PLANTS

Transpiration

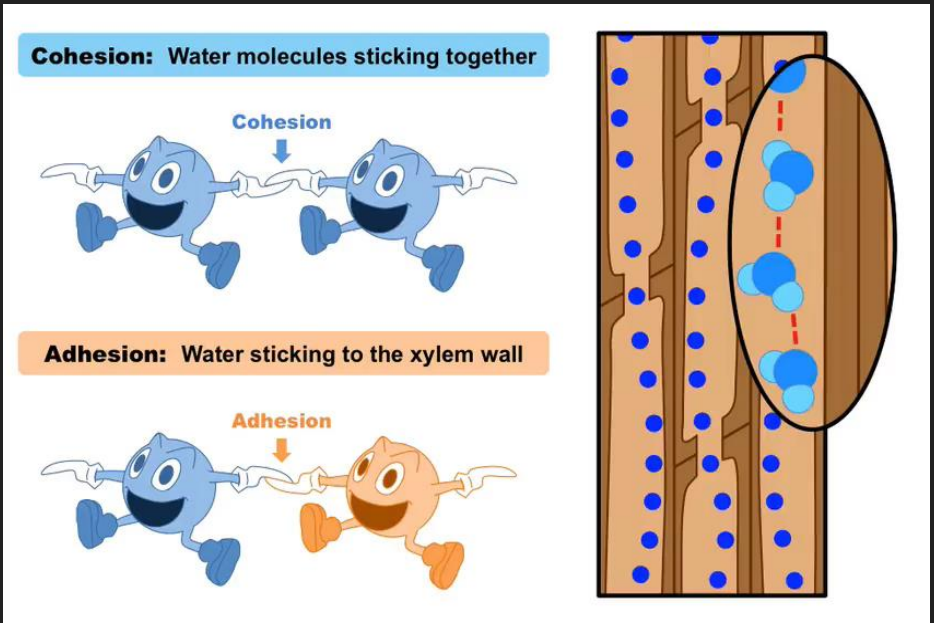
- Loss of water vapor from stems and leaves of plants
  - Light energy converts water in the leaves to vapour, which evaporates from the leaf via stomata
  - New water absorbed from soil by roots, creating a pressure difference between the leaves (low) and roots (high)
  - Water will flow, via the xylem, along the pressure gradient to replace the water lost from leaves (transpiration stream)

Why does it happen?

- Stomata must be open for gas exchange for photosynthesis
- Water vapor escapes via stomata
- Transpiration rates directly affected by level of photosynthesis
- Inevitable consequence of gas exchange in the leaf

