Transport through plants and plant cells

Transport through plants

For chemical changes to happen in a plant molecules and ions must be able to move from place to place, including in and out of cells where the chemical reactions in plants take place.

Plants have two types of tissue designed to transport materials from one part of the plant to another:

- **Phloem** is living cells arranged end to end to form bundles of tubes. They branch into the veins in the leaves, where they pick up sugars and other food molecules made in photosynthesis. They transport the food from the leaves to all the other parts of the plant, especially to growing points in the tips of roots and shoots, and to areas where food is stored, such as fruits and seeds or root storage tissue.
- **Xylem** transports water and dissolved ions from the roots to the leaves. These cells also form tubes, but the cells are dead with woody walls. This woody tissue is strong and helps to support the plant.

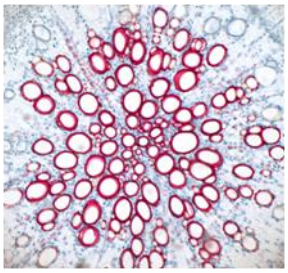

Figure 1 A section through the centre of the young root of a sunflower. A central core of hollow xylem vessels have been stained red. Thinner walled phloem cells surround them. Sunflowers are dicots. Monocots like maize and wheat have the same kinds of cells arranged in various patterns.

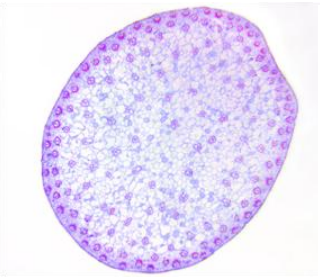

Figure 2 A section through the young stem of a maize plant. Scattered groups of large xylem vessels and smaller phloem cells form veins (vascular bundles). Dicots have their vascular bundles in a ring near the outside of the stem.

Flowering plants may be monocots which have branching veins in their leaves or dicots which have parallel veins.

Note: ‘Monocot’ and ‘dicot’ are abbreviations for monocotyledons, which have one embryonic leaf (cotyledon) in their seeds, and dicotyledons, which have two.

Plant cells and diffusion

Plant cells have a cellulose cell wall which is porous and is no barrier to the diffusion of molecules or ions. The cell membrane, which is normally pressed up against the inside of the cell wall, regulates the movement of molecules and ions in and out of the cell.

Small molecules such as water, glucose and amino acids and ions such as sodium ions, Na^+, and chloride ions, Cl^-, diffuse passively through tiny holes in the cell membrane. These holes are called pores. The cell membrane is said to be partially permeable because only small molecules can pass through and larger molecules such as starch or proteins cannot.

Diffusion is the movement of particles from a region of higher concentration to one of lower concentration. No extra energy is required, as the molecules and ions move at random, eventually evening themselves out, so as many move in one direction as in the opposite direction.

Carbon dioxide diffuses from the air into a leaf through the stomata, then into the photosynthesising cells. This is because carbon dioxide is used up in photosynthesis, so the concentration in the leaf cells is lower than that in the air outside and also lower than in the spaces inside the leaf.

Active transport

The cell membrane also contains protein carrier molecules which can use energy to actively move molecules and ions through the membrane. This active transport moves particles through cell membranes from regions of lower concentration to ones of higher concentration. In this way, for example, carrot root cells can move potassium and chloride ions into the carrot root even though the ions are at a lower concentration in the soil.

Osmosis

Osmosis is a special case of diffusion. It is the diffusion of water molecules from a region of higher water concentration to one of lower water concentration through a partially permeable membrane.

When a plant cell takes up ions or molecules by active transport, the solution in the cell cytoplasm and vacuole become more concentrated than those outside the cell. Water therefore moves into the cell - where the solutions are more concentrated and the water is less concentrated – through the cell membrane.

Transpiration

Transpiration is the evaporation of water from the leaves of a plant. Water on the surface of the spongy and palisade cells in a leaf evaporates and diffuses out through the stomata. This draws water out of the xylem in the leaves, pulling more water all the way up the xylem cells in the stem and from the roots.

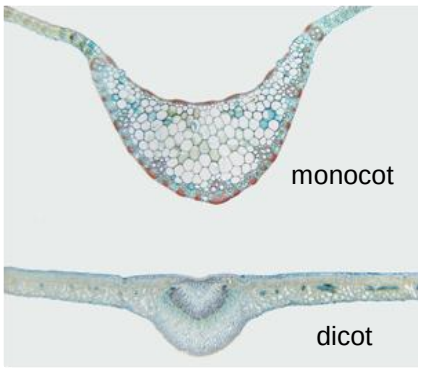

Figure 3 Sections of monocot and dicot leaves. Small veins (vascular bundles which run parallel to each other) can be seen, each with phloem cells and large xylem vessels. A large vein can be seen in the centre of the midrib of the dicot leaf, with smaller branching veins in the leaf blade.

Because water is being taken out of the roots this causes more water to enter into root cells from the soil. The surface of the roots is covered with root hair cells. Each of these has a long hair like projection. The root hair cells hugely increase the surface area of the root so that it is able to take up water and dissolved minerals efficiently from the soil.

Factors affecting transpiration

Light	In bright light, the guard cells open stomata to allow more carbon dioxide to diffuse in for photosynthesis. This allows more water to diffuse out, so more water evaporates and the transpiration rate increases. At night the stomata close and the plant conserves water.
Temperature	Molecules move faster at higher temperatures, so evaporation and diffusion and the rate of transpiration increase when it gets warmer.
Humidity	If there is more water in the air, this slows down diffusion from leaves and the transpiration rate falls.
Wind	Air currents remove water vapour from around the leaves, so diffusion rates and transpiration increase when it is windier.

Finding out

In diffusion, why do particles move from a region of higher concentration to one of lower concentration?