Plants – Week 2
Focus on Movement of Materials

Objectives
To identify the unique plant cell and note how its features are especially adapted in plants.
Focus on plant processes:
- Photosynthesis
- Transpiration
- Theory of water & mineral movement.
- Pressure flow hypothesis

Photosynthesis
6 CO₂ + 6 H₂O + light → C₆H₁₂O₆ + 6 O₂
Reactants:
Carbon Dioxide
Water
Products
Glucose (sugar for energy)
Oxygen (waste product)

Cross Section of a Leaf
Transport of Sugars

Sugars flow from:
Source (leaf) → Sink
Sink = any structure that uses up sugars or stores them e.g. fruits, roots, stems.

Pressure-Flow Theory

1) Production of sugars via photosynthesis.
2) Sucrose actively transported into companion cells of the phloem.
3) Water enters into the sieve tube by osmosis from the nearby xylem.
4) Sucrose is directed towards developing fruit, lowering concentration in sieve tube cells.
5) Water follows sucrose into the fruit, thus hydrostatic pressure drops within the tube.
6) Pressure gradient causes flow of sugar from source (leaf) towards the sink (fruit) - Bulk flow.

Transpiration

The loss of water vapor from the surface of a plant, primarily from the leaves.

Factors that increase transpiration.
- Low humidity (dry conditions)
- High temperatures
- Moving air (windy conditions)

Most water is lost is through open stomata during water transport.

Stomata

A pore found on the leaf.
Portal for gas exchange
Site of water loss
Regulated by guard cells.
- Open (turgid)
  .....plenty of water
- Closed (flacid)
  .....very thirsty
Under the control of ABA hormones – produced in roots.

**Fig. 29-12, p. 503**
Cohesion-tension theory

Water is pulled up the xylem, powered by transpiration.

Cohesion in water is due to hydrogen bonding between water molecules.

Tension - The water chain is pulled up the xylem; the energy that drives this reaction is evaporation of water out the pores of the stomata.

How Materials move in the Xylem

Transpiration and cohesion tension theory

Method by which water moves from the roots to the shoot system through the xylem.

- Loss of water out of stomata by evaporation.
- Hydrogen bonds link water molecules together.
- Water moves “up” and the xylem in a long chain.
- Water molecules pull each other up one molecule at a time from previous location below.
- Column of water is under “tension.” - Cohesion

Obtaining nutrients

- Roots extract water and minerals from the soil.
- Only minerals dissolved in the soil water are available to the plant.
- Most minerals are moved into the cells of a plant via active transport.

Water Stress

Occurs when a break in the water chain contained in the xylem vessel elements breaks.

May occur:
- When transpiration rates increase
- During very hot, dry weather
- Windy conditions

Note - Extreme wilting can kill the plant.

Xylem Cells

Fig. 29-6, p. 498
Required Nutrients

Plants require nutrients*:
- Carbon*
- Hydrogen
- Oxygen
- Phosphorous*
- Nitrogen*
- Magnesium
- Calcium*
- Oxygen
- Potassium*

*Essential elements

Mineral and Water Uptake by Roots

Vascular cylinder
- Parenchyma cells that make up the layer secrete a waxy substance into their walls wherever they touch. The secretions form a Casparian strip, which prevents water from seeping around the cells into the vascular cylinder.

Water and ions can only enter the vascular cylinder by moving through cells of the endodermis. They enter the cells via plasmodesmata or via transport proteins in the cells' plasma membranes.

Cortex

Plant Partnerships I

Mycorrhizae - root-fungus relationships that help plants to secure scarce nutrients such as nitrogen. This relationship allows the plant to extract and absorb minerals in its environment. The fungus in return is supplied sugars, amino acids and vitamins that it needs from their host plants.

Plant Partnerships II

Bacteria-Filled Nodules - Symbiotic bacteria that live in nodules (swellings) in the roots of legume plants. These nitrogen-fixing bacteria can take up nitrogen converting it to ammonium and nitrate ions.

The plants use these nitrogen ions for manufacturing amino acids, nucleic acids and chlorophyll.

The bacteria in turn receive sugars, which it needs for metabolic processes.
O HORIZON Fallen leaves and other organic material littering the surface of mineral soil

A HORIZON Topsoil, with decomposed organic material; variably deep (only a few centimeters in deserts, elsewhere extending as far as 30 centimeters (1 foot) below the soil surface)

B HORIZON Compared with A horizon, larger soil particles, not much organic material, more minerals; extends 30 to 60 centimeters (1 to 2 feet) below soil surface

C HORIZON No organic material, but partially weathered fragments and grains of rock from which soil forms; extends to underlying bedrock

BEDROCK