

**Ocular Anatomy and Physiology for Opticians**

**PHERNELL WALKER, MBA, ABOM, LDO**  
Renowned National Speaker  
Pure Optics LLC

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- ❖ Principle | Pure Optics LLC
- ❖ Author | Pure Optics (text-book)
- ❖ American Board of Opticianry | Board of Directors
- ❖ Pacific University College of Optometry | Past Adjunct Professor
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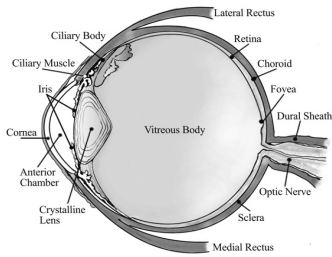
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### Ocular Anatomical Structures



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### Orbital Bones

- **Ethmoid bone** – separates nasal cavity and brain
- **Frontal bone** - two parietal bones, forms superior portion of the socket
- **Lacrimal bone** – provides structure for orbit
- **Maxilla bone** – creates the floor of the orbital over all structure
- **Palatine bone** – forms the orbital floor and lateral walls
- **Sphenoid bone** – forms the orbital floor and lateral walls of the orbit
- **Zygomatic bone** – lateral bone forms the cheek area

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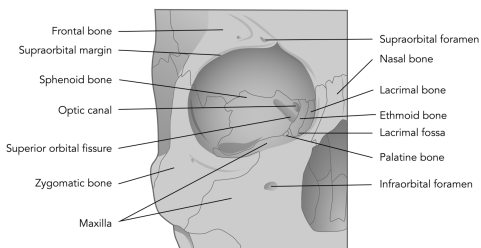
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### Orbital Bones



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## Conjunctiva

- **Palpebral Conjunctiva** is a mucous membrane extending from the lid margins over the sclera to the limbal margins
- **Bulbar Conjunctiva** - mucous membrane that covers the globe

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## Conjunctiva



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## Conjunctiva

**Conjunctivitis (pink eye) — red, inflammation of the conjunctiva**



**Causes**

bacteria or viral infection

allergic reaction from chemical irritants

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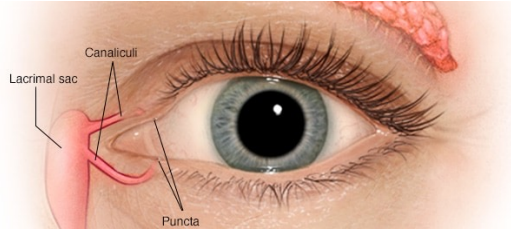
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### Tear Gland and Ducts



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### Lacrimal Gland

- **Lacrimal Gland** - located above the orbital globe under the eyebrows
- Responsible for producing tears
- Tears moisturize the eyes, distribute oxygen
- Tears contain lysosomes
- **Lysosome** - antibacterial enzyme (germ killer)

Pure Optics | Vision Using Lasers to Explore How the Eye Works

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### Palpebrae

- Distribute tears across the cornea and wash away bacteria
- Protects the eye from foreign objects and bright light

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## Palpebrae

- Orbicularis oculi muscle is responsible for blinking
- Levator palpebrae superioris muscle keeps the lid open
- Interpalpebral fissure - widest opening (approximately 10mm vertically and 30mm horizontally) between the upper and lower palpebrae

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## Meibomian Glands

- **Meibomian glands** (also called tarsal glands) are located along the rims of the eyelid in the tarsal plate (25 upper and 20 on lower lids)
- Produce meibum, an oily substance that prevents evaporation of the tear film
- Meibum prevents tears from spilling onto the cheek, traps them between the oiled edge and the eyeball, and makes the closed lids airtight

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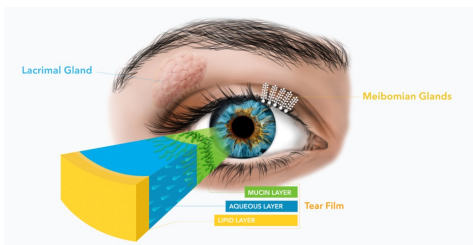
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## Tear Film



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## Precorneal Tear Film

### Precorneal Tear Film

- Lipid – First layer. Oily layer that prevents evaporation of the aqueous layer.
- Aqueous – Second layer. Maintains a moist outer eye.
- Mucoid – Third layer. Provides a smooth distribution for tears and adherence.

