Transport in Plants

- Three levels:
  - at cellular level
  - lateral transport (short-distance)
  - whole plant (long distance)

Transport in Plants

Cellular Level:

- Diffusion
  - movement from an area of high concentration to an area of lower concentration
- Active transport

Transport in Plants

Cellular Level:

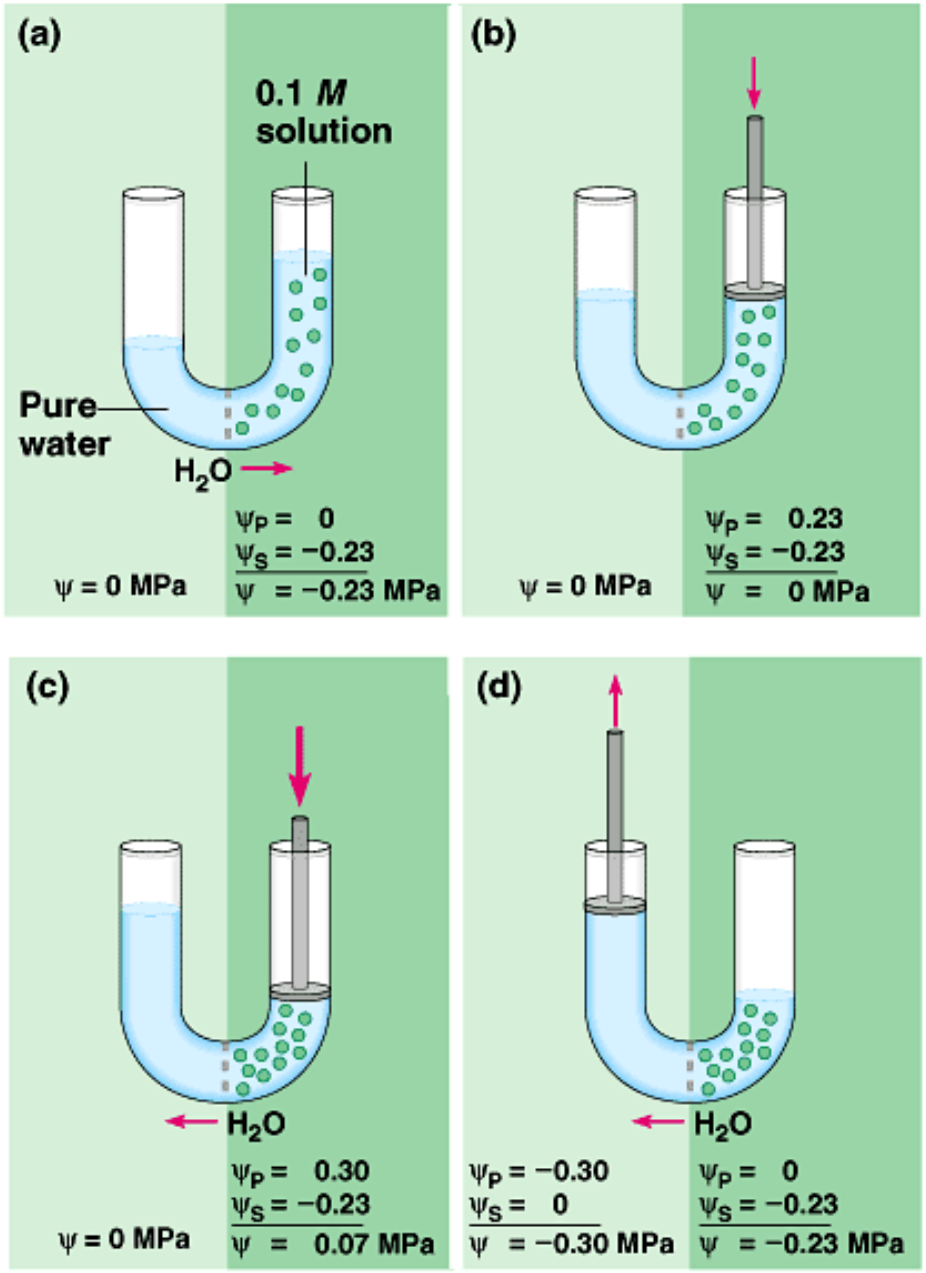
- **Osmosis**:
  - passive transport of water across a semipermeable membrane
  - In plants it depend on solute concentration and pressure (due to the cell wall)

