# Transport in plants

## Model Answers 2

| | |
|---|---|
| Level | A Level |
| Subject | Biology |
| Exam Board | OCR |
| Module | Exchange and transport |
| Topic | Transport in plants |
| Booklet | Model Answers 2 |

**Time allowed:** **69 minutes**

**Score:** **/51**

**Percentage:** **/100**

**Grade Boundaries:**

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

## Question 1

**Fig. 25.1** shows a potometer.

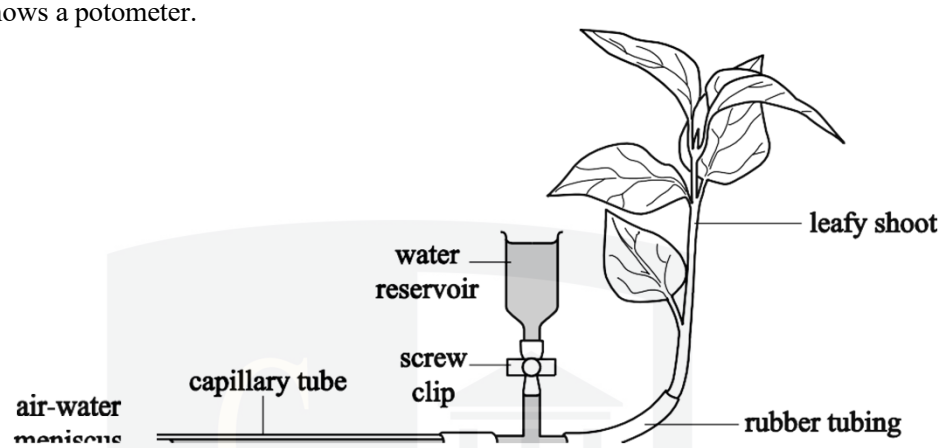



**Fig. 25.1**

**(a)** A student used this apparatus to investigate the role of stomata in transpiration. The student noted the position of the air–water meniscus each minute for five minutes.

The student then covered the underside of one of the leaves in petroleum jelly before repeating the measurements. This was continued until the undersides of all the leaves had been covered.
**Table 25.1** shows the results.

| Number of leaves with undersides covered in petroleum jelly | Position of meniscus (mm) at | | | | | |
|---|---|---|---|---|---|---|
| | 0 min | 1 min | 2 min | 3 min | 4 min | 5 min |
| **0** | 0 | 23 | 44 | 65 | 84 | 102 |
| **1** | 0 | 20 | 40 | 58 | 77 | 95 |
| **2** | 0 | 16 | 31 | 47 | 61 | 76 |
| **3** | 0 | 11 | 23 | 37 | 50 | 62 |
| **4** | 0 | 9 | 17 | 24 | 32 | 40 |
| **5** | 0 | 6 | 11 | 16 | 22 | 28 |

**Table 25.1**

The student presented these results as a graph. **Fig. 25.2** shows the graph.

