Ch. 6 - Metabolism, Energy and Enzymes - overview

- Living things require energy
- All energy in living things comes originally from _____
- Living things store energy in chemical bonds. They transfer energy from one form to another in chemical reactions
- Metabolism is the sum of all reactions in an organism
- Enzymes catalyze reactions and govern metabolism

Isaac Says…

- Let's learn about energy!

Physical Laws Describe Energy Transfer

- First law of thermodynamics: energy cannot be created or destroyed - it can only be transferred or changed from one form to another.

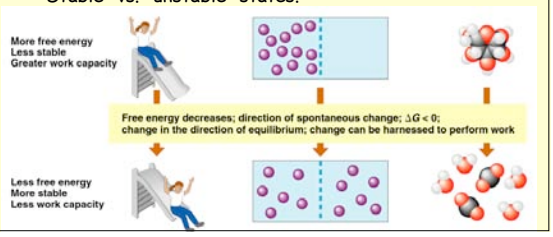
Energy Comes in Different Forms

- Kinetic

- Potential

Potential Energy

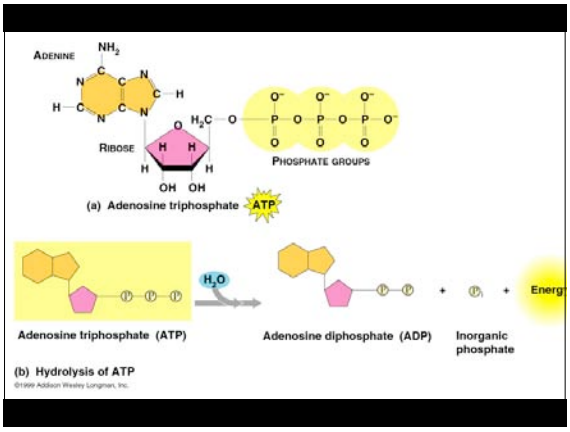
- Stored energy
  - Chemical bonds contain potential energy
  - There are other forms of potential energy
  - "Stable" vs. "unstable" states.



Second Law of Thermodynamics

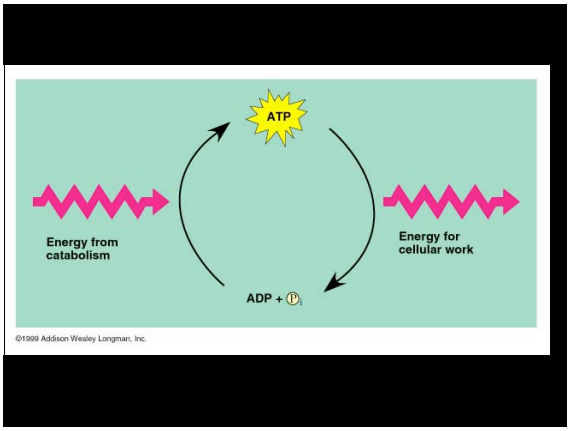
- Energy transfer is never 100% efficient - some energy is always converted to disorder, or *entropy*
- Entropy in living things takes the form of heat

Adenosine Triphosphate, or ATP, is the energy currency of the cell



ATP stores energy in the bonds that connect phosphate groups

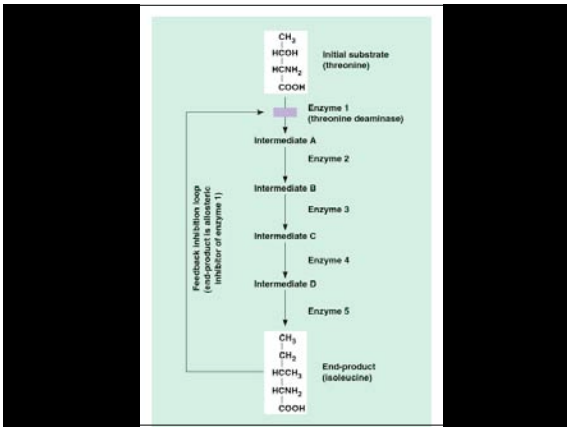
- Breaking the bonds releases energy: ATP -> ADP + P_i + Energy
- Putting in energy can reverse the reaction: ADP + P_i + Energy -> ATP

