Transport in Plants

(Past Year Topical Questions 2010-2015)

May/June 2011 (23)

3 **(a)** Plants take in mineral ions through their root hair cells. This may happen by a process which moves the ions from a low concentration in the soil to a higher concentration in the root hair cell.

(i) Name and describe this process by which mineral ions are taken in.

name .....

description .....

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..... [3]

(ii) Phosphate is an example of an ion transported in this way. State **one** use for this ion in plant cells.

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..... [1]

Fig. 3.1 is a plan diagram of a transverse section of a plant root.

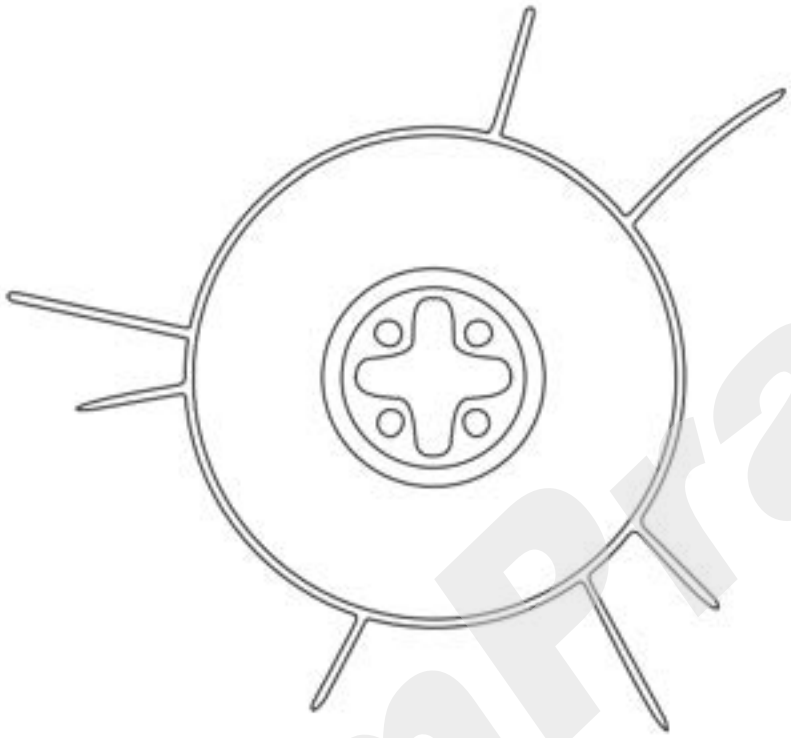

Fig. 3.1

(b) (i) Write the letter **W** on Fig. 3.1 in the area where cells are specialised for the transport of water and mineral ions. [1]

(ii) Water is also absorbed from the soil by the root hair cells.

Outline the mechanism by which this occurs.

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(iii) Describe the pathway taken by water as it passes from the root hair cells into the cells which are specialised for transport of water and mineral ions.

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5 Fig. 5.1 is an electron micrograph of a transverse section through part of a plant stem.

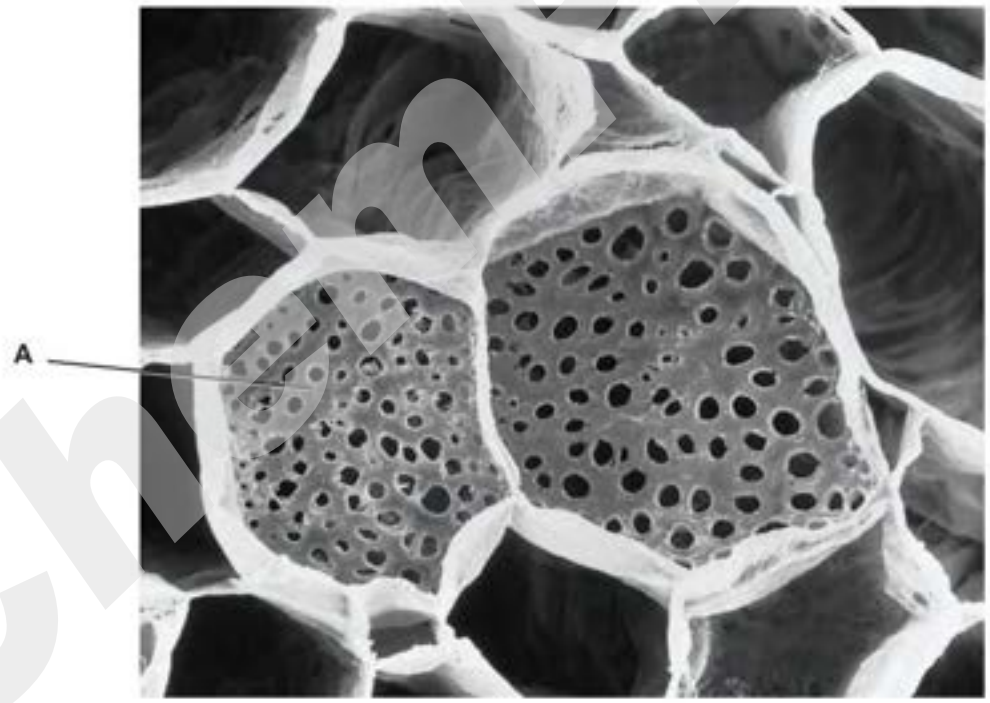

Fig. 5.1

(a) Name structure **A**.

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(b) Specialised cells visible in Fig. 5.1 are involved in transporting assimilates through the plant from source to sink.

(i) Name **one** assimilate transported by these cells.

..... [1]

(ii) Give **one** example of a source and **one** example of a sink.

source .....

sink ..... [2]

(c) Describe how the assimilate you have named in **(b)(i)** is transported from the source to the sink.

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(d) Aphids are insects with mouthparts adapted to penetrating the cells of plants which transport assimilates.

Suggest why aphids feed specifically from these cells.

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Oct/Nov 2011 (21)

5 Phloem transfer cells are modified companion cells that move sucrose and other assimilates from mesophyll tissue into phloem sieve tube elements.

Fig. 5.1 is an electron micrograph of a phloem transfer cell.

