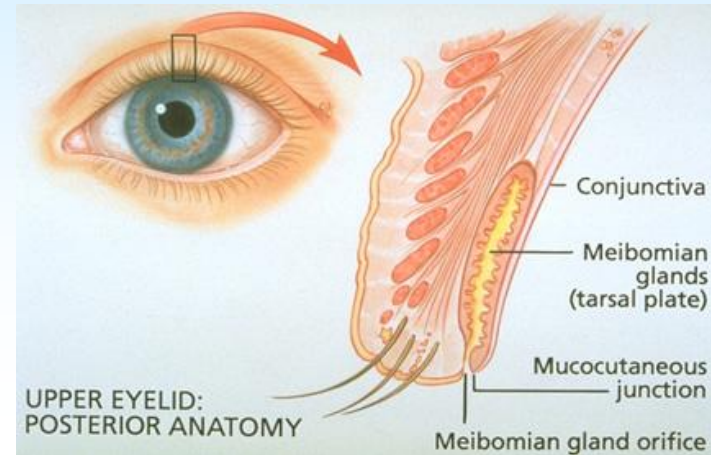


Protective apparatus of the eye

Development of the eye



Dr. Andrea D. Székely

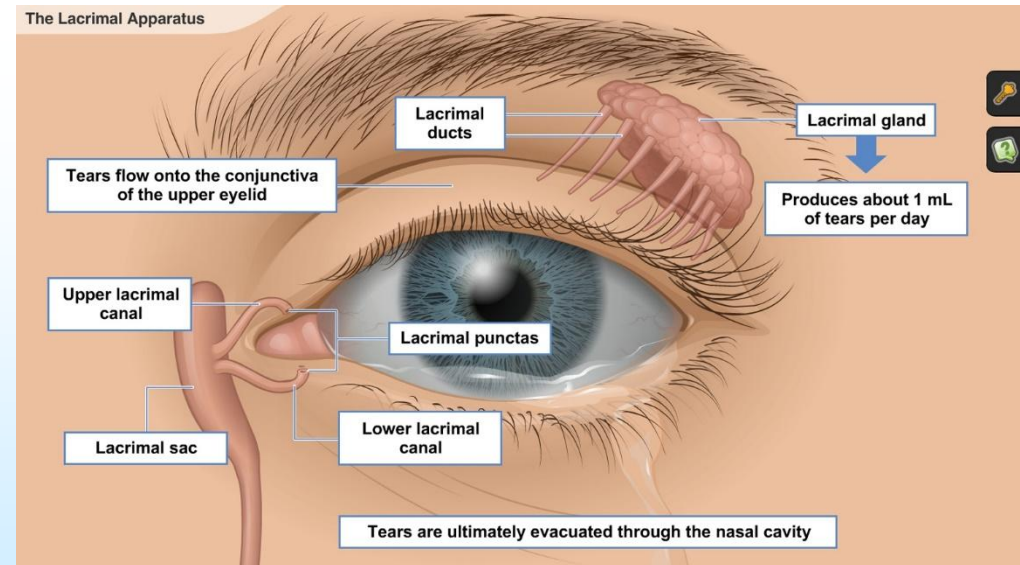
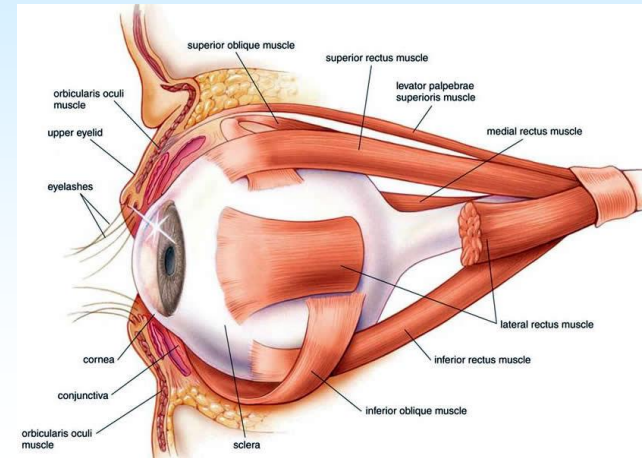
Semmelweis University

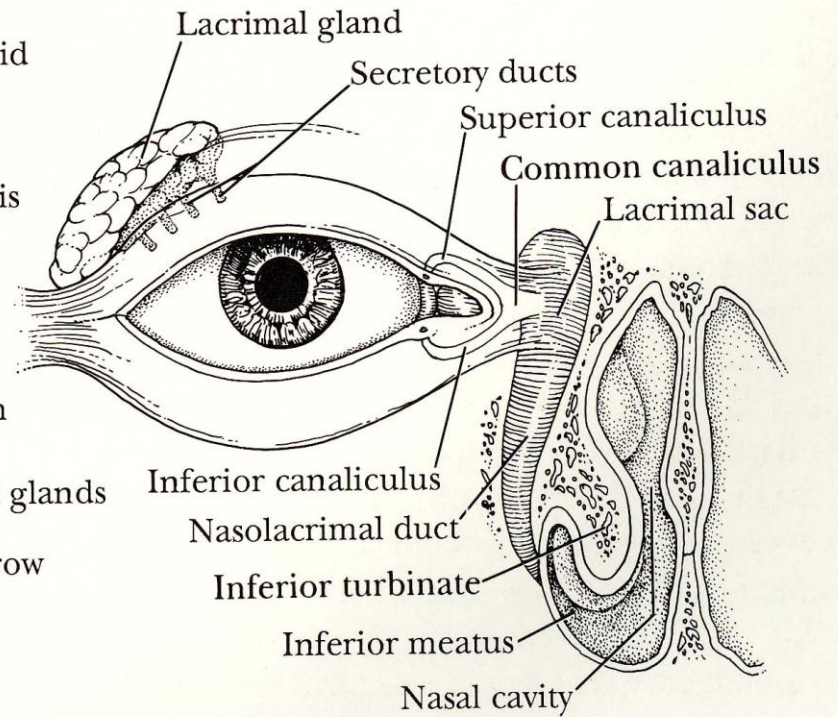
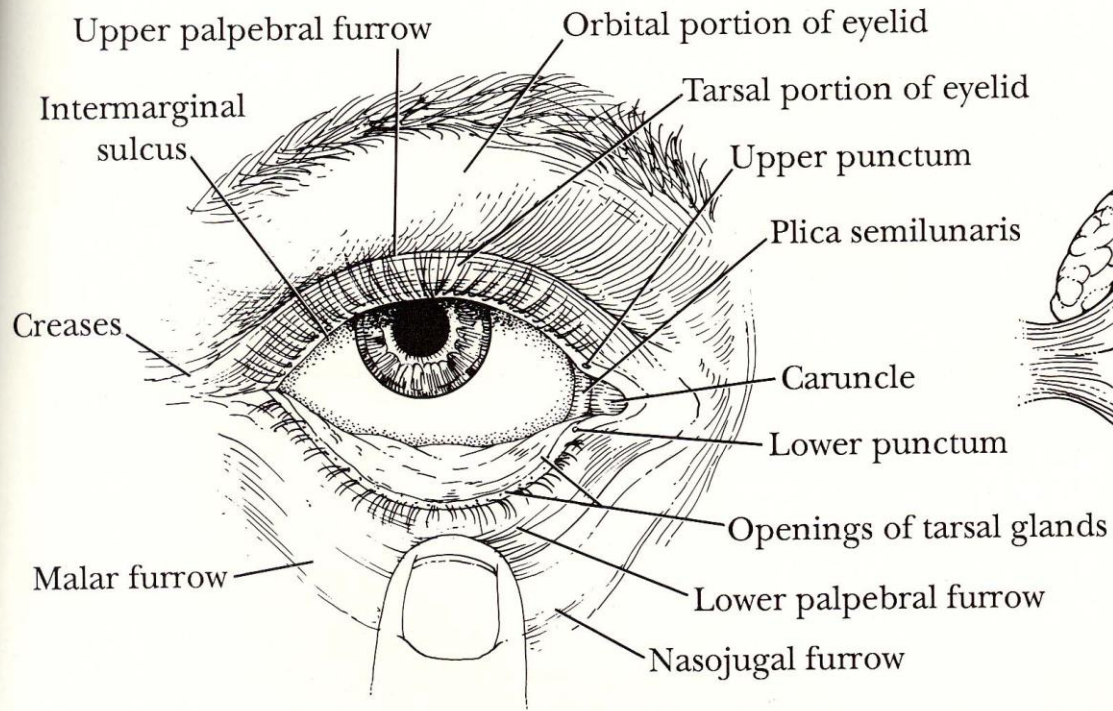
Department of Anatomy, Histology and Embryology

Budapest

ACCESSORY ORGANS OF THE EYE BULB

- Extraocular muscles
- Eyebrows
- Eyelids and the conjunctiva
- Lacrimal apparatus
- Corpus adiposum orbitae
- Tenon capsule





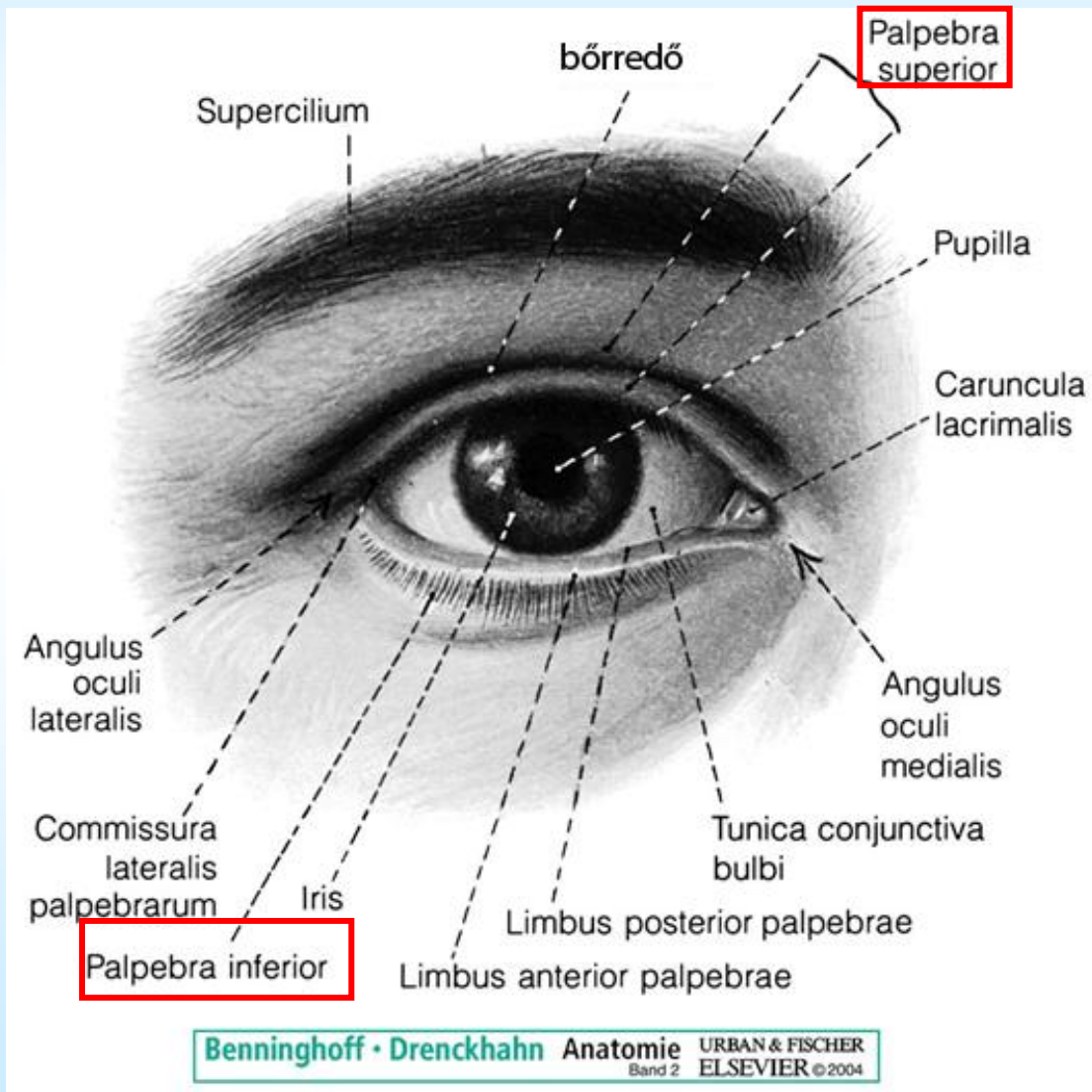
EYEBROWS

The **Eyebrows** (*supercilia*) are two arched eminences of integument, which surmount the upper circumference of the orbits, and support numerous short, thick hairs, directed obliquely on the surface. The eyebrows consist of thickened integument, connected beneath with the Orbicularis oculi, Corrugator, and Frontalis muscles.

EYELIDS

The **Eyelids** (*palpebræ*) are two thin, movable folds, placed in front of the eye, protecting it from injury by their closure. The upper eyelid is the larger, and the more movable of the two, and is furnished with an elevator muscle, the Levator palpebræ superioris. When the eyelids are open, an elliptical space, the palpebral **fissure** (*rima palpebrarum*), is left between their margins, the angles of which correspond to the junctions of the upper and lower eyelids, and are called the **palpebral commissures** or **canthi**.

