

Unit 1

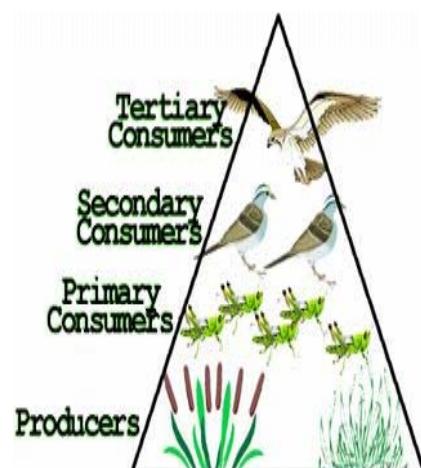
Matter & Energy for Life

Chapter 3
Energy For Cells

Biology 2201

Energy in Cells

- Only about 2% of the sun's energy reaches the earth
 - Energy is harvested by photosynthesizes
 - 10% of this energy is passed up the food chains from primary consumers up to tertiary consumers.
 - Some energy is lost as heat during each conversion



Types of Energy

- Energy
 - The capacity to do work
 - Light, heat, electrical, etc
- Potential Energy
 - Stored energy
 - Sugar, ATP
- Kinetic Energy
 - Energy of Motion
- Chemical Energy
 - Energy stored in bond in the atoms between molecules
 - Once bonds are broken the energy is released
- Metabolism
 - Total of all the chemical reactions that take place within a cell
 - Includes all of the building up and breaking down of substances in a cell
 - Relies on chemical energy within the cell

Photosynthesis

- The process by which an organism captures the energy of the sun to convert CO₂ and water into glucose.
- Light energy is converted into chemical energy.
- The process looks as follows:
 Light , chlorophyll
 carbon dioxide + water → glucose + oxygen

$$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow 6\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$$

Importance of Photosynthesis

1. It is the chief source of energy on earth.
2. It supplies most of the oxygen found in the atmosphere.
3. It is the first step in food chains.

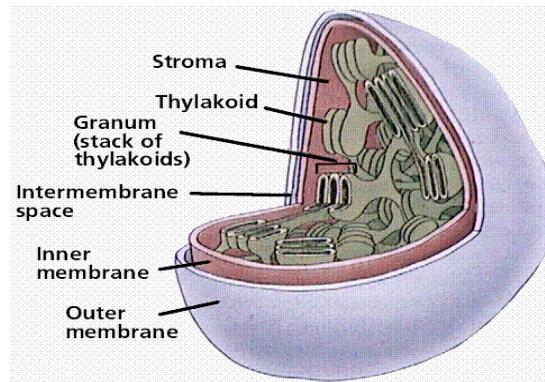


Who Does It? Who Doesn't?

- Organisms that carry on photosynthesis are called *autotrophs* or *producers*. They contain *chlorophyll* inside cell organelles called *chloroplasts*.
- Organisms that are not able to carry on photosynthesis are called heterotrophs and capture their food. They depend on plants directly or indirectly as their source of food.

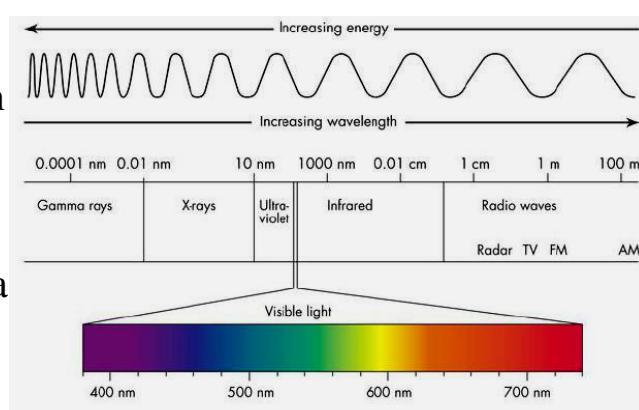
Chloroplast

- Energy is put into this system during a 'Light reaction' in the Thylakoid.
- Sugars are created during a 'synthesis reaction' that can take place in the dark. Also called 'dark reaction' or 'Calvin Cycle'



What is Light?

