Unit 5: Cellular Respiration and Photosynthesis

How do cells obtain energy from food molecules?

1. Cellular respiration release energy from food molecules
2. Glycolysis begins the production of Energy
3. The Krebs Cycle completes the breakdown of glucose
4. The Electron Transport System packages energy from glucose to ATP
5. Anaerobic respiration works in the absence of oxygen

How do plants use photosynthesis to convert solar energy to chemical energy?

1. Photosynthesis harnesses light energy
2. The Calvin Cycle combines hydrogen with Carbon Dioxide to produce sugars.
3. Environmental factors affect the rate of photosynthesis

It is an extremely simple cellular process.

That is also extremely important

It takes place in the Chloroplasts

And requires the green pigment **Chlorophyll.**

It was used to create the oxygen in the Earth's atmosphere.

It transformed the way organisms **use energy.**

And it requires **light.**

It takes place in two phases.

It takes place in two phases.

The light dependent reactions capture light and turn it into ATP and NADPH

The Calvin Cycle uses ATP and NADPH to make glucose.

The formula is the thinnest and most light (dependent) yet

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

And heterotrophs can't wait to see where it turns up next.

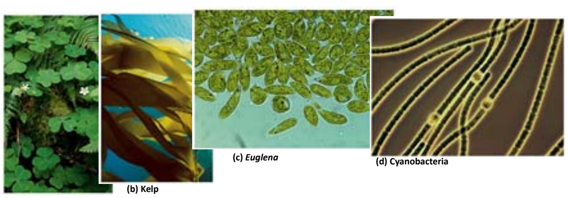
Introducing…

Photosynthesis

Designed by Leaf in Connecticut

THE BASICS OF PHOTOSYNTHESIS

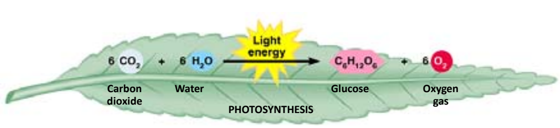
- Green plants are photosynthetic autotrophs, as are some bacteria and protists
  - Autotrophs generate their own food through photosynthesis
  - Solar energy is transferred to the chemical bonds in sugar



(a) Mosses, ferns, and *flowering plants* (b) Kelp (c) *Euglena* (d) Cyanobacteria

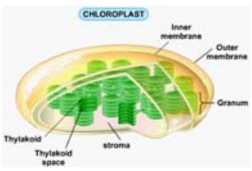
AN OVERVIEW OF PHOTOSYNTHESIS

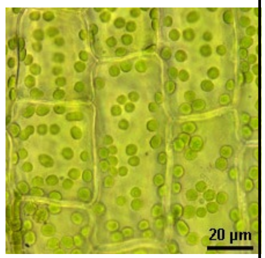
- Photosynthesis is the process by which autotrophic organisms use light energy to make sugar and oxygen gas from carbon dioxide and water



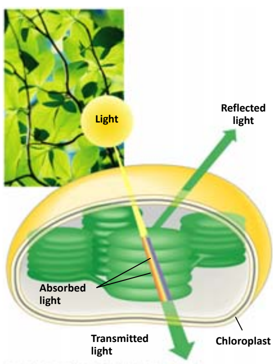
Plant Cells have Green Chloroplasts

The membranes inside the chloroplast are impregnated with the green photosynthetic pigment chlorophyll

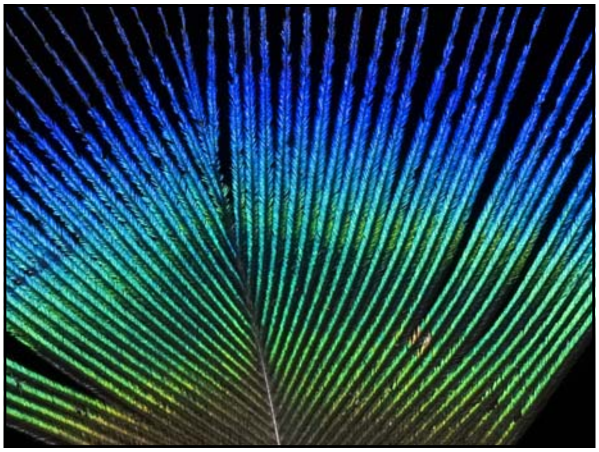




Chloroplasts absorb **light energy** and convert it to **chemical energy**



Why do plants look green?



In order to understand the plant's response to light you must first understand light itself.

Light is electromagnetic radiation

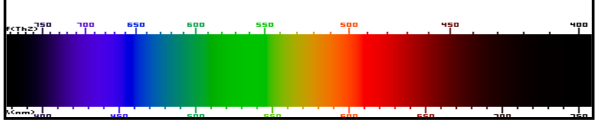
Light is **electromagnetic radiation** with a wavelength that is visible to the eye.

A typical human eye will respond to wavelengths from 400 to 700 nm.

The different wavelengths are detected by the human eye and then interpreted by the brain as colors, ranging from red at the longest wavelengths of about 700 nm to violet at the shortest wavelengths of about 400 nm.

The color of an object depends both on physics and on perception.
Physically surfaces can be said to have the color of the light reflecting off them.

