

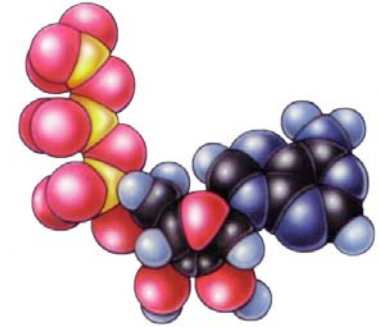
Chapter 9.

Cellular Respiration

Harvesting Chemical Energy



What's the point?

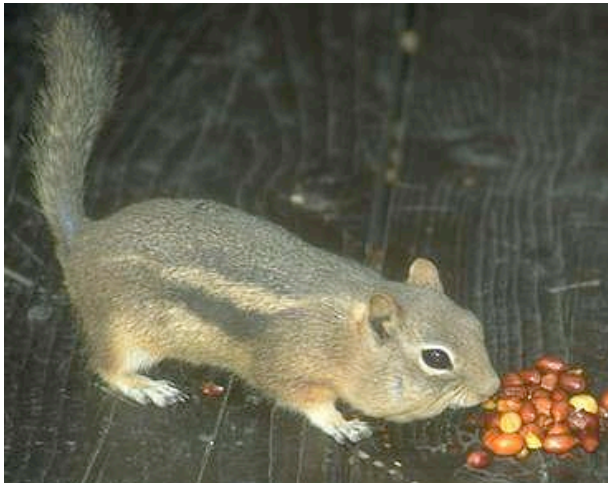


ATP

The Point is to Make ATP!

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 + water + energy
dioxide



combustion = making heat energy
by burning fuels in one step



fuel
(carbohydrates)

