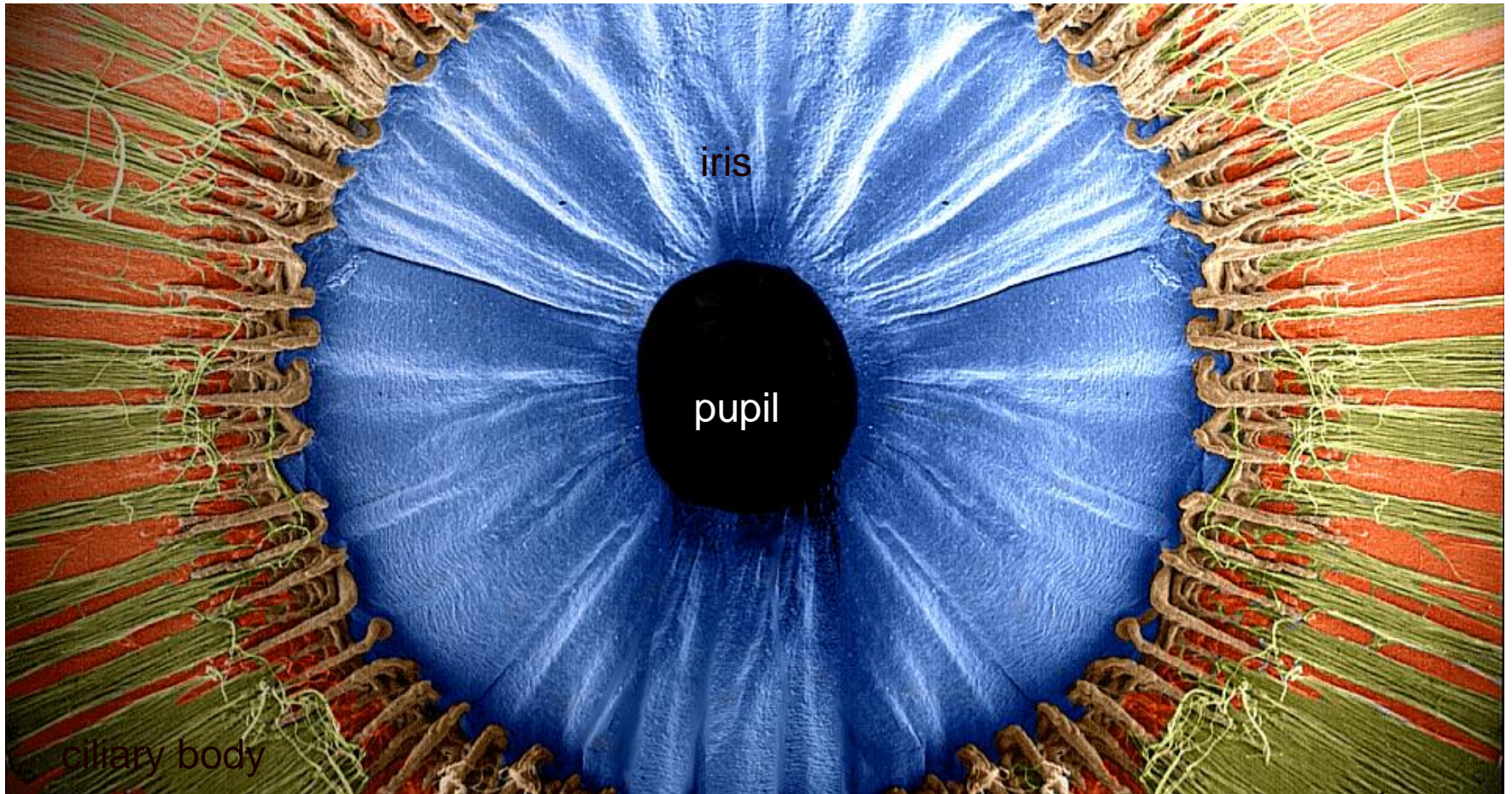


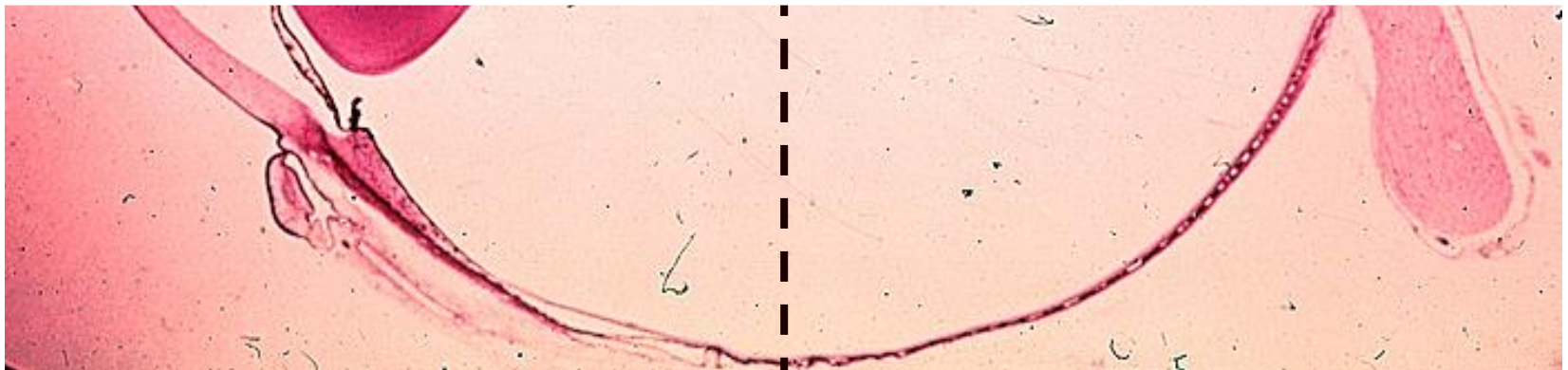
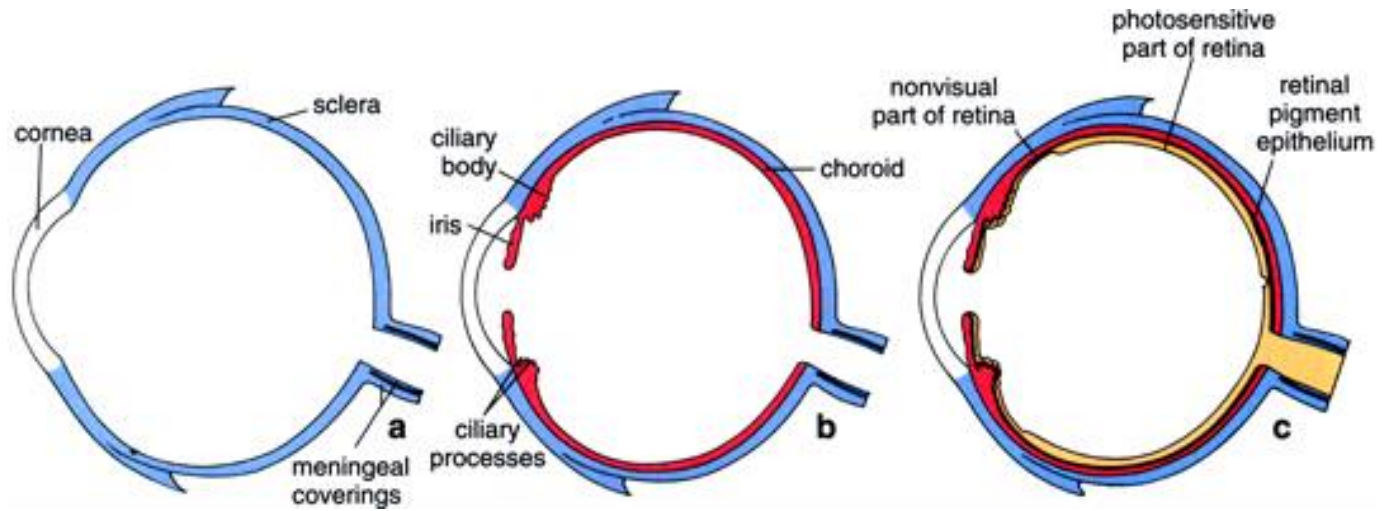
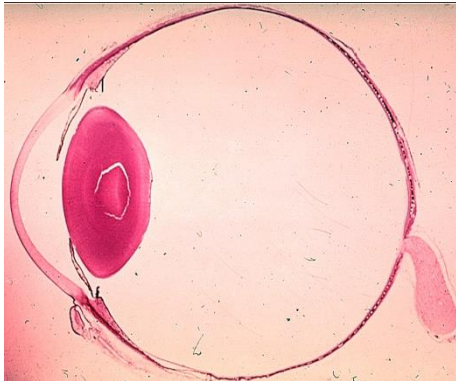
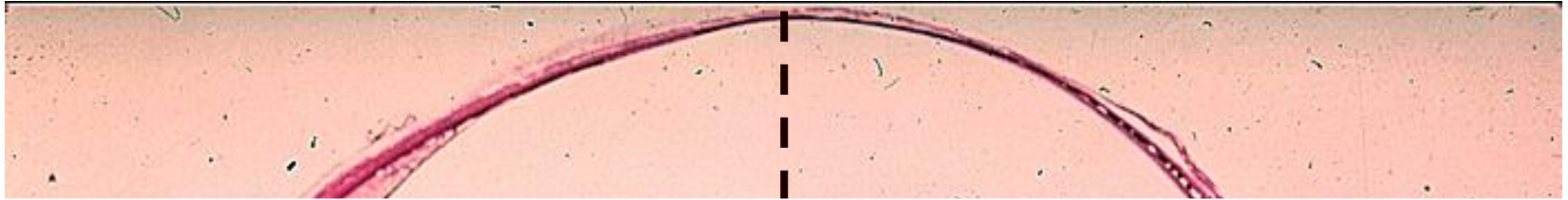
Eye



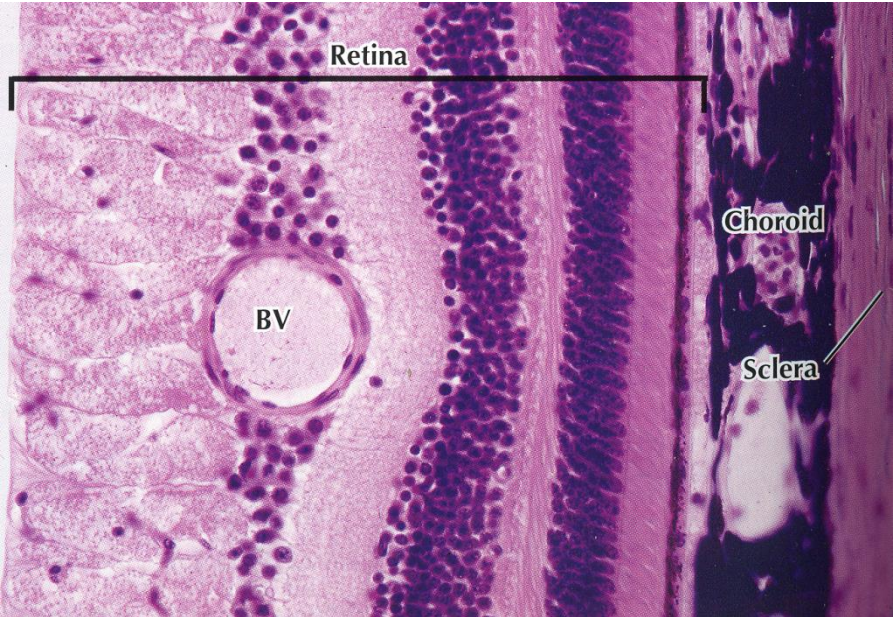
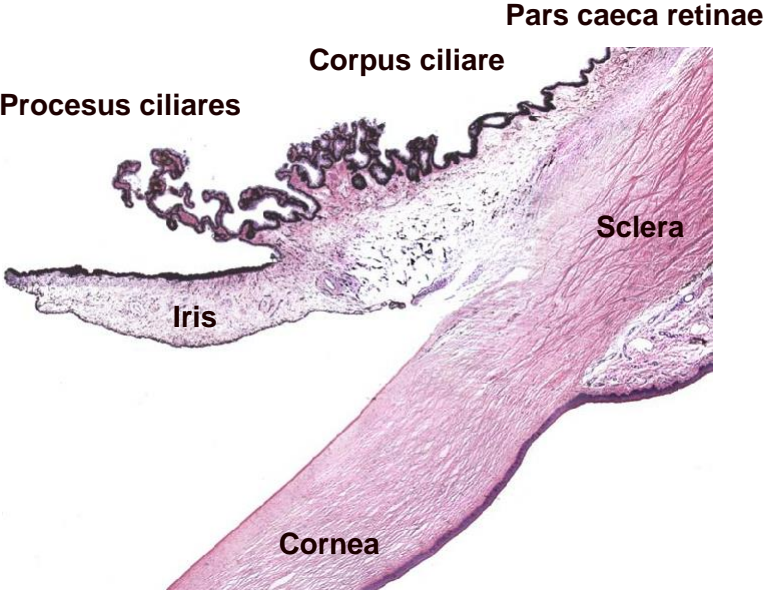
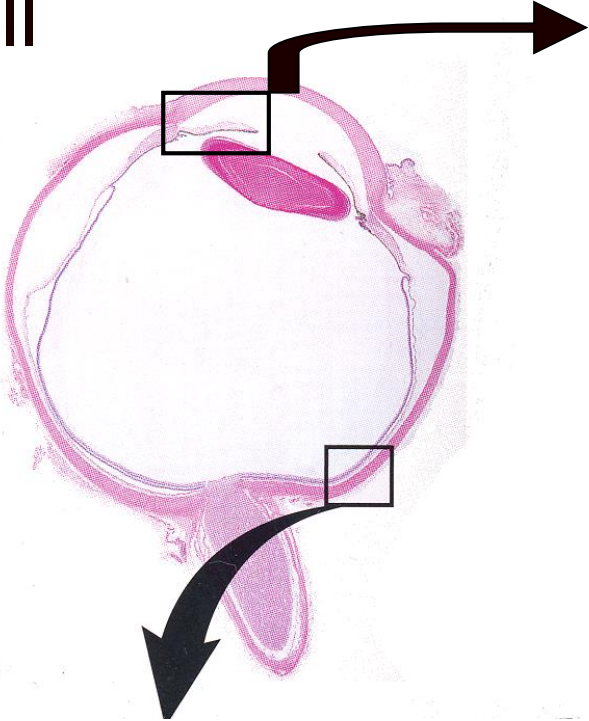
Eyeball

Anterior segment

Posterior segment



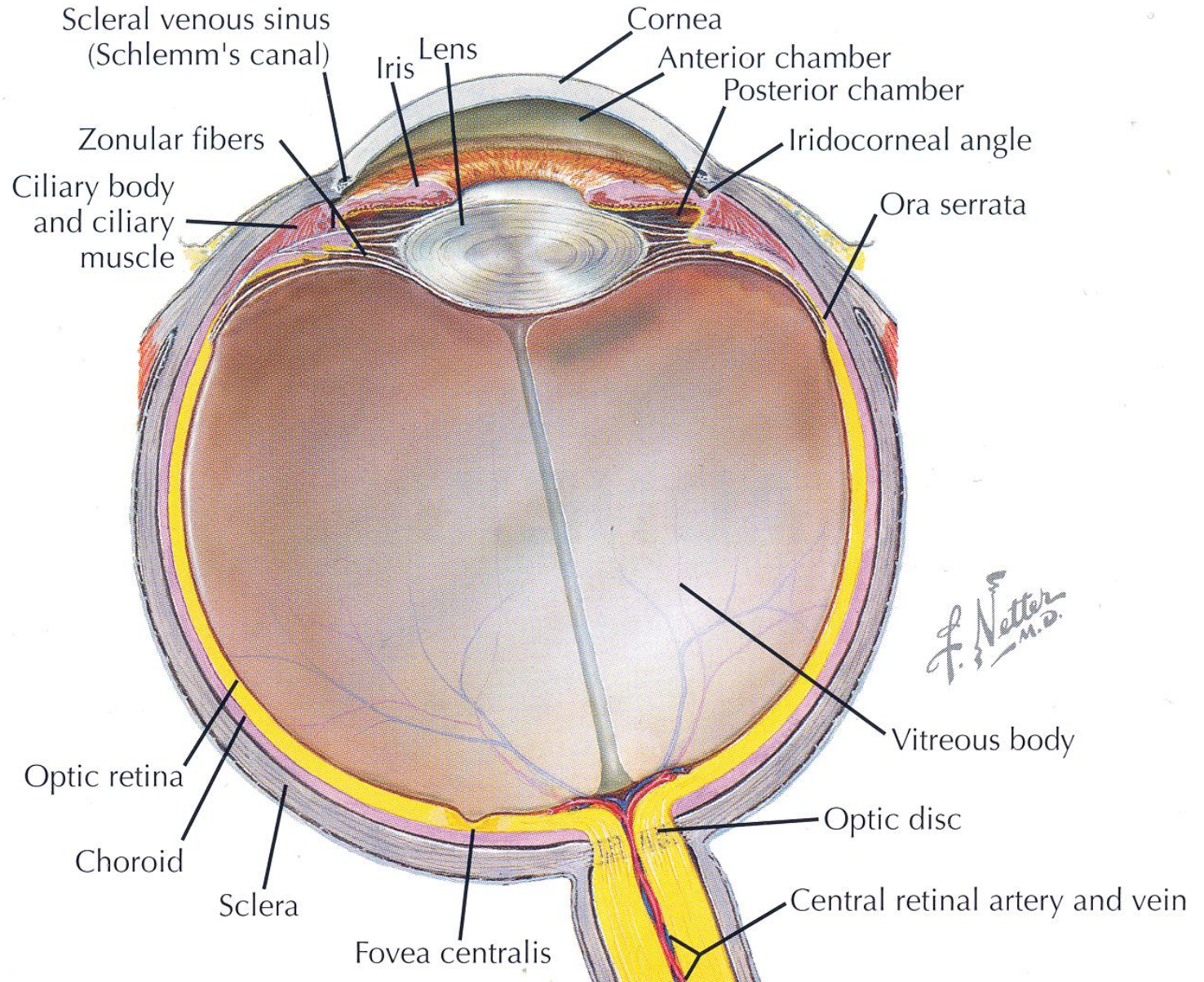
Eyeball



Eyeball wall	Posterior segment	Anterior segment
Tunica externa (fibrosa)	Sclera	Cornea
Tunica media (vasculosa)	Chorioidea	Iris, Corpus ciliare
Tunica interna (nervosa)	Pars optica retinae	Pars caeca retinae

Eyeball

▼ Horizontal section.

