Slide 1

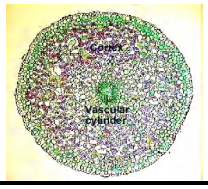
Transport of water and water soluble minerals

- Plants absorb water mostly through root hair cells. They have and increased surface area so water enters faster by diffusion/osmosis

Slide 2

Water potential gradient

- Because water is lost through stomata, which are open to allow in oxygen and carbon dioxide there is a water potential gradient across the root from the outside to the central column of vascular tissue.



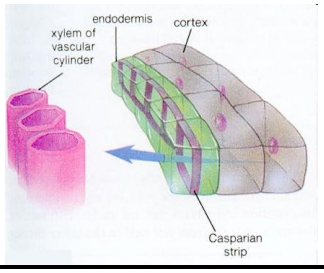
Slide 3

The pathway of water across the root

- Water can travel from one cell to the next or, since it is entirely permeable to water, water can travel along the cell walls.
- However water travelling by this latter pathway cannot be "processed" by the cell machinery in the cytoplasm. So to prevent any potentially dangerous chemicals entering a plant's transport system when water reaches the "outskirts" of the vascular tissue – called the endodermis – it is forced to enter the cells of this region.
- This occurs because the cell walls in the endodermis have an impervious strip – Casparian strip – of the chemical suberin.

Slide 4

Casparian strip picture

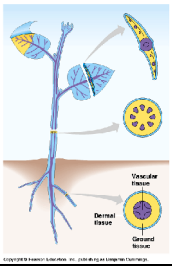


Slide 5

Xylem carries water and dissolved minerals

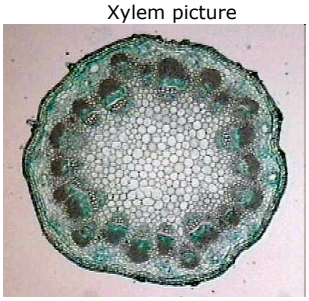
How can we know that the cells known as xylem carry water up the plants?

Remove a plant from the soil and wash the roots. Place the roots in a some water containing a water soluble dye and leave for the dye to enter the plant. After some time cut the stem and observe in cross section that the water soluble dye is present in the xylem.



Slide 6

Xylem picture



Slide 7

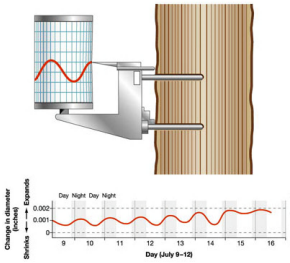
The transpiration Stream

As we saw last time water is lost from the leaves as vapour. This is replaced by water in adjacent cells which in turn is replaced by water in the xylem. Since xylem cells are dead, empty and have no cross walls, the water columns in them are continuous. Water is therefore pulled up the plant because of the great cohesion that water molecules have for one another.

When the water columns are pulled up tall trees tension is generated in them. The trunk gets thinner and this can be measured by a dendrograph.

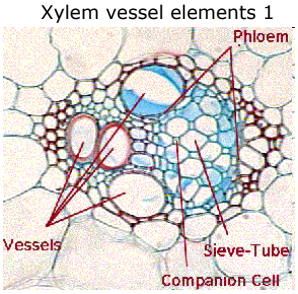
Slide 8

Dendrograph picture



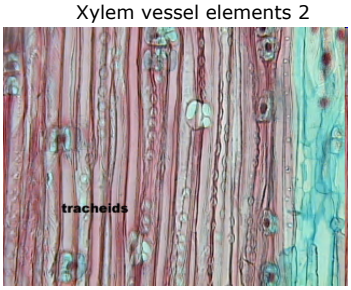
Slide 9

Xylem vessel elements 1



Slide 10

Xylem vessel elements 2



Slide 11

Stomata

You can observe stomata by painting some nail varnish on the under surface of leaves, leaving it to dry and then pealing it off. The stomata leave a imprint in the varnish which can be seen under a microscope or magnifying lens.

Slide 12

Phloem

Use of radioactive tracers like ^{32}P containing compounds enables the path of a chemical in a plant to be traced.

So a plant with half its roots in beaker A containing ^{32}P and the other half in water can be left for a few hours. After this time the ^{32}P can be detected in the other beaker.

Downward transport of chemicals occurs in the phloem.

It is mostly sugar (sucrose) made in photosynthesis that is transported downwards in the phloem – and how do we know that?

Slide 13

Aphid mouthparts.

Slide 14

Other evidence

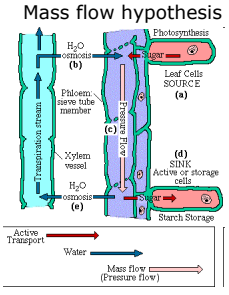
Ringing experiments.

Radioactive tracers tracers $^{14}CO_2$ and micro-autoradiographs taken of stem sections show ^{14}C in the phloem.

Respiratory poisons show need for ATP, so unlike the transpiration stream transport in the phloem is an active process.

Slide 15

Mass flow hypothesis



Slide 16

Phloem

Phloem tissue is composed of **sieve tube cells**, which form long columns with holes in their end walls called **sieve plates**. These cells are alive, but they lose their nuclei and other organelles, and their cytoplasm is reduced to strands around the edge of the cells. These **cytoplasmic strands** pass through the holes in the sieve plates, so forming continuous filaments. The centre of these tubes is empty. Each sieve tube cell is associated with one or more **companion cells**, normal cells with nuclei and organelles. These companion cells are connected to the sieve tube cells by **plasmodesmata**, and provide them with proteins, ATP and other nutrients

Slide 17

Phloem picture