CAIE Biology IGCSE

8: Transport in Plants

Notes

(Content in **bold** is for Extended students only)

Xylem and Phloem

Plants have a transport system made up of **xylem and phloem vessels**. These transport nutrients from the roots of the plant to the stem and leaves, and vice versa.

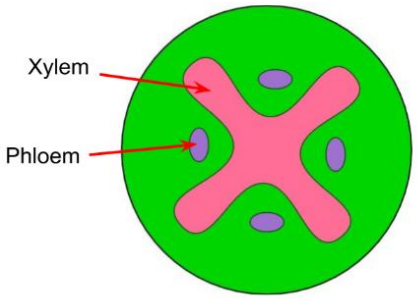
The **xylem** is used to transport **water and mineral ions** through plants from the roots in **transpiration**. **Some of the adaptations of the xylem which made them suitable to be used to transport water are:**

- **Surrounded with thick walls with lignin**
- **They are hollow, with no cell contents, providing more rooms to transport water**
- **Xylem cells are joined end-to-end with no cross walls to form a long continuous tube for water to pass through.**

The **phloem** is made of **living cells** and is used to **transport sucrose and amino acids** in **translocation**.

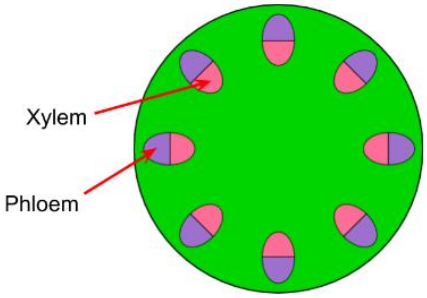
Position of xylem and phloem In roots:

The **xylem** is in the middle of the root in an X shape. The **phloem** is on the outside of the **xylem**.



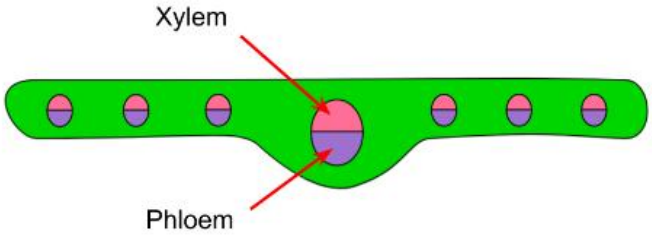
Position of xylem and phloem in stem:

The **xylem** is on the inside of the stem while **phloem** is on the outside.



Position of xylem and phloem in leaf:

The **xylem** is on the top of the **phloem**.

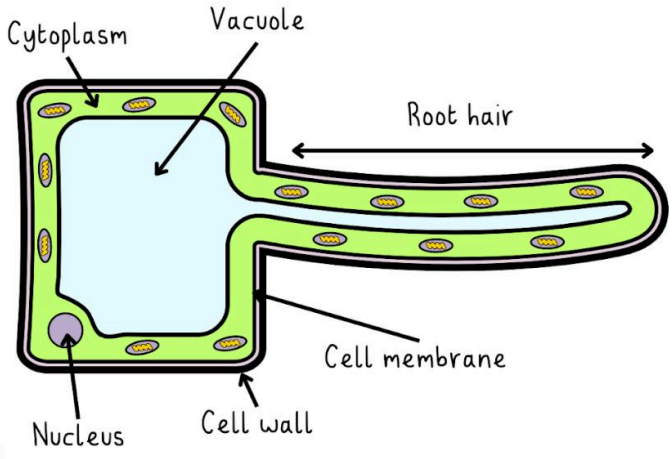


Water uptake

Water is taken up by **root hair cells** via osmosis. The water then moves into the **root cortex cells** by osmosis (as the root hair cells now have a higher water potential than the cortex cells), before entering the **xylem vessel** where it is drawn up the **stem to the leaves**. At the leaf it diffuses into **mesophyll cells** where it is used in metabolic reactions such as **photosynthesis**.

The pathway above can be investigated by placing a plant into a beaker of water with stain added to it. Place it under room temperature and under bright light. After several hours, the leaves of the plant should turn the same colour as the dyed water. This proves that water is being taken up by the plant. When a cross-section of the plant is taken, it can be seen that only the **xylem vessels** are stained.

The **root hairs** increase the **surface area** of the cell. This increases the rate of **osmosis** into the root, which maximises the rate of water uptake. The rate of ion uptake is also increased by **active transport**. They also have a **thin wall**, so the diffusion distance is shortened.



Transpiration

Transpiration is the **loss of water vapour** from the leaves due to **evaporation.** The water evaporates from the surface of the **mesophyll cell** into the **air spaces** and then diffuses out of the leaves through the **stomata** as water vapour. **The interconnecting air spaces between the mesophyll cells create a large internal surface area. This increases the amount of water which can evaporate from the leaf. A greater number of stomata leads to more evaporation of water vapour from the leaves, thus greater rate of transpiration. A larger size of stomata also leads to a higher transpiration rate.**

Water molecules are drawn up the xylem by transpiration pull (not osmosis). Water molecules are cohesive, meaning they stick together. This means that as the water evaporates at the leaf and diffuses out of the stomata, more water is drawn up the plant from the roots.

The **rate of transpiration** depends on the **temperature and wind speed**. On warm days the temperature is higher, **so water evaporates more easily, therefore there is more diffusion of water vapour out of the plant,** so the **rate of transpiration is high.** On windy days, **the wind will blow away more water vapour from the surface of the leaves,** causing an **increase in rate of transpiration**. **A high humidity, however, decreases the rate of transpiration as the concentration gradient of water vapour between the inside and outside of the plant is comparatively low, so diffusion out of the plant is slower.**

Water helps maintain plant structure by keeping cells turgid. If the plant loses too much water which is not replaced, it begins to wilt as water moves out of cells and turgor pressure decreases. To limit water loss, the plant closes the stomata to prevent water vapour diffusing out.

Translocation

Translocation occurs in the phloem vessels and involves the transport of amino acids and sucrose from sources to sinks. Areas where amino acids and sucrose are produced are called sources. Regions where they are stored or used for respiration and growth are called sinks. Materials are always transported from source to sink.

Sucrose and amino acids are produced in the leaves, before being transported to the roots for storage. They are later transported to regions where they are used in respiration and for growth. Some parts of the plant, such as the leaves, can act as both source and sink within a plant's life as they synthesise molecules and use them in metabolic reactions.