

Vision Using Lasers to Explore How the Eye Works



—

Carri Rivera FCLSA, NCLEM on behalf of

█

Phernell Walker, MBA, ABOM, LDO
Pure Optics LLC

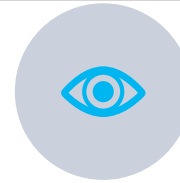
TOPICS



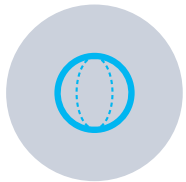
Lasers and
Lenses



Orbital
Structure Bones



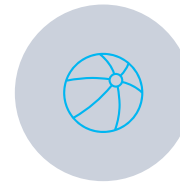
Visual System



Cornea and
Sclera



Aqueous



Retina



Crystalline Lens

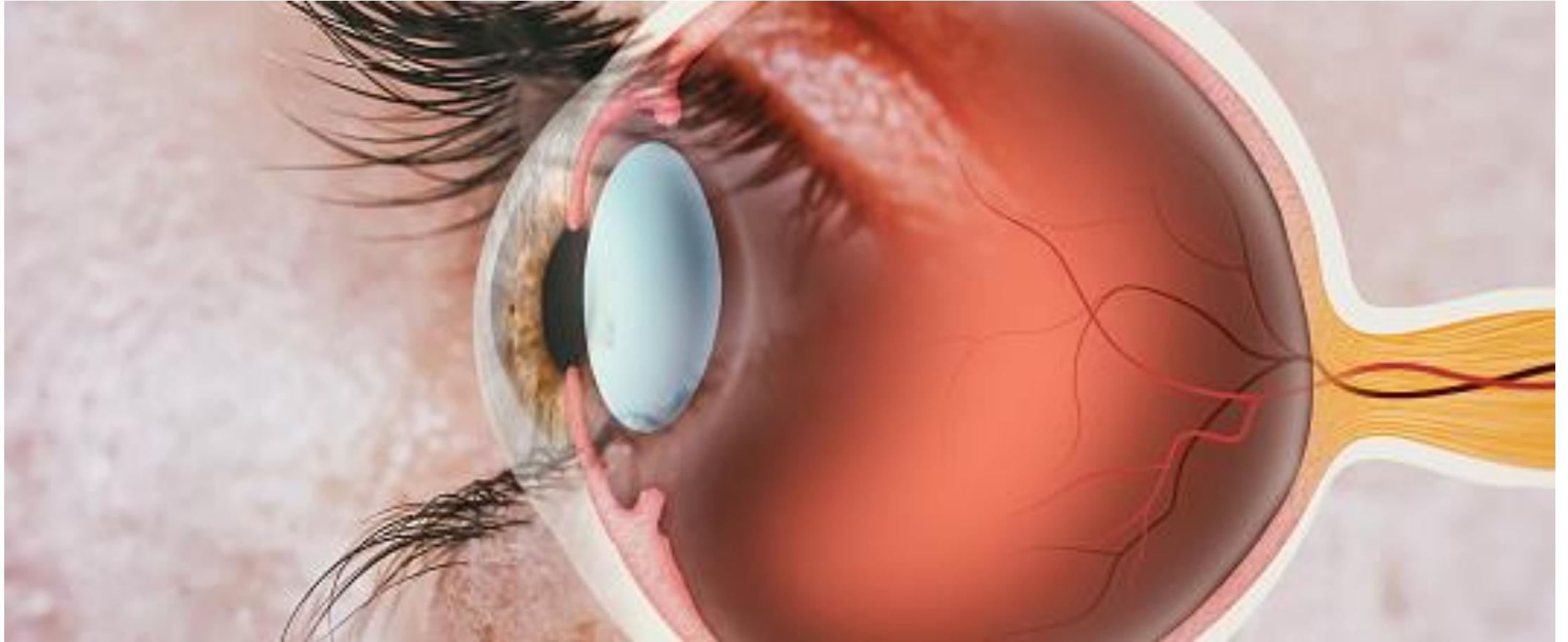


Cranial Nerves

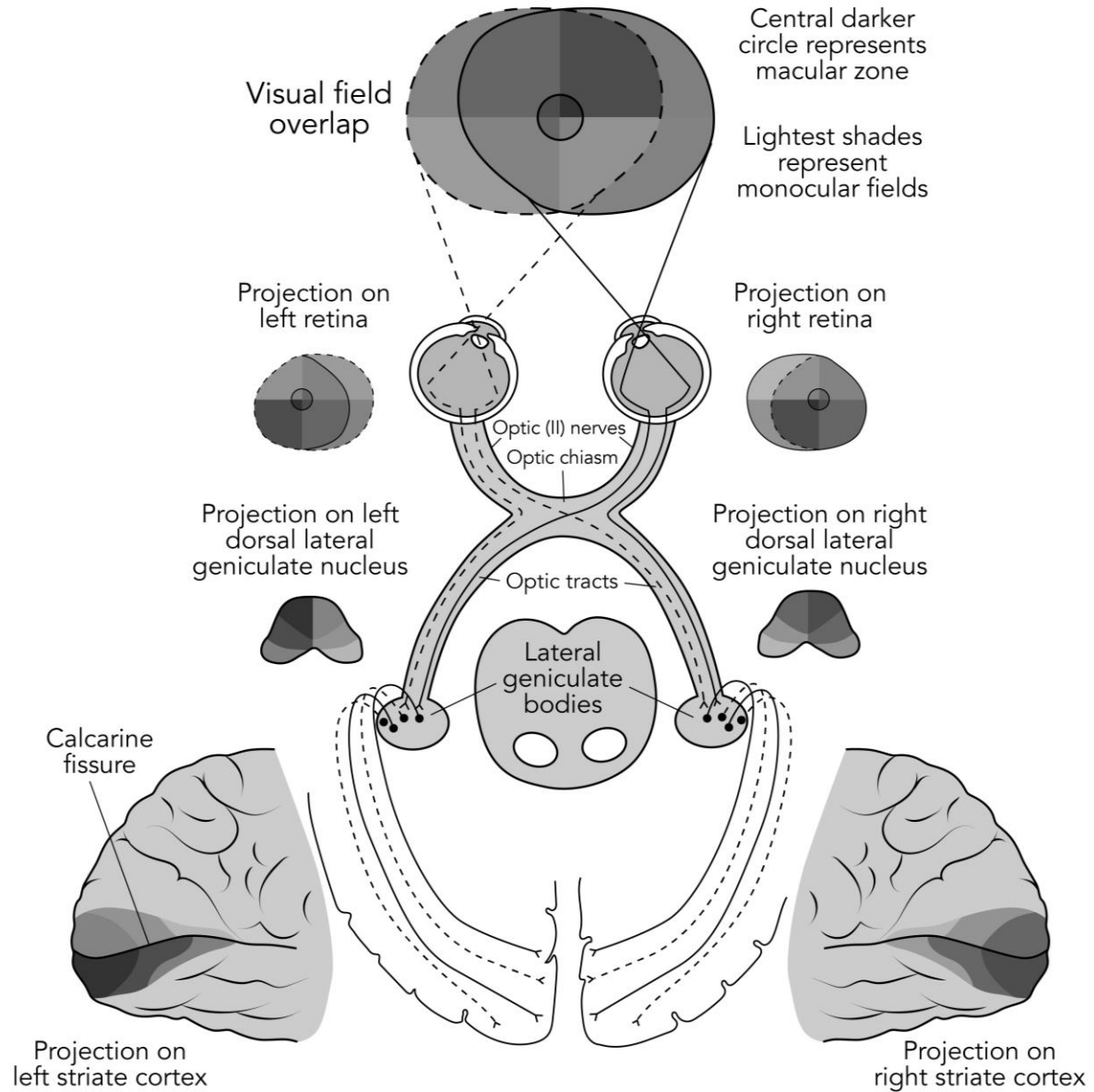