EYELIDS - PALPEBRAE



rima palpebrarum

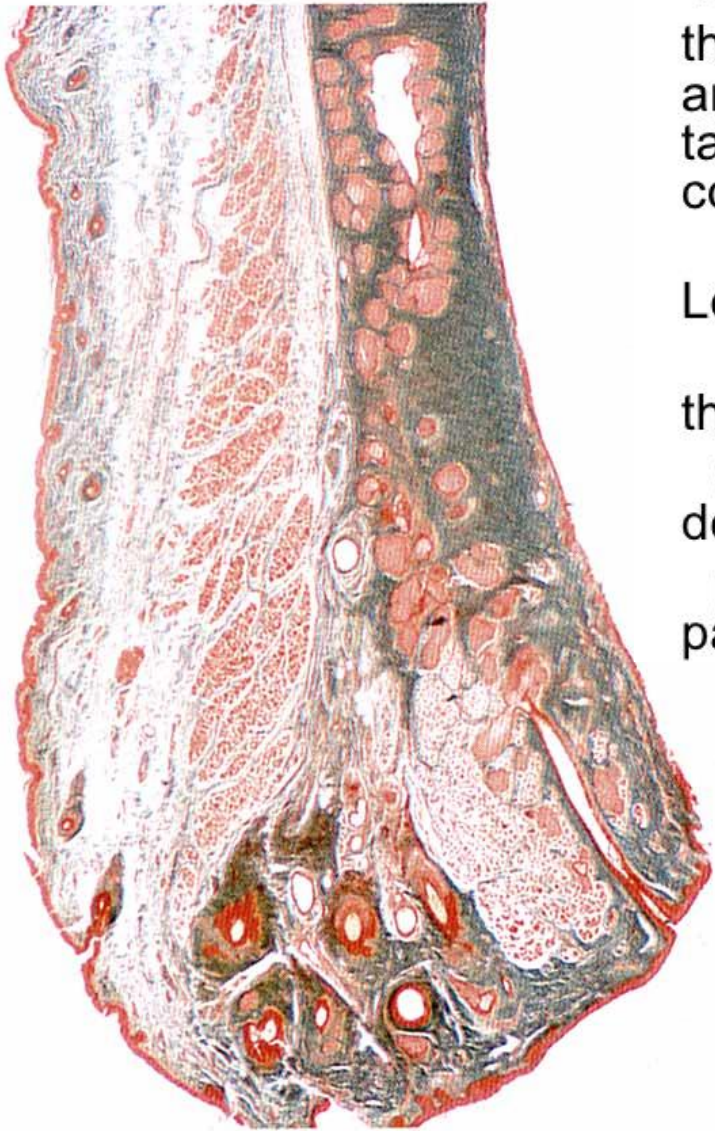
cilia

punctum lacrimale

lacus lacrimalis

caruncula lacrimalis

LAYERS OF THE EYELIDS



~ composed of the following structures taken in their order from without inward: integument, areolar tissue, fibers of the Orbicularis oculi, tarsus, orbital septum, tarsal glands and conjunctiva.

The upper eyelid has the aponeurosis of the Levator palpebræ superioris.

integument - extremely thin, and continuous at the margins of the eyelids with the conjunctiva.

subcutaneous areolar tissue - very lax and delicate, and seldom contains any fat.

palpebral fibers of the Orbicularis oculi: thin, pale in color, and possess an involuntary action

LAYERS OF THE EYELIDS

Stratified squamous epithelium

Areolar connective tissue

Orbicularis oculi muscle

Submuscular areolar tissue

Tarsal plate (tarsus)

Meibom glands

+ cilia + sebaceous glands

serous tarsal glands (Zeiss, Moll)

Conjunctiva

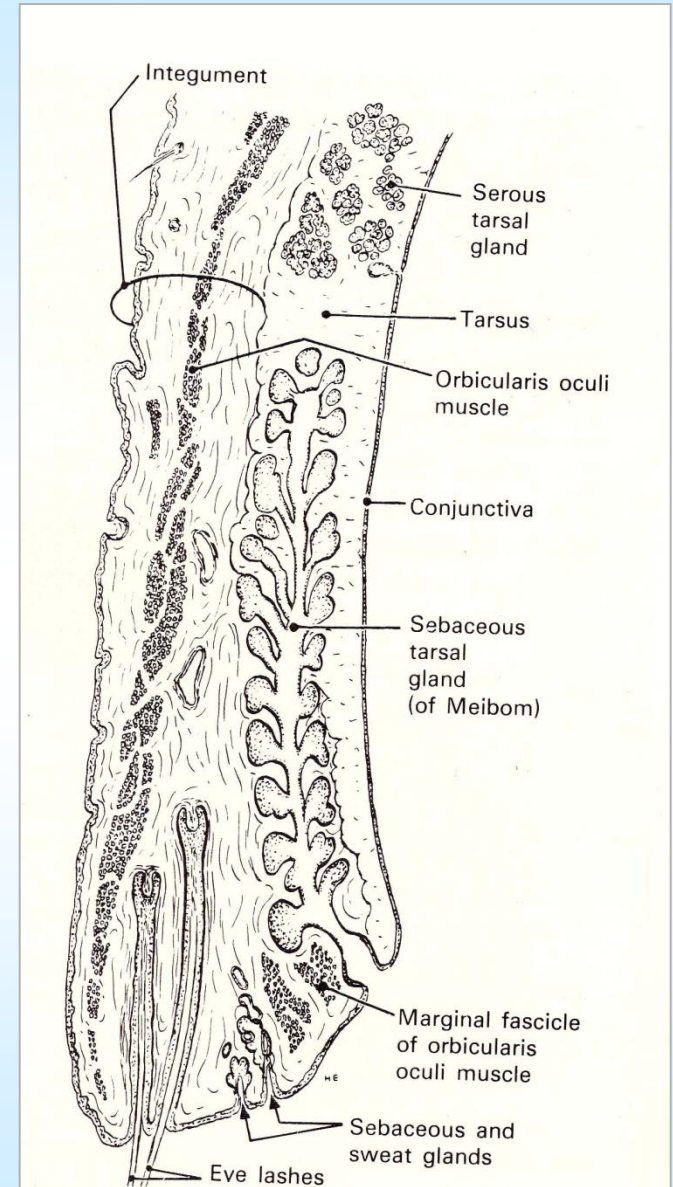


Fig. 16-16. Sagittal section of upper lid.

CONJUNCTIVA

the mucous membrane of the eye
lines the inner surfaces of the eyelids
reflected over the forepart of the sclera and cornea.

1) Palpebral Portion (tunica conjunctiva palpebrarum)

- thick, opaque, highly vascular, and covered with numerous papillæ,
- at the lateral angle of the upper eyelid the ducts of the lacrimal gland open on its free surface
- at the medial angle it forms a semilunar fold, the plica semilunaris

2) Bulbar Portion (tunica conjunctiva bulbi)

- upon the sclera the conjunctiva is loosely connected to the bulb of the eye;
- thin, transparent, destitute of papillæ, and only slightly vascular

The line of reflection of the conjunctiva from the upper eyelid on to the bulb of the eye is named the superior fornix, and that from the lower lid the inferior fornix.

Lymphatics arise in the conjunctiva in a delicate zone around the cornea, and run to the ocular conjunctiva.

CONJUNCTIVA

- palpebral part
- bulbar part
- fornix conjunctivae

ARTERIES

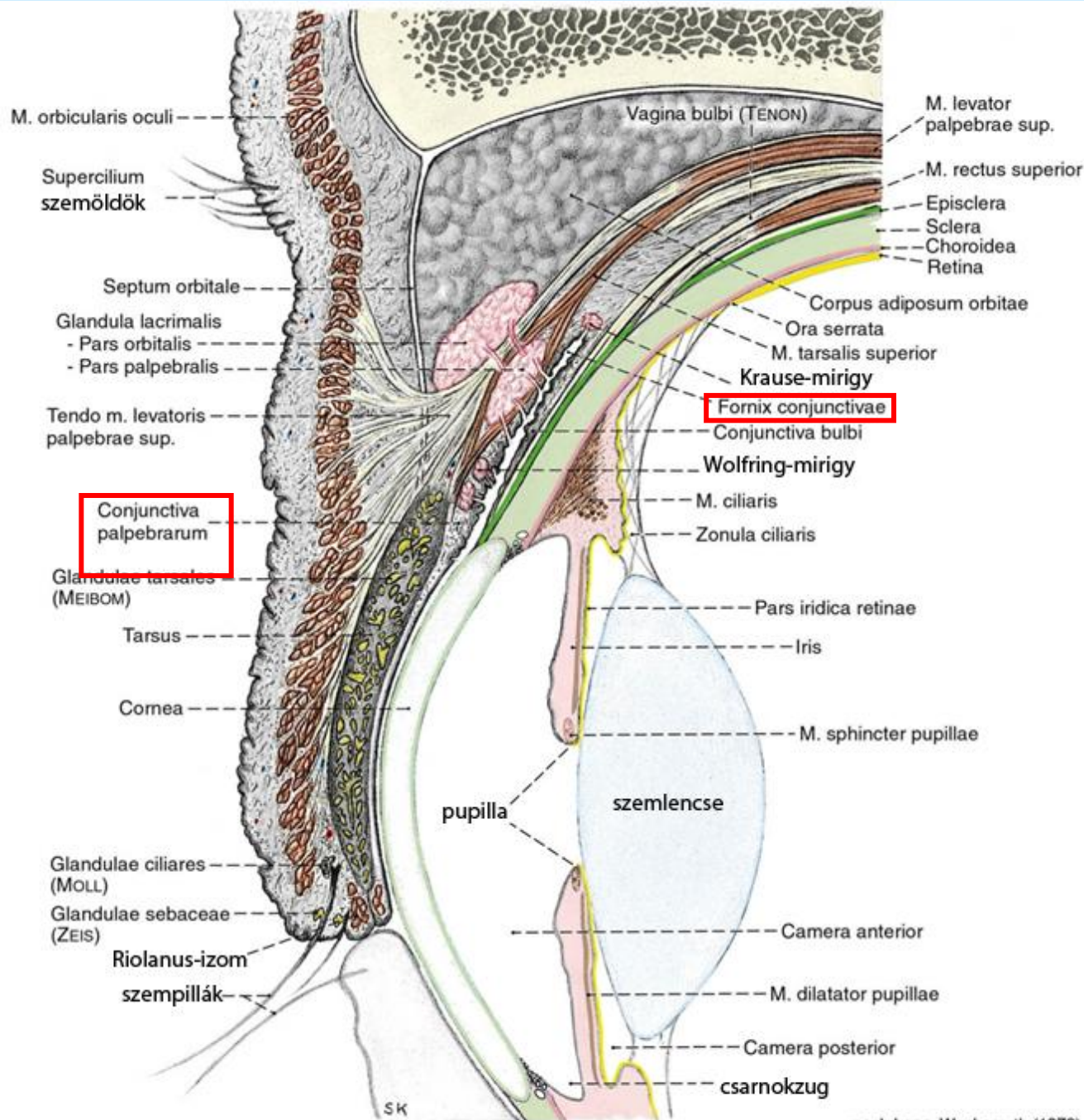
Ophthalmic a →
Muscular branches →
Ant. Ciliary branches

