

GENERAL BOTANY Lecture 20 - Absorption & Transport

- I. Water potential**
- A. Water potential (Ψ) = pressure potential (Ψ_p) + osmotic potential (Ψ_s) + matrix potential (Ψ_m)**
1. Water potential - a measure used to predict the direction of water flow (from high to low)
 - a) Pressure potential - turgor pressure (associated with cell growth & expansion)
 - b) Osmotic potential - can be used to regulate turgor - regulates plant water movement
 - c) Matrix potential - force with which water is held to plants by adsorption and capillarity
- II. Water and mineral absorption by roots**
- A. Absorption of water by roots**
1. Driven by transpiration - negative pressure in xylem draws water in through free space - water must move through living cells of endodermis
 2. Root pressure (driving force when transpiration is low - high humidity)
 - a) Solutes (sugars) built up in roots cause an osmotic drive of water from surrounding media solution to inner root (i.e., water moves from higher potential to lower potential)
 - b) Xylem transport driven by positive pressure - source for guttation
- III. Uptake of mineral nutrients**
- A. Passive uptake of minerals (mineral ions move freely into free space of cortex)**
1. Movement of ions by the "sweeping effect"
 - a) Ions can cross the endodermal cell membranes passively by being "swept" into the stele with water
- B. Active uptake of minerals**
1. Energy-requiring transport of ions into cells of the cortex (mostly mineral in low abundance in soil solution - nitrate, potassium, sulfate, phosphate, etc.)
 2. Movement into xylem is blocked by special barrier (Casparian strip of an endodermis) - promotes active transport
 - a) Endodermis (with Casparian strip) requires that molecules pass through a plasma membrane to enter (or leave) the vascular cylinder
- IV. Xylem & phloem transport**
- A. Mechanism of xylem transport (cohesion-adhesion-tension hypothesis)**
1. Tracheids and vessels usually dead, empty cells
 2. Transport by bulk flow - driven by transpiration
 - a) Transpiration causes "suction" and negative pressure on water in xylem
 3. Important characteristics of water
 - a) Cohesion - attraction of water molecules to each other
 - b) Adhesion - attraction of water to other molecules (like cell walls)
 - c) Tension - ability of water to withstand negative pressure
- B. Mechanism of phloem transport (pressure-flow hypothesis)**
1. Source is high pressure; sink is low pressure
 2. "Source-sink" directionality (photosynthesis is source; meristem is sink)
 - a) Sugar (photosynthate) is actively transported into sieve tube at a source
 - b) Water moves into sieve tube by osmosis
 - c) Water uptake pushes sieve tube sap (photosynthate) towards sink
 - d) Sap (photosynthate) is unloaded at sink;
 - e) Water returns to xylem
- V. Mineral nutrition**
- A. CHOPKNS CaFe Mg B Mn CuZn Cl Mo**
1. CHO - carbohydrates
 2. P - ATP K - enzymes & stomates N - proteins
 S - amino acids Ca - membranes Fe - ETS & photosynthesis
 Mg - chloro. B - CHO breakdown Mn, Cu, Zn - enzymes
 Cl - OEC Mo - enzymes