Visual Pathway

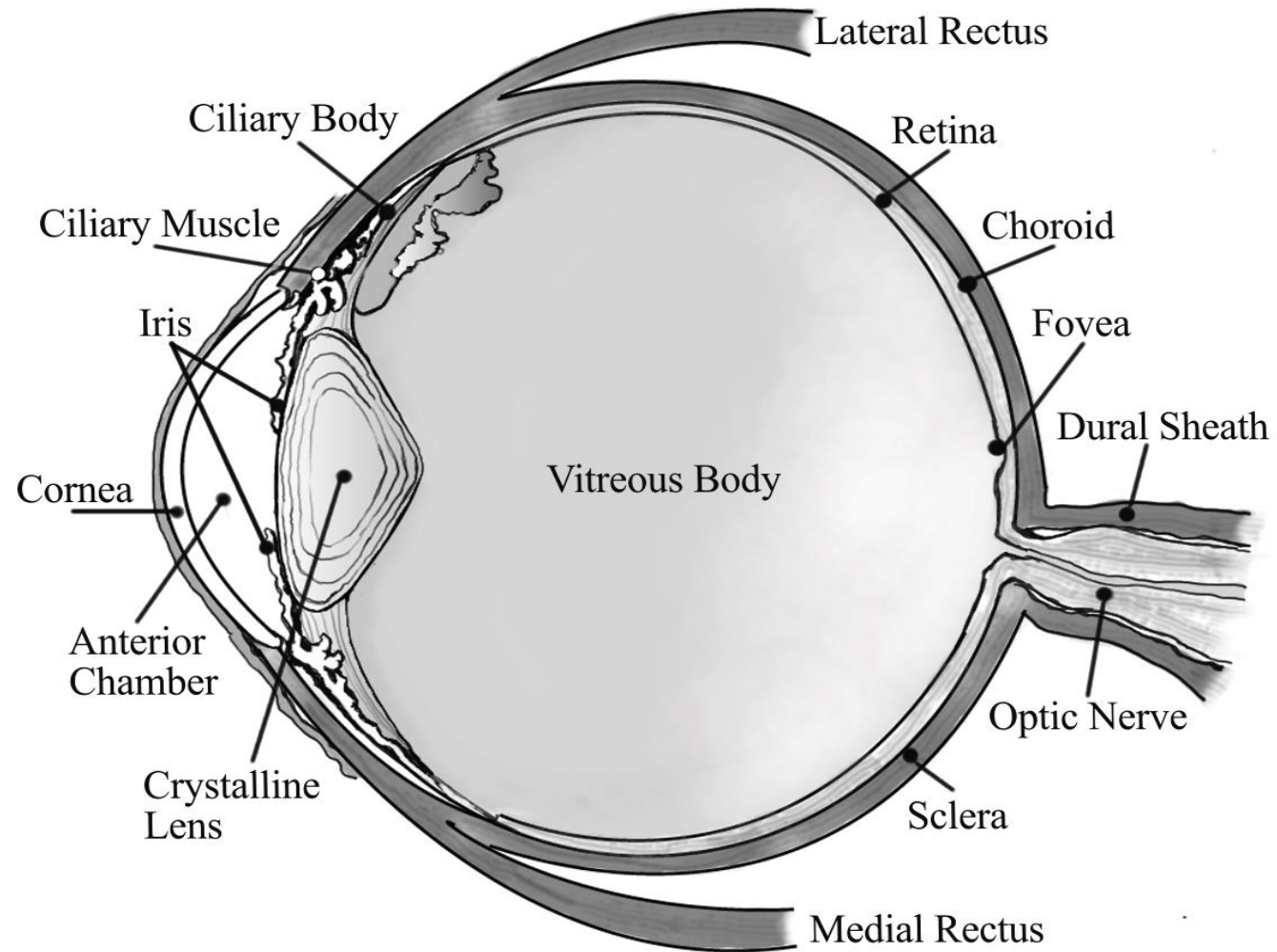
Amazing Optical System



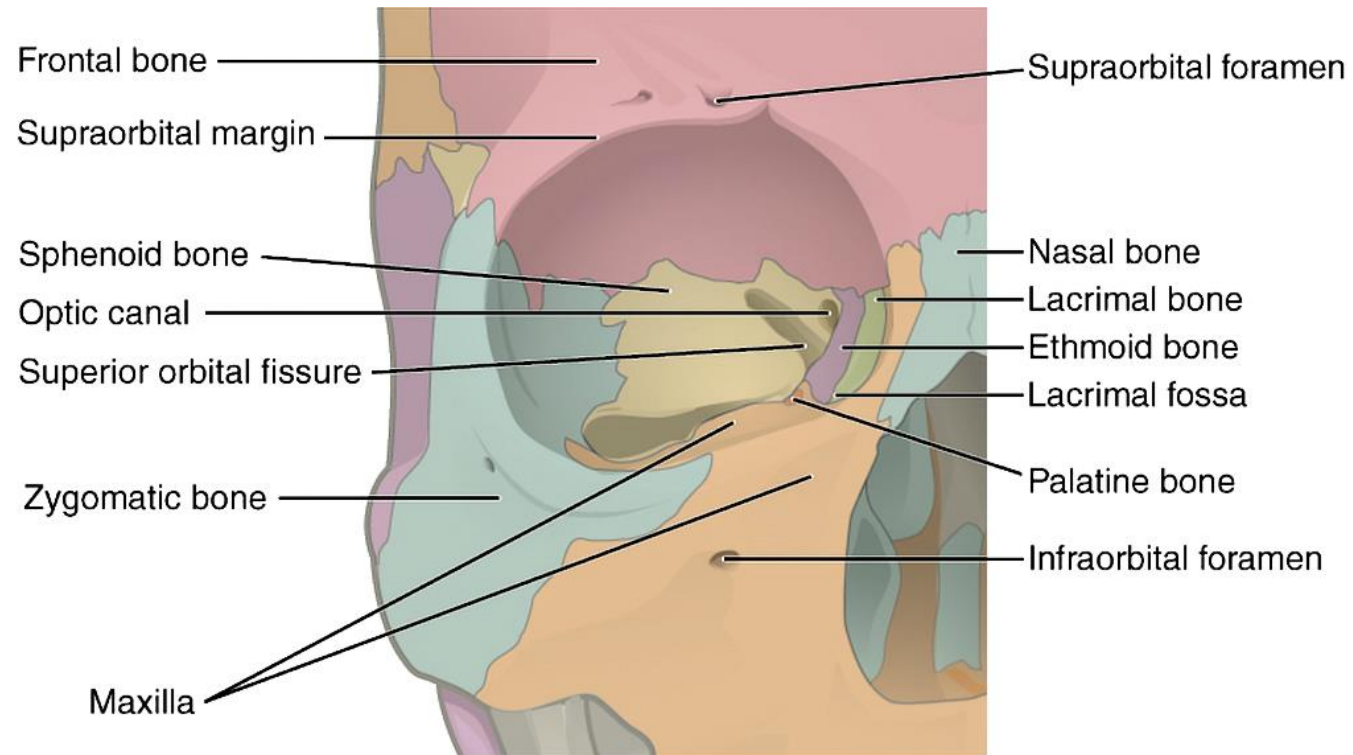
Visual Pathway



Ocular Globe



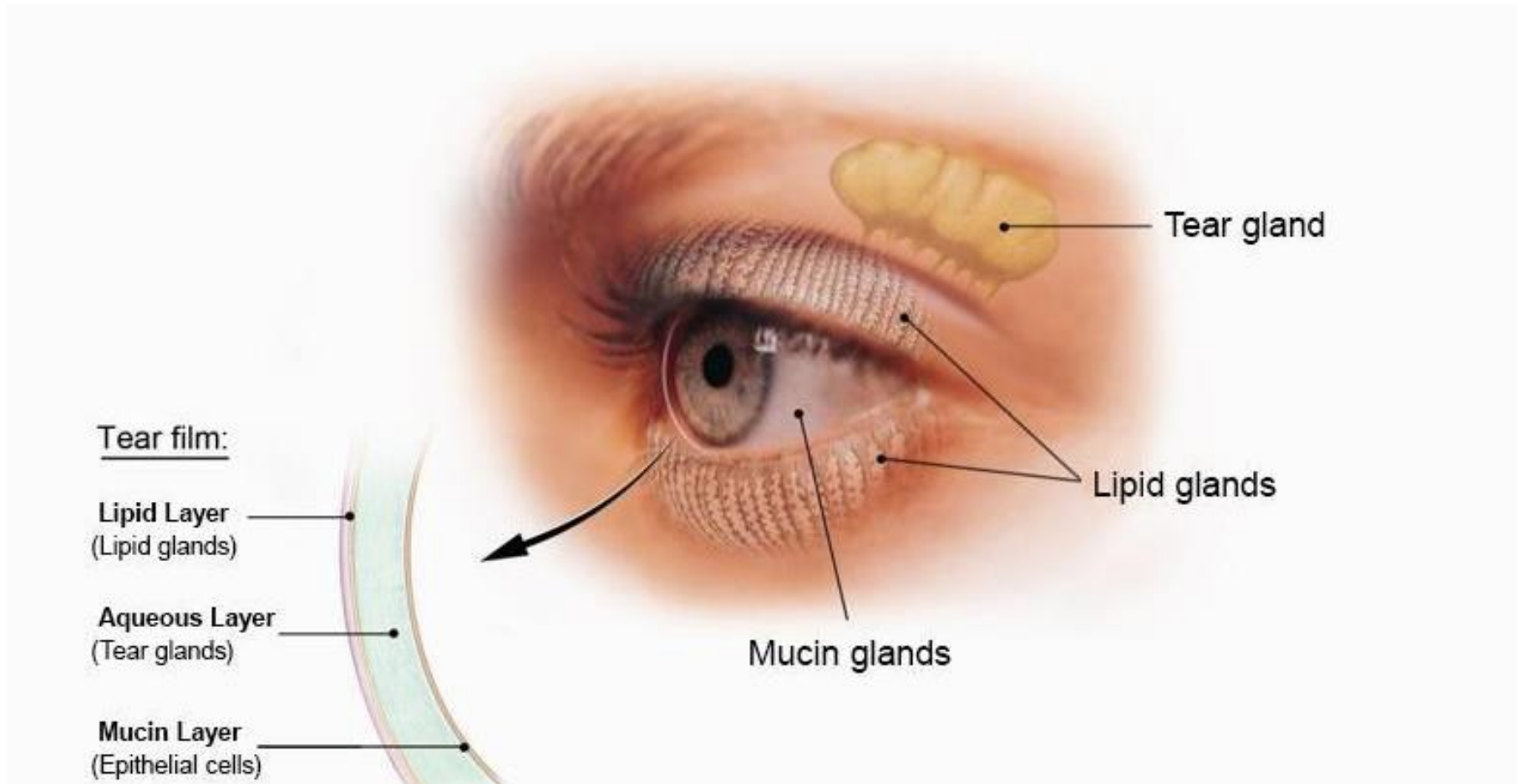
Orbital Structure



Iris and Pupil

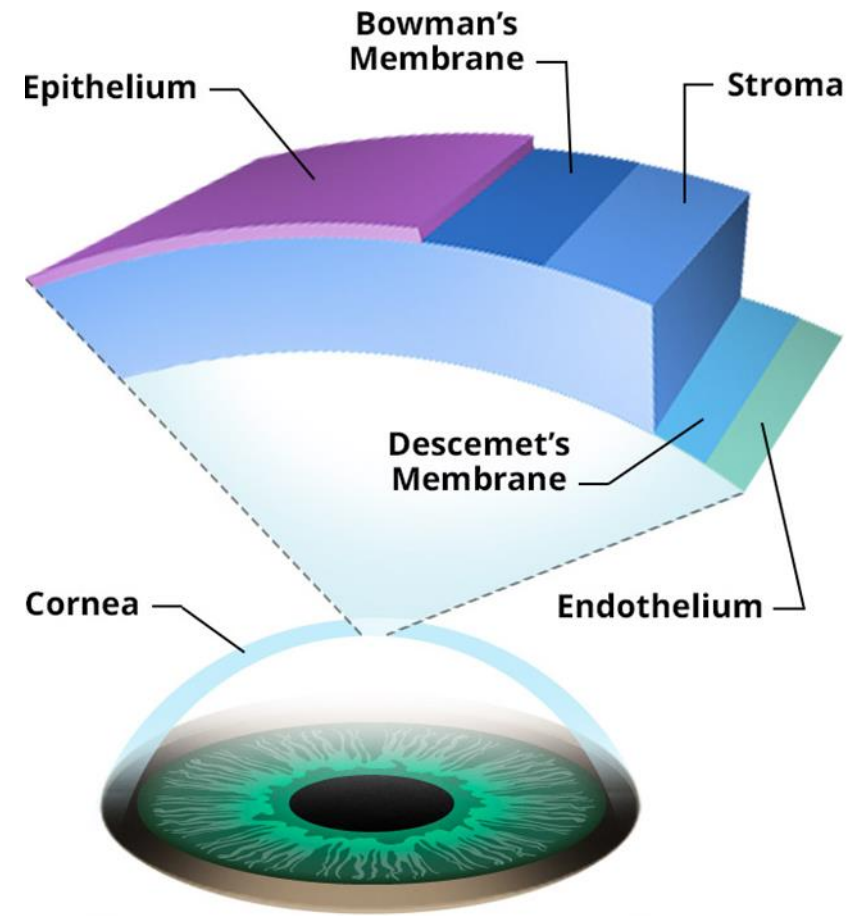
- **Iris** - circular muscle with an opening in the center
 - Color pigment gives the color
- **Pupil** - the center opening of the iris is the pupil
 - Regulates the amount of light entering the eye
 - Pupil Size – avg 3 to 4 mm diameter

