Chapter 6

Energy Enzymes, and Metabolism

PHOTOSYNTHESIS

Conversion of sunlight energy to chemical bonds.

RESPIRATION

Breaking of chemical bonds in food to produce useful energy.

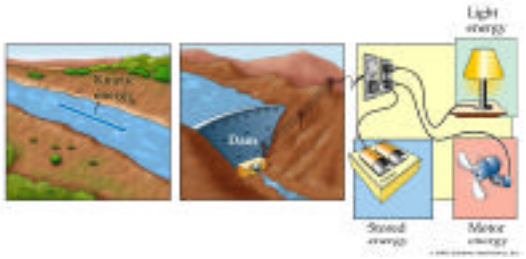
AUTOTROPH (self food)

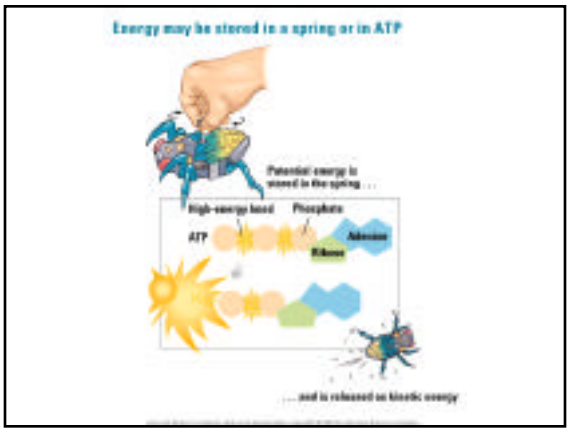
Do not require food molecules from other organisms. (Typically photosynthetic organisms)

HETEROTROPHS (other food)

Organisms that can not make their own energy and require food from other organisms.

Kinetic vs potential energy



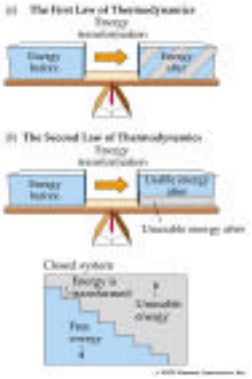


LAWS OF THERMODYNAMICS

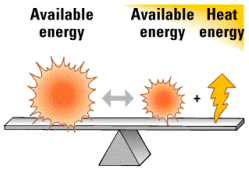
1. Energy can not be created or destroyed.

2. In any change of energy from one form to another some useful energy is converted to useless heat energy.

The Laws of Thermodynamics

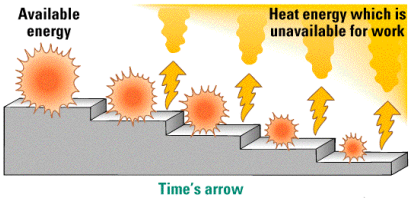


First Law of Thermodynamics



Conservation of energy: energy is neither gained nor lost, it is only transformed.

Second Law of Thermodynamics



Energy available for work decreases as energy is lost to heat.

Gibbs' Free Energy

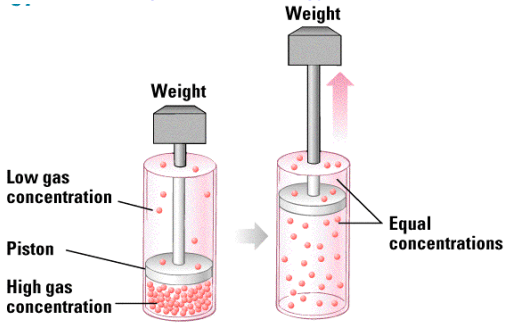
$$\Delta G = G_{products} - G_{reactants}$$

Changes in entropy determine reaction direction

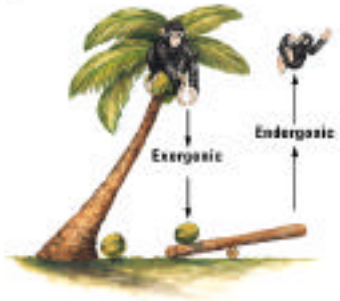
$$\Delta G = \Delta H - T\Delta S$$

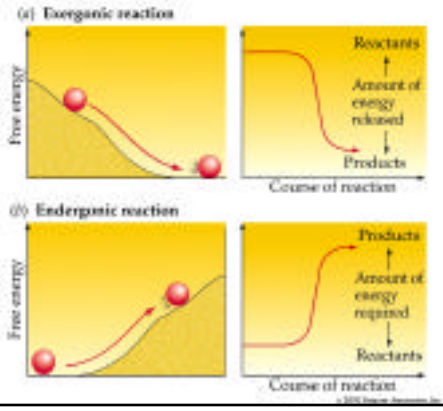
ΔG = change in Gibbs' free energy (useable energy)
ΔH = change in enthalpy (total energy in the system)
ΔS = change in entropy (measure of disorder)
T = absolute temperature (°K)

