Chapter 8

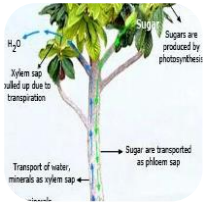
TRANSPORT

OVERVIEW

8.0 TRANSPORT SYSTEM

8.1 Mammalian heart and its regulation

8.2 Human Lymphatic System



8.3 Transport In Plants

8.3 TRANSPORT IN PLANT

a) State the pathway of water movement in root

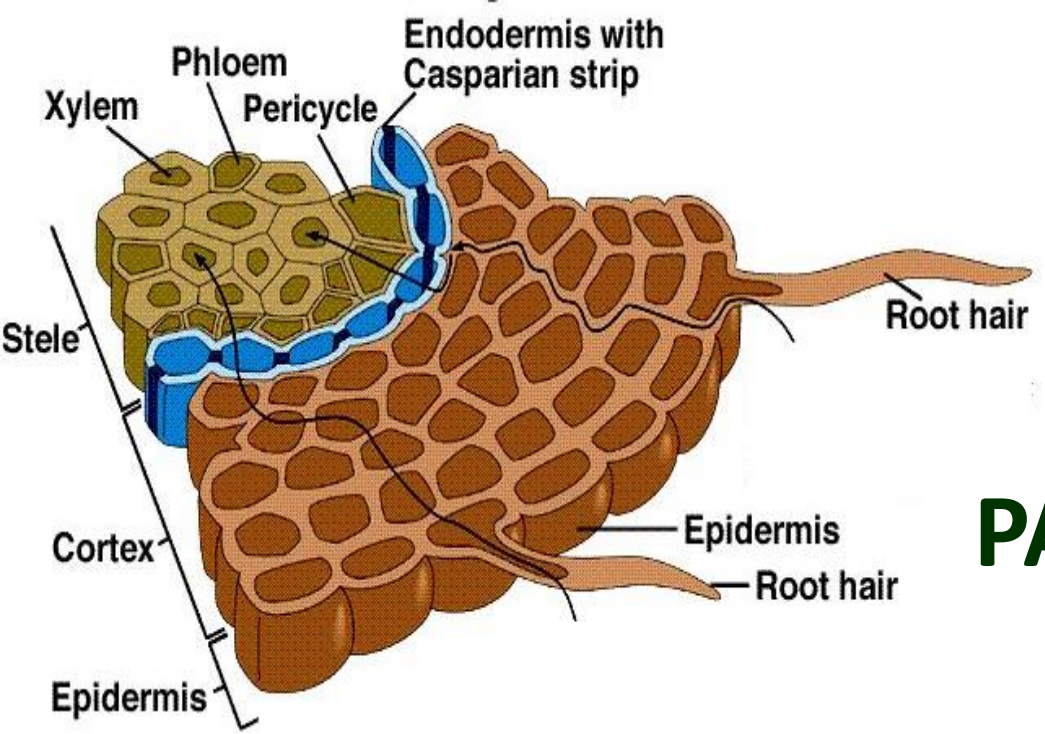
b) State the water and mineral movement via xylem in stem

c) Explain the lateral pathway of water and mineral is transported from surrounding

d) Describe water movement via xylem by transpiration-cohesion-tension mechanism and root pressure

e) State the Pressure Flow hypothesis in phloem

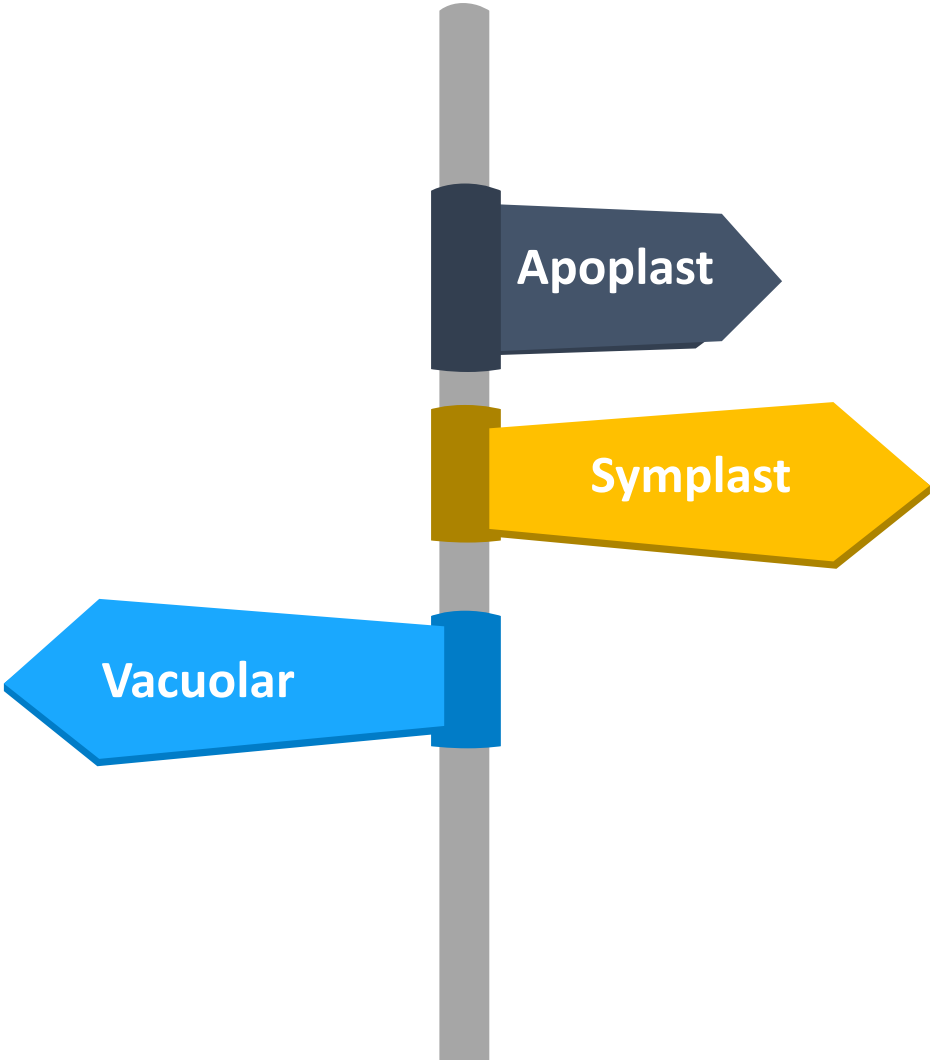
f) Explain the Pressure Flow hypothesis in phloem



