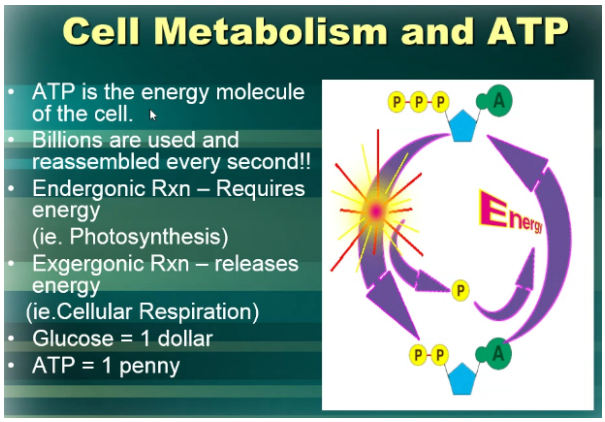
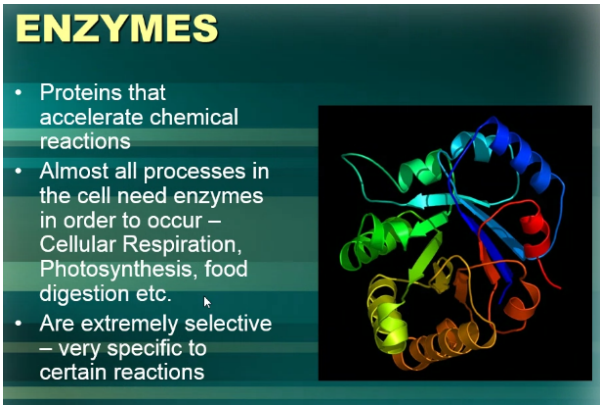
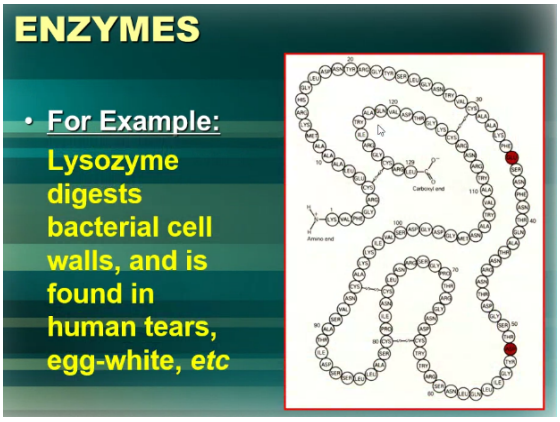
Cells at work

- 

- Enzymes → key to biochemical reactions
- 

- 

ENZYMES

- Enzymes are known to catalyze about 4,000 reactions in the human body
- Remain unchanged after reactions
- Most are named after the reaction they catalyze and their names end in "-ase"
  Ex: Lactase breaks down lactose

HOW ENZYMES WORK:

- By providing a lower activation energy for a reaction and dramatically accelerating its rate
- *For example…*

the reaction catalysed by orotidine-phosphate decarboxylase will consume half of its substrate in 78 million years if no enzyme is present. However, when the decarboxylase is added, the same process takes just 25 milliseconds

HOW ENZYMES WORK:

Enzyme

SUBSTRATE ⟶ PRODUCT(S)

Reactant

Eg:

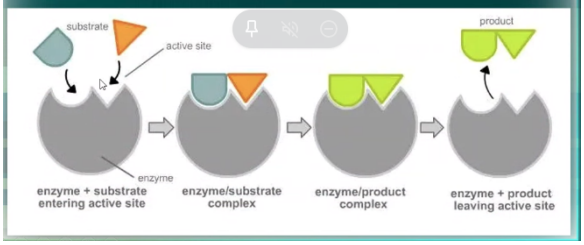
Sucrase

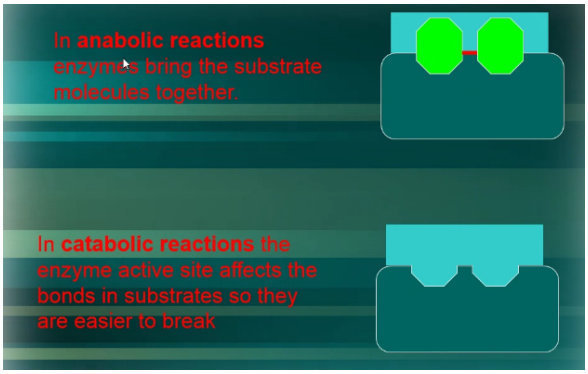
Sucrose + Water ⟶ Glucose + Fructose

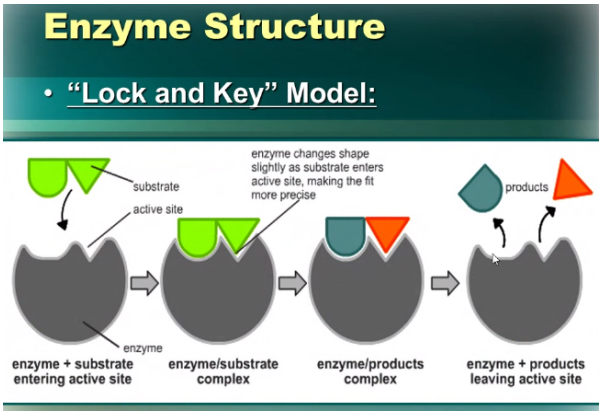
Enzymes help a reaction to occur … without being directly involved!!!

