Transport in plants

Model Answers 4

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Exchange and transport
Topic	Transport in plants
Booklet	Model Answers 4

Time allowed: **65 minutes**

Score: **/48**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

(a) A student used a potometer to investigate the effect of light intensity on the rate of transpiration in a healthy leafy shoot.

The results obtained are shown in Table 5.1.

Table 5.1

light intensity in arbitrary units (a.u.)	rate of transpiration (mm min^{-1})			
	trial 1	trial 2	trial 3	mean
10	5.0	7.0	5.0	5.7
20	5.0	7.0	5.0	5.7
30	12.0	12.0	11.0	11.7
40	24.0	23.0	26.0	24.3
50	32.0	33.0	32.0	32.3

(i) Describe the trend shown in the mean rate of transpiration as light intensity increases from 20 to 50 a.u.

[2]

- The mean rate of transpiration **increases** from 20 to 50 arbitrary units
- For example, in trial 1, the rate of transpiration increases from **5.0 mm min^{-1} at 20 a.u to 32.0 mm min^{-1} 50 a.u.**

***Note**: this is a **describe** question. Do not explain why this is happening here, simply describe the trend and give data with units to support your description.*

(ii) Suggest why the rate of transpiration did not change between light intensities 10 a.u. and 20 a.u.

[1]

It may be that the rate of transpiration did not change between 10 and 20 a.u. because

- at this point the **light intensity was not high enough**
- so the **stomata were closed**

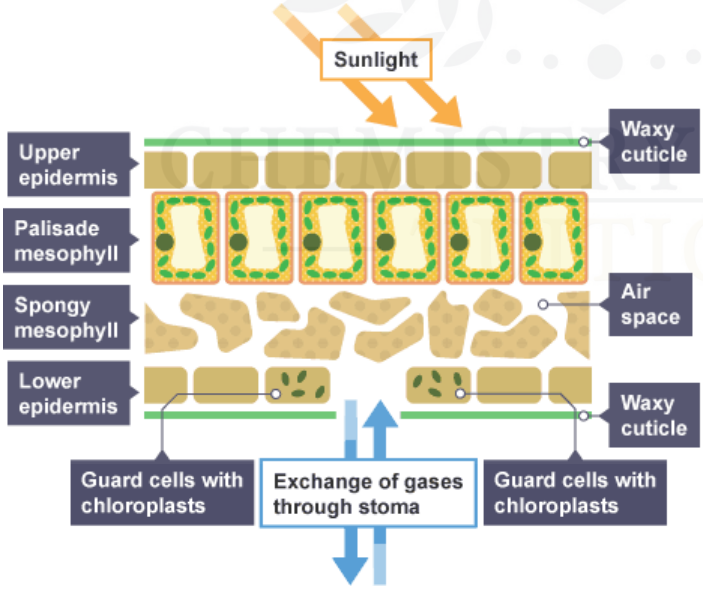
(b) (i) Explain why transpiration is unavoidable during the day. **[3]**

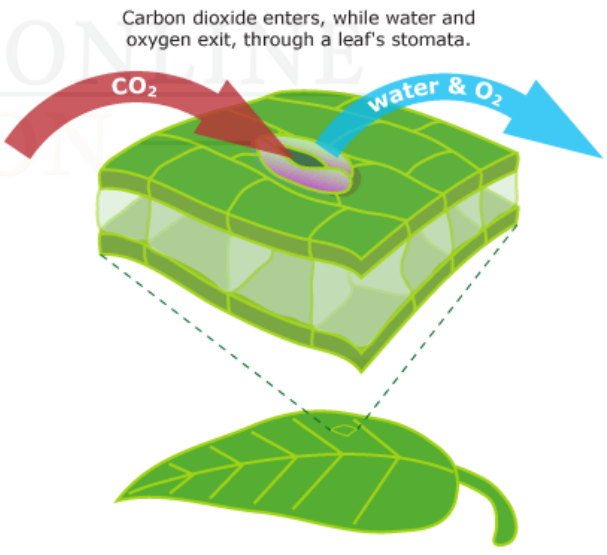
Transpiration is unavoidable during the day because

- The **stomata** open
- To allow **gas exchange**
- So that **photosynthesis** can take place in the leaves
- As a consequence water vapour leaves the leaf through open stomata
- Down a water **potential gradient**
- Higher temperatures during the day
- Cause greater **evaporation**

***Remember**! The function of the stomata is to open to allow carbon dioxide in for photosynthesis. A plant does not 'want' to lose water, as its cells rely of water for their turgidity. It is as a consequence of gas exchange that evaporation of water occurs.*

Diagrams to show the structure of the leaf, showing the position of the stomata and an open stomata:





(ii) Fig. 5.1, **on the insert**, is a photograph of a transverse section of a leaf taken from a xerophyte.