PATHWAY OF WATER MOVEMENT IN ROOT

PATHWAY OF WATER MOVEMENT IN ROOT

3 pathways of water transported from the surrounding soil to the root



LATERAL PATHWAY OF WATER AND MINERAL FROM SURROUNDING TO THE XYLEM

Apoplastic route

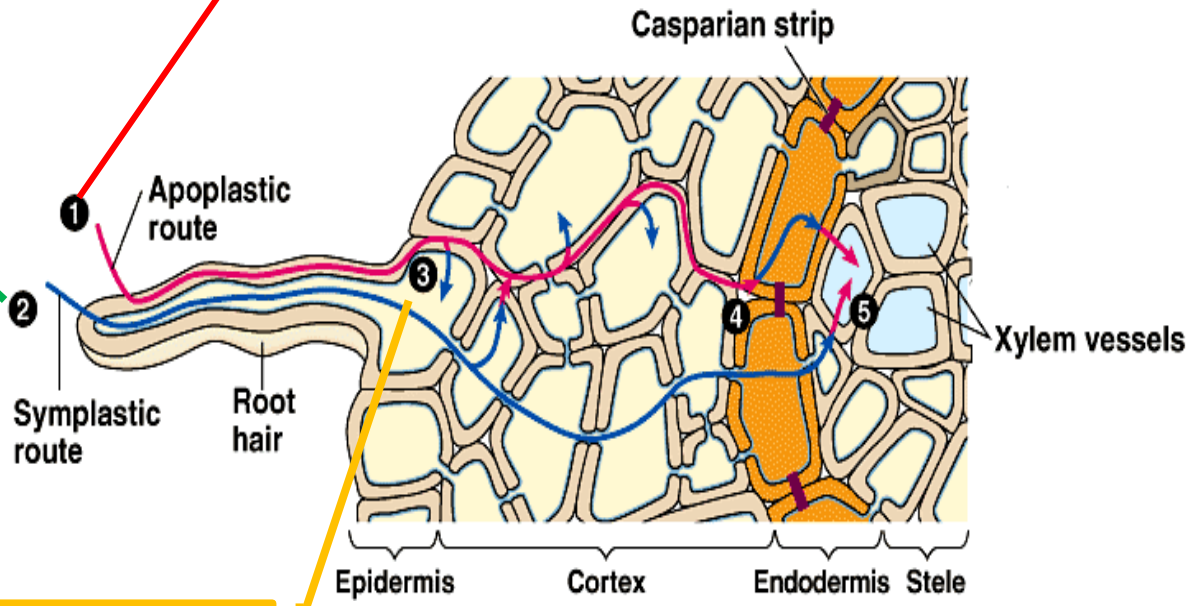
- Water& mineral ions a transported along cell wall without passing through the membrane.
- **Casparian strip** blocks apoplast pathway at endodermis.
- Water enters stele through symplastic pathway.