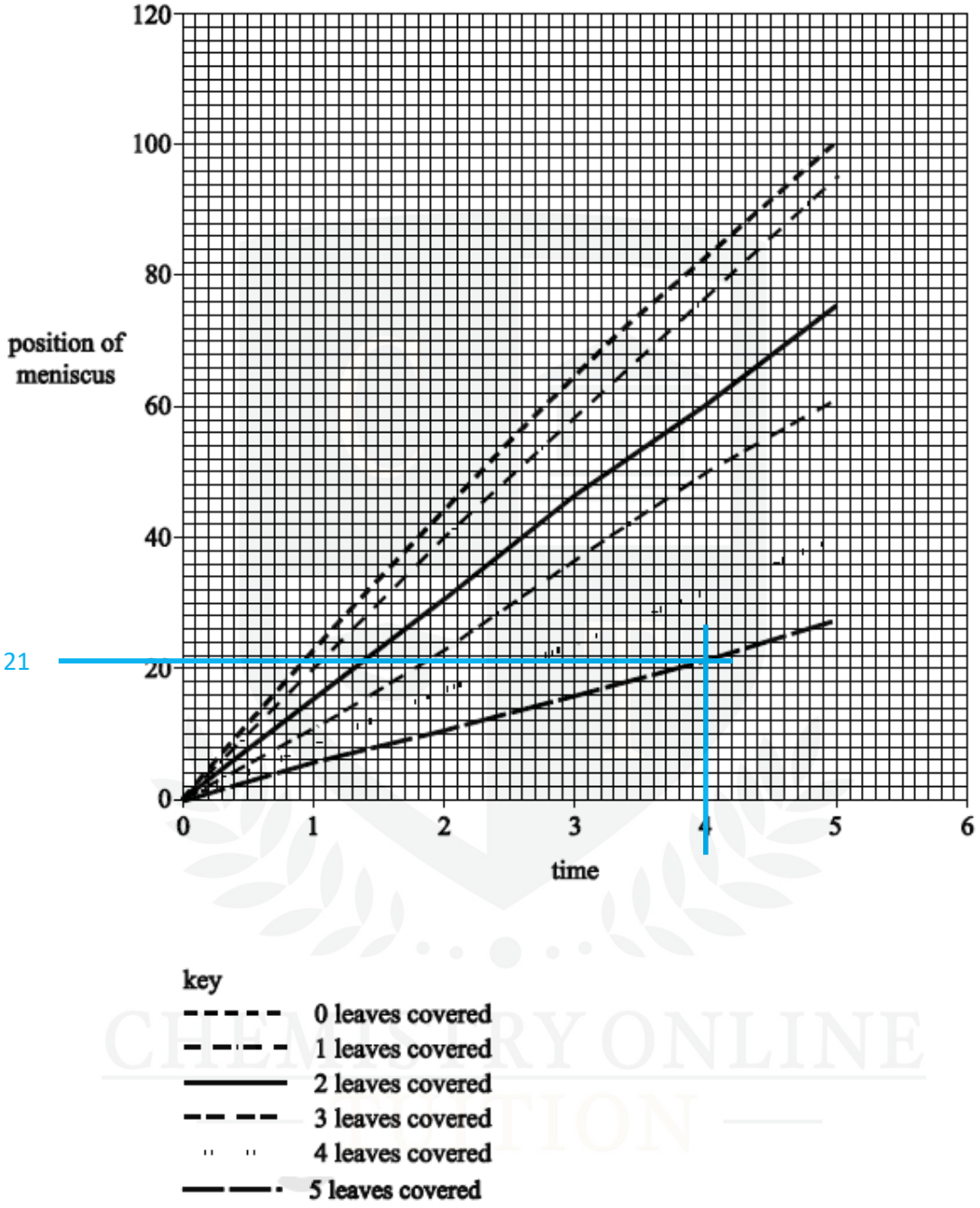



Fig. 25.2

**(i)** State two different types of information the student has missed from the graph. [2]

- No units
- No points plotted
- No title

**(ii)** Use the graph to calculate the minimum rate of transpiration. **[2]**

5.25%

It rose by 21 over a period of 4 minutes so 21 ÷ 4 = 5.25

Always read off the graph carefully and never approximate. For example it rose to 21 and not 20

**(b)** Suggest how water is being lost from the cut stem when all the leaves have been treated with petroleum jelly. **[2]**

- By evaporation
- From the upper leaves

Water can also be lost via the stem

**(c)** Suggest **two** possible sources of error in this investigation. **[2]**

- Not all the leaf was covered
- The meniscus was read inaccurately
- The shoot was not cut under water
- There may have been a leak

This is a standard practical and the whole apparatus is placed underwater and the shoot cut underwater.

**[Total: 8]**

## Question 2

**(a)** Following their formation, assimilates are transported throughout the plant by translocation in phloem.

Phloem sap mainly consists of carbohydrate in the form of sucrose, but also contains other solutes.

**(i)** Suggest why it is beneficial to the plant for the carbohydrate to be transferred throughout the plant in the form of sucrose rather than as an alternative carbohydrate.