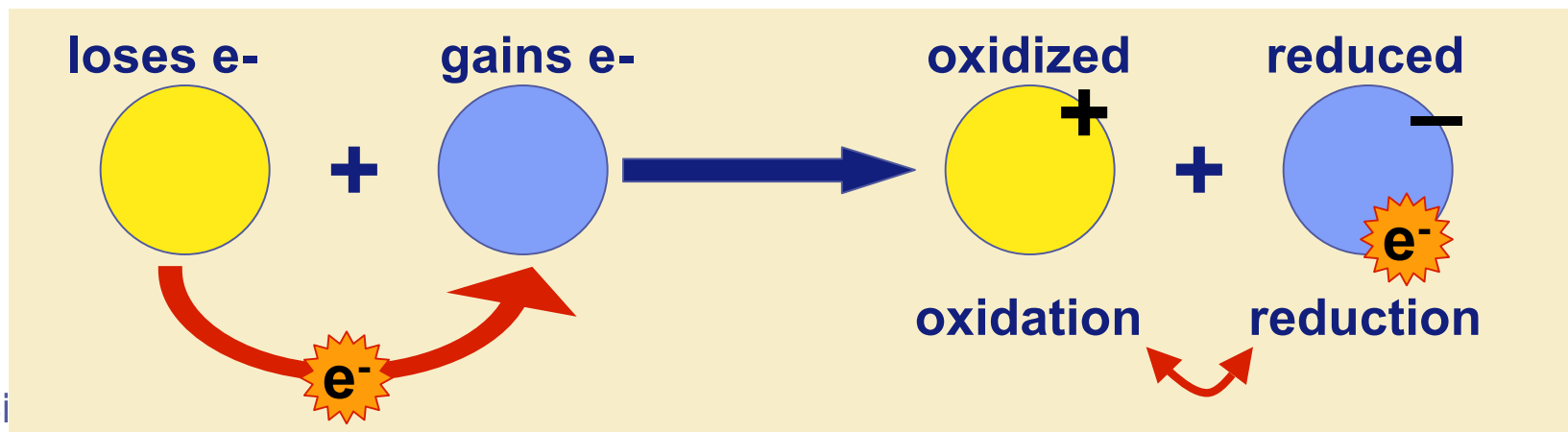


respiration = making ATP (& less heat)
by burning fuels in many small steps



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

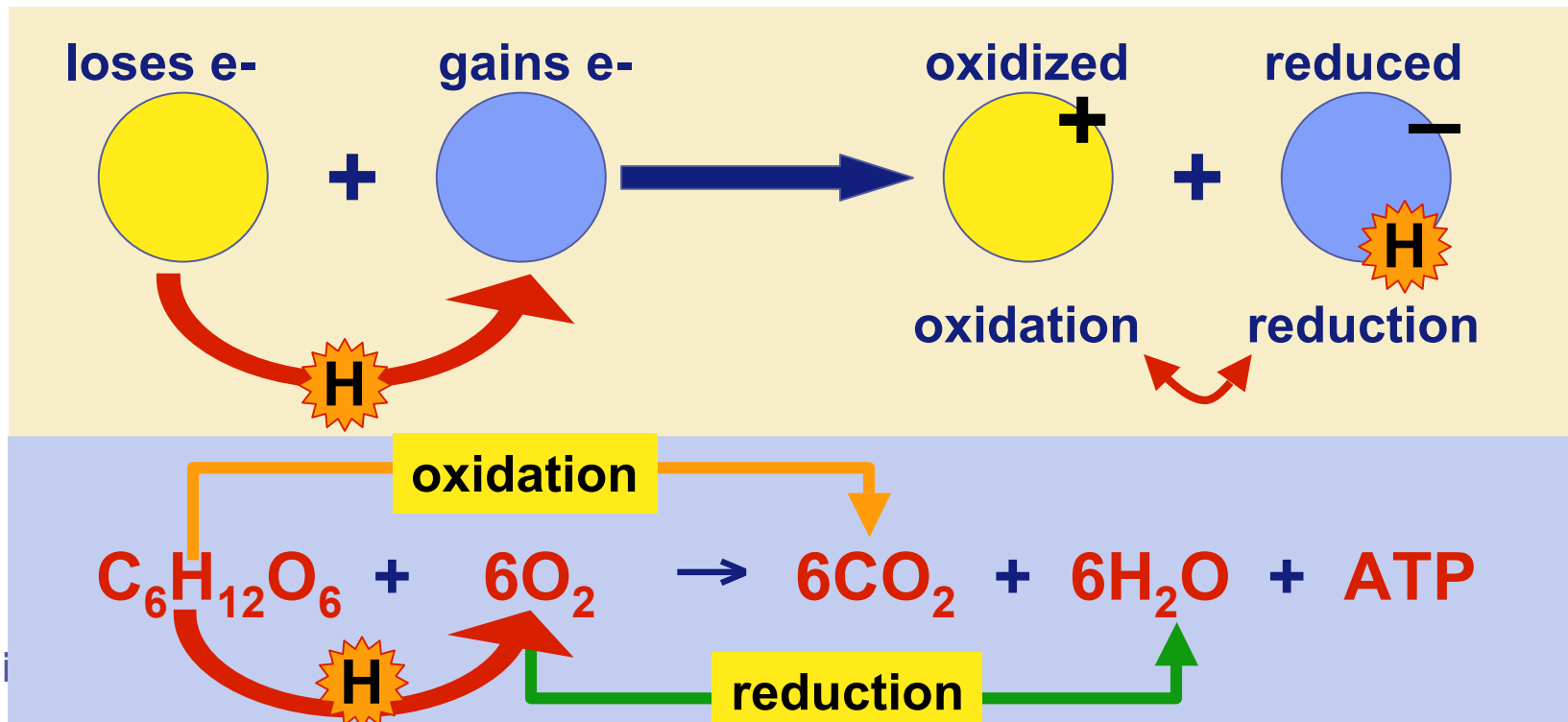


How do we move electrons in biology?

- Moving electrons

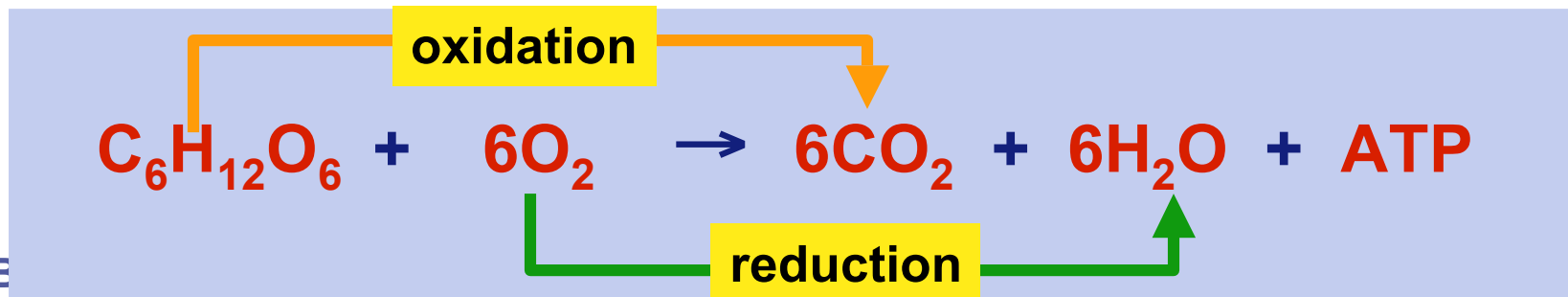
- ◆ in living systems, electrons do not move alone

