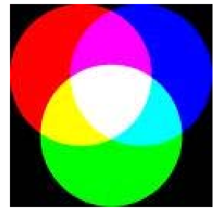


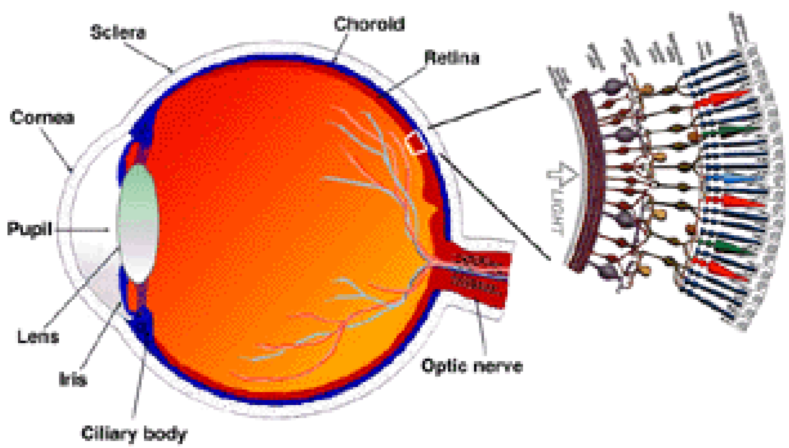
Color Mixing with Roy G. Biv

Summary:

Have you ever wondered why we see color? We see light that bounces off things around us. In the background section, we will talk about the how our eyes allow us to see. A reference at the end of the activity explains in detail the anatomy of the eye. After we discover how our eyes "see," we will move on to an activity that explains color.

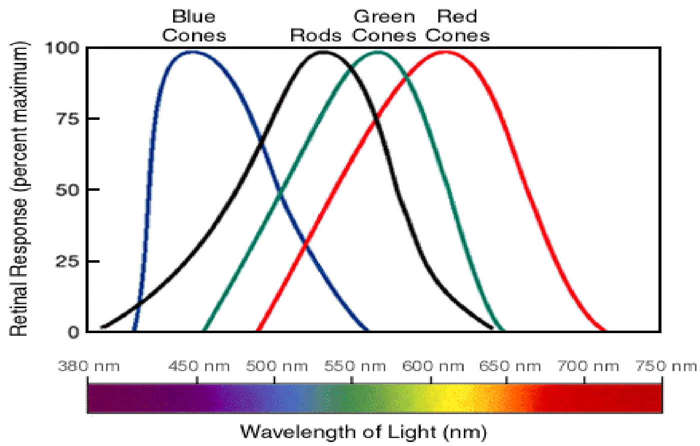
Background: Vision

Light that reflects off of objects around us is imaged onto the retina by the lens. The retina is responsible for detecting the light from these images and then sending signals to the brain along the optic nerve. The brain decodes these images into the information that we know as vision.



Two different cells in the retina respond to light: the **rod** cells and the **cone** cells. These cells were named because of their shape when viewed under a microscope. The **cones** in our retina are sensitive to color. Although, the **rods** cannot detect color they are very sensitive to light at low levels. The **rod** cells are responsible for our night vision.

Our eyes contain three types of cones. If you look at the graph below, you can see each cone is able to detect a range of colors. Even though each cone is most sensitive to a specific color of light they also can detect other colors. The three types of cones are commonly labeled by the color they are most sensitive (blue, green and red). However, we can see many other colors than red blue and green. The overlap of the cones allows us to see many other colors. For example, the color yellow results from green and red cones being stimulated while the blue cones have very little stimulation.



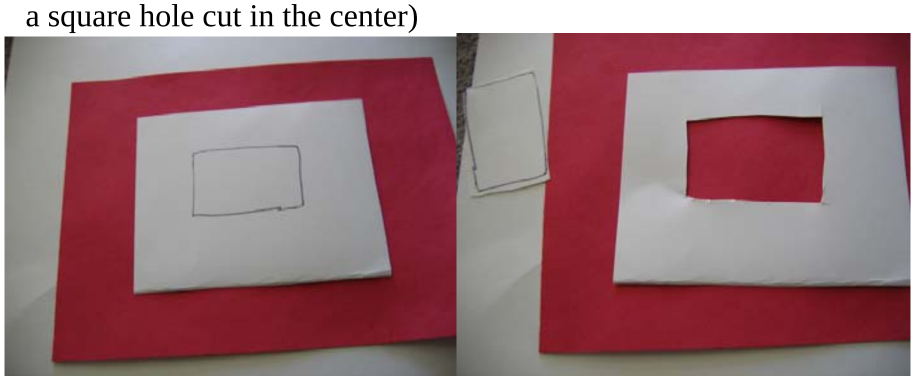
Our eyes are detectors. When the cones are stimulated by light they send signals to the brain. The brain is the actual interpreter of color. When all the cones are stimulated equally the brain perceives the color as white. We also perceive the color white when our rods are stimulated. Unlike cones, rods are able to detect light at a much lower level. This is why we see only black and white in dimly lighted rooms or while out viewing a star filled night sky.

In this activity we will:

- Understand that light is a form of radiation that can be broken into many wavelengths; these wavelengths in the visible spectrum of light are the colors we see.
- To recognize how we see color. If possible, also to recognize what colors are seen by colorblind people that may be present.
- Identify the three primary colors of light as red, blue and green. Distinguish that every other color is caused by an overlap of the primary colors.