Difference in concentration constitutes potential energy

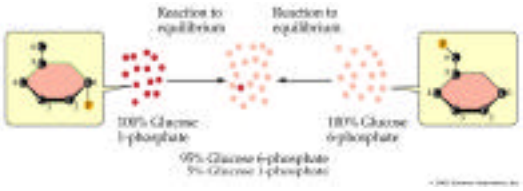


A coupled reaction

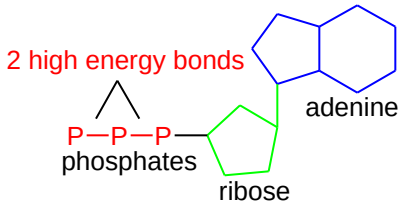




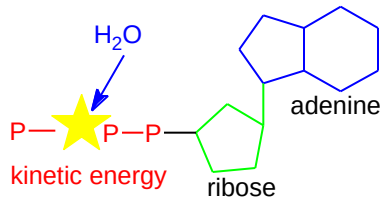
Equalibrium

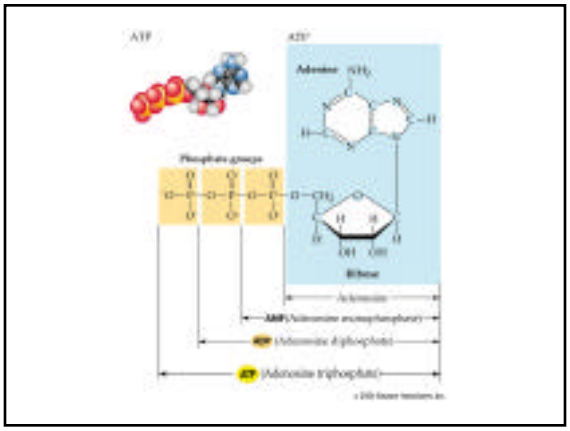


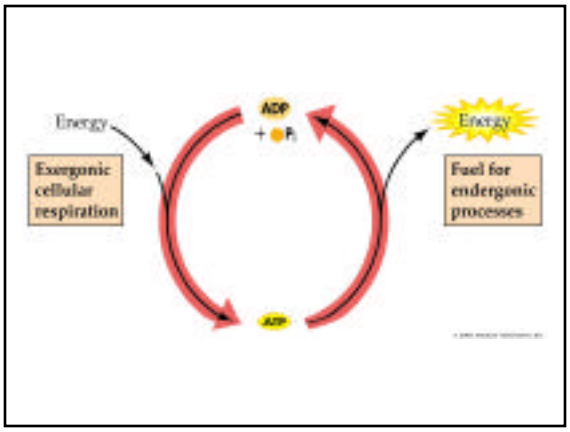
ATP has 2 high energy bonds

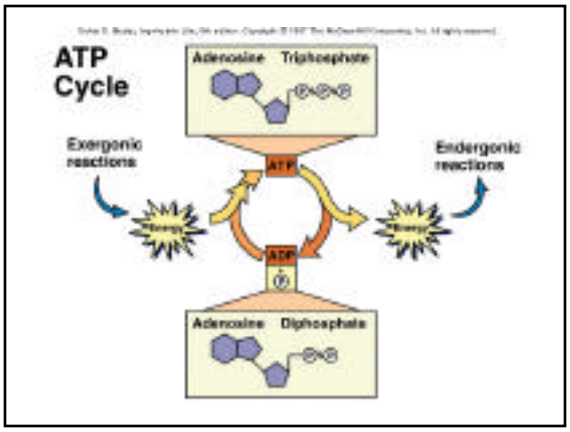


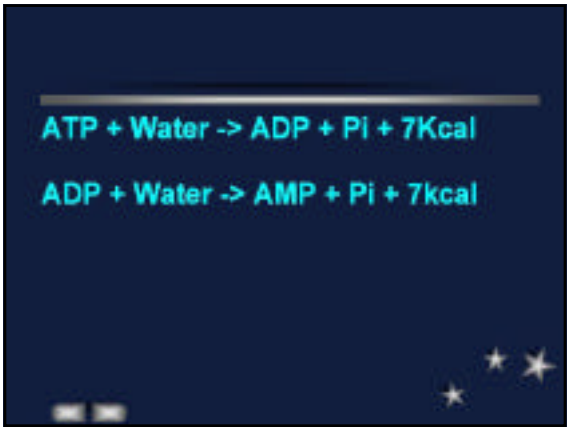
Breaking bonds releases energy



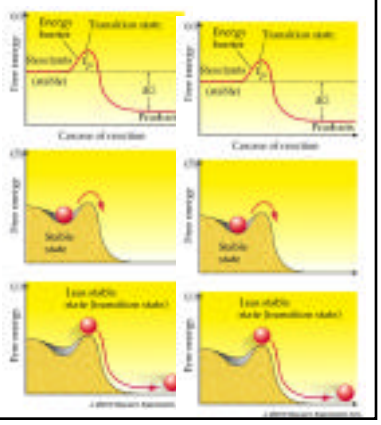