- 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
 - ◆ $C_6H_{12}O_6 \rightarrow CO_2$ = 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



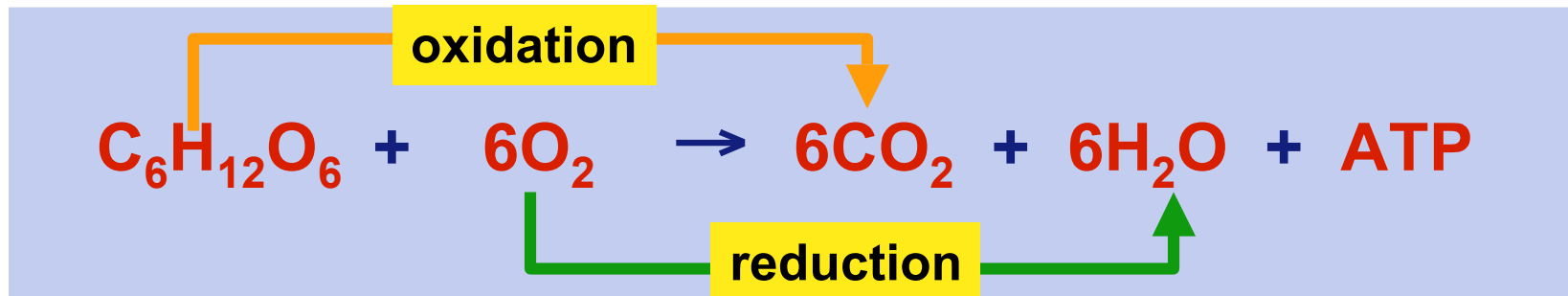
Oxidation & reduction

■ Oxidation

- ◆ adding O
- ◆ removing H
- ◆ loss of electrons
- ◆ releases energy
- ◆ exergonic