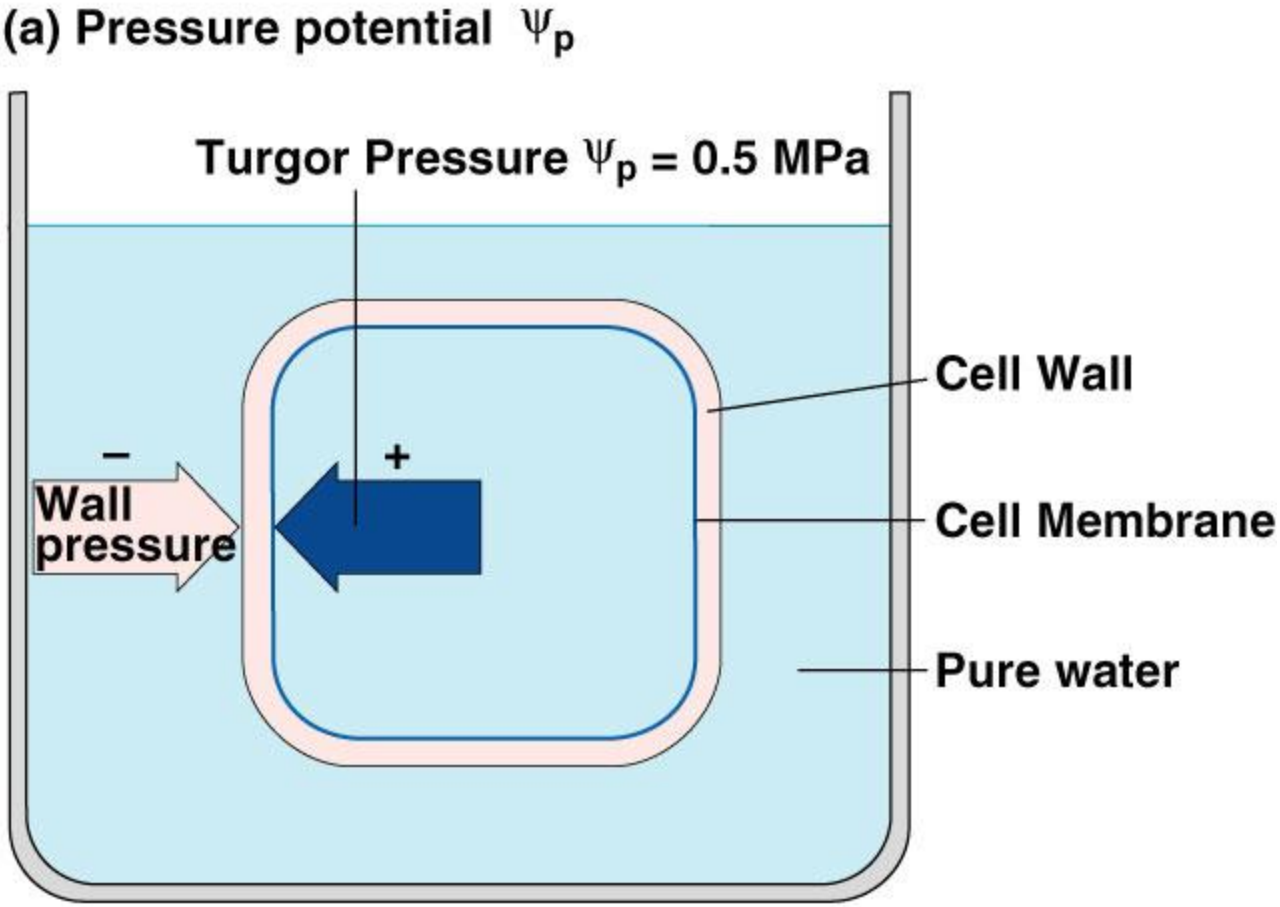
Transport in Plants

Cellular Level:

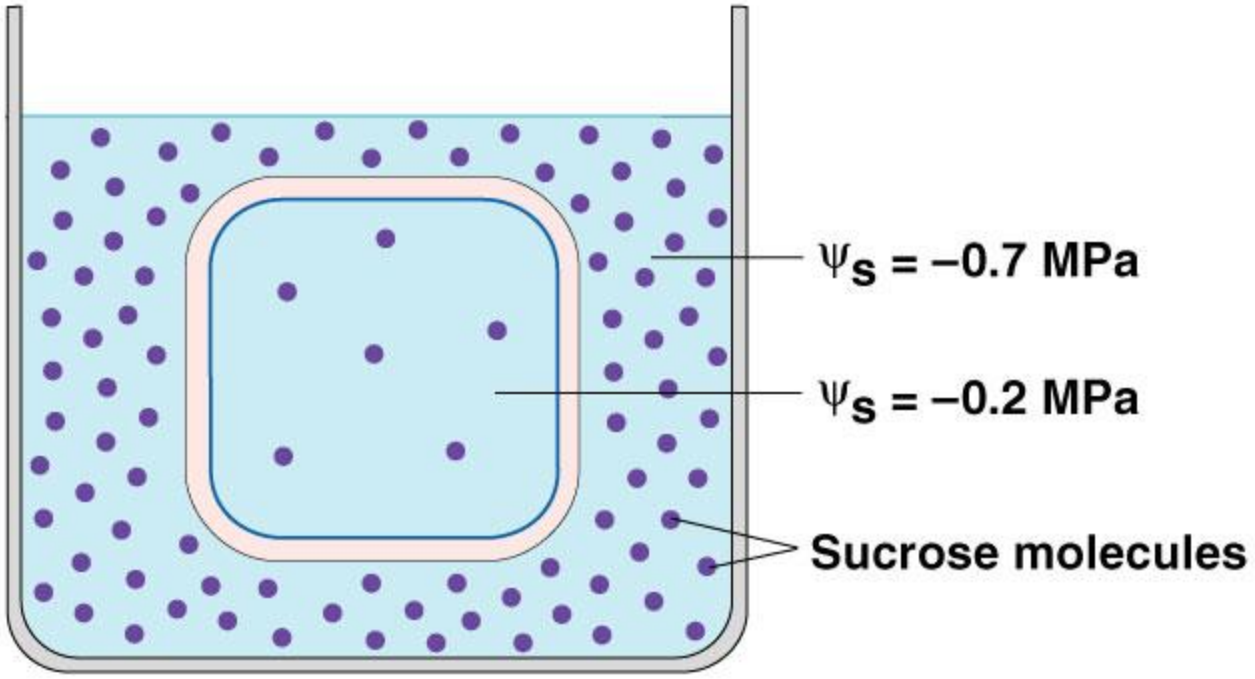
- **Water potential**
  - Addition of solutes lowers
  - Increasing pressure raises
- **Water moves from high water potential to low water potential**
- **Turgor pressure**

Figure 36.3 Water potential and water movement: a mechanical model

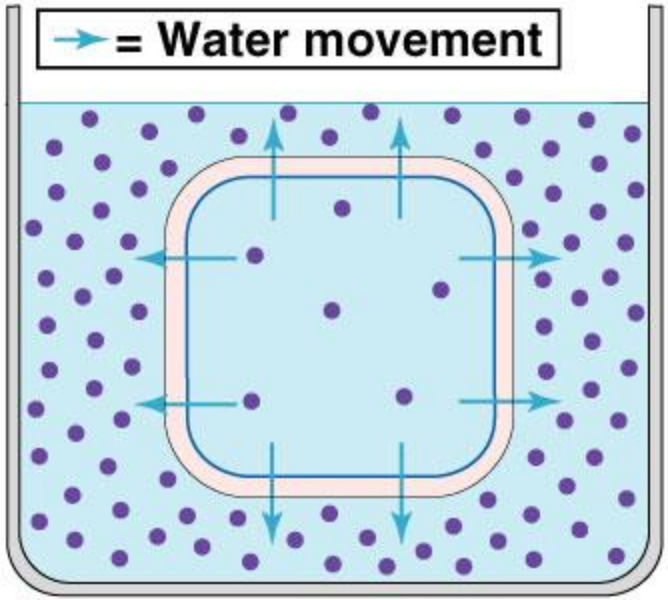




(b) Solute potential Ψ_S



(c) Water potential



$\Psi = \Psi_s + \Psi_p$

$\Psi_{cell} = -0.2\ MPa + 0.5\ MPa = 0.3\ MPa$

$\Psi_{solution} = -0.2\ MPa$ (solution has no pressure potential)