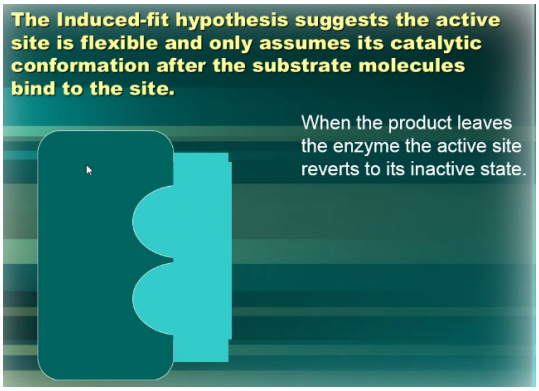
Enzyme Structure

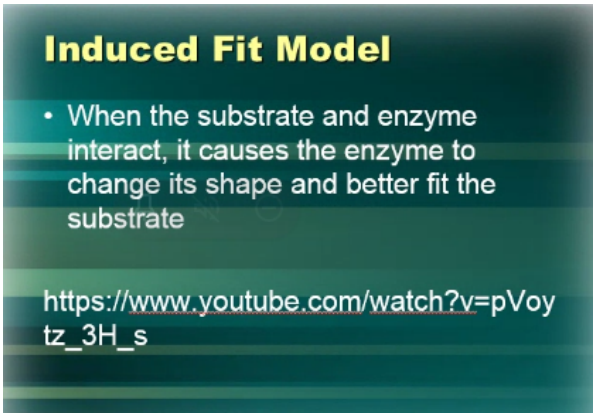
- The substrate must fit precisely in the active site in order for the reaction to proceed
- All enzymes are highly specific!