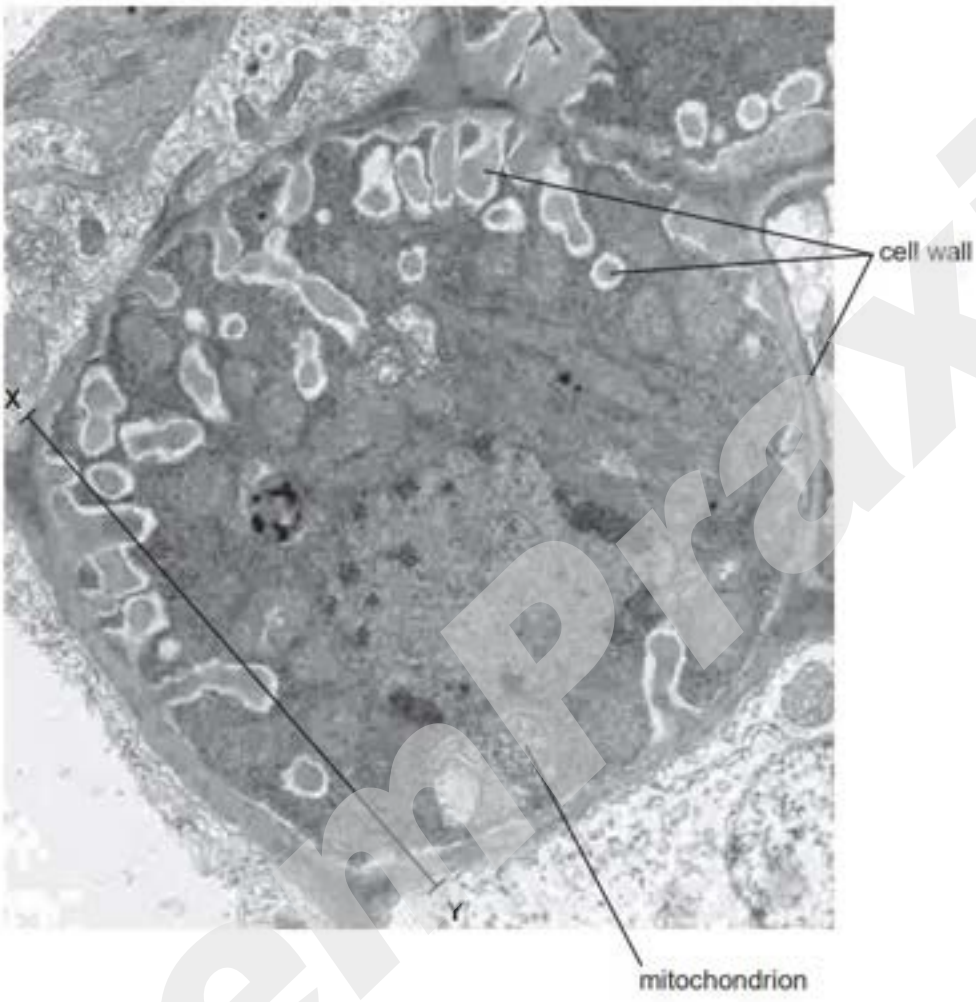

Fig. 5.1

(b) With reference to Fig. 5.1, explain how phloem transfer cells help in the movement of sucrose from the mesophyll of a leaf into a phloem sieve tube element.

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(c) Explain how sucrose in the phloem sap is moved from sieve tube elements in leaves to cells in a sink, such as a root.

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Oct/Nov 2011 (22)

6 Fig. 6.1 shows a phloem sieve tube element, its companion cell and a mesophyll cell in the leaf of a photosynthesising plant.

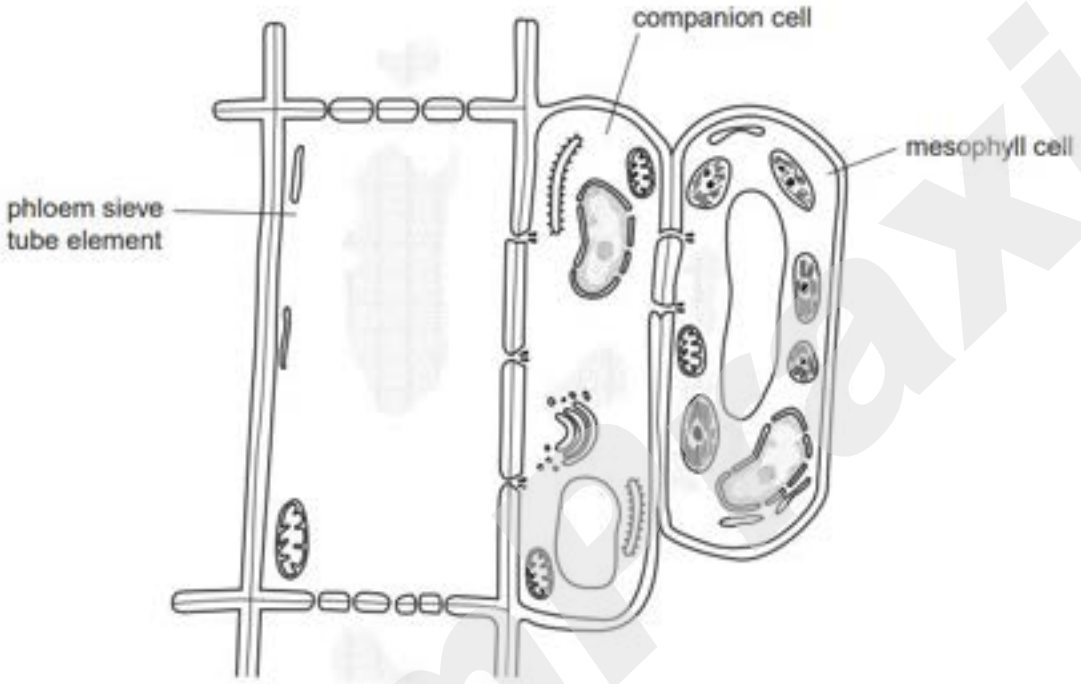

Fig. 6.1

(a) Use label lines and the letters **C** to **E** to identify the following on Fig. 6.1.

C – a structure involved in ribosome synthesis

D – an organelle that is involved in the modification and packaging of proteins

E – an organelle that is involved in aerobic respiration [3]

(b) The concentration of sucrose in the sap of the phloem sieve tube element is much higher than in the cytoplasm of the photosynthesising cell.

Describe **and** explain how sucrose is transported from the photosynthesising cell to the phloem sieve tube element.

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Oct/Nov 2011 (23)

3 Fig. 3.1 is a photomicrograph of a transverse section through a leaf from a tea plant, *Camellia sinensis*.

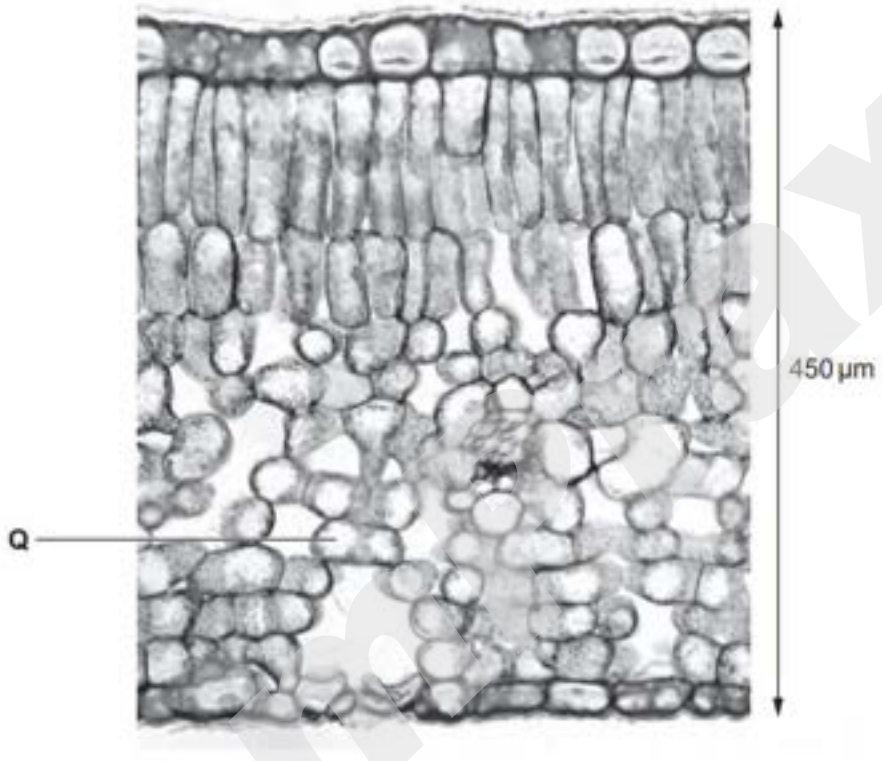

Fig. 3.1

(a) Use label lines and the letters **X**, **Y** and **Z** to label the following features on Fig. 3.1.