Describe the xerophytic features of this leaf **and** explain how each feature reduces loss of water vapour.

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

[5]

Xerophytic leaves have the following adaptations (any four of):

- A thick waxy cuticle
- The leaf is folded
- Which reduces the exposed surface area for evaporation
- They often have hairs
- Which reduces evaporation from the surface
- As these hairs trap water vapour
- Which creates a high water potential outside the stomata
- And therefore reduces the water potential gradient

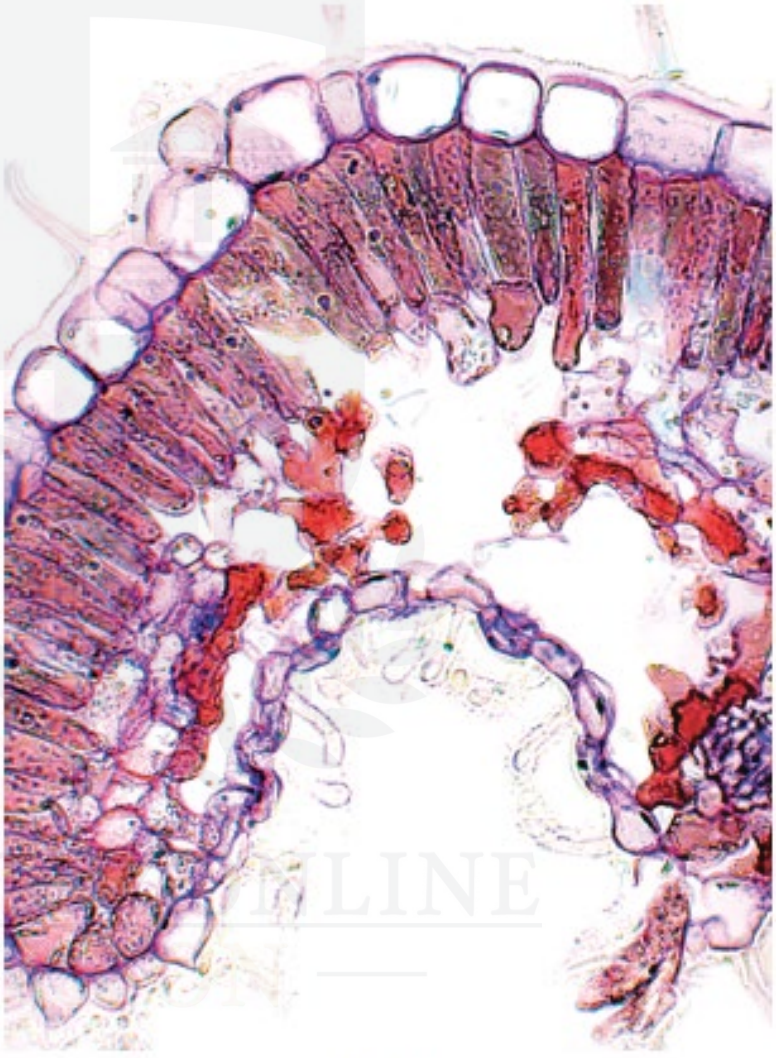
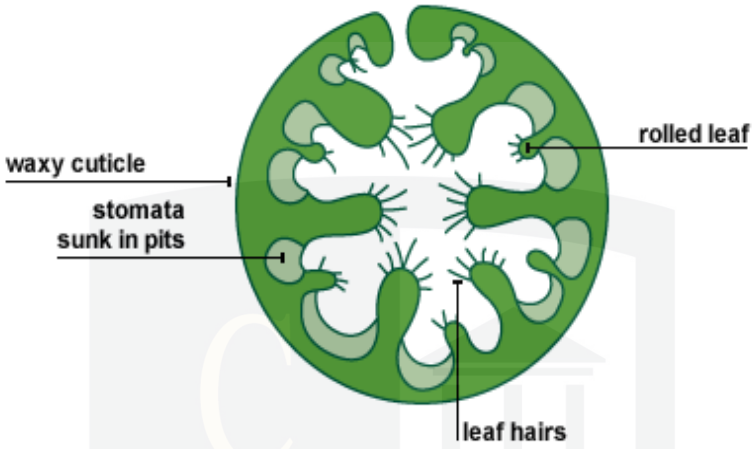