Figure 36.4 Water relations of plant cells

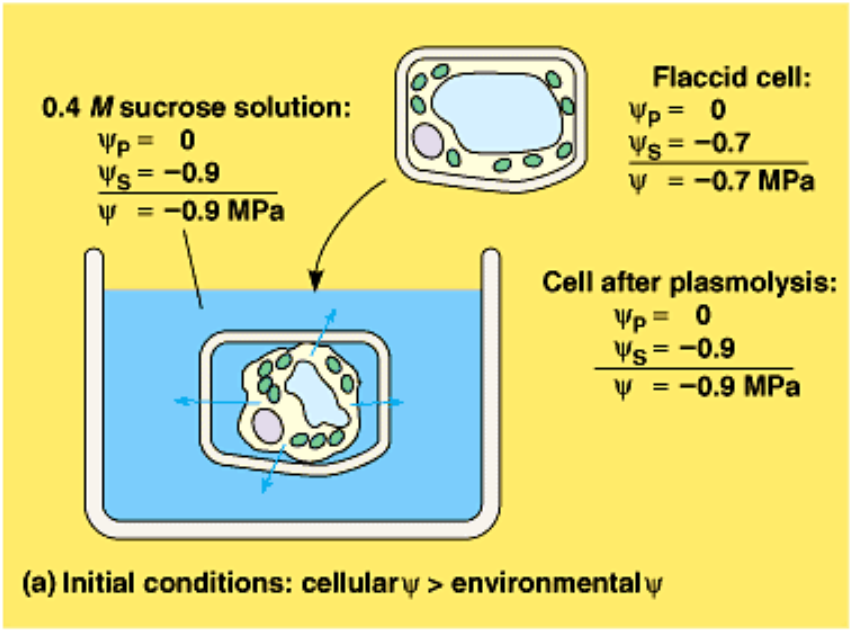


Figure 36.5 A watered tomato plant regains its turgor

Transport in Plants

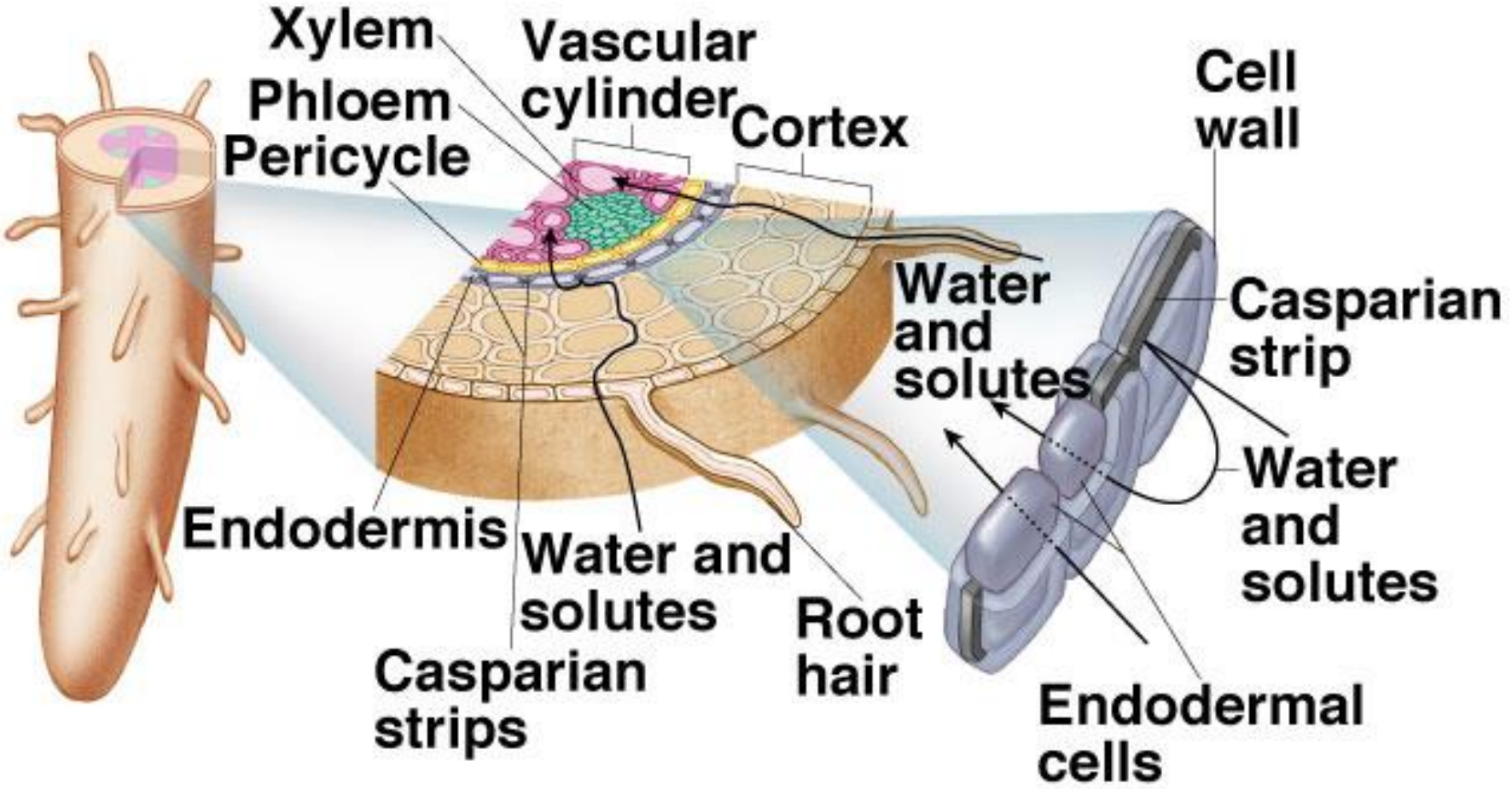
Lateral Transport

How water & dissolved minerals get into roots...