**[2]**

- Sucrose is soluble it's easily transported
- Sucrose metabolically inactive so it won't be used up

A really important role of sugars as a transport medium is that they are soluble.

**(ii)** How is transport in the phloem similar to and different from transport in the xylem? **[2]**

**Similar** Both use mass flow / both carry mineral ions/ both carry solutes

**Different**

- Xylem transports in one direction, the phloem in both
- The phloem carries carbohydrates not the xylem
- Phloem uses living cells, the xylem are dead
- The xylem uses capillary action / cohesion tension the phloem does not

**(b)** Assimilates are loaded into the phloem at the 'source' and then transported to the 'sink'.

**(i)** Explain, with a suitable example, how some parts of the plant can act as both a 'source' and a 'sink'.

**[2]**

- Some parts of a plant can store carbohydrate then release it when needed
- Some parts, like the leaf can act as sources and sinks at different times of the year

The source is where sugars are loaded, for example the leaf makes sugars by photosynthesis. The root may be a sink where sugars are used up in respiration

A potato is made when sugars from the leaf are stored as starch (so it's a sink) and when the starch is hydrolysed to sugars in spring it behaves as a source.

**(ii)*** **Fig. 19.1** is a diagram that represents the loading of sucrose into the phloem at the 'source'.

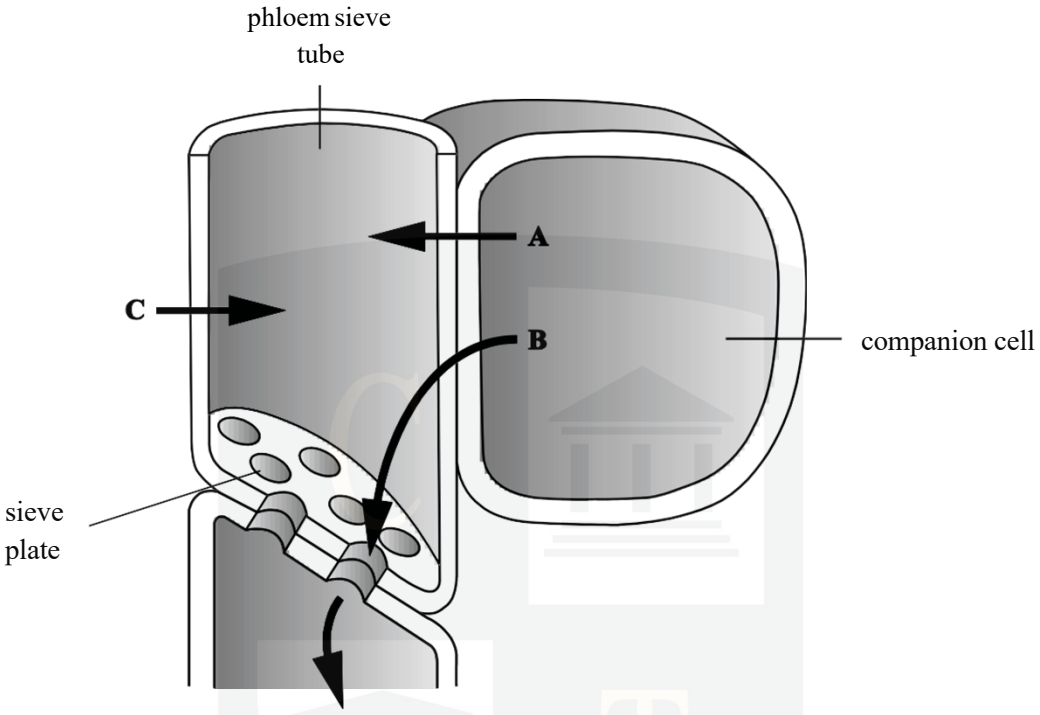



**Fig. 19.1**

With reference to **Fig. 19.1**, explain the process of the loading of sucrose into the phloem and its movement in the phloem.

