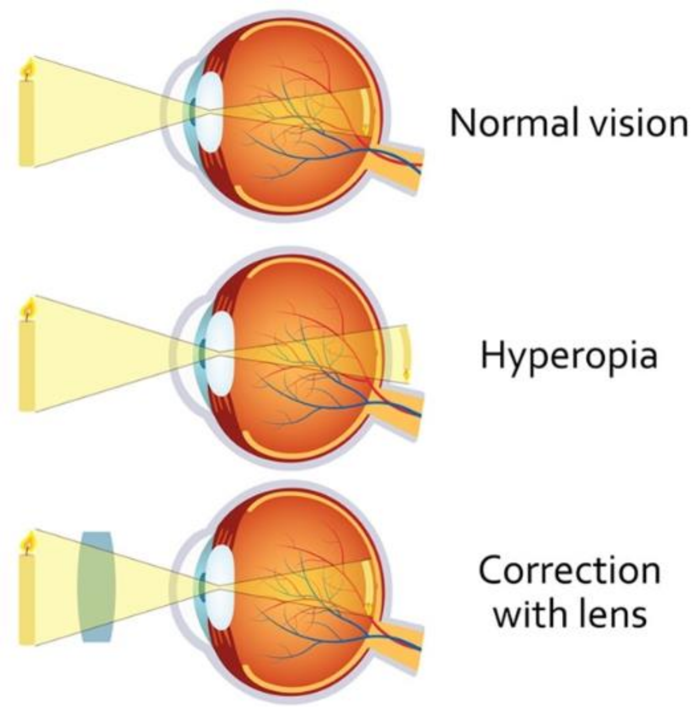
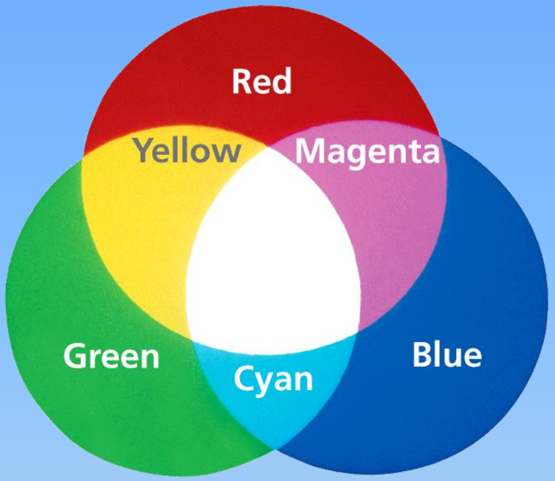
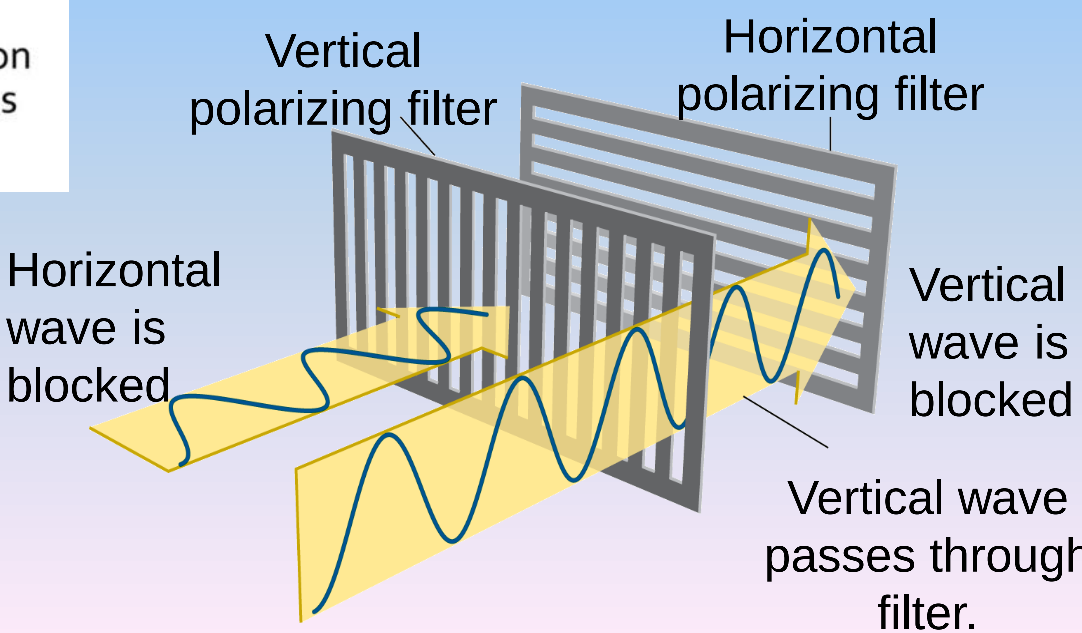
Optics Human Eye Color







Polarization of Light

Incident light (e.g. from the sun) vibrates in more than one plane. When light passes through "filters" it becomes "Polarized" or aligned in a particular plane.

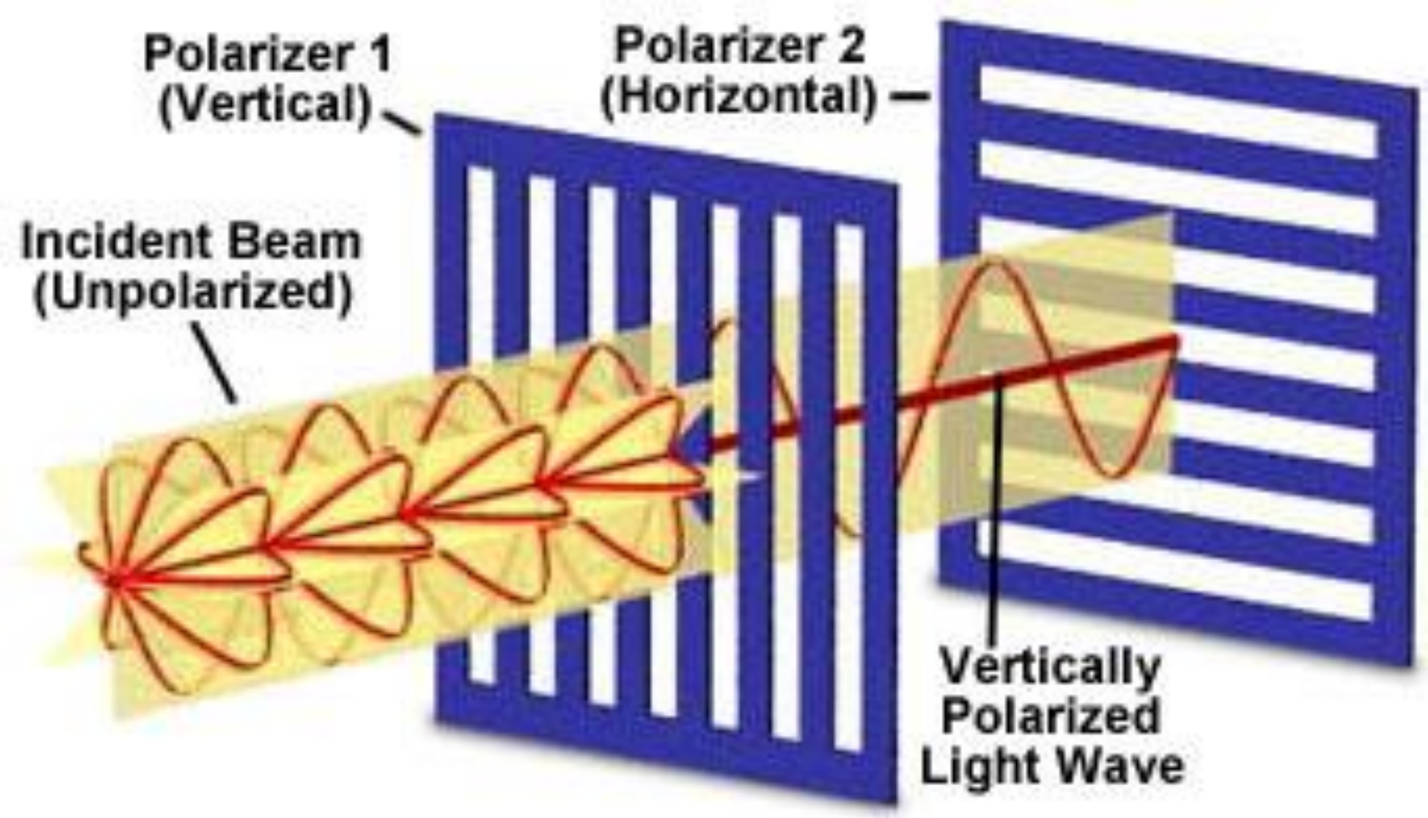
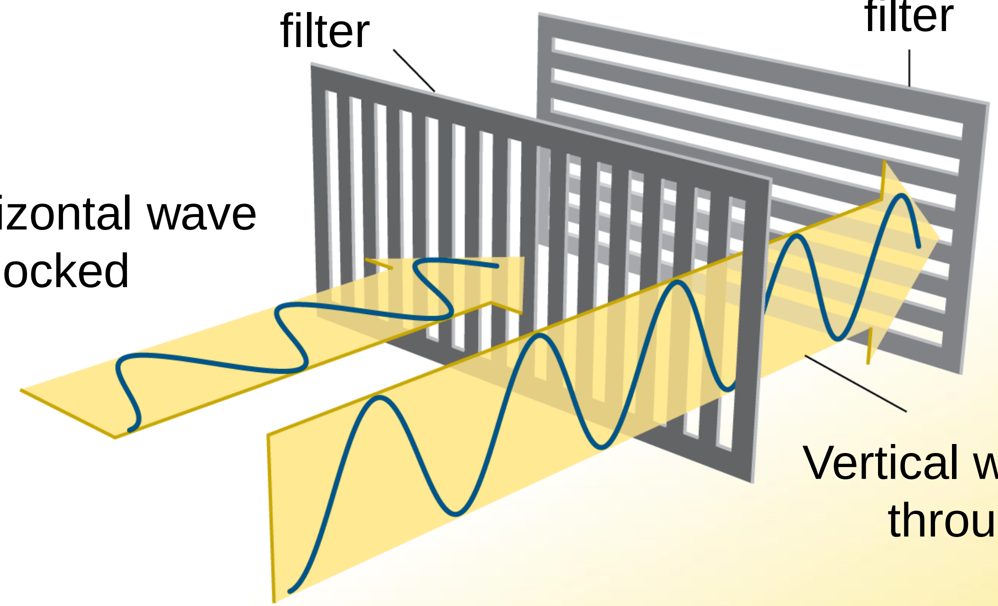


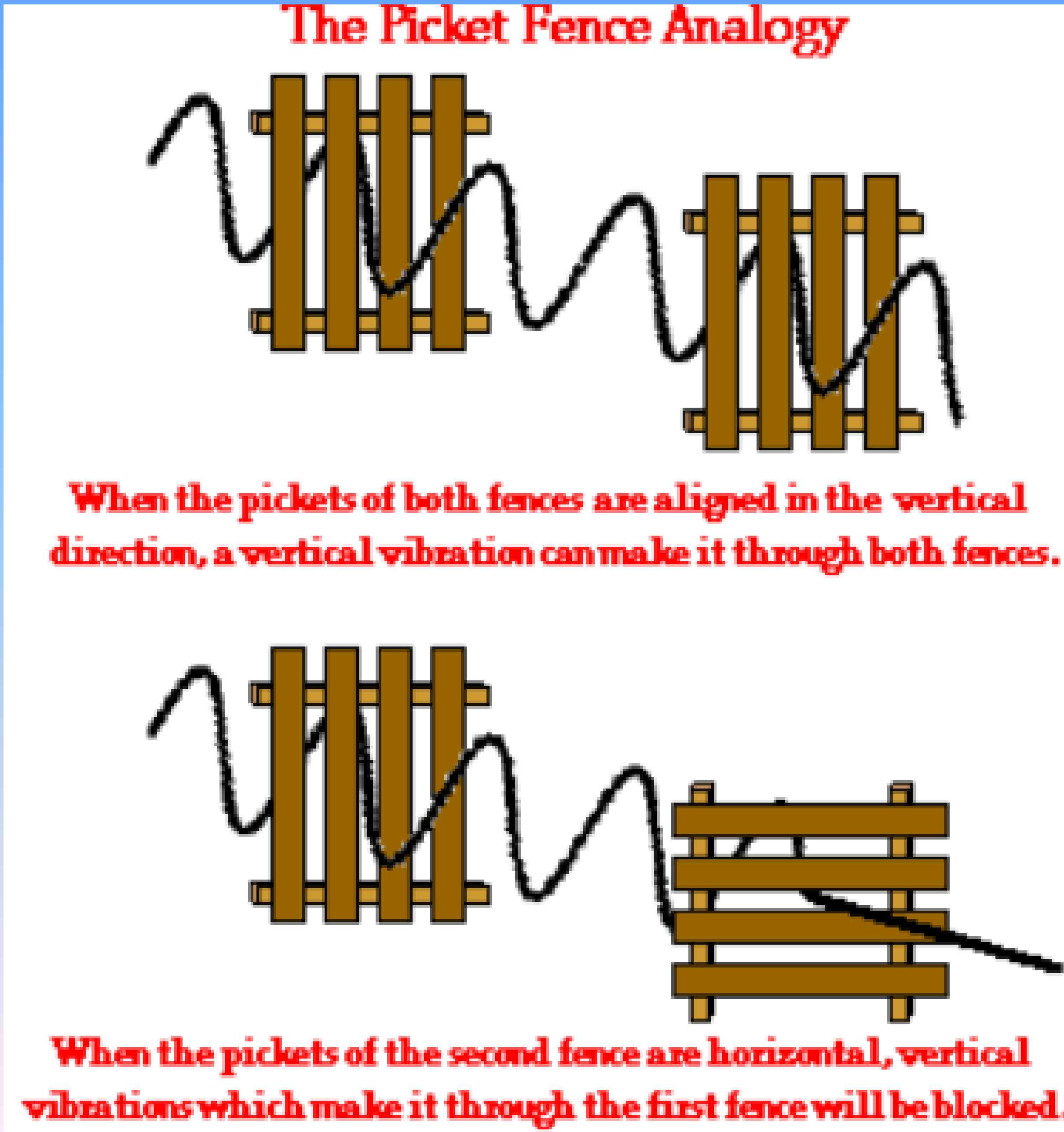
Figure 1

Interactions of Light

This simplified model shows how polarizing filters behave. A vertical polarizing filter blocks light that is horizontally polarized.



Polarization of Light



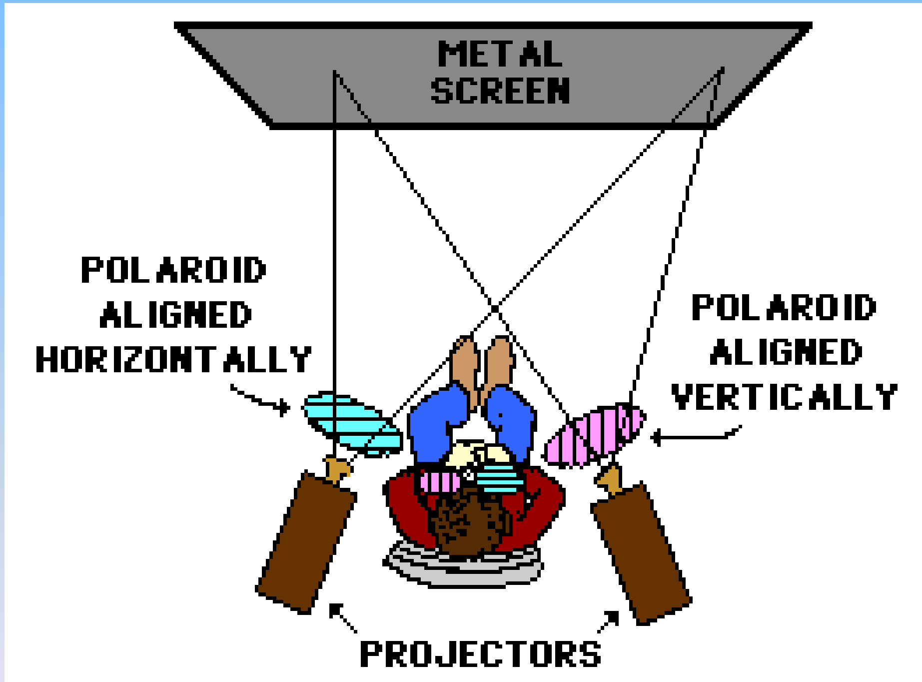
Imagine standing straight up and passing through the first "fence" (filter).

