Notes 10/24

Wednesday, October 24, 2007
9:59 AM

Notes 1024

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Enzymes: Introduction, Rates of Reactions

Oct. 24, 2007

Intro to Enzymes

- What is an enzyme?
- Properties
- Classes (Nomenclature)
- Coenzymes

What are Enzymes?

- Proteins (sometimes RNA)
- Catalyze metabolic rxns
- For example: Oxidized form of carbon to more reduced form
- $6CO_2 + 6H_2O$ ---> $C_6H_{12}O_6$ (glucose) + $6O_2(g)$. <- photosynthesis in plants
- Living systems use enzymes to accelerate and control the rates of vitally important rxns

- Organisms must be able to catalyze reactions efficiently and selectively
- Catalytic activity depends on native conformation of protein.
- Catalytic activity is lost if protein is denatured or degraded.
- Primary, secondary, tertiary, and quaternary are important for activity.

More examples

Catalase

$2H_2O_2 \rightarrow 2H_2O + O_2$

Catalase
- Peroxiomes of aerobic cells
- Protects cells from H_2O_2
- Catalase is a tetramer (4 polypeptides)
- 1 catalase can break 40million times in 1 second

Carbonic anhydrase

$CO_2 + H_2O <-> H^+ + HCO_3^-$

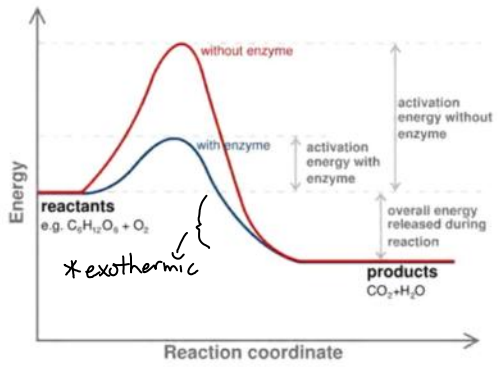
(H_2CO_3)

Carbonic anhydrase
- Monomer; metallenzyme (Zinc 2^+)
- Important in stomach, pancrease, kidney, red blood cells
- Converts CO_2 gas to carbonic acid which can travel through blood
- 1 carbonic anhydrase can process 1million reactions per second

Properties of Enzymes

1. Higher rxn rates
2. Milder rxn conditions
   - physiological pH and temperature
3. Greater rxn specificity
   - Recognize specific reactants and make specific products
   - High degree of stereospecificity
4. Capacity for regulation
   - Regulate enzyme amount and reactivity
   - Regulate by phosphorolation, glycosylation

Free energy diagram



$E + S \rightleftharpoons E\text{-}S^{\ddagger} \rightleftharpoons E + P$

E → enzyme
S → substrate
P → product

Thermodynamics of the system remains the same with or without catalyst. Same energy starting point and same energy needed/released.

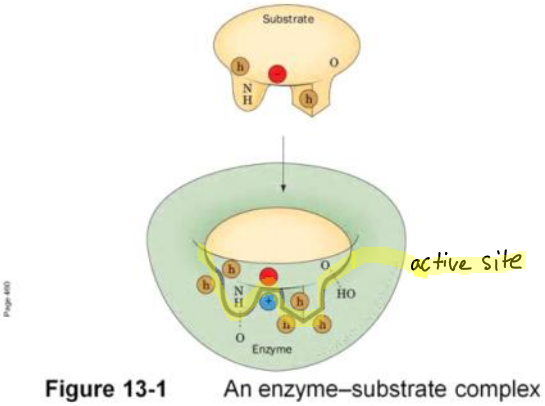


Figure 13-1 An enzyme–substrate complex

- Active site:
  - Pocket
  - Surface is lined with amino acids that react with the substrate
  - Pocket provides what we call a microenvironment that favors a reaction energetically

Need to know these:

Classes of Enzymes

- Enzymes are classified based on the reaction they catalyze.
- Enzymes catalyze reactions in either direction depending on which is thermodynamically favored