X a cell of the upper epidermis

Y a palisade mesophyll cell

Z a guard cell

[3]

(b) Describe **and** explain how water moves from inside the leaf at point **Q** on Fig. 3.1 to the atmosphere outside the leaf during transpiration.

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(c) The leaf of *C. sinensis*, shown in Fig. 3.1, has developed in a sunny position.

State three features of the leaf, **visible in** Fig. **3.1**, which show that it has developed in a sunny position.

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2. .....

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3. .....

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May/June 2012 (21)

2 Fig. 2.1 shows a drawing made from an electron micrograph of two adjacent cells in a leaf.

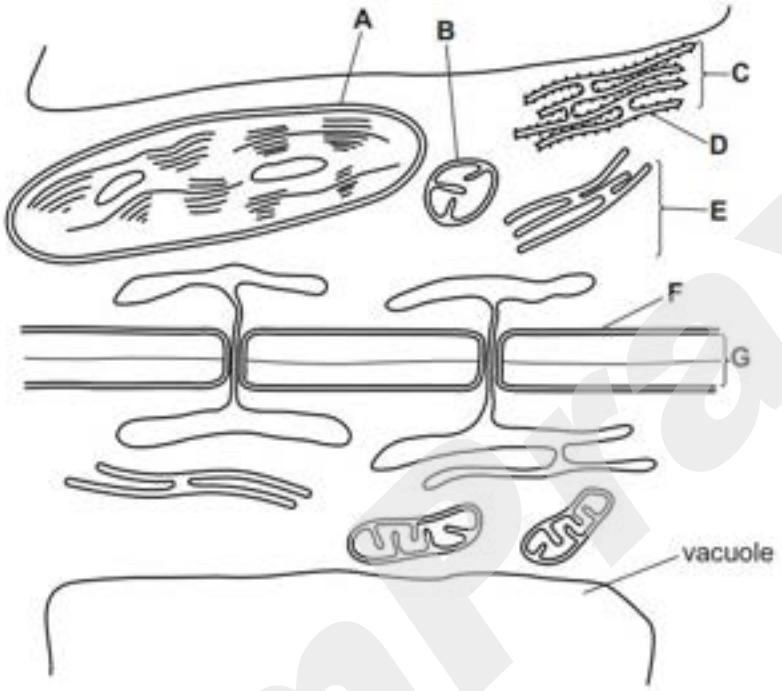

Fig. 2.1

(e) Fig. 2.1 shows two plasmodesmata connecting the adjacent cells.

Describe the roles of plasmodesmata in transport in plants.

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May/June 2012 (22)

3 **(a)** With reference to the structure of a leaf, explain the difference between evaporation and transpiration.

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(b) Apple, *Pyrus malus*, sour cherry, *Prunus cerasus*, and peach, *Prunus persica*, are dicotyledonous trees that are of importance to commercial growers for the fruit that they produce.

A student chose a small area of land where all three species of fruit tree were growing. Leaf samples were removed and, using a microscope, the mean number of stomata per square millimetre was estimated for each species.

The rate of transpiration of each species was then measured on each of three separate occasions. The student performed the investigation outside where the trees were located and recorded the weather conditions on each day.

The mean transpiration rate was calculated per unit area of leaf.

The results are shown in Table 3.1.

Table 3.1

fruit tree	mean number of stomata / mm^{-2}	mean transpiration rate / $cm^3 h^{-1}$		
		hot dry day	warm dry day	warm rainy day
apple	266	0.19	0.35	0.21
sour cherry	284	0.09	0.28	0.25
peach	190	0.03	0.08	0.07

(i) With reference to Table 3.1, describe **and** explain the results of the investigation.

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(ii) The mean transpiration rate of each species was calculated over a 24 hour period.

Describe how the transpiration rate during the night would differ from the transpiration rate during the day.

Explain your answer.

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(iii) Suggest which of the three species of fruit tree has been described as 'drought-resistant' and would be economical to grow in areas where water is scarce.

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May/June 2012 (23)

2 Fig. 2.1 shows an apparatus used to measure the rate of water uptake by leafy parts of plants.

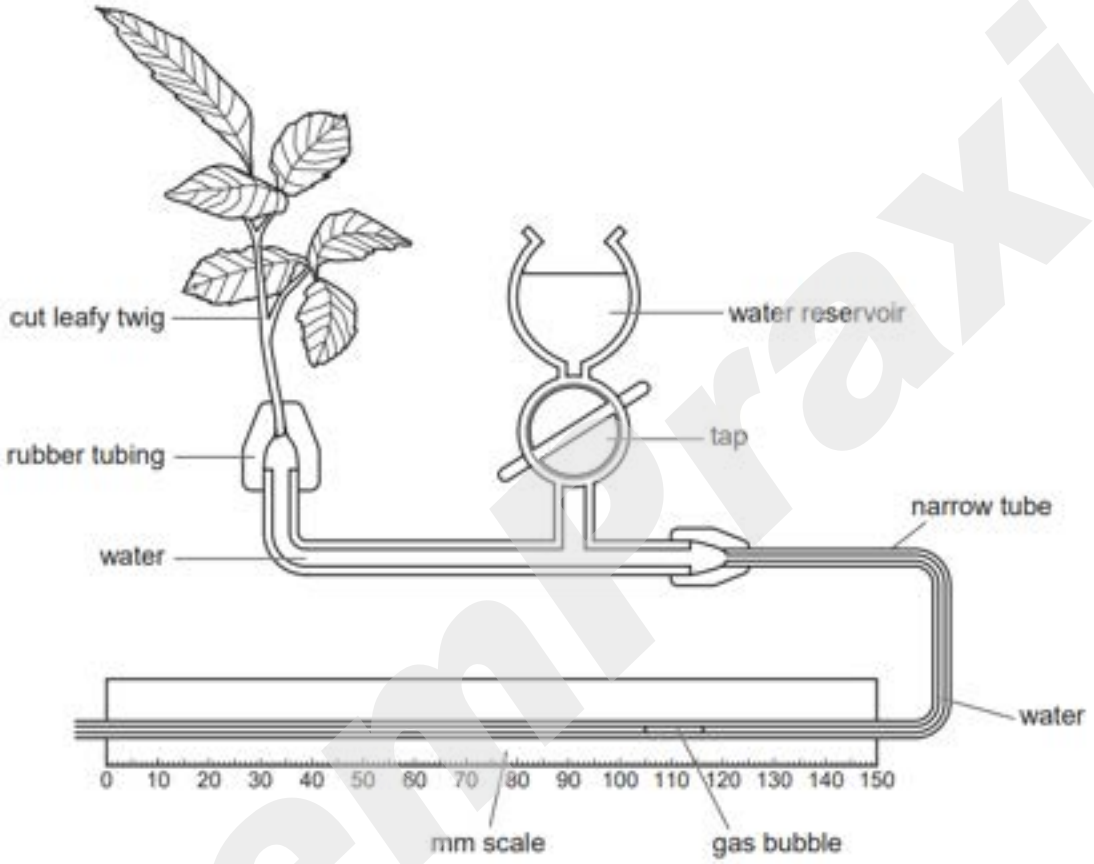

Fig. 2.1

(a) State the name of this apparatus.