Can you pass through the second fence (filter) standing up?

Polarization of Light

Light is aligned along particular planes by filters, making it more useful to us.

- 3D movie projection, digital clocks, scoreboards



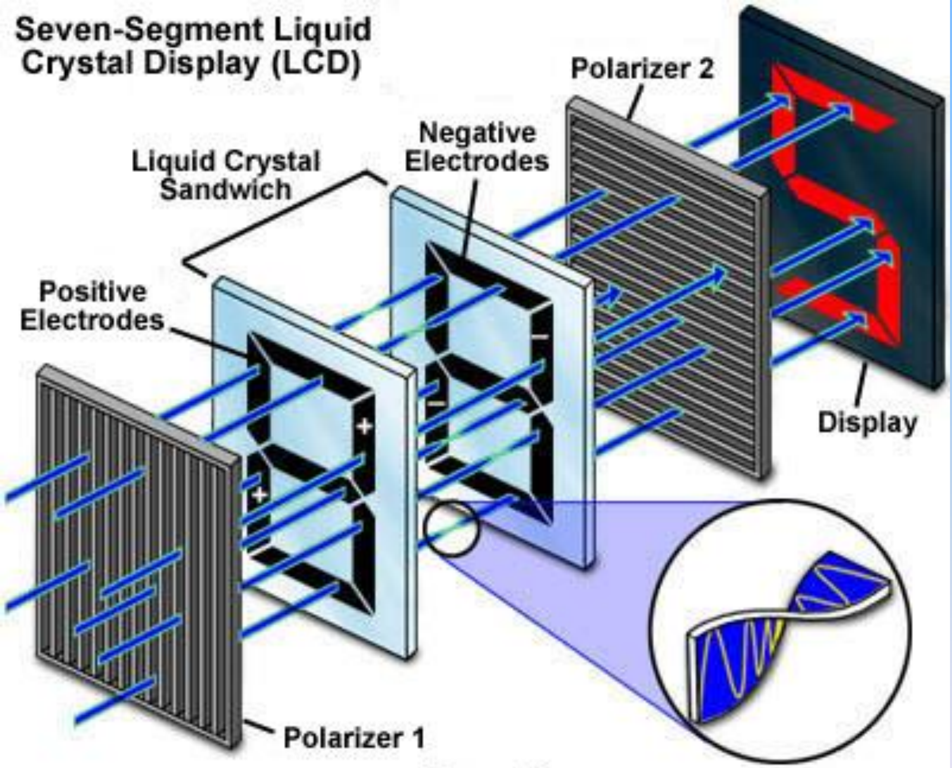
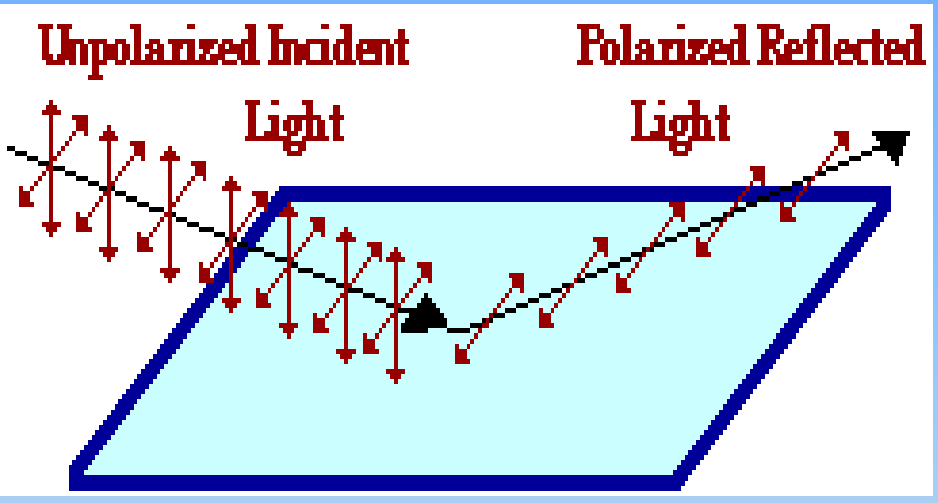
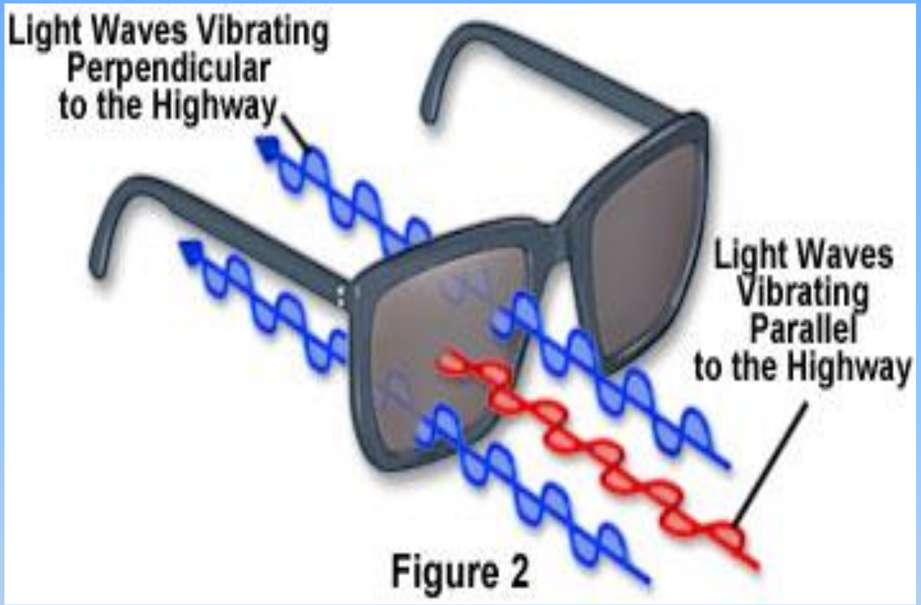


Figure 3

Polarization of Light

How do sunglasses work?





Light from the sun reflects off the road or water (e.g. at a lake), becoming polarized horizontally.

Sunglasses are polarized vertically so the horizontal "glare" from the road or lake will not pass through them.

Behavior of Light

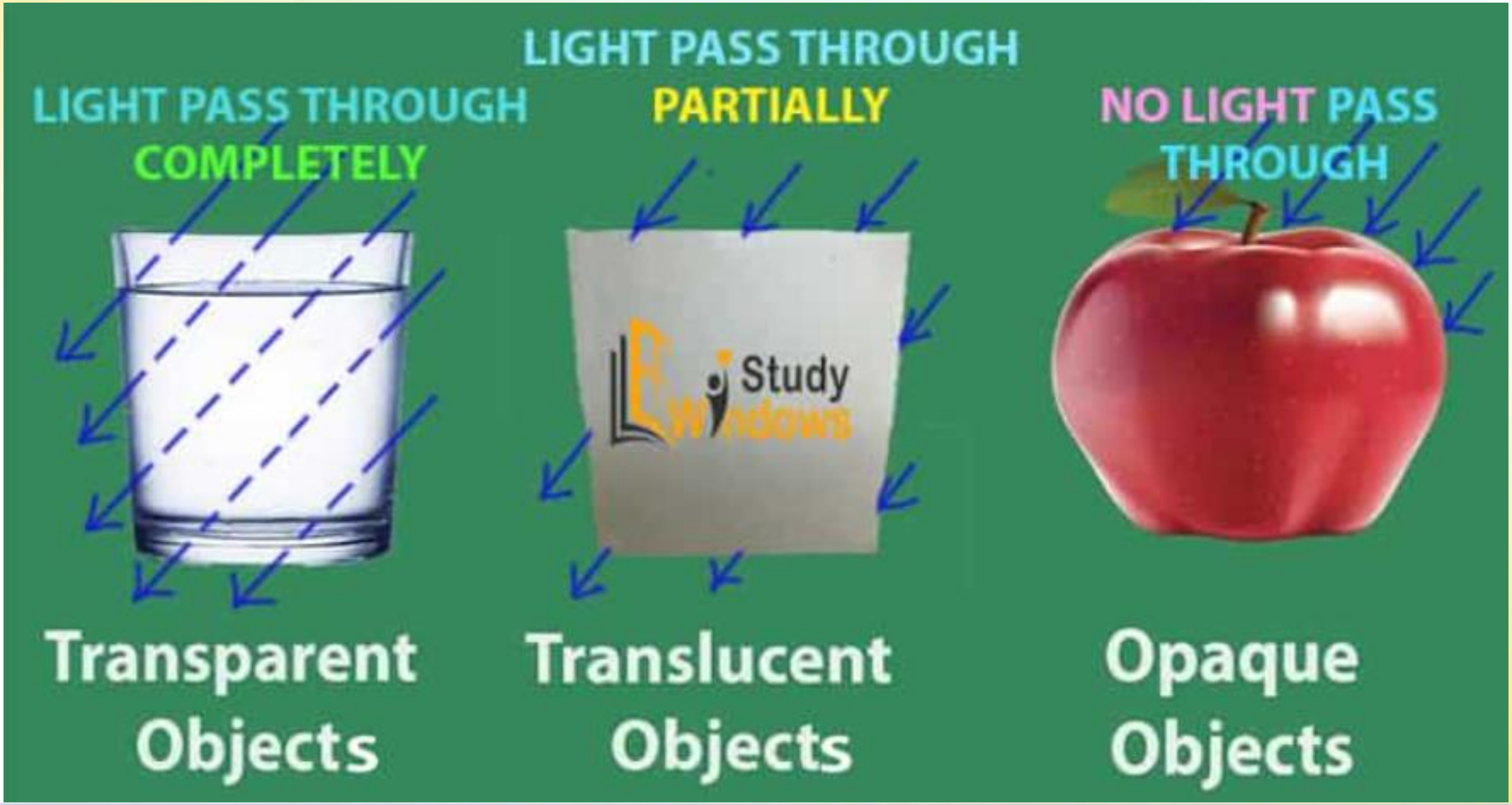
Transparent

Translucent

Opaque

Scattering

Materials can be transparent, translucent, or opaque.

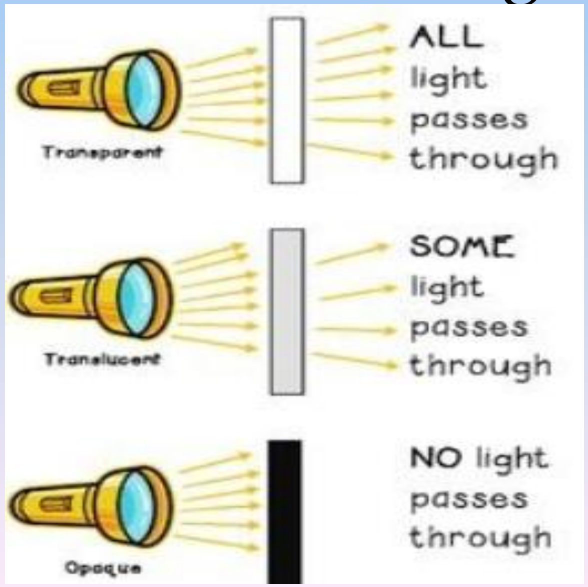


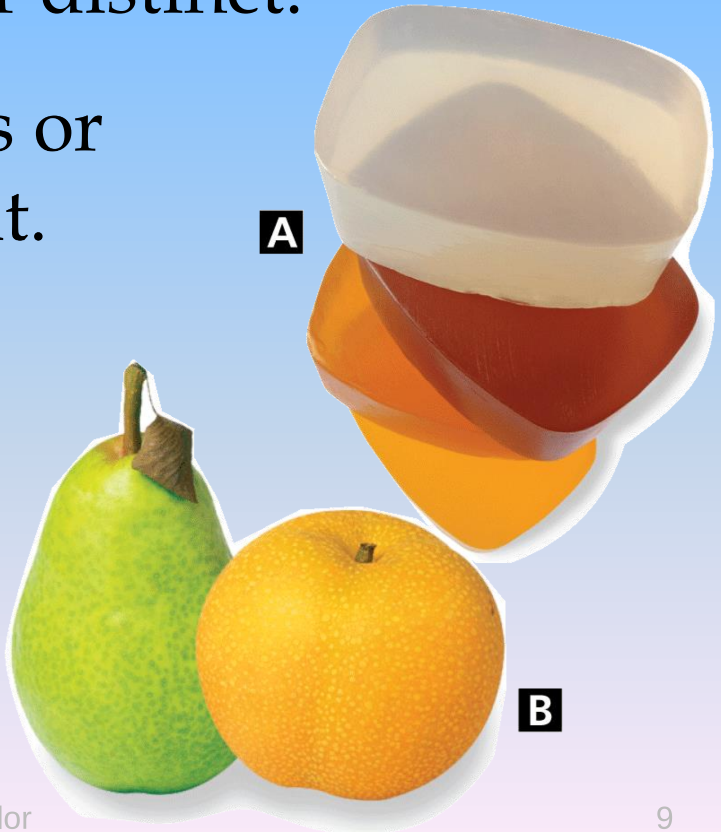
Light in Materials

A **transparent** material transmits light. Light can pass through it mostly or fully unimpeded.

A **translucent** material scatters light. Light passes through but objects are not clear or distinct.

An **opaque** material either absorbs or reflects all of the light that strikes it.