- Visible light makes up a very small portion of the range of radiations known as the **electromagnetic spectrum**.
 - All light travels as a wave that behaves as a particle
 - Composed of small packets of energy called **photons**



Photosynthetic Pigments

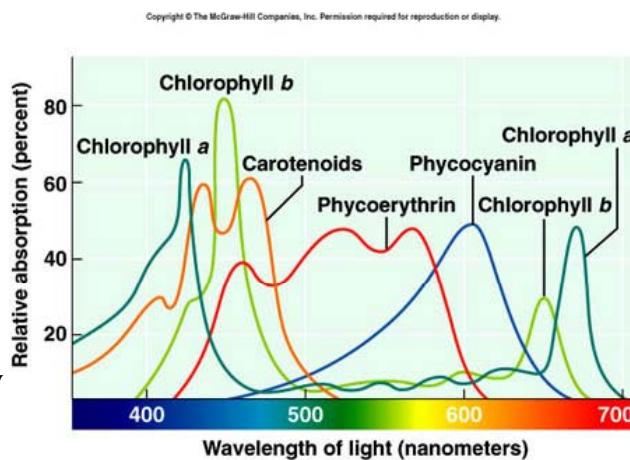
- In order to capture sunlight, plants require special pigments.
- A pigment is any substance that can absorb light.
- Several types of pigments are necessary to trap the full light spectrum.
- These pigments consist of
 - red, orange, yellow, green, blue, and violet

Pigments - Chlorophyll

- Most important pigment
 - Present in the largest numbers compared to other pigments
 - Capture red and blue light while reflecting green
 - Green in color
 - There are two types
- Chlorophyll A
 - This is the primary photosynthesis pigment. It directly converts light energy to chemical energy.
 - Chlorophyll B
 - Absorbs light energy and transfers it to chlorophyll A.

Carotene & Xanthophylls

- Carotenes
 - Orange in colour
- Xanthophylls
 - Yellow in colour
- Both absorb light in the regions of the colour spectrum no covered by chlorophyll



Light Reaction vs. Dark Reaction

Light Reaction

- Requires light and takes place on the thylakoid membrane of the chloroplast.
- Chlorophyll captures the sun's energy and uses it to produce oxygen and high energy compounds which are used in the dark reaction.

Dark Reaction

- Does not require light, but does depend upon the high energy chemical products made in the light reaction.
- This reaction occurs in the stroma.
- The reaction produces glucose and is often called carbon fixation

Rate of Photosynthesis – 4 Factors

1. Light Intensity

- The greater the amount of light, the more photosynthesis occurs

2. Temperature

- below 0°C and above 35°C there is little photosynthesis

3. Water

- when in short supply, photosynthesis slows down

4. Minerals

- When in short supply, photosynthesis slows down

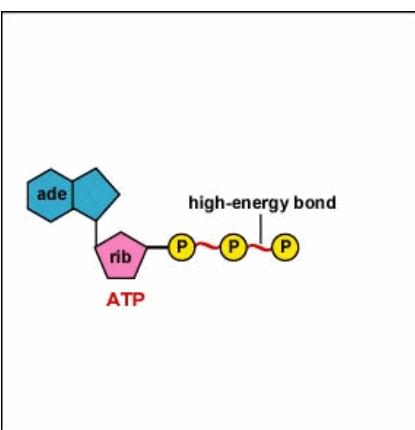
Cellular Respiration

- This is the process of releasing energy, within a cell, through a complex series of chemical reactions.
- It occurs at the mitochondria, and consists of the step-by-step breakdown of a nutrient, most commonly glucose, in order to release energy.
- This energy is then stored in the cell in the form of ATP.
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$
glucose + oxygen → carbon dioxide + water + ATP

Importance of ATP formation

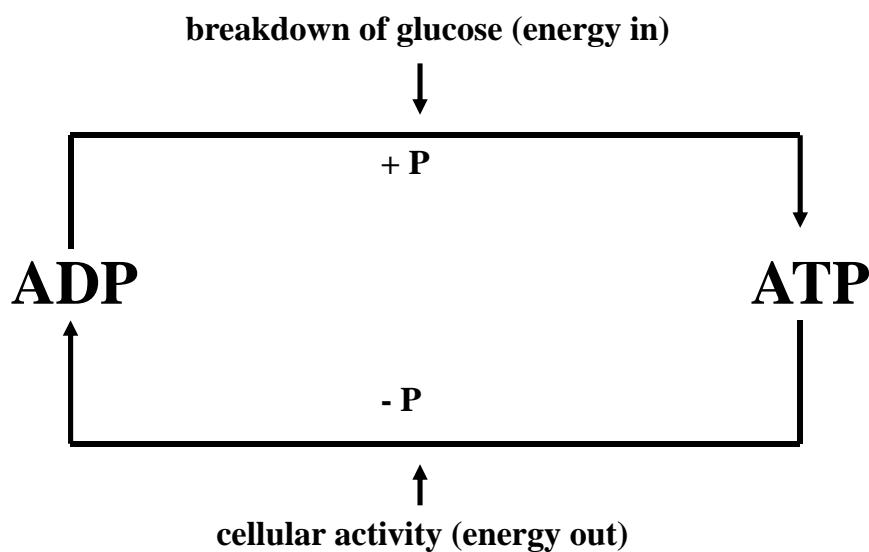
- The energy stored in glucose is not readily available to all cell parts, whereas ATP is.
- Releases energy in the cell with greater control than if the energy came directly from glucose.
- The ATP acts as the intermediary between energy-releasing (exergonic) and energy-requiring (endergonic) reactions in the cell

What is ATP?



