

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. $\Delta S_{\text{system}} + \Delta S_{\text{surroundings}} > 0$ 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 Δ V), T is temperature, and S is entropy (disorder)
 - 2. $\Delta G = -RT\ln K_{\text{eq}}$, 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 ϕ to low ϕ
 - B. Measurement of water potential (ϕ)
 - 1. $\phi = \phi_p + \phi_s + \phi_g + \phi_m$ (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
 - $\phi_s = -miRT$, where m = molality, i = ionization constant, R is a constant, and T is temperature