Plant Transport

Transport systems

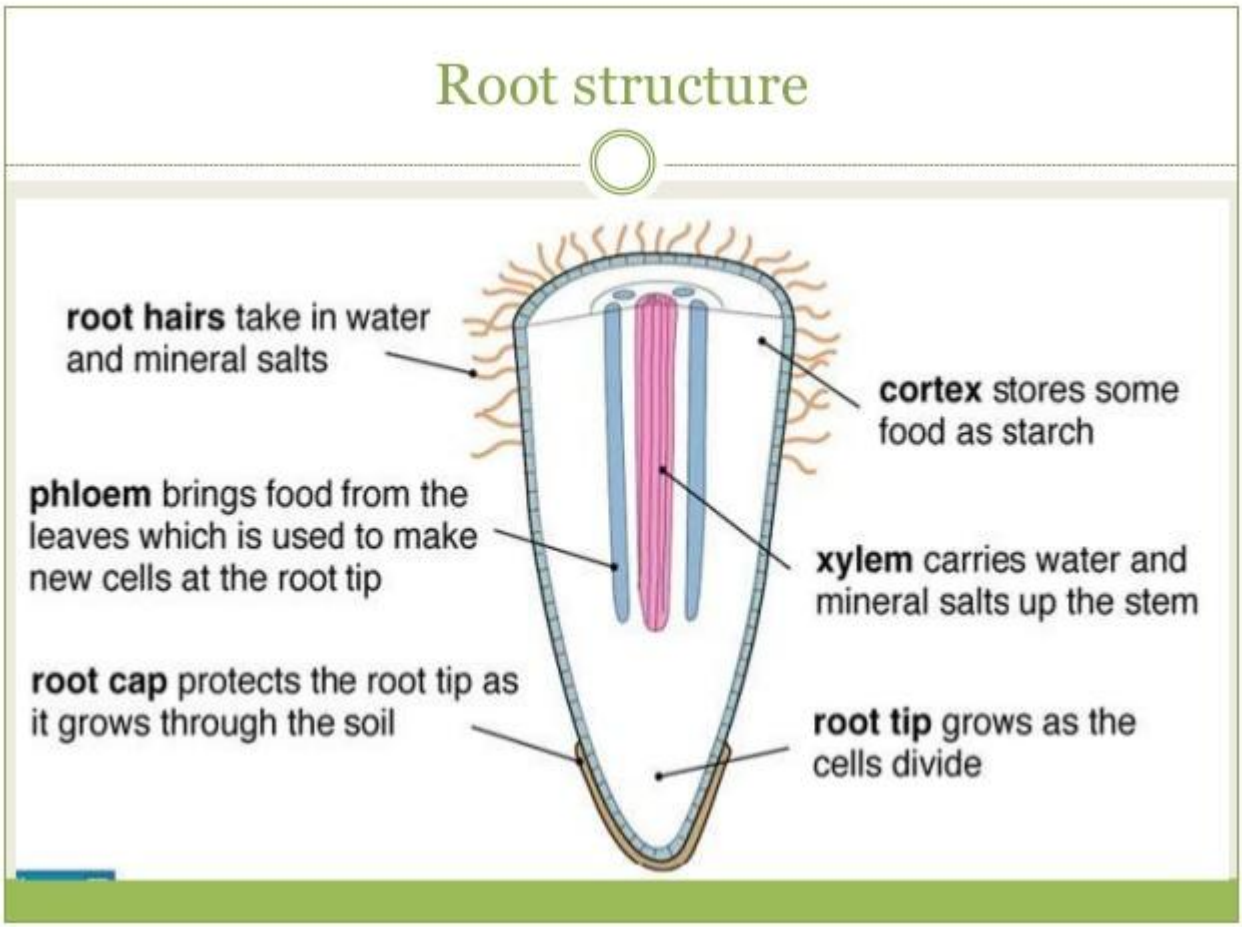
- Small organisms don't need transport systems, they have small, flat bodies so they rely on diffusion
- Large organisms have transport systems which move fluids through tubes so that all the fluid moves in the same direction in each tube. This type of transport is called mass flow
- Vertebrates have a circulatory system with a pump
- Plants have two separate transport systems: xylem and phloem