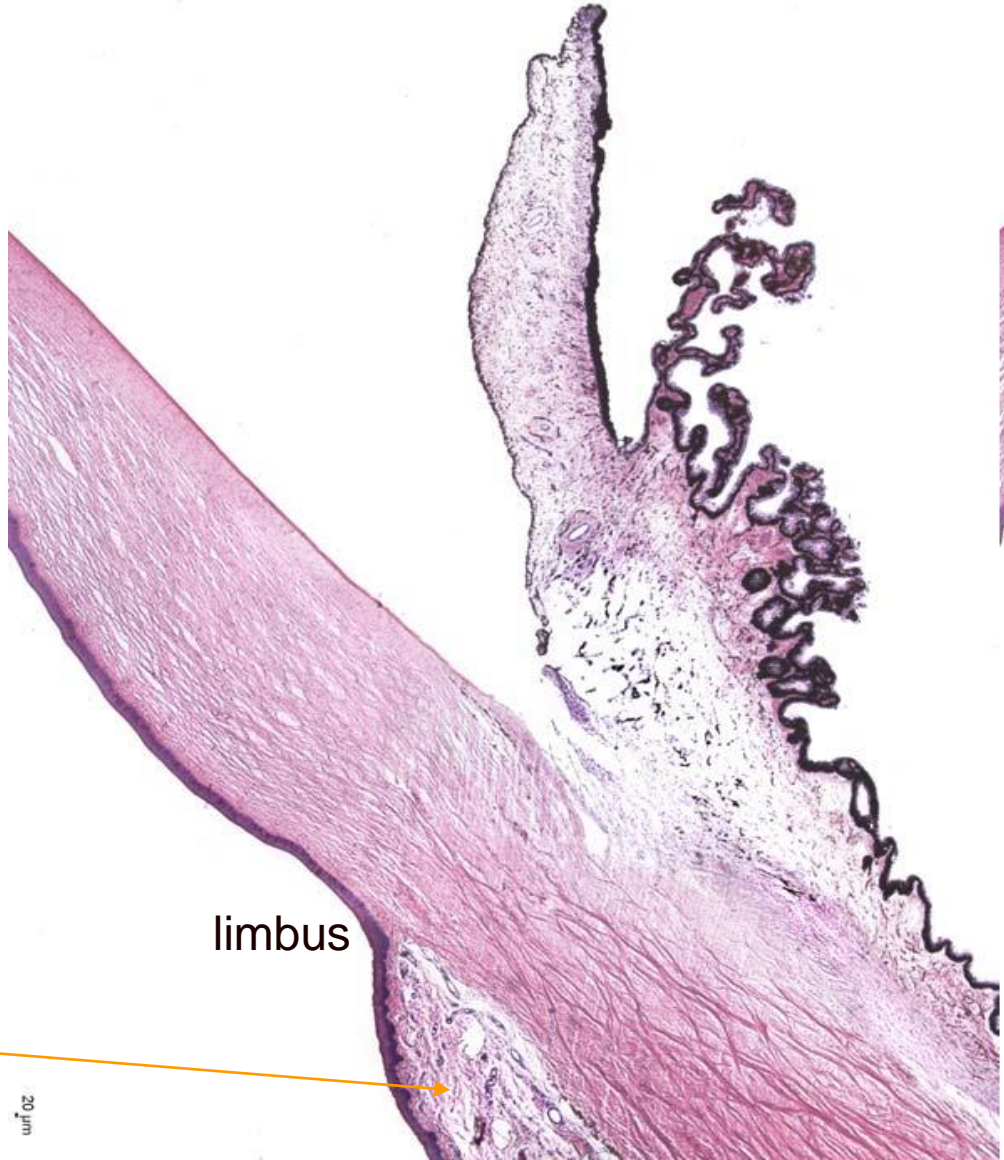


Fibrous tunic - tunica externa oculi

- Cornea
- Sclera

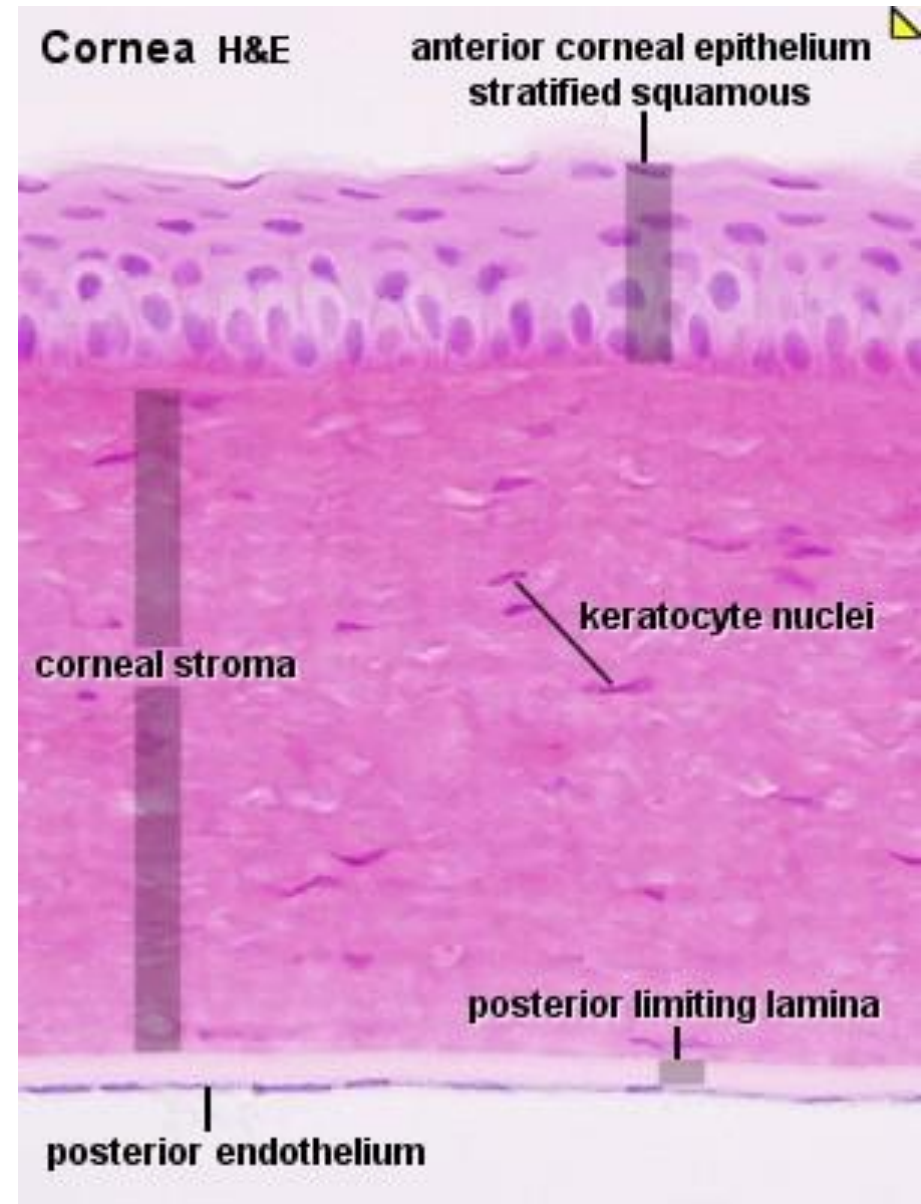
conjunctiva

limbus

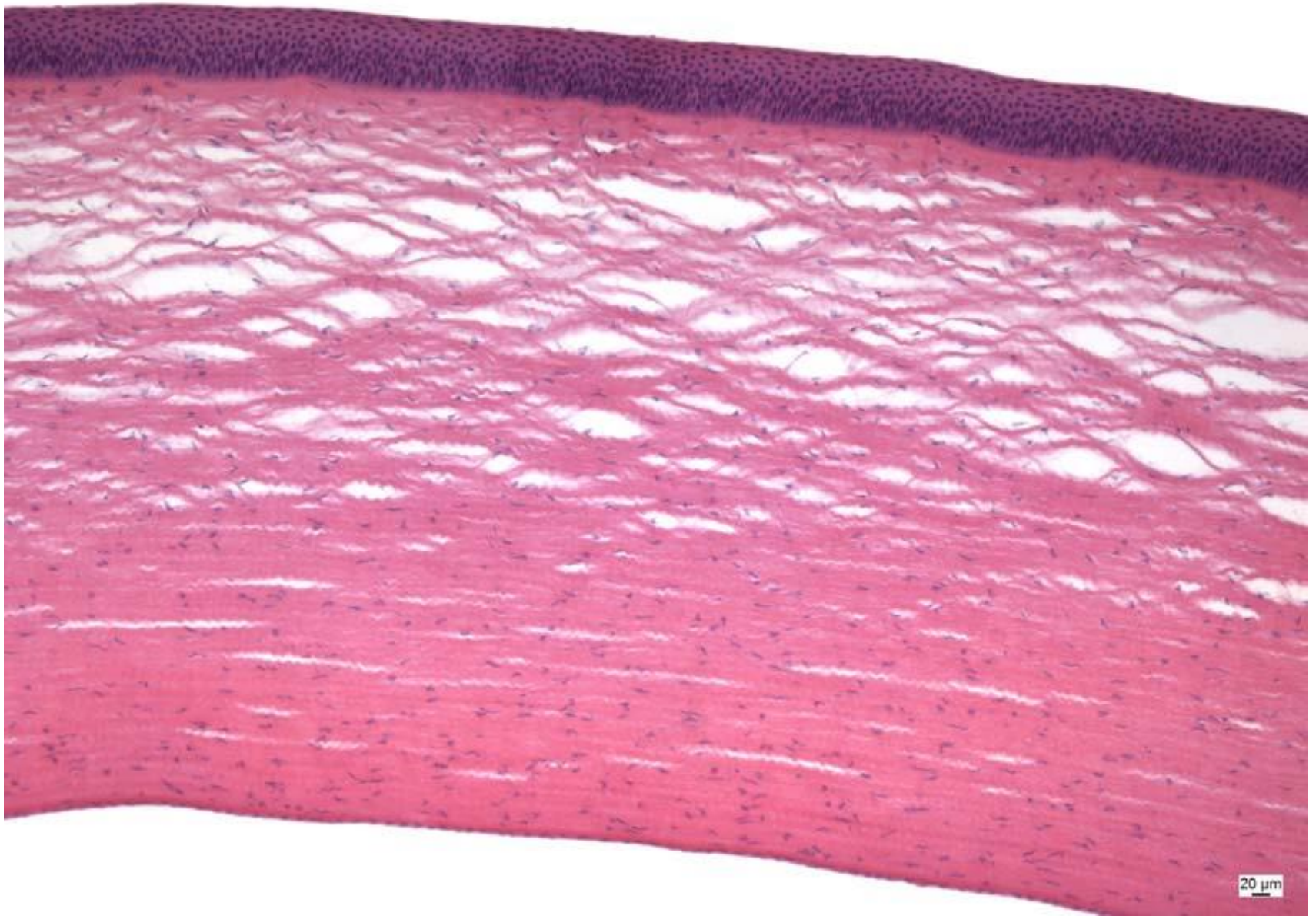


Cornea

1. Stratified squamous epithelium
2. Bowman's membrane-anterior limiting lamina
3. Substantia propria corneae
 - 200 - 250 layers of regularly organized collagen fibrils
 - fibrocytes /keratocytes/
4. Descemet's membrane-posterior limiting lamina
 - the basement membrane of the posterior endothelium
 - Posterior endothelium
 - simple squamous epithelium

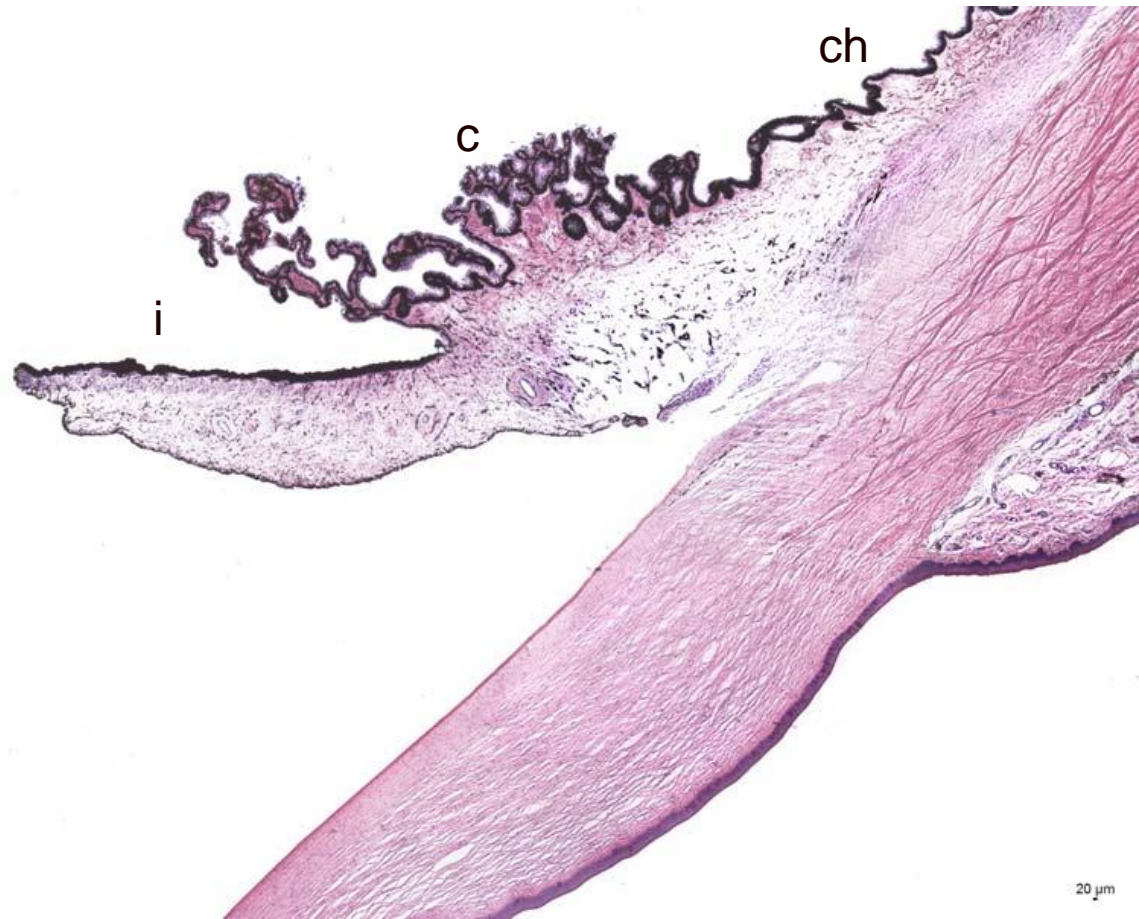


Cornea



Vascular tunic - tunica media oculi


- Choroid
 - loose c.t. with network of blood vessels, numerous pigment cells
- Ciliary body
 - loose c.t. with smooth muscle cells – *musculus ciliaris /accomodation/*
 - ciliary processes – generate *aqueous humor*
- Iris
 - central opening of the iris the *pupil*



Choroid


1. Lamina suprachoroidea /lamina fusca sclerae/
2. Lamina vasculosa
3. Lamina chorocapillaris
4. Lamina vitrea /Bruch 's membrane/

sclera




L. suprachoroidea - perichoroidal space with melanocytes, collagen and elastic fibers, fibroblasts, macrophages, lymphocytes

choroid

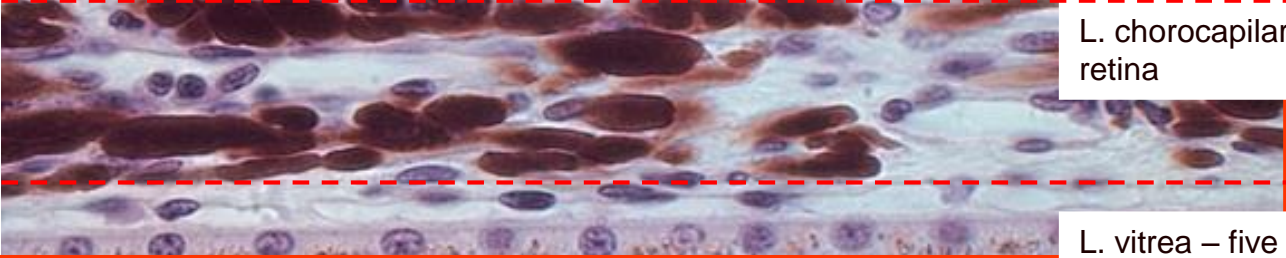


L. vasculosa – blood supply – parallel veins – c. ciliare



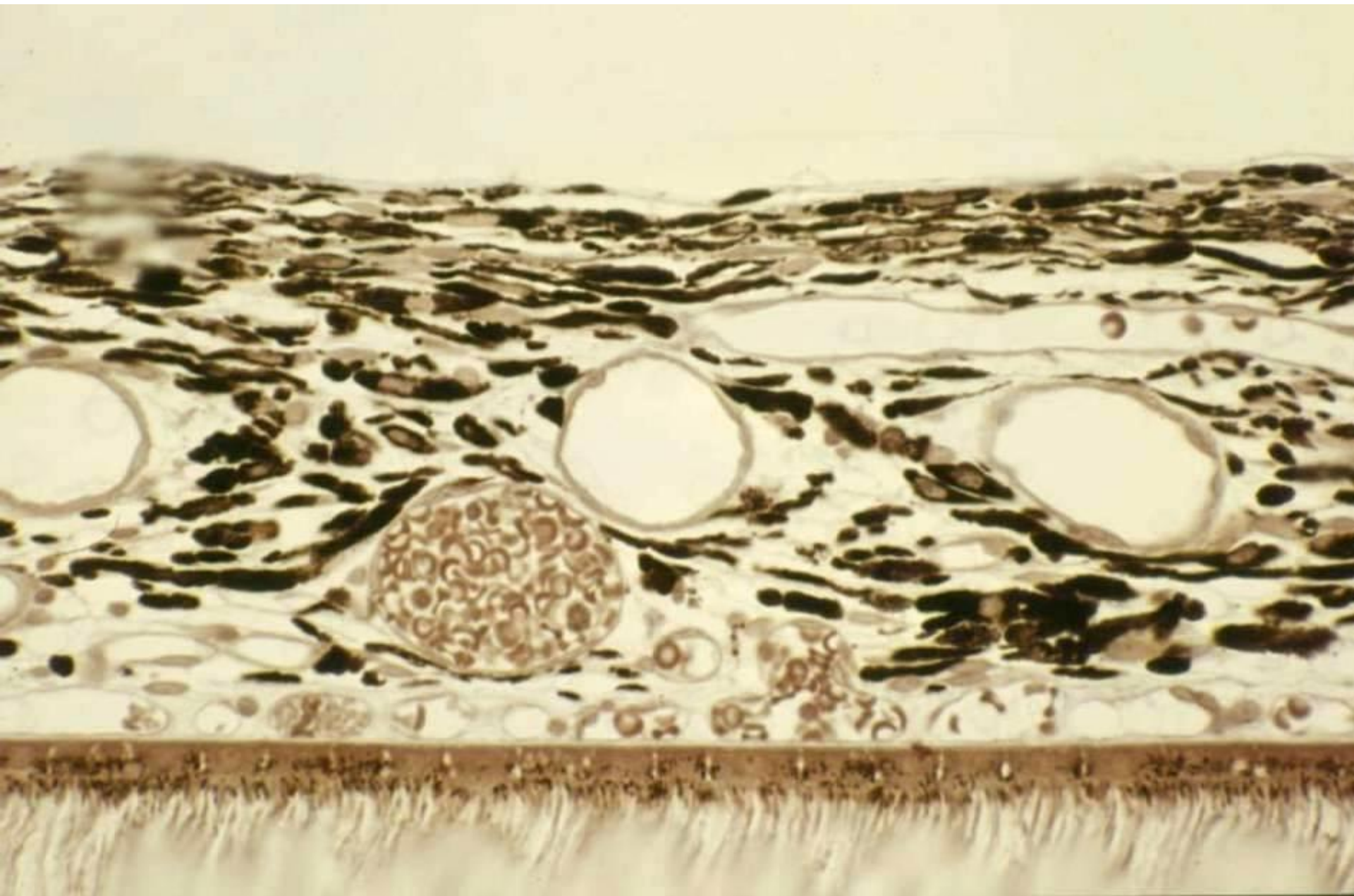
L. chorocapillaris – capillary plexus for retina

retina

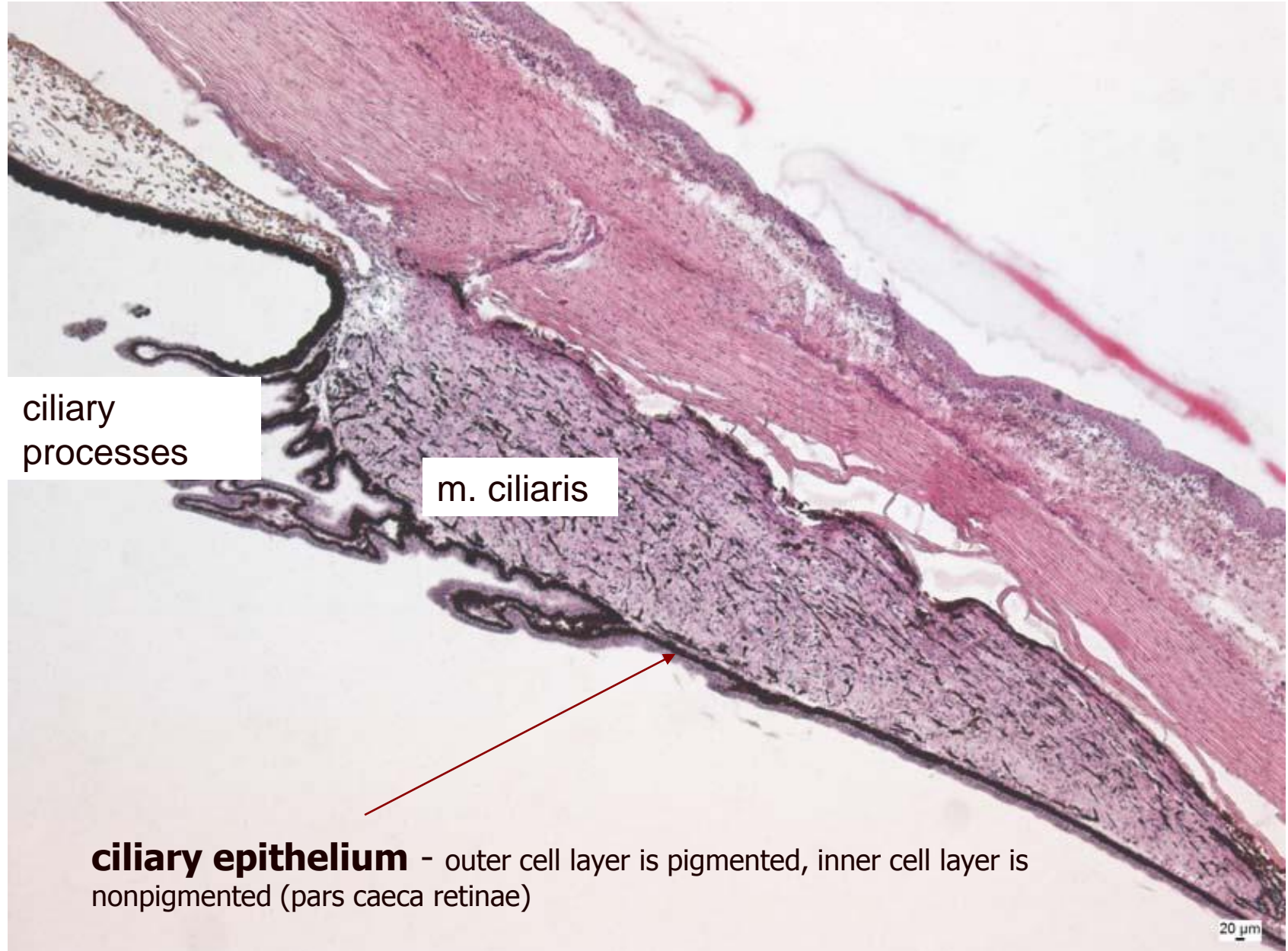


L. vitrea – five layers, including basal lamina of choroid endothelium and retinal pigment epithelium, collagen and elastic fibers.

Choroid



Ciliary body - structure

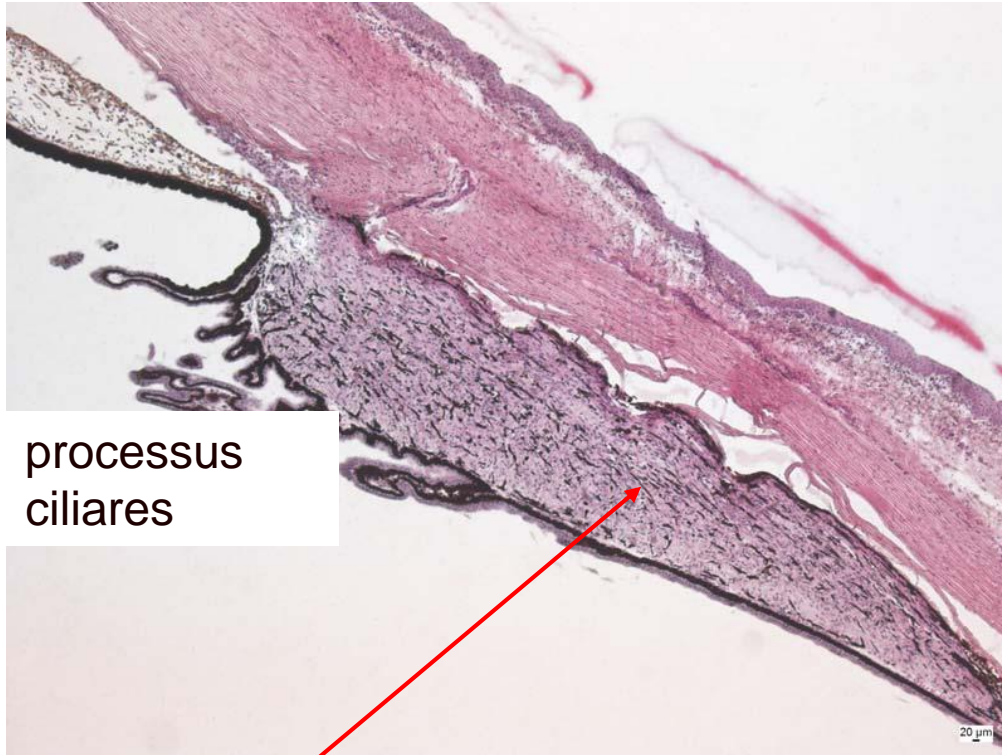


ciliary
processes

m. ciliaris

ciliary epithelium - outer cell layer is pigmented, inner cell layer is nonpigmented (pars caeca retinae)

Ciliary body



processus
ciliares

m. ciliaris

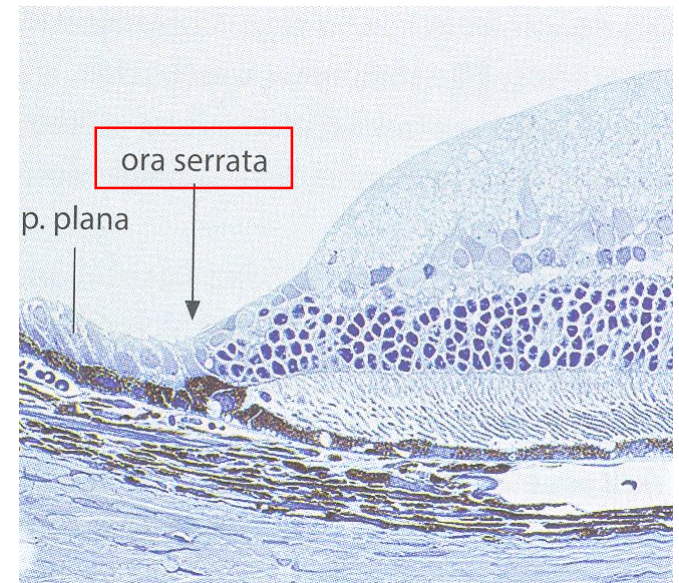
Muscle cells oriented in three directions

