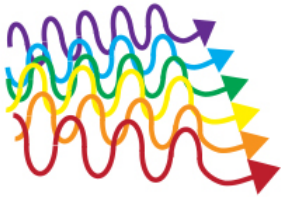
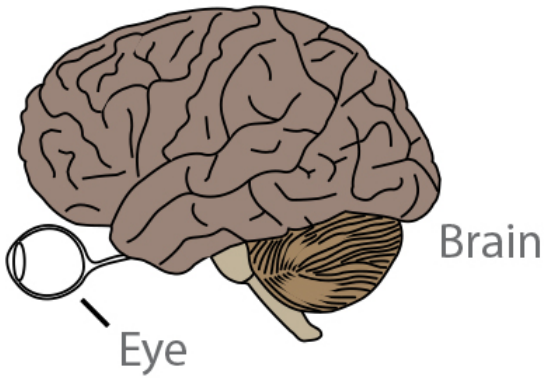
Seeing Color

Written by Kimberly Pegram

For more information on vision, visit:
http://askabiologist.asu.edu/explore/seeing-color

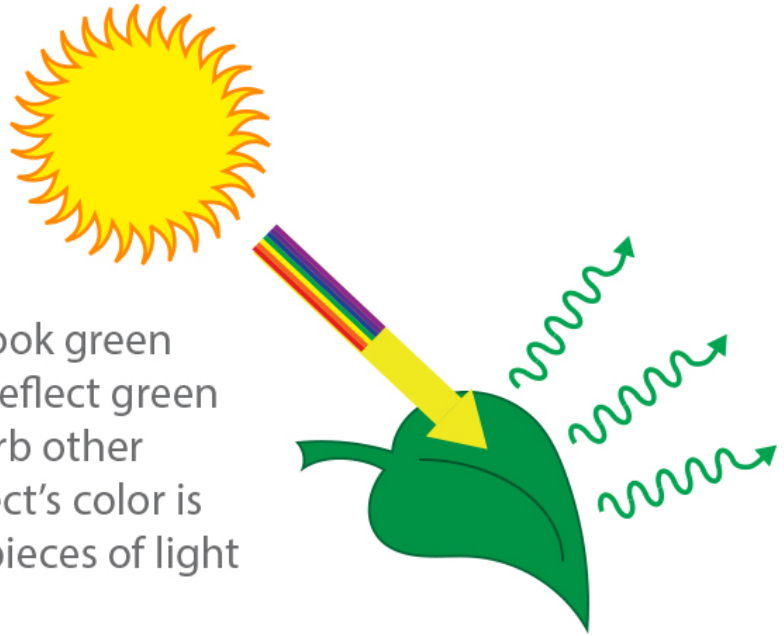
We can see the world and the colors around us because of light. When light reaches your eyes, your eyes tell your brain about the light. If more light hits your eyes, your brain knows that something is bright. The colors that reach your eyes are particular pieces of light.



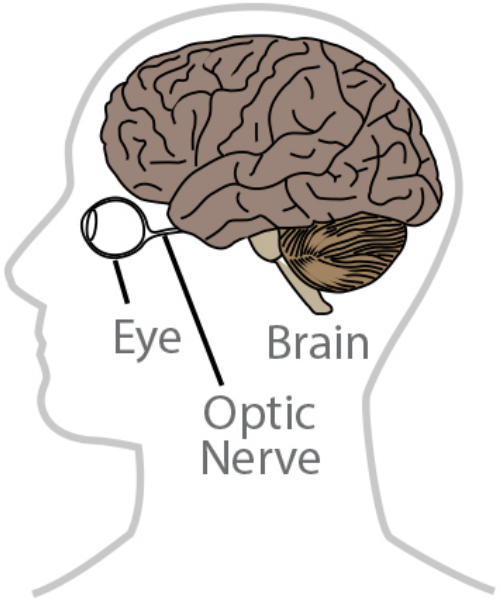


The "white" light that you see from the sun and from some lightbulbs holds all the colors of the rainbow. To you it might look clear, until one or some of the colors reflect off of an object.