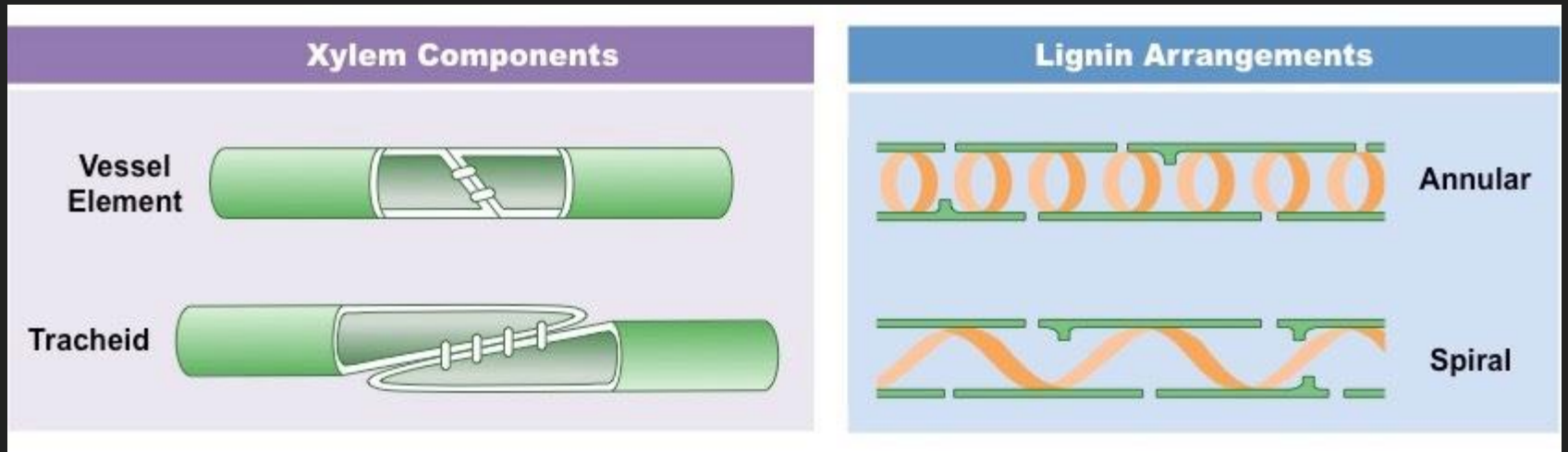
Transpiration Stream

- Flow of water against gravity through the xylem
- Caused by cohesion and adhesion of water



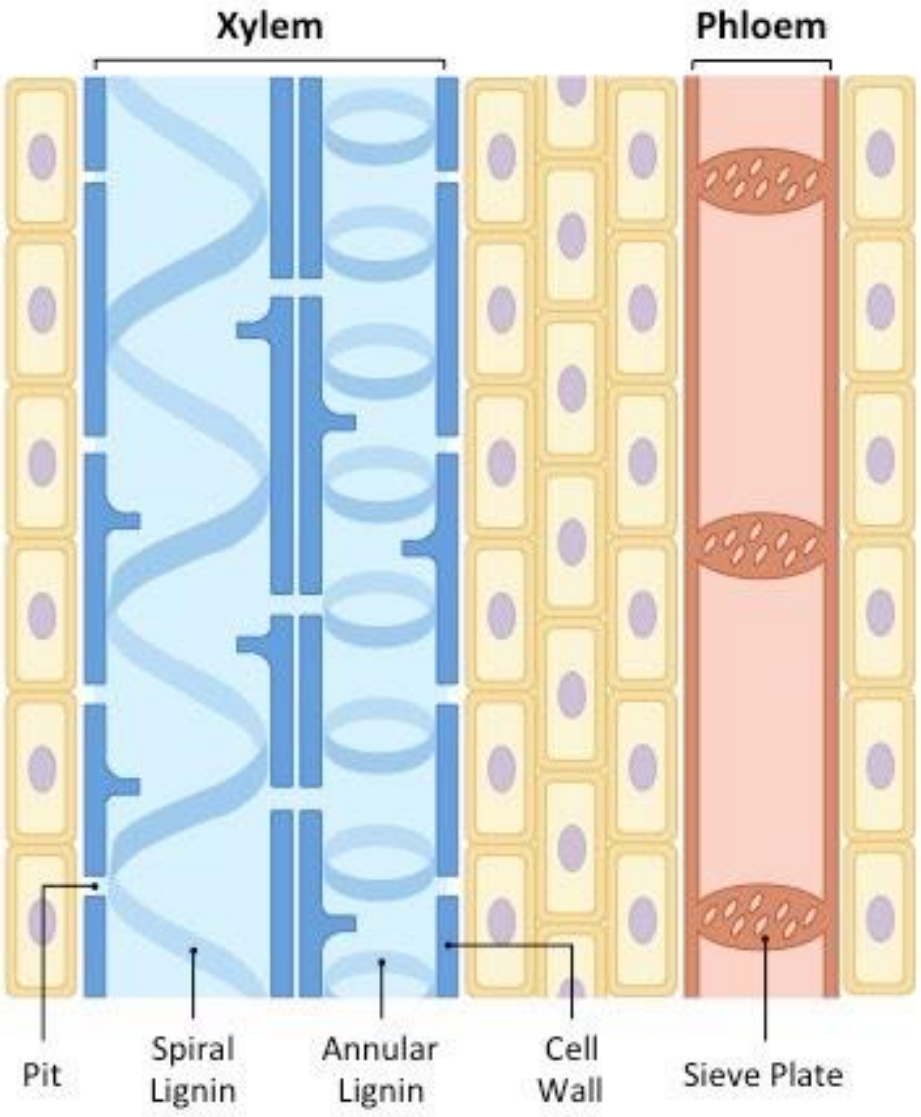
Structure of Xylem

- Tube of hollow, dead cells with numerous pits to allow movement of water between cells.
- Thickened cell walls reinforced by lignin (Spiral or annular)- Can be vessel element (cells fused) or tracheid (pits only)
- B/c cells are dead, movement is one way



