NOTES: Ch 8 – Metabolism and Enzymes

8.1 - METABOLISM

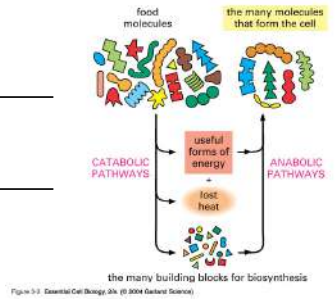
● Metabolism is the _____

● Metabolism arises from interactions between molecules within the cell

Organization of the Chemistry of Life into Metabolic Pathways

● A metabolic pathway begins with a specific molecule and _____

● Each step is catalyzed by a _____



Metabolism includes reactions that are:

● **CATABOLIC** pathways _____ _____ into simpler compounds

● **ANABOLIC** pathways _____ from simpler ones

Forms of Energy

● Energy is the _____

● Energy exists in various forms, some of which can perform work

● **Kinetic energy** is energy associated with _____

-Heat (thermal energy) is kinetic energy associated with random movement of atoms or molecules

● **Potential energy** is energy that matter possesses because of its location or structure

-Chemical energy is _____ ( ) _____ available for release in a chemical reaction

● _____

Energy Transformations:

● A closed system is isolated from its surroundings

● In an open system, energy and matter can be transferred between the system and its surroundings

● _____ **!**

Living things have order!...this takes energy to achieve!

8.2 – Free Energy

● **FREE ENERGY**: the portion of a system's energy that is _____

● Systems tend to change spontaneously _____ **(** **)**

Exergonic and Endergonic Reactions in Metabolism

● An **exergonic reaction** proceeds with a net _____ and is spontaneous

● An **endergonic reaction** _____ from its surroundings and is nonspontaneous

8.4 - ENZYMES:

Enzymes speed up metabolic reactions by lowering energy barriers

● A catalyst is a chemical agent that speeds up a reaction _____ _____

● An enzyme is a _____

● Hydrolysis of _____ by the enzyme _____ is an example of an enzyme-catalyzed reaction

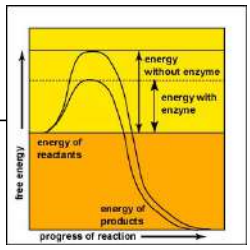
The Activation Energy Barrier

● Every chemical reaction between molecules involves _____ and _____

● **The initial energy needed to start a chemical reaction** is called the free energy of activation, or _____

_____

● Activation energy is often supplied in the form of heat from the surroundings



How Enzymes Lower the E_A Barrier:

● Enzymes catalyze reactions by _____

● Enzymes do not affect the change in free-energy (ΔG); instead, they hasten reactions that would occur eventually anyway

Substrate Specificity of Enzymes

● The reactant that an enzyme acts on is called the enzyme's _____

● The enzyme binds to its substrate, forming an _____

● The _____ is the region on the enzyme where the substrate binds

● **ENZYMES** are very selective for which reaction they will catalyze

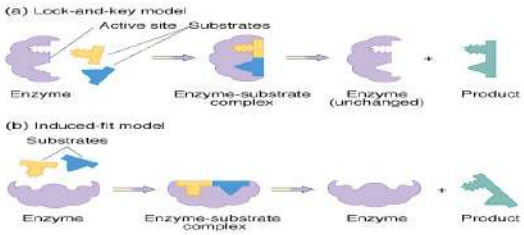
● **ENZYMES** are not changed or "used up" by a reaction; _____

● **ACTIVE SITE** = region of an enzyme which binds to the substrate

-is usually a _____

-determines enzyme's specificity

-_____ " _____ " between shape of enzyme's active site and shape of substrate ("Lock-and-Key" analogy)



● **INDUCED FIT**: a change in the shape of an enzyme's active site, which is induced by the substrate

● Induced fit of a substrate brings chemical groups of the active site into positions that enhance their ability to catalyze the reaction

Catalysis in the Enzyme's Active Site:

● In an enzymatic reaction, the substrate binds to the active site

● The active site can lower an E_A barrier by

-_____

-_____

-Providing a favorable microenvironment

-Covalently bonding to the substrate

Enzyme Reaction Rate:
Substrate Concentration:

-the higher the substrate concentration, _____

-if the substrate concentration is high enough, the enzyme is saturated; in this case, the reaction rate can be increased by _____.