Fig. 5.1

Diagram to show a rolled xerophytic leaf and some of the other adaptations to reduce water loss:



[Total: 11]

Question 2

(a) Translocation is the movement of assimilates along the phloem from one part of a plant to another.

(i) Name the sugar molecule most commonly translocated. **[1]**

The sugar molecule commonly translocated is called:

- **Sucrose**

(ii) A tissue may act as a source or a sink at different times.

For each tissue listed below, state whether it is acting as a source, a sink or neither. The first one has been done for you. **[3]**

tissue	source, sink or neither
a leaf in summer	source
a developing bud	**Sink**
xylem	**Neither**
an actively growing root tip	**Sink**

A source is a cell or tissue that can produce sucrose. A sink in a cell or tissue that requires sucrose. Both the developing bud and actively growing root tip require plenty of sugar for respiration for active growth. The xylem is made from dead cells, so neither requires nor produces sucrose.

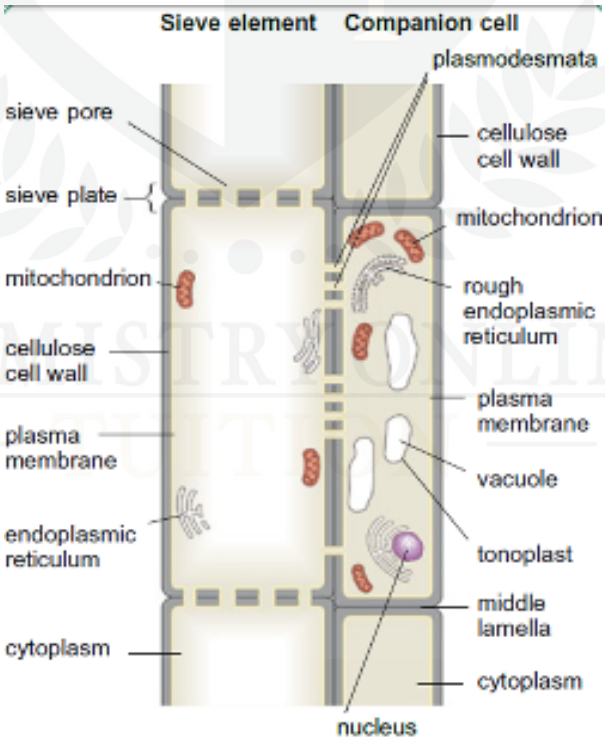
(b) The sap in the phloem sieve tubes is moved by mass flow.

State **two** adaptations of sieve tubes that enable mass flow to occur. **[2]**

Two adaptations of the sieve tubes that allow for mass flow are:

- The presence of elongated **elements**
- that are joined end to end to create a **column**
- There are sieve **plates** with **pores** at the end that allow flow of assimilates like sucrose
- The cells have little **cytoplasm** so that there is little resistance to flow
- The cells have very few **organelles**

A diagram to show the structure of the phloem (including companion cells):



Note: Sieve elements have no nucleus, tonoplast or ribosomes.

(c) Describe how assimilates are loaded into the phloem.