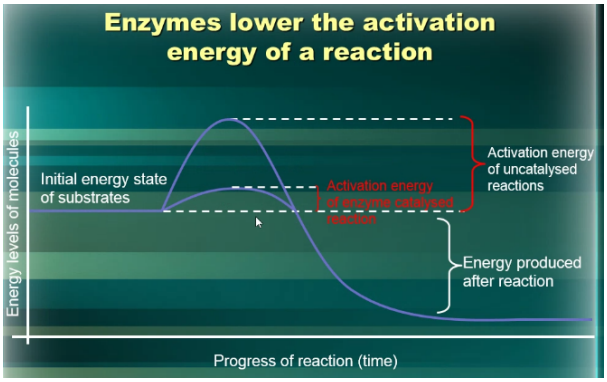


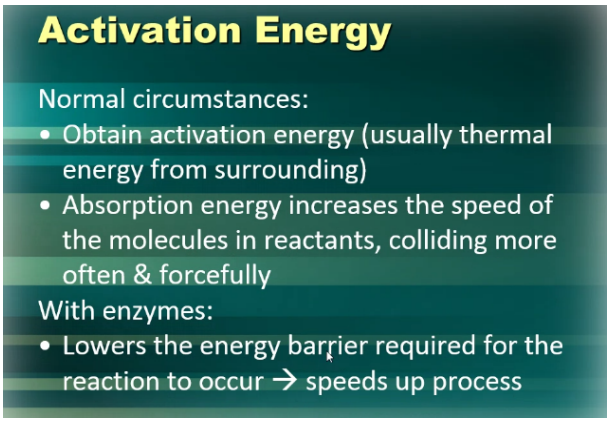
- 

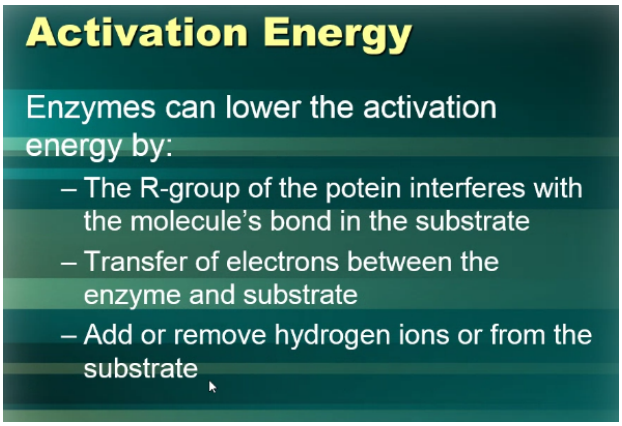
    - A is like add, C is like cut
- 

- Lock and key is prob wrong cuz proteins have been proven to be flexible
- 

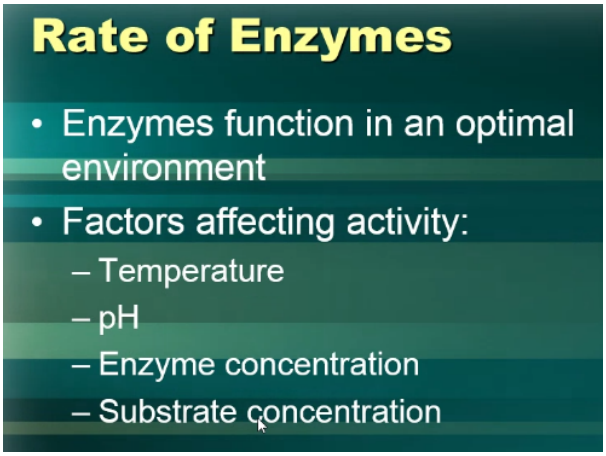
- 

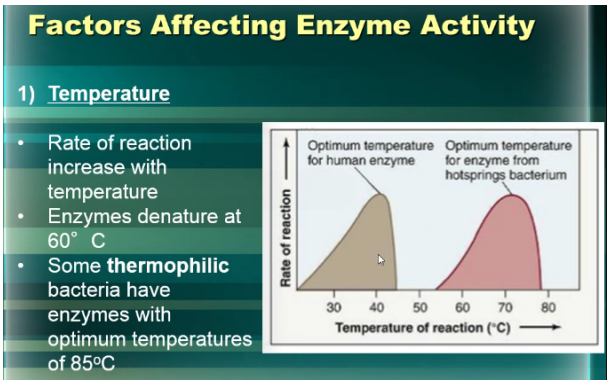
- 

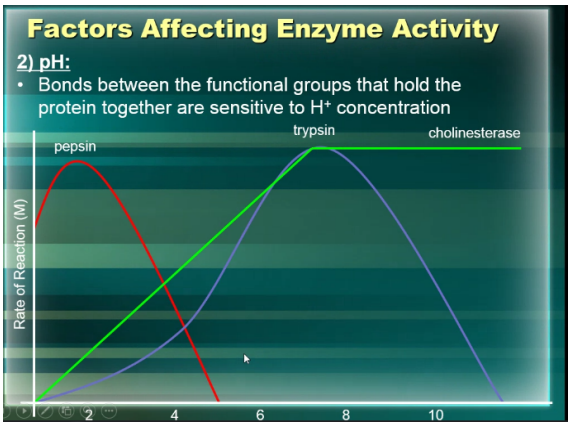
- 

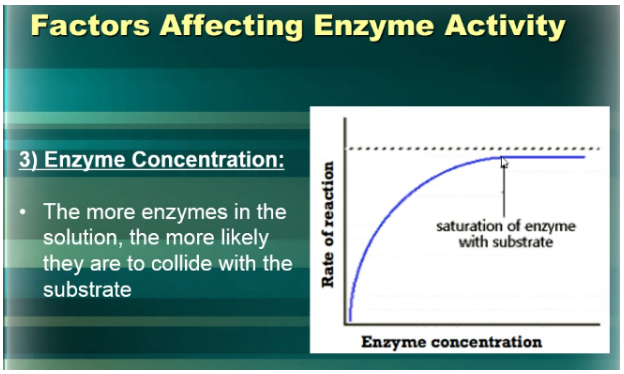
- 

- Factors affecting enzyme activity

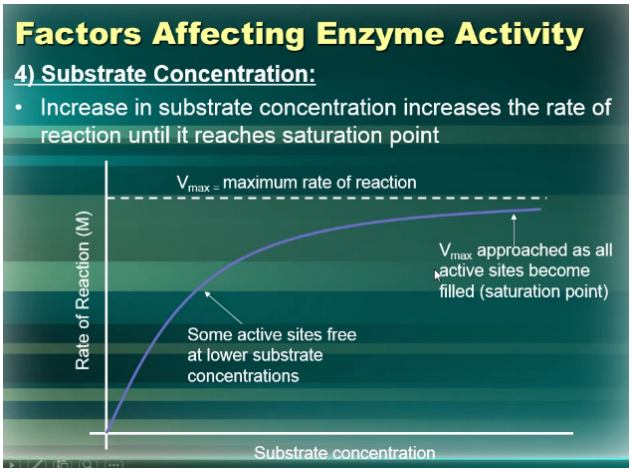
- 

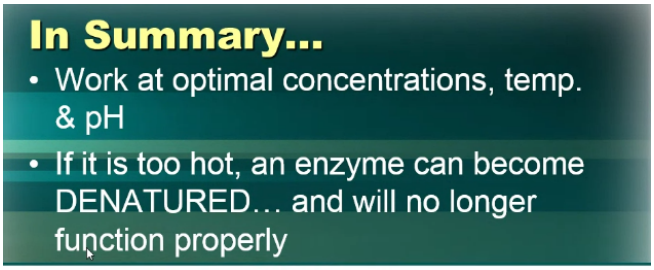
- 

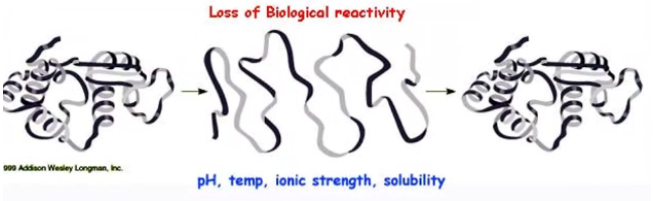
- 

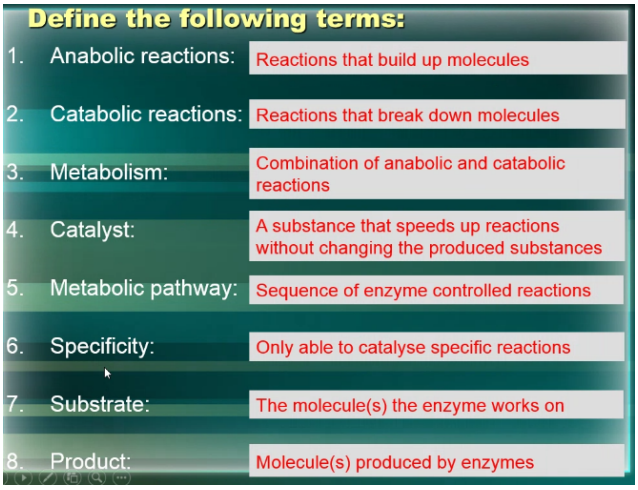
- 

- The more seats u have in a movie theater, the more people that can sit

- 

- Summary
  - 

  - 

  - 

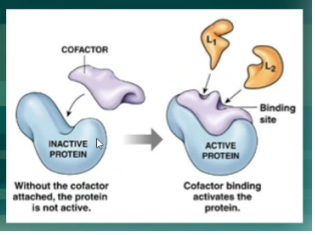
- Enzyme regulation

Enzyme Regulation

- Regulation mechanisms:
  - Cofactors/ Coenzymes
  - Competitive inhibitors
  - Non-Competitive inhibitors
  - Allosteric Changes
  - Feedback Inhibition
  - Precursor Activation

