Plant Structures Notes

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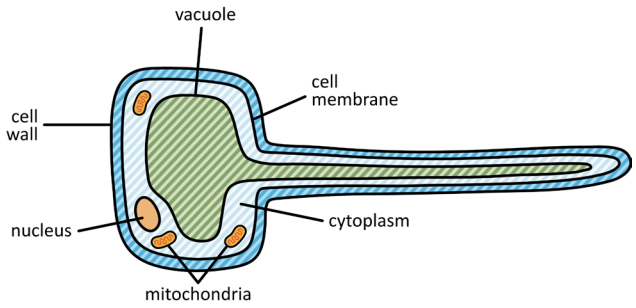
Plants have many tissues that perform many functions, let's start with the root hair cells.

Root Hair Cell

Root hair cell: the function of these cells is to absorb water and mineral ions from the soil and transport them to the vascular tissue.

Vascular tissue: the plants transport system (think of them a bit like arteries and veins), it is made of xylem and phloem tissue. Xylem transports water while phloem transports sucrose.



How is the root hair cell adapted for its role?

1. It has thin walls which make uptake of water easier and osmosis faster.
2. It has a large projection with very thin walls into the soil. This projection increases the surface area.
3. They have many mitochondria to provide the energy required for the active transport of mineral ions from the soil into the root.

Water

All living things need water, plants have root hair cells to absorb it from the soil but how does the water get from the soil into the plant and then how does it move through the plant to the leaves? Let's start with that first question 😊

How does the water get from the soil into the plant? Water moves into root hair cells from the soil by osmosis.

Osmosis: the movement of water from an area of high concentration to an area of low concentration through a partially permeable membrane.

How does it move through the plant to the leaves? Now that the water is in the root hair cell it must get to the xylem. Water moves by osmosis from cell to cell in the root until it gets to the xylem vessels.

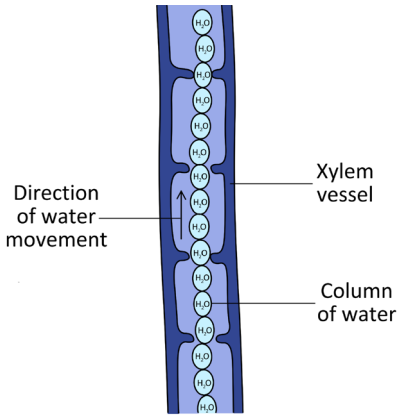
Xylem

Xylem vessels: carry water from the roots to the leaves of the plant. The movement of water through the plant is called transpiration. Transpiration always moves in one direction, from the roots, up the stem, to the leaves.

Transpiration: the loss of water vapour from the surface of the leaves.

What are the adaptations of xylem to transport water?

1. Xylem is made of a non-living substance called lignin.
   As lignin isn't alive it doesn't absorb any of the water that it transports.
2. Xylem is impermeable, meaning once water enters it can't get back out.
3. Xylem is very thin.
4. Xylem is very narrow.