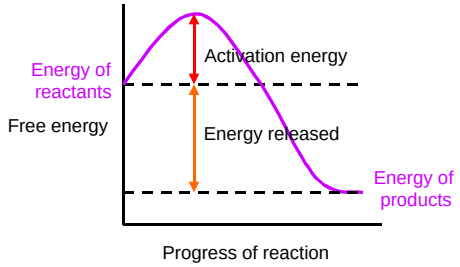




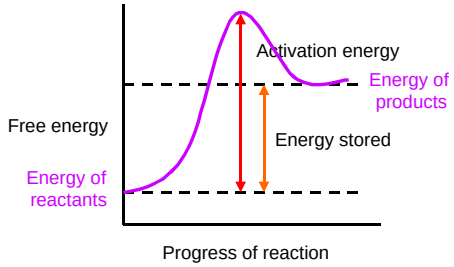
Energy of activation

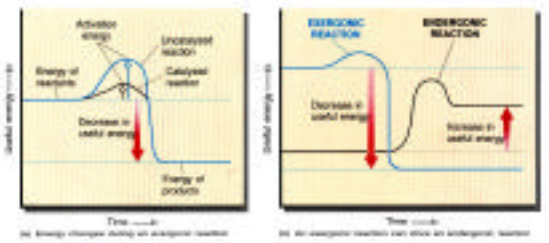


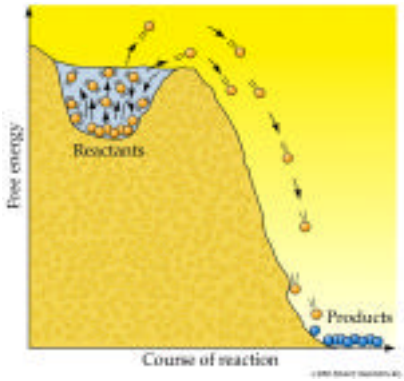
Exergonic reactions



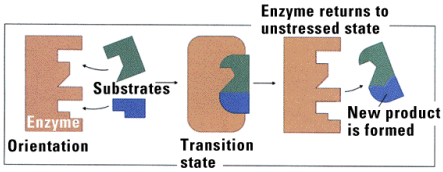
Endergonic reactions

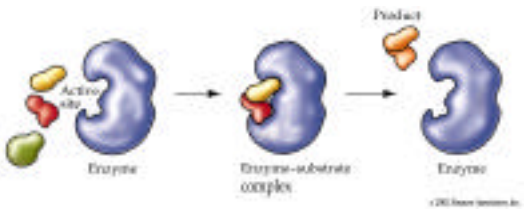




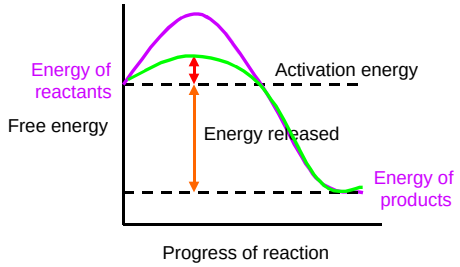


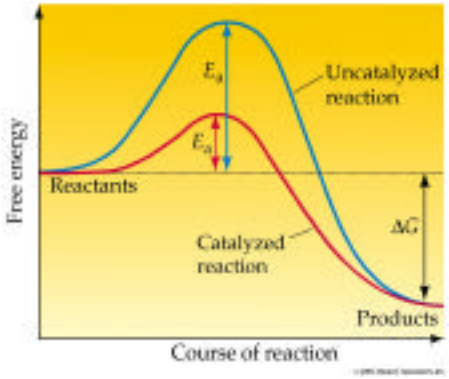
Biological reactants are called substrates