- through the cells of the root
- along the extracellular pathway consisting of cell walls

Figure 36.8 Mycorrhizae, symbiotic associations of fungi and roots

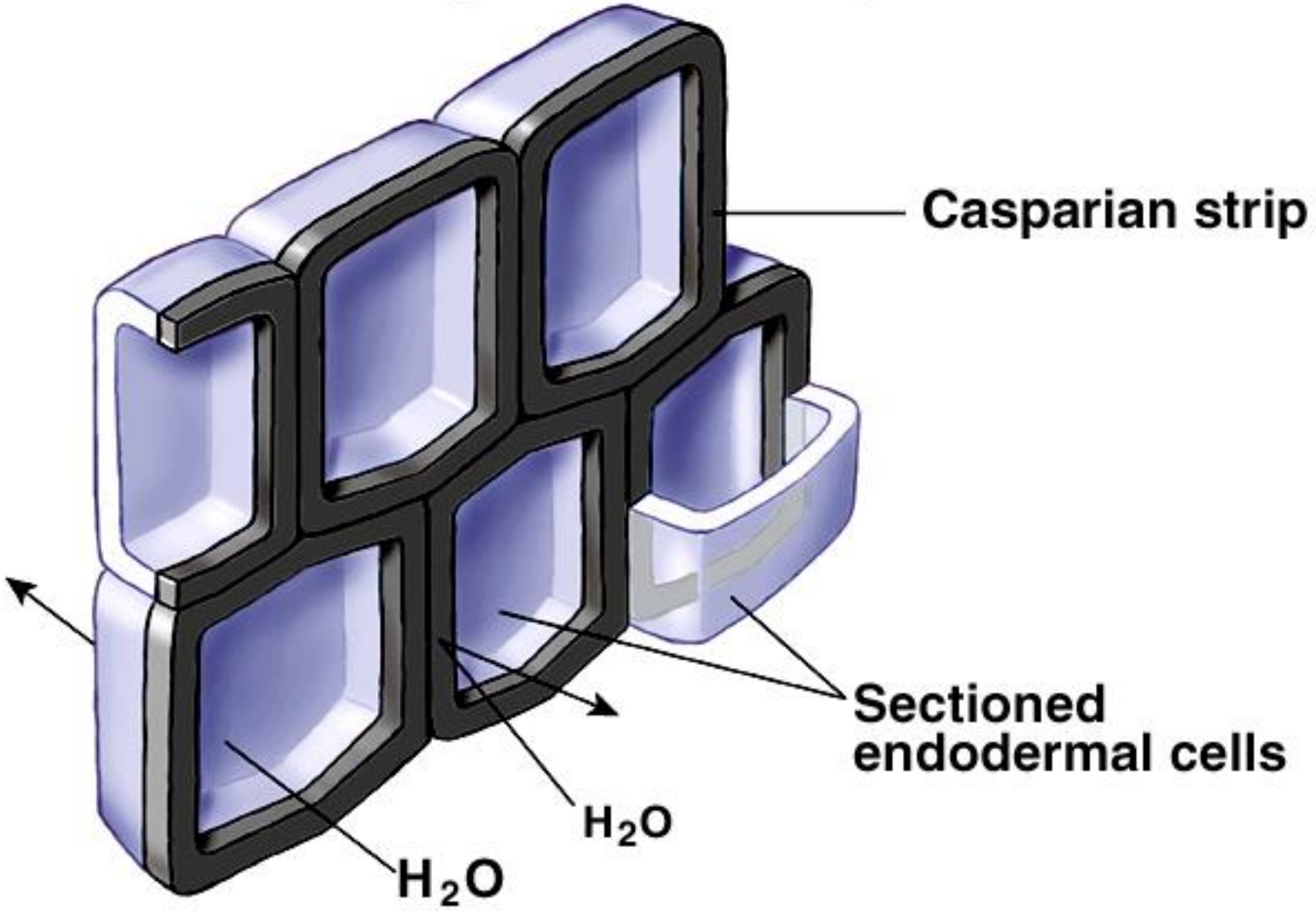
Lateral transport of minerals and water in roots



Casparian Strip

- A waxy material that surrounds endodermal cells
  - prevents material from crossing the endodermis between cells
- Substances must enter the cells of the endodermis in order to pass into the vascular cylinder
  - Allows selectivity

Casparian Strip



Transport in Plants

Long Distance Transport

- Diffusion too slow
- Instead substances move by **bulk flow**
  - the movement of fluid due to pressure

Xylem

- **dead at functional maturity**
- Only the cell walls remain to form tubes, connected by pores, through which water can move.

Xylem

- ***Xylem sap*** brings minerals to leaves and water to replace what is lost by transpiration
  - **Transpiration** is the evaporation of water from leaves or other aerial parts of the plant
- rates of >15 m per hour
- distances of 100m in the tallest trees.