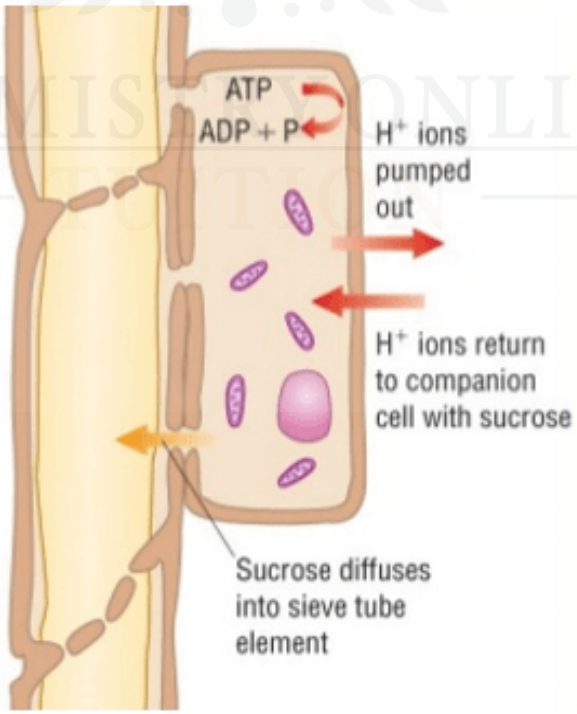
In your answer, you should use appropriate technical terms, spelt correctly. **[4]**

Assimilates are loaded into the phloem by:

- The **active transport** of **hydrogen ions** out of **companion** cells
- Which creates a hydrogen ion **concentration gradient**
- The hydrogen ions then **diffuse** back into the **companion** cells by **facilitated** diffusion
- Assimilates move in with the hydrogen ions
- By **cotransport**
- The assimilates diffuse through the **plasmodesmata** from companion cell
- Into the **sieve element**

Exam tip: *You must include key scientific words, shown here in bold, in order to gain your QWC mark.*

A diagram to show the active loading of assimilates into the phloem:



[Total: 10]

Question 3

(a) Fig. 4.1 is a diagram showing the position of the vascular bundles in a transverse section of the stem of a young dicotyledonous plant.

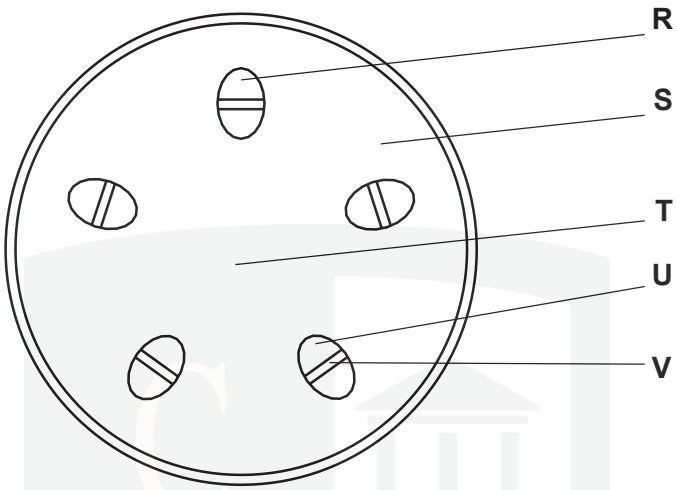


Fig. 4.1

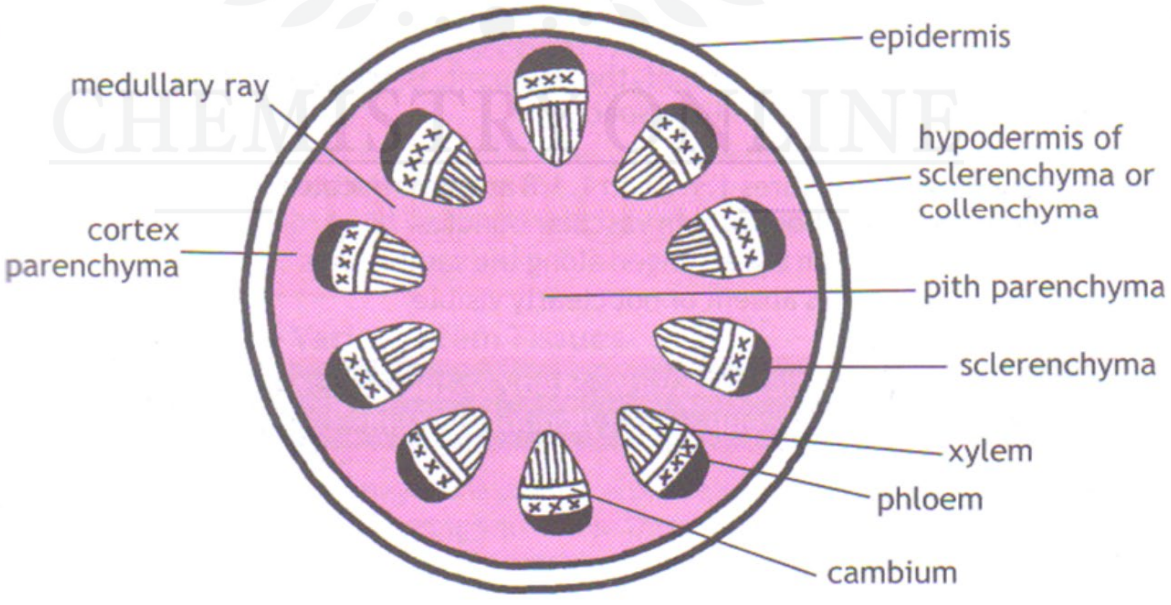
Select the correct letter from Fig. 4.1 to identify each of the following tissues in the stem. **[3]**

