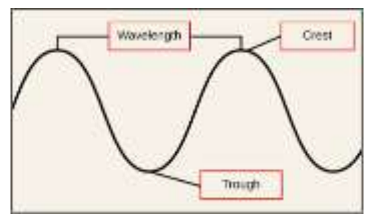
Light and photosynthetic pigments

DIRECTIONS: *Read and annotate the article to learn about properties of light and how pigments absorb light. Summarize the sections by addressing each focus question.*

If you've ever stayed out too long in the sun and gotten a sunburn, you're probably well aware of the sun's immense energy. Unfortunately, the human body can't make much use of solar energy, aside from producing a little Vitamin D (a vitamin synthesized in the skin in the presence of sunlight).
Plants, on the other hand, are experts at capturing light energy and using it to make sugars through a process called photosynthesis. This process begins with the absorption of light by specialized organic molecules, called **pigments**, that are found in the chloroplasts of plant cells. Here, we'll consider light as a form of energy, and we'll also see how pigments – such as the chlorophylls that make plants green – absorb that energy.

SUMMARY: What molecules help plants utilize the sun's energy?



Light is a form of electromagnetic radiation, a type of energy that travels in waves. Other kinds of electromagnetic radiation that we encounter in our daily lives include radio waves, microwaves, and X-rays. Together, all the types of electromagnetic radiation make up the **electromagnetic spectrum**. Every electromagnetic wave has a particular **wavelength**, or distance from one crest to the next, and different types of radiation have different characteristic ranges of wavelengths (as shown in the diagram below). Types of radiation with long wavelengths, such as radio waves, carry less energy than types of radiation with short wavelengths, such as X-rays.

SUMMARY: What is light energy and how does it travel? What are some examples of light energy?

The electromagnetic spectrum is the entire range of wavelengths of electromagnetic radiation. A longer wavelength is associated with lower energy and a shorter wavelength is associated with higher energy. The types of radiation on the spectrum, from longest wavelength to shortest, are: radio, microwave, infrared, visible, ultraviolet, X-ray, and gamma ray. Visible light is composed of different colors, each having a different wavelength and energy level. The colors, from longest wavelength to shortest, are: red, orange, yellow, green, blue, indigo, and violet.

SUMMARY: How do the different types of light that make up the electromagnetic spectrum vary?

Adapted from: https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-light-dependent-reactions-of-photosynthesis/a/light-and-photosynthetic-pigments

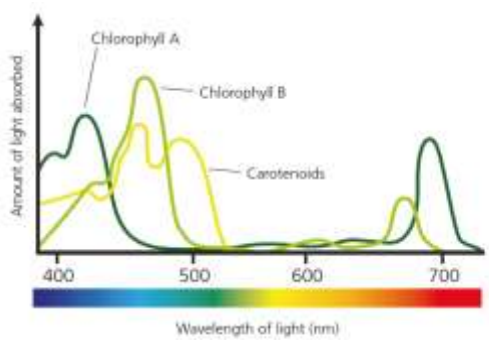
The **visible spectrum** is the only part of the electromagnetic spectrum that can be seen by the human eye. It includes electromagnetic radiation whose wavelength is between about 400 nm and 700 nm. Visible light from the sun appears white, but it's actually made up of multiple wavelengths (colors) of light. You can see these different colors when white light passes through a prism: because the different wavelengths of light are bent at different angles as they pass through the prism, they spread out and form what we see as a rainbow. Red light has the longest wavelength and the least energy, while violet light has the shortest wavelength and the most energy.

SUMMARY: How do the different types of light that make up the visible spectrum vary?

In photosynthesis, the sun's energy is converted to chemical energy by photosynthetic organisms. However, the various wavelengths in sunlight are not all used equally in photosynthesis. Instead, photosynthetic organisms contain light-absorbing molecules called **pigments** that absorb only specific wavelengths of visible light, while reflecting others. The set of wavelengths absorbed by a pigment is its **absorption spectrum**. In the diagram below, you can see the absorption spectra of three key pigments in photosynthesis: chlorophyll *a*, chlorophyll *b*, and β-carotene. The set of wavelengths that a pigment doesn't absorb are reflected, and the reflected light is what we see as color. For instance, plants appear green to us because they contain many chlorophyll *a* and *b* molecules, which reflect green light.

SUMMARY: How is light energy from the sun absorbed by photosynthetic organisms?

Each photosynthetic pigment has a set of wavelengths that it absorbs, called an absorption spectrum. Absorption spectra can be depicted by wavelength (nm) on the x-axis and the degree of light absorption on the y-axis. The absorption spectrum of chlorophylls includes wavelengths of blue and orange-red light, as is indicated by their peaks around 450-475 nm and around 650-675 nm. As a note, chlorophyll *a* absorbs slightly different wavelengths than chlorophyll *b*. Chlorophylls do not absorb wavelengths of green and yellow, which is indicated by a very low degree of light absorption from about 500 to 600 nm. The absorption spectrum of β-carotene (a carotenoid pigment) includes violet and blue-green light, as is indicated by its peaks at around 450 and 475 nm.



The absorption spectra of extracted chlorophyll and carotenoids (accessory pigments). The primary light harvesting chlorophylls absorb light in the blue and red regions. Carotenoids absorb in the blue and green regions.

SUMMARY: What is an absorption spectra and how do they vary?

Adapted from: https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-light-dependent-reactions-of-photosynthesis/a/light-and-photosynthetic-pigments