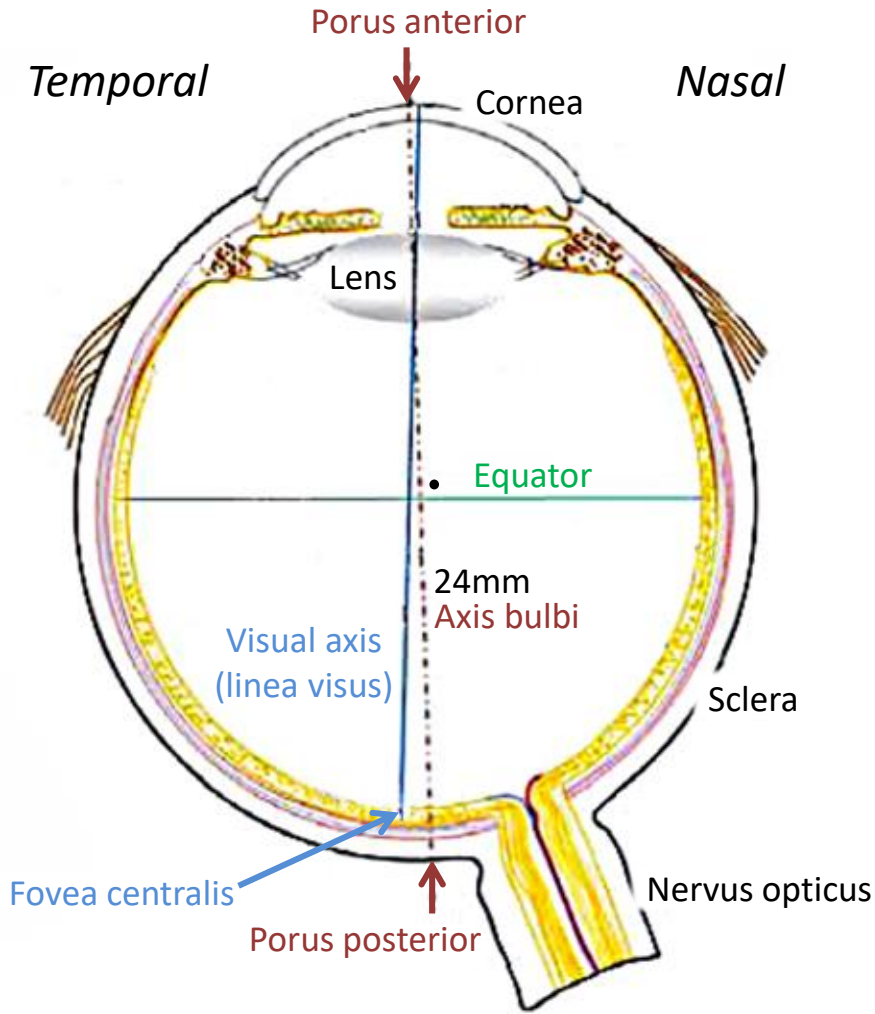


Fibrous and vascular coats of the eyeball

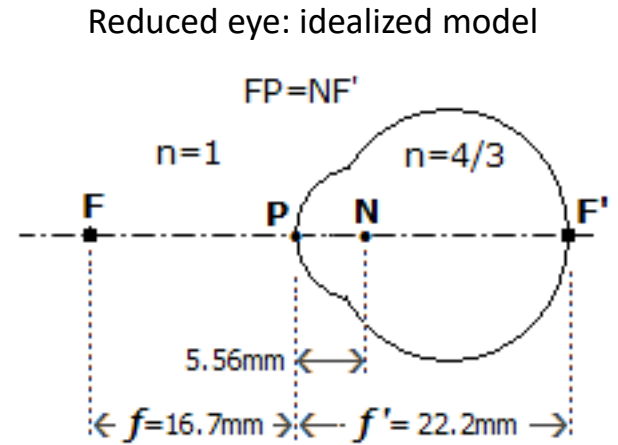


Zsuzsanna Tóth, PhD
Semmelweis University,
Department of Anatomy, Histology- and
Embryology

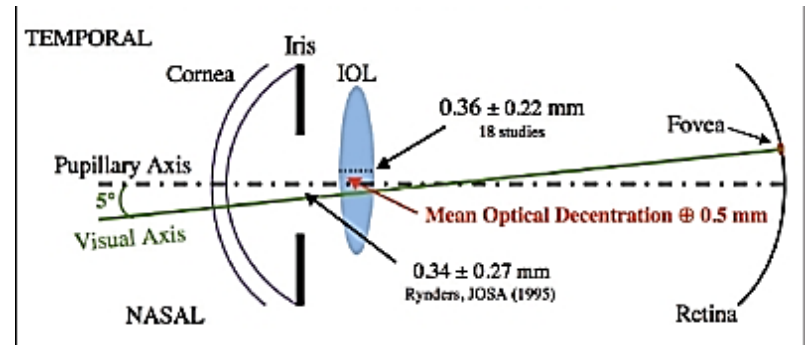
Bulbus oculi-decentralized optical system



Axis bulbi externus and interus



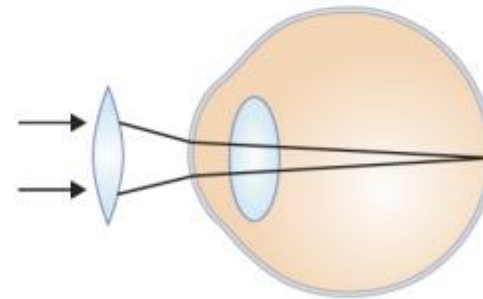
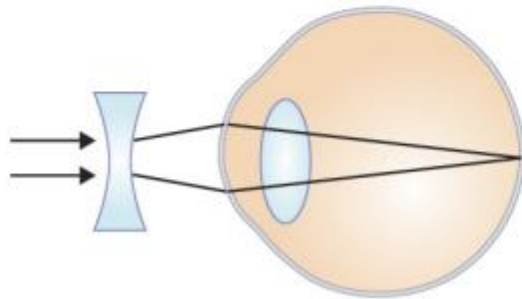
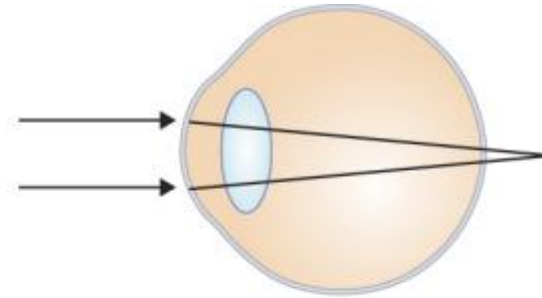
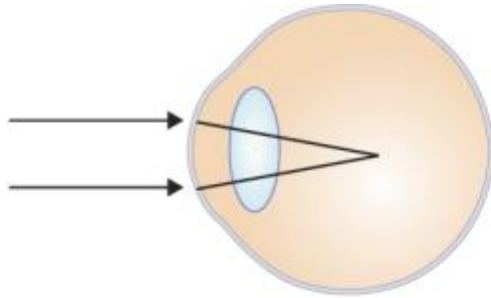
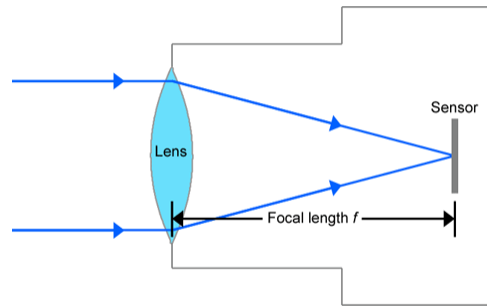
F: focal point, P: principal point, N: nodal point



Optical axis (linea visus) :

an imaginary line passing from the midpoint of the visual field to the fovea centralis.

