

Transport in plants

IGCSE Biology 0610 · Topic 8 revision notes

Everything from the 4 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Xylem and phloem

2. Water uptake

3. Transpiration

4. Translocation

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1 Xylem and phloem

Syllabus 8.1

Xylem transports **water and mineral ions** and gives the plant **support**. **Phloem** transports **sucrose and amino acids**. In a root the xylem forms a star in the centre with phloem between its arms; in a stem the xylem and phloem are grouped in vascular bundles arranged in a ring, xylem towards the centre; in a leaf they run in the veins, xylem on the upper side. Extended: xylem vessels have thick walls with lignin, no cell contents and no cross walls, forming long continuous tubes.

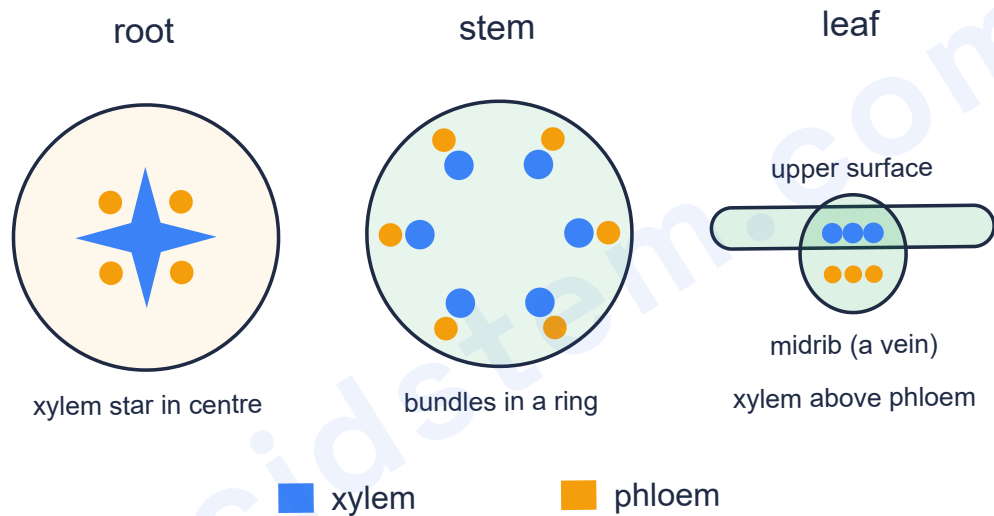


Fig. 1: transverse sections of a non-woody dicotyledonous root, stem and leaf, showing where the xylem and phloem are found

Two tissues, three organs.

- ✓ **Xylem:** water and mineral ions, plus support.
- ✓ **Phloem:** sucrose and amino acids.
- ✓ **Positions:** root = xylem star in the centre; stem = ring of bundles, xylem inside; leaf = veins, xylem on top.
- ✓ **Extended:** lignin (strength), no contents and no cross walls (continuous tube).

Watch out!

Do not mix up the cargoes. Xylem never carries sucrose and phloem never carries the plant's water supply up from the roots. A quick memory aid: *phloem* carries food (sucrose and amino acids).

Lignin makes xylem strong; it does not make it "living" or help it carry sugar. A xylem vessel is dead and empty: that is exactly what makes it a good pipe.

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2 Water uptake

Syllabus 8.2

Root hair cells absorb water (by osmosis) and mineral ions from the soil. Their long, thin extensions give a **large surface area**, which increases the uptake of water and mineral ions. Water then follows the pathway **root hair cells** → **root cortex cells** → **xylem** → **mesophyll cells**. Standing a plant in a coloured dye shows that water travels up the above-ground parts in the xylem.

