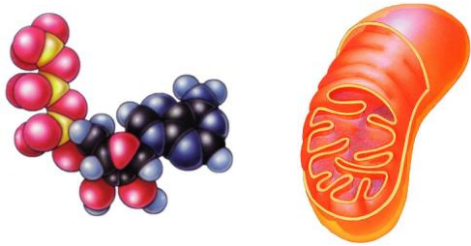



Chapter 7

Cellular Respiration: Harvesting Chemical Energy



Harvesting stored energy

- Energy is stored in organic molecules
 - ◆ heterotrophs eat food (organic molecules)
 - digest organic molecules
 - ◆ serve as raw materials for building & fuels for energy
 - controlled release of energy
 - ◆ series of step-by-step enzyme-controlled reactions
 - ◆ **“burning” fuels**
 - carbohydrates, lipids, proteins, nucleic acids



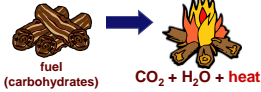
Harvesting energy stored in glucose

- Glucose is the model
 - ◆ catabolism of glucose to produce ATP

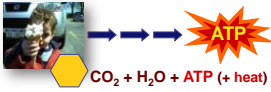
respiration
glucose + oxygen → carbon dioxide + water + energy

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP + \text{heat}$$

combustion = making heat energy by burning fuels in one step

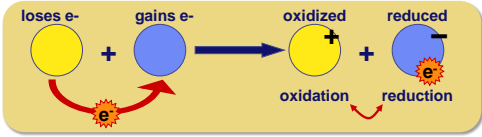


respiration = making ATP (& less heat) by burning fuels in many small steps



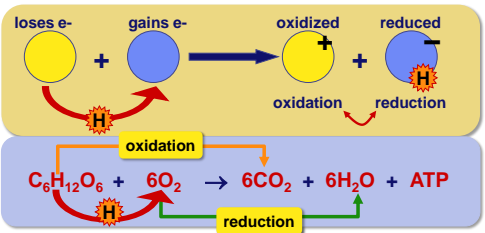
How do we harvest energy from fuels?

- Digest large molecules into smaller ones
 - ◆ break bonds & move electrons from one molecule to another
 - as electrons move they carry energy with them
 - that energy is stored in another bond, released as heat, or harvested to make ATP



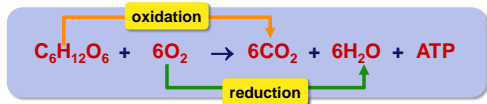
How do we move electrons in biology?

- Moving electrons
 - ◆ in living systems, electrons do not move alone
 - electrons move as part of H atom



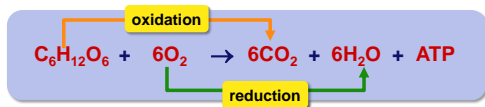
Coupling oxidation & reduction

- Redox reactions in respiration
 - ◆ release energy as breakdown molecules
 - break C-C bonds
 - strip off electrons from C-H bonds by removing H atoms
 - ◆ C₆H₁₂O₆ → CO₂ = fuel has been oxidized
 - electrons attracted to more electronegative atoms
 - ◆ in biology, the most electronegative atom? →
 - ◆ O₂ → H₂O = oxygen has been reduced
 - release energy to synthesize ATP



Oxidation & reduction

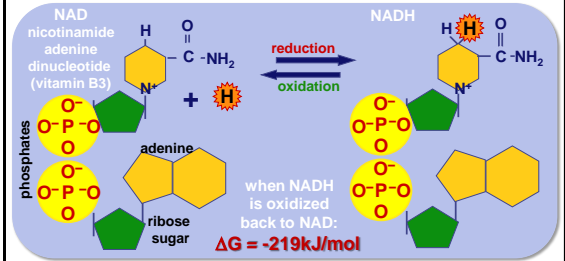
- | | |
|---|--|
| <ul style="list-style-type: none"> ▪ Oxidation ◆ adding O ◆ removing H ◆ loss of electrons ◆ releases energy ◆ <u>exergonic</u> | <ul style="list-style-type: none"> ▪ Reduction ◆ removing O ◆ adding H ◆ gain of electrons ◆ stores energy ◆ <u>endergonic</u> |
|---|--|



Moving electrons in respiration

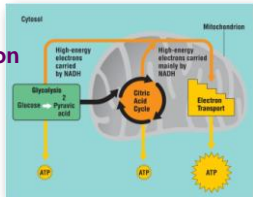
- Electron carriers move electrons by shuttling H atoms around
- ◆ $NAD^+ \rightarrow NADH$ (reduced)
- ◆ $FAD^{+2} \rightarrow FADH_2$ (reduced)

now has reducing power!



Overview of cellular respiration

- 4 metabolic stages
- ◆ Anaerobic respiration
 - 1. Glycolysis
 - ◆ respiration without O_2
 - ◆ in cytosol
- ◆ Aerobic respiration
 - ◆ respiration using O_2
 - ◆ in mitochondria
 - 2. Pyruvate oxidation
 - 3. Kreb's cycle
 - 4. Electron transport chain



What's the point?



The Point is to Make ATP!
Any Questions??