1. Cofactors/Coenzymes

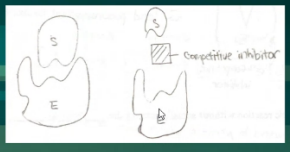
- Non-protein helper
- Enzymes can't speed up reaction without them



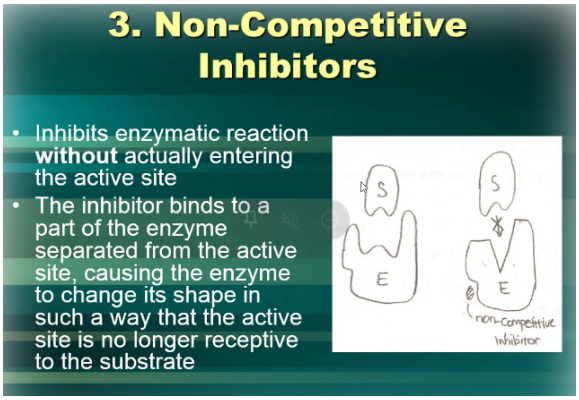
1. Cofactors/Coenzymes

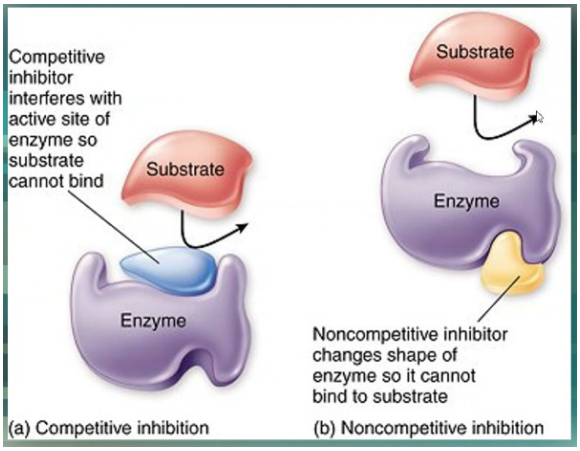
- Example: Vitamin B_2 (riboflavin)
- Involved in energy metabolism (ie. metabolism of fat, carbohydrates and proteins)
- Deficiency: body will have problem metabolizing (fats, carbs, proteins)
- Often caused by dietary inadequacy
- Can be obtained from meat, nuts, cheese, eggs
- Diagnosis: measure activity of enzyme gluthathione
- Symptoms: bloodshot eyes, mouth, inflammation, sores, burning tongue
- Not common because most countries fortify their breads and cereals with vitamin B_2