Light in Materials

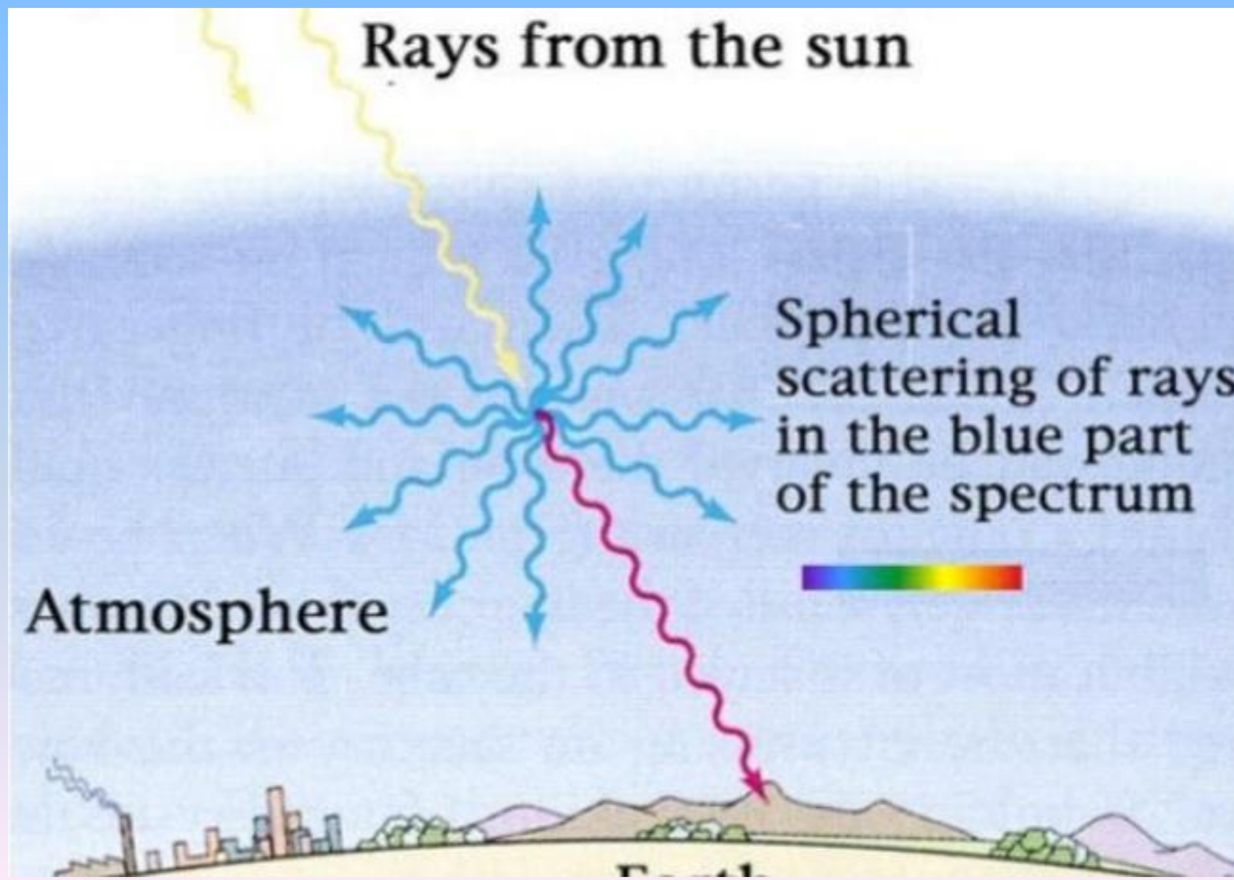
Scattering

Light is redirected as it passes through a medium.

- When the sun is close to the horizon, sunlight travels farther through the atmosphere.
- By the time the sunlight reaches your eyes, most shorter-wavelength light (ROY) has been scattered.

Scattering - Why is the sky blue?

- Small particles scatter shorter-wavelength (**B**IV) light more than light of longer wavelengths (ROYG).
- **Our eyes recognize Blue light (not much violet).**



How do polarized sunglasses reduce glare?

a. by scattering light as it passes through the glasses
b. by providing a smooth surface that light can reflect off
c. by absorbing all light
d. by blocking horizontally polarized light

Glass block windows allow light to pass through, but people can’t see clear images of whose inside. This is an example of a ___ material.

The sun appears huge and orange sometimes at sunset. Why?

QUICK CHECK

How do polarized sunglasses reduce glare?

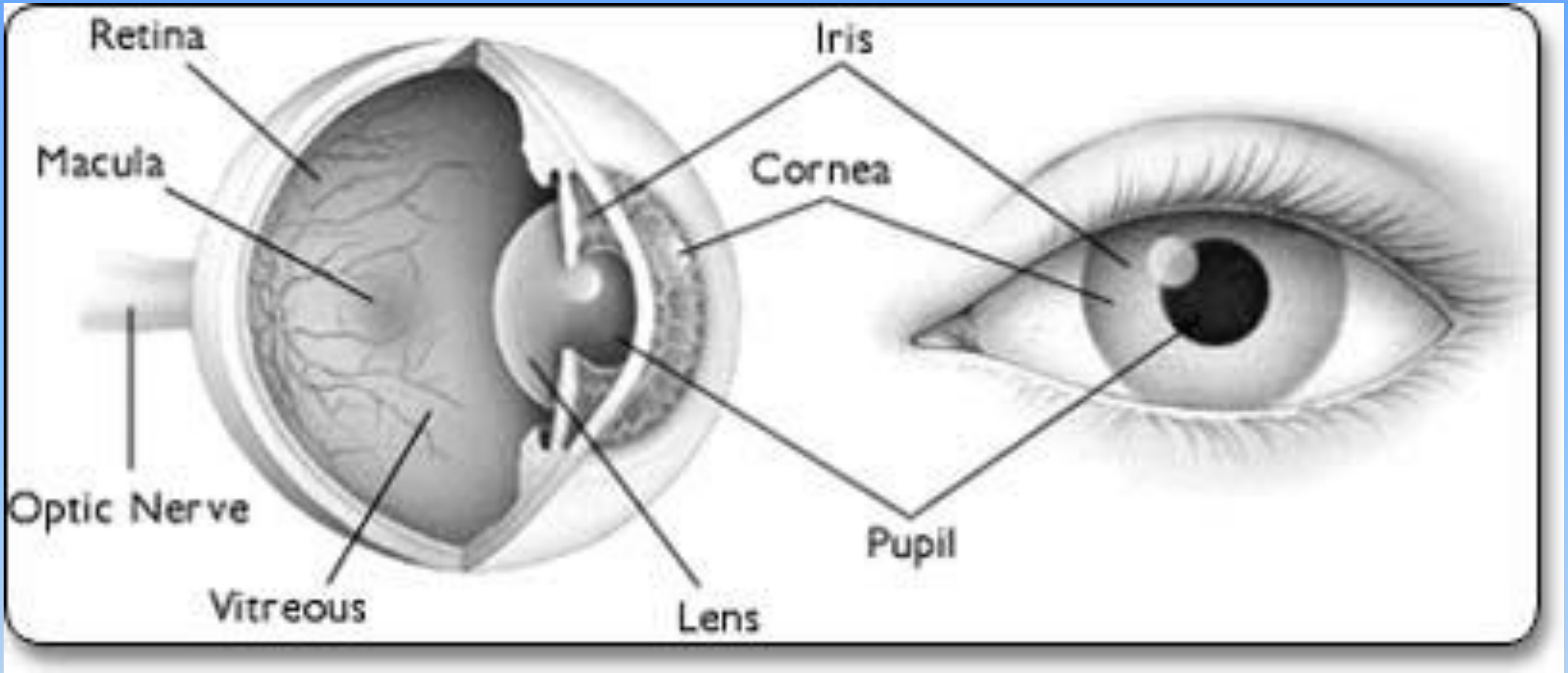
a. by scattering light as it passes through the glasses
b. by providing a smooth surface that light can reflect off
c. by absorbing all light
d. **by blocking horizontally polarized light**

QUICK CHECK

Glass block windows allow light to pass through, but people can't see clear images of whose inside. This is an example of a **translucent** material.

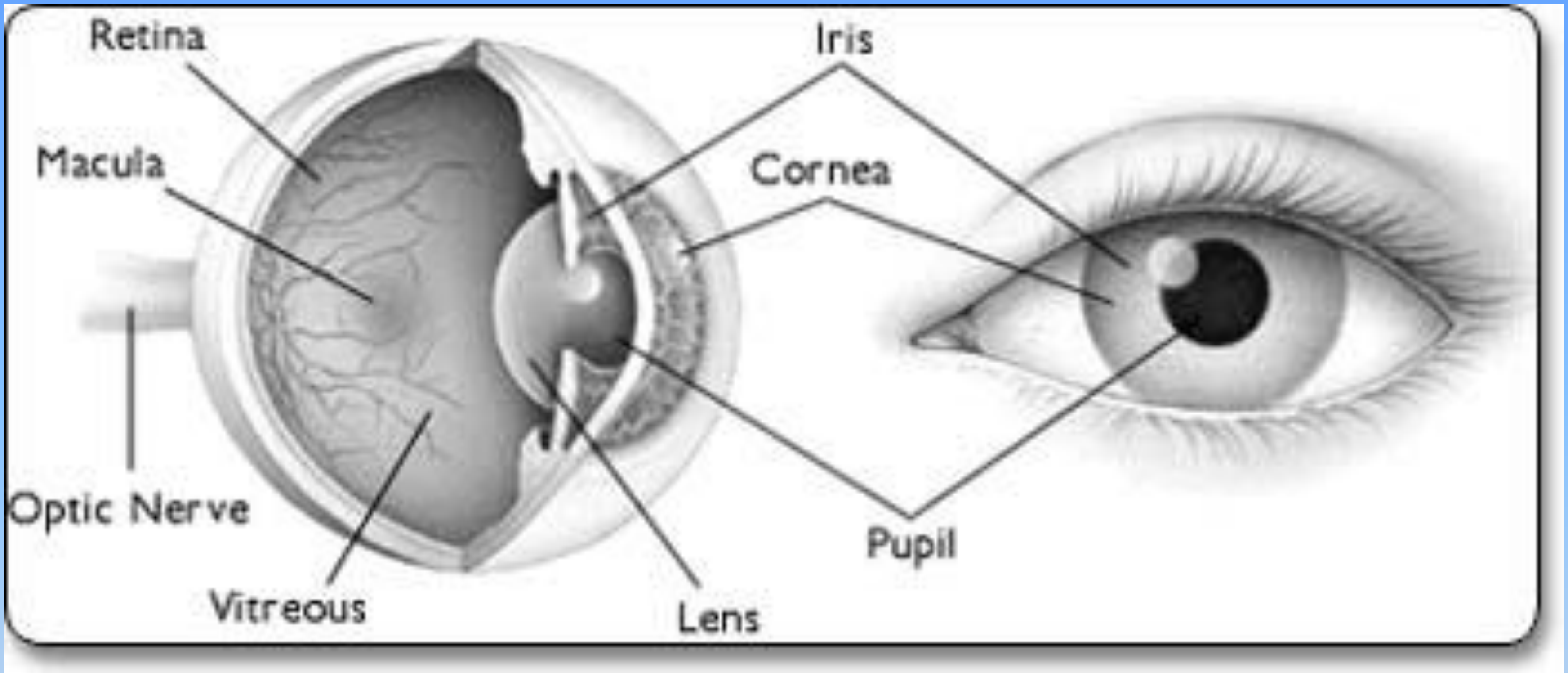
The sun appears huge and orange sometimes at sunset. Why? **Refraction (light bends in earth's atmosphere) and scattering of longer wavelengths (ROY) of light.**

Anatomy of the Human Eye



Cornea	45% of the focal power of sight; transparent; protective
Iris	muscle surrounding pupil, giving eye color
Pupil	like the diaphragm of a camera regulating light
Lens	25% of the focal power of sight; convex

Anatomy of the Human Eye



Retina receives light impulses & sends them to the optic nerve

Macula blood vessels come together (nourish eye)

Vitreous solution; 30% of the focal power of sight; nutrition

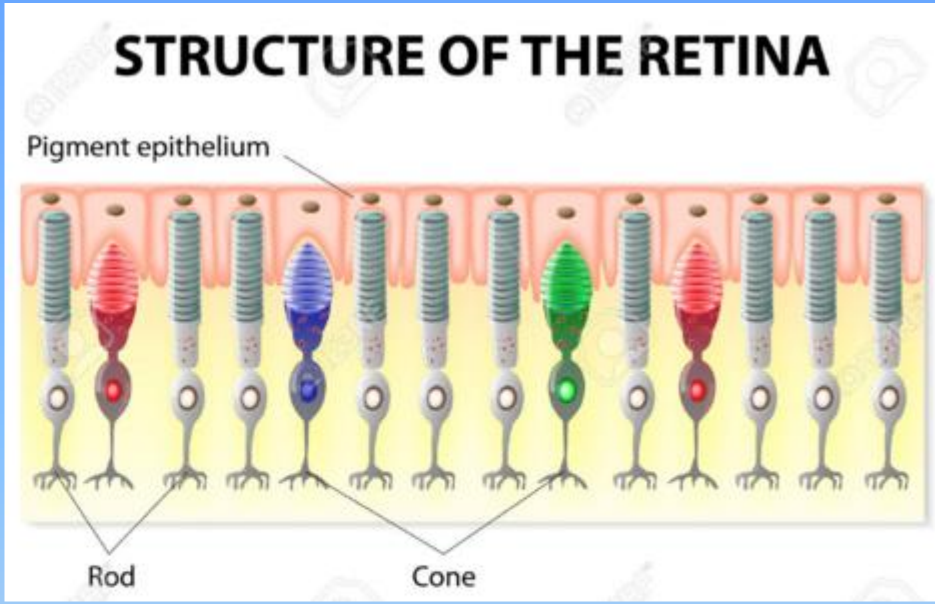
Optic Nerve receives nerve impulses from the retina and sends them to the brain

Anatomy of the Human Eye

The eye is an utterly amazing creation of God. Even Darwin was quoted as saying that to think the eye was formed by random natural selection is absurd in the highest degree (London: Penguin Classics, 1985, p. 217). Yet, he still advocated evolution as the source.????

13 This is why I speak to them in parables: "Though seeing, they do not see;
though hearing, they do not hear or understand.
14 In them is fulfilled the prophecy of Isaiah: "'You will be ever hearing but never
understanding; you will be ever seeing but never perceiving. Matthew 13:13-14

Anatomy of the Retina



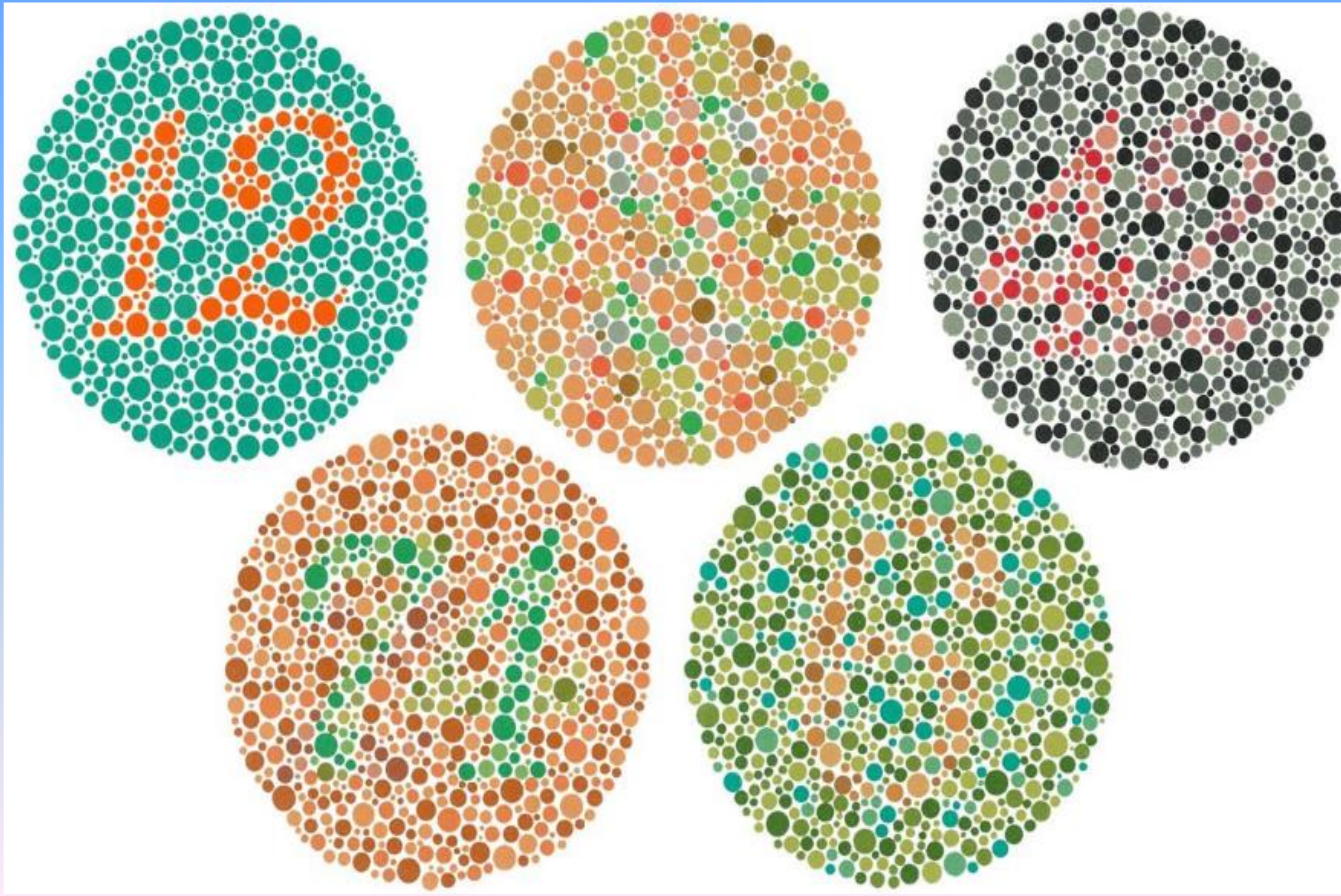
There are two types of photoreceptors in the human retina: rods and cones.

