Unit 1: Biochemistry

Section 1-6: Energy Transformations & Enzymes
Book Reading: Chapter 8 pages 141-157

Metabolism and Metabolic Pathways

- Metabolic Pathways
  - Metabolism-*define*
  - Metabolic pathways- *define*
  - *How are metabolic pathways regulated?*

- Catabolic Pathways
  - *Define*
  - *Release or absorb energy? How?*
  - Example: cellular respiration

- Anabolic Pathways
  - *Define*
  - *Release or absorb energy? How?*
  - Example: synthesizing proteins from amino acids

Energy Transformations

- Common Forms of Energy
  - Energy – *define*
  - Kinetic Energy- *define*
  - Thermal Energy- *define*
  - Light Energy- *define*
  - Potential- *define*
  - Chemical- *define*

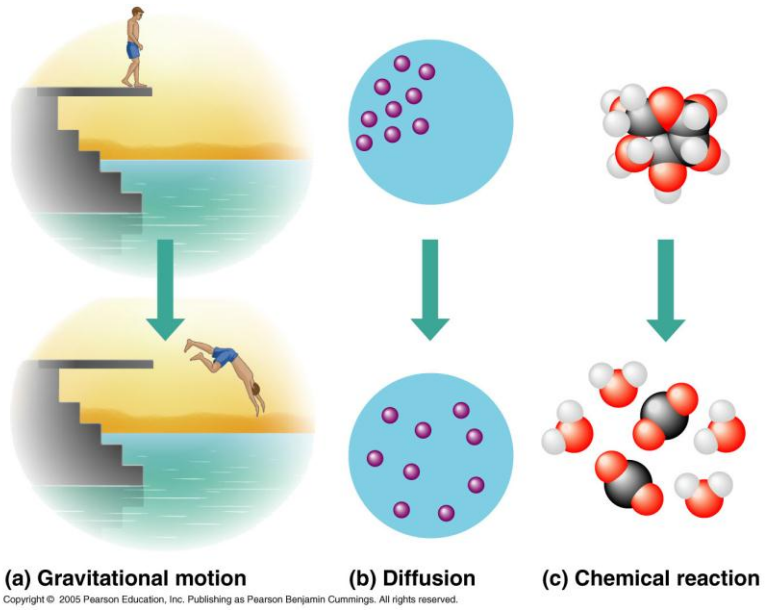
- The Laws of Thermodynamics
  - Energy transformations must adhere to the laws of thermodynamics
  - First Law of Thermodynamics- *state*
  - Second Law of Thermodynamics- *state*

❖ System vs. Surroundings

- System-
- Surroundings-

❖ Free Energy

- Free Energy (ΔG)
  - Spontaneous reaction-
  - Nonspontaneous reaction-



- Exergonic Reactions
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- Endergonic Reactions
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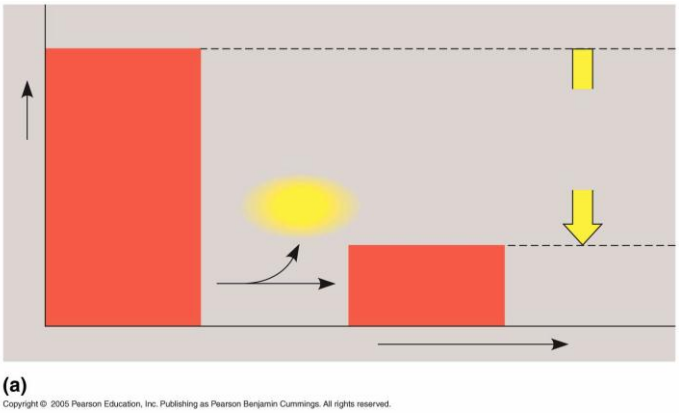
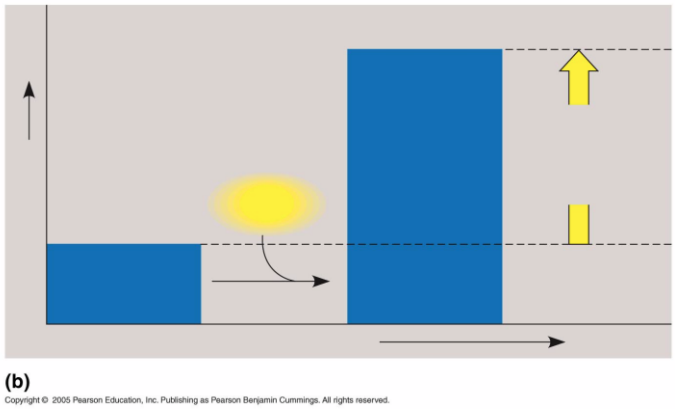