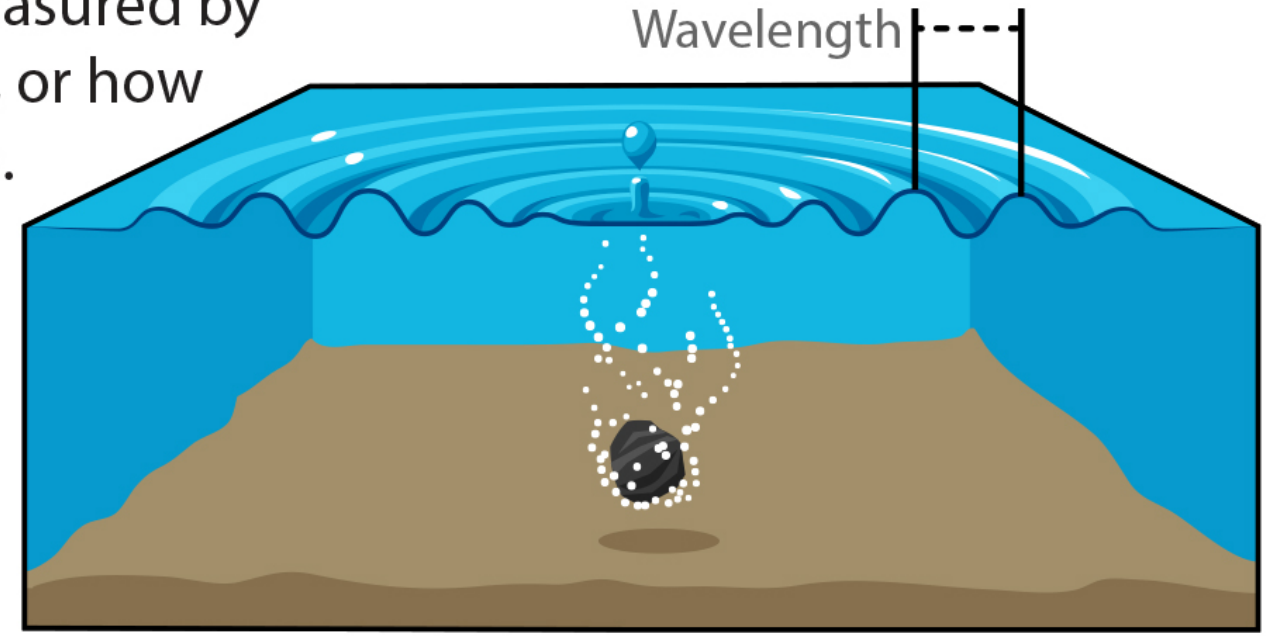
Most light holds all the colors of the rainbow. When that light hits an object like a leaf, the leaf absorbs a lot of the light. The reds and blues get absorbed, but some light gets reflected. For green leaves, the green light is reflected.



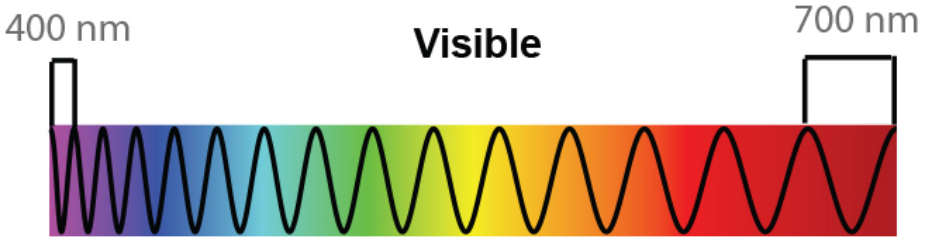
Green leaves look green because they reflect green light and absorb other colors. An object's color is based on the pieces of light that it reflects.



Wave is something you might do when you see a friend. It's also the crashing water you see at the beach. But both of those actions are named after the true wave. A wave is a change that moves through a liquid—think of ripples in a pond. These waves can be measured by how tall they are, or how far apart they are. This second measure (the space between waves) is called wavelength.

