Development of Eye (Embryology)

DR SHAHAB

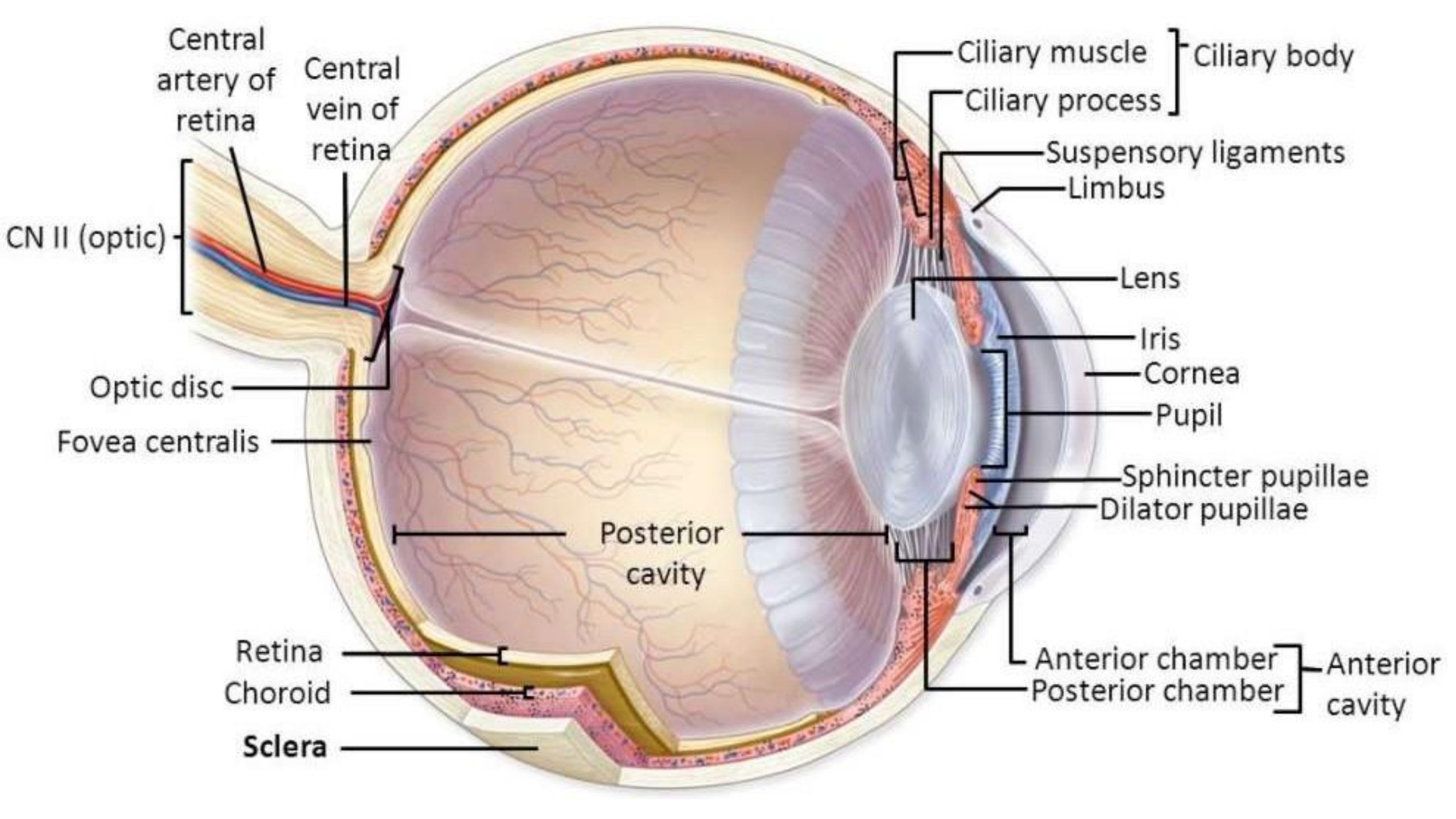
Associate Professor

Anatomy KGMC

Learning Objectives:

By the end of this discussion you must be able to-

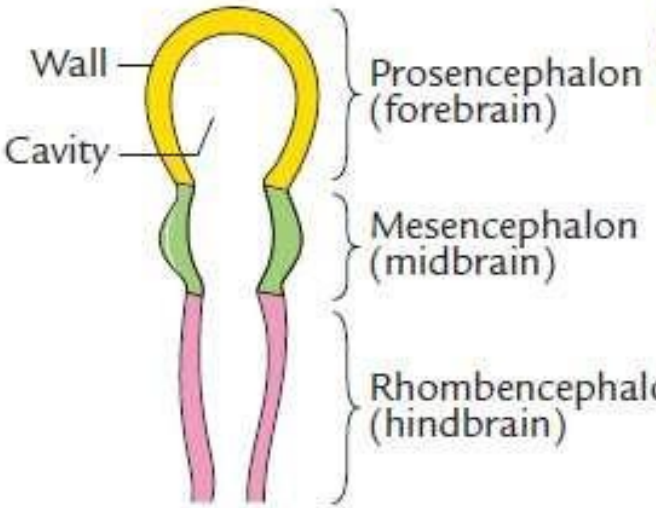
- Tell the sources of development of eye
- Tell the structures derived from each sources.
- Congenital defects of eye

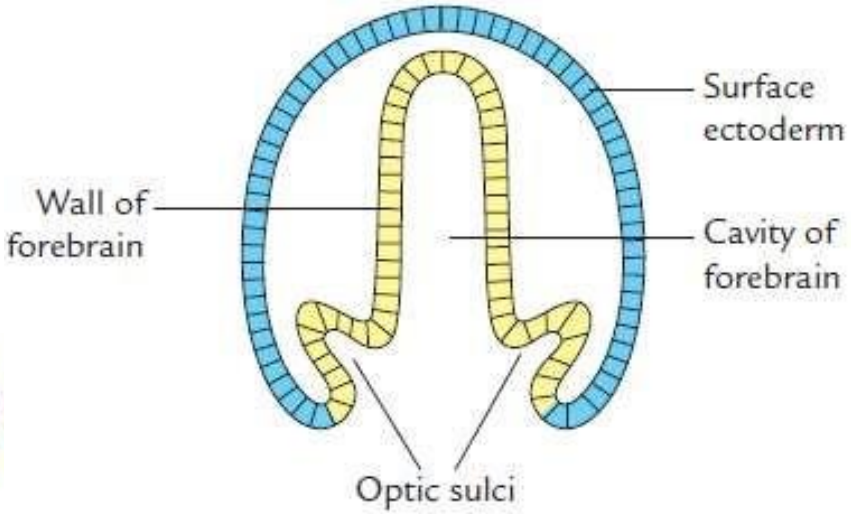

Central artery of retina
Central vein of retina
CN II (optic)
Optic disc
Fovea centralis
Posterior cavity
Retina
Choroid
Sclera
Ciliary muscle
Ciliary process
Ciliary body
Suspensory ligaments
Limbus
Lens
Iris
Cornea
Pupil
Sphincter pupillae
Dilator pupillae
Anterior chamber
Posterior chamber
Anterior cavity

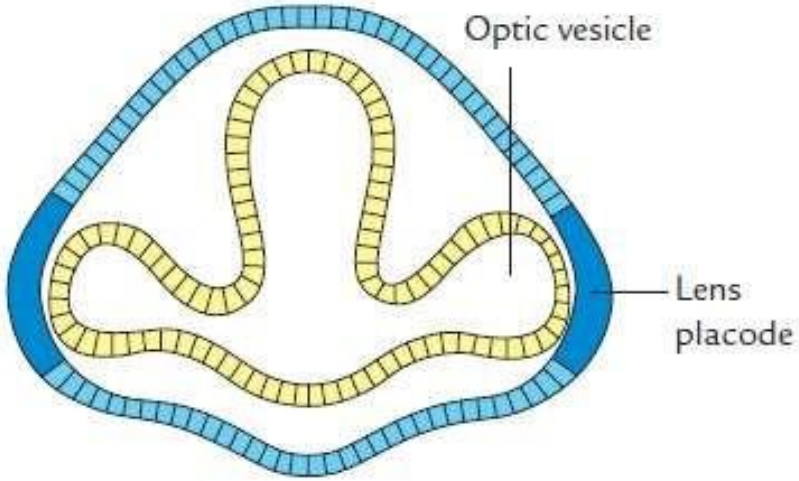
on day 22 Development of eye begins

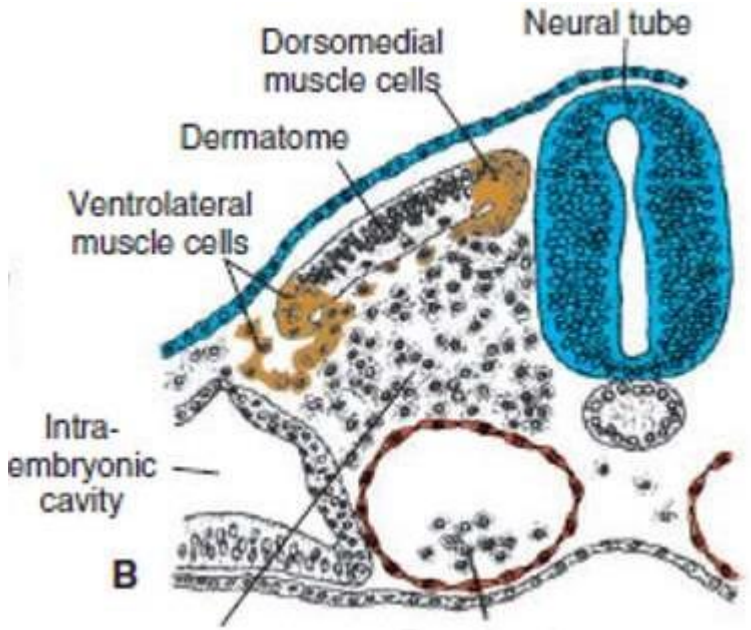
Components of eyeball are derived form:

a. Optic vesicle- Outgrowth form prosencephalon
b. Lens placode- specialized area of surface ectoderm
c. Mesoderm- surrounding optic vesicle.



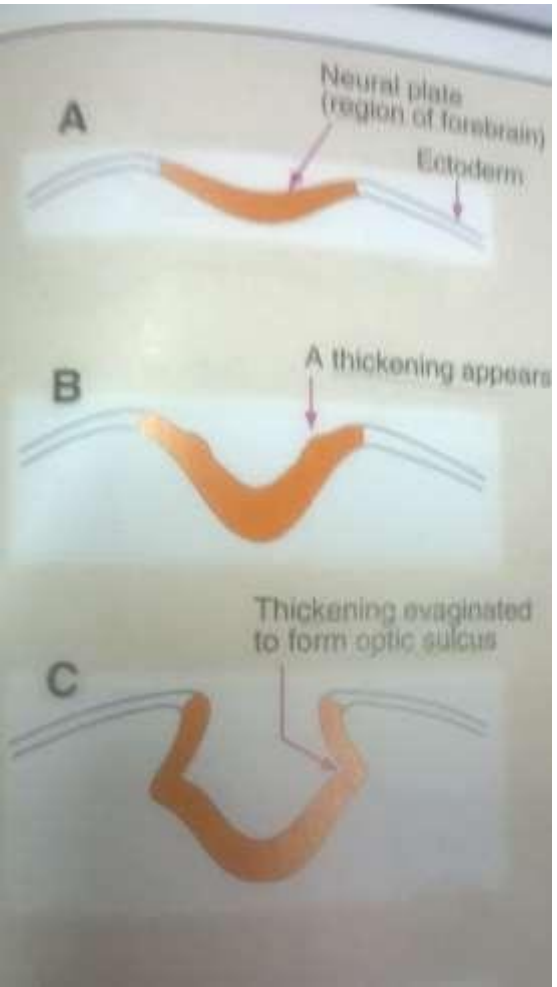


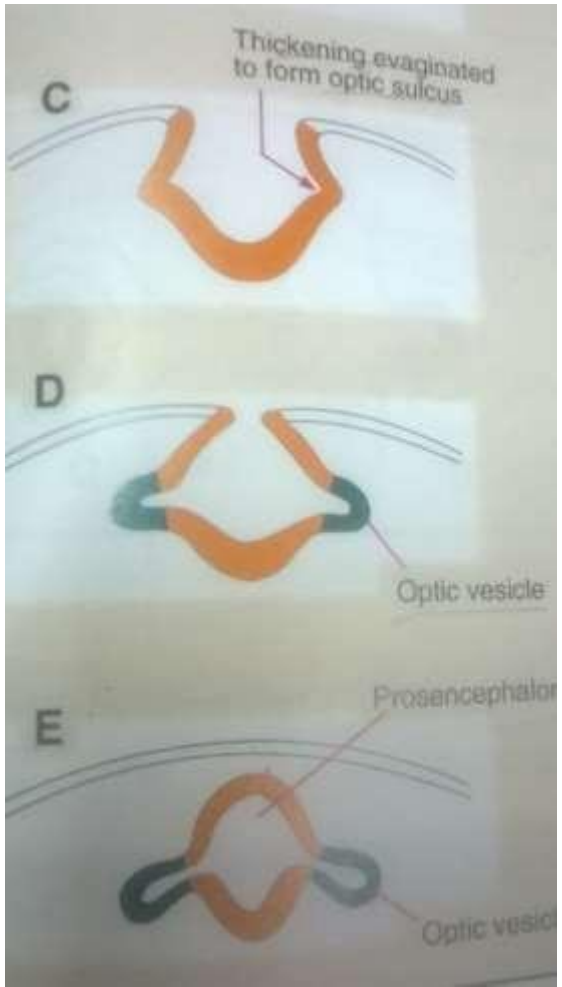


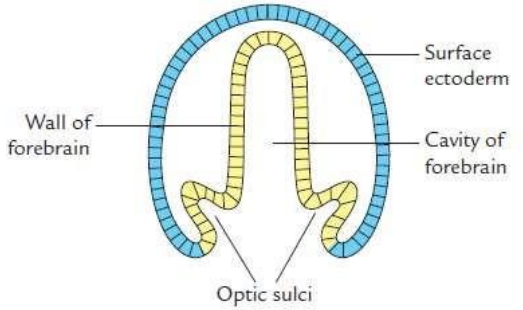


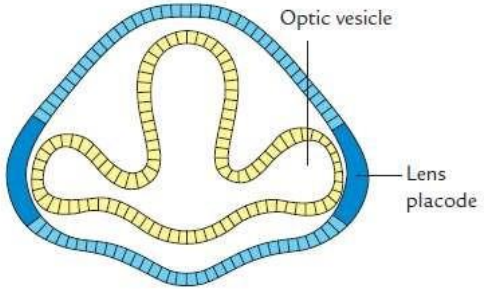
Formation of Optic vesicle:

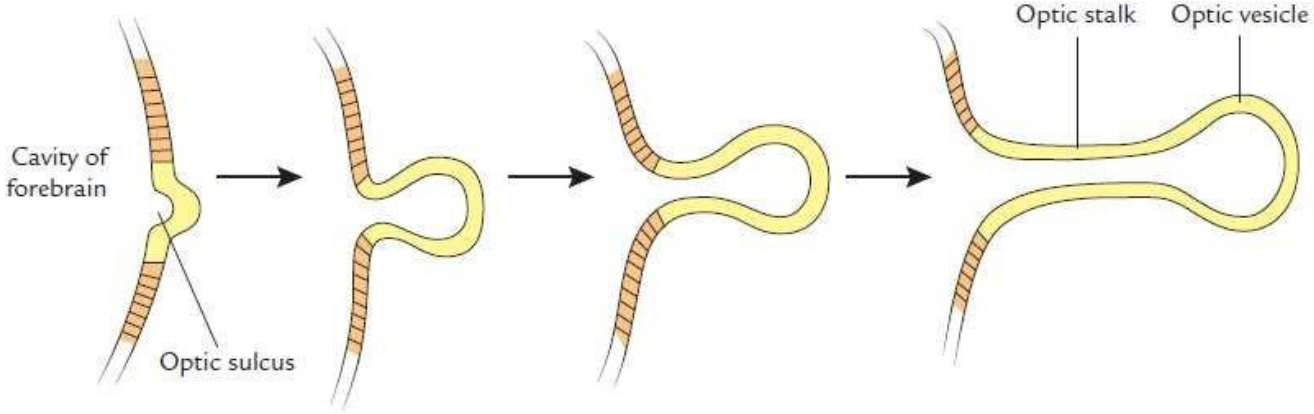
- Neural plate destined to form prosencephalon shows thickened area on each side that become depressed to form optic sulcus
- Optic sulcus bulges outward to form optic vesicle.
- Proximal part of optic vesicle becomes constricted and elongated to from optic stalk