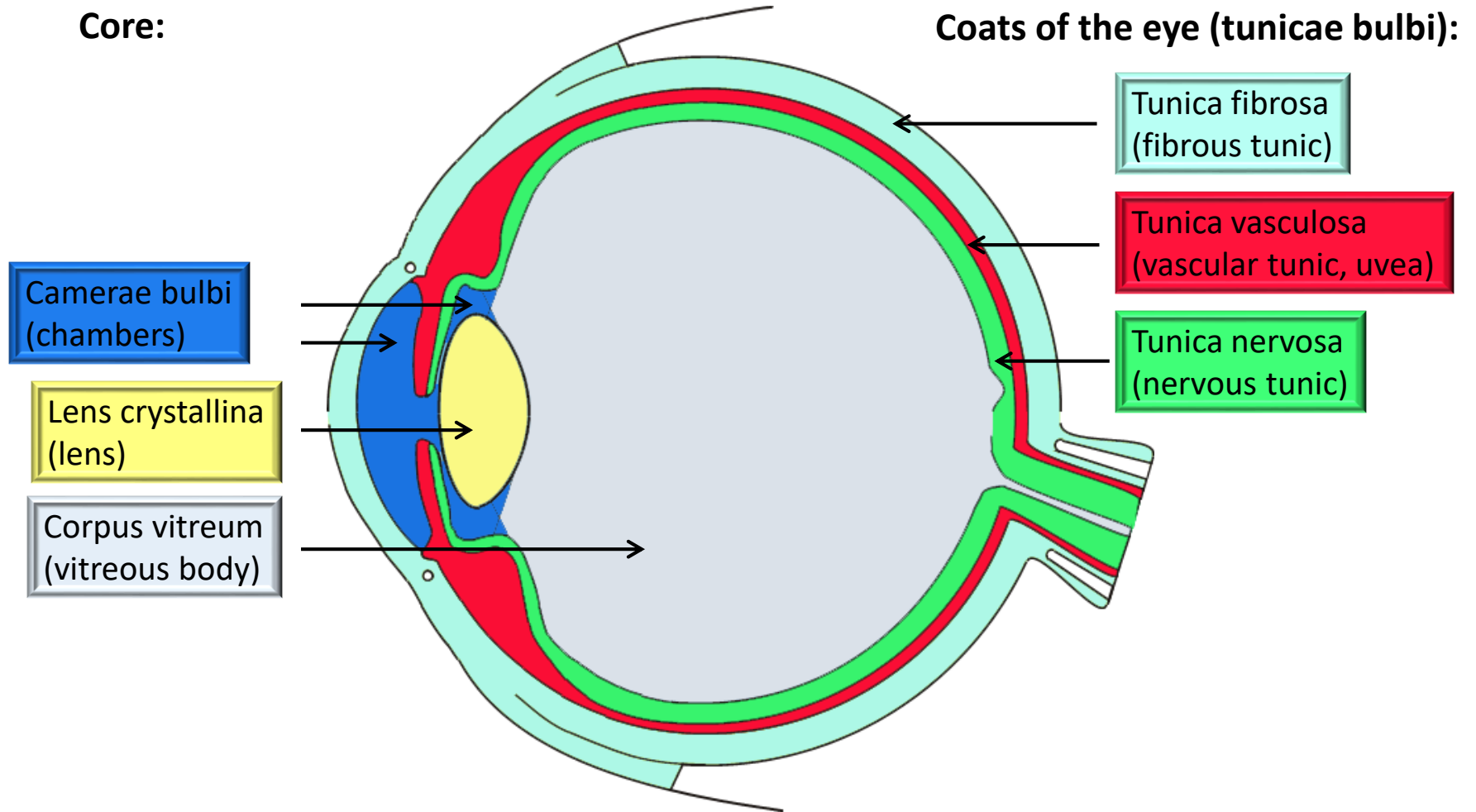
Refractive errors of the eye



myopia - nearsightedness

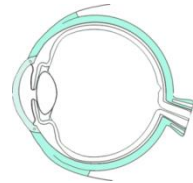
hypermetropia-farsightedness

Parts of the eye

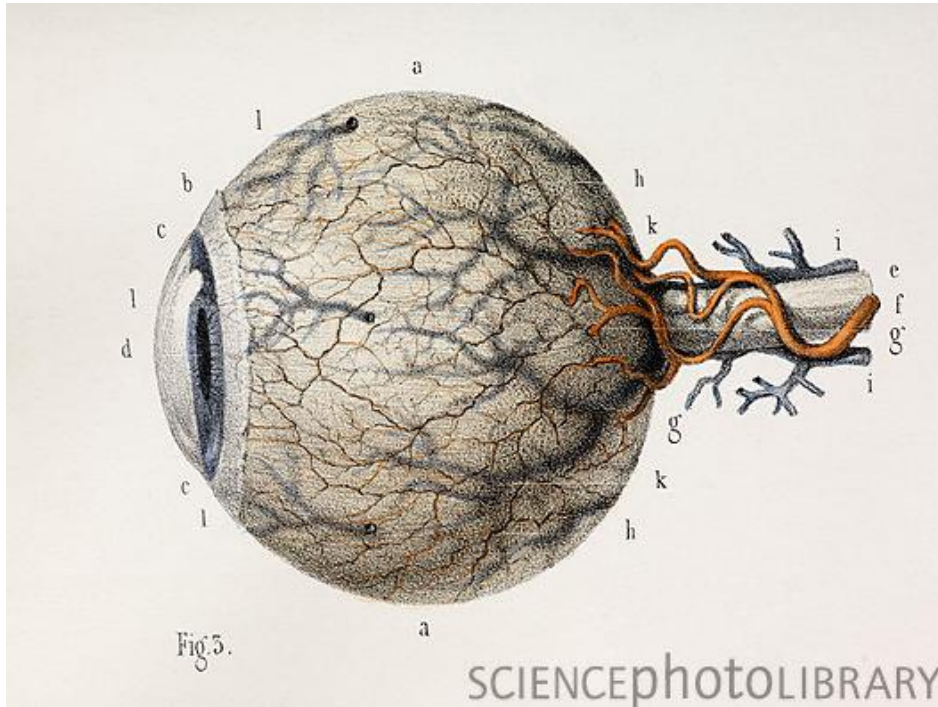


Sagittal

From prof. Ágoston Szél

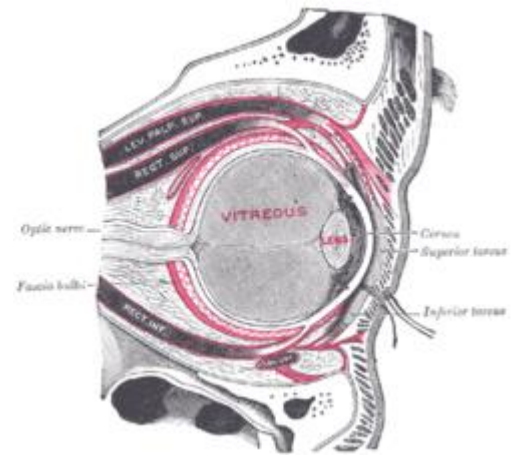
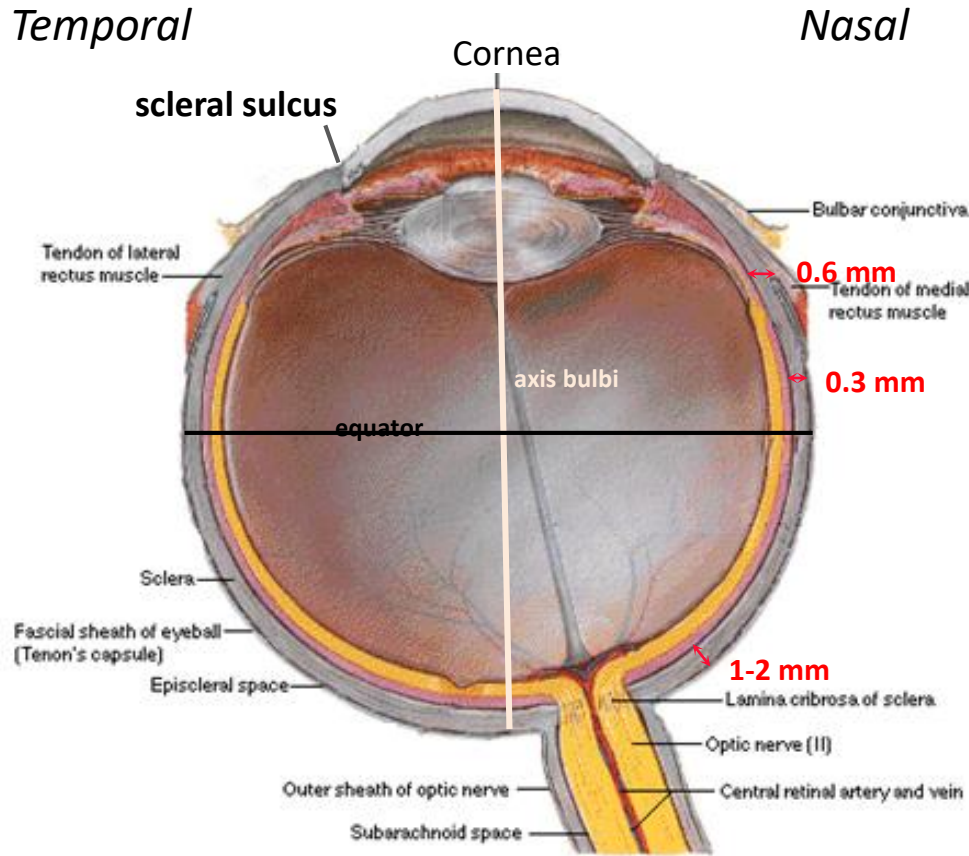
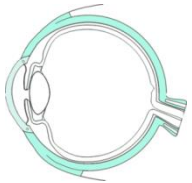


Fibrous tunic



- Continuous with the dura mater.
- Dense connective tissue
 - 1. Sclera:**
 - non-transparent
 - nerves and vessels penetrate
 - 2. Cornea:**
 - transparent,
 - more convex
 - gives 80% of the refractive power of the eye.

Sclera

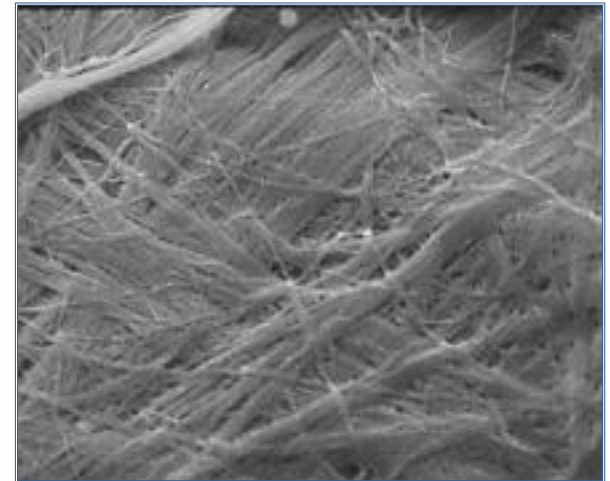
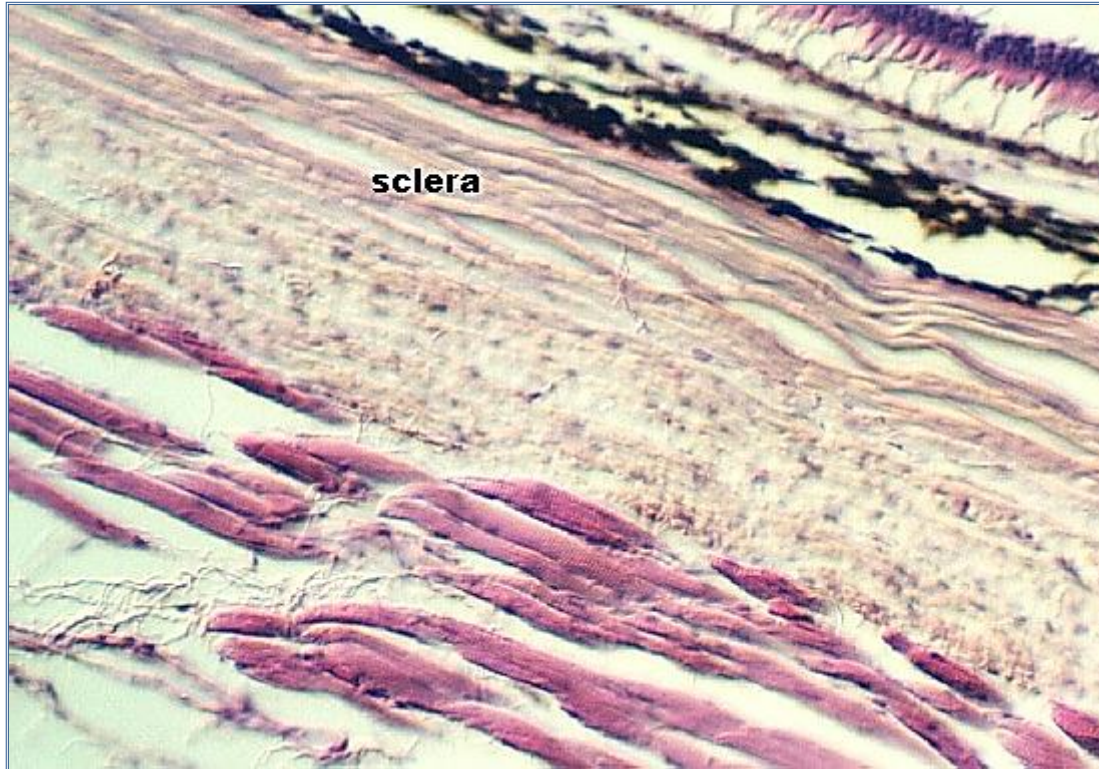
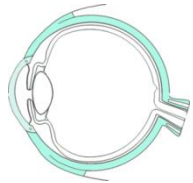


lateral view



horizontal view

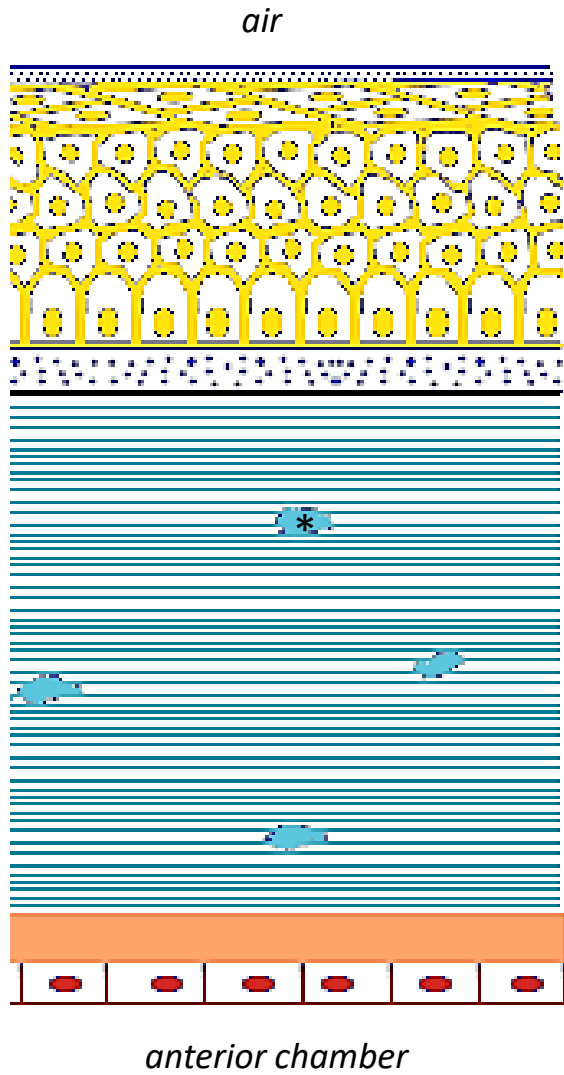
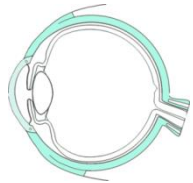
Histology of the sclera



Collagen fiber network, sclera (EM).