Rods are responsible for vision at low light levels and specialize in light and dark contrast (sensitivity).

Cones are active at higher light levels and specialize in color vision. There are 3 main "cone" cells corresponding to Red, Green, and Blue light.

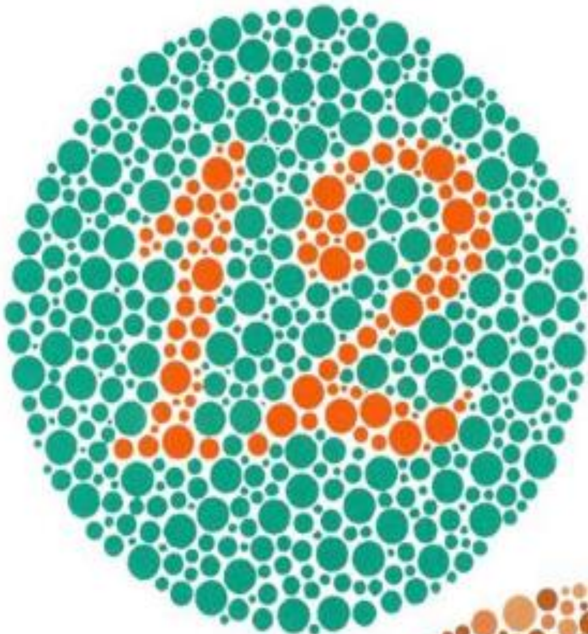
?

Color Blindness



Color Blindness

12



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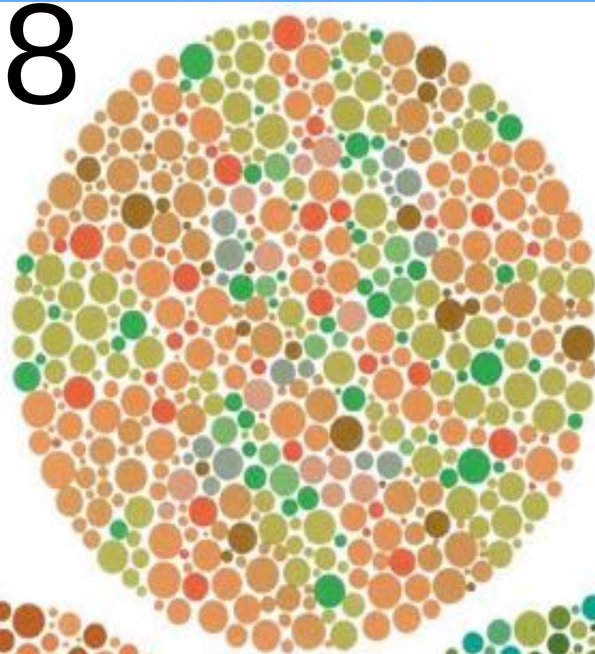

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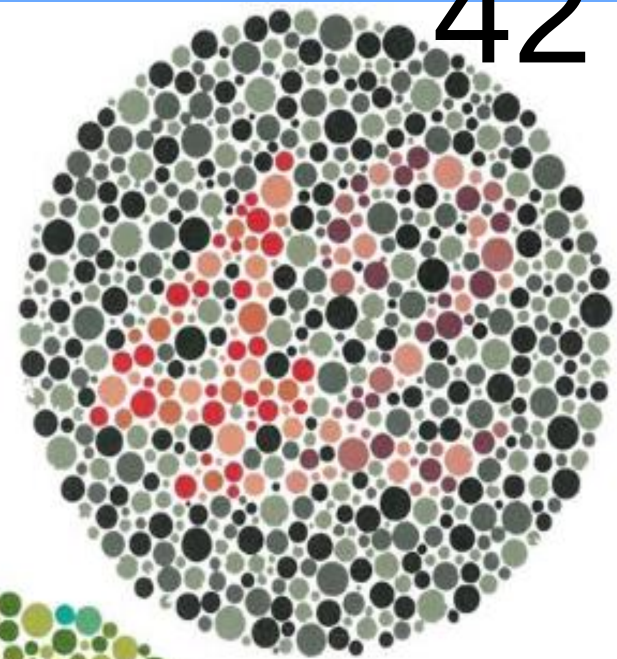

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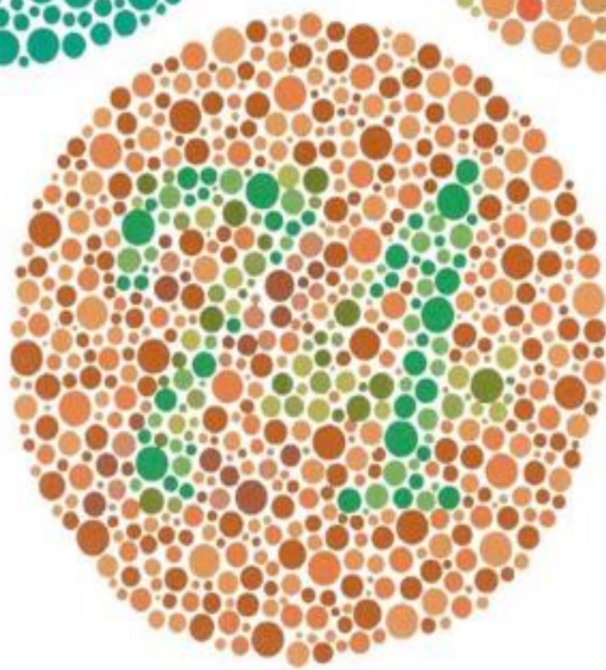

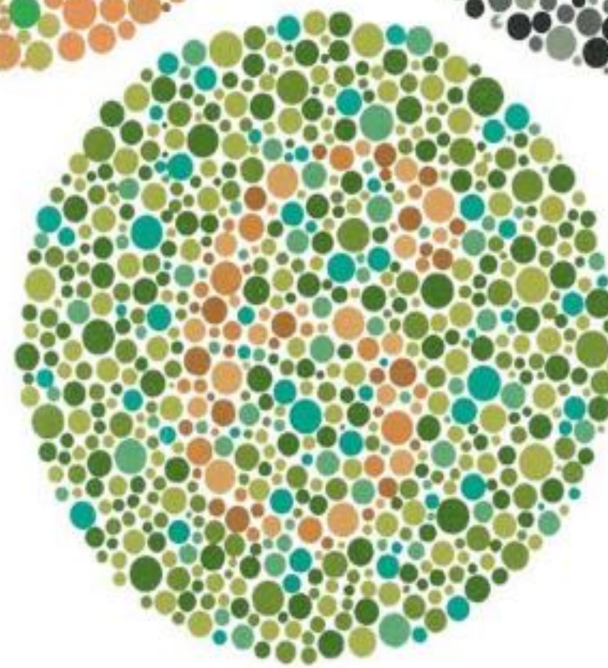

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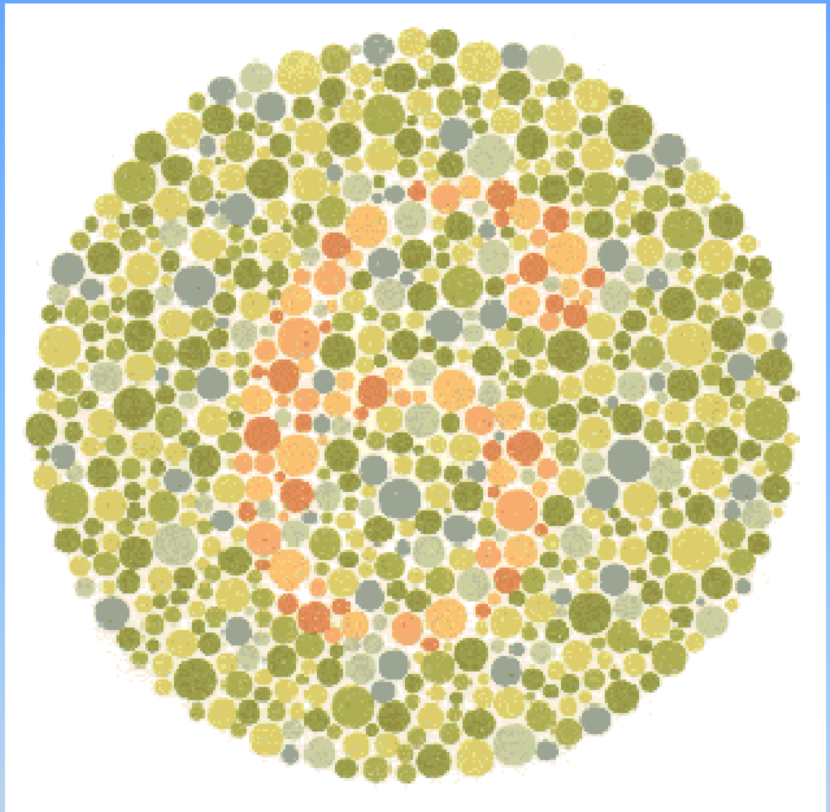
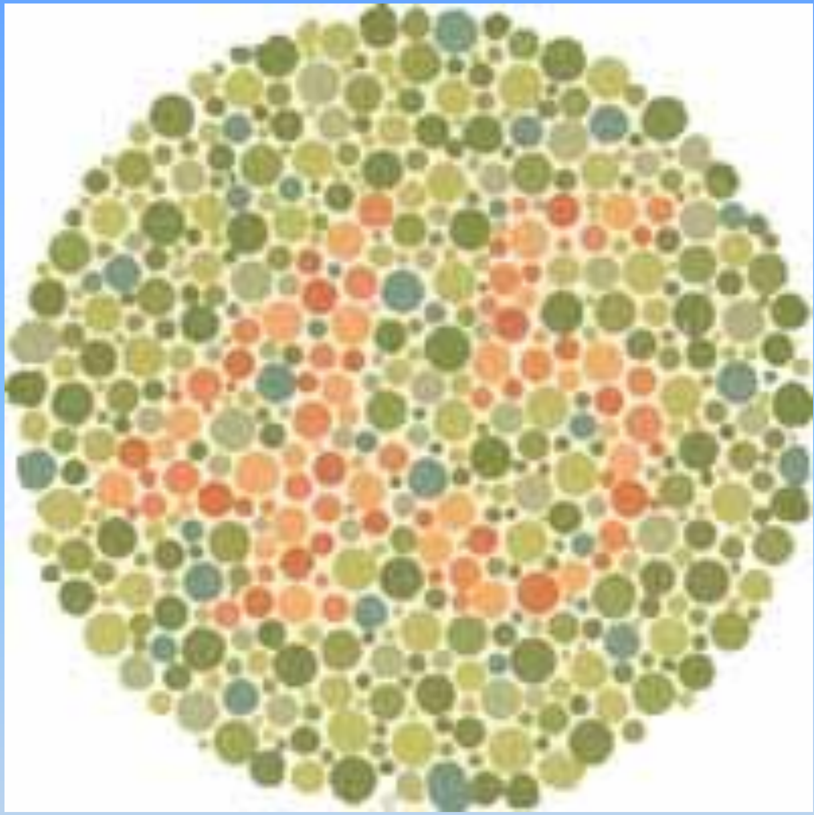
Color Blindness

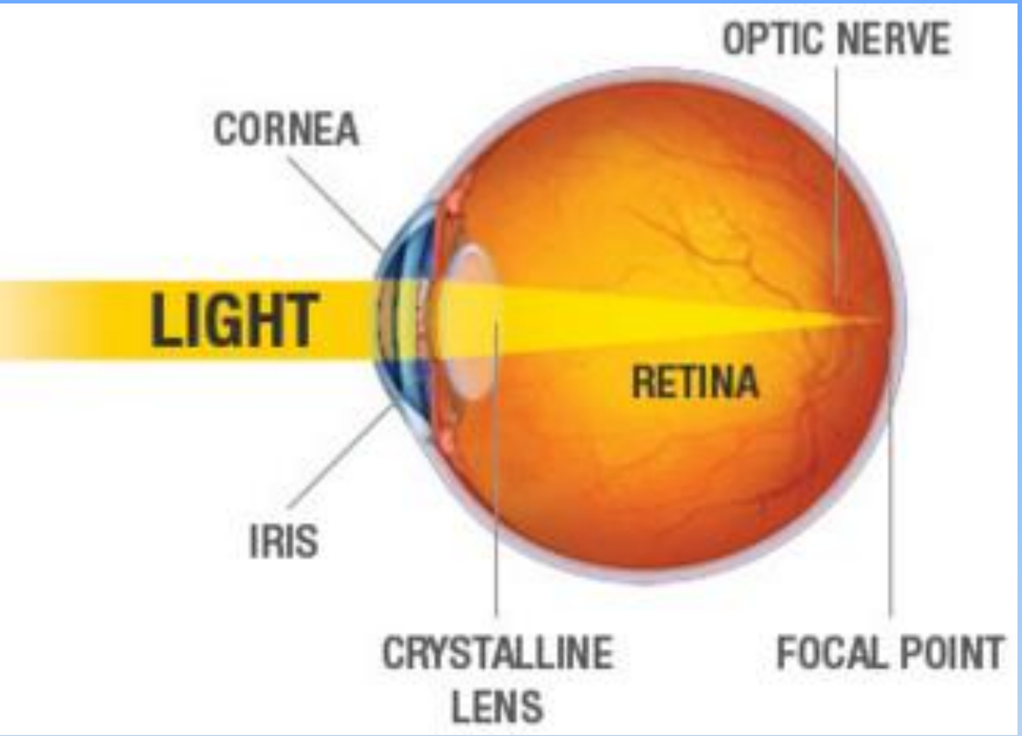


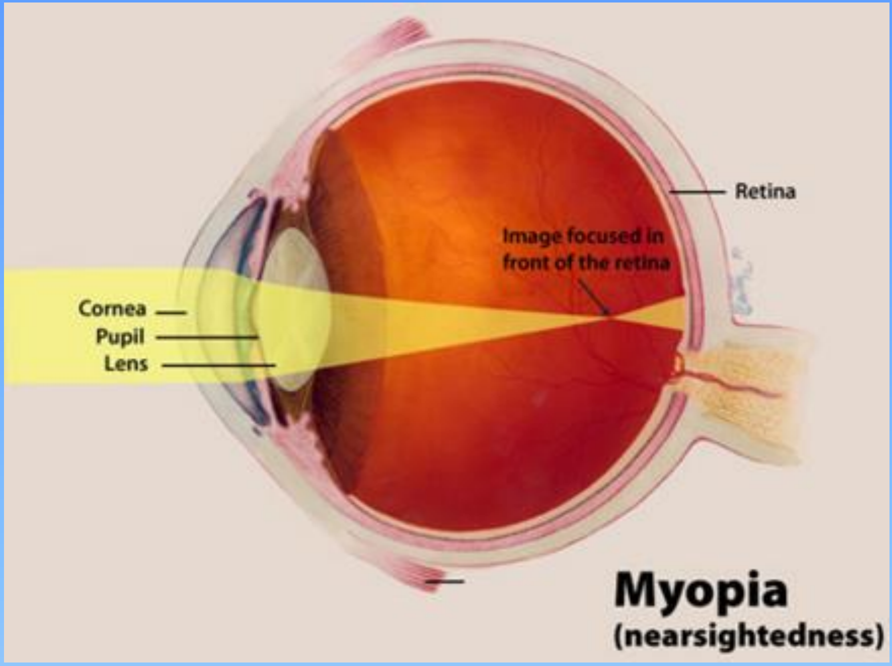
?

