Transport in plants

IGCSE Biology

Xylem and phloem

A tree moves water up from its roots through xylem vessels.

Plants have two transport tissues that run through the roots, stems and leaves:

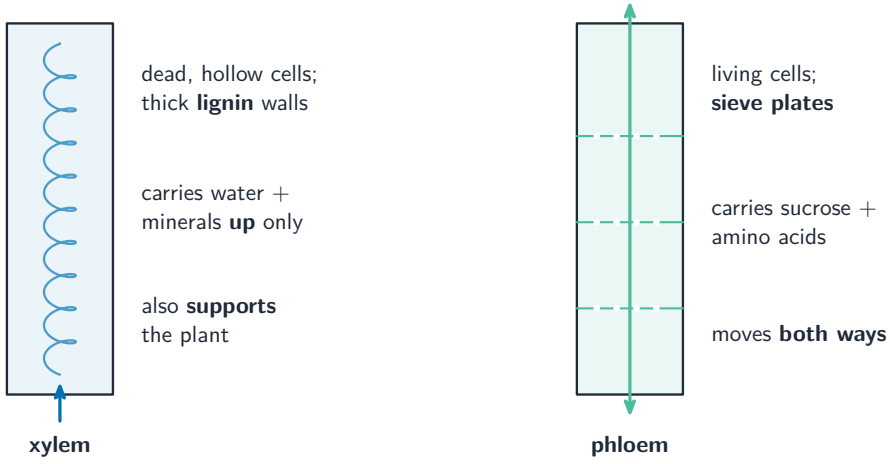
- **xylem** – carries water and **mineral ions** up from the roots, and gives the plant **support**.
- **phloem** – carries **sucrose** and **amino acids** to wherever they are needed.

In a root, stem or leaf, the xylem and phloem lie side by side in **vascular bundles**.

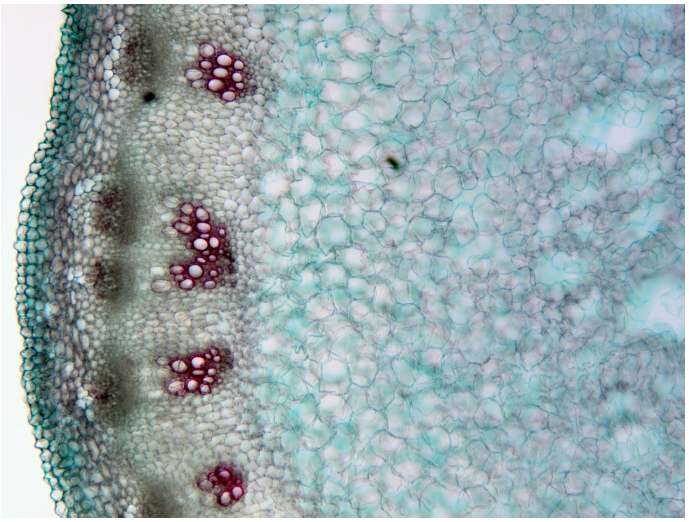
■ Xylem structure (Supplement)

Xylem is made of long tubes called **vessels**, well suited to carrying water:

- their walls are thick and strengthened with **lignin**, which also helps support the plant.
- the cells are dead and empty (they have no cell contents), so water flows through freely.
- the cells are joined end to end with no walls across the tube, making one long, continuous pipe.



Xylem carries water up in dead lignified tubes; phloem carries sucrose in living cells



A stem in cross-section: the red-stained xylem sits in vascular bundles near the edge

Water uptake

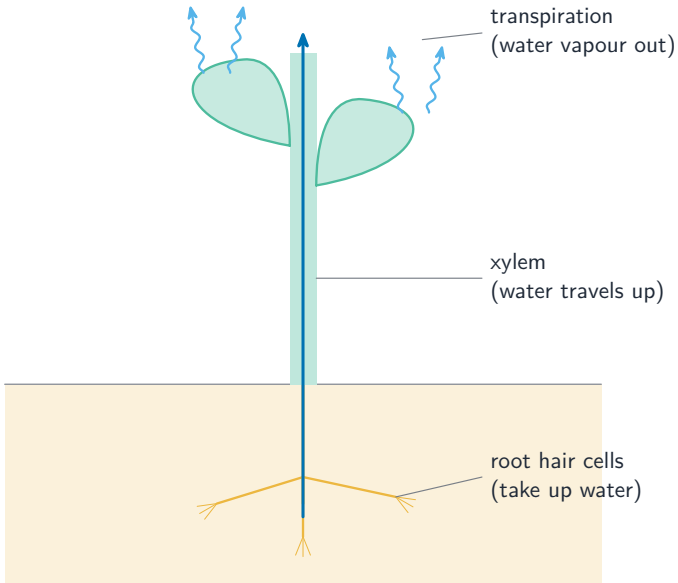
Water and mineral ions enter the plant through **root hair cells**. The huge number of **root hairs** gives a very large **surface area**, which speeds up the uptake of water and mineral ions.