VEINS

sup. orbital v. →
episcleral vv. →
vorticosae vv. of choroid

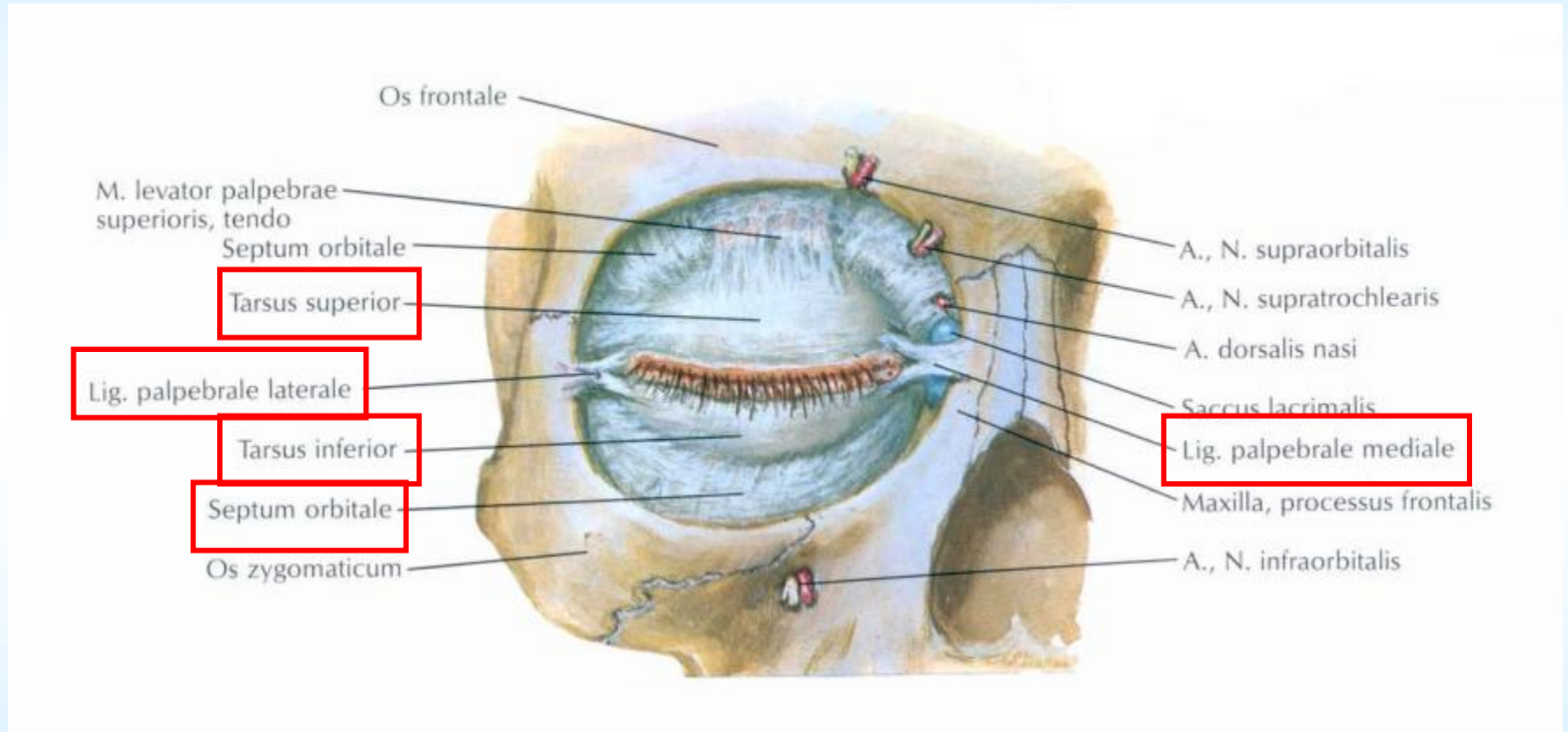
INNERVATION

Long post. ciliary nn

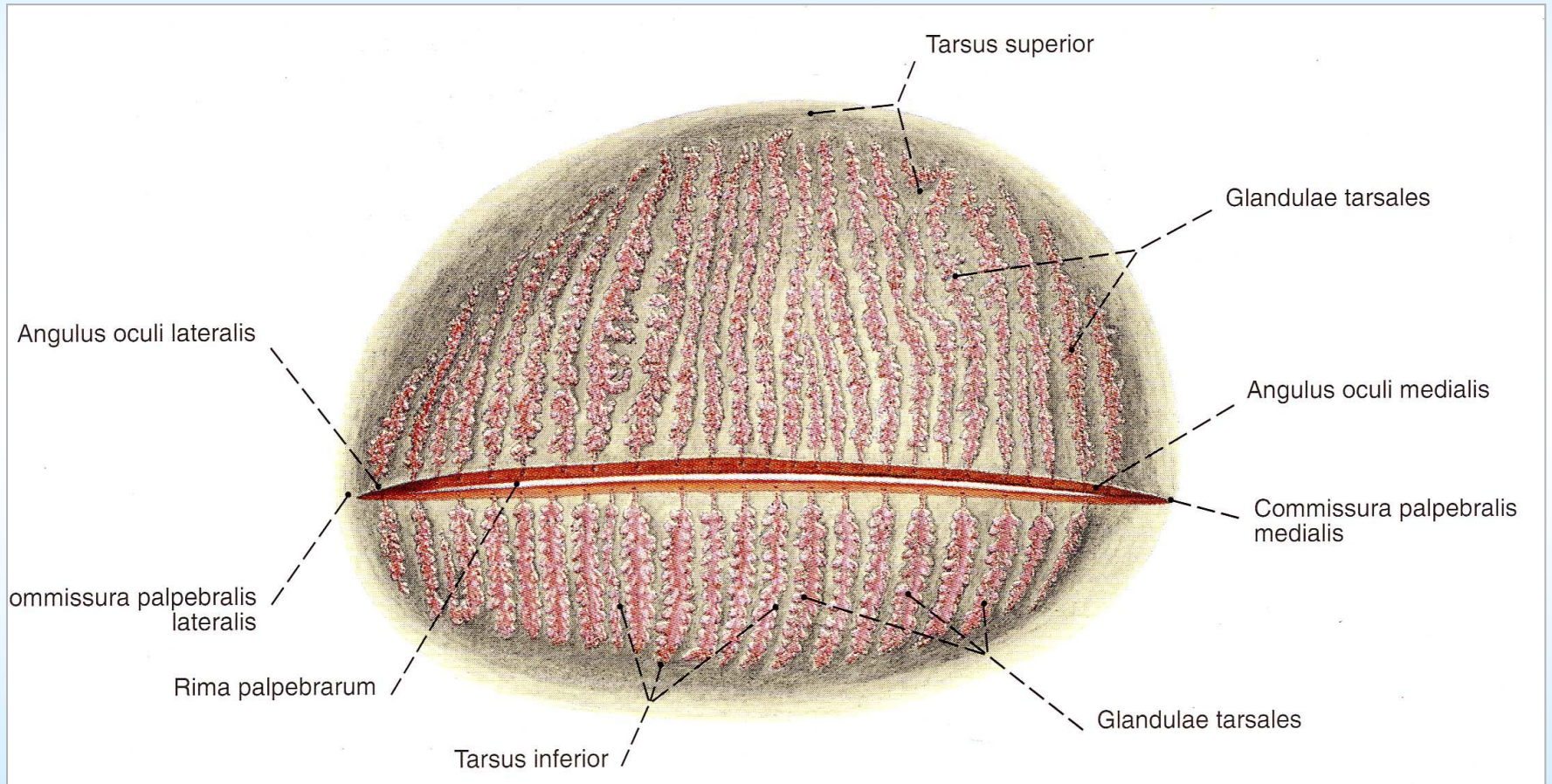


nach Lang, Wachsmuth (1979)

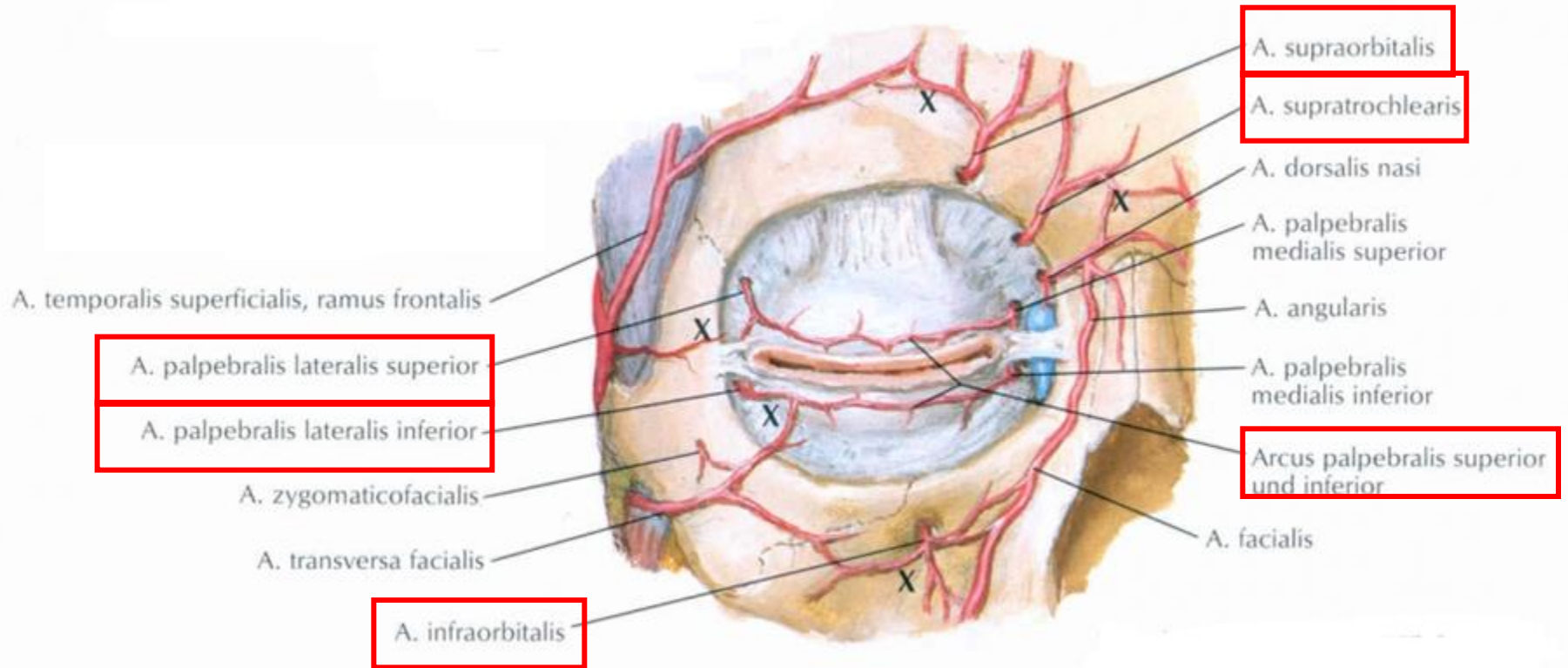
TARSAL PLATES - FRAMEWORK OF THE EYELIDS



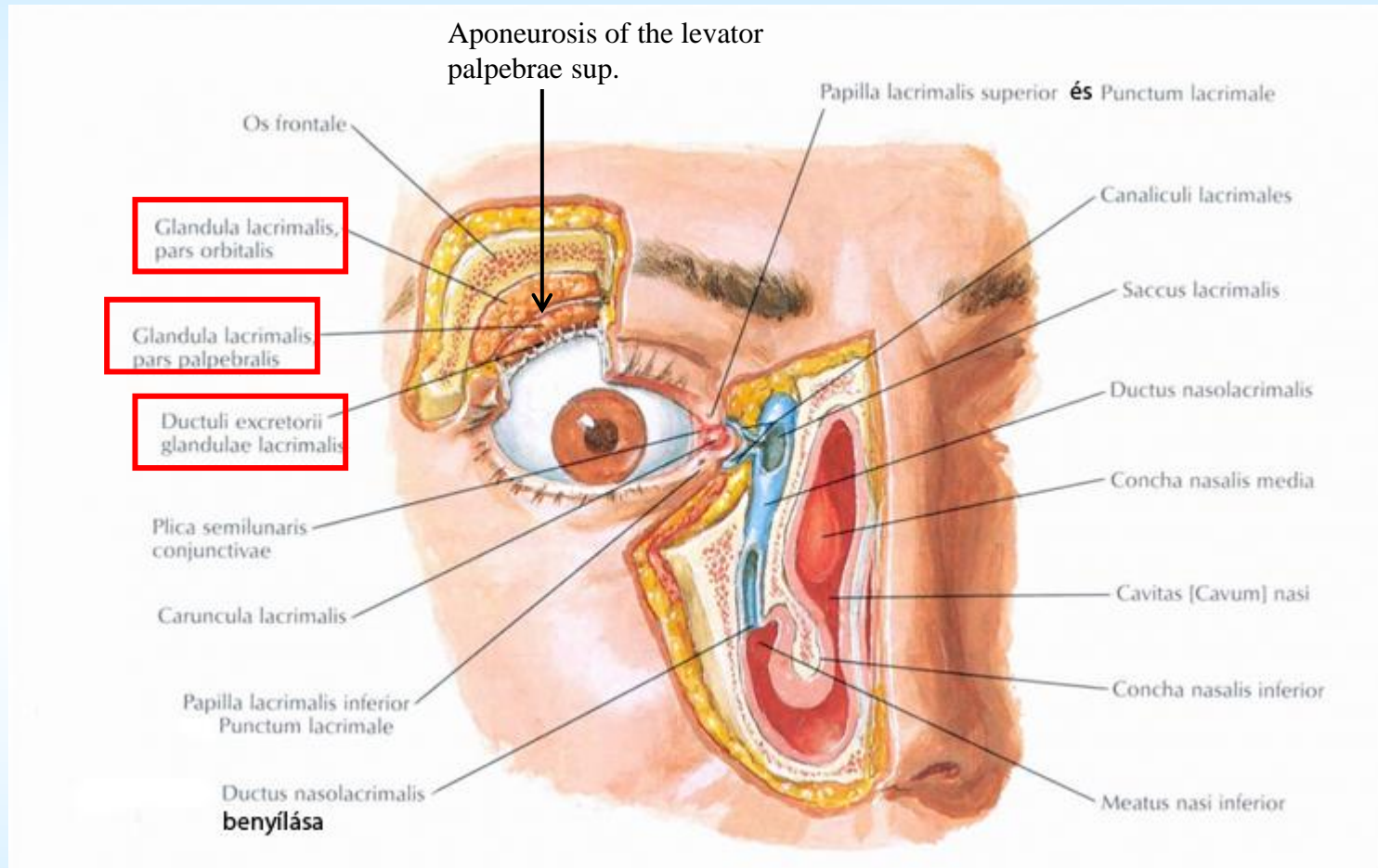
TARSAL GLANDS (Meibom)



BLOOD SUPPLY



LACRIMAL APPARATUS



The Lacrimal Apparatus

~ consists of:

(a) the lacrimal gland, which secretes the tears, and its excretory ducts, which convey the fluid to the surface of the eye;

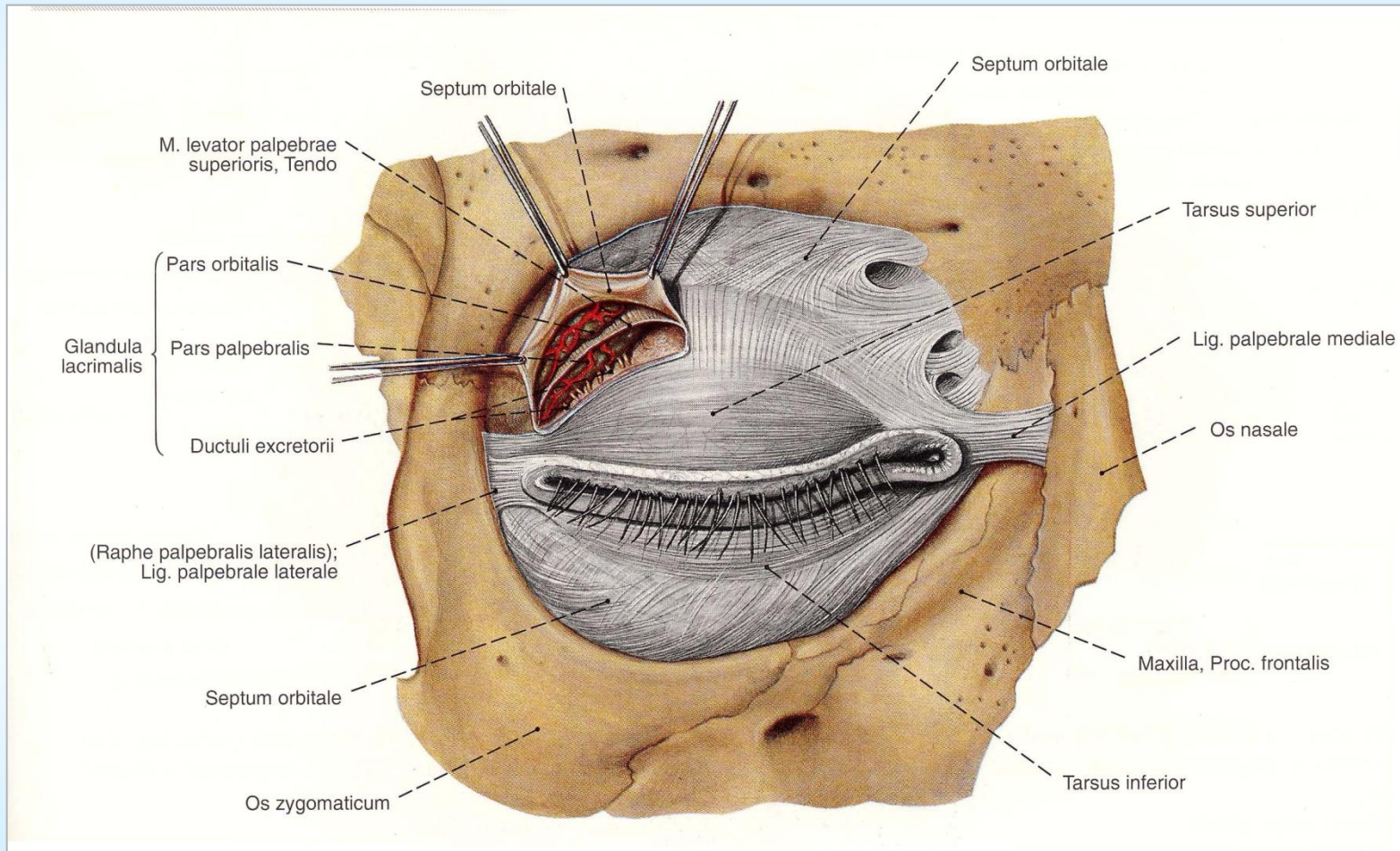
(b) the lacrimal ducts, the lacrimal sac, and the nasolacrimal duct by which the fluid is conveyed into the cavity of the nose.

