

Color Blindness

A Reading A-Z Level T Leveled Book

Word Count: 1,075

LEVELED BOOK • T

Color Blindness

Connections

Writing

Choose two forms of color blindness. Write a report that compares the two conditions and their effects on a person's life.

Math

Research the statistics about the number of people with the various forms of color blindness in your country. Organize your results in a pie chart.

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**Multi
level
Q•T•W**

Color Blindness



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Focus Question

What causes color blindness, and how can it affect a person's life?

Words to Know

ancestors	retina
apps	rod cells
color-blind	tissue
cone cells	wavelength
gene	

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Correlation

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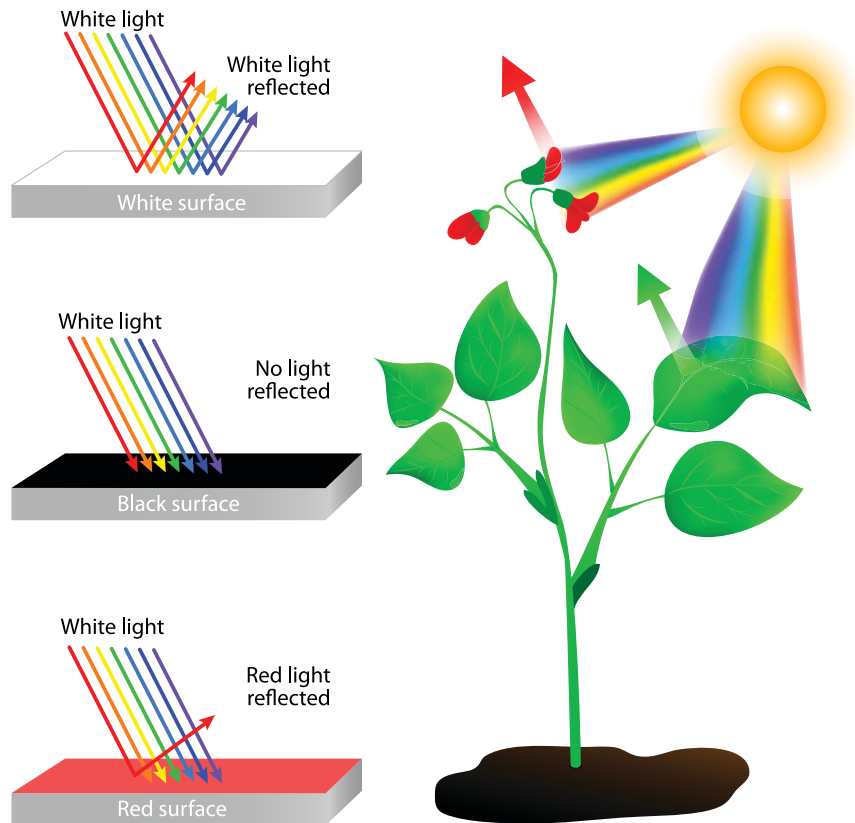
Choosing a red crayon is much easier for someone with full-color vision (top) than someone with red-green color blindness (bottom).

What Colors Do You See?