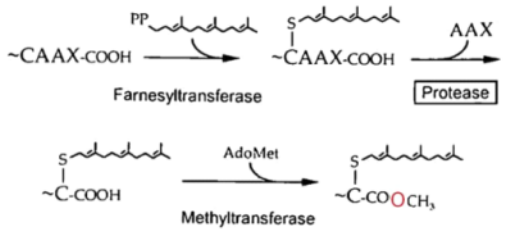
1. Oxidoreductases--- oxidation-reduction reactions
   ex: catalase
2. Transferases-- transfers functional groups.
3. Hydrolases--hydrolysis reactions
   ex: protease
4. Lyases-- a) group elimination to change a single bond to a double bond
   b) breaking of a single bond to form 2 products, one of which has a new double bond.
5. Isomerases-- isomerization
6. Ligases-- bond formation coupled to ATP hydrolysis

4 levels of classification (by Enzyme Commision E.C.)

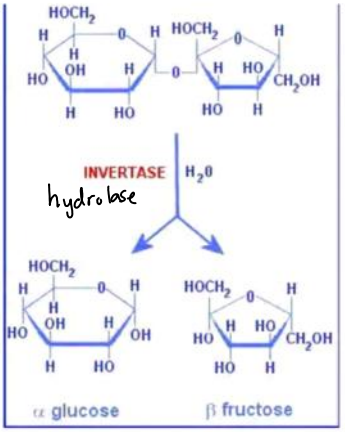
Catalase E.C.1.11.1.6

*just need to know that this naming exist.

Correction from 10/23 Notes:



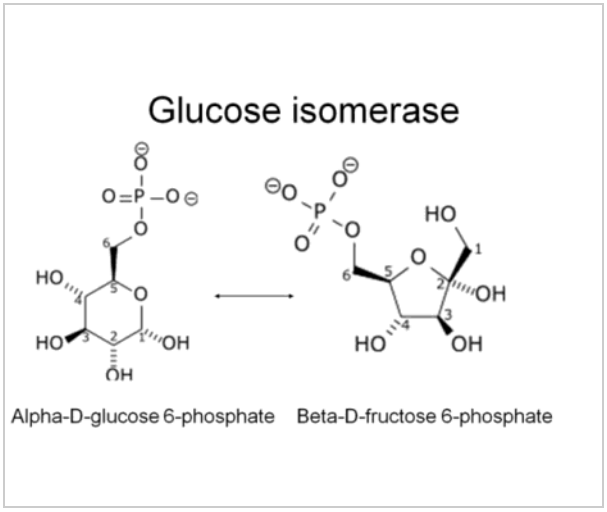
Sucrose



- Invertase is a hydrolase.
  - More technical name is beta-fructosidase
- "inverted" sugar refers to broken down sucrose of glucose and fructose because when broken down it becomes a syrupy mixture (bees do this naturally to make honey)
- Glycosidase
- Used in industry
- Yeast
- Humans have sucrase in the small intestine
- To detect sucrose, use invertase to break down then Tollen's Reagent or Benedicts solution to detect glucose.

Invertase

Use invertase to make gooey centers in candy, chocolate, etc.



- Enzymes sometimes work by themselves, other times need "sidekick" called a cofactor
- Cofactor can be
  - Inorganic ion (Fe^{2+}, Mg^{2+}, Mn^{2+}, Zn^{2+})
  - Coenzyme - organic or organometallic molecule
  - When cofactor is tightly or covalently bonded to protein it is considered a prosthetic group
  - Carbonic anhydrase uses Zn^{2+}
  - Holoenzyme
    - Protein part is apoenzyme or apoprotein

- Lipid Bilayers
  - Fluid Mosiac Model… plasma membrane is fluid, not static
    - Lateral diffusion
    - Transverse diffusion (flip-flop)
      - Rare
      - Dive into hydrophobic region to go to other side