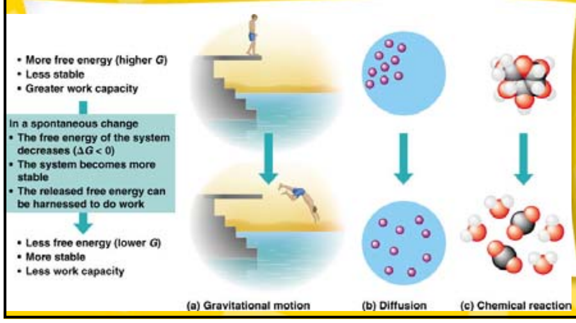
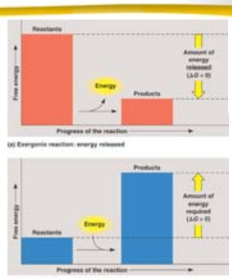
Enzymes

Free Energy and ΔG



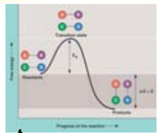
ΔG

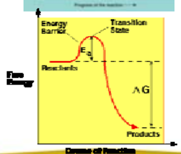
- Energy of Products vs. Energy of Reactants



Activation Energy

- Enzymes Lower Activation Energy





Activation Energy E_A

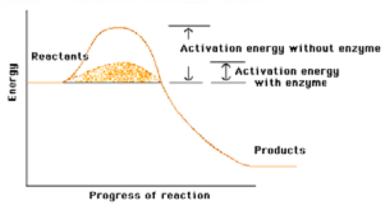


Fig. Lowering the activation energy for chemical reactions by enzymes.

Enzymes

- Catalyst = chemical agent that accelerates a reaction without being permanently changed in the process.
- Enzymes= biological catalysts made of protein.
  - Enzymes lower the activation energy required to get it going.

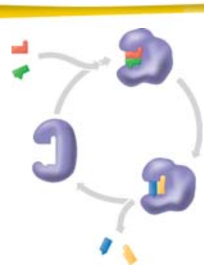
Enzymes

- Energy of activation (activation energy or E_A)= amount of energy that reactant molecules need to absorb to start a reaction.
- Enzymes:
  - Are proteins.
  - Lower activation energy.
  - Do not change the nature of the reaction but only speed it up.
  - Are very selective.
  - Can continue their function after a reaction.

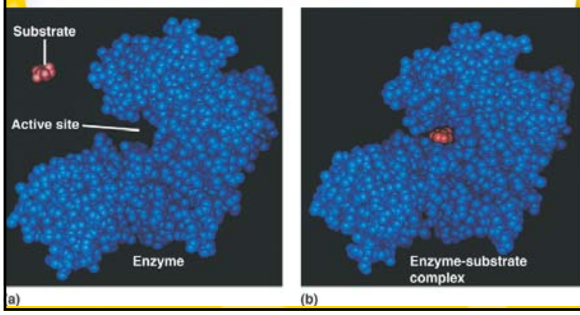
Enzymes

- Substrate specific.
  - Substrate – the substance an enzyme acts on.
  - Place where enzyme binds to substrate is called the active site.

Enzyme Function



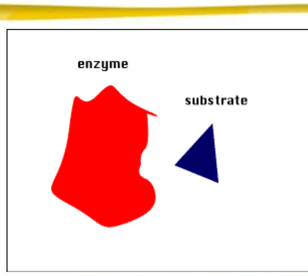
Induced Fit vs. Old "Lock and Key"



Active Site

- Restricted region of an enzyme that binds to substrate.
  - Usually a pocket or groove on proteins surface.
  - Formed with only a few of the enzymes amino acids (charged etc…)
  - Determines specificity.
  - Changes shape in response to substrate.

Induced Fit



Enzymes Lower Activation

- Active site hold two or more reactants in proper position.
- Induced fit may distort bonds making it easier.
- Active site provides proper microenvironment.
- Amino acids may play a direct role in reaction.

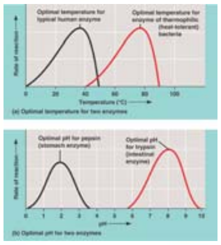
Rates of Reaction

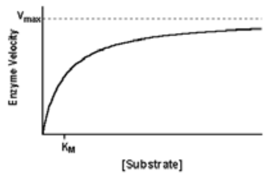
- The higher the substrate the higher the rate of reaction up to a point.
- Enzyme become saturated at a point.
  - Then it depends on how fast the reaction happens.
  - Can increase if more enzyme is added up to a point.

Cell's Environment

- Temperature- each has an optimal temperature. Most between 35-40°C.
- Increases with temp up to a point.
- Ph- amount of charge in the environment.

Temp, pH, and Substrate Conc.





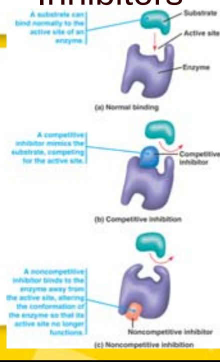
Cofactors

- Cofactors – small non-protein molecules that are required for proper enzyme function.
  - May bind to active site.
  - May bind loosely to enzyme and substrate.
  - Some are inorganic (metals like magnesium).
  - Some are organic (coenzymes; Most are vitamins).