**[6]**

- The companion cell pumps out hydrogen ions by active transport
- The hydrogen ions diffuse back into the companion cell combined with a molecule of sucrose
- Via cotransporter proteins
- Sucrose builds up in the phloem and is pumped into the sieve tube element (B) the sucrose entering the sieve tube lowers its water potential
- Water diffuses by osmosis from the companion cell (A)
- Water diffuses by osmosis from the xylem (C)
- Increased hydrostatic pressure forces the flow of sap down the phloem
- It accesses the sieve tubes via the sieve pores

This model answer is in more detail than the mark scheme, so don't panic. Better to be over-prepared in the exam. Sucrose is 'loaded' into the phloem at the source. When it's loaded, it lowers the water potential in the sieve tubes and water enters the sieve tube by osmosis. This increases the hydrostatic pressure in the phloem. Where the mass flow comes unstuck is the evidence that travel can go in opposite directions at the same time in the same sieve tube at the same time

**(c)** **Fig. 19.2** is a diagram of a potato plant. Potatoes are tubers which are underground storage organs.

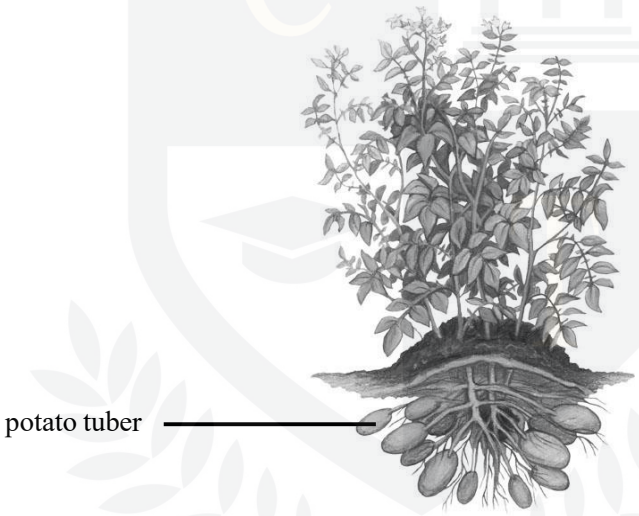



**Fig. 19.2**

Actively growing tissues have a high demand for carbohydrates. This means that a lot of phloem sap is directed to these tissues and requires sucrose to be unloaded in large amounts.

In an investigation, potato plants were modified by having a gene for invertase inserted into their DNA so that the gene for invertase would be expressed in the tubers. Invertase is responsible for catalysing the hydrolysis of the disaccharide sucrose.

A trial experiment was carried out to compare the properties of the modified plants with those that had not been modified. After harvesting, the tubers of three of each type of plant were compared. The results are shown in **Table 19.1**.

| | Modified | Not modified |
|---|---|---|
| Mean number of tubers per plant | 2.2 | 5.3 |
| Mean mass per tuber (g) | 49.7 | 16.8 |
| Mean sucrose concentration (mg $g^{-1}$ tuber mass) | 1.4 | 13.7 |
| Mean glucose concentration (mg $g^{-1}$ tuber mass) | 36.3 ± 3.5 | 1.9 ± 0.3 |
| Invertase activity (arbitrary units) | 62.1 | 1 |

**Table 19.1**

**(i)** Name the bond that is hydrolysed by invertase. **[1]**

glycosidic

Sugars are joined by gycosidic bonds, amino acids by peptide bonds and fatty acids and glycerol by ester bonds.

**(ii)** The potato tubers contain monosaccharides.

Compare the concentration of monosaccharides in the modified tubers with those that were not modified.

**[2]**

- The concentration of glucose is x19 greater in modified tubers
- The standard deviation is greater in modified tubers

Glucose is the monosaccharide being referred to. When you manipulate data make sure you either quote percentages or ratios and don't just refer to the actual numbers.

(iii) In the modified plants, the unloading of sucrose is increased in the tubers compared with those that were not modified.

The transport of sucrose to the tubers was also increased in the modified plants.