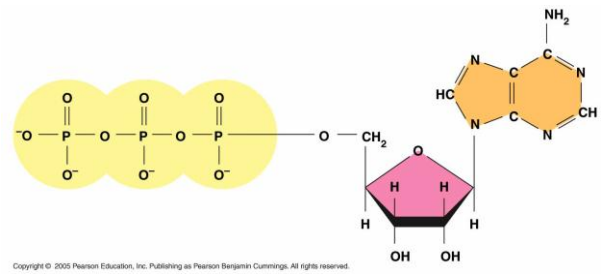


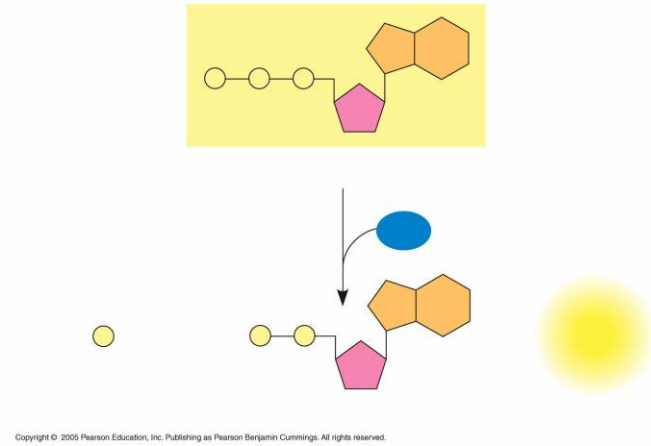
- ❖ Equilibrium in Biological Systems
  - Most chemical reactions are reversible and proceed in both direction until the reach a balance known as chemical equilibrium
  -
  - Cells at equilibrium=
  - The key to maintaining a lack of equilibrium is that the product of one reaction becomes the reactant of the next step until waste is eventually released from the cell

<u>Cellular Work is Powered by ATP</u>

- ❖ Energy Coupling
  - Energy coupling- *define*
  - ATP acts as the intermediate source of energy that powers cellular work

- ❖ Hydrolysis of ATP
  - Hydrolysis reaction can break an inorganic phosphate off of ATP resulting in the release of a substantial amount of energy and the formation of ADP
  - Ordinarily this energy would be released in the form of heat= bad for organisms