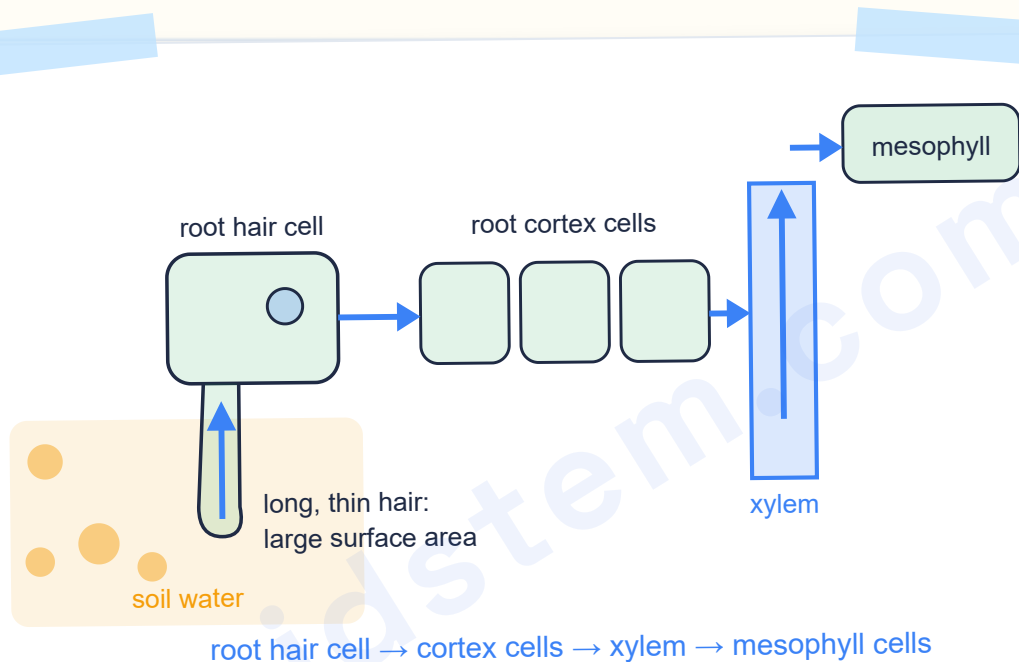


Fig. 1: the pathway of water from the soil, through a root hair cell and the root cortex, up the xylem to the mesophyll cells of a leaf

Hair, cortex, xylem, mesophyll.

- ✓ **Root hair cells:** absorb water (osmosis) and mineral ions (active transport).
- ✓ **Large surface area** increases uptake of water and mineral ions.
- ✓ **Pathway:** root hair cells → root cortex cells → xylem → mesophyll cells.
- ✓ **Stain test:** the dye moves with the water, so it marks the xylem.

Watch out!

A root hair is part of one cell, not a separate cell and not a whole root. And the hairs increase the surface area; they do not make the water move faster through the plant.

The dye is carried up with the water, so it shows the xylem, not the phloem. Say the dye "moves with the water in the xylem", not that the dye is "absorbed by the leaves".

3 Transpiration

Syllabus 8.3

Transpiration is the loss of water vapour from leaves. Water **evaporates from the surfaces of the mesophyll cells into the air spaces** and then **diffuses out of the leaves through the stomata** as water vapour. Higher temperature and higher wind speed increase the rate. Extended: the loss of water pulls a continuous column of water molecules up the xylem (the **transpiration pull**), because water molecules are attracted to each other; high humidity slows transpiration; and when water is lost faster than it is taken up, cells become flaccid and the plant **wilts**.

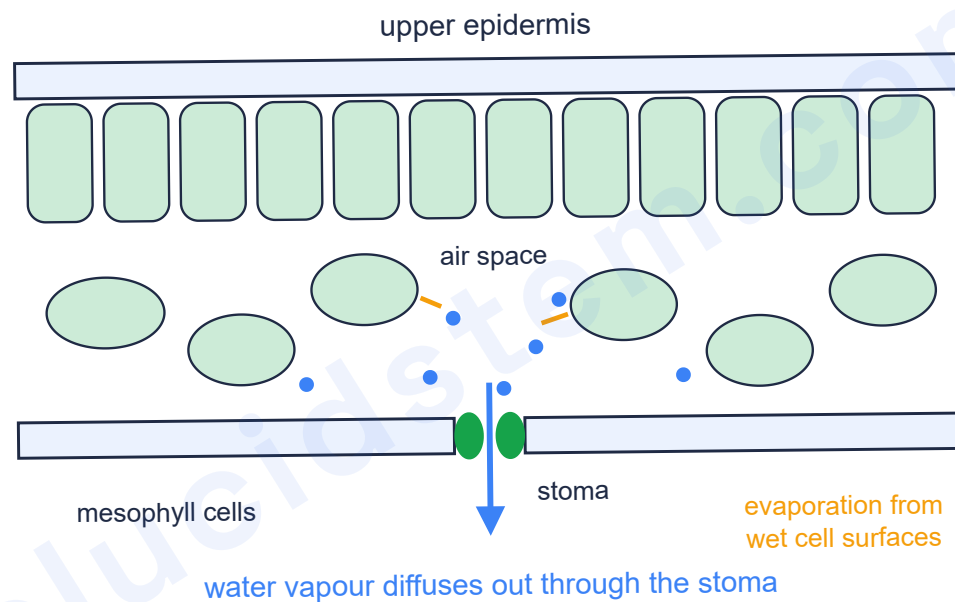


Fig. 1: water evaporates from the wet surfaces of mesophyll cells into the air spaces, then diffuses out of the leaf through an open stoma as water vapour

Two steps, three factors.

