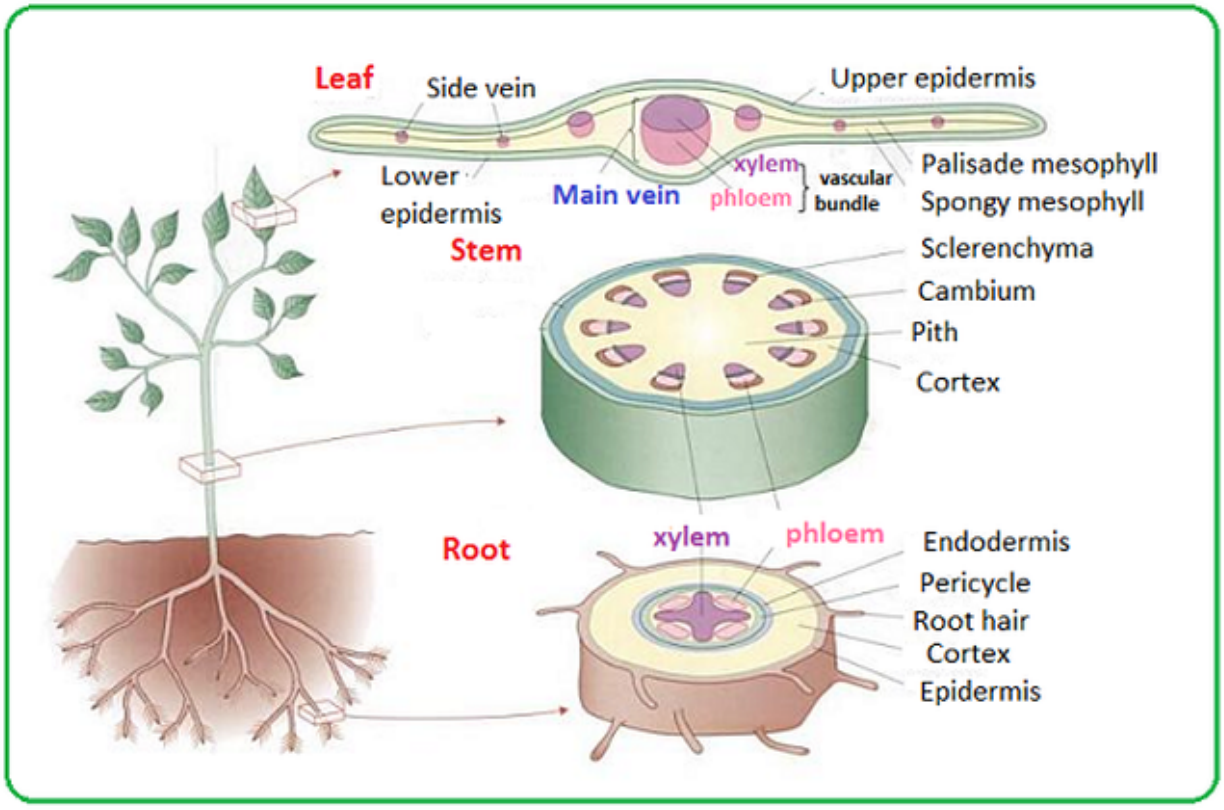
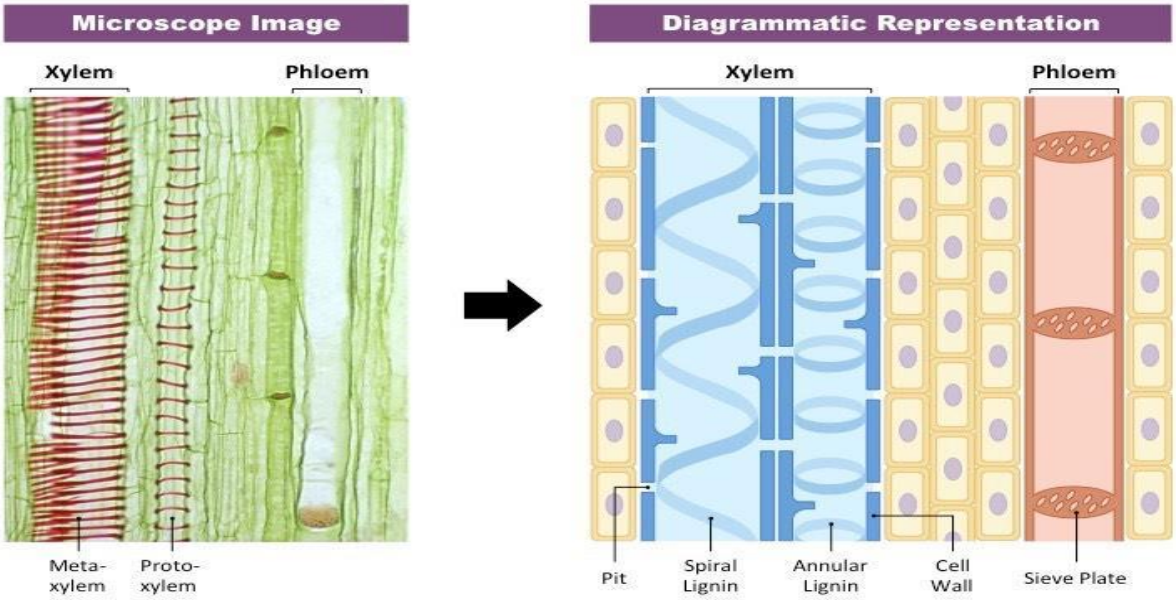
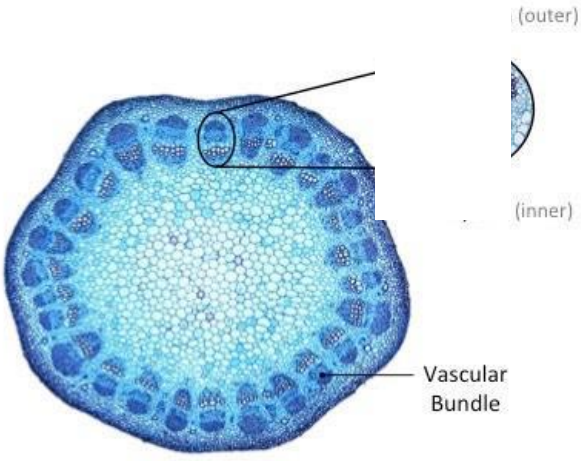
LO: Identify the positions and explain the functions of xylem vessels, phloem (sieve tube elements and companion cells) in sections of a herbaceous dicotyledonous leaf and stem, using the light microscope