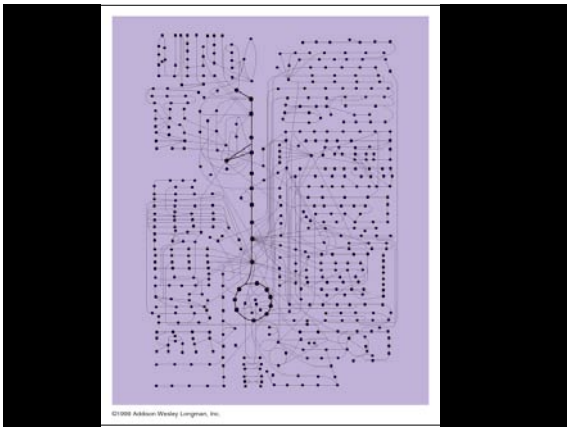


Metabolism

- Metabolism consists of anabolic reactions (building larger molecules) and catabolic reactions (breaking down large molecules)
- Metabolic pathways can be complex
  - Compounds are built in stepwise fashion
  - Different pathways interlock

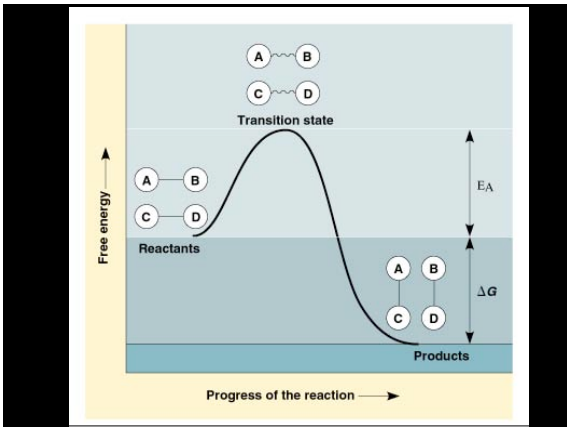
- **7 1/ T butter**
- **2 1/2 c flour**
- **1/2 c lard**
- **3T sugar**
- **1/2 t salt**
- **5-6 T ice water**
- **6 lemons**
- **3 eggs**
- **1/2 c sugar**
- **a pinch salt**
- **4T corn starch**
- **1 1/2 T butter**





Metabolic Reactions Transfer Energy

- *Exergonic* reactions release free energy - the products contain less potential energy than the reactants
- *Endergonic* reactions require energy input. The products contain more potential energy than the reactants.
- Endergonic reactions can only proceed if linked to an exergonic reaction



Anabolic and Catabolic rxns.

- *Anabolic* reactions are reactions that build complex molecules from simpler parts
- Anabolic reactions are generally endergonic

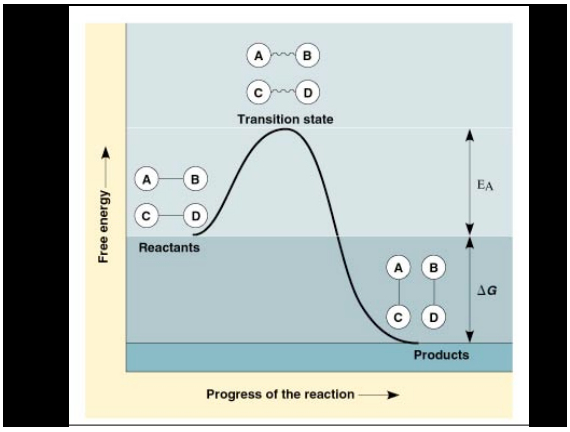
- *Catabolic* reactions break large molecules into smaller ones.
- Catabolic reactions are exergonic