xylem ..... U

phloem ..... R

cambium V

Diagram to show the structures within the stem:



T/S of a young dicotyledonous stem, in plan

(b) Fig. 4.2, **on the insert**, shows the cut end of a stem from a woody plant. The other end of the stem is being heated in a fire. Steam can be seen coming from the vascular tissue at the cut end of the stem.

Describe the features of the xylem that enable the steam to pass from the heated end of the stem to the cut end.

[2]

The features of the xylem are:

- Xylem is made up of cells joined end to end to form a **continuous** structure
- The cells in xylem tissue have **no contents**, so steam is able to pass through them easily
- The walls of the xylem are **lignified**
- They have **pits** in their walls

Diagram to show the structure of a xylem vessel:

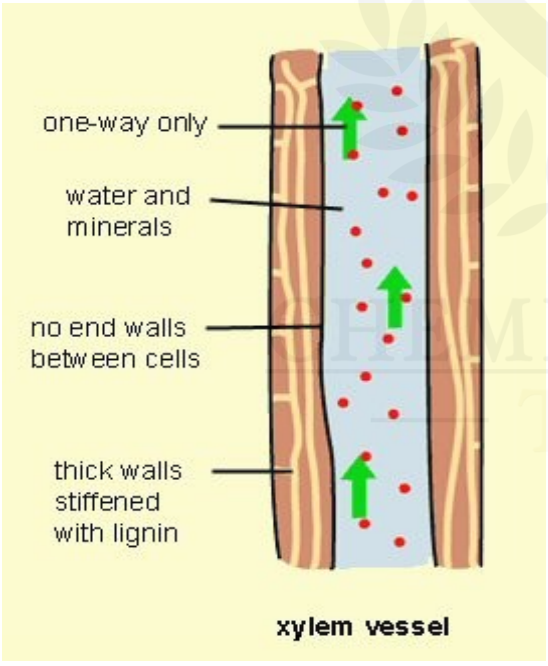


Fig. 4.2

(c) (i) Define the term *transpiration*. **[2]**

Transpiration is:

- The **evaporation** of **water vapour**
- from **aerial** parts of the plant
- via **stomata**

***Exam tip**: learn this definition!*

(ii) Describe **and** explain how transpiration contributes to the mechanism of water transport up the stem.

In your answer, you should use appropriate technical terms, spelt correctly. **[5]**