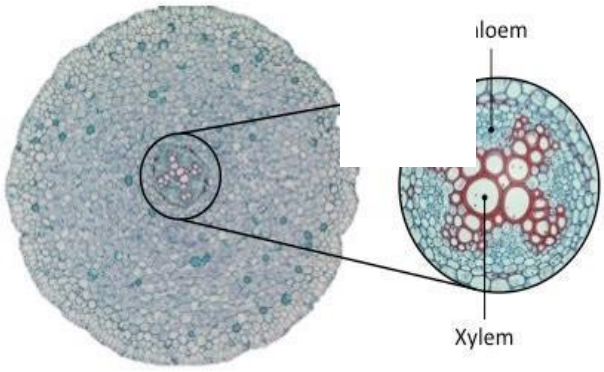


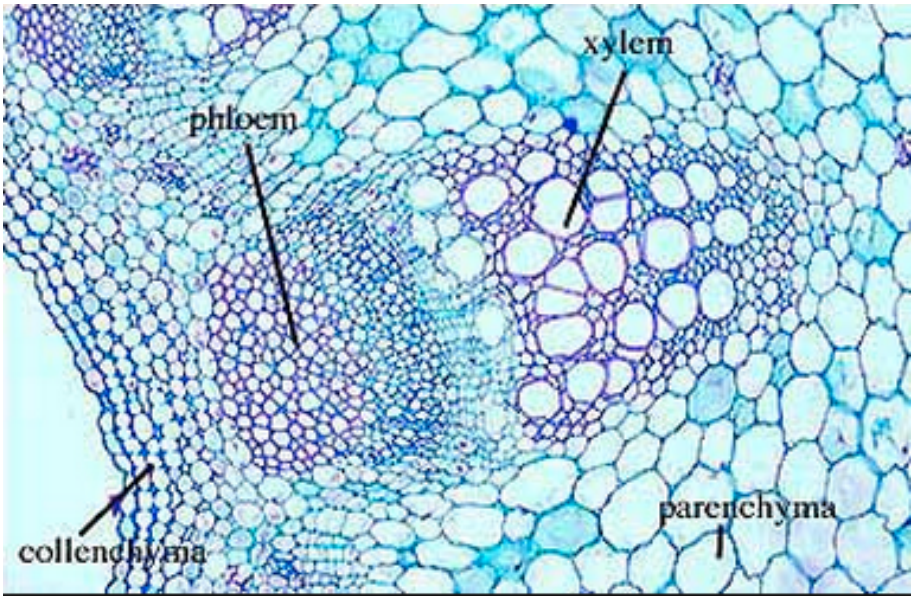


Dicotyledon **Stem**



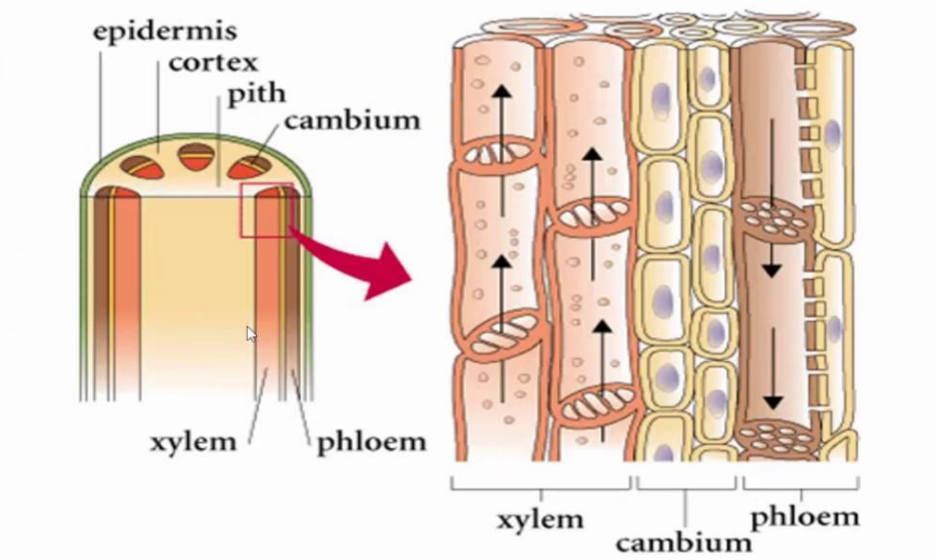
Dicotyledon **Root**





- Function of xylem: <u>Transports water and mineral salts</u> from roots to leaves (no nucleus and no protoplasm)
- Function of phloem: <u>Transports sucrose and amino acids</u> from the leaves to the storage organs and other parts of the plant