lacrimal gland: lodged in the lacrimal fossa, on the medial side of the zygomatic process of the frontal bone

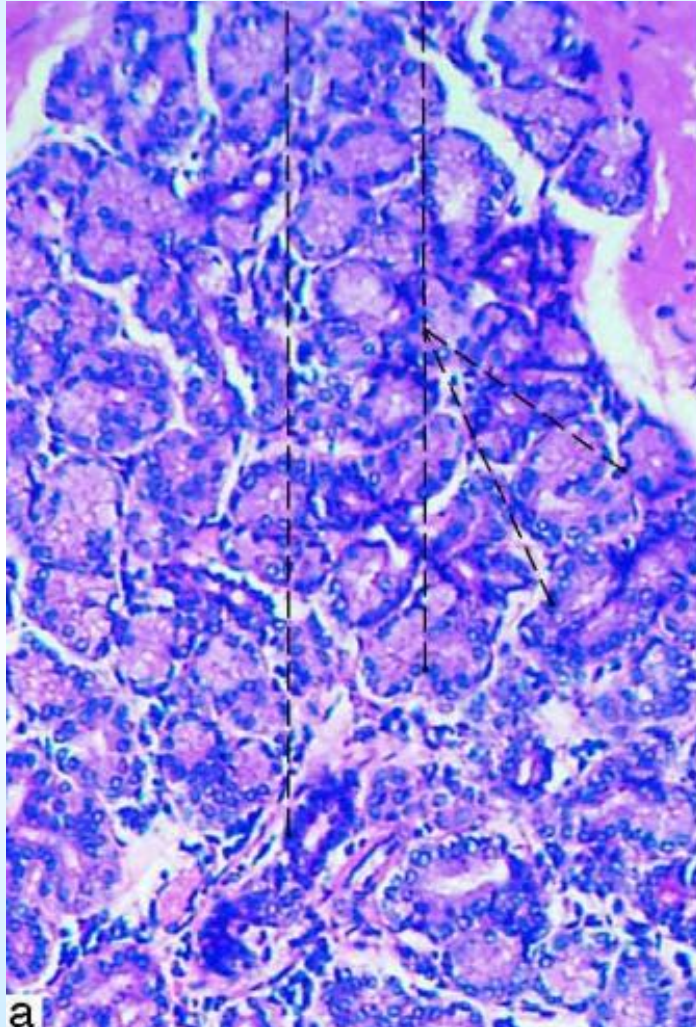
: oval form, about the size and shape of an almond, and consists of two portions, described as the superior and inferior lacrimal glands

: in structure and general appearance the lacrimal resembles the serous salivary glands

RELATION OF THE TARSUS AND THE LACRIMAL GLAND



HISTOLOGY OF THE LACRIMAL GLAND



- Purely serous
- Tubuloalveolar, dilated lumen
- NO intercalated or salivary ducts (NO salt reabsorption – salty secretional product)

TEAR = lacrima:

water, Na^+ , K^+ , Cl^- , HCO_3^- , laktoferrin (bakteriostatic), lyzozim, lipocalin, EGF, IgA, mucin

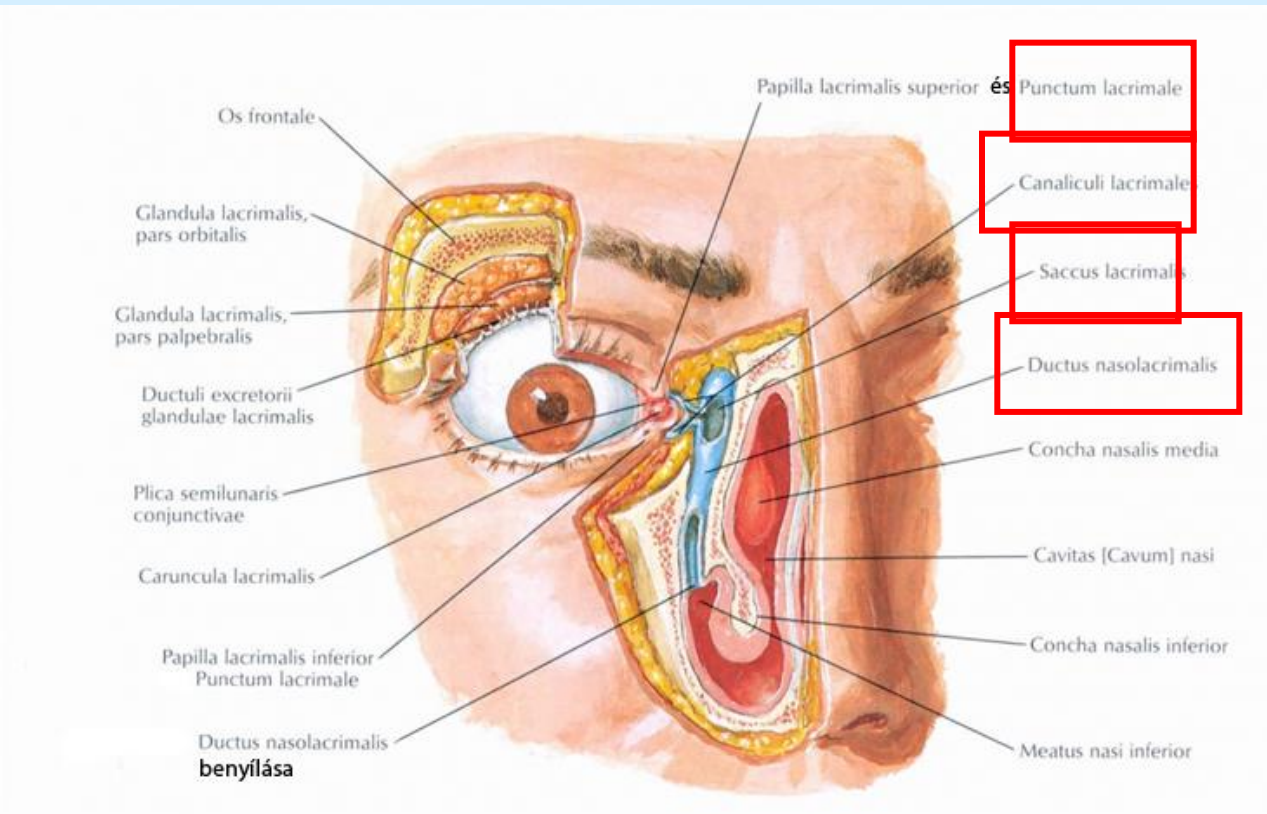
Tear film:

Superficial layer: Meibom secretum → lipid layer (0,1-0,2 μm)

Middle layer: secrete of the lacrimal gland → wateri layer réteg (7-8 μm)

Deep layer: from lacrimal gland and goblet cells → mucin (20-30 μm)

LACRIMAL DUCTS

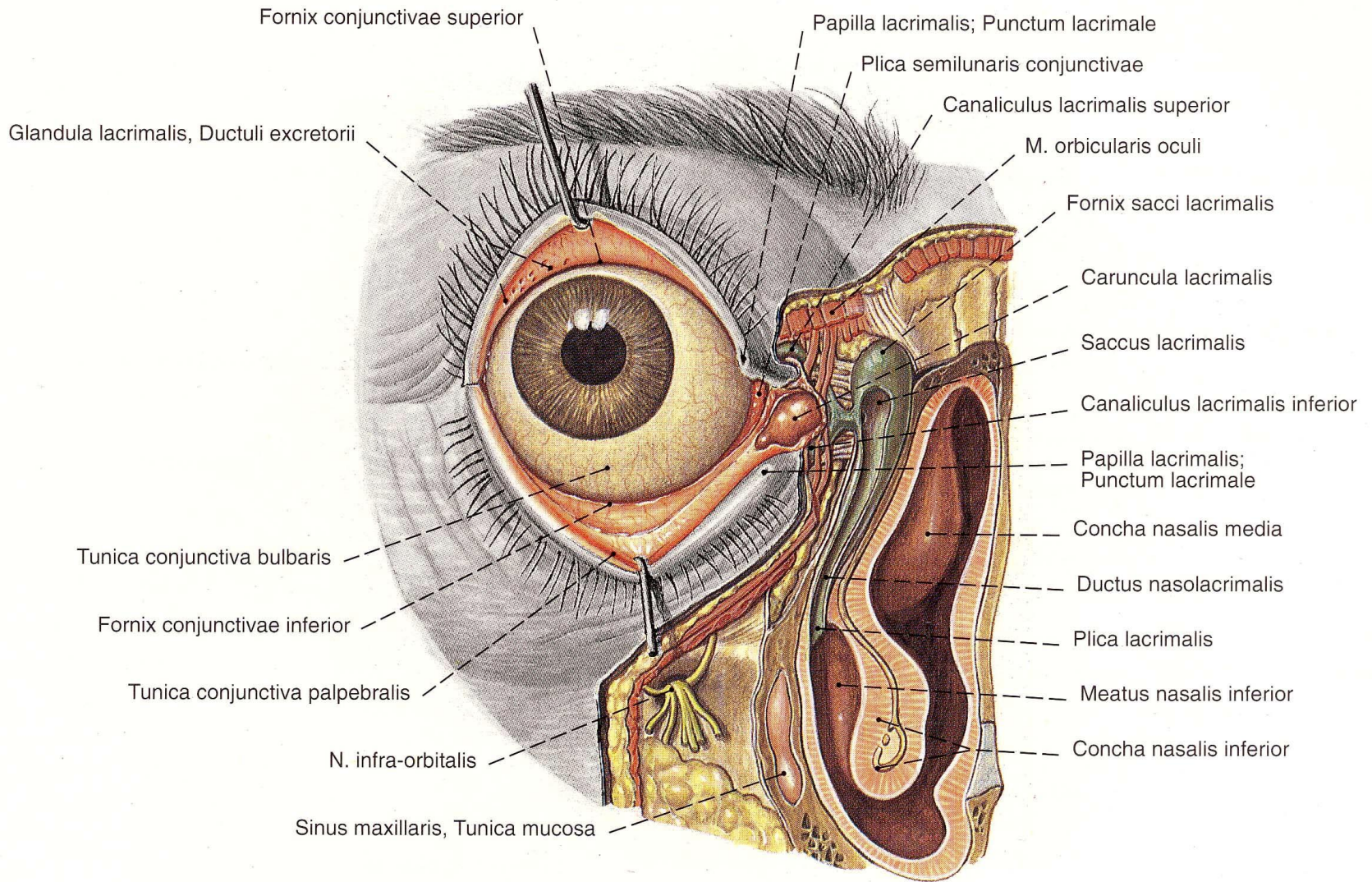


Drainage:

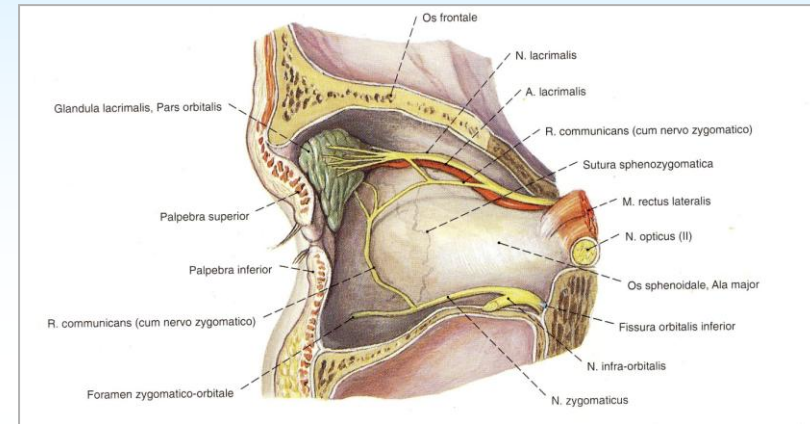
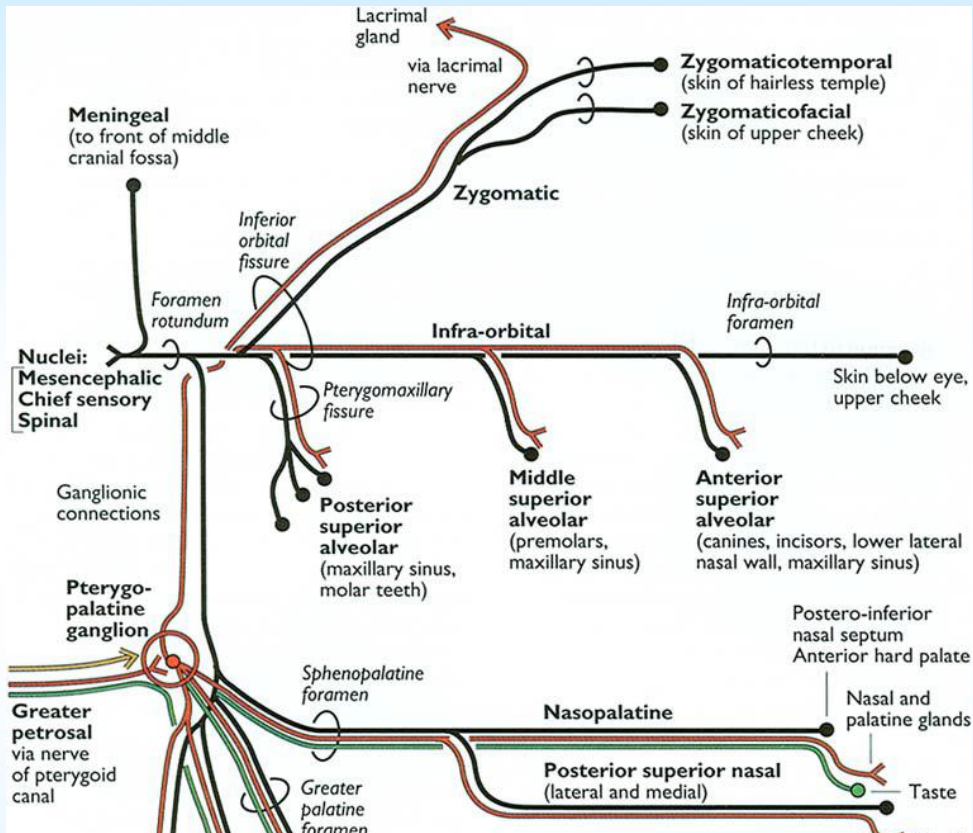
- Blinking → eyelids move to medial, Tear moves medial
- orbicularis oculi m, pars lacrimalis Dilates the ducts capillarity