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## Lacrimal Lake

- Collection of tears in the medial angle between the eyelids towards the medial canthus
- Blinking causes the tears to be pumped into the punctum

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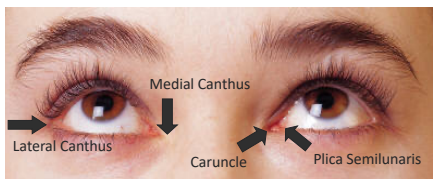
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## Palpebrae and Canthi



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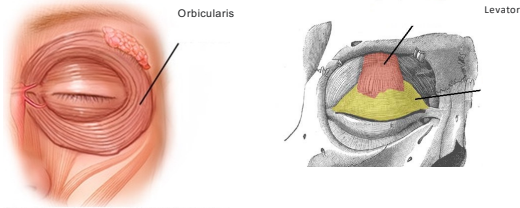
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### Orbital Muscles



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### 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

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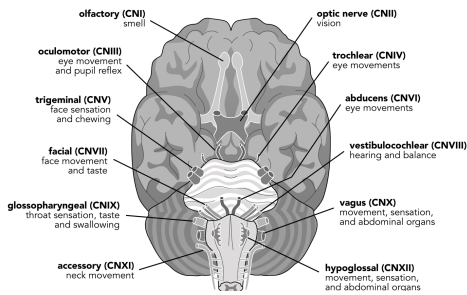
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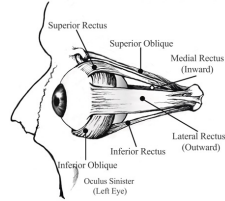
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## Motility

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



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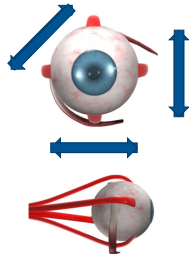
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## Extraocular Muscles

Muscle	Primary Action
Lateral rectus	Abduction
Medial rectus	Adduction
Superior rectus	Elevation
Inferior rectus	Depression
Superior oblique	Intorsion
Inferior oblique	Extorsion



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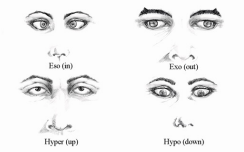
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## Strabismus

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



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## Tunics

- Outer Fibrous Layer - cornea and sclera
- Middle Vascular Layer (uvea) - iris, ciliary body and choroid
- Inner Neural Layer - retina

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## Cornea



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## Cornea

- Thin, transparent membrane that focus' light.
- The corneas attenuates UV radiation between 240 an 310nm.
- Over exposure can result in photokeratitis

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## Cornea

- 43.00 D (fixed power)
- 0.5 mm center thickness
- 1.0 mm edge thickness
- Index = 1.376<sub>n</sub>
- 5 layers
- Steeper center
- Flatter periphery

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## Corneal Layers

- Corneal Epithelium
- Bowman's
- Stroma (thickest layer 90%)
- Decemets
- Endothelium

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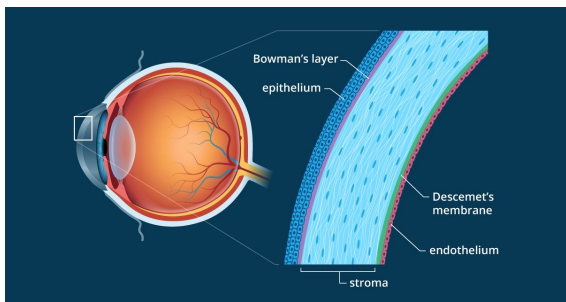
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### Corneal Epithelium

- **Corneal Epithelium** – outermost layer
- 5 to 7 cells thick
- Microvilli - fingerlike projections increases tear film stability
- Highly sensitive to pain
- Injury causes lacrimation and photophobia