.....[1]

(b) Explain why the rate of water uptake by the leafy part of the plant shown in Fig. 2.1 will **not** be the same as the rate of transpiration.

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(c) Using the apparatus as shown in Fig. 2.1, the rate of water uptake at 25 °C was found to be greater than at 20 °C.

(i) Explain the effect of increasing the temperature on the rate of water uptake.

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(ii) State two environmental conditions, **other than temperature**, which will affect the rate of water uptake of a leafy twig as shown in Fig. 2.1.

1. .....

2. ..... [2]

(d) Transpiration is sometimes described as an 'inevitable consequence of gas exchange' in plants.

Explain this statement.

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.....[3]

Oct/Nov 2012 (21)/Q2

(b) Describe the pathway taken by water from the cytoplasm of the root hair cell to a xylem vessel in the centre of the root.

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An investigation was carried out to find the effect of an enzyme in *A. thaliana* on the composition of the cuticle. The enzyme is involved in the production of lipid that accumulates in the cuticle.

Plants were discovered with a mutation of the gene that codes for the enzyme.

Some of these mutant plants (Group **A**) were grown in pots and their rate of transpiration was determined over three days. They were compared with control plants (Group **B**) in which the gene was switched on and the enzyme present. The results are shown in Fig. 2.2.

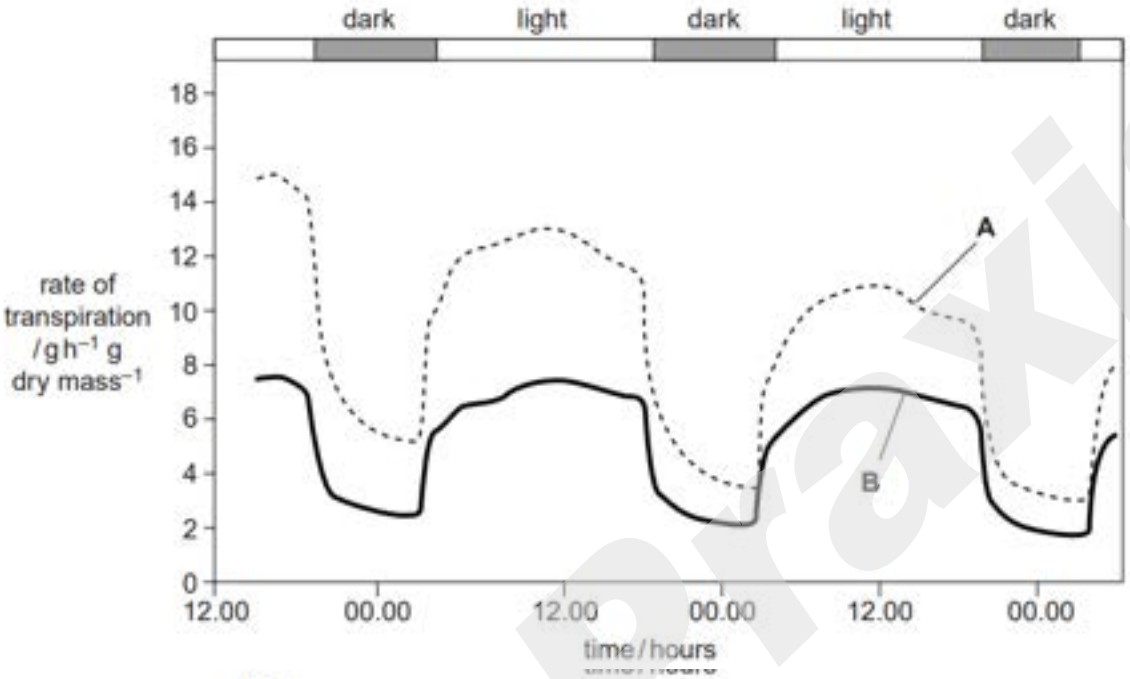

Fig. 2.2

(c) With reference to Fig. 2.2, explain:

(i) why the rate of transpiration is higher during the day than at night in both groups of plants

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(ii) how the results show that the cuticle is less effective in the mutant plants.

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Oct/Nov 2012 (23)/Q4

(b) Describe how the structure of xylem vessels is adapted to their function.

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(c) Describe **and** explain how water moves from the xylem vessels in the leaves to the atmosphere surrounding the leaves of the plant.

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May/June 2013 (21)

3 **(a)** Transpiration is often described as an 'inevitable consequence of gas exchange in plants'.

Explain what is meant by this statement.

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.....[3]

The buttonwood tree, *Conocarpus erectus*, grows in coastal areas of the Americas. A study was carried out on its ability to survive on Socorro Island off the Pacific coast of Mexico. The island is exposed to high winds, which can lead to high rates of transpiration.

The transpiration rates of trees at sheltered and exposed locations at the same altitude on Socorro Island were compared. The results are shown in Fig. 3.1.

