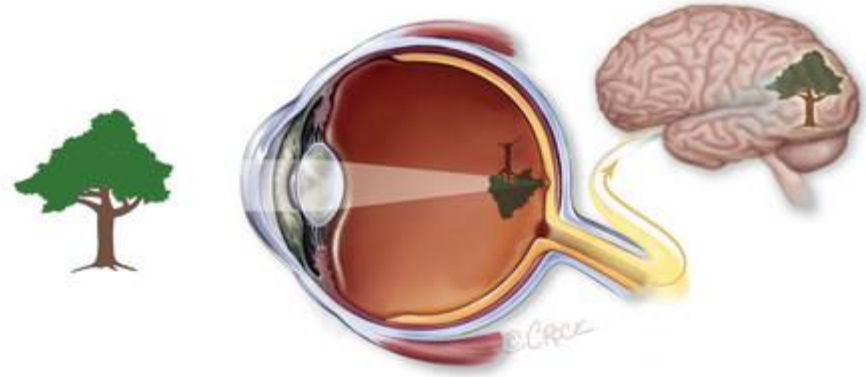


# Human Vision

Lesson 22b

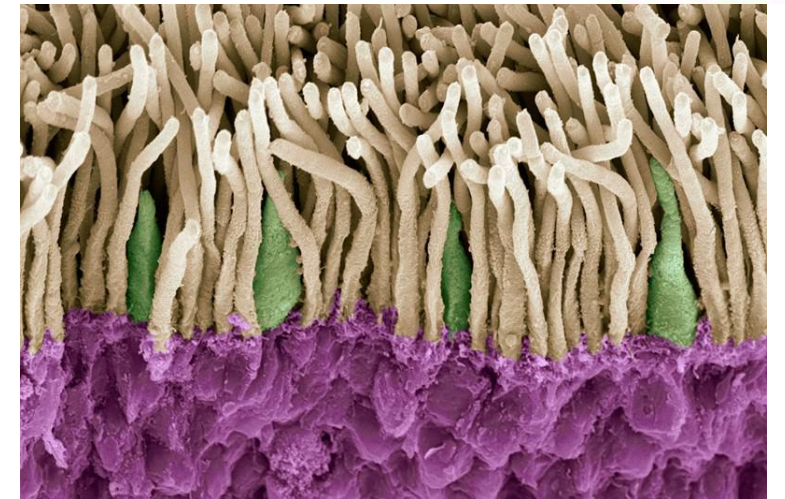
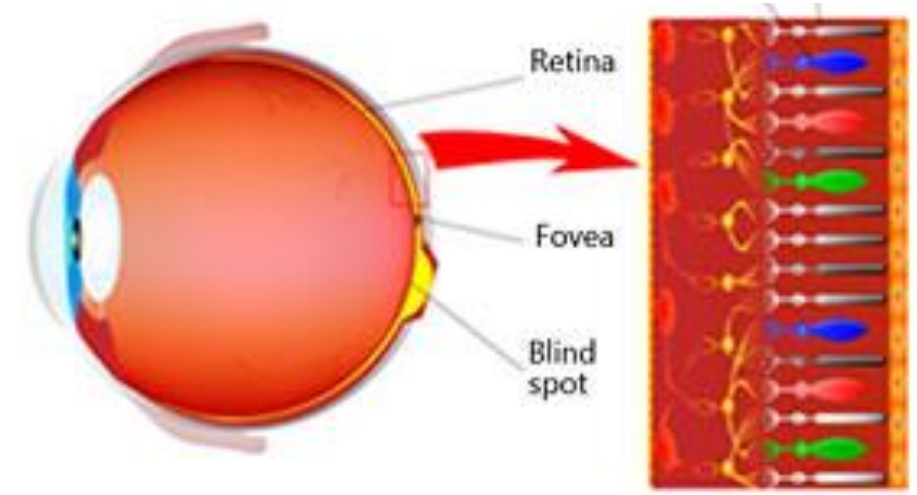
# Recap



- Light enters the eye through the pupil
  - The iris is a muscle that contracts and dilates to either let in less or more light
- The cornea refracts the incoming light and does most of the focusing
- The lens fine-tunes our focus
- Images formed by the lens are inverted, but our brain interprets the image as being upright
  - Light rays that enter the eye from a spot at the top of an object come together at one place at the bottom of the retina
  - Light rays that enter the eye from a spot on the base of an object come together in one place at the top of the retina
- Our blind spot is where the optic nerve enters the retina and does not have any light-sensing cells