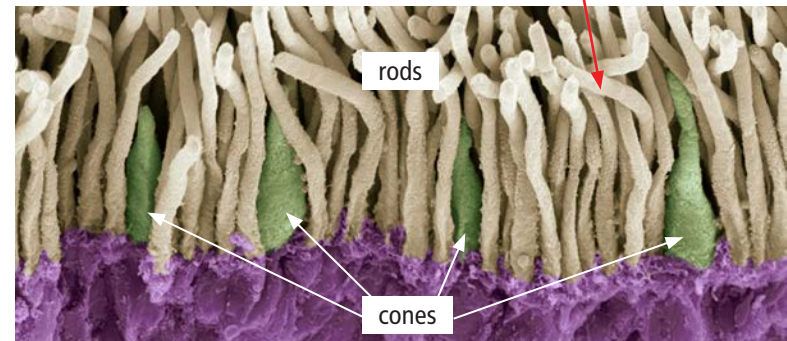
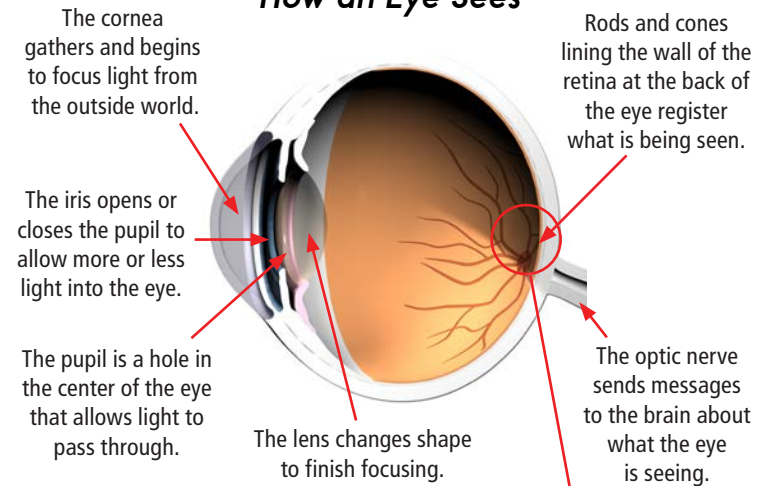
Imagine looking at a box of crayons and seeing only shades of gray, blue, and yellow. That's what they look like to many people who are **color-blind**. Most people who are color-blind can still see some colors. They just can't see as many colors as most people.

Where Do Colors Come From?

White light actually has every color of the rainbow hidden inside it. Each color is a different **wavelength**. Objects appear to be different colors because they absorb and reflect different wavelengths of light. A strawberry looks red because it reflects red wavelengths while absorbing most other wavelengths.



How an Eye Sees



How Color Vision Works

People see colors because our eyes respond differently to different wavelengths of light. When light enters one of your eyes, the lens focuses it on the **retina**, a thin layer of **tissue** at the back of the eyeball. There, it triggers light-sensitive **rod cells** and **cone cells**. These cells send signals to the brain, which uses the signals to make images.

Rods and Cones

Rod cells are the most sensitive cells in your eye. They allow you to see in very dim light, but they can't tell different colors apart.

Cone cells handle color vision. There are three types of cone cells, which absorb blue, green, or red light. Combining these three main colors allows us to see thousands of colors. When one or more types of cone cells aren't working, though, color blindness results. The type of color blindness depends on which cone cells are affected and how much they're affected.



Color Vision in Animals

Most animals can see fewer colors than humans. For instance, dogs can only see shades of blue and yellow, and bulls are completely color-blind! Other animals—including some birds, bees, and butterflies—see more colors than humans do, including wavelengths of light that are invisible to humans.

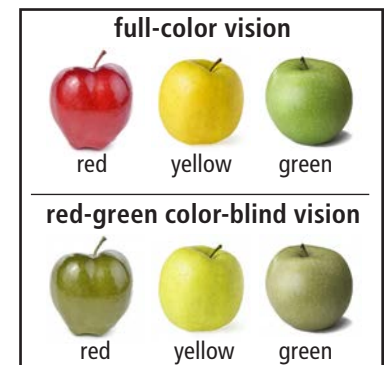
Different Types of Color Blindness

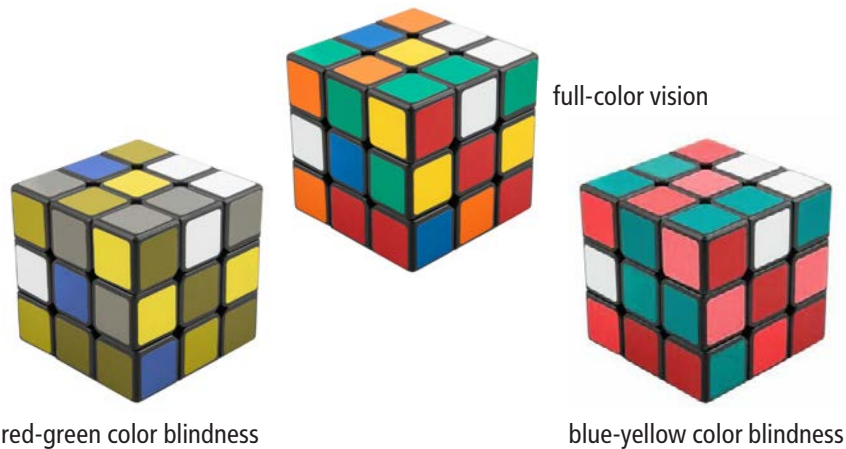
Red-Green Color Blindness

Red-green color blindness is the most common type of color vision problem. It occurs most often in people whose **ancestors** came from northern Europe. It affects one out of every twelve men and is less common in women.