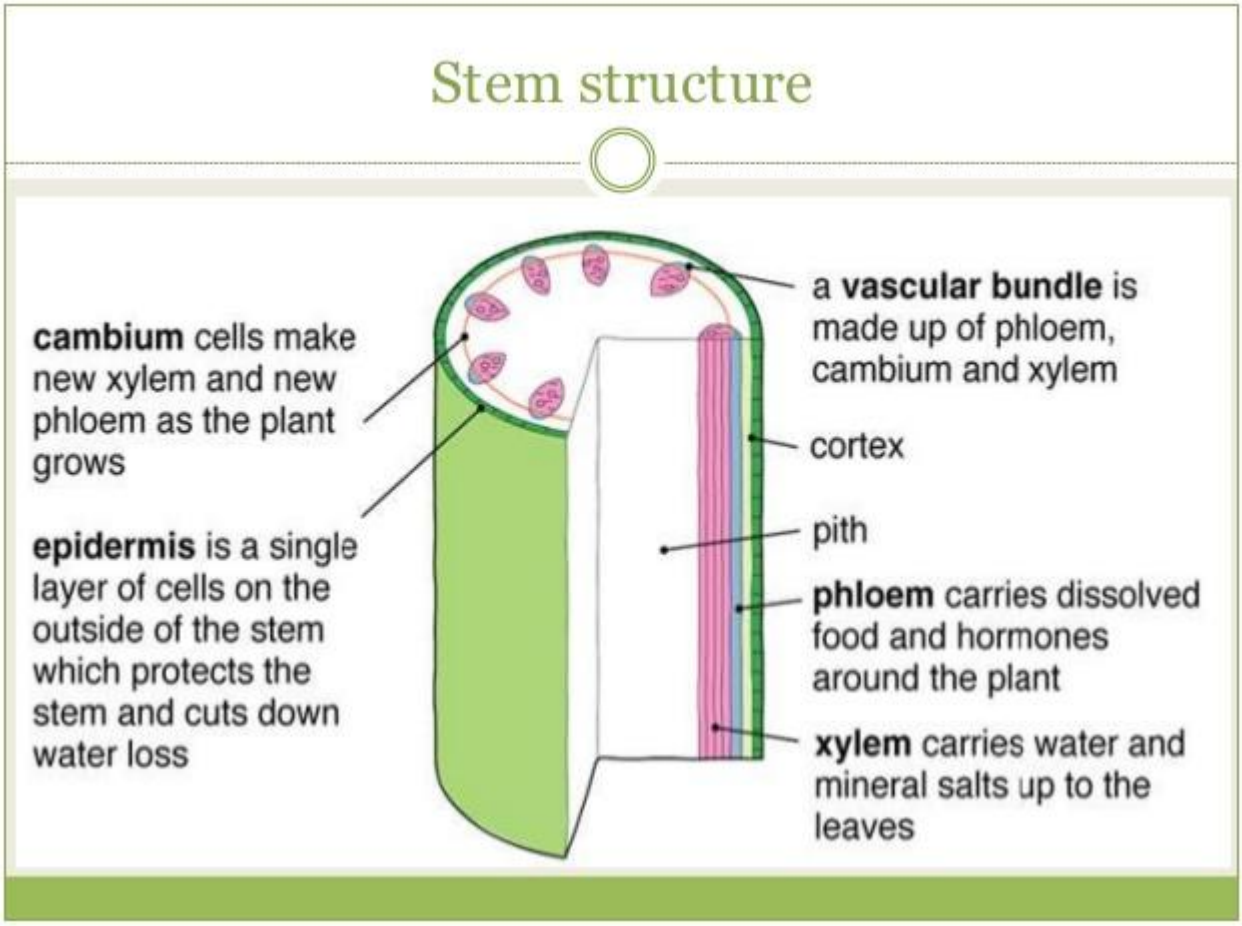
Xylem

- Water and minerals travel in xylem vessels
- Xylem vessels have thick cellulose cell walls strengthened by lignin. The inside of the walls are hollow. Xylem vessels are dead cells
- Xylem vessels transport water and minerals from the root to the shoot and leaves. This transport only occurs in one direction
- Thick walls also help support the plant

Phloem

- Phloem is made of columns of living cells. They transport food in the form of sugars
- Sugars are carried from the leaves to the growing and storage parts of the plants. This movement takes place in both directions
- Phloem cells are also called sieve tubes. Cells are joined by small holes in the cell walls at the end of each cell forming a continuous system. The end of the cell walls are called sieve plates.