# Black-and-White Vision and Colour Vision

- Once the light rays are focused correctly on the retina, the cells that absorb the light begin their job
  - Some cells in your retina specialize in detecting low levels of light
  - Other cells detect bright light
- The cells in your retina that absorb light come in two basic shapes: long cylindrical ones called **rod cells** and rounder ones called **cone cells**



# Rod cells – shapes, movement, and shades of grey

- **Rod cells** can absorb almost any colour of light, but they absorb green light particularly well
- Even so, our brain does not use any of the signals from rod cells to determine colour – just shades of light and dark
- This is called our black-and-white vision system
  - In low-light conditions it helps us see shapes and movement



A Rod Cell

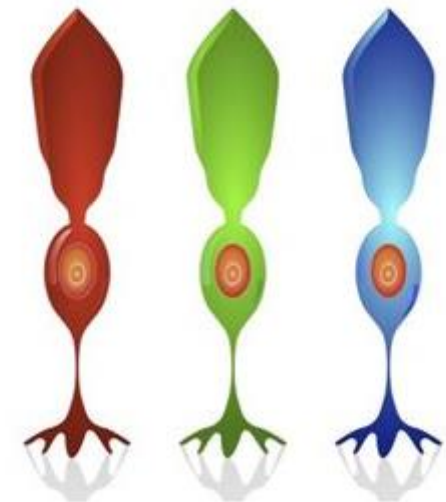


# Cone cells – seeing the rainbow

- **Cone cells** allow us to detect colour
- We have three kinds of cone cells, each possessing a slightly different kind of pigment
  - Recall that by using only red, green, and blue it is possible to see all the colours of the rainbow
- If our brain receives an equal amount of all three colours, then we see the object as white
- The human brain can combine and balance the different colour signals that it receives
  - This is why the white page of a book can appear white to us under varying amounts of daylight



Cone cell



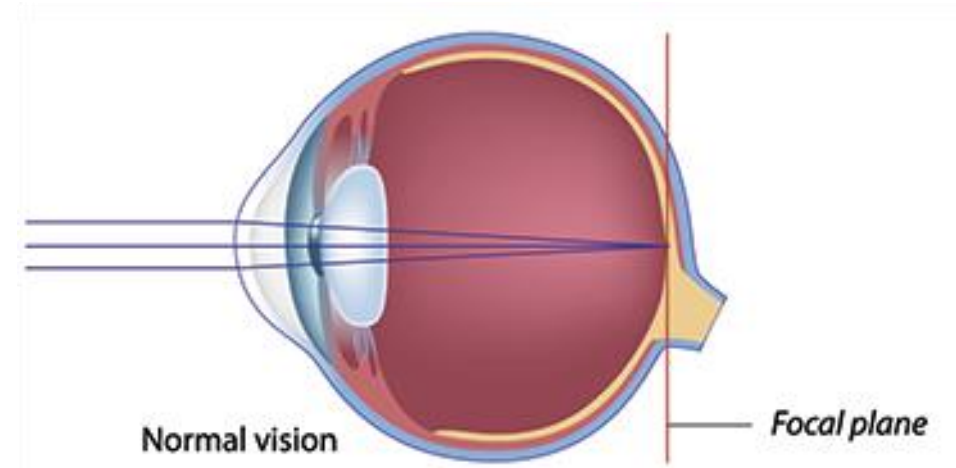
# Correcting Focus Problems

- Most people have trouble focusing clearly at some time in their lives
- As children grow, especially in their teen years, the shape of their eye changes
  - The change of shape can affect their ability to focus and may require the temporary uses of eyeglasses
- As adults age, the flexibility of the eyes' lenses often decreases, making it harder to focus on nearby objects