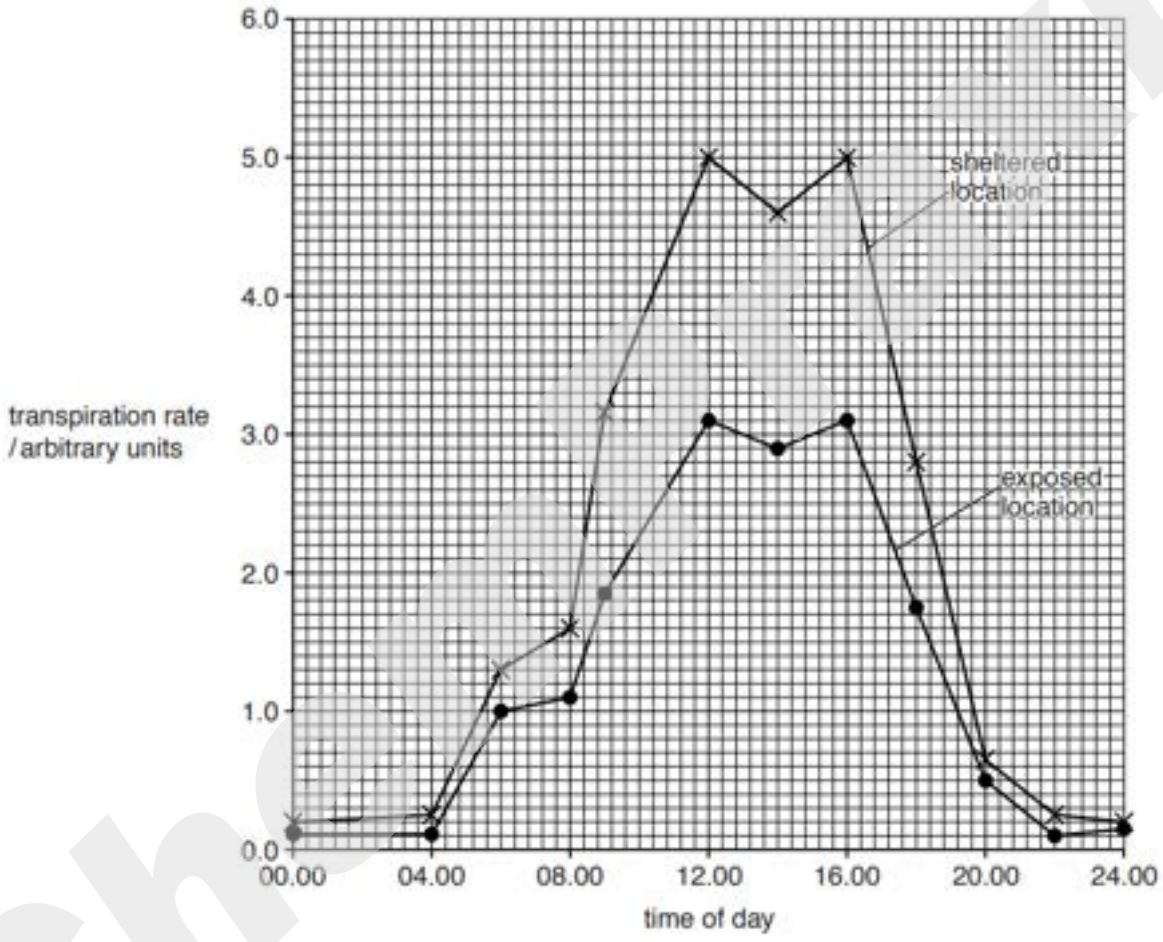

Fig. 3.1

(b) Describe the results shown in Fig. 3.1.

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(c) The leaves of the buttonwood trees at the exposed site were significantly smaller than those at the sheltered site.

Describe three ways, other **than small size**, in which leaves are adapted to reduce the rate of transpiration.

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2. .....

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May/June 2013 (22)

2 Fig. 2.1 shows xylem tissue in a longitudinal section through the stem of a dicotyledonous plant.

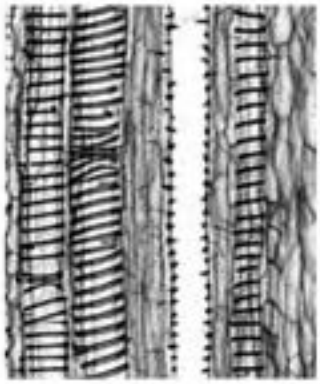

Fig. 2.1

(a) Describe and explain how the structure of xylem vessels is suited to their function.

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May/June 2013 (23)/Q1

(d) Palisade mesophyll cells have very large vacuoles.

Explain how water moves from the xylem in the leaf into these vacuoles.

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..... [3]

Oct/Nov 2013 (22)

3 **(a)** Explain the need for transport systems in plants.

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.....[3]

(b) Fig. 3.1 is a drawing of a transverse section through part of the stem of a dicotyledonous plant. Cell **A** and cell **B** are involved in the transport of dissolved organic molecules.

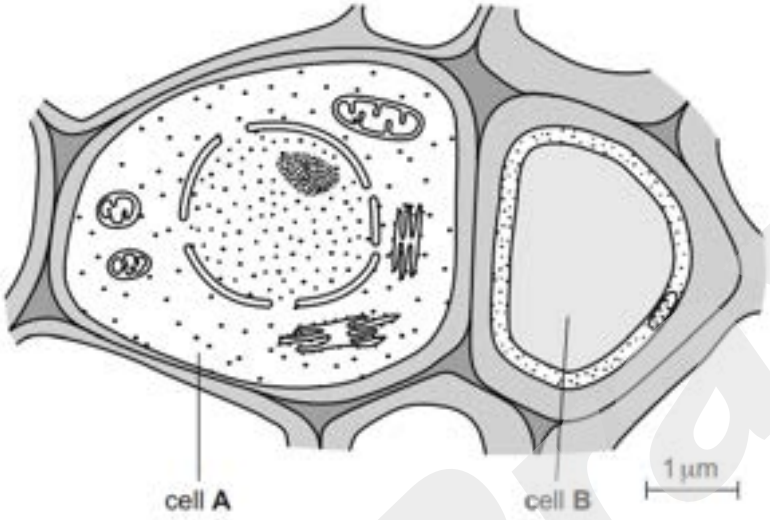

Fig. 3.1

(i) Name cell **A** and cell **B**.

cell A .....

cell B .....[1]

(ii) With reference to Fig. 3.1, explain how the different structures of cell types **A** and **B** are related to their function.

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Oct/Nov 2013 (23)

6 Fig. 6.1 is a photomicrograph of phloem sieve tubes from a plant stem.

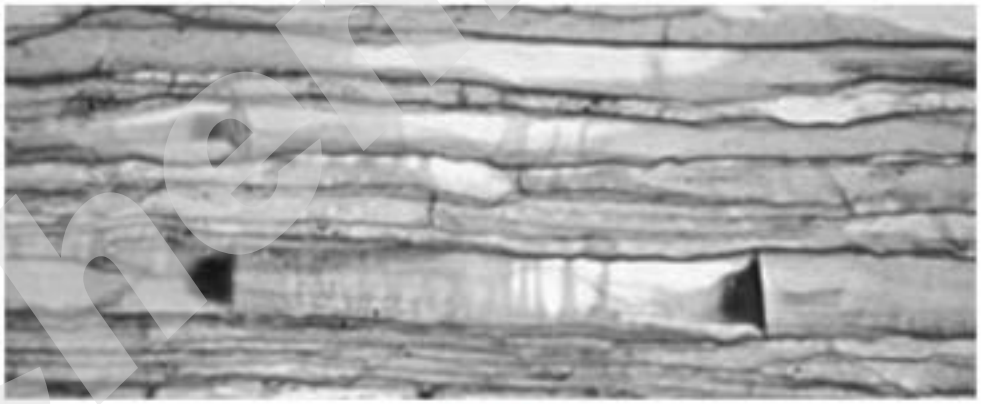

Fig. 6.1

(a) State two features, **visible in Fig. 6.1**, which distinguish sieve tubes from xylem vessels.

1. .....

2. .....

[2]

(b) Explain briefly how sucrose is **moved**, or translocated, **through** sieve tubes.

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..... [2]

May/June 2014 (22)/Q2

(c) Water is transported up the stem, to the spinach leaf, in the xylem. Once it leaves the xylem it moves via the apoplast and symplast pathways, to reach the cells in Fig. 2.1.

Outline the differences between the apoplast and symplast pathways after the water has left the xylem.

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(d) Water, containing dissolved mineral ions such as magnesium, enters spinach leaf cells.

(i) State **two** ways that water is used in the leaf cell.

1. .....

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2. .....

