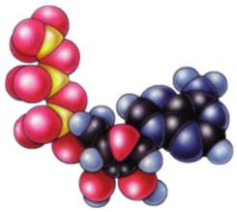
Chapter 9.1
Cellular Respiration: Harvesting Chemical Energy



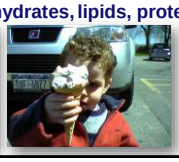

Nutritional Requirements

- Animals are heterotrophs
  - need to take in food
  - Why? fulfills 3 needs…
    - fuel = chemical energy for production of ATP
    - raw materials = carbon source for synthesis
    - essential nutrients = animals cannot make
      - elements (N, P, K, Fe, Na, K, Ca...), NAD, FAD, etc.

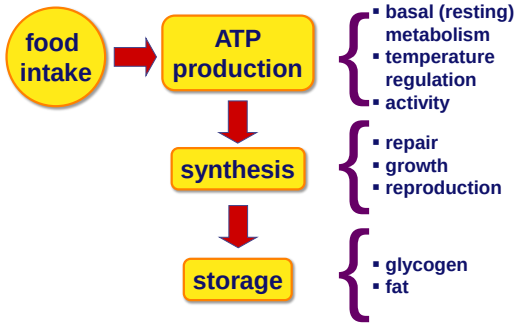


Harvesting stored energy

- 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

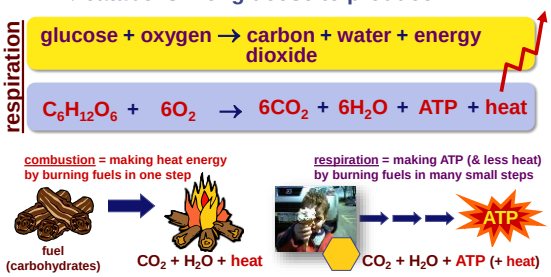




Energy Budget



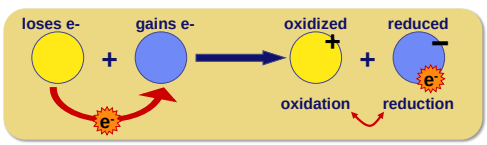
Harvesting energy stored in glucose

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



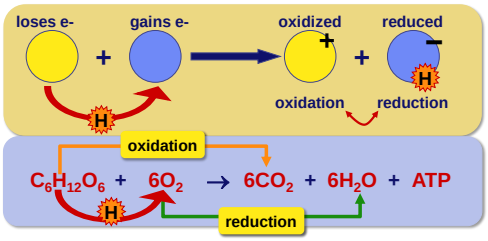
How do we harvest energy from fuels?

- 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



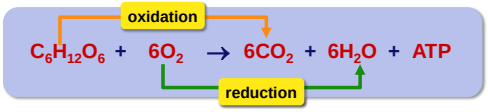
How do we move electrons in biology?

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



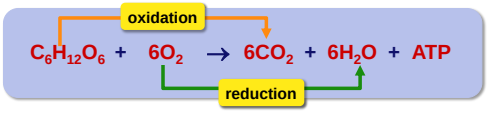
Coupling oxidation & reduction

- Redox reactions in respiration
  - release energy as breakdown molecules
    - break C-C bonds
    - strip off electrons from C-H bonds by removing H atoms
      - $C_6H_{12}O_6 \rightarrow CO_2$ = fuel has been oxidized
    - electrons attracted to more electronegative atoms
      - in biology, the most electronegative atom? $\rightarrow O_2$
      - $O_2 \rightarrow H_2O$ = oxygen has been reduced
    - release energy to synthesize ATP



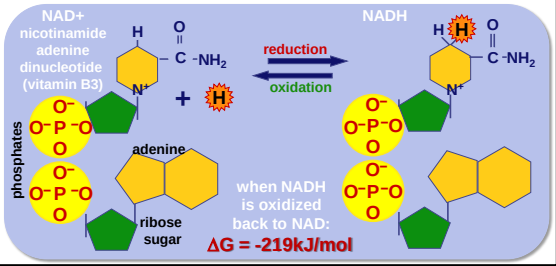
Oxidation & reduction

- Oxidation
  - adding O
  - removing H
  - loss of electrons
  - releases energy
  - exergonic
- Reduction
  - removing O
  - adding H
  - gain of electrons
  - stores energy
  - endergonic



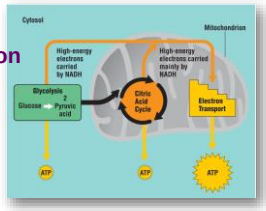
Moving electrons in respiration

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



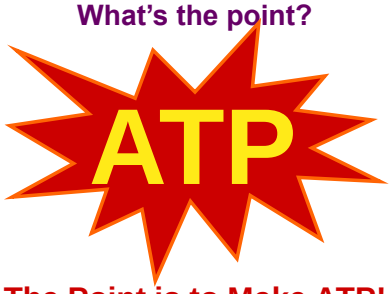
Overview of cellular respiration

- 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



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

What's the point?



The Point is to Make ATP!

Any Questions??