Hello Everyone

Hope You Are Having
A Wonderful Physiological Day

☺☺☺


ARE YOU
READY ?
LET'S GET STARTED!

Refractive Media of the eye

Sem 4

Mahmoud El Tohamy

M.D, Ph.D.

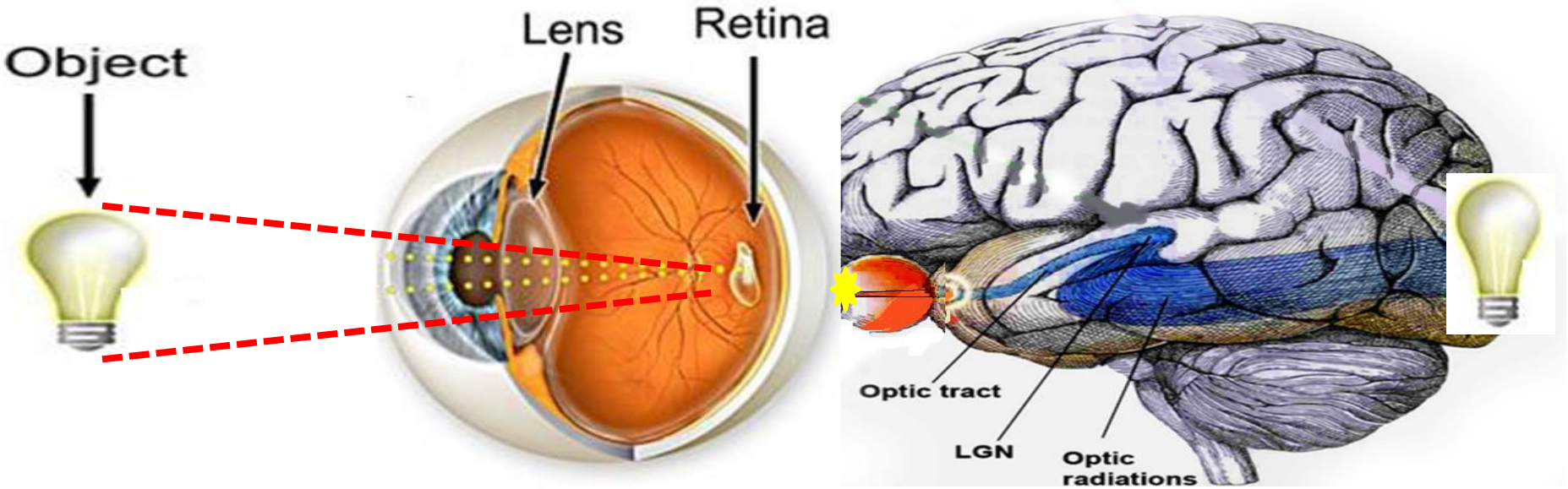
Lecturer of Medical Physiology

Faculty of Medicine, MU

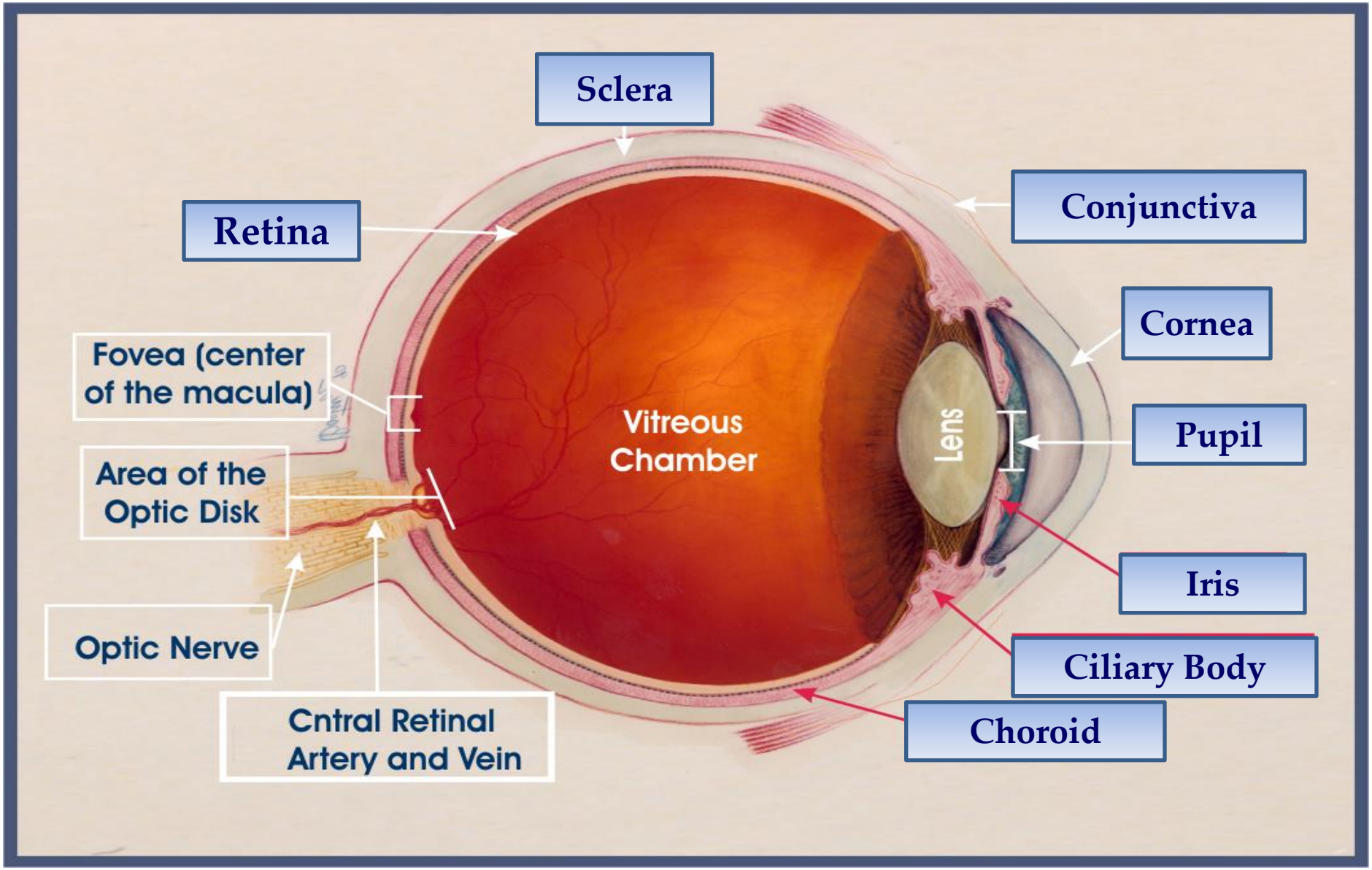
Dr.m.eltohamy@mans.edu.eg


We
Will
Do It

Vision

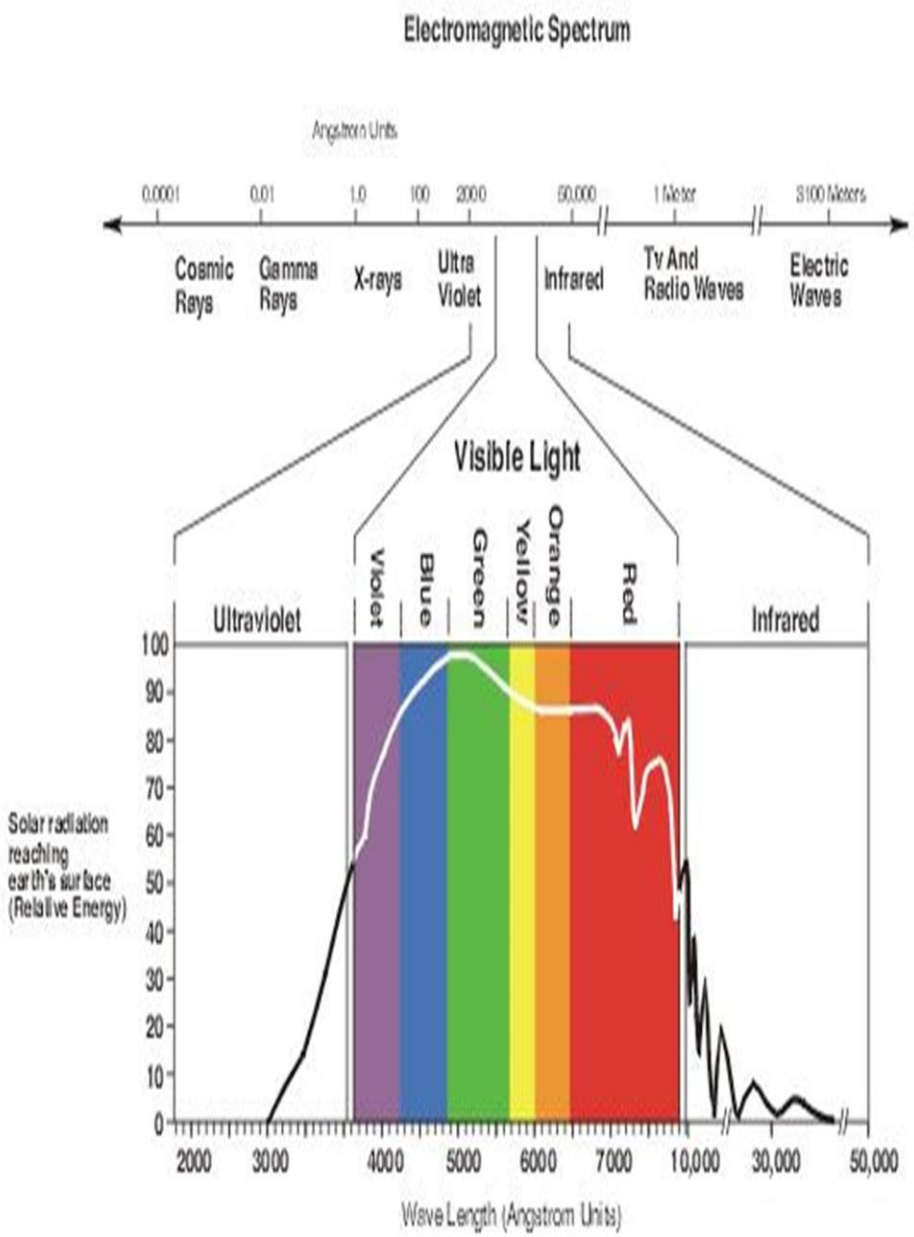


Organ of Vision (Eyeball)



Light

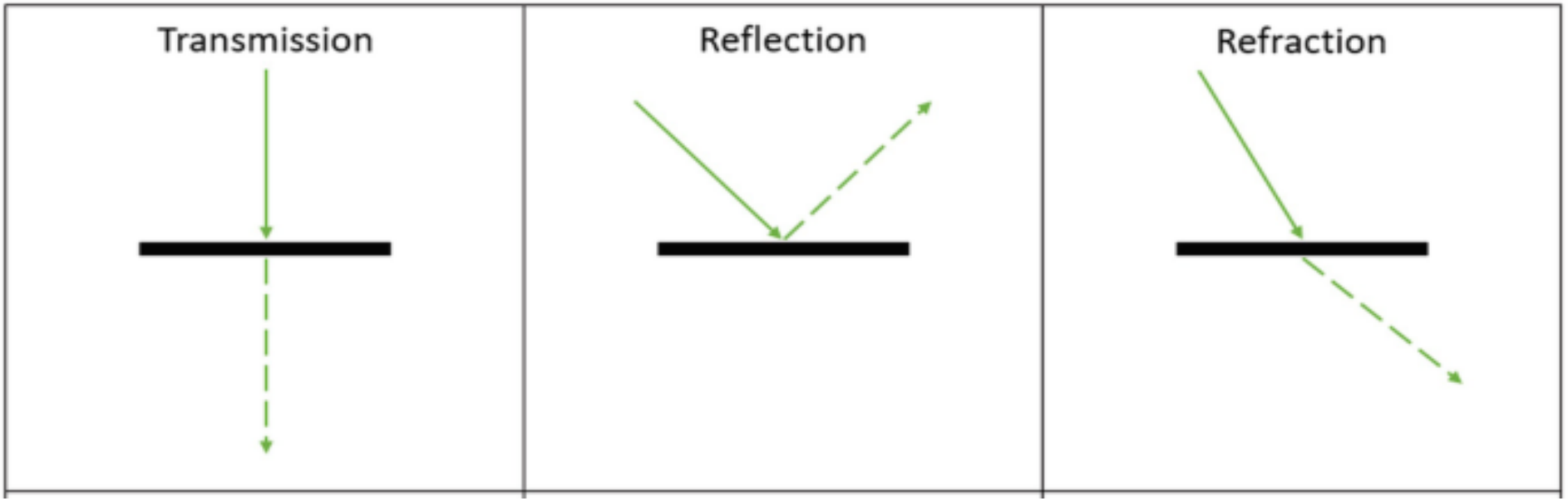
- Light is a form of **radiant energy**, consisting of **electromagnetic waves**
- The wave-length of **visible light** to the human eye ranges from **400 to 750 nm**
- Its **velocity** in **air** it is **300,000 km/second**, but it is much slower through transparent solids & liquids e.g. in the **glass** it is **200.000 Km/sec**



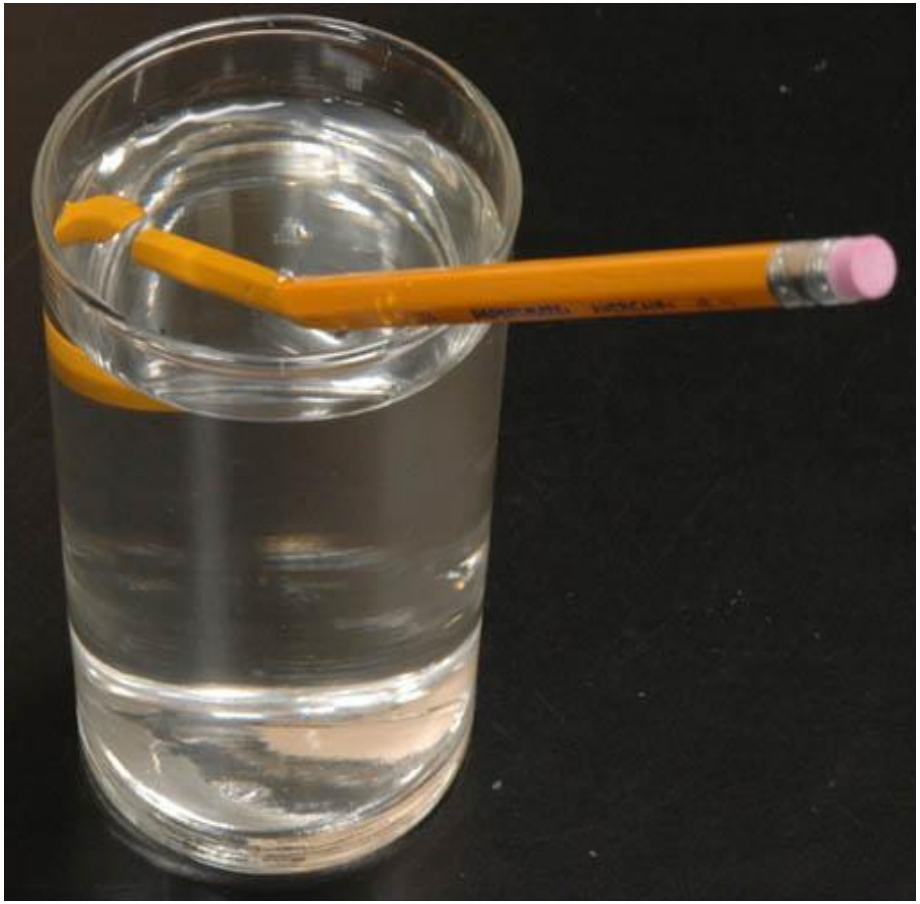
Physics of Light

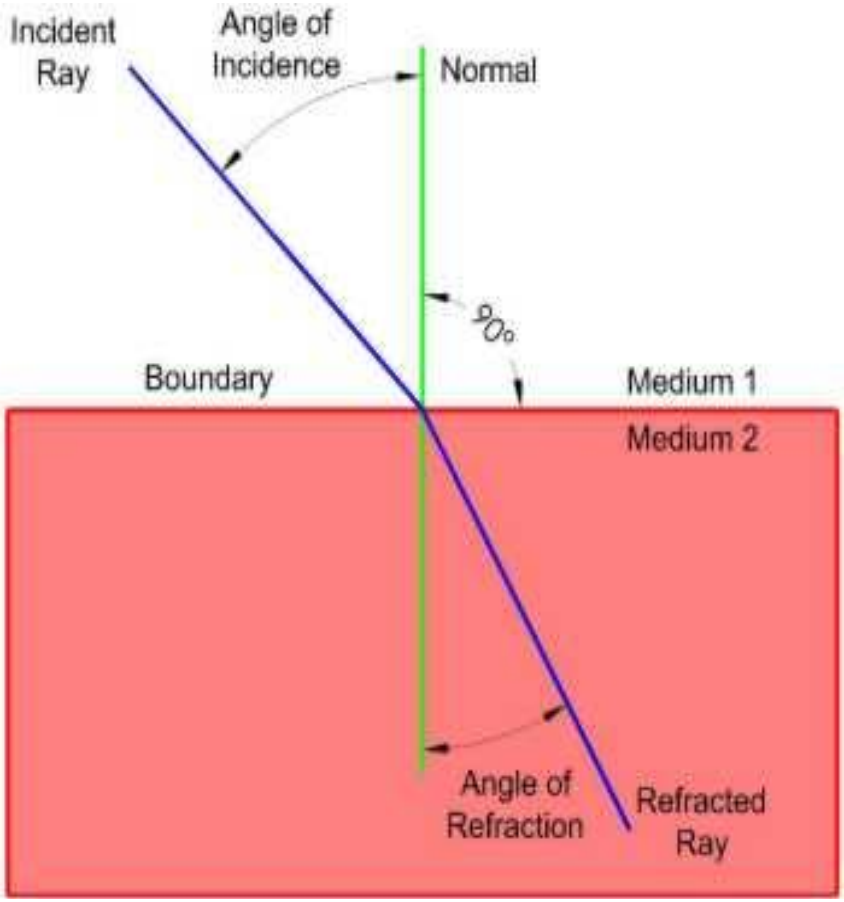
- When light rays strike a surface, they are either;

1. **Reflected** (white objects reflect all light)
2. **Transmitted** through it, with or without **refraction**



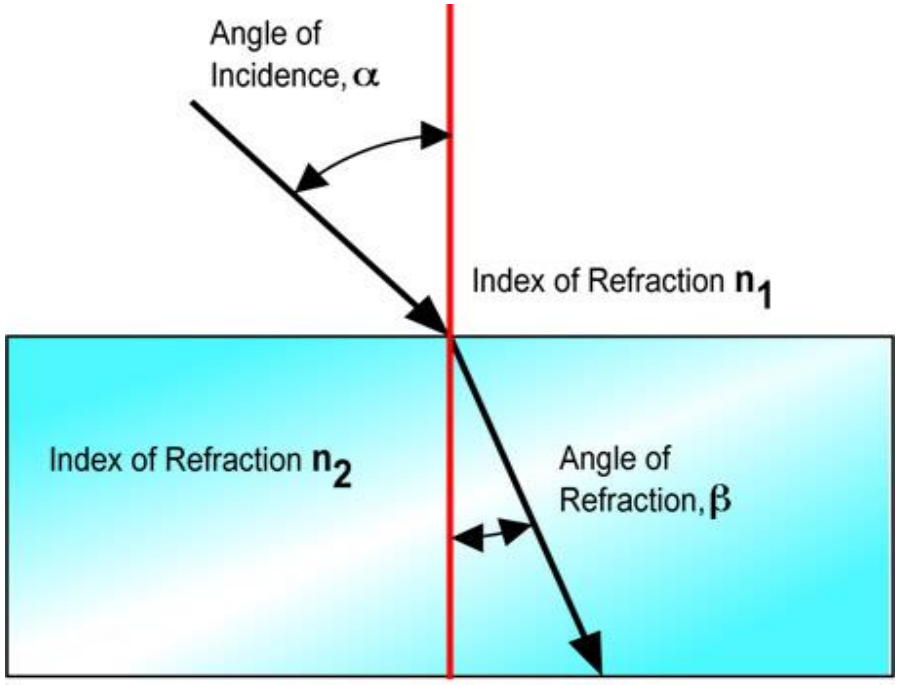
Refraction of Light





Refractive index (RI)