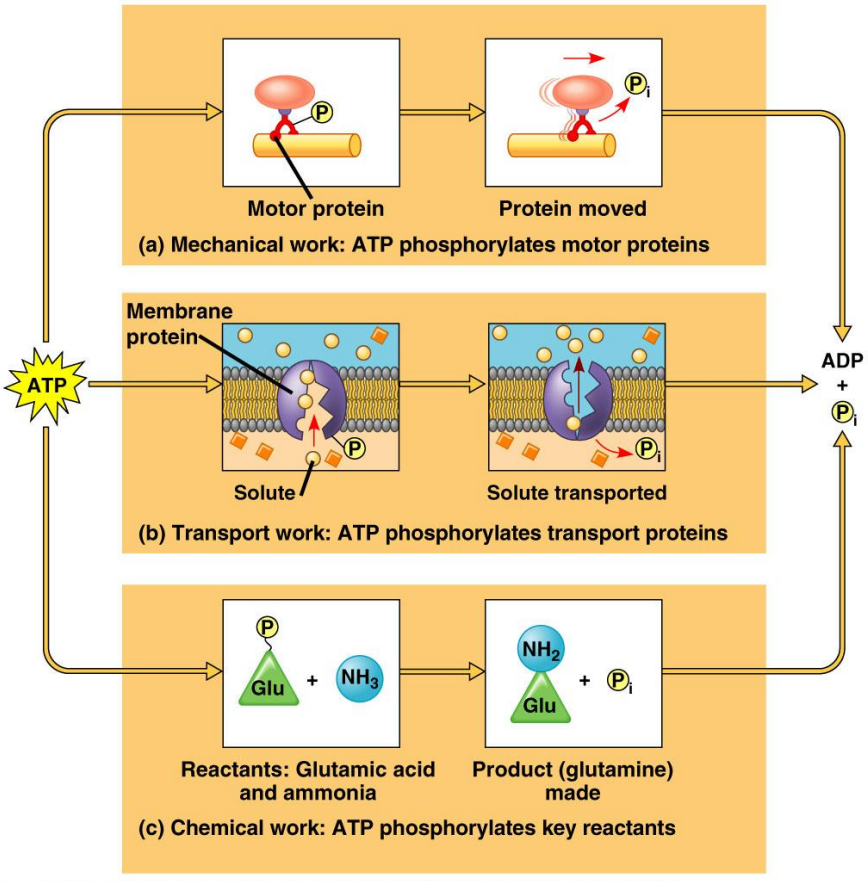




- Phosphorylation
  - *define*
  - Mediated by enzymes
  - The molecule that accepts the phosphate is said to be *what?*
  -

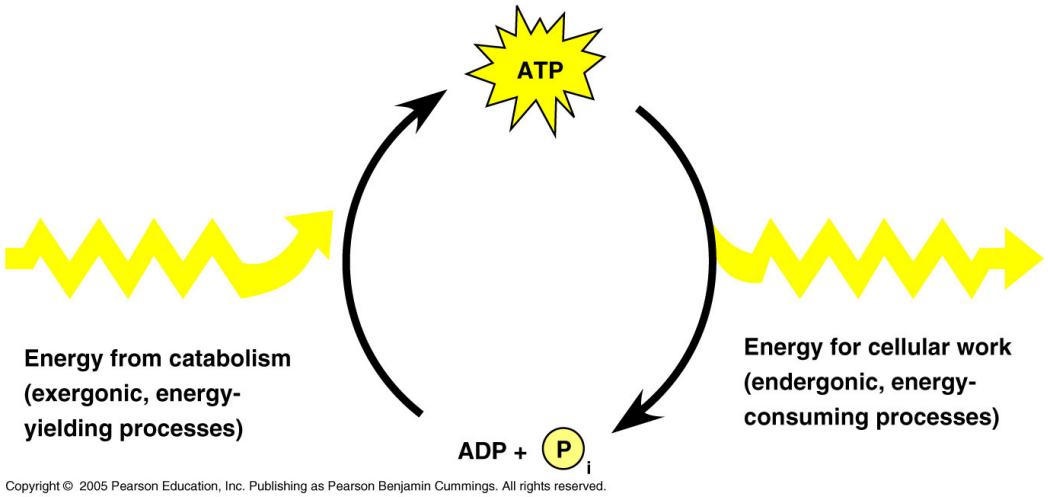
❖ Three Types of Cellular Work

- Mechanical Work
  - *define*
  - Movement of chromosomes, beating of cilia, contraction of muscles
- Transport Work
  - *define*
  - Active transport
- Chemical Work
  - *define*
  - Formation of polymers



❖ Regeneration of ATP

- Energy for endergonic process of making ATP comes from *where?*
- This process happens rapidly!!



<u>Activation Energy</u>

❖ Chemical Reactions

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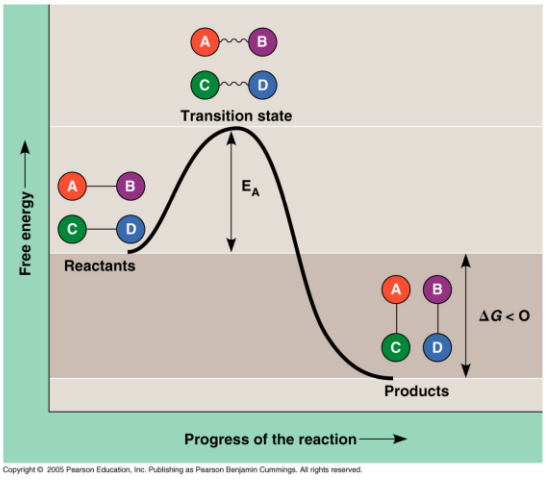
❖ Activation Energy E_A

- *define*
- It provides a barrier that determines the



- It is often provided in the form of heat because heat energy causes

- Heat is Unfavorable for Organisms for Two Reasons
  - *List*
  -

Enzymes Lower Activation Energy

- Enzmyes
  -
  - Always catalyze reactions
  - After an enzyme mediated reaction,

- Enzyme Structure
  - Enzymes are catalytic proteins
    - Catalysts- *define*
    - Proteins have a three deminsional shape
  - Active Site- *define*