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31

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### Bowman's Layer

- Bowman's – anterior limiting membrane
- 10 to 12 micrometers
- Collagen fibers
- Non-regenerative
- Barrier from infection

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### Stroma

- Stroma (thickest layer 90%)
- ~200 sequentially arranged lamellae
- Collagen fibers

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### Descemet's Layer

- Descemet's – basement membrane
- Acellular – two laminae
- Constantly produced and thickens over time
- Doubles by the age of 40 years

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### Endothelium

- Endothelium – innermost layer
- Single layer five and seven sided cells
- Osmotic pump – pumps aqueous from cornea

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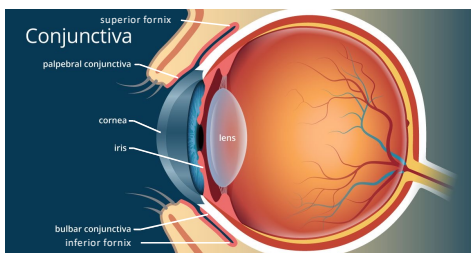
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### Conjunctiva



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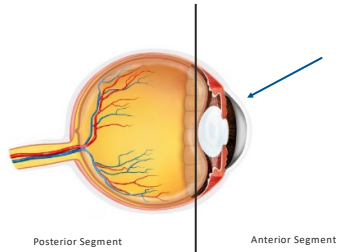
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### Anterior Segment



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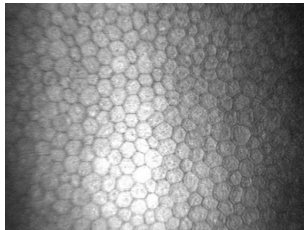
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### Cornea - Endothelial Cells



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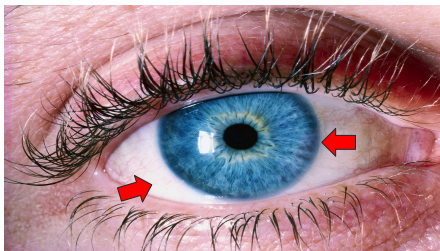
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### Sclera & Limbus



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### Iris and Pupil

- Iris - circular muscle with an opening in the center
- Regulates the amount of light entering the eye
- Color pigment gives the color
- Pupil - the center opening of the iris is the pupil
- Pupil Size - average's 3 to 4 mm diameter
- **Limbus** - outer dark ring around the cornea. Boundary between sclera and cornea

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### Limbus

- Limbus - outer dark ring around the cornea
- Boundary between sclera and cornea



44

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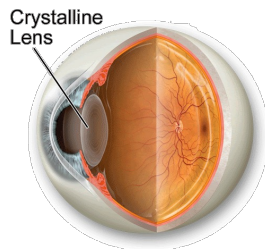
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### Crystalline Lens



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## Crystalline Lens

- Crystalline Lens - biconvex, transparent lens
- Approximately 19 D. diopters of focusing power
- Refractive index 1.427n
- Primary function is to focus light on the retina using accommodation
- Accommodation - ability to focus at varying distances
- Attenuates longer Ultraviolet Radiation (UV)

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## Cataract

**Cataract** - opacity of the crystalline lens resulting in reduced vision

- **Nuclear Sclerosis (NS)** — lens appears cloudy / hazy. Can be brunescant (brownish color)
- **Cortical** - white edges of streaks similar to spokes on a bicycle wheel

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

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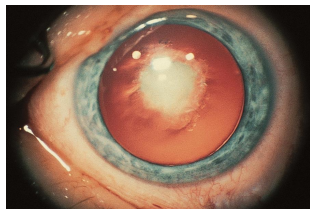
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## Congenital Cataract



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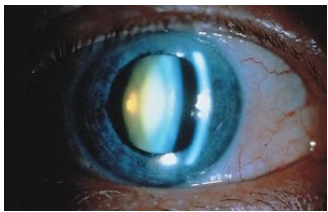
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### Nuclear Sclerosis