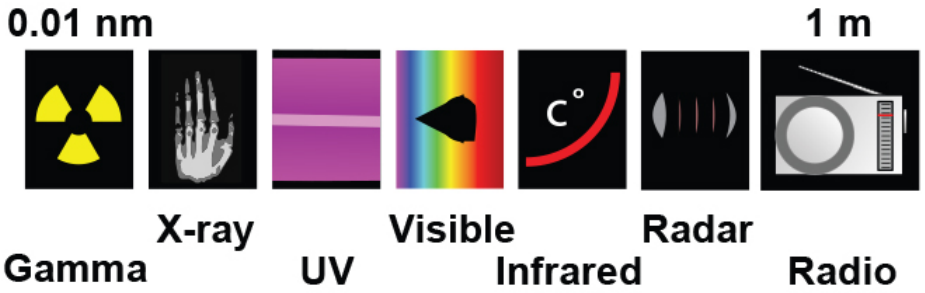


There are so many different colors, it would be very hard to try to name them all. There are blues and reds, greens and oranges, and many others in between. These different colors are caused by the wavelength of light. If we think again about the ripples in a pond, wavelength is the distance between ripples. When the ripples of light are close together, we see violets and blues. When they are far apart, we see reds.



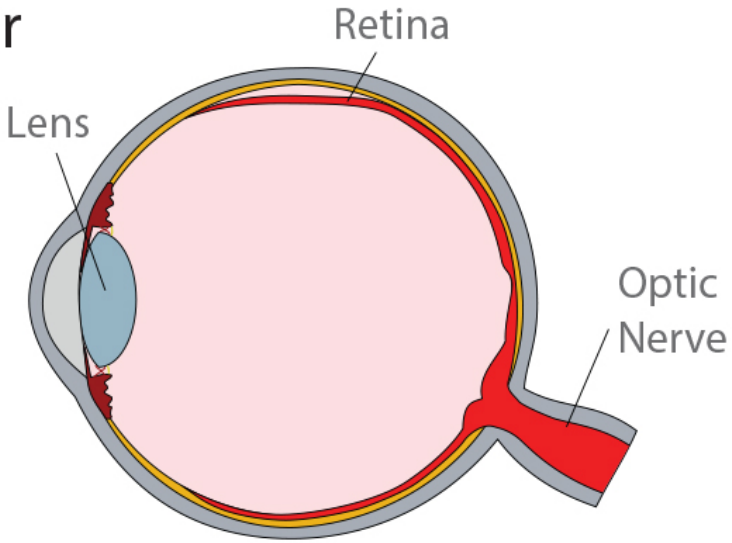
Different colors are caused by different light wavelengths. Purple is 400 nanometers (nm) while red is 700 nm. Humans can only see from 400 to 700 nm, so this is called the visible spectrum.

The pieces of light are called photons. Photons are like very tiny fields of electricity that are weightless. Our eyes are only sensitive to some wavelengths of energy. These wavelengths fall into what we call visible light. Other energy waves go all the way from very tiny wavelengths (gamma rays) to very large ones (radio waves).



From smallest to largest wavelengths of light (left to right) we have gamma rays, x-rays, ultraviolet rays, visible light, infrared rays, radar, and radio waves. The scale above goes from nanometers (nm) up to meters (m).

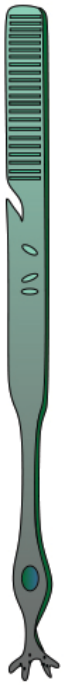
How do your eyes tell your brain about light? Along the back of each of your eyes is a layer of special cells called the retina. These cells are photoreceptors, because they receive light (photo means light). When a photon enters one of these cells a signal is sent to the brain using the optic nerve. Signals from these cells tell your brain about the color and amount of light you see.



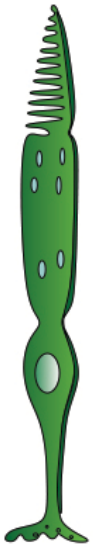
Light enters the eye through the lens and is absorbed by special molecules in the retina.

Sometimes when it is dark out, the world almost looks black and white. That is because we have different photoreceptors for different light conditions. Rods are used to see in low light, but do not detect color. The other photoreceptors are called cones. Cones allow us to see color but do not work well in low light.