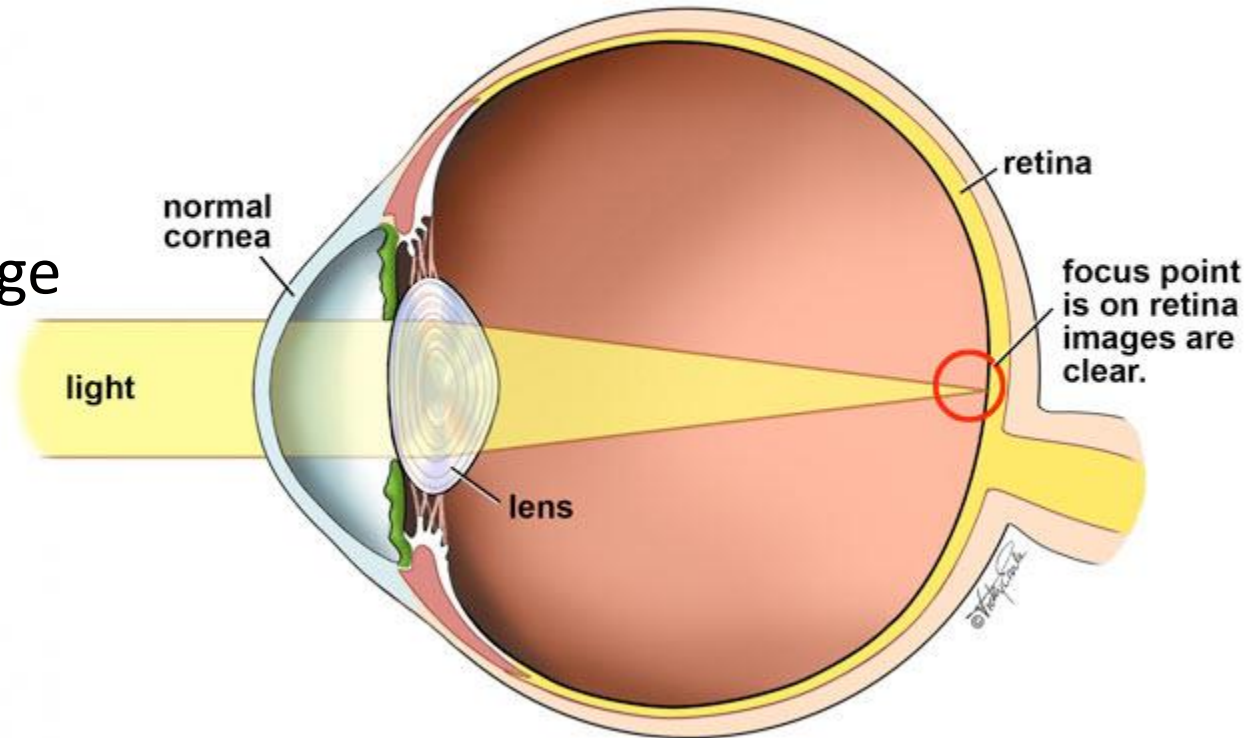


# Normal Vision

- When light rays from a distant object enter the eye, the rays are nearly parallel
- The lens, which is convex, causes the rays to converge (come together) at the retina, producing a sharp image
- Light rays from a nearby object are diverging when they enter the eye, so muscles in the eye cause the lens to change shape, making the lens thicker
  - This gives the lens a greater ability to converge the light rays to form a clear image