Movement of Xylem Sap

- ***Pushed or Pulled?***

Movement of Xylem Sap

Pushed…

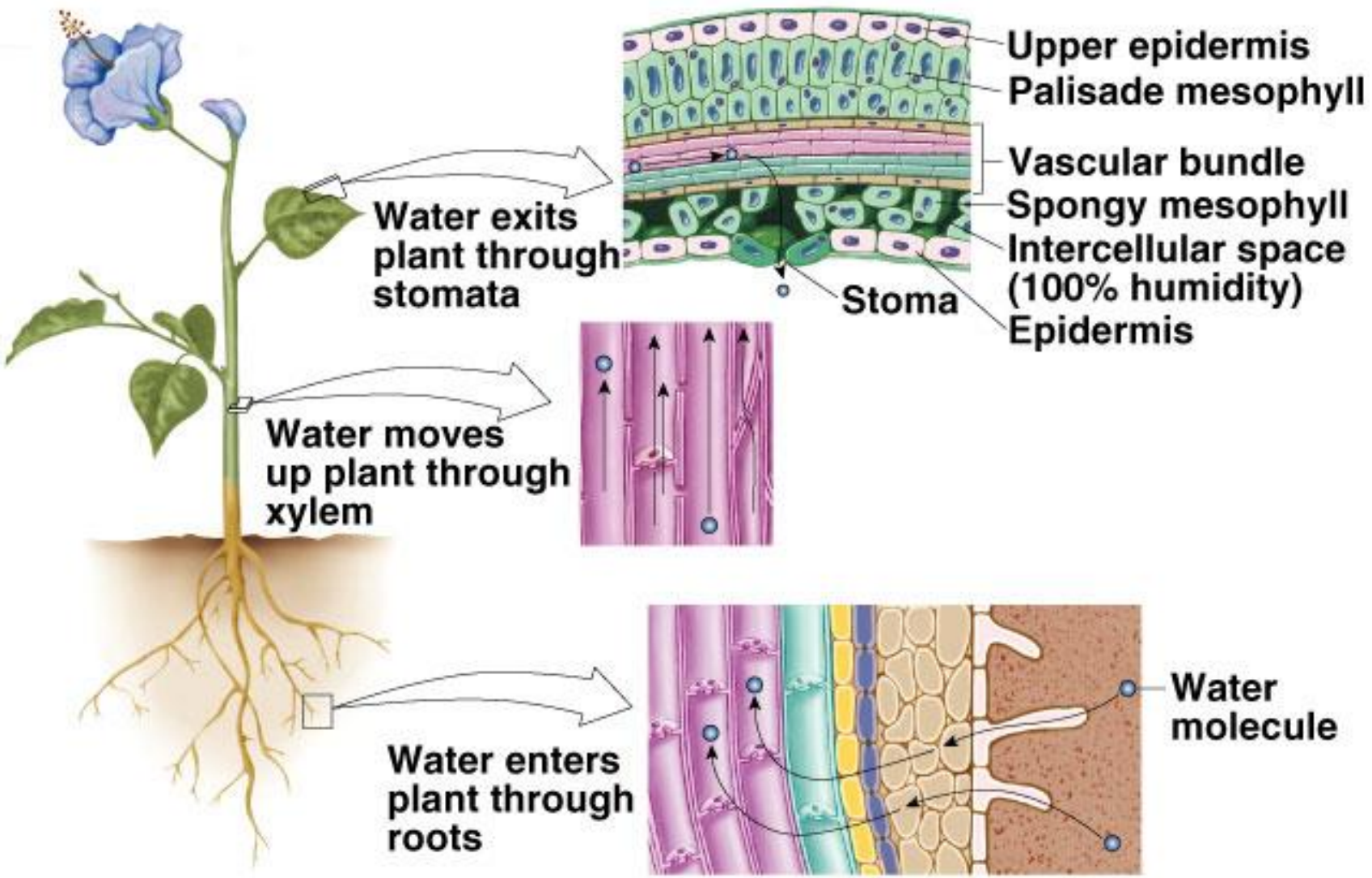
- by root pressure
  - minerals actively pumped into the xylem
  - causes water to move in by osmosis
  - positive pressure is generated
  - When transpiration is low

Figure 36.9 Guttation

Movement of Xylem Sap

Pulled…

- **by transpiration-cohesion**
- Water is pulled out of the xylem to replace the water that is lost from leaves through stomata



Movement of Xylem Sap

Pulled…

- transpiration pull is translated all the way to the roots by
  - cohesion
  - Adhesion
- Costs no energy to transport xylem sap up to leaves

Phloem

- cells that are living at functional maturity
- **Phloem sap** consists primarily of sugar, primarily sucrose (30%)
  - hormones, amino acids, minerals