- dense connective tissue
- interlacing bundles of type I collagen, elastic fibers are also present
- fibers run parallel with the eyeball
- fibrocytes, melanocytes

The cornea avoids vessels and pigment cells



tear film

Epithelium:

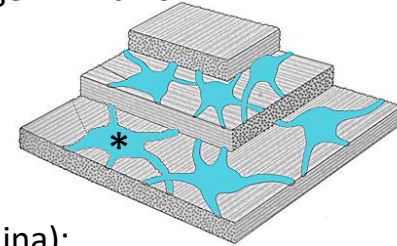
- stratified non-keratinized squamous epithelium, basal lamina
- pain sensitive nerve endings (ophthalmic nerve),
- easily regenerates,
- laterally it is continuous with the conjunctiva and sclera

Bowmann's membrane (anterior limiting lamina):

- densely packed collagen fibrils embedded in ground substance
- protects against pathogenic agents and trauma,
- acellular, nonregenerating layer

Stroma (substantia propria):

- 200 - 250 lamellae of regularly organized collagen I. fibrils
- keratocytes between the layers (*),
- parallel orientation within layers
- adjacent layers are perpendicular,
- extracellular matrix-proteoglycans+water.



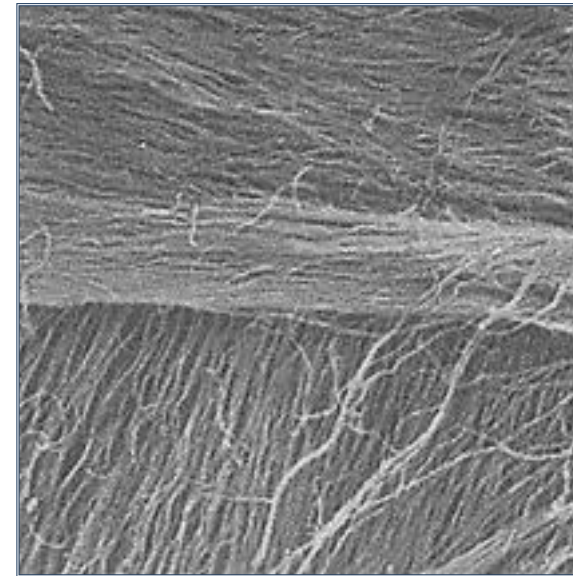
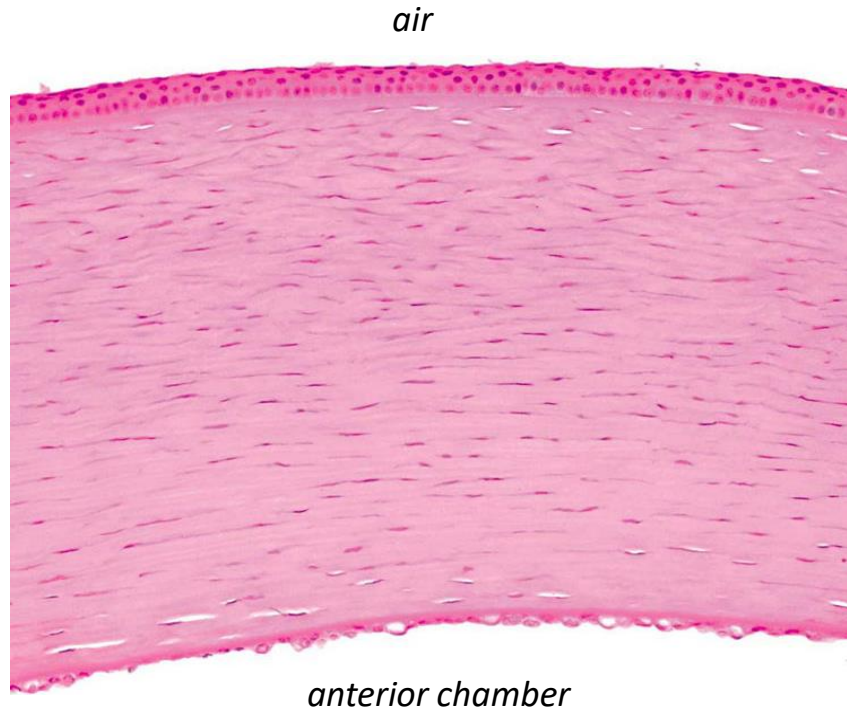
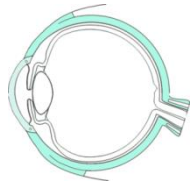
Descemet's membrane (posterior limiting lamina):

- a special basal lamina of the endothelial cells,
- mechanical support

Endothelium of the anterior chamber:

- simple squamous cells,
- responsible for the active dehydration of the stroma

The cornea eliminates light scattering in all directions except forwards



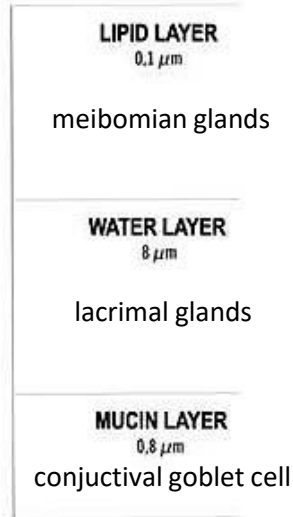
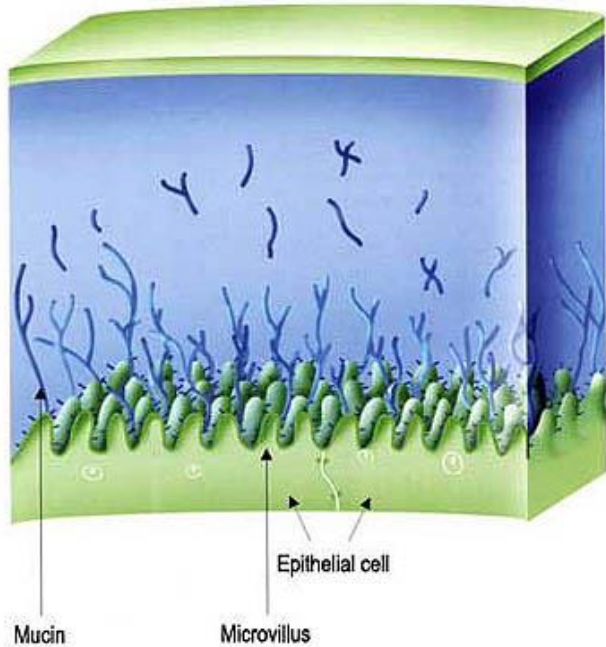
Corneal stroma: Parallel type I collagen fibers , perpendicular lamellae, (EM).

Optical properties:

- High refractive index (80% of the refractive power of the eye)
- Transparency:
 - absence of vessels and melanocytes,
 - dehydrated state
 - the diameter of the collagen fibers and the distance between them are equal
 - the collagen fibers and the lamellae are oriented regularly

The structure and function of the tear film

TEAR FILM



With kind permission from Allergan

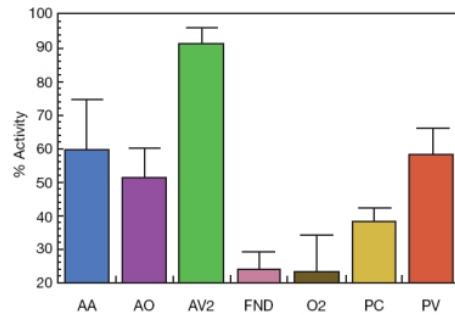
The functions of the tear film:

- preventing dryness
- ocular lubrication
- smooth the surface of the cornea so that light is refracted correctly
- supplying oxygen and nutrients
- preventing infection

TABLE 1

Major tear film proteins. Other tear film protein concentrations are less than 0.1 mg • ml⁻¹.⁴

Protein	Molar mass (daltons)	Concentration (mg • ml ⁻¹)
Lysozyme	14,000	2.07
Lipocalin	17,500	1.55
Lactoferrin	90,000	1.65
Secretory IgA	385,000	1.93



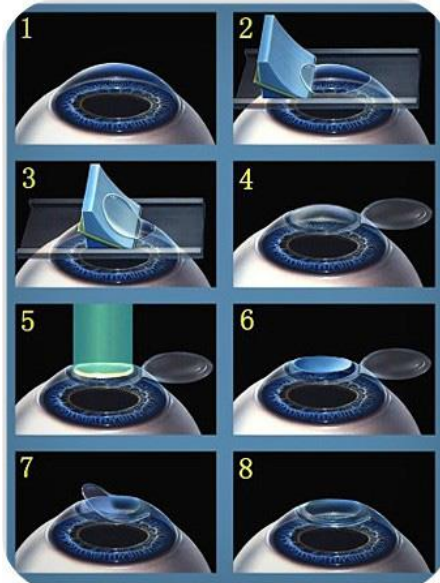
AA = Acuvue Advance; AO = Acuvue Oasis; AV2 = Acuvue 2;
FND = Focus Night and Day; O2 = O₂ Optix;
PC = Proclear compatibles; PV = PureVision.

