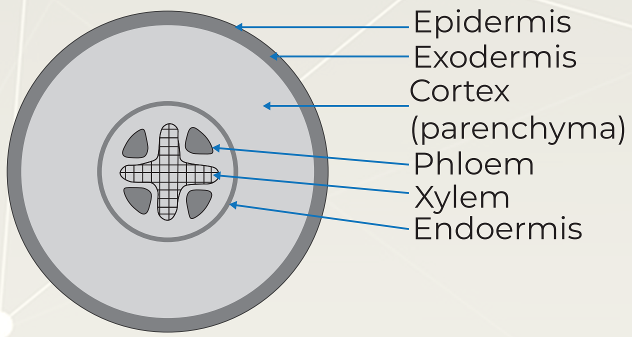
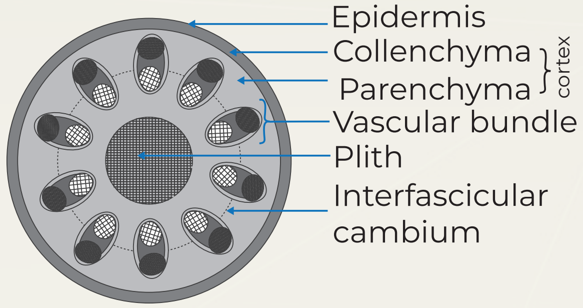
Adaptations for transport in plants

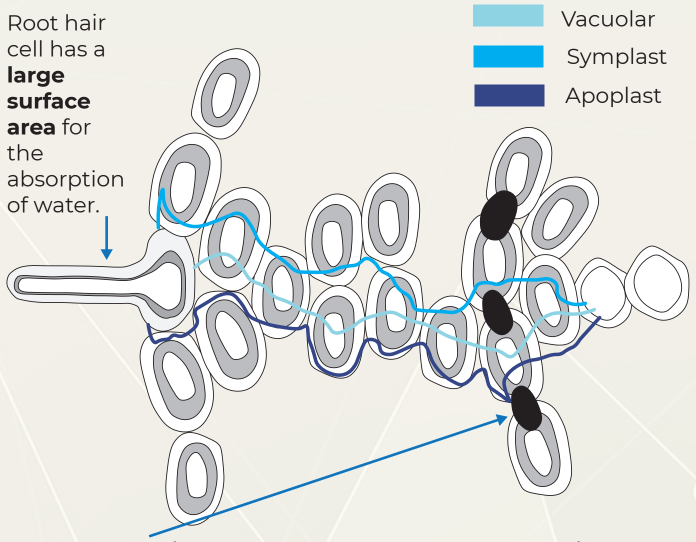
Structure of the root



Structure of a stem



Apoplast, symplast and vacuolar pathways



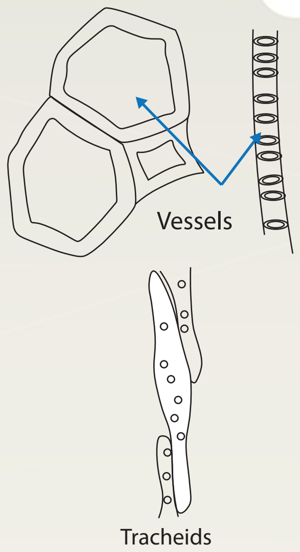
The **endodermis** is impregnated with areas of **suberin** called the **casparian strip**. This blocks the apoplast pathway, forcing water into the symplast pathway. Minerals are selected to move into the symplast by **active transport**. This sets up a water potential gradient, lower in the xylem so water moves in by osmosis resulting in a force called **root pressure**.

Pathway	Movement of water across the root cortex
Apoplast	From cell wall to cell wall.
Symplast	From cytoplasm to cytoplasm through plasmodesmata.
Vacuolar	From vacuole to vacuole.