Meridionally, radially and circularly

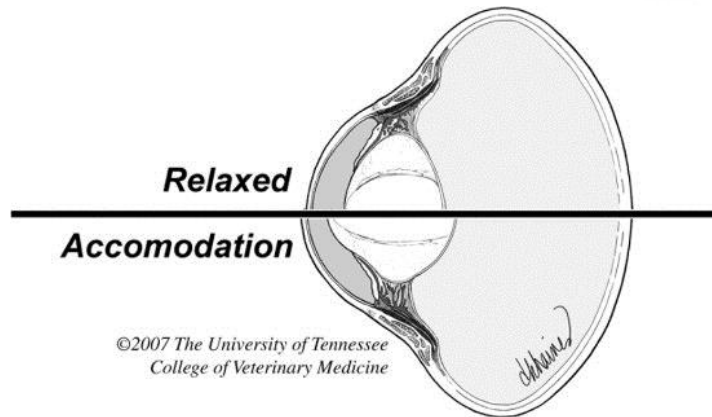
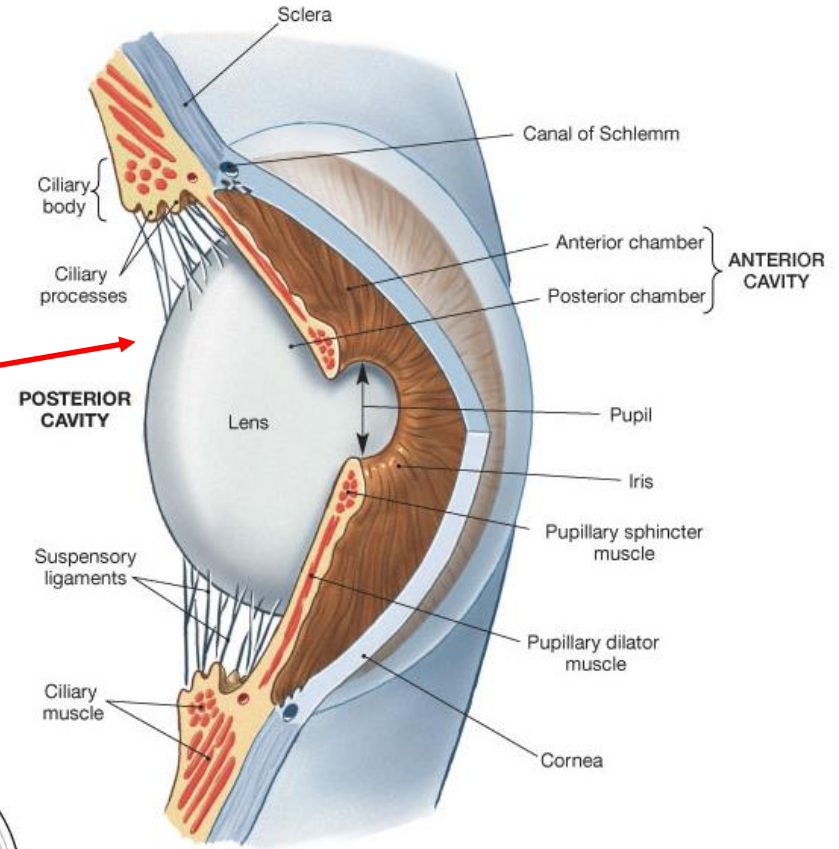
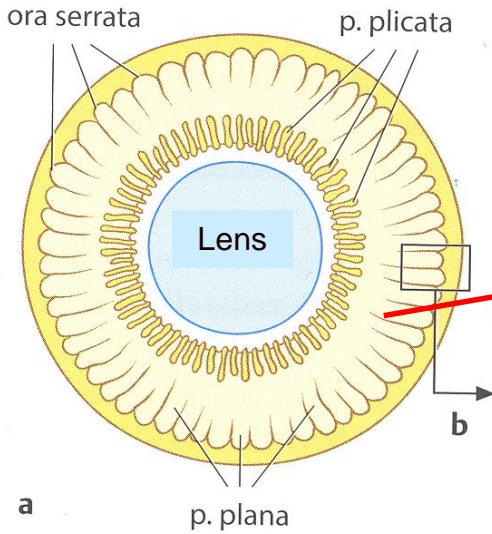
Epithelium

two layers – basal, pigmented (fuscin), surface w/o pigment

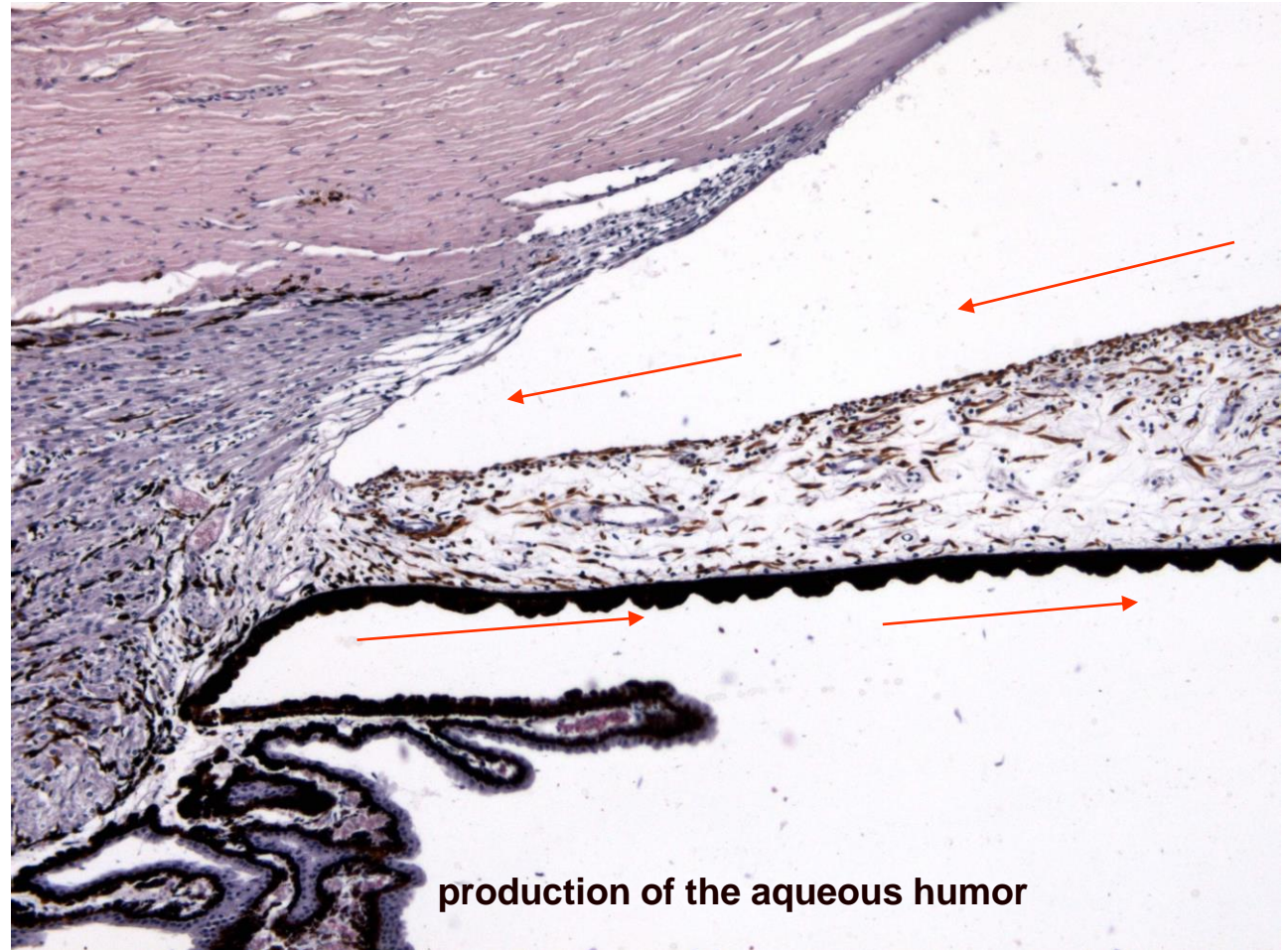
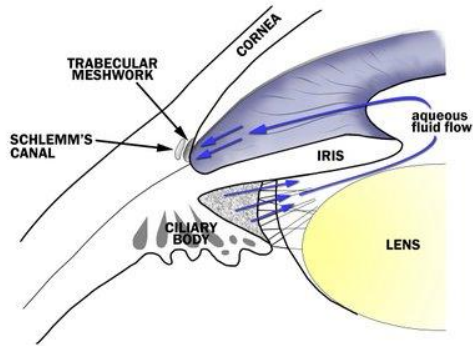
- Continuous with optical part of retina = **pars caeca retinae**



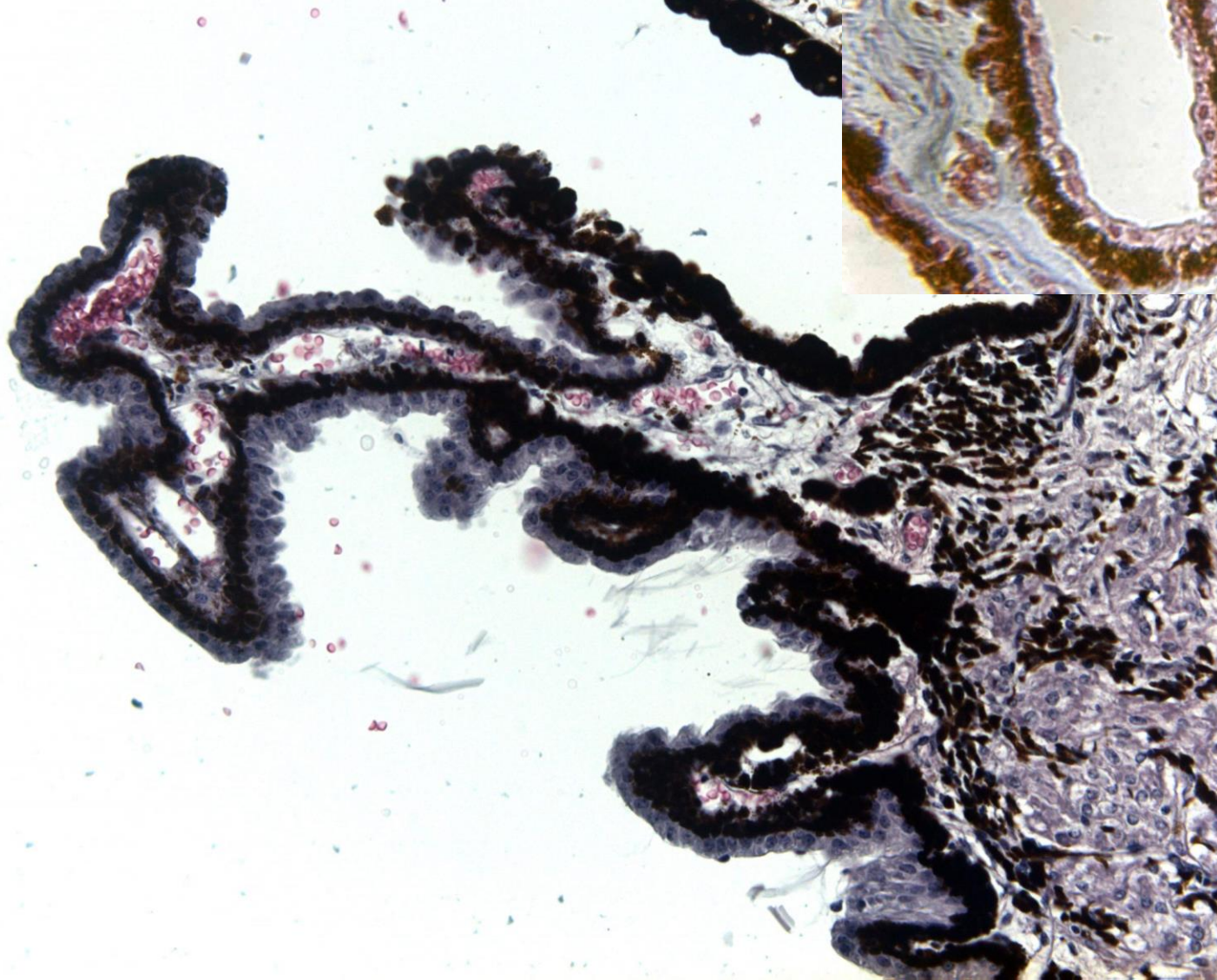
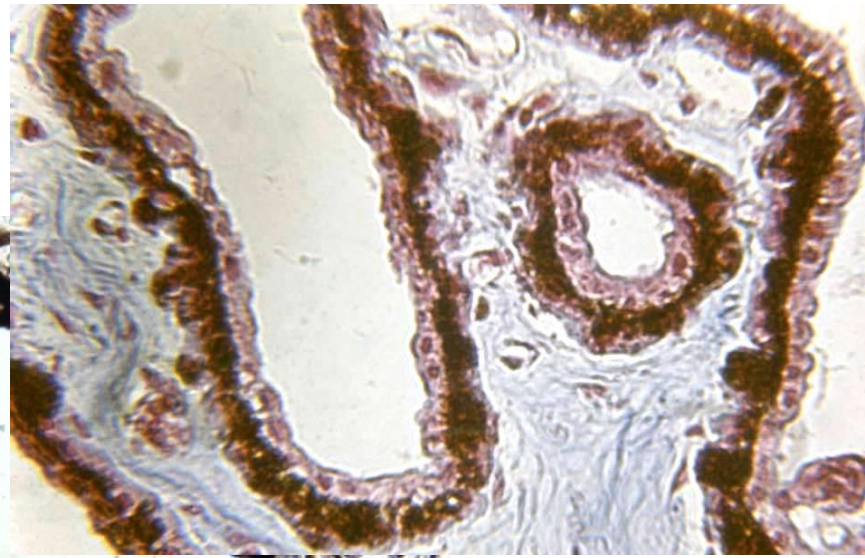
Ciliary body and accommodation



Ciliary body production of aqueous humour

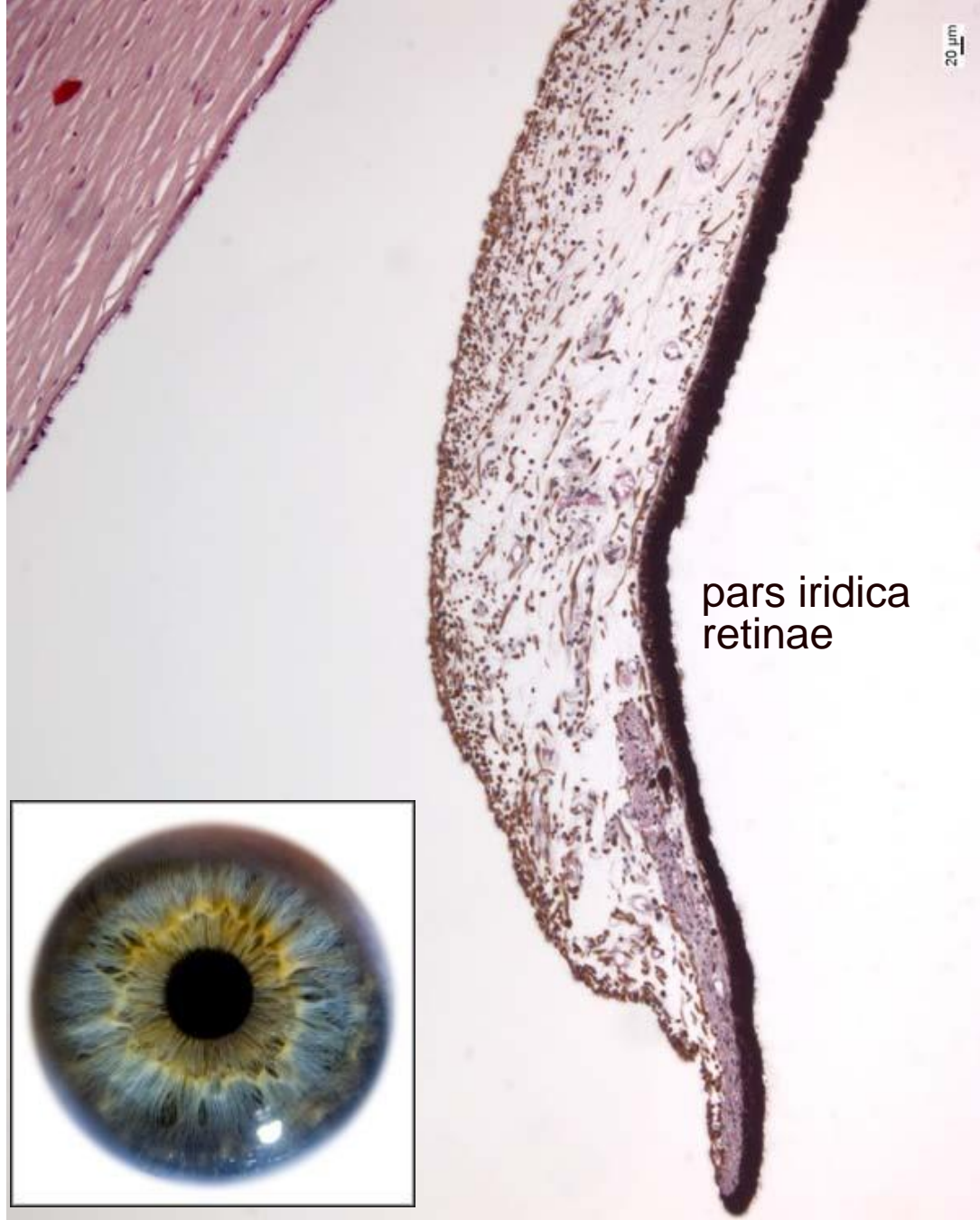


Ciliary processes



Iris

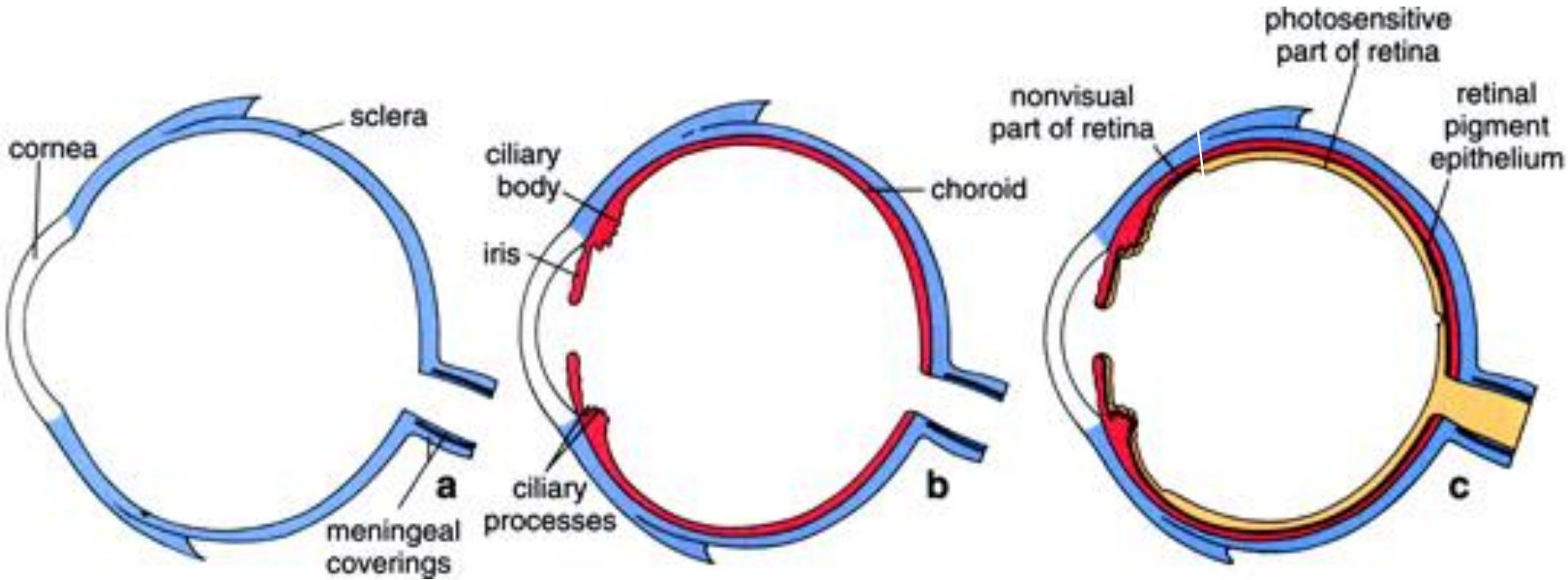
- 1. Anterior epithelium**
 - discontinued layer
- 2. Anterior border layer**
 - pigment cells
- 3. Stroma iridis**
 - gelatinous c.t., pigment cells
 - smooth muscle cells - annular sphincter pupillae muscle
- 4. Posterior border layer**
 - m. dilatator pupillae (myoepithelial cells)
- 5. Posterior epithelium**
 - one layer of pigmented cells