Denaturation of tear proteins on the contact lenses – less antibacterial protection, discomfort, conjunctivitis

The contact lenses disrupt the tear film the evaporation of the tear- eye dryness

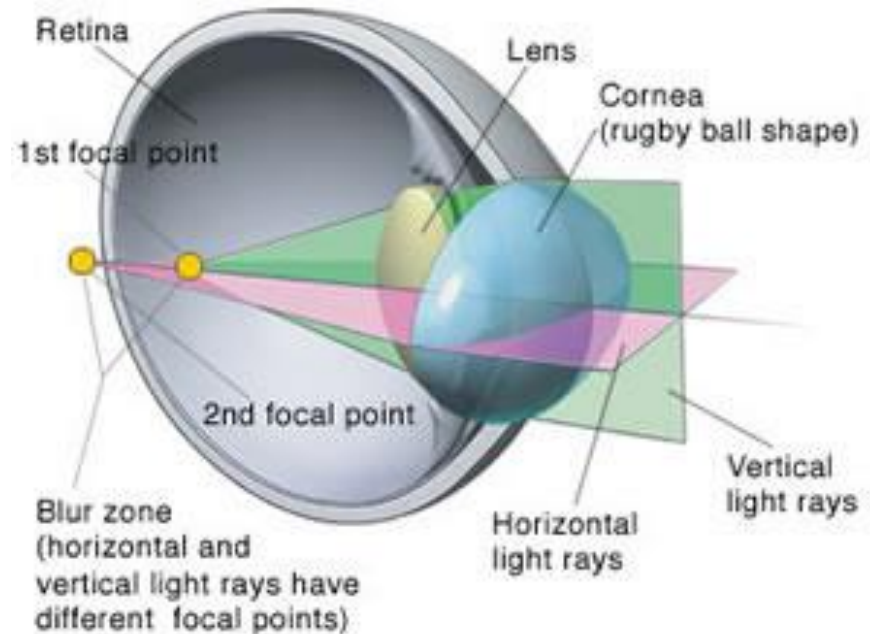
The dissymmetry of the shape of the cornea is the most common reason of astigmatism

Astigmatism causes blur along one direction



laser assisted in situ keratomileusis
LASIK

CROSS SECTION OF ASTIGMATIC EYE



Correction:

- glasses
- special contact lenses
- laser eye surgery

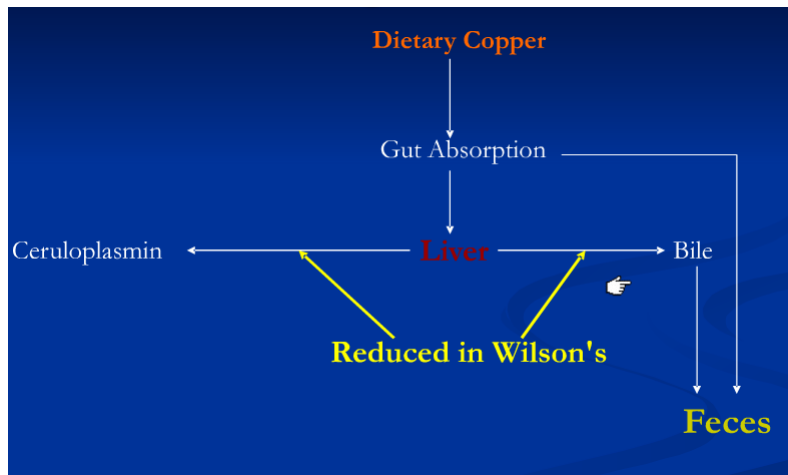
Kayser–Fleischer ring



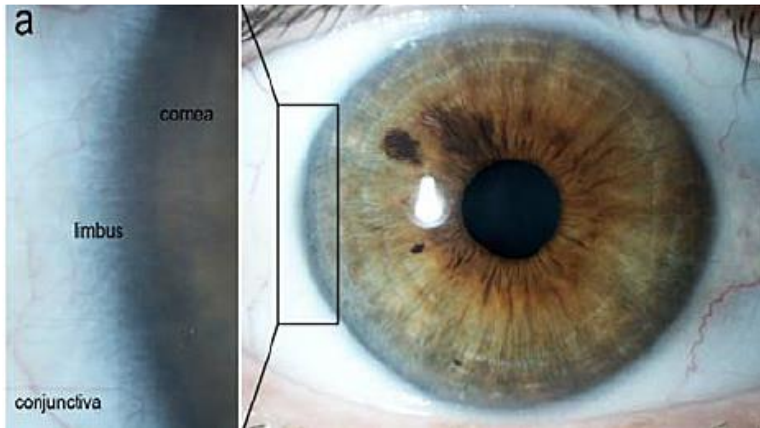
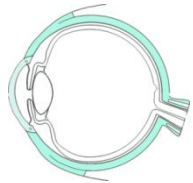
- **KF ring:** copper deposition in the Descemet's membrane

Wilson disease:

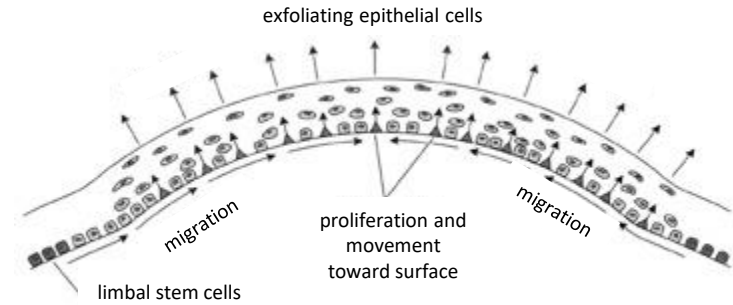
- KF ring is a diagnostic marker
- genetic disease of the copper metabolism
- fatal without treatment
- copper accumulation destroys the liver and the brain
- neurological and psychiatric symptoms, liver dysfunction



Limbus: cornea-sclera transitional area

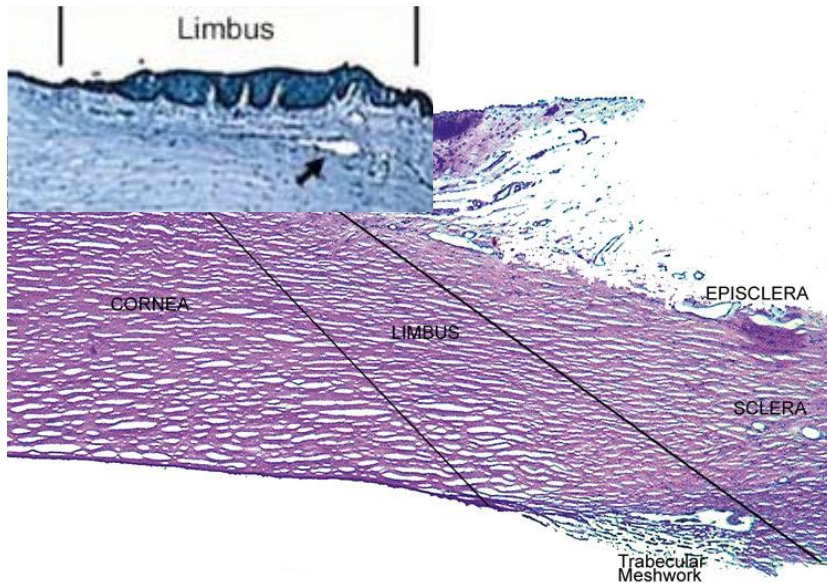


Journal of Clinical Medicine 4(2):318-342



Limbus:

- surgical landmark – clinically the blue zone,
- inner surface -outflow pathway for the aqueous humor (trabecular meshwork)
- outer surface- Vogt palisad: fibrovascular papillae, limbal stem cells (LSCs) in the epithelium
- LSCs:
 - corneal epithelium renewal
 - conjunctival barrier
 - pathologies: conjunctivalization, cancer