Rod

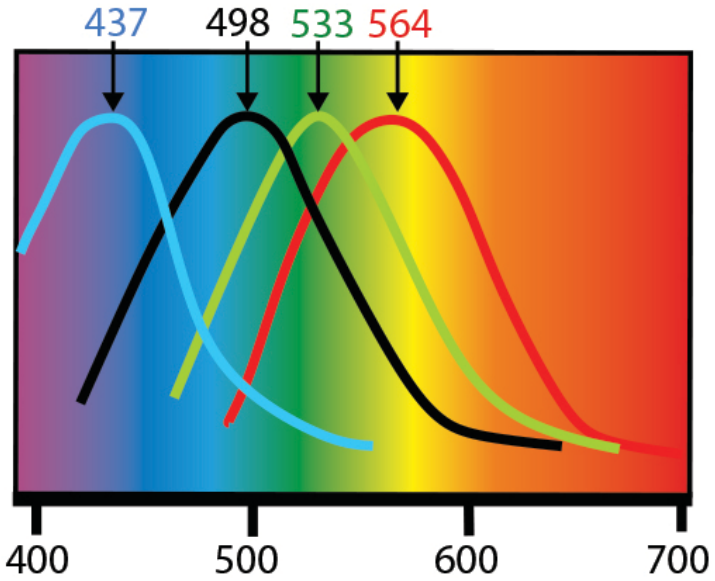


Cone



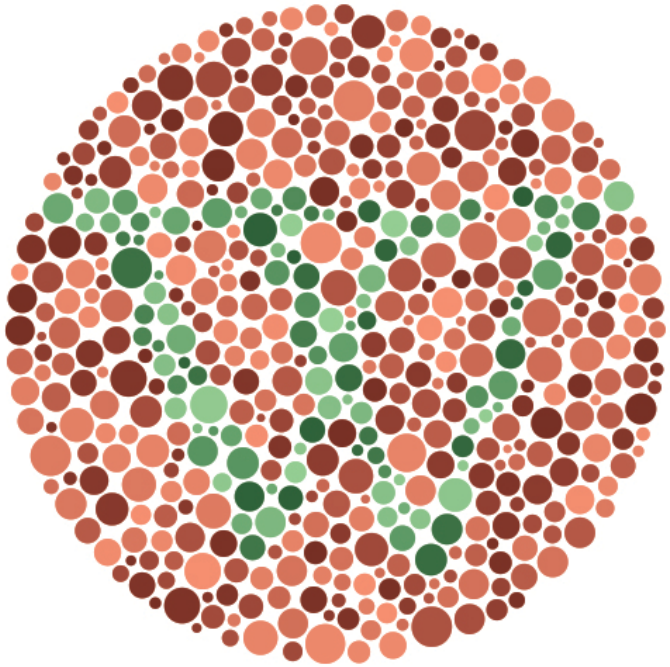
The eye has two types of photoreceptors. Rods are used in low light and do not detect color. Cones let us see color, but do not work well when it is dark.

Most humans have three types of the photoreceptors called cones. These types are red, green, and blue. Cones are named for the color that they pick up the best. We can see more than just these three colors because the cones each pick up a range of colors. The brain then compares the signals from the red, green, and blue cones.



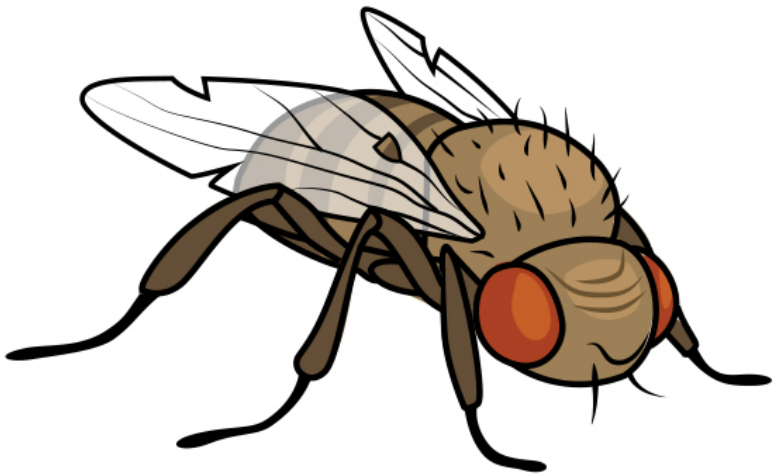
Each cone only picks up a small range of colors. The brain compares the signals, letting you see a variety of colors. Rods are in black and pick up their own set of wavelengths.