In other words a green plant is green because it *reflects green light* (and therefore absorbs all other colors). A white object reflects all colors of light and a black object absorbs all.



When using the additive method, the primary colors are red, blue, and green. The more additive primaries you add, the lighter the resultant color. Mix all three and you get white.

The subtractive primaries are red, blue, and yellow--to be exact, magenta, cyan (light blue), and yellow. These are the colors that, together with black, are used in color printing.

The more subtractive primaries you mix, the darker the color. Mix all three and you get black (OK, brown, but with the school's art supplies budget you can't expect miracles).

In general additive primaries involve adding more LIGHT (as in a color TV), while subtractive primaries involve mixing more PIGMENT (as in paints and crayons).

How do we make yellow?

By adding full-strength red and full-strength green. Adding two-thirds strength blue gives us a lighter (not darker) yellow.

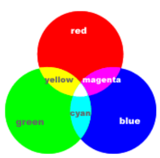
This is a counterintuitive result if you learned your color-mixing skills in kindergarten. But we know that white light can be broken into all the colors of the rainbow. So we shouldn't be surprised to learn the process also works in reverse--i.e, the colors of the rainbow can be combined to make white.

http://www.cbu.edu/~jvarrian/applets/color1/colors_g.htm

Besides, it only stands to reason that the more light you shine on something, the brighter (that is, closer to white) it gets.

Proceeding with our experiments we fill out the additive color- mixing chart as follows:

Green + red = yellow
Green + blue = cyan (light blue)
Red + blue = magenta
Red + blue + green = white



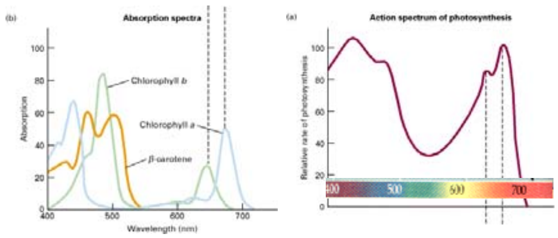
Subtractive colors, as the name suggests, work by subtracting certain colors from white light and reflecting the rest, like so:

Yellow pigment absorbs blue--reflects red, green
Cyan absorbs red--reflects green, blue
Magenta absorbs green--reflects red, blue
Blue absorbs red, green--reflects blue
Red absorbs blue, green--reflects red
Green absorbs blue, red--reflects green

If white light strikes yellow paint, the paint absorbs blue and reflects red and green. Then the additive principle takes over--red and green combine to make yellow.

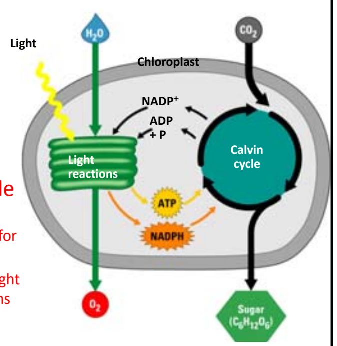
Now mix cyan (light blue) and yellow paint. The cyan pigment absorbs red light; the yellow pigment absorbs blue light. What's left is green, the color you see.

Different pigments absorb light differently



PHOTOSYNTHESIS

- The light reactions convert solar energy to chemical energy
  - Produce ATP & NADPH
- The Calvin cycle makes sugar from carbon dioxide
  - ATP generated by the light reactions provides the energy for sugar synthesis
  - The NADPH produced by the light reactions provides the electrons for the reduction of carbon dioxide to glucose



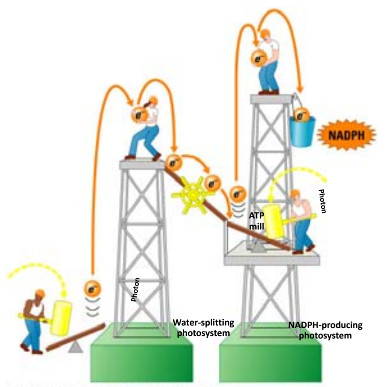
Steps of Photosynthesis

In the light reactions light hits reaction centers of chlorophyll, found in chloroplasts

Chlorophyll vibrates and causes water to break apart.

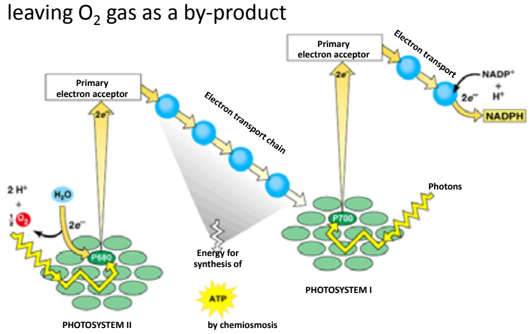
The Oxygen is released into air and the Hydrogen remains in chloroplast where it is attached to NADP to form NADPH

Two types of photosystems cooperate in the light reactions



Noncyclic Photophosphorylation

- Photosystem II regains electrons by splitting water, leaving O_2 gas as a by-product



Steps of Photosynthesis

The DARK Reactions = The Calvin Cycle

CO_2 from atmosphere is joined to H from the water molecules (NADPH) to form glucose

Plants produce O_2 gas by splitting H_2O

- The O_2 released by photosynthesis is made from the oxygen in water