Enzyme Inhibitors

- Can be reversible or irreversible.
- Competative inhibitors- compete for active site.
  - Sulpha drugs.
- Non-competitive inhibitors – don't bind to active site.
  - Metals, antibiotics, DDT or another molecule in the metabolic pathway.

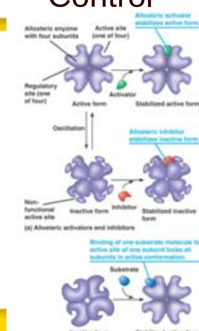
Inhibitors



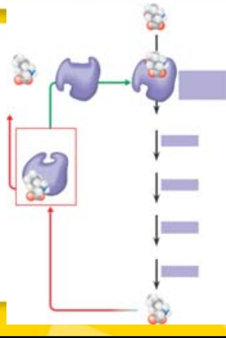
Controlling Reaction Rates

- Allosteric regulation.
  - Specific site on enzyme other than active site.
  - Allosteric regulator can bind and then make the enzyme effective or visa versa.
- Feedback inhibition.
- Cooperativity- substrate may enhance the enzymes function.
- Compartmentilization helps regulation.

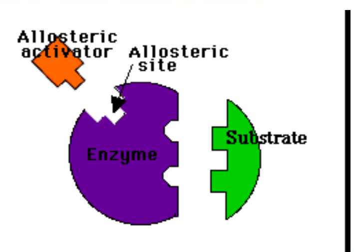
Allosteric Control

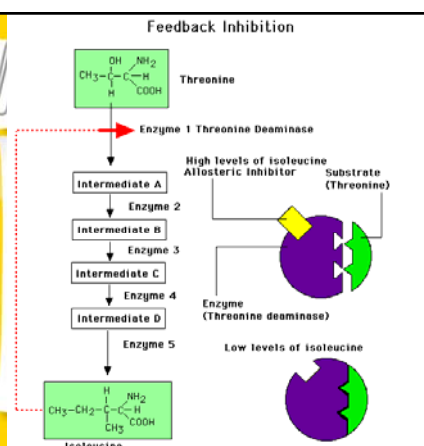


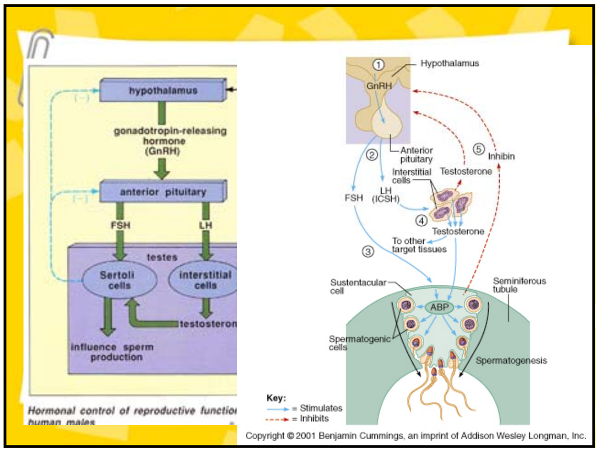
Allosteric Control



Allosteric Control






hypothalamus
gonadotropin-releasing hormone (GnRH)
anterior pituitary
FSH
LH
testes
Sertoli cells
interstitial cells
testosteron
influence sperm production
Hormonal control of reproductive functio
human males
Hypothalamus
GnRH
Anterior pituitary
Inhibin
Interstitial cells
Testosterone
FSH
LH (ICSH)
Testosterone
To other target tissues
Sustentacular cell
Seminiferous tubule
ABP
Spermatogenic cells
Spermatogenesis
Key:
= Stimulates
= Inhibits
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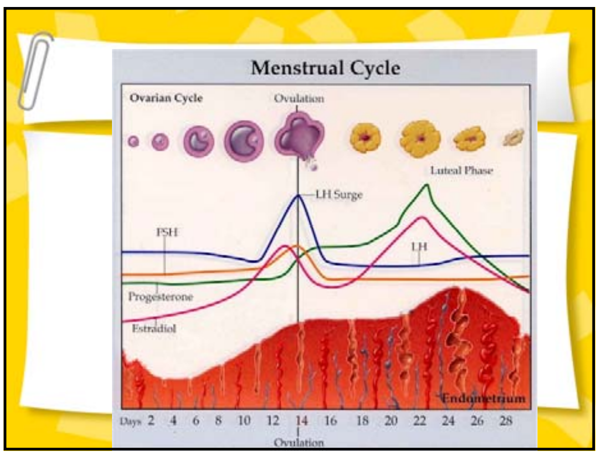
Menstrual Cycle
Ovarian Cycle
Ovulation
Luteal Phase
LH Surge
FSH
LH
Progesterone
Estradiol
Endometrium
Days 2 4 6 8 10 12 14 16 18 20 22 24 26 28
Ovulation