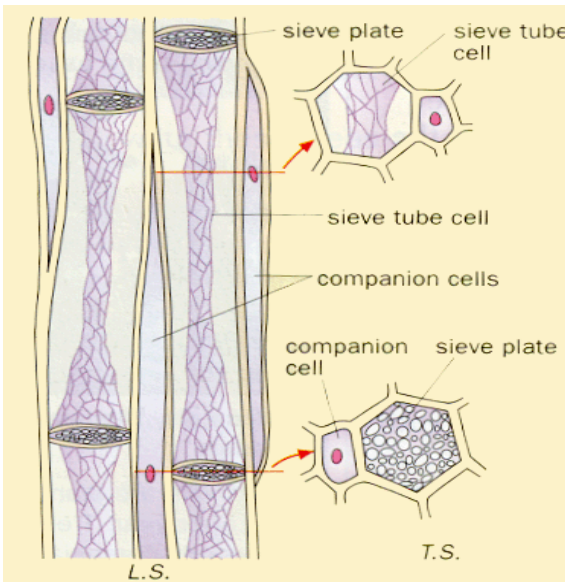
<u>Xylem vessel</u>

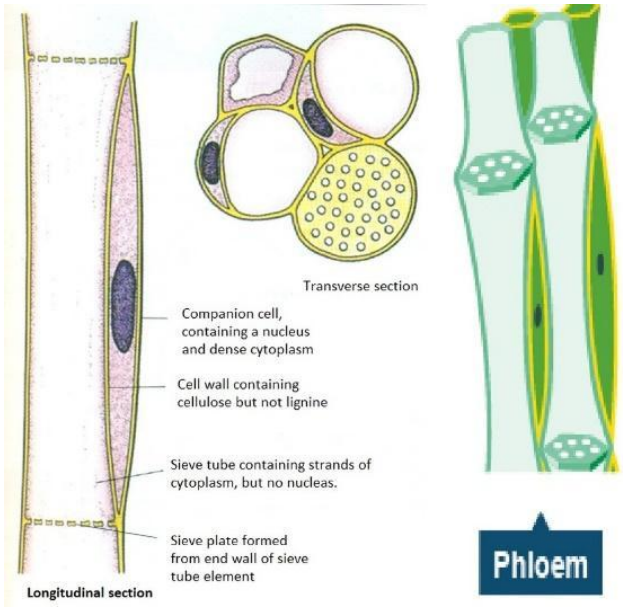


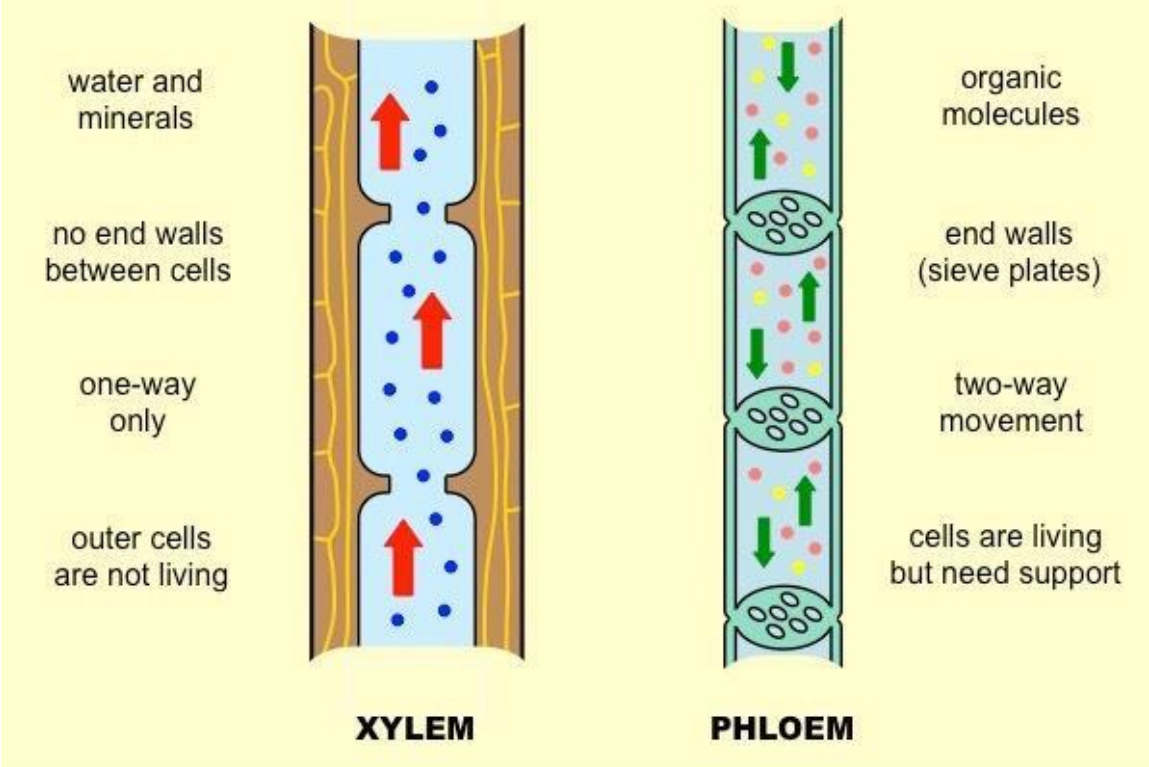
- Thick, lignified cell wall: strengthens the vessel and prevents plant from collapsing, provides mechanical support.
- Narrow, hollow, long lumen with no cross wall: For faster transportation of water and mineral salts from roots to leaves.