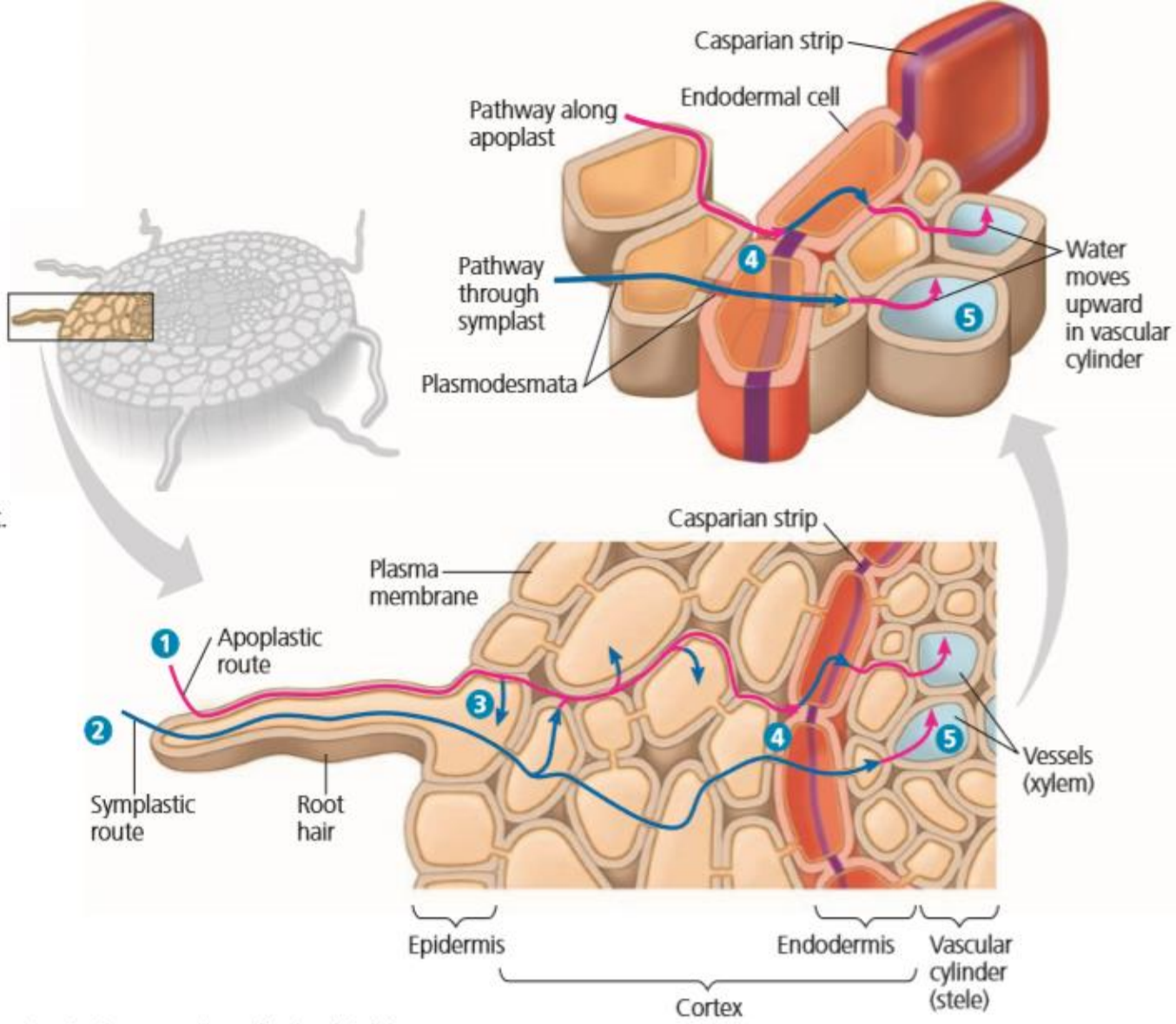
Symplastic route

- Water & ions are transported through the cytoplasm/ protoplasm
- From a cell to another cell through plasmodesmata

Vacuolar route

- The symplast can also have the subdivision of the **vacuolar** pathway
- Water & ions are transported from vacuole to vacuole of the neighbouring cells across the cytoplasm & tonoplasts





1 **Apoplastic route.** Uptake of soil solution by the hydrophilic walls of root hairs provides access to the apoplast. Water and minerals can then diffuse into the cortex along this matrix of walls and extracellular spaces.

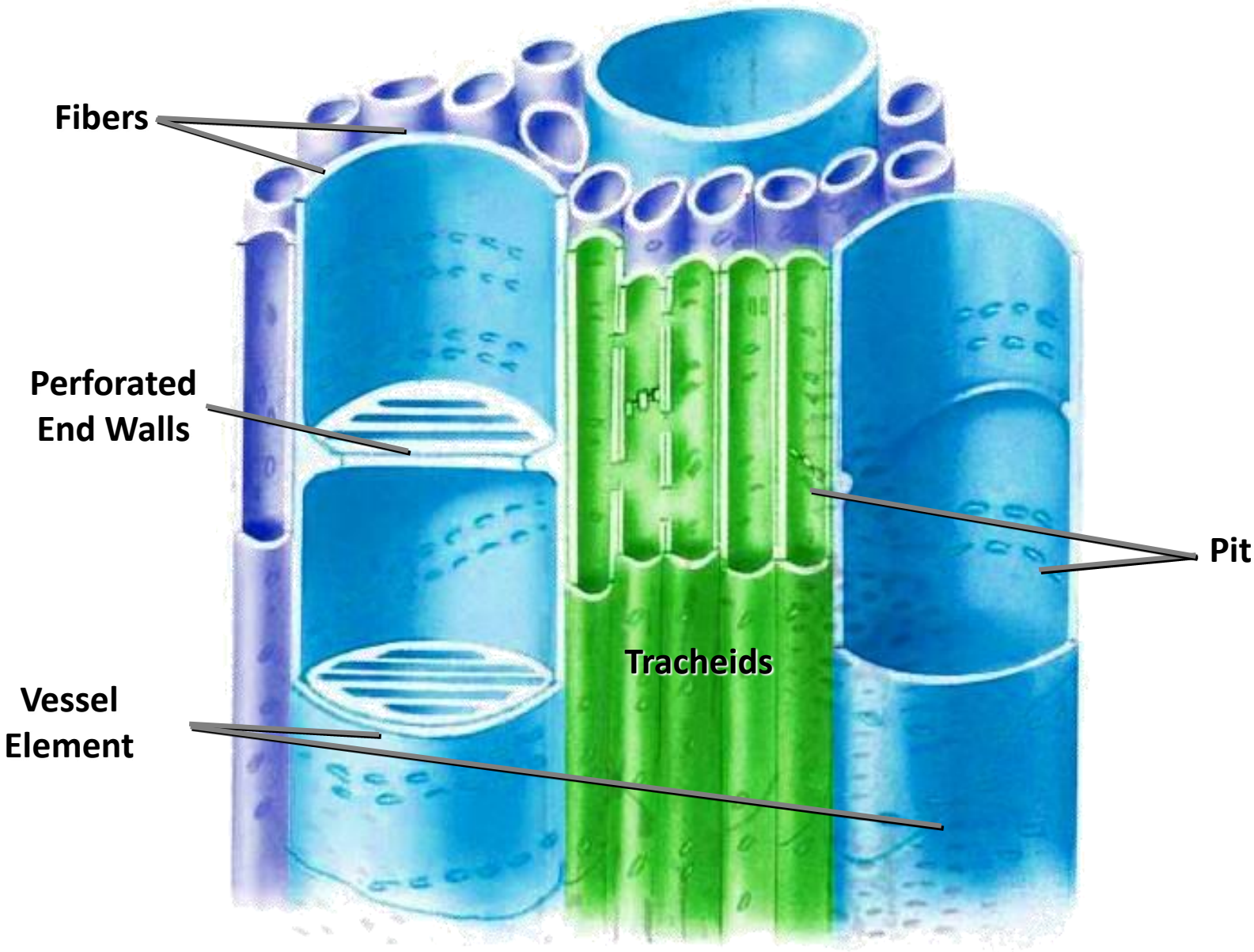
2 **Symplastic route.** Minerals and water that cross the plasma membranes of root hairs can enter the symplast.

