Chapter 8 - Photosynthesis

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Section 8-1: Energy and Life

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Energy is the ability to do work.

Living things depend on energy. Without the ability to obtain and use energy, life would cease to exist.

<u>Autotrophs and Heterotrophs</u>

producers consumers

Greek: *trophe* -> food
autos -> self
heteros -> other

↑ living thing

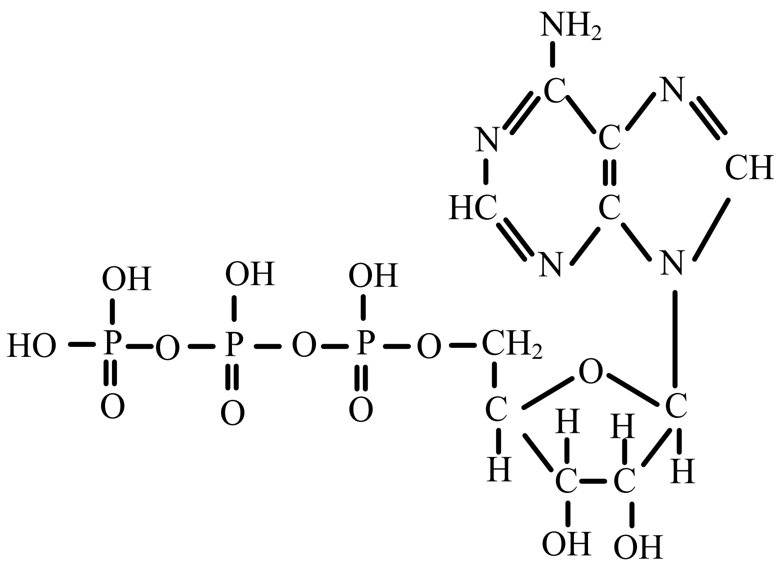
<u>Autotrophs</u> are organisms that use light energy from the sun to make food for themselves.

<u>Heterotrophs</u> are organisms that obtain energy from the foods they consume.

To live, all organisms must release the energy in sugars and other compounds.

Chemical Energy and ATP

One of the principal chemical compounds that cells use to store and release energy is adenosine triphosphate, ATP.



ATP consists of adenine (a nitrogenous base), a 5-carbon sugar called ribose, and three phosphate groups. The phosphate groups are the key to ATP's ability to store and release energy.

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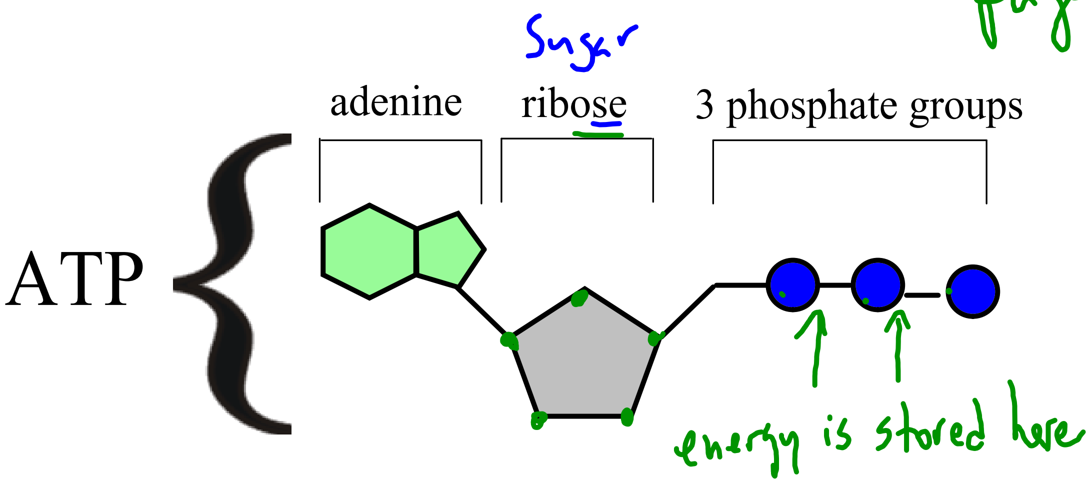
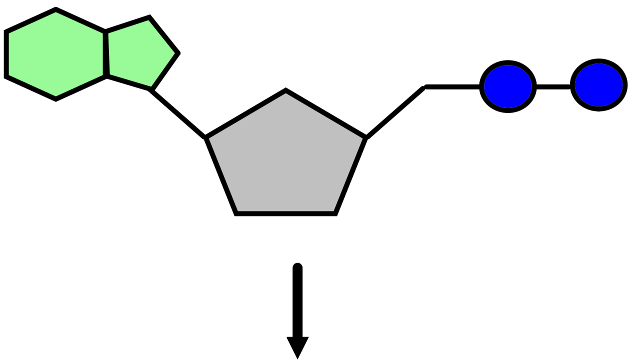