Nasolacrimal Duct :

- Starts blind, 1,2-2,4 cm
- opens into the inf. nasal meatus (behind the plica lacrimalis *Hasneri*)
- Histology: pseudostratified columnar

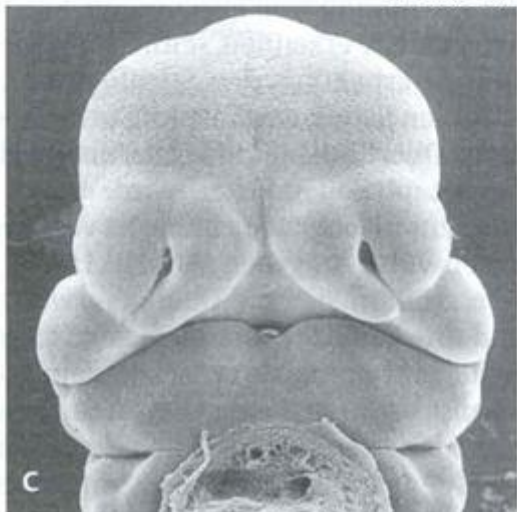
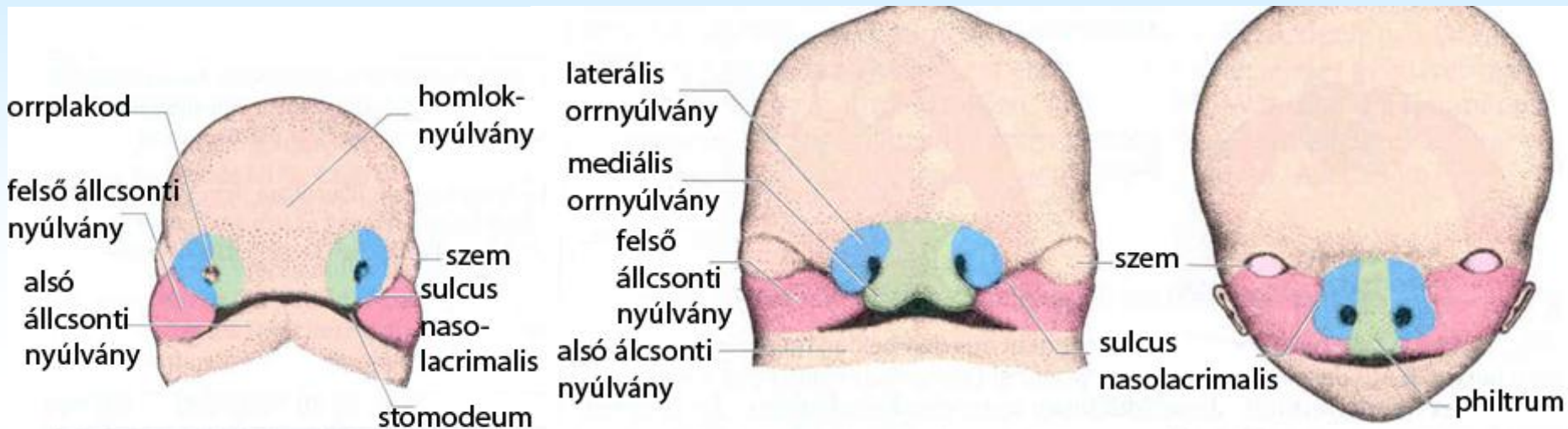


INNERVATION OF THE LACRIMAL GLAND



Sup. salivatory nucl → greater petrosal nerve → pterygopalatine ggl.
 → zygomatic n. → lacrimal n. (ACh, VIP)
 sup cervical ggl → sympathetic plexus (NA)

DEVELOPMENT OF THE NASOLACRIMAL DUCT

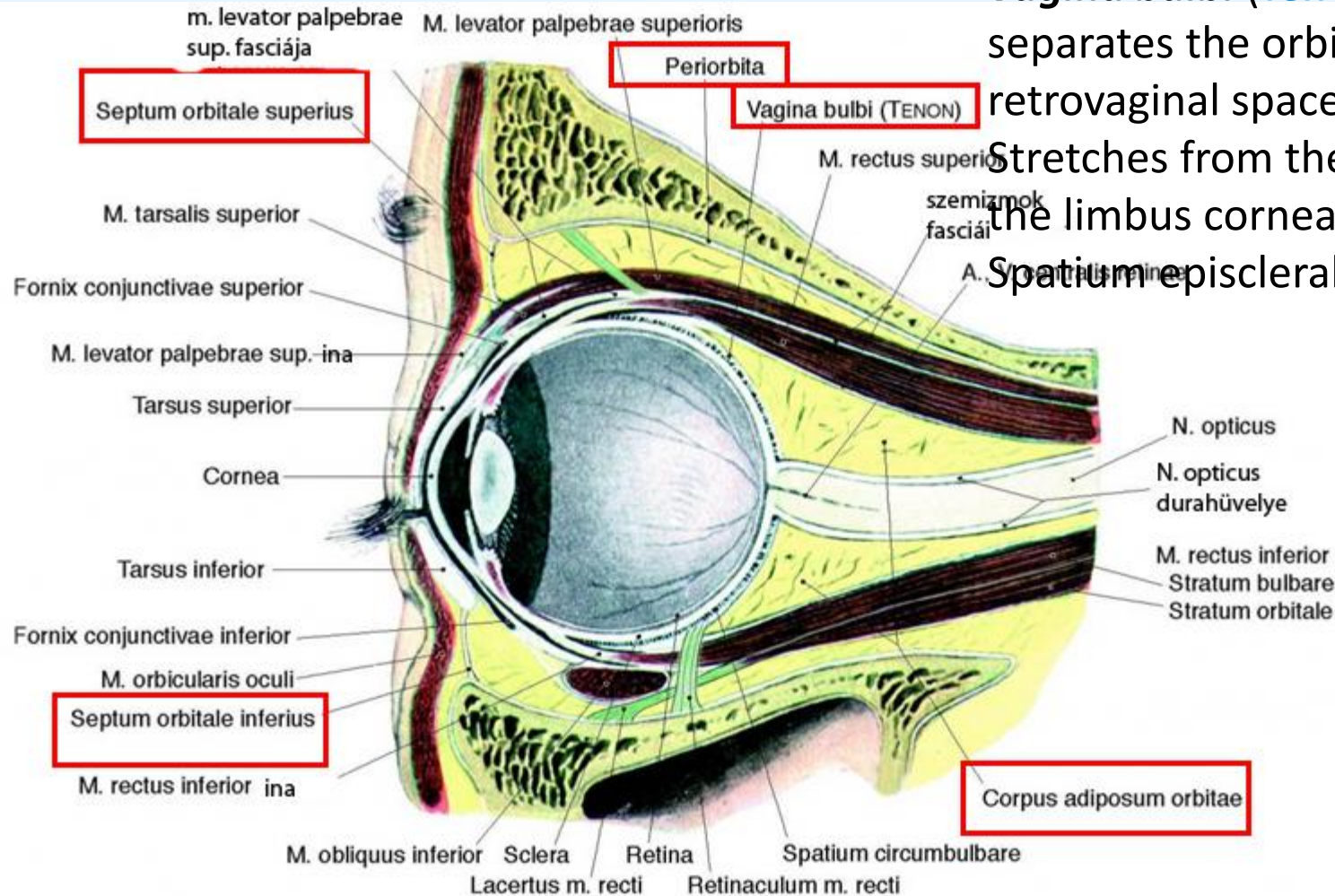


Stenosis: little or no lumen

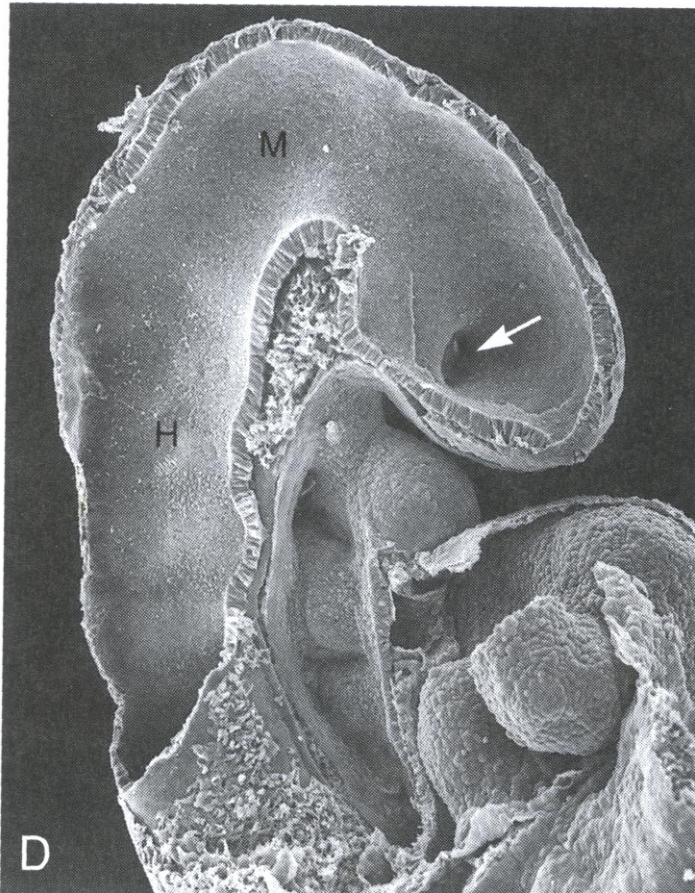
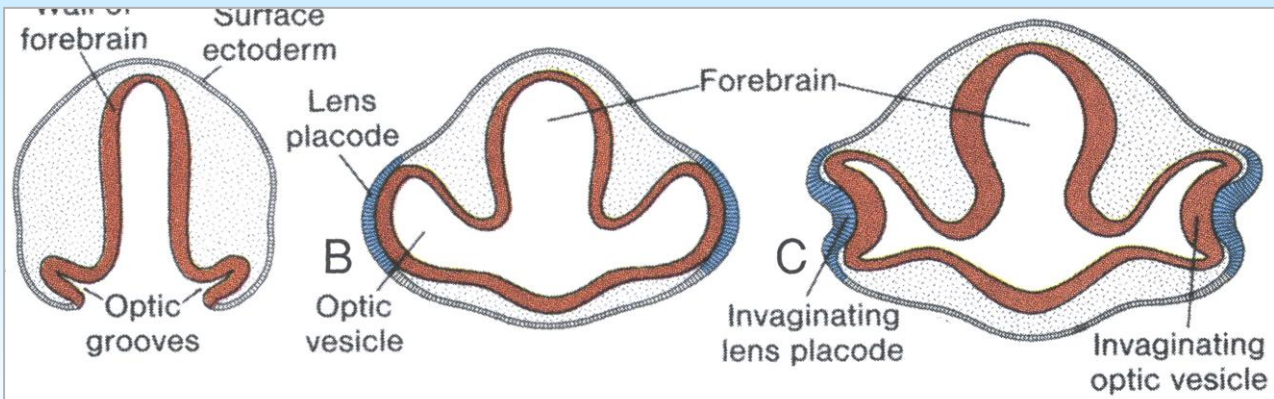
Lateral fissure

