PLANT PHYSIOLOGY Lecture 18 - Water Potential and Xylem Transport

I. Measuring water potential
- A. Water potential (Ø)
  - 1. Ø = $Ø_p$ + $Ø_ð$ (water potential = pressure + osmotic potentials)
  - 2. When water moves it causes a ÄØ (note ÄG)
    - a) Water moves from high to low (low ÄG - high ÄG = negative ÄG)
  - 3. Why is water potential important?
    - a) It is the chemical potential of water in a system
    - b) It is the indirect determinant of water movement
  - 4. How is water potential measured?
    - a) Thermocouple ps ychrometry - based on relative humidity of equilibrated sample
    - b) Pressure bomb - leaf placed in a chamber with pressure (assume osmotic potential is negligible)
    - c) Chardakov's Method (assume $Ø_p$[solute for assay] = 0; so, Ø = $Ø_ð$)
      - 1) Line up tubes of known solute concentration and add some dye
      - 2) Immerse tissue in duplicate samples of solute and allow to equilibrate
      - 3) Remove tissue and the add one drop of colored solution to each corresponding tube
        - a)) If drop rises, water potential of tissue is lower
        - b)) If drop sinks, water potential of tissue is higher
      - 4) Then calculate Ø assuming Ø = $Ø_ð$
        $Ø_ð$ = -miRT, where m = molality, i = ionization constant, R is a constant, and T is temperature
  - 5. What are units of water potential?
    - a) Bars (1 bar = 0.98 atmospheres or 0.10 MPa)
- B. Other potentials - destroy pressure potential by freezing (rupturing) cells

II. How does water move (remember apoplast, xylem, tracheids, vessels, water, dead)?
- 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. Example of flow from soil to air (from Oosterhuis, Univ. Arkansas)

Units are in bars

Soil:	$Ø_p$ = 0, $Ø_ð$ = -1, Ø = -1
Root surface:	$Ø_p$ = 12, $Ø_ð$ = -14 Ø = -2
Inside root:	$Ø_p$ = -2, $Ø_ð$ = -1 Ø = -3
Xylem:	$Ø_p$ = -3, $Ø_ð$ = -1, Ø = -4
Leaf:	$Ø_p$ = 15, $Ø_ð$ = -20 Ø = -5
Stem meristem:	$Ø_p$ = 17, $Ø_ð$ = -22 Ø = -5
Air:	Ø = -270