PLANT PHYSIOLOGY Lecture 17 - Thermodynamics and Water Potential

I. Ability to perform work
- **A. Gibbs Free Energy ΔG**
- **B. Want: ΔG to be negative**

II. System and surroundings
- **A. System: part of particular interest**
- **B. Surroundings: stuff around the system (environment)**

III. Laws of thermodynamics
- **A. First Law: conservation of energy**
  - **1. $\Delta E = Q - W$, where E = energy, Q = heat absorbed by system, and W = work done by system**
- **B. Second Law: entropy**
  - **1. $\Delta S_{system} + \Delta S_{surroundings} > 0$ for spontaneous process**
- **C. Combine Laws**
  - **1. $\Delta G = \Delta H - T\Delta S$, where G = free energy, H = change in enthalpy (work done by the system, or $P\Delta V$), T is temperature, and S is entropy (disorder)**
  - **2. $\Delta G = -RT\ln K_{eq}$, where G = free energy, R is a constant, and K_{eq} is the equilibrium constant**
- **D. What does it all mean?**
  - **1. Conservation and disorder**

IV. Water movement and thermodynamics
- **A. How does water move? From high potential to low potential**
  - **1. Water moves from**
    high activity to low activity
    high temperature to low temperature
    high pressure to low pressure
    high chemical potential to low chemical potential
    high Ψ to low Ψ
- **B. Measurement of water potential (Ψ)**
  - **1. $\Psi = \Psi_p + \Psi_s + \Psi_g + \Psi_m$ (water potential = pressure + osmotic + gravitational + matrix potential)**
    - **a) Pressure - force caused by pressure**
    - **b) Osmotic - influenced by solute concentration**
    - **c) Gravitational - due to gravity**
    - **d) Matrix - forces of absorption and capillarity**
- **C. Calculation of water potential**
  - **1. What's important? .... pressure and osmotic**
  - **2. Calculating osmotic water potential**

    $\Psi_s = -miRT$, where m = molality, i = ionization constant, R is a constant, and T is temperature