

Photosynthesis

Definition of Photosynthesis:

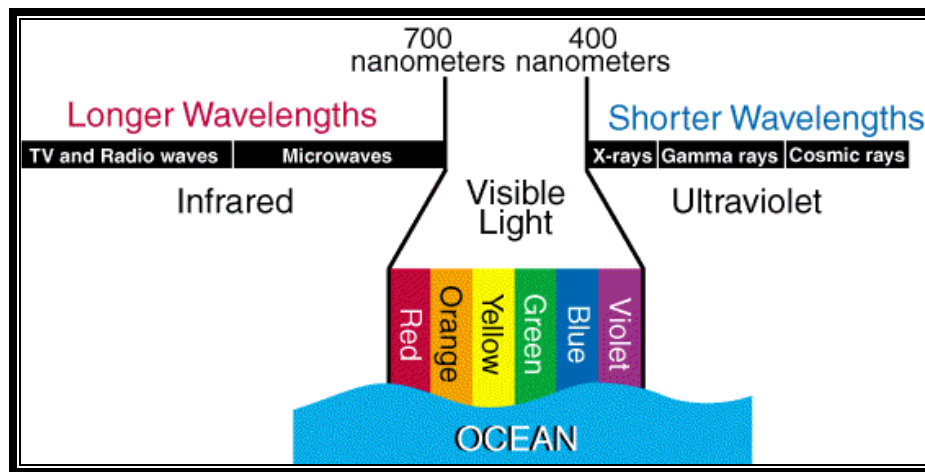
A form of *autotrophic nutrition* in which the energy of light is converted into chemical bond energy of organic compounds

- ◆ Most chemical energy used by all living organisms comes from photosynthesis in plants, algae, and phytoplankton
- ◆ During photosynthesis, oxygen is released. Most of the oxygen in our air is from this process.

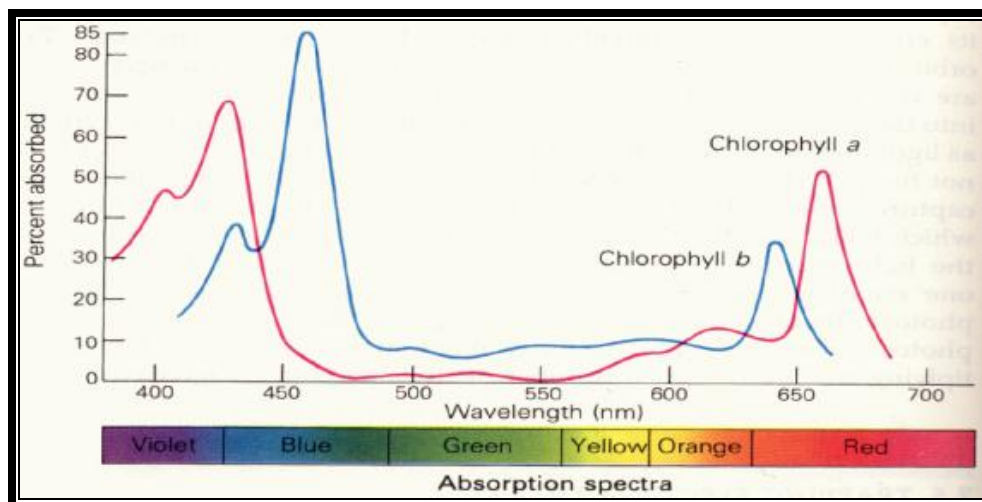
Photosynthetic Pigments

Most cells that carry on photosynthesis have specialized organelles that contain a variety of photosynthetic pigments that absorb certain wavelengths of visible light and reflect others.

- ◆ Color of these pigments occurs from wavelengths of light that a particular pigment reflects.
- ◆ For example, *chlorophyll*, the photosynthetic pigment found in *chloroplasts* is green because it reflects the green wavelengths of light and absorbs the remaining colors of the visible spectrum (ROY G. BIG).



- ◆ Chlorophyll absorbs red and blue wavelengths of light the best. Chlorophyll reflects green light, so it gets the least amount of energy from wavelengths of green light.



- ◆ *When chlorophyll absorbs light, energy is now available for the conversion to chemical bond energy.*

Question: *Why do green leaves turn so many beautiful colors in the fall?*

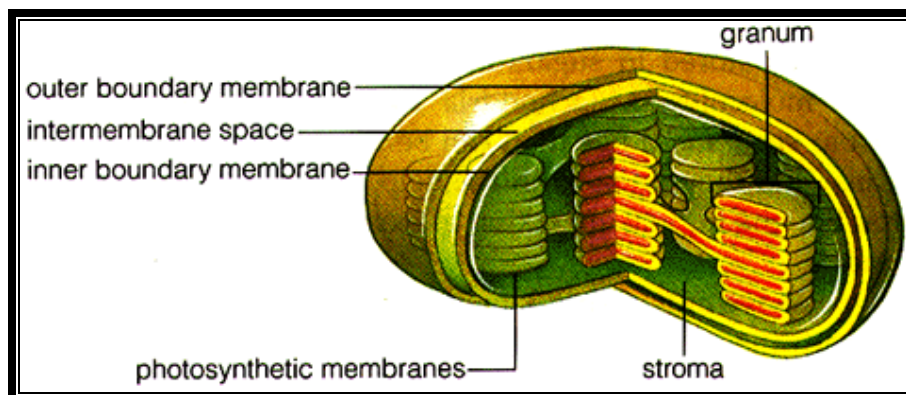
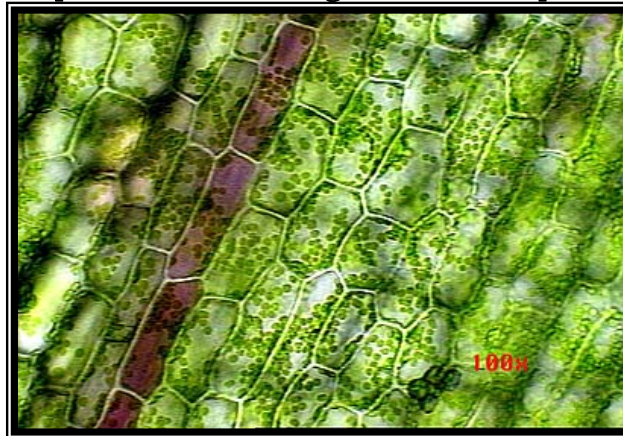
- ◆ In addition to chlorophyll, green leaves have other accessory pigments called xanthophylls (yellow pigments) and carotenes (orange pigments).
- ◆ When the sun is the strongest during the spring and summer months, the chlorophyll gene is stimulated by the intensity of the sun to produce a great deal of chlorophyll.
- ◆ The chlorophyll covers or masks the other pigments during these months.
- ◆ When the fall comes, sunlight is less intense and the gene for chlorophyll is not longer stimulated to make chlorophyll – production goes down and the beautiful reds and yellows of the leaf can now be seen.

