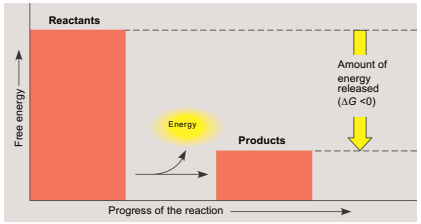
Repetition

Summary of last lecture

Exergonic and Endergonic Reactions in Metabolism

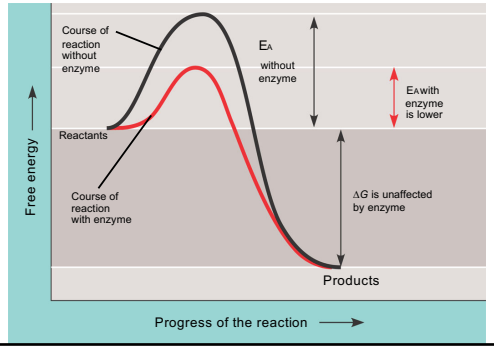
- An **exergonic** reaction
  - proceeds with a net release of free energy and is spontaneous



Exergonic reaction: energy released

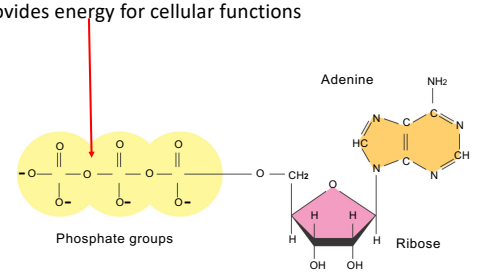
Enzymes Act as Catalysts and Lower the Reaction Activation Energy (E_A) Barrier

- An enzyme catalyzes reactions by lowering the E_A barrier
- The effect of enzymes on reaction rate



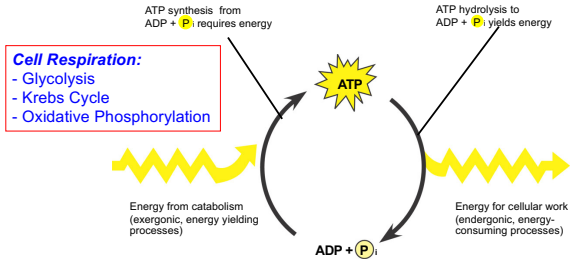
The Structure and Hydrolysis of ATP

- ATP (adenosine triphosphate)
  - is the cell's energy shuttle ('currency')
  - provides energy for cellular functions

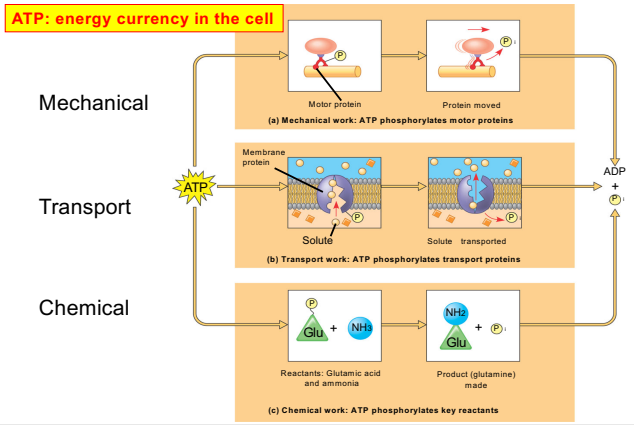


The Regeneration of ATP

- Catabolic pathways
  - drive the regeneration of ATP from ADP and phosphate

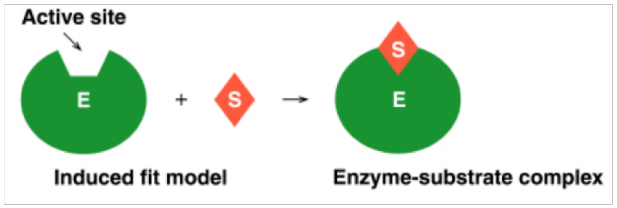


Three types of cellular energy-dependent processes

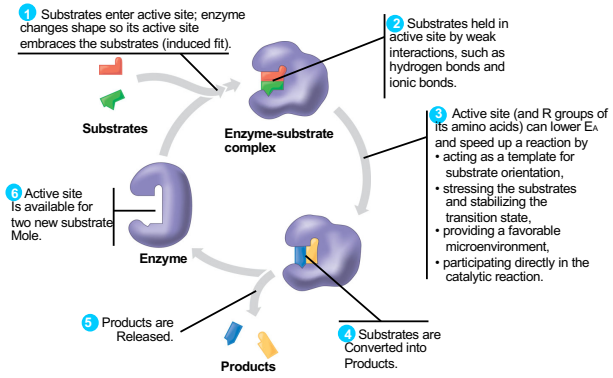


Induced Fit Model

- In the **induced-fit model** of enzyme action:
  - the active site is flexible, not rigid
  - the shapes of the enzyme, active site, and substrate adjust to maximize the fit, which improves catalysis
  - there is a greater range of substrate specificity
- This model is more consistent with a wider range of enzymes

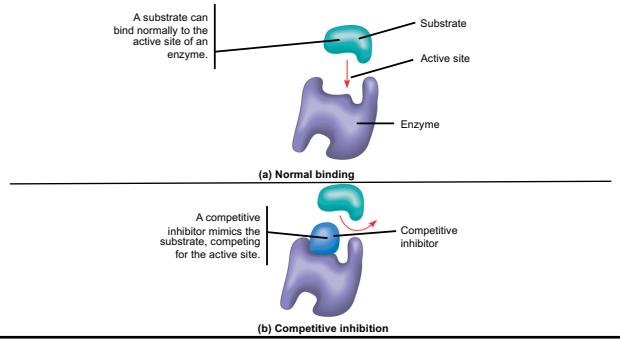


- **The catalytic cycle of an enzyme** (conformation changes during the cycle)