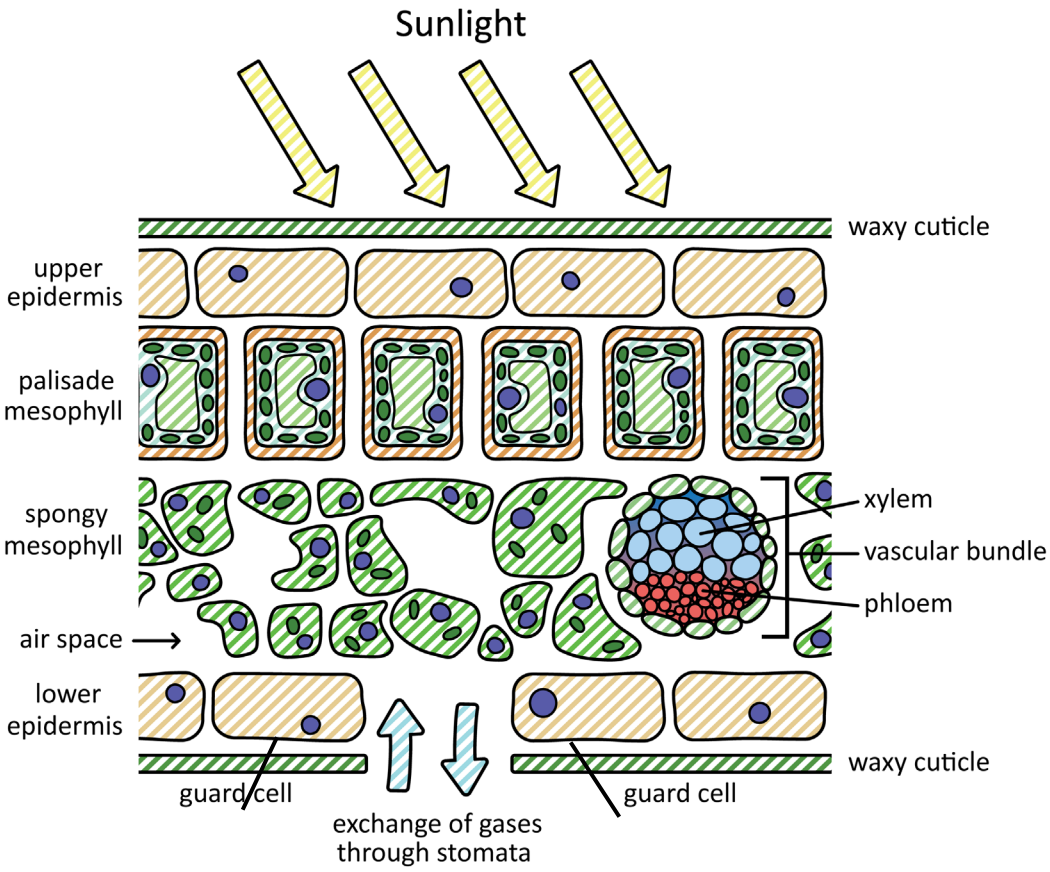


How does water move up through the Xylem vessels? Water moves up through the xylem vessels by **adhesion** and **cohesion**. Adhesion means that water sticks to the sides of the xylem vessels and cohesion means that water sticks to other water molecules. So we get an unbroken chain of water molecules all the way from the root to the leaves 😊

This cohesion means when one water molecule is lost from the leaf the whole column of water in the xylem vessel is pulled up one molecule. This keeps happening, over and over again, moving water up the xylem vessels.

The Leaf

Leaves are the main photosynthetic organ of the plant. They have a very large surface area but an even larger volume. This very large volume is really useful for gas exchange. The figure below shows a section through a leaf.



Waxy cuticle is made of wax – this reduces the amount of water lost from the leaf.

Upper epidermis – this allows light to pass through freely and reduces water loss.

Palisade mesophyll – is the main region for photosynthesis, cells are quite long and packed close together with a large number of chloroplasts in each cell.

Spongy mesophyll – has lots of air spaces between cells which allow gaseous exchange. Carbon dioxide diffuses from the air spaces to the cells and oxygen diffuses from the cells to the air spaces during photosynthesis.
Some photosynthesis also takes place here as the cells have some chloroplasts.

Vascular bundle – this is the transport tissue of the leaf, made up of xylem and phloem.

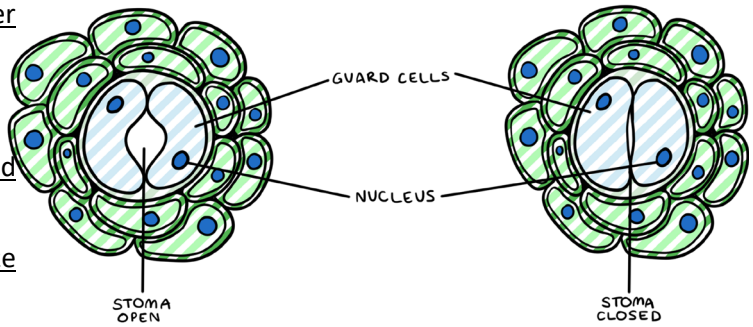
Xylem vessels –transports water from the root to the leaves in a process called transpiration.