Phloem

- Sieve tube elements: Allow rapid transport of sucrose and amino acids due to little protoplasm and a continuous column (no nucleus)
- Companion cells: Release energy needed for translocation of sucrose and amino acids due to presence of numerous mitochondria







Functions of xylem and phloem:

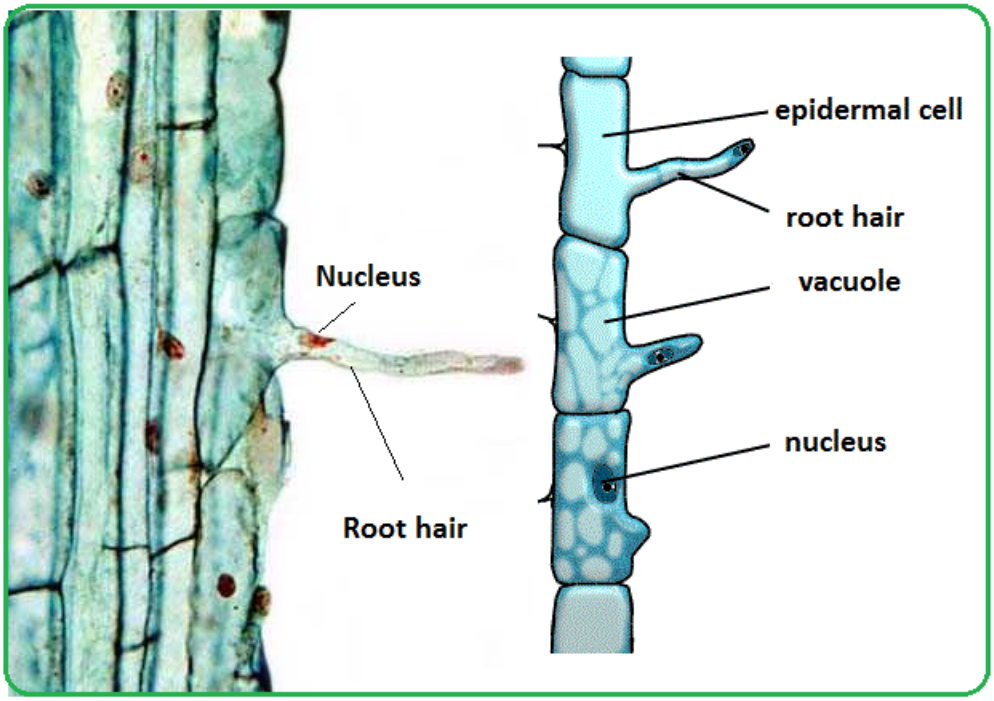
Similarities:

- Xylem and phloem both transport substances/materials to different parts of the plant.
- Xylem and phloem both transport substances as a solution to different parts of the plant.

Differences:

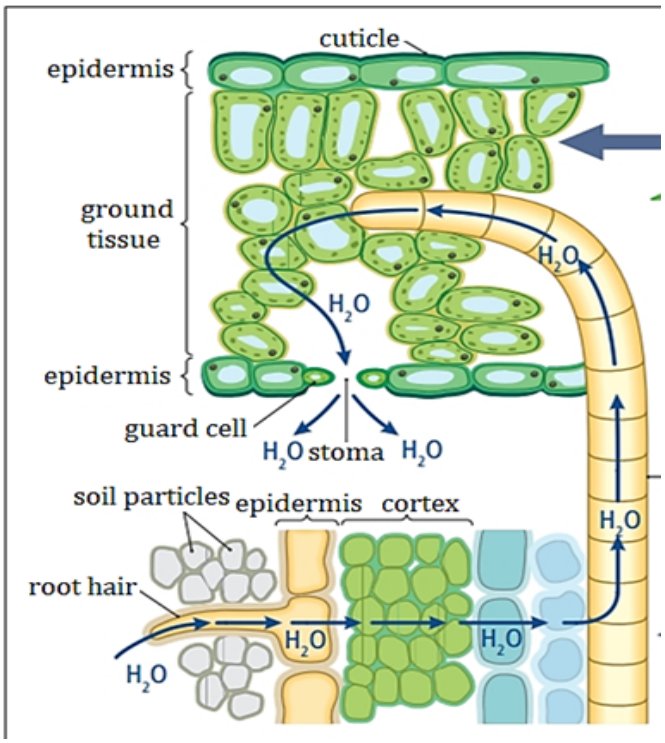
- Xylem transports water and mineral salts while phloem transports sucrose and amino acids.
- Xylem transports water and mineral salts in one direction up the plant while phloem transports sucrose and amino acids in both directions.
- Xylem transports water and mineral salts from the roots to the leaves while phloem transports sucrose and amino acids from the leaves to other parts of the plant.
- Xylem transports water and mineral salts by root pressure, transpiration pull and capillary action while phloem transports sucrose and amino acids by pressure flow as a result of loading sucrose into the phloem via active transport.

