# The impossibility of photosynthesis without a light source

[Science](), [Biology]()

Photosynthesis is a process that occurs in plant cells that is required for life in all organisms. It creates energy for the plant and other organisms that consume the plant, while it also creates oxygen for animals. Light energy is converted into chemical energy through photosynthesis within a plant cell (Campbell). Some of the reactions that take place require the use of light while others do not. The light-dependent reactions directly produce ATP and NADPH. Photosystem I and II are primarily responsible for the light dependent reactions as they capture photons from the air and transform them through a variety of process into energy usable by the cell (Department of Biological Sciences 2014). They also use water in the process to create a hydrogen ion concentration gradient in the thylakoid lumen to create ATP. The light dependent reactions consist of the calvin cycle, glucose biosynthesis, and starch biosynthesis. Carbon dioxide is fixed during the calvin cycle and a small amount of glucose is also produced (Cambell).

Plant pigments that are involved in photosynthesis are located in either photosystem one or photosystem two in the thylakoid membranes of chloroplasts. Plants consist of a variety of pigments, all which work together to gather chemicals from the environment and transform them into a useable form of energy for both plants and other organisms, mainly ATP and NADPH. They work together to capture different wavelengths of light and each reflects back a different color. Chlorophylls a and b absorb all colors of light except green, which gives plants their generic green color. Carotenoids generally give plants a yellow to red color, which means they can absorb wavelengths of light outside the yellow to red range (Department of Biological Sciences 2014). Xanthophylls are yellow and can absorb wavelengths of light outside the yellow range (Tanaka, Y., Sasaki, N. and Ohmiya, A). Plants consist of many pigments so that they are able to absorb all wavelengths of light and maximize photosynthesis. Chlorophylls are the most numerous pigments whereas the other pigments are referred to as accessory pigments. It is these accessory pigments which are used by the cells to increase the range of wavelengths that can be absorbed by the cell. Anthocyanidins, which reflect a blue or purple color, do not participate directly in photosynthesis but are instead located on cell vacuoles.

Chromatography is used to separate a mixture into its component parts. The solution to be separated is placed on chromatography paper near the bottom and is allowed to dry. The bottom of the paper is then placed in a small amount of water and is allowed to sit as the solvent travels up the cellulose fibers in the paper and carried the solute with it. The different solutes stop traveling at various places along the paper because of the polarity of the molecules within. The more polar an object is, the less far it travels. This does so because the polar molecule will dissolve quicker in the water that is stored in the cellulose fibers. The nonpolar molecules will continue to climb with the solvent up the paper (Department of Biological Sciences 2014). The relative distance that a pigment travels is signified by its calculated Rf value. The Rf value is calculated by dividing the distance traveled by the compound, divided by the distance traveled by the solvent. The smaller the Rf values signify less movement by the compound, and the larger values signify greater movement (Department of Biological Sciences 2014). Spectrophotometry is used to determine the absorbance of a plant's individual pigments. Different pigments have varying absorbance values for varying wavelengths, which show what pigments of light each individual pigment can absorb the best.

It was questioned as to which of the plant pigments chlorophyll a, chlorophyll b, xanthophylls, carotenes, or anthocyanidins would be the most and least polar pigments. By observing the structure of the molecules, the most polar pigment would be expected to be anthocyanidins followed by chlorophyll b, chlorophyll a, xanthophylls, and lastly carotenes, and they would appear on the chromatography paper in the above order from top to bottom. It was questioned as to what wavelengths of the visible spectrum of light did each of the individual pigments absorb. It was hypothesized that the pigments would absorb wavelengths of light other than the color that was reflected by the pigment and would resemble Figure 7. 13 in the lab manual (Department of Biological Sciences 2014).