Red-green color blindness is usually caused by problems in the green cone cells, which make green and yellow objects appear reddish in color. Problems in the red cone cells also cause red-green color blindness. In this case, red, orange, and yellow objects appear green or black.

Although people with red-green color blindness have trouble telling some colors apart, they can still see clearly. That's because red and green cones have some overlap in the light they detect.





red-green color blindness

full-color vision

blue-yellow color blindness

Blue-Yellow Color Blindness

Blue-yellow color blindness occurs when the blue cone cells are missing or not working properly. This type of color blindness is fairly rare, affecting only about one out of every ten thousand people worldwide. Unlike red-green color blindness, it's equally common in men and women.

Some people with blue-yellow color blindness have no blue cone cells, which causes them to see blue as green and yellow as violet or gray. More commonly, people who are blue-yellow color-blind have blue cone cells that still work at some level. As a result, it's difficult for them to tell yellow and red from pink.



Complete color blindness (right) is very rare.

Complete Color Blindness

Complete color blindness is the most serious form of color blindness. It occurs when there are problems in two or more of the three types of cone cells.

People who are missing two or more types of cone cells are often extra-sensitive to light. They may also have difficulty seeing clearly, especially in bright light. This is because they rely on rod cells for most or all of their vision, and rod cells only work in low light.

Only about one in thirty thousand people worldwide are missing all three types of cone cells. People without any working cone cells see the world in shades of black, white, and gray.

Color Blindness Is No Joke

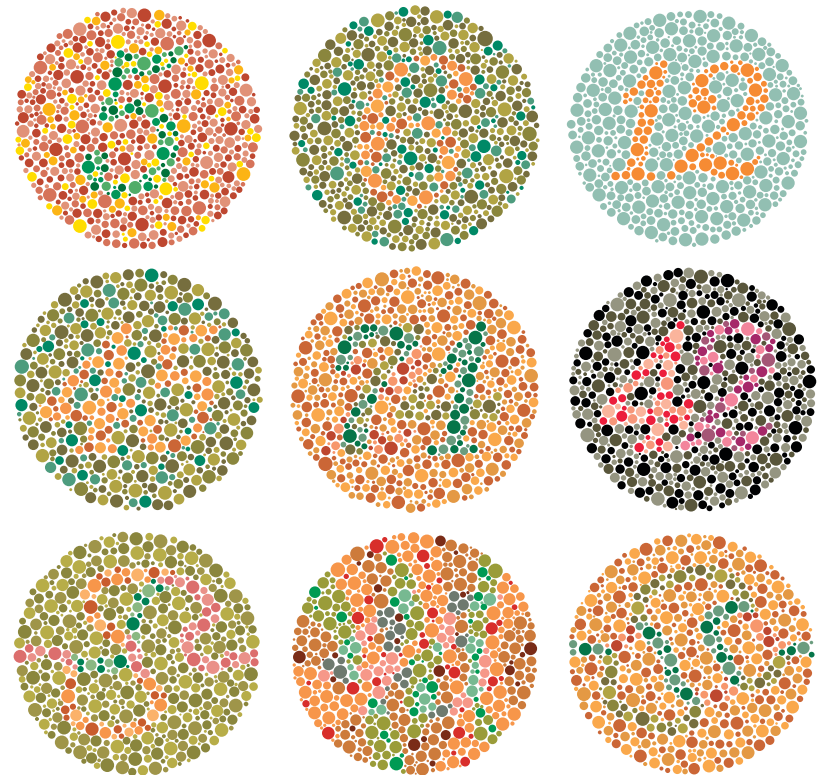
Color blindness can cause serious problems. People who are color-blind have trouble reading color-coded information on maps. Children with color blindness may have trouble in school. Red-green color blindness makes it difficult to read yellow chalk on a green chalkboard. All types of color blindness make it difficult to choose the correct colors for art and science projects.