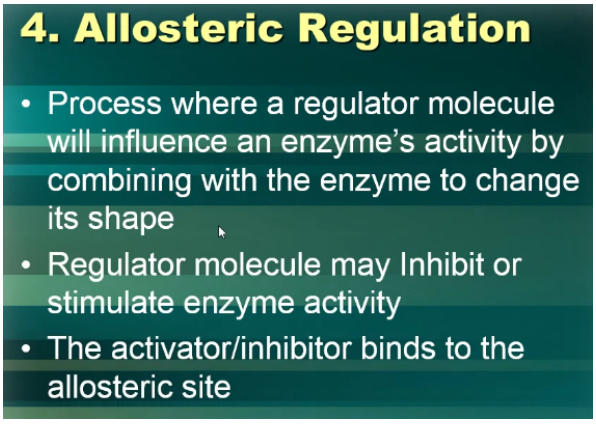
2. Competitive Inhibitors



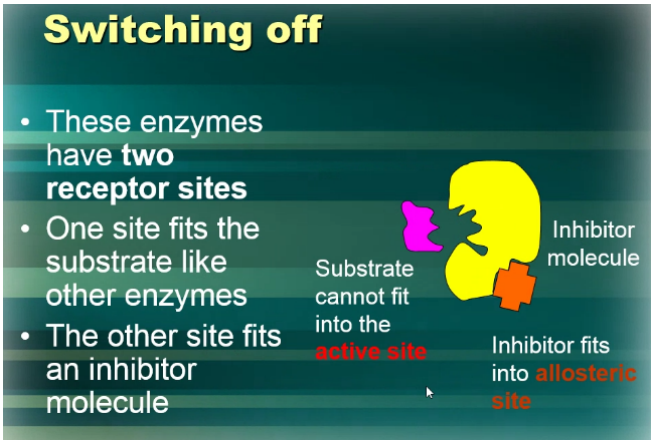
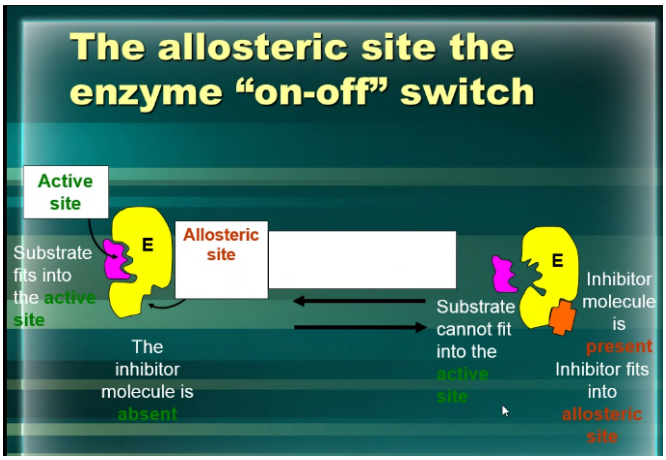
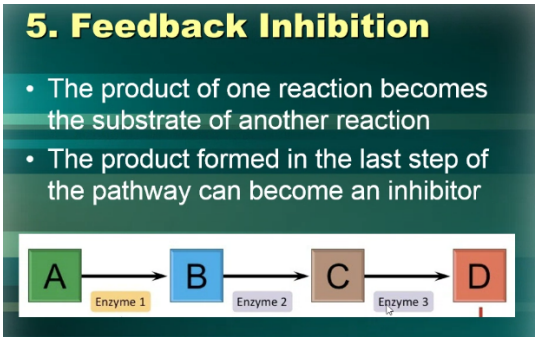
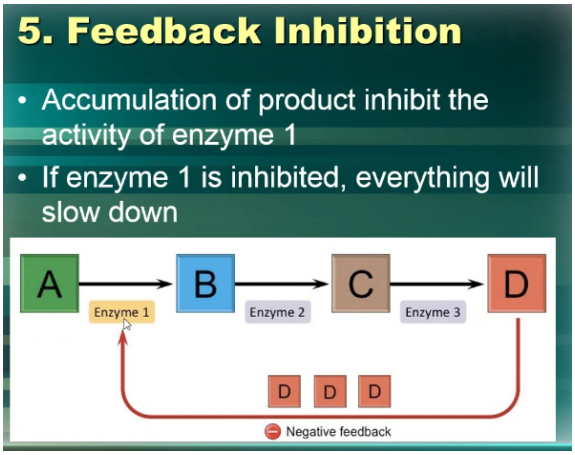
- Resembles the normal substrate and compete for admission into the active site
- Reduces the productivity of the enzyme by locking the active site from substrate
- If the inhibitor attaches to the enzyme by covalent bond, the inhibition is usually irreversible (ex. nerve gas, cyanide, arsenic)
- If the inhibitor bins to the enzyme by a weak bond, the inhibition is reversible, it can be overcomed by increasing the concentration of substrate

- 

- 

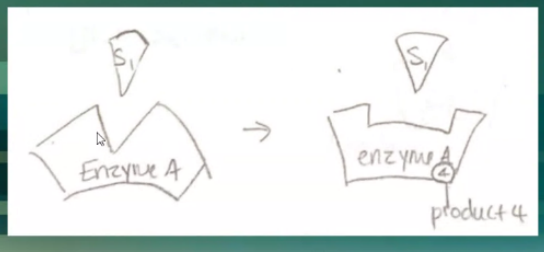
- Inhibitors r there to either poison or to save energy
- 

    - This one can also start the reaction
- Missed one

- 
Switching off
• These enzymes have two receptor sites
• One site fits the substrate like other enzymes
• The other site fits an inhibitor molecule
Inhibitor molecule
Substrate cannot fit into the active site
Inhibitor fits into allosteric site
- 
The allosteric site the enzyme "on-off" switch
Active site
E
Allosteric site
Substrate fits into the active site
The inhibitor molecule is absent
Substrate cannot fit into the active site
E
Inhibitor molecule is present
Inhibitor fits into allosteric site
- 
5. Feedback Inhibition
• The product of one reaction becomes the substrate of another reaction
• The product formed in the last step of the pathway can become an inhibitor
A
Enzyme 1
B
Enzyme 2
C
Enzyme 3
D
- 
5. Feedback Inhibition
• Accumulation of product inhibit the activity of enzyme 1
• If enzyme 1 is inhibited, everything will slow down
A
Enzyme 1
B
Enzyme 2
C
Enzyme 3
D
D
D
D
Negative feedback

5. Feedback Inhibition

- Product 4 binds to allosteric site of enzyme 1, changing its shape



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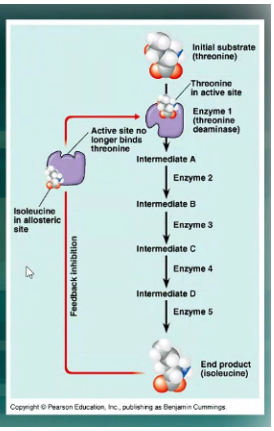
This example demonstrates how an end product can inhibit the first step in its production.

1.Isoleucine binds to the allosteric site of threonine deaminase and prevents threonine from binding to the active site because the shape of the active site is altered.
2.When the level of isoleucine drops in the cell's cytoplasm, the isoleucine is removed from the allosteric site on the enzyme, the active site resumes the activated shape and the pathway is "cut back on" and isoleucine begins to be produced.