Phloem Sap

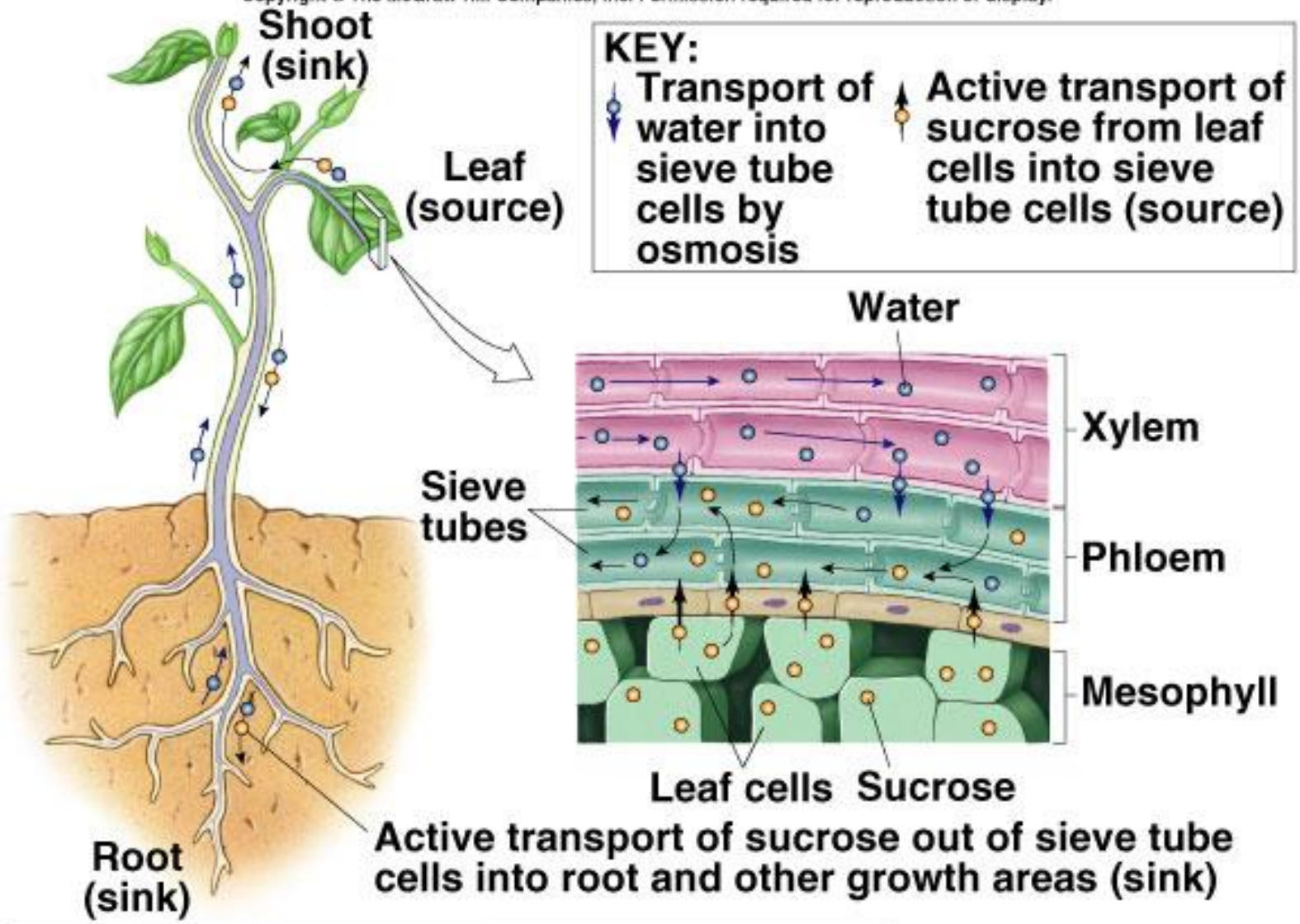
- Direction of flow in phloem is variable
- Bulk Flow or Mass Flow Hypothesis

Phloem Sap

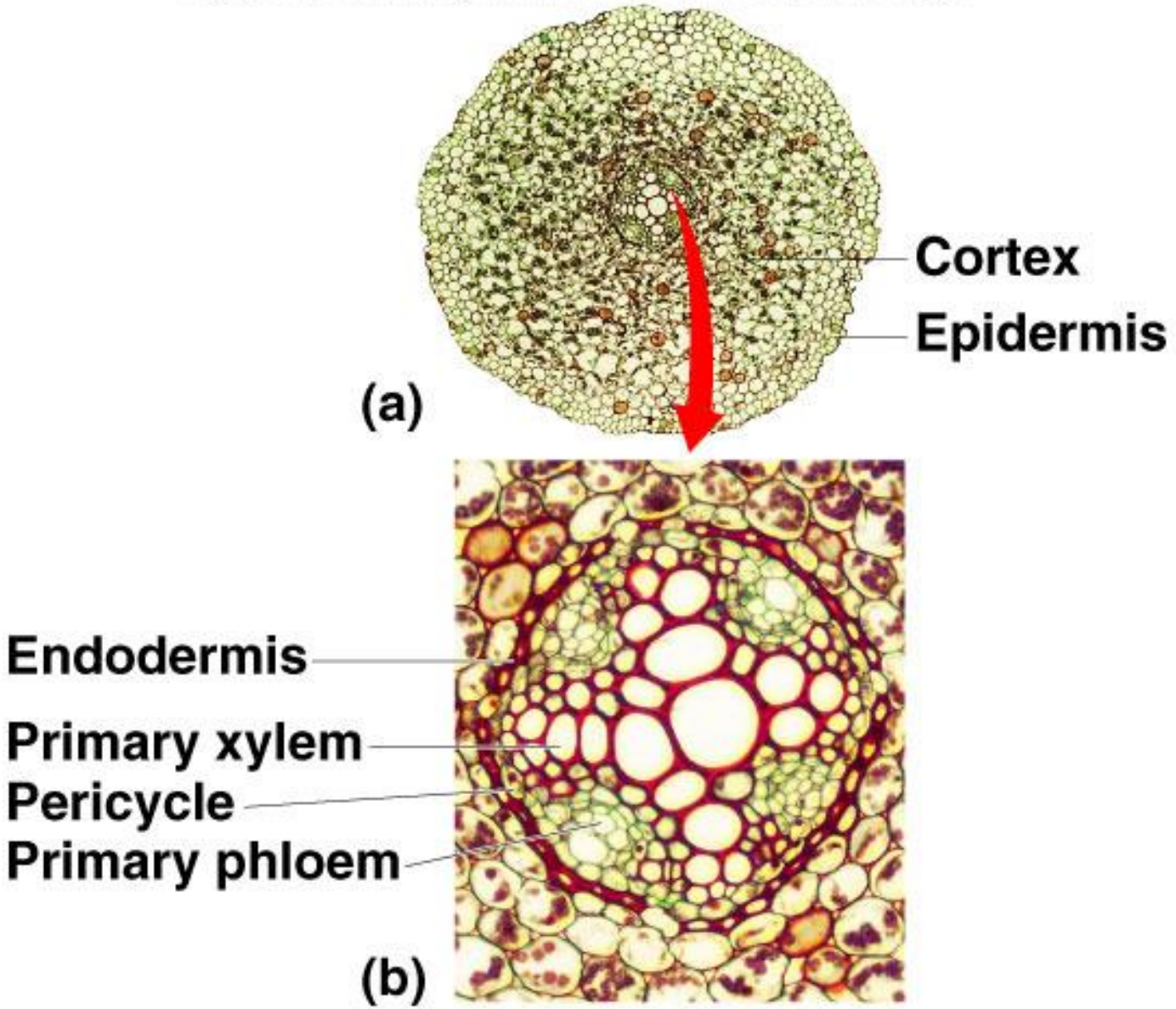
- flows from sugar sources
  - where sugar is produced by photosynthesis or the breakdown of starch
  - Leaves, storage organs
- to sugar sinks
  - that consume sugar
  - non green plant parts, growing shoots and roots, fruits