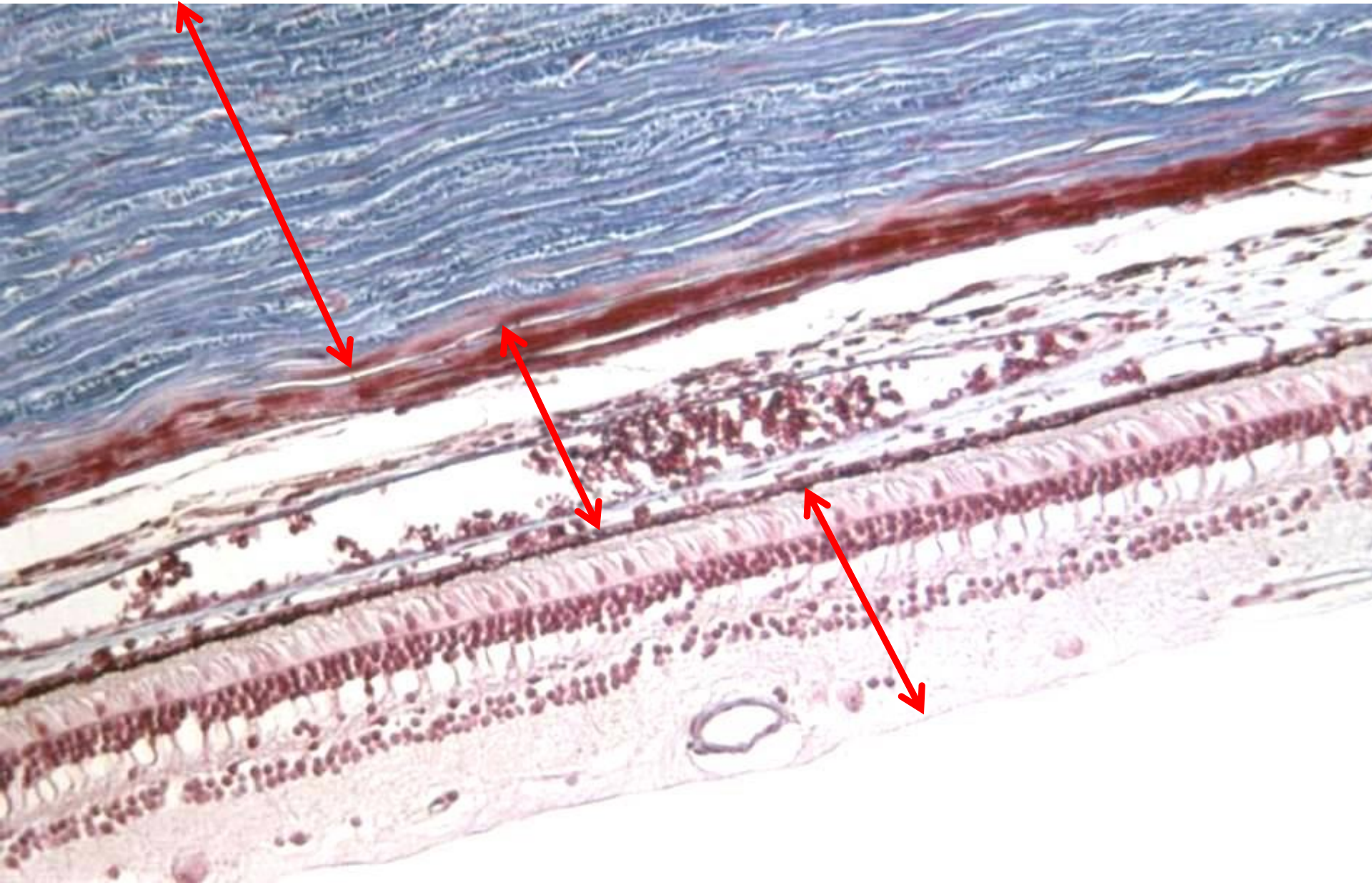
Eye color

Retina

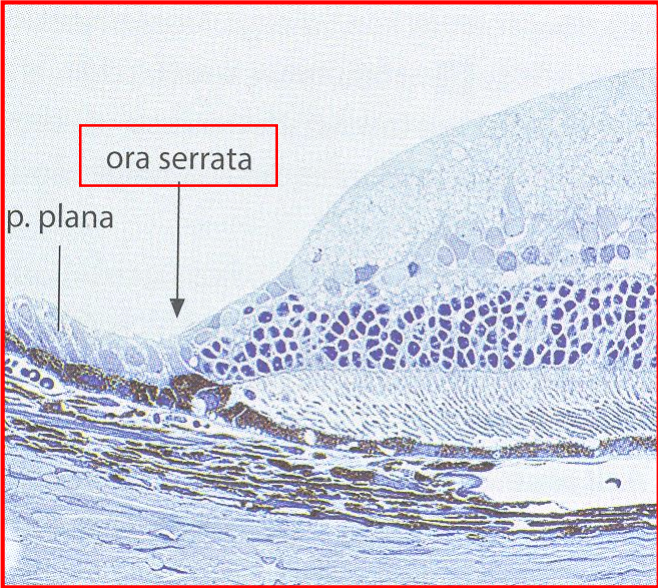
ora serrata



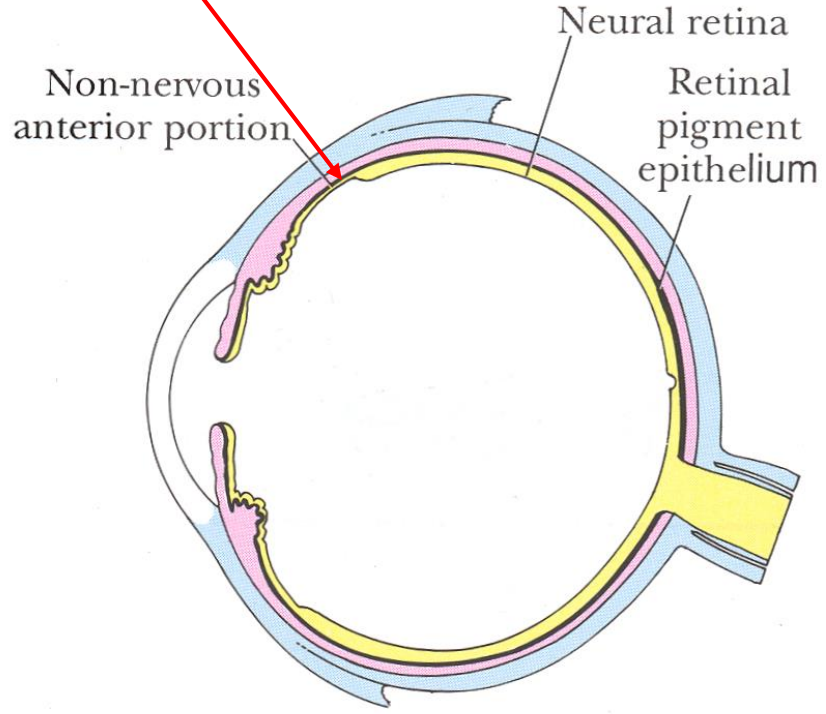
Sclera – Choroidea - Retina



Retina



ora serrata



Retina – cell types

Pigment cells

Neurons

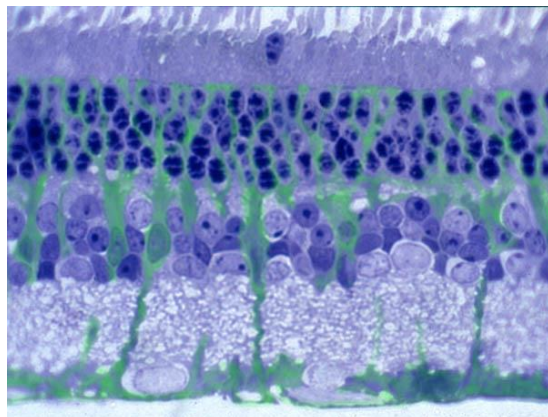
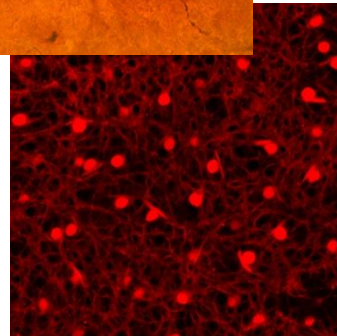
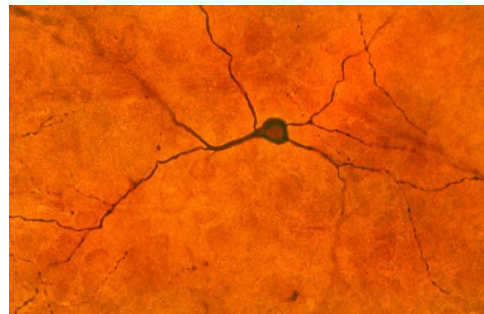
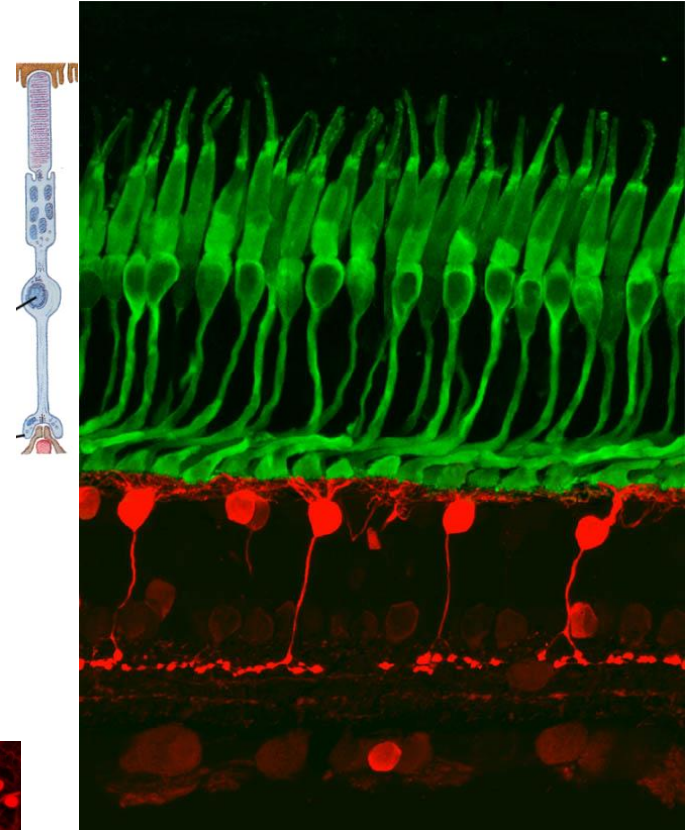
1. rod and cones
2. bipolar neurons
3. ganglionic multipolar neurons

interneurons

- Horizontal cells
- Amacrine cells

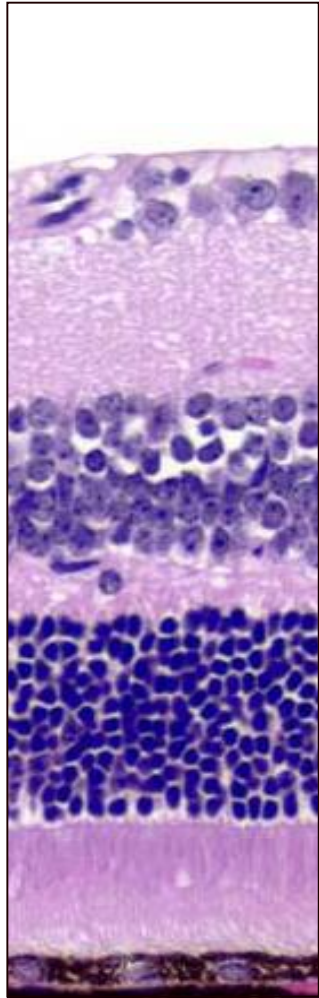
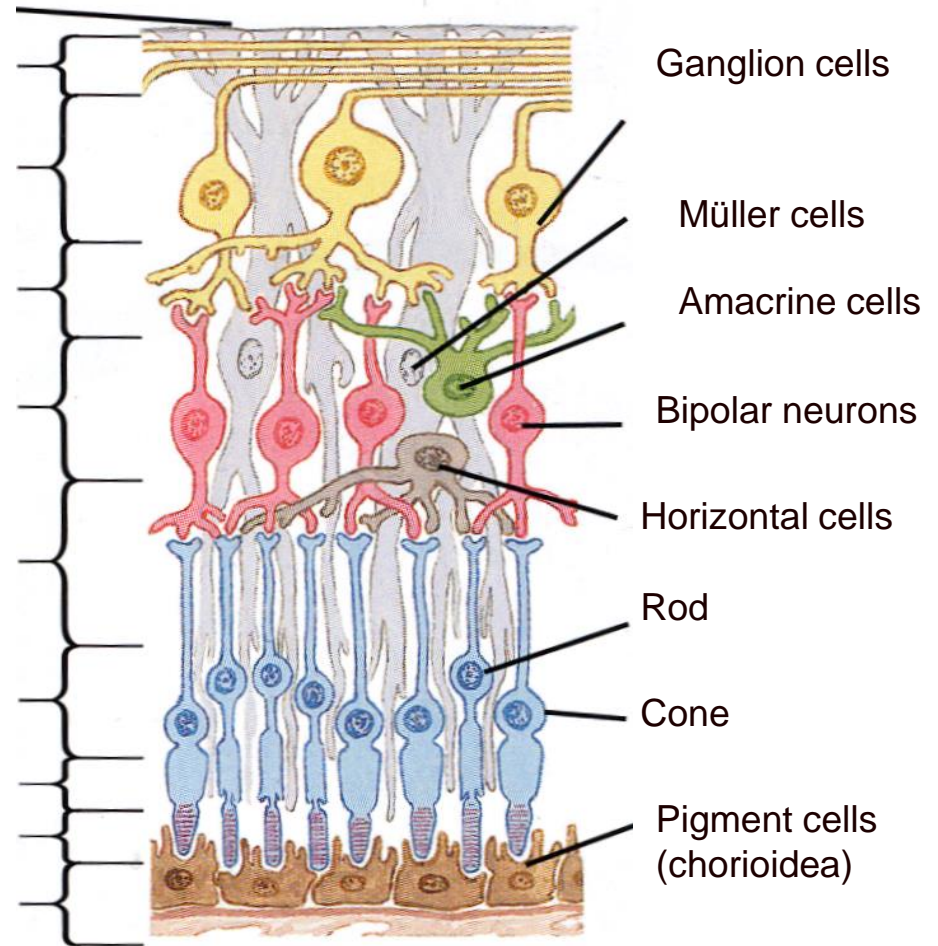
Neuroglia

Müller cells



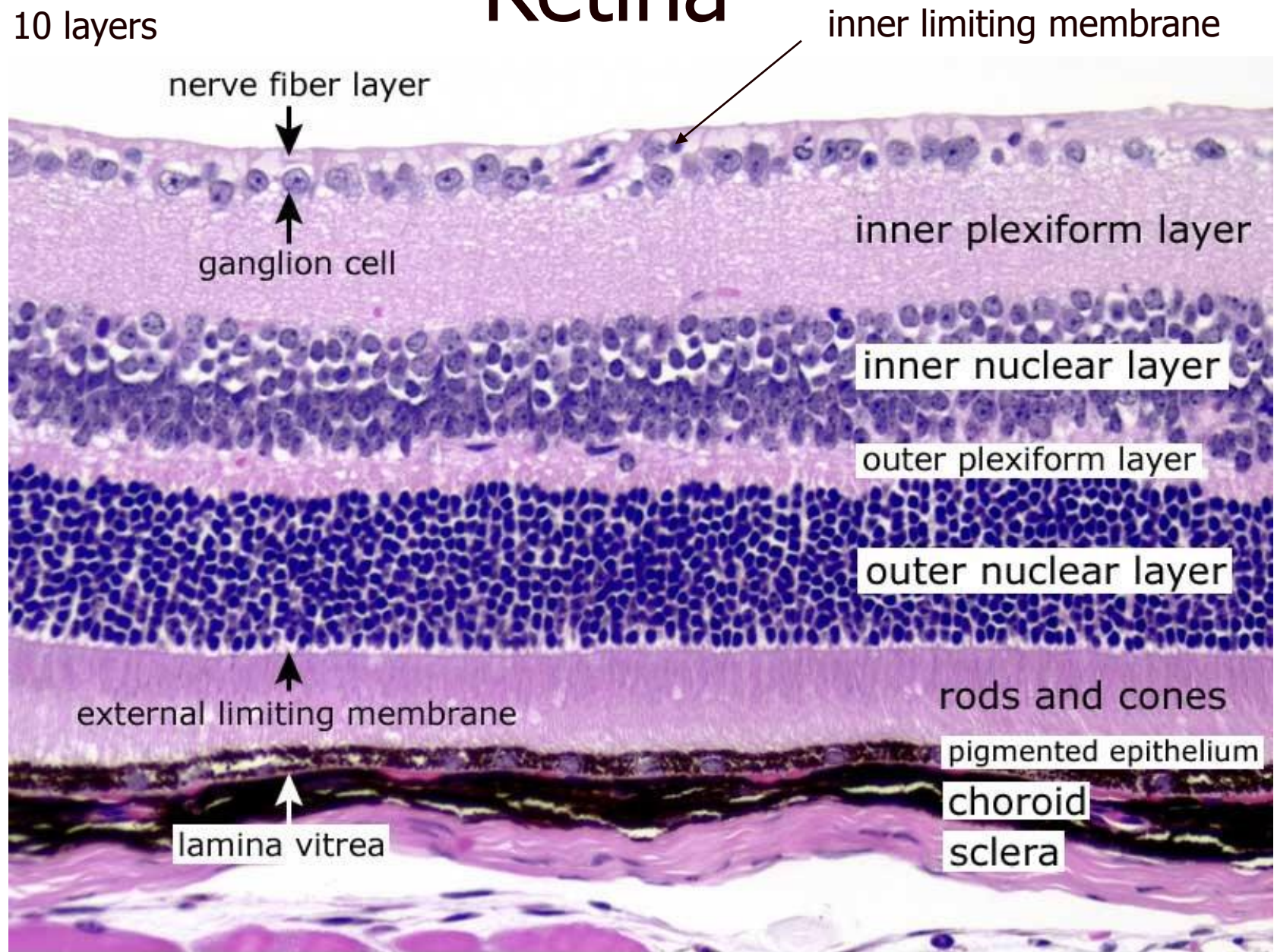
Retinal architecture

- 1 Membrana limitans interna
- 2 Layer of optic nerve fibers
- 3 Ganglion cell layer
- 4 Inner plexiform layer
- 5 Inner nuclear layer
- 6 Zevní vrstva plexiformní
- 7 Inner plexiform layer
- 8 Membrana limitans externa
- 9 Layer of rods and cones
- 10 Pigment epithelium