3 **Transmembrane route.** As soil solution moves along the apoplast, some water and minerals are transported into the protoplasts of cells of the epidermis and cortex and then move inward via the symplast.

4 **The endodermis: controlled entry to the vascular cylinder (stele).** Within the transverse and radial walls of each endodermal cell is the Casparian strip, a belt of waxy material (purple band) that blocks the passage of water and dissolved minerals. Only minerals already in the symplast or entering that pathway by crossing the plasma membrane of an endodermal cell can detour around the Casparian strip and pass into the vascular cylinder (stele).

5 **Transport in the xylem.** Endodermal cells and also living cells within the vascular cylinder discharge water and minerals into their walls (apoplast). The xylem vessels then transport the water and minerals by bulk flow upward into the shoot system.

Structure of Xylem



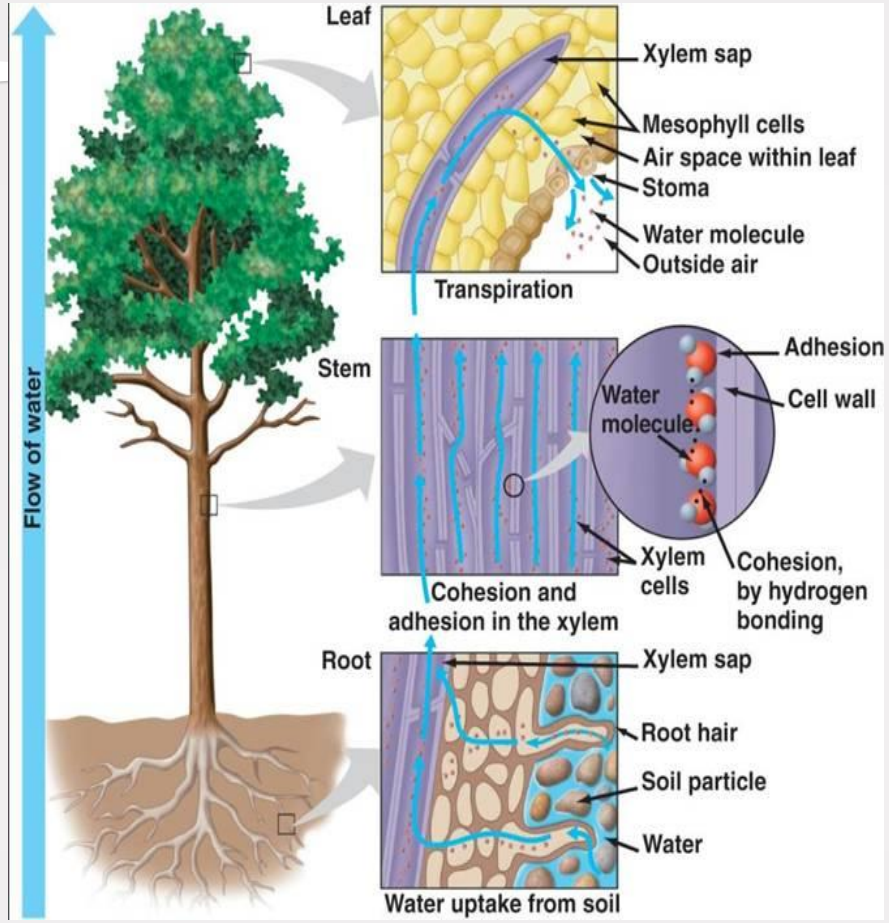
WATER MOVEMENT VIA XYLEM

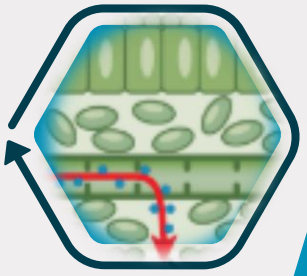
01 Root Pressure

02 Cohesion

03 Adhesion

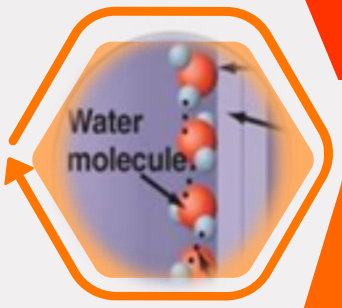
04 Transpiration pull





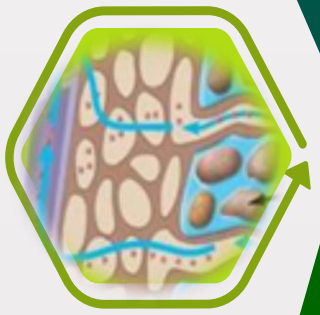
TRANSPIRATION PULL

Force which aids in drawing the water upward from roots to leaves results from evaporation of water