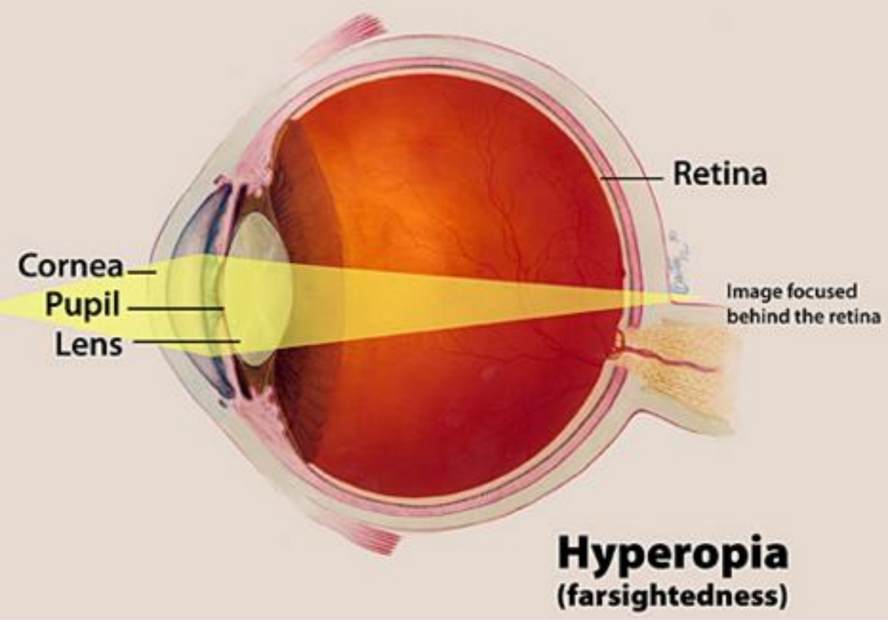


Red – Green color blindness is the most common deficiency in human vision. In the case of Red – Green color blindness people struggle with shades of color, especially related to blue.

Eyesight





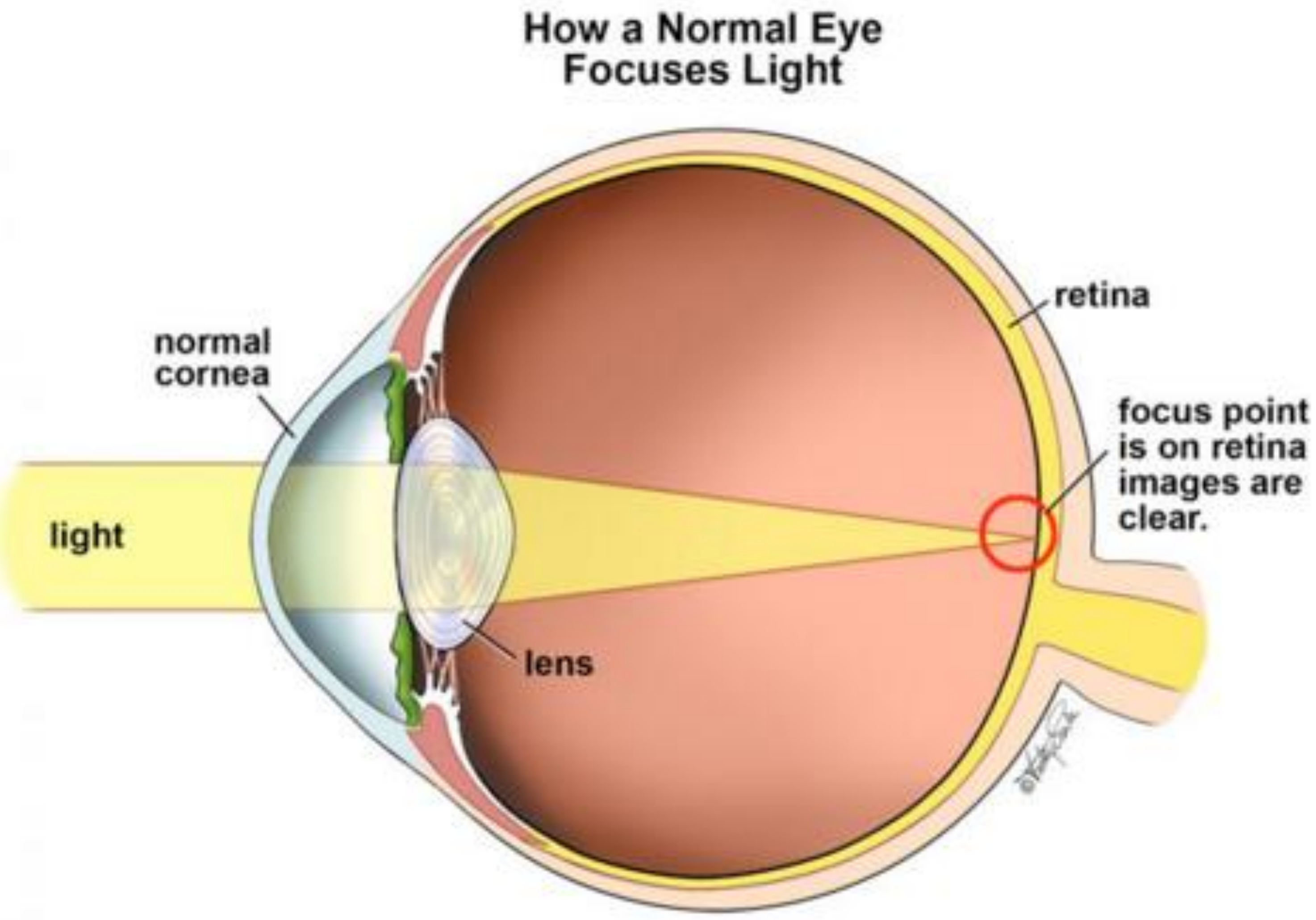


What produces nearsighted vision?

What produces farsighted vision?

Normal Vision

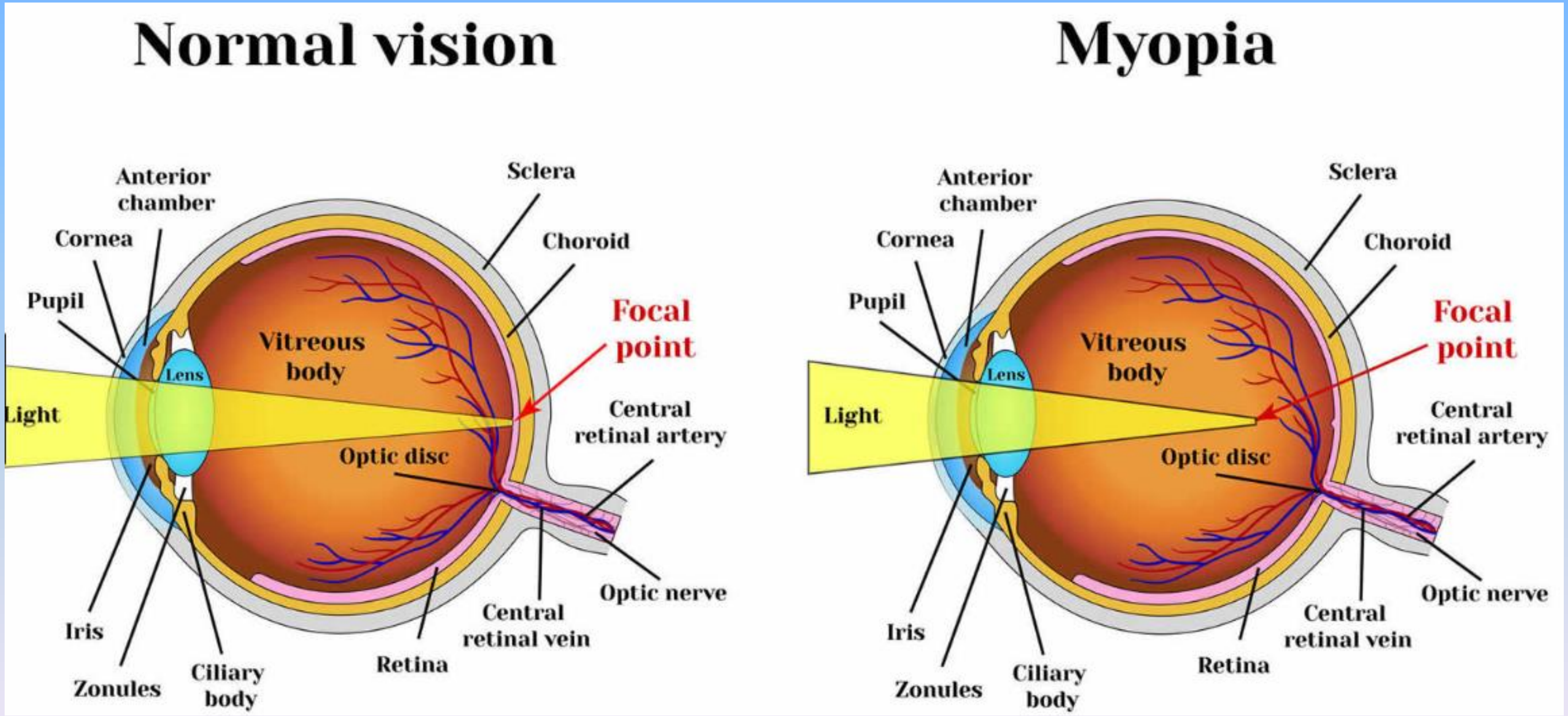
In normal vision, light rays from an object entering the eye are focused by the *lens*



(*transparent tissue that changes shape to help focus incoming light*) onto the *retina* (*the membrane at the back of the eye that transmits images of external objects to the optic nerve*).

NEARsightedness

Also called **myopia**; impaired vision in which a person sees near objects clearly while distant objects appear blurred.

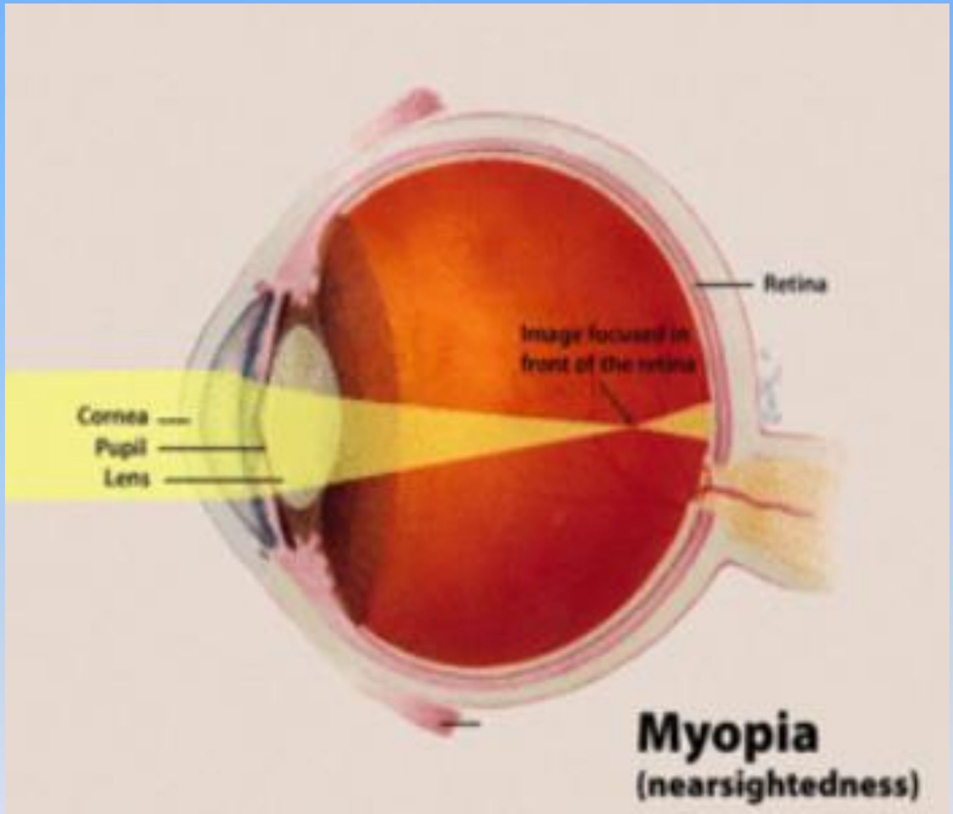


NEARsightedness

The distance between the lens and the retina is too long.

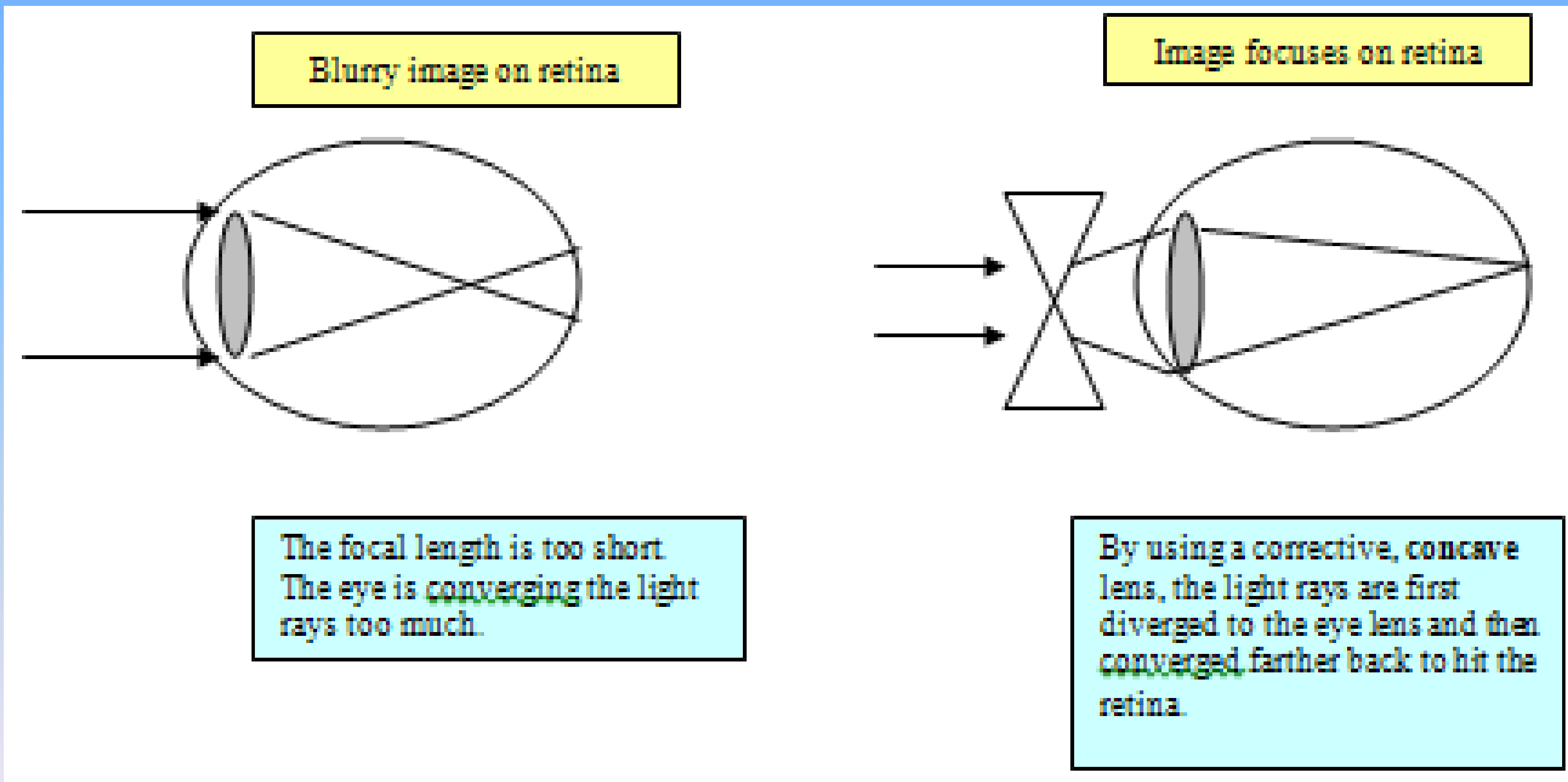
As a result, light rays from distant objects focus before they strike the retina.