- It is the **ratio** of **velocity of light in air to** the velocity in **the medium**.
- It is **1.0** for **air**, **1.5** for **glass**, and **1.33** for **water**



$n_1 \sin \alpha = n_2 \sin \beta$

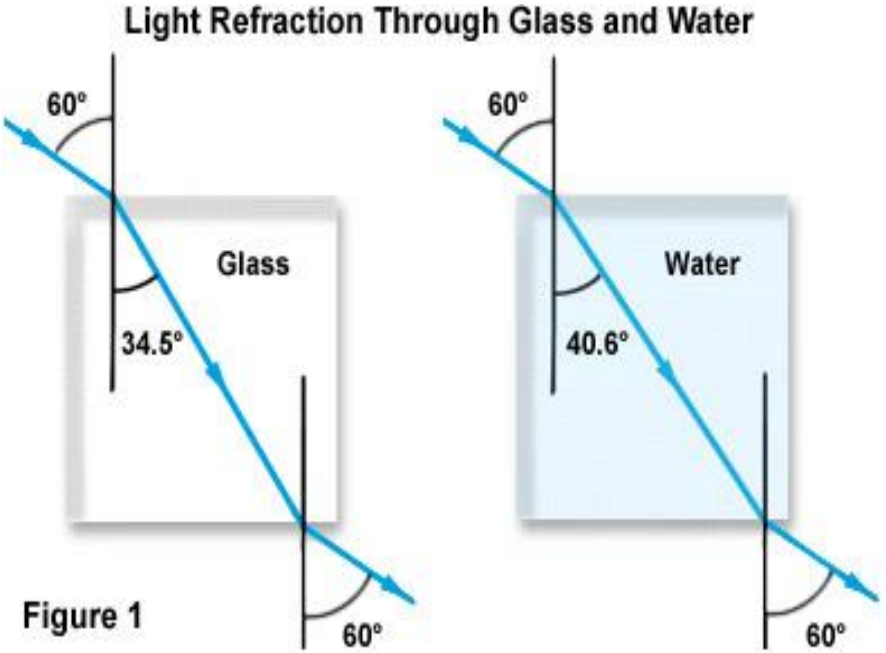
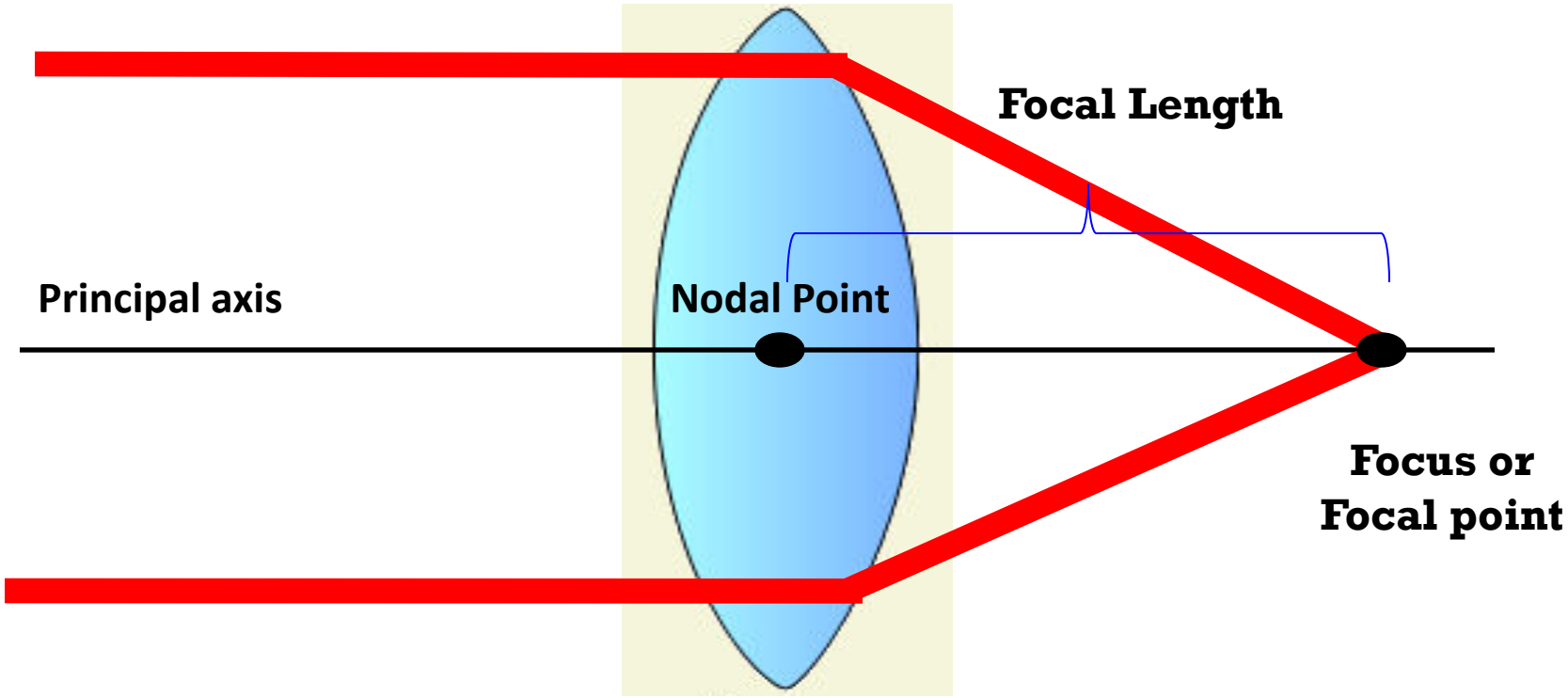
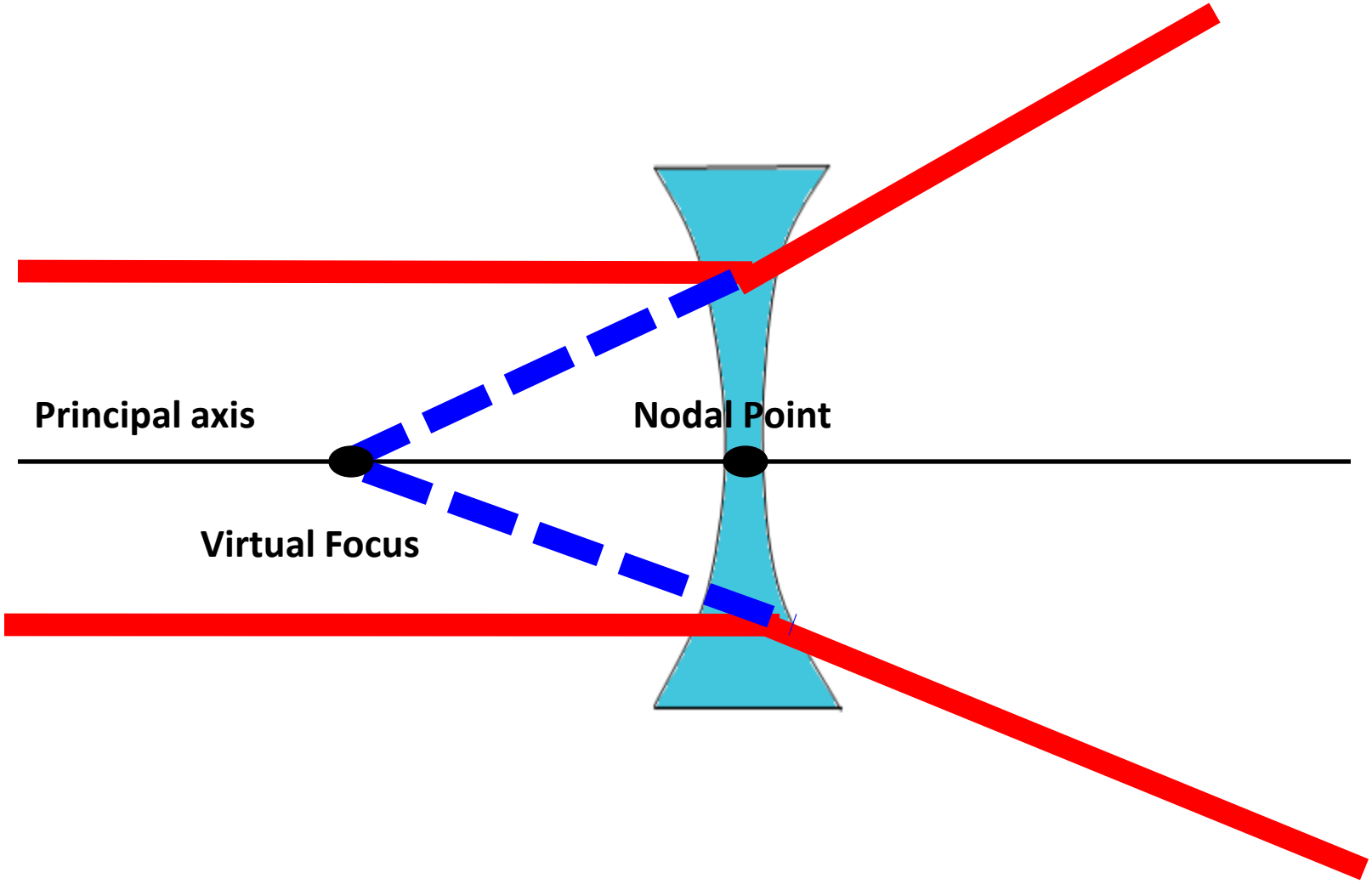


Figure 1

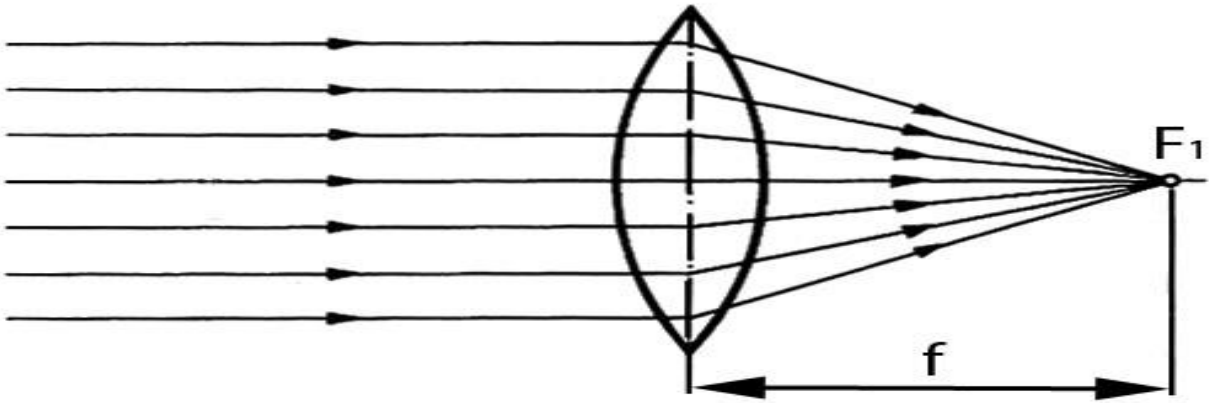
Refraction of Light through Convex Lens



Refraction of Light through Concave Lens



Refractive Power of Lens

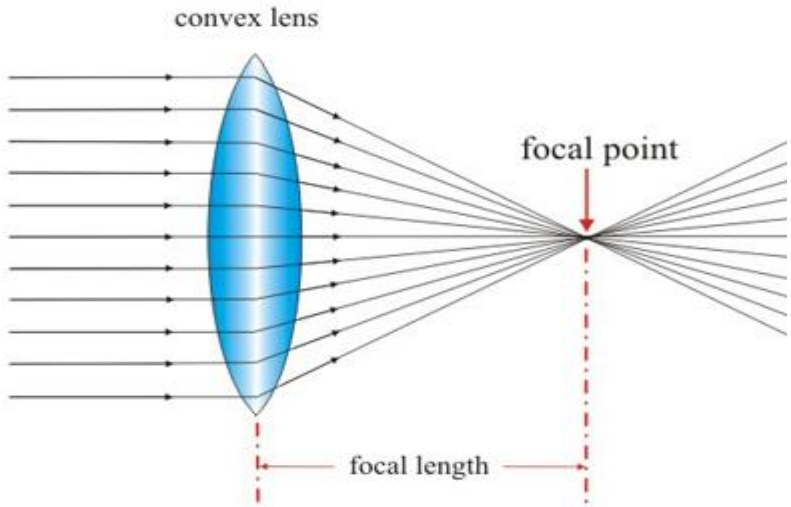


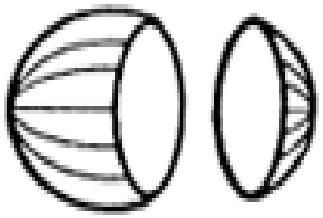
$$\text{Refractive power} = \frac{1}{\text{Focal length in meters}} = \text{diopters}$$

- The **power** (or strength) of lenses is measured in **diopters**
- e.g. the power of a lens having a focal length 0.1 meter = 1/ 0.1 = 10 diopters.

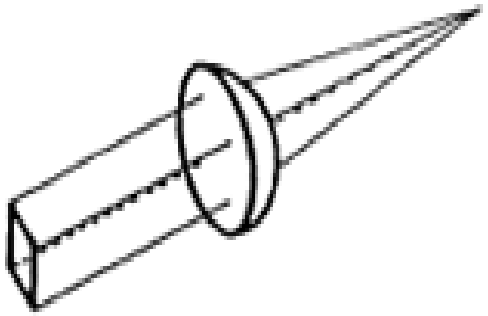
Types of Lenses

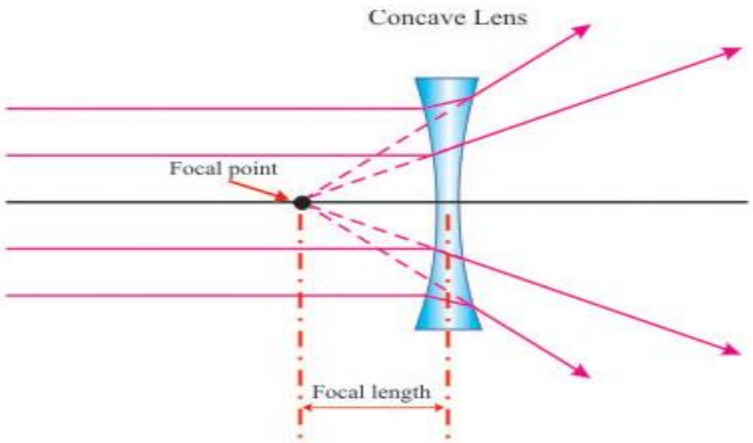
1. **Convex and concave** lenses
2. **Spherical and cylindrical** lenses

