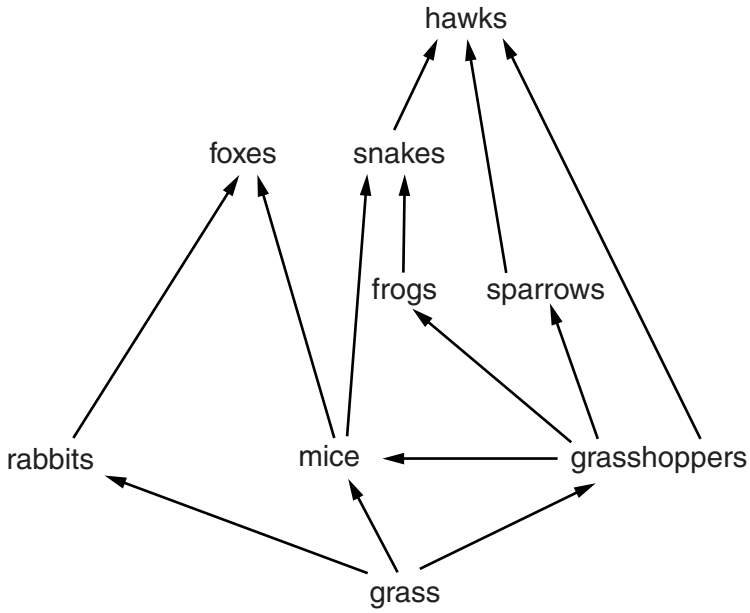


Fig. 6.1

(a) From the food web in Fig. 6.1, name:

(i) the producer

..... [1]

(ii) an organism feeding only as a primary consumer.

..... [1]

(iii) The hawks are top predators.

Name **one other** top predator shown in Fig. 6.1.

..... [1]

(b) Name the processes in the nitrogen cycle in which the following changes occur:

nitrate ions ⟶ nitrogen gas

.....

ammonium ions ⟶ nitrate ions

.....

nitrogen gas ⟶ ammonium ions.

..... [3]

[Total: 6]

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BIOLOGY **9700/22**

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1 hour 15 minutes

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Answer **all** the questions

1 A student compared an image of a plant cell with an image of an animal cell. Both images were at the same magnification.

Parts **(a)** to **(c)** are four correct comparative statements about these images.

(a) Both cells contain large numbers of an organelle, bound by a double membrane. The inner membrane of these organelles is folded. These organelles all have a similar structure but do not always appear to have the same shape.

(i) State the name of the organelles described.

..... [1]

(ii) Suggest **one** reason why the organelles described do not always seem to have the same shape.

.....

.....

..... [1]

(b) Both cells contain cell structures that are approximately 25 nm in diameter and are **not** bound by a membrane.

(i) State the name of the cell structures described.

..... [1]

(ii) Draw a circle around the measurement that has the same value as 25 nm.

0.00025 μm **0.0025 μm** **0.025 μm** **0. 25 μm** **2.5 μm**

[1]

(c) There are strands of cytoplasm passing through channels in the cell wall of the plant cell. These are not visible in the animal cell.

(i) State the name of the cell structures described.

..... [1]

(ii) Explain **one** advantage to the plant cell of having these structures.

.....

.....

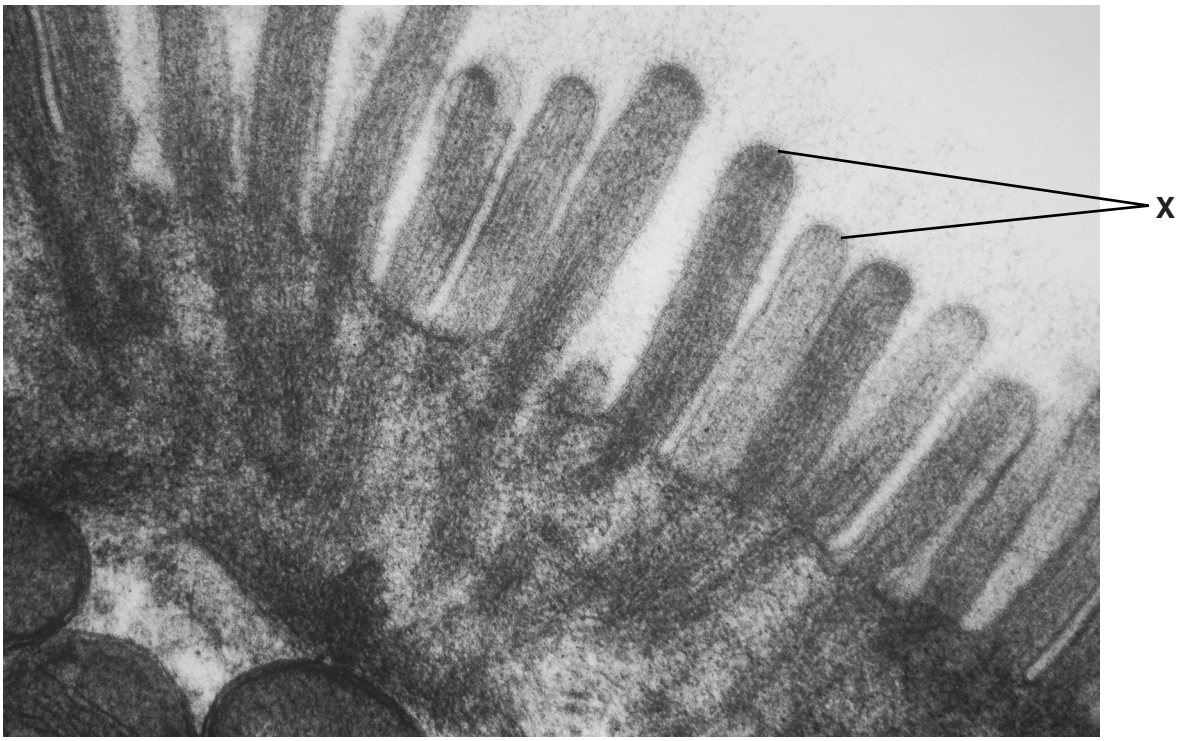
.....

..... [1]

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(d) Fig. 1.1 is a transmission electron micrograph of part of an epithelial cell from the small intestine of a mammal.



magnification × 65000

Fig. 1.1

Name the cell structures labelled **X** in Fig. 1.1 **and** state their function.

.....

.....

.....