Microscope Image

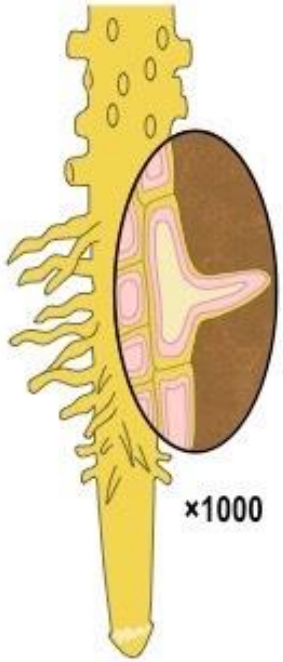
Diagrammatic Representation



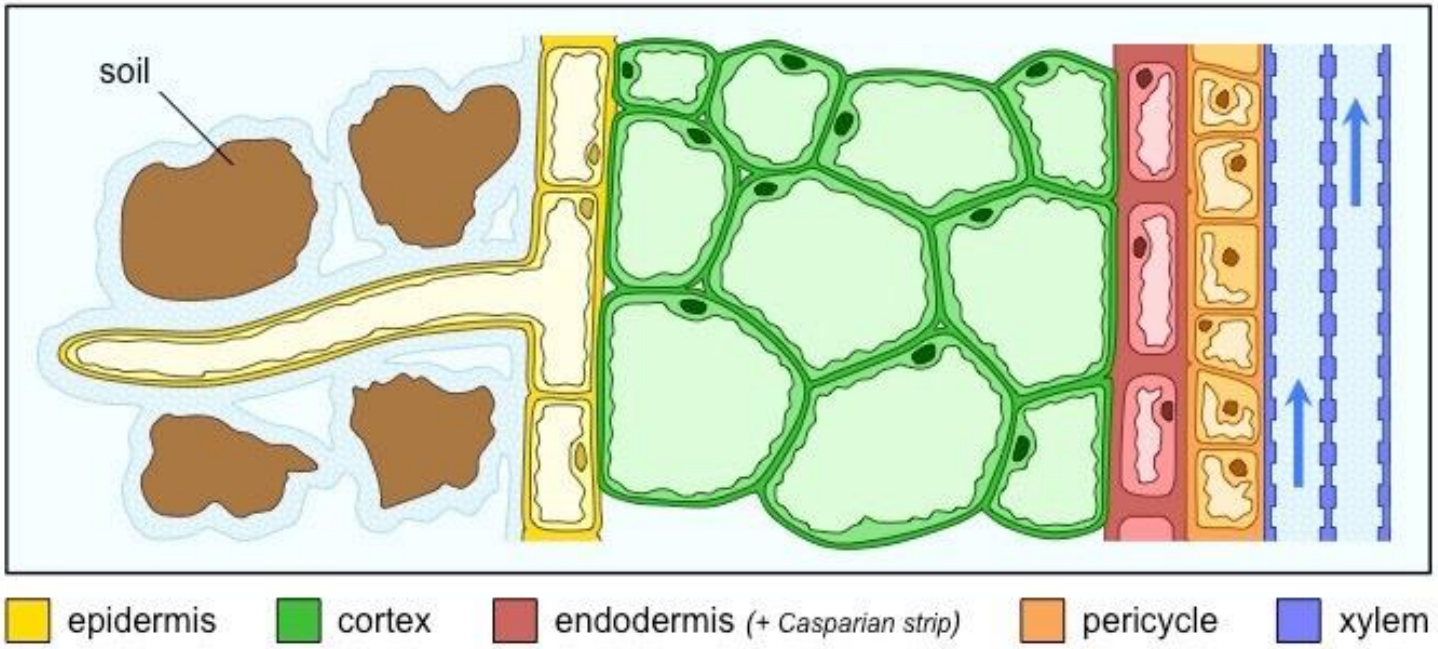
Absorption in the Roots

- Water and minerals are absorbed via the roots
  - Roots can be fibrous and branching (increases surface area) or tap roots (penetrate soil to access deeper water)
  - Epidermis of roots covered in root hairs to increase surface area.
- Water diffuses from epidermis to the stele (where xylem and phloem are)
- Must be pumped across Casparian Strip (impermeable)- allows for control of uptake

Tap Root

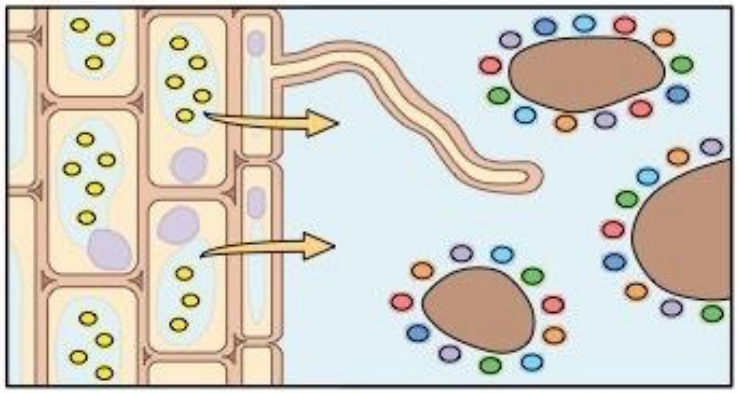


Tissue Distribution in Root

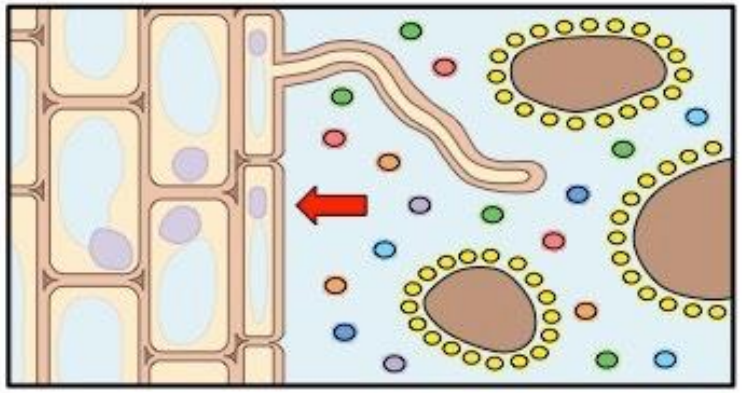


Mineral Uptake

- + charged ions attached to clay particles in the soil
- Move into root cells through indirect active transport



Hydrogen ions are actively transported **out** of the vacuoles of root cells and into the soil