Enzymes lower the activation energy



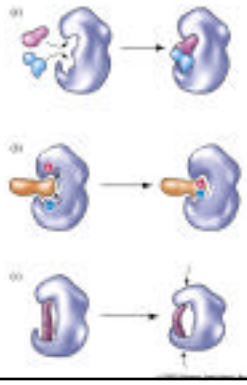


Substrate-enzyme interaction

Orientation

Charges

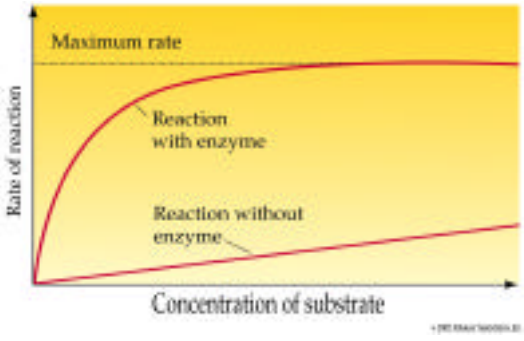
Physical strain



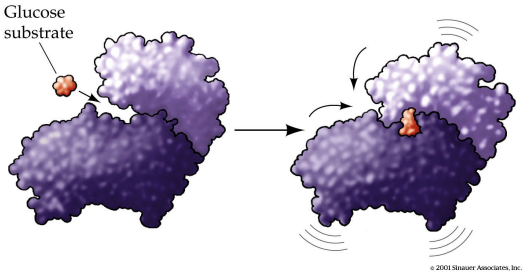
Enzymes

- ✓ Biological catalysts
- ✓ Are most often proteins.
- ✓ Lower the activation energy of a reaction.
- ✓ Speed up the rate of reactions which they catalyze by bringing substrates closer together.
- ✓ Do not alter the equilibrium of the reaction.
- ✓ Are efficient, specific, and controllable
- ✓ Are not consumed by the reactions they catalyze.
- ✓ Are usually influenced by pH and temperature

Increase in reaction rate



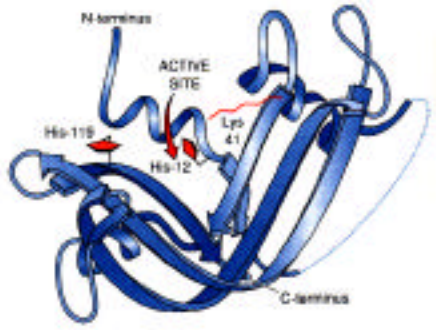
Induced fit of the enzyme



Features of the active site

- ✓ The active site is a relatively small part of the enzyme.
- ✓ The active site is 3-dimensional.
- ✓ Substrates are bound to enzymes by multiple weak attractions.
- ✓ The active site is a nonpolar cleft or crevice.
- ✓ Specificity of binding in the active site depends on the arrangement of atoms in the active site.

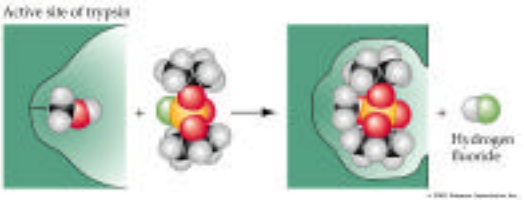
Ribonuclease



6.1 A Few Examples of Nonprotein Molecular "Partners" of Enzymes

TYPE OF MOLECULE	ROLE IN CATALYZED REACTIONS
Cofactors	
Iron	Oxidation/reduction
Copper	Oxidation/reduction
Zinc	Helps bind NAD
Coenzymes	
Biotin	Carries $-COO^-$
Coenzyme A	Carries $-CH_2-CH_3$
NAD	Carries electrons
FAD	Carries electrons
Prosthetic groups	
Heme	Binds ions, O_2 and electrons; contains iron cofactor
Flavin	Binds electrons
Retinal	Converts light energy