Materials:

- 3 flashlights
- Red, green and blue light bulbs for flashlights. ** If available, 3 colored LED flashlights work the best to generate a single wavelength of light. **
- Colored construction paper, other colored items such as clothing
- White paper or white surface
- 1 5”x7” notecard to make “color mixer” (Piece of cardboard or tagboard with a square hole cut in the center)



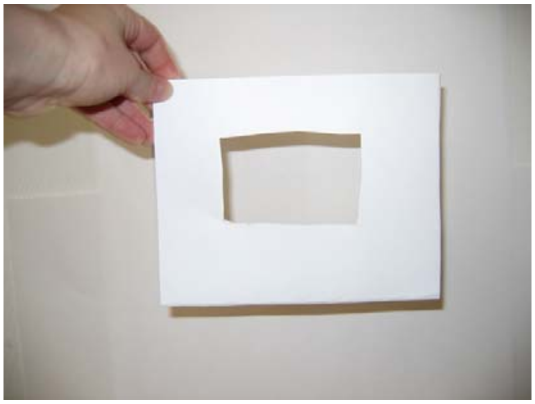
Activity:

When we look at the visible light, we see colors. Although there are many colors that make up our surroundings, colors from just three areas of the spectrum could be mixed to form any other color, including white! These three colors are also called "primary colors."

What are the three primary colors? (Hint: think about the types of cones in our eyes) List the three primary colors below:

____________________, ____________________ and ____________________

1. Using your three sources of light (red, blue and green) to mix the colors. When mixing the colors, shine the colors added through the color mixer onto a white wall, piece of paper or cardboard (hold the color mixer about 4-6 inches away from the white wall or white posterboard). Then, take your flashlight and shine it through the square in the middle of your Color Mixer. The flashlight should be no more than 6-8 inches away from the Color Mixer.



Colors Added:	Predicted Color:	Actual (Resulting) Color:
Red + Blue + Green		
Red + Blue		
Red + Green		
Green + Blue		

2. How did your predictions match the actual colors that resulted? Are any surprising?

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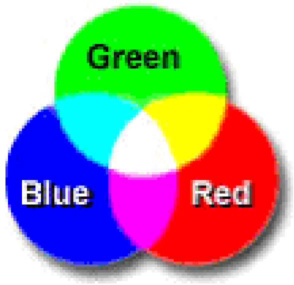

The primary colors shown to the left are Red, Blue and Green. When they combine, they make other colors. Red + Blue + Green combine to make white. Red and Green combine to make Yellow. Blue and Green make Cyan. Red and Blue make Magenta

3. Find some colored objects around your house; list the objects in the table below according to their color in white light. Examples: clothing, construction paper, be creative!!

4. Test these objects that you find in red, green and blue light. Make your prediction in the table below and then note the actual color that results.

Color of object (white light)	Color of light used (red, green or blue)	Predicted Color	Actual (Resulting) Color
1.	Red		
	Green		
	Blue		
2.	Red		
	Green		
	Blue		
3.	Red		
	Green		
	Blue		
4	Red		
	Green		
	Blue		
5.	Red		
	Green		
	Blue		
6.	Red		
	Green		
	Blue		
7.	Red		
	Green		
	Blue		
8.	Red		
	Green		
	Blue		

Extension Activities:

1. Art: Where else is color mixing used?

Have you ever used markers or paints to mix colors and create new ones? Do you get the same results from mixing colors of light as you do with markers or paints? Make your prediction and then use markers or paint on white paper to test your theory. What are some of these similarities and differences when you mix colored pigments and colored light?

2. Botany/Scientific Method/Technology: Growing plants, the practical side of color mixing.

Does the color of light affect the way plants grow? If you have indoor plants that your parents do not mind you experimenting with, design an experiment to see if light effects plant growth. Use white light (sunlight) as your control. You can add other plants to sources of red, green and blue light. Remember to design your hypothesis before you experiment.

3. Biology/Technology: What is it like to be color blind?

What is it like to be color blind? Do an internet search to find information on color-blindness. What is the most common type of color-blindness? What is it like for a person to be color blind? Are there any animals that are color blind?

4. Animals and colored vision.

Many animals do not have color vision: the ability to discern different wavelengths evolved in animals that became diurnal, or active in the daytime. Among these, birds are especially color sensitive. Some have four or more cone pigments, allowing them to distinguish more accurately among colors than we do (probably seeing more shades), and to see into the ultraviolet range, which we cannot.

Most primates other than humans have just two visual pigments, one for short (blue) wavelengths, and one that varies in different animals but detects light somewhere in the red to green part of the spectrum. Familiar animals such as dogs and cats also have two types of cones. Old World monkeys have three cone types, as humans do.

Some invertebrates have color vision: like birds, some insects can see ultraviolet light. Insects also have different screening materials in the corneal covering of their eye facets; this allows for tuning different eye units (called ommatidia) to different wavelengths.

References:

<u>For more information on the anatomy of the eye:</u>
<u>http://retina.anatomy.upenn.edu/~lance/eye/eye.html</u>

<u>Color blindness, animal vision and general vision information:</u>

http://faculty.washington.edu/chudler/eyecol.html
http://lsvl.la.asu.edu/askabiologist/research/seecolor/rodsandcones.html

Light and the Electromagnetic Spectrum:
http://imagine.gsfc.nasa.gov/docs/science/know_l1/emspectrum.html
http://csep10.phys.utk.edu/astr162/lect/light/spectrum.html

Color Mixing:
http://en.wikipedia.org/wiki/Primary_colors