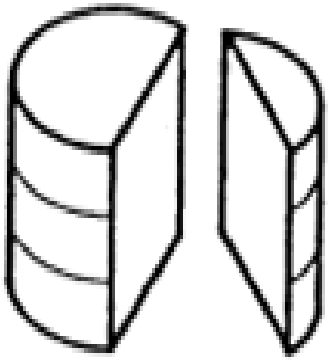




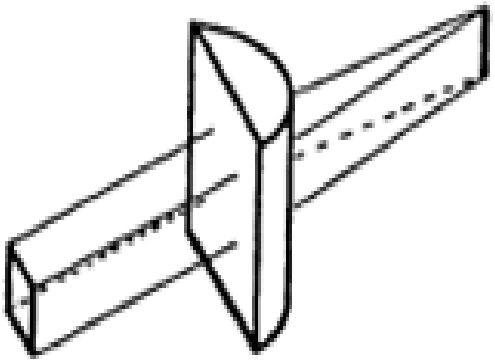
SPHERICAL



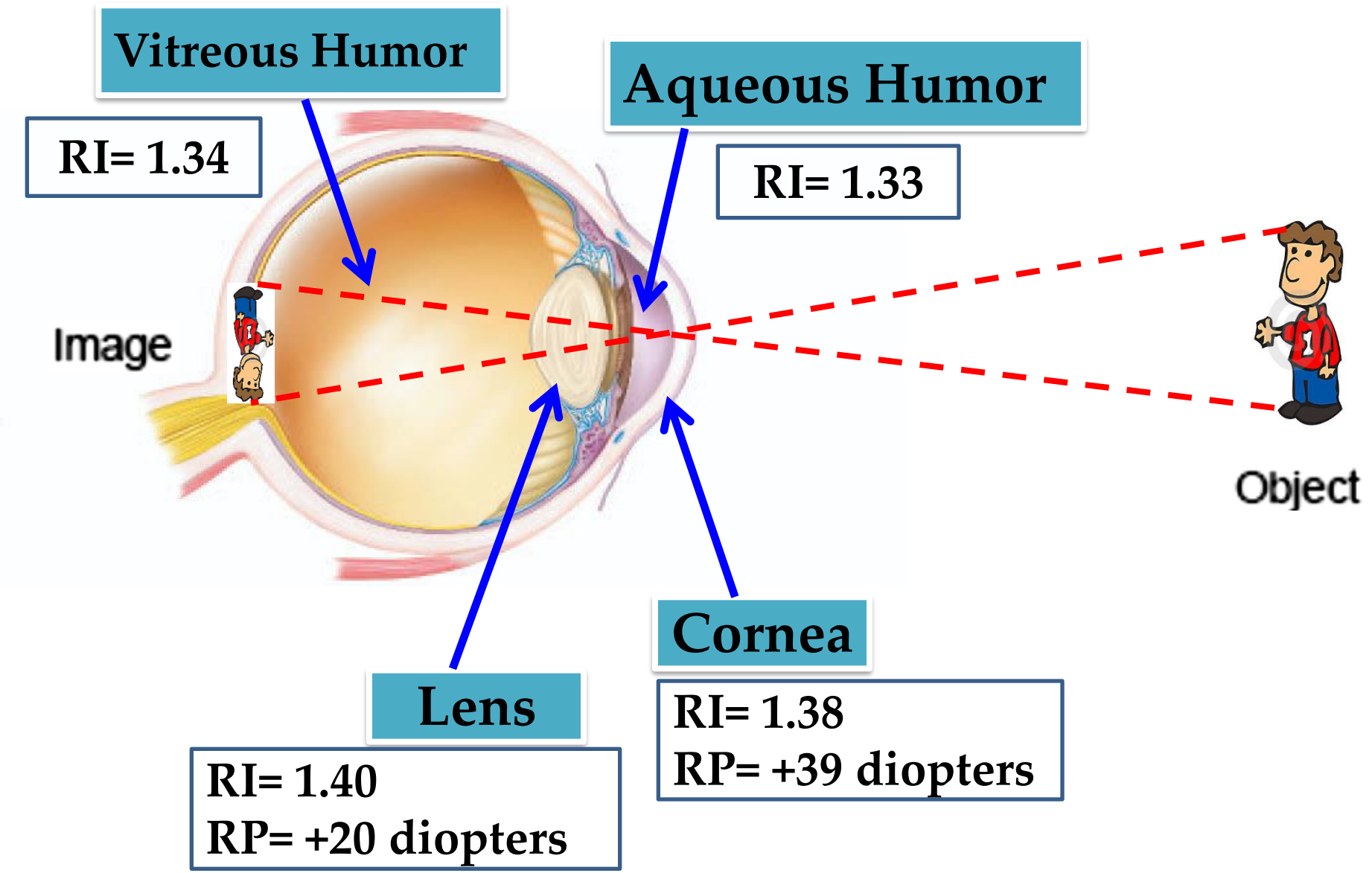




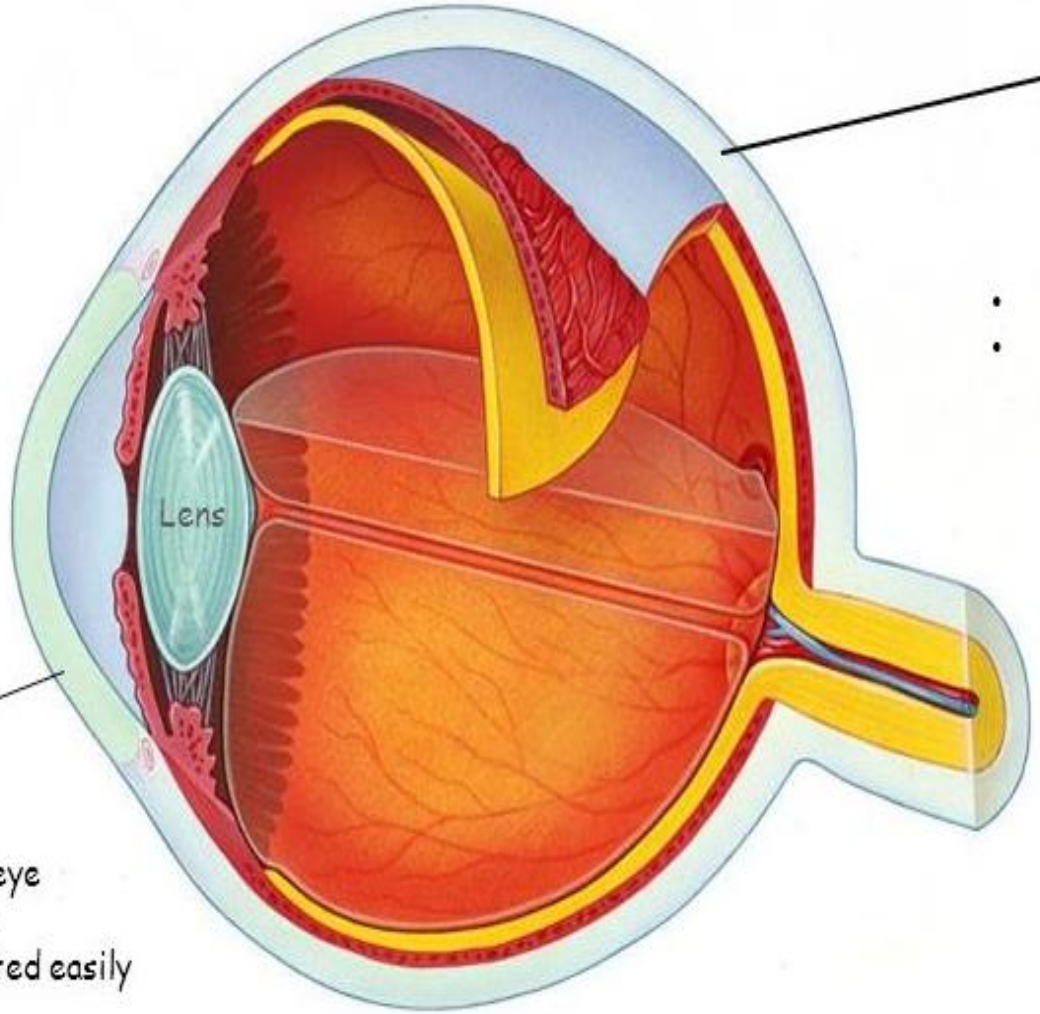
CYLINDRICAL



Refractive Media of the Eye



Outer Layer of the Eye



Sclera

(white of the eye)

- Protects the eye
- Attaches eye muscles

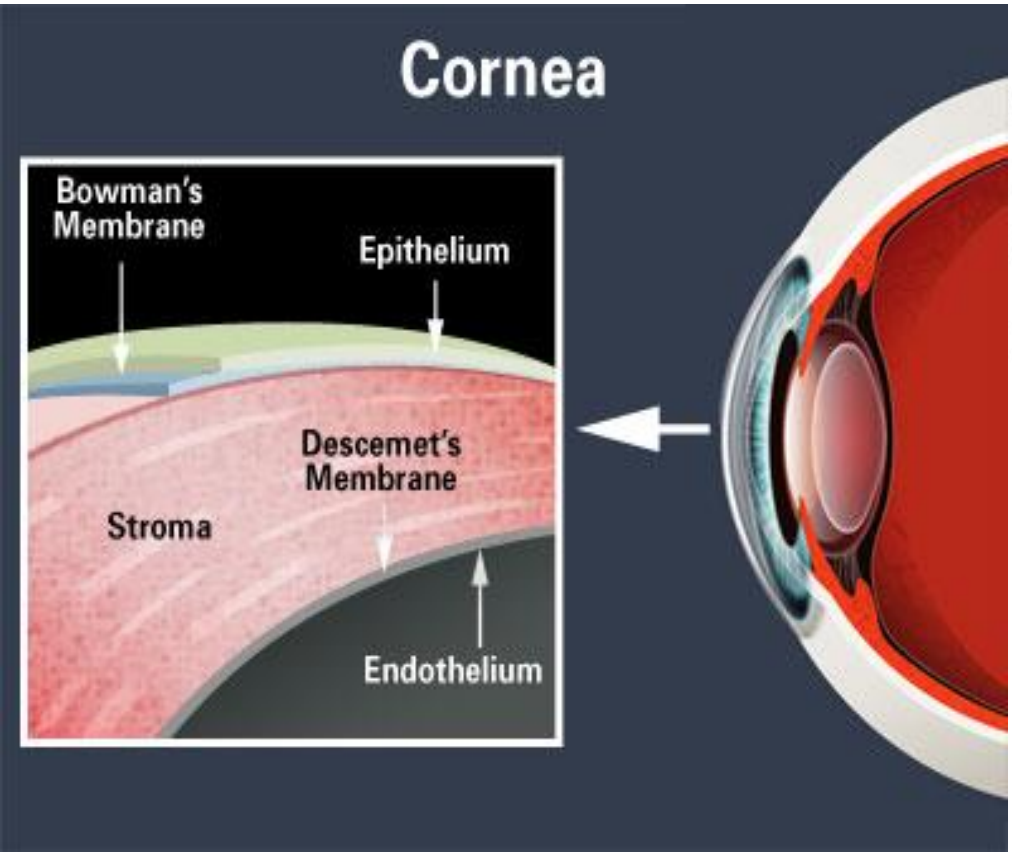
Cornea

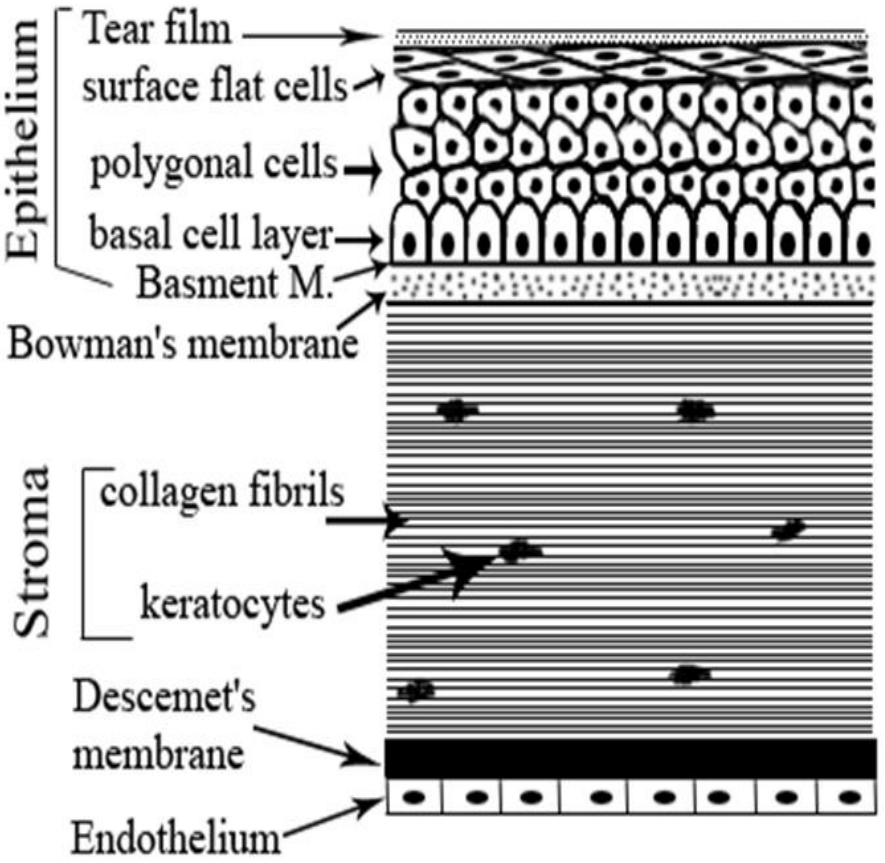
- Window
- Lets light enter eye
- No blood vessels
- Can be transplanted easily

Cornea

Histology

- The cornea is the **transparent** anterior **1/6** of outer coat of the eyeball.
- It is **11 mm** in diameter & **1.0 mm** in thickness.
- **5 layers;**





Cornea

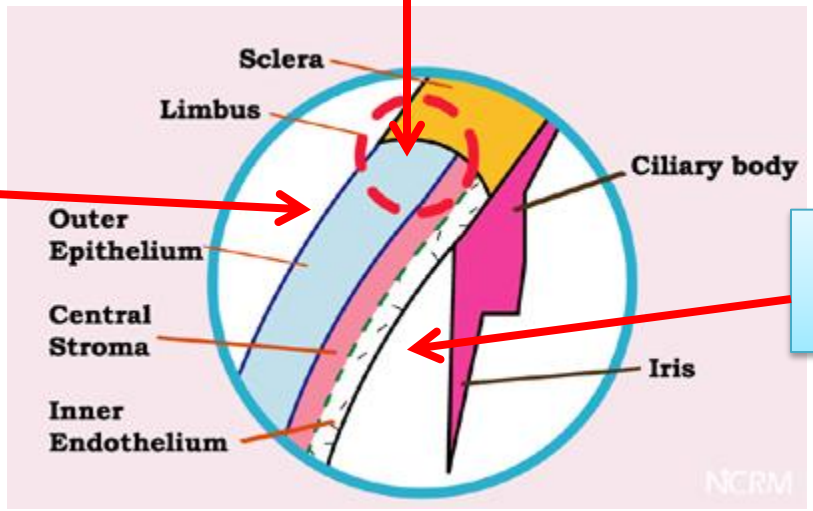
Corneal metabolism:

- **Maintains dehydration and transparency** of the cornea

Sources:

Corneo-scleral junction
(O2 and glucose)

Tears
O2



Aqueous humour
(glucose)

Cornea

Causes of transparent cornea:

Anatomic factors

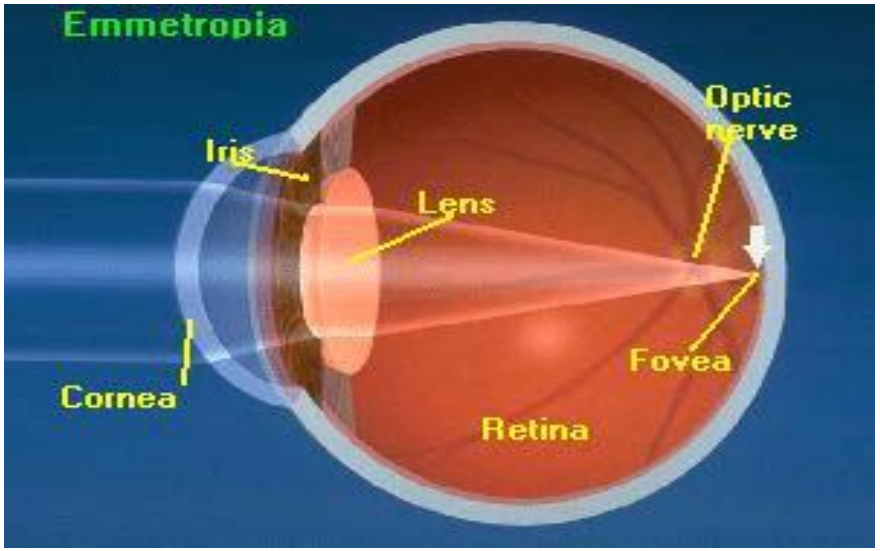
1. **Regular** & uniform **arrangement** of the **epithelial cells** & **lamellae.**
2. **Absence** of **blood vessels** & **myelinated nerve** fibers

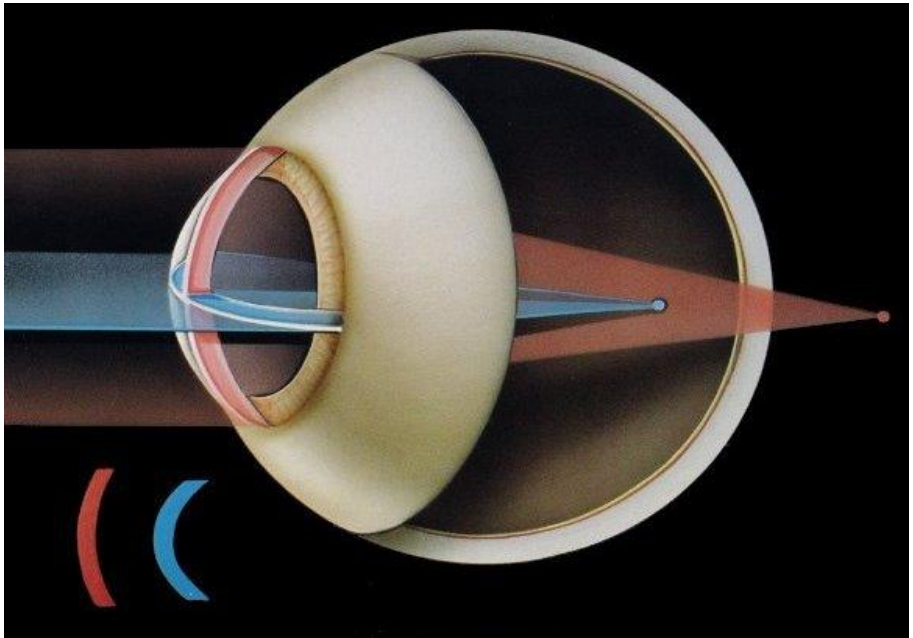
Physical factors

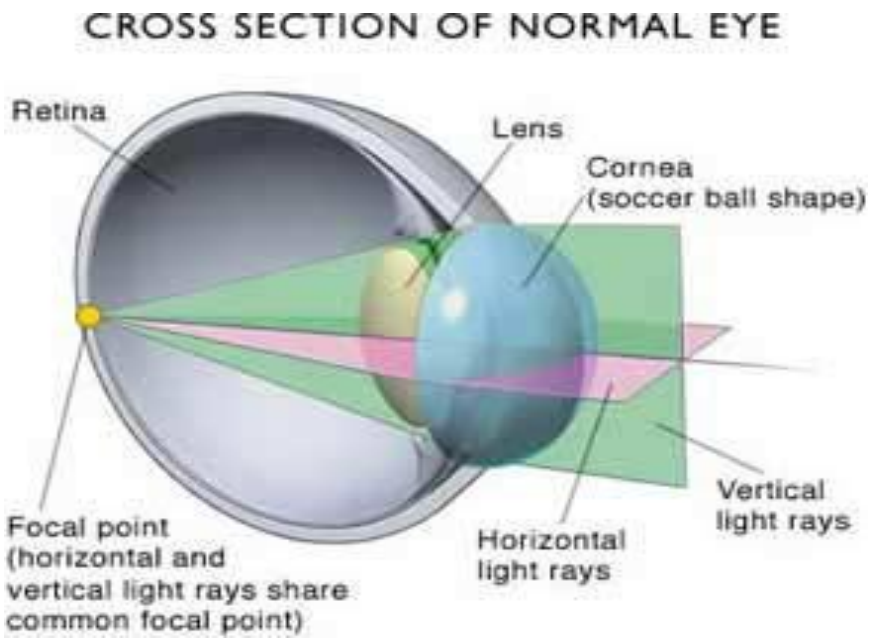
1. The **refractive index** of various layers of cornea is the **same**.
2. Relative **corneal dehydration** by **osmotic pump** and **metabolic pump mainly in the endothelial cells.**
   - **Osmotic pump**: The **aqueous humor & tears are hypertonic** relative to corneal tissue, so they draw water from the cornea.
   - **Metabolic pump** (Na+ pump in endothelium) is an **active process** using energy produced by corneal metabolism. It **pumps Na+ from the cornea** to aqueous humor followed with water.

Functions of the cornea

1. It is **transparent** structure allowing the **passage of light** rays into the eye.
2. The **regular curvature** of the corneal surface helps the formation of **sharp clear images** on the retina.

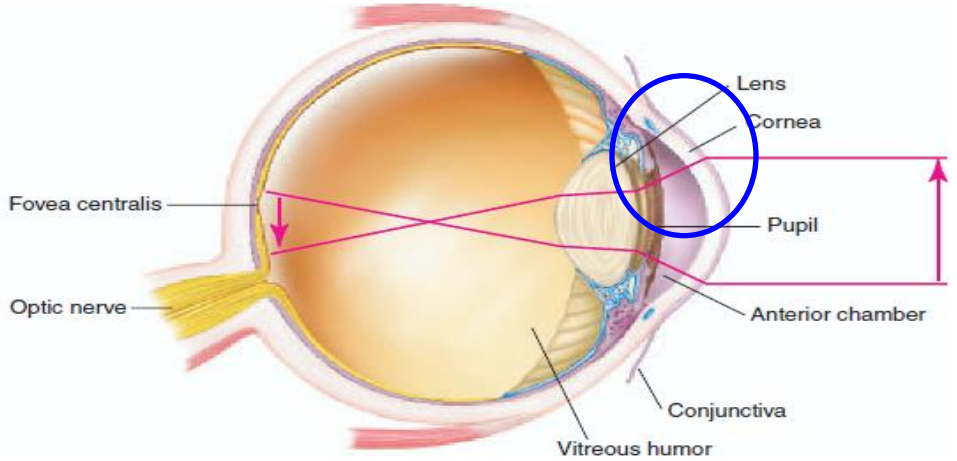






Functions of the cornea

3. It acts as a **powerful convex lens (+ 39- 43 diopters)** having 70% of total diopteric power of the eye



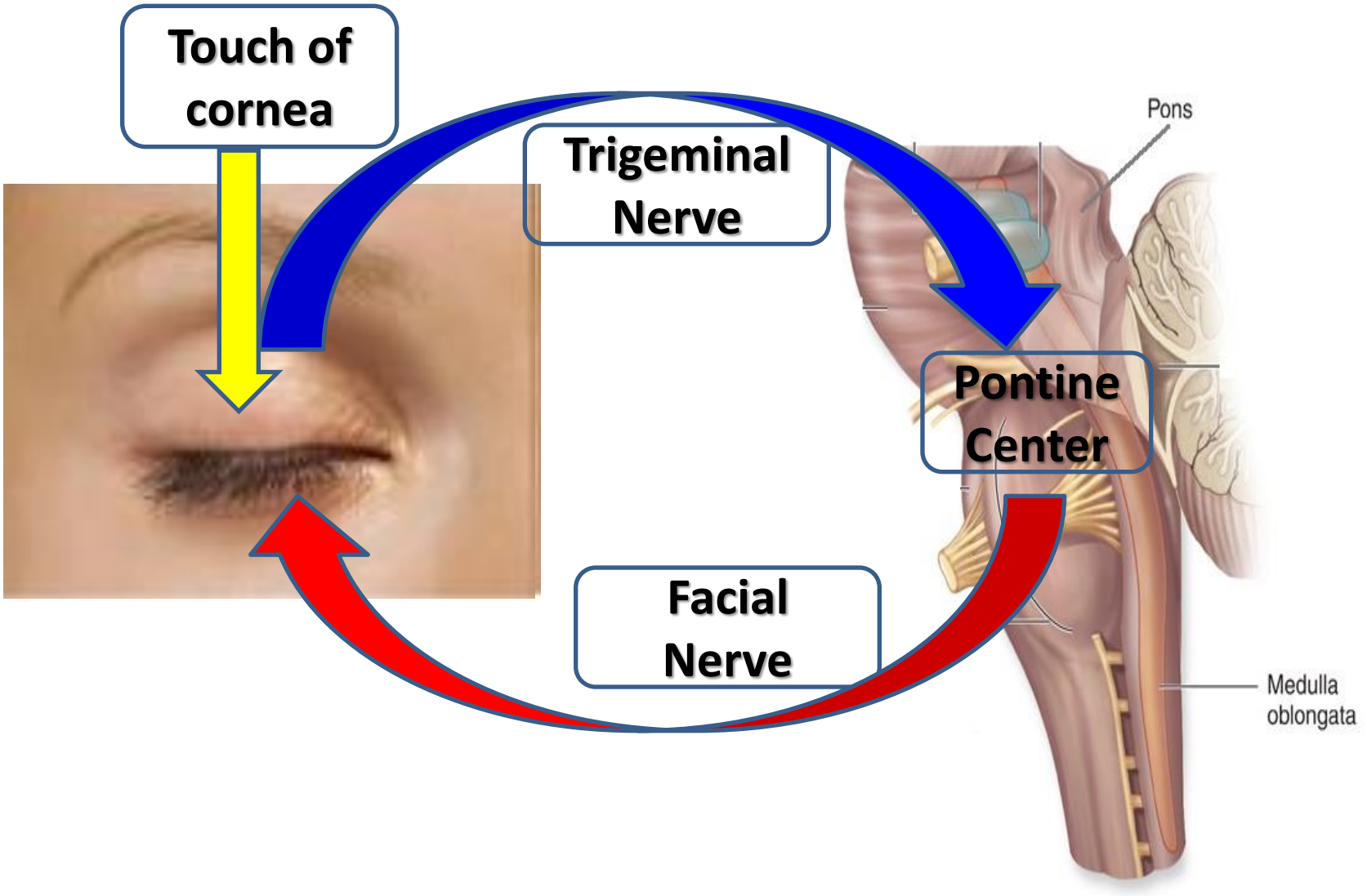
4. Protection of inner structures of the eyeball by

a. Its **fibrous structure**

b. It **absorbs ultraviolet rays** that fall on the eye (protect the retina)