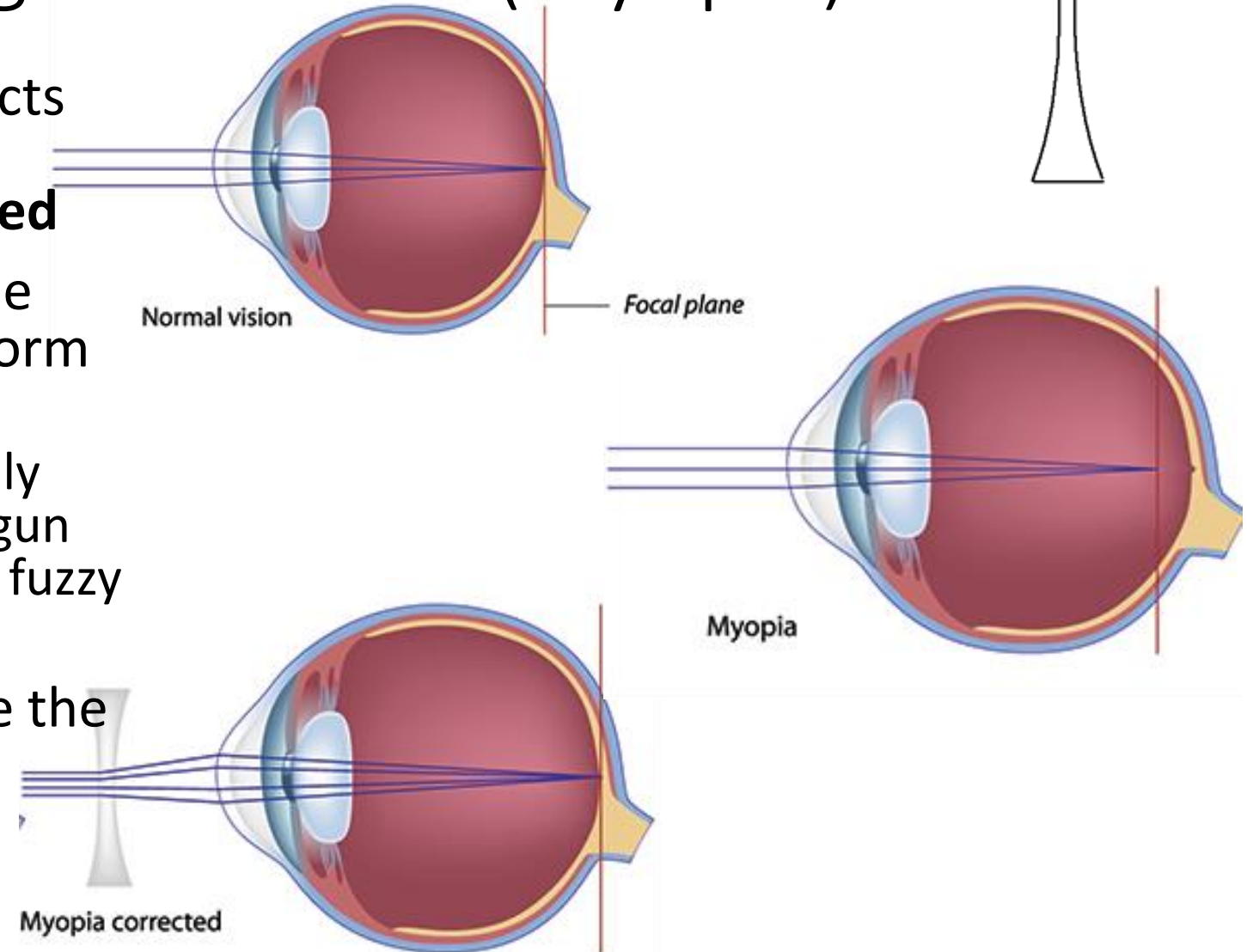


How a Normal Eye Focuses Light



# Correcting near-sighted vision (myopia)

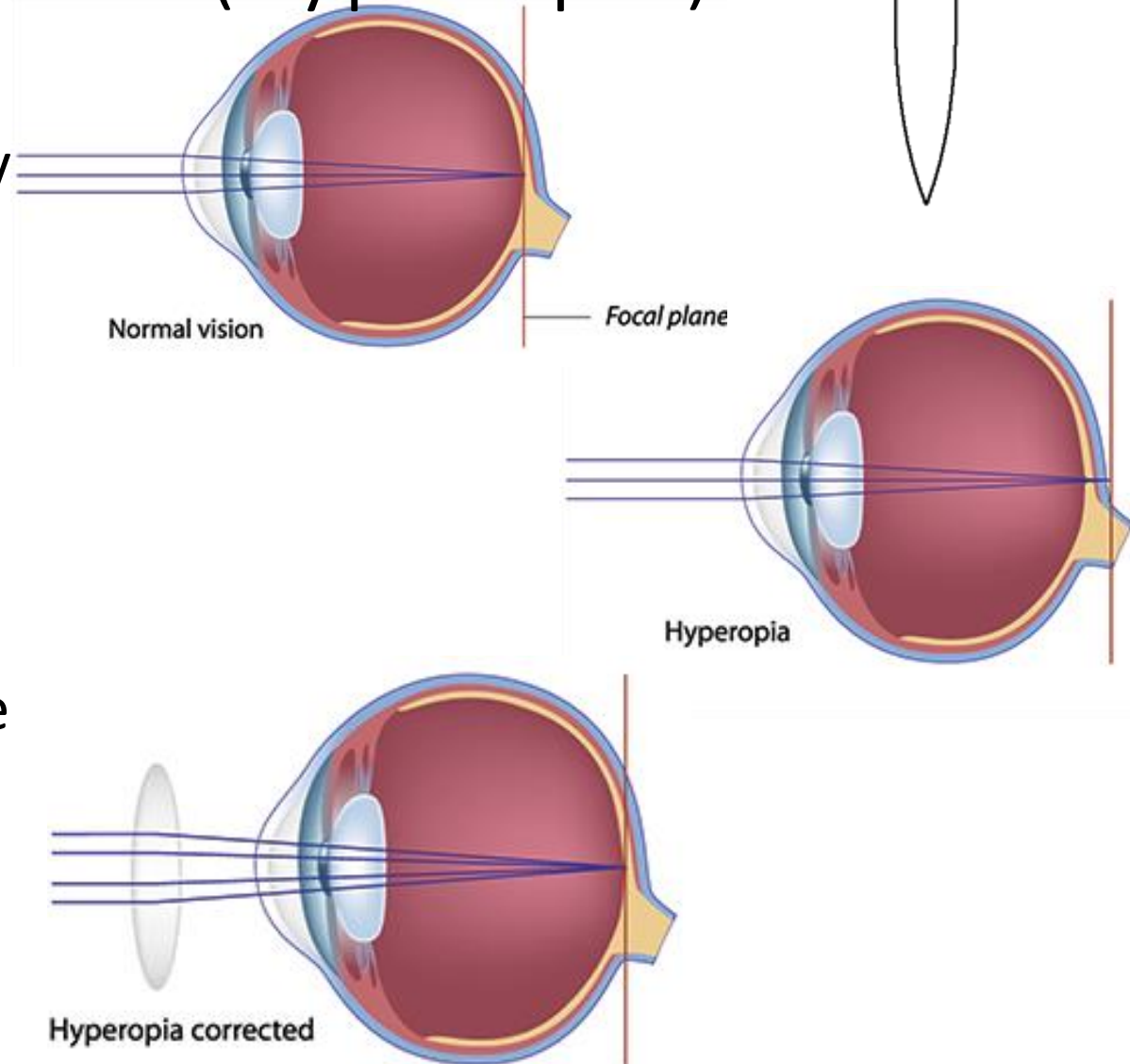
- People who can see nearby objects clearly but cannot bring distant objects into focus are **near-sighted**
- This condition occurs because the lens converges the light rays to form an image in front of the retina
  - By the time the light rays actually strike the retina, they have begun to spread out again → causes a fuzzy image
- A **concave lens** is used to diverge the parallel rays slightly so that the image forms farther back on the retina





