



Physiology of the eye and refraction

Objectives:

- ❖ To Describe different components of the eye and function of each.
- ❖ Describe the refraction of light as it passes through the eye to the retina.
- ❖ Identifying the refractive media of the eye.
- ❖ Know fluid system of eye & glaucoma.
- ❖ binocular vision .
- ❖ Know layers of retina, blind spot, and fovea.
- ❖ Know principles of optics and errors of refraction.

Done by :

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Colour index:

- important
- Numbers
- Extra

Introduction to the eye

- Human vision is one of the most complex visual systems among animals.
- The eye is a complex sensory organ, which capable of transduction physical stimuli of light rays into electrical and chemical signals that can be interpreted by the brain to construct physical images.

Functions of vision:

- Discrimination (Light vs Dark)
- Detection of movement
- Detect colour (adaptive value of color vision)

Eye layers

Outer fibrous layer

★ Sclera

★ Cornea

Middle vascular layer

Iris:

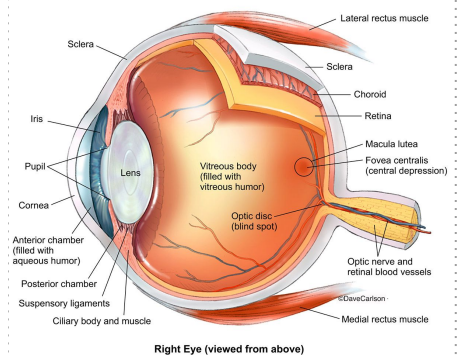
- Is the colored part of the eye
- Has aperture (pupil) control & allow light to enter the eye.

ciliary body;

Ciliary body consists of:

- Ciliary muscles
- Ciliary glands
- Suspensory ligaments which attached to the lens.
-

choroid



Retina

Outer pigmented part

inner neural part

containing Photoreceptors called Rods and Cones

Rods

1. are best for vision in dim light (scotopic vision)
2. are better than cones for detection of flicker (sudden movements of objects).

Cones are best for:

1. vision in daylight or bright light (photopic vision) .
2. Color Vision (color perception).
3. Perception of detail (acuity of vision) .

The Anterior & Posterior Cavities

The Ciliary Body (& its suspensory ligament) and lens divide the eye into :

Anterior cavity:

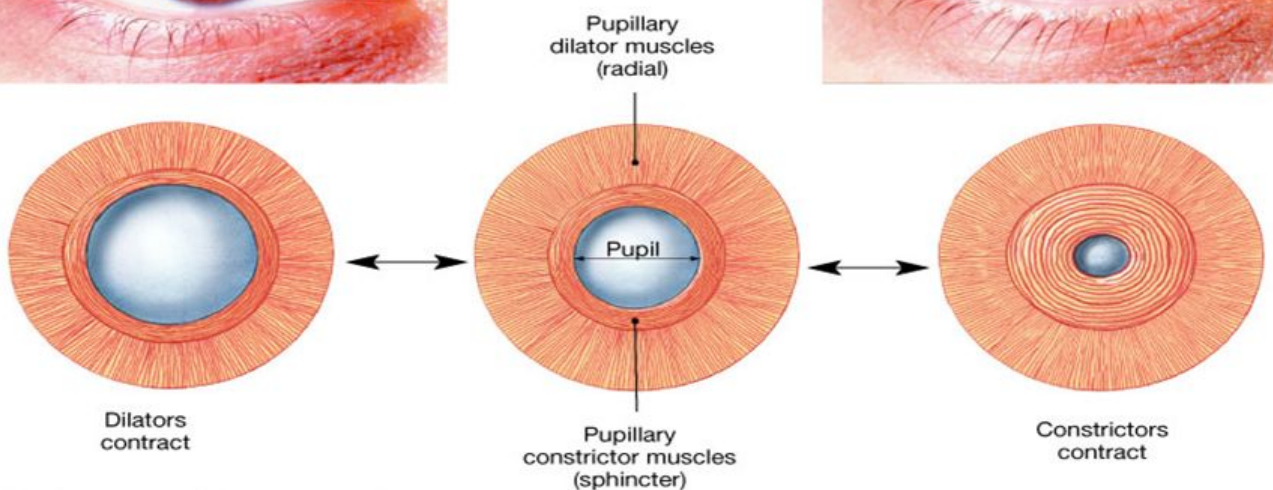
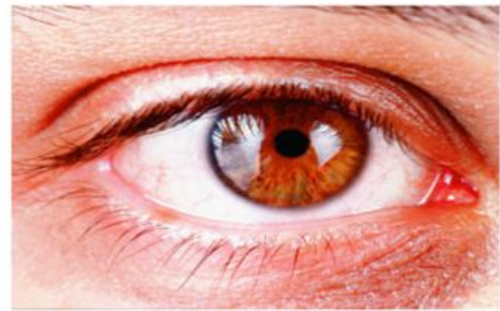
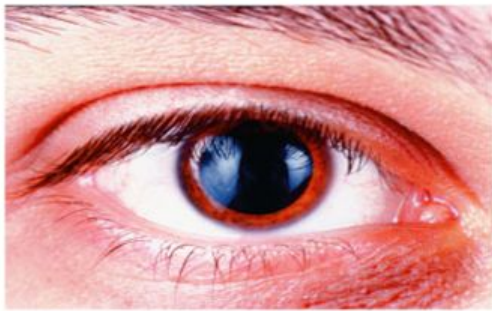
- which contains a fluid called Aqueous Humor.
- In the front of the iris.

Posterior cavity :

- which contains fluid called Vitreous Humor.
- behind the iris:
between the iris and lens.

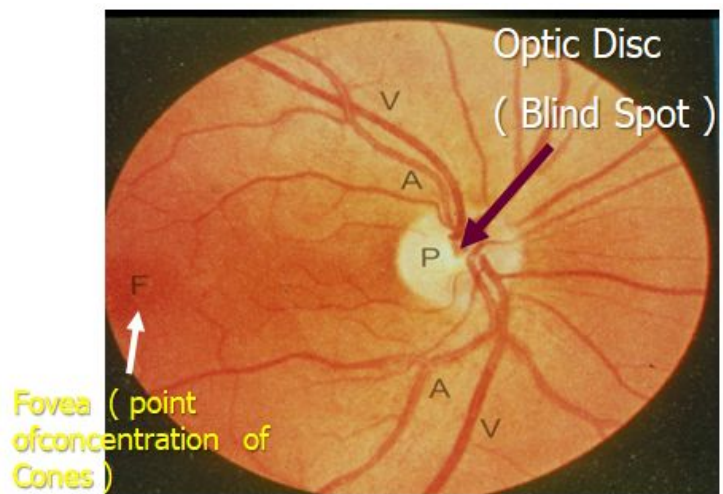
Pupillary muscles

The Pupillary Muscles: consists of **Radial** and **Circular** parts

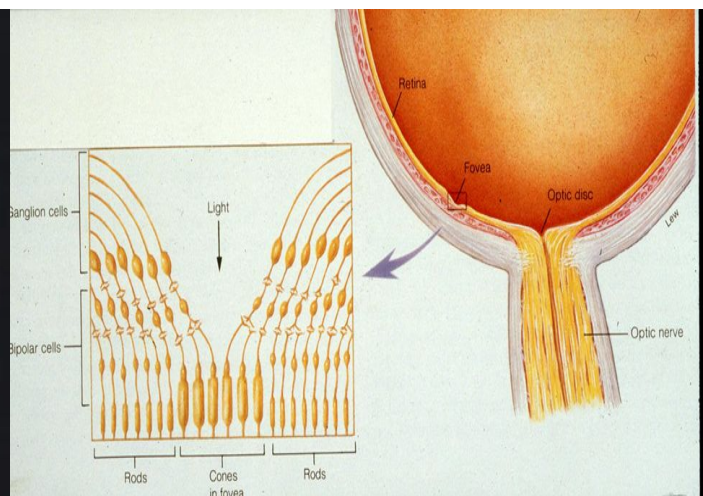
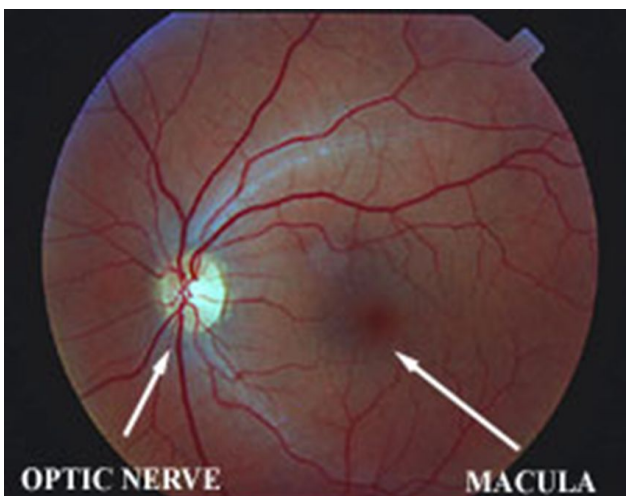


Macula & Fovea Centralis

- An important part of the retina is the Macula Lutea .
- At the center of the Macula we find the Fovea Centralis .
- In the Fovea we find the maximum concentration of cones consequently the Fovea is the point of maximal visual activity in the retina .
- Cones are densely packed at the Fovea .
- When you turn your eye to look at an object you tend to place its image in the Fovea



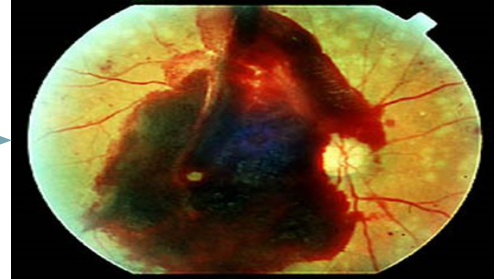
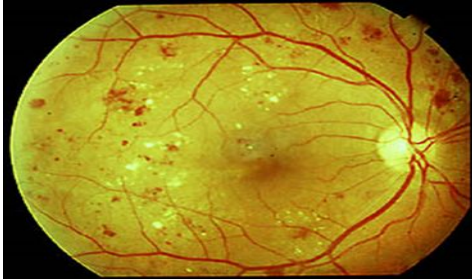
Normal Ophthalmoscopic View of Eye



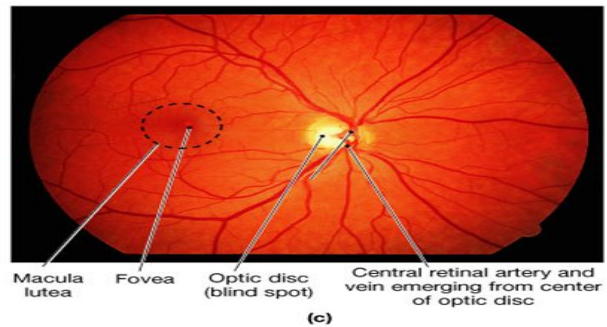
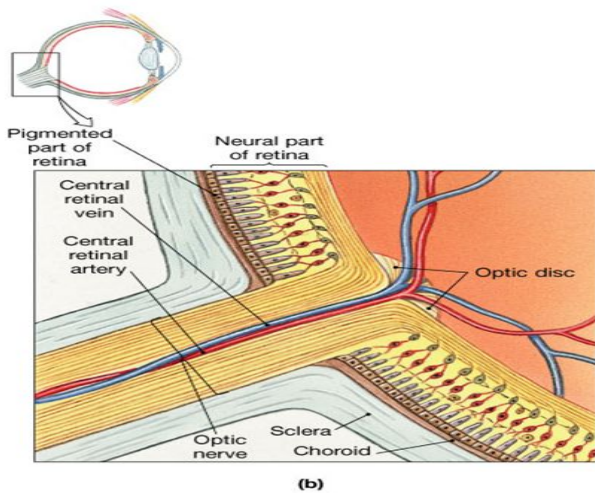
Disorders of the Eye and Vision

Retinopathy in **diabetes**

Vessels have weak walls – causes hemorrhaging and blindness



Organization of the Retina



External Protection of The Eye

1. Bony orbit
2. Eyelids with their lashes
3. Conjunctiva
4. Tears from lacrimal gland:
 - has antibacterial, lubricating effect keep cornea moist & clear.
 - provide nutrition to the cornea.

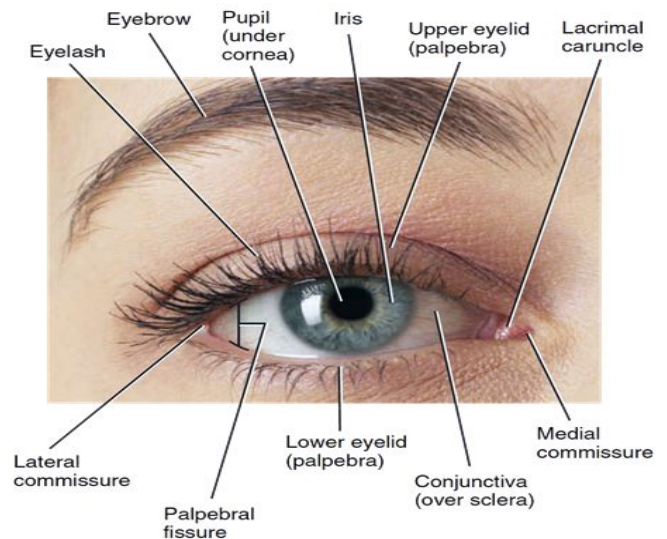
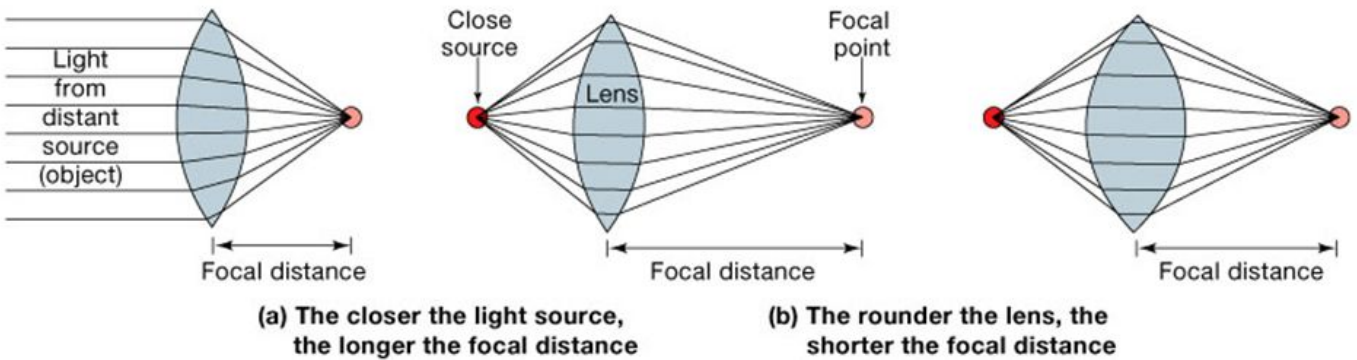


Image Formation



Principles of Optics

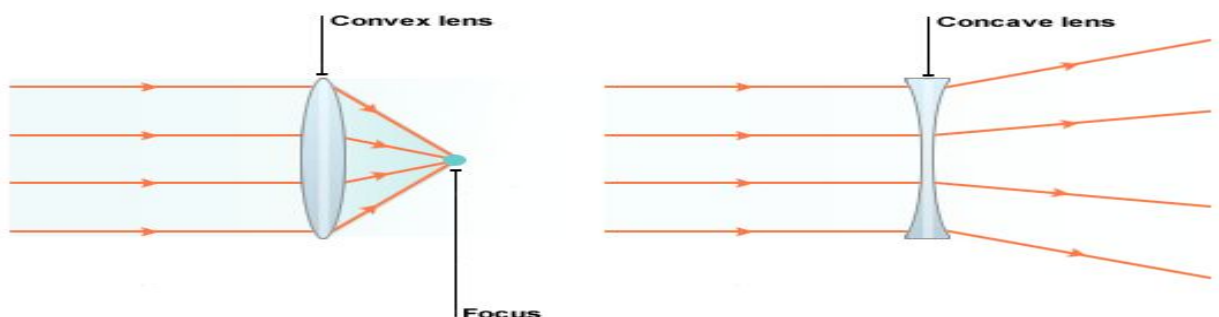
Term	Description
Principle focus point	Parallel rays strike biconvex lens refracted in this point.
Principle axis	PF lies on line pass through centers of lens curvatures
Principal focal distance	Distance between lens & PF. Biconvex lens(converge) & biconcave lens(diverge)

- Biconvex lens → Converge
- Biconcave lens → Diverge
- **Diopter** : The distance beyond a convex lens at which parallel rays converge to a common focal point , It is the unit of measurement for **Refractive Power (R.P)**

- Lens-retina distance = 15mm
- Dioptre (s) = $1 / \text{Focal length distance (in meters)}$
- Dioptric power of the eye:
 - Cornea \rightarrow 40-45 D (max refraction)
 - Lens \rightarrow 15-20 D
 - Accomodation by lens \rightarrow +12 D

Example : If principal focal distance of a lens is 25cm , then its R.P = $1 / 0,25 \text{ (meter)} = 4\text{D (Diopter)}$

- ***The greater the curvature of the lens \rightarrow The greater the refractive power of the eye***
- If the lens has exactly the proper curvature, parallel light rays passing through each part of the lens will be bent exactly enough so that all the rays will pass through a single point, which is called **the Focal point.**



- Concave lenses *neutralize* the refractive power of the convex lenses \rightarrow therefore if we put a 1 Diopter concave lens immediately in front of the 1 D convex lens results in a lens system with zero refractive power

Emmetropic eye : Is the normal eye vision has image on retina , and has Dioptric power = 59D , It can see all distant objects clearly with its ciliary muscle relaxed & see close objects clearly with its ciliary muscle contracted , In other words **Normal eye = Emmetropic eye**



Refractive media of the eye

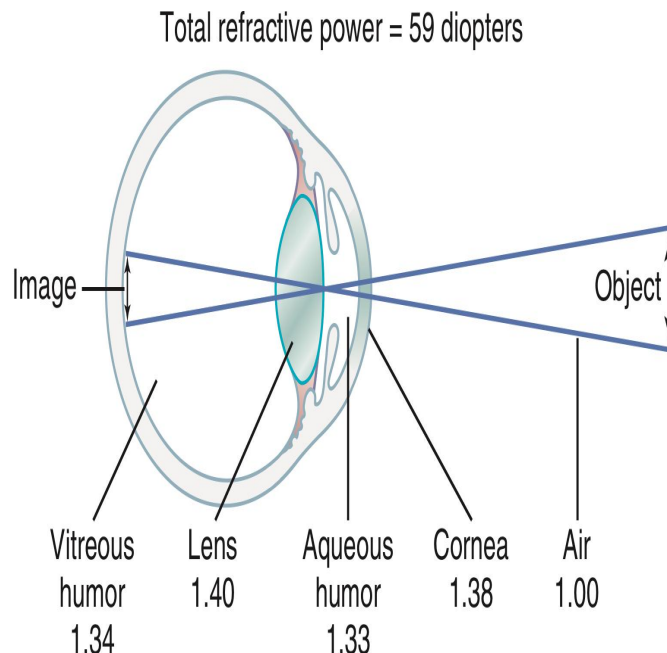
- (1) The interface between air and the anterior surface of the cornea
- (2) The interface between the posterior surface of the cornea and the aqueous humor
- (3) The interface between the aqueous humor and the anterior surface of the lens of the eye
- (4) The interface between the posterior surface of the lens and the vitreous humor.

A total refractive power of 59 dioptres when the lens is accommodated for distant vision.

- N.B/** The internal index of air is 1
- the cornea, 1.38
 - the aqueous humor, 1.33
 - the crystalline lens 1.40
 - the vitreous humor 1.34

Refractive Media of the Eye

Medium	Refractive Index (RI)	Refractive power
Air	1	
Cornea	1.38	+39 Dioptres
Aqueous Humour	1.33	
Lens	1.40	+20 Dioptres
Vitreous Humour	1.34	



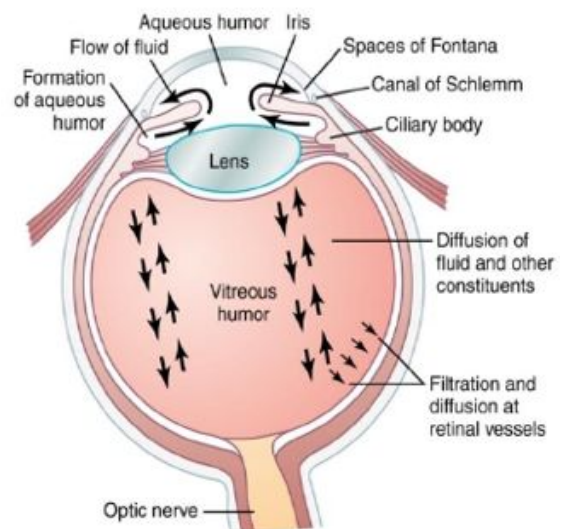
1. Cornea

- Its dioptric power is 40-45 diopter at its anterior surface.
- About two thirds of the 59 diopters of refractive power of the eye is provided by the anterior surface of the cornea
- The principal reason for this is that the refractive index of the cornea is markedly different from that of air, (whereas the refractive index of the eye lens is not greatly different from the indices of the aqueous humor and vitreous humor).

2. The Aqueous humour:

aqueous humour is a **transparent**, slightly gelatinous (**gel-like**) fluid similar to plasma.

- Is continually being formed and reabsorbed.
- The balance between its formation and reabsorption regulates the total volume and pressure of the intraocular fluid.
- Nourishes the cornea and iris
- **produced in the ciliary body** by an active secretion by ciliary processes..
- Go to → posterior chamber → to pupil → Anterior chamber → drained into canal of Schlemm in anterior chamber angle, which is a venous channel at the junction between the iris and the cornea (anterior chamber angle).
- It causes intraocular pressure 10-20 mmhg
- Obstruction of this outlet leads to increased intraocular pressure , a critical risk factor for **glaucoma**

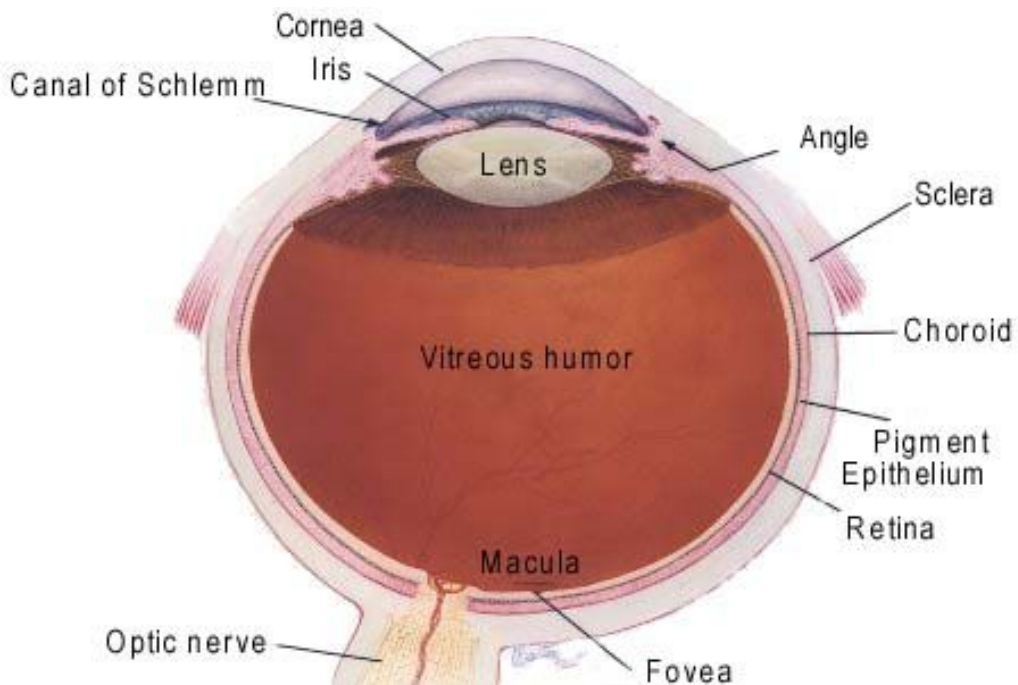


3. Lens

- Has dioptric power 15-20D (1/3 refractive power of eye).
- More important than the cornea, why?
 - i. In response to nervous signals from the brain, its curvature can be increased markedly to provide **accommodation**.

4. The Vitreous humour

- Is the transparent, colourless, gelatinous mass, fills the vitreous chamber between the posterior surface of lens and the retina.
- (for nourishing retina & keep spheroid shape of the eye)
- the vitreous humour is clear and allows light to pass through
- Vitreous humours remains from birth



What is glaucoma?

(intraocular pressure more than 20mm Hg)

- Build up of Aqueous Humor Volume
- Increases pressure in eye
- Damages nerve Meds/surgery



Glaucoma is an eye condition that develops when too much fluid pressure builds up inside of the eye. The increased internal pressure can damage the optic nerve, which transmits images to the brain. Without treatment, glaucoma can cause blindness within a few years. Glaucoma is most often inherited, meaning it is passed from parents to children. Less common causes of glaucoma include a blunt or chemical injury to the eye, severe eye infection, blockage of blood vessels in the eye and inflammatory conditions of the eye. Glaucoma usually occurs in both eyes, but it may involve each eye to a different extent.

Why it causes damage of optic nerve?

1. Obstruction of AQ H outlet leads to increased intraocular pressure.
2. Excessive aqueous humour pushes the lens backwards into vitreous, which pushes against the retina.
3. this compression causes retinal and optic nerve damage that can cause blindness if not treated?
4. the axons of the optic nerve are compressed at the optic disc.
5. This lack of nutrition of the optic nerve fibers, which causes death of the involved fibers & blindness

what is the Binocular Vision?

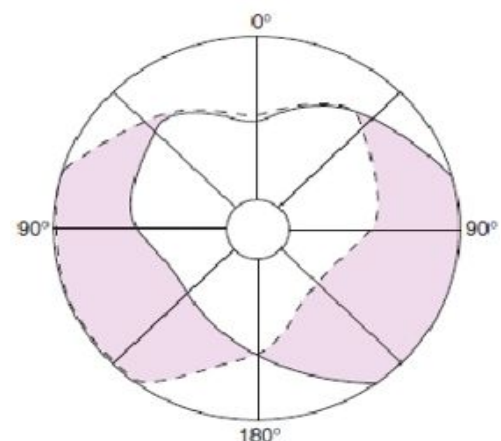
Are the areas in the centre of visual field of the two eyes in which any object in this area will be seen by both eyes.

Binocular Vision For :-

- 1- Large visual field
- 2- cancel the effect of blind spot
- 3- stereoscopic vision
- 4- one eye lesion does not affect vision

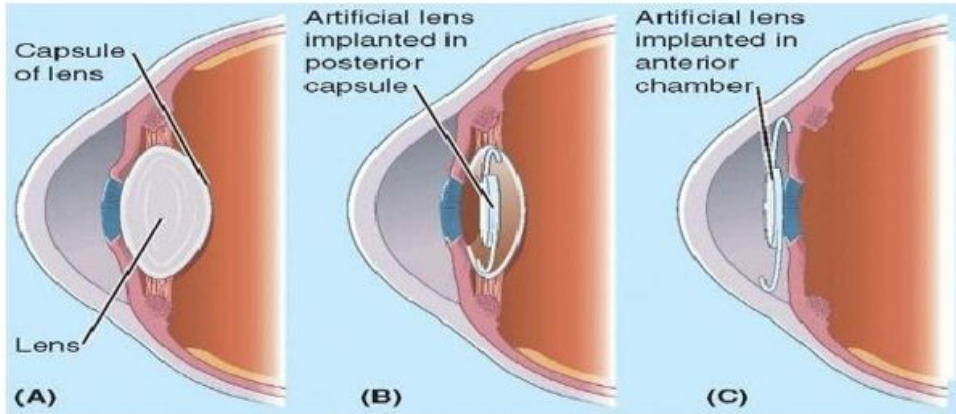
Monocular And Binocular Visual Fields.

- The dashed line encloses the visual field of the left eye; the solid line, that of the right eye.
- The common area (heart-shaped in the center) is viewed with binocular vision.
- The colored areas are viewed with monocular vision.



Cataracts:

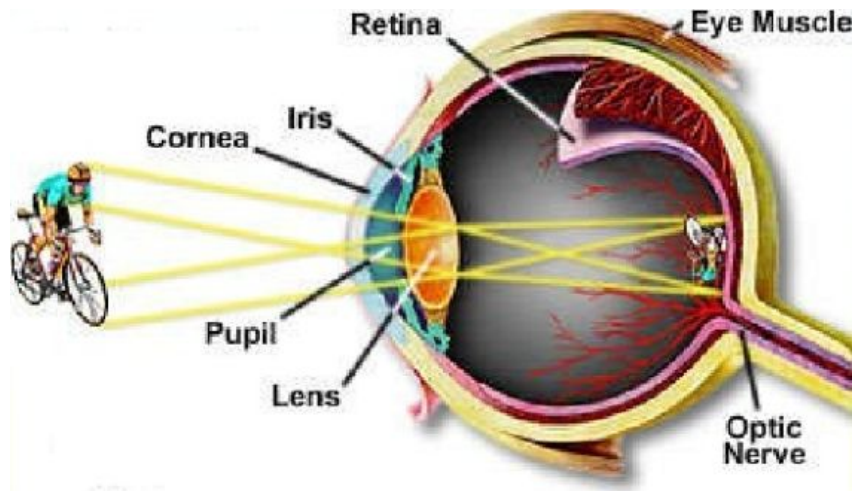
- is a cloudy or opaque area or areas in the lens.
- occurs in older people.
- the proteins in some lens fibers become denatured and coagulated to form opaque areas.
- When a cataract has obscured light transmission so greatly that it impairs vision



- The lens system of the eye will focus an image on the retina upside down

- the image is inverted and reversed with respect to the object

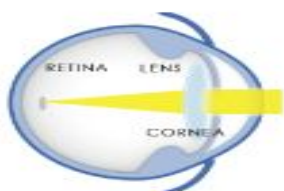
- however, the brain perceives objects in the upright position despite the upside-down orientation on the retina



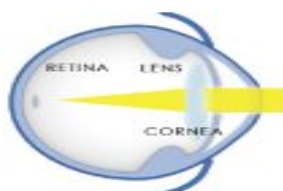
- The reason does not look inverted and reversed is that the brain learns "early" in life to coordinate visual images with the orientations of objects

Errors of refraction

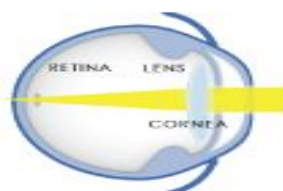
Name	Description	Correction
<p>Hyperopia (Farsightedness)</p>	<ul style="list-style-type: none"> • Small eye ball with weak lens system. • Focus is behind retina • Causes headache and blurred vision. • Continuous accommodation to bring image on retina causes muscular effort on ciliary muscles & prolonged convergence, which will lead to headache and finally squint. 	<p><i>Biconvex lens</i></p>
<p>Myopia (near-sightedness)</p>	<ul style="list-style-type: none"> • Genetically large eyeball or too much R.P (refractive power) of the lens system or cornea due to its curved surface, or due to long anterior-posterior diameter of the eye. • Extensive close work, E.g : Studying. • Focus will be IN FRONT of the retina. 	<p><i>Biconcave lens</i></p>
<p>Astigmatism :</p>	<p>Mainly due to <i>Uneven and Nonuniform</i> corneal curvature and very little due to uneven lens curvature</p> <ul style="list-style-type: none"> • Rays reflected to different foci resulting in ---> Blurred vision 	<p><i>Cylindrical lens</i></p>



Emmetropia
Normal



Myopia
Near-Sighted



Hyperopia
Far-Sighted



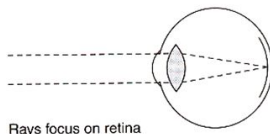
Astigmatism
Irregular Vision

Helpful illustrations

Image Focusing

Emmetropia
(normal vision)

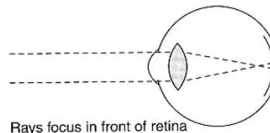
EMMETROPIA
(eyeball length just right)



Fully relaxed unaccommodated lens

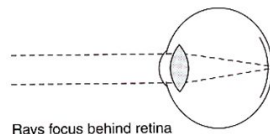
Myopia
(Short sight)

MYOPIA
(eyeball length too long)

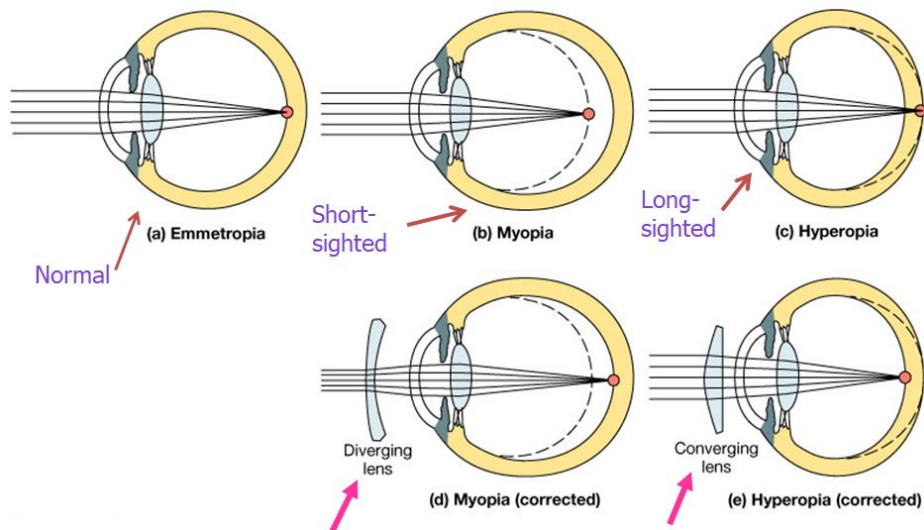


Hyperopia
(long sight)

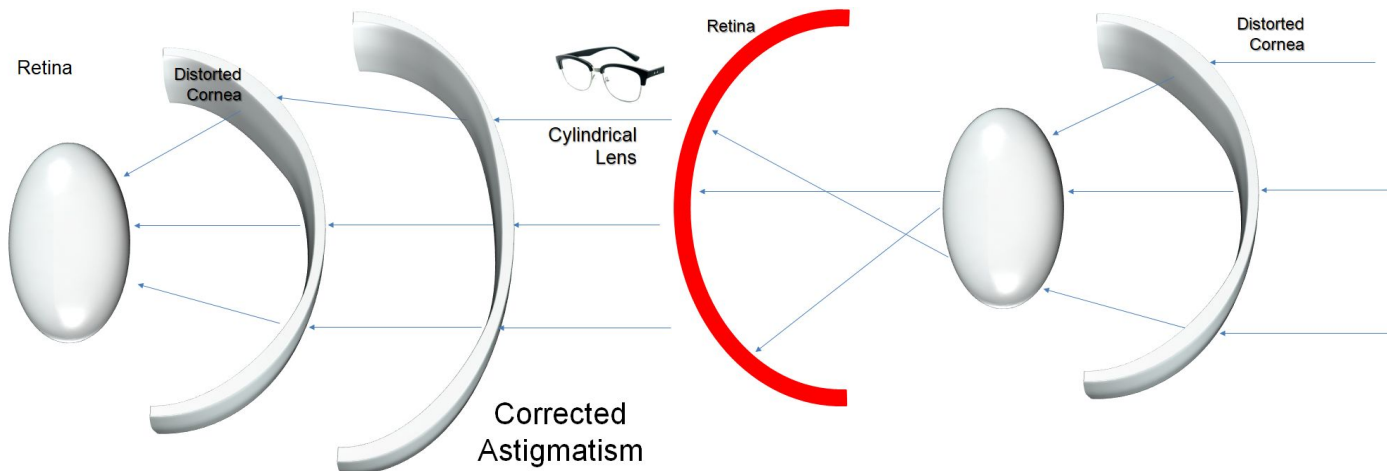
HYPEROPIA
(eyeball length too short)