..... [1]

[Total: 7]

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2 Tobacco smoking is known to be associated with atherosclerosis and emphysema.

(a) Outline ways in which tobacco smoking can contribute to atherosclerosis.

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.....

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.....

..... [3]

(b) Fig. 2.1 is a scan of the lungs of a person with emphysema. One common feature in the damaged areas labelled is a loss of the elastic fibres of the alveoli. Another feature is an increased number of macrophages and neutrophils.

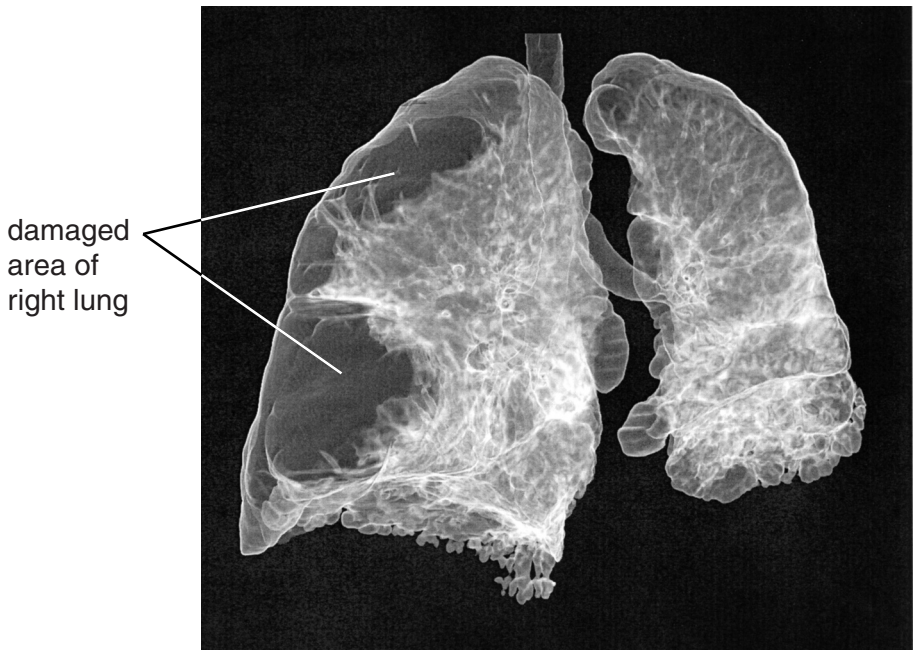


Fig. 2.1

(i) State the general role shared by macrophages and neutrophils.

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..... [1]

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(ii) Suggest how the loss of the elastic fibres would cause the enlargement of the lung shown in Fig. 2.1.

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..... [2]

(c) The synthesis and release of elastase enzymes by macrophages and neutrophils is an important feature in the development and progression of emphysema. Elastase causes the breakdown of the protein elastin, the main component of elastic fibres.

(i) Explain what is meant by an enzyme.

.....

.....

..... [2]

(ii) Elastase has an active site with a specific shape. The mode of action of this enzyme supports the lock and key hypothesis.

Explain the mode of action of elastase.

You may use the space below to draw a diagram or diagrams to help your answer.

.....

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.....

.....

..... [3]

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(d) There are two inhibitors of elastase that are produced in the body, TIMP-1 and A1AT:

- macrophage elastase is inhibited by TIMP-1
- neutrophil elastase is inhibited by A1AT.

The inhibitors can be inactivated by the elastase enzymes:

- macrophage elastase can inactivate A1AT
- neutrophil elastase can inactivate TIMP-1.

In healthy lungs, the activity of elastase enzymes is regulated. Tobacco smoke can disrupt this regulation.

(i) One effect of tobacco smoke is to cause changes in the structure of A1AT, a competitive inhibitor.

Suggest how structural changes to A1AT will affect its mode of action.

.....

.....

..... [1]

(ii) A1AT is a protein. Some non-smokers have a mutation in the gene coding for A1AT and are at risk of developing emphysema as there is a lack of A1AT in the lung tissue.

Explain why a lack of A1AT in these non-smokers means that they are at risk of developing emphysema.

.....

.....

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..... [3]

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(e) Tobacco smoke is known to cause increased production of macrophage elastase. *MMP12* is the gene coding for macrophage elastase. Copies of this gene are produced as messenger RNA (mRNA).

Describe how this mRNA is used in translation to produce macrophage elastase.

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..... [5]

[Total: 20]

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[Turn over

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3 The photomicrographs in Fig. 3.1 show stages of the mitotic cell cycle occurring in the root tip of the onion, *Allium sp*. They are all of the same magnification. Stages **A** to **C** are in the correct sequence and stages **K** to **N** are **not** in the correct sequence.