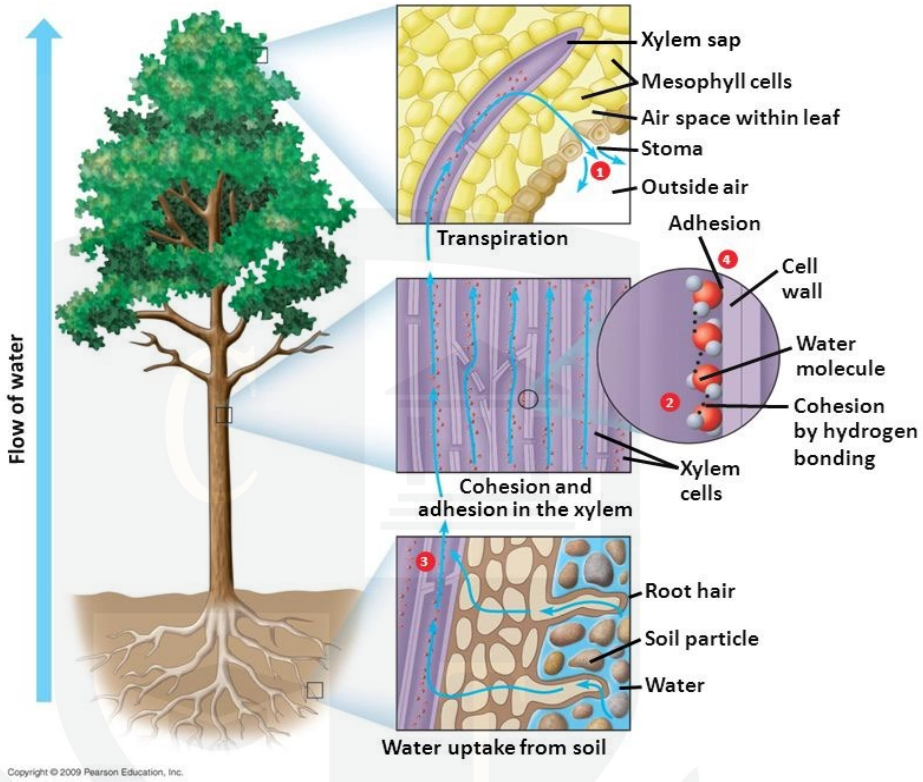
Transpiration is vital for water transport in a plant because:

- The water loss from the leaf is replaced
- Via the **apoplast**, **symplast** and **vacuolar**, pathways
- Down a **water potential gradient**
- The lost water is replaced by water from the xylem
- In the xylem the loss of water causes a low **hydrostatic** pressure at the top (creating a pressure **gradient**)
- Water moves from higher pressure to lower pressure
- It is drawn up the xylem under **tension**, as a column
- by **mass flow**
- Due to **cohesion** between water molecules

***Exam tip**: ensure you use your key terminology here, in order to gain your QWC mark. These words have been shown in bold.*

Remember that transpiration causes a loss in pressure at the top of the plant. This gradient, and the polar property of water that allows it to hydrogen bond to itself (cohesion) and other materials (adhesion) means that water is drawn up the plant as a continuous column, against gravity. This is different to osmosis, which is where water molecules individually cross a membrane.

Diagram to show the process of the transpiration stream:



(iii) Suggest why a bunch of flowers may survive longer if the ends of the stems are removed immediately before the flowers are placed in water. **[2]**

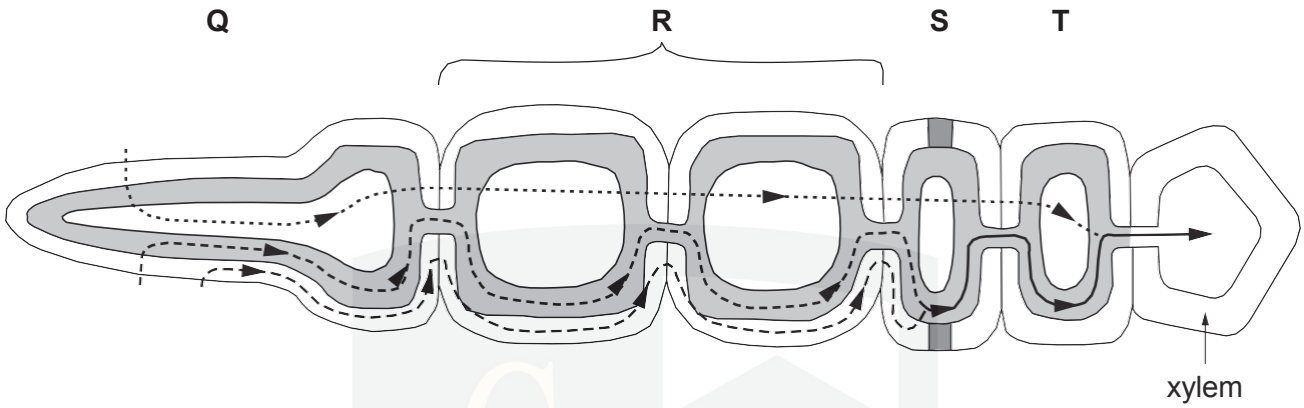
Cutting the stems on the flowers may

- allow bubbles trapped in the **xylem** to escape
- which will restore a continuous stream of water

[Total: 14]

Question 4

Fig. 5.1 shows the possible pathways taken by water across the root of a plant.