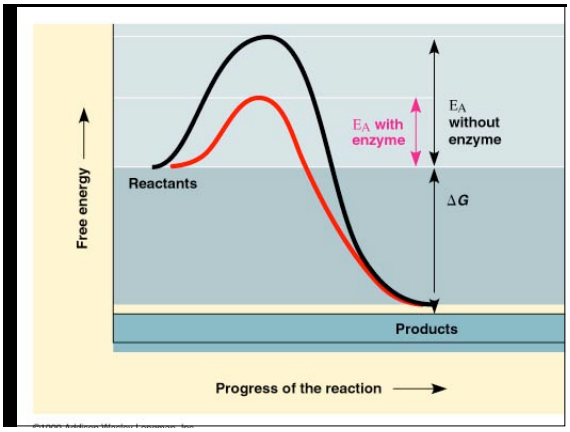
Enzymes are Catalysts

- Enzymes speed up metabolic reactions

Activation Energy is the energy required to start a reaction

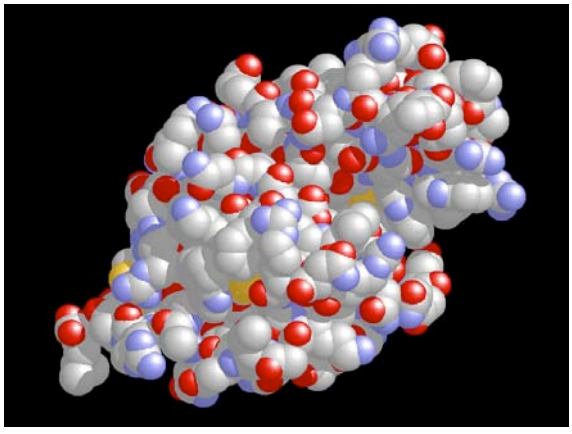
- Enzymes reduce the activation energy, which speeds the reaction
- Enzymes do *not* affect the overall energy balance between reactants and products