Tear Film



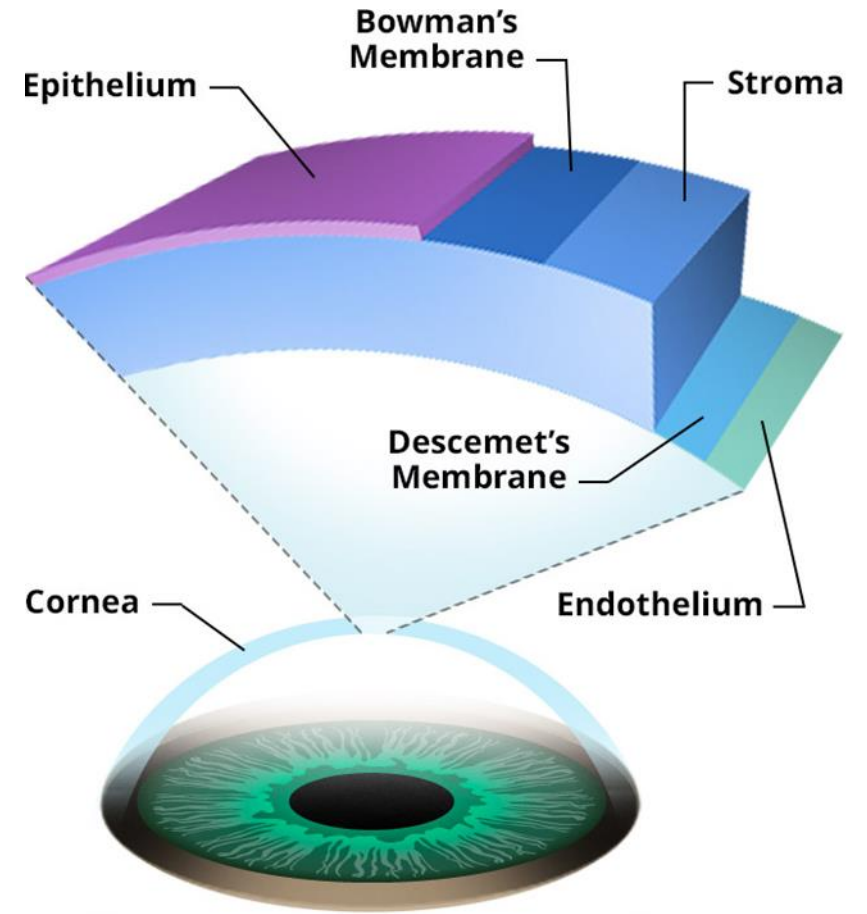
Cornea

- Cornea is most powerful refracting surface of the eye
 - 43.00 D (fixed power)
 - Index = 1.376
- Clear window to focus light
- The cornea attenuates UV radiation between 240 and 310nm.
- Accounts for approx. 2/3 of the eye's total optical power
- 5 layers
 - Epithelium
 - Bowman's Layer
 - Stroma
 - Descemet's Membrane
 - Endothelium



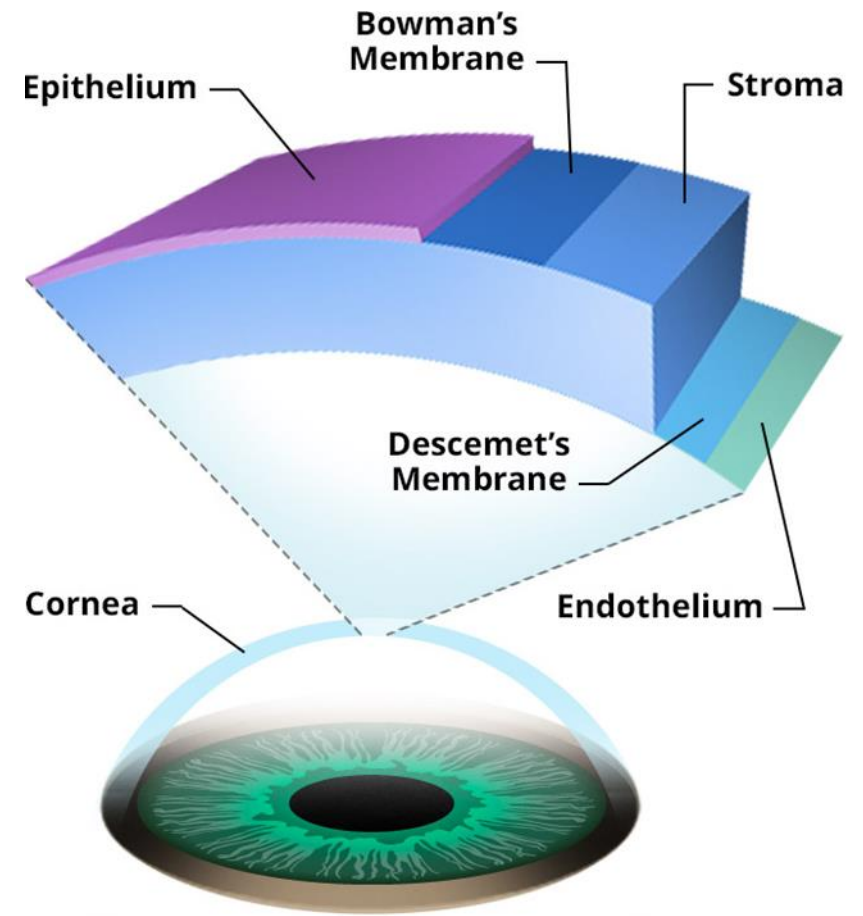
Cornea

- Epithelium
 - The outer layer of cells act as a barrier against damage and infection
 - Comprises about 10% of the total corneal thickness
 - Regenerates every 7 days
 - Provides a smooth surface that absorbs oxygen and cell nutrients from tears
- Bowman's membrane
 - A thin, tough membrane to help protect the cornea from penetration
 - Cannot regenerate if damaged and therefore will scar
- Stroma
 - Accounts for 90% of the cornea's thickness
 - Consists primarily of water (78%) and collagen fibers (16%)
 - Collagen gives the cornea its strength, elasticity and form
 - Cannot regenerate if damaged and therefore will scar



Cornea

- Descemet's membrane
 - A thin membrane of collagen and elastic fiber
 - Serves as a protective barrier against infection and injuries
- Endothelium
 - A layer of very delicate cells that are responsible for maintaining partial corneal dehydration and transparency
 - This layer of cells pumps water from the cornea, keeping it clear.
 - Without this pumping action, the stroma would swell with water, become hazy, and ultimately opaque.
 - Cannot regenerate if damaged
 - With normal aging, there is approximately 80% reserve of cells



Ocular Refractive Conditions

No Refractive Error

- Emmetropia
- Glasses or Contacts not indicated

Ametropia (Refractive Errors)

- Myopia (nearsighted)
- Hyperopia (farsighted)
- Astigmatism
- Glasses or Contact Lenses indicated

Emmetrope

Cornea: +43.00 D (t = .5 mm center)

Crystalline Lens = +20.00 D

Index of Refraction:

- Cornea: 1.376n
- Crystalline lens: 1.416n
- Aqueous/ Vitreous: 1.336n
- Abbe Value: 45

Axial length: 24 mm (eye measured from front to back)