Xylem

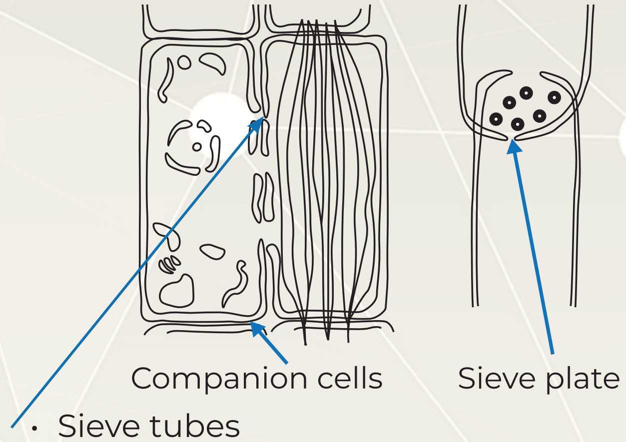
- Vessels
- Tracheids
- Fibres
- Parenchyma

Xylem are dead cells that transport water and minerals up the plant and provide mechanical strength and support as it is strengthened by waterproof lignin.



Phloem

Phloem sieve tubes carry **sucrose and amino acids.** Sieve elements end in **sieve plates** containing **pores** through which **cytoplasmic filaments** extend linking cells. No other organelles are in the sieve elements. **Companion cells** contain many **mitochondria for ATP** and the organelles for **protein synthesis** which are passed to the sieve elements through **plasmodesmata**.



- Sieve tubes
- Fibres
- Parenchyma

Transpiration

Transpiration is the loss of water, as water vapour from the leaves of plants. It leads to the transpiration stream.

Transpiration stream– water moves into the root and enters the xylem (root pressure). Cohesive forces between water molecules and adhesive forces between water molecules and the hydrophilic lining of the xylem creates a transpiration pull as the water leaving the xylem into the leave pulls on molecules below. This is cohesion–tension theory.

Factors increasing transpiration

Lower humidity	Higher temperature
Higher light intensity	Higher air movement (wind speed)

Adaptations to environment

Plant	Adaptations
Hydrophyte- Water plants, e.g Water Lily	Little/no waxy cuticle as no need to conserve water. Stomata on upper surface as lower surface submerged. Poorly developed xylem as no need to transport water. Large air spaces reservoirs of gas and for buoyancy.
Mesophyte- Live with adequate water	Close stomata at night to decrease water loss. Shed leaves in unfavourable conditions, e.g. Winter. Underground organs and dormant seeds survive winter.
Xerophyte- Water is scarce, e.g Marram grass	Thick waxy cuticle reducing water loss by evaporation from epidermal tissue. Sunken stomata increasing humidity in an air chamber above the stomata, reducing transpiration. Rolled leaves - reduces area of leaf exposed directly to air. Stiff interlocking hairs trap water vapour inside rolled leaf, reducing water potential gradient and therefore water loss.

Translocation

The phloem transports the products of photosynthesis from source (the leaf) to sink (area of use or storage). This is called translocation and there is evidence to show this is bidirectional through the phloem.

Evidence for bidirectional flow in the phloem

1. Ringing experiments (removal of phloem) show accumulation of sucrose products on leaf side of the ring but none on root side. Movement of sucrose was blocked by removal of phloem...phloem is the route of transport.
2. Using Aphids to sample sap from the phloem. An aphid stylus extends into sieve tube elements. If a laser is used to remove the stylus from the body, the stylus then becomes a micropipette and sap drips out which can be analysed to show sucrose and amino acids are carried in the phloem, both above and below leaves.
3. Radioactive labelling of carbon dioxide which will become incorporated into sucrose can be used in conjunction with the above technique. Sap sampled can be analysed using autoradiography.

Theory of Mass Flow

For	Against
Sucrose made at source lowers water potential. Water enters cells and sucrose is forced into phloem (loading) increasing hydrostatic pressure so mass flow occurs along the phloem to the root where sucrose is stored as starch, water potential is less negative and water moves into the xylem.	Sieve plates impede flow. Translocation is faster than expected with diffusion. This theory does not explain bidirectional flow or different rates of flow of sucrose and amino acids. Does not explain companion cell mitochondria, high O_2 intake or stopping of translocation by cyanide.