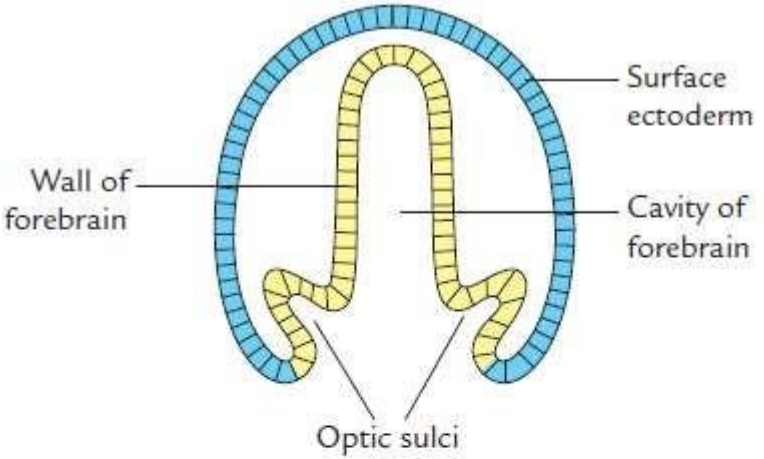
- As optic vesicle comes in contact with surface ectoderm, it thickens and forms **Lens placode— primordium of lens**

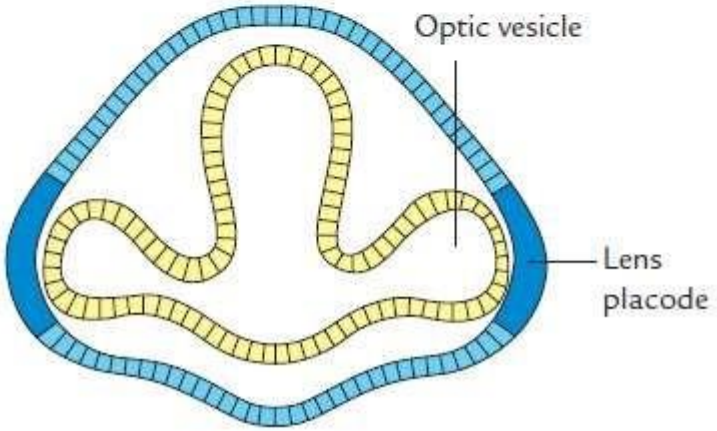
- lens placode gets depressed to form **lens pit**.

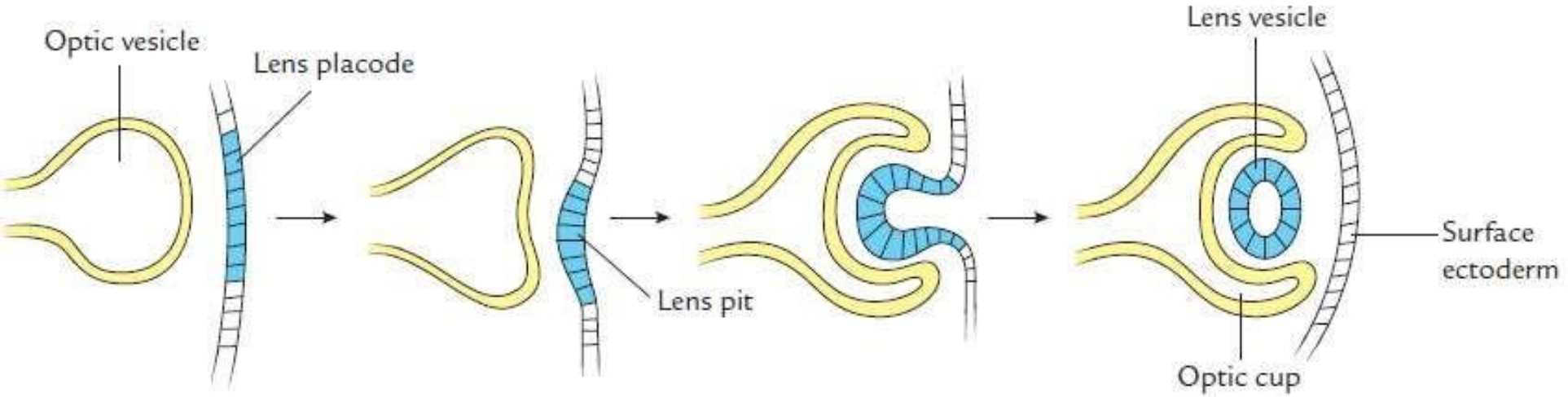
--As the lens pit deepens its edges approach each other and fuse to form **lens vesicle**, which gets cut off from the surfaceectoderm.

- While lens vesicle is being formed, optic vesicle invaginate to form double-layered **optic cup**.

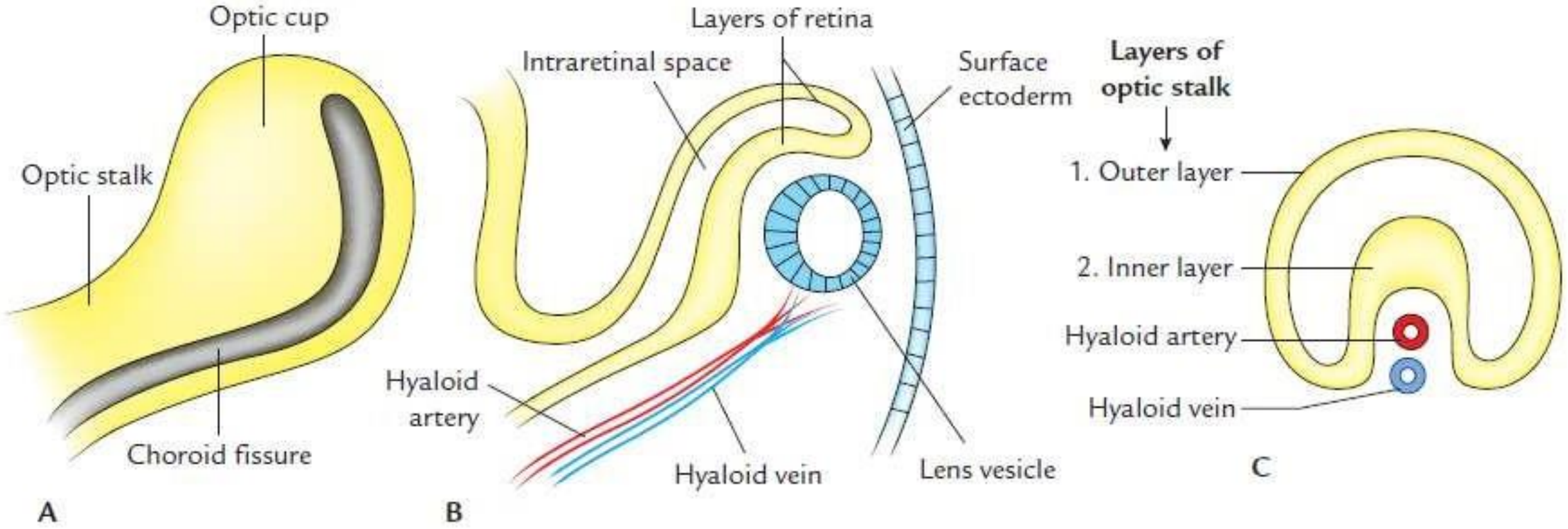
- Margins of the optic cup grow and enclose the lens vesicle.



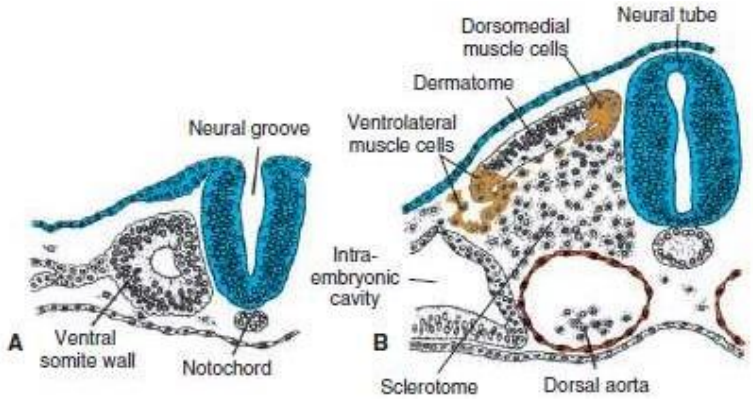


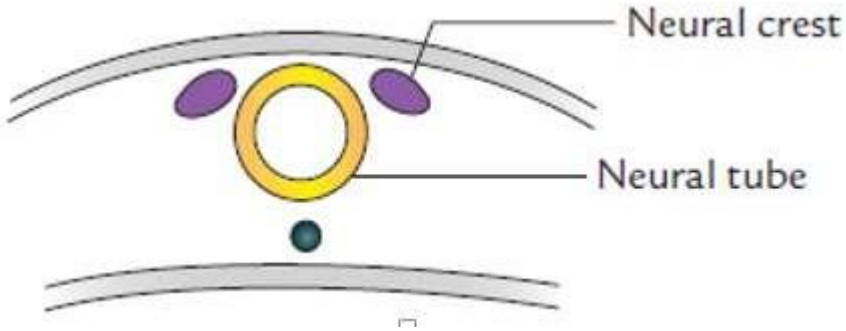


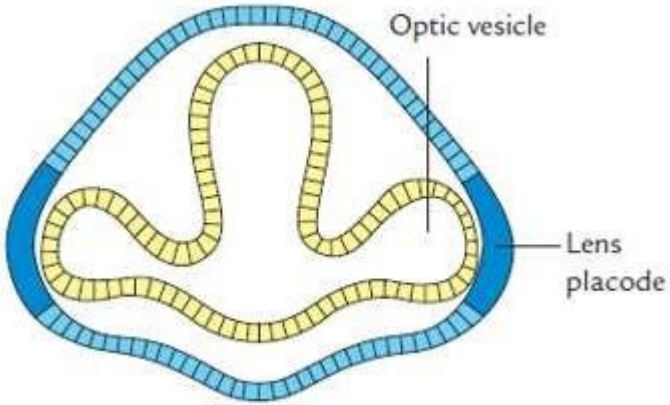
Margin of the optic cup grow over upper & lateral side of lens & does not grow on the inferior aspect forming **choroidal (fetal) fissure** that extend for some distance along inferior surface of optic stalk.

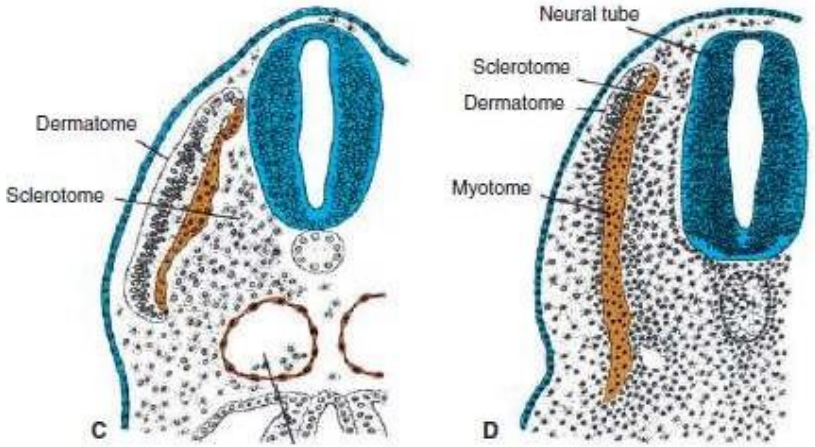


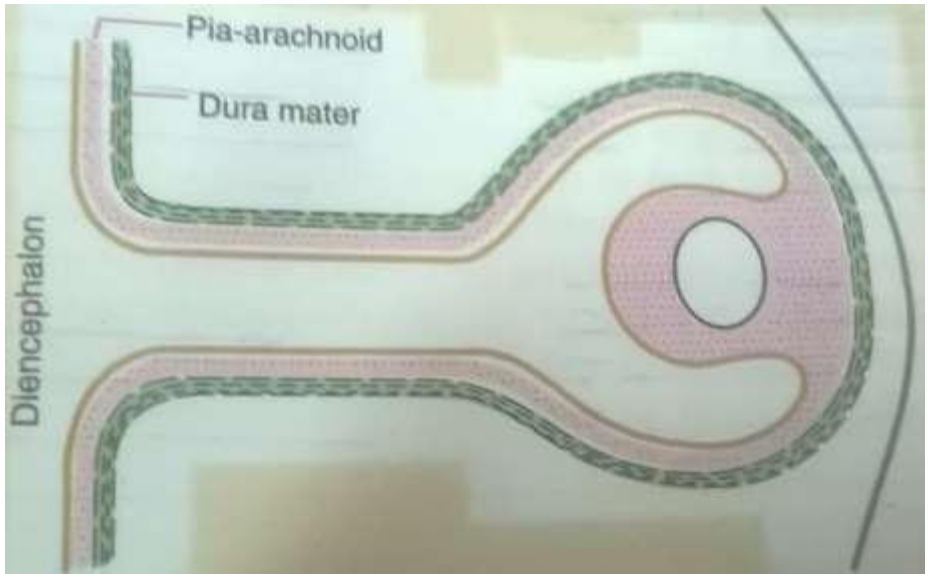
- Developing neural tube is surrounded by mesoderm, which condenses to form meninges.
- An extension of this mesoderm covers optic vesicle that differentiate to form:
  Superficial fibrous layrer – dura mater &
  Deeper vascular layer --- pai-arachnoid .



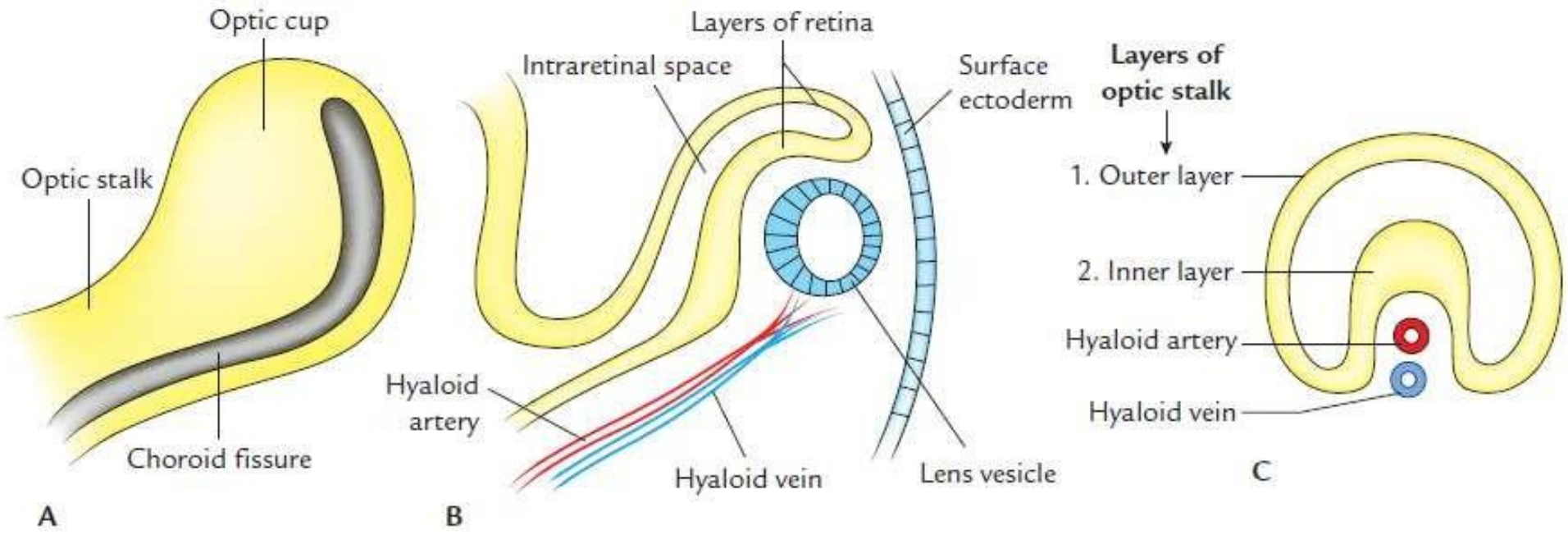


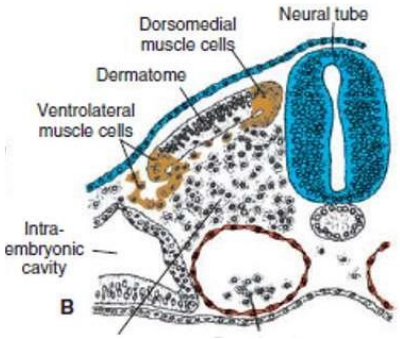


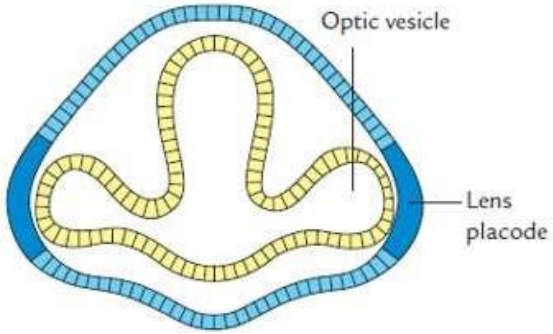




- Vascular mesoderm enters into the choroidal fissure & gets trapped in the optic vesicle & optic stalk.
- Vascular mesoderm forms hyaloid vessels (**hyaloid artery and hyaloid vein**)- supply to the layers of optic cup, mesoderm in the optic cup, and lens vesicle.
- Distal parts of hyaloid vessels eventually degenerate whereas their proximal parts persist as **central artery and vein of retina**.

