PLANT PHYSIOLOGY Lecture 9 - Structure & Function of Enzymes

I. Definition of metabolism
- **A. The sum of biochemical processes in living cells involved in the synthesis, breakdown, and inter-conversion of constituents in the cell**

II. Where does energy come from? - Laws of thermodynamics
- **A. First law of thermodynamics - conservation**
- **B. Second law of thermodynamics - disorder**
- **C. How does the world of life continue to flow?**
  - **1. Energy is constantly supplied by energy lost from some pl ace else**

III. Reactions & metabolic pathways
- **A. Metabolic pathways**
  - **1. Orderly sequence of reactions**
    - **A) Reactants (precursors, substrates)**
    - **B) Metabolites (intermediate compounds in pathway)**
    - **C) Enzymes (catalysts)**
    - **D) Cofactors (coenzymes - NADH, Mg, etc)**
    - **E) Energy carriers (ATP)**
    - **F) End products (final outcome)**

IV. Enzymes - catalyze metabolic events
- **A. Characteristics**
  - **1. High turnover number (make lots of product per unit enzyme)**
  - **2. Almost all enzymes are proteins (exception is RNA - ribozymes)**
  - **3. Catalysis occurs at the active site**
  - **4. Enzymes do not change equilibrium: E + S ===> E + P**
  - **5. Enzymes exhibit specificity**
- **B. Mechanism of catalysis - lower activation energy**

$$E + S \underset{}{\overset{K_s}{<====>}} ES \overset{k_3}{====>} E + P \qquad \text{velocity} = k_3[ES]$$

$$\frac{[E][S]}{[ES]} \text{ or, } \frac{[E]}{[ES]} = \frac{K_s}{[S]}$$

$$E_T = [E] + [ES] \qquad K_s = \frac{[ES]}{[E][S]}$$

$$\text{Thus, } \frac{E_T - [ES]}{[ES]} = \frac{K_s}{[S]}$$

$$E_T/[ES] - 1 = K_s/[S] \quad \text{let } [ES] = \text{velocity}/k_3$$

$$\text{so that } k_3E_T/\text{velocity} = 1 + K_s/[S] \text{ and velocity} = k_3E_T/1+K_s/[S]$$

$$\text{and if velocity}_{max} = k_3E_T \text{ when [S] is high, velocity} = V_{max}/1 + K_s/[S]$$

which is the Michaelis-Menten Equation

- **C. Structure - complex**
  - **1. Active site**
  - **2. Enzyme-substrate complex**
  - **3. Induced fit model**
- **D. Interactions - regulations**
  - **1. pH and temperature**
  - **2. Allosteric enzymes (with a regulatory site)**
  - **3. Feedback inhibition**
  - **4. Cofactors FAD, NAD, NADP**
    - **a) Simultaneous reaction(s) coupled to key reaction**
      - **1) Acetaldehyde = ethanol; NADH = NAD (Reaction driven)**

$$\text{Acetaldehyde} + NADH + 2H^+ + 2 \text{ electrons} =====> \text{ethanol} + NAD$$

$$HCOCH_3 =====> H_2C(OH)CH_3$$

(This is a reduction of acetaldehyde)