Using the data and the information given, deduce a possible mechanism to account for the increased unloading and transport of sucrose in the modified plants. **[4]**

- The modified tubers had greater invertase activity so more sucrose was hydrolysed to glucose in the tubers
- Less sucrose in the tubers increases the concentration gradient between the phloem and the sink
- More sucrose is unloaded from the phloem to the sink
- More water is then removed from the phloem so the pressure gradient between the source and the sink increases

Divide your answer into two explaining the unloading AND transport of sucrose.

Make sure your terminology is correct for example; load, unload, concn gradient, pressure gradient

(iv) The trial experiment compared the properties of modified potato plants with those that were not modified.

Analyse the data and draw conclusions about the yield of the tubers of modified plants compared with those tubers from plants which had not been modified. [3]

- The modified plants had fewer tubers but larger tubers
- Modified plants had tubers with greater mass
- 109.34g compared to 89.04g a difference of 20.3g

3 marks for this analysis so make sure you use the data

**[Total: 22]**

## Question 3

Mosses are small plants with no true roots. Each plant is anchored by simple root-like structures which do not contain vascular tissue.

The leaves of moss plants are usually one cell thick and are attached to a thin stem. Neither the leaves nor stem contain vascular tissue.

Fig. 5.1 shows a leaf from a typical moss plant.

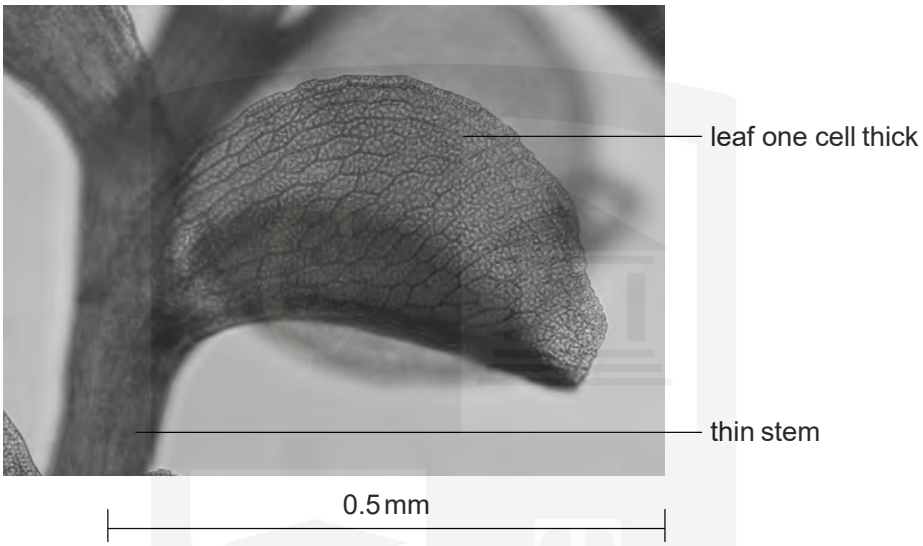



**Fig. 5.1**

**(a)** Suggest **and** explain how the absence of vascular tissue might affect the size to which moss plants can grow.

**[2]**

The absence of vascular tissue will ensure that the moss:

- Remains small
- As there is no support from vascular tissues
- They can use only diffusion
- And diffusion is too slow to enable substances to move large distances
- So they must have a short diffusion pathway

**(b)** Although a moss plant has no vascular tissue, water still moves through the plant from the root-like structures to the leaves.

Use your knowledge of the mechanisms of water transport to explain the movement of water through the moss plant.

