#5: Enzyme Catalysis

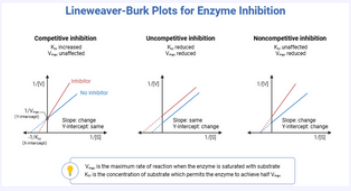
BIOCHEM2280

What are Enzymes?

- Enzymes are **biological catalysts**
  - Most enzymes are proteins
- Enzymes can do **post-translational modifications:**
  - Modifications to proteins *after* they are translated
  - Modifications can alter *stability, signalling, protein folding, secretion, binding to other molecules or solubility.*
- **Examples:**
  - Phosphorylation by kinases - these are enzymes that catalyze the transfer of phosphate groups to substrate molecules
  - Conversion of maltose into glucose - the enzyme maltase converts maltose to glucose
  - Proteolysis - peptidases cleave peptide bonds between amino acids in proteins

Enzymatic Inhibition

- **Reversible: Competitive**
  - *Inhibitor has similar structure to substrate/product*
  - Inhibitor binds to the *active site* of the enzyme
  - Blocks substrate access
  - Affects Km not Vmax
- **Irreversible: Allosteric Inhibition**
  - **Cooperative**
    - Binding to one site *influences binding* at other site
  - **Conformational**
    - Binding *changes conformation* of enzyme to affect its *activity*



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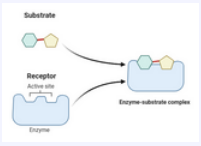
Enzyme Characteristics

- Specific
- Low error
- Rapid (accelerate reactions by a large magnitude)
- Can work under mild conditions

Enzyme + Substrate ⟶ Enzyme Substrate Complex ⟶ Enzyme + Product

What are Co-Factors?

- Cofactors are non-protein chemical compounds that bind to apoenzymes to turn them into the holoenzyme form, i.e. the fully activated form
  - Cofactors are essential for enzyme's activity and can act synergistically to increase the rate of reaction



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Enzyme Kinetics

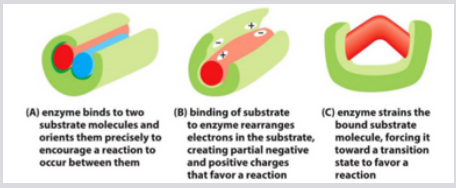
- **Michaelis-Menten Equation**
  - Mathematical relationship between the *rate of an enzyme-catalyzed reaction* and the *concentration of the substrate.*
- **Vo** = initial velocity
- **Vmax** = maximal velocity
- **[S]** = concentration of substrate
- **Km** = Michaelis constant

$$V = \frac{V_{max}[S]}{K_m + [S]}$$

transformed into a linear equation

Enzymes as Catalysts

- **What is the transition state of a reaction?**
  - *Intermediate* state in the reaction between a reaction's starting reagents (**substrate**) and products.
  - *Highest energy point* where bonds are in between breaking and forming
- **How do enzymes function as a catalyst for reactions?**
  - Enzymes reduce the *activation energy* of biological reactions → lowering the *free energy* of the transition state
- **Mechanisms of Transition State Lowering**



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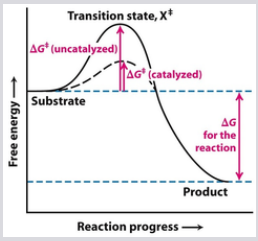

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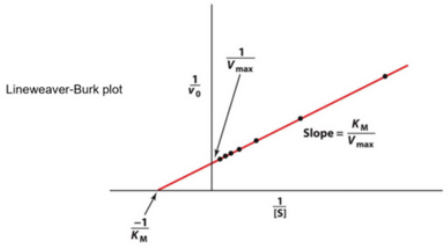
$$\frac{1}{v_0} = \left(\frac{K_M}{V_{max}}\right)\frac{1}{[S]} + \frac{1}{V_{max}}$$



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-The WebStraw team

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Note: Marvin was used for drawing, displaying and characterizing chemical structures, substructures and reactions, Marvin 24.4.1, Chemaxon (https://www.chemaxon.com)

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