Phloem vessels – transports sucrose in a process called translocation.

Lower epidermis – Reduces water loss. Also has stomata present.

Stomata – the stomata are just holes in the leaf that allow exchange of gases and transpiration.
The figure below shows stomata with their guard cells. The singular is stoma.

Guard cells – each stoma has two guard cells on either side. These open and close the stoma or stomata.



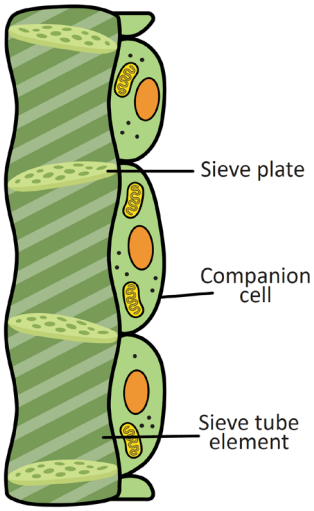
How are guard cells adapted for their role?

1. Guard cells are able to take up water by osmosis and swell in size (become turgid) this opens the stoma.
2. Guard cells lose water by osmosis and decrease in size (become flaccid) and close the stoma.
3. Guard cells actively pump potassium ions into themselves. This lowers their water potential, so water rushes in by osmosis, making them turgid and opening the stoma. At night, the ions leave, the water follows by osmosis, and the guard cells become flaccid, closing the stoma to save water!

Phloem Tissue

Phloem vessels transport sucrose from source to sink in a plant. The movement of sucrose within phloem tissue is called **translocation**. The **source** is where the sucrose comes from. The **sink** is where the sucrose is used/stored.

Unlike the one way flow of water in the xylem, translocation is bidirectional, meaning it can move substances both up and down the plant. One section of Phloem is called a sieve tube element.



What are the adaptations of phloem to transport sucrose?

1. **Companion cells**: each sieve tube element has a companion cell.

   These cells have a very large nucleus as they effectively manage both themselves and the sieve tube element they are attached to.

   They are involved in controlling the direction of translocation.

2. Companion cells **contain mitochondria** these provide energy for **active transport**.

3. **Sieve plates:** allow sucrose to move through.

Rate of Transpiration

You could potentially see a question that asks you for a factor that could affect the rate of transpiration and what that factor will do. The factors that can affect the rate of transpiration are:

1. **Light intensity**
2. **Air movement**
3. **Temperature**
4. **Humidity**

Question. Increases in which factor will **increase** the rate of transpiration?
Answer. An increase in **light intensity, air movement and temperature** will all increase the rate of transpiration.

Question. Increases in which factor will **decrease** the rate of transpiration?
Answer. An increase in **humidity** (the amount of water in the air) will decrease the rate of transpiration.

Calculating Rate of Transpiration

These calculations are much easier than they look 😊 They normally appear as a table of data in which we are asked to use the data to calculate the rate of transpiration. But it really doesn't matter how the question appears, we need to be able to calculate the rate. How do we do this?

Rate of transpiration is calculated using this equation:

$$\textbf{Rate of transpiration} = \frac{\textit{Distance moved by the bubble}}{\textit{Time taken}}$$

Note: the units of both distance and time can be different from question to question. The most common two being cm per minute or mm per second. But cm per minute is a common unit used in exam questions.

How are plants adapted for extreme environments?

At GCSE questions appear on how cacti are adapted for their desert environment.

Adaptation	Benefit to the plant
Spines	These reduce the surface area of the plant and so also reduce water loss. The spines can also protect the cacti by discouraging animals from eating them.
Thick waxy cuticle	Reduces water loss by evaporation.
Less stomata	Reduces the water loss from transpiration.
Modified Stems	These can store large volumes of water for long periods.
Huge root system	Allows the plant to absorb water from a very large area.