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

**[4]**

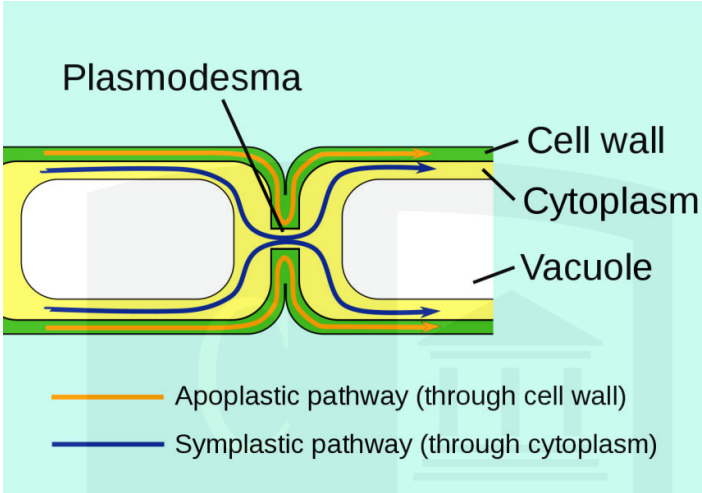
Water moves through the moss plant by:

- **Evapotranspiration**
- Water moves by **symplast** and **apoplast** pathways
- In the **apoplast** pathway, water moves through cell walls by **capillary action**
    - The water loss reduces the **water potential** of leaf cells
- In the **symplast** pathway, water moves from higher **water potential** to lower **water potential**
    - by **osmosis**
    - through **plasmodesmata**

We know from the question that water moves through the moss from the root-like structures to the leaves. You need to use your knowledge of how water moves through the roots of a dicotyledonous plant to answer this question.

***Exam tip**: to gain a QWC mark, you need to ensure you use the key terminology, shown here in **bold**.*

Diagram to show the movement of water by apoplast and symplast pathways:




**(c) (i)** What is meant by the term *tissue*? **[2]**

A tissue is:

- a group of cells
- working together

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

**(ii)** Leaves of dicotyledonous plants contain types of cells that are not found in the leaves of mosses, such as that shown in Fig. 5.1.

Other than the cells found in vascular tissues, name **two** types of cell found in the leaves of dicotyledonous plants that are not found in the leaves of mosses.

Two types of cell found in the leaves of dicotyledonous plants that are not found in the leaves of mosses are: **[2]**

- palisade mesophyll cells
- spongy mesophyll cells
- guard cells
- upper / lower epidermal cells

**[Total: 10]**

## Question 4

**(a)** Transpiration is the loss of water vapour from the aerial parts of a plant.

(i) Name the pores through which most water vapour is lost from a leaf. **[1]**

Stomata

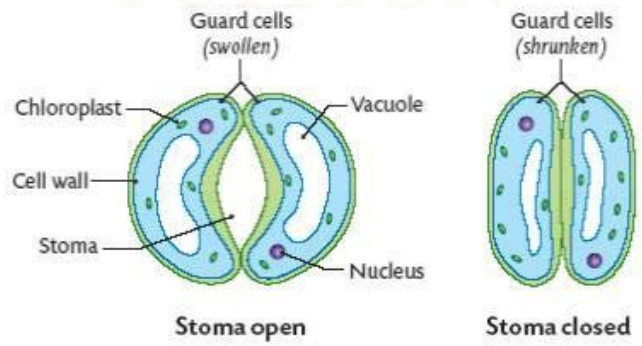
***Exam tip:*** *Be careful here to write the name of the structure and not the process (i.e. transpiration)*

**(ii)** Describe how the guard cells surrounding the leaf pores are adapted to their role. **[2]**

- Guard cells have unevenly thickened cell walls
- This allows the cell to bend and open the pore
- There are ion pumps present in the plasma membrane
- Guard cells also have chloroplasts to make ATP

***Exam tip:*** *Make sure you make the link between the cells swelling and changing shape (i.e. bending causing the pores to open)*

Below is a diagram to show the guard cells with their unevenly thickened cell walls, which allow them to bend. This occurs due to active pumping of K+ ions into the cells, which lowers the water potential. Water follows by osmosis, causing the cells to swell and bend:



**(iii)** Name **one** other part of the leaf from which water may be lost. **[1]**

Cuticle/ epidermis

**(b)** Water lost from the leaf must be replaced with water from the xylem.

Complete the following passage about movement of water from the xylem to the cells of the leaf using the most appropriate terms.