Key:

pathway 1

pathway 2

pathway 3

common pathways

Fig. 5.1

(a) (i) Name the process by which water enters cell **Q** from the soil. **[1]**

The process by which water enters cell Q is called: Osmosis

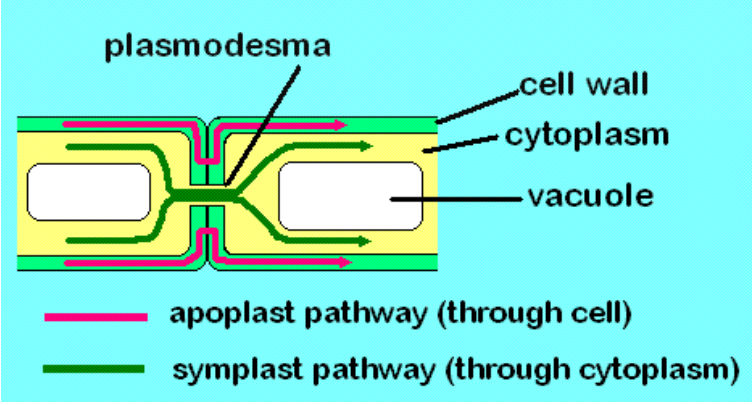
(ii) Pathway 1 is known as the vacuolar pathway, as the water passes into and through the cell vacuoles.

Name pathway 2 and pathway 3. **[2]**

pathway 2 **Symplast** pathway

pathway 3 **Apoplast** pathway

Diagram to show the different routes water can take through the root of a plant:



(iii) State which letter, **Q**, **R**, **S** or **T**, on Fig. 5.1, represents the endodermis. **[1]**

The endodermis is represented by letter:

- **S**

The endodermis is a strip of tissue that contains a waxy substance. This is called the Casparian Strip. It ensures the water passes through a membrane so that the level of solute uptake into the xylem can be controlled.

(b) Describe **and** explain how water is moved up the xylem from the roots to the leaves.

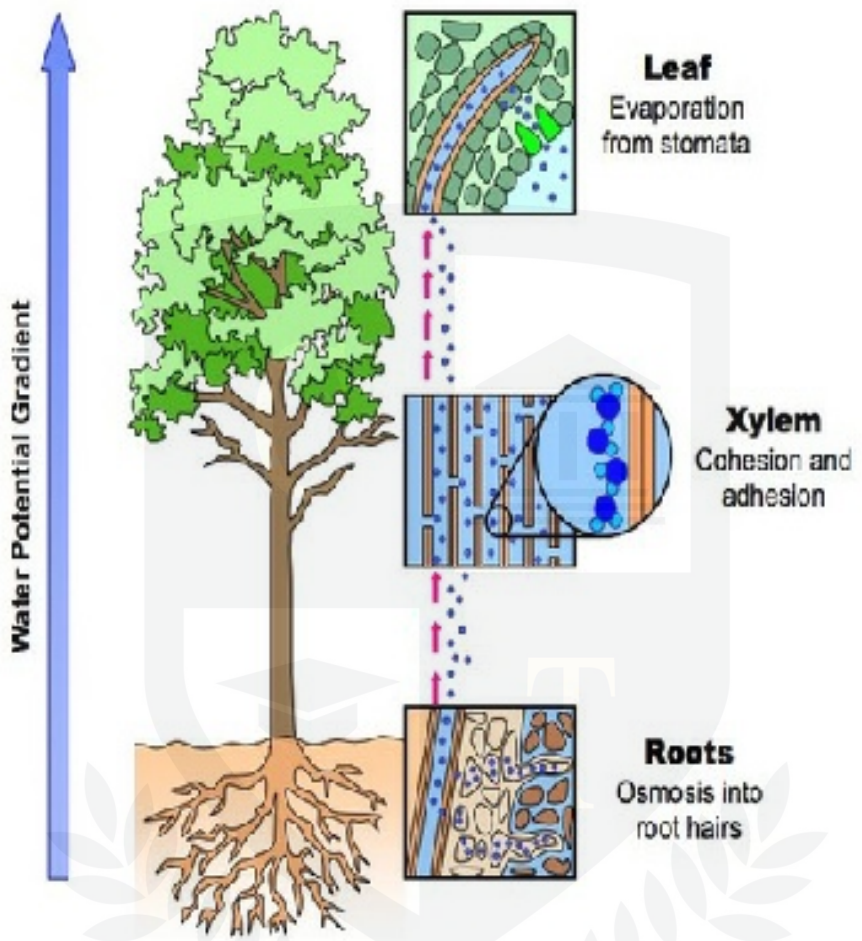
In your answer you should use appropriate technical terms, spelt correctly. **[5]**