Phloem Sap

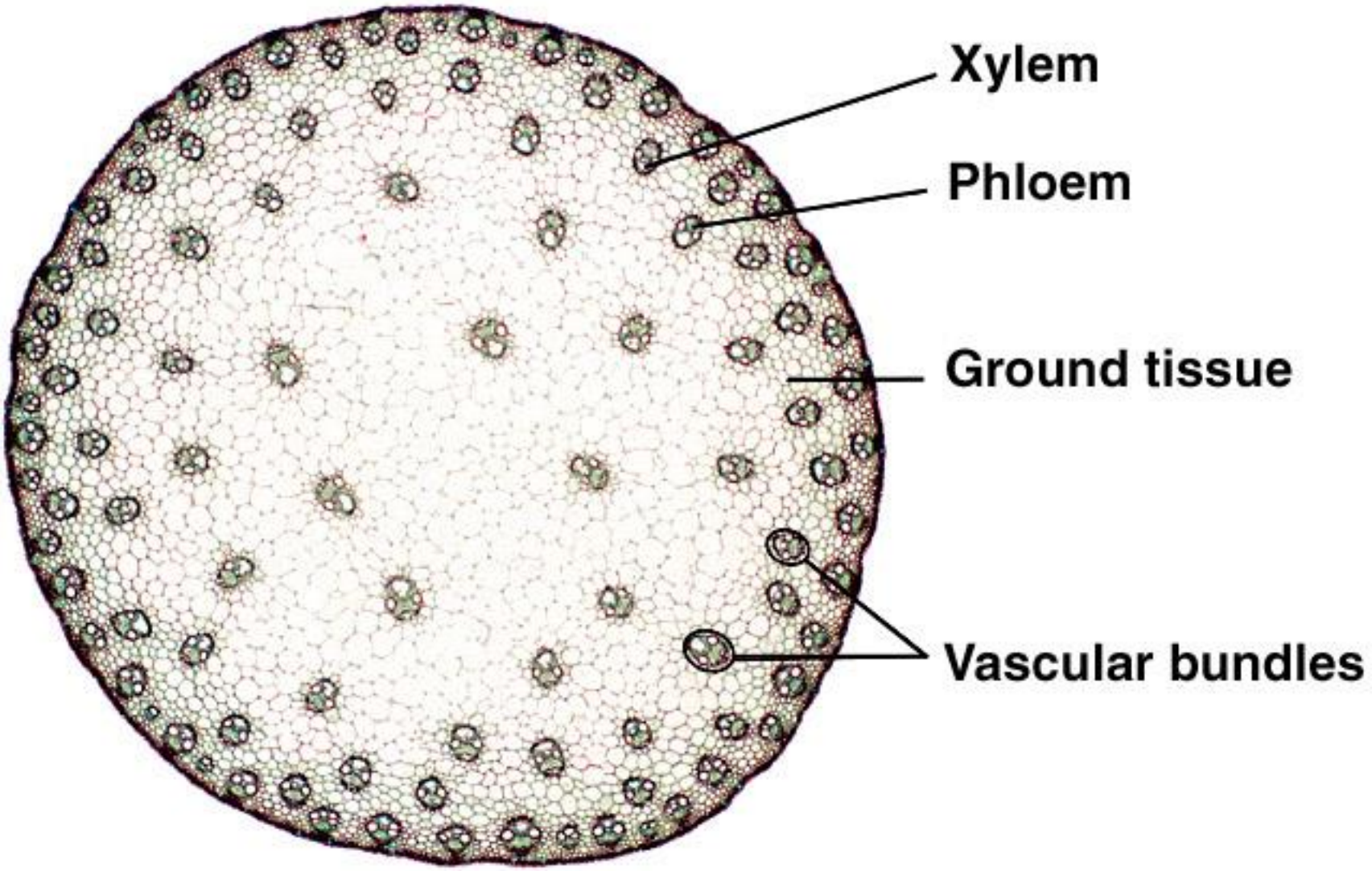
- sugars are actively loaded into phloem at the source
  - water follows and there is a high pressure
- sugars are actively transported out of the phloem at the sink
  - water follows and pressure is lower
- sap flows from high to low pressure