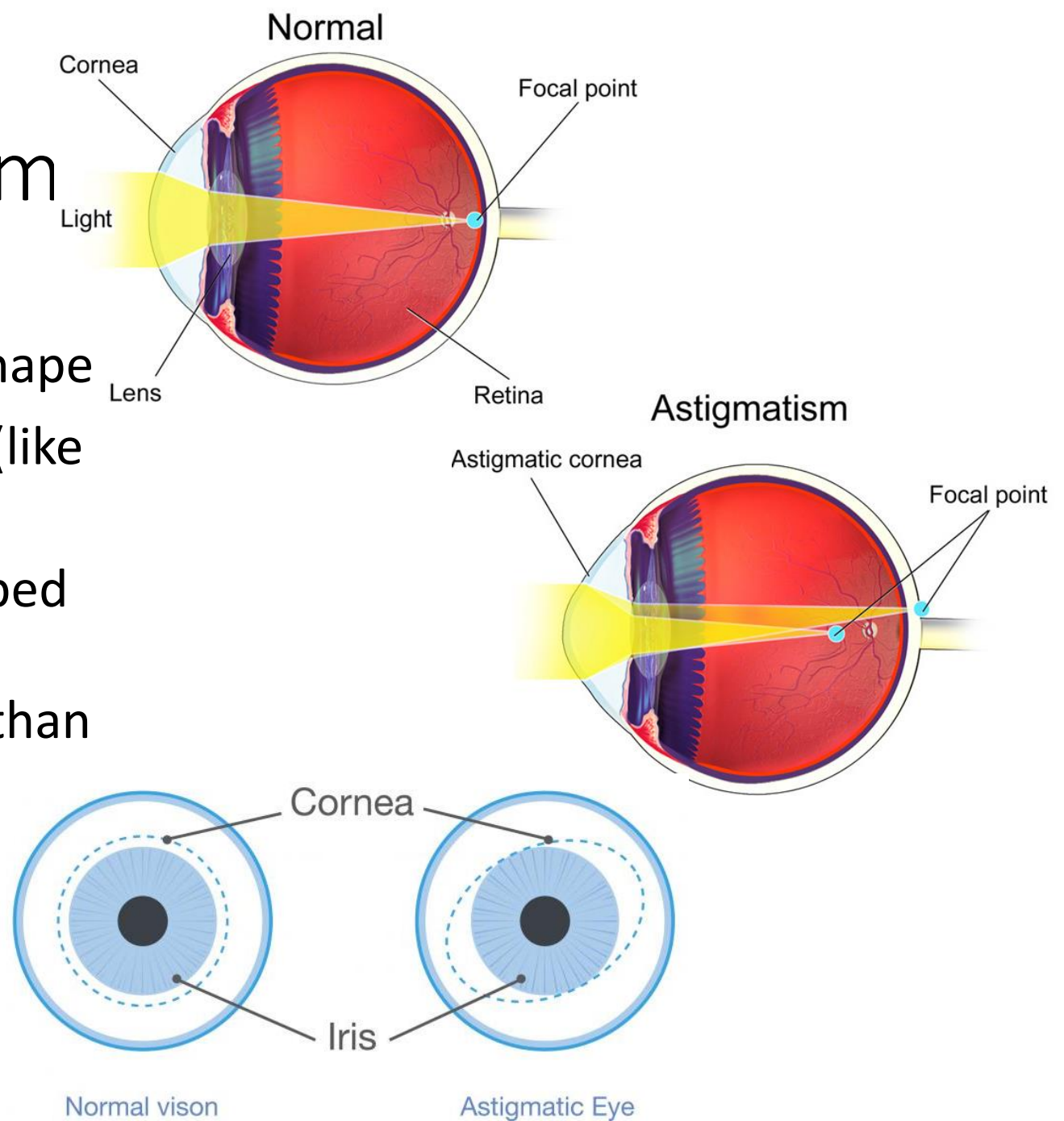
# Correcting far-sighted vision (hyperopia)

- Some people can see distant objects clearly but nearby objects remain fuzzy no matter how hard they try to focus on them
- Light rays from distant objects are nearly parallel, and require less refraction to converge them than light from nearby objects
- However, light rays from nearby objects are diverging as they enter the eye
  - A **convex lens** is needed for the light rays to come into focus exactly on the retina



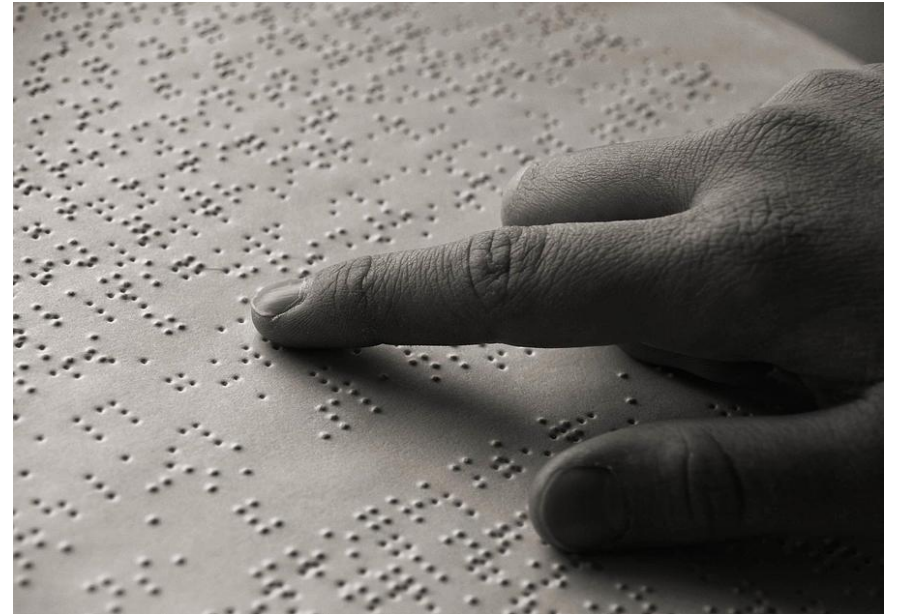
# Correcting astigmatism

- Some people need vision correction because their cornea has a distorted shape
- A normal cornea is shaped spherically (like a soccer ball)
- An astigmatic eye has an irregular-shaped cornea
  - Causes an image to focus on more than one point on the retina, resulting in blurred vision
- Can be corrected using eyeglasses or contact lenses or with laser surgery to reshape the cornea