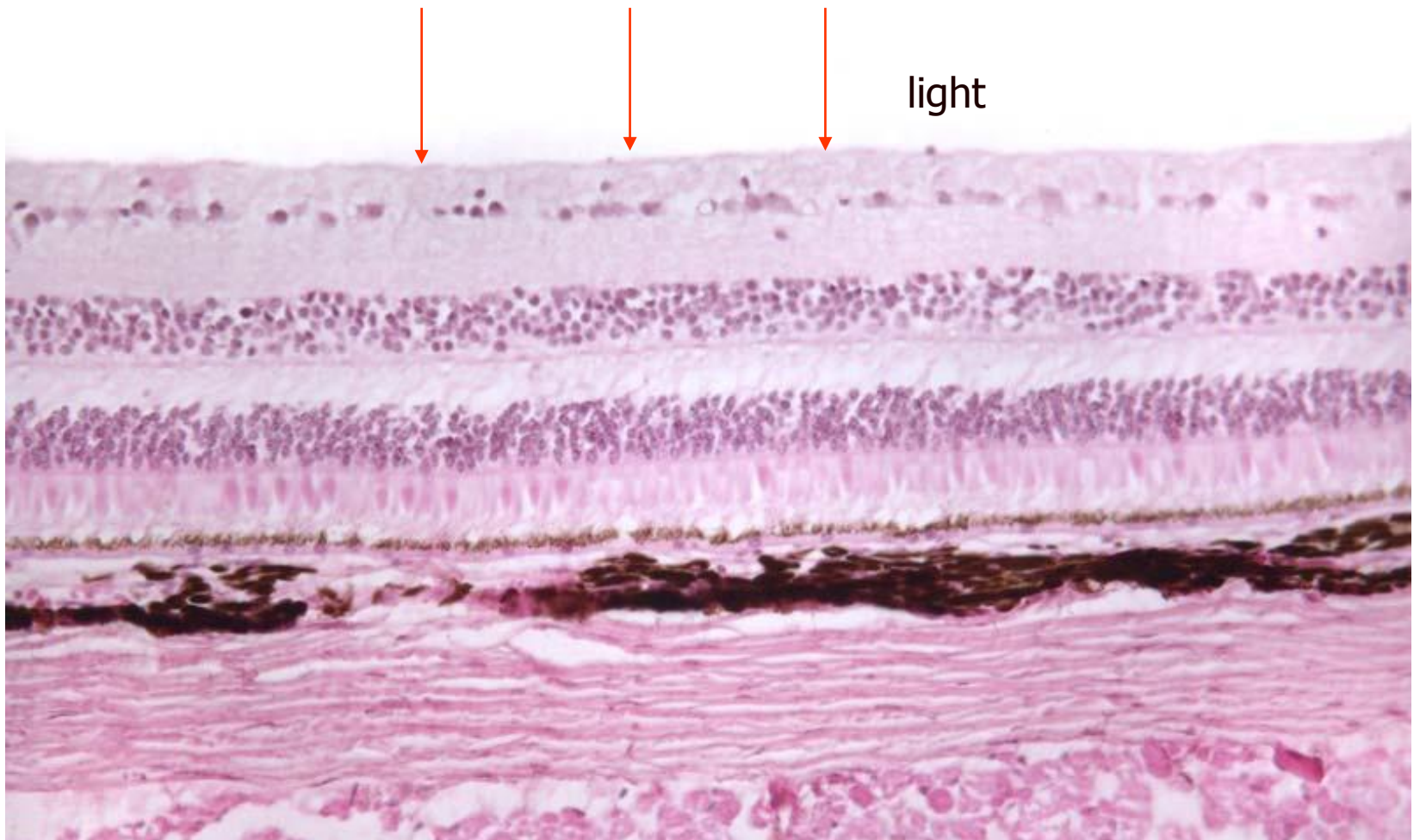


Retina

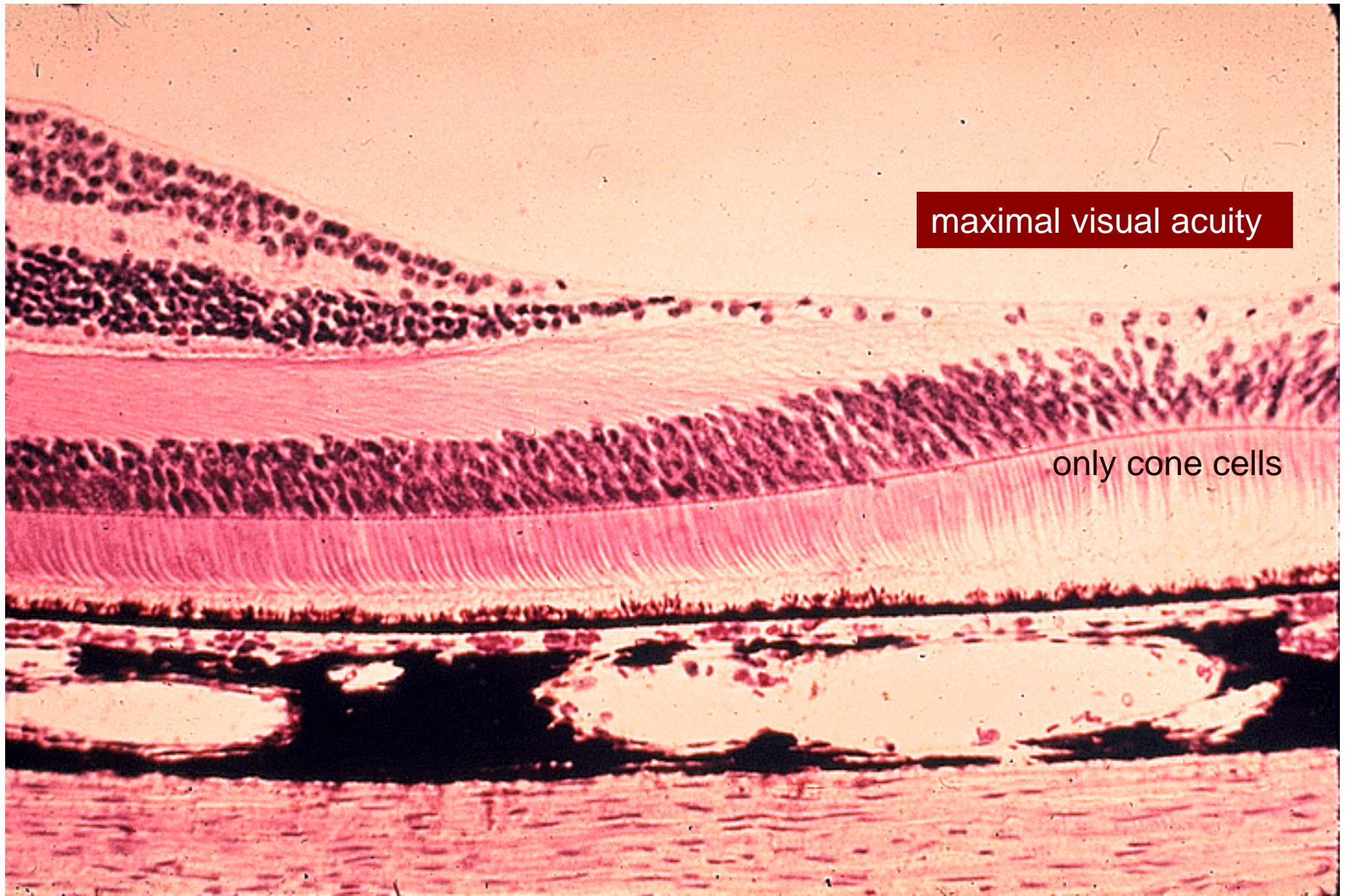
10 layers



Retina



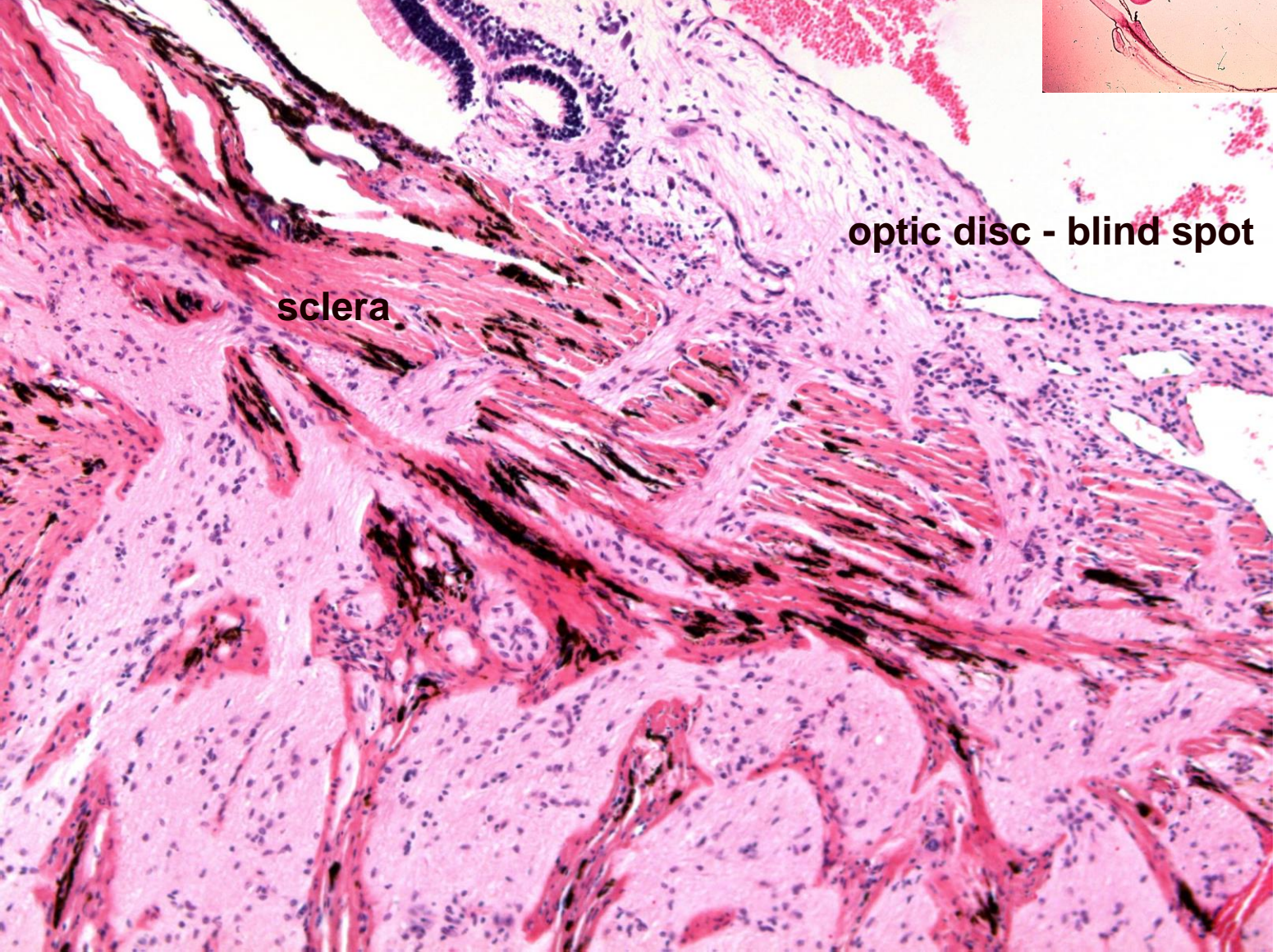
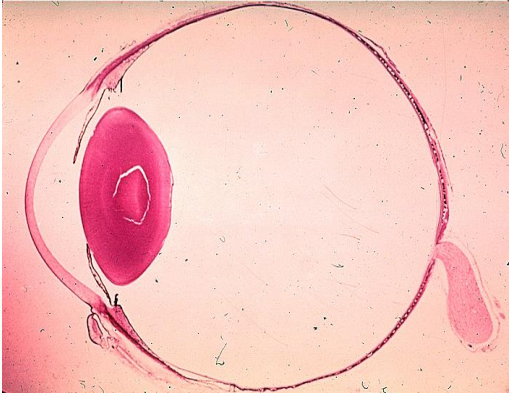
Retina - fovea centralis



maximal visual acuity

only cone cells

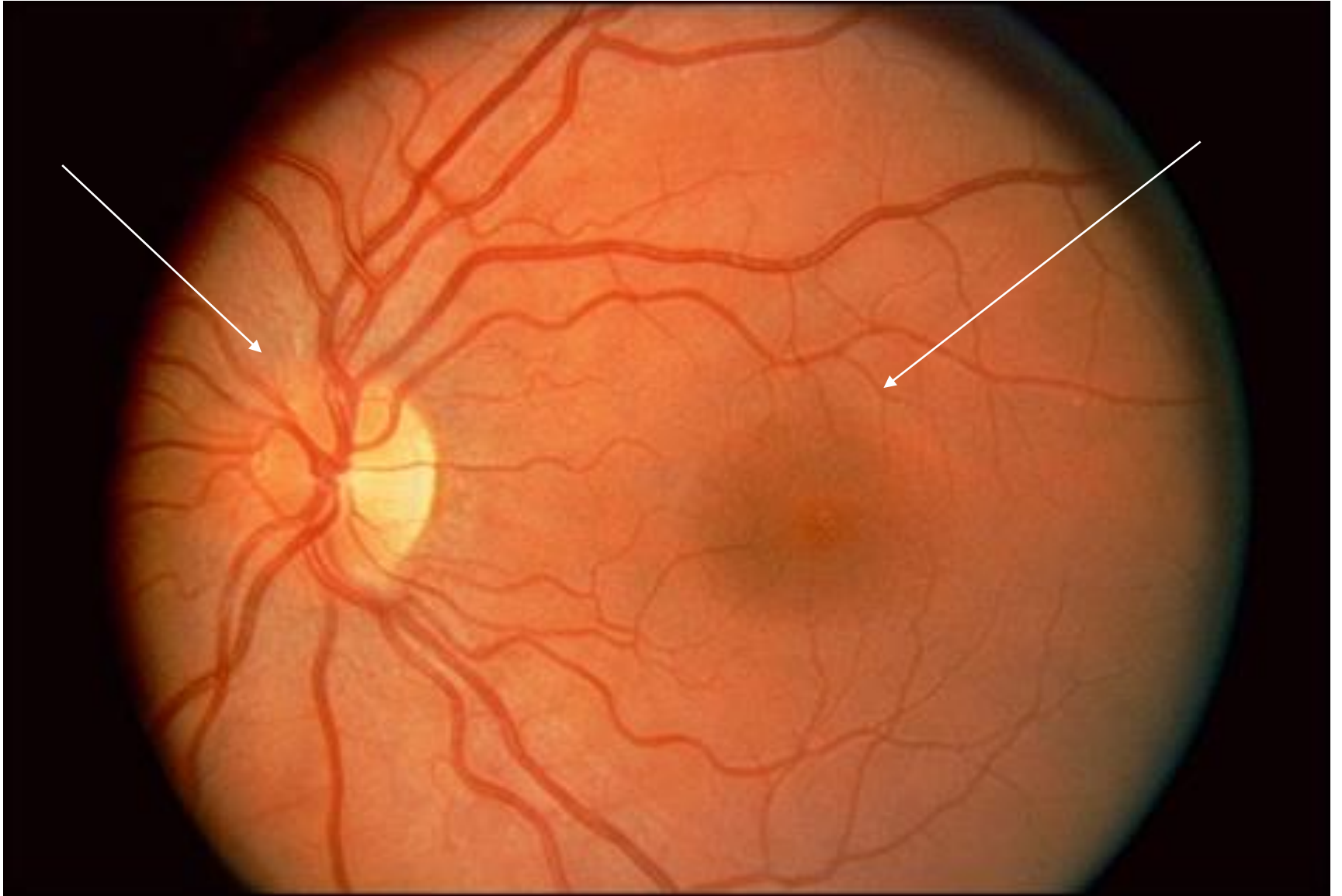
Retina - discus nervi optici



sclera

optic disc - blind spot

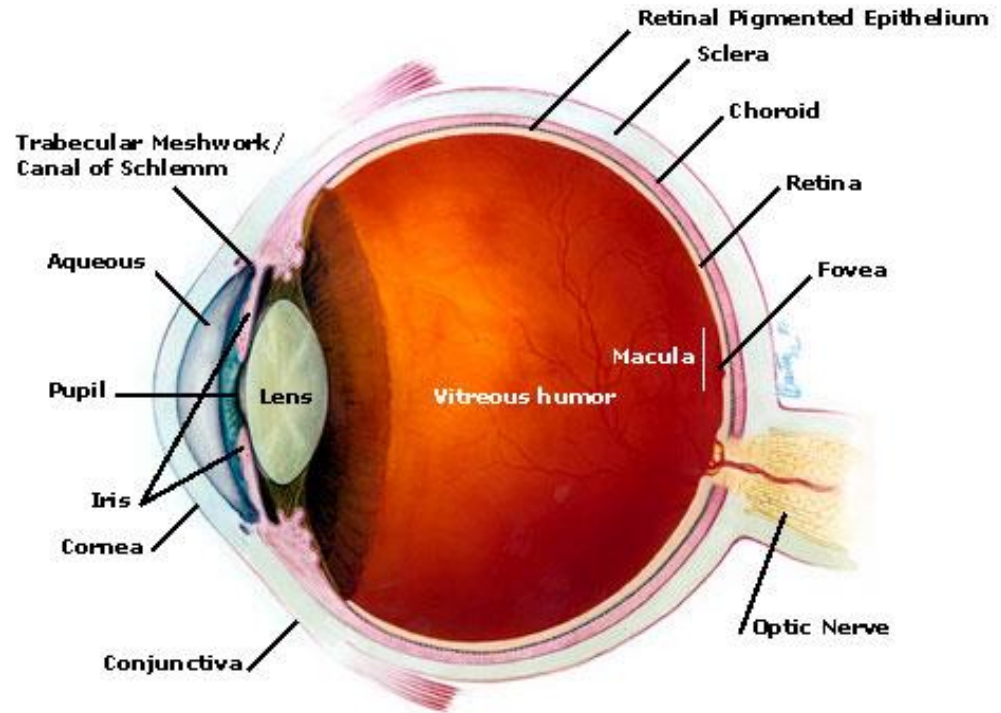
Retina



Refractive media

- Cornea
- Aqueous humor
- Lens
- Vitreous body

Refractive media are characterized by



Lens

- **Capsula lentis**

Formed by subcapsular epithelium

- **Subcapsular epithelium**

Produces capsula lentis and lens fibers

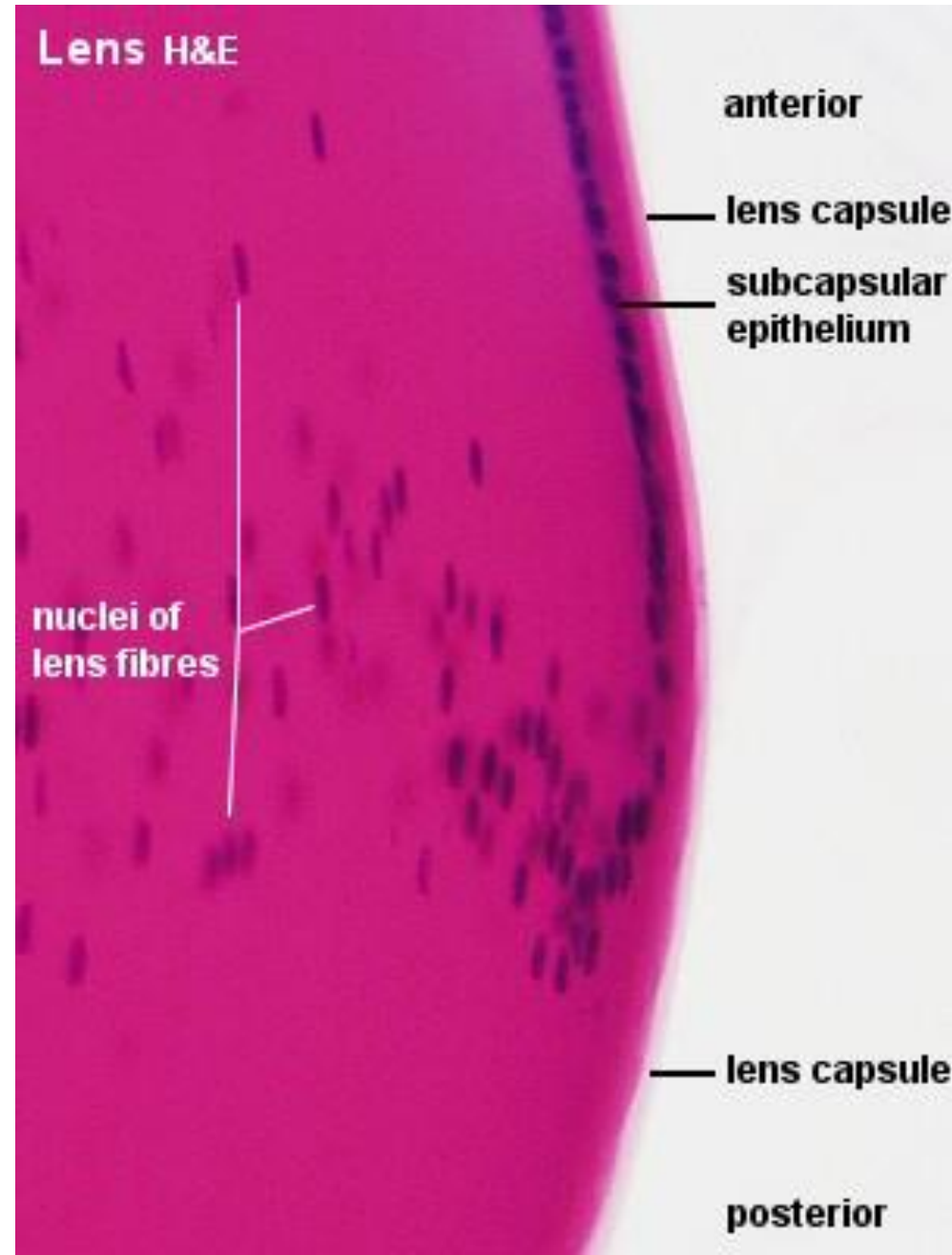
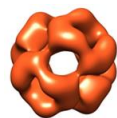
- **Lens fibers**

Very long (up to 12 mm), hexagonal cells, form the body of the lens

Lens fibers are nucleated in the soft, outer *cortex of the lens*

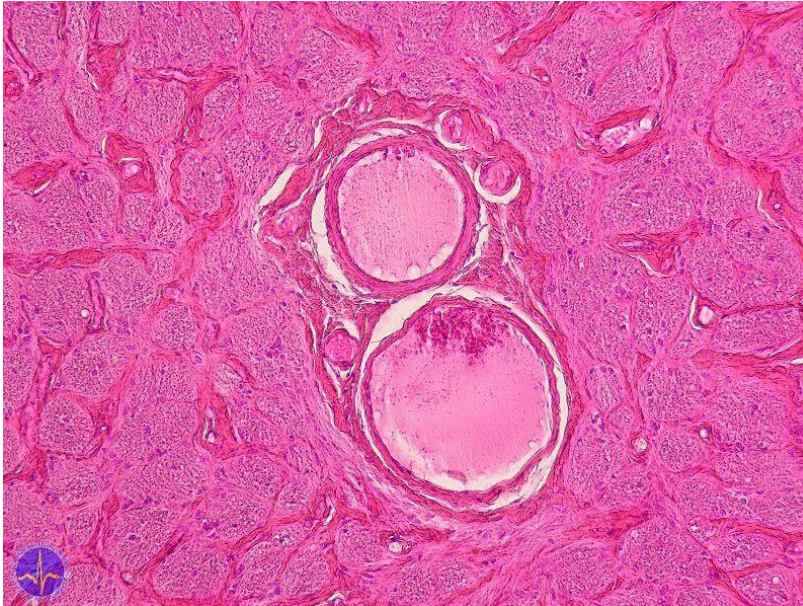
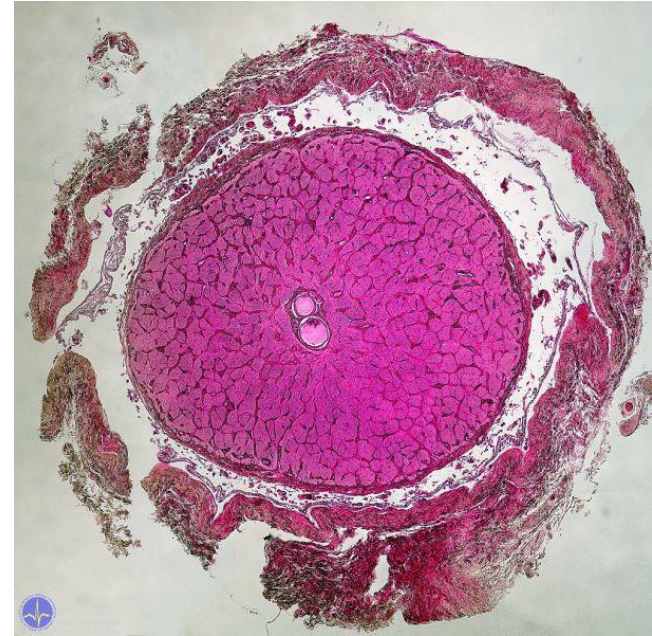
Lens fibers located deeper lose their nuclei and become part of the harder *nucleus of the lens*

Crystallins

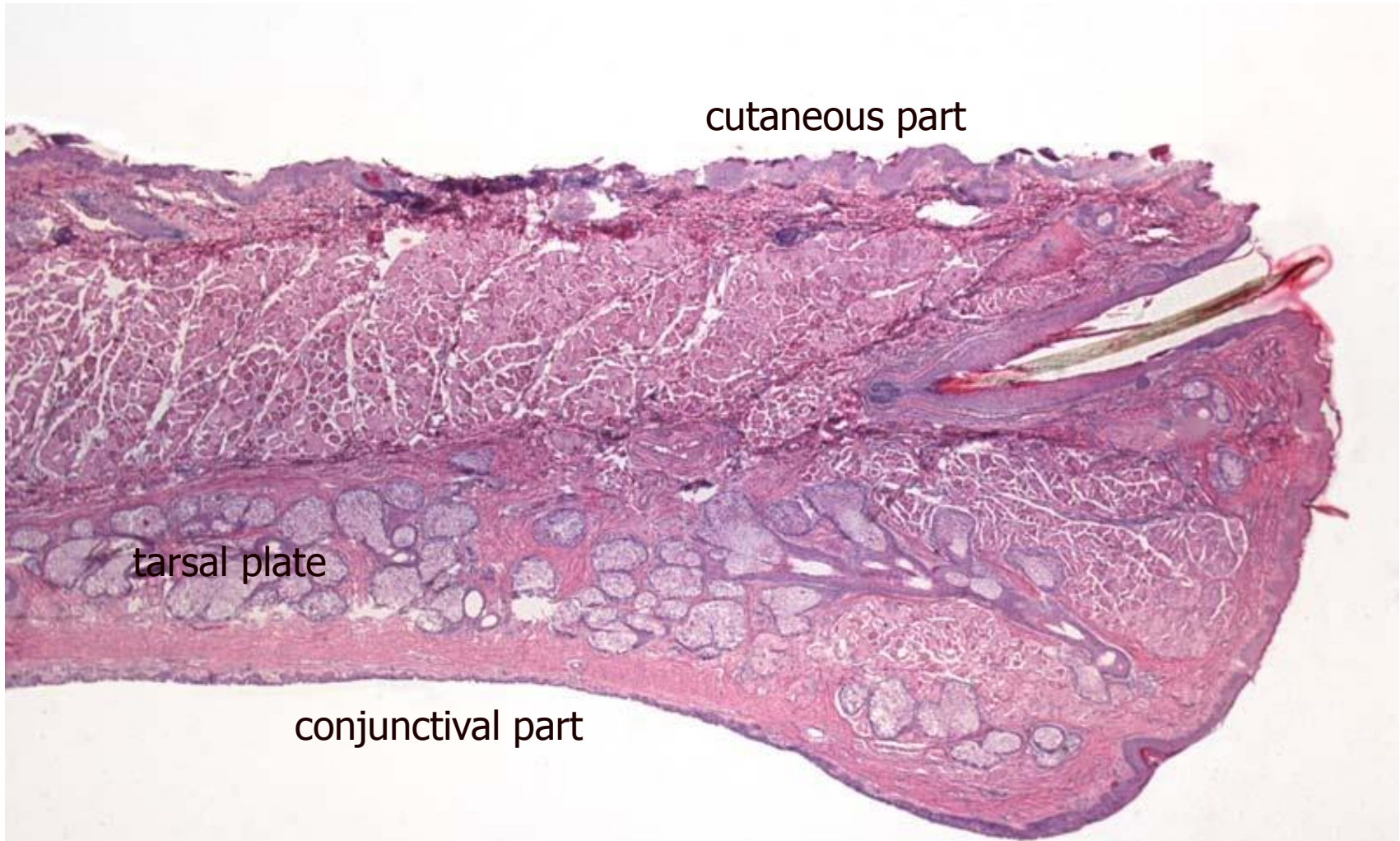


Fasciculus opticus – optic nerve

- surrounded by the **three meninges**
(dura mater, arachnoidea, pia mater)
- c.t. septa from pia mater, separate the fibre bundles in the optic nerve
- the axons in the optic nerve are supported by astrocytes and **oligodendrocytes** + microglia