LO: Relate the structure and functions of root hairs to their surface area, and to water and ion uptake



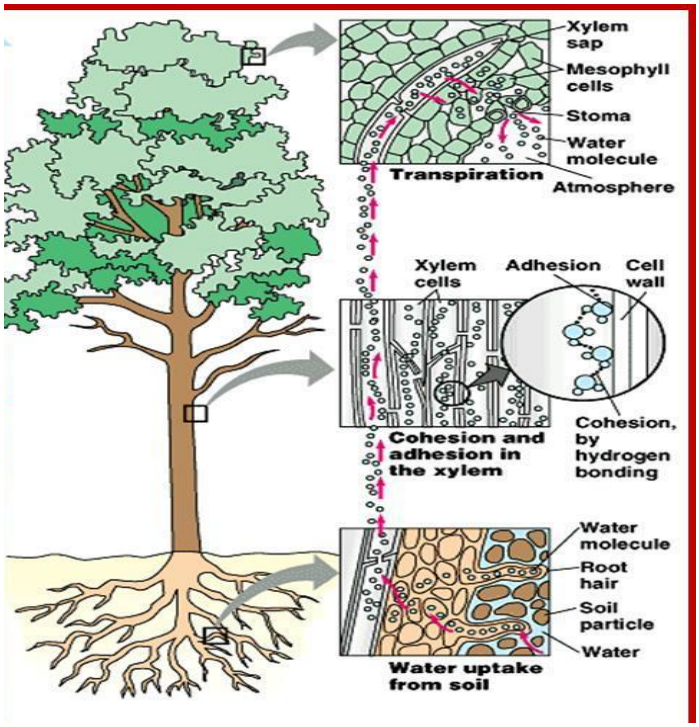
Structure	Function
Long and narrow protrusion	Increases surface area for faster absorption of water and mineral salts
Concentrated cell sap	Provides a water potential gradient for water molecules to move from higher water potential (soil) into lower water potential (cell sap of root hair cell) by osmosis
Presence of many mitochondria	To release energy during aerobic respiration for active transport of mineral ions from the soil into the cell sap of the root hair cells

LO: Explain the movement of water between plant cells, and between them and the environment in terms of water potential (calculations on water potential are not required)



- As water moves from xylem vessel into a plant cell, the cell has higher water potential than the adjacent cells hence net movement of water molecules moves into the next cell by osmosis.
- Water moves out of the mesophyll cells and forms a thin film of moisture.
- Water from the thin film of moisture evaporates to form water vapour.
- Concentration of water vapour in leaf is higher than that in the surrounding, thus water vapour diffuses out of the leaf into the surroundings down a concentration gradient through the stomata by transpiration.

LO: Outline the pathway by which water is transported from the roots to the leaves through the xylem vessels



