

PLANT ANATOMY Lecture 14 - 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**
 - 1. **"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 - ATPK - 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