■ Reduction

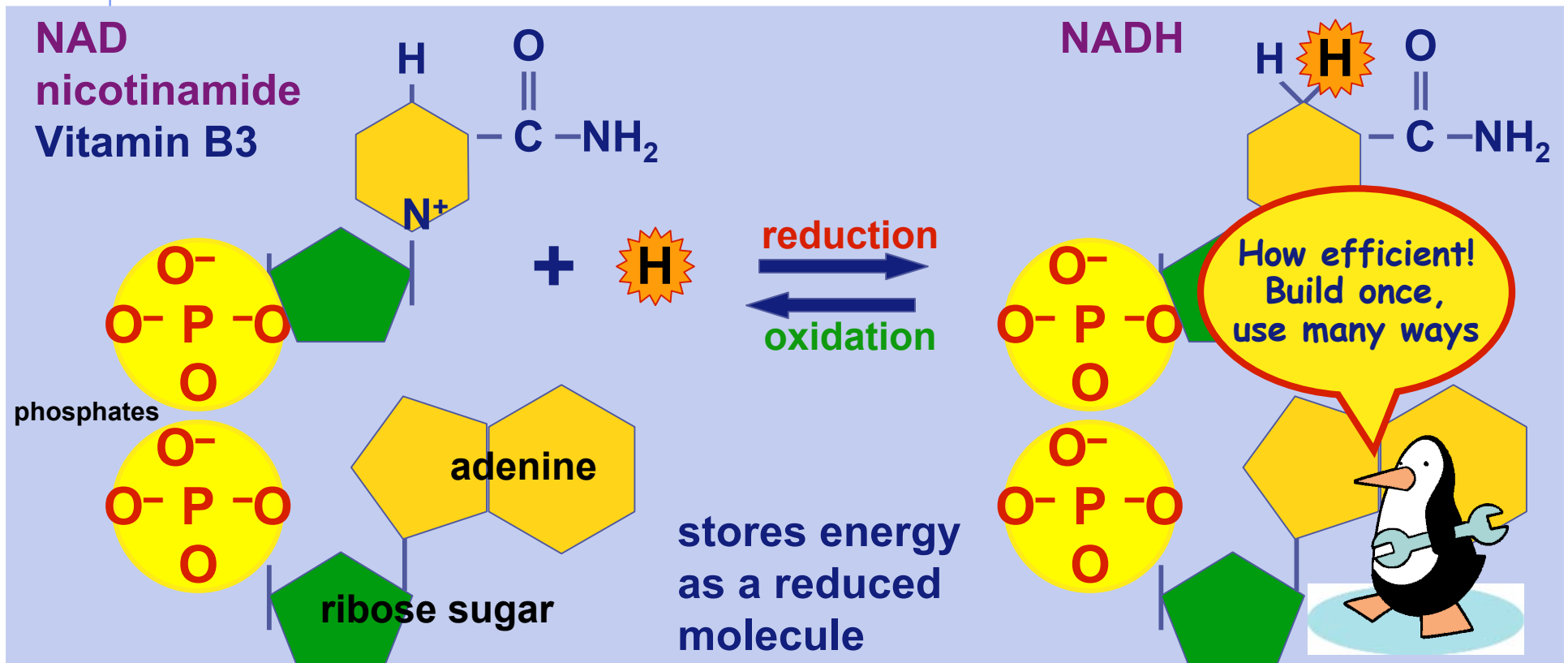
- ◆ removing O
- ◆ adding H
- ◆ gain of electrons
- ◆ stores energy
- ◆ endergonic



Moving electrons in respiration

- Electron carriers move electrons by shuttling H atoms around
 - ◆ $\text{NAD}^+ \rightarrow \text{NADH}$ (reduced)
 - ◆ $\text{FAD}^{+2} \rightarrow \text{FADH}_2$ (reduced)

reducing power!



Overview of cellular respiration

- 4 metabolic stages

- ◆ Anaerobic respiration

- 1. Glycolysis

- ◆ respiration without O_2
- ◆ in cytosol

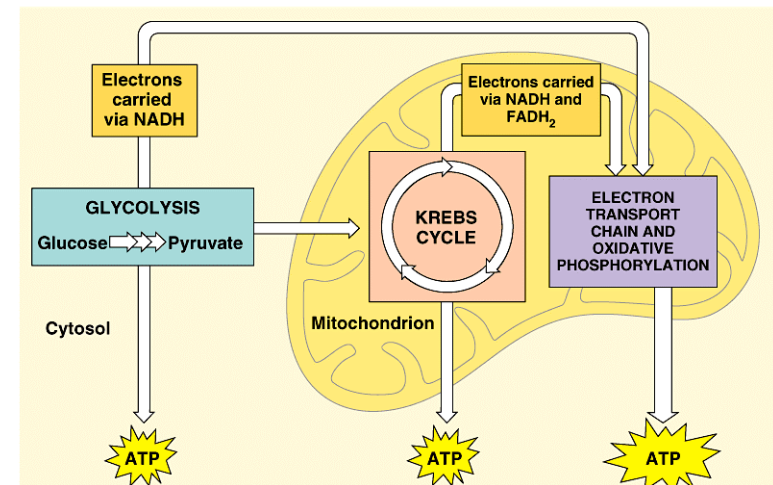
- ◆ Aerobic respiration

- ◆ respiration using O_2
- ◆ in mitochondria

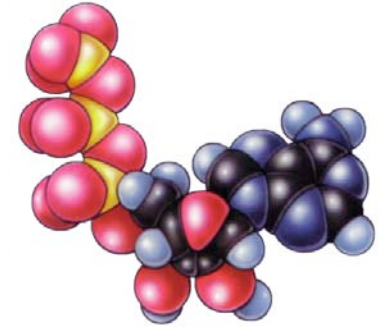
- 2. Pyruvate oxidation

- 3. Kreb's cycle

- 4. Electron transport chain



What's the point?



The Point is to Make ATP!



Any Questions??