Near objects appear clearly because light rays from them focus correctly on the retina.



NEARsightedness

Nearsighted people need eyeglasses that are concave lenses.



NEARsightedness

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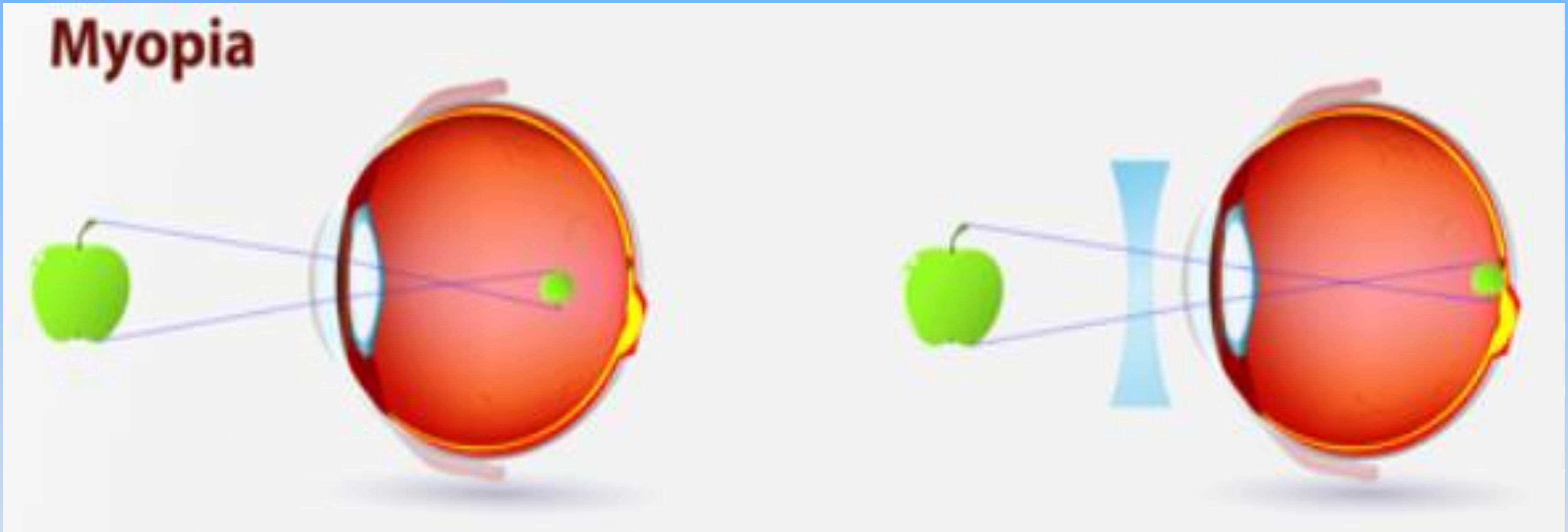


NearSighted Vision (myopia)

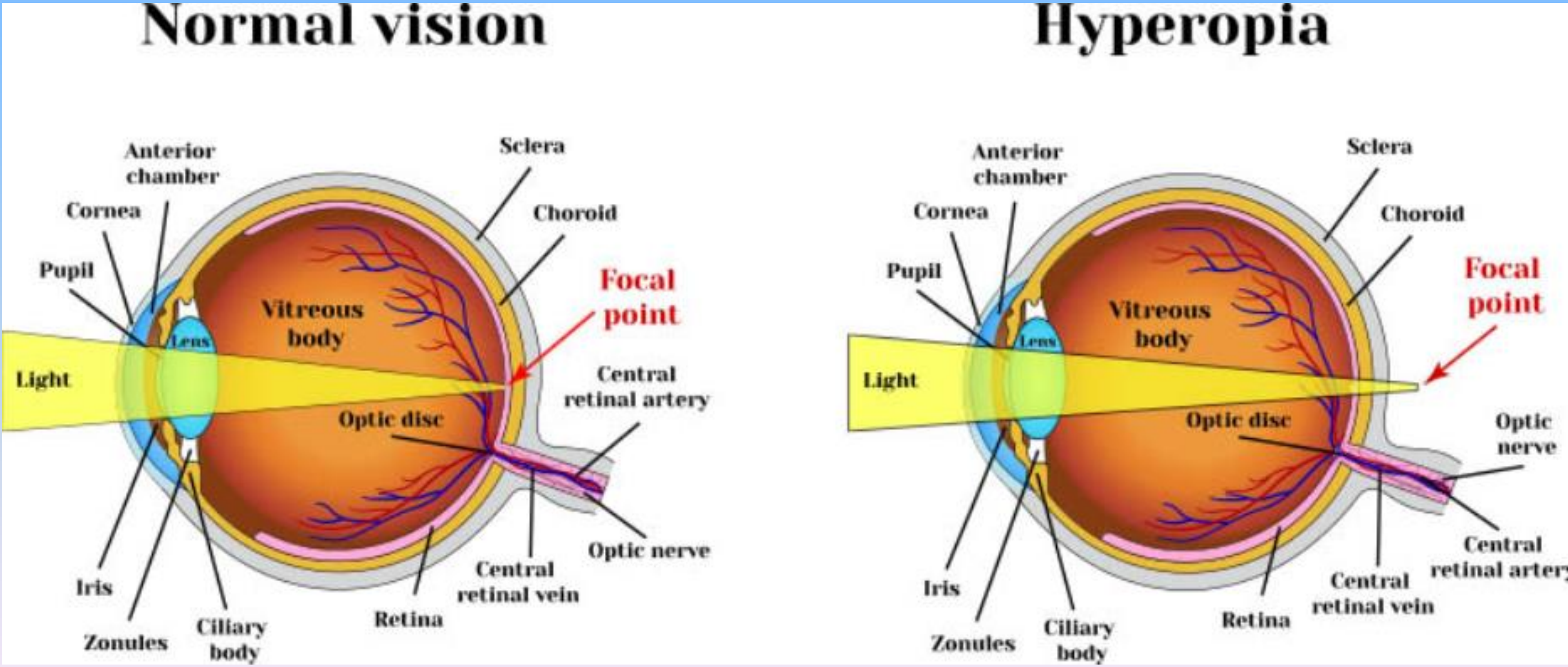
Watch video:

http://somup.com/cFfhb7VpOt (2:05)

What is myopia? How is it corrected?

FARsightedness

Also called **hyperopia**; impaired vision in which a person sees near objects with blurred vision, while distant objects appear in sharp focus.



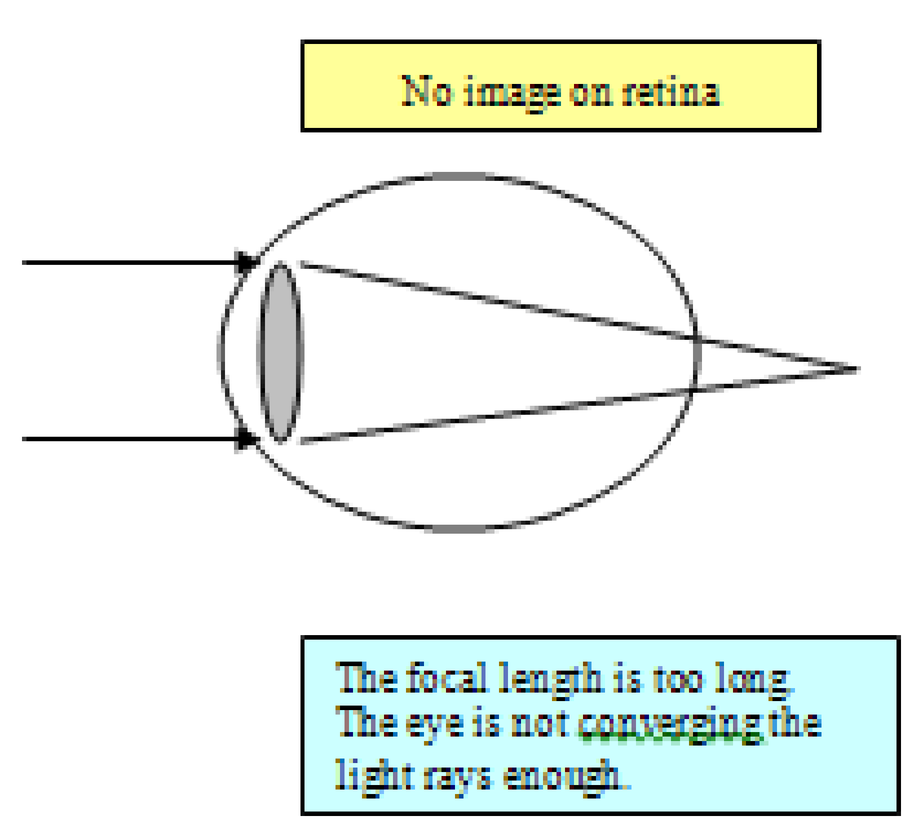
FARsightedness

The distance between the lens and the retina is too short.

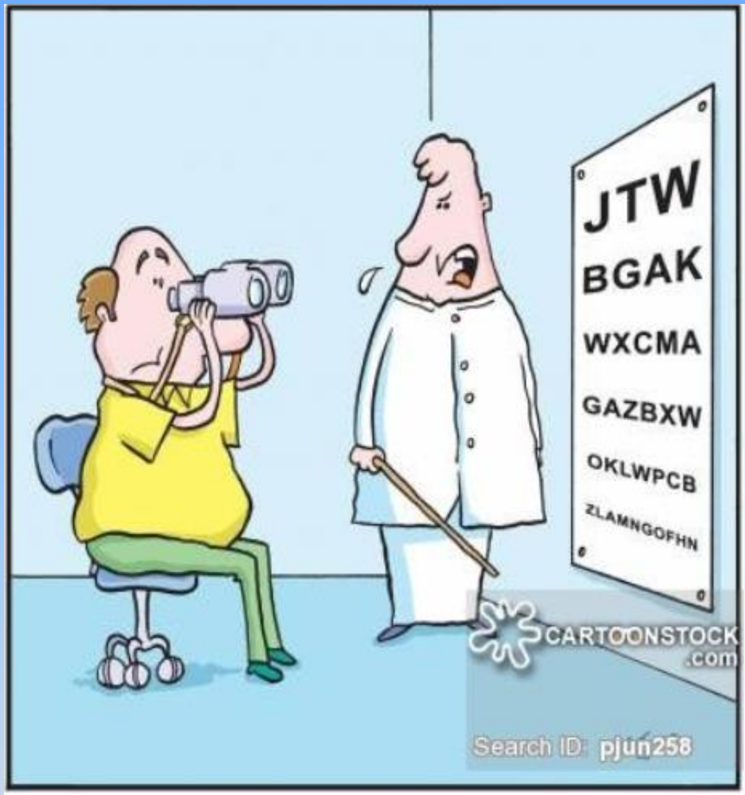
As a result, light rays from near objects strike the retina before they are in focus, which causes blurred vision.

Distant objects appear clearly because light rays from them focus correctly on the retina.

Picture is exaggerated for simplicity.