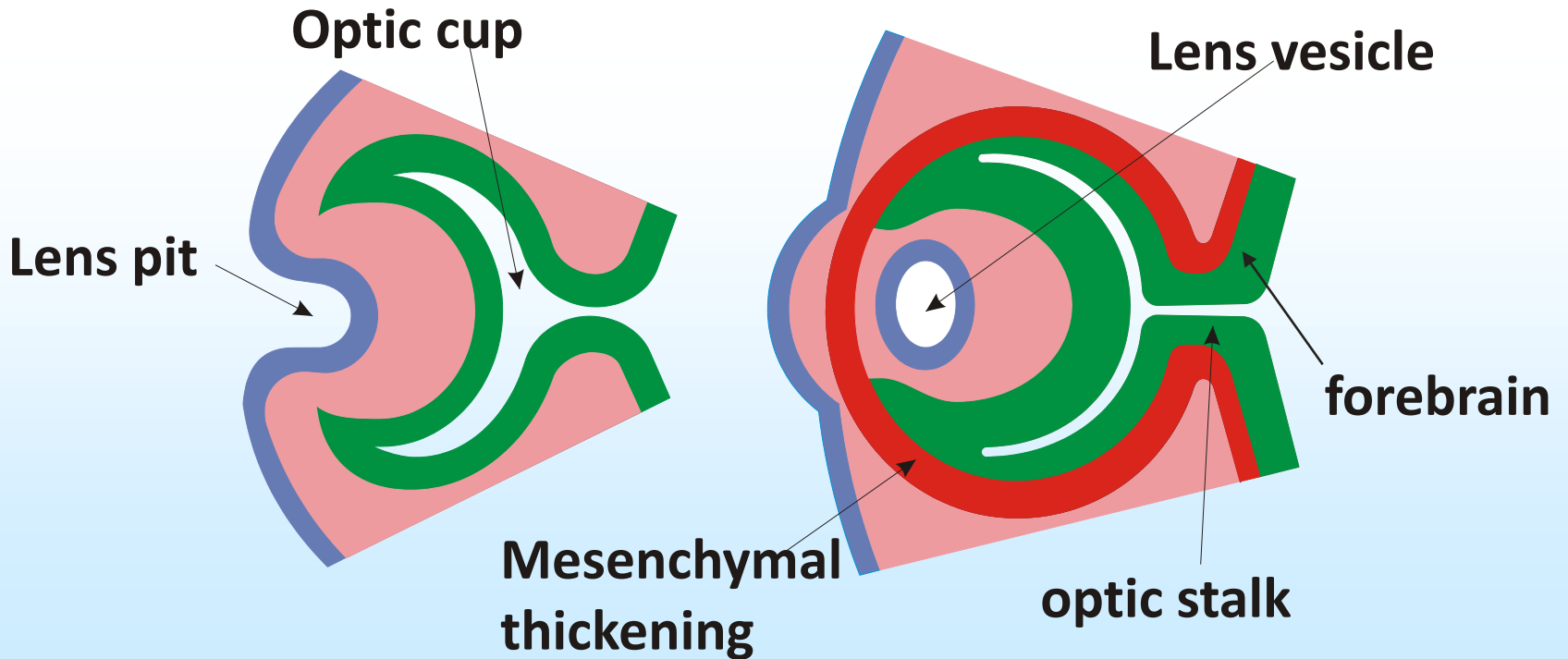
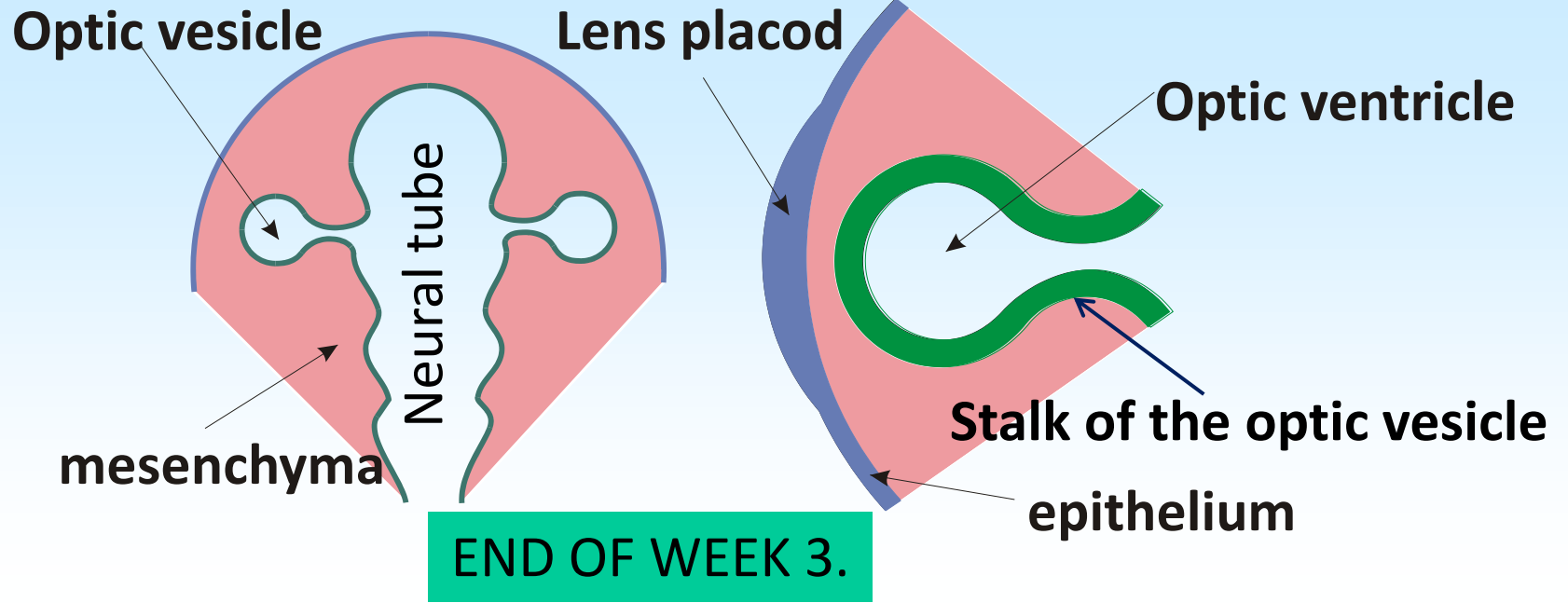
CORPUS ADIPOSUM ORBITAE, VAGINA BULBI, PERIORBITA

Vagina bulbi (*Tenon capsule*)
 separates the orbit into pre- and retrovaginal spaces
 Stretches from the opticus n. to the limbus corneae
 Spatium episclerale

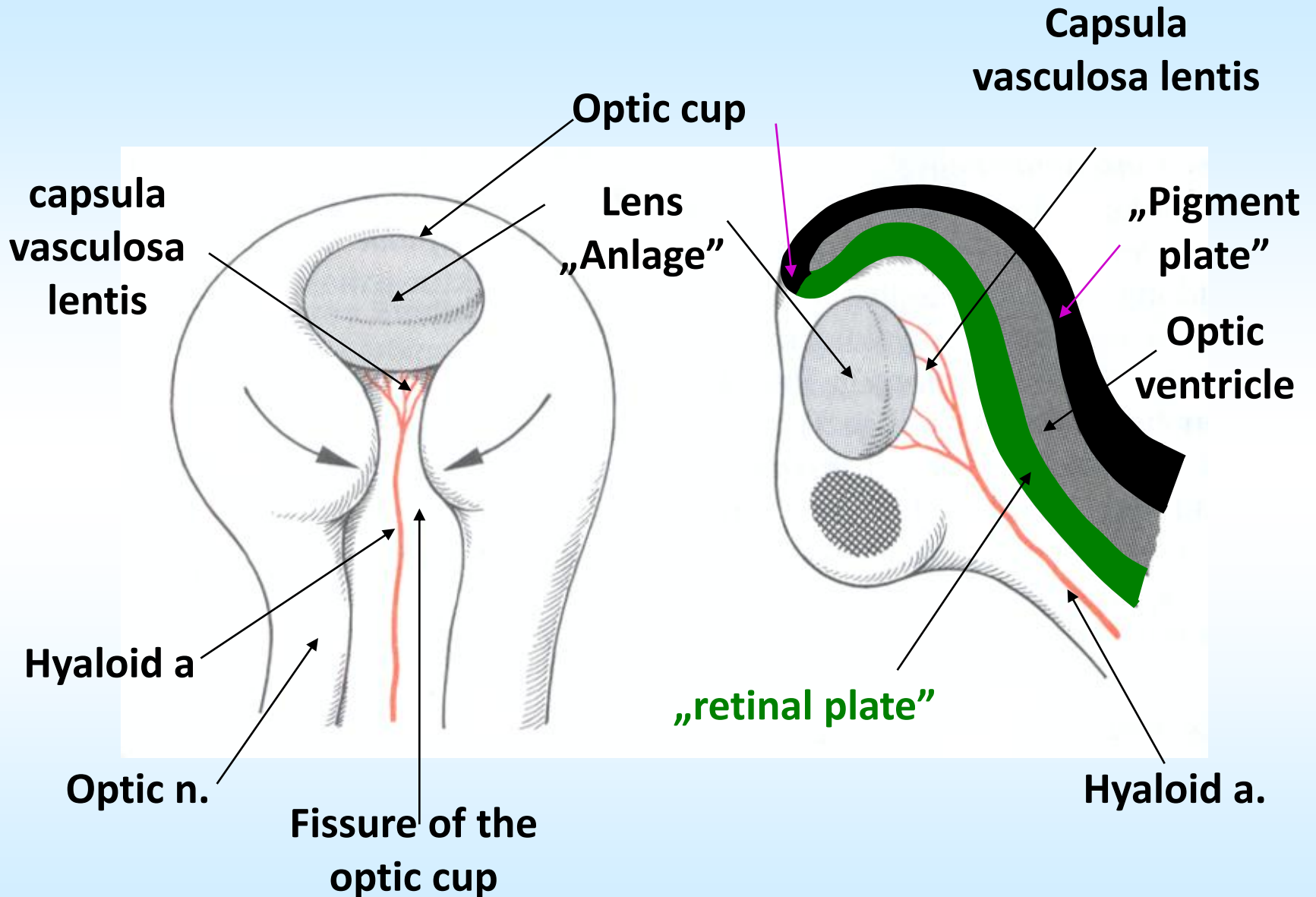


DEVELOPMENT OF THE EYE





OPTIC FISSURE

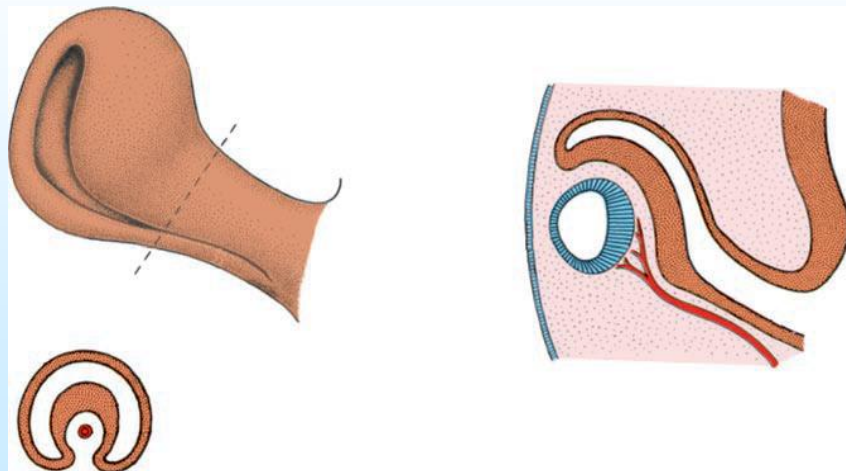


Usually disappears by the end of week 7.

COLOBOMA (means „defect”)
(developmental malformation)



Persisting Fissure of the optic cup



ECTODERMAL DERIVATIVES

LENS AND CORNEA

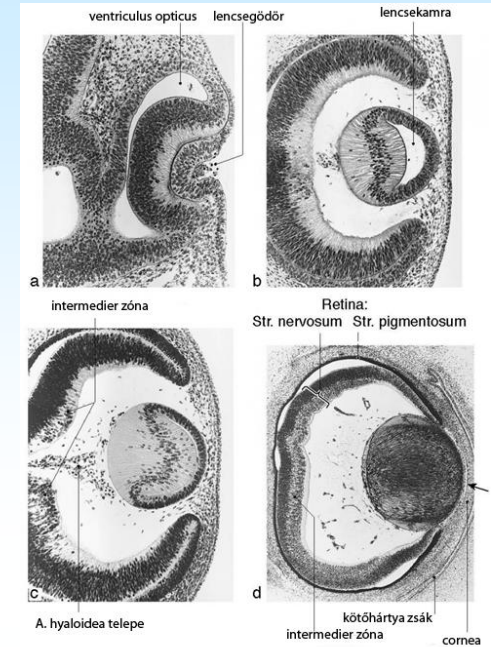
Lens

- will be separated from the surface ectoderm by Week 5.
- Posterior cells produce crystallins, turn into lens fibres → primary and secondary lens nuclei
- hyaloid a → perilental network (capsula vasculosa lentis), on the anterior surface it forms the iridopupillary membrane

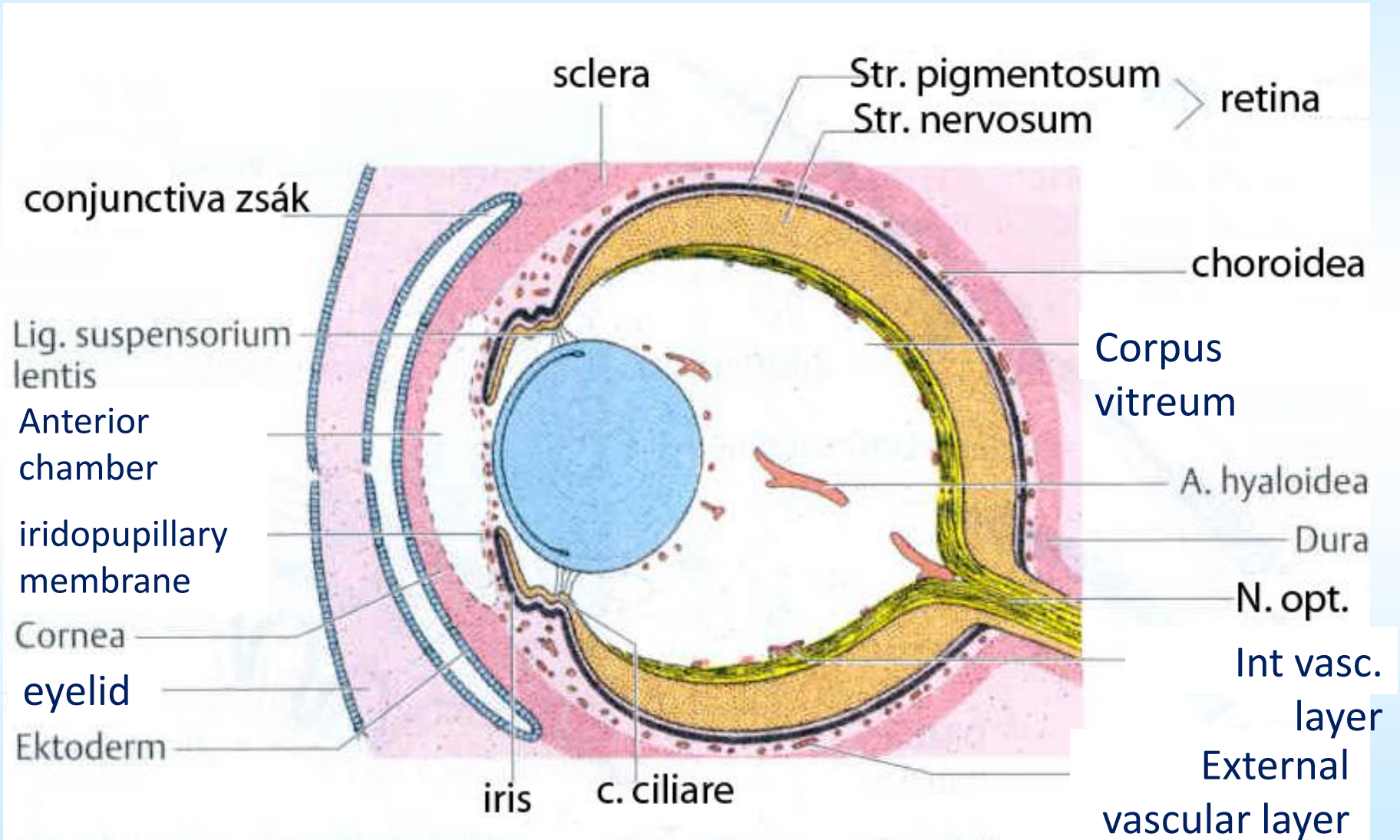
Cornea

Lens induction in surface epithelium → epithelium corneae

Neural crest cells → endothelium corneae, stroma



THE EYE AT WEEK 15.