Myopia



Nearsighted



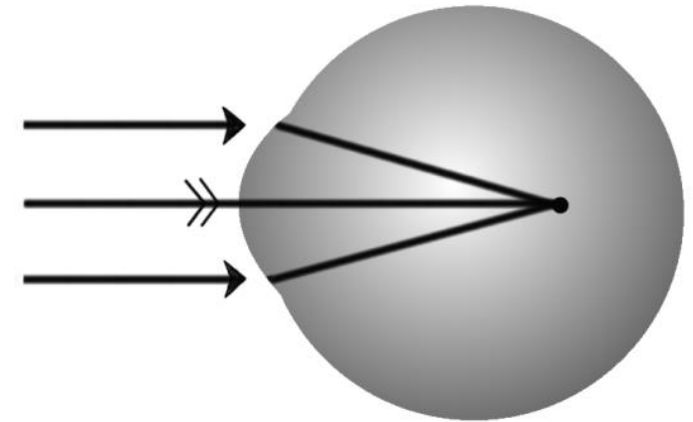
Eyeball is too
long



Light's focus is before
the retina



Corrected using
minus lenses



Hyperopia



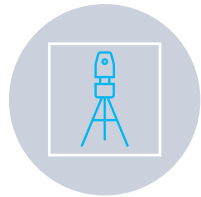
Farsighted



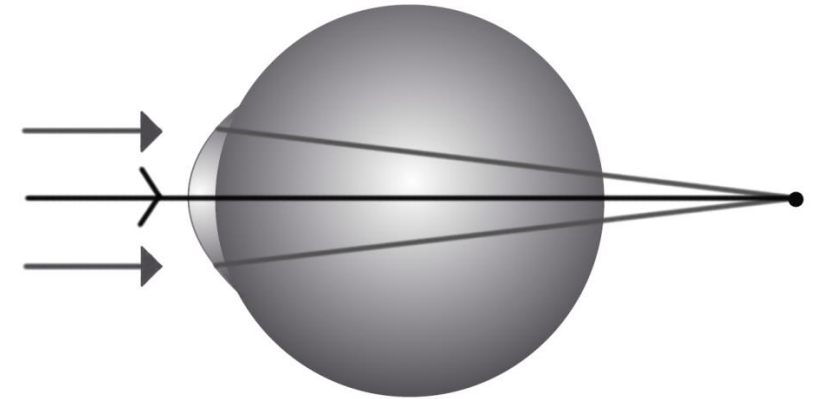
Eyeball is too short



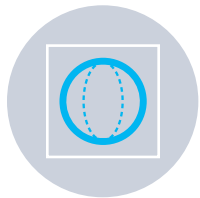
Light's focus is after the retina



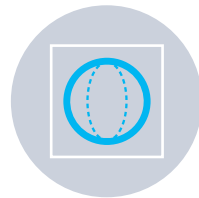
Corrected using plus lenses



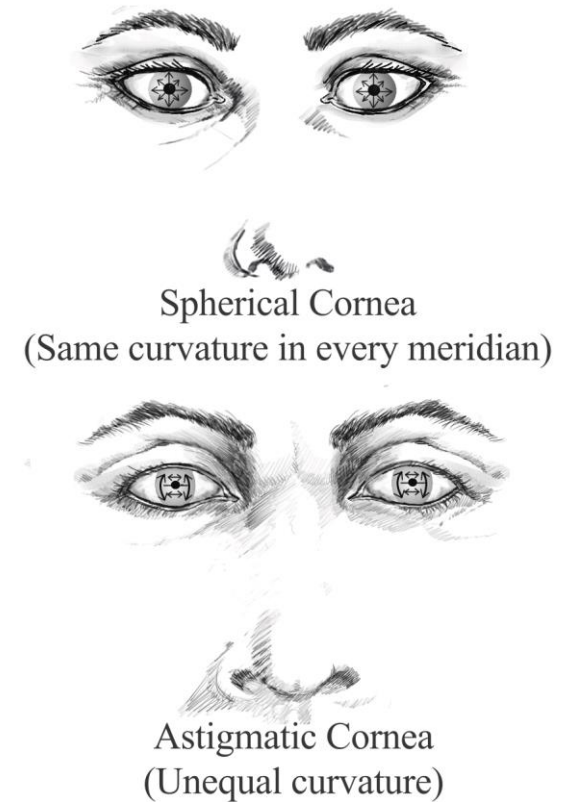
Astigmatism

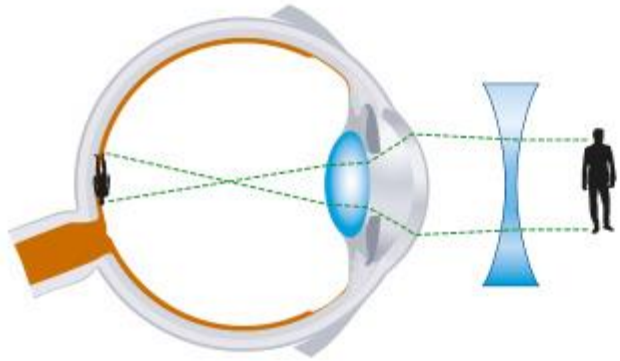
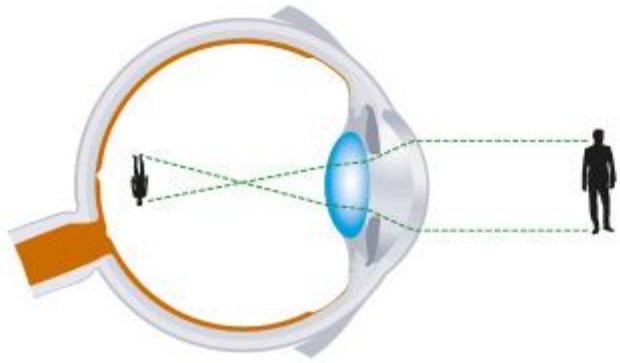


Most common refractive error

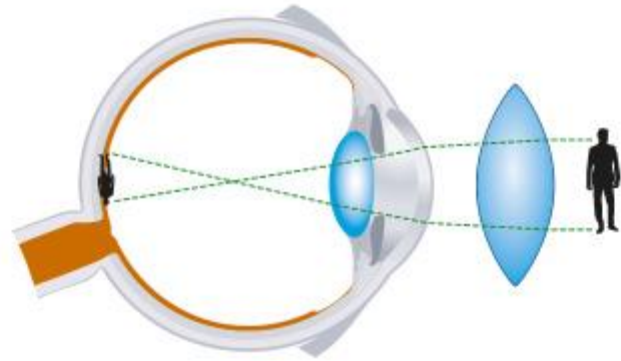
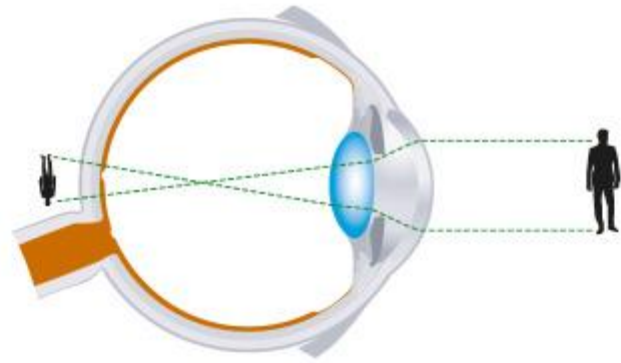


Causes': irregular shaped cornea or lenticular lens

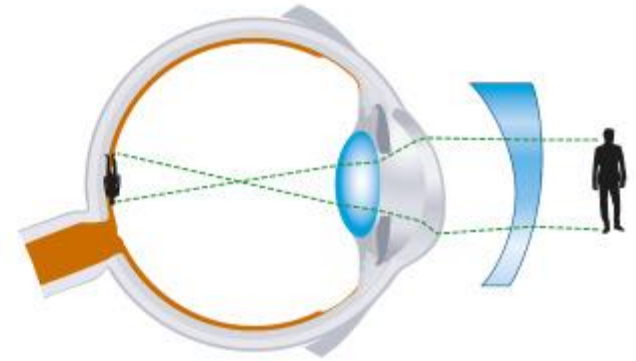
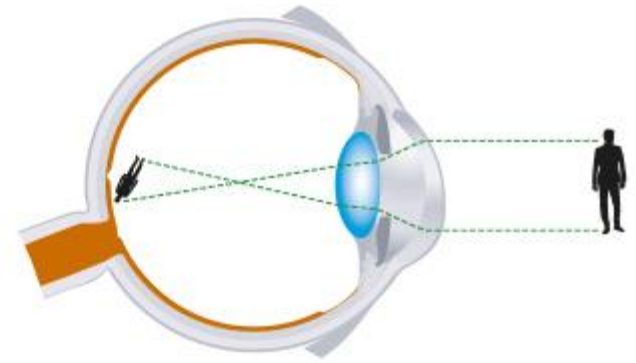




Myopia
Concave

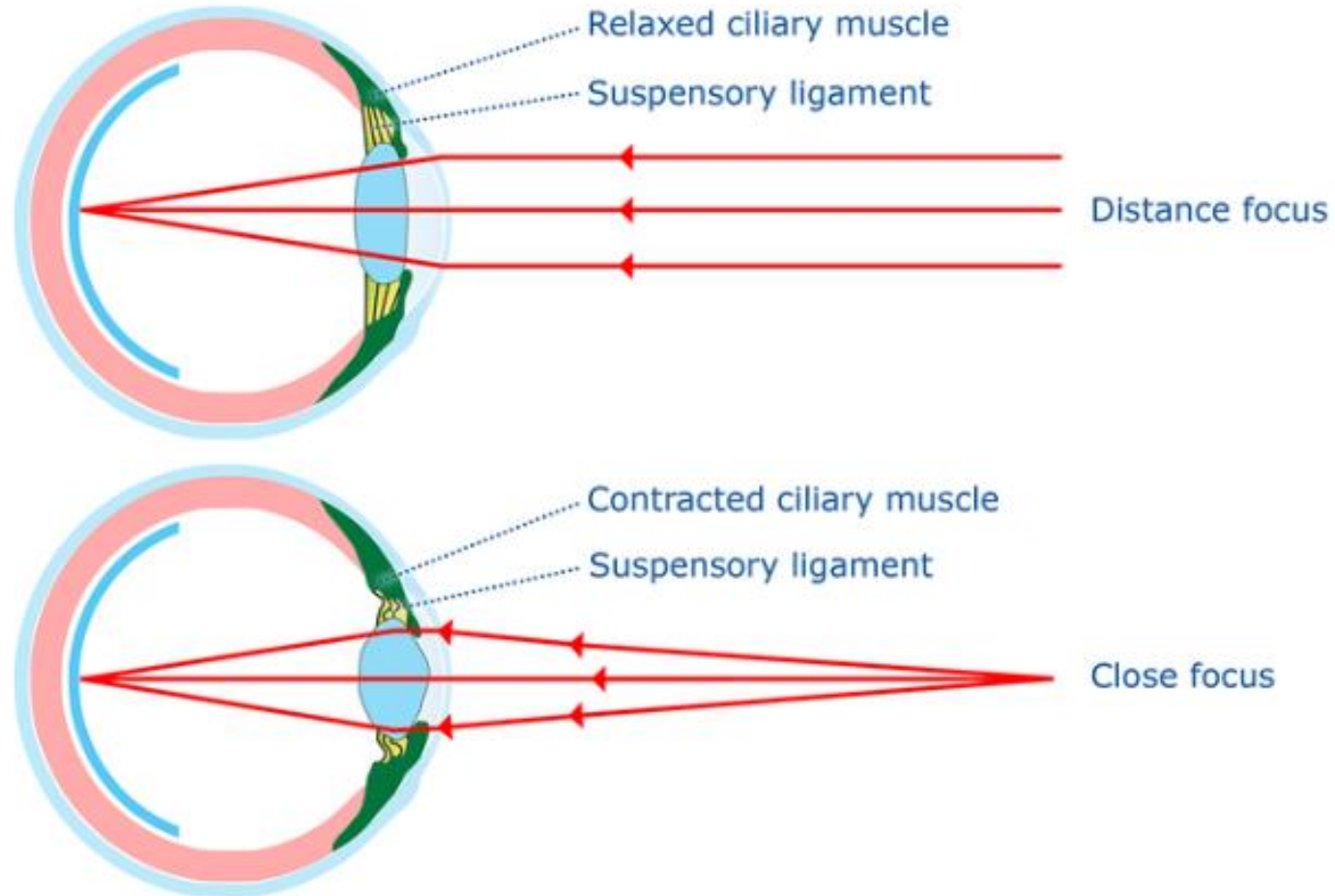


Hyperopia
Convex



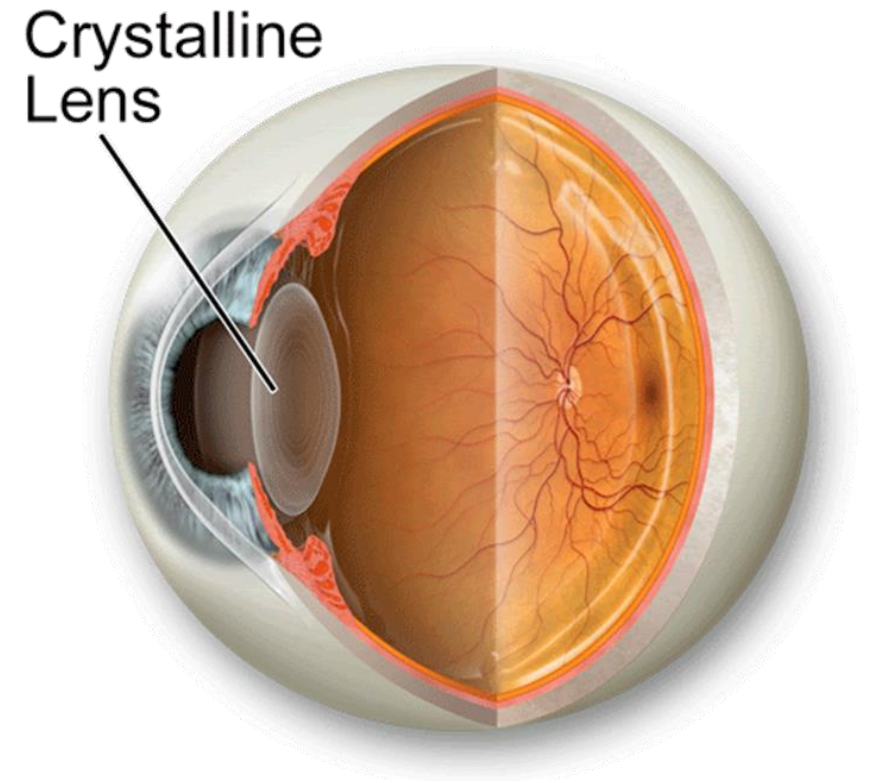
Astigmatism
Cylinder

How The Eye Focuses Light



Crystalline Lens

- Crystalline Lens - biconvex, transparent lens
- Approximately 20 D. diopters of focusing power
- Refractive index 1.427n
- Accommodation - ability to focus at varying distances
- Attenuates longer Ultraviolet Radiation (UV)