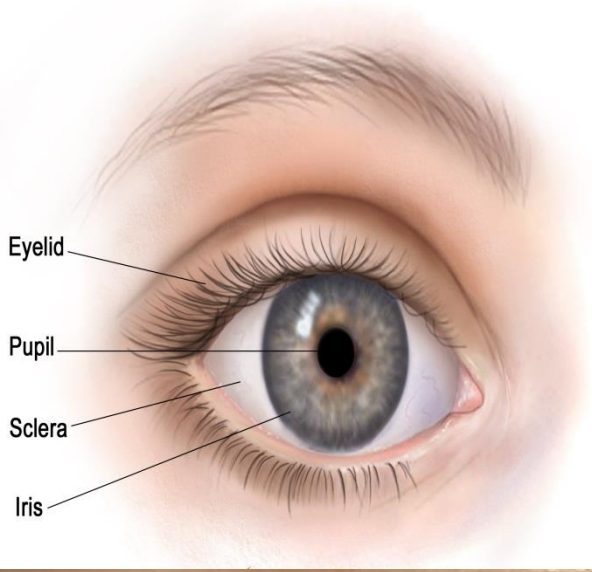
c. The **corneal reflex** (touch of the cornea by any foreign body e.g. piece of cotton results in reflex blinking of both eyes)

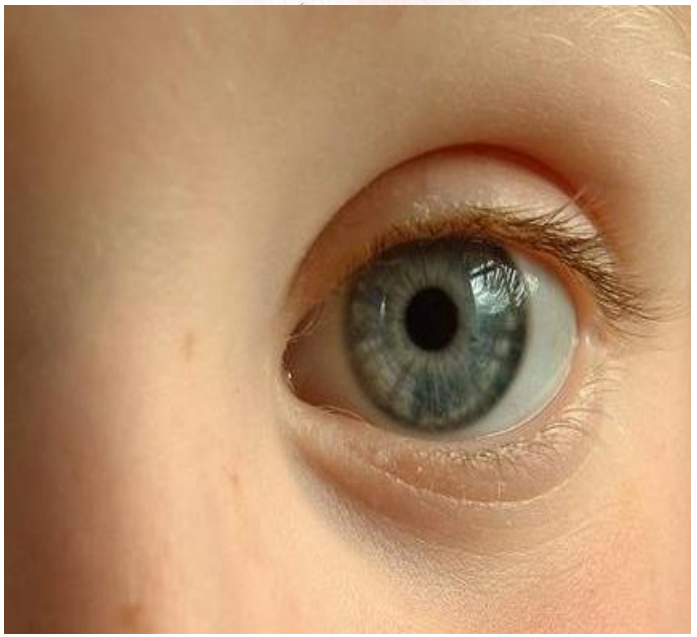
Corneal reflex



The Sclera

- **Constitutes** the posterior **opaque 5/6** of the outer coat of the eye.
- Covered anteriorly by the **conjunctiva**.
- Normally, it is **whitish** in adults & **bluish** in infants & young children.
- It is **opaque** due to marked **irregularity** of its fibres

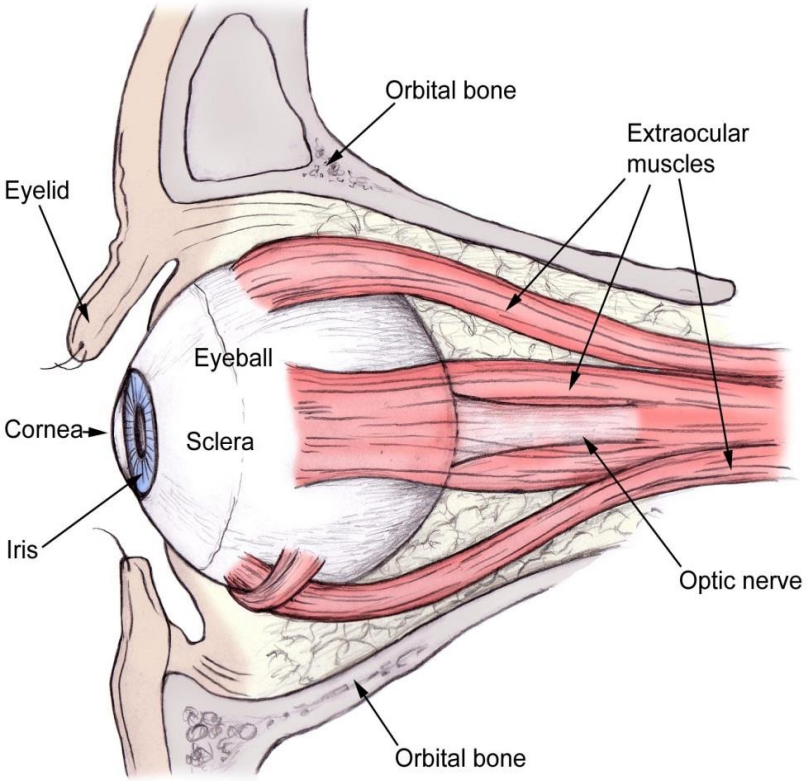




The Sclera

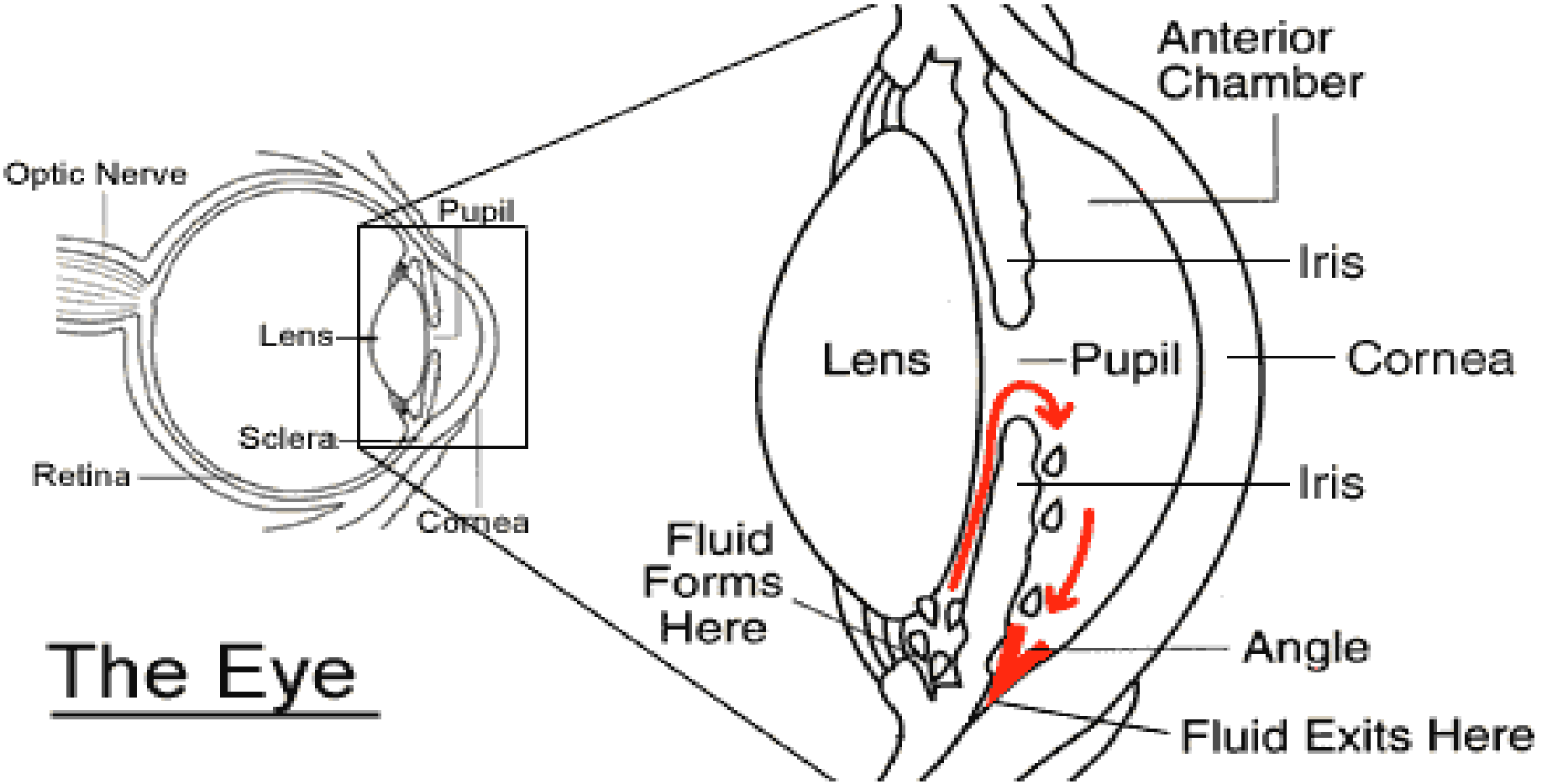
- **Functions of Sclera:**

1. It **protects** the delicate inner eye structures
2. It gives **attachment** to the external **ocular muscles**.



The Aqueous Humour

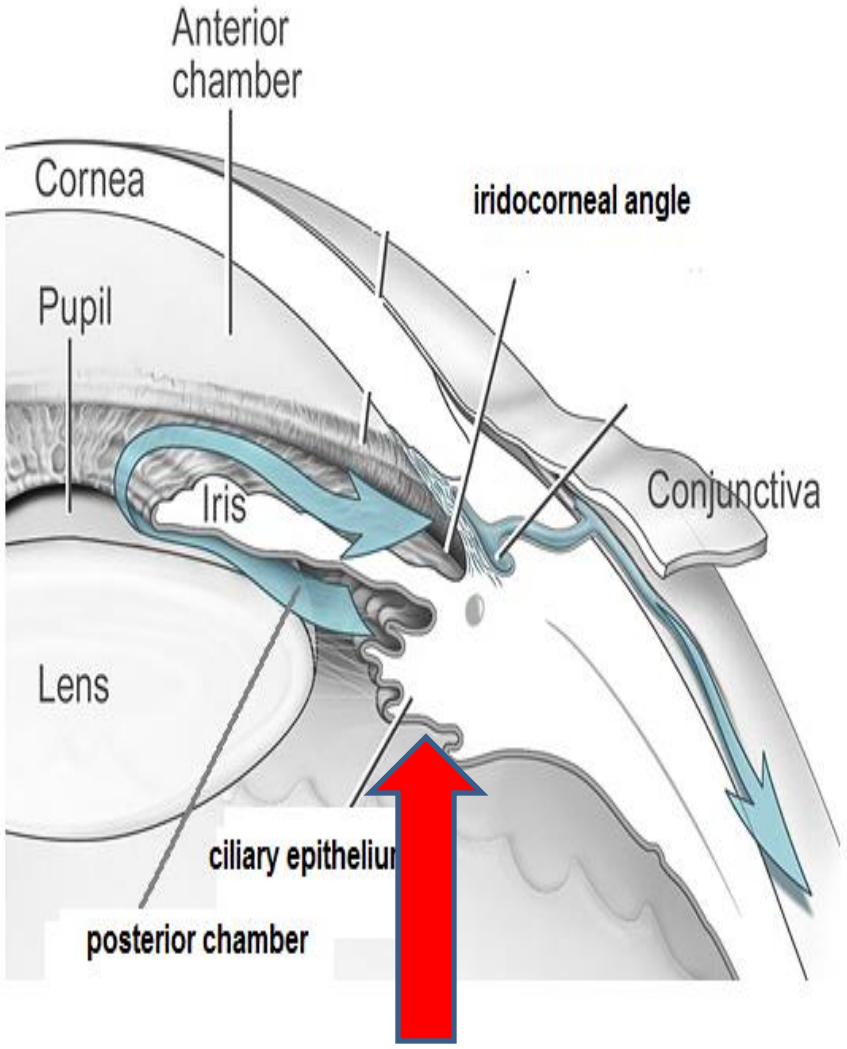
- Transparent colorless **alkaline?? fluid**
- **Fills** the **anterior** and **posterior chambers** of the eye



The Aqueous Humour

Mechanism of formation

- **Formed** continuously by the **Ciliary epithelium by facilitated diffusion** and **active transport** mechanisms
- **Na** by active transport
- **Cl and HCO_3 ?? and H2O** follow Na passively



Rate

- At a rate **1-2 µL/min**

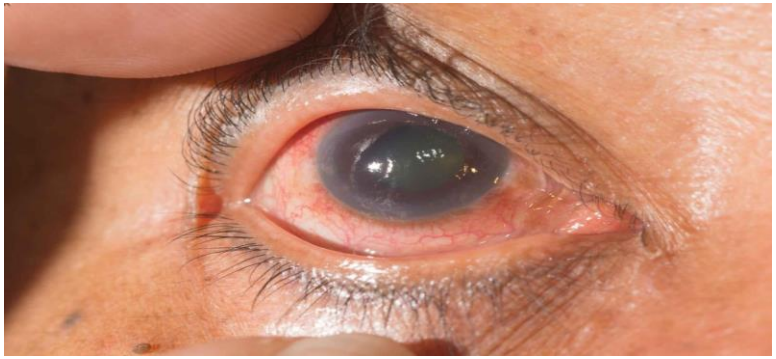
The Aqueous Humour

Functions:

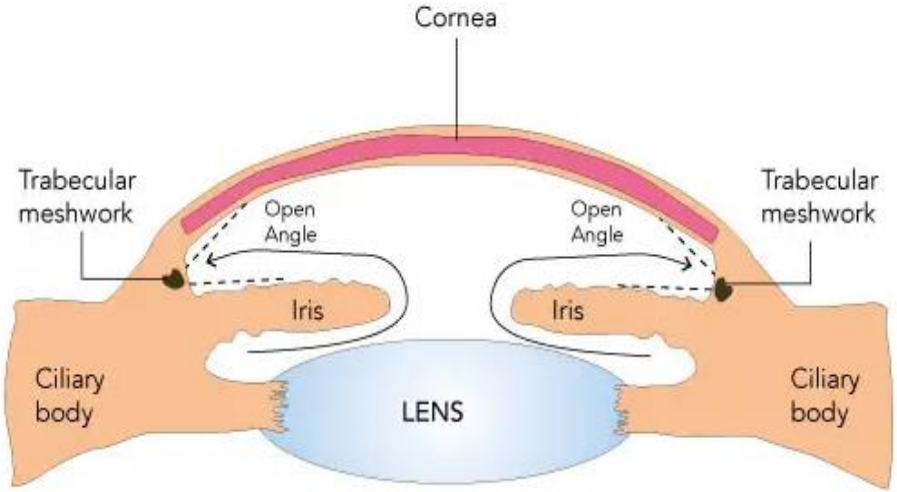
1. One of the important refractive media of the eye
2. Nourishes the avascular cornea and lens.
3. Buffers the acid produced by the anaerobic metabolism of the cornea and lens.
4. Has a mechanical function to keep the eyes rigid and to maintain its refractory power.
5. Maintains the intraocular pressure (12 - 20 mmHg) constant by means of its steady formation and drainage

Glucoma

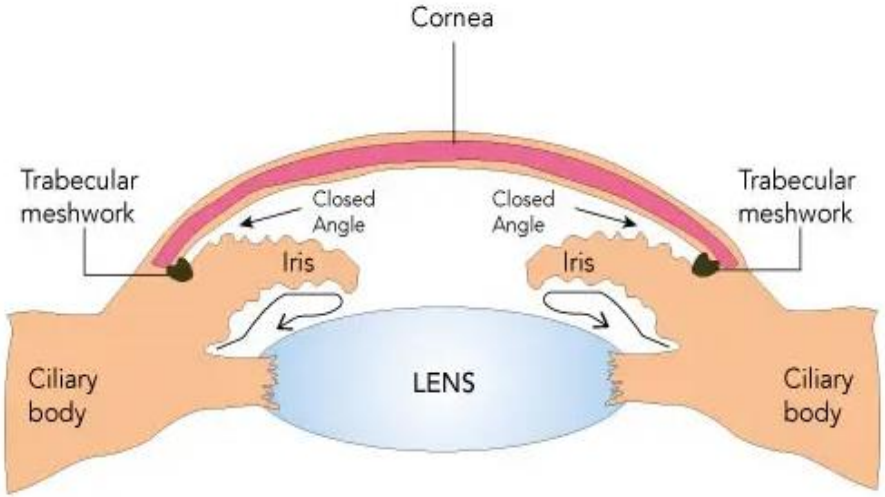
- It is **high Intraocular Pressure** and is a Principal Cause of Blindness