- Enzyme Names
  - All enzyme names contain the suffix "-ase"
  - The name usually hints at what the enzyme does in the cell
    - Example: DNA Polymerase- makes DNA polymers, Primase- lays down primers
- Substrate
  - Substrate- *define*
  - Enzmyes are substrate specific- *define*
  - Specificity is based on *what?*
  - Enzyme-Substrate Complex
    - *When does it form?*
    - Induced Fit- *define/describe*

- Enzymes Lower Activation Energy by:
  - *List*
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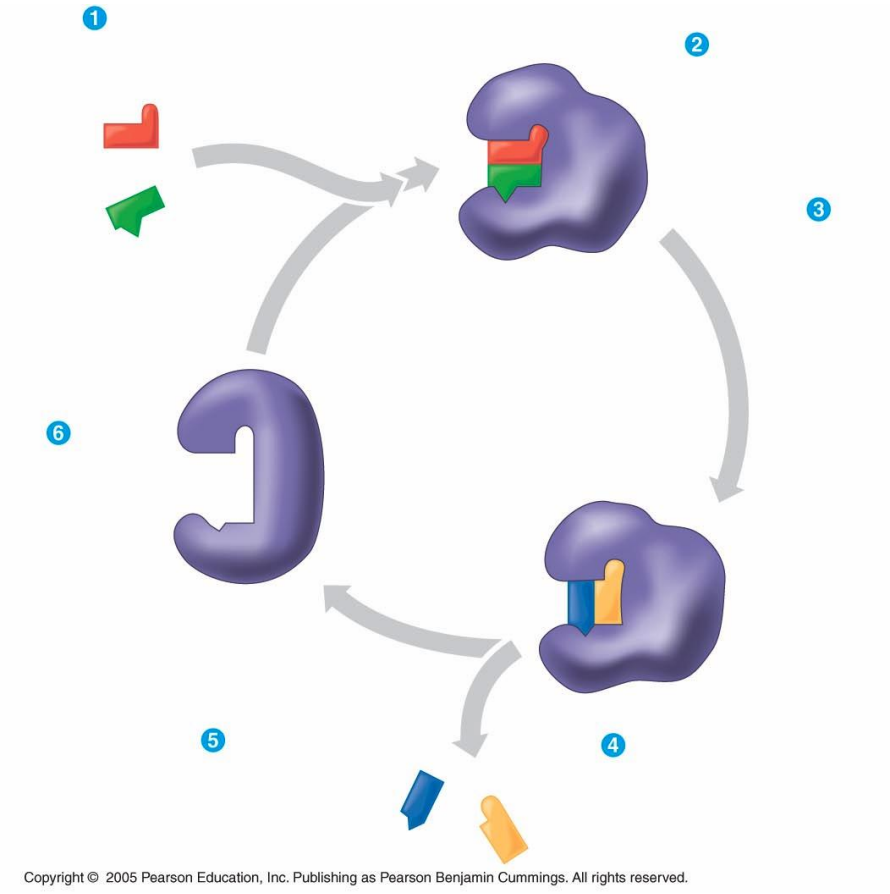


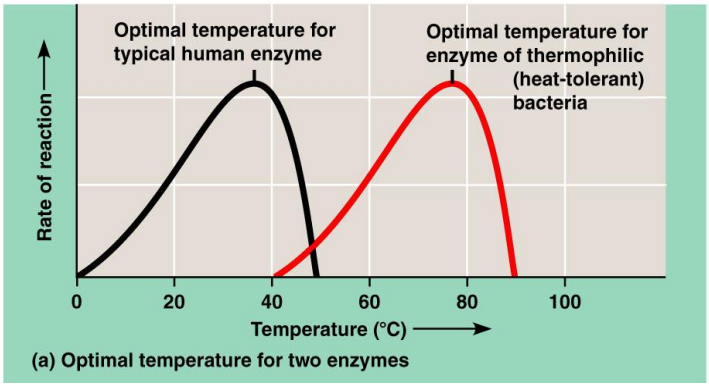
Factors that Affect Enzyme Activity

- ❖ Substrate Concentration
  - Increasing the substrate concentration *increases or decreases reaction rate?*
  - At some point however the enzyme is said to be "concentrated" *meaning what?*
    - At this point no matter how much substate is added the reaction rate will not increas
    - The only way to increse the reaction rate would be to *do what?*
- ❖ Temperature
  - Increasing the temperature
    - *Does what to the rate of collisions?*