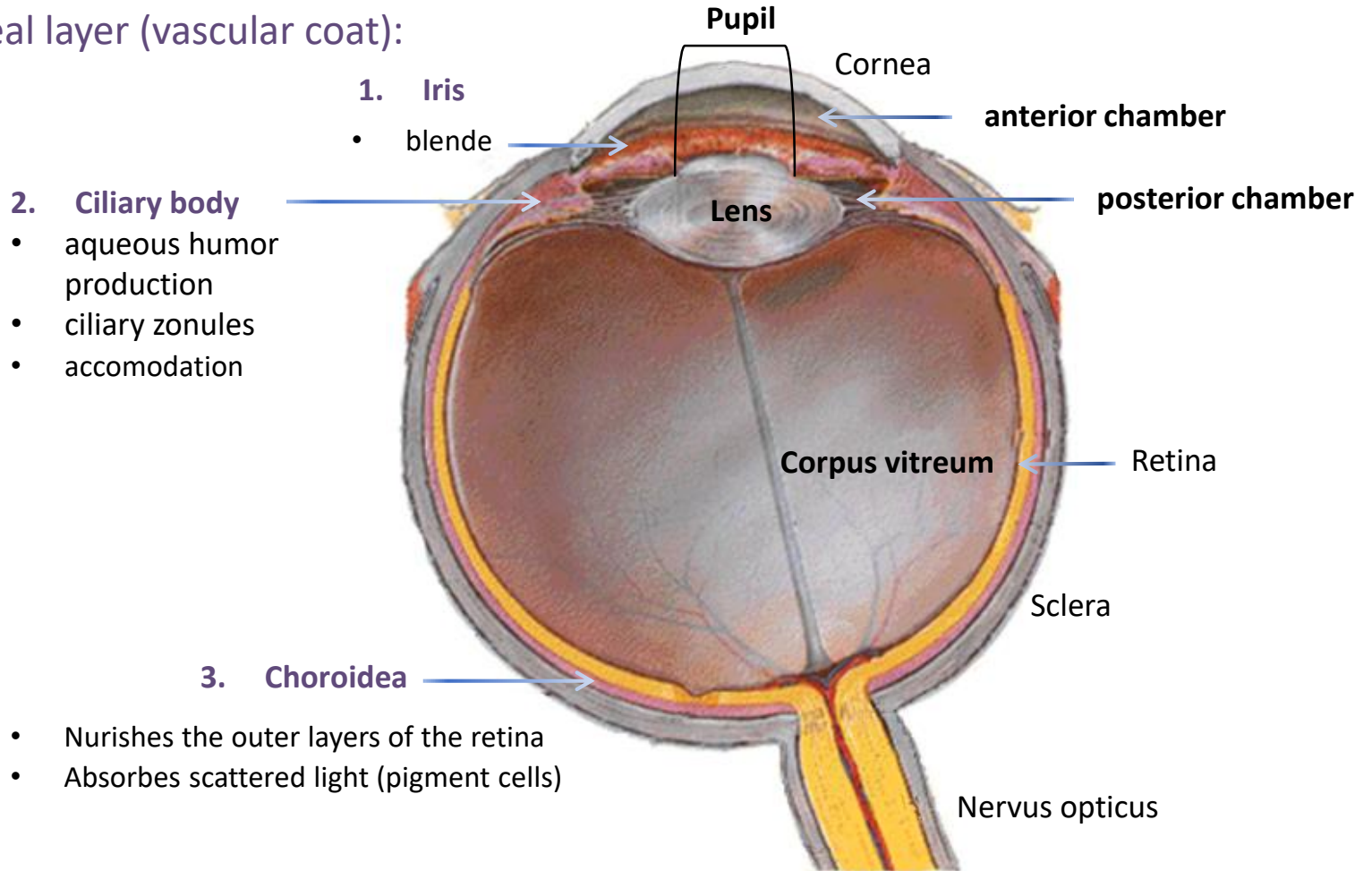


The vascular tunic



inner surface: neuroectodermal epithelium

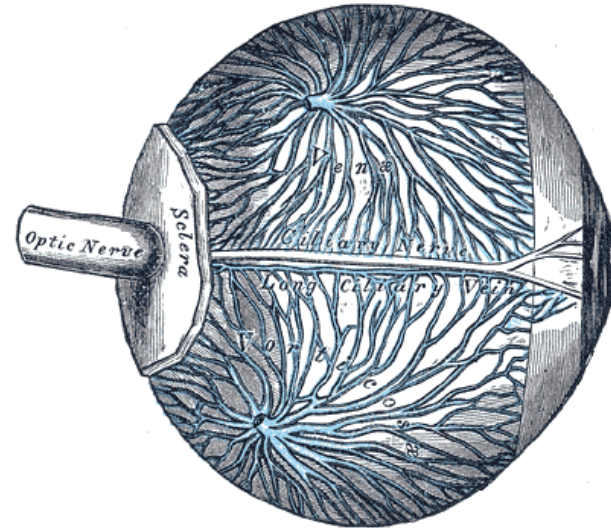
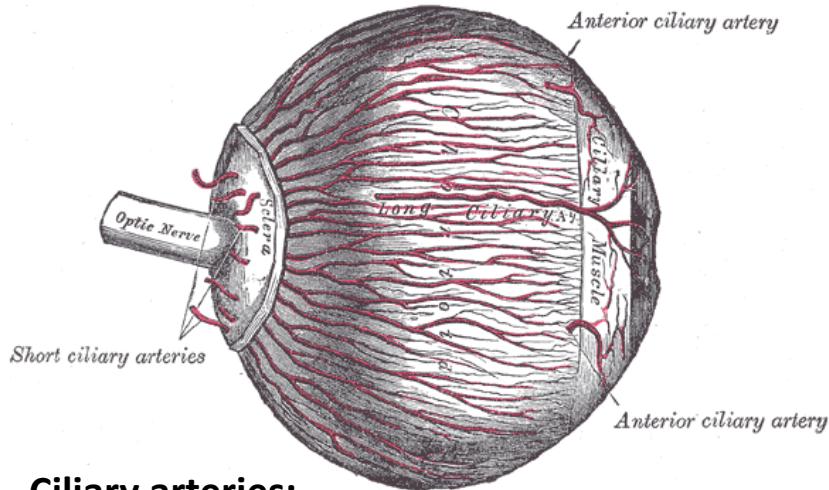
Uveal layer (vascular coat):



Horizontal

Perichoroid space I.

Loose connective tissue between the sclera and the choroidea

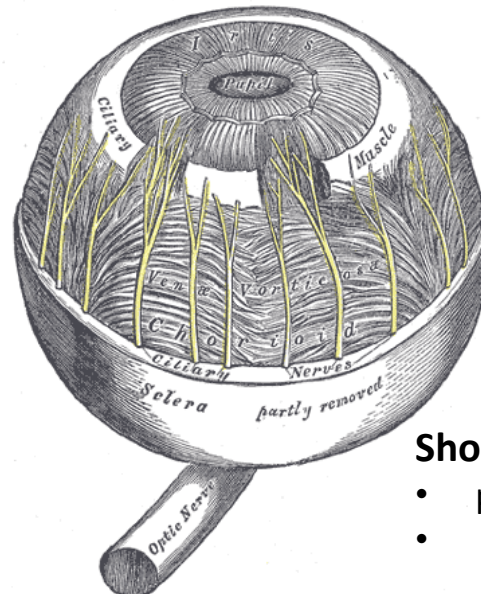


Ciliary arteries:

- posteriores longi, (2)
- posteriores breves, (6-12)
- anteriores (7-8)
- from the branch of the a. ophthalmica

Vortex veins:

- 1 in every quadrant
- drained by the orbital veins

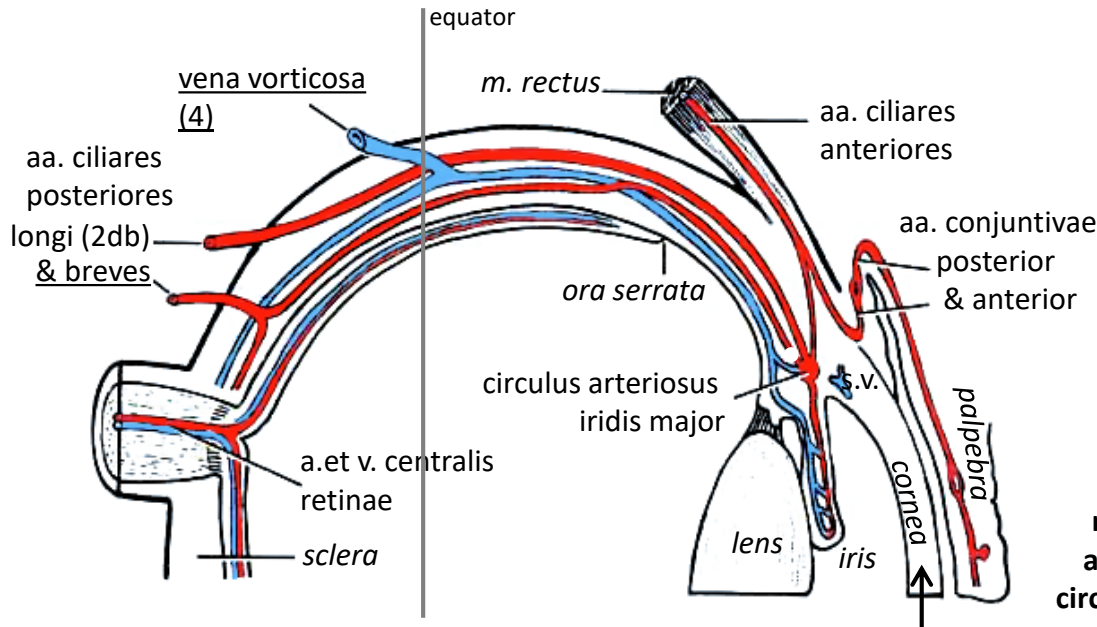


Short and long ciliary nerves:

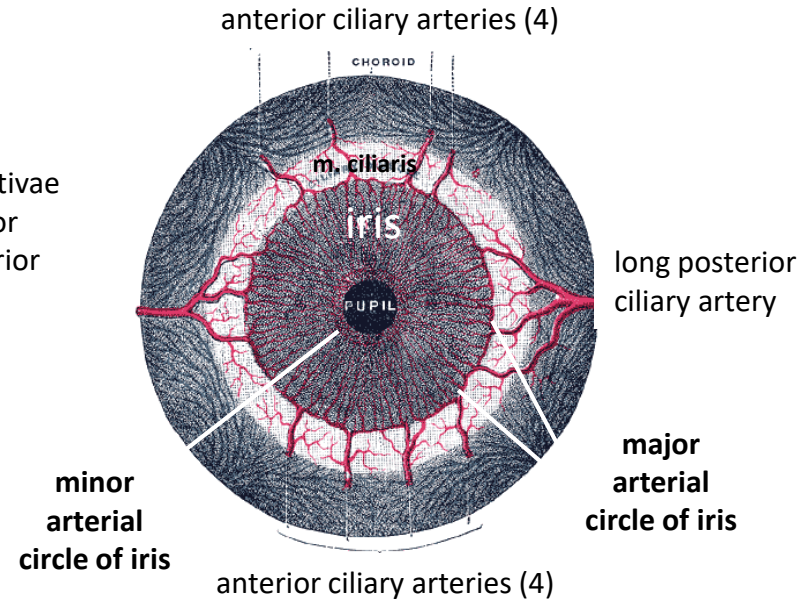
- penetrate at the optic nerve
- give branches at the level of the ciliary body



Perichoroid space II.



NO VESSELS!!



Arterial supply (aa. ciliares):

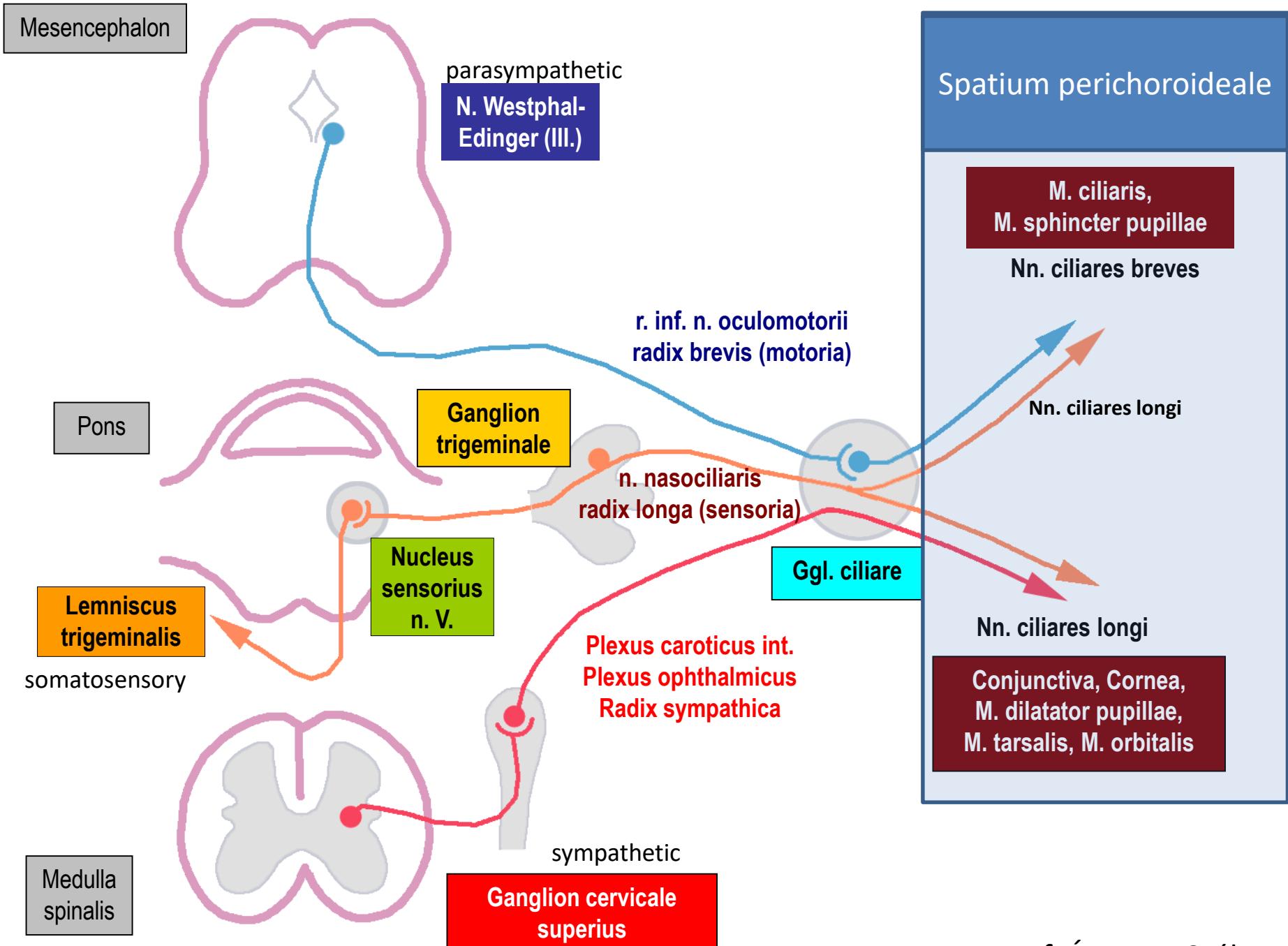
- Short arteries: choroidea, caudal part of the ciliary body
- Long and anterior arteries: anterior part of the ciliary body's iris