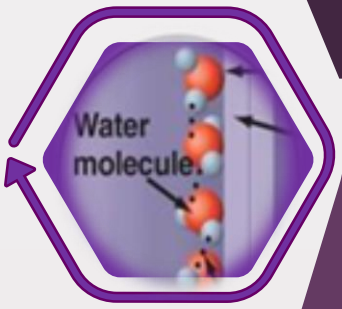
COHESION

The force of attraction between water molecules caused by hydrogen bonding



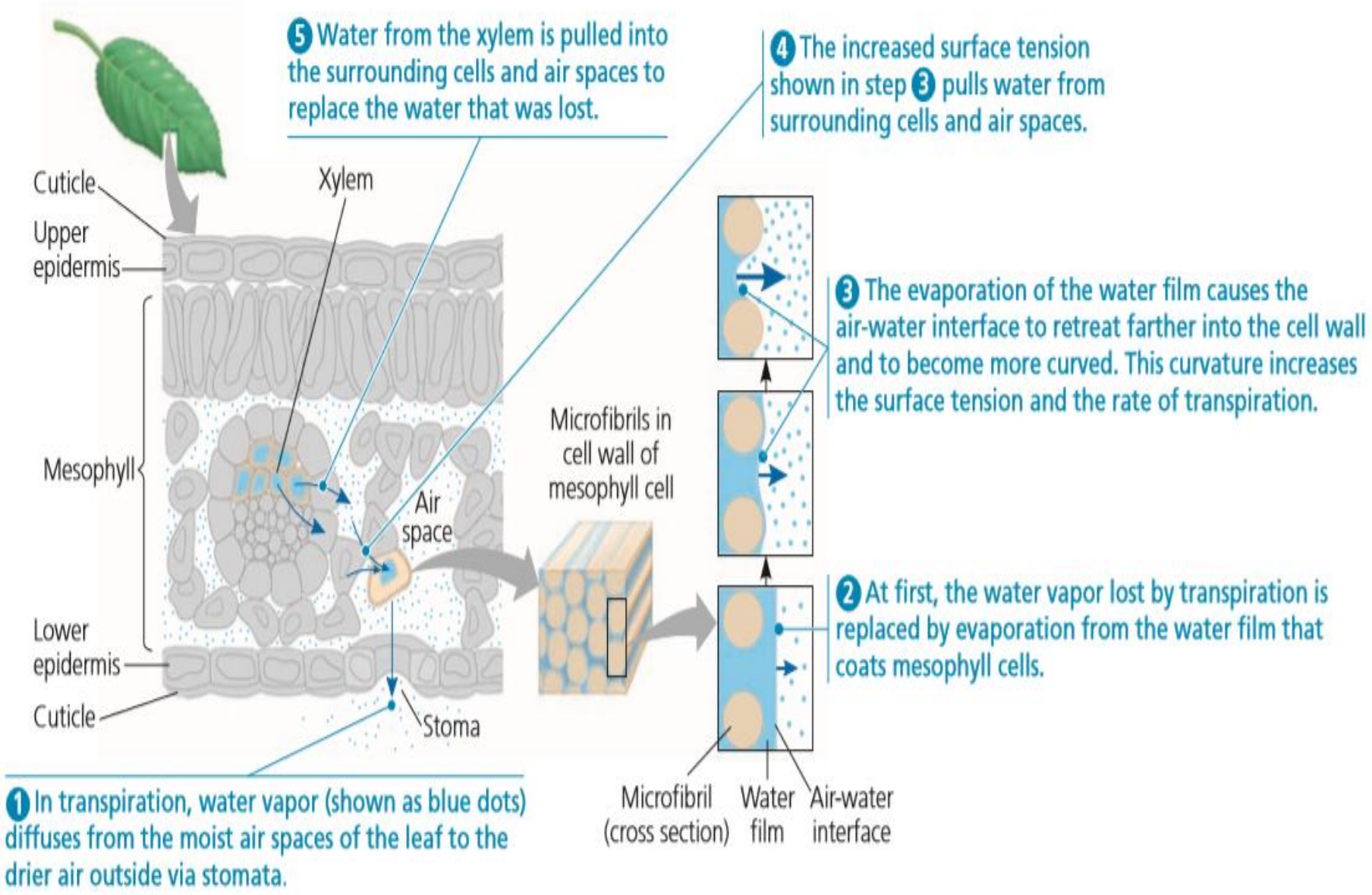