Cataract

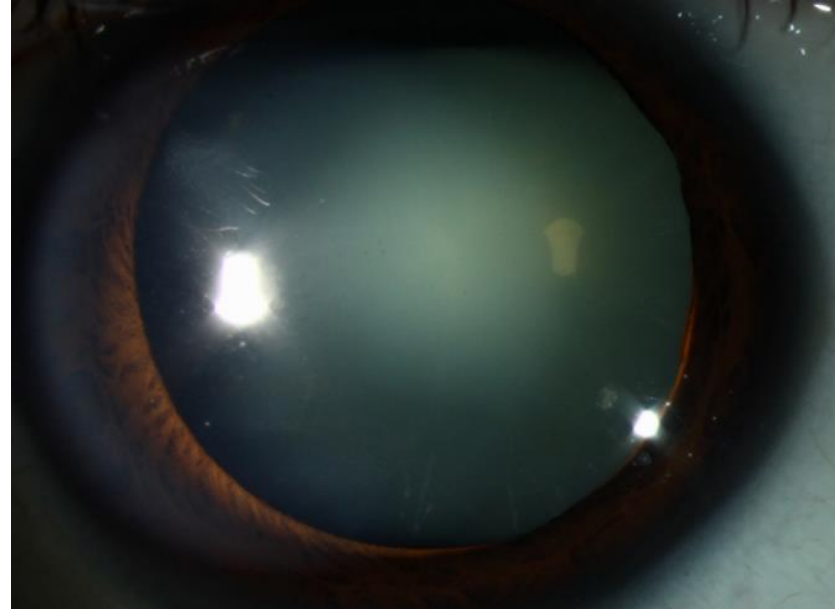
Cataract - opacity of the crystalline lens resulting in reduced vision

- **Nuclear Sclerotic** (NS) — slow progression; lens appears cloudy / hazy. Can be brunescent (brownish color)
- **Cortical** - white edges of streaks similar to spokes on a bicycle wheel; more common in diabetics
- **Posterior Subcapsular** – form on the back of the lens; rapid progression; more common in diabetics or from high doses of steroids

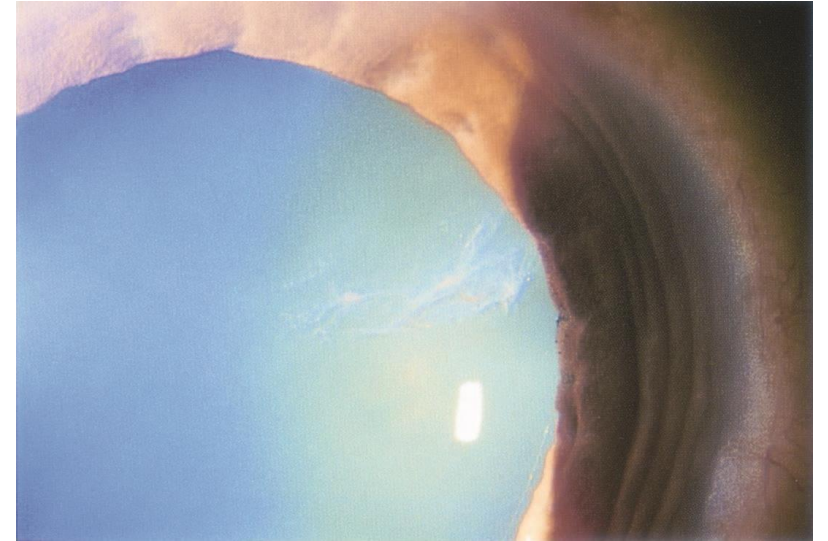
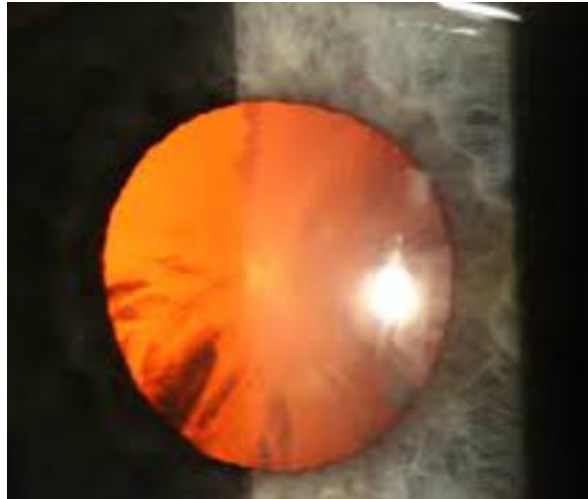
Three Categories:

- **Senile** - age related or could be environmental (steroid induced or other)
- **Traumatic** - injury to the crystalline lens (examples: bb gun, hard blow to the eye, arrow or other bruises the lens)
- **Congenital** - occurs at birth

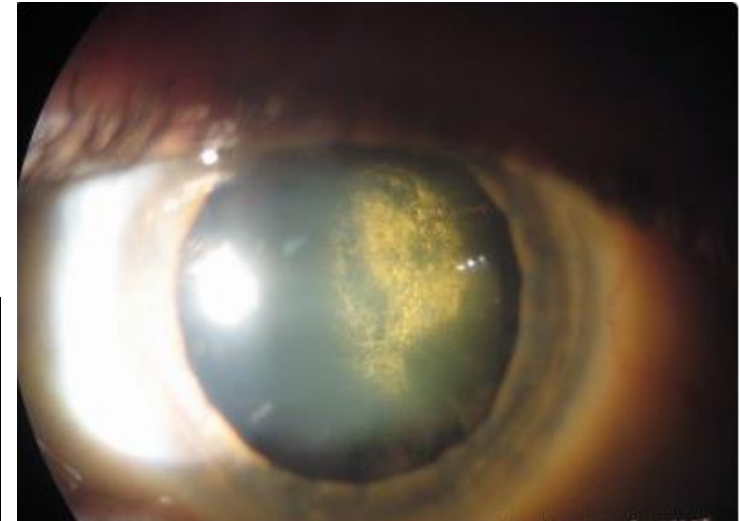
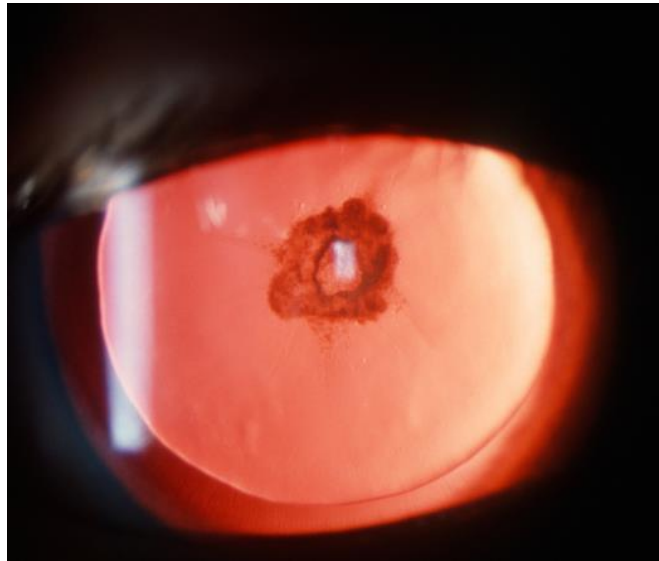
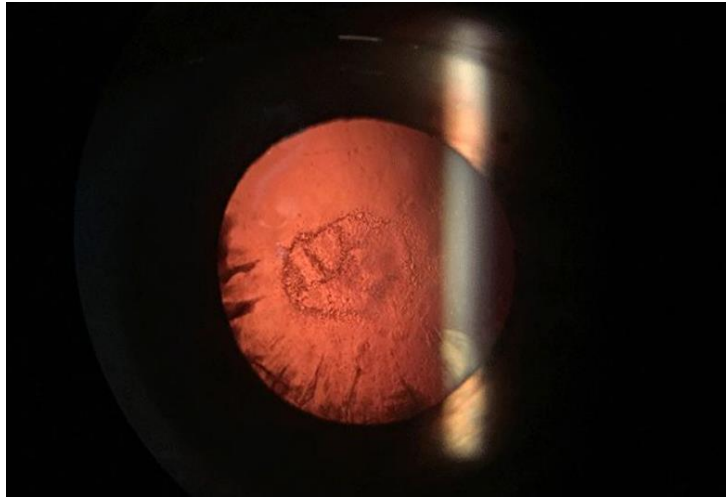
Nuclear Sclerosis



Cortical Cataract



Posterior Subcapsular Cataract (PSC)