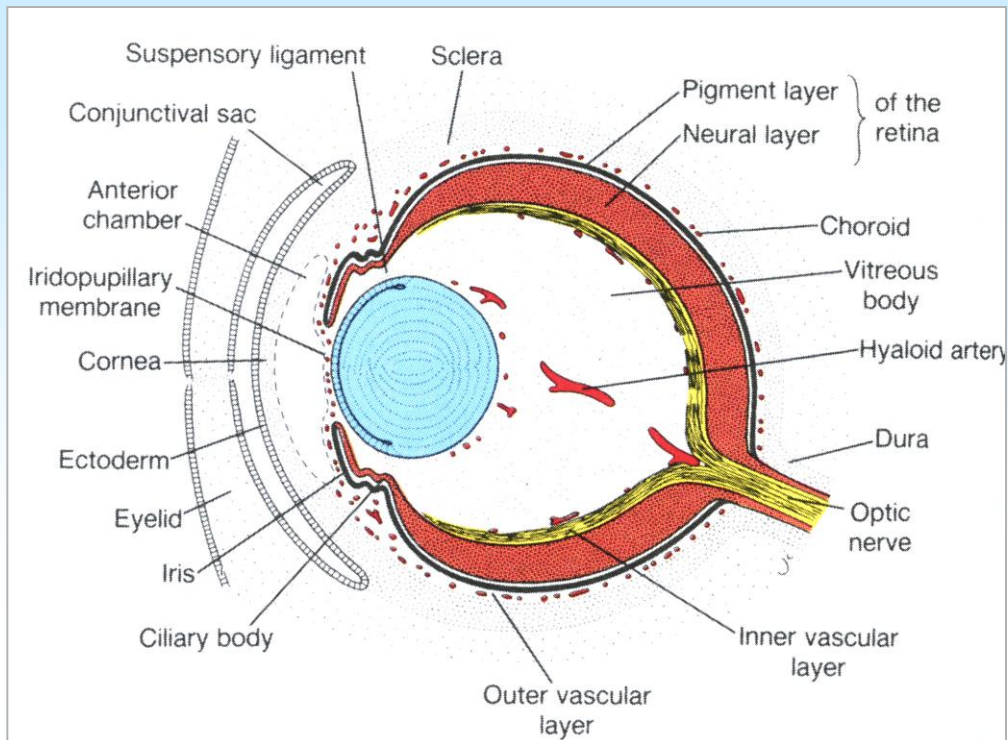


Figure 18.7. Section through the eye of a 15-week fetus. Note the anterior chamber, iridopupillary membrane, inner and outer vascular layers, choroid, and sclera.

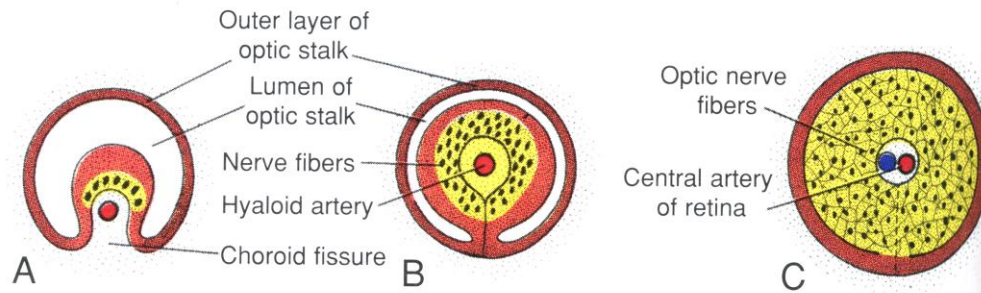


Figure 18.8. Diagrams showing transformation of the optic stalk into the optic nerve. **A.** Sixth week (9 mm). **B.** Seventh week (15 mm). **C.** Ninth week. Note the central artery of the retina in the optic nerve.

DEVELOPMENT OF THE EXTRINSIC EYE MUSCLES

External muscles:

- from week 5.
- Prechordal mesoderm
- 3 mesenchymal thickenings

Internal eye muscles :

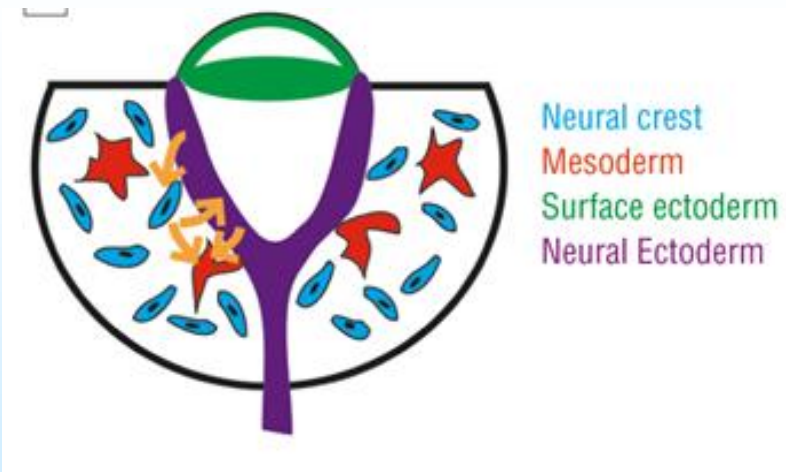
M. ciliaris

M. sphincter pupillae

(probably from the placod)

M. dilatator pupillae

most probably corresponds to the outermost layer of the Iris.



DEVELOPMENT OF THE RETINA

Optic cup - external layer
retinal pigment epithelium

Optic cup – internal layer
Post 4/5: **Pars optica retinae**
Sensitive to light (photons)

Ant 1/5: **Pars ceca retinae**
The inner layer will be cuboidal

Pars ciliaris retinae

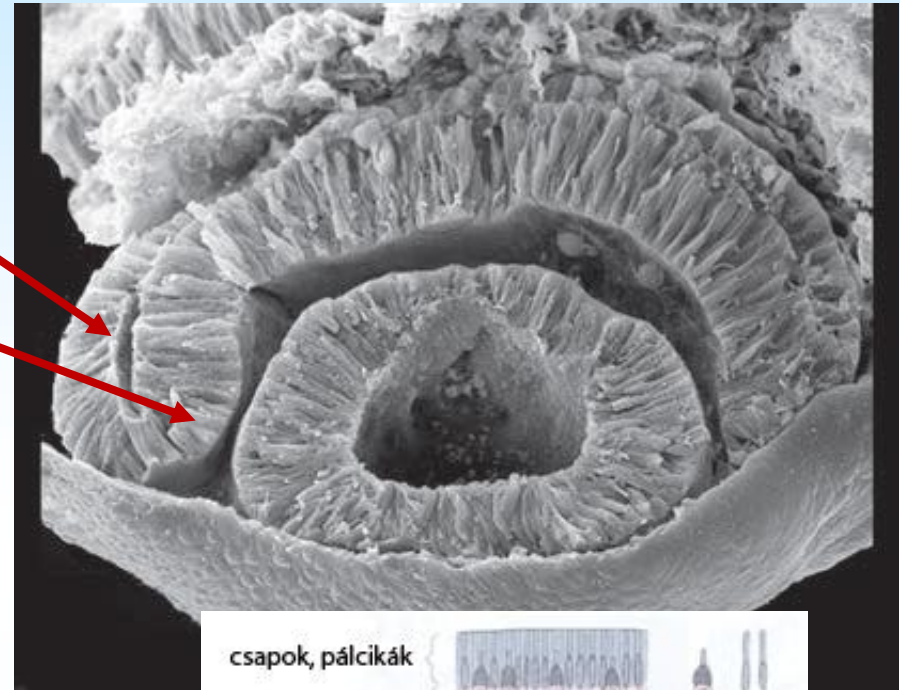
NON-pigmented inner layer

Pars iridica retinae

Pigmented inner layer

Temporal line

ganglion-, Müller-, amacrin zellen
horizontalen, bipolar zellen,
Photorezeptoren , external segments



SUMMARY

Formation of the optic groove on each side of the forebrain

Formation of the optic vesicles

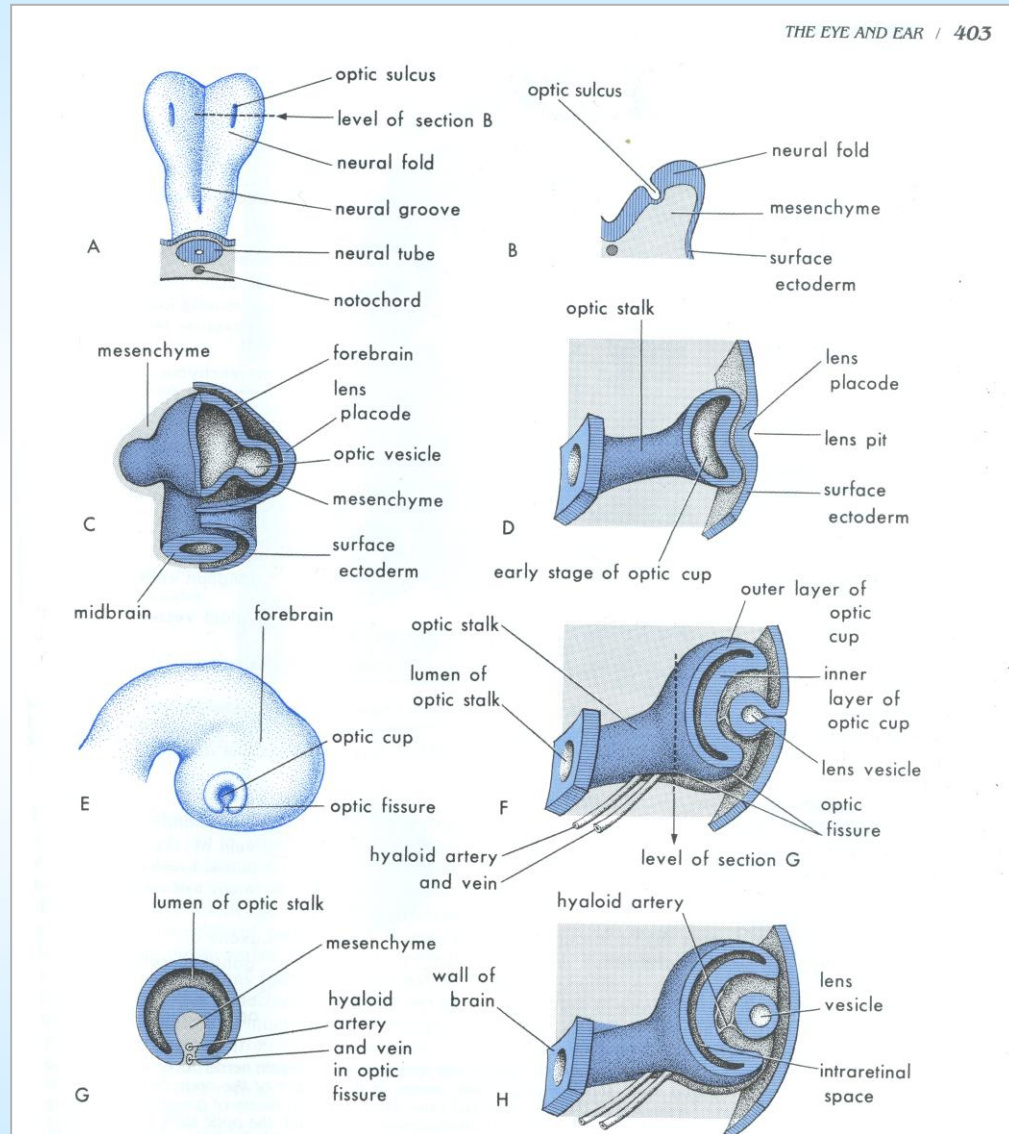
Formation of the lens placods

Invagination of the optic vesicles

Formation of the double-walled optic cup and lens vesicle

Choroid fissure is formed for the hyaloid artery

The lens vesicle loses the contact with the surface ectoderm



SUMMARY OF TRANSCRIPTION FACTORS

Mastergene - Pax-6

It regulates the expression of further 2500 genes (e.g. shh, Pax-2, Prox-1, Otx-1, 2)

NEURAL PLATE : optic cup (Pax-6 positivity)

Neural retina, pigment epithelium,
Iris (epithel), m. sphincter pupillae
m. dilatator pupillae, ciliary body epithelium
Optic n.

NEURAL CREST: (Pax-6 negativity)

Trabecular system, stroma-iris
Ciliary body,
muscles, choroid, sclera, cornea
stroma and endothelium, CT of the
extraocular muscles, optic n., membranes ,
orbital bone,

Mesoderm: (Pax-6 negativity)

Myoblasts
endothelium (erek, chorio-
capillaris, canal)
Blood, temporal part of sclera
üvegtest, a. hyaloidea

Surface ectoderm: (Pax-6 positivity)

Epithelium of Lens, cornea és
conjunctiva
Lacrimal gland,
Epithelium of the skin, hairs 😊,