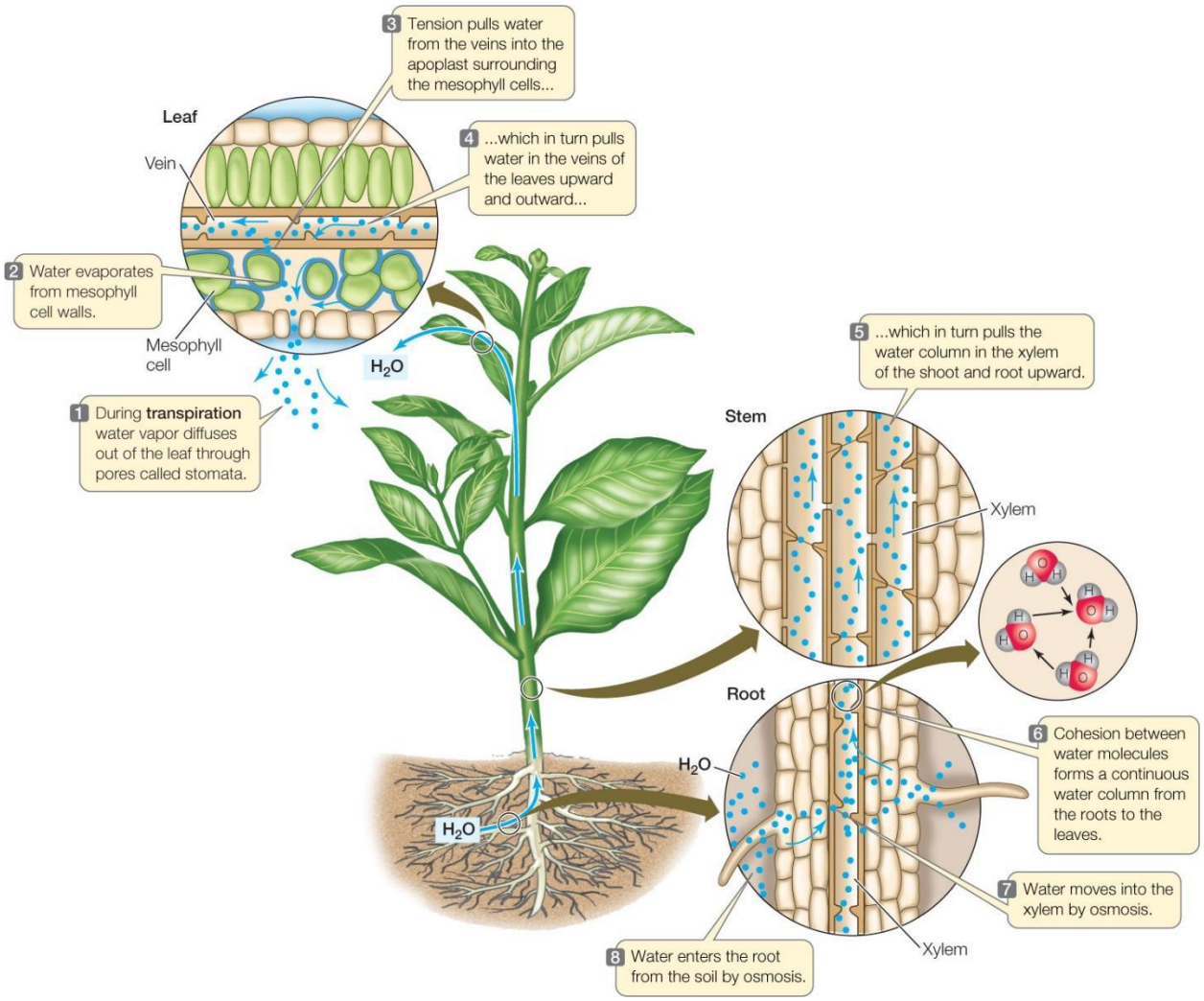
1. From the soil, by osmosis due to the water potential gradient
2. Enters the root hair cells
3. Moves from cell to cell, via osmosis until it reaches the xylem.
4. Root pressure moves water from cells into and up the xylem.
5. Moves up the xylem in the stem by capillary action and transpiration pull.
6. In the leaf, water moves from cell to cell, via osmosis until it reaches the mesophyll cells.

- Root pressure is the pressure resulting from the constant entry of water into the roots.
- Capillary action is the tendency of water to move up narrow tubes and depends on forces of cohesion and adhesion.
- Transpiration pull is the suction force caused by transpiration which draws water up the xylem.

LO: Define the term transpiration and explain that transpiration is a consequence of gaseous exchange in plants

Transpiration is the loss of water vapour from the aerial parts of the plant especially through the stomata of the leaves.

When stomata open in the day, carbon dioxide diffuses into the leaves. Oxygen and water vapour, which is in higher concentration in the leaf, will diffuse out of the leaf.



LO: Describe and explain

- ***the effects of variation of air movement, temperature, humidity and light intensity on transpiration rate***
- ***how wilting occurs***

Factors affecting transpiration:

- **Air movements (Wind)**
  Wind removes water vapour and reduces the concentration of water vapour around the leaf, making the concentration gradient steeper, increasing the rate of diffusion of water vapour out of the stomata of the leaves. Rate of transpiration increases.

- **Temperature**
  The higher the temperature, the faster the water evaporates into intercellular spaces, which causes a steeper concentration gradient, increasing the rate of diffusion of water vapour out of the stomata of the leaves. Rate of transpiration increases.

- **Humidity**
  Humid surrounding has higher concentration of water vapour, making the concentration gradient less steep, decreasing the rate of diffusion of water vapour out of the stomata of the leaves. Rate of transpiration decreases.