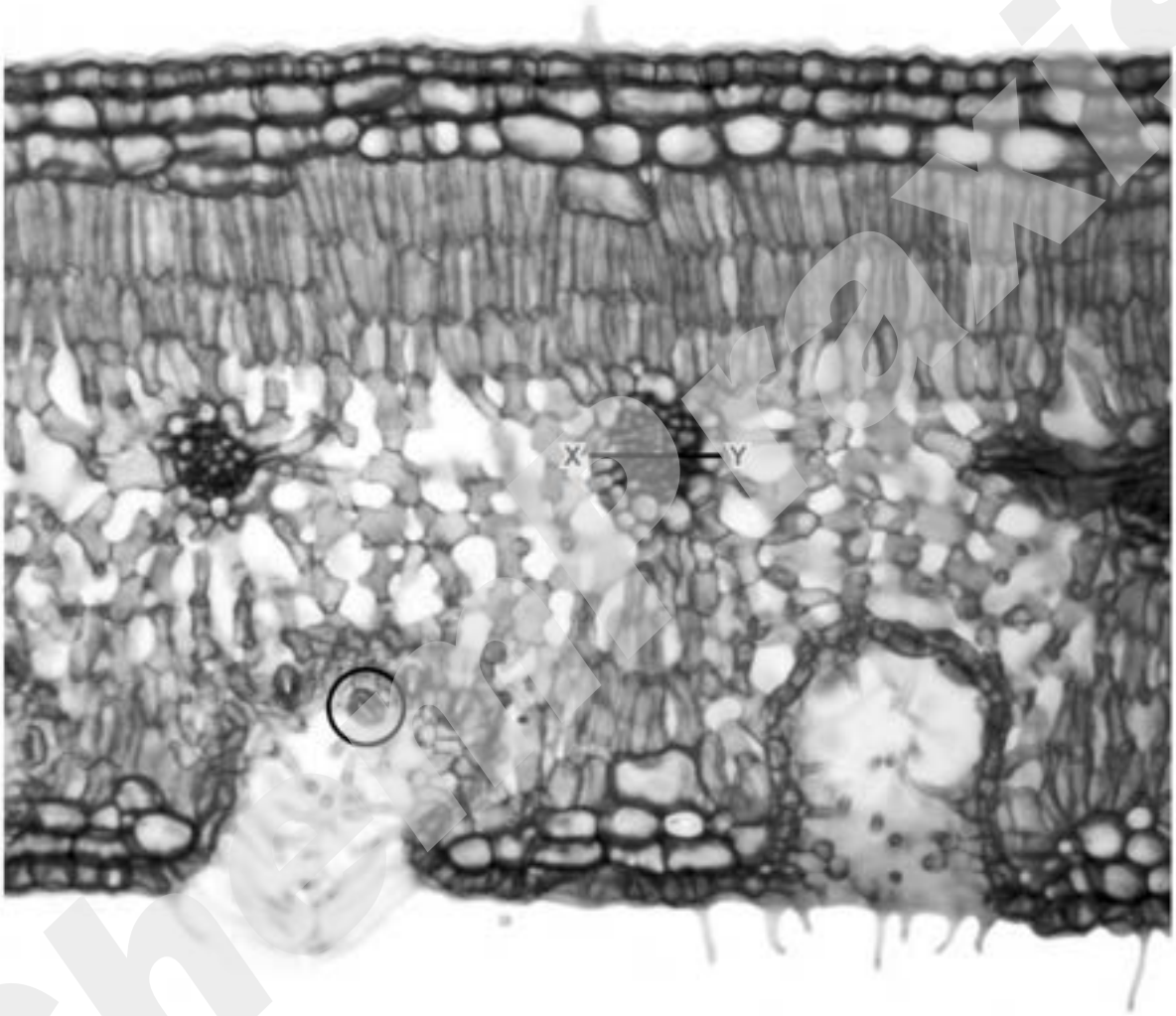
..... [2]

(ii) State **one** role of magnesium ions in the leaf cell.

.....[1]

May/June 2014 (23)

4 Fig. 4.1 is a light micrograph of a section through a leaf of the xerophytic plant *Nerium oleander*. An area containing one of the plant's stomata is circled.



(a) List three adaptations, visible in Fig. 4.1, which are characteristic of xerophytic plants.

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[3]

(c) Describe the process of transpiration in plants such as *N. oleander*.

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Oct/Nov 2014 (21)

6 Fig. 6.1 shows the pathway taken by water as it enters the root of a flowering plant.

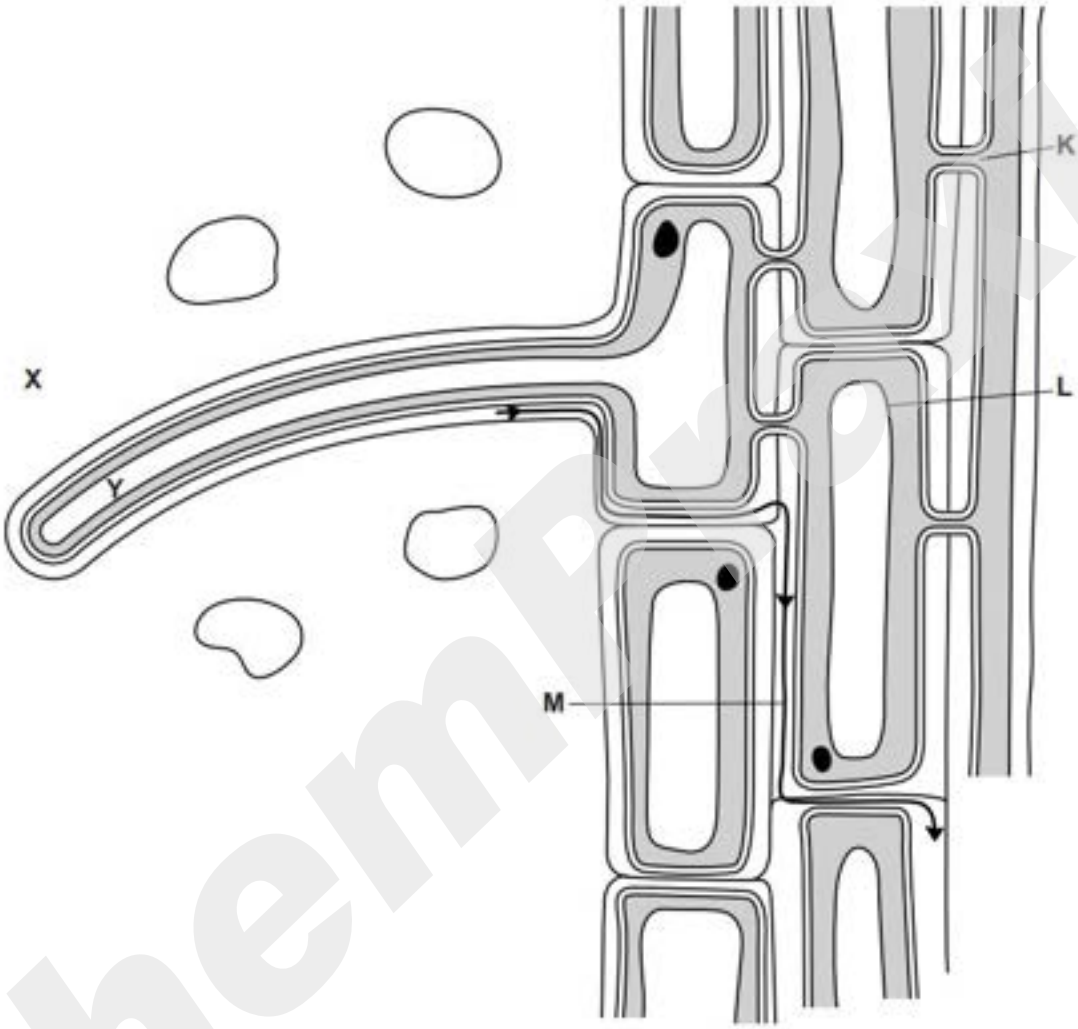

Fig. 6.1

(a) Explain how water passes from **X** to **Y**.