The water then follows this pathway:

root hair cells → root **cortex** cells → xylem → **mesophyll** cells in the leaf.

You can show this pathway by standing a plant or a white flower in water that contains

a coloured **stain**. The stain is carried up the xylem and colours the veins.

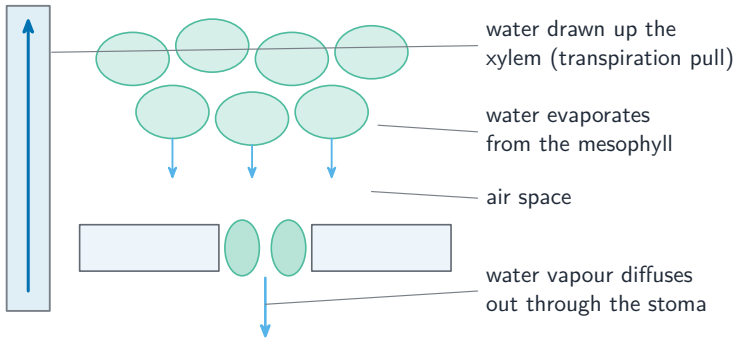


Water is taken up by root hairs, carried up the xylem, and lost from the leaves

Transpiration

Transpiration is the loss of **water vapour** from the leaves.

- Water **evaporates** from the wet surfaces of the mesophyll cells into the **air spaces** inside the leaf.
- The water vapour then **diffuses** out of the leaf through the **stomata**.



Water evaporates from the mesophyll and diffuses out of the stomata as water vapour

What changes the rate of transpiration

Factor	Transpiration is faster when...	Why
temperature	it is hotter	water evaporates faster
wind speed	it is windier	wind carries the water vapour away
humidity (Supplement)	the air is drier	a bigger difference makes water diffuse out faster

> **Worked example.** In a potometer the air bubble moves 60 mm in 5 minutes. Find the rate of water uptake, and say what happens when a fan is switched on. Rate = distance ÷ time = 60 ÷ 5 = **12 mm per minute**. Always give a rate its full unit, "mm per minute", not just "12". A fan raises the wind speed, which carries water vapour away from the leaf, so transpiration speeds up and the bubble moves further in the same 5 minutes.

How water rises up the xylem (Supplement)

As water vapour leaves the leaf, it pulls more water up behind it. This pull is called the **transpiration pull**. The water molecules stick to one another by **forces of attraction**, so they are drawn up the xylem together as one long **column** of water.

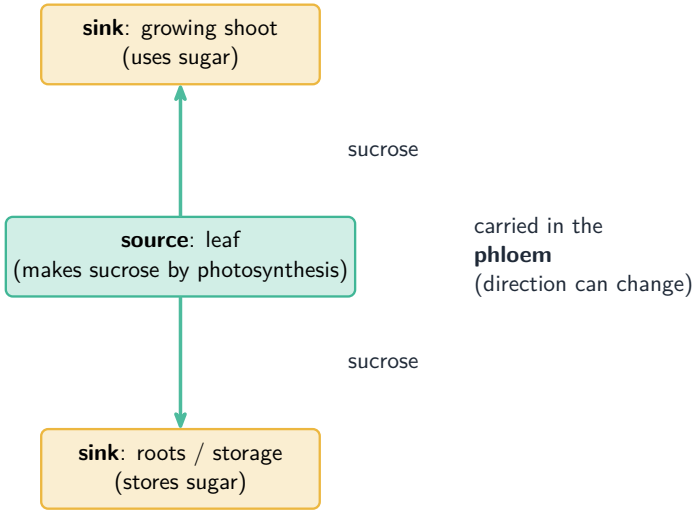
Wilting (Supplement)

If a plant loses water faster than it can take it up, its cells become soft and the plant **wilts** – the leaves and stem droop. This often happens on a hot, dry, windy day.

Translocation (Supplement)

Translocation is the movement of sucrose and amino acids in the phloem, from **sources** to **sinks**.

- sources are the parts that **release** sucrose or amino acids – for example the leaves, which make sugar by photosynthesis.
- sinks are the parts that **use or store** them – for example growing roots, or a storage organ.



The phloem moves sucrose from a source to a sink; the direction can change

Exam tips

- Xylem: water and mineral ions, upward only, plus support – its cells are dead, with thick lignin walls. Phloem: sucrose and amino acids, in living cells.
- Learn the water pathway: root hair cell → cortex → xylem → mesophyll.
- Transpiration = evaporation from the mesophyll, then diffusion out of the stomata. It is faster when hotter, windier or drier.
- Water rises by the **transpiration pull**; the water molecules hold together as a column.
- Translocation goes from a **source** (where sugar is made or stored) to a **sink** (where it is used). The direction can change with the season.