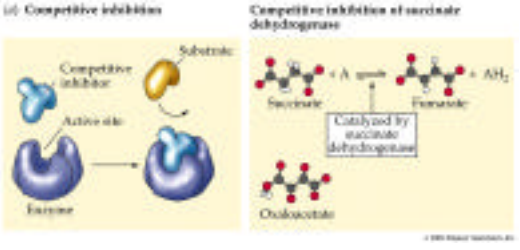
Irreversible inhibition



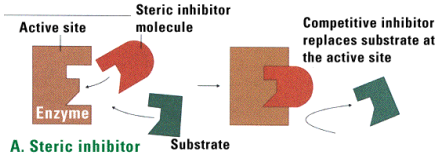
Diisopropylphosphofluoridate (DIPF) bind to the OH on the side chain of serine in the active site

Reversible inhibition

Competitive inhibition will compete for the active site

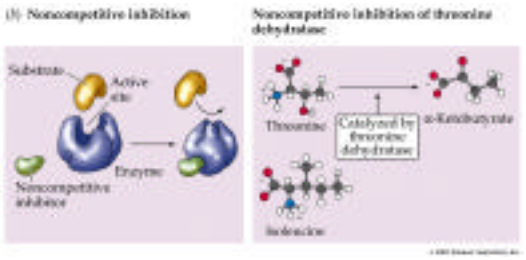


Competitive inhibition

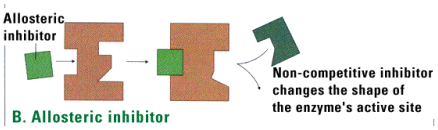


Reversible inhibition

Uncompetitive alters the enzyme by binding to site other than the active site-this alters the shape of the enzyme
Allosteric enzymes are multi-subunit enzymes

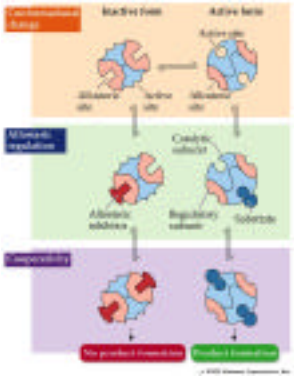


Allosteric inhibition

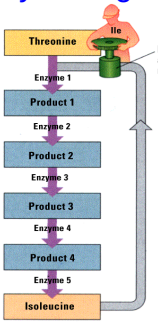


un-competitive inhibition

Allosteric regulation

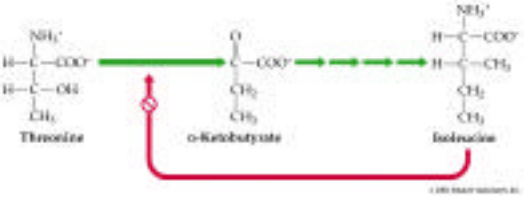


Enzyme regulation

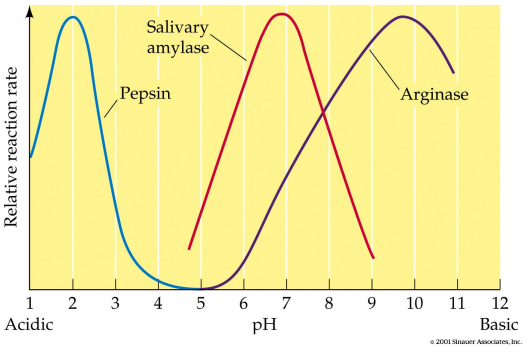


- ✓ Production of enzymes is often regulated by the concentration of the end-product.
- ✓ This is called feedback inhibition.

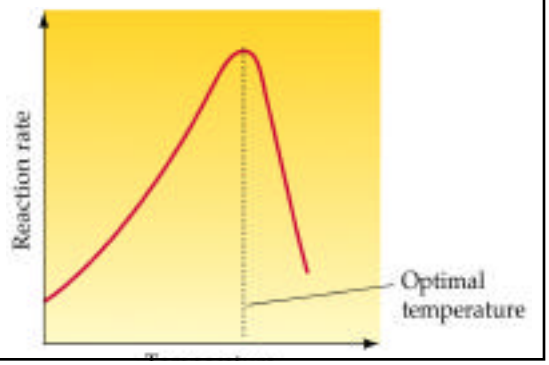
Feed back inhibition (allosteric)



pH effects



Temperature effects



Desert Limo