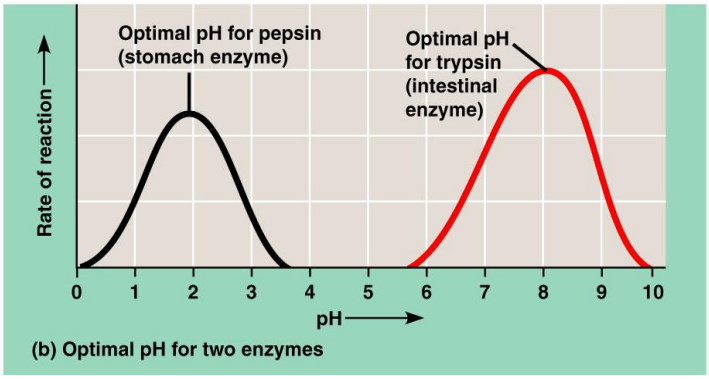
- *Does what to the reaction rate?*

- If the temperature is elevated too much,

- Each enzyme has an optimal temperature



(a) Optimal temperature for two enzymes



(b) Optimal pH for two enzymes

❖ pH

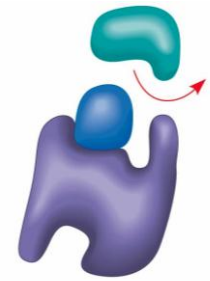
- each enzyme has an optimal pH
- even slight changes in pH will denature enzymes

❖ Cofactors

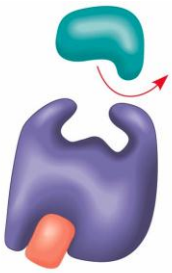
- Cofactors- *define*
- May be bound tigltly to the enzyme ore may bind loosly and reversibly with the substrate
- Coenzymes- *define*

❖ Enzyme Inhibitors

- Competitive Inhibitors
  - Bind the *where?*
  - *How do they effect enzyme productivity?*
  - *How can there effects be overcome?*



- Noncompetitive Inhibitors
  - Do not bind the active site, *but where?*
  - *How does their binding effect the enzyme? Be specific?*



Regulation of Enzyme Activity

- Production
  - Enzymes are often regulated by when and in what quantity they are produced through transcription and translation

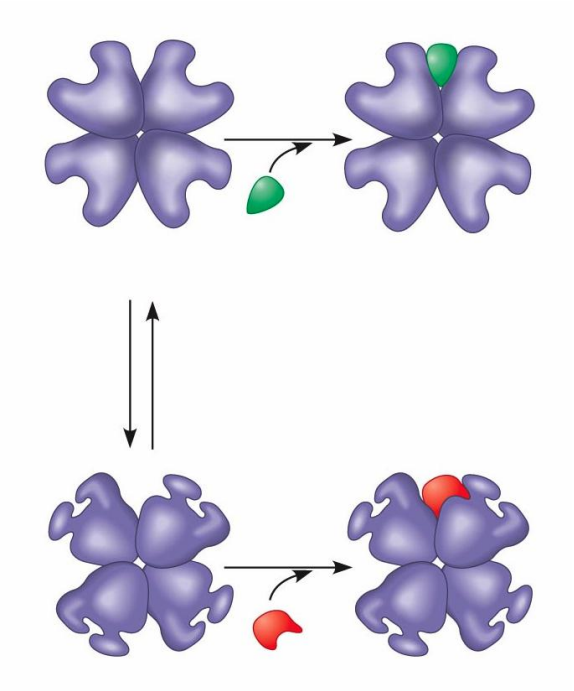
- Allosteric Regulation
  - *Define*

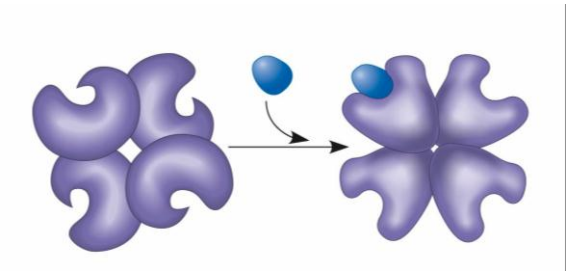
  - Allosterically regulated enzymes usually have multiple subunits

- Allosterpic Activation and Inhibition
  - Enzymes often have active and inactive conformations
  - Allosteric activators- *define*

  - Allosteric inhibitors- *define*

  - Cooperativity- *define*





- Feedback Inhibition
  - *When/how does it occur?*
  - *How does this benefit the cell?*