# Blindness

- Can be any vision impairment that keeps people from doing important life activities (i.e. riding a bike, reading, recognizing friends/family through sight)
- In rare cases, a blind person may not be able to detect any light whatsoever
- Most people who are legally blind can perceive some light or even have limited amount of vision



# Blindness

- In some types of blindness a person can only see only a tiny part of the middle of a whole scene – they can see on the edges of their vision, but not directly ahead
- Of the approximately 40 million people who are blind in the world, about 80 percent could have some or all of their sight restored through treatment



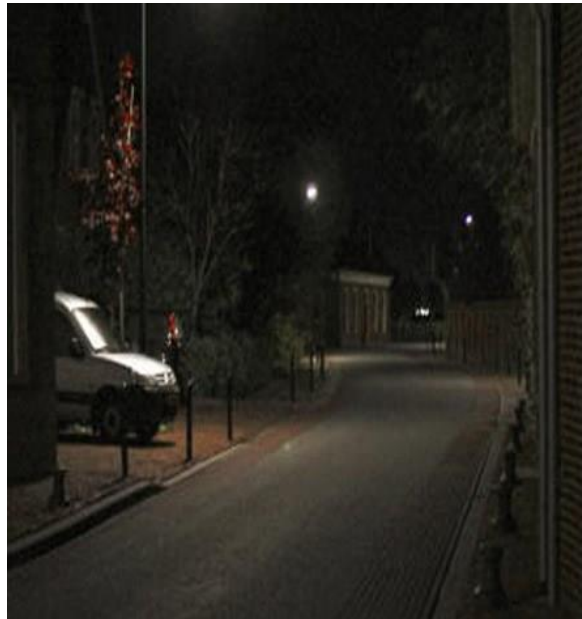
# Other types of blindness

- **Snow blindness** is a painful condition of temporary partial or complete blindness caused by overexposure to the glare of sunlight (i.e. snow fields at high altitudes)
  - *Treatment* – resting the eyes in a dark room for several days to allow inflammation to decrease
  - The Inuit traditionally wore goggles with thin slits to help prevent snow blindness



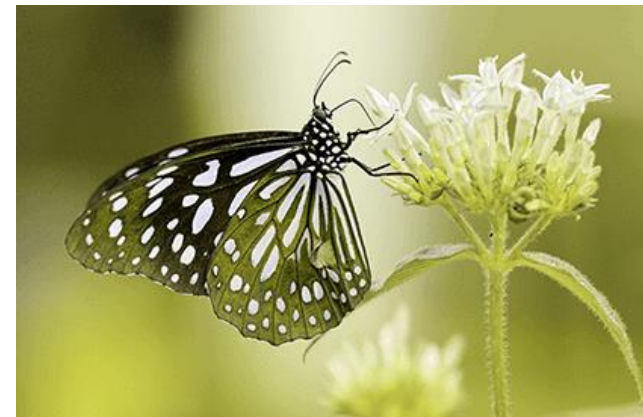
# Other types of blindness

- **Night blindness** is a condition in which it is difficult or impossible to see in dim light
  - The most common cause is the rod cells losing their ability to respond to light
  - A person might be born with night blindness, or it could develop due to injury or malnutrition



# Other types of blindness

- **Colour blindness** is the ability to see only shades of grey, and occurs in about one person in every 40 000
  - Usually considered a disability, but there are situations in which a person who is colour-blind has an advantage over a person who sees colour
    - For example, a person who is colour-blind may find it easier to pick out an object from a confusing background
- Colour blindness is rare but **colour vision deficiency** is quite common
  - About 8% of males and 1% of females



# Other types of blindness

- **Colour vision deficiency** is an inability to distinguish certain colours
- There are many kinds of **colour vision deficiency** because one, two, or all three kinds of cone cells may be involved
  - The most common involves the inability to tell red and green apart
    - For many people, both colours appear to be shades of yellow





# Test Your Colour Vision

Go to <http://enchroma.com/test/instructions/>

- Read the instructions and then click START TEST
  - Take your time