TYPES OF GLAUCOMA

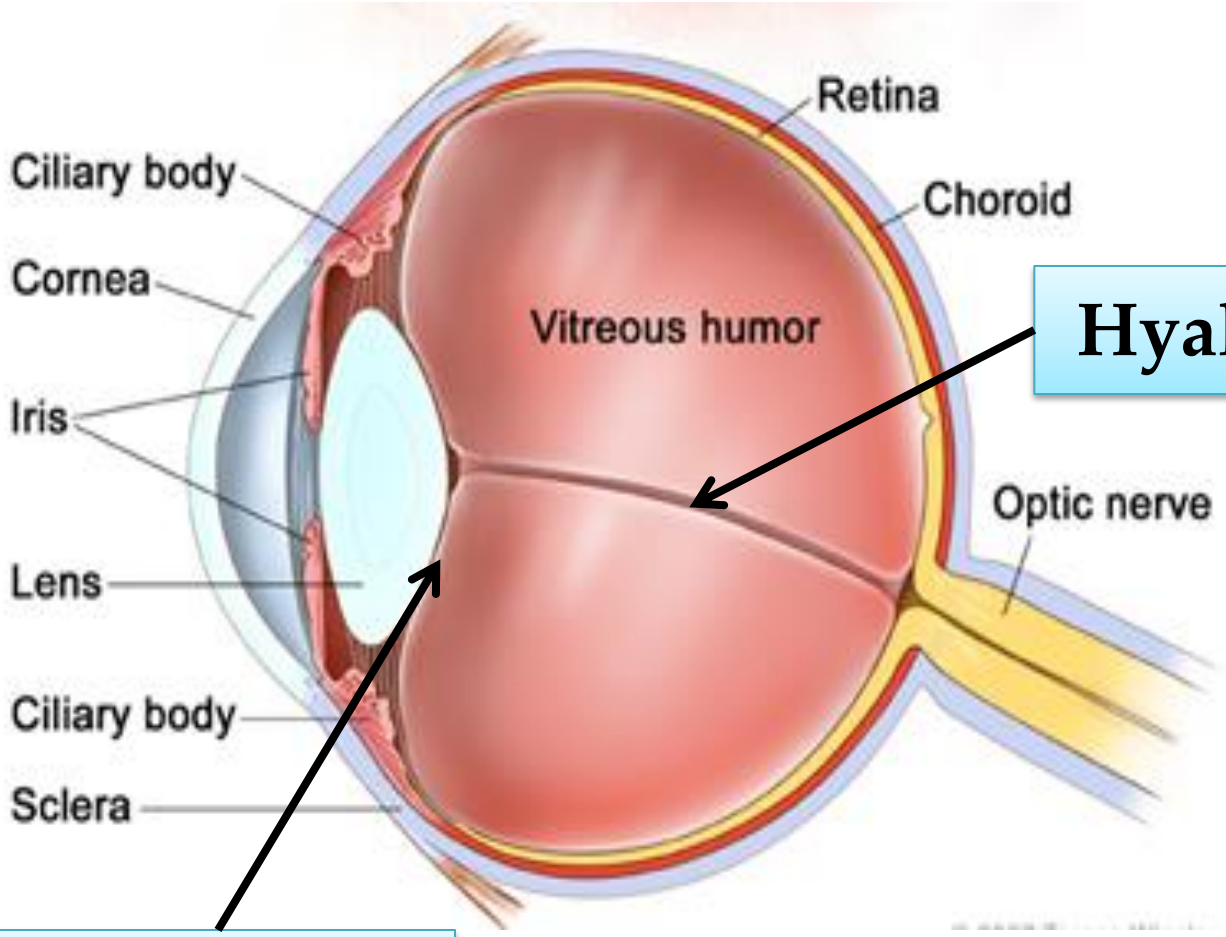


Open-Angle Glaucoma



Angle-Closure Glaucoma

Vitreous Body



Hyaloid canal

Retrolental space

Vitreous Body

Functions

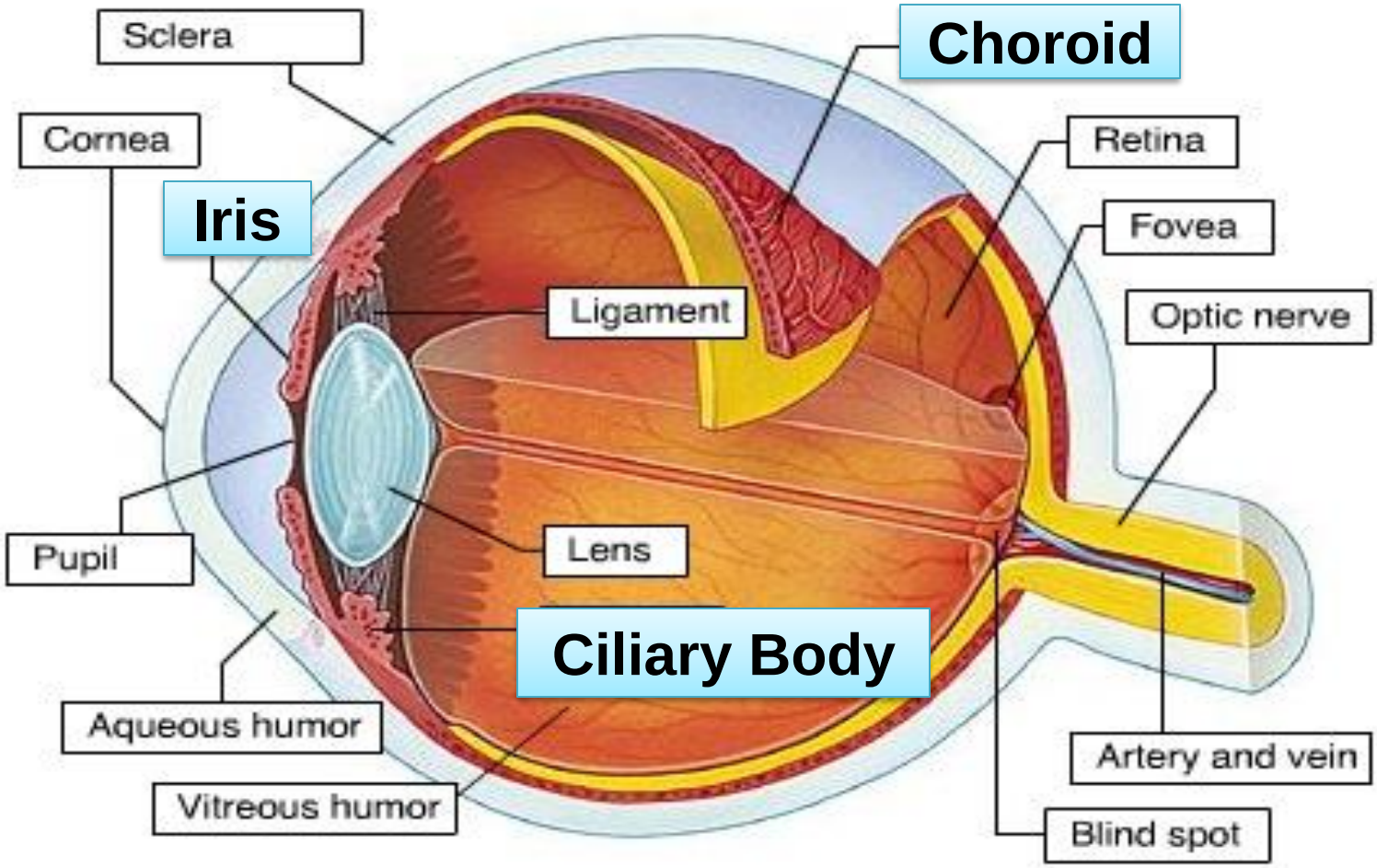
1-One of the refractive media of the eye.

2- Supports the retina

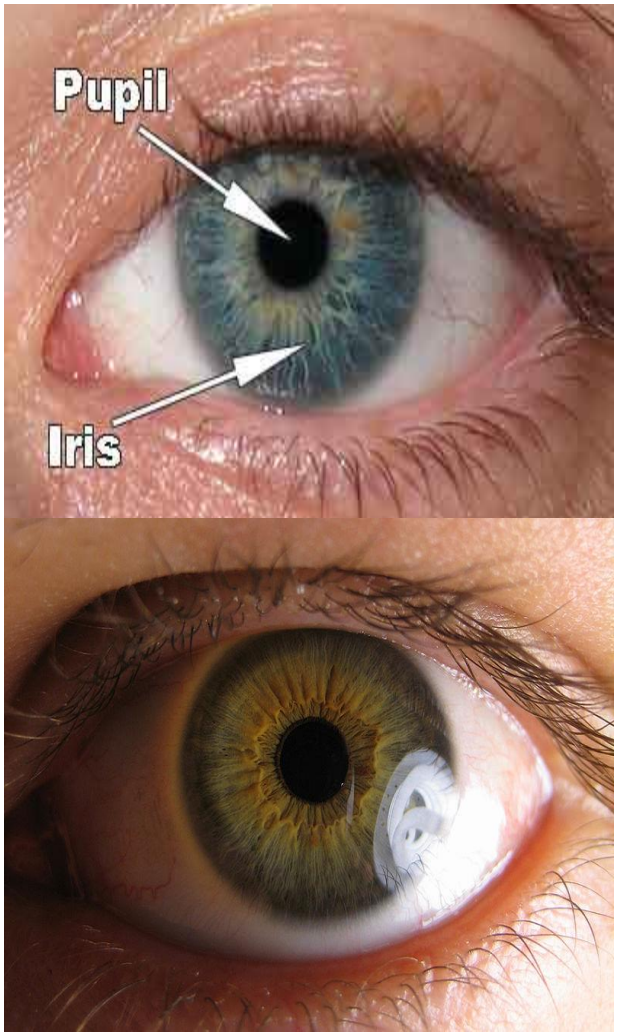
3- Supports the crystalline lens and prevents it from falling back

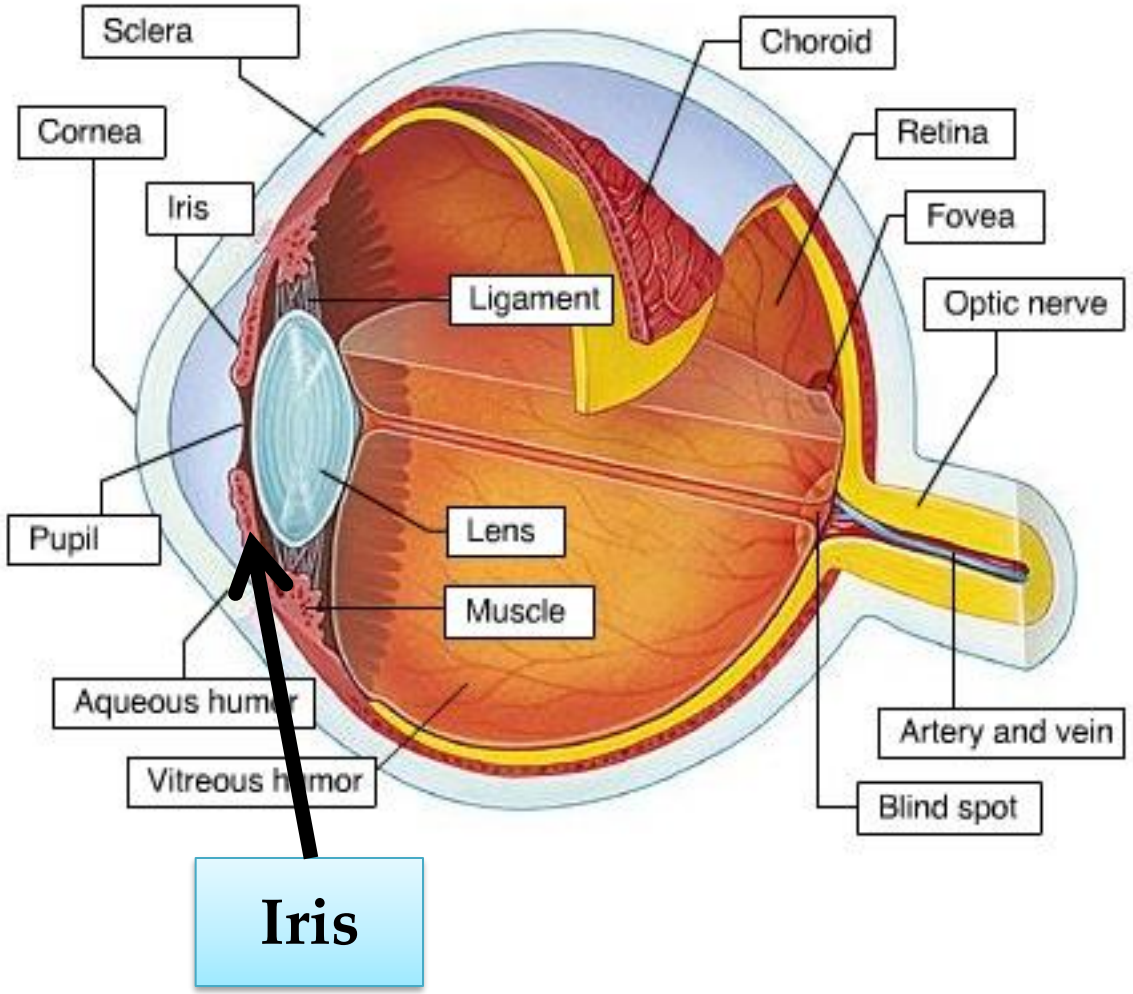
4- Maintains the spherical shape of the eye

Uveal Tract


Sclera
Choroid
Cornea
Retina
Iris
Fovea
Ligament
Optic nerve
Pupil
Lens
Ciliary Body
Aqueous humor
Artery and vein
Vitreous humor
Blind spot

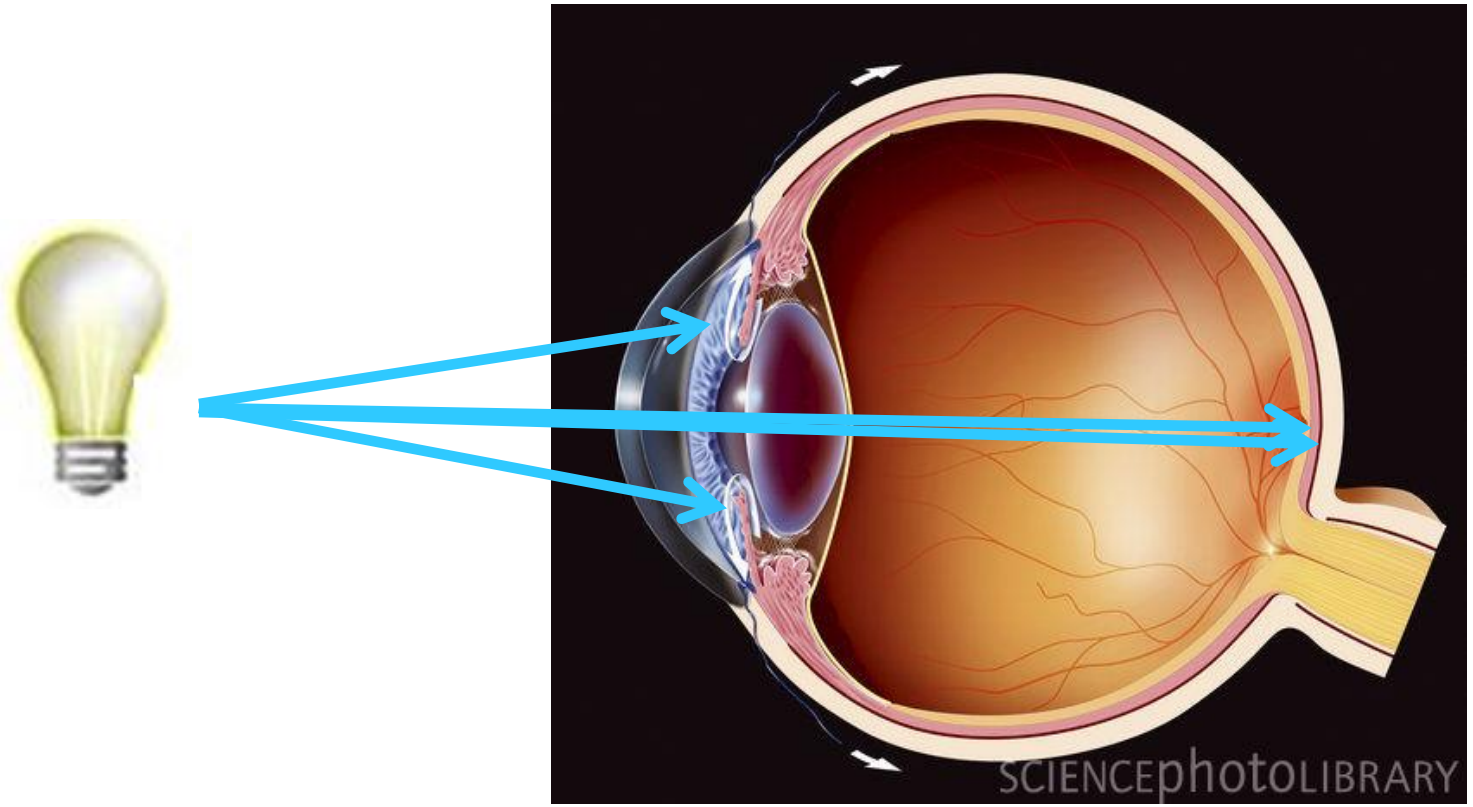
The Iris


Pupil
Iris


Sclera
Choroid
Cornea
Retina
Iris
Fovea
Ligament
Optic nerve
Pupil
Lens
Muscle
Aqueous humor
Artery and vein
Vitreous humor
Blind spot
Iris

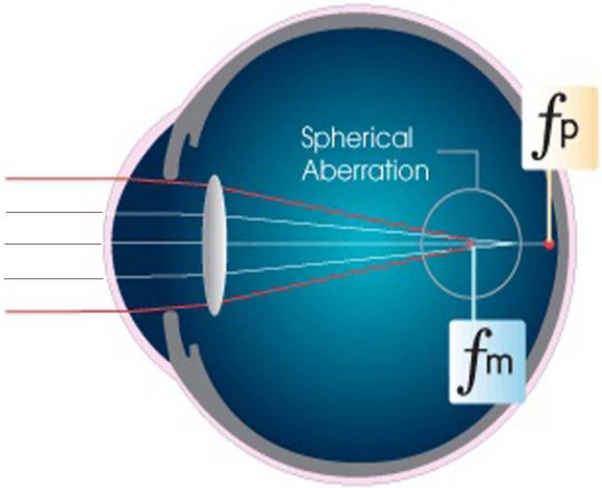
Functions of the Iris

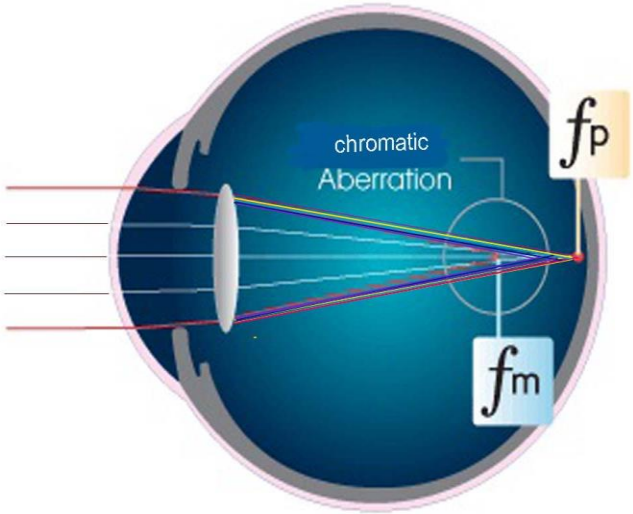
1. Pigments of **iris** **absorb** all light rays which enter into the eye except though which **pass** through the **pupil**.