Eyelid



cutaneous part

tarsal plate

conjunctival part

Meibomian glands – tarsal /sebaceae/

Zeiss glands /gl. sebaceae ciliares/

Moll glands /gl. sudoriferae ciliares – apocrine/

Eyelid /palpebra oculi/



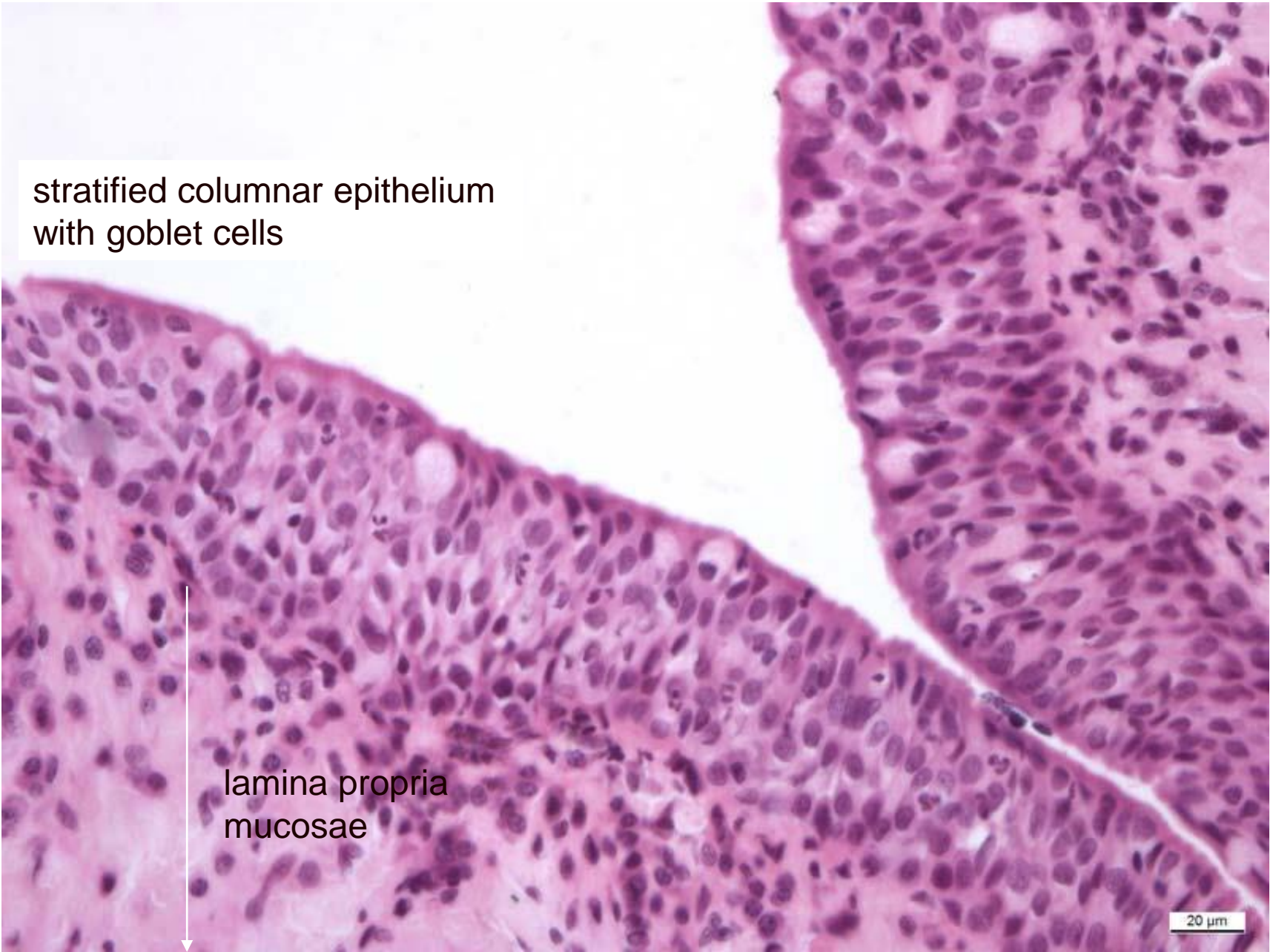
tarsal plate and tarsal Meibomian glands
/sebaceae/

Conjunctiva

stratified columnar epithelium
with goblet cells

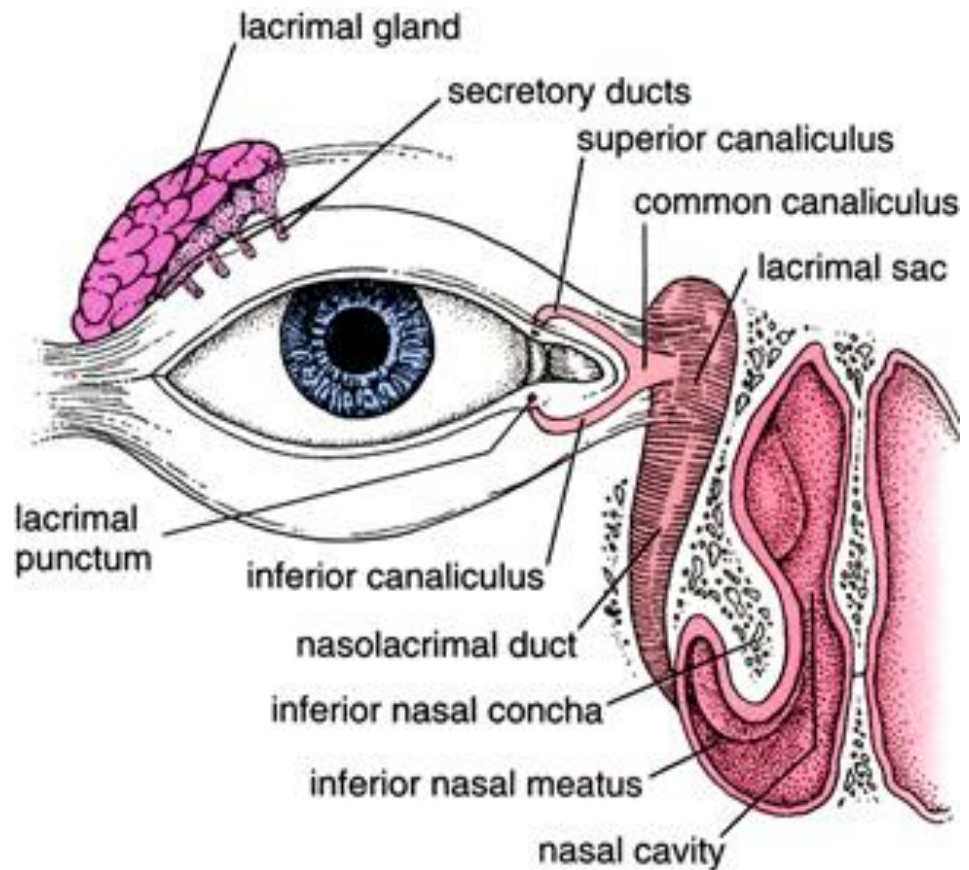
lamina propria
mucosae

20 μ m

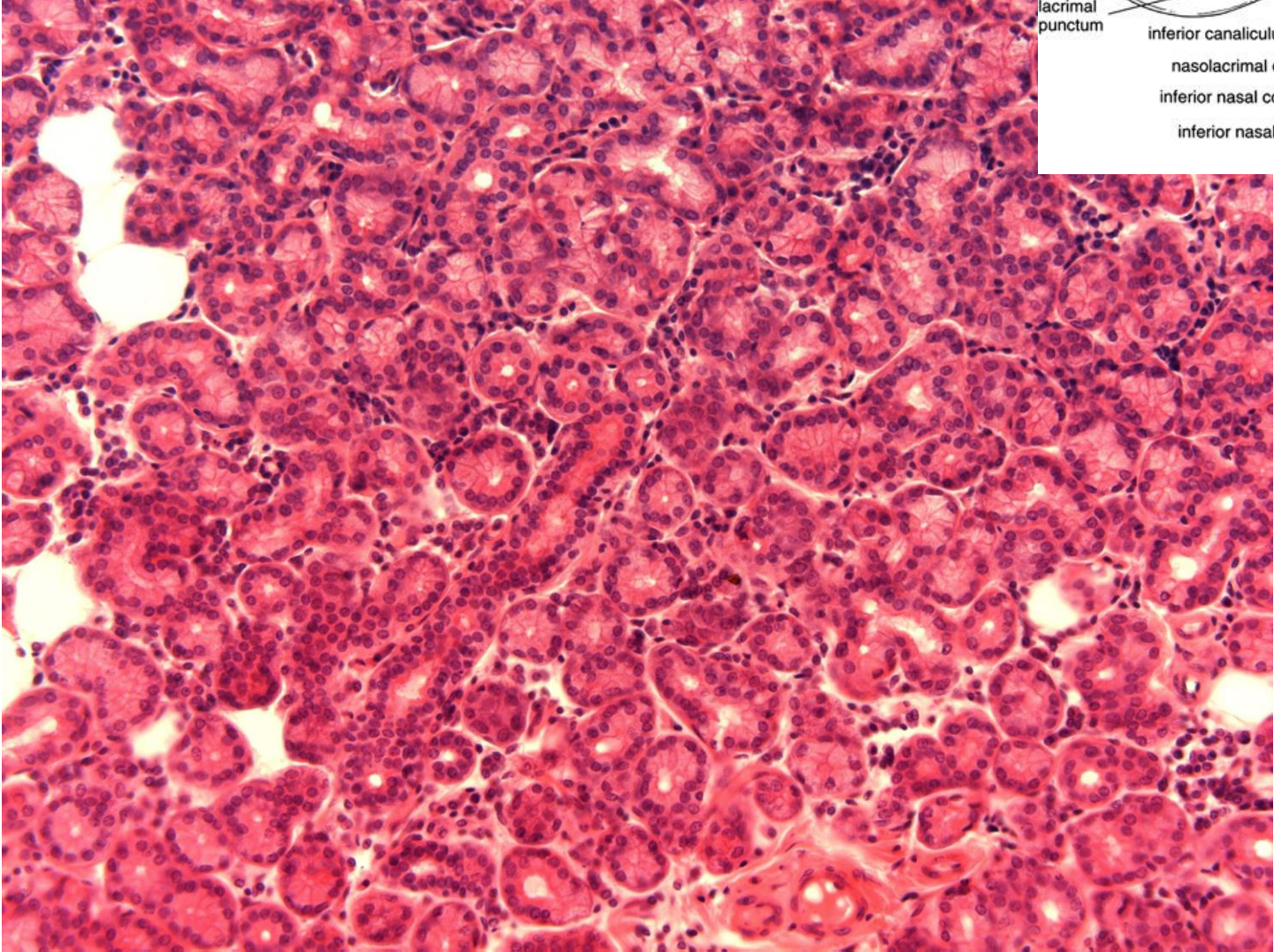
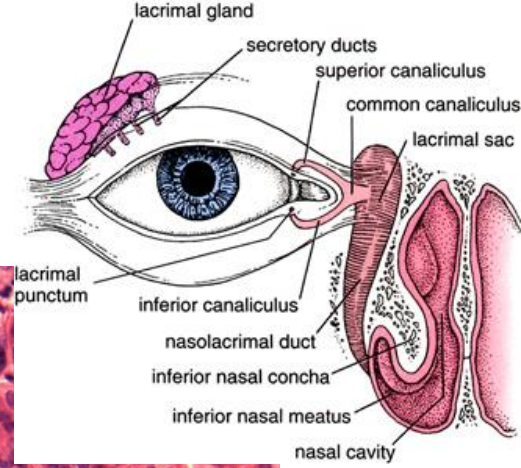


Lacrimal apparatus

- **lacrimal gland**
 - compound tubuloalveolar gland producing a lysosyme-rich serous fluid
- **lacrimal canaliculi**
 - superior
 - inferior
 - length: 8 mm, lined with s.s. epithelium
- **lacrimal sac**
- **nasolacrimal duct**
 - opens into the meatus inferior
 - lined with a pseudostratified ciliated epithelium

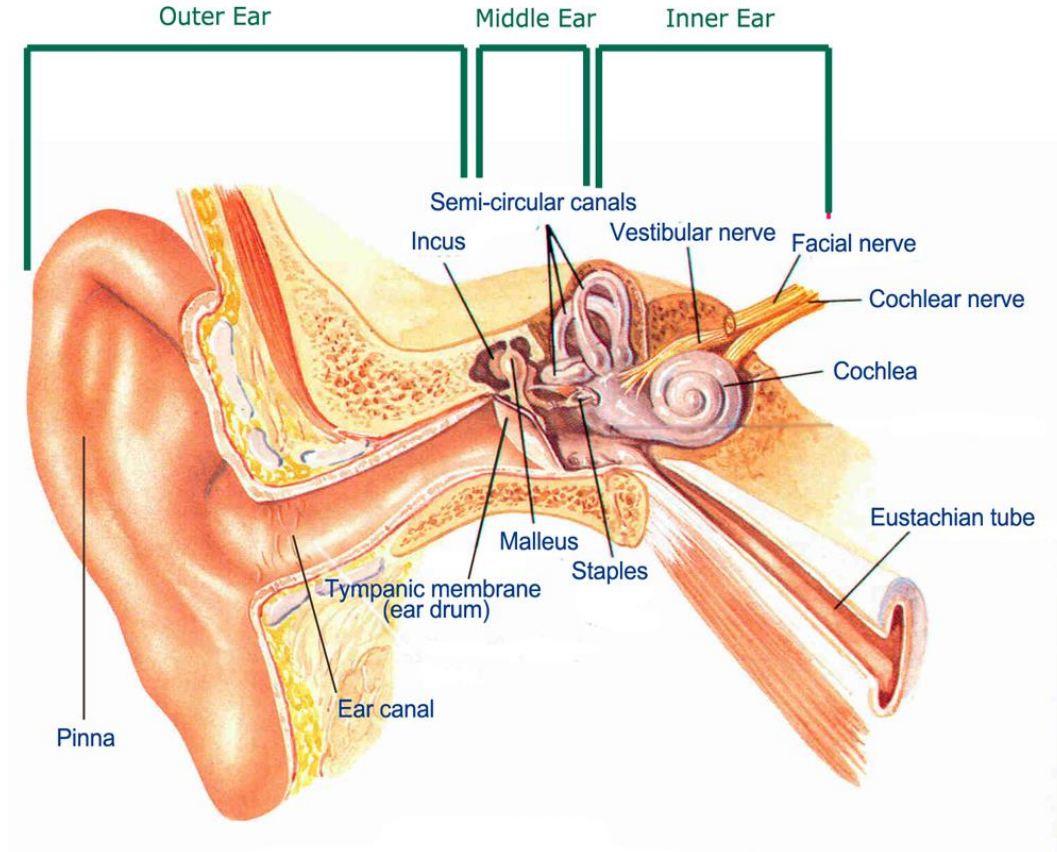


Lacrimal gland

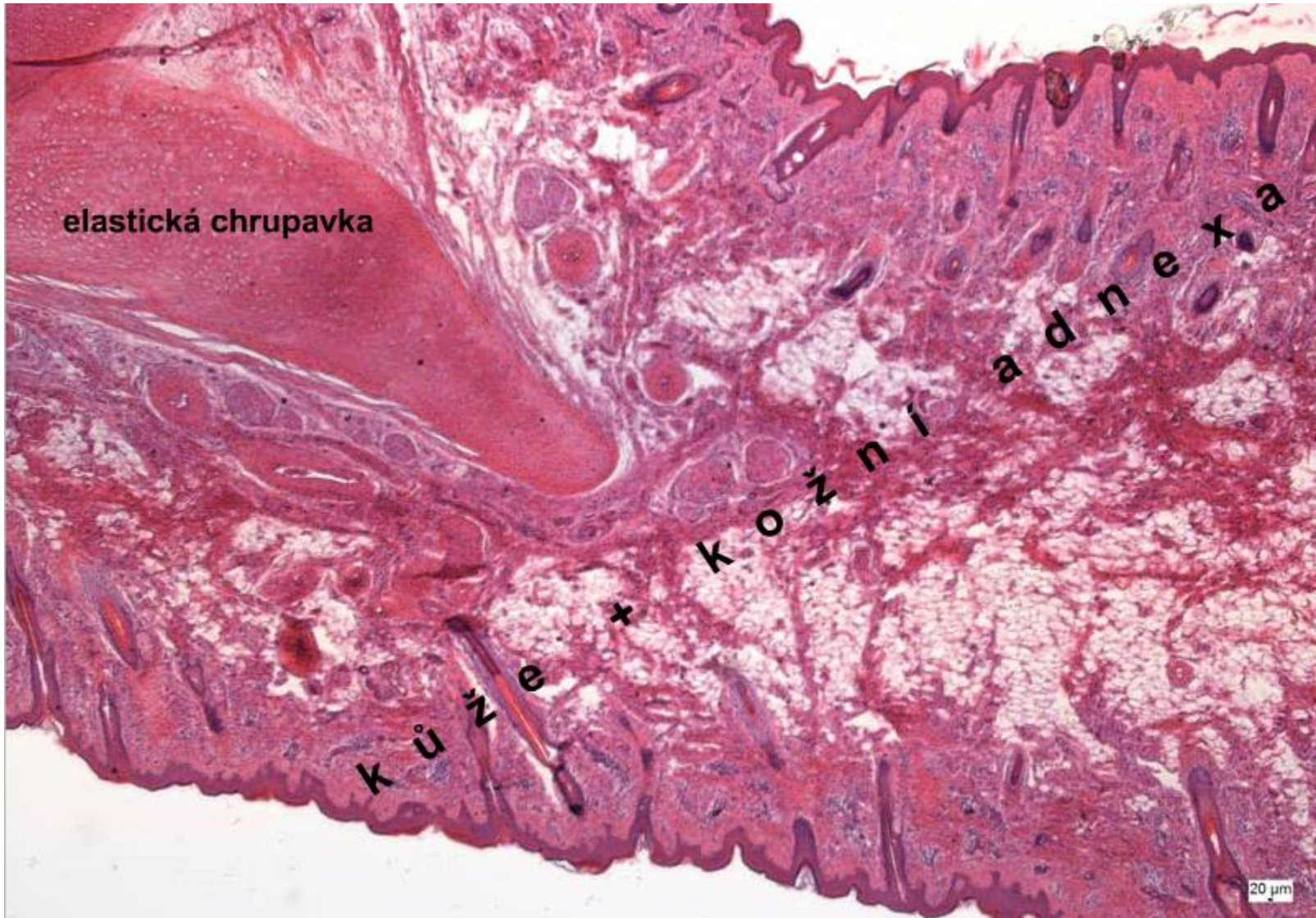


EAR

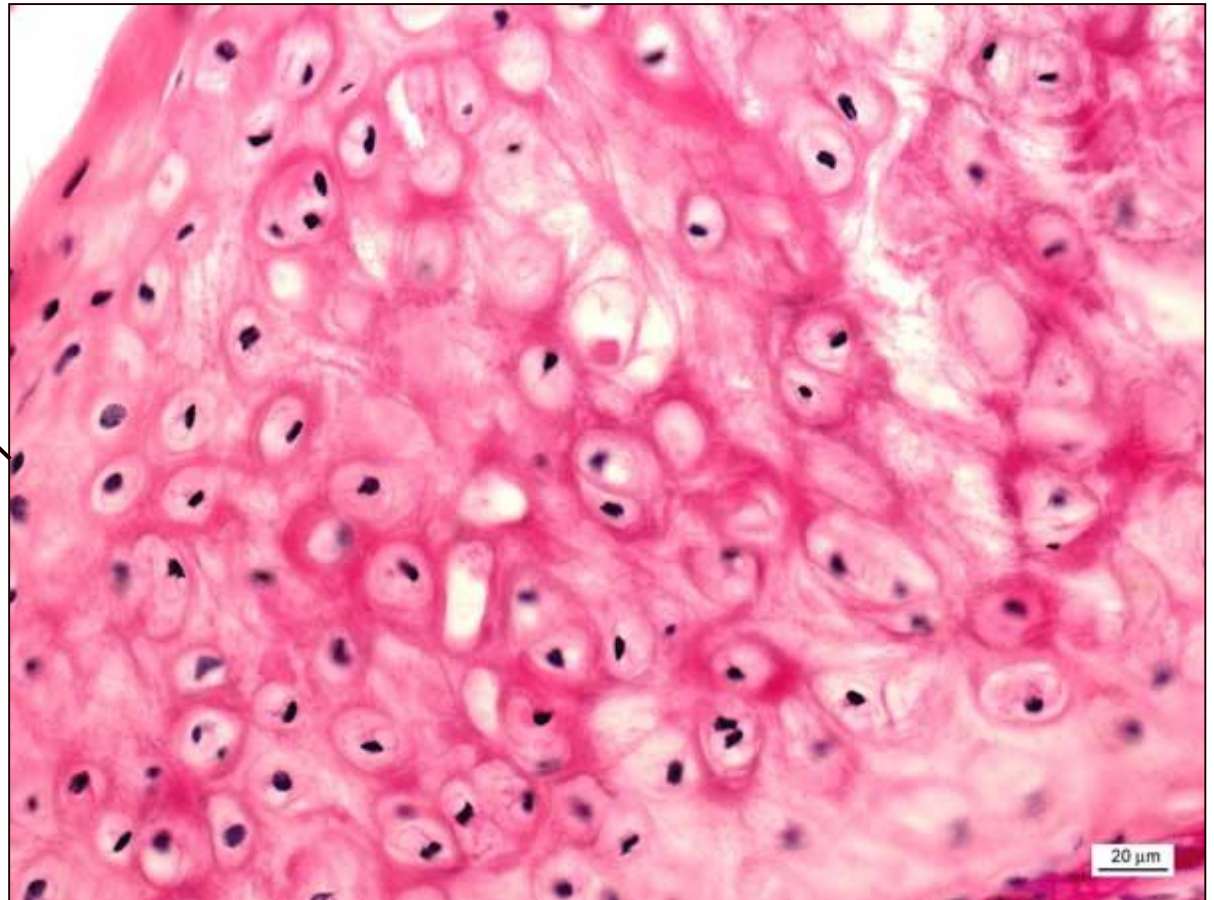
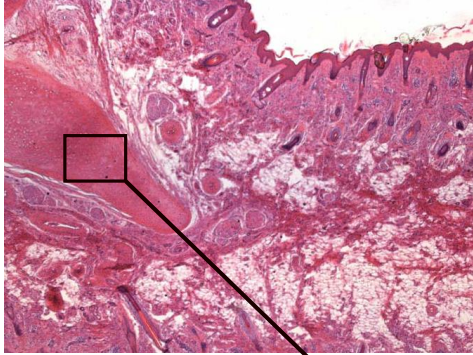
Structure of the Ear