Congenital Cataract

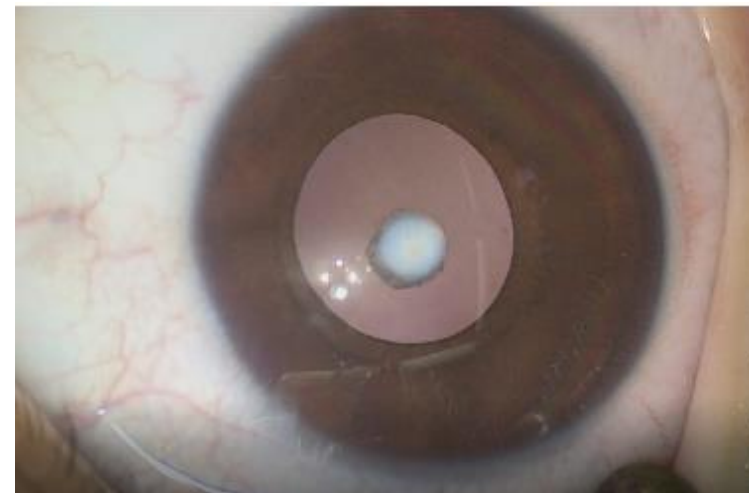
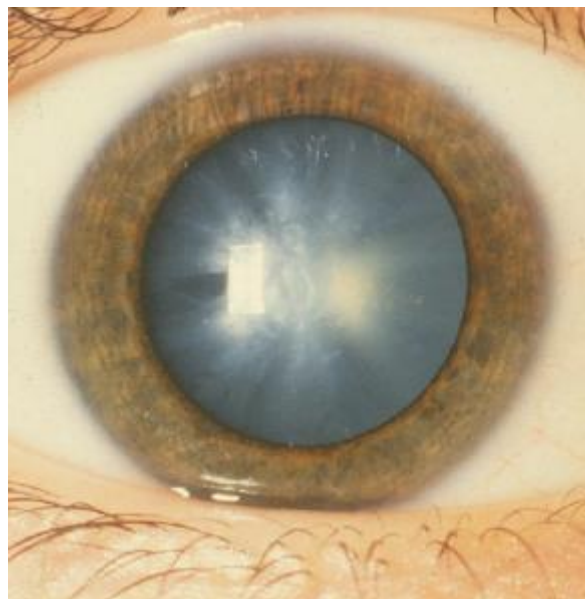
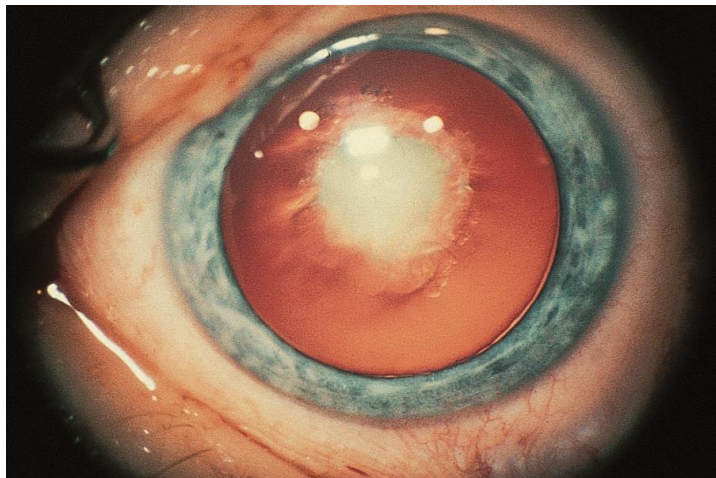


Image Formation

System	Anatomical Structure	Provides
Physiological Lens System	Cornea	43 diopters of static power
	Pupil	Depth of field
	Crystalline Lens	19 diopters of variable focus power

Image Formation

Physiological

- a. Refractive structures of the eye
- b. Accommodation by the crystalline lens
- c. The depth of field controlled by pupil size
- d. Photoreceptors (light receiving)

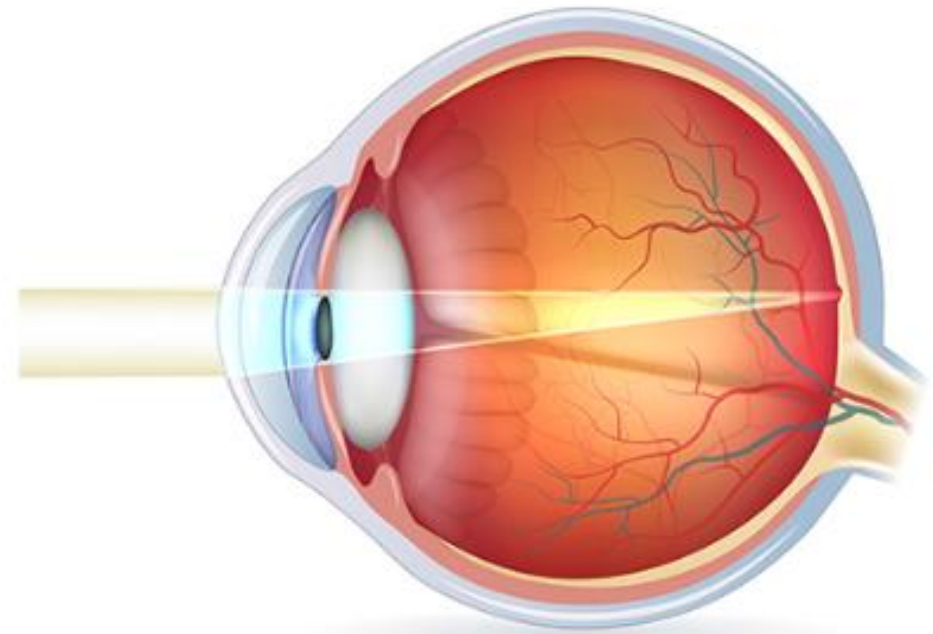


Image Formation

	Rod Cells	Cone Cells
Location in retina	Found around periphery	Found around centre (fovea)
Optimal light conditions	Dim light ('night' vision)	Bright light ('day' vision)
Visual acuity	Low resolution (many rods : one bipolar cell)	High resolution (one cone : one bipolar cell)
Colour sensitivity	All wavelengths	Certain wavelengths (red, green, blue)
Type of vision	Achromatic (black and white)	Colour
Number of types	One (all contain rhodopsin)	Three different iodopsin pigments
Relative abundance	Many	Fewer

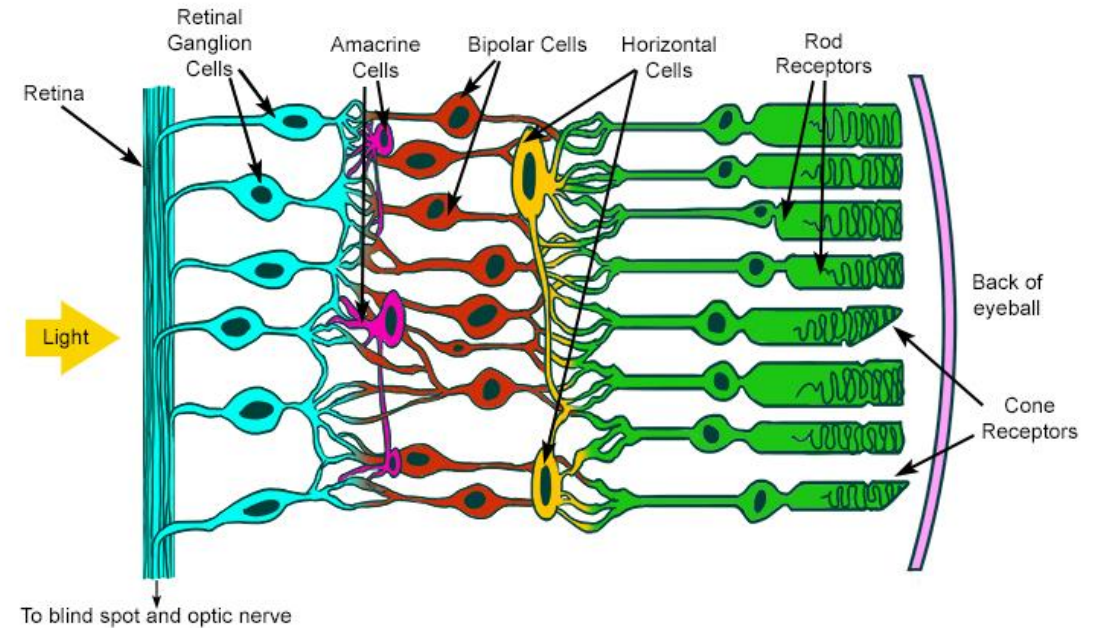


Image Formation

- **Optic Nerve** - bundle of nerves that carry chemical energy (visual impressions) to the brain
- **Scotoma (blindspot)** — does not contain rods nor cone photoreceptors
- **Occipital Lobe** - area of the brain that interprets images we perceive (vision occurs in the brain not the eye)