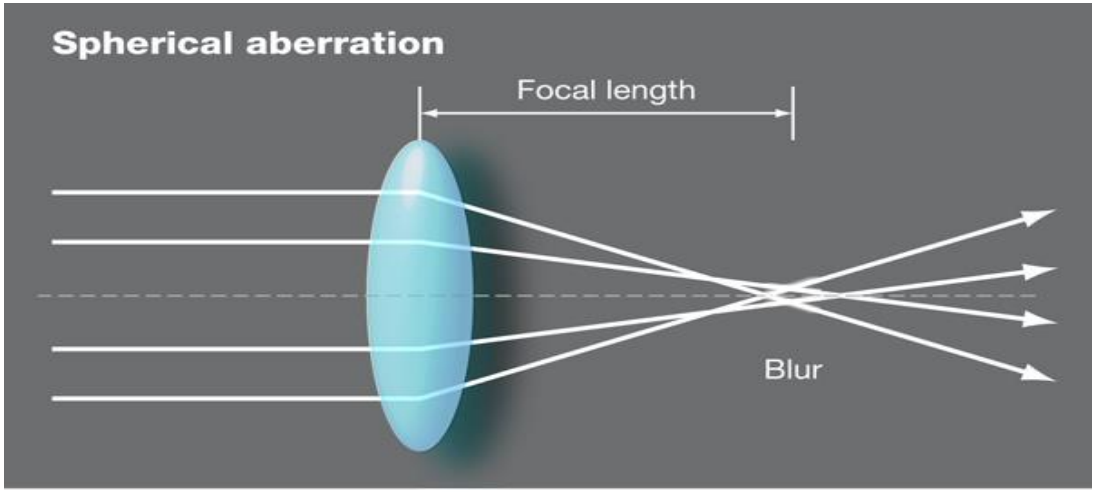


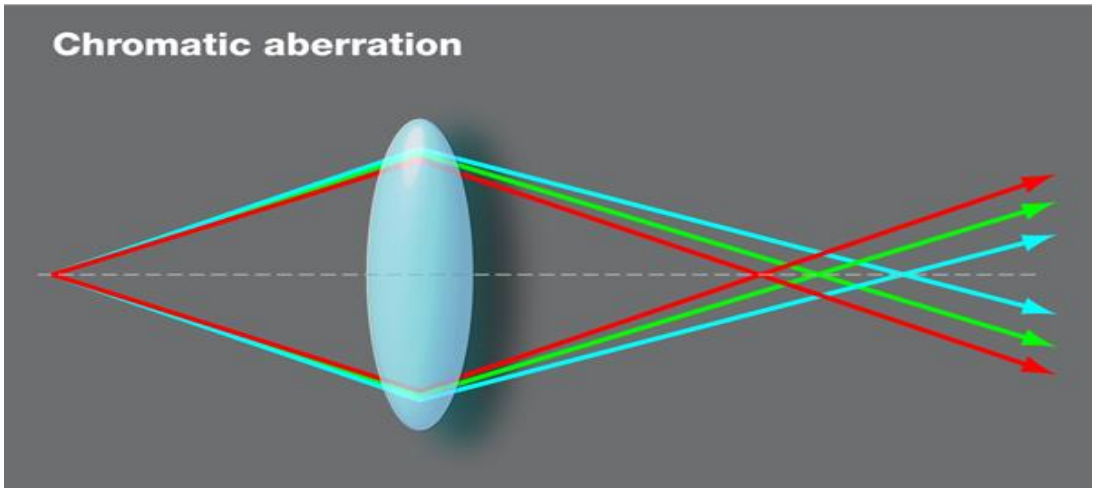
Functions of the Iris

2. **Prevents** light from falling on the peripheral parts of the lens. Thus, it prevents **spherical and chromatic aberration.**



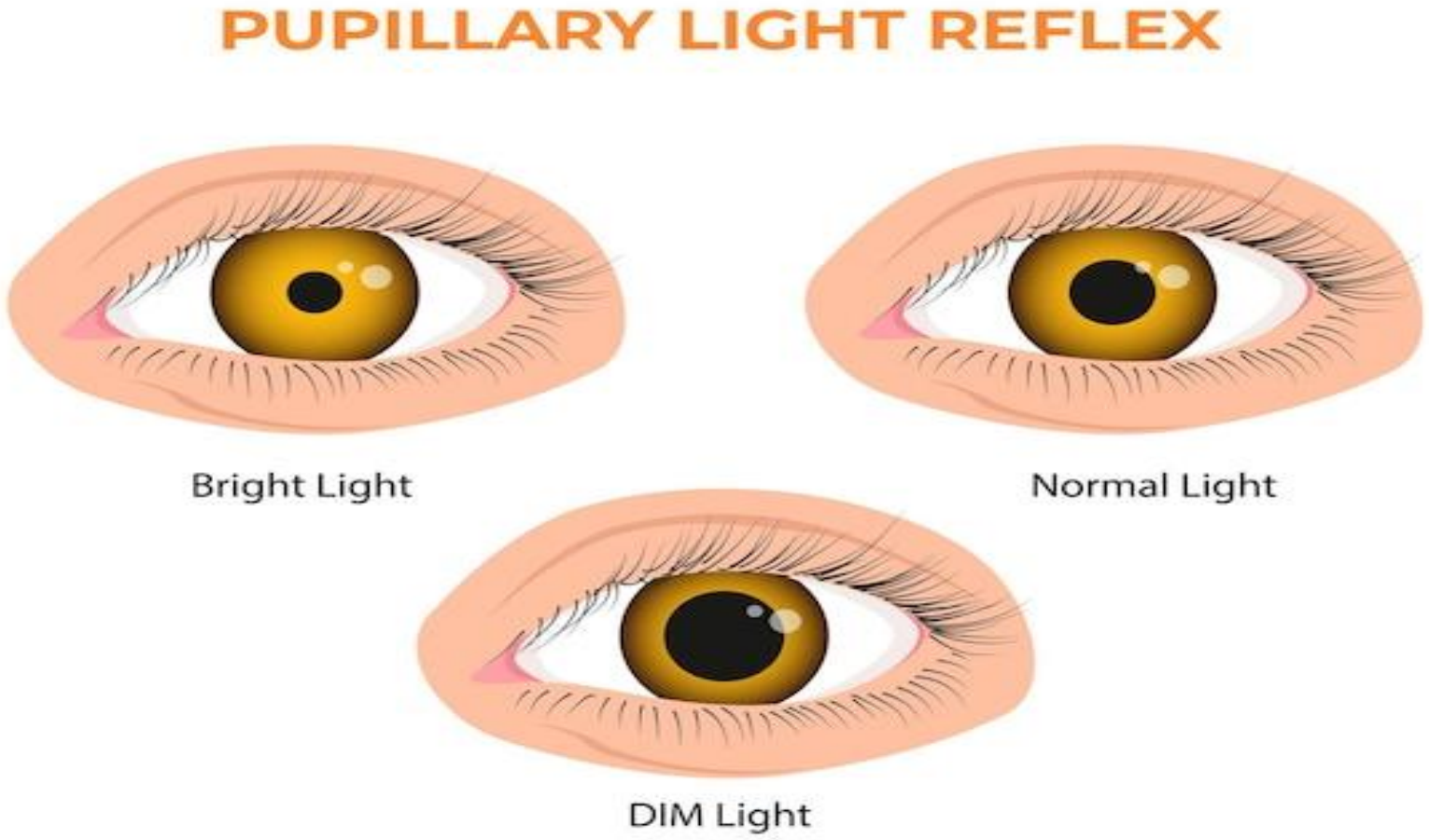






Functions of the Iris

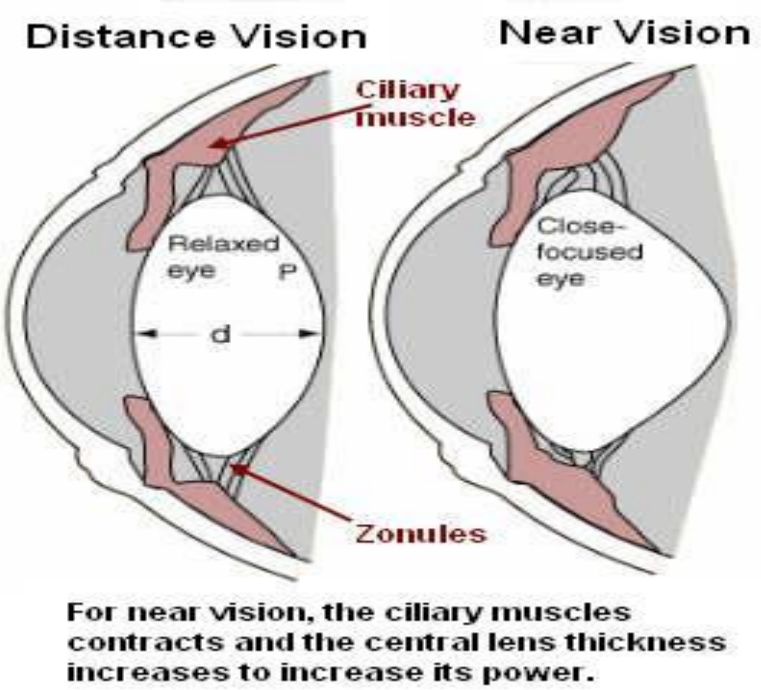
3. **Regulates** the **amount of light** which enters the eye by **regulating the size** of the pupil **(pupillary light reflex).**



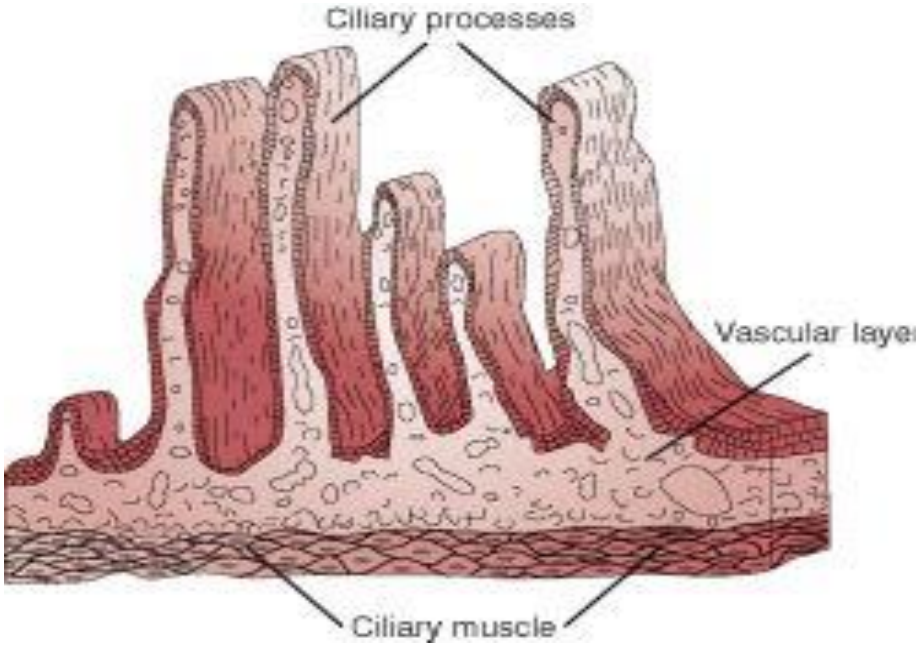
Functions of the Ciliary Body

1. **Ciliary muscle** is essential for **accommodation**

2. **Ciliary processes** **secrete the aqueous humor** into the posterior chamber & **give attachment to the suspensory ligament** of the lens.



For near vision, the ciliary muscles contracts and the central lens thickness increases to increase its power.

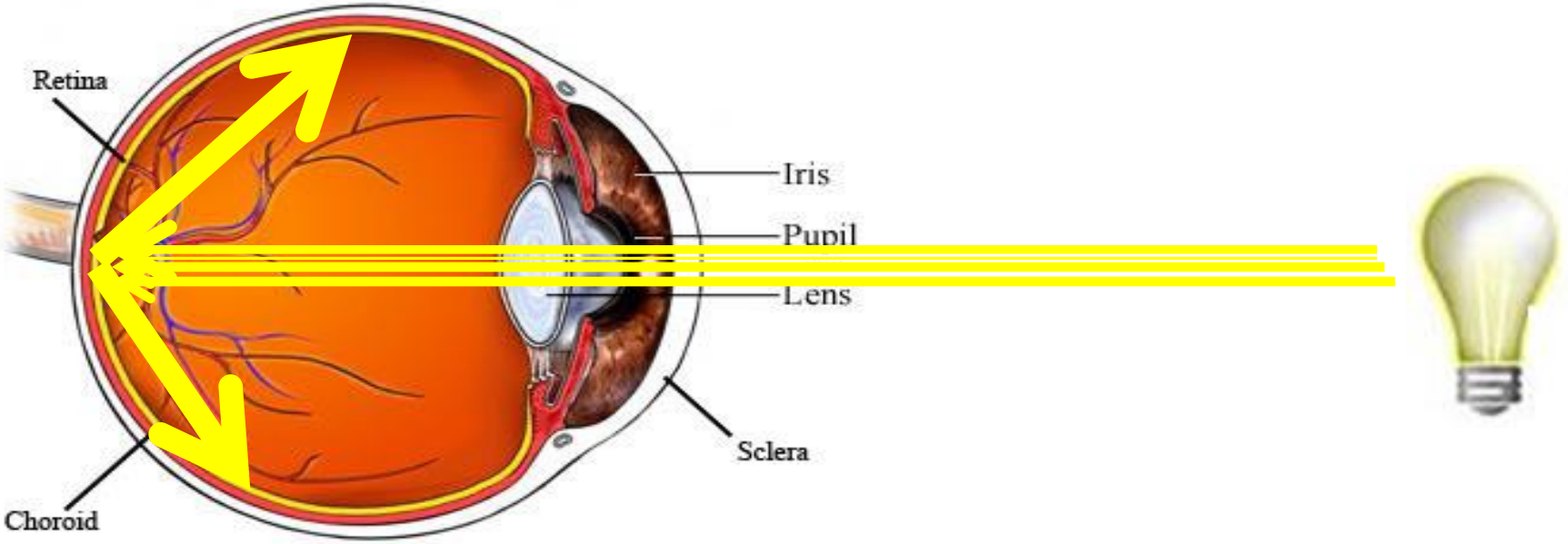


Functions of the Choroid

1. **provides blood supply** to the eye

2. **Pressure** inside its **vessels** **maintains** the **intraocular pressure**

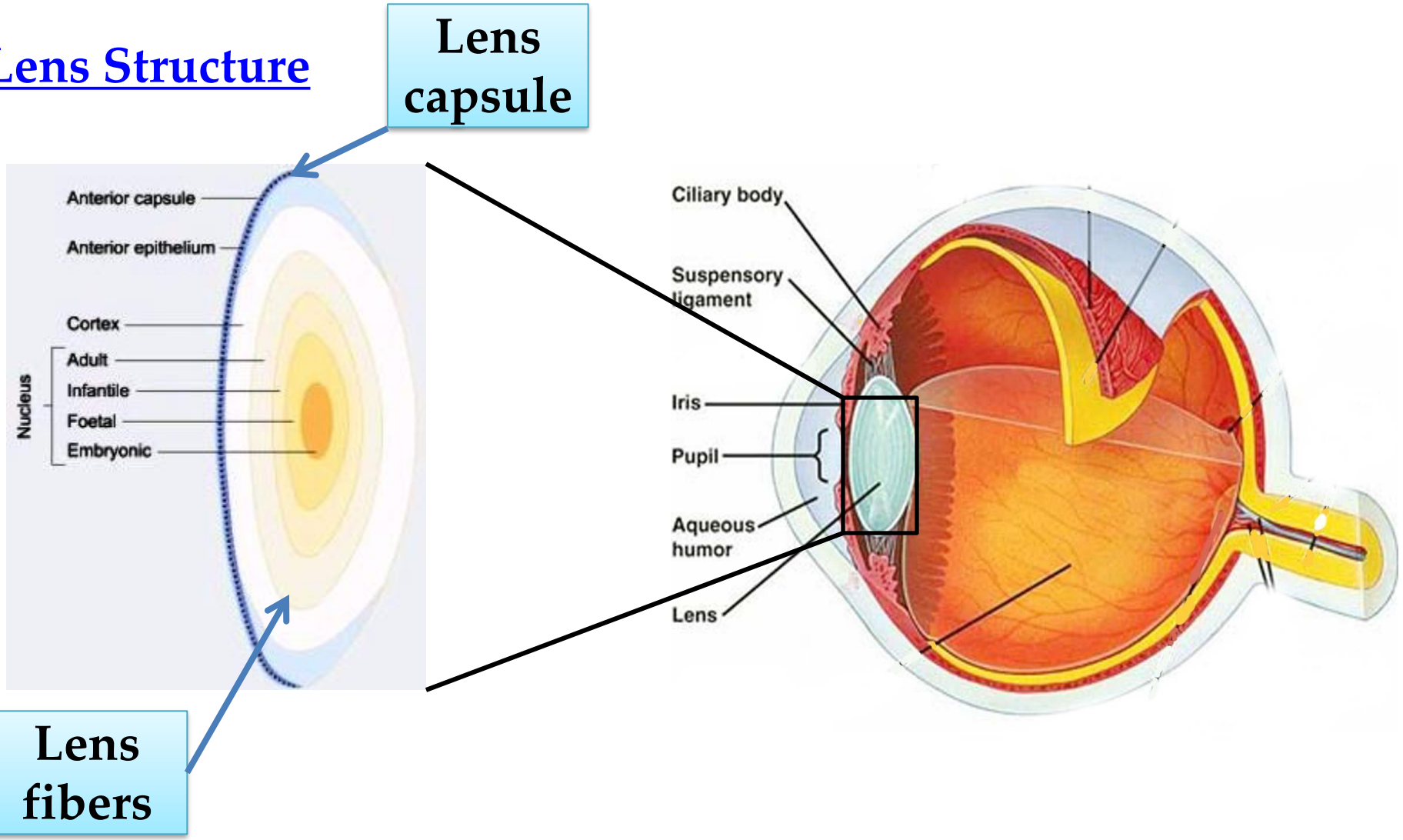
3. Contains **melanin pigments** which **absorb light** & prevent its reflection inside the eye which cause **blurring of vision**



The Crystalline Lens

- It is **avascular, transparent** biconvex elastic structure

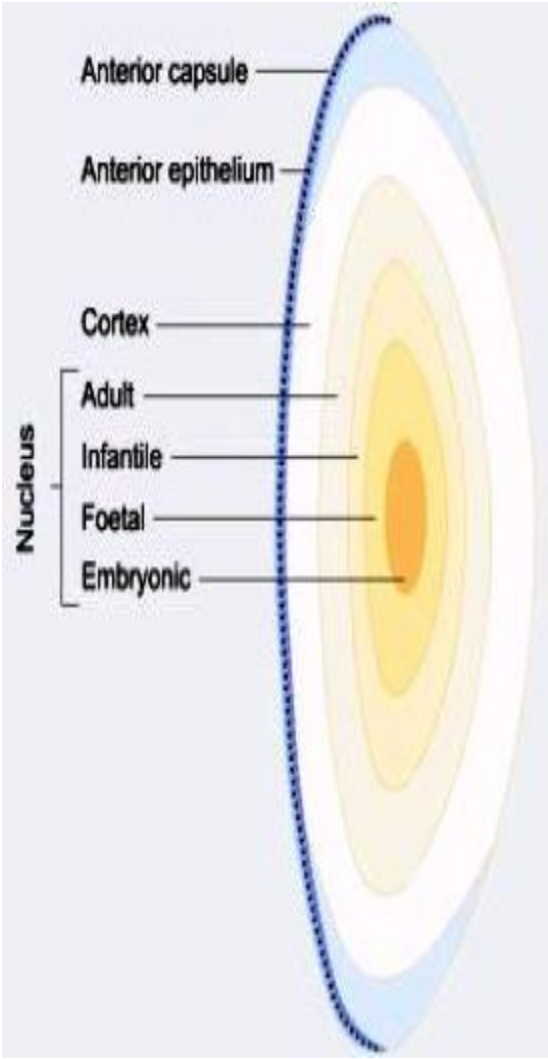
Lens Structure



The Crystalline Lens

Lens transparency

- Uniform arrangement of lens fibres
- Absence of blood vessels
- Dehydration maintained by an active process
- Constancy of its chemical composition
- The refractive indices of the various materials in the lens are nearly equal



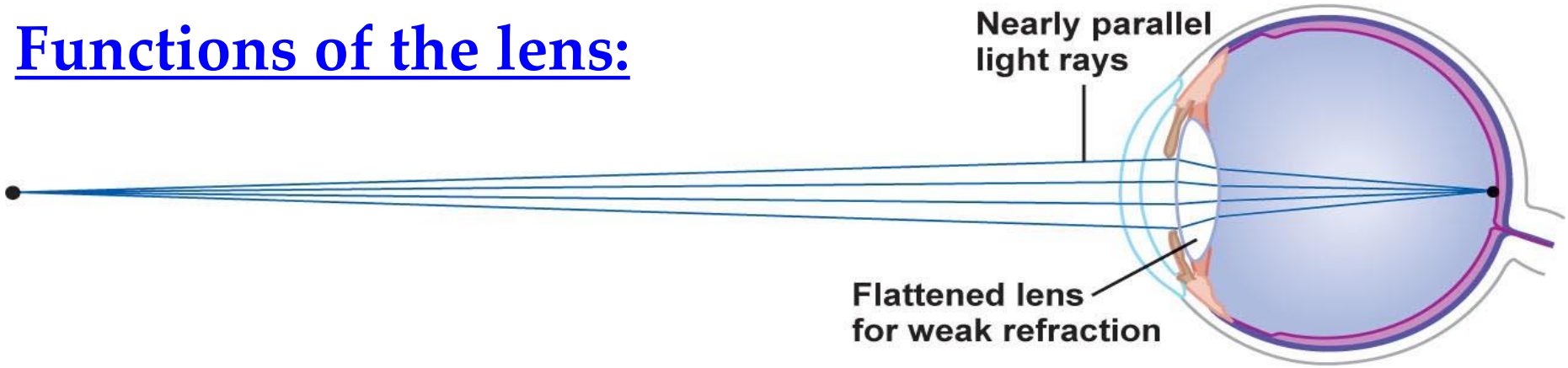
The Crystalline Lens

Functions of the lens:

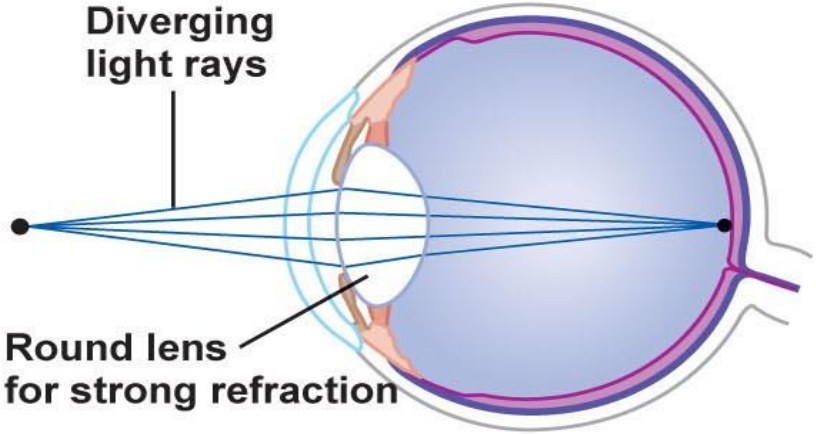
- Provides about 30% of the total diopteric power of the eye. Its R.I. is 1.4
- Protects the retina by absorbing ultraviolet waves
- **Accommodation to near vision**: the lens enables the eye to see far and near objects clearly by the mechanism of accommodation that changes its power from 20 to 32 D

The Crystalline Lens

Functions of the lens:



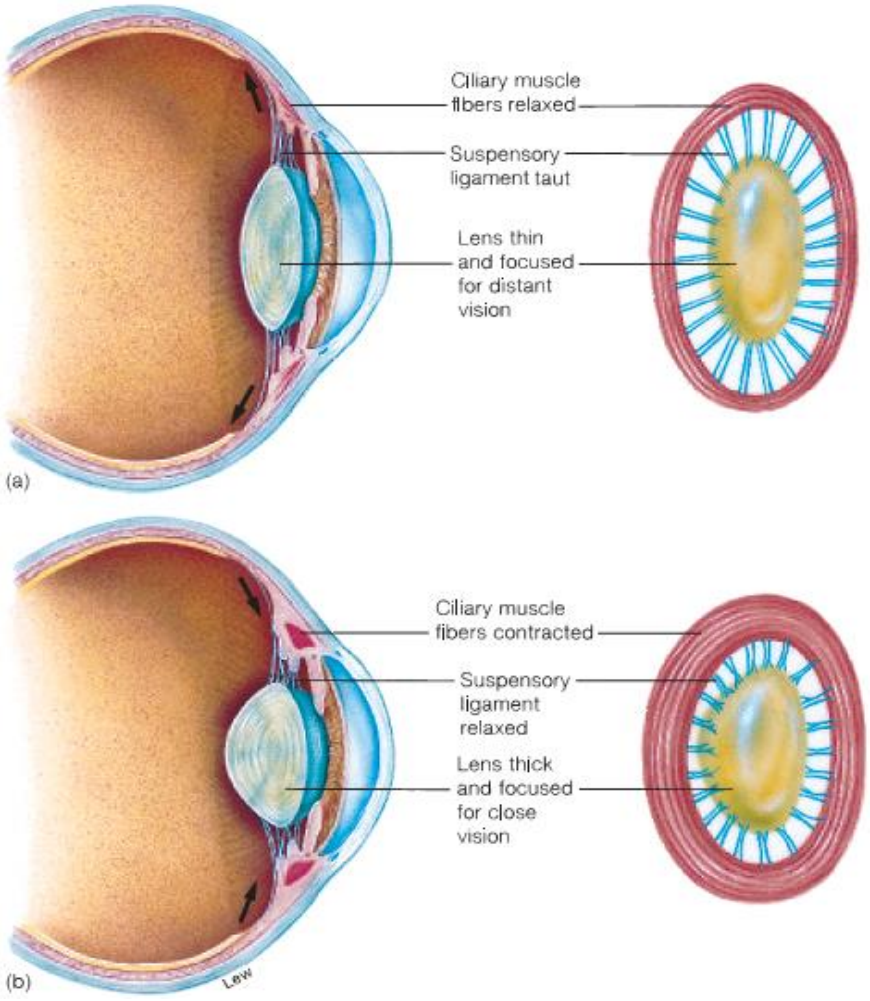
(a) Viewing a distant object

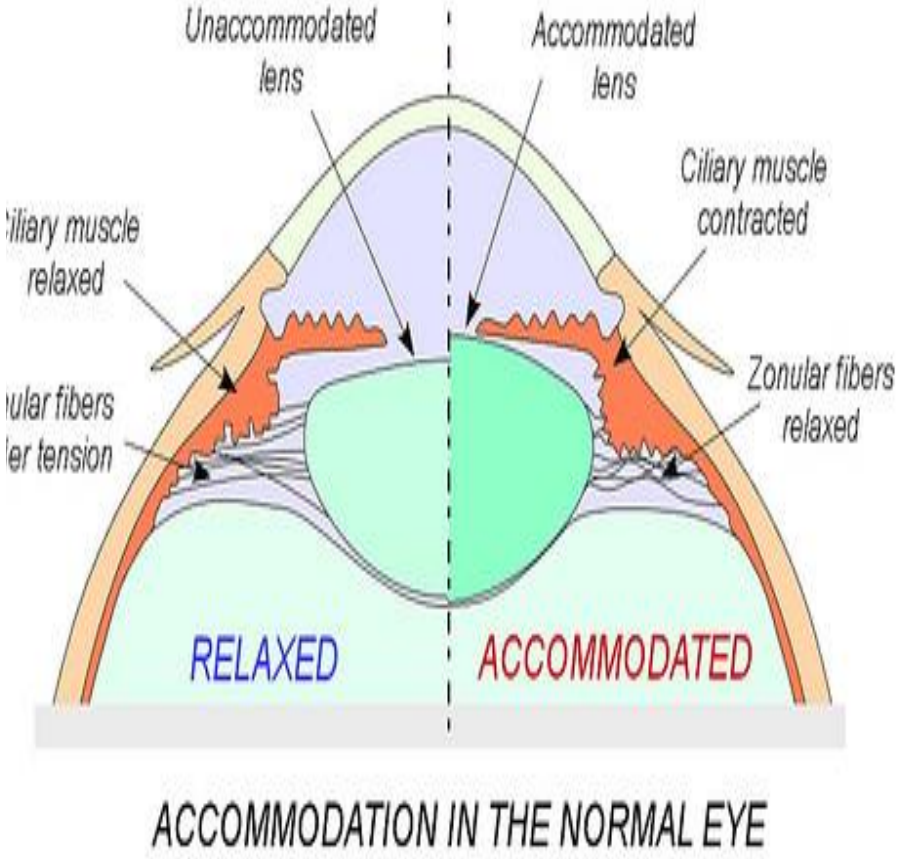


(b) Viewing a near object

The Crystalline Lens

Functions of the lens:





ACCOMMODATION IN THE NORMAL EYE

The Crystalline Lens

Abnormal conditions of the lens

1) Aphakia:

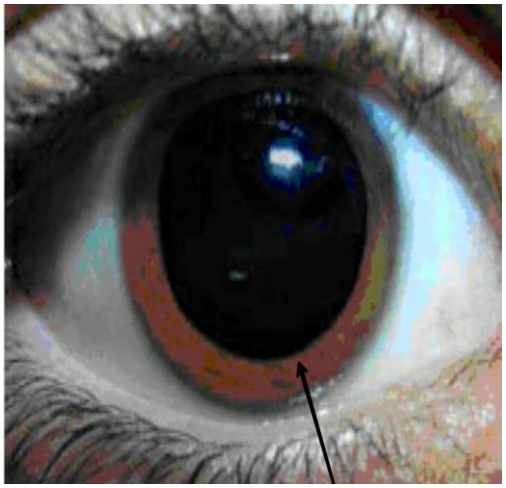
2) Presbyopia:

3) Cataract:

4) Errors of Refraction:

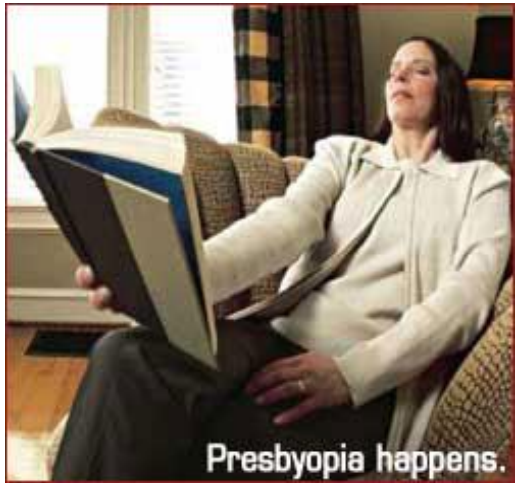
Aphakia

Means **absence** of the lens from the eye.



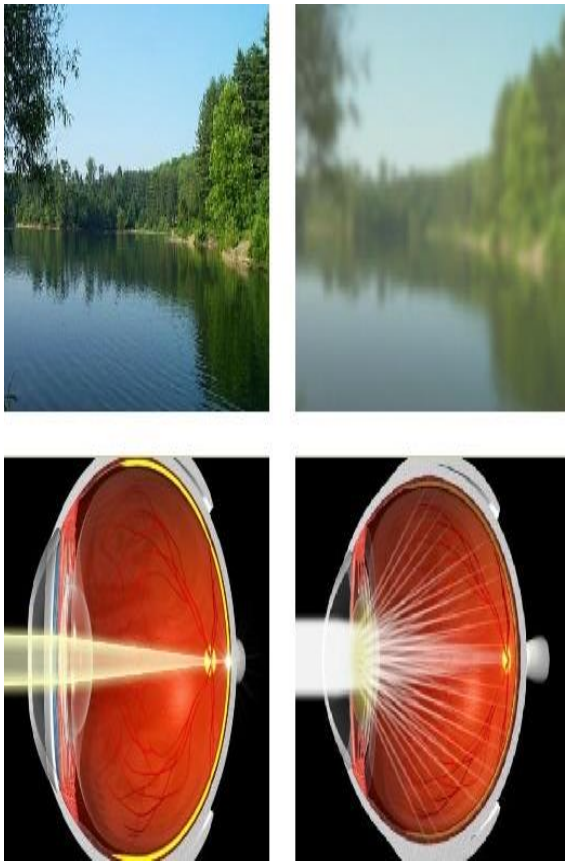
Presbyopia

Failure of **accommodation** to near objects due to **gradual diminution** of lens elasticity **with** advancing **age**



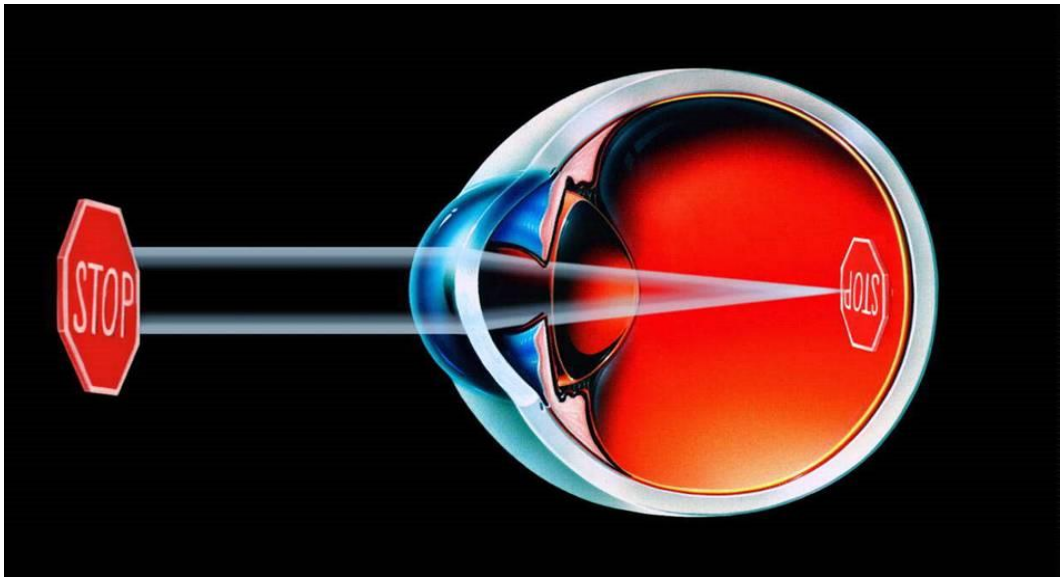
Cataract

Means loss of lens transparency

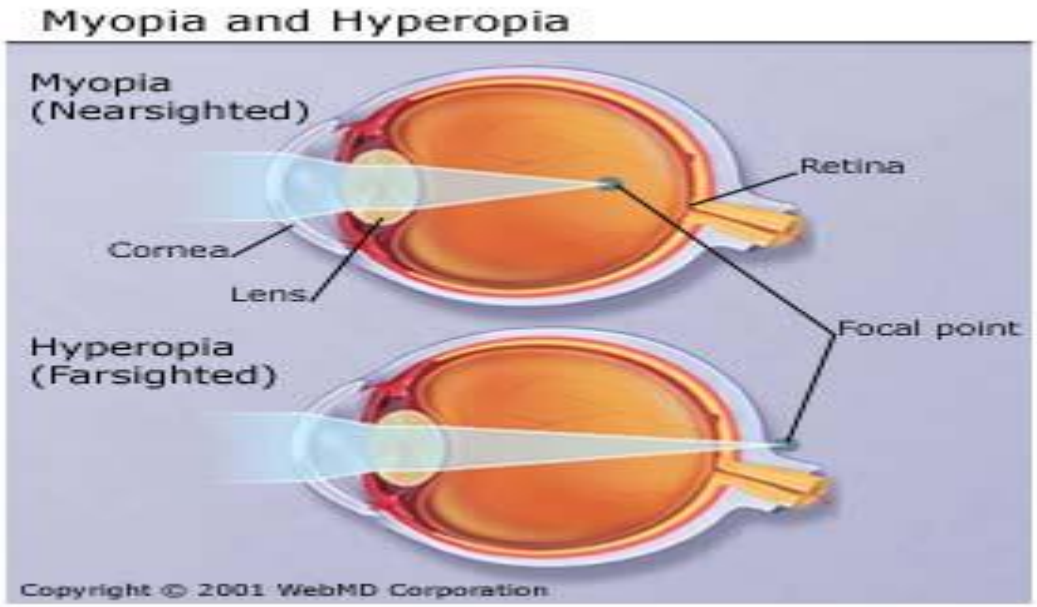


Errors of Refraction

- **Emmetropic** (Normal) eye: is the eye in which parallel rays converge to a focus on the retina.



- **Ammetropic eye**: is the eye in which parallel rays can not converge to a focus on the retina



Myopia (short-sight)

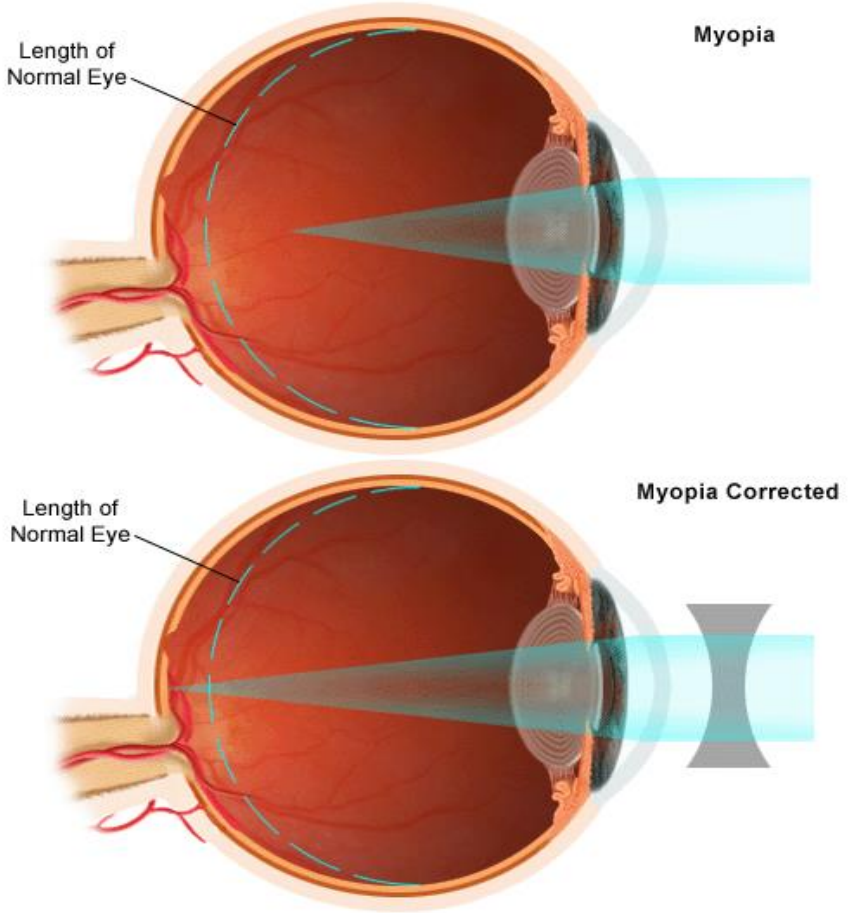
- Is a **condition** in which **parallels rays converge** to point in front of the retina

Causes

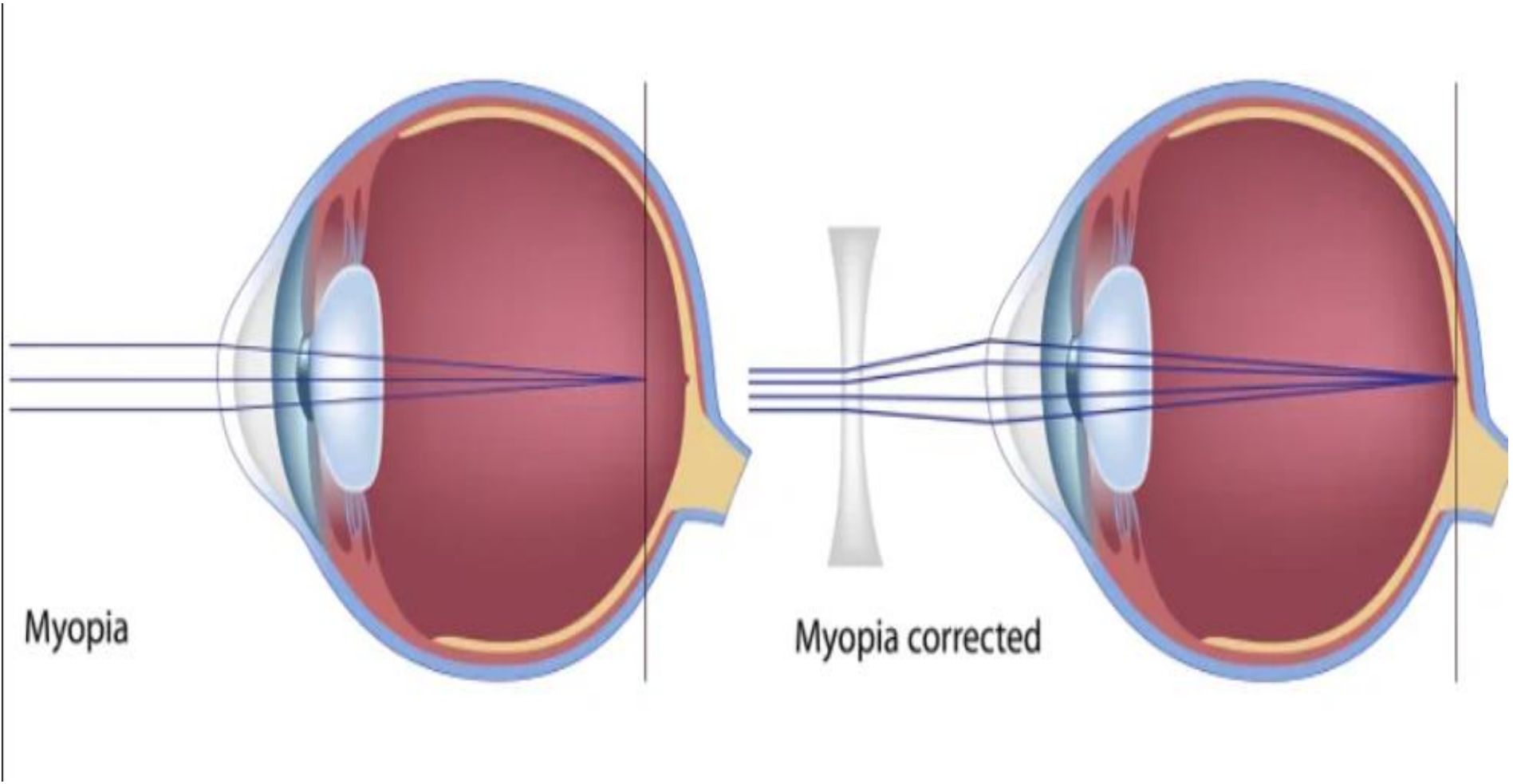
1. **In most cases**, it is due to **abnormally long eyeball**.
2. Occasionally, it is due to **abnormally great curvature** of **cornea or lens.**

- Objects can be brought nearer to the eye to be seen distinctly.