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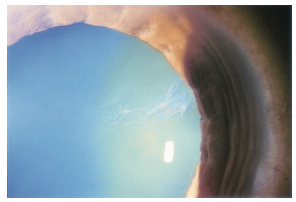
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### Cortical Cataract



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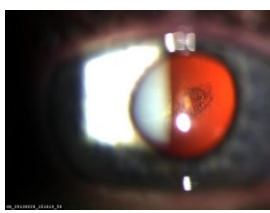
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### Posterior Subcapsular Cataract (PSC)



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### Cataract Surgery

- **Aphakia** (absence of a lens) – crystalline lens, or its nucleus is removed
- **Pseudophakia** (Intraocular Lens or I.O.L.) – cataract surgery is performed. A synthetic lens that is surgically inserted to replace the old lens
- **IOLs** lack accommodative power

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### Phacoemulsification

**Phacoemulsification (phaco)** is method of cataract surgery in which the crystalline lens is emulsified using ultrasonic energy and replaced with an intraocular lens implant (IOL).

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### Posterior Chamber

- Triangular in shape
- Apex is located where the iris rests on the lens
- Base is the valley between the ciliary processes
- Posterior wall is the lens and zonules
- Anterior wall - pigment epithelium layer of the iris

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### Crystalline Lens

- Bi-convex Lens - attenuates UV radiation
- Primary Function - accommodation
- Dioptric Power – ~19 D

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### Anterior Chamber

- Aqueous Humor - clear fluid behind the cornea in the anterior and posterior chamber
- Refractive index of 1.33n
- Maintains the corneal shape and intraocular pressure
- The Ciliary Body produces the aqueous fluid
- Remains clear due to the filtering through the angle and the “trabecular meshwork”
- Intraocular pressure measured with a tonometer
- Normal pressure is between 15 to 20 Hg (millimeters of mercury)

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### Optic Disc

- **Optic Disc (optic nerve head)** – site where ganglion cell axons accumulate and exit the eye.
- Horizontal Diameter = ~1.7mm
- Vertical Diameter = ~1.9mm
- Zero photoreceptors = blind spot

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## Optic Nerve

- **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)

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## Glaucoma

- **Glaucoma** - ocular disease characterized by optic nerve head damage due to excessive intraocular pressure
- Patients with glaucoma require treatment with prescription medication (example: xalatan, latanoprost and others)

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## 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

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## Retina

Retina – light sensitive innermost nerve network of the eye

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Inner coat posterior 3/4 surface

Contains the macula, rods, cones, and optic disc

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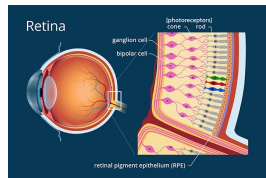
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## 10-Retina Layers

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



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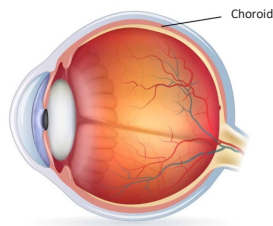
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## Choroid



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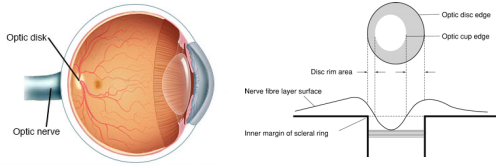
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### Optic Nerve & Disc



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64

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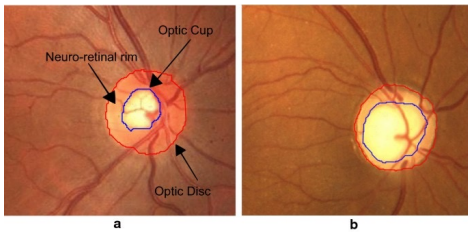
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### Cup to Disc Ratio (.30, .40, etc...)



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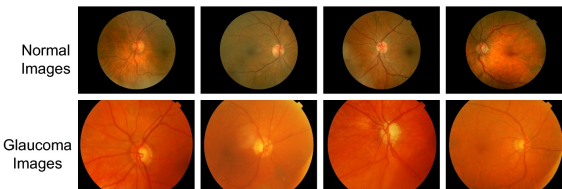
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### Normal vs. Glaucoma



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