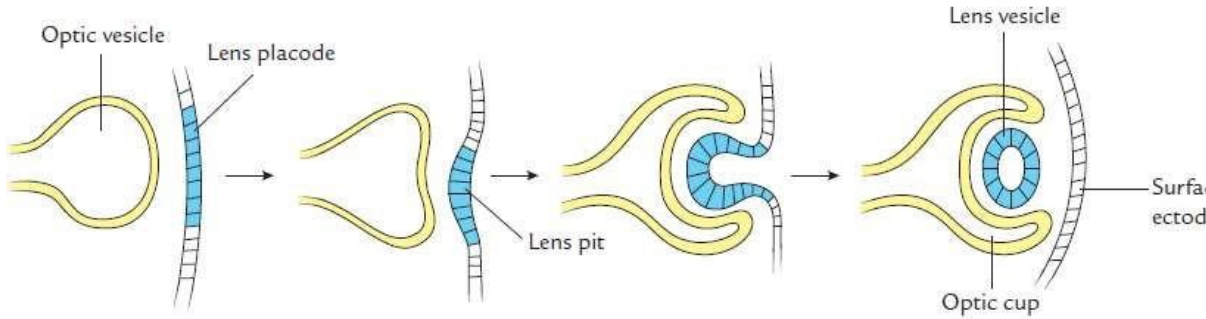






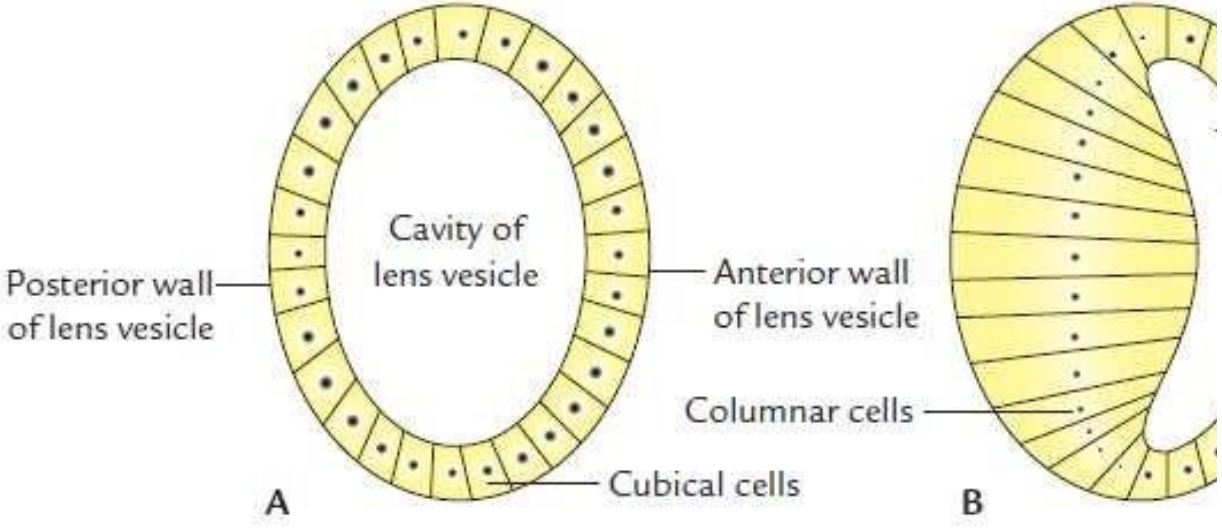
Derivation of Various Parts of Eyeball

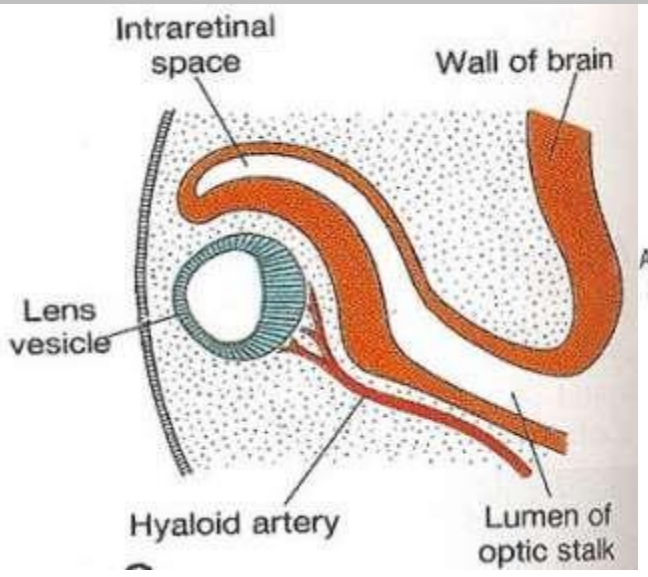
Lens: develops from lens vesicle—(surface ectoderm)

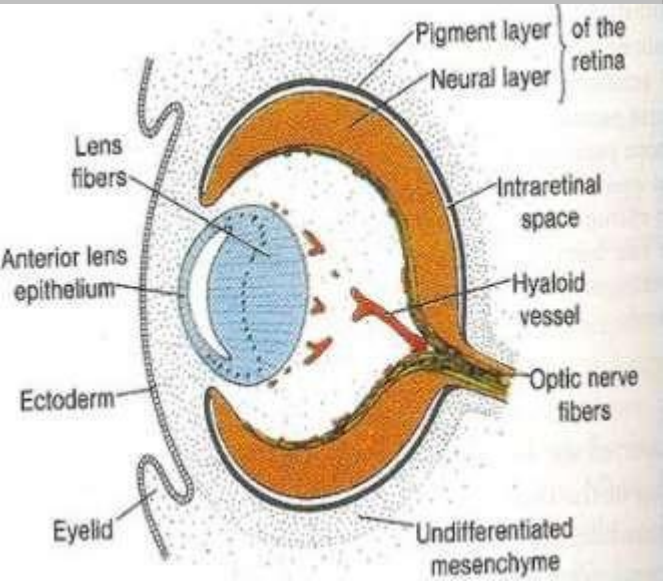


- Initially lens vesicle is lined by a single layer of cuboidal cells.
- Cells of anterior wall remain cuboidal that persist as epithelium.
- Cells of posterior wall - columnar & extend into the cavity causing obliteration of the cavity.
- Elongated cells of posterior wall further elongate considerably & lose their nuclei to form **lens fibers**.

- Lens is supplied by hyaloid artery—a branch of the ophthalmic artery. Later, distal part of hyaloid artery disappears; blood supply to lens is stopped. Lens- avascular structure.







Retina: develops from optic cup which is divisible into:

a. Posterior part (Optical Part of Retina): forms Ratina Proper

b. Anterior part (Ciliary & Iridal parts of ratina): forms epithelial covering for ciliary body & iris

Thin Outer wall of posterior part forms:

<u>pigment layer of the retina.</u>

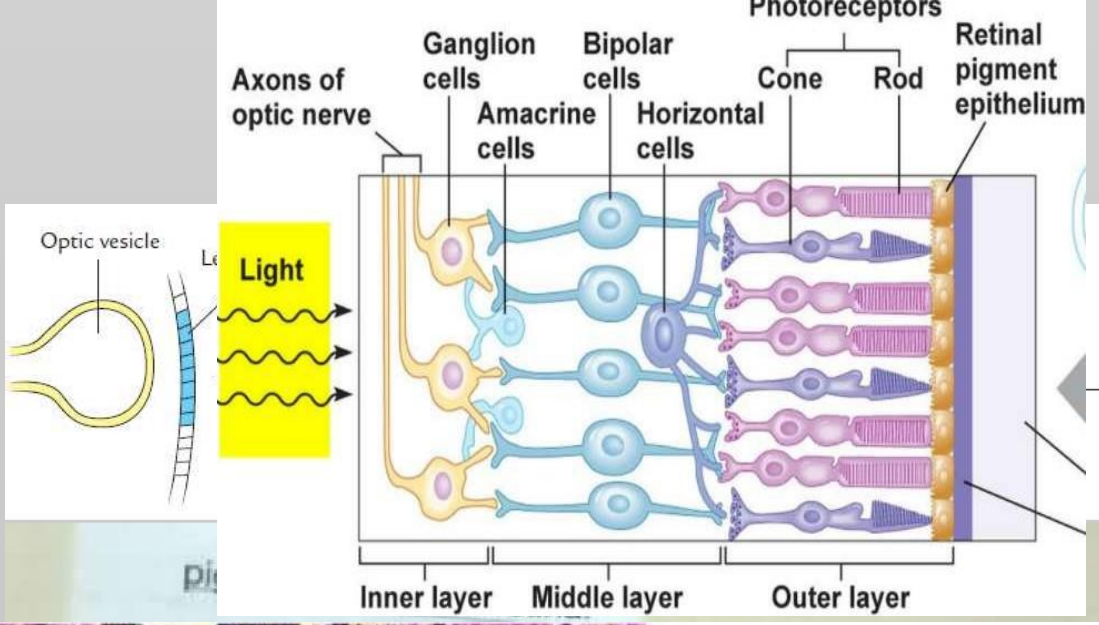
Thick Inner wall of cup forms: <u>neural layer of the retina.</u> Inner wall differentiates into:

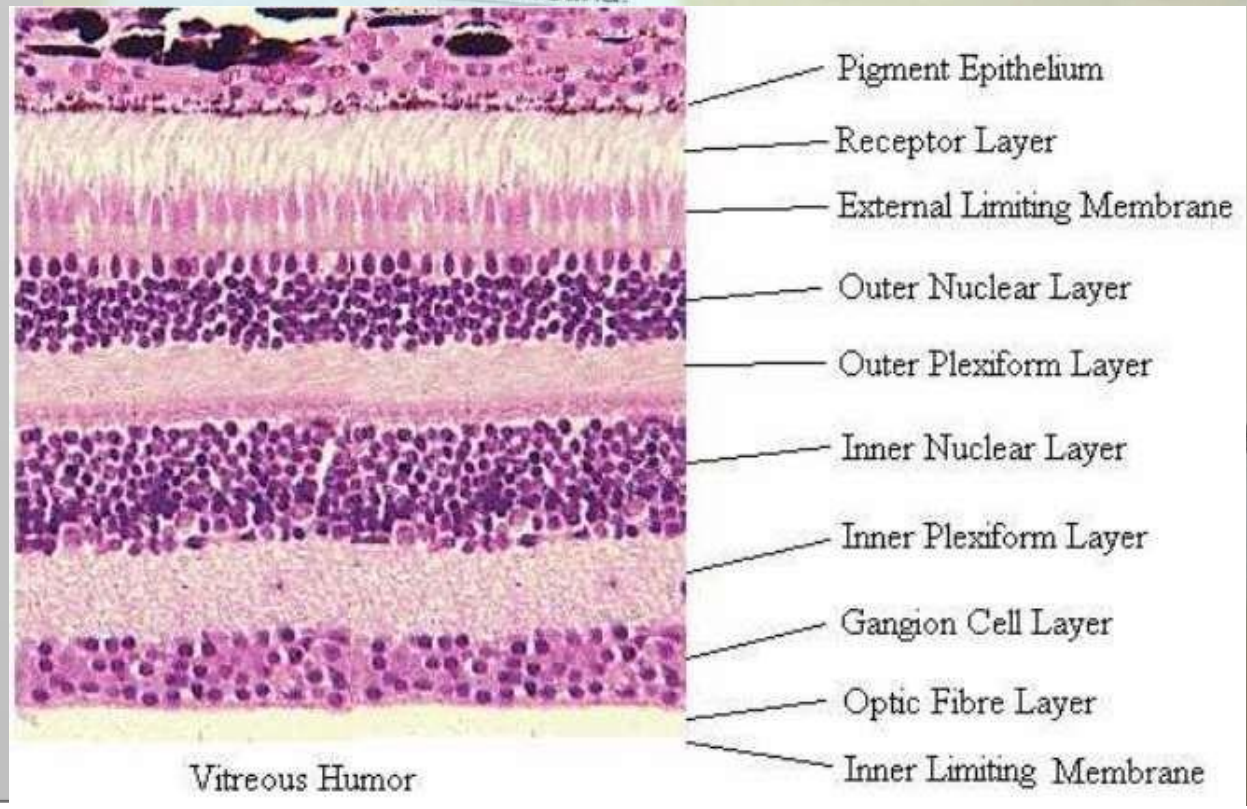
Matrix cell, Mental & Marginal layer

- Cells of matrix layer form: Rods & Cons
- Mental layer forms: Bipolar cells, Ganglionic cells & other neuron of ratina,
- Marginal layer –

Axon of ganglionic cell grow into marginal layer to form layers of nerve fibres that grow into the optic stalk passing through choroidal fissure.