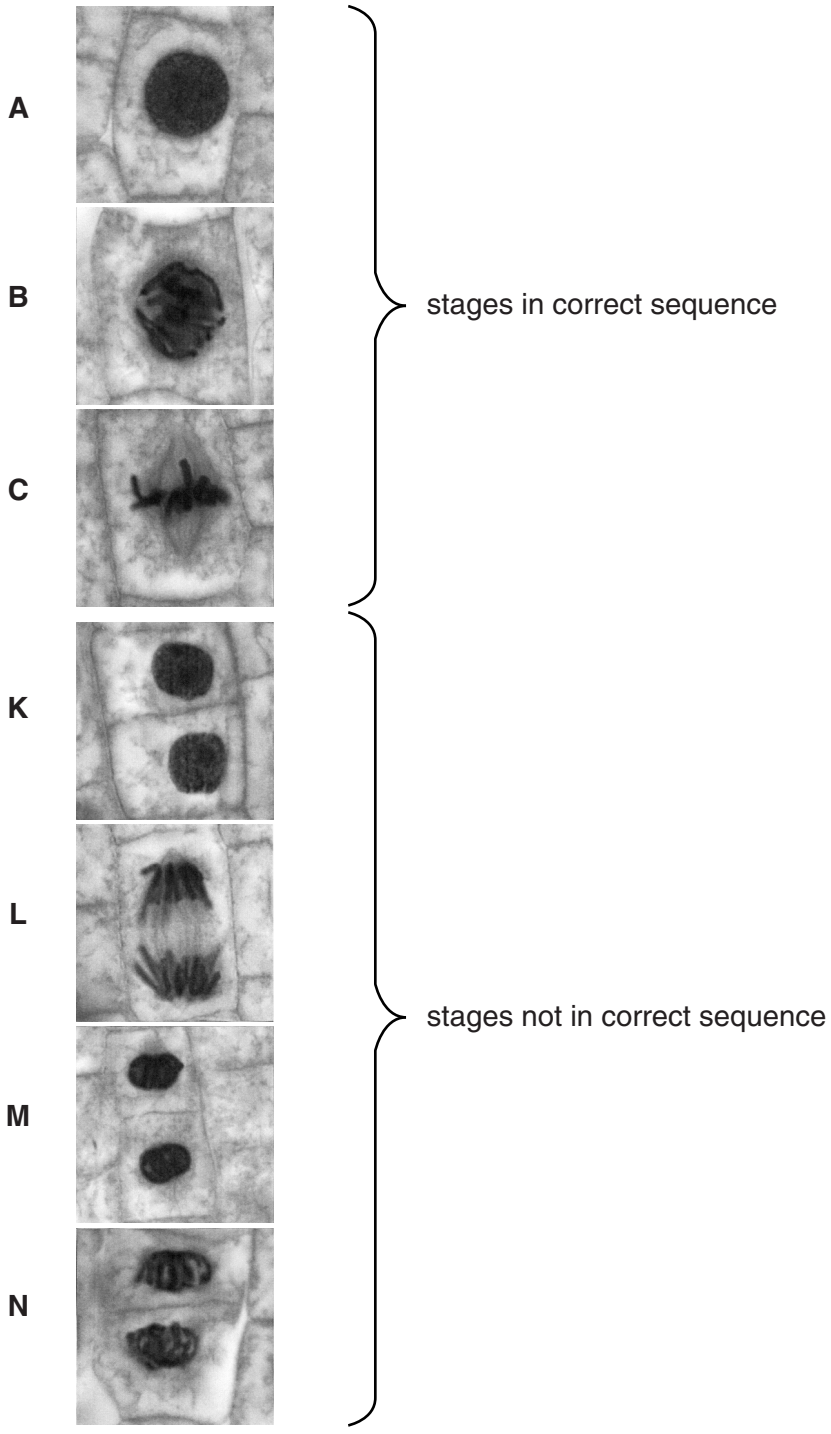


Fig. 3.1

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(a) Name stages **A** and **C**.

A .....

C ..... [1]

(b) Put stages **K** to **N** in the correct sequence, starting with the stage that immediately follows stage **C**.

C ⟶ ..... ⟶ ..... ⟶ ..... ⟶ ..... [1]

(c) Explain how the behaviour of the chromosomes and spindle during stage **L** in Fig. 3.1 ensures that the two daughter cells will be genetically identical.

.....

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..... [3]

[Total: 5]

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4 **(a)** Table 4.1 describes three examples of substances moving into or out of cells.

Complete Table 4.1 by identifying the transport mechanism involved for each example.

Table 4.1

example	transport mechanism involved
uptake of magnesium ions from a lower concentration in the soil solution to a higher concentration in the cytoplasm of a root hair cell	
release of antibodies from an active B-lymphocyte (plasma cell)	
movement of sucrose from a companion cell into a phloem sieve tube element via plasmodesmata	

[3]

(b) Oxygen moves into and out of red blood cells. Fig. 4.1 shows an oxygen dissociation curve for adult human haemoglobin.

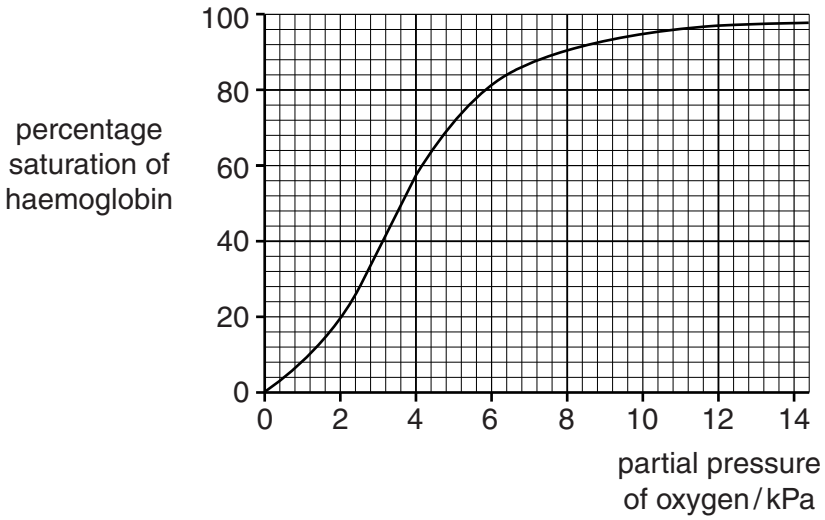


Fig. 4.1

The steepest part of the curve is between 2.6 kPa and 4.2 kPa.

Explain the importance of this for respiring tissues.

.....

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.....

..... [2]

[Total: 5]

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5 Diseases can be infectious or non-infectious.

(a) Explain the difference between an infectious and a non-infectious disease.

.....

.....

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..... [2]

Malaria is an infectious disease caused by *Plasmodium*. *Plasmodium* requires two hosts to complete its complex life cycle. One of the hosts is the *Anopheles* mosquito, which acts as a vector of malaria.

Transmission of malaria occurs when females of some species of *Anopheles* take blood meals from humans infected with *Plasmodium*, and then feed on uninfected individuals.

Both male and female *Anopheles* mosquitos have piercing and sucking mouthparts. The female mosquito is shown in Fig. 5.1.

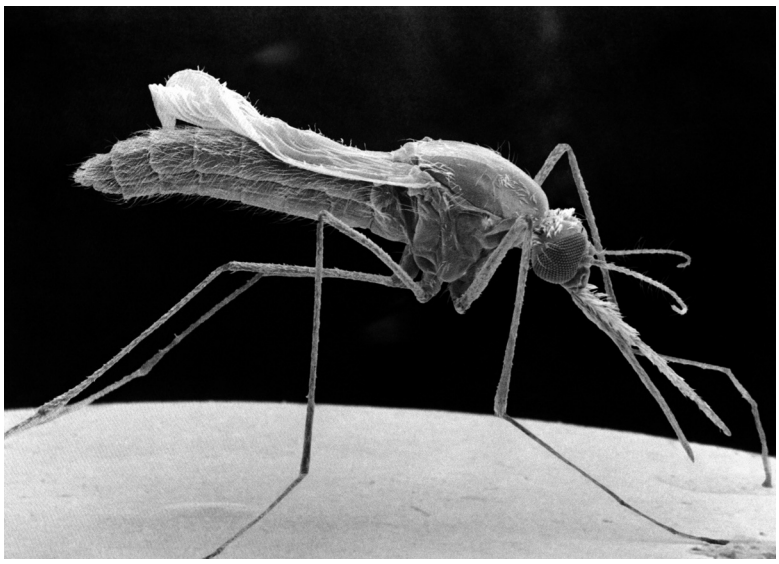


Fig. 5.1

(b) The blood meals are a good source of protein for *Anopheles* for the production of eggs.