Outer ear



Elastic cartilage



Membrana tympani

Stratum cutaneum

- skin

Stratum fibrosum

- collagen fibers
- *stratum radiatum*
- *stratum circulare*

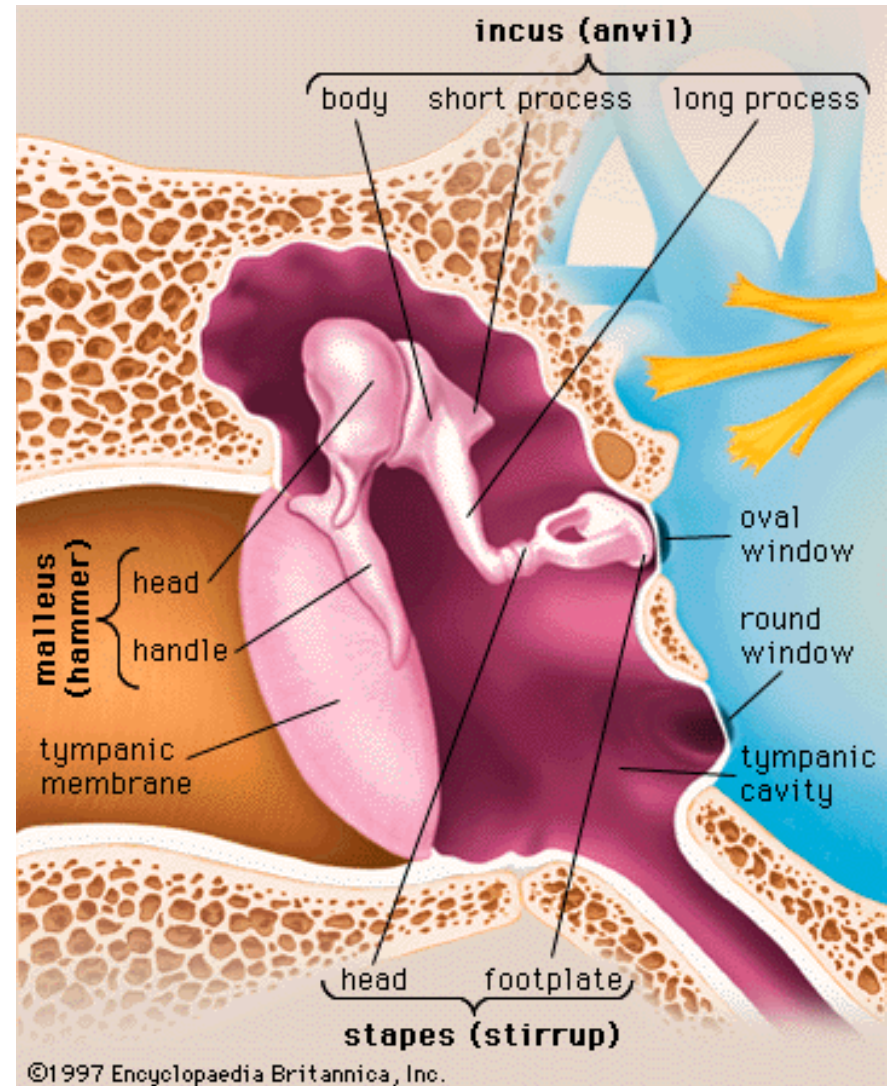
Stratum mucosum

- Mucosa as in the cavum tympani



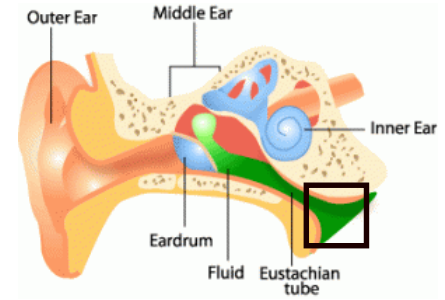
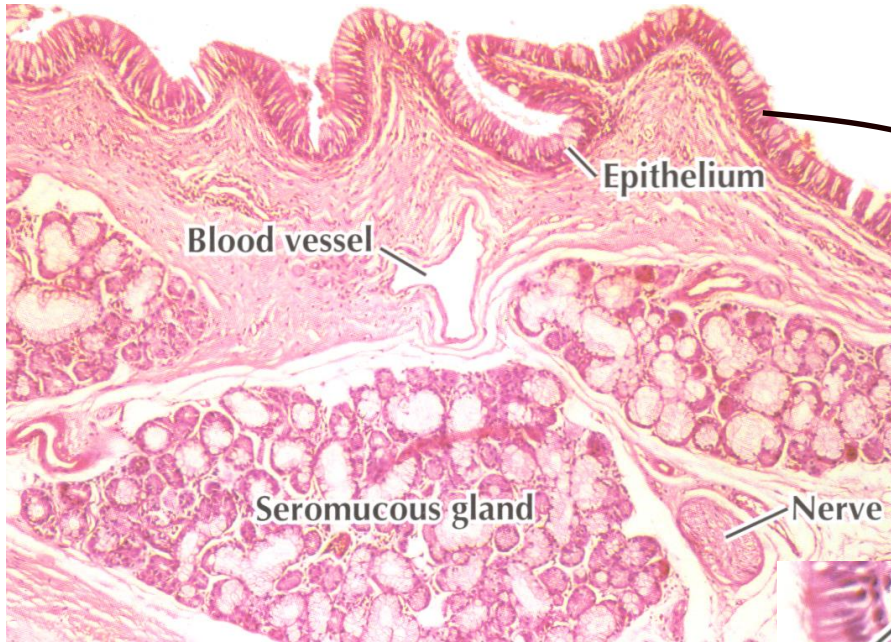
Middle ear

- **Cavum tympani**
 - mucosa
 - epithelium – simple squamous, flat, cubic, with cilia
 - lamina propria
- **Tuba auditiva** (Eustach tube)
 - pars ossea – two layers of columnar cillitaded epithelium continuous with epithelium of c. tympani
 - pars cartilaginea – pseudostratified columnar cillitaded epithelium
 - tonsila tubaria

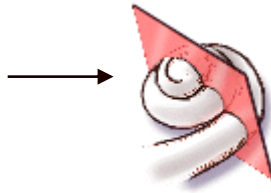
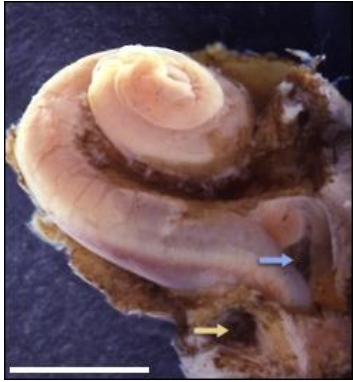


Tuba auditiva

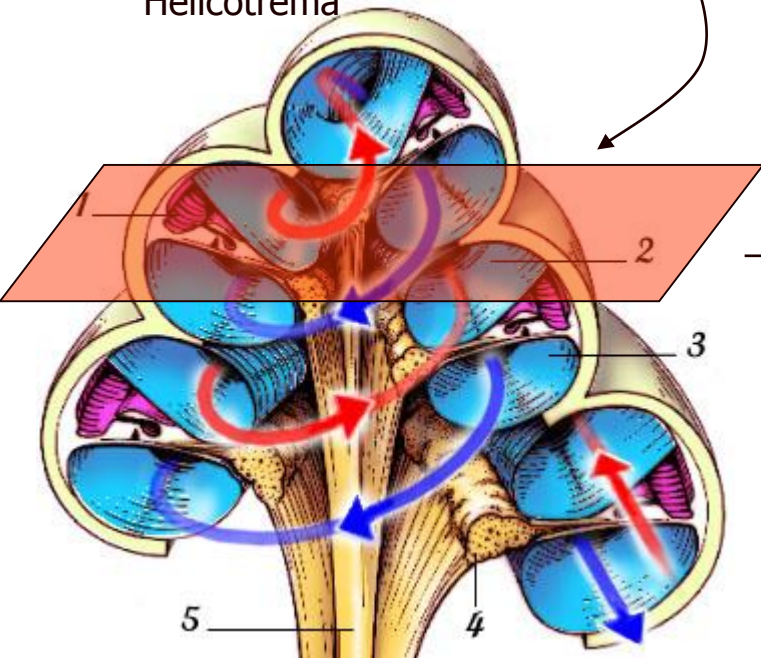
Pars cartilaginea



Inner ear/cochlea/

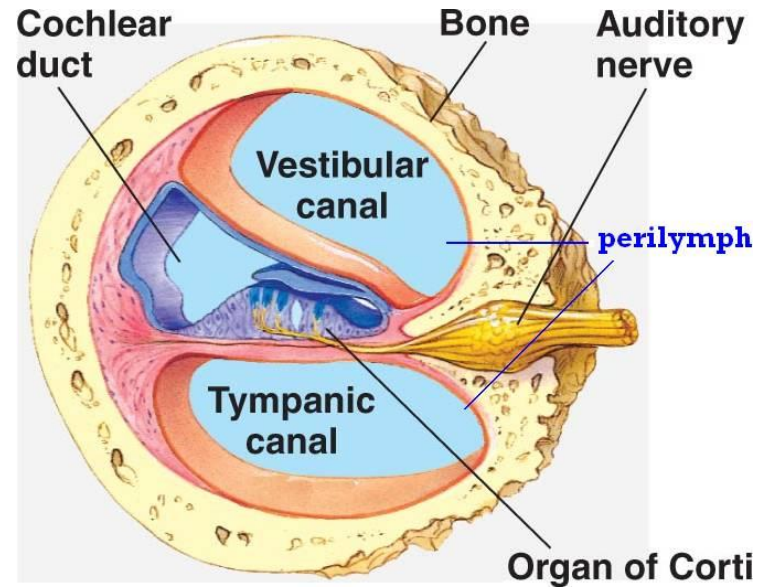


Helicotrema



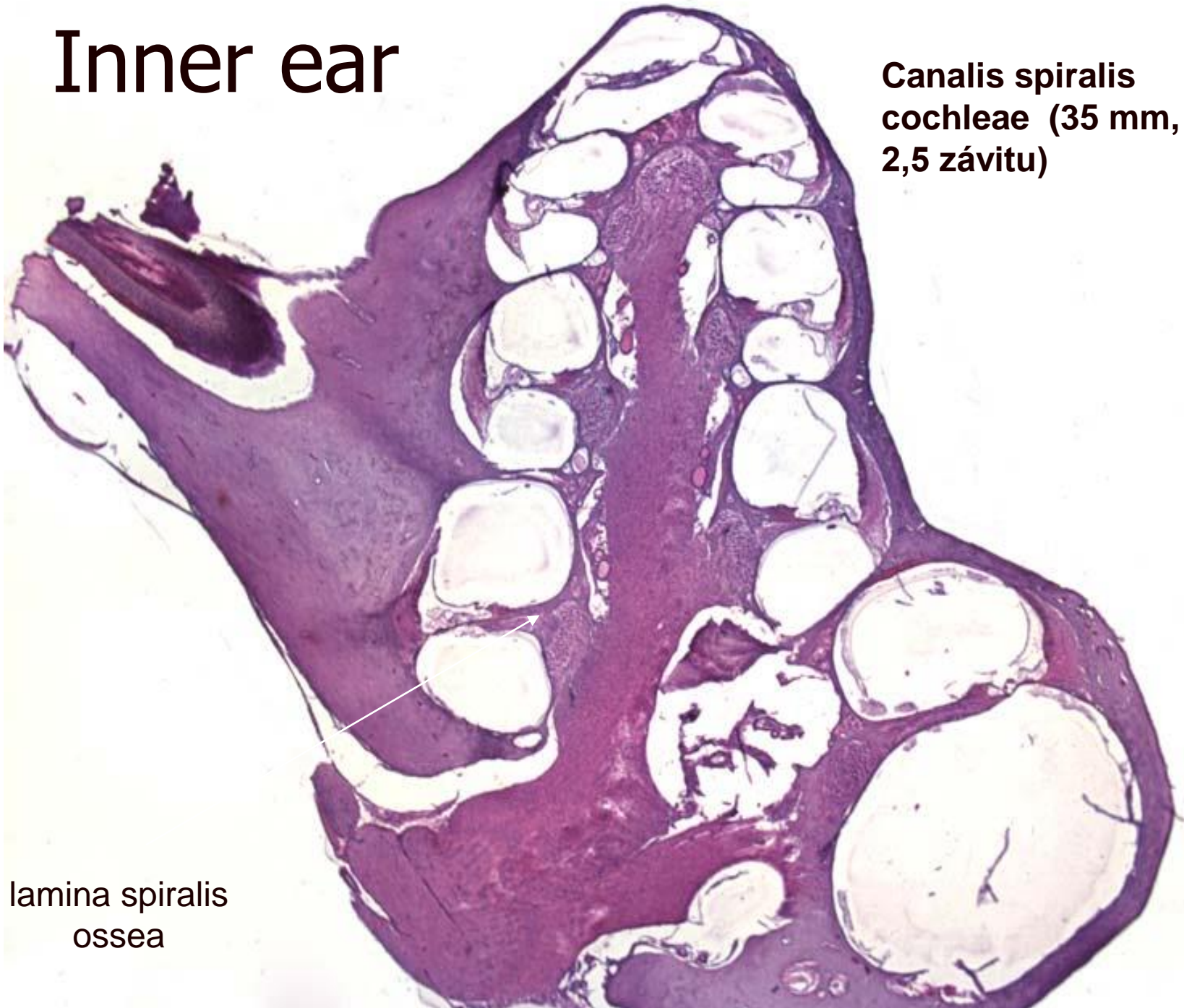
Modiolus

Bone a membranous labyrinth
Spatium perilymphaceum + perilymfa
Pars statica + auditiva I. m.
Modiolus, helicotrema



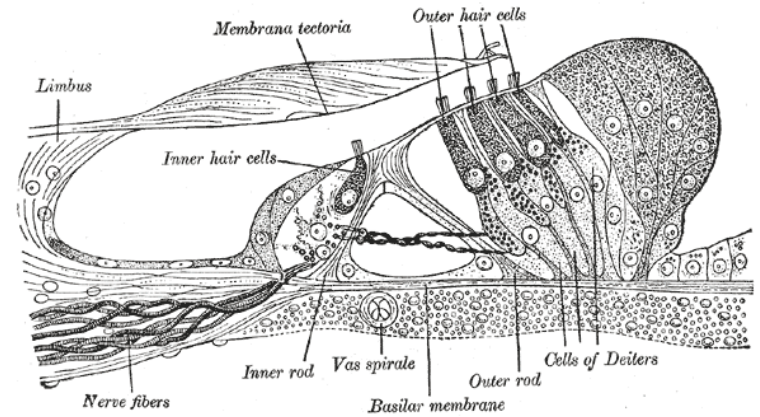
Inner ear

Canalis spiralis
cochleae (35 mm,
2,5 závitu)

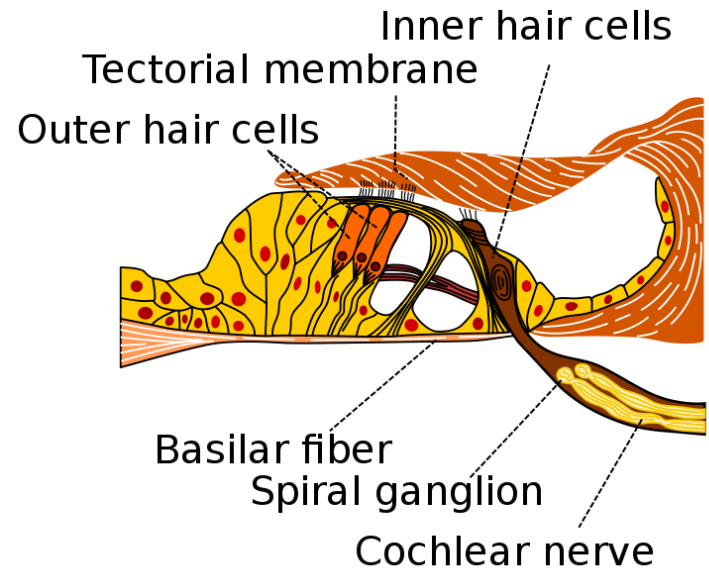
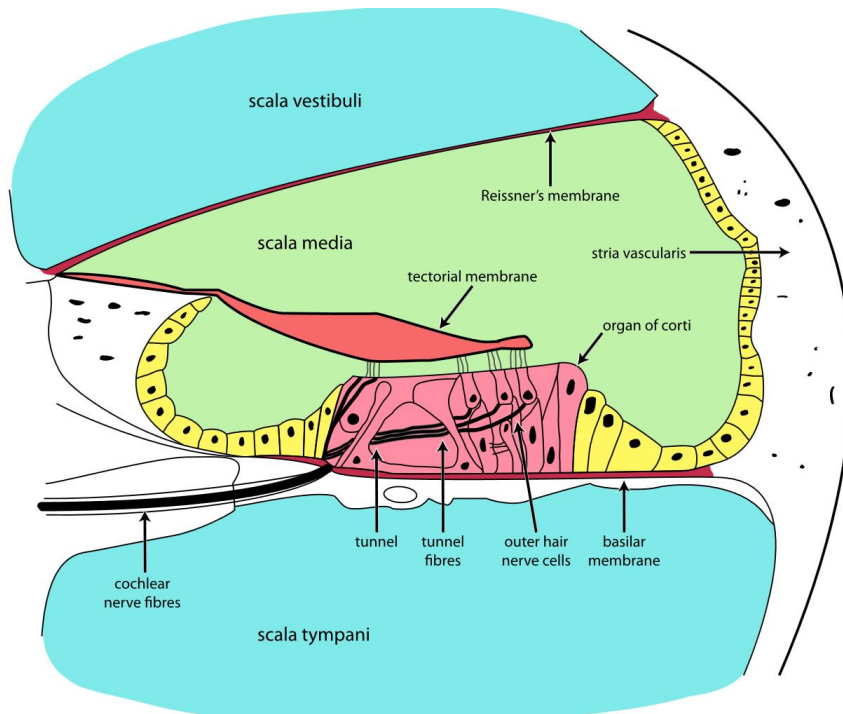


lamina spiralis
ossea

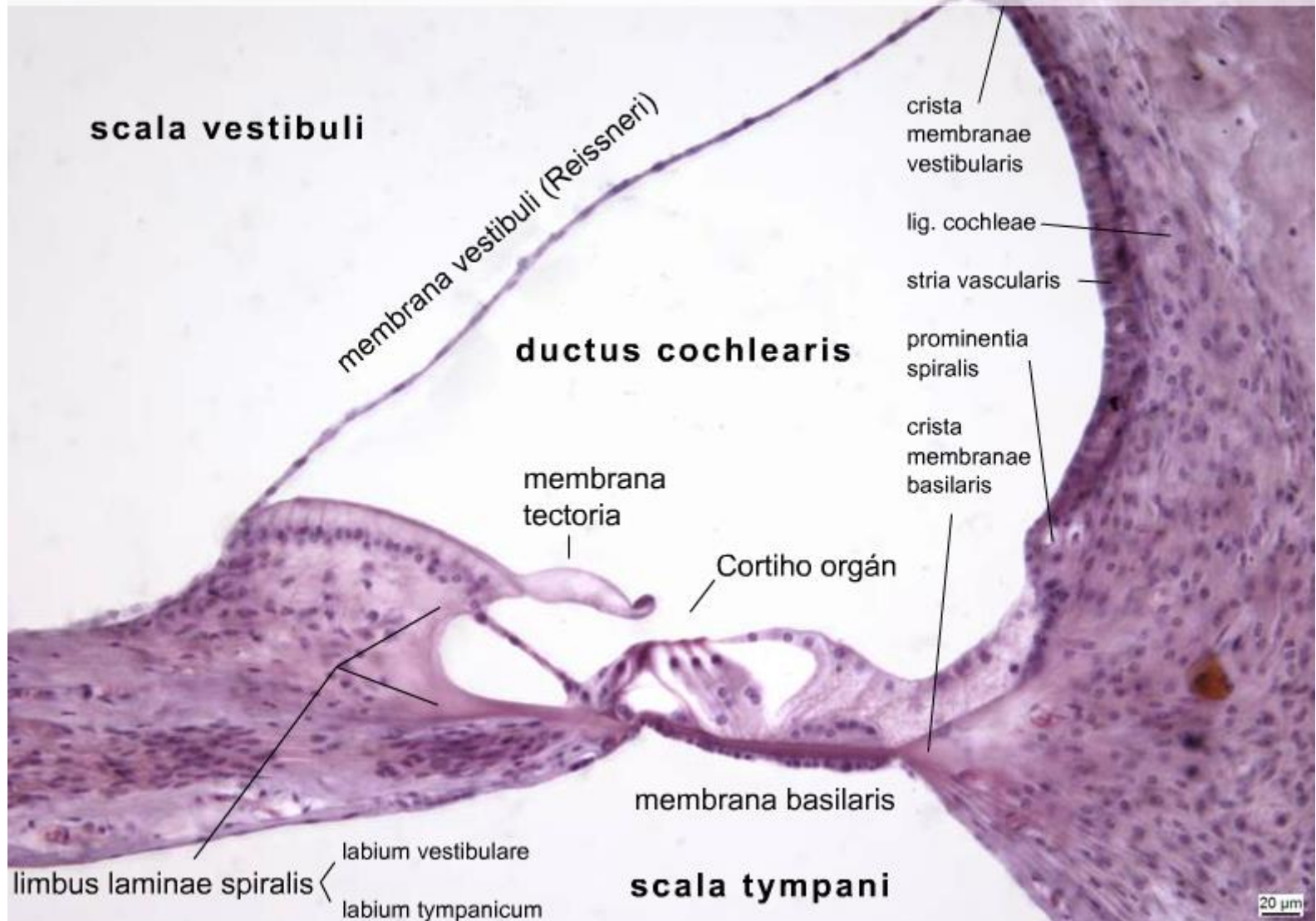
Inner ear



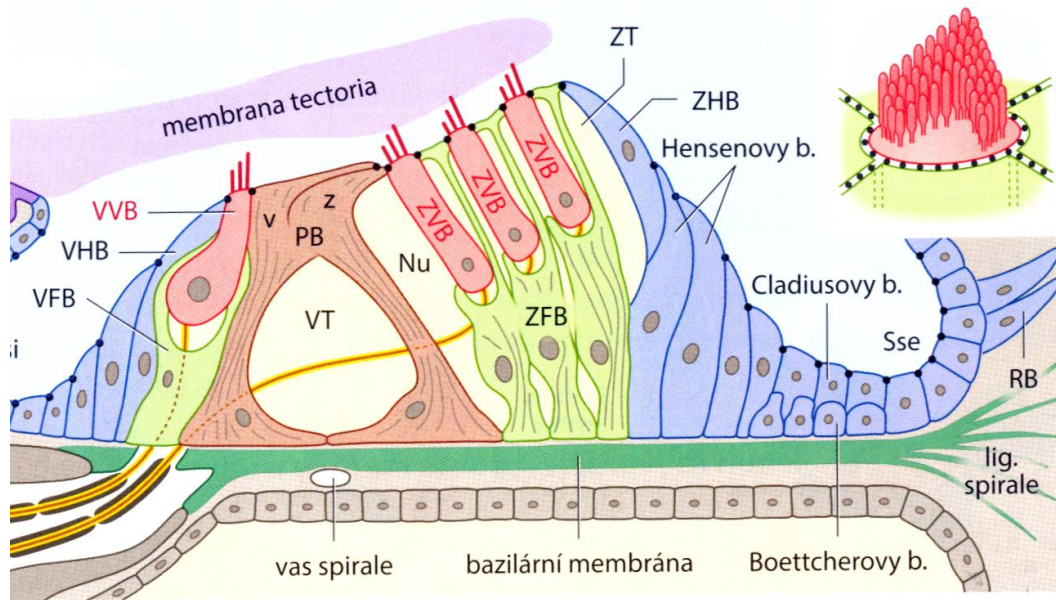
20th U.S. edition of Gray's Anatomy of the Human Body, originally published in 1918