ADP adenosine diphosphate

AMP adenosine monophosphate

Nitrogenous base: A molecule that contains nitrogen and has the chemical properties of a base. The nitrogenous bases in DNA are adenine (A), guanine (G), thymine (T), and cytosine (C). The nitrogenous bases in RNA are the same with one exception: adenine (A), guanine (G), uracil (U), and cytosine (C) adenosine diphosphate

ADP



When a cell has energy available, it can store small amounts of it by adding a phosphate group to ADP molecules, producing ATP.

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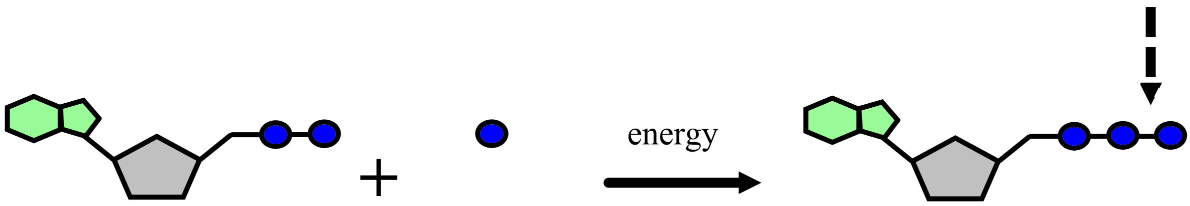


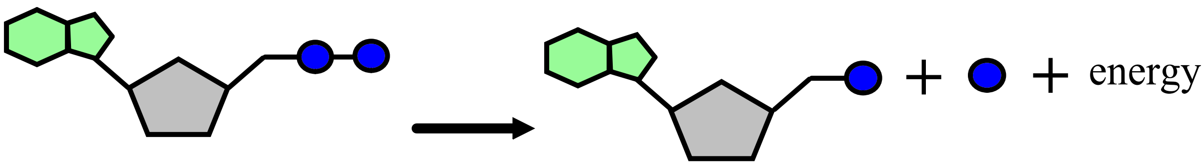
adenosine diphosphate ADP	+	phosphate	energy →	adenosine triphosphate ATP

"partially charge battery"

"fully charged battery"

The addition of a phosphate group is called phosphorylation.

Occasionally.....



adenosine diphosphate
ADP

adenosine monophosphate
AMP

ATP has enough energy to power a variety of cellular activities, including active transport across cell membranes, protein synthesis and muscle contraction.

Most cells have only a small amount of ATP - enough to last a few minutes of activity.

A single molecule of glucose stores more than 90 times the chemical energy of a molecule of ATP. It is more efficient for cells to keep only a small supply of ATP on hand.

Exergonic chemical reactions release energy. They supply needed energy for the synthesis of ATP.

exer → outside
release

Photosynthesis

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The key cellular process identified with energy production is photosynthesis - a process in which plants use the energy of sunlight to convert water and carbon dioxide into high-energy carbohydrates (sugars and starches) and oxygen, a waste product.

Greek: *photo* -> light
synthesis -> putting together

The Photosynthesis Equation
(Page 206)

* Word Equation

carbon dioxide + water $\xrightarrow{\text{light}}$ sugars + oxygen

reactants products

Unbalanced Chemical Equation

$$CO_2 + H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + O_2$$

Balanced Chemical Equation

$$6CO_2 + 6\,H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$$

6C ✓ 12O | 12H ✓ 6O | 6C ✓ 12H ✓ 6O | 12O

What contributions did the following make to the understanding of how plants carry out photosynthesis? (Page 204-205)

Jan van Helmont
Joseph Priestley
Jan Ingenhousz
Julius Robert Mayer
Melvin Calvin
Rudolph Marcus

Jan van Helmont - 1643

After careful measurements of a plant's water intake and mass increase, he concludes that trees gain most of their mass from water.

Joseph Priestley - 1771

Using a bell jar, a candle and a plant, he finds that the plant releases oxygen.

Jan Ingenhousz - 1779

He finds that aquatic plants produce oxygen bubbles in the light but not in the dark. He concludes that plants need sunlight to produce oxygen.

Julius Robert Mayer - 1845

Mayer proposes that plants convert light energy into chemical energy.

Melvin Calvin - 1948

He traces the chemical path that carbon follows to form glucose. These reactions are also known as the Calvin cycle.