Visual Abnormalities

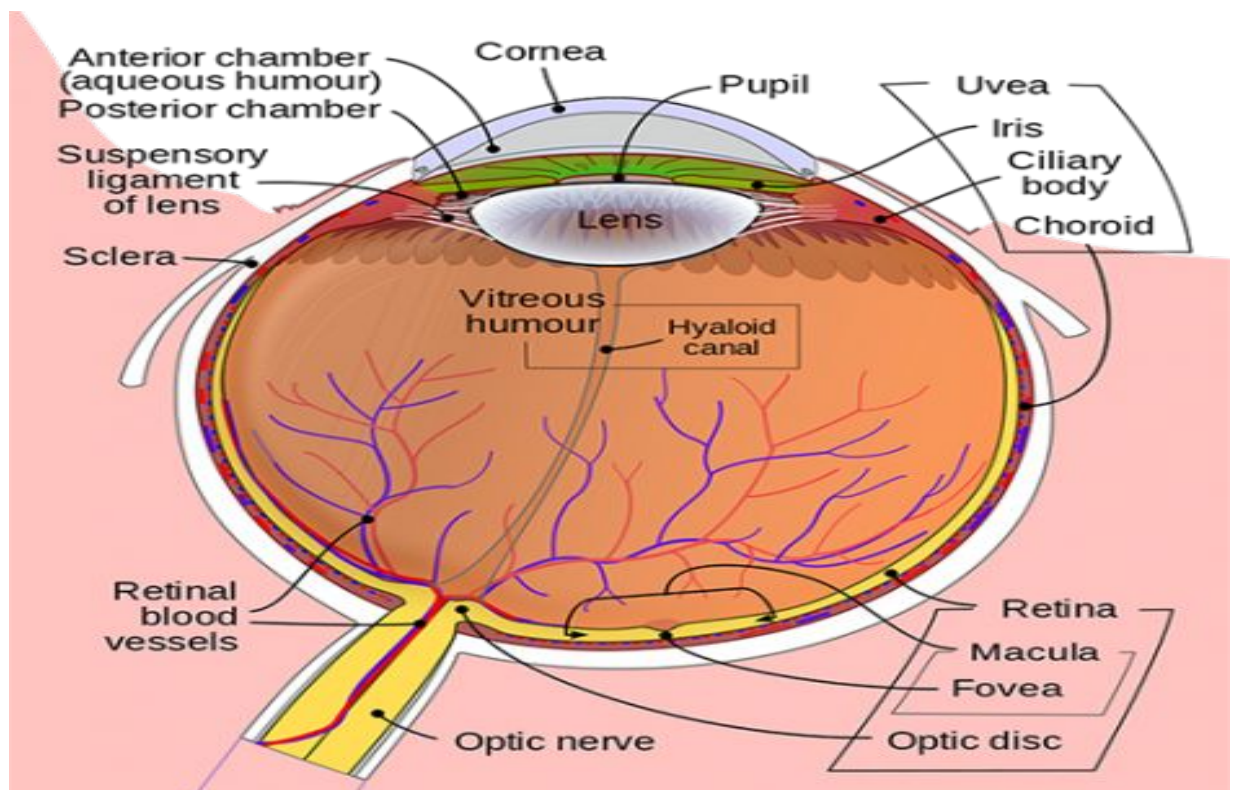


Astigmatism



Light pathway in the eye :

1. After the light passes through the lens system of the eye and then through the vitreous humor , it enters the retina from inside the eye
 2. It then first passes through the ganglion cells and then through the plexiform and nuclear layers before it finally reaches the the layers of rods and cones located all the way on the outer ridge of the retina
 3. Then impulses pass from the rods and cones the rest of the layers finally to the ganglion cell layer and then to the Optic nerve
- Light absorbed by the pigment cell layer contains **Melanin pigment**
 - The visual acuity is decreased by this passage through Non-homogenous tissue
 - However in the **Central foveal** region of the retina , the inside layers are pulled aside to decreases the loss of acuity . **This allows light to pass unimpeded to the cones.**



Watch this 3 min video →

<https://www.youtube.com/watch?v=Qp066aaqpsw>

1. which of the following is the coloured part of the eye ?

- A- .cornea
- B- iris
- C- .choroid
- D- sclera

2.Q/the posterior cavity of the eyes contain a fluid called ?

- A- Aqueous humuor
- B- Ciliary fluid
- C- Vitreous humuor
- D- Conjunctival fluid.

3.Q/which one of the following situations are rod photoreceptors used rather than cons ?

- A- in daylight
- B- colour perception
- C- Perception of detail
- D- detection of flickers

4.Q/ if Principal focal distance of a patients lens is 13m what's the refractive power of the lens and what is the normal dioptre?

- A- 0,007:59
- B- 7,69:56
- C- 0,007:56
- D- 7,69:59

5.Q/ an eye condition that develops when too much fluid pressure builds up inside of the eye is called?

- A- Glaucoma
- B- Conjunctivitis
- C- Fuchs' dystrophy
- D- Keratoconus

6.Q/which of the following Errors of refraction is corrected by a cylindrical lens?

- A- Hypermetropia
- B- Myopia
- C- Astigmatism
- D- None of the above

7.Q/most of the dioptric power of the eye (between 40-45) is found in the..?

- A- Anterior part of lens
- B- anterior part of cornea
- C- posterior part of lens
- D- anterior part of retina

8.Q/ which of the following is the region where the optic nerve and blood vessels leave the eye?

- A- Fovea
- B- Zonulas
- C- Optic disk
- D- Optic foramen

9.Q/ This is a thin, light-sensitive tissue that lines the back of the eye and acts much like film in a camera?

- A- Cornea
- B- Lens
- C- retina
- D- petal

10.Q/These are responsible for nourishing the inner layers of the retina.

A: eye tissues

B: pupil veins

C: cornea muscles

D: retinal blood vessels

Answers:
1. B
2. C
3. C
4. C
5. A
6. D
7. C
8. C
9. C
10. D