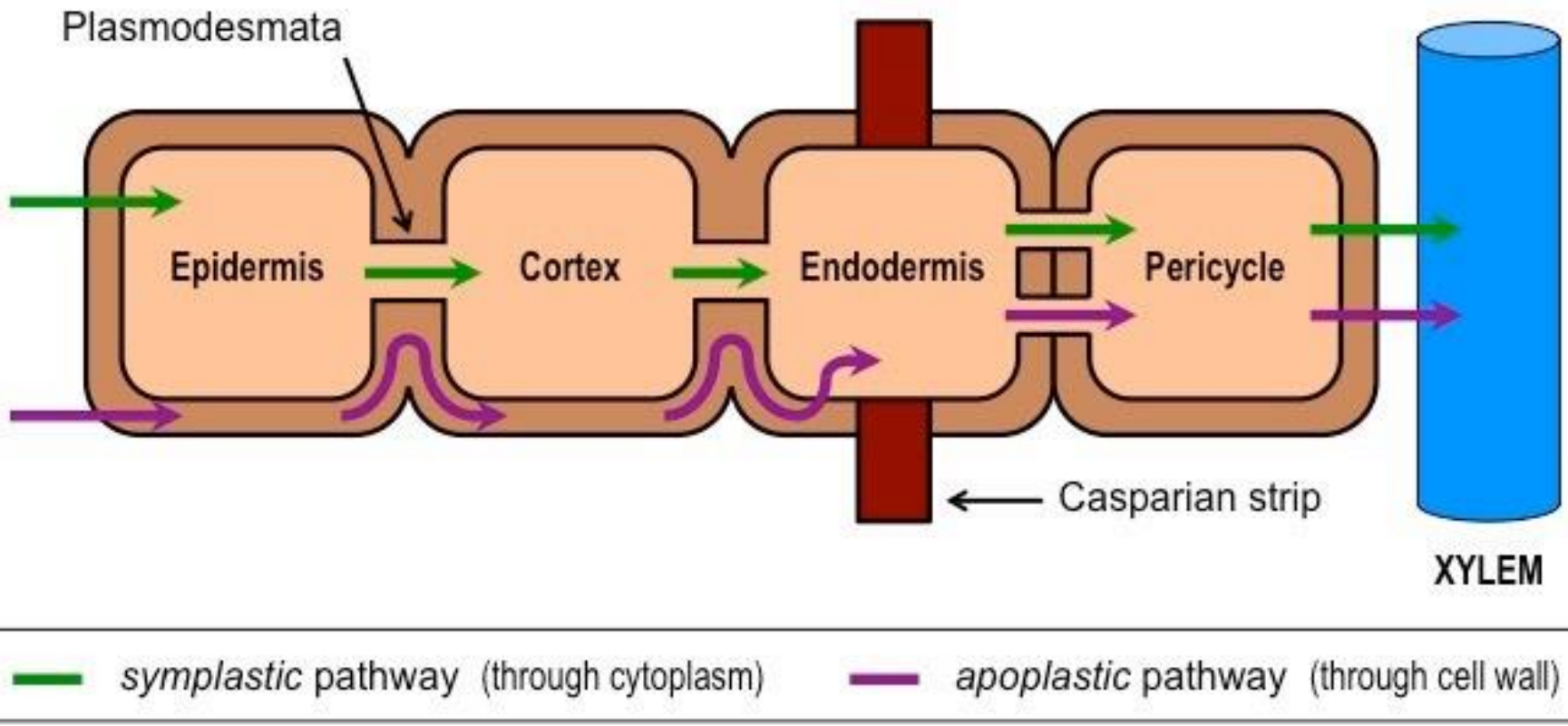


H^+ ions displace minerals from clay particles, which diffuse into root (move along gradient)

Water Uptake Through Roots

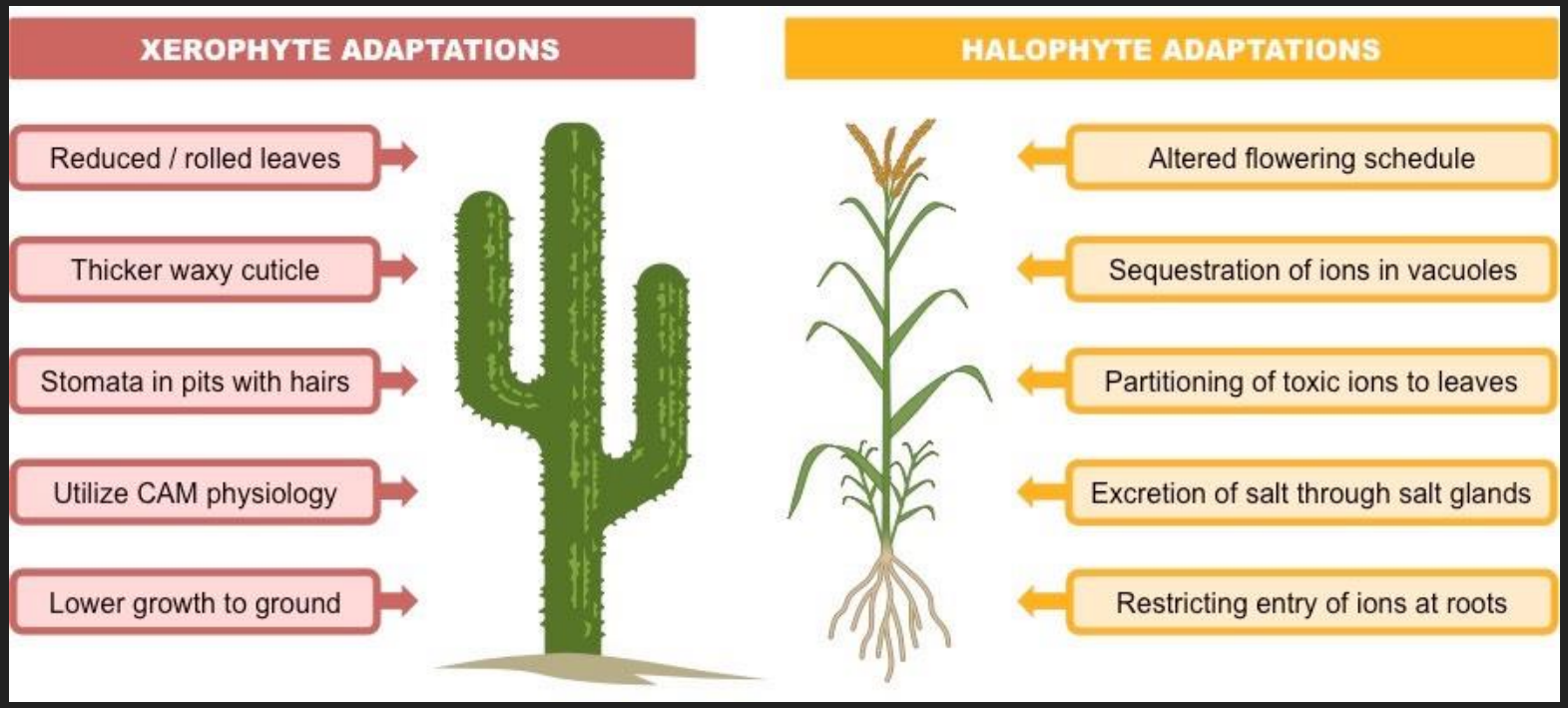
- Water follows minerals through osmosis
  - Water moves into the area with higher solute concentration
  - Regulated by aquaporins
- Water moves from root cells through to the xylem by the cytoplasm (symplastic) or the cell walls (apoplastic)

Symplastic vs Apoplastic



Plants in atypical conditions

- Desert plants (xerophytes) and plants that live in high salinity (halophytes) have special adaptations that allow for water conservation

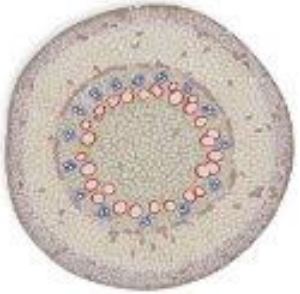
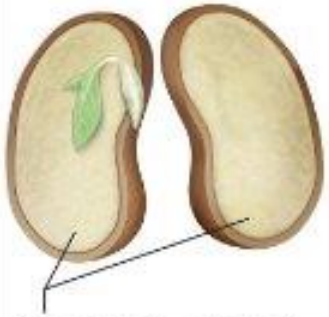


Xerophyte Adaptations

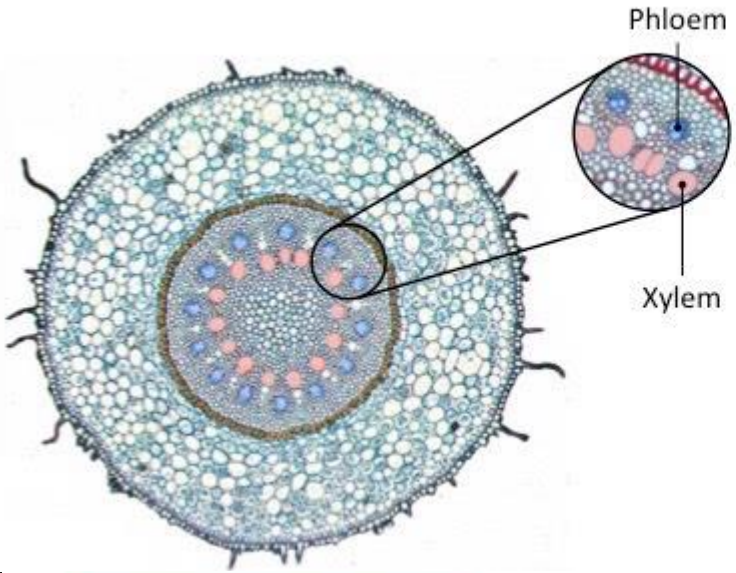
- **Reduced leaves** – reducing the total number and size of leaves will reduce the surface area available for water loss
- **Rolled leaves** – rolling up leaves reduces the exposure of stomata to the air and hence reduces evaporative water loss
- **Thick, waxy cuticle** – having leaves covered by a thickened cuticle prevents water loss from the leaf surface
- **Stomata in pits** – having stomata in pits, surrounded by hairs, traps water vapour and hence reduces transpiration
- **Low growth** – low growing plants are less exposed to wind and more likely to be shaded, reducing water loss
- **CAM physiology** – plants with CAM physiology open their stomata at night, reducing water loss via evaporation

Halophyte Adaptations

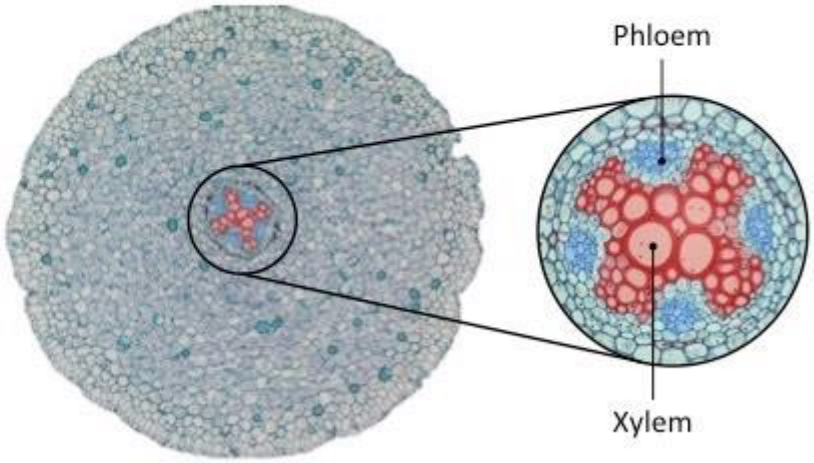
- **Cellular sequestration** – halophytes can sequester toxic ions and salts within the cell wall or vacuoles
- **Tissue partitioning** – plants may concentrate salts in particular leaves, which then drop off (abscission)
- **Root level exclusion** – plant roots may be structured to exclude ~95% of the salt in soil solutions
- **Salt excretion** – certain parts of the plant (e.g. stem) may contain salt glands which actively eliminate salt
- **Altered flowering schedule** – halophytes may flower at specific times (e.g. rainy seasons) to minimize salt exposure

	Seed	Root	Stem	Leaf	Flower
Monocots	 One cotyledon in seed	 Root xylem and phloem in a ring	 Vascular bundles scattered in stem	 Leaf veins form a parallel pattern	 Flower parts in threes and multiples of three
Eudicots	 Two cotyledons in seed	 Root phloem between arms of xylem	 Vascular bundles in a distinct ring	 Leaf veins form a net pattern	 Flower parts in fours or fives and their multiples

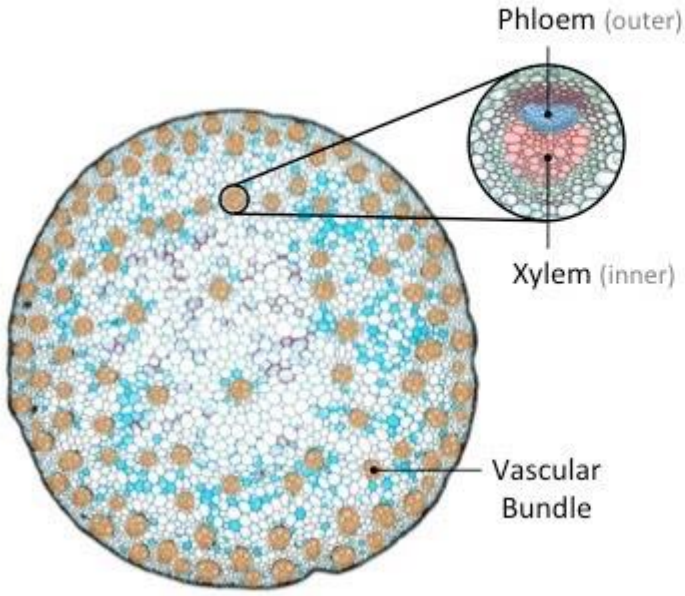
Monocotyledon



Dicotyledon



Monocotyledon



Dicotyledon