Explain why blood is a good source of protein.

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..... [2]

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(c) Fig. 5.2 shows the global distribution of those species of *Anopheles* that are able to act as hosts for Plasmodium.

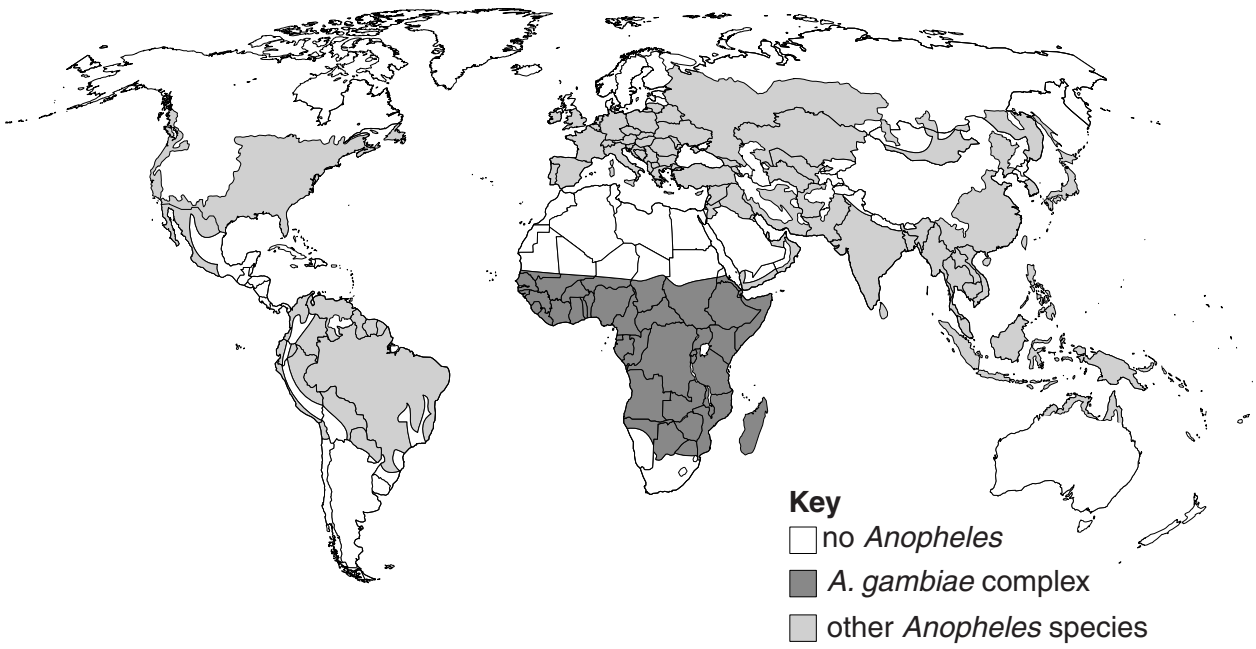


Fig. 5.2

(i) Describe **and** explain the difference between the global distribution of *Anopheles* shown in Fig. 5.2 and the global distribution of malaria.

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..... [3]

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(ii) The distribution of *Anopheles* shown in Fig. 5.2 includes over forty different species that are vectors of malaria. The areas with the highest number of cases of malaria are also the areas where *Anopheles gambiae* occurs. *A. gambiae* is responsible for most of the transmission of the disease in these areas.

Suggest why *A. gambiae* is responsible for most of the transmission of *Plasmodium*.

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..... [3]

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Fig. 5.3 is part of a complex food web in an area of Kenya where the larvae and adults of *A. gambiae* occur.

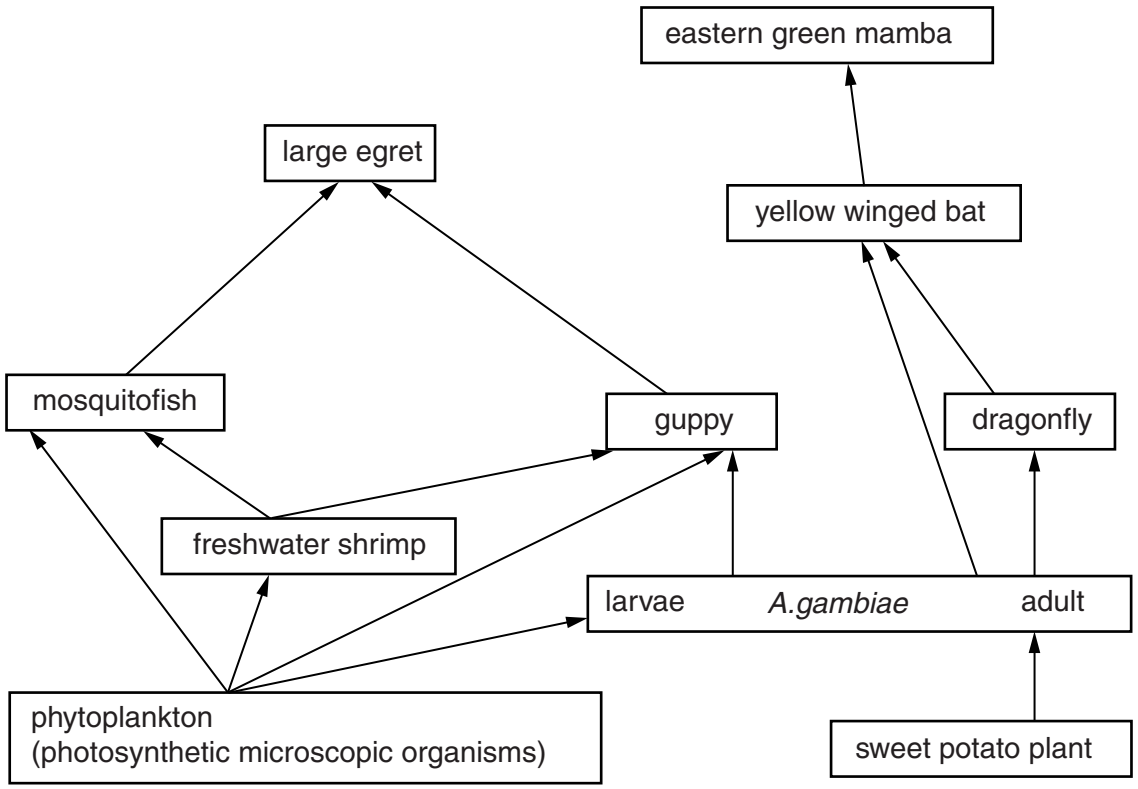


Fig. 5.3

(d) (i) Name **one** organism in Fig. 5.3 that is a tertiary consumer.