Drainage:

- • vortex veins
- • vortex veins, episcleral veins

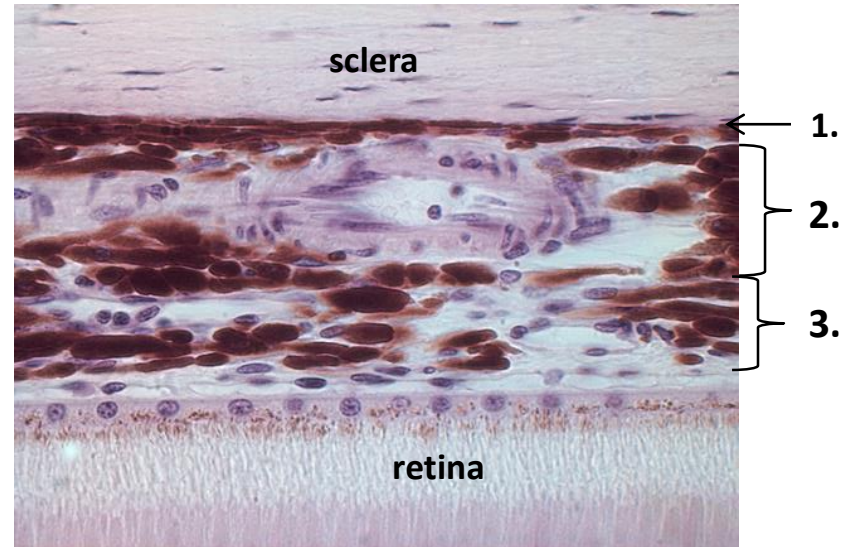
The chroid can easily be detached from the sclera. Fixation points:

- at the optic nerve
- at the vortex veins.



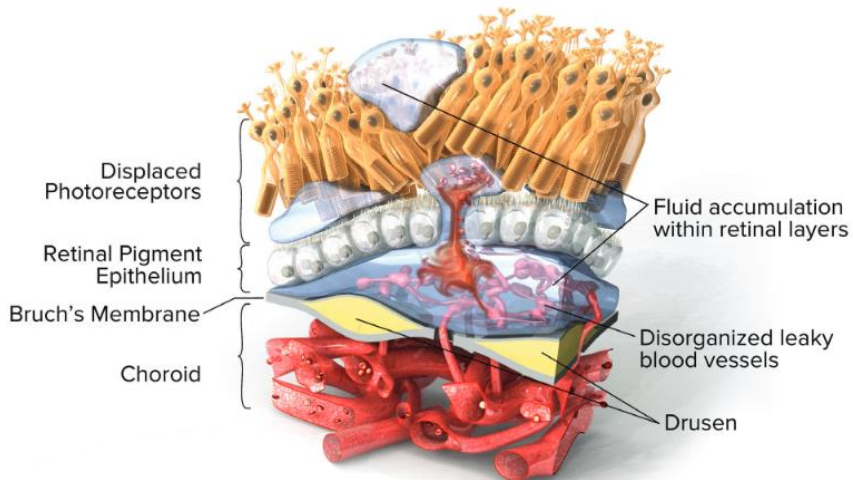
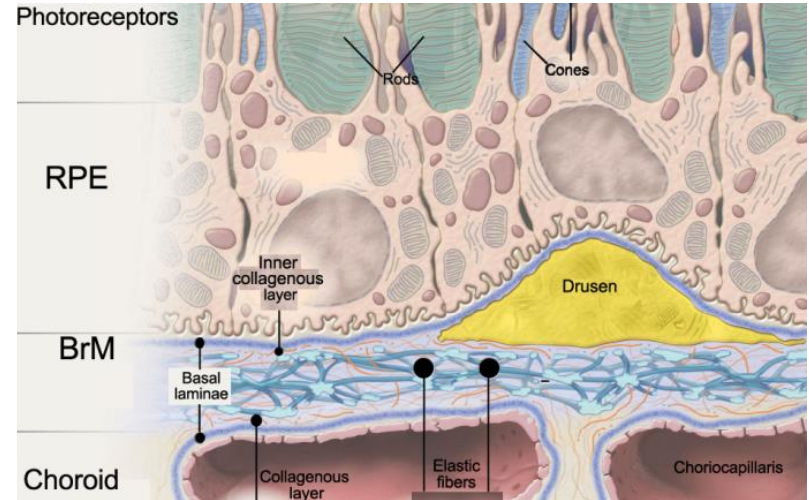
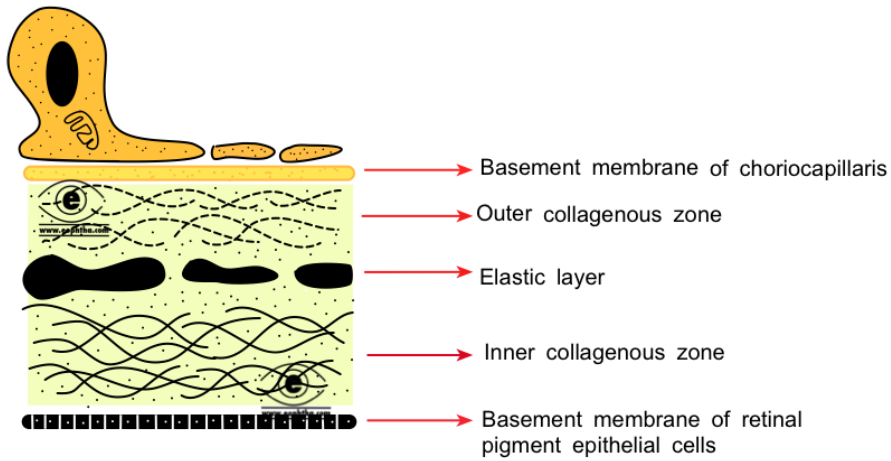
From prof. Ágoston Szél

Choroid laminas



1. **Suprachoroid lamina** = perichoroid space (=lamina fusca sclerae): loose connective tissue, fibroblasts, macrophages, melanocytes, elastic fibers, vessels, nerves.
2. **Vascular lamina** : small arteries and veins with a smaller diameter approaching the retina, melanocytes, smooth muscle.
3. **Capillary lamina**: dens fenestrated capillary system, supplies the outer photoreceptor layer of the retina
4. **Bruch's membrane**: blood –retinal barrier, adherence of ciliary muscles, double basal lamina

Macula degeneration

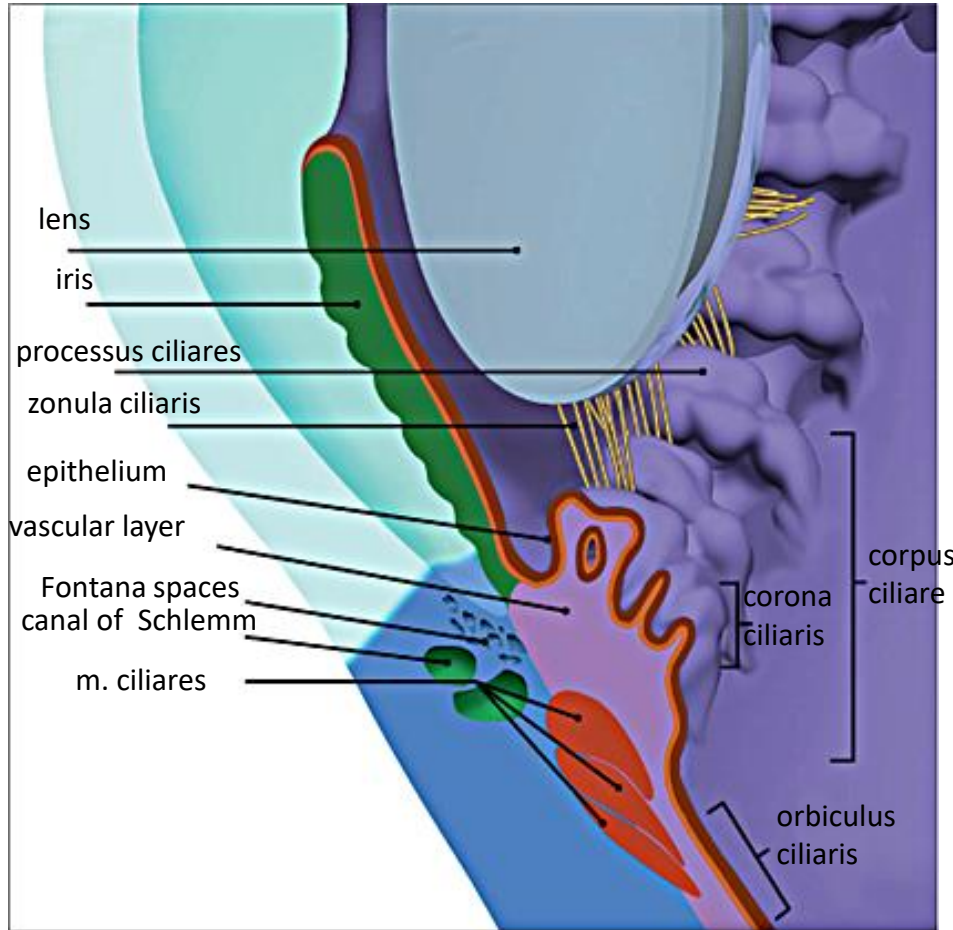


gradual loss of vision





Ciliary body



Ciliary muscles:

- oblique (Brücke), radial, circular (Müller) muscles
- parasympathetically innervated,
- smooth muscle in mammals
- melanocytes, elastic fibers
- Accomodation, drainage of aqueous humor

Vascular layer:

- continous with the vascular lamina of the choroid,
- fenestrated capillaries
- production of aqueous humor

Epithelium:

- ciliary part of the retina,
- two cell-thick
- secretion of aqueous humor

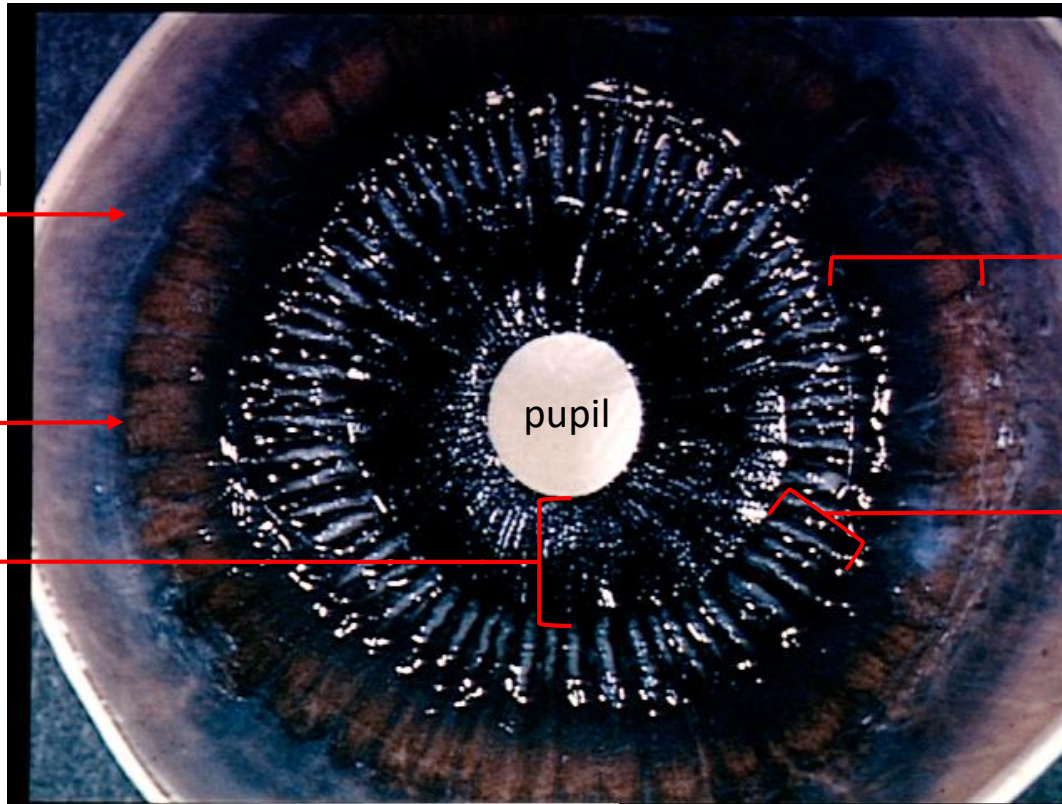
Ciliary body



optic part of the retina

ora serrata

iris



corpus ciliare:

1. orbiculus ciliaris
(plicae ciliares)

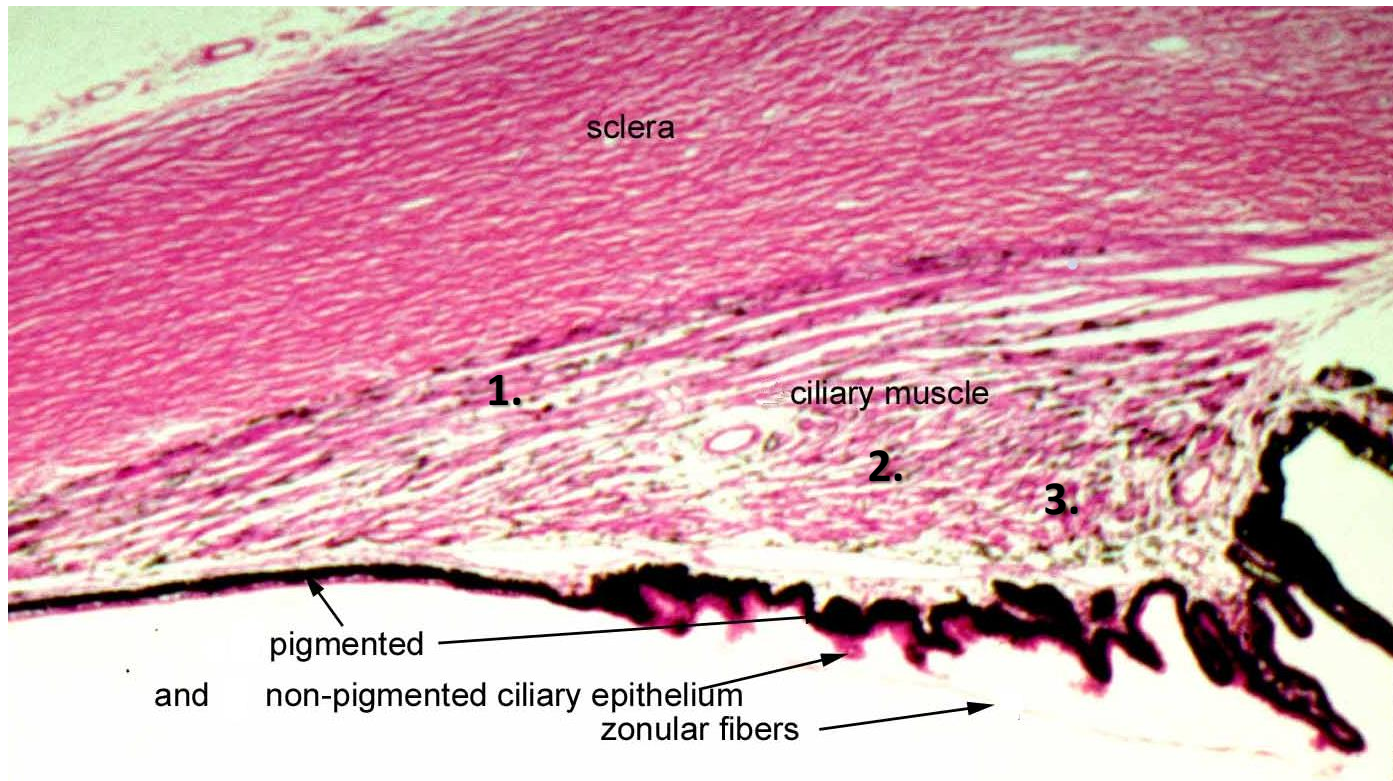
2. corona ciliaris
(ciliary muscles & ciliary processes)

inside view, lens removed

Ciliary muscles



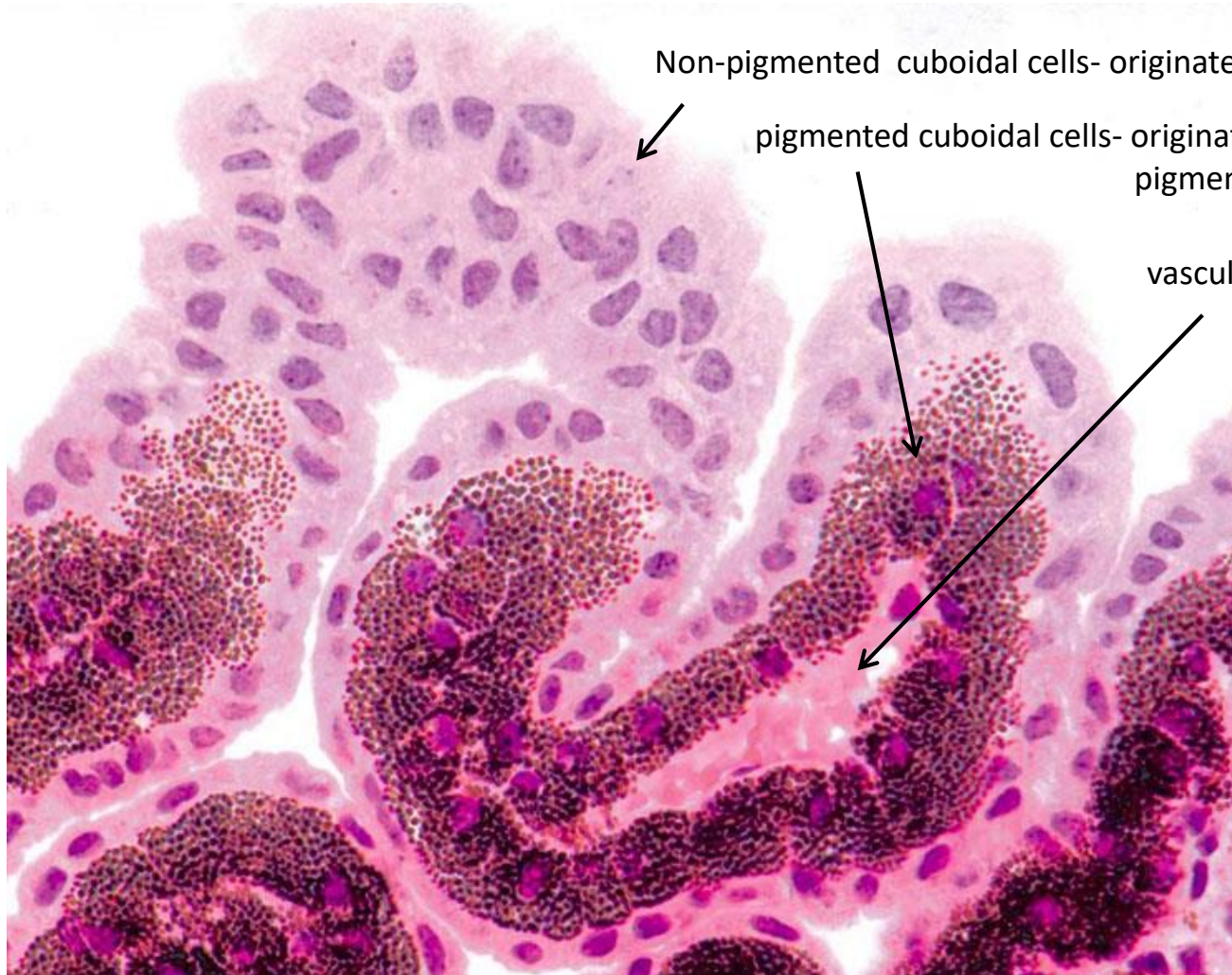
1. Oblique fibers (of Brücke) – adjacent and parallel to the sclera
2. Radial fibers-middle layer, from the sclerar spur toward the ciliary processes
3. Circular fibers (Müller's)-innermost annular muscle, sphincter type of action near the iris