- **Corrected by spherical concave lens.**

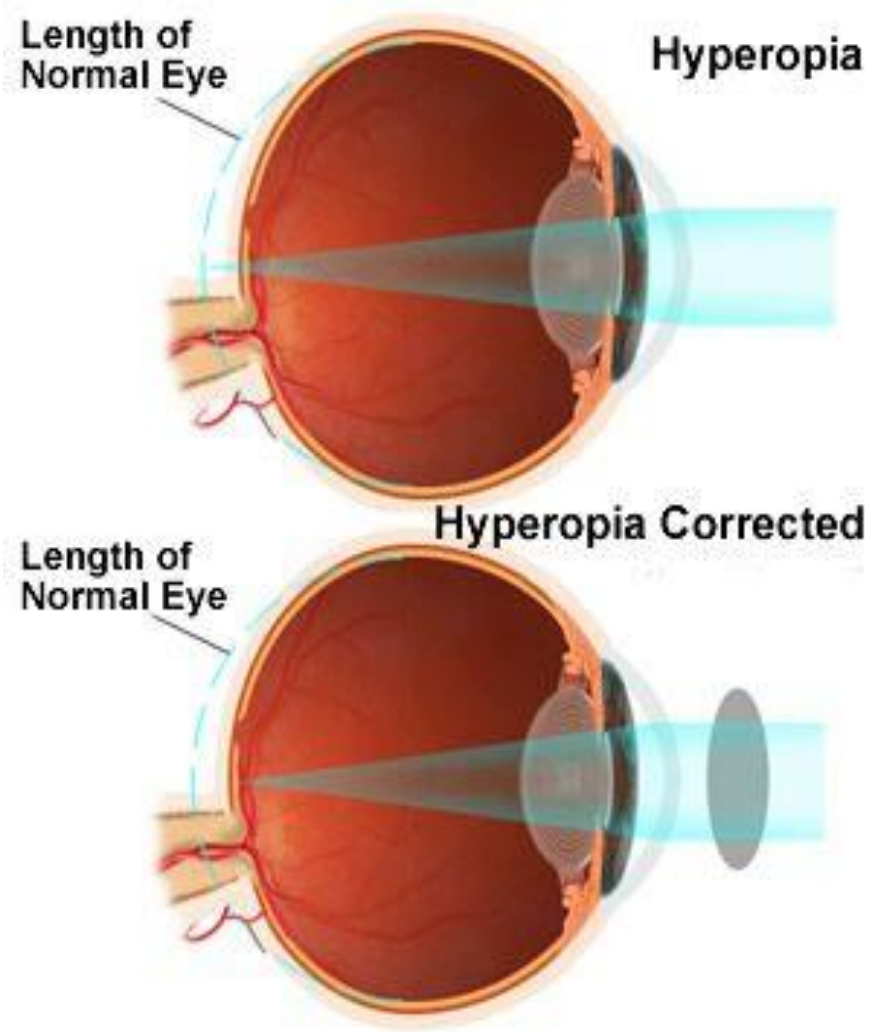


Myopia (short-sight)



Hypermetropia (long-sight)

- It is a condition in which parallels rays converge to point behind the retina

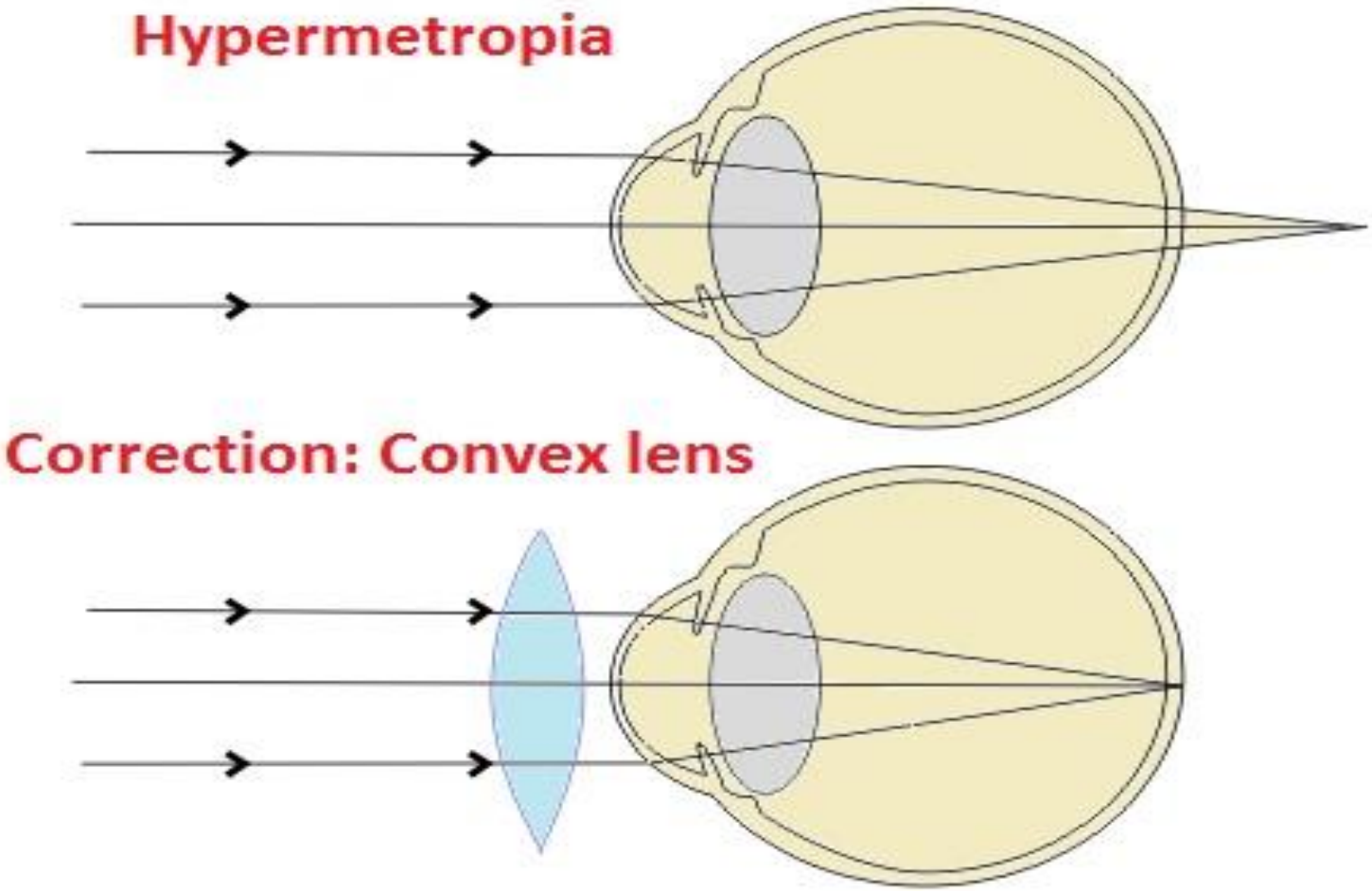


Causes

1. In most cases, it is due to **abnormally short eyeball**.
2. Occasionally, it is due to **abnormally small curvature** of cornea or lens.

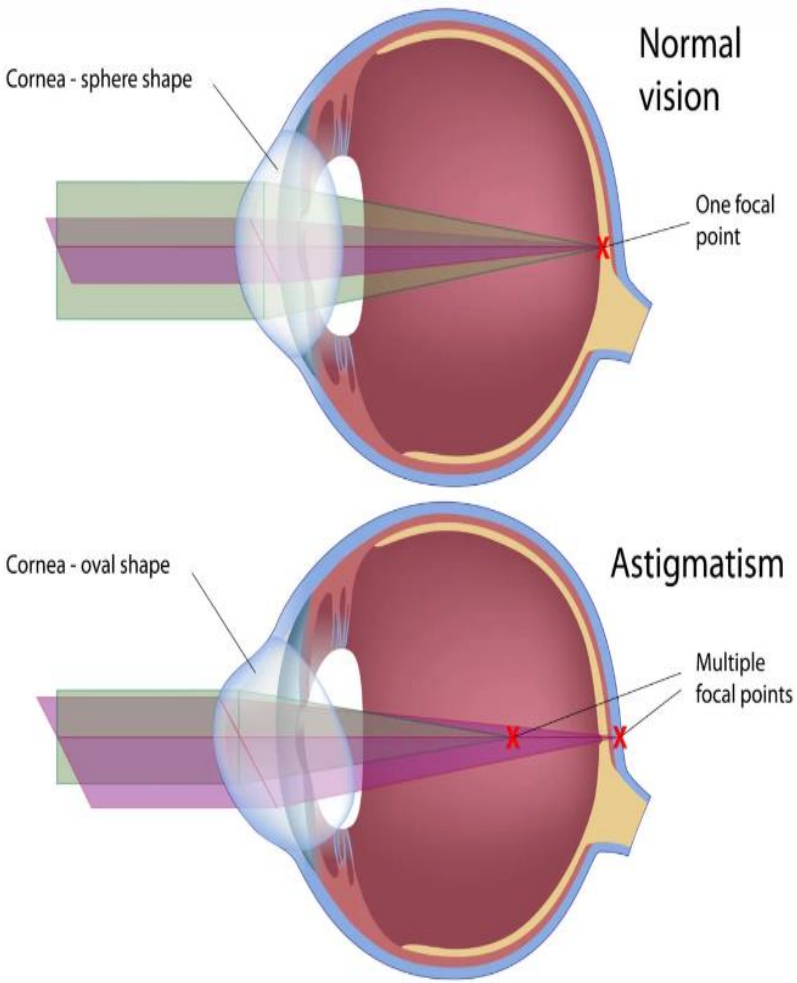
- **Corrected by spherical convex lens**

Hypermetropia (long-sight)



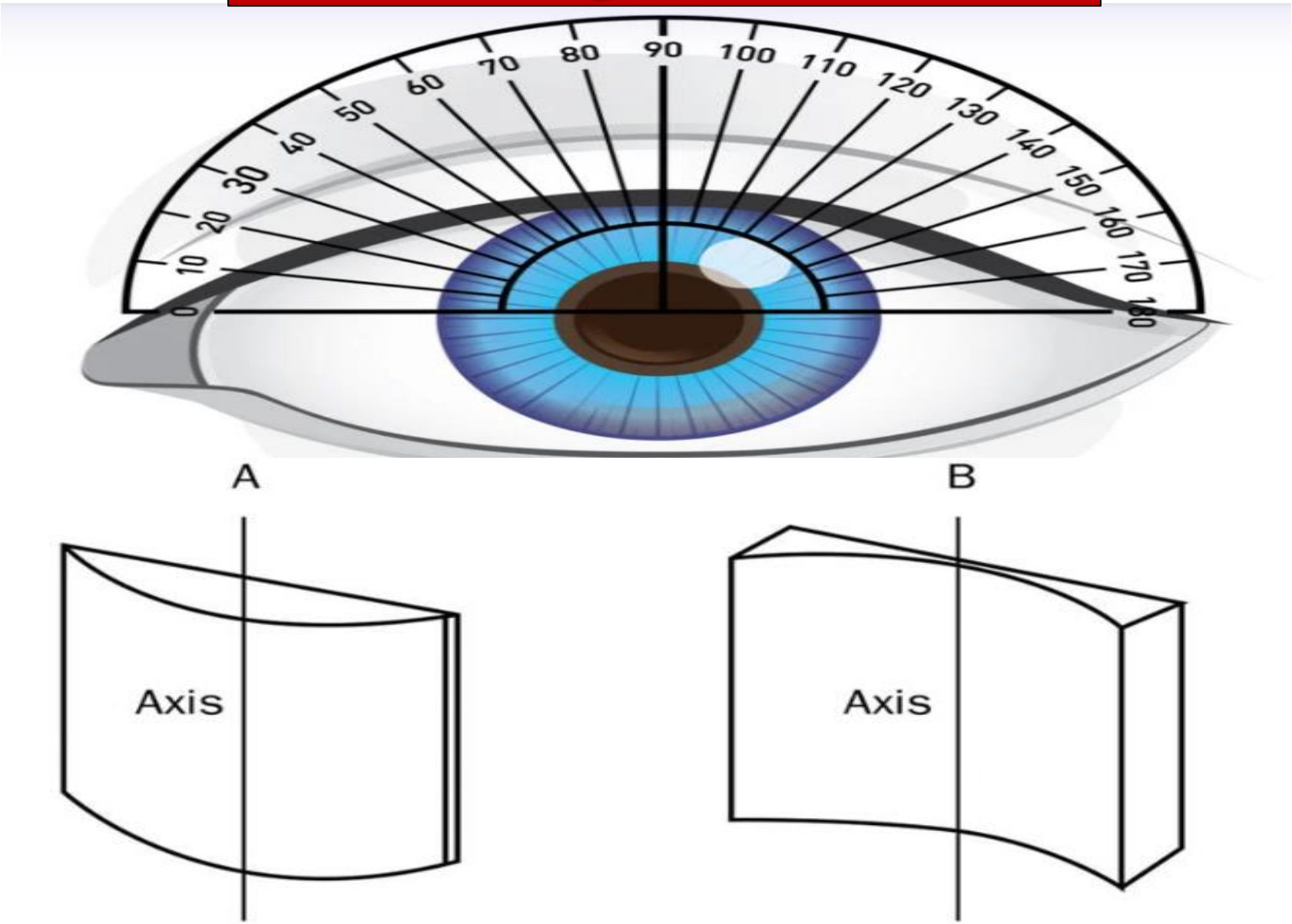
Astigmatism

- It is a condition in which the **curvatures of the cornea** or to less extent the lens are **not the same in all planes**
- so that rays fall on the eye are **not focused in one focus**



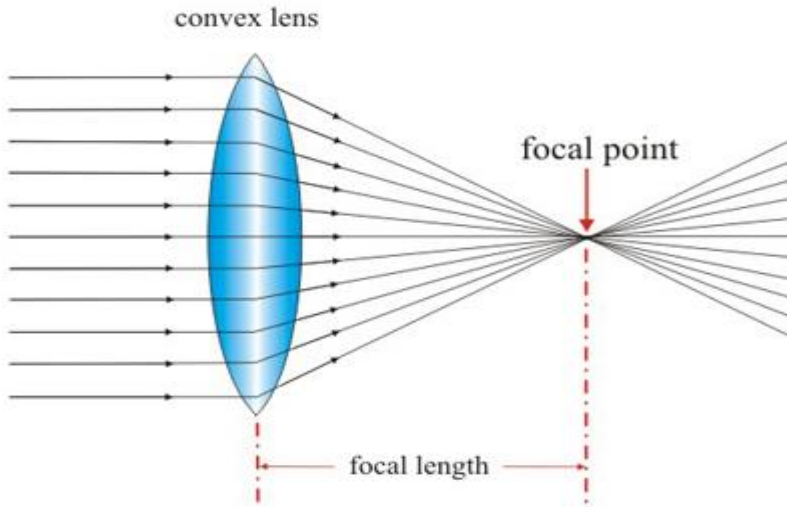
- The condition is **corrected by cylindrical lens** with its longitudinal axis perpendicular to the plane to be corrected ??

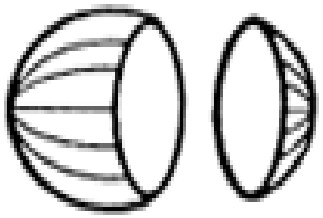
Astigmatism



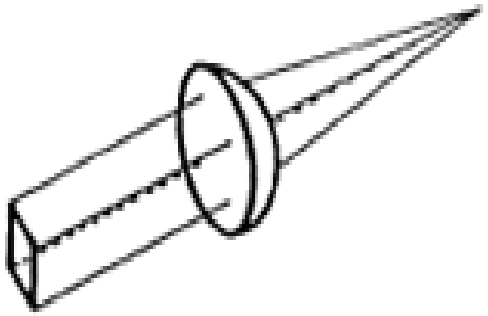
Types of Lenses

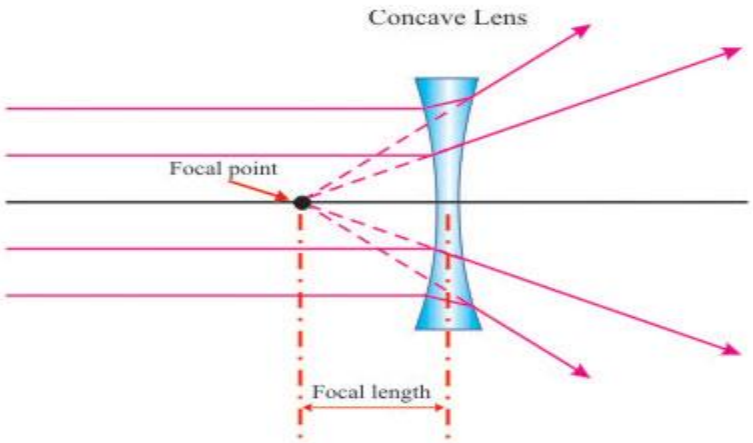
1. **Convex and concave** lenses
2. **Spherical and cylindrical** lenses

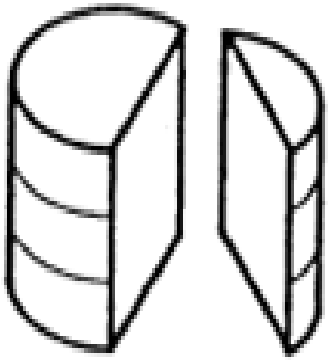




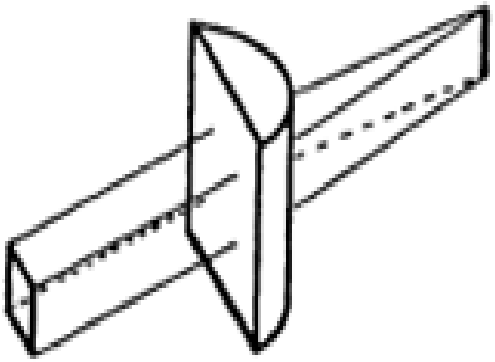
SPHERICAL







CYLINDRICAL



Types of Lenses

Single Vision (myopia or hyperopia) → Sphere

Indicate astigmatism → Cylinder, Axis

Rx	Sphere	Cylinder	Axis
Right (OD)	-1.75	-2.00	50°
Left (OS)	+1.00	-2.00	0°
			PD

	Right Eye 0.7 +			Left Eye 0.7 +		
	Sphere	Cylinder	Axis	Sphere	Cylinder	Axis
Dist	1.75	3.75	175	1.25	5.00	170
Read						


We
Have
Done
It !!
THANKS