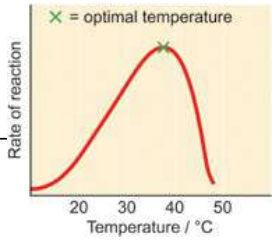
Factors Affecting Enzyme Activity

1) Temperature:

-as temp increases, _____

-if temp gets too high, enzyme denatures and _____

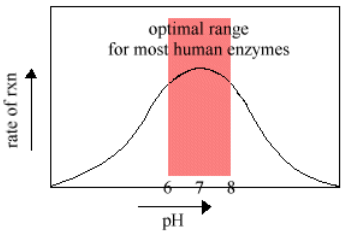
-optimal range for human enzymes: _____



2) pH:

-optimal range for most enzymes: **pH 6-8**

-some enzymes operate best at extremes of pH (e.g. digestive enzyme pepsin, found in the acidic environment of the stomach, works best at pH 2)



3) Cofactors: small non-protein molecules _____

-may bind to active site or substrate

-some are inorganic (e.g. Zn, Fe, Cu)

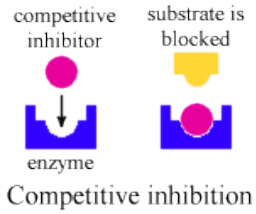
-some are organic and are called **coenzymes** (e.g. vitamins)

4) Enzyme inhibitors:

-COMPETITIVE INHIBITORS: chemicals that resemble an enzyme's normal substrate and compete with it for the active site

➔ _____

(example: _____)

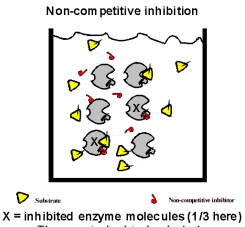


Competitive inhibition

-NONCOMPETITIVE INHIBITORS: enzyme inhibitors that do not enter the active site, _____ _____ molecule

➔ cause enzyme to change its shape so active site cannot bind substrate (less effective!)

➔ may act as metabolic poisons (e.g. DDT, some antibiotics)



X = inhibited enzyme molecules (1/3 here)
The remainder bind substrate and behave normally (2/3)
Total activity is inhibited by 1/3 here.

8.5 - Regulation of enzyme activity helps control metabolism

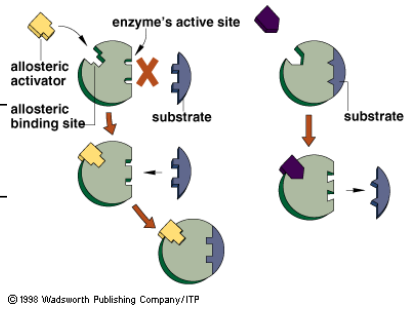
- Chemical chaos would result if a cell's metabolic pathways were not tightly regulated
- To regulate metabolic pathways, the cell switches on or off the genes that encode specific enzymes

Allosteric Regulation of Enzymes

- Allosteric regulation is the term used to describe cases where a protein's function at one site is affected by binding of a regulatory molecule at another site
- Allosteric regulation may either inhibit or stimulate an enzyme's activity

Allosteric Activation and Inhibition

- Most allosterically regulated enzymes are made from polypeptide subunits
- Each enzyme has _____ and _____ forms
- The binding of an **activator** _____ of the enzyme
- The binding of an **inhibitor** _____ of the enzyme



- **Cooperativity** is a form of allosteric regulation that can amplify enzyme activity
- In cooperativity, binding by a substrate to one active site stabilizes favorable conformational changes at all other subunits

Feedback Inhibition

- In feedback inhibition, the end product of a metabolic pathway _____ _____
- Feedback inhibition prevents a cell from wasting chemical resources by synthesizing more product than is needed

Specific Localization of Enzymes Within the Cell:

- Structures within the cell help bring order to metabolic pathways
- Some enzymes reside in specific organelles, such as: _____ _____