Water is moved up the xylem:

- Water moves into the xylem from the roots down a **water potential** gradient
- This produces a high **hydrostatic pressure** at the bottom of the xylem (**root pressure**)
- **Evaporation** of water vapour at the top of the plant
- Creates a low **hydrostatic pressure** at the top of the xylem
- Water is pulled up the xylem, under **tension**, in a continuous column
- **Cohesion** between water molecules causes them to move together
- **Adhesion** of water molecules attracts them to the xylem vessel walls
- This allows water to move up the xylem by **mass flow**
- Down the **hydrostatic pressure gradient**

***Exam tip**: the description of the transpiration stream is quite common, and will always require you to use key scientific terminology, shown here in **bold**. Ensure you use as many of these words as possible to gain your QWC mark.*

Diagram to show the process of water moving up the xylem, in the transpiration stream:



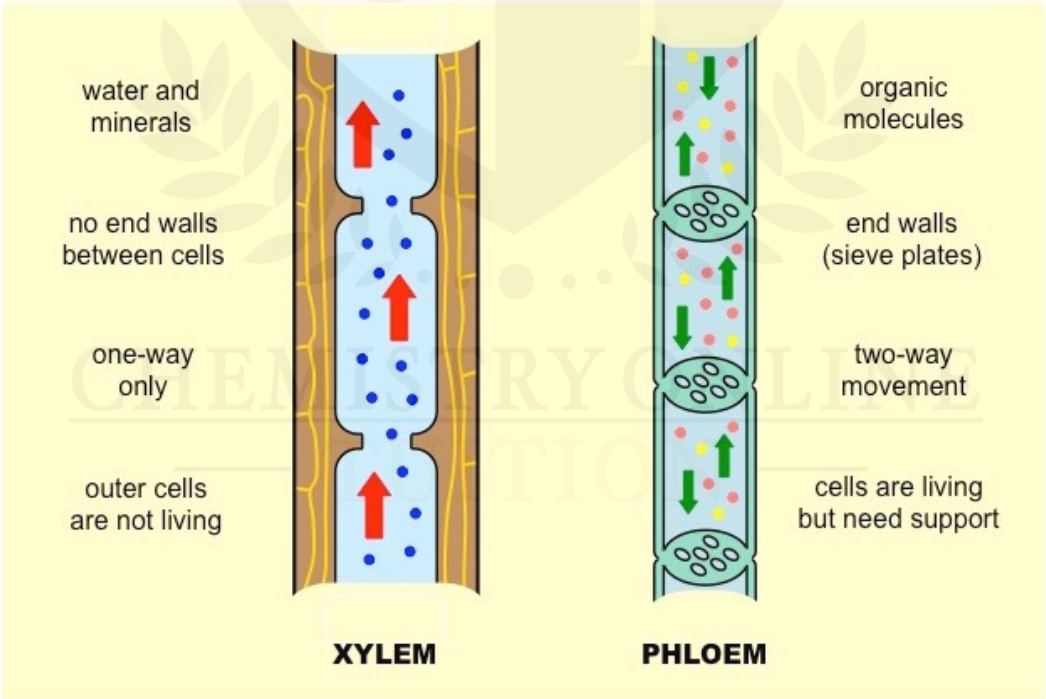
(c) Table 5.1 shows a comparison of xylem vessels and phloem sieve tube elements.

Complete the table. The first row has been done for you. **[4]**

Table 5.1

Feature	Xylem vessel	Phloem sieve tube element
Cells living or dead	Dead	Living
Bordered pits present or absent	Present	Absent
Lignin present or absent	Present	Absent
Substances transported	Water and minerals	Sucrose and other assimilates
Direction of transport	Up the stem	Up and down

Diagram to show the structures of the xylem and phloem vessels:



[Total: 13]