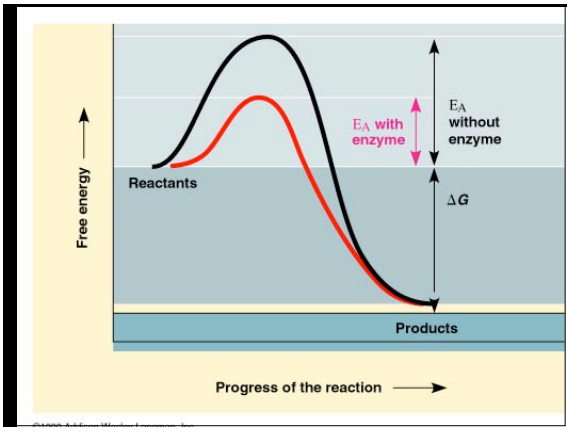


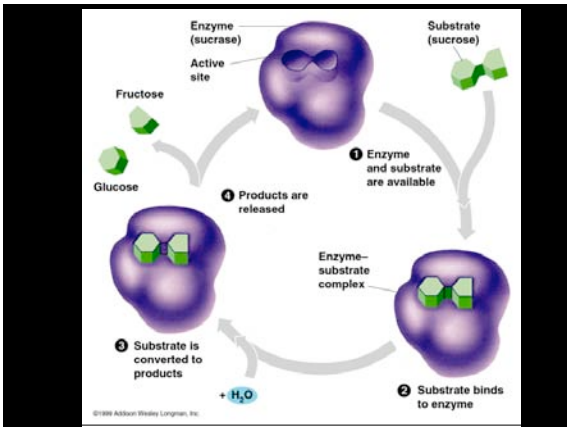


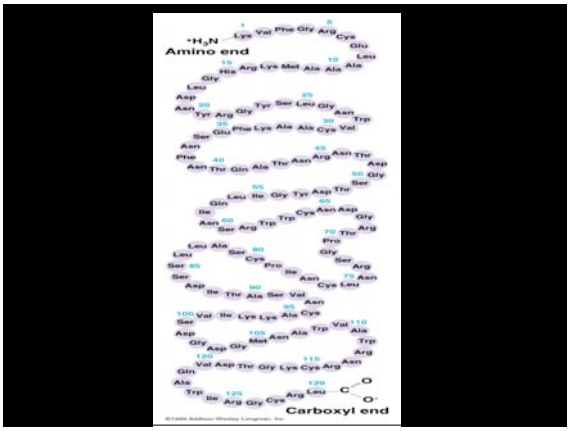
More about Enzymes

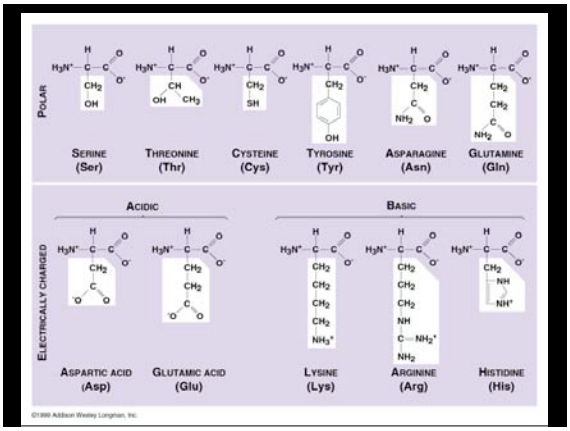
- Enzymes work by forming an enzyme-substrate complex
- Each enzyme bonds to substrates at an active site
- Enzymes work best at a particular pH and temperature

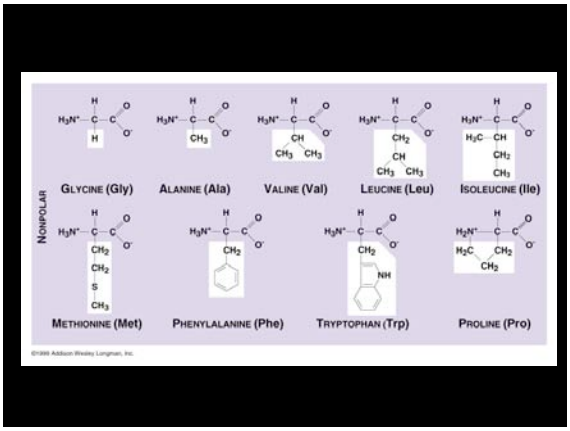






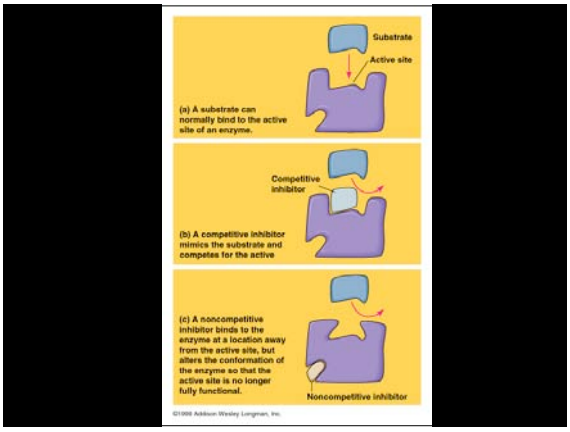






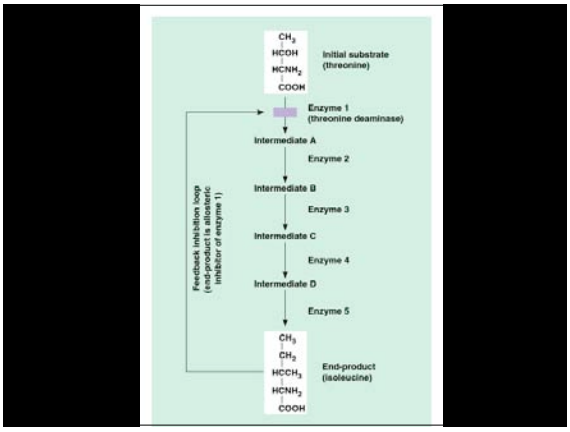
Cells Tightly Regulate their Metabolic Reactions

- Cells
  - Control the quantity of enzyme present
  - Turn enzymes off with competitive inhibitors and noncompetitive inhibitors
  - Many enzymes work only in the presence of other substances, cofactors or coenzymes



Cells regulate metabolism, cont.

- Enzymes can be grouped within cells on membranes or in compartments
- Feedback inhibition is a common way cells regulate metabolic pathways



Five questions you should be able to answer

- What are enzymes made of?
- What do enzymes do?
- How does an enzyme do that?
- Why do only appropriate substrates bind to an enzyme?
- How do cells control enzyme action?