When water is lost from the cells of the leaf it reduces the **water potential** .....

in those cells. As a result, water enters the cells by **osmosis** ..... .

This process occurs across the plasma membrane which is **partially permeable** ..... .

If all the water lost from the leaf cells is not replaced, they lose **turgor** .....

and the leaf may wilt. **[4]**

Note that the correct term for a plant cell filling with water is gaining '**turgidity**'.

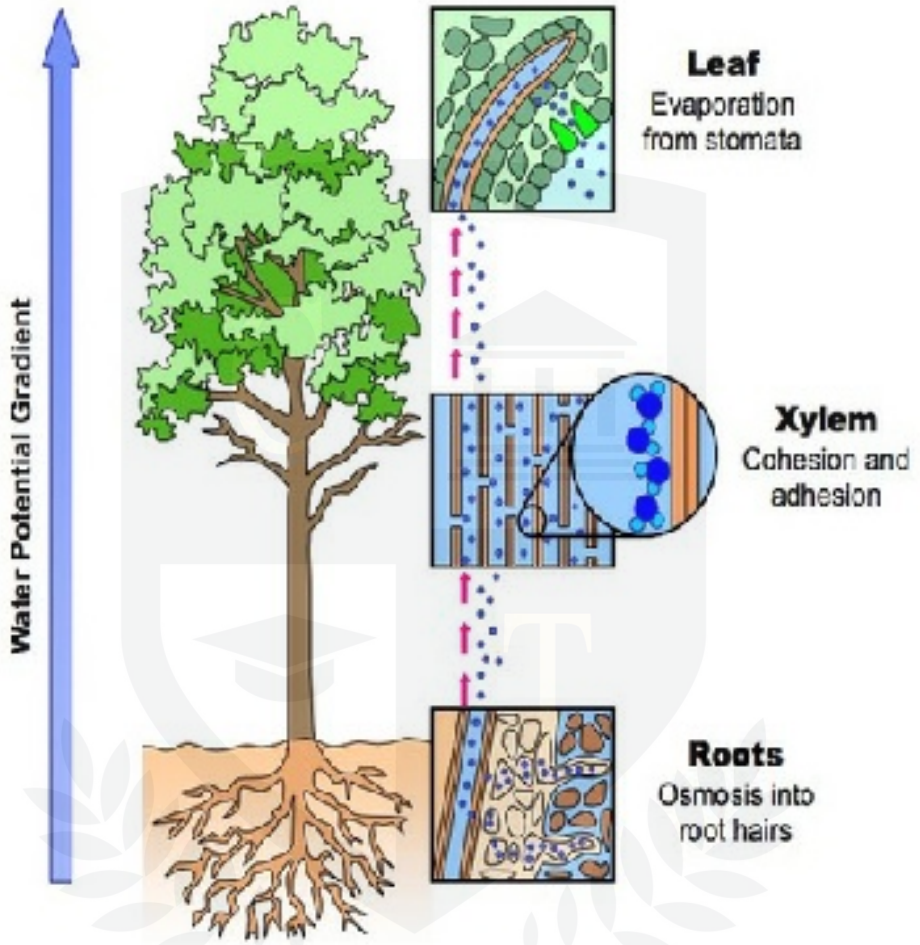
**(c)** The cohesion-tension theory is often used to explain the mechanism by which water moves up the xylem from the roots to the leaves.

Use this theory to explain how water moves from the roots to the leaves. **[3]**

- Water moves from the roots to the leaves because there is **evaporation** at the top of the plant/leaf
- This creates **tension** in the **xylem**
- Water molecules stick together **(cohesion)** and form a column
- The column of water is **pulled up** the xylem by tension

***Exam tip:*** *Here, information about how water enters at the roots is unnecessary. Make sure you are specifically talking about cohesive and adhesive forces.*

Below is a diagram to show how transpiration occurs in a plant due to cohesion and adhesion:




**[Total: 11]**