- ✓ **Steps:** water evaporates from mesophyll cell surfaces into air spaces, then water vapour diffuses out through the stomata.
- ✓ **Faster with:** higher temperature, higher wind speed; slower with higher humidity (Extended explanations: kinetic energy, gradient).
- ✓ **Potometer:** measures water uptake; $\text{rate} = \text{distance} \div \text{time}$; change one factor at a time.
- ✓ **Extended:** transpiration pull on a column held together by attraction between water molecules; wilting = flaccid cells.

Watch out!

Transpiration is the loss of water vapour, and the vapour leaves by diffusion through the stomata.

Liquid water does not flow out of the stomata, and the stomata are not where the water evaporates: it evaporates inside the leaf from the mesophyll cell surfaces.

A potometer measures water uptake, not water loss. A small amount of the water taken up is used in the plant, for example in photosynthesis, so uptake is only approximately equal to transpiration.

The transpiration pull is a pull from the top, caused by water loss from the leaves. Do not describe it as the roots pushing water up, and do not say the molecules are "sucked" up: the key idea is the attraction between water molecules holding the column together.

4 Translocation

Syllabus 8.4

Extended. **Translocation** is the movement of **sucrose and amino acids in the phloem** from **sources** to **sinks**. A source is a part of the plant that **releases** sucrose or amino acids, such as a photosynthesising leaf. A sink is a part that **uses or stores** them, such as a growing tip, a root, a developing fruit or a storage organ. Because sources and sinks can be anywhere, phloem carries its contents both up and down the plant, and an organ such as a tuber can be a sink at one time and a source at another.

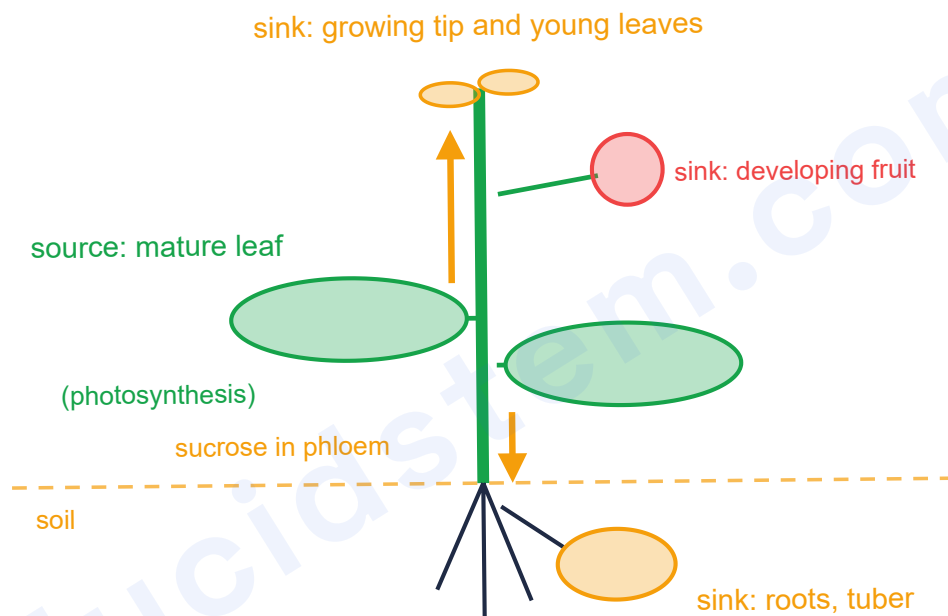


Fig. 1: in summer the mature leaves are the source; sucrose moves in the phloem both up and down to the sinks

Release or receive?

- ✓ **Translocation:** sucrose and amino acids, in phloem, from sources to sinks.
- ✓ **Source:** releases sucrose or amino acids (e.g. a photosynthesising leaf).
- ✓ **Sink:** uses or stores them (growing tips, roots, fruits, seeds, storage organs).
- ✓ **Same organ, two roles:** a tuber is a sink in summer and a source in spring.

Watch out!

Translocation happens in the phloem and carries sucrose and amino acids. Do not say glucose is translocated (it is converted to sucrose first), and do not confuse it with transpiration, which is water loss through the xylem and leaves.

A storage organ is not "always a sink" and a leaf is not "always a source". Exam questions often describe a season or a growth stage on purpose: decide whether the organ is releasing or receiving sucrose at that time.