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..... [3]

(b) Name:

(i) the structures **K** and **L**

K .....

L .....

[2]

(ii) the pathway indicated by **M**.

.....[1]

Oct/Nov 2014 (22)/Q2

(f) Describe **and** explain how water and nitrate ions are transported in the xylem from roots to leaves.

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.....[4]

Oct/Nov 2014 (23)

6 Table 6.1 contains some information about xylem vessels and phloem sieve tube elements in plants.

Table 6.1

features	xylem vessels	phloem sieve tube elements
living cells		yes
substances transported		dissolved sugars and amino acids
direction of flow of substances	one direction, roots to leaves	
permeability of cell walls to water	not permeable	
cell wall material		

(a) Complete Table 6.1. [4]

(b) State **one** use for magnesium ions in plants.

.....[1]

May/June 2015 (21)

3 When a leaf is first formed it is described as a sink for carbohydrate. As the leaf continues to grow, it starts to photosynthesise and becomes a source of carbohydrates and other assimilates.

Fig. 3.1 shows the changes that occur to the structure of plasmodesmata in the leaf as it grows.

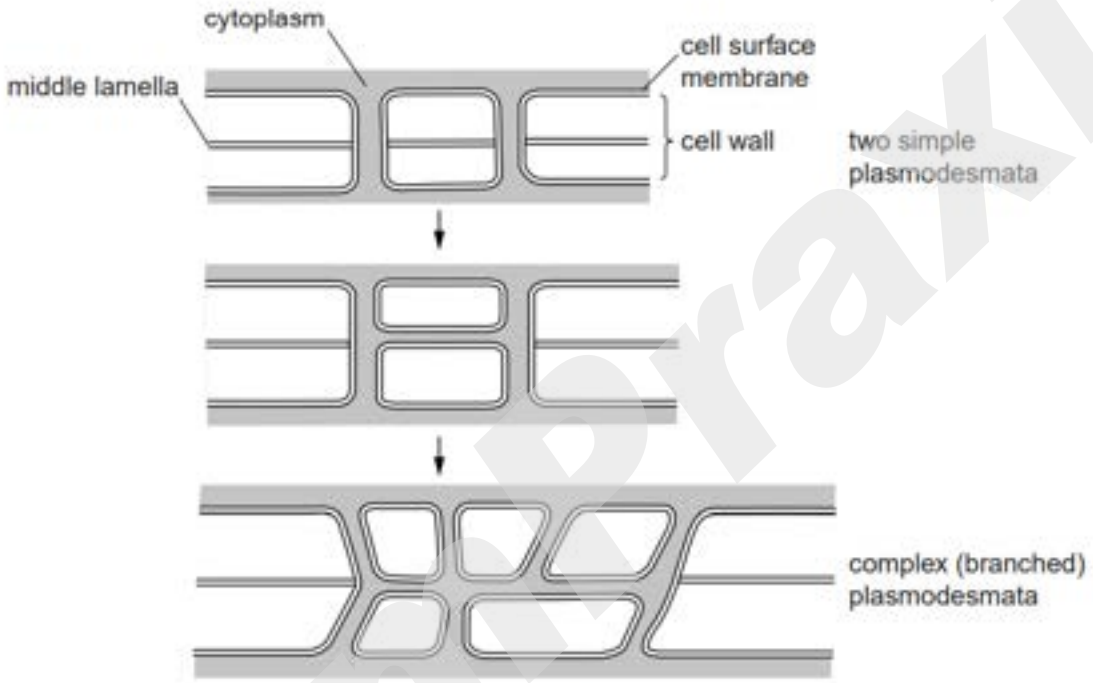

Fig. 3.1

(a) Suggest the advantage of complex plasmodesmata between cells in leaves.

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.....[2]

(b) Assimilates are transported into phloem sieve tubes.

Explain how assimilates in phloem sieve tubes move from the veins in a mature leaf to sinks, such as flowers and fruits, in the rest of the plant.

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.....[4]

May/June 2015 (23)

5 Fig. 5.1 is a light micrograph of some unicellular photosynthetic organisms called *Chlamydomonas*.

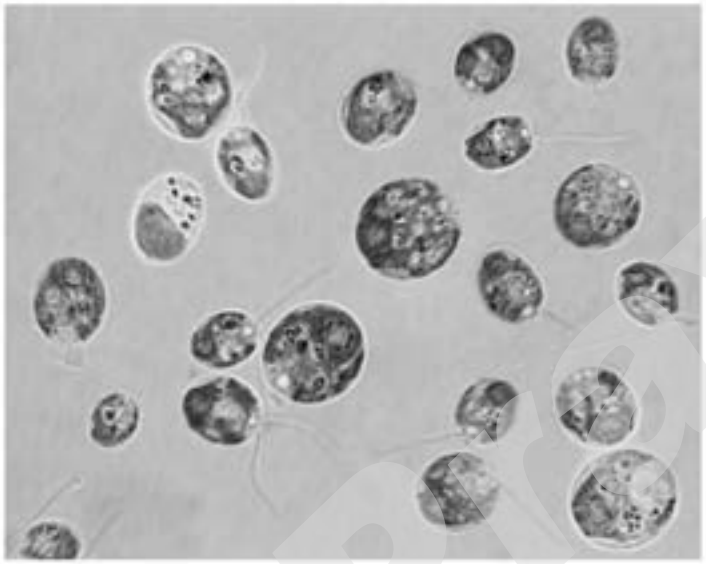

Fig. 5.1

(b) *Chlamydomonas* live in water and obtain minerals, such as magnesium ions, from the water.

(i) State **one** role of magnesium ions in photosynthetic organisms.

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.....[1]

(c) Explain why multicellular organisms require transport systems while unicellular organisms, such as *Chlamydomonas*, do not.

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(d) Some plants, such as the banana plant, *Musa acuminata*, produce fruit. The banana fruit has a high content of carbohydrate.

Describe how sugars are transported in phloem sieve tubes from source to sink in plants such as *M. acuminata*.

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.....[5]

Oct/Nov 2015 (21)

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.