- Adenosine Triphosphate
- A high-energy compound found within cells
- Composed of a molecule of adenine and three molecules of phosphate. The phosphates are held to the adenine by high energy bonds
- The bonds break, releasing energy along with ADP (adenosine diphosphate) and a phosphate

ATP –ADP Cycle



Aerobic vs. Anaerobic Respiration

Aerobic Respiration

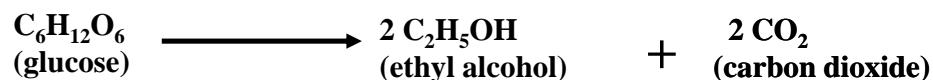
- Glucose is completely oxidized into CO_2 and H_2O in the presence of O_2 to release energy.
- It is the most common form of glucose breakdown, and allows for the maximum amount of energy to be released from the glucose
- Ongoing in all cells most of the time to produce energy

Anaerobic Respiration

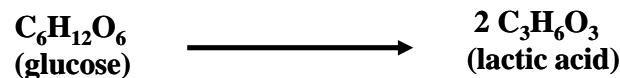
- Glucose is broken down in the absence of oxygen to release energy.
- It creates little energy for the cell. It occurs in smaller organisms and in larger organisms when oxygen is not present.
- Location
 - It occurs in the cytoplasm of plant and animal cells.
- Muscles get sore during exercise because of the lactic acid build-up in the tissues resulting from A.R

Two Aerobic Respiration

Alcohol Fermentation:



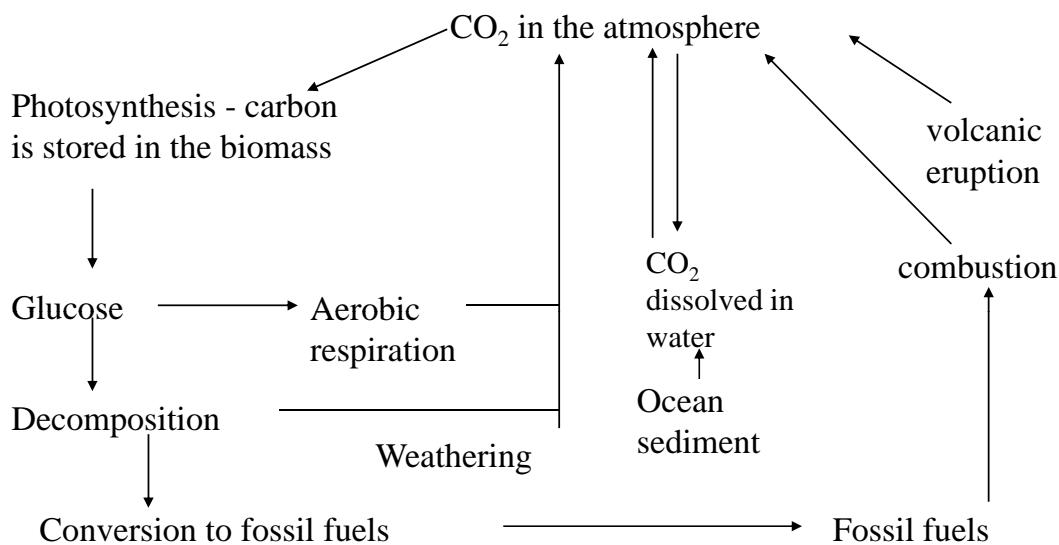
Lactic Acid Fermentation:



The Carbon Cycle

- Respiration and photosynthesis are dependant upon each other
 - Two halves of the carbon cycle
- Photosynthesis produces the raw materials for respiration, and respiration produces the raw materials for photosynthesis

The Carbon Cycle



How Do we Affect the Carbon Cycle?

- Agriculture
 - Clear-cutting
 - Mining
 - Burning fossil fuels
 - Each of these has an overwhelming effect on the levels of carbon available for cycling
 - All of which add carbon to the atmosphere, affecting levels stored in biotic sources (plants / animals)
- See page 88 in textbook

Chapter 3 Review and Test

- Chapter Review Assignment

Hand-out Questions

Due: _____

- Test Date:
