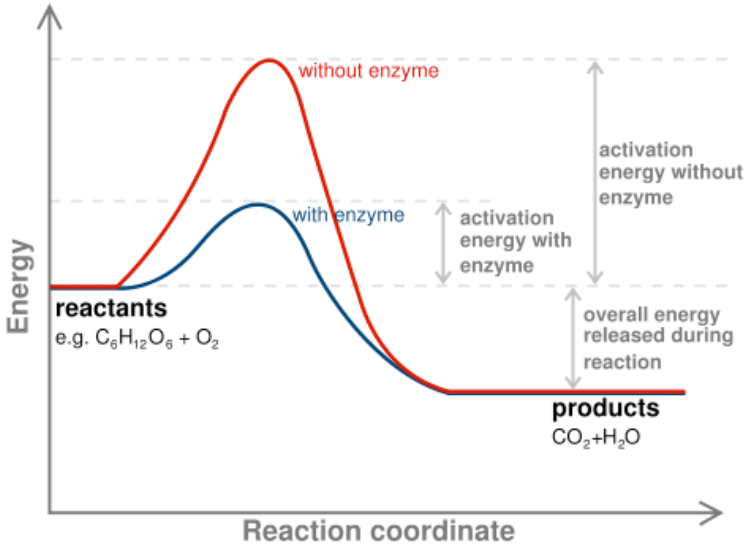
Enzymes – Summary

Definition:

Enzymes biological catalysts that change the rate of a reaction, *without being consumed*. Some enzymes are globular proteins. Others are ribonucleic acids.

Absorption of thermal energy

- Increases speed of reactant molecules
- Collide more often
- Collide more forcefully
- Thermal agitation of atoms – bonds more likely to break



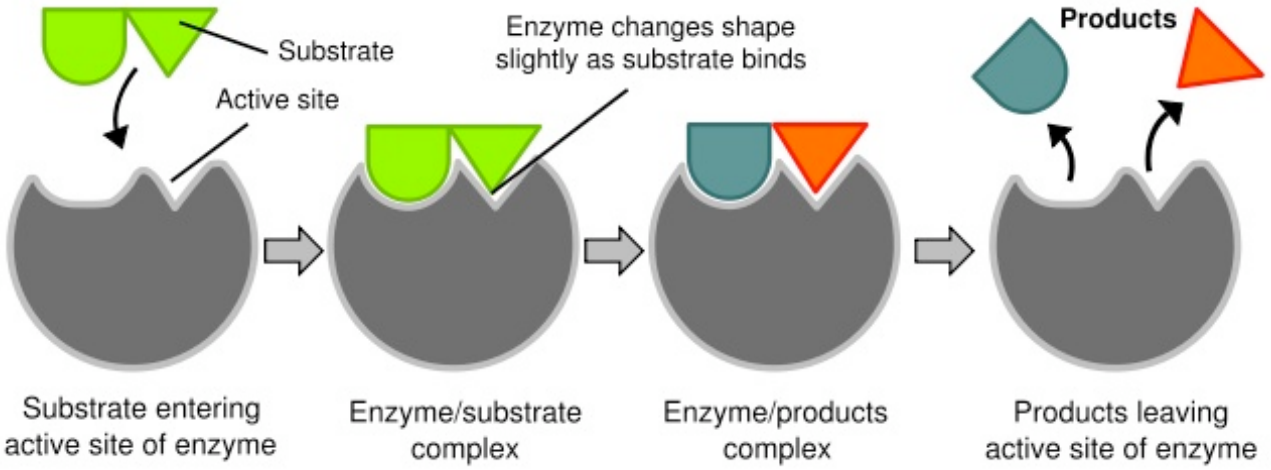
Either *exergonic* or *endergonic*

Lock and Key Hypothesis

- Substrate's (key) shape complementary to the enzyme (lock)
- When they collide in the correct orientation, substrate attached to active site of enzyme
- Enzyme-Substrate complex formed
- Once formed, products no longer fit into active site, escape into surrounding media

Induced Fit Theory

- Both the enzyme and the substrate change shape straining the bonds during the reaction.