Color blindness can also cause safety issues. Fire hydrants, car warning lights, and emergency equipment are often colored red or yellow to make them more visible. These bright colors may be obvious to those with full-color vision but unnoticeable to those who are color-blind. People may also have difficulty noticing sunburns, rashes, or undercooked meat without color vision.

Color blindness can even limit a person's career options. Geologists and airline pilots need full-color vision. Other careers, such as interior design, photography, and food inspection, are much more difficult without it.

Testing for Color Blindness

Doctors use several types of tests to detect color blindness. The Ishihara Test is the most common. It uses images made up of dots that are different sizes and colors. People with full-color vision can see numbers or shapes inside the pictures. People with red-green color blindness find it difficult or impossible to identify the hidden symbols.



Can you see the hidden numbers or shapes in the circles in this Ishihara Test?



These special glasses from EnChroma allow people with red-green color blindness to see a much more colorful world.

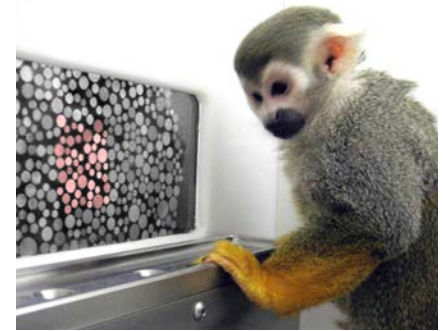
Tools to Help Color-Blind People

Currently, there's no known cure for color blindness. However, there are many new tools to help people deal with color blindness. Smartphone **apps** can perform tasks such as identifying colors and picking colors that go together well. These apps can help people choose matching clothes or tell which fruits are ripe at the grocery store.

Researchers have also created high-tech lenses that filter out specific wavelengths of light. Special sunglasses that use these lenses allow people with red-green color blindness to tell the two colors apart and see a full range of colors.

Treating Color Blindness

Recently, scientists were able to correct red-green color blindness in squirrel monkeys. The monkeys lacked red cone cells and, as a result, couldn't tell the difference between red and green. Researchers used a virus to insert the red **gene** into the monkeys' retinas. Within about twenty weeks, treated monkeys could tell the difference between red and green dots.



A squirrel monkey takes a color test.

This was exciting news because the monkeys had been color-blind since birth. Many doctors and scientists thought that color-blind monkeys' brains would not have grown in a way that would allow them to see a full range of colors. These parts of the brain usually develop when the animals are young.

Now that we know that color blindness can be cured in adult squirrel monkeys, there's hope for a cure in adult humans, too.

Color Vision for All?

Every year, researchers gain a better understanding of color blindness and its causes. New tools help color-blind people choose ripe fruit and pick out matching clothes. People with red-green color blindness can use special glasses to allow them to tell the difference between shades of red and green.

Best of all, a treatment for color blindness may be available in the near future. Who knows? Maybe someday soon, color blindness will become a thing of the past!



Glossary

ancestors (<i>n.</i>)	family members from long ago (p. 8)
apps (<i>n.</i>)	computer programs or applications designed for mobile devices such as cell phones (p. 13)
color-blind (<i>adj.</i>)	lacking the ability to distinguish between two or more colors (p. 4)
cone cells (<i>n.</i>)	cells in the eye's retina that are color sensitive and work best in bright light (p. 6)
gene (<i>n.</i>)	a basic unit of heredity that transfers a trait from one generation to the next (p. 14)
retina (<i>n.</i>)	tissue at the back of the eye that receives images and transmits them to the brain (p. 6)
rod cells (<i>n.</i>)	cells in the eye's retina that are light sensitive and work best in dim light (p. 6)
tissue (<i>n.</i>)	material made up of a group of cells that are similar in form and perform a certain function (p. 6)
wavelength (<i>n.</i>)	the distance between two consecutive high or low points of a wave (p. 5)