Ciliary epithelium- pars ciliaris retinae



interior of the eyeball

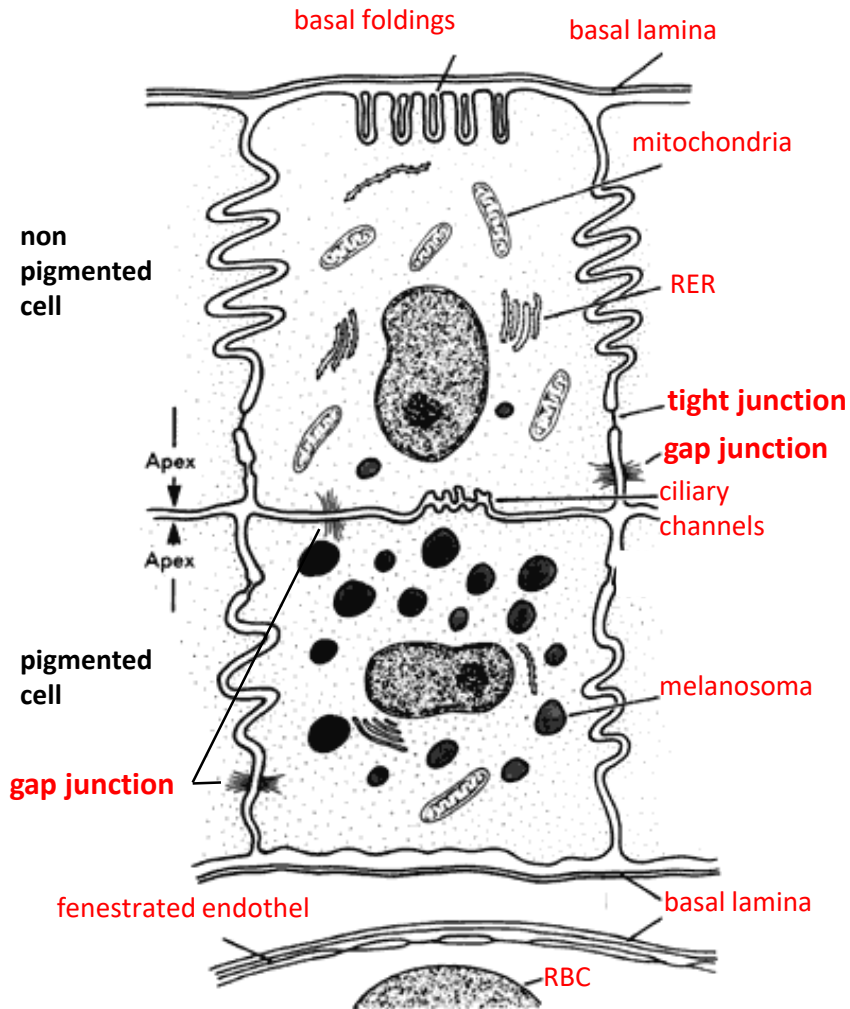


Non-pigmented cuboidal cells- originate from the neural retina

pigmented cuboidal cells- originate from the retinal pigment epithelium

vascular layer

Ciliary epithelium– aqueous humor



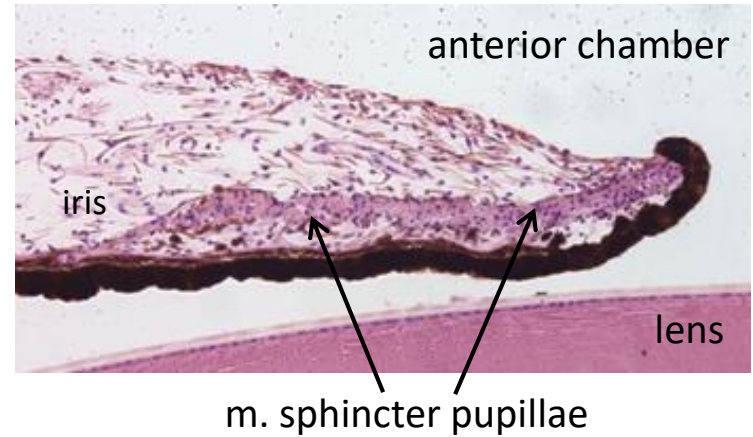
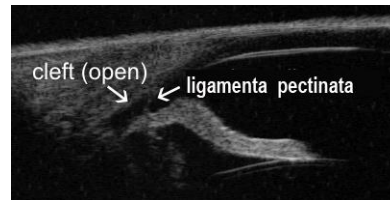
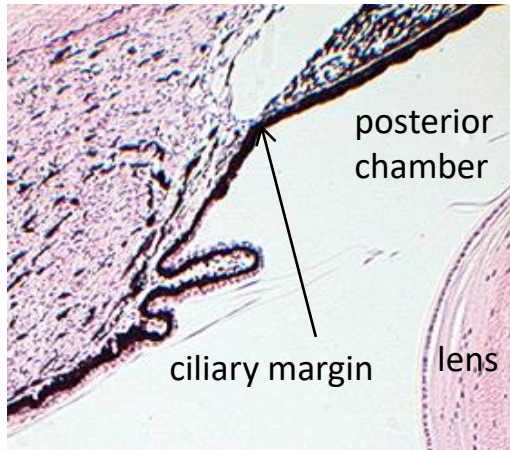
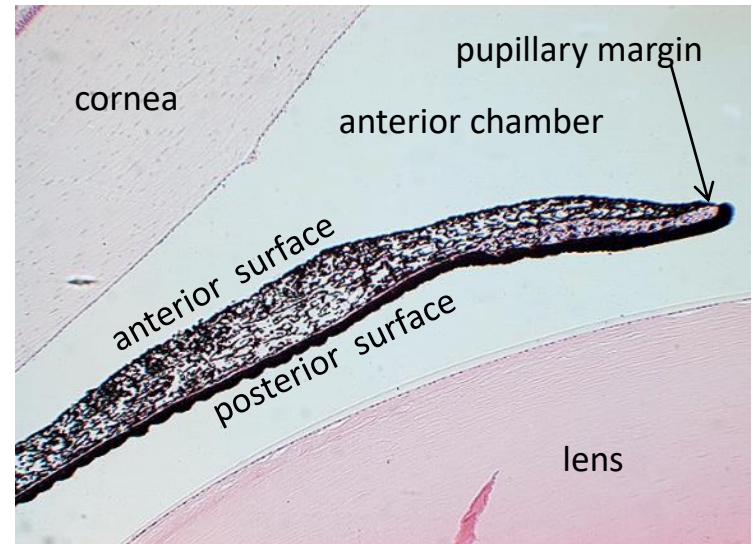
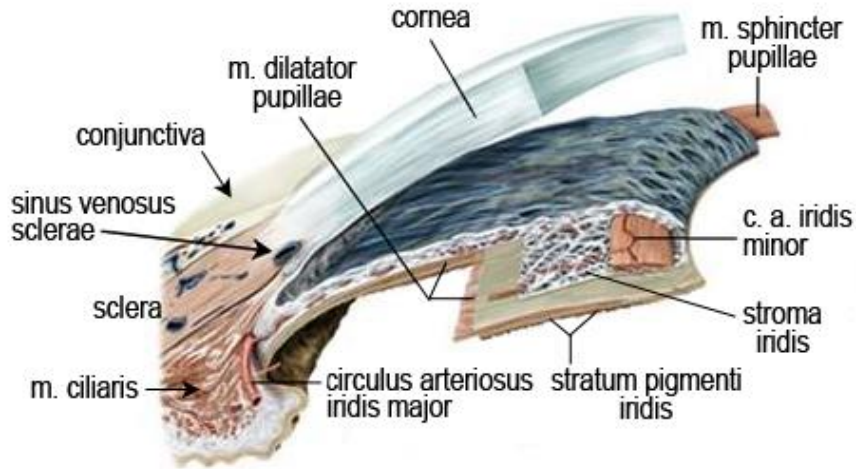
Structure:

- fluid transporting cells
- basal laminas, tight junctions between NPE cells:
blood-aqueous barrier

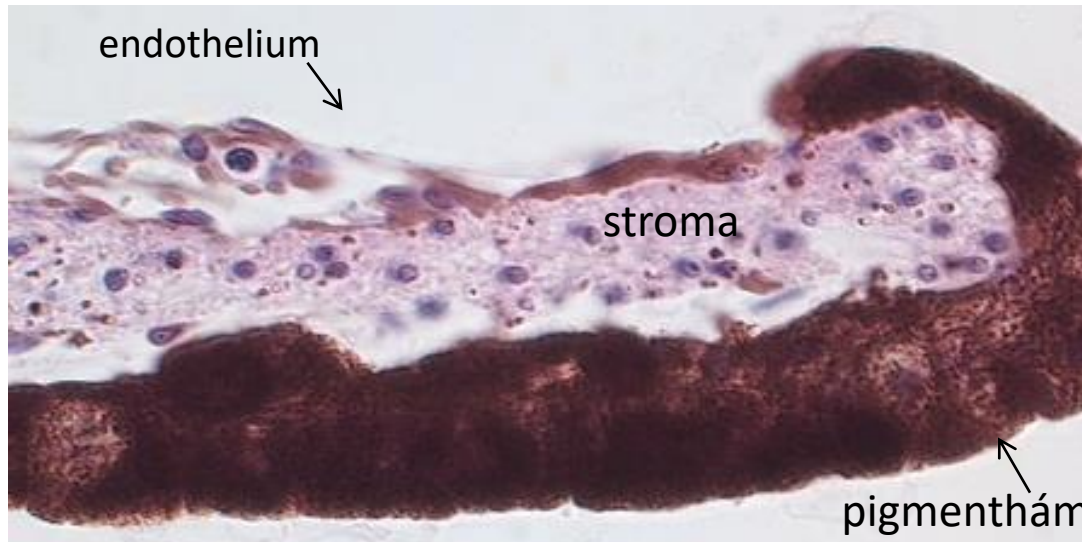
Aqueous humor:

- an ultrafiltrate of blood,
- NaCl is actively secreted ,
- water follows the NaCl movement,
- maintains the intraocular pressure ,
- provides nutrition for the cornea, lens, vitreous body, inner retina,
- relative composition to the plasma:
lower protein and glucose content,
higher amino acid, lactate, ascorbic acid content

Iris



Iris - layers I.



Endothelium of the anterior chamber:

- continuous with the corneal endothelium,
- irregular
- fibrocytes, melanocytes,
- continuous with the posterior surface

individual variations of the stromal tissue



simple-smooth

crypts

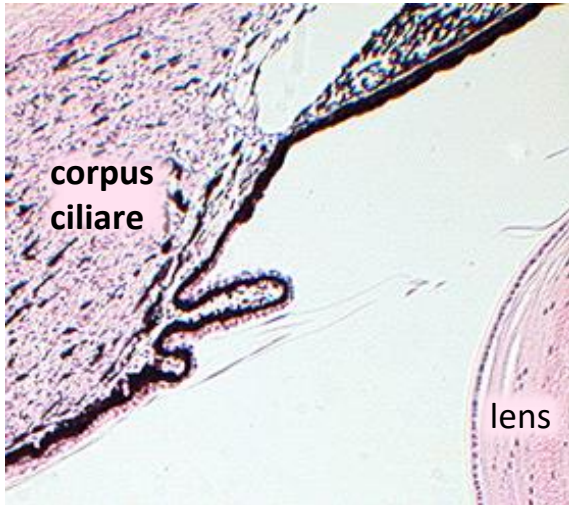
contraction ring

Stroma:

- highly vascularized (major and minor arterial circles)
- loose connective tissue
- Individual pattern of crypts-openings
- sphincter muscle at the pupillary margin,
- gives the color of the eye

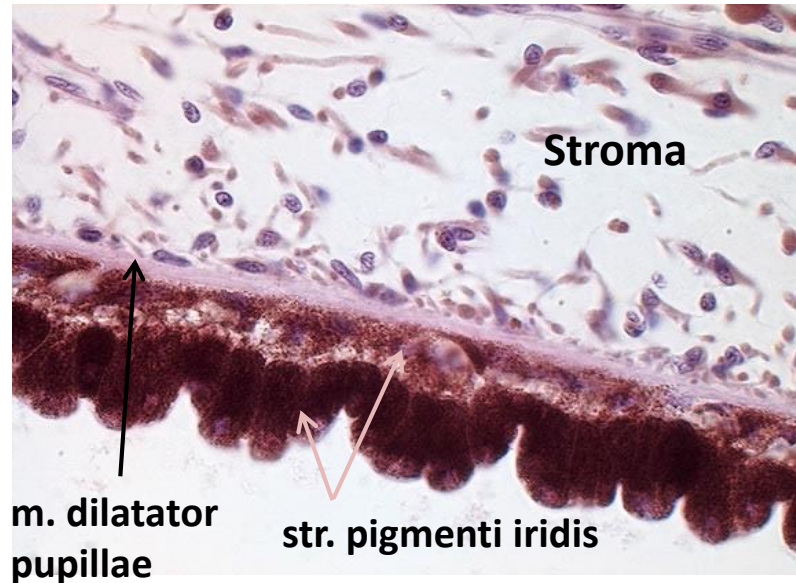


Iris - layers II.



Stratum pigmenti iridis-pars iridica retinae:

- two pigmented cell layers
- myoepithel cells facing the stroma constitute the dilatator muscle of the pupil.



Regulation of the size of the aperture:

- sphincter muscle: parasympathetic innervation → miosis
- dilatator muscle – sympathetic innervation → mydriasis



Picasso: Eyes



S. Dali: Eye