ROOT PRESSURE

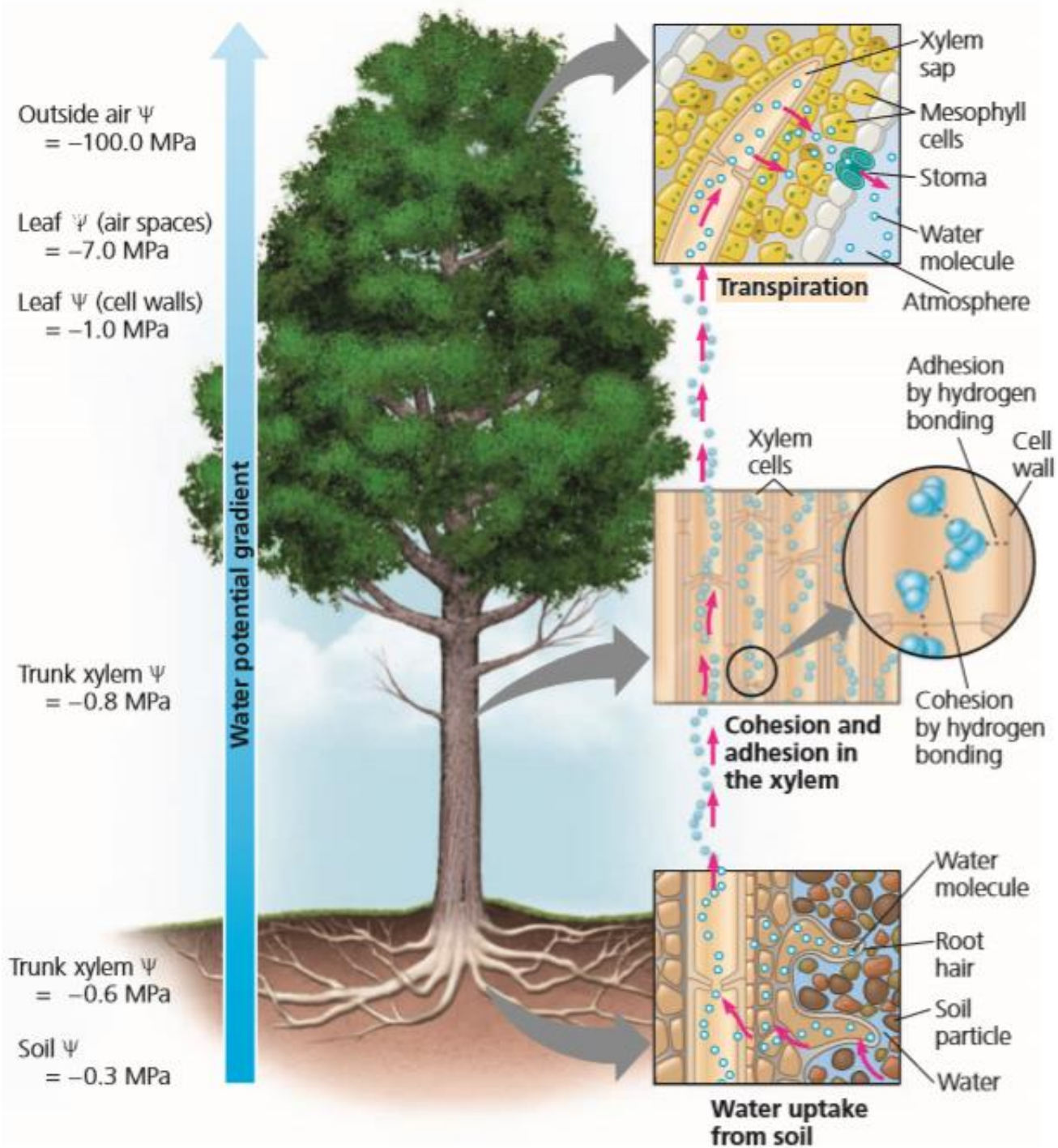
The pressure in the xylem sap as a result of the active absorption of mineral ions