Have you ever met someone who doesn't see color the same way as most people? That person may not have all three types of cones. Nine percent of humans are missing at least one cone type. This means they cannot see all colors. This is known as color blindness. It is very rare for someone to not be able to see any color at all.



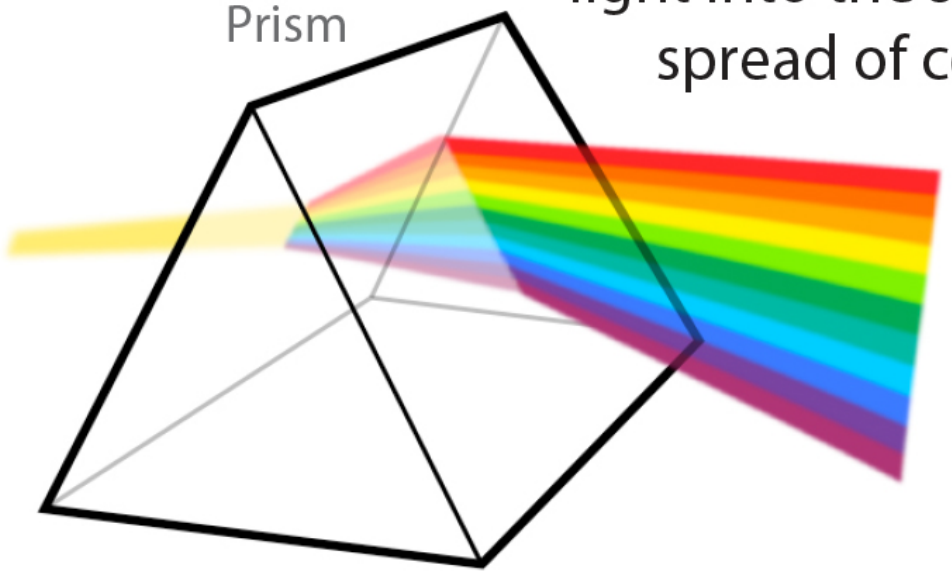
Can you see the W in this picture? If not, you might see colors a bit differently than most other people.

Humans are different from many other animals. And not just in the way they look. The eyes of most animals and the way they see color differs from humans. Some scientists study animal eyes. They can tell what types of cones each animal has. The cones tell them what colors the animals can see. Some animals can see light that humans cannot see. For example, many insects can see ultraviolet light, which is the part of sunlight that can give you a sunburn.



Many insects, like this fly, can see ultraviolet (UV) light. For the most part, humans cannot see UV light.

If it's raining, but the sun is out, you can often see a rainbow. Rainbows show all of the colors that humans can see. Raindrops act like tiny prisms. Prisms are clear, angled objects that can affect light. Some of the light is refracted (changes directions) through a raindrop. This spreads the light into the spectrum of colors. The spread of colors makes the rainbow.



Raindrops cause light to refract and spread into a rainbow. The same effect is seen with prisms.

Some of what we know about color was found a long time ago. Sir Isaac Newton was a physicist. Physicists study objects and the way they move. Newton particularly liked studying math, gravity, and motion. His study of math made a lot of discoveries about physics possible. He also studied optics, or the physics of light. Newton first saw the color spectrum using a glass prism.

Newton may be best known for discovering gravity, but he also learned a lot of new things about light.

How do you say?

Absorb – [ab-**zohrb**]

Infrared – [in-**frah**-red]

Molecule – [**mol**-uh-cue-el]

Nanometer – [**nan**-oh-me-ter]

Photoreceptor – [foe-toe-re-**sep**-tor]

Photon – [**foe**-tawn]

Physics– [**fizz**-icks]

Prism – [**priz**-uhm]

Radar– [**ray**-dahr]

Retina– [**ret**-in-uh]

Spectrum – [**speck**-truhm]

Ultraviolet – [uhl-truh-**vie**-uh-let]