Water uptake by the roots

- The main function of the roots is to anchor the plant and take up water and mineral ions

Explaining how water is taken up by the roots:

1. Osmosis is the net movement of water molecules through a semi permeable membrane (root hair cells) from a high water potential (inside the cells) down a concentration gradient
2. The water potential gradient in the soil is higher than that in the cell because there are more mineral ions in the soil water
3. The water molecule then moves from cell to cell until it reaches the xylem vessels. Once water enters the vacuoles, it increases the water potential of that vacuole, thus creating another water potential gradient as the cortex neighbouring cells have a lower water potential. This process repeats itself until it reaches the xylem vessels
4. From here it moves up the plant towards the stem and spongy mesophyll cells in the leaves

It's a push, not a pull

- Water needs to flow against gravity. The slight push from water entering from below is not enough to overcome gravity
- Transpiration is the evaporation of water from the surfaces of the mesophyll cells in the leaves which leads to water vapour diffusing out of the stomata and into the atmosphere
- Water is pulled up the xylem using transpiration pull
- Mass flow of water in the xylem depends on two properties:
    i. Cohesion: water molecules sticking together
    ii. Adhesion: water molecules sticking to the inside of a vessel
- Transpiration stream- a continuous flow of water through the xylem
  → Keeps the plant from wilting

→ Provides water for photosynthesis

Wilting

- Stomata open during the day for the diffusion of carbon dioxide into cells
- Close at night to reduce transpiration
- If the soil water is scarce, the plant will wily

→ Water lost from cells result in turgidity

→ No support for plant so leaves start to droop

→ Wilting helps move the leaves out of direct sunlight to reduce transpiration

Factors affecting transpiration

1. Light
   - Stomata open when light intensity increases
   - Increase in transpiration
2. Humidity
   - In humid conditions water vapour levels close to that in stomata, slows down diffusion, slows down transpiration
3. Air temperature
   - High temperature, more kinetic energy in water molecules, faster diffusion from cell to atmosphere
4. Air movement
   - Humid air taken away by wind which maintains the concentration gradient between the leaf and air

Functions of xylem and phloem

Xylem

- Transports water and mineral ions from roots to stems, leaves, flowers and fruits
- Movement is only in one direction

Phloem

- Transports sucrose, amino acids and hormones throughout the plant
- Sucrose is a complex sugar used for energy
- Made in the leaves using sugars from photosynthesis and starch from storage organs (roots and stems)
- Hormones control cell division for growth in all parts of the plant
- Movement in two directions: leaves to roots and leaves to flowers (upwards and downwards)

Translocation

- Translocation is the movement of organic solutes from a source to a sink through the phloem by means of mass flow

Sucrose

- Broken down to simple sugars used for respiration
- Changed to starch for storage in root cortex or seeds
- Used to make cellulose (cell walls) in root and shoot tips
- Stored in fruits to make them sweet in order to attract animals

Aphids and phloem transport

- Aphids- insects feed on phloem sap (food)
- Piercing mouthparts called stylets-inserted into a single phloem tube
- Pressure of the sap causes it to pass into the stylet
- Used to study sugar transport
- Passage of sugars are traced using isotopically labelled sugars
- Some systemic pesticides are taken up in sap which kills aphids

Transpiration vs Translocation

- Transpiration helps to create a pull that allows for water and minerals to move up in the plant →Passive process that depends on diffusion

- Translocation is an active process in the phloem

→ Leaves are the source and the place of respiring tissues, regions of growth, regions of storage and sink

→ Phloem cells are alive and contain cytoplasm

→ Active transport needed to move sugars against a concentration gradient

A source is the place in the plant where the substance begins its journey

A sink is the place where the journey ends

	Transport	From	To	Mechanism	High Rate
Transpiration	Water Mineral ions	Soil	Leaves Flowers Fruits	Passive process, using a tension in the xylem produced by evaporation	On hot, sunny, windy and dry days
Translocation	Sucrose Amino acids	Leaves	Shoot Root tips Root cortex Seeds	Active process where the water enters the tubes to build up a head of pressure that forces phloem sap to the sinks	On warm, sunny days when plants are producing more sugars