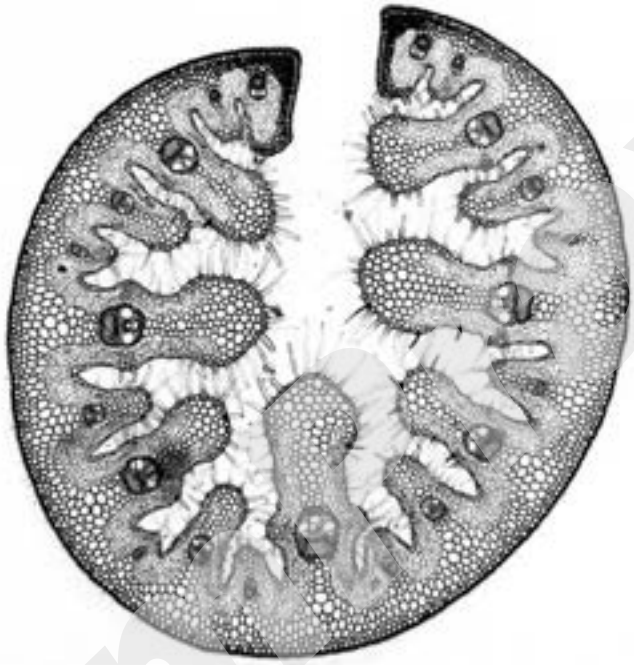

Fig. 4.1

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

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

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..... [3]

(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

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explanation

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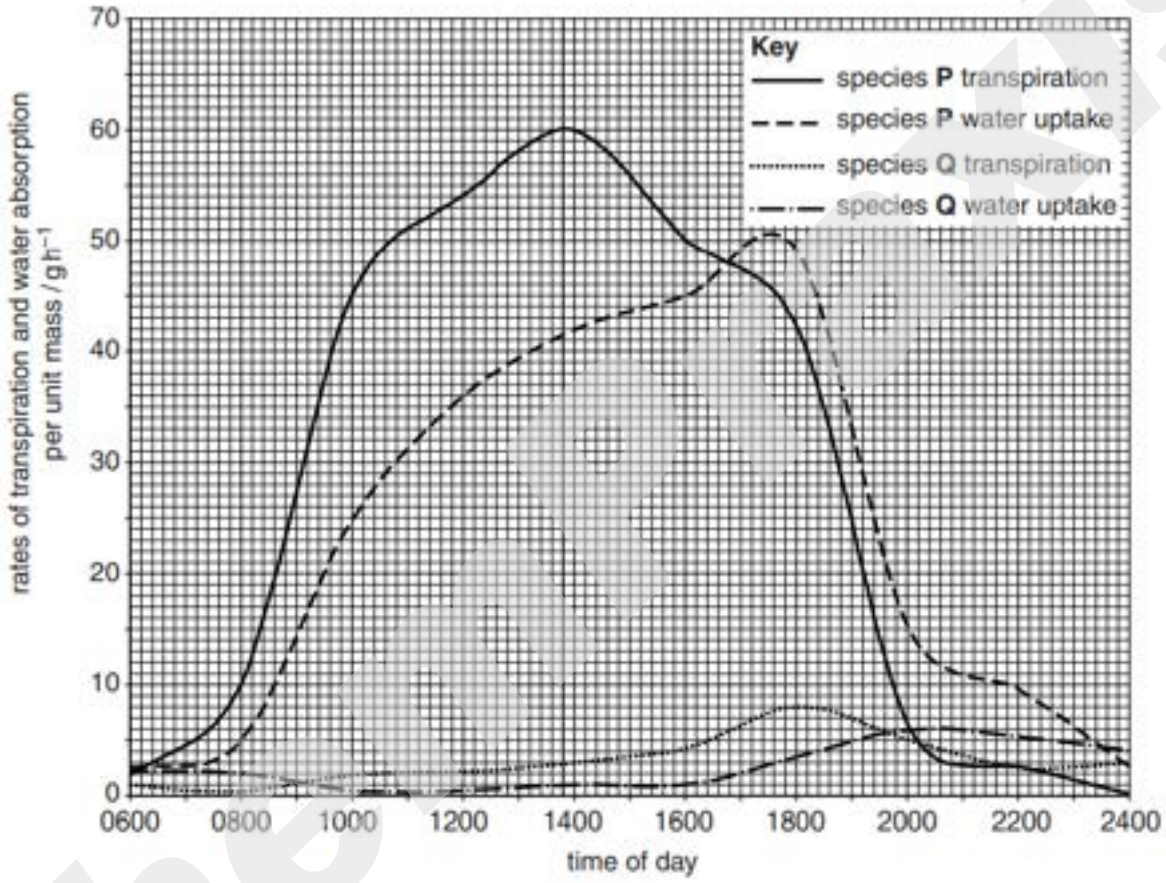
(b) A student investigated the rates of transpiration and absorption of water by two species of plants, **P** and **Q**, over an 18 hour period between 0600 and 2400. The environmental conditions for the two species were the same.

The results are shown in Fig. 4.2.



(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]

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

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

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Oct/Nov 2015 (22)/Q6

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

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

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

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Oct/Nov 2015 (23)

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.

The results are shown in Fig. 2.2.

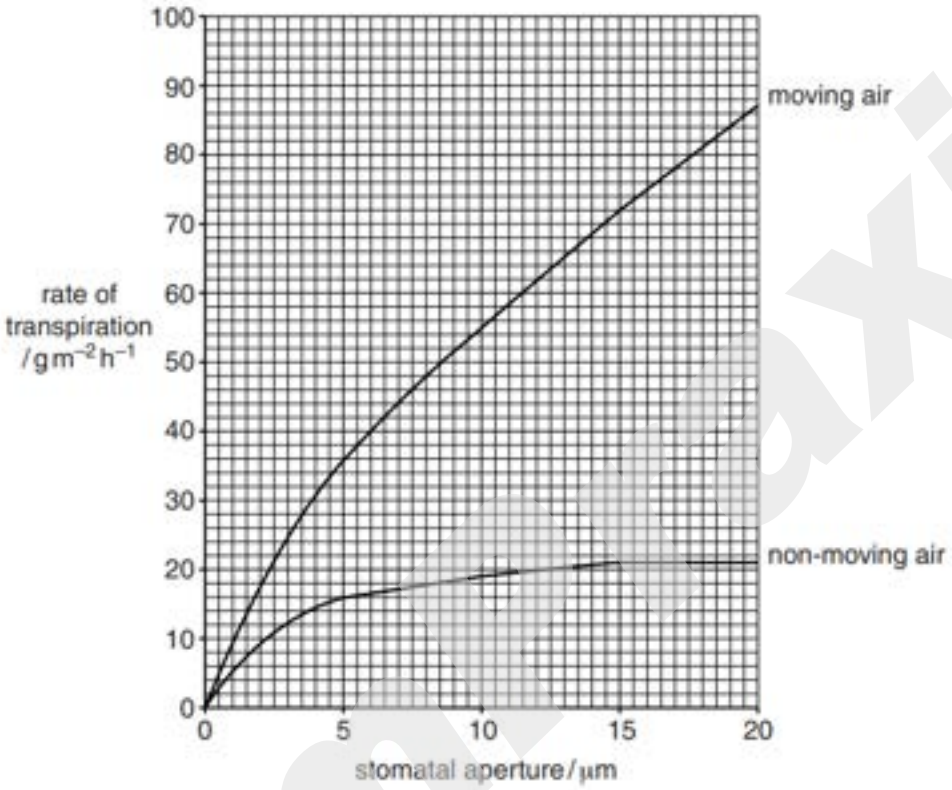

Fig. 2.2

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

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

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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.

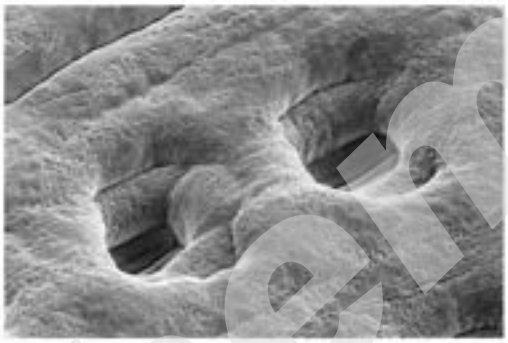

Fig. 2.3

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]