Cochlea – ductus cochlearis, (HE), objektiv 20×



Organ of Corti



Cells

Supportive

- Cells of Hensen
- Phalangeal – outer and inner
- Pillar of Corti – outer and inner
- Border cells – outer and inner
- Cells of Claudius
- Cells of Bottcher

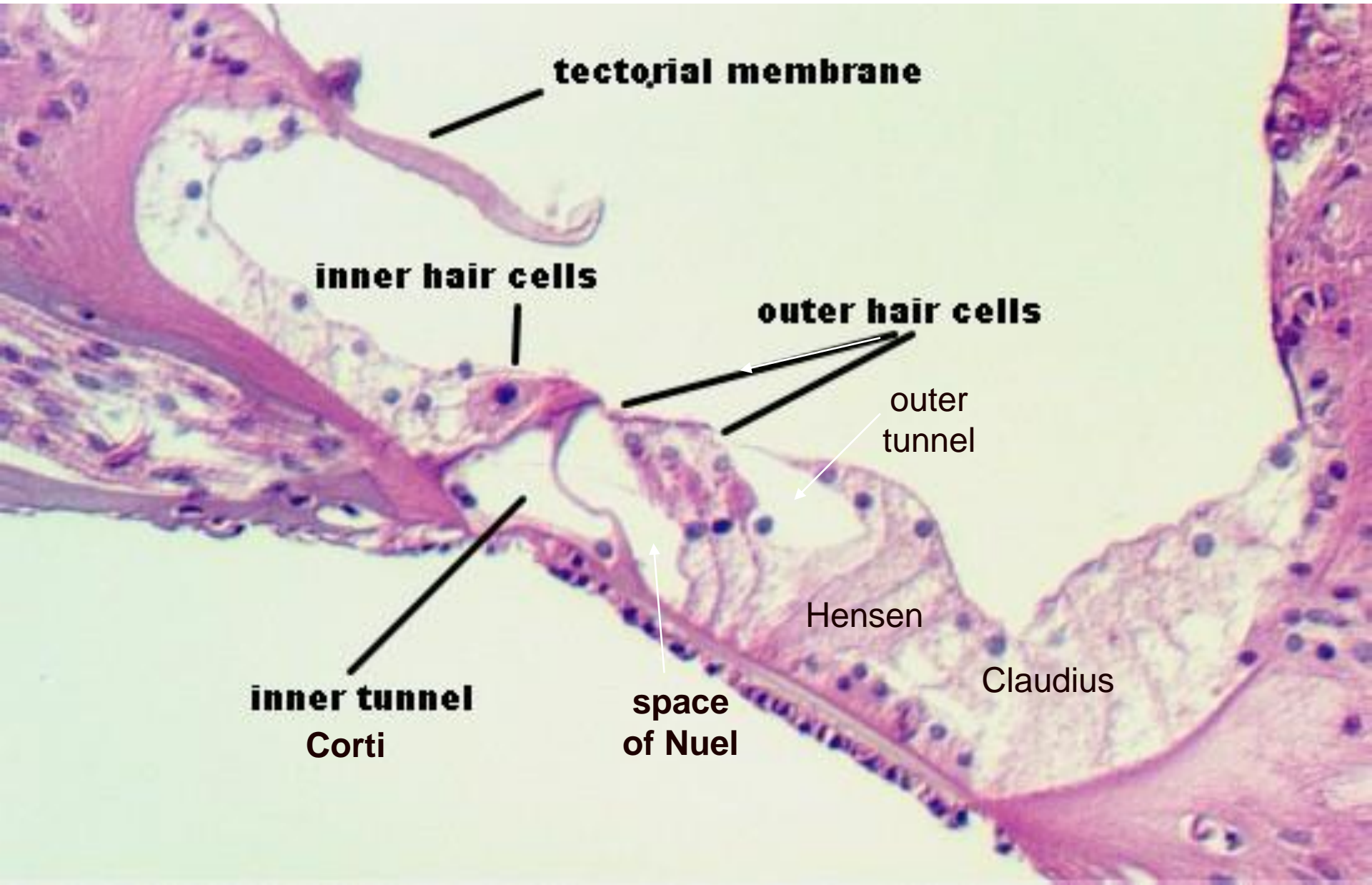
Hair cells

- Hair cells – inner and outer

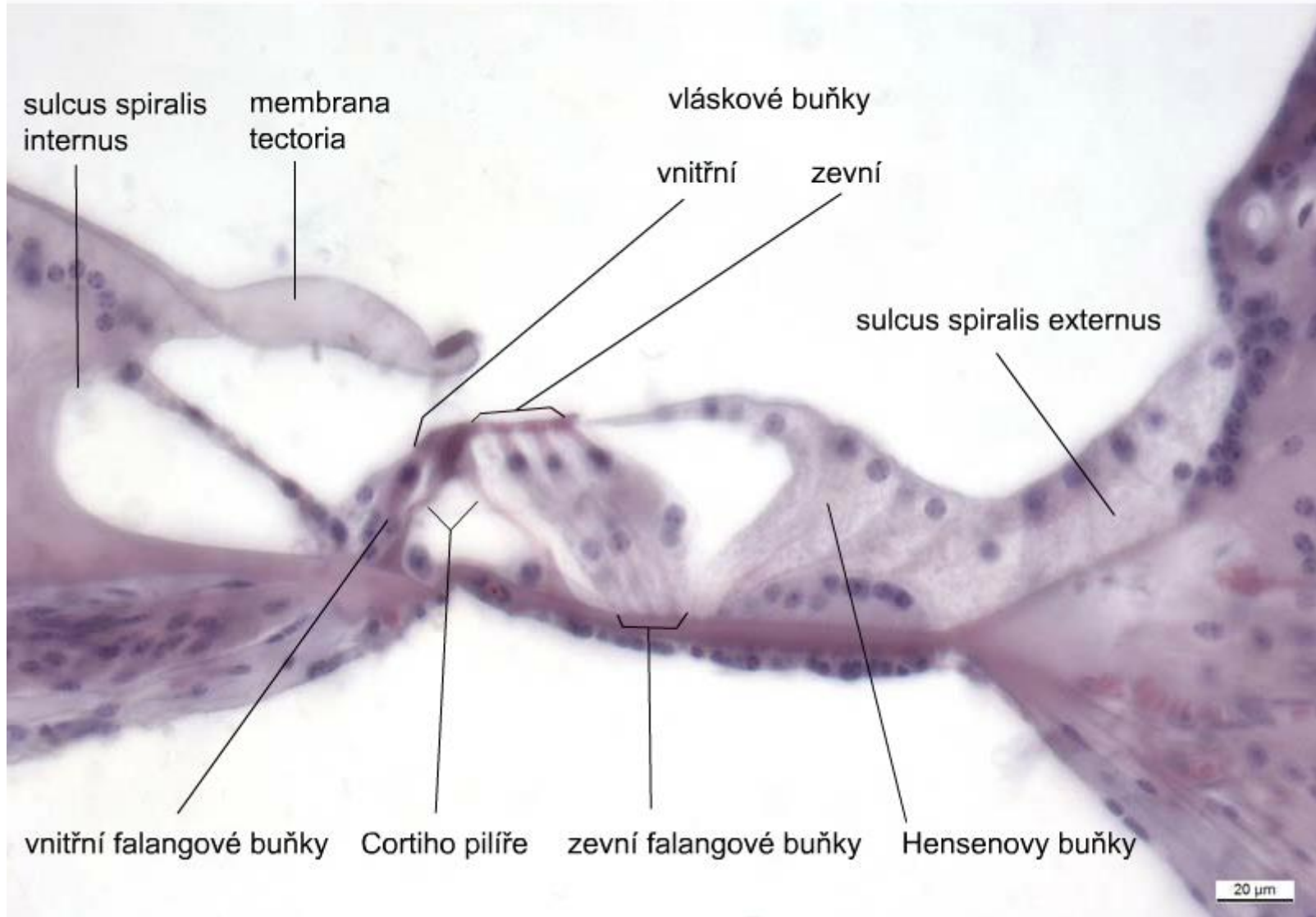
Tectorial (Reissner's) membrane

Space of Corti, space of Nuel

Organ of Corti



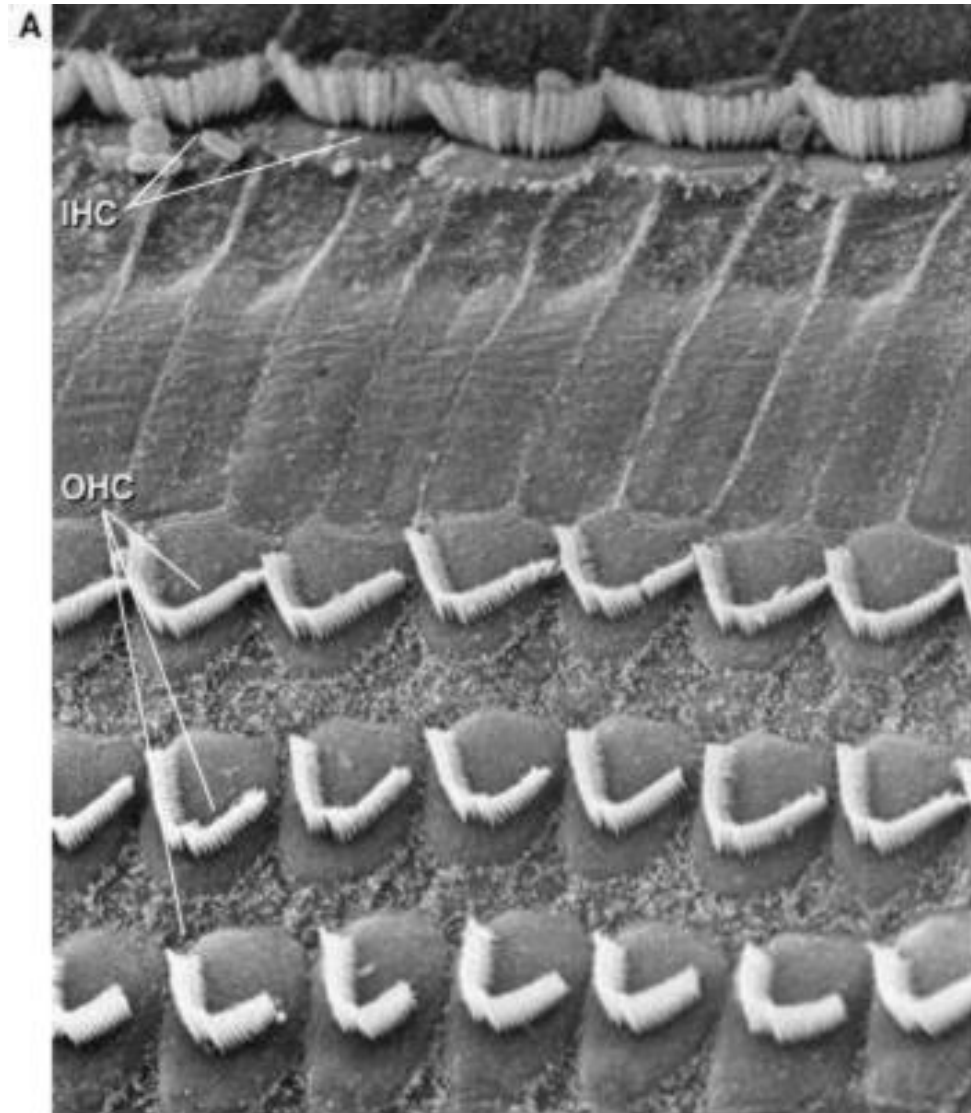
Cochlea – Cortiho orgán, (HE), objektiv 40×



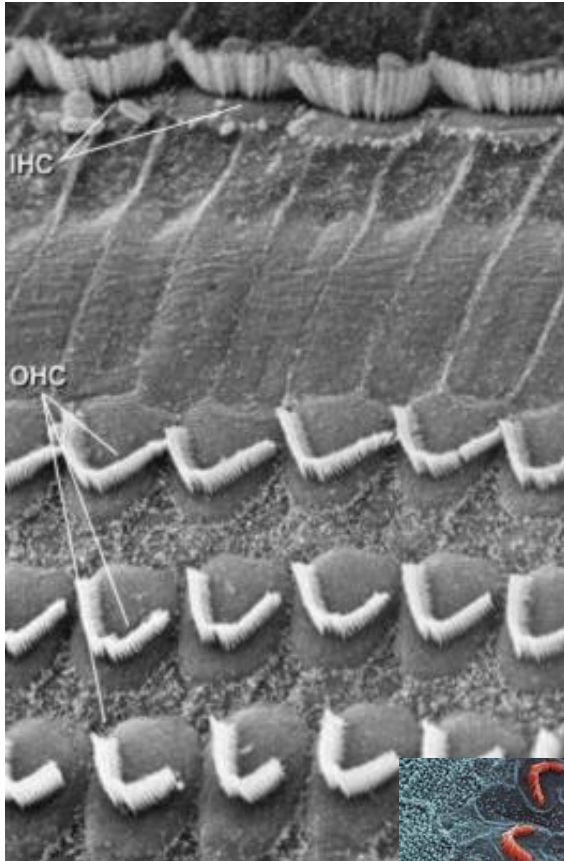
Hair and phalangeal cells



Membrana reticularis



Hair cells

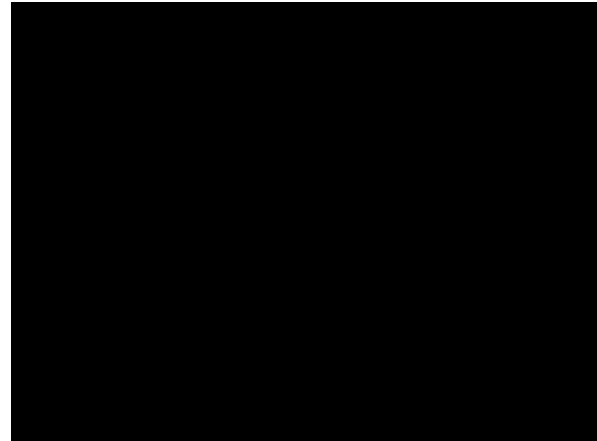
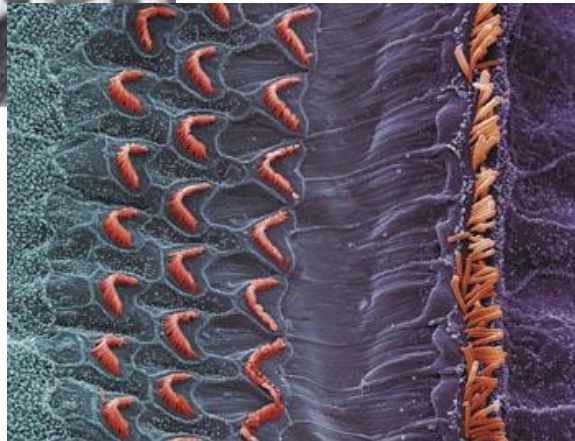


Outer hair cells

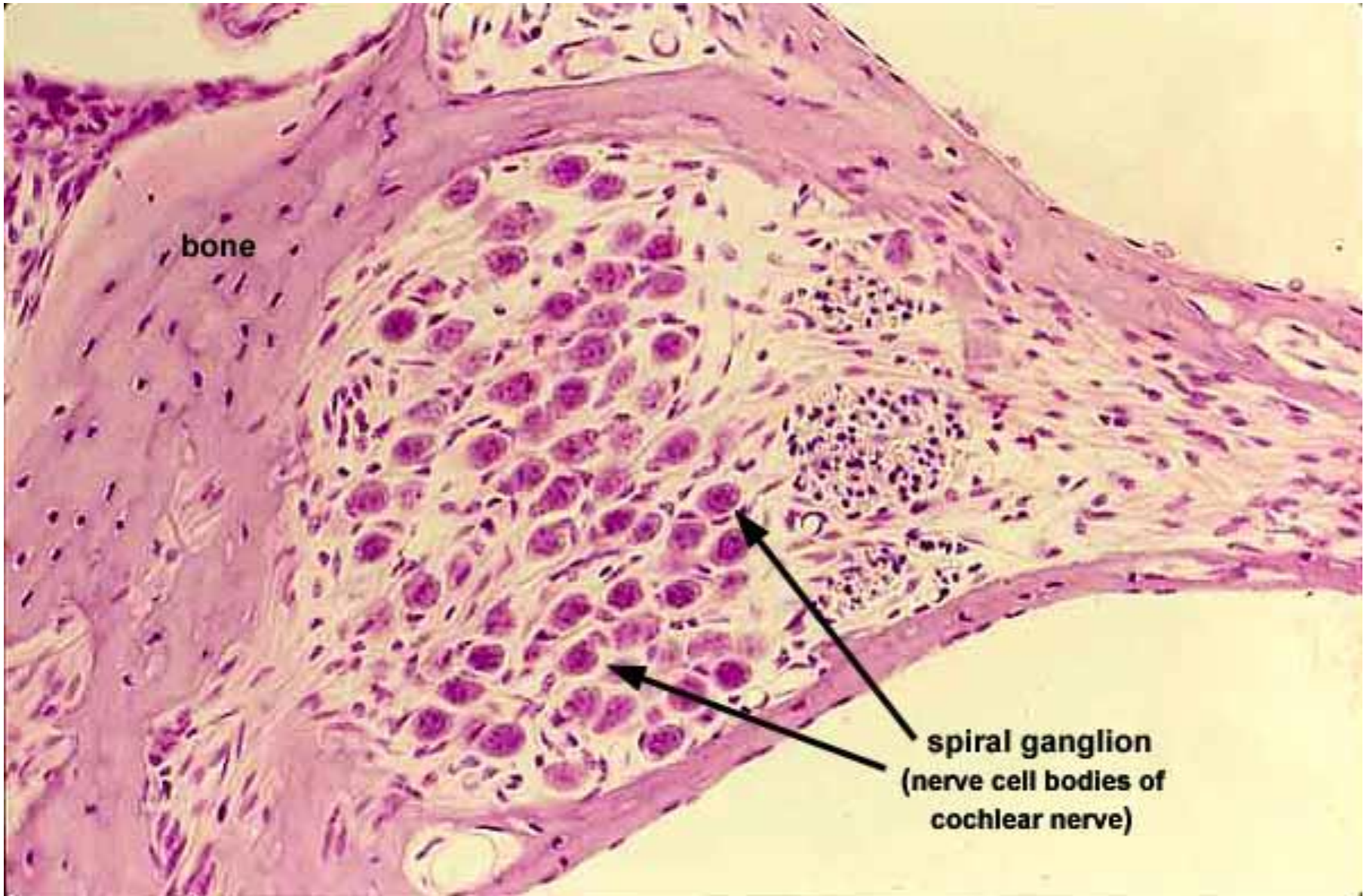
- **Electromechanical amplification of incoming vibrations**
- waves (16-16000Hz) induce oscillation of basilar membrane and shifts of the the sensory epithelium against tectorial membrane
- deflection of stereocilia opens mechanically controlled ion chanells
- depolarization and repolarization of cell membrane
- vibration of whole cells induces oscillation of inner hair cells that excitates nerve fibers
- loss of outer hairy cells affect recognition of frequencies, treshold of audibility, etc.

Inner hair cells

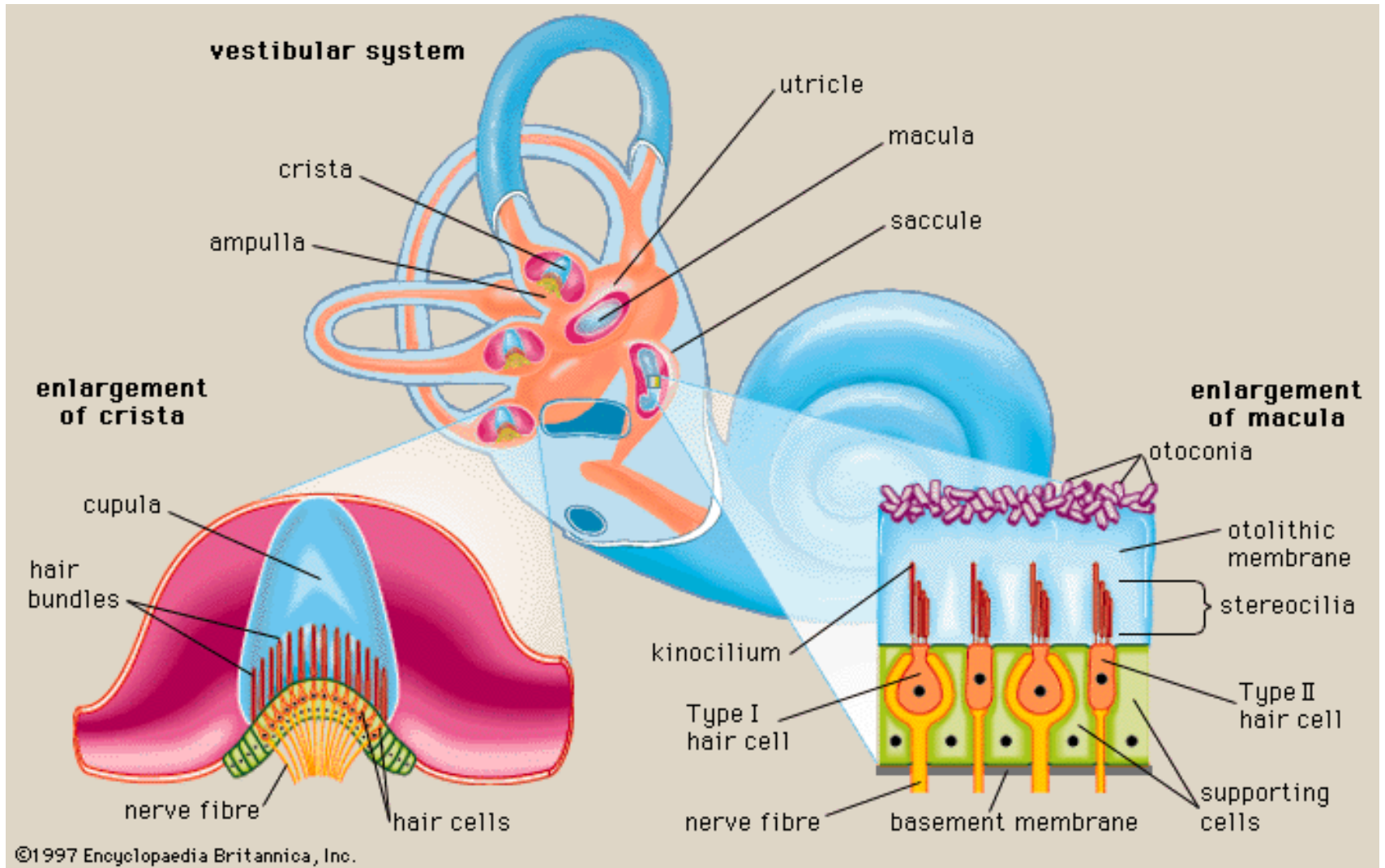
- depolarization of cell membrane releases glutamate (neurotransmitter)
- induction of excitation in nerve fiber



