General Biology Lecture Outline

Lecture 12

Overview: Energy Use

- Ch. 8: Respiration
  - Photosynthesis vs. respiration
  - Overview of cellular respiration
  - Glycolysis
  - Fermentation pathways

ATP & Energy

- Autotrophs
- Heterotrophs
- Energy
  - Acquired by photosynthesis
  - Converted to ATP
  - Stored in larger molecules
  - Broken down to make ATP

Photosynthesis vs. Respiration

Photosynthesis

- Stores energy in sugars
- Uses CO_2 & water
- Increases mass
- Requires light
- In cells with chlorophyll
- Releases oxygen
- Makes ATP with energy from light

Respiration

- Releases energy from sugars
- Releases CO_2 & water
- Decreases mass
- Doesn't require light
- In all living cells
- Uses oxygen (if aerobic)
- Makes ATP with energy from sugars

Assignment 1

- Think, Pair, Share
- Topic: Cellular respiration did not develop in cells until after photosynthesis had been established. Fermentation pathways were used instead. Why didn't cellular respiration develop sooner?

Cellular Respiration

- Requires glucose & O_2
  - Releases CO_2 & H_2O
- Energy released gradually → ATP

Assignment 2

- Topic: In cellular respiration, the breakdown of one glucose molecule releases 686 kcal of energy.
  - The energy stored in each ATP is 7.5 kcal. How much energy is stored in all ATP (36 total)?
  - What is the efficiency of aerobic respiration (the energy in ATP / the energy released × 100%)?
  - What happens to the energy that is lost?

Efficiency of Cellular Respiration

- More efficient than most processes
  - E.g., energy in gasoline to car motion only 20% - 30% efficient

Oxidation-Reduction

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

- Hydrogen atoms ($H^+ + e^-$) transferred from $C_6H_{12}O_6$ to O_2
  - Glucose is oxidized (electrons lost)
  - Oxygen is reduced (electrons gained)

Oxidation-Reduction

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

- Oxidizes glucose to CO_2
  - Releases energy: energy in glucose → ATP
  - Requires coenzymes to carry electrons
    - $NAD^+ + 2e^- + H^+ \rightarrow NADH$
    - $FAD + 2e^- + 2H^+ \rightarrow FADH_2$

Cellular Respiration

- Glycolysis (anaerobic)
  - Glucose → 2 pyruvate
    - To fermentation if no oxygen available
  - NADH
  - 2 ATP (net)