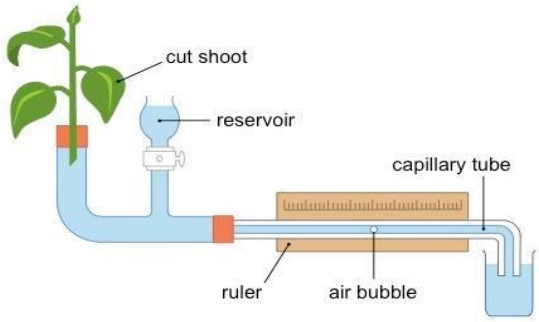
- **Light Intensity**
  Stomata open wider under high light intensity as guard cells become more turgid. Faster rate of diffusion of water vapour out of the leaf. Rate of transpiration increases.

Wilting

Wilting occurs when the rate of water loss through transpiration is greater than the rate of water absorption.

Ways to measure rate of transpiration

Potometer



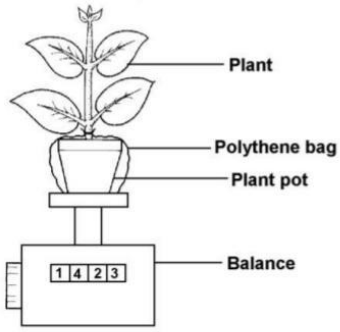
Apparatus:
A **potometer** is a device used to estimate *transpiration rates*

Experimental Method:
The distance moved by an air bubble can be recorded every minute and used to indicate the rate of water uptake by the plant

- **Assumption:** rate of absorption of water by the plant is equal to the rate of water loss from the plant.
- As water moves into the plant, the air bubble moves to the left. By measuring the distance moved by the air bubble per unit time, we can measure the rate of water loss from the leafy shoot.

Weight potometer

- **A potted plant is well watered.**
- **A plastic bag is wrapped around the pot to prevent water loss from the soil.**
- **The apparatus is weighed at intervals and changes in weight indicate water loss.**

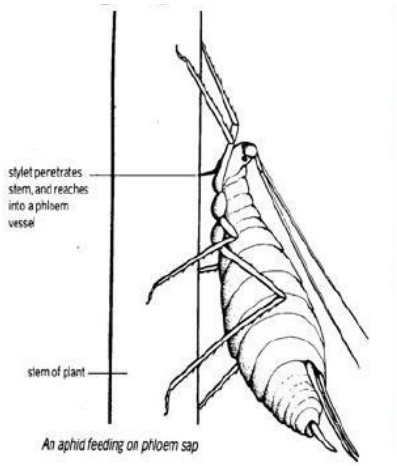


LO: Define the term translocation as the transport of food in the phloem tissue and illustrate the process through translocation studies

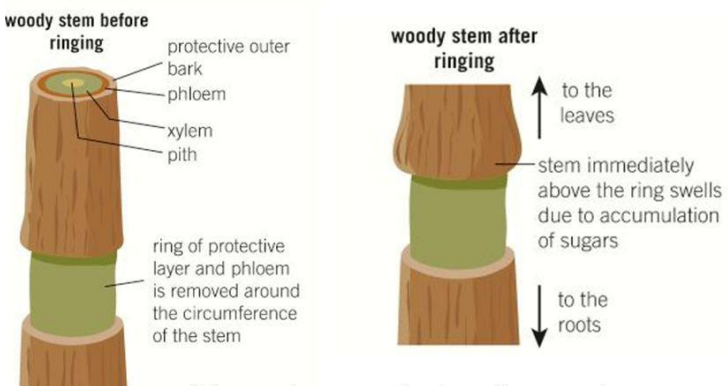
Translocation is the process by which sucrose and amino acids are transported in the phloem from the leaves to other parts of the plant.

Translocation studies:

1. Aphids: Anaesthetised with carbon dioxide and cut off, the stylet of the aphid remained in the phloem to collect pure phloem sap through the stylet for analysis (Analysis showed that sap contains sucrose and amino acids)



2. Ringing experiment: A ring of bark was removed from a stem. There was a swelling above the ring, reduced growth below the ring and the leaves are unaffected (Evidence showed that sugars were transported downwards in the phloem)



Stem above missing tissue ring swells with liquid rich in sucrose
Non-photosynthetic tissues below the ring wither and die