ADHESION

Attractive force between water molecules and the xylem walls

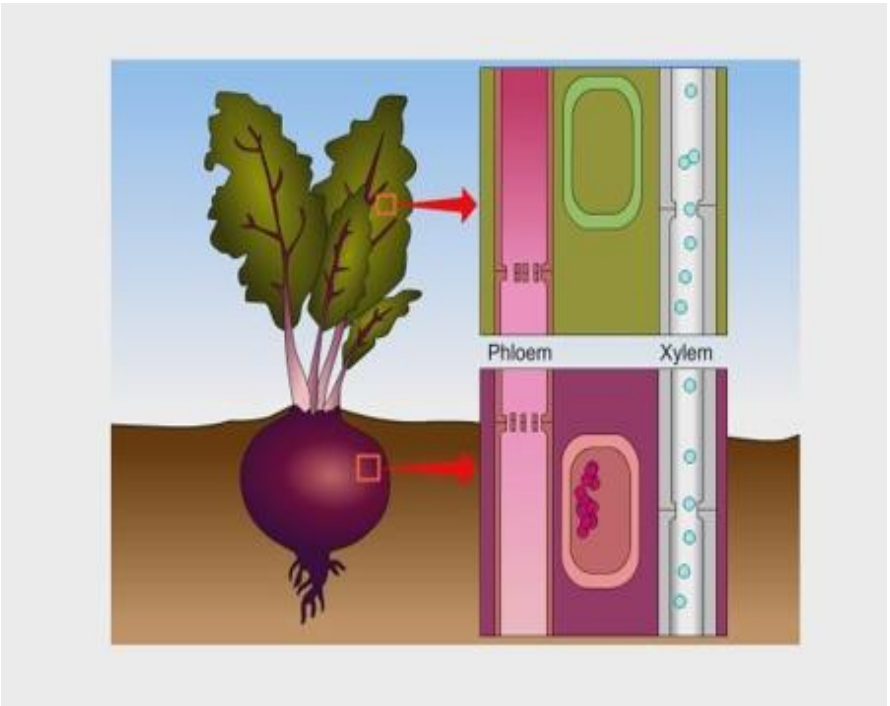

5 Water from the xylem is pulled into the surrounding cells and air spaces to replace the water that was lost.
4 The increased surface tension shown in step 3 pulls water from surrounding cells and air spaces.
Cuticle
Upper epidermis
Xylem
Mesophyll
Air space
Microfibrils in cell wall of mesophyll cell
3 The evaporation of the water film causes the air-water interface to retreat farther into the cell wall and to become more curved. This curvature increases the surface tension and the rate of transpiration.
Lower epidermis
Cuticle
Stoma
2 At first, the water vapor lost by transpiration is replaced by evaporation from the water film that coats mesophyll cells.
1 In transpiration, water vapor (shown as blue dots) diffuses from the moist air spaces of the leaf to the drier air outside via stomata.
Microfibril (cross section)
Water film
Air-water interface


Outside air Ψ
= –100.0 MPa
Leaf Ψ (air spaces)
= –7.0 MPa
Leaf Ψ (cell walls)
= –1.0 MPa
Trunk xylem Ψ
= –0.8 MPa
Trunk xylem Ψ
= –0.6 MPa
Soil Ψ
= –0.3 MPa
Water potential gradient
Xylem sap
Mesophyll cells
Stoma
Water molecule
Atmosphere
Transpiration
Adhesion by hydrogen bonding
Cell wall
Xylem cells
Cohesion by hydrogen bonding
Cohesion and adhesion in the xylem
Water molecule
Root hair
Soil particle
Water
Water uptake from soil

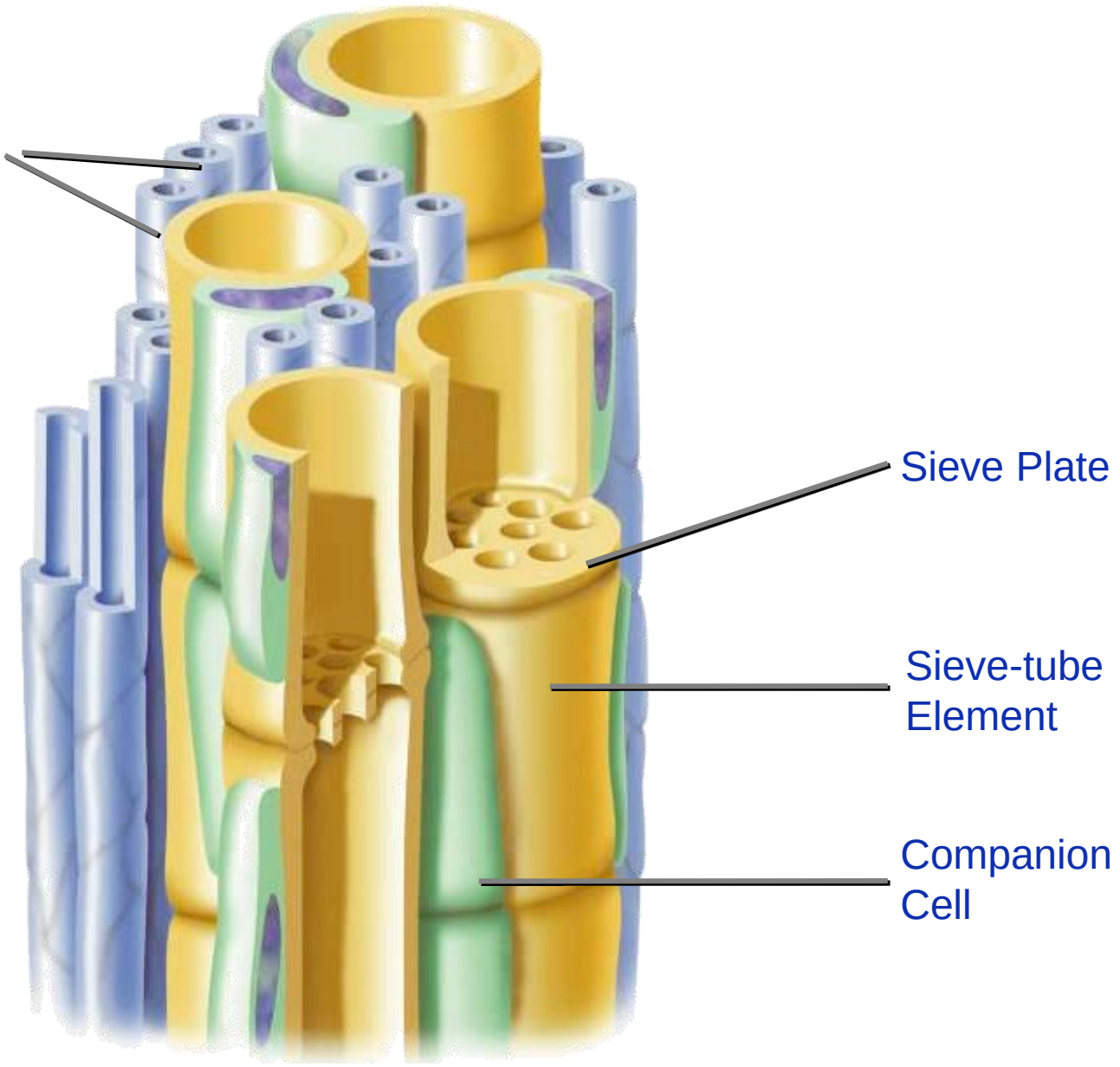
PRESSURE FLOW HYPOTHESIS IN PHLOEM

Translocation

Movement of organic solute from the leaves (source) to the sieve tubes and to be carried to other parts of the plant (sink) (source)