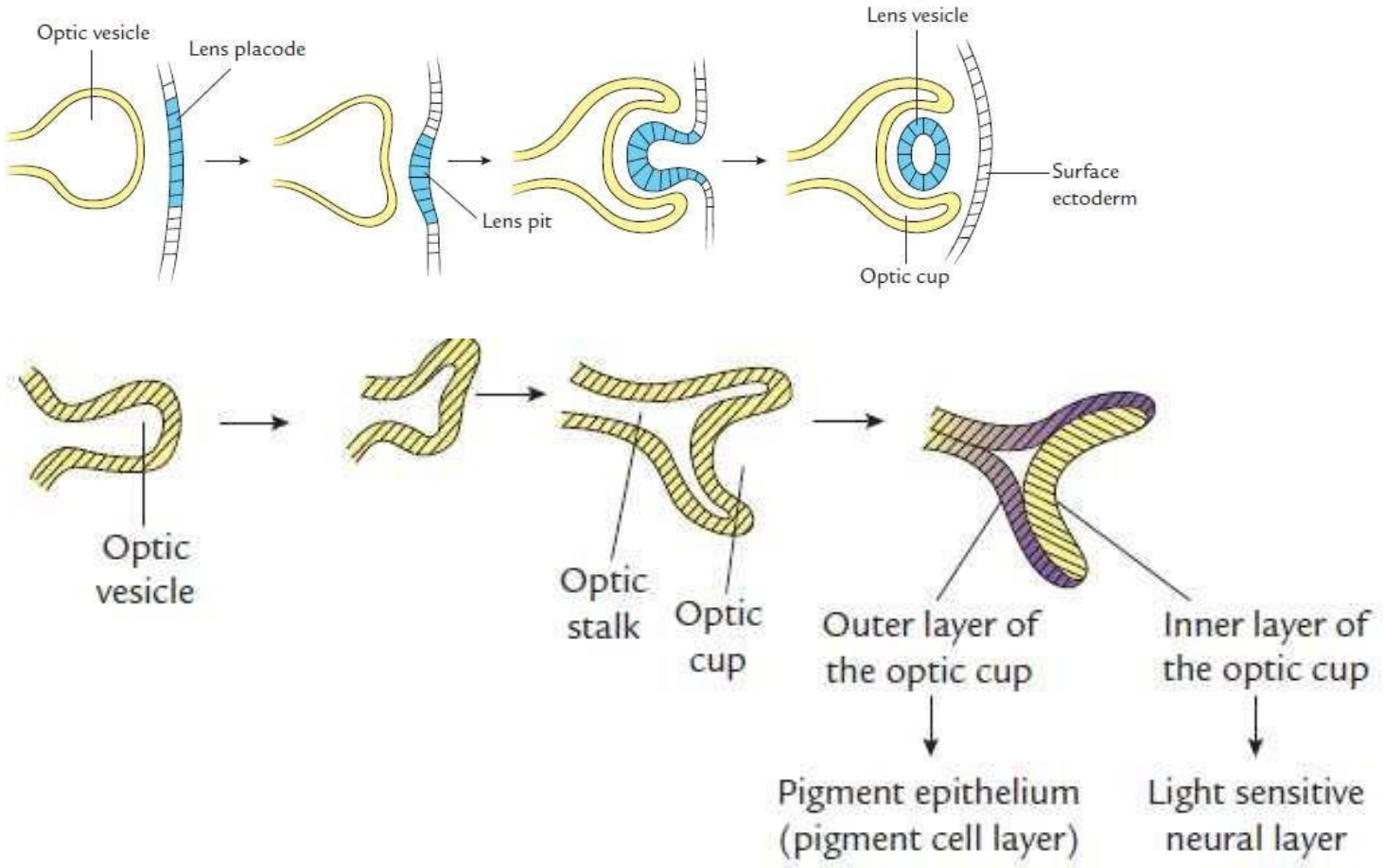
<u>Optic stalk</u> is thus converted into <u>Optic nerve</u>

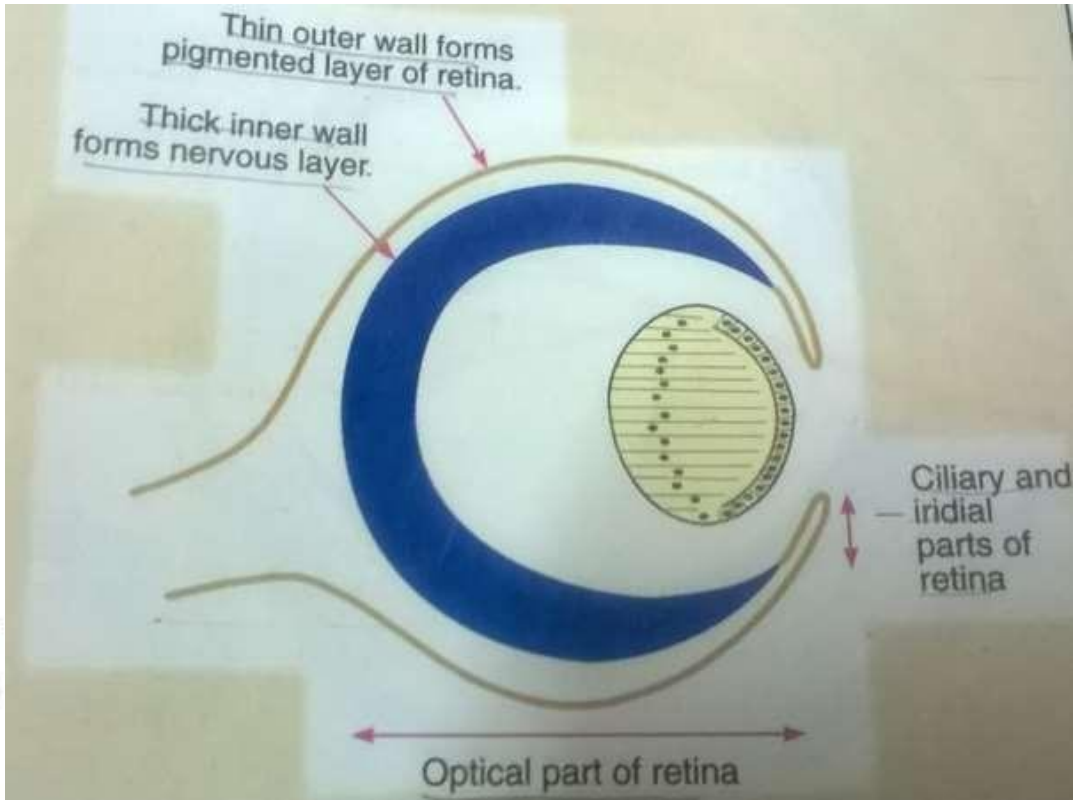




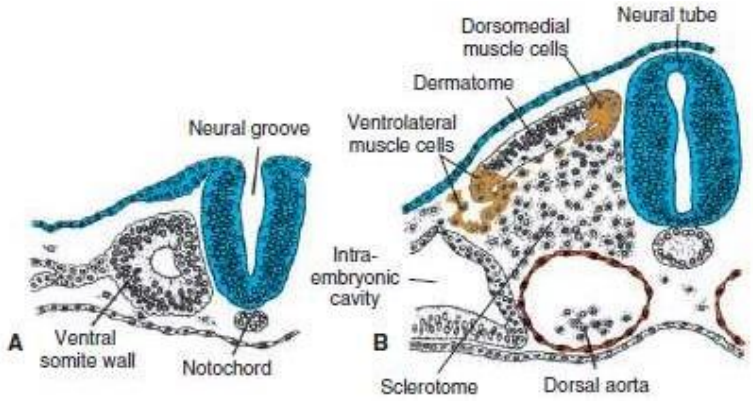
- During embryonic & early fetal periods, pigment & neural layers of retina are separated by **intraretinal space-** representing the original cavity of the optic cup.

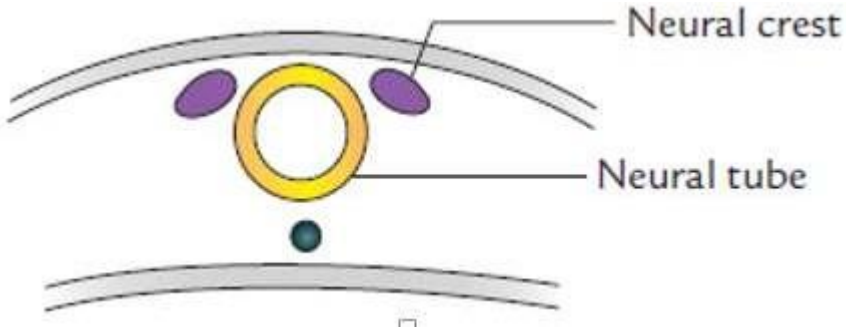
- Before birth the space is obliterated with proliferation of cells of the inner layer. Thus, rod & cone cells come in contact with pigment layer of the retina.

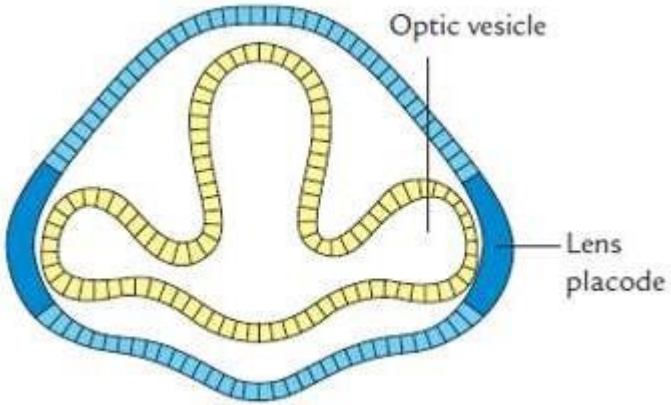


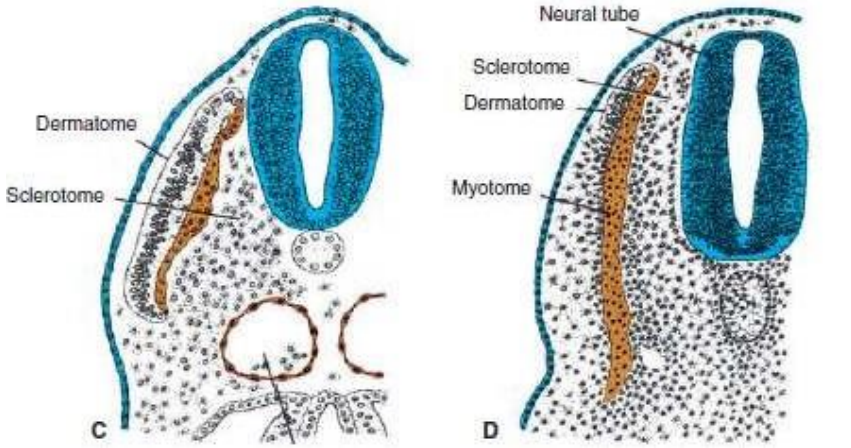


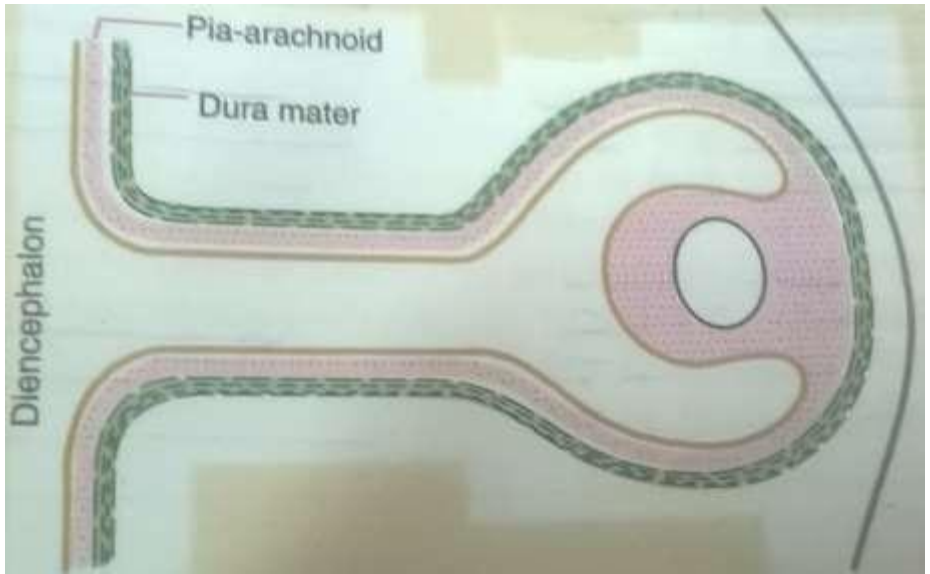
- Developing neural tube is surrounded by mesoderm, which condenses to form meninges.
- An extension of this mesoderm covers optic vesicle that differentiate to form:
  Superficial fibrous layrer – dura mater &
  Deeper vascular layer corresponding to pai-arachnoid .









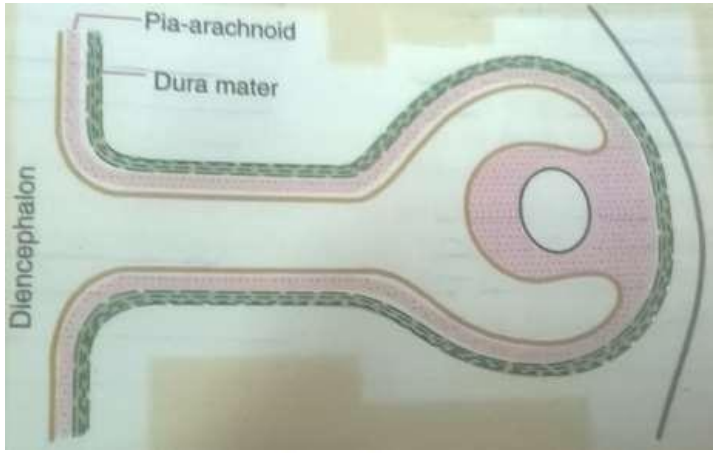


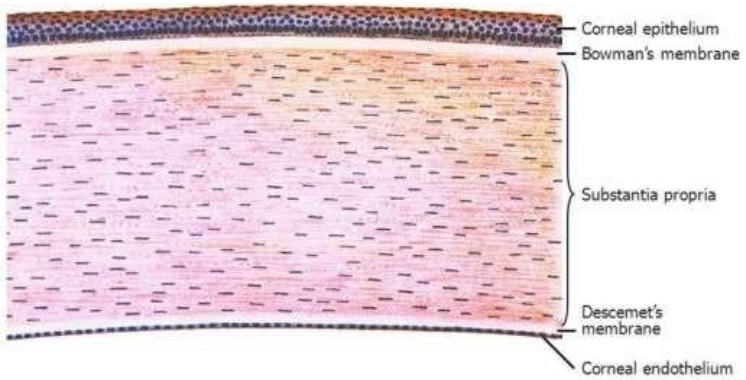
Sclera and Choroid

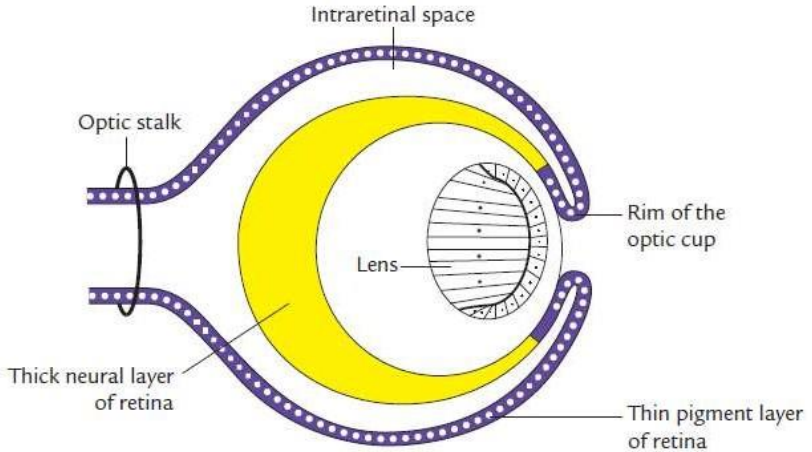
Mesoderm around the optic cup differentiates into
(a) Outer fibrous layer -sclera.
(b) Inner vascular layer- choroid

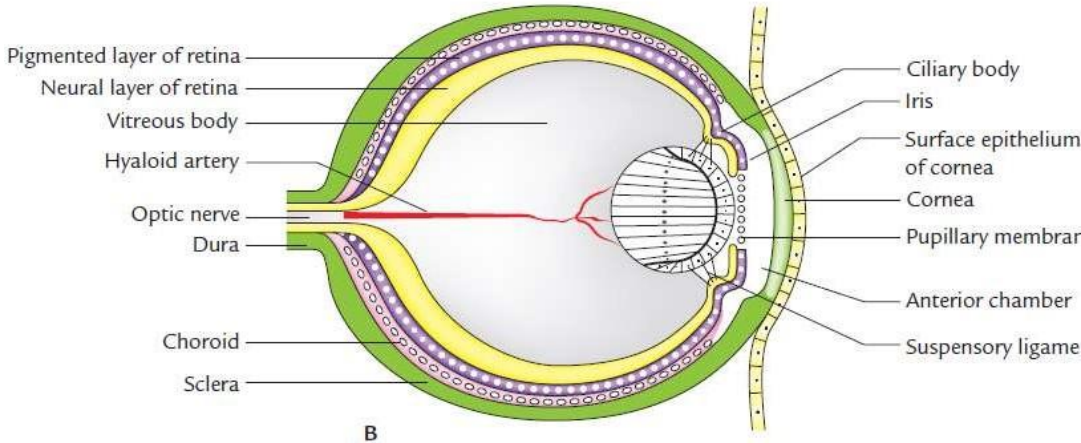
- ❑ Sclera is continuous
  - Anteriorly with substantia propria of cornea,
  - posteriorly with dura mater, that surrounds optic nerve.

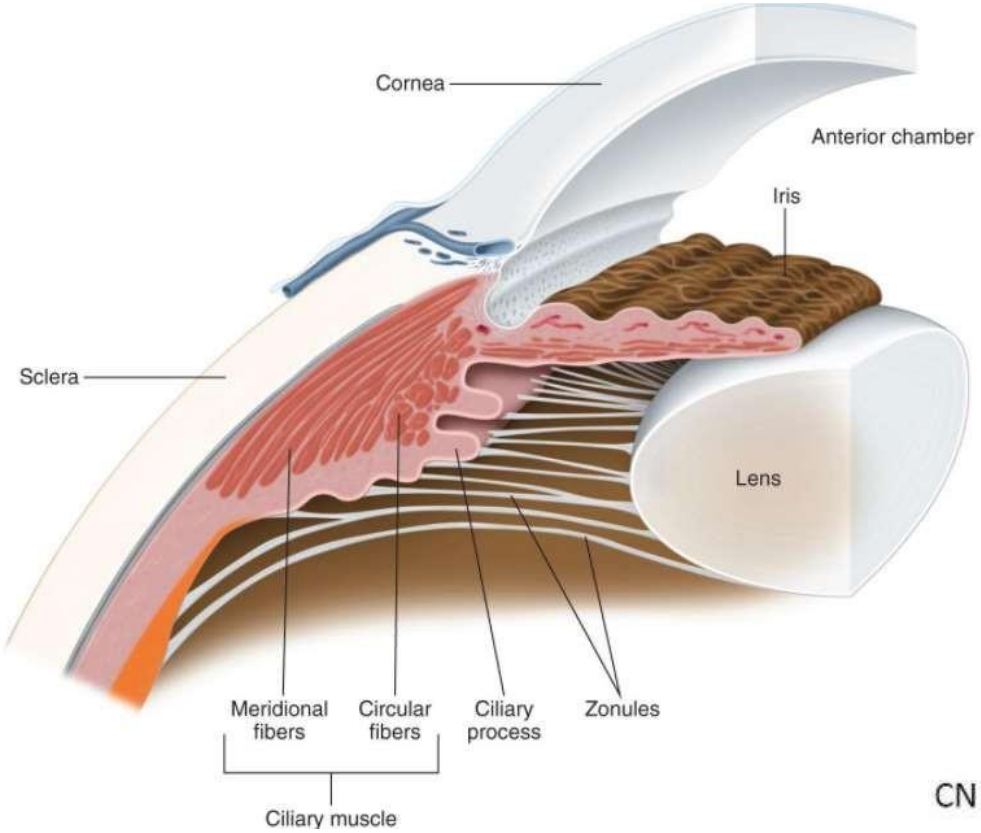
- ❑ Choroid is continuous
- Anteriorly on each side with ciliary body
- Posteriorly with piaarachnoid around optic nerve.

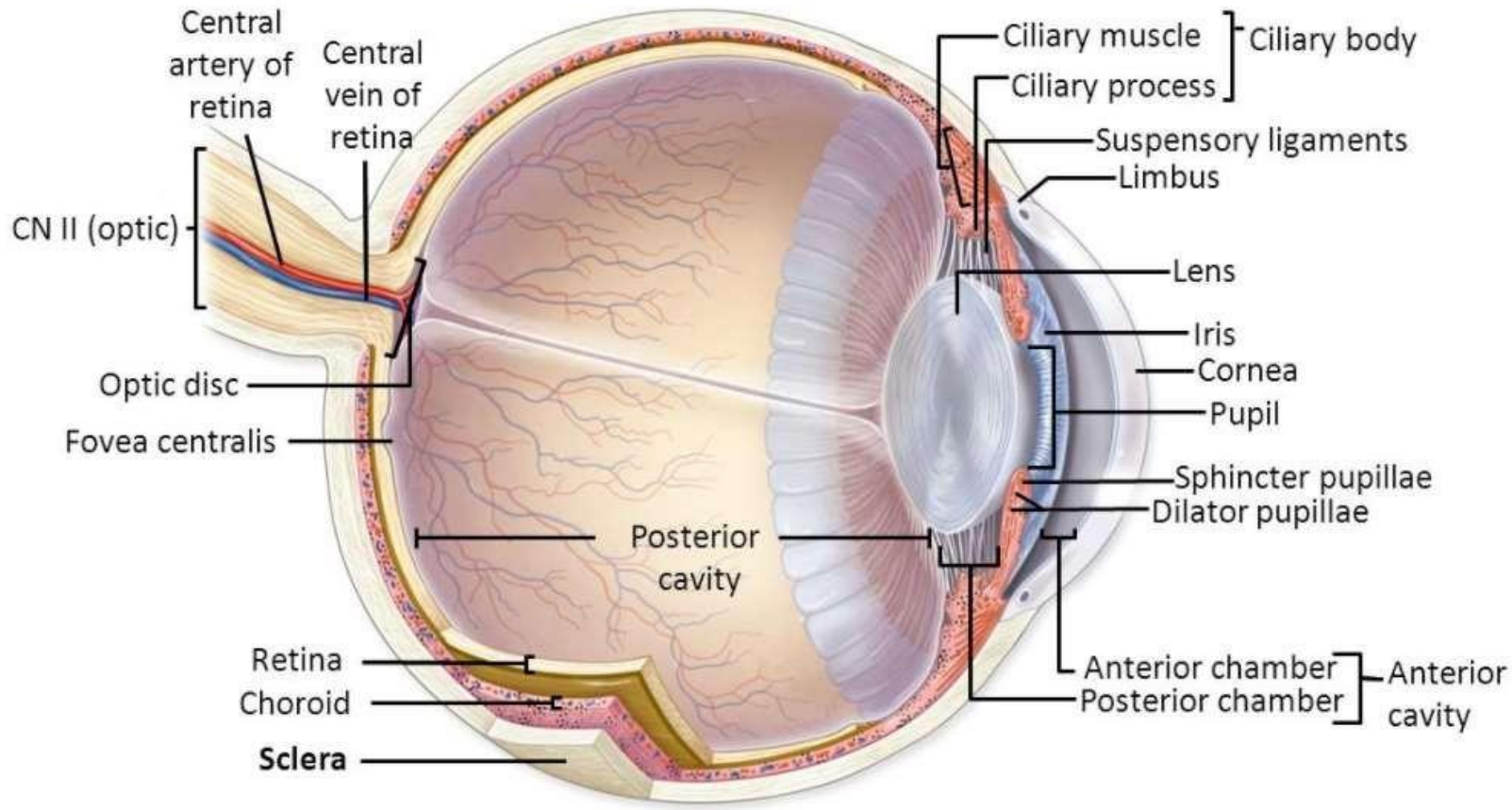









Cornea
Anterior chamber
Iris
Sclera
Lens
Meridional fibers
Circular fibers
Ciliary process
Zonules
Ciliary muscle

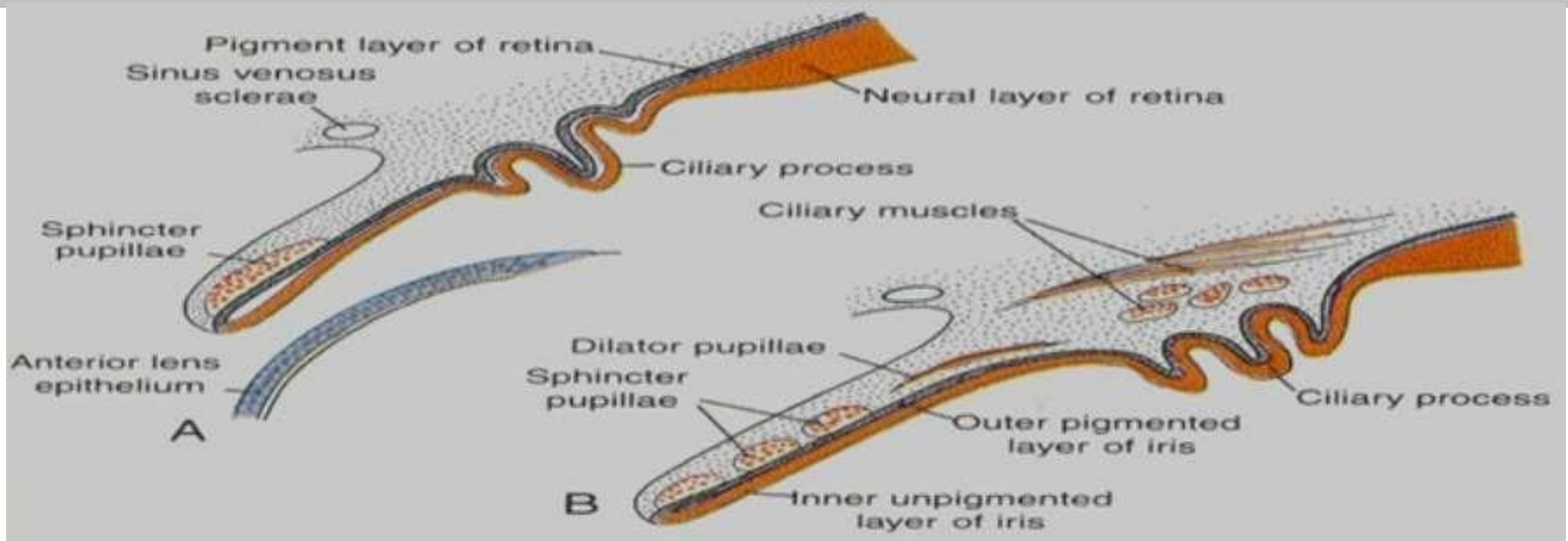

Central artery of retina
Central vein of retina
CN II (optic)
Optic disc
Fovea centralis
Retina
Choroid
Sclera
Ciliary muscle
Ciliary body
Ciliary process
Suspensory ligaments
Limbus
Lens
Iris
Cornea
Pupil
Sphincter pupillae
Dilator pupillae
Posterior cavity
Anterior chamber
Posterior chamber
Anterior cavity

Ciliary body & Iris: Derived form forward prolongation of mesoderm forming the choroid

Posterior surface of this mesoderm comes to be lined by rim of optic cup- projects towards the lense forming cilary process.

Outer pigmented layer of ciliary epithelium - outer layer of optic cup Inner nonpigmented layer of ciliary epithelium - Neural layer

Ciliary muscle & connective tissue are derived from mesoderm

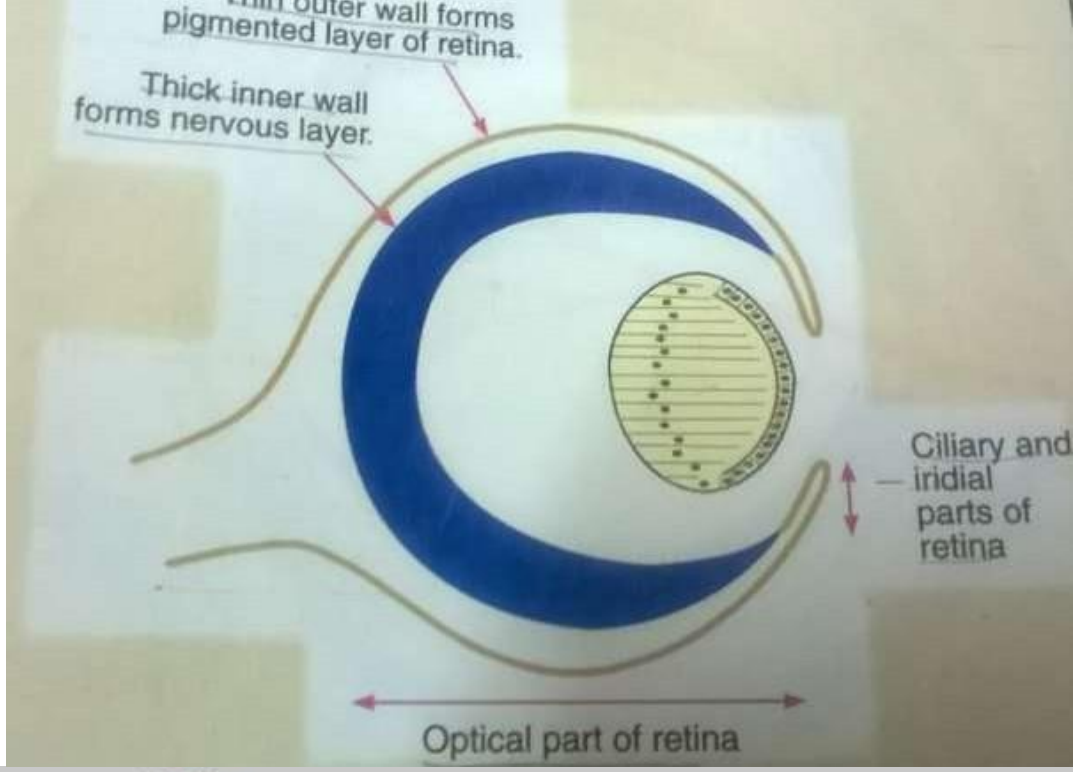


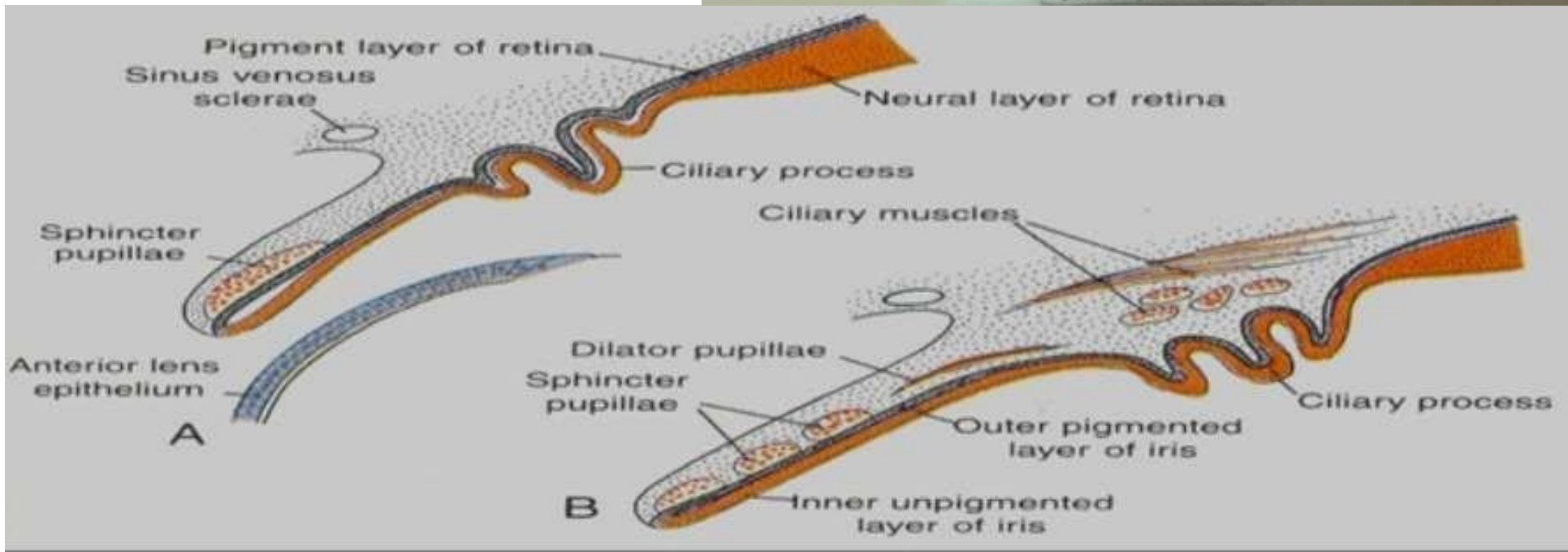
Iris:

Epithelium of iris is derived from both layers of optic cup

Muscles of the iris (**sphincter and dilator pupillae**)- Neuroectodermal cells of the optic cup

Vascular connective tissue of iris - derived from mesoderm located anterior to the optic cup

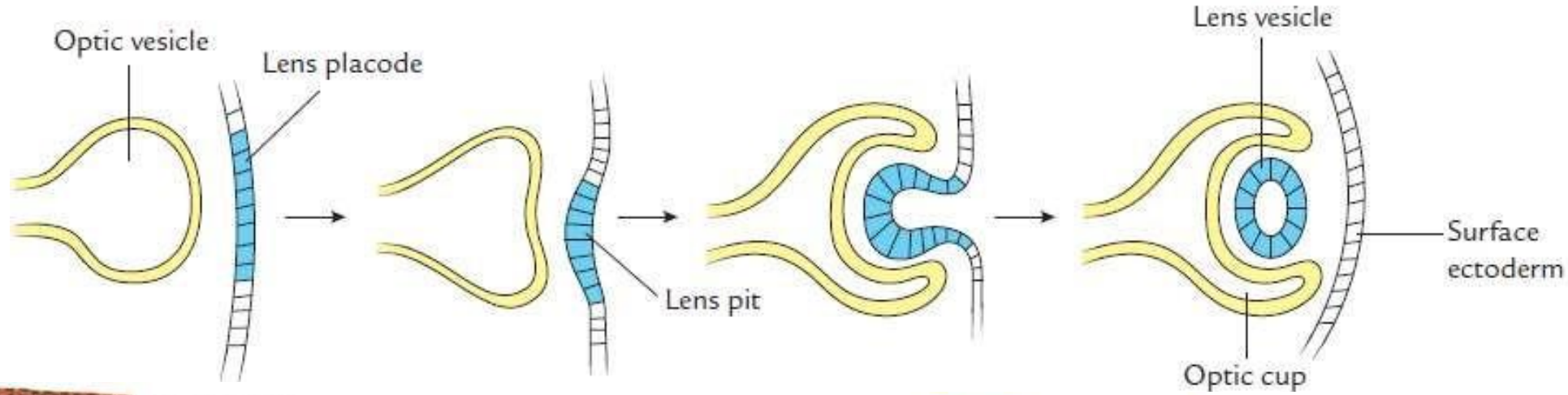


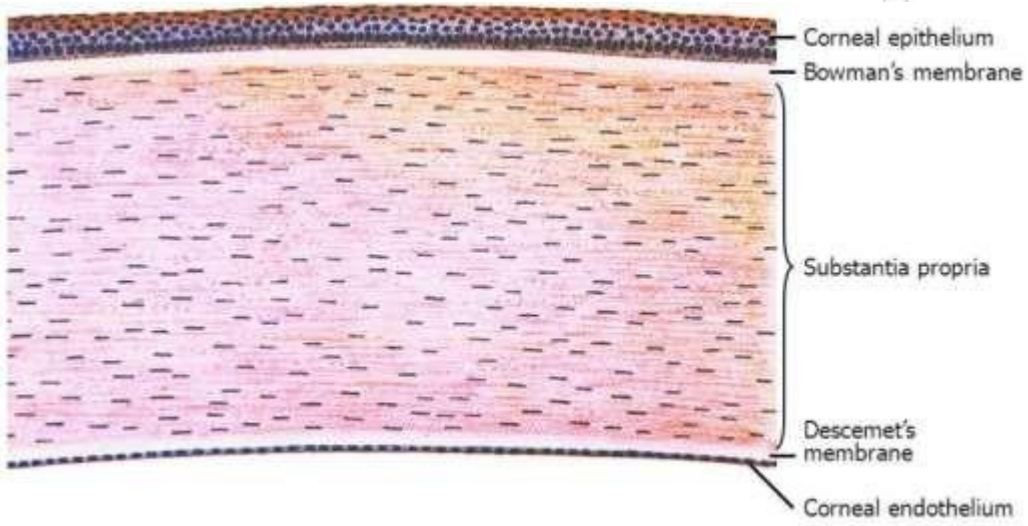


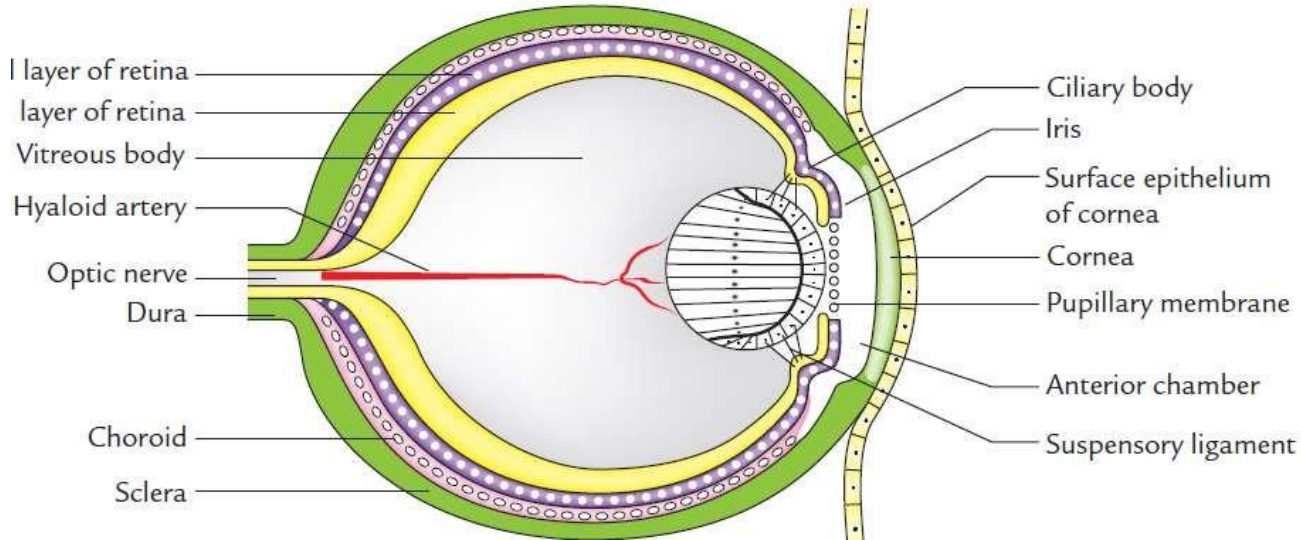
Cornea: Development of cornea is induced by the lens vesicle.

The cornea is derived from following sources:

- *Outer stratified squamous epithelium* is derived from the **surface ectoderm**.
- *Substantia propria of the cornea* is derived from the **mesoderm**. It is continuous with sclera.
- *Inner corneal epithelium* is derived from the **mesoderm**.

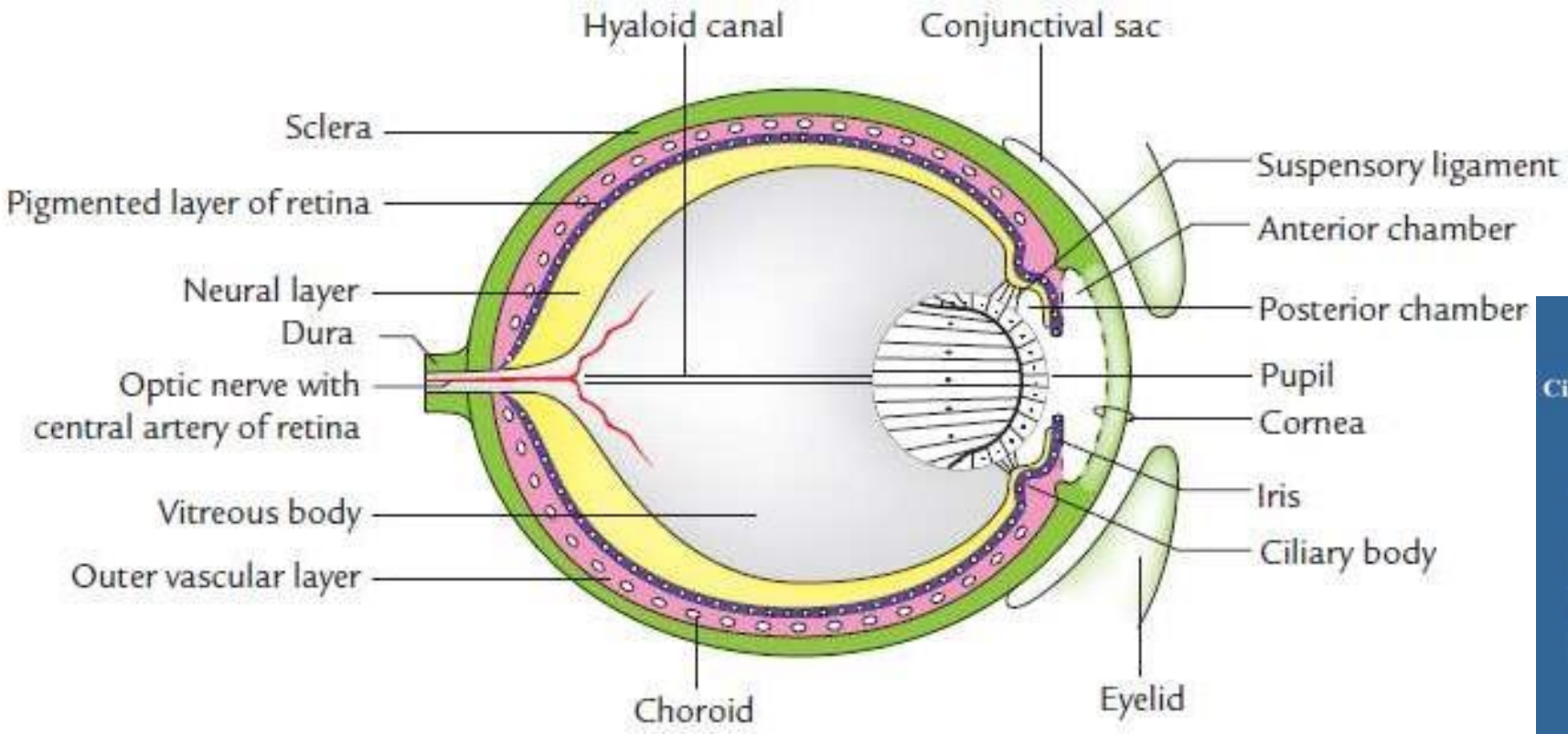


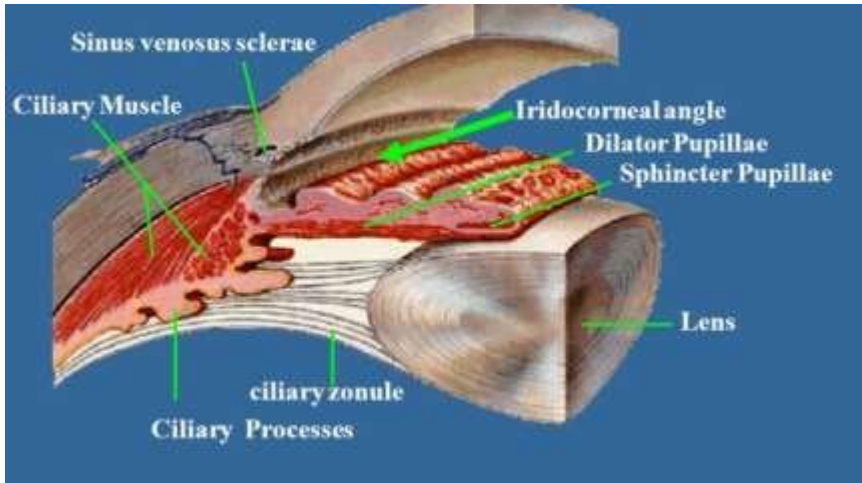




Anterior and Posterior Chambers (Aquous chamberof the Eye):

- Mesoderm located between developing iris and cornea splits to form - **anterior chamber**.
- Mesoderm located between the developing iris and lens splits to form- **posterior chamber**
- Disappearance of **pupillary membrane** form a communication between anterior & posterior chamber.
- Anterior & Posterior chambers are filled by aqueous humor secreted by ciliary processes of ciliary body.
- Aqueous humor is drained by **sinus venosus sclerae** (canal of Schlemm)





Vitreous Body (Vitreous Humor)

primary vitreous humor - is formed by neural crest (ectoderm)

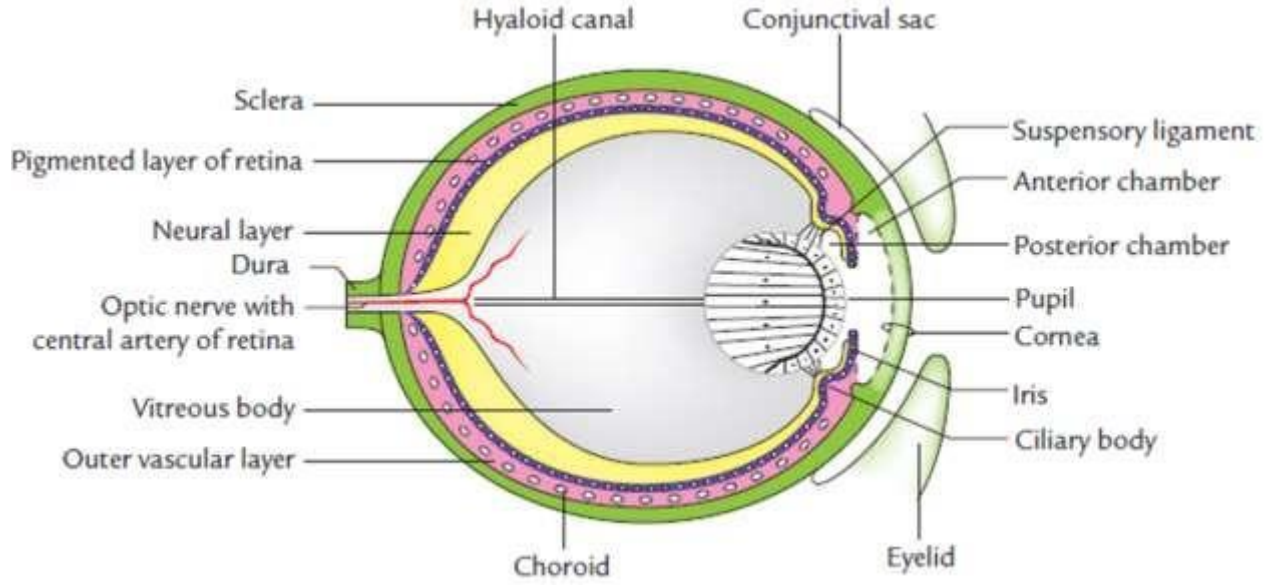
secondary vitreous humor - inner layer of the optic cup (ectoderm) and a little bit from lens vesicle.

Vitreous body is made up of a vascular mass of transparent gel-like intracellular substance. It contains hyaloid artery that later obliterates to form a **hyaloid canal** of adult eye

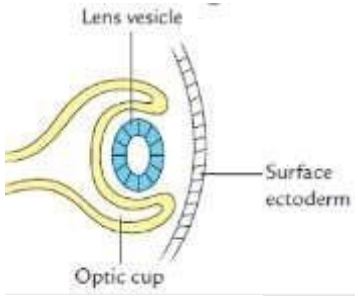
Mesodermal component comes into the optic cup through the choroidal fissure.

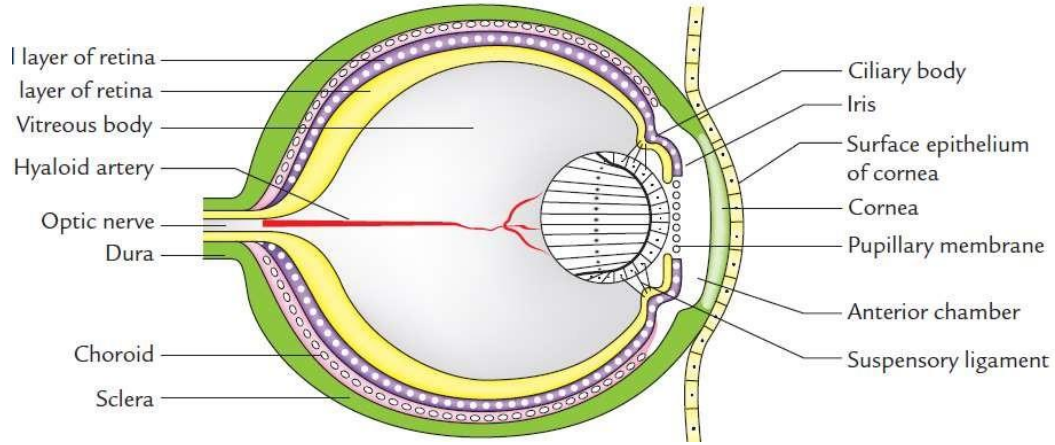
Blood vessels of the eyeball: formed in mesodermal layer that is continuation of the pia-arachnoid .

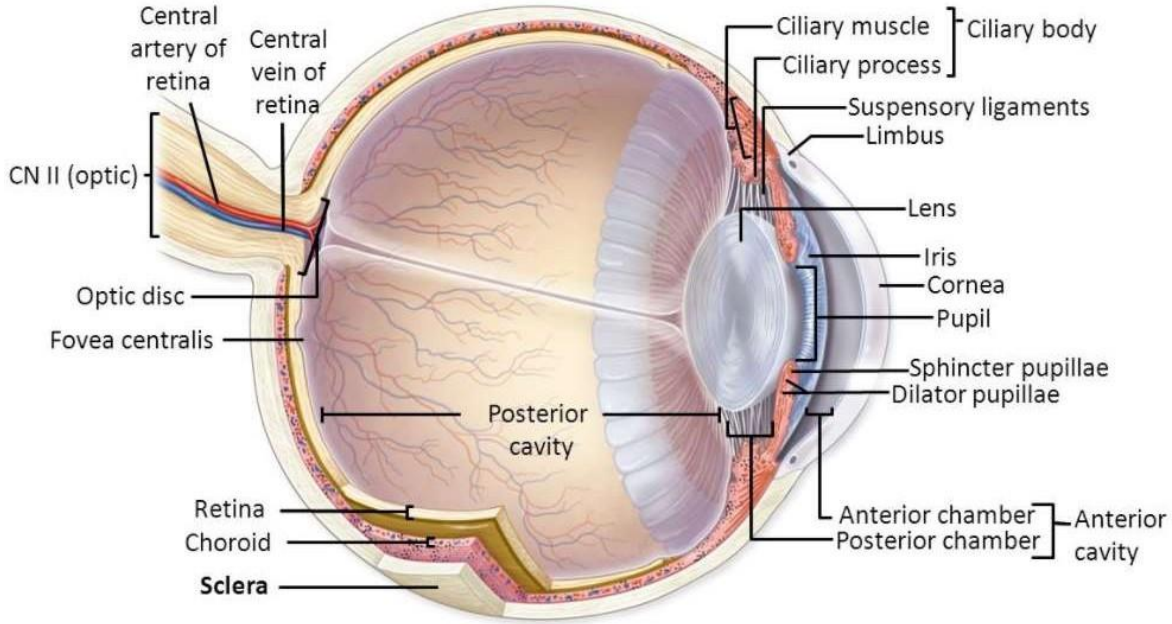
Mesoderm that gets invaginated into optic cup forms retinal vessels



Structure	Source
Anterior epithelium of cornea	Surface ectoderm
Substantia Propria	Mesoderm
Posterior epithelium of cornea	mesoderm
Sclera	Mesoderm
Choroid	Mesoderm
Ciliary body	Mesodem
Stroma of Iris	Mesoderm
Dilator & sphincter pupillae	Optic cup (neuroectoderm)
Epithelium of Iris & ciliary body	Rim of optic cup
Lens	Surface ectoderm
Vitreous body	Mesoderm
Neural layer of retina	Inner layer of optic cup
Pigment layer of retina	Outer layer of optic cup
Optic Nerve	Optic stalk
Central artery & vein of retina	Mesoderm



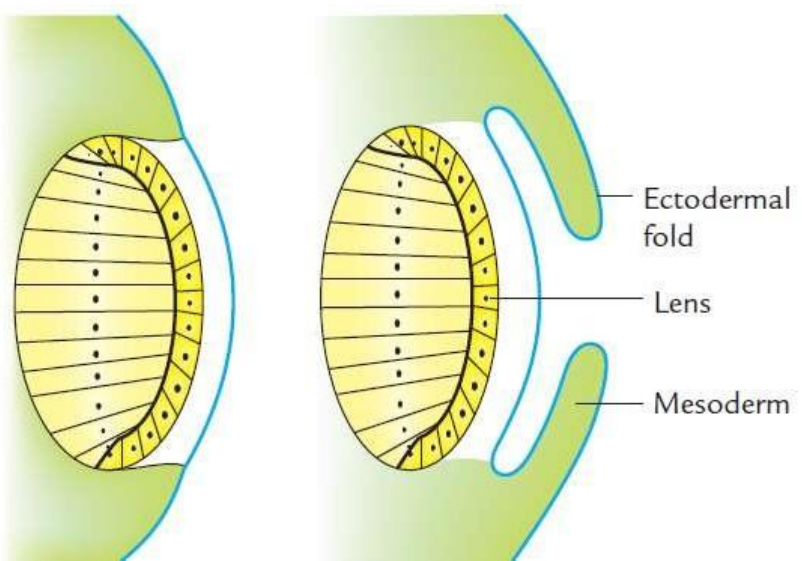


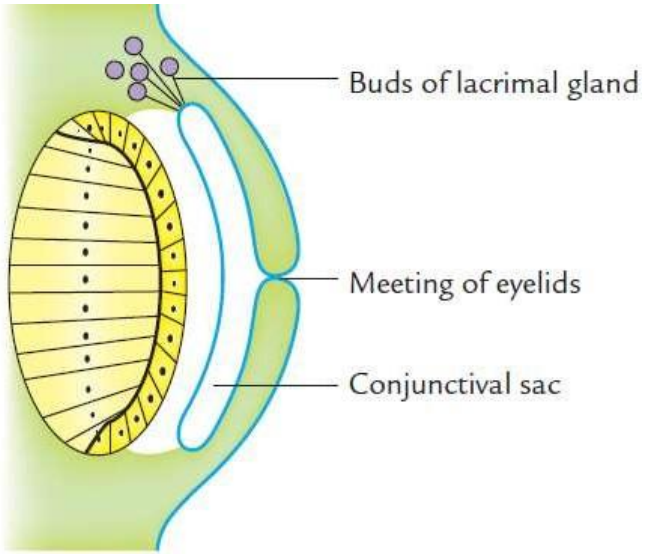


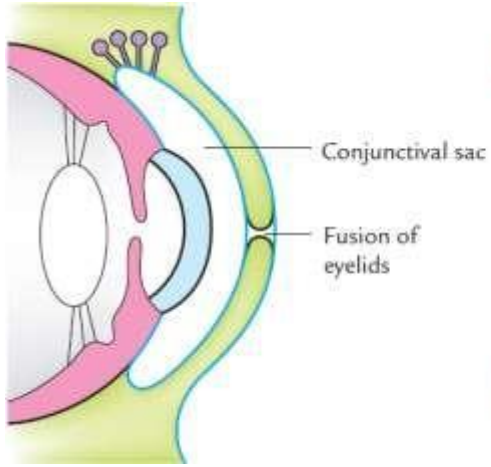
Accessory Structures of the Eyeball

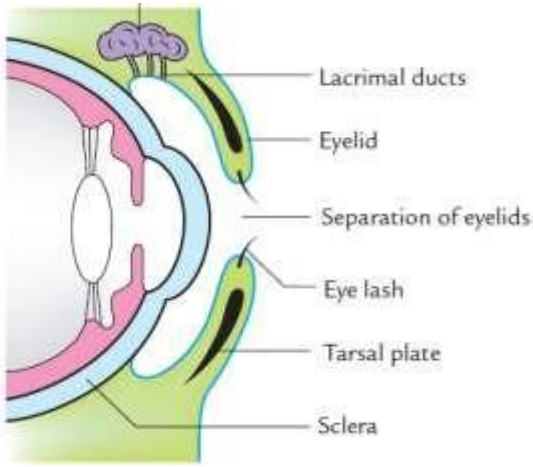
Eyelids:

- Develop from reduplication of surface ectoderm above and below the cornea.
- Ectodermal folds contain a core of mesoderm- *gives rise to muscles & tarsal plates*.
- Upper & Lower folds grow -fuse with each other, enclosing a space - **conjunctival sac**. Thus conjunctiva is of ectodermal origin.
- Eyelids remain fused with each other till 10th week and remain adhered to each other until 7 month of IUL.
- Eyelashes and glands develop from **surface ectoderm** covering the eyelids





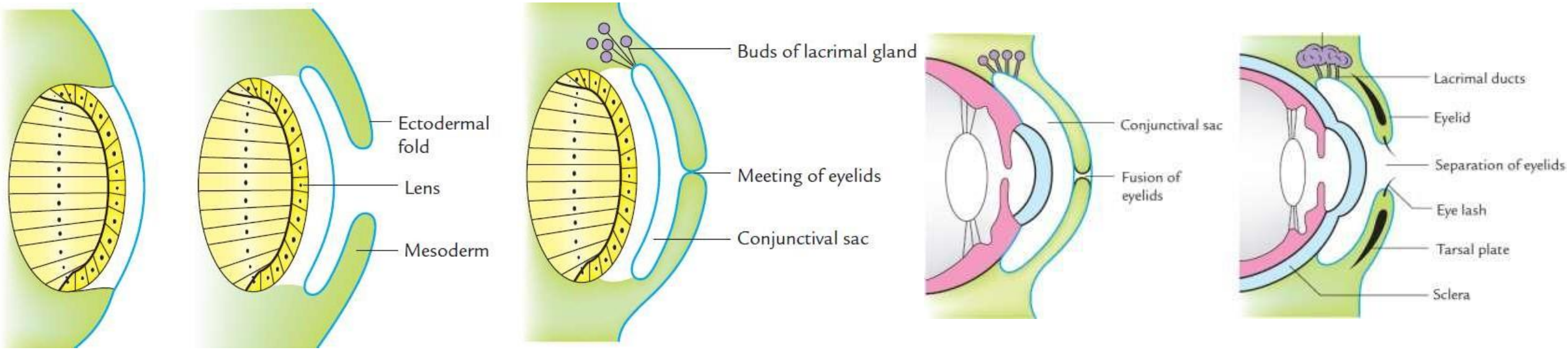




Lacrimal Glands:

Develops from 15 to 20 buds that grow from the superolateral angle of the conjunctival sac.

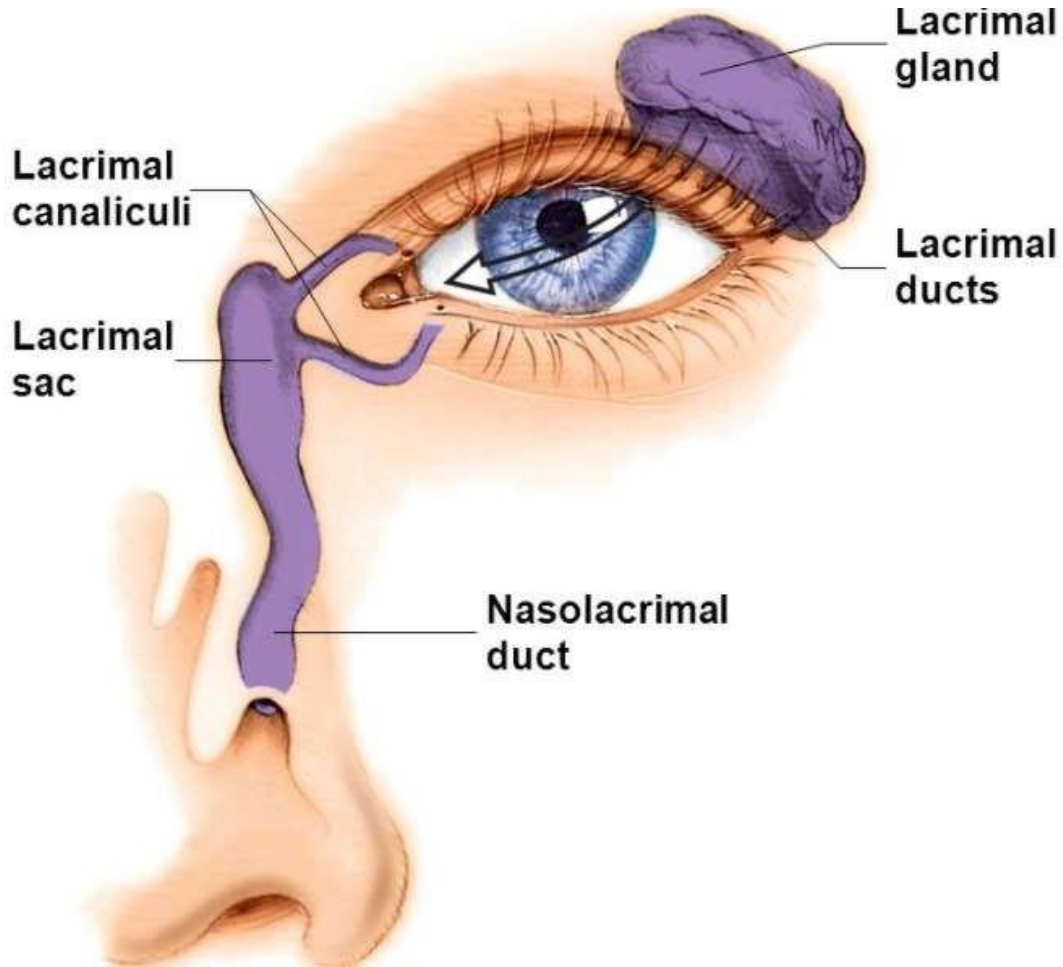
Buds elongate and get canalized to form ducts that open in conjunctival sac.

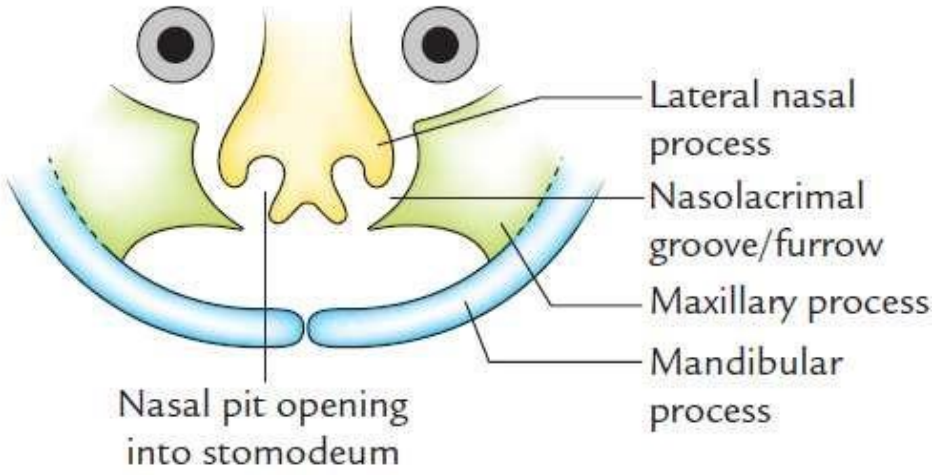


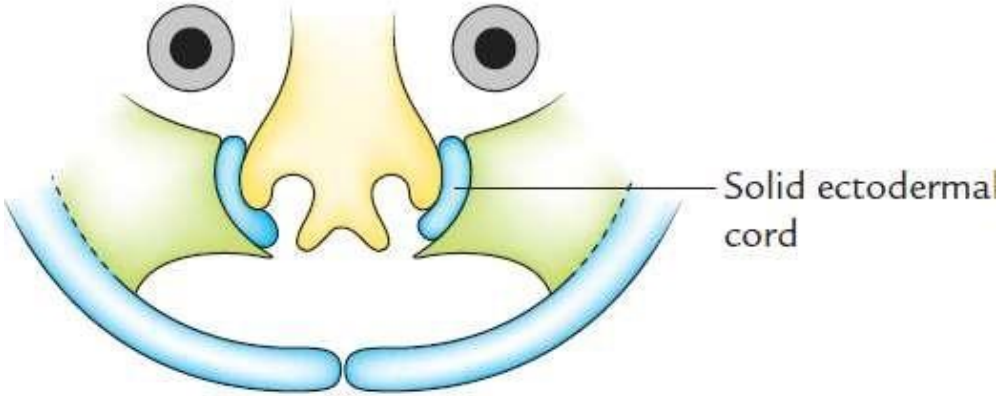
Lacrimal Sac and Nasolacrimal Duct

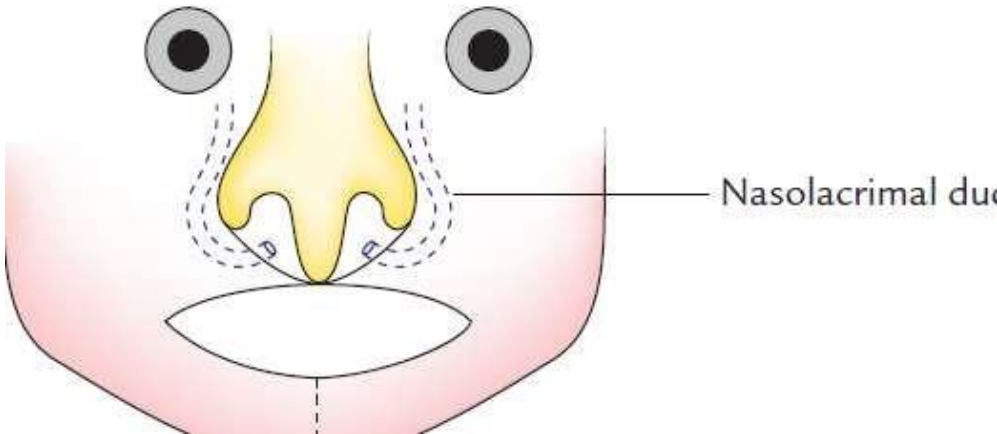
Develop from the ectoderm of **nasolacrimal/Naso-optic forrow** present along the line of fusion of maxillary &lateral nasal processes.

L**acrimal canaliculi** develop from canalization of the <u>ectodermal buds</u> that grow from medial ends of of each eyelid to the lacrimal sac.









Congenital anomalies of the eye :

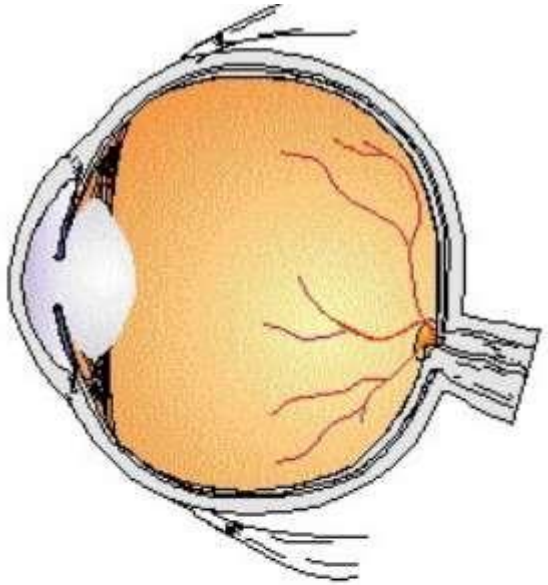
1. Anophthalmia (absence of an eye): optic vesicle fails to form.

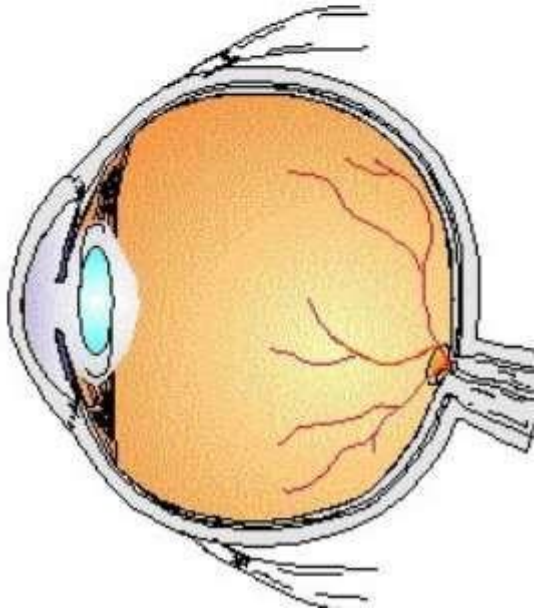
2. Microphthalmia (a small eye): optic vesicle is small; Lens is usually not formed.

3. Cyclopia: two eyes may fuse completely

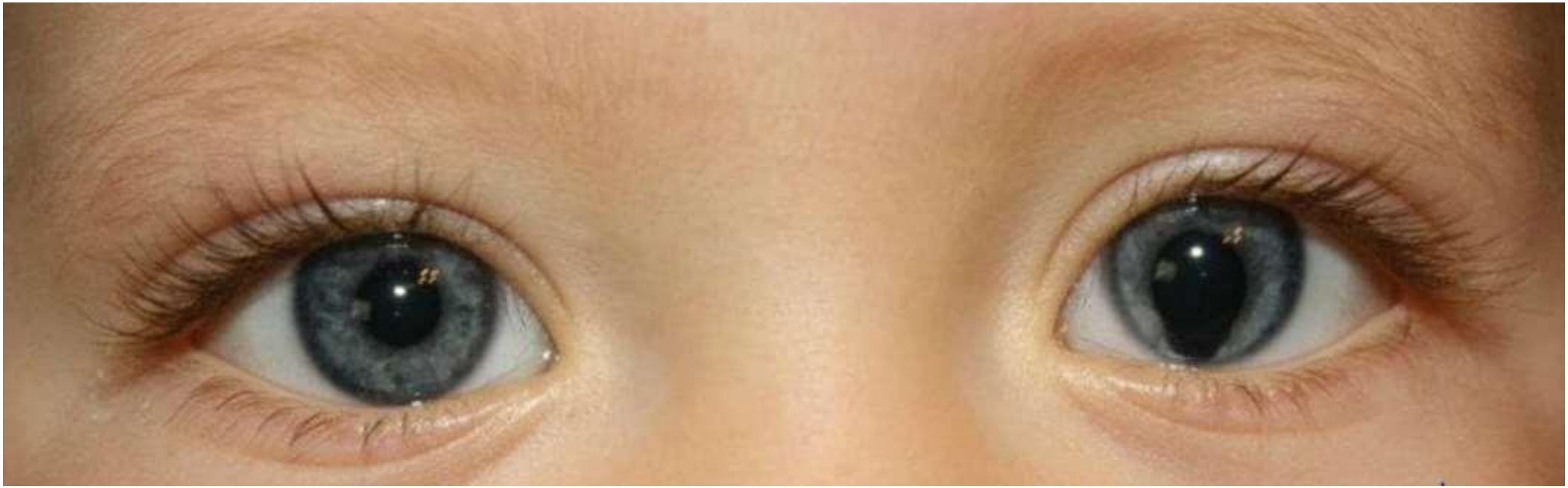
4.Synopthalmos: two eyes may fuse partially to form one midline organ; Nose is usually absent at the normal site but may be represented by a tubular appendage called **proboscis** above the median eye.

Congenital aphakia : absence of the lens of the eye.
occurs if lens placode fails to develop following failure of induction by optic vesicle





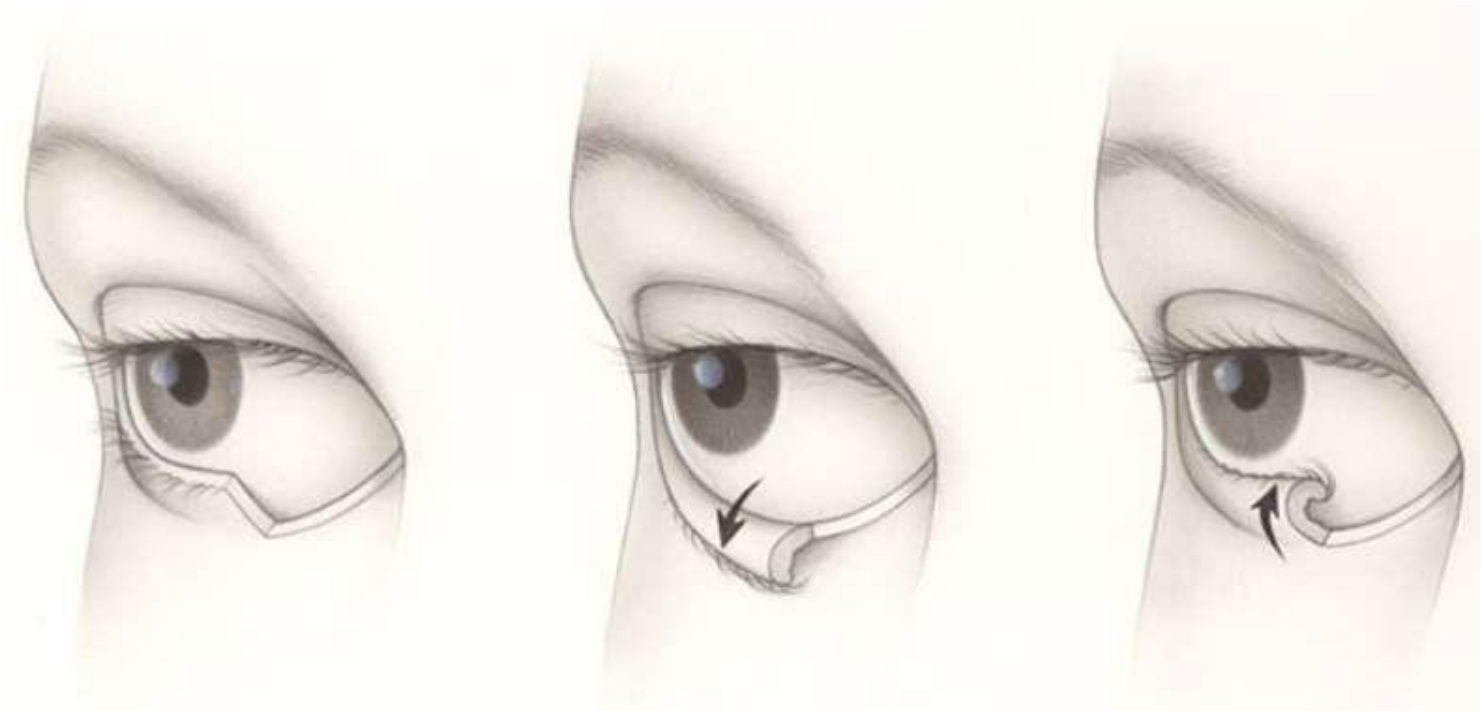
Coloboma of the iris: Congenital notch or cleft on the inferior aspect of the iris.
Occurs due to failure of choroid fissure to close.



Coloboma of eyelid: part of the eyelid is missing;
usually occurs as a small notch in the upper eyelid

Entropion and ectropion: lid margins are turned inward - *entropion*,
lid margins are turned outwards- *ectropion*.

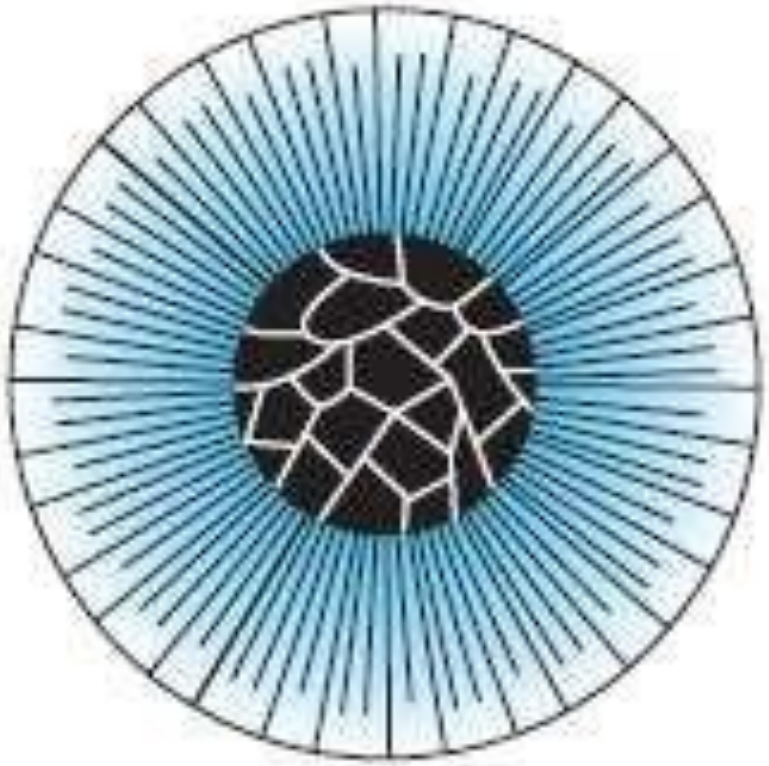
Congenital ptosis: occurs if the levator palpebrae superioris muscle fails to develop



Cryptophthalmos :congenital absence of the eyelids. eyeball is small, defective &is covered by the skin i.

Persistent pupillary membrane :

- Pupillary membrane persist as a whole or may persist in the form of few strands of connective tissue.
- It may obstruct the vision completely or partially



Persistent pupillary membrane

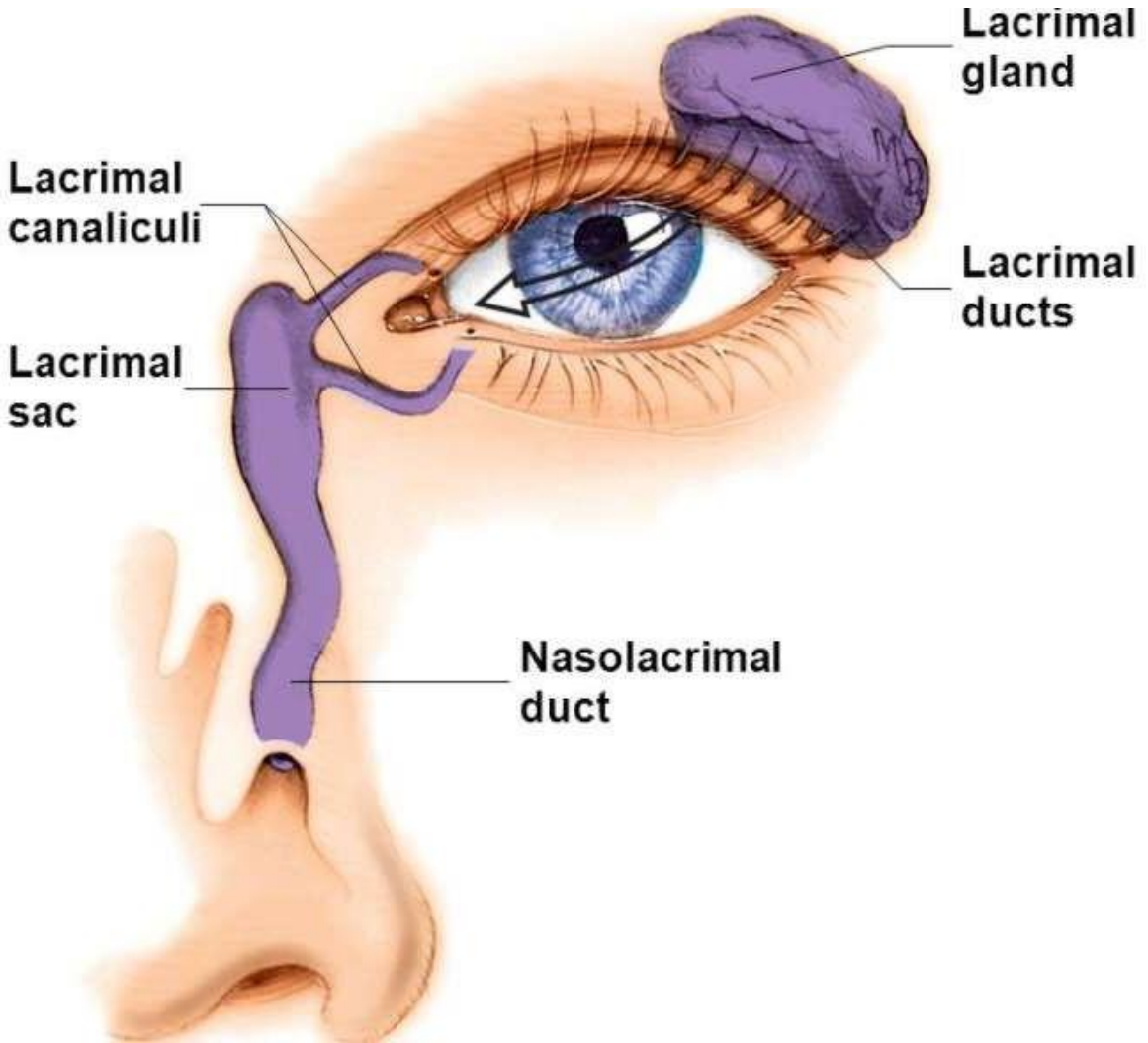
Anomalies of the lacrimal apparatus

(a) Lacrimal gland may be absent or nonfunctional.

(b) Absence of lacrimal passages in whole, in part, or atresia of some part.

(c) Supernumerary puncta or canaliculi.

(d) Presence of cysts in any part of the lacrimal apparatus, mostly close to the lacrimal puncta.



THANK YOU