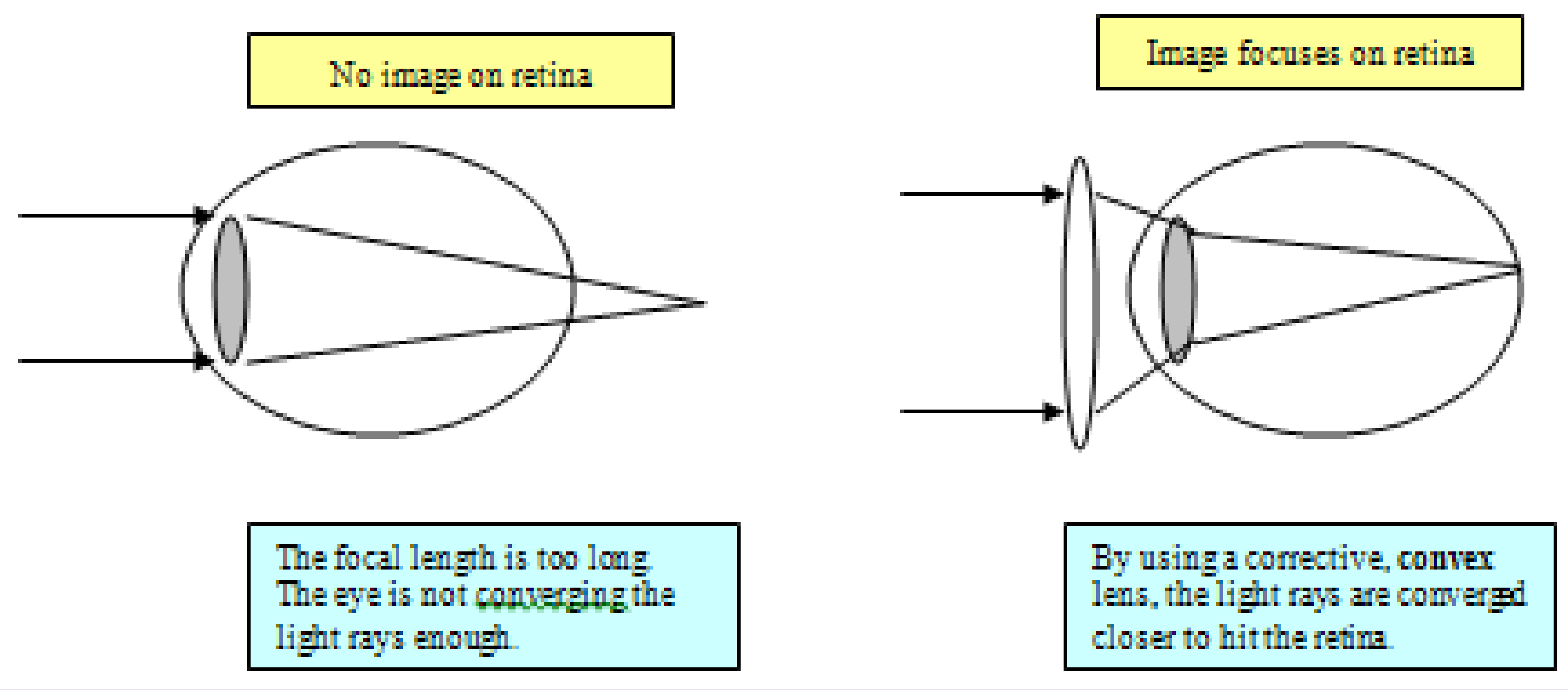
FARsightedness



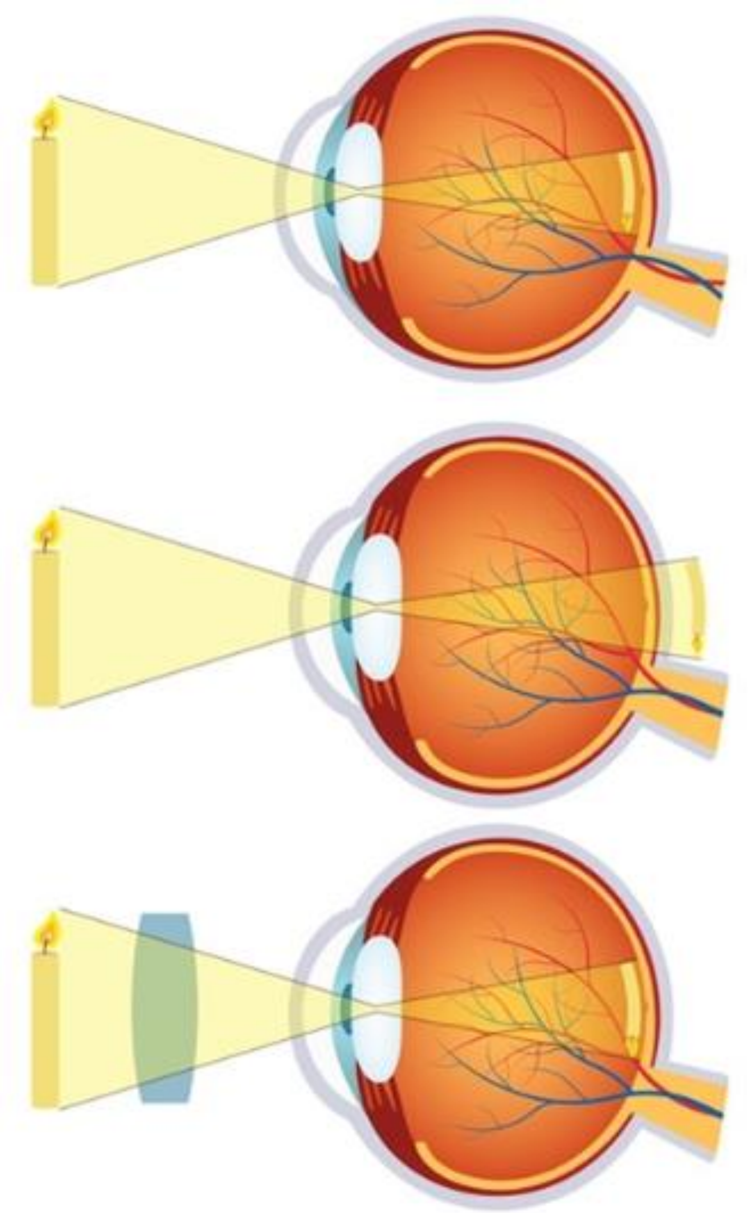
"No cheating!"

FARsightedness

Farsighted people need eyeglasses that are convex lenses.
Most corrective issues are due to farsightedness.



FARsightedness



Farsighted people need eyeglasses that are convex lenses. Most corrective issues are due to farsightedness.

Far Sighted Vision (hyperopia)

Watch video:

http://somup.com/cFfO3EVEo7 (0:58)

What is hyperopia? How is it corrected?

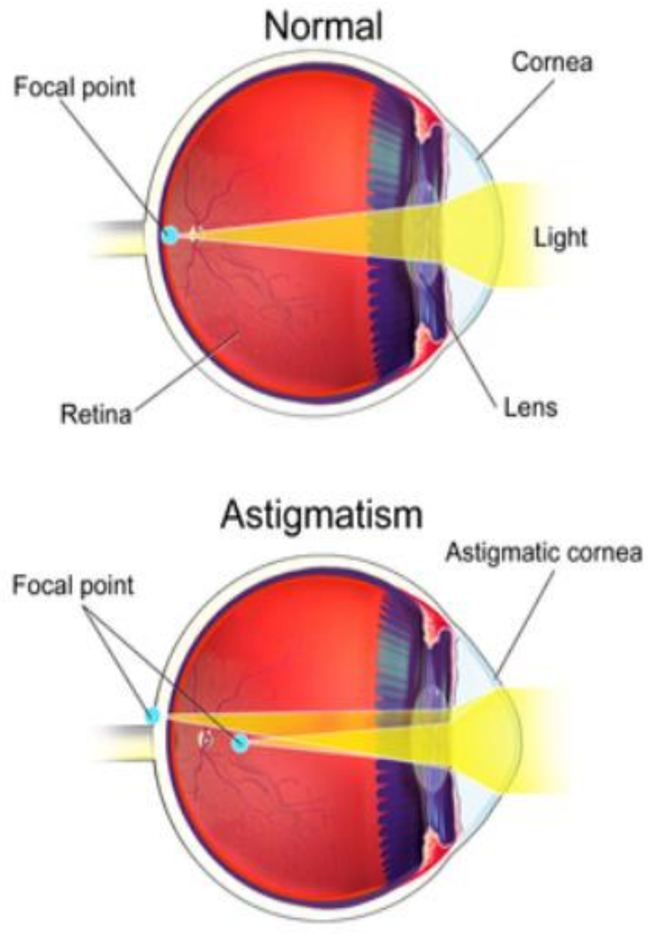
Correcting Vision Problems

Astigmatism

When the cornea or lens is misshapen, a defect in vision called astigmatism results.

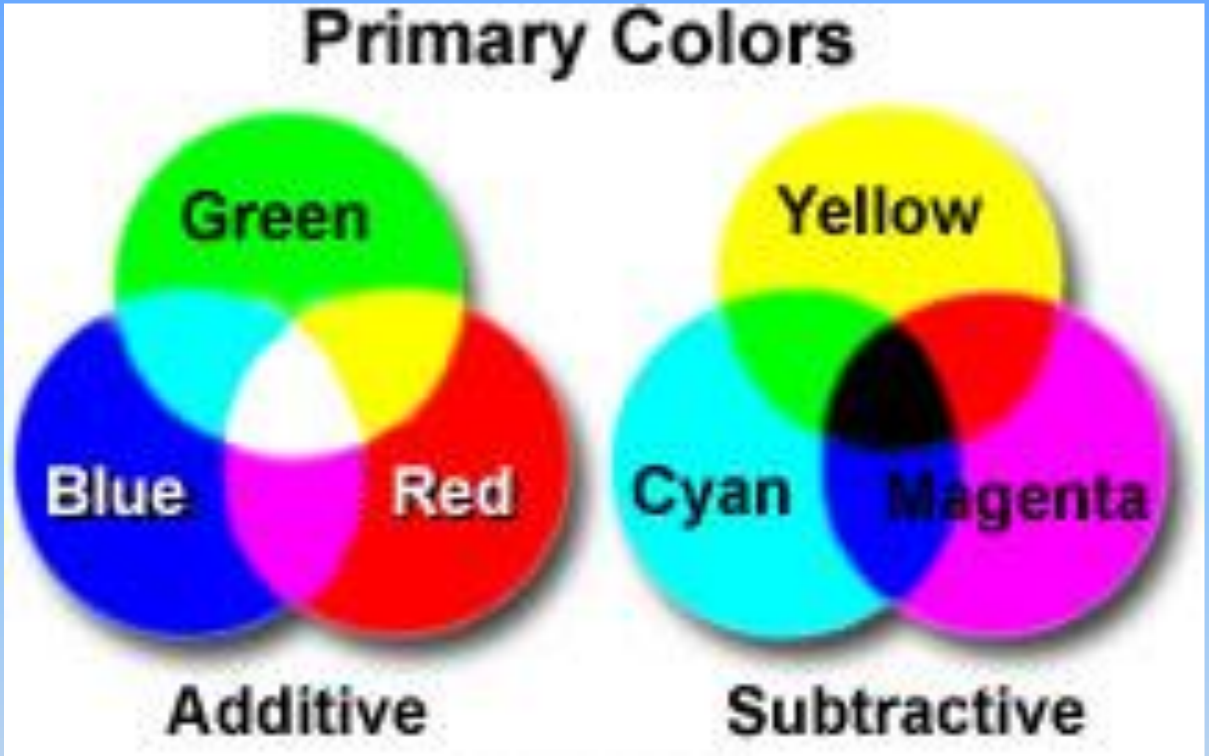
Astigmatism is a condition in which objects at any distance appear blurry because the cornea or lens is misshapen.

Specialized eyeglass lens shapes are used to correct astigmatism.



Astigmatic cornea distorts the focal point of light in front of and/or behind the retina

Color of Light



How important is color in our lives?

Name ways we use color to enrich our lives.

Importance of Color of Light

Colors make us happy (**red**, **blue**, **yellow**)

Colors can put us in a sad, gloomy, bad mood (**black**, **gray**).

Color in clothing is also important to how we appear.

- Make you look thinner or not (**one color** versus multi-)
- Make you look healthy or unhealthy (**lighter, more yellow**)
- Make you feel happy or unhappy (greens, blues)

Color can change the look of your skin (rosy cheeks).

Color combinations change the look of other colors you wear.

- *Yellow, orange and red are associated with the heat / warmth of sun and fire*
- *Blue, green and violet are associated with the coolness of leaves, sea, and the sky.*
- *Red has been shown to stimulate the senses and raise the blood pressure, while blue has the opposite effect and calms the mind.*

Importance of Color of Light

Cosmetics Eye shadow, lipstick, blush, facial creams, facial cleansers, facial scrubs and strippers, eye brow size and colors

Food many foods add coloring for appeal – Coke/soft drinks, gravies, toppings, ice cream, jello, meats, desserts, etc.

Vehicle colors (e.g. the "bad" guys drive dark colored cars and the "good" guys drive bright and light colored cars)

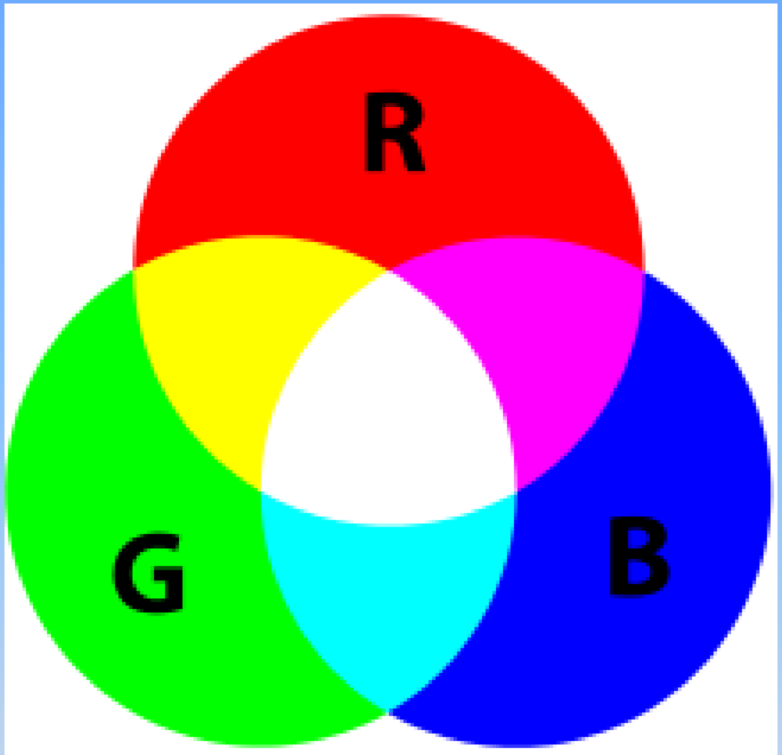
Multi-media color is so critical to setting mood; (*e.g. scary movies use a lot of grays and dark colors with bright red blood and gory parts*) *lights, costumes, props, stage settings, cosmetics have particular colors to gain a specific effect*

Rooms Classrooms, offices, meeting rooms, interior decorating, our homes, etc.

Child care facilities are brightly colored with lots of blues, reds and yellows – making the children happier, more active – giving the appearance of a fun, clean environment

Jewelry

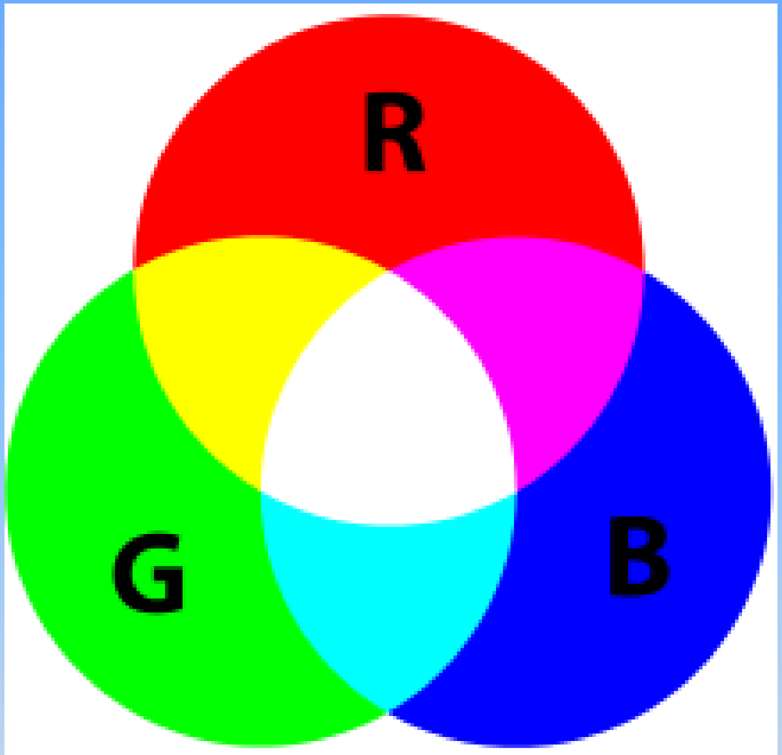
Additive Primary Colors of Light



Additive color processes, such as in television and multi-media presentations, work by having the capability to generate an image composed of red, green, and blue light.

Overlapping all three Additive Primary Colors (red, Green, Blue) of Light in equal intensities, yields white light as shown at the center.

Additive Primary Colors of Light



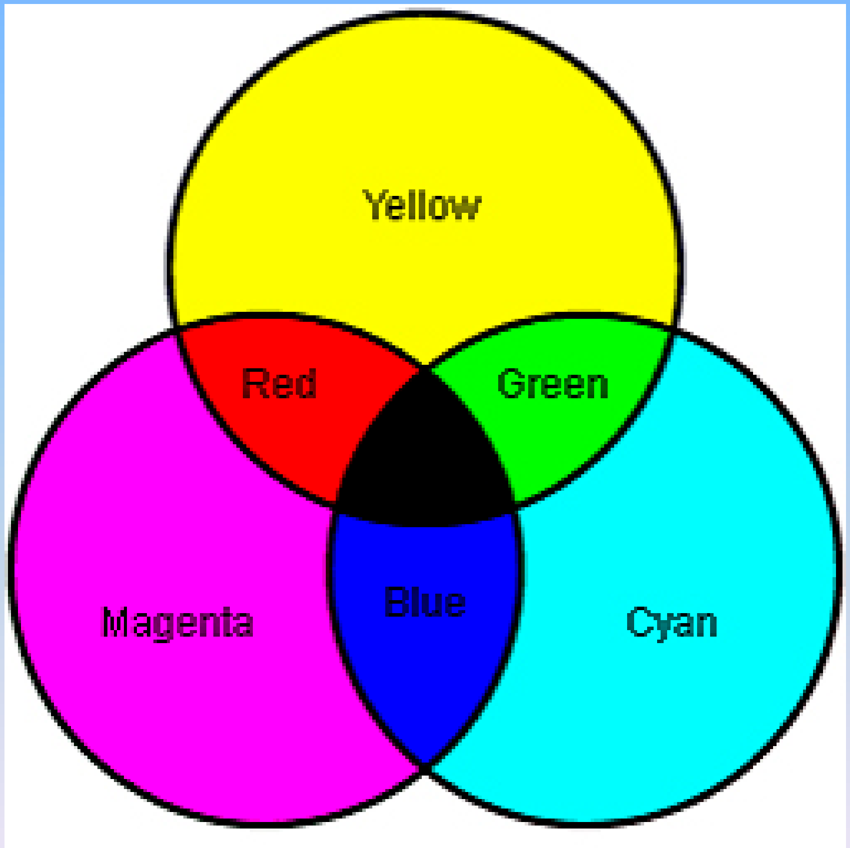
The combination of TWO of the three additive primary colors in equal proportions produces an additive secondary color — cyan, magenta or yellow.