..... [1]

(ii) Explain, in terms of energy transfer, why it is likely that the eastern green mamba feeds on other organisms in addition to yellow winged bats.

.....

.....

.....

.....

.....

.....

..... [3]

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(iii) Suggest how the information in Fig. 5.3 can be used in the control of malaria in other areas of Kenya.

.....

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.....

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..... [2]

(e) Both male and female adult *A. gambiae* feed on sweet potato plants. Fig. 5.4 shows a sweet potato plant.



Fig. 5.4

Suggest the parts of the sweet potato plants that are the main source of food for adult *A. gambiae* **and e**xplain your answer.

.....

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.....

.....

..... [2]

[Total: 18]

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6 **(a)** The thickness of the different chambers of the mammalian heart is due to the amount of cardiac muscle present. The atria have less cardiac muscle than the ventricles, and hence thinner walls.

In terms of their functions, explain why the atria have thinner walls than the ventricles.

.....

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.....

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..... [2]

(b) Name the dividing wall separating the right and left sides of the mammalian heart.

..... [1]

(c) Transpiration and translocation are both processes occurring in plants.

(i) State **one** way in which transpiration differs from translocation.

.....

.....

..... [1]

(ii) State **one** way in which transpiration and translocation are similar.

.....

.....

..... [1]

[Total: 5]

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BIOLOGY **9700/23**

Paper 2 Structured Questions AS **October/November 2015**

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Answer **all** the questions

1 Antibodies are secreted by activated B-lymphocytes known as plasma cells.

Fig. 1.1 is a diagram showing the cellular processes involved in the production of a polypeptide of an antibody molecule (not drawn to scale).

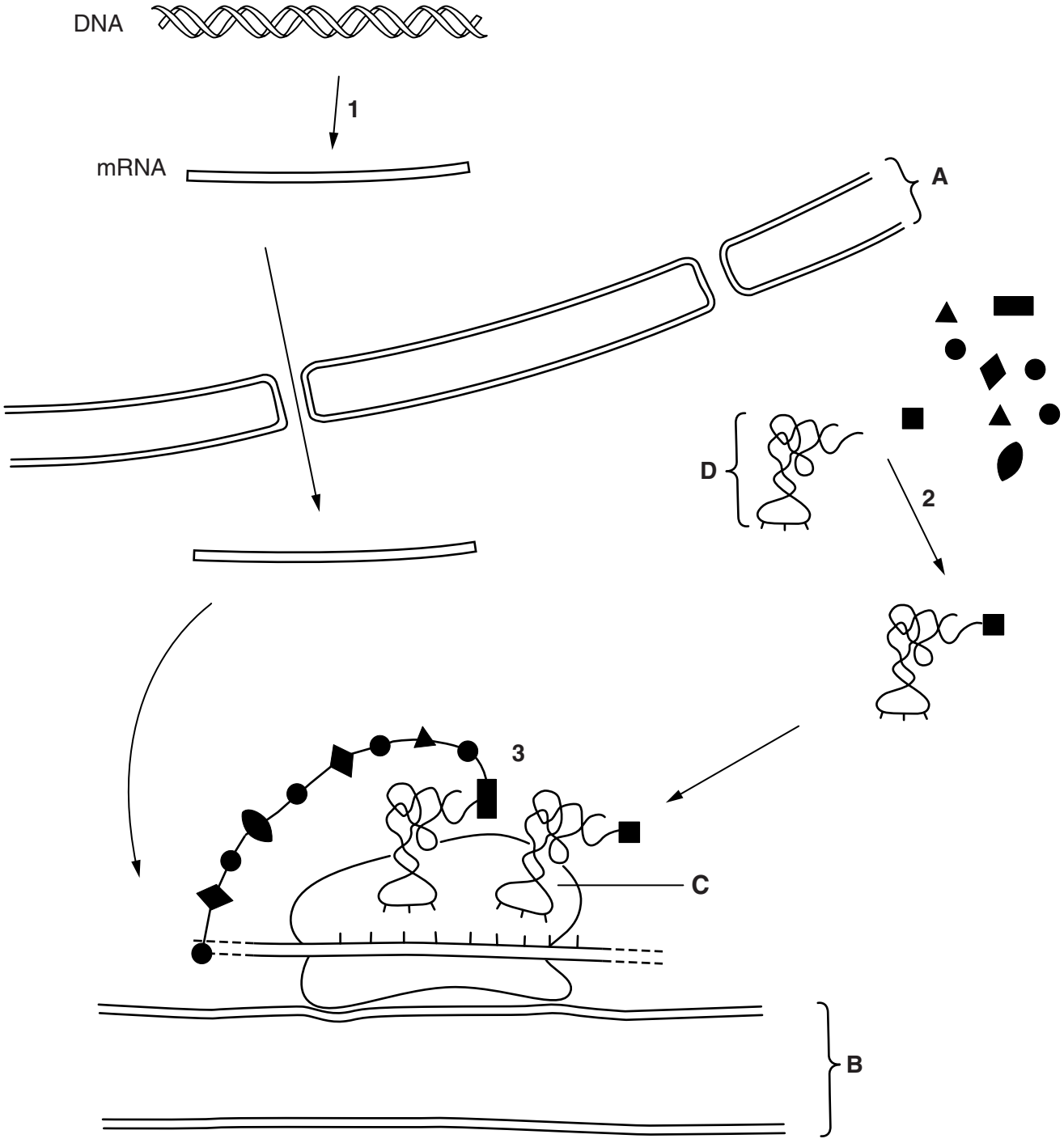


Fig. 1.1

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(a) **(i)** Name structures **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(ii) Name molecule **D**.