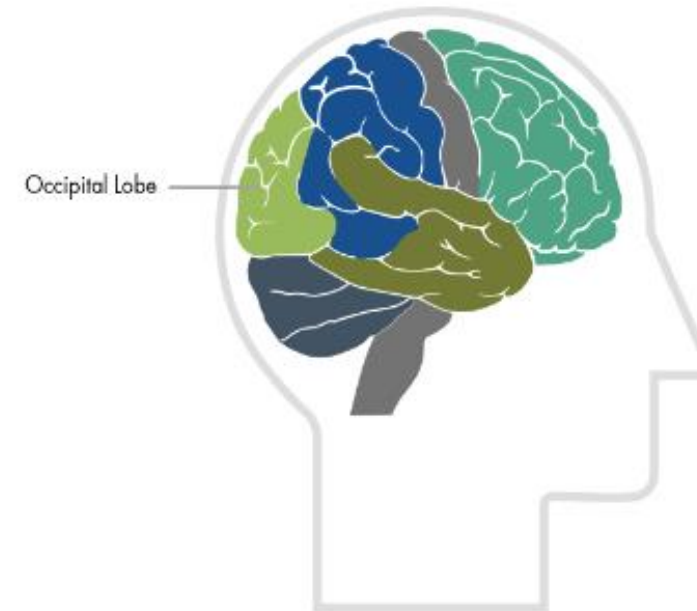
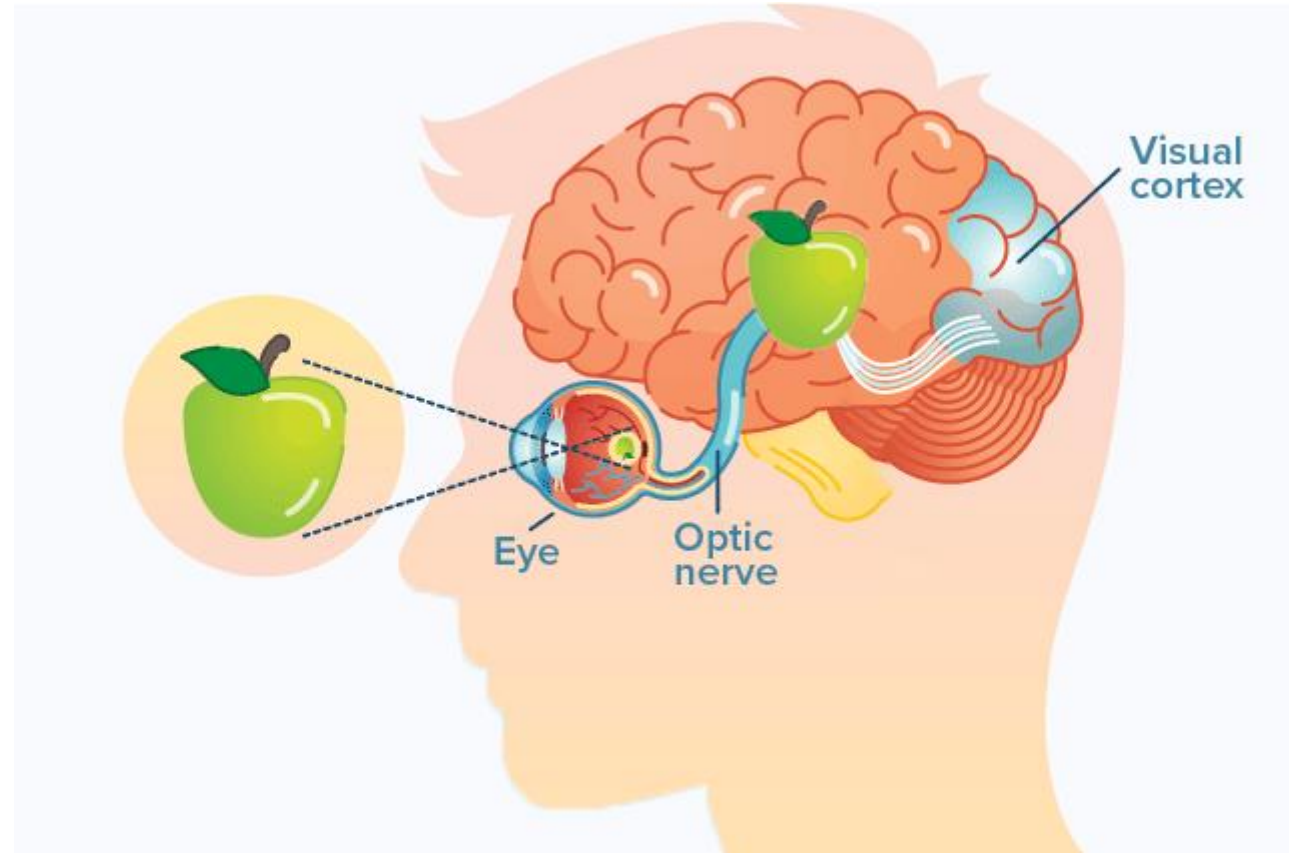
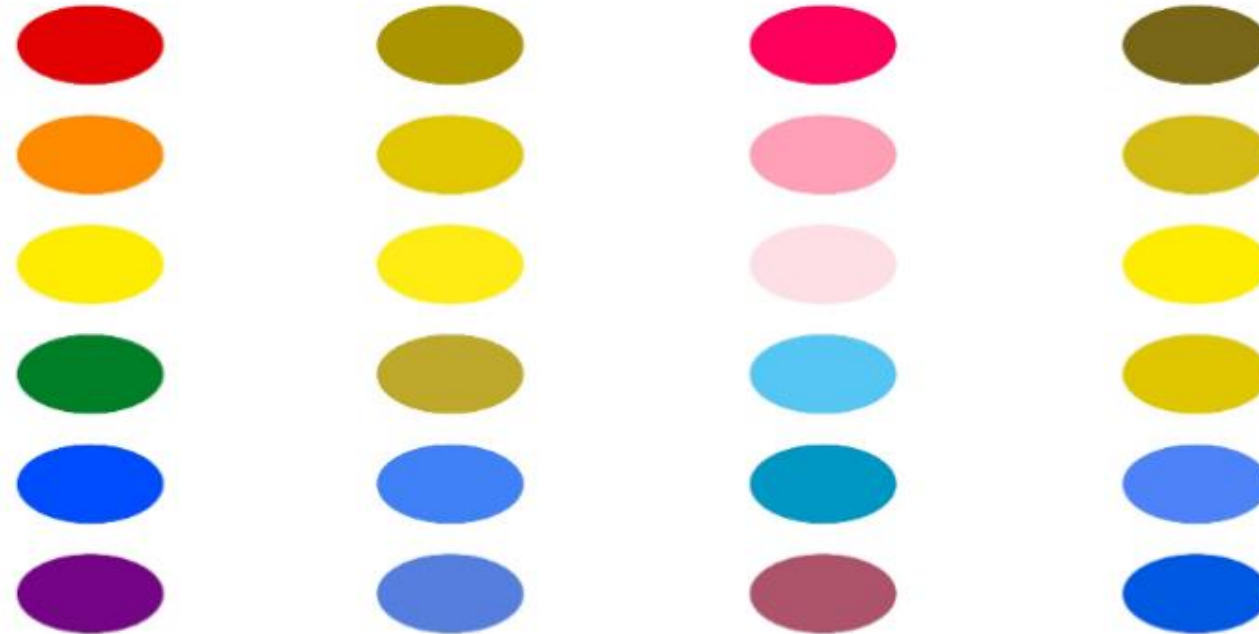