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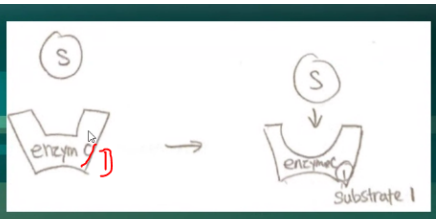
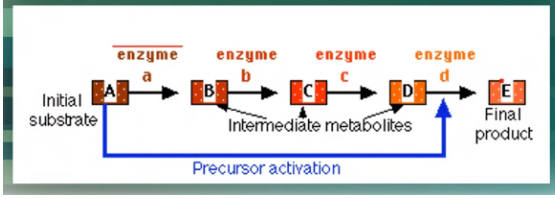
6. Precursor Activation

- Requires a reactant to activate enzyme further along a reaction series
- It may combine with the enzyme, changing its shape, so that the active site fits with its substrate
- Substrate 1 activates enzyme C

-





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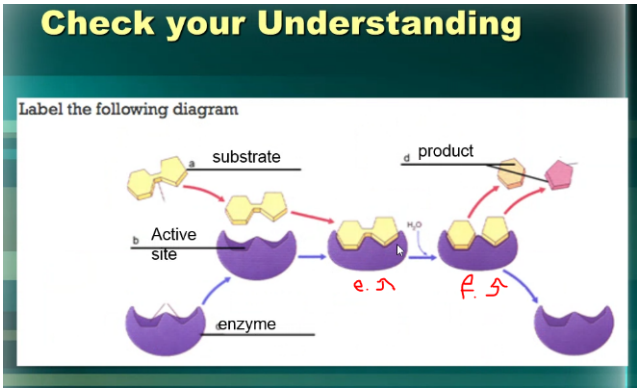
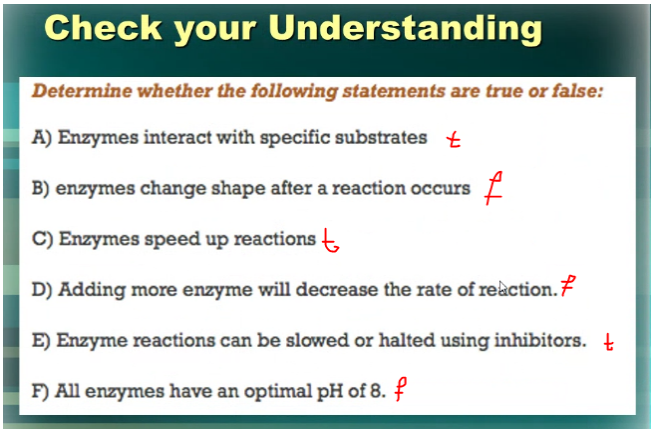
- 

    - E. substrate-enzyme complex
    - F. product-enzyme complex
- 

Homework

- 50 - 56 textbook
- Optional enzyme worksheet
- Enzyme gizmo lab → for marks

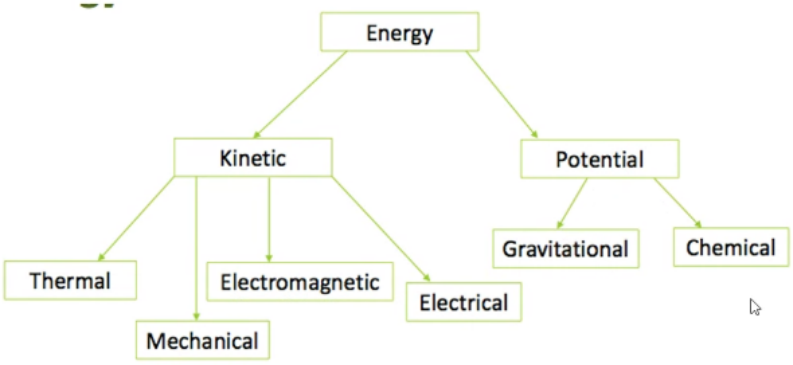
Nomenclature Functional Group Priority for Bio

- Carboxylic Acid + derivatives like ester
- Amino
- Aldehyde
- Ketone
- Alcohol
- Alkyne
- Alkene
- /33, 10 marks for MC, 3 naming diagrams,
- Acetone is the common name for 2-propanone
- Prioritize triple over double bonds

Metabolism

Energy

- Ability to do work
- Must continuously capture, store and use energy
- Organisms do majority of work on a cellular level
- Must manage amount of energy used w amount produced
- Anabolic reactions:
    - Energy + small molecules → larger molecules
- Catabolic reactions:
    - Large molecules → energy + smaller molecules
- Kinetic energy (Ek) has to do with movement, potential energy (Ep) is stored



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Laws of Thermodynamics

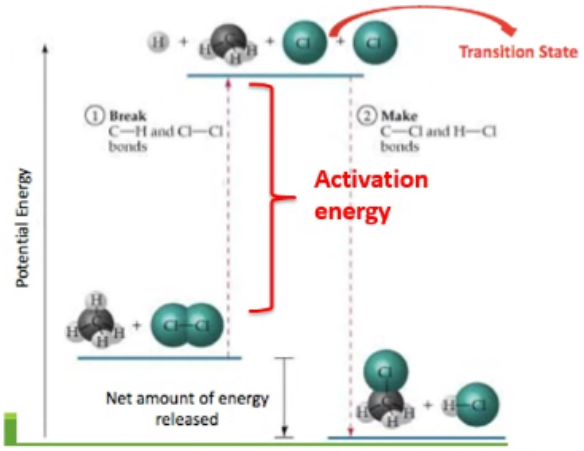
- Looks at physical rules of organisms and how energy is transferred between them

1. Total amount of energy in any closed system is constant. Energy cannot be created or destroyer, only converted from one form to another
    - Bond energy
        - Measured in kJ/mol
        - Farther the electrons away from nucleus the more potential energy
        - Energy is released when bonds break and is absorbed when they form new bonds
        - Enthalpy: sum of internal energy (heat content) of a system
            - $H = U + P(v)$
            - Energy is absorbed when reactant bonds break and energy is released when product bonds form

Enthalpy

A few terms…

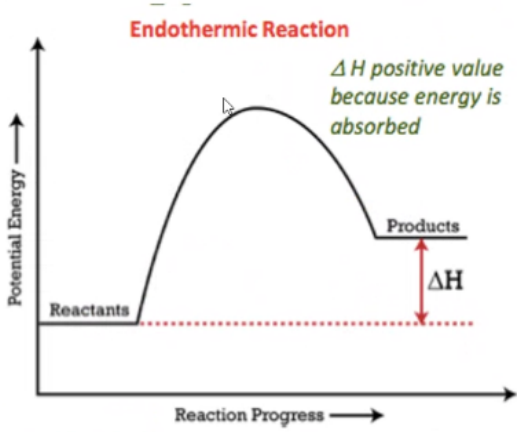
- Activation energy (E_a) – the minimum amount of energy that reactants must absorb to start a reaction
- Transition state – a temporary condition during a chemical reaction in which the bonds in the reactants are breaking and the bonds in the products are forming
- Change in potential energy (ΔH)



- Exothermic reactions
-

Endothermic Reaction

- energy absorbed, products have higher E_p than reactant
- Positive ΔH



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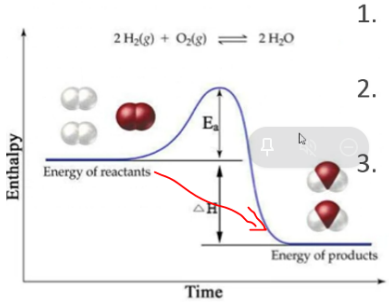


1. What does E_a stand for?
2. What does ΔH stand for?
3. Is this endothermic or exothermic? Why?

-

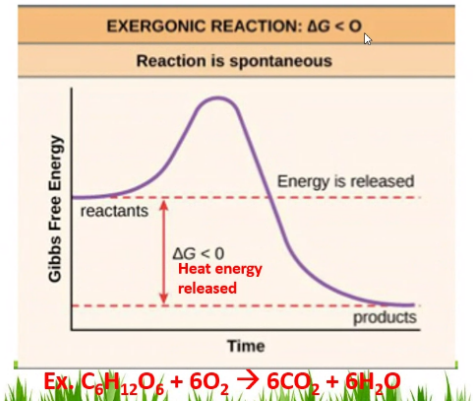
2. In every transfer or conversion, some of the useful energy in the system becomes unusable and increases the entropy
    a. Energy transformation in never 100% efficient
    b. Entropy is a measure of disorder in a system
    c. Think of a room and how it always gets messier
    - Entropy: in chemical reactions, entropy will increase in following circumstances
        - Solid becomes liquid
        - Liquid becomes gas
        - Complex molecule becomes simpler
        - .
    - Catabolic reaction → energy released, entropy increases
        - exothermic reaction and spontaneous process
    - Anabolic reactions → cells trying to become less messy as their building things
        - While it seems this way, its prob not cuz anabolic reactions require energy which they most likely get from catabolic reactions
        - There is order within the disorder
    - Look at cells and atp using entropy tomorrow
    - Gibbs free energy
        - Gibbs discovered relationship between energy change and temperature of reaction n how relationship could help determine…
    - • The free energy change can be calculated:

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

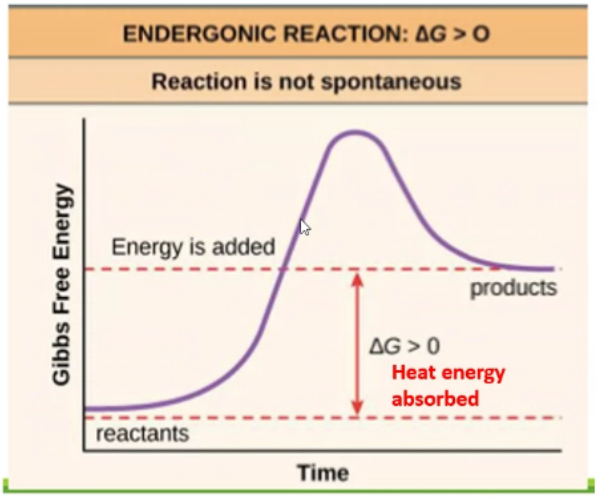
      Where
      ΔG = change in free energy
      ΔH = change in enthalpy
      T = Temperature in Kelvin
      ΔS = change in entropy

      Gibb's Free Energy $\Delta G = \Delta H - T\Delta S$

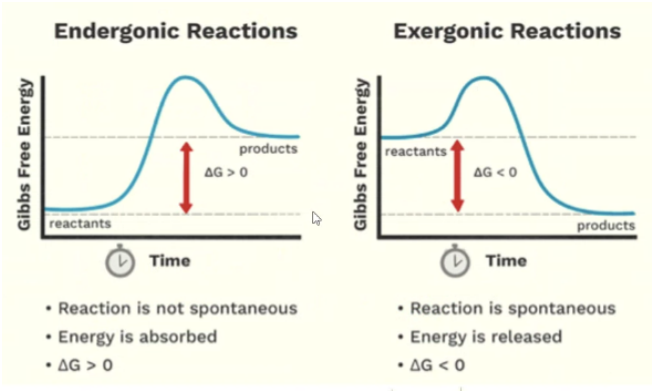
	ΔH < 0	ΔH > 0
ΔS > 0	ΔG < 0	ΔG < 0 at higher temp ΔG > 0 at lower temp
ΔS < 0	ΔG < 0 at lower temp ΔG > 0 at higher temp	ΔG > 0

    - 

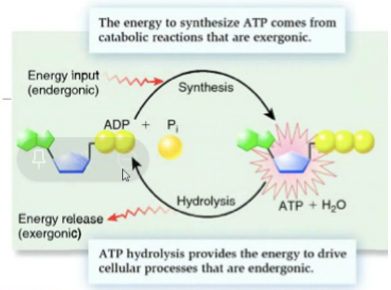
    - Ex. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
    - Exergonic means like if theres free energy



- Ex. $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
- So many words starting with E → review lol



- Delta G not affected by enzyme
- Coupled reactions
  - Cells are able to make endergonic reactions from the energy supplied by the exergonic reactions.
  - Energy coupling is the transfer of energy from one reaction to another in order to drive the second reaction.

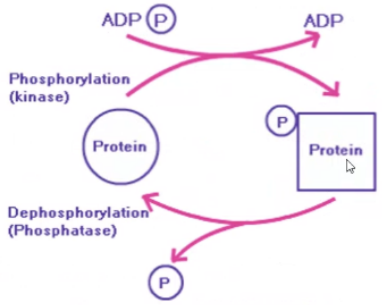


ADP and Inorganic Phosphate

The inorganic phosphate can participate in a wide range of chemical reactions:

1. Phosphorylation
2. Substrate level Phosphorylation
3. Oxidative phosphorylation

1. Phosphorylation

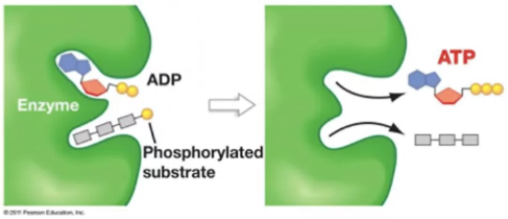


*The inorganic phosphate attaches to a protein. This process is known as **phosphorylation.***

2. Substrate Level Phosphorylation

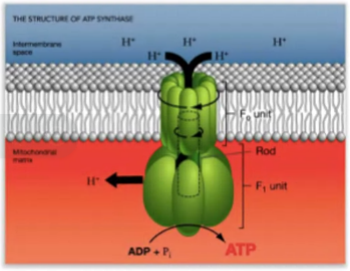
Used to form ATP directly in an enzyme-catalyzed reaction.

The inorganic phosphate is removed from the protein and attached to ADP to make ATP.



3. Oxidative Phosphorylation

- Used in cellular respiration within mitochondria to produce ATP
- Channel opens when there is a high concentration of H^+ in the intermembrane space
- H^+ are pumped back in to create ATP



- Redox oml LEO says GER
  - Oxidation or “Ox”
    - Energy metabolism in cells involves oxidation reactions
    - Oxidation involves the transfer of an electron from a molecule which is said to be oxidized to another molecule which is said to be reduced
    - .
  - Reduction
    - Overall charge is reduced i.e. gains electrons

Oxidation	Reduction
Addition of Oxygen	Removal of Oxygen
Removal of Hydrogen	Additional of Hydrogen
Loss of electron	Gain of electron

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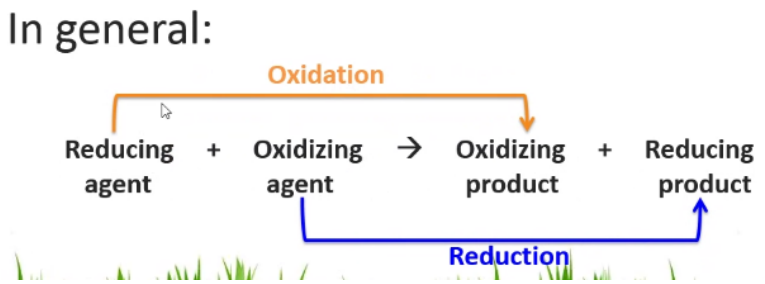

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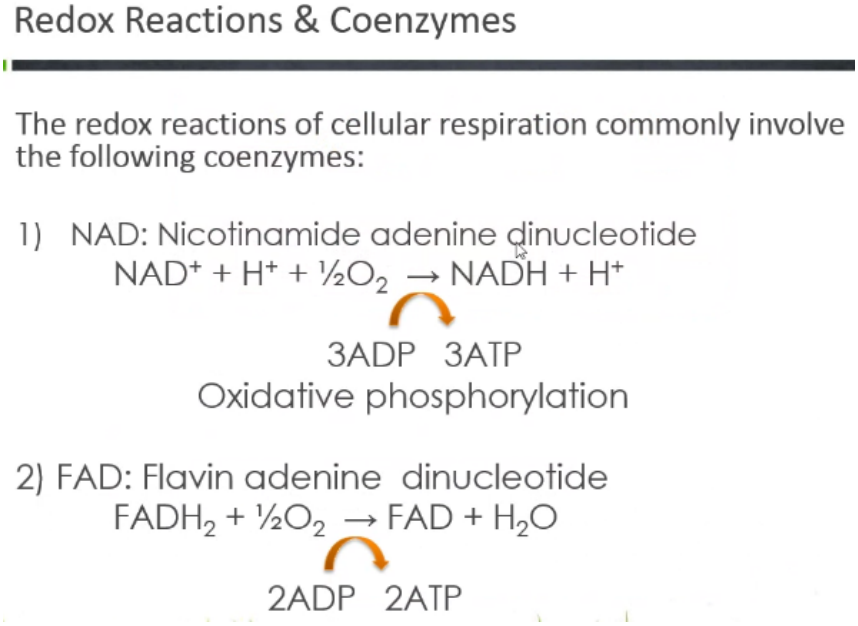

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3. a

Glycolysis

- The breakdown of glucose to produce: 1 NADH, 4 ATP - 2 ATP,