White contains all the colors.

Red + Green + Blue = White

Mixing pigments produces different results than combining light.

Subtractive Primary Colors when mixing dyes, paint, or ink



Each subtractive primary color absorbs one of the additive primary colors and reflects the rest.

Cyan absorbs Red, reflecting green and blue.

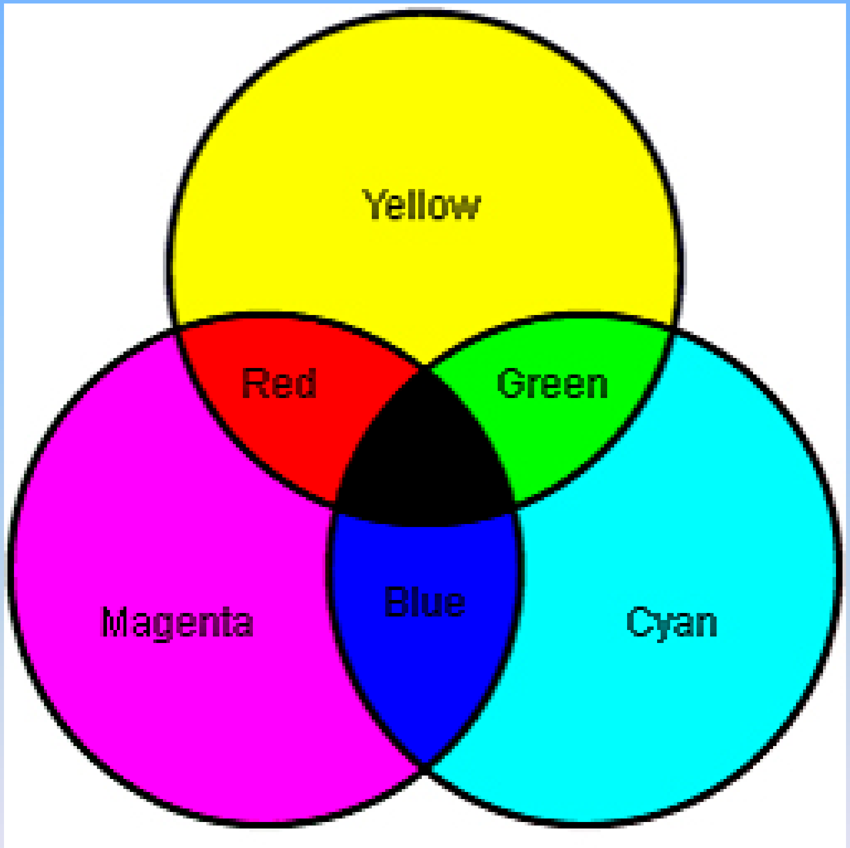
Magenta absorbs Green, reflecting red and blue.

Yellow absorbs Blue, reflecting red and green.

Subtractive Primary Colors when mixing dyes, paint, or ink

We see reflected light. White light (which contains all colors of light) shines on the shirt and shorts. Red is reflected from the shirt, meaning that all the other colors are absorbed into the shirt. Blue is reflected from the shirt, meaning that all the other colors are absorbed into the shirt.

Subtractive Primary Colors when mixing dyes, paint, or ink



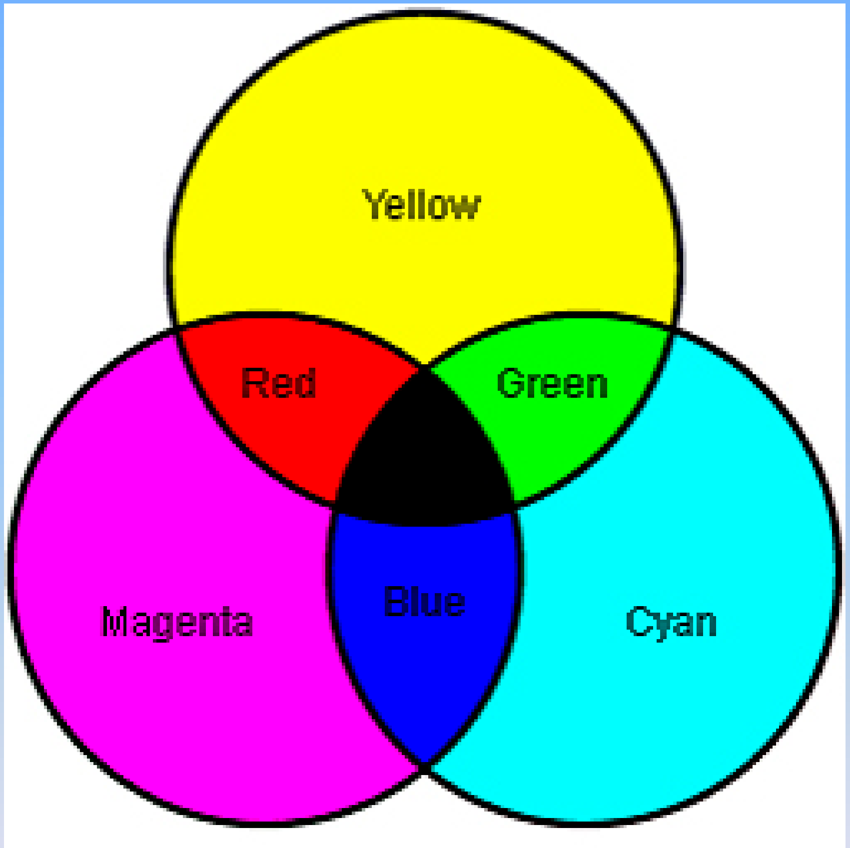
Adding TWO subtractive primary colors together will transmit one of the primary additive colors.

Yellow plus Cyan reflects Green to our eyes, absorbing the rest.

Magenta plus Yellow reflects Red, absorbing the rest.

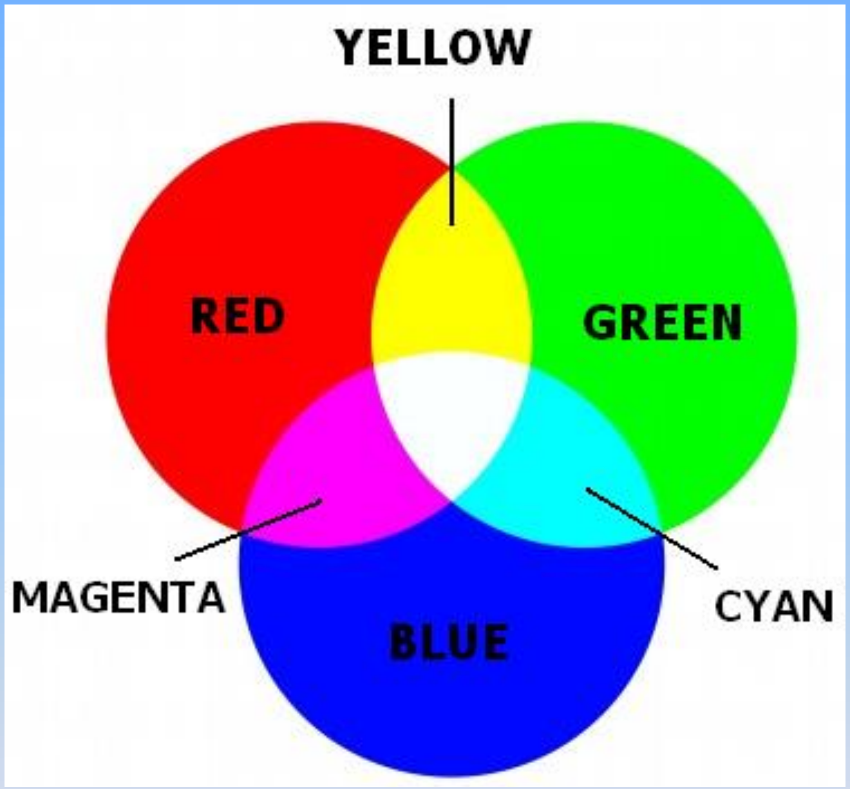
Cyan plus Magenta reflects Blue, absorbing the rest.

Subtractive Primary Colors when mixing dyes, paint, or ink



Adding all three subtractive primary colors together will absorb all the colors of the white light, leaving no color (interpreted as "black" by our brain).

Complementary Colors of Light

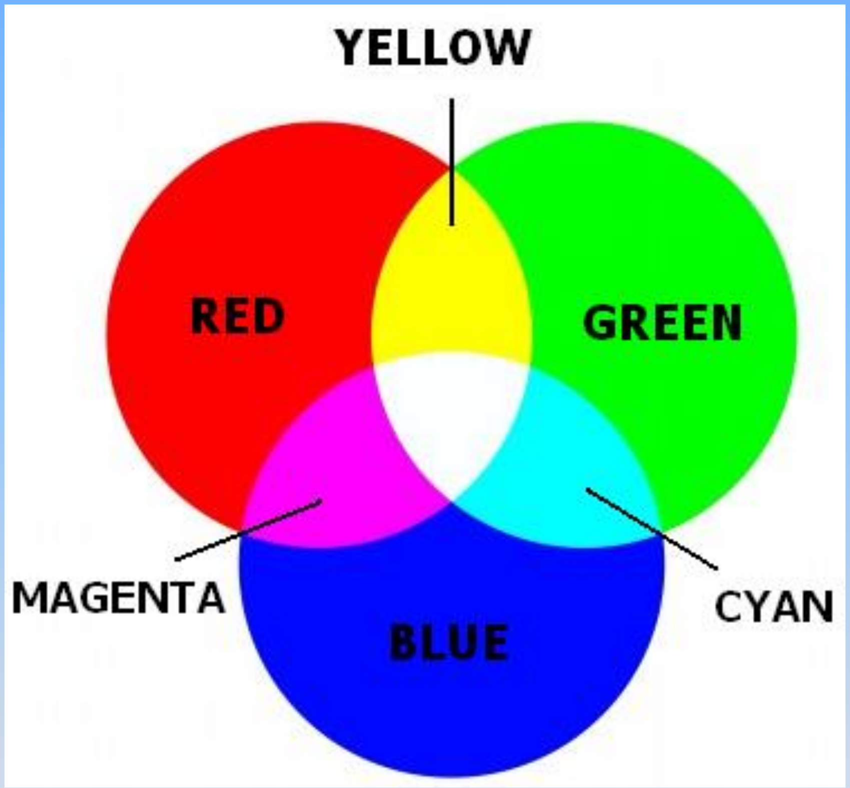


Two colors that produce white when added together are called complementary.

The color complementary to a primary color is called a secondary color.

The complementary or secondary colors for red, green and blue are cyan, magenta and yellow respectively.

Complementary Colors of Light



Complementary colors are also called "Color Opposites" …

Red is "opposite" cyan.

Blue is "opposite" yellow.

Green is "opposite" magenta.

Addition of complementary colors (color "opposites") produce white.

Complementary Colors of Light

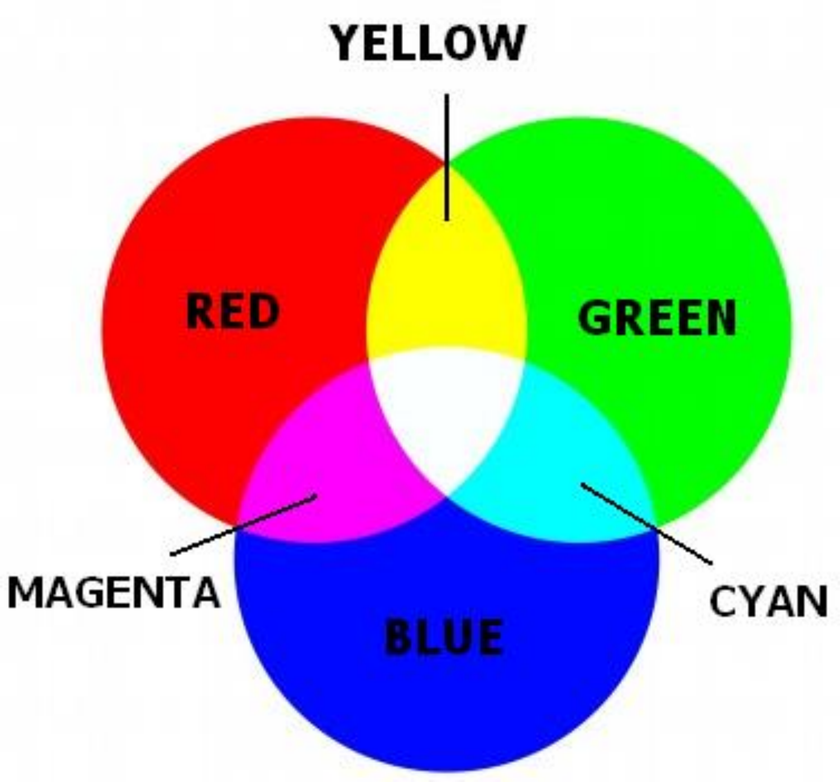
Red plus cyan (green & blue)

Green plus magenta (red & blue)

Blue plus yellow (green & red)

"Color Opposites"

Red + Green + Blue = White



Colors of Light - fill in the chart

QUICK CHECK

Primary Additives	Red	Blue	Green
Red			
Blue			
Green			
R + B + G =			

Subtractive Primary Colors	Yellow (R + G)	Cyan (B + G)	Magenta (B + R)
Yellow (R + G)			
Cyan (B + G)			
Magenta (B + R)			
Y + C + M =			

Complementary Colors	Complement	Result
Red		
Green		
Blue		

Colors of Light

STRATEGY

Primary Additives	Red	Blue	Green
Red	red	Magenta	Yellow
Blue	Magenta	Blue	Cyan
Green	Yellow	Cyan	Green
R + B + G = white			

Subtractive Primary Colors	Yellow (R + G)	Cyan (B + G)	Magenta (B + R)
Yellow (R + G)	yellow	Green	Red
Cyan (B + G)	Green	cyan	Blue
Magenta (B + R)	Red	Blue	magenta
Y + C + M = black			

Complementary Colors	Complement	Result
Red	Cyan (B + G)	White
Green	Magenta (B + R)	White
Blue	Yellow (R + G)	White

Assessment Questions

1. A prism separates white light into the visible spectrum because
   a. longer wavelengths are absorbed more than shorter wavelengths.
   b. shorter wavelengths refract more than longer wavelengths.
   c. shorter wavelengths reflect more than longer wavelengths.
   d. longer wavelengths experience more interference.

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   ANS: B

Assessment Questions

2. The color of an object depends on what the object is made of and on
   a. the intensity of light that strikes the object.
   b. the color of light that strikes the object.
   c. the direction of the light that strikes the object.
   d. the speed of the light that strikes the object.

Assessment Questions

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Assessment Questions

3. Which of these colors is one of the primary colors of light?
   a. green
   b. magenta
   c. yellow
   d. white

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   b. magenta
   c. yellow
   d. white

   ANS: A (red, green, blue)