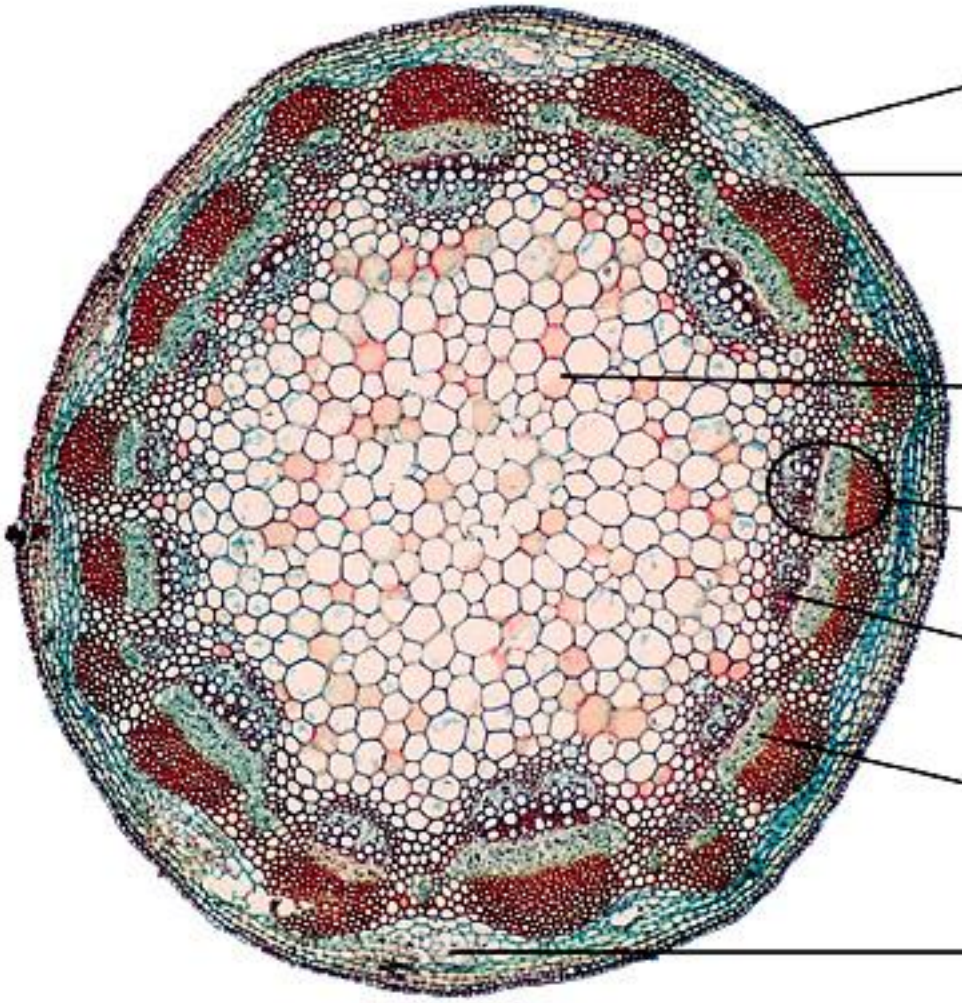
Eudicot Root



Monocot Stem



Dicot Stem



Epidermis (outer layer)

Collenchyma (layers below epidermis)

Pith

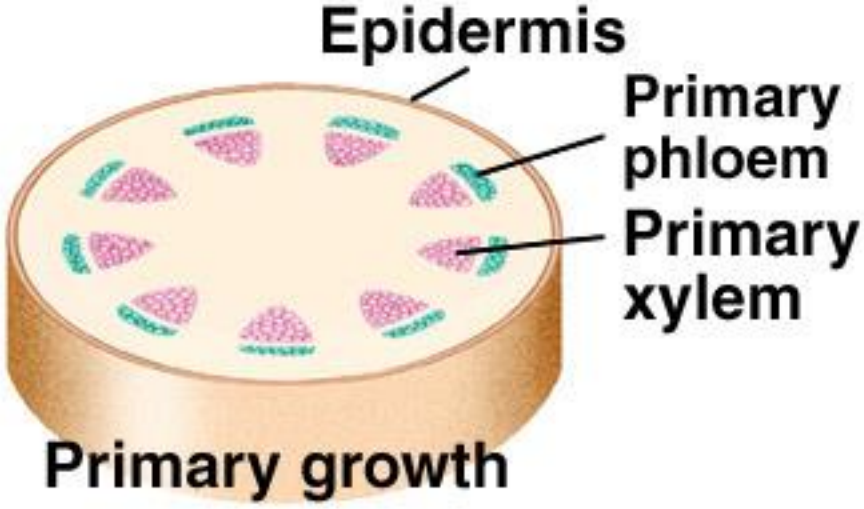
Vascular bundle

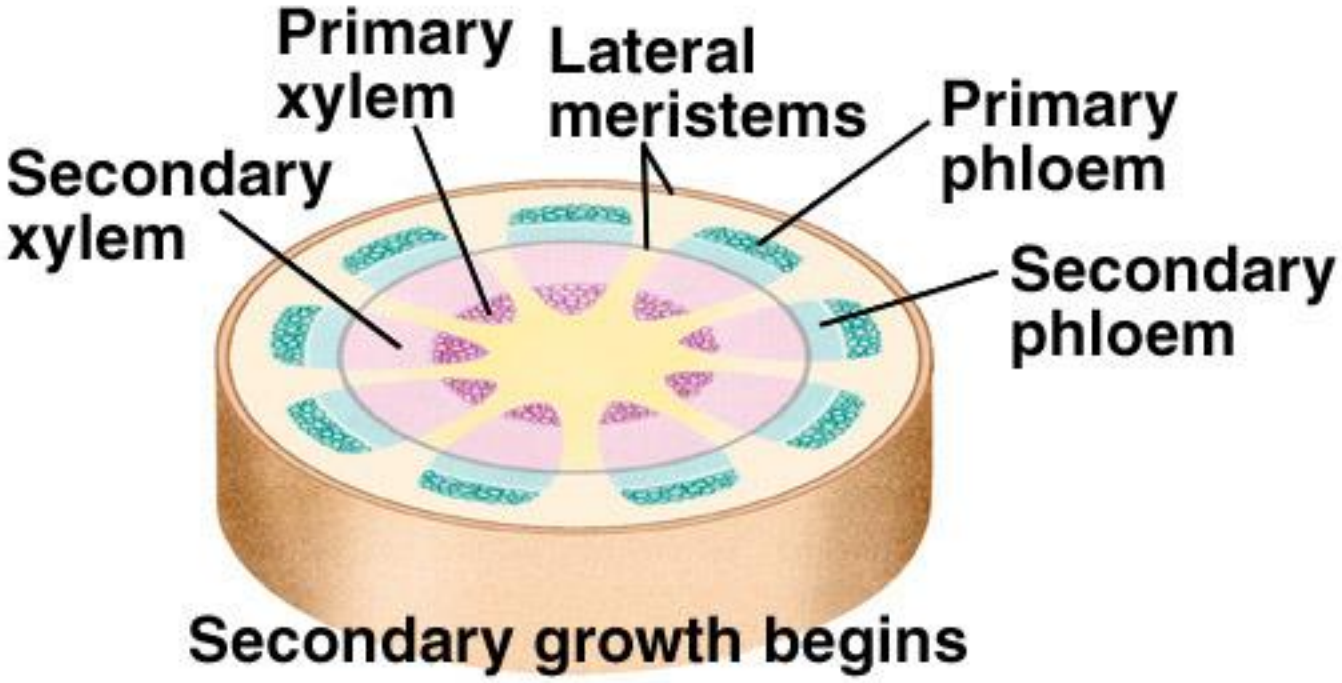
Xylem

Phloem

Cortex

Secondary Growth





Continued Secondary Growth