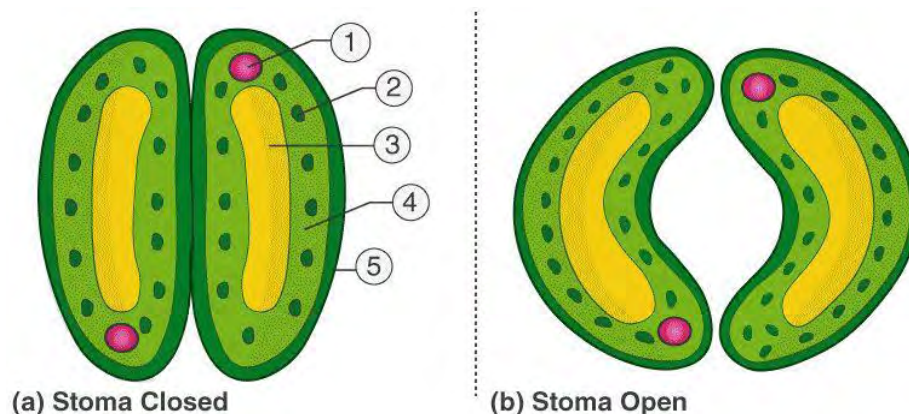


Transpiration:

- Loss of water vapour from the stems and leaves of plants.
- CO₂ is absorbed and O₂ is released through the stomata on epidermis (underside) of the leaf. Results in the loss of water vapour (transpiration).
 - Inevitable consequence of gas exchange in the leaf.
- New water is absorbed from the soil by the roots, creating a difference in pressure 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).
- **“Pull” from leaf “pulls” water from the bottom.**

Guard Cells:

- Guard cells minimise water loss, which controls the aperture of the stoma.
- Can either be flaccid or turgid.
 - Flaccid at low water
 - Turgid at high water
- Closing helps prevent water loss.
- Closed by water shortness and darkness
 - Via hormone abscisic acid
 - Low light → lose water and become flaccid, stomata closes.
 - Bright light → take in water by osmosis, become plump and turgid.

**Xylem structure helps withstand low pressure:**

- Cohesive property of water and the structure of xylem vessels allow transport under tension.
- Xylem: long continuous tubes, walls thickened with lignin, which strengthens the wall to withstand very low internal pressures.
- Xylem vessels are arranged end-to-end.
- Mature xylem vessels are non-living so water flow is passive (cohesion and adhesion).
- Internal pressures are much lower than atmospheric pressure.
- Cohesion:
 - Formed due to hydrogen bonding in water, due to its polar structure.
- Adhesion:
 - Water is attracted to hydrophilic parts of the xylem.
- Cohesion and adhesion allow for passive movement of water up the xylem (capillary action).

Translocation occurs from source to sink:

- Phloem is composed of sieve tubes, which are made up of specialised sieve tube cells.
- Sieve tube cells are separated by perforated walls called sieve tube plates.
- Plants transport organic compounds from source to sink in a process called translocation.
- Sugars and solutes are translocating.
- Phloem can transport biochemical in both directions.
- Pressure gradients caused movement of fluid.
- Energy is required to generate pressures (active process).

Phloem loading:

- Active transport is used to load organic compounds into phloem sieve tubes at the source.
- Sucrose is the most prevalent solute in phloem sap.
- Makes a good transport form of carbohydrate because it is not readily available to be metabolised.
- Phloem loading is the process by which sugars are brought into the phloem.
- Apoplast route:
 - Sucrose travels from cell walls of mesophyll cells to cell walls of companion cells.
 - Transport proteins then actively transport sugar into the phloem. Hydrogen ions are pumped out of the companion cells into the interstitial spaces of the cell wall of the companion cell.
 - They then flow back into the cell through a co-transport protein, which provides the energy to carry sucrose into the companion cell-sieve tube complex.
- Symplast route:
 - Sucrose travels through plasmodesmata, which run between cells.
 - This is down a concentration gradient.
 - Sucrose converted to oligosaccharide in the companion cell to maintain the sucrose concentration gradient.

Pressure and water potential differences play a role in translocation:

- Incompressibility of water allows transport by hydrostatic pressure gradients.
- Build up of sucrose in phloem draws water into the companion cell through osmosis from the xylem.
- Rigidity of cell walls plus incompressibility of water results in hydrostatic pressure buildup.
- Water flows down pressure gradient.
- Sucrose is withdrawn from phloem at the sink end of the phloem and used as an energy source or converted to starch.
- Loss of solute results in reduction in osmotic pressure and water is drawn back into the transpiration stream (xylem).

Phloem sieve tubes:

- Sieve tubes consist of sieve tube cells.
- They have a nucleus and cytoplasm.
- They are living and depend on living cells to establish sucrose/organic molecule concentrations through active transport.
- Sieve tube cells and companion cells share the same parent cell.
- Companion cells perform the genetic and metabolic functions of the sieve tube cells.
- Companion cells contain large amounts of mitochondria for active transport of H^+ ions for sucrose cotransport.
- Infolds of plasma membrane in companion cells increases the loading capacity of phloem using the apoplastic route.
- Plasmodesmata link cytoplasm of companion cells with sieve tube cells.
- Rigidity of cell walls of the sieve tube cell allow for establishment of a pressure gradient.
- Perforated walls (sieve plates) plus reduced cytoplasm means that phloem sap will move easier.