Image Formation



Color Deficiencies



*Normal
vision*

Deuteranopia
Green-blind

Tritanopia
Blue-blind

Protanopia
Red-blind

Cranial Nerves

CN II - vision

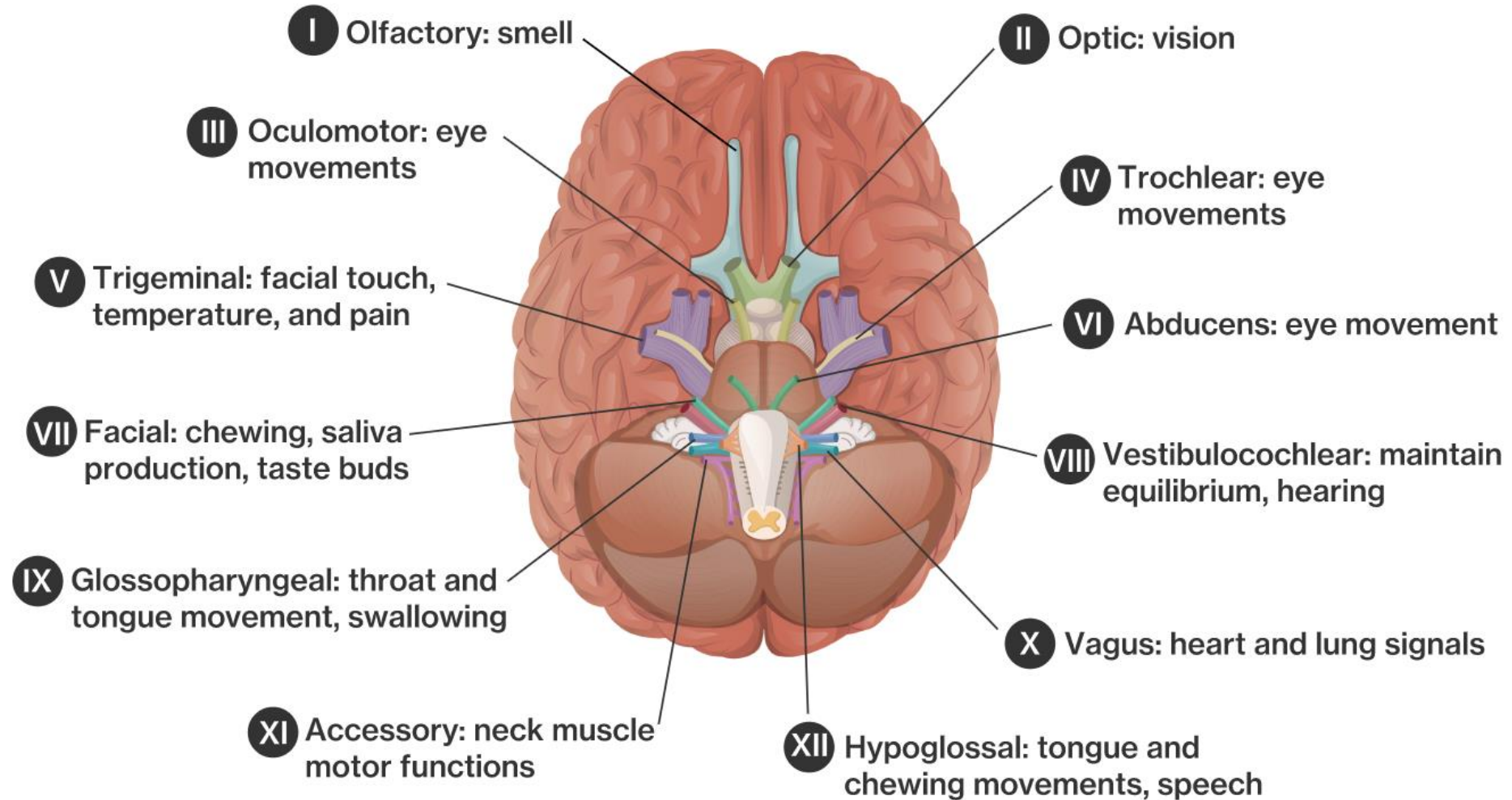
CN III - eye motility

CN IV - superior oblique eye muscle

CN VI - lateral rectus eye muscle

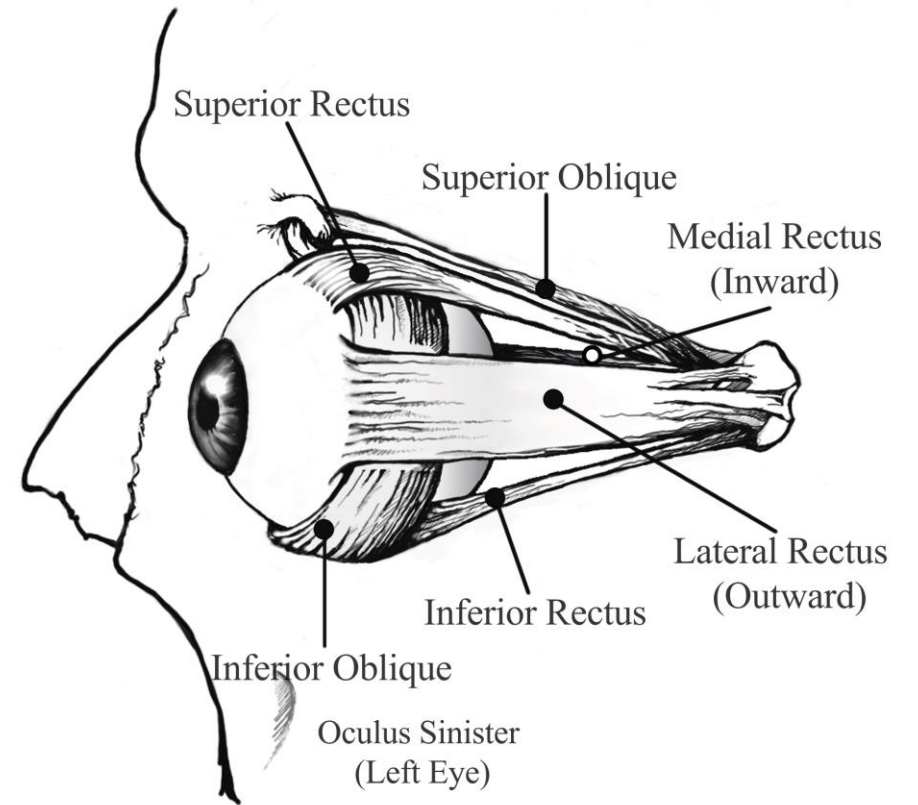
CN VII - facial and lacrimal gland

Locations of the Cranial Nerves



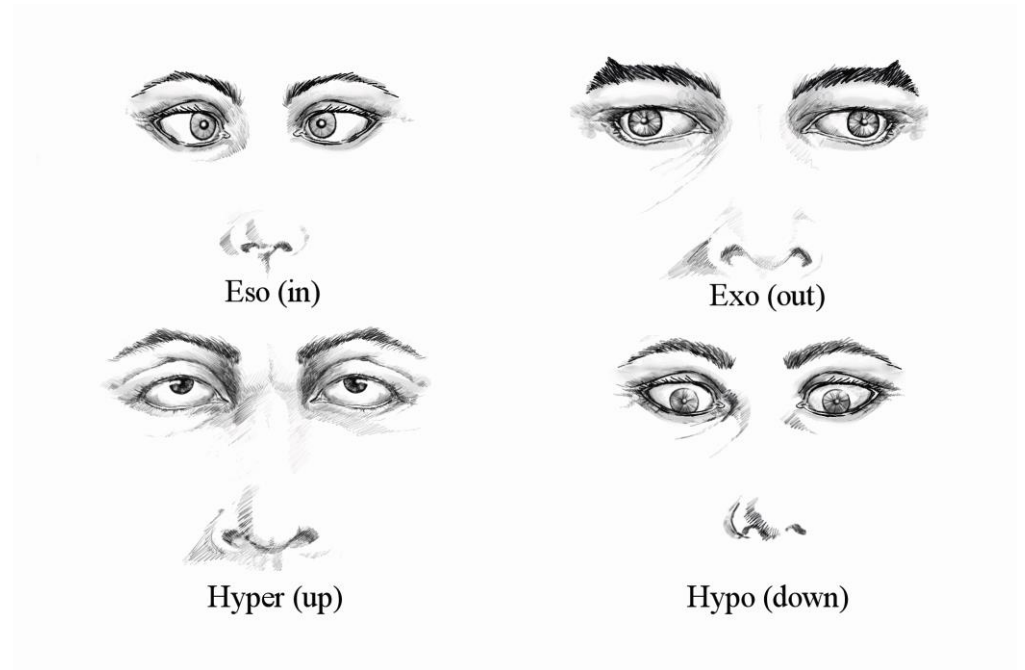
Motility

- Superior
- Inferior
- Medial
- Lateral
- Superior Oblique
- Inferior Oblique



Strabismus

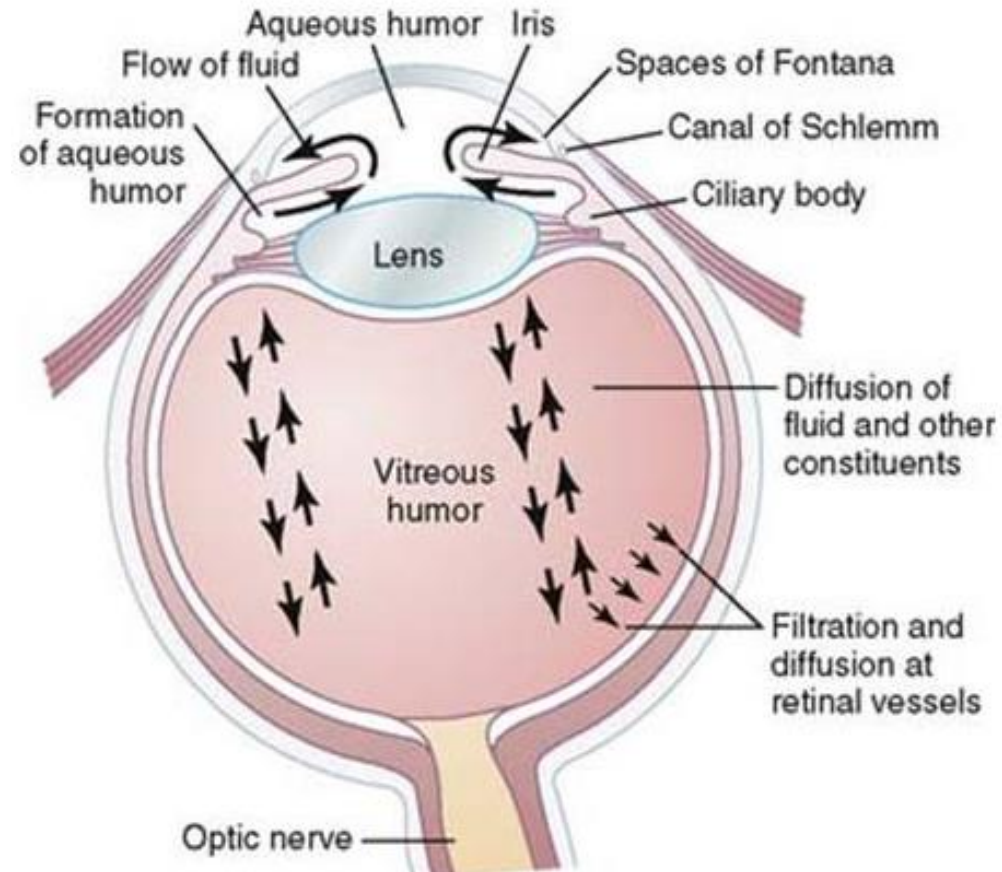
- Esophoria or Esotropia medial
- Exophoria or Exotropia lateral
- Hyperphoria or Hypertropia superior
- Hypophoria or Hypotropia inferior



Vitreous

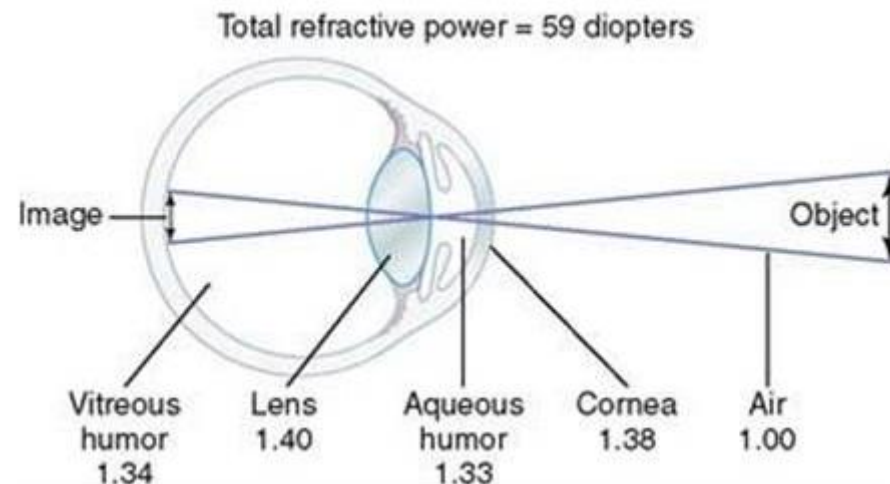
- Vitreous Humor - transparent, gelatinous mass in the posterior chamber
- Floaters - separation of the vitreous particles that appear in the line of sight as moving (floating) dark spots

Fluid System of the Eye



Refractive Media of the Eye

MEDIUM	REFRACTIVE INDEX	REFRACTIVE POWER
AIR	1	
CORNEA	1.38	+39 DIOPTERS
AQUEOUS HUMOR	1.33	
CRYSTALLINE LENS	1.40	+20 DIOPTERS
VITREOUS HUMOR	1.34	

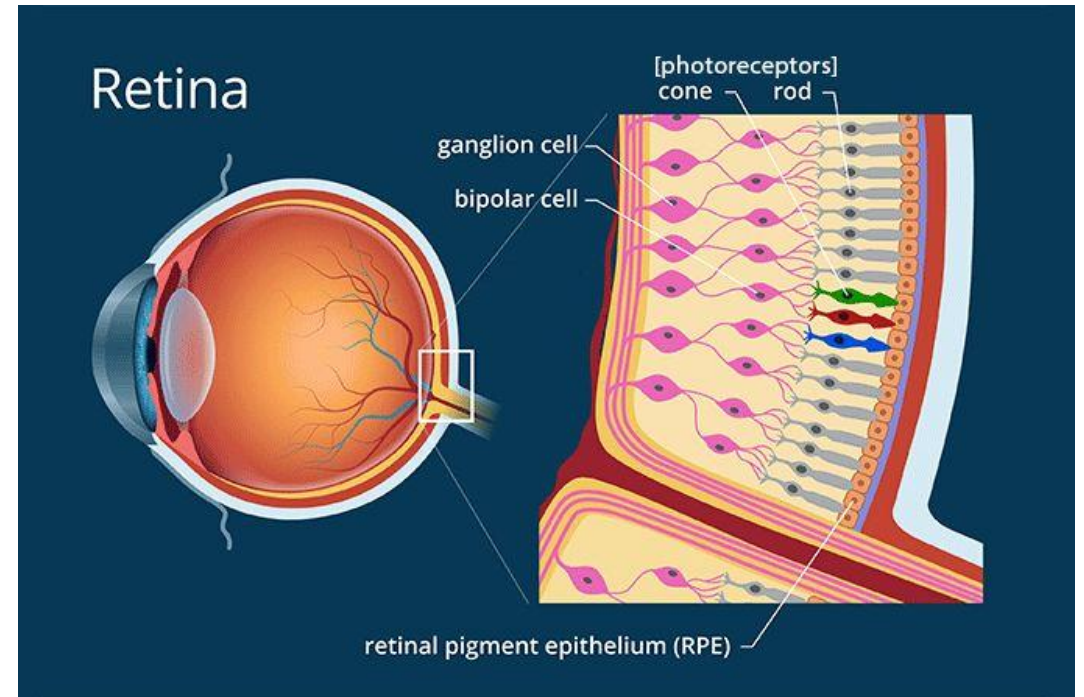


Retina

- Retina – light sensitive innermost nerve network of the eye
- 10 layers
- Inner coat posterior $\frac{3}{4}$ surface
- Contains the macula, rods, cones, and optic disc

10-Retina Layers

1. RPE - Retinal pigment epithelium
2. Photoreceptor layer
3. External limiting membrane
4. Outer nuclear layer
5. Outer plexiform layer
6. Inner nuclear layer
7. Inner plexiform layer
8. Ganglion cell layer
9. NFL - Nerve fiber layer
10. Internal limiting membrane



Laser Ray Tracing Video

Lasers Phernell Walker, MBA, ABOM, LDO -
YouTube

A lighthouse with a glowing red light inside, set against a blue sky. The lighthouse is on the right side of the image, and the light is bright and circular, creating a lens flare effect. The sky is a gradient of blue, darker at the top and lighter at the bottom.

Questions?

THANK YOU



PURE OPTICS