NOTE: the masking of accessory pigments by chlorophyll during the spring and summer is an example of how *GENE ACTION is INFLUENCED by the ENVIRONMENT!*

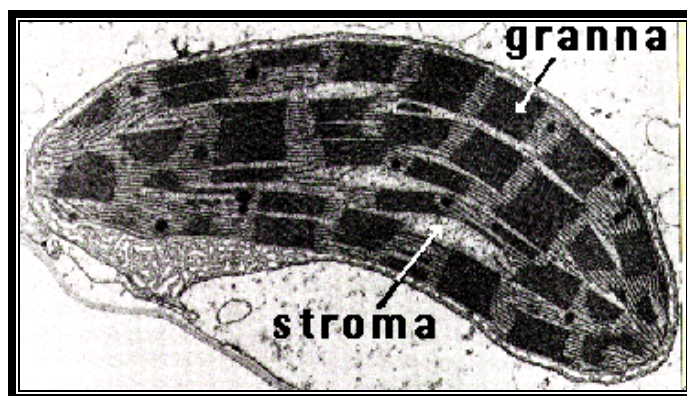
Structure of Chloroplasts

- ◆ Chloroplasts contain the green photosynthetic pigment chlorophyll
- ◆ Chloroplasts are made up of two parts: **GRANA and STROMA**
- ◆ Photosynthesis takes place in both parts of the chloroplast
- ◆ Chlorophyll is found the **GRANA**, stacks of parallel membranes also called **thylakoid membranes** – this is where light energy is first absorbed.

Chloroplasts (Dots) in Living Elodea (water plant) Cells



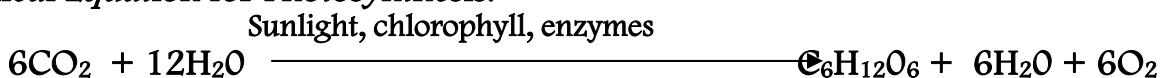
Electron Micrograph of the Inside of a Chloroplast



Overview of the Chemical Process of Photosynthesis

- ◆ Photosynthesis takes place inside the chloroplast
- ◆ The raw materials needed are H₂O and CO₂
- ◆ With the help of enzymes, these raw materials are formed into glucose.
- ◆ The energy of light is converted to chemical bond energy that holding the glucose molecule together.
- ◆ The metabolic wastes that are formed as a result of photosynthesis are H₂O and O₂.

Chemical Equation for Photosynthesis:



Results of Photosynthesis

- ◆ **Glucose formed during photosynthesis may be:**
 - used as an immediate energy source during aerobic respiration
 - used to synthesize other organic compounds such as lipids and proteins
 - converted into starch for storage
 - *when plants used their stored materials, they must first break down starch into soluble materials such as glucose. This digestion occurs **INTRACELLULARLY** (within each cell)
 - *Once digestion of the starch is complete, the simple sugars may be used within the same cells or may be transported to other cells of the plant for use or further storage.

Investigations of Photosynthesis

- ◆ Current understanding of the metabolic pathways of the light and dark reactions come from the use of carbon and oxygen isotopes.
- ◆ Many isotopes are radioactive and can be detected by the radiation they give off.
- ◆ These properties make it possible for isotopes to be used as tracers to follow the sequence of the various biochemical reactions of photosynthesis.
- ◆ Using water tagged with oxygen-18, the pathway of water was traced as it entered the leaf.
 - It was found the oxygen released during photosynthesis comes solely from the photolysis of water during the light reactions.
- ◆ Using carbon dioxide tagged with the isotope carbon-14, it was found that all the carbon used to synthesize sugars during the dark reactions comes from the intake of atmospheric CO₂.

Check your Understanding:

1. Why are autotrophic organisms so important to most living organisms?
 2. Which wavelengths of light provide the most energy for photosynthesis?
 3. How does the environment influence gene action in the production of chlorophyll?
 4. Where does photosynthesis take place?
 5. Where is chlorophyll located in the chloroplast?
 6. Why are H₂O and CO₂ called raw materials?
 7. Explain why sunlight, chlorophyll and enzymes are written above the arrow.
 8. Why are water and oxygen considered metabolic products?
 9. Why is the photosynthesis equation considered to be a “balanced equation”?
 10. How is glucose utilized by the autotrophic organisms?
 11. Why do plants store excess glucose as starch?
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