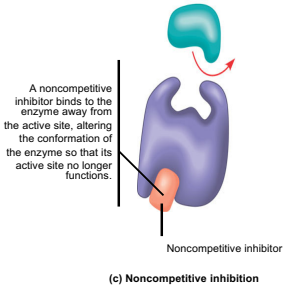


Enzyme Inhibitors

- Competitive inhibitors
  - Bind to the active site of an enzyme, competing with the substrate



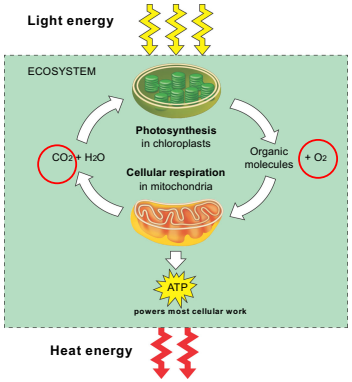
- Noncompetitive inhibitors
  - bind to another part of an enzyme, changing the function



Repetition

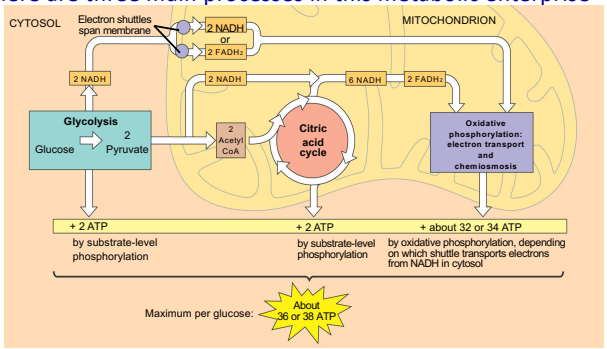
Summary of last lecture

Energy flows into an ecosystem as sunlight and leaves it as heat



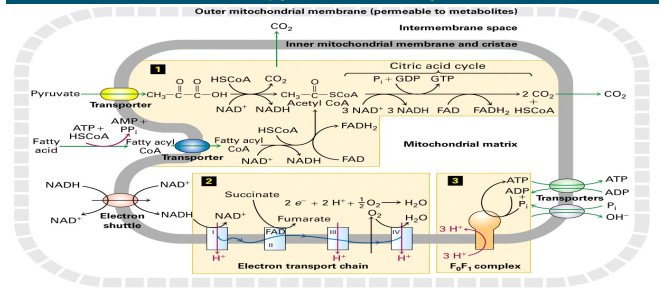
Cell Respiration

There are three main processes in this metabolic enterprise



- About 40% of the energy in a glucose molecule is transferred to ATP during cellular respiration, making approximately 38 ATP

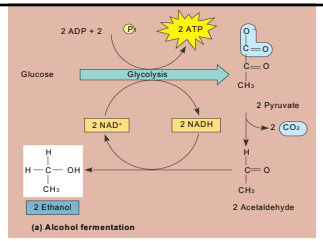
Aerobic oxidation of pyruvate and fatty acids in mitochondria



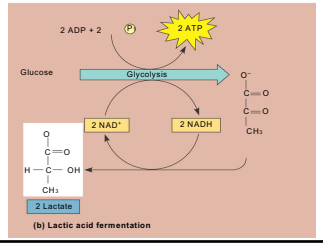
The outer membrane is freely permeable to all metabolites, but specific transport proteins (colored ovals) in the inner membrane are required to import pyruvate (yellow), ADP (green), and P_i (purple) into the matrix and to export ATP (green). NADH generated in the cytosol is not transported directly to the matrix because the inner membrane is impermeable to NAD^+ and NADH; instead, a shuttle system (red) transports electrons from cytosolic NADH to NAD^+ in the matrix. O_2 diffuses into the matrix and CO_2 diffuses out. Stage-1: fatty acyl groups are transferred from fatty acyl CoA and transported across the inner membrane via a special carrier (blue oval) and then reattached to CoA on the matrix side. Pyruvate is converted to acetyl CoA with the formation of NADH, and fatty acids (attached to CoA) are also converted to acetyl CoA with formation of NADH and $FADH_2$. Oxidation of acetyl CoA in the citric acid cycle generates NADH and $FADH_2$. Stage-2: electrons from these reduced coenzymes are transferred via electron transport complexes (blue boxes) to O_2 concomitant with transport of H^+ ions from the matrix to the intramembrane space, generating the proton-motive force. Electrons from NADH flow directly from complex I to complex III, bypassing complex II. Stage 3: ATP synthase, the F_0F_1 complex (orange), harnesses the proton-motive force to synthesize ATP. Blue arrows indicate electron flow; red arrows transmembrane movement of protons; and green arrows indicate transport of metabolites.

Types of Fermentation
(ATP without the use of oxygen)

- Fermentation consists of
- - glycolysis plus reactions that regenerate NAD^+, which can be reused by glyocolysis



- In alcohol fermentation
  - pyruvate is converted to ethanol in two steps, one of which releases CO_2
- During lactic acid fermentation
  - pyruvate is reduced directly to NADH to form lactate as a waste product



- **Glycolysis and the citric acid cycle connect to many other metabolic pathways**

The Versatility of Catabolism

- Catabolic pathways
  - Funnel electrons from many kinds of organic molecules into cellular respiration
- The catabolism of various molecules from food