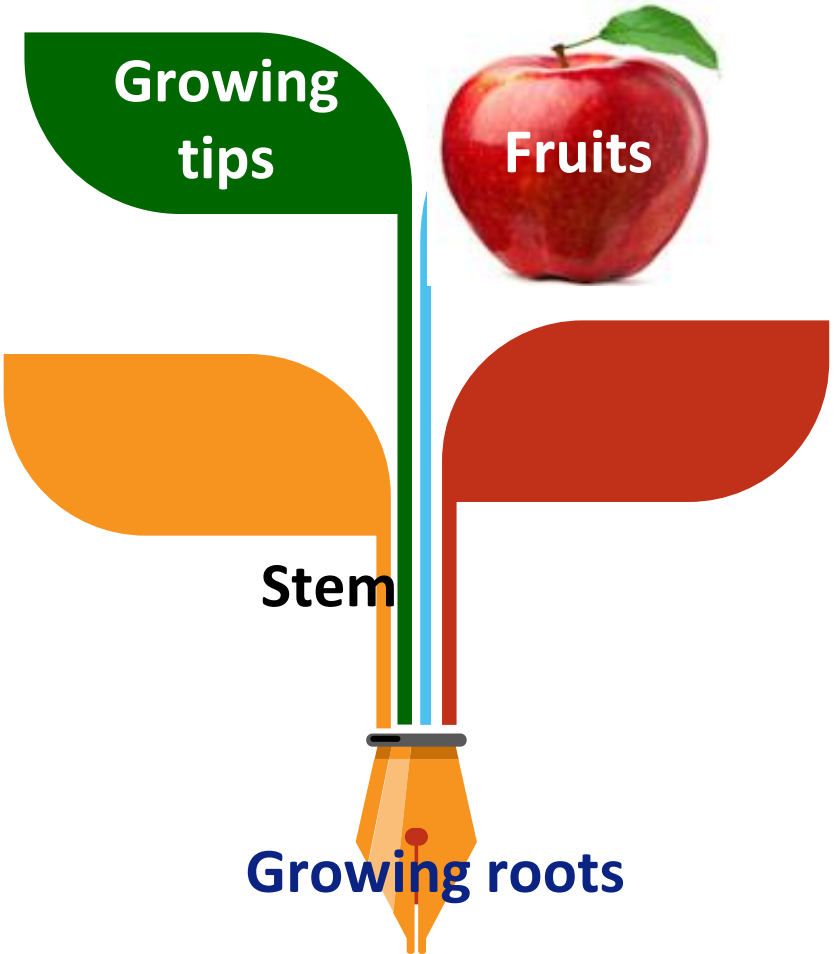


Structure of Phloem



PRESSURE FLOW HYPOTHESIS IN PHLOEM

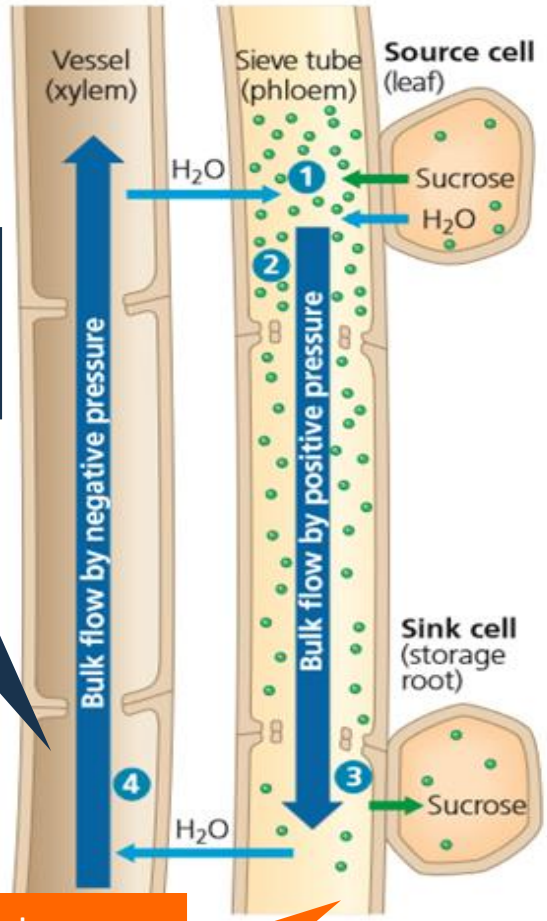
- ✓ Sugar sink : sugar storage organ



- ✓ Sugar source : sugar production organ

- At source, sucrose produced by photosynthesis
- Sucrose actively transported from source into sieve tube
- Accumulation of sucrose (solute) lowers water potential in sieve tube
- Water moves by osmosis from the xylem into sieve tube

1



2

- Entry of water generates a high hydrostatic pressure in sieve tube
- Creates a difference of hydrostatic pressure along the sieve tube
- Sucrose passively transported along sieve tube from the part near the source to the part near the sink

3

- At the sieve tube near the sink, sucrose is actively transported into the sink
- Hydrostatic pressure at the sieve tube

4

- Xylem recycle water from sink to source