Rudolph Marcus - 1992

He wins the Nobel Prize in chemistry for describing the process by which electrons are transferred from one molecule to another in the electron transport chain.

Background

Sunlight is perceived by your eyes as "white" light.

Sunlight is actually a mixture of different wavelengths of light.

Many of the wavelengths of light are visible to your eyes and make up what is known as the visible spectrum.

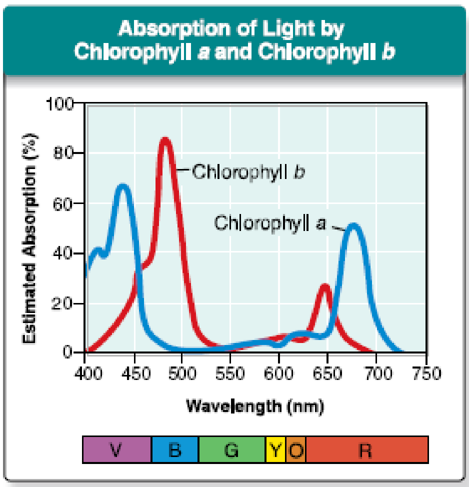
Your eyes see the different wavelengths of the visible spectrum of light as different colors.

Light and Pigments

Plants gather the sun's energy with light-absorbing molecules called pigments. The plant's principal pigment is chlorophyll which is found in chloroplasts.

green leaf

There are two types of chlorophyll, chlorophyll *a* and chlorophyll *b*.



▲ **Figure 8–5** **Photosynthesis requires light and chlorophyll.** In the graph above, notice how chlorophyll *a* absorbs light mostly in the blue-violet and red regions of the visible spectrum, whereas chlorophyll *b* absorbs light in the blue and red regions of the visible spectrum.

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When chlorophyll absorbs light, much of the energy is transferred directly to electrons in the chlorophyll molecule raising the energy levels of these electrons. The high-energy electrons make photosynthesis work.

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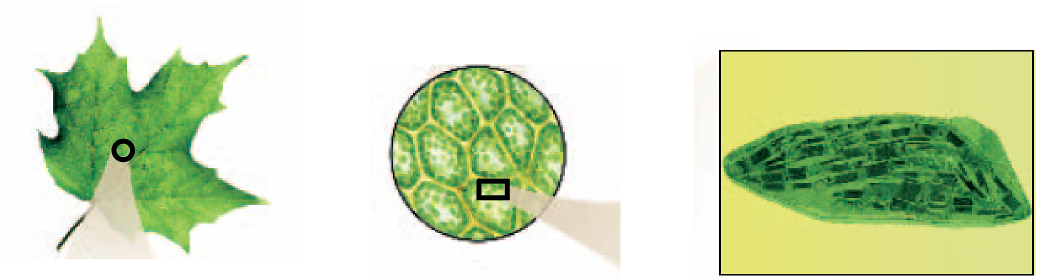
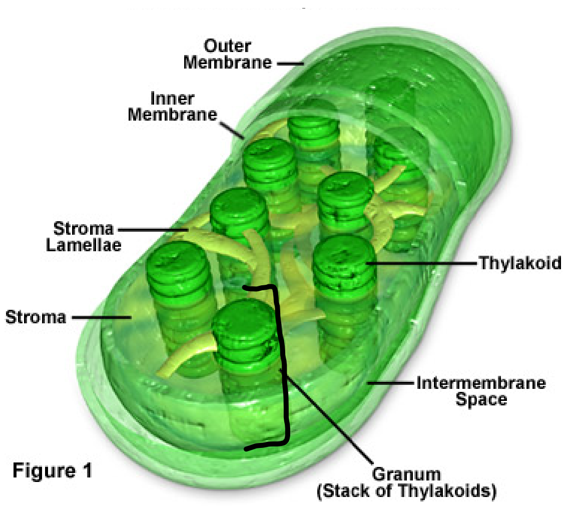
Chloroplasts

In plants and other photosynthetic eukaryotes, photosynthesis takes place inside chloroplasts.



Plant | Plant Cells (500x) | Chloroplast (10000x) *two membranes*

Plant Cell Chloroplast Structure



* grana - plural

thylakoid -> saclike photosynthetic membrane

granum -> a stack of thylakoids

photosystems -> clusters of chlorophyll and other pigments found in the membranes of the thylakoids that absorb light energy

stroma -> semi-fluid material that contains enzymes and makes up most of the chloroplast's volume

stroma lamellae - act like the skeleton of the chloroplast

Attachments

Two_Types_of_Cells__Prokaryotic_and_Eukaryotic.asf

Bacteria.asf