Transport in Plants

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Transport in Plants

Plants do not have a heart or blood, but they have two specialised vascular tissues for transport: xylem and phloem.

Xylem

Xylem carries **water and dissolved mineral ions** from the roots upward through the stem to leaves and other organs.

Xylem vessels are well-suited for this:

- dead cells with no cell contents — form hollow tubes for unobstructed flow
- lignified walls — strong and waterproof; prevent collapse under tension
- no end walls — water moves freely along the tube

Water moves through xylem by a pull from the top (transpiration pull), aided by cohesion between water molecules.

Phloem

Phloem carries **dissolved sugars (sucrose)** from leaves to other parts of the plant — both upward and downward. This movement is called **translocation**.

Phloem is made of living sieve tube cells connected end-to-end, with companion cells alongside that supply energy for active loading and unloading of sugars.

Feature	Xylem	Phloem
Contents transported	water and minerals	sucrose and other organic solutes
Direction	upward only (roots ’leaves)	both directions
Cells	dead (no living contents)	living sieve tube cells
Wall	lignified	not heavily lignified
Energy required	no (passive: transpiration pull)	yes (active loading/unloading)

Transpiration

Transpiration is the loss of water vapour from plant leaves, mainly through stomata.

Water is drawn up through the xylem by the tension created at the top as water evaporates from leaf cells — this is the **transpiration pull** or transpiration stream.

Factors affecting the rate of transpiration

Factor	Effect on transpiration rate	Reason
Light intensity	increases	stomata open in light; more evaporation
Temperature	increases	water evaporates faster; air holds more vapour
Humidity	decreases	less concentration gradient for water vapour
Wind speed	increases	removes water vapour at leaf surface, maintaining gradient

Investigating Transpiration

A potometer estimates the rate of water uptake by a cut shoot, which is used as an indirect measure of transpiration rate.

Typical procedure:

- 1. Cut the shoot under water to prevent air entering the xylem.
- 2. Assemble the apparatus under water and make it airtight.
- 3. Introduce an air bubble into the capillary tube.
- 4. Record the distance moved by the bubble in a set time.
- 5. Change one factor, such as light intensity, temperature, wind speed, or humidity.
- 6. Repeat and compare rates.

Precautions include making all joints airtight, keeping leaf area constant when comparing treatments, allowing the shoot to adjust before timing, and changing only one variable at a time.

Plant adaptations to reduce water loss

Plants in dry habitats conserve water through:

- thick waxy cuticle on leaves
- stomata mainly on the lower (cooler, shadier) surface
- sunken stomata (protected from wind)
- leaf rolling (reduces exposed surface)
- few stomata
- reduced leaf surface area (needles, spines)

Storage of Food

All organisms store energy for times when food is scarce.

Organism	Storage substance	Form	Location
Plants	starch	insoluble polysaccharide	roots, stems, seeds
Plants	oils	lipids	many seeds and fruits
Plants	proteins	amino acid polymers	seeds, especially beans and peas
Animals	glycogen	polysaccharide	liver, muscle
Plants and animals	fats/oils	lipids	seeds (plants); adipose tissue (animals)

Storage as insoluble molecules (starch, glycogen) avoids osmotic problems — they do not raise the solute concentration of cells. When energy is needed, enzymes break these down into soluble forms (glucose) that can be respired.

PRACTICE — TRANSPORT IN PLANTS

Xylem
Dead, lignified plant vessels that carry water and minerals upward from roots to leaves.

Phloem
Living plant tissue that transports dissolved sugars in both directions.

Transpiration
The loss of water vapour from leaves, mainly through stomata.

Translocation
The transport of dissolved sugars through the phloem.

Transpiration pull
The tension created by evaporation at the leaf surface that draws water up through the xylem.