$\frac{20}{200}$

O

1

$\frac{20}{100}$

M G

2

$\frac{20}{70}$

W T F

3

$\frac{20}{50}$

S T F U

4

$\frac{20}{40}$

P W N 3 D

5

$\frac{20}{30}$

U R A N O O B

6

$\frac{20}{20}$

L M A O R O T F

7

$\frac{20}{15}$

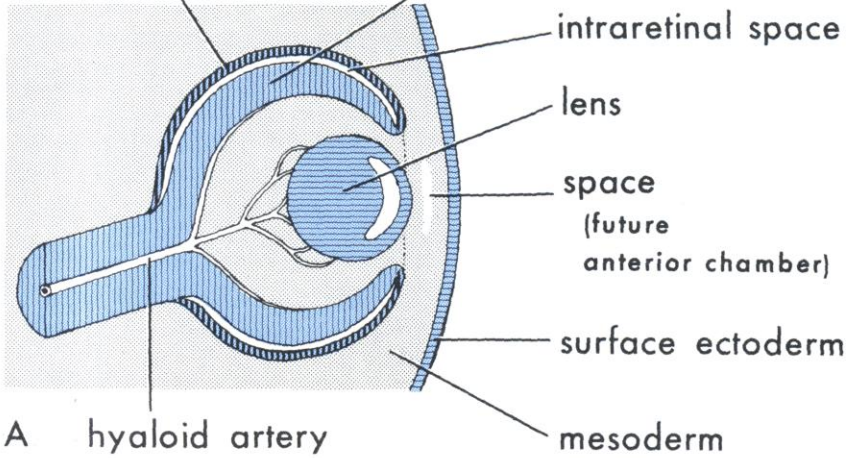
K T H X B Y E : P

8

IF YOU CAN READ THIS, UR EYEZ R TEN 1337. 777L

developing pigment epithelium of the retina

developing neural layer of the retina



sclera

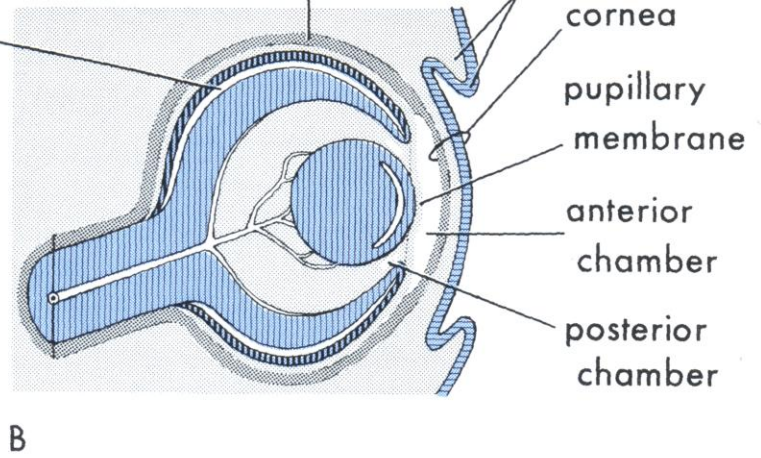
eyelid

cornea

pupillary membrane

anterior chamber

posterior chamber



tunica vasculosa

vitreous body

lentic

anterior chamber

eyelids fused

cornea

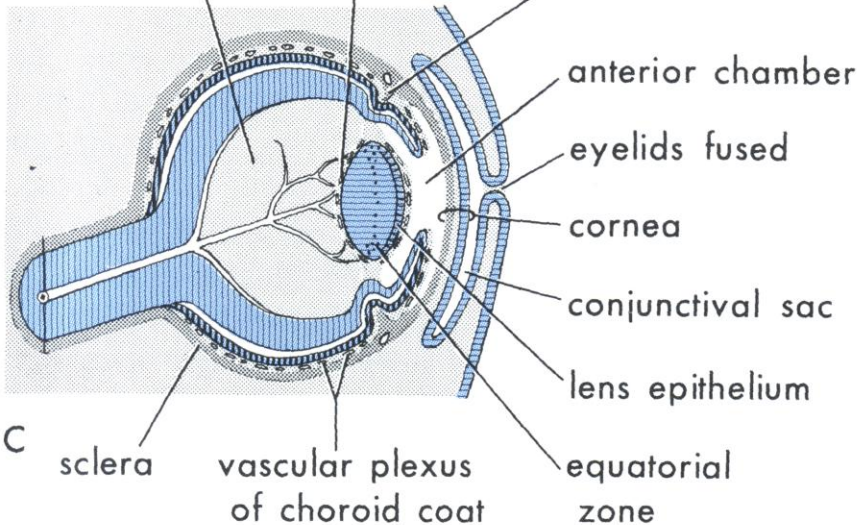
conjunctival sac

lens epithelium

equatorial zone

vascular plexus of choroid coat

C sclera



pigment epithelium and neural layer of the retina

sinus venosus sclerae

iris

cornea

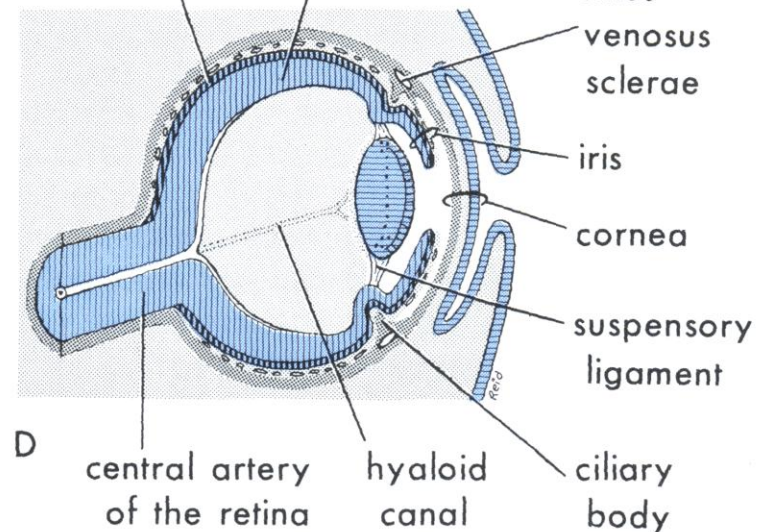
suspensory ligament

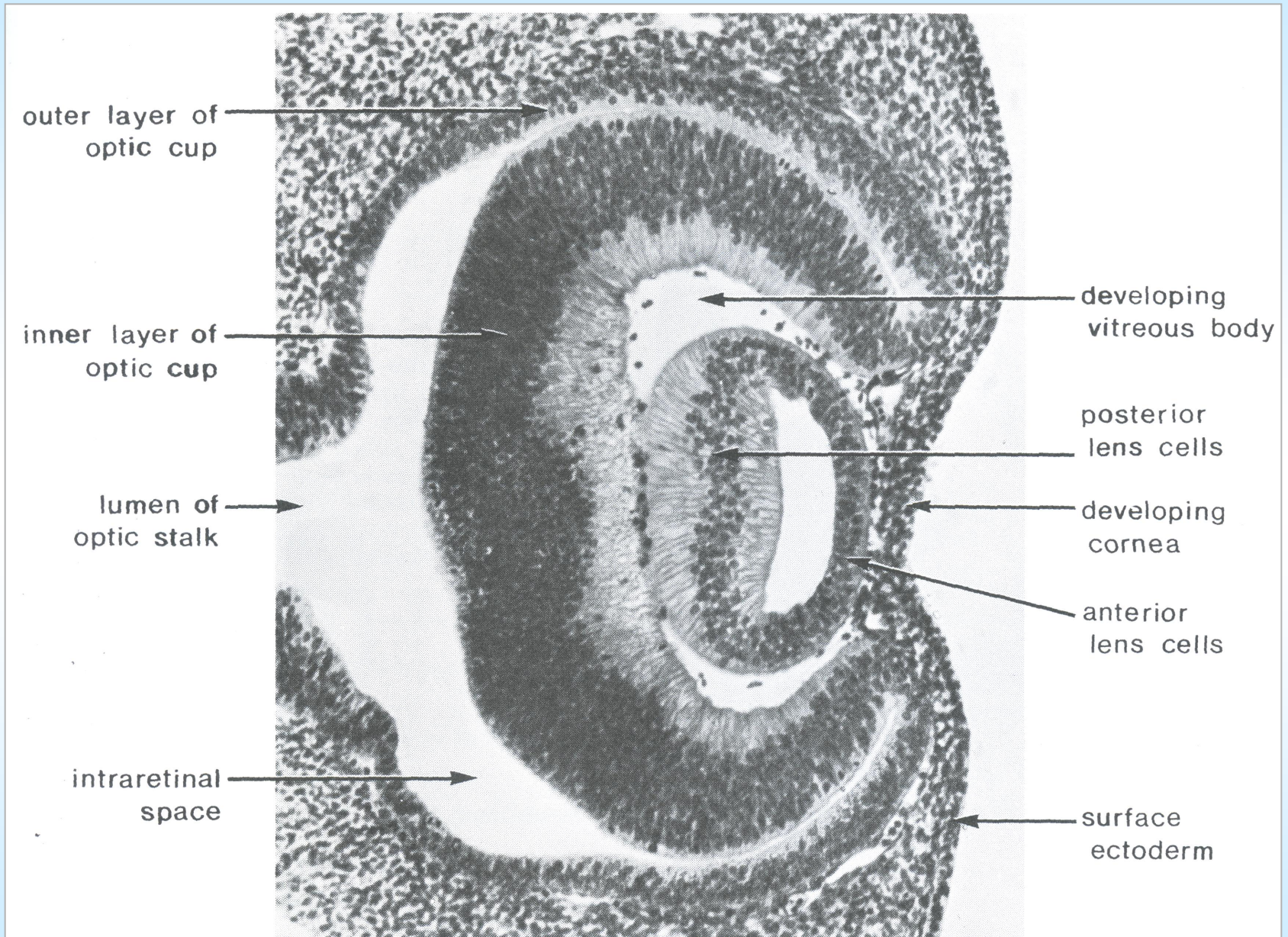
central artery of the retina

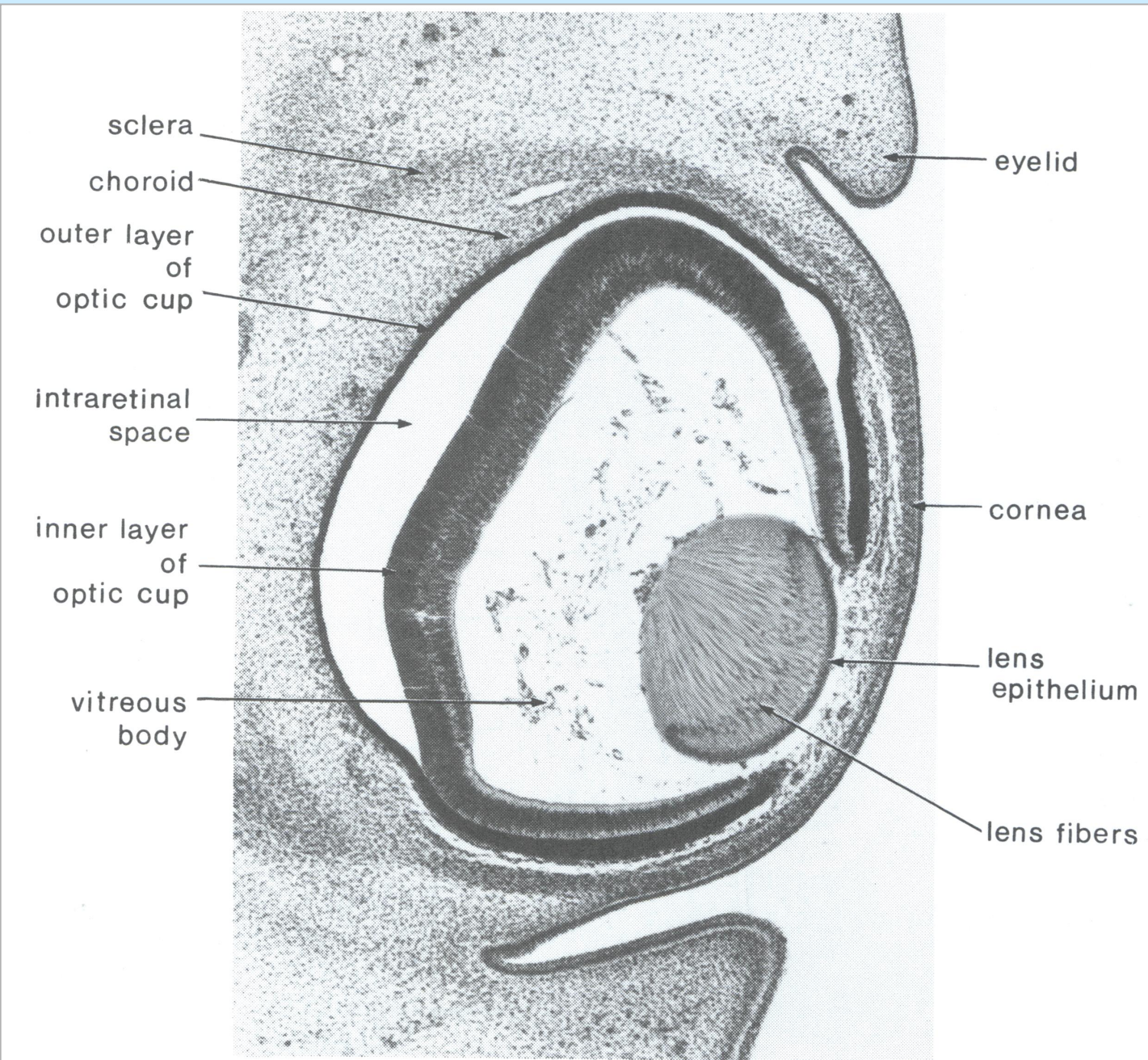
hyaloid canal

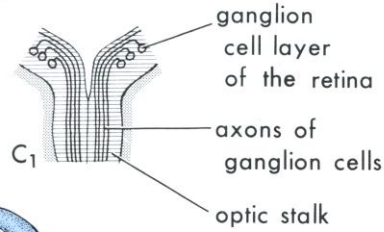
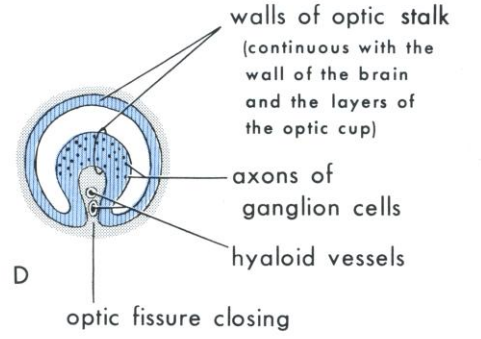
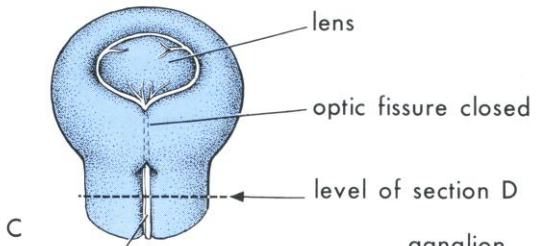
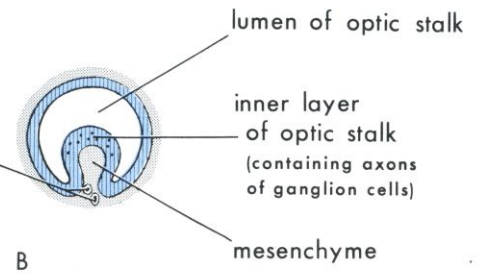
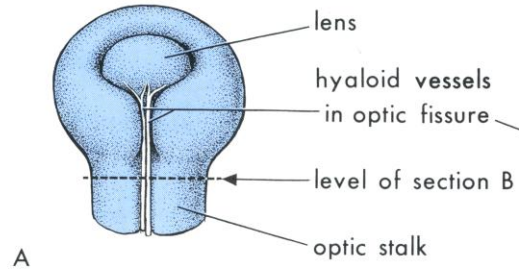
cilial body

D









sheath of the optic nerve
(continuous with the meninges of the brain
and the choroid and sclera)