Molecular basis of enzyme action

Method	**Comment**
Proximity effects	Temporary binding of reactants next to each other on an enzyme increases the chance of a reaction. Uncatalysed reactions depend on random collisions between substrate molecules
Strain effects	Slight distortion of the reactants as they bind to the enzyme strains the bonds which are to be broken and increases the chance of breakage.
Orientation effects	Reactants are held by the enzyme in such a way that bonds are exposed to attack.
Microenvironment effects	Hydrophobic amino acids create a water-free zone in which non-polar reactants may react more easily
Acid-base catalysis	Acidic and basic amino acids in the enzyme facilitate the transfer of reactants to and from the reactants.

Factors affecting rate of reaction:

- Temperature
- pH
- Enzyme concetration
- Substrate concentration

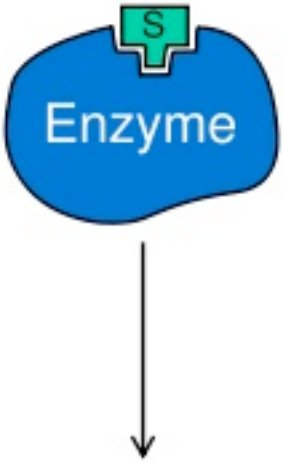
Know how to explain/describe rate of reaction vs temperature graph:

- initial increase
- peak
- decrease

Know how to explain/describe rate of reaction vs concentration graph:

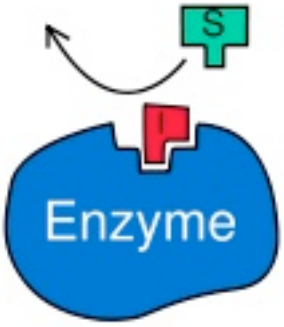
- initial increase $\propto$ increase in concentration
- decrease in rate of increase
- plateau

Competitive Inhibitor

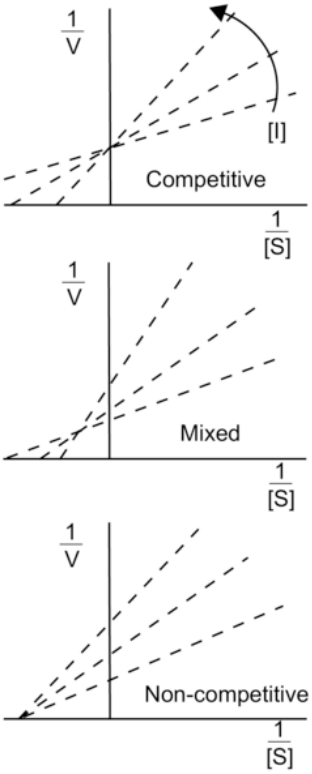


- resembles substrate
- binds reversibly to active site
- competes with substrate to bind to active site
- overcome by increasing [substrate]
- at sufficiently high [substrate], reaction velocity reaches the V_{max} observed in the absence of inihibitor

Non-competitive Inhibitor



- no structural similarity to substrate molecule
- does not compete for active site
- forms enzyme-inhibitor complex
  - at point on enzyme other than the active site
- alters globular structure of the enzyme
  - rendering active site unreceptive to substrate
- substrate can still bind to enzyme
  - but catalysis cannot occur
- effect cannot be overcome by high [substrate]
- ↑[enzyme] ↓rate of reaction
  - when rate of inhibitor saturation is reached, rate of reaction will be almost zero
- REVERSIBLE
  - CN-
- IRREVERSIBLE
  - Nerve gas
  - Sarin



Allosteric Regulation

- Protein's function at one site is affected by binding of a regulatory molecule at a separate site.
- Either stimulation or inhibition of enzyme's activity
- Enzyme has two or more subunits
  - Each has its own active site
- Two conformational states
  - One catalytically active

    - The other inactive
- Binding of activator stablises the functionally active conformation
- Binding of allosteric inhibitor stabilizes the inactive form of enzyme
- ***Binding of one activator/inhibitor affects al subunits