D ..... [1]

(iii) State what is occurring at **1**, **2** and **3**.

*at **1*** .....

.....

*at **2*** .....

.....

*at **3*** .....

..... [3]

(b) Antibodies are glycoproteins.

State what is meant by the term glycoprotein.

.....

.....

..... [1]

(c) The genes responsible for antibody production are found on different chromosomes, such as chromosomes 2 and 14 in humans.

Explain how one antibody molecule is the product of more than one gene.

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..... [2]

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[Turn over

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(d) Describe **and** explain how the structure of an antibody molecule is related to its functions.

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..... [4]

[Total: 14]

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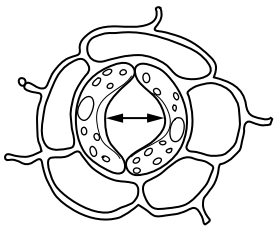
PAPA CAMBRIDGE

Question 2 starts on page 6

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2 Most of the water lost from plants passes out through the stomata of leaves.

The distance between open guard cells is known as the stomatal aperture, as shown in Fig. 2.1.



↔ stomatal aperture

Fig. 2.1

Researchers investigated the effect of stomatal aperture on rates of transpiration in leaves of *Tradescantia zebrina* under two conditions:

- air kept moving by a fan (moving air)
- non-moving air.

The results are shown in Fig. 2.2.

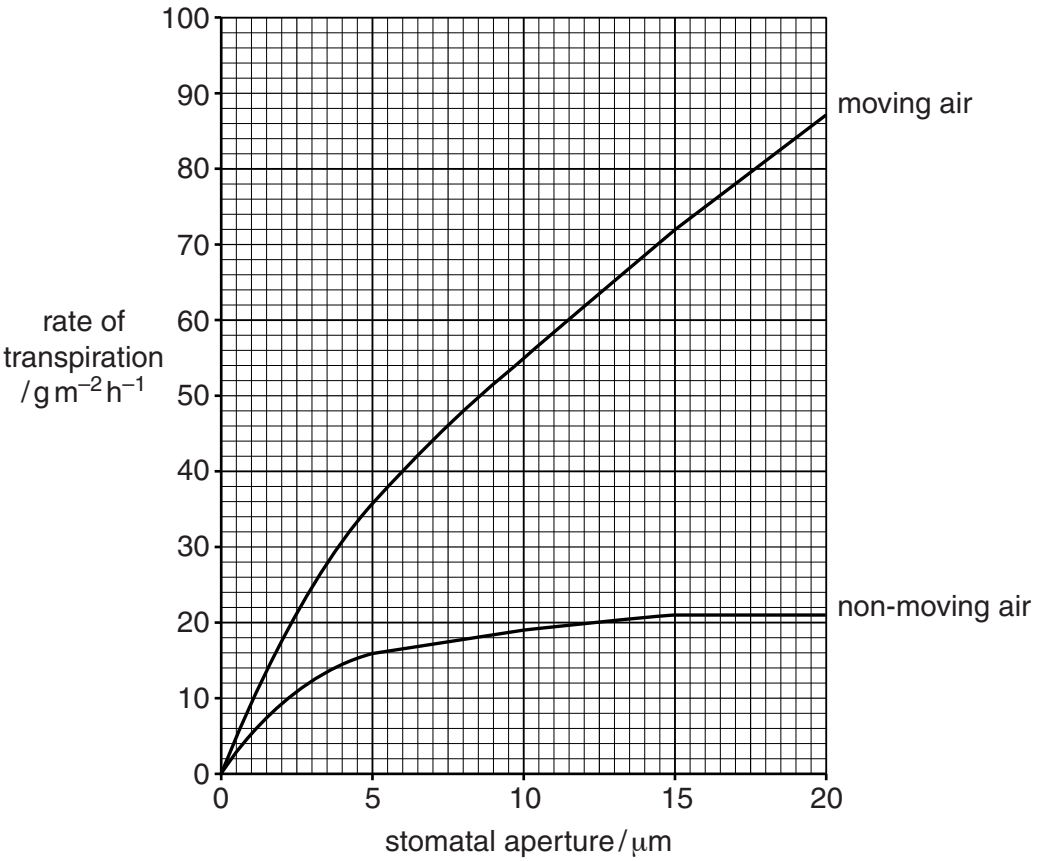


Fig. 2.2

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(a) (i) Compare the effect of stomatal aperture on the rate of transpiration in *T. zebrina* in the two conditions.

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..... [3]

(ii) Explain the effect of stomatal aperture on rates of transpiration in non-moving and moving air.

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..... [3]

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(b) Spruce trees and pine trees are adapted to dry conditions where water can be in limited supply.

Fig. 2.3 shows two stomata in a spruce leaf and Fig. 2.4 shows a vertical section through a stoma from a pine leaf.

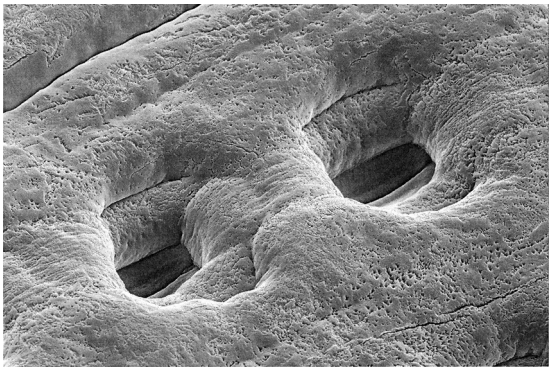


Fig. 2.3

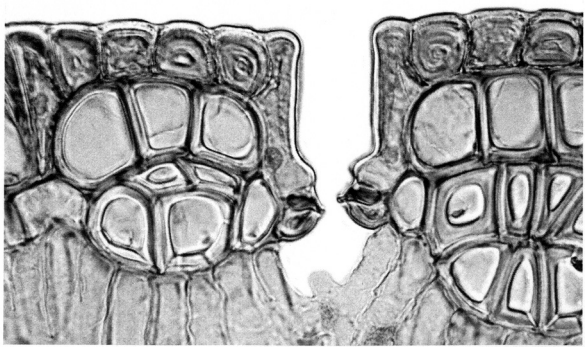


Fig. 2.4

(i) Explain how the stomatal features shown in Fig. 2.3 and Fig. 2.4 give an advantage to plants such as spruce and pine.

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..... [2]

(ii) Some plants that live in very dry conditions close their stomata during the day and open them at night.

State **one** disadvantage of this for these plants.

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..... [1]

(iii) State **and** explain two adaptations that plant leaves have for survival in dry conditions **other** than those involving number or structure of stomata.

1. .....

.....

2. .....

..... [2]

[Total: 11]

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Question 3 starts on page 10

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3 The enzyme catalase is found in many plant and animal tissues.
The enzyme catalyses the decomposition of hydrogen peroxide, which is a toxic product of metabolism. The reaction is:

$$2H_2O_2 \xrightarrow{\text{catalase}} O_2 + 2H_2O$$

A research team investigated the activity of two forms of catalase, **P** and **Q**, extracted from *Anopheles gambiae*, an important vector of malaria. The team investigated the effect of increasing concentrations of hydrogen peroxide on the activity of these two forms of catalase.

The results are shown in Fig. 3.1.

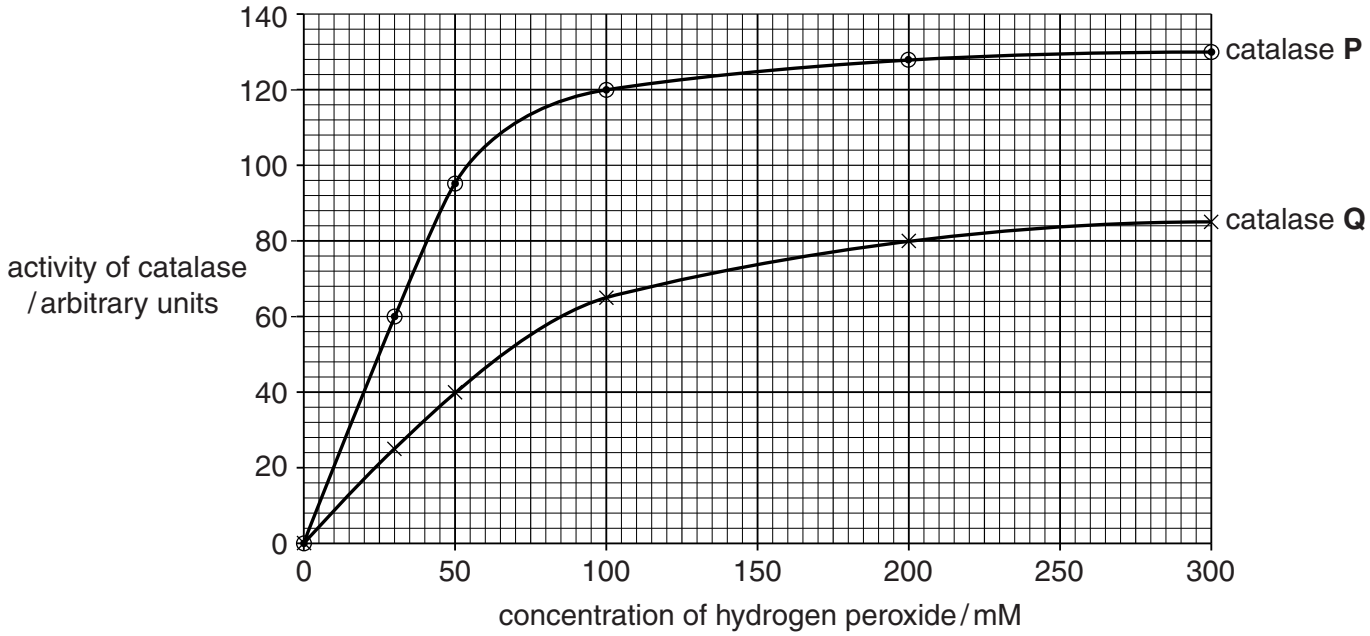


Fig. 3.1

(a) With reference to Fig. 3.1, describe **and** explain the effect of increasing the concentration of hydrogen peroxide on the activity of catalase **P**.

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..... [5]

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(b) Each molecule of catalase consists of four identical polypeptides. The two forms of catalase in *A. gambiae* differ by only one amino acid at position 2 in the amino acid sequence. Catalase **P** has serine and catalase **Q** has tryptophan.

Suggest how the difference in one amino acid is responsible for the lower activity of catalase **Q** compared with catalase **P**.

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..... [2]

(c) Female mosquitoes feed on blood in order to produce their eggs. After feeding, the metabolic rate increases for egg production.

The researchers allowed female mosquitoes to feed on blood. They found that female mosquitoes with only catalase **P** produced more eggs than those with only catalase **Q**.

Suggest why there is a difference in egg production between the two types of *A. gambiae*.

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..... [2]

(d) Metal ions can act as a non-competitive inhibitor of catalase.

Explain how copper ions can act as a non-competitive inhibitor.

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..... [2]

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(e) Enzyme inhibitors can also inhibit carrier proteins in cell surface membranes.

Explain why carrier proteins are required in cell surface membranes.

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..... [2]

(f) Describe three roles of cell surface membranes, **other than** the transport of substances into and out of cells.

1. .....

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2. .....

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3. .....

..... [3]

[Total: 16]

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4 Glycogen is a highly branched polysaccharide molecule that is stored in the liver, kidney and muscles of mammals.

Fig. 4.1 shows a small part of a molecule of glycogen.

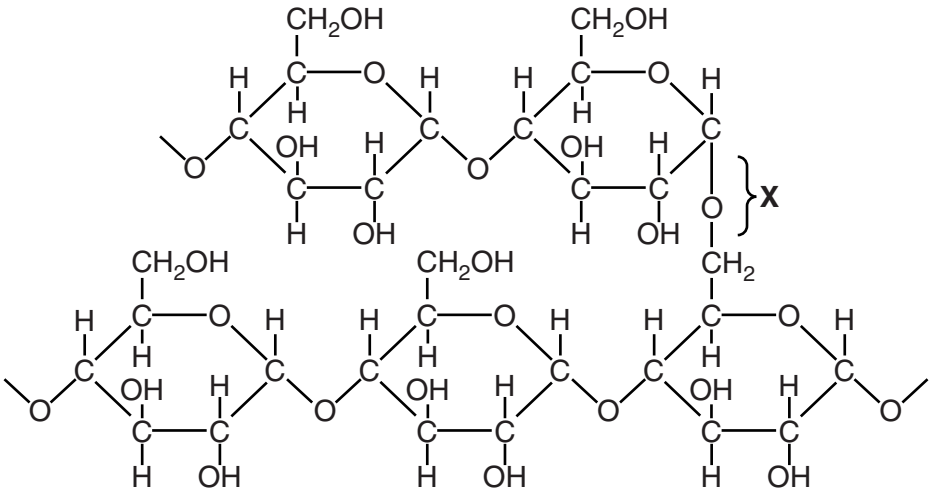


Fig. 4.1

(a) (i) Name the bond at **X**.

..... [1]

(ii) State the advantages for a mammal of having a storage molecule that is highly branched.

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..... [2]

(iii) State two ways in which the structure of cellulose differs from the structure of glycogen.

1. .....

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2. .....

..... [2]

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(b) Glycogen from animals and starch from plants form a large part of the energy intake of humans.

Fig. 4.2 is a flow chart that shows the energy input, in one growing season, into a field of a cereal crop which is processed to provide animal feed.

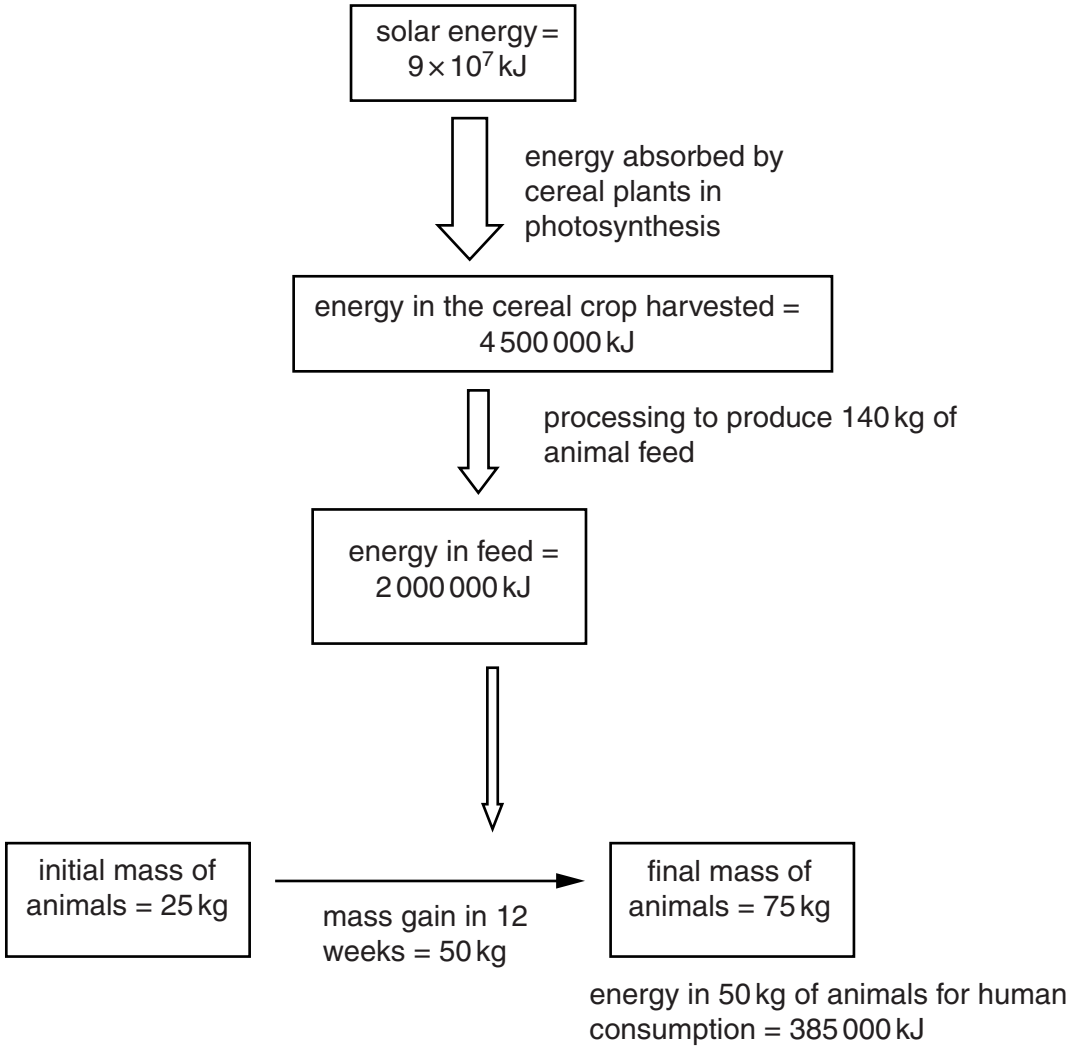


Fig. 4.2

(i) Calculate the percentage of the energy in animal feed that is converted into energy available for human consumption. Show your working.

answer ..... [2]

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(ii) Explain why the energy available to humans from feeding on animal products is much less than if the energy came directly from crop plants, such as cereals.

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..... [3]

[Total: 10]

5 Nicotine and carbon monoxide in tobacco smoke contribute to damage to the cardiovascular system.

(a) Explain how nicotine and carbon monoxide contribute to damage to the coronary arteries.

nicotine .....

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carbon monoxide .....

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..... [3]

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(b) One type of surgical treatment for coronary heart disease is to use arteries from the chest and veins from the leg to by-pass blockages as shown in Fig. 5.1.

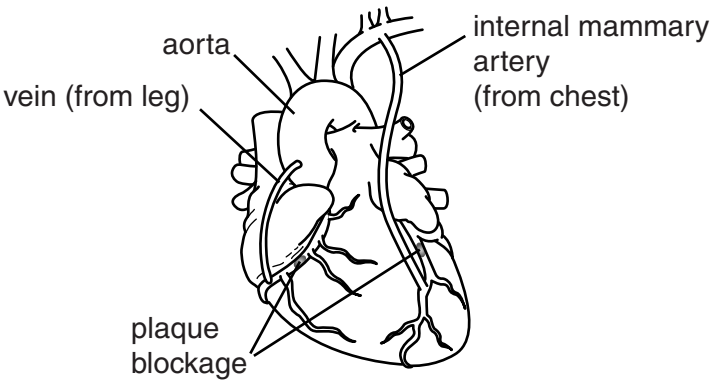


Fig. 5.1

(i) Explain how the two by-passes shown in Fig. 5.1 provide an effective treatment for coronary heart disease.

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..... [3]

(ii) The cost of treating heart disease is very high.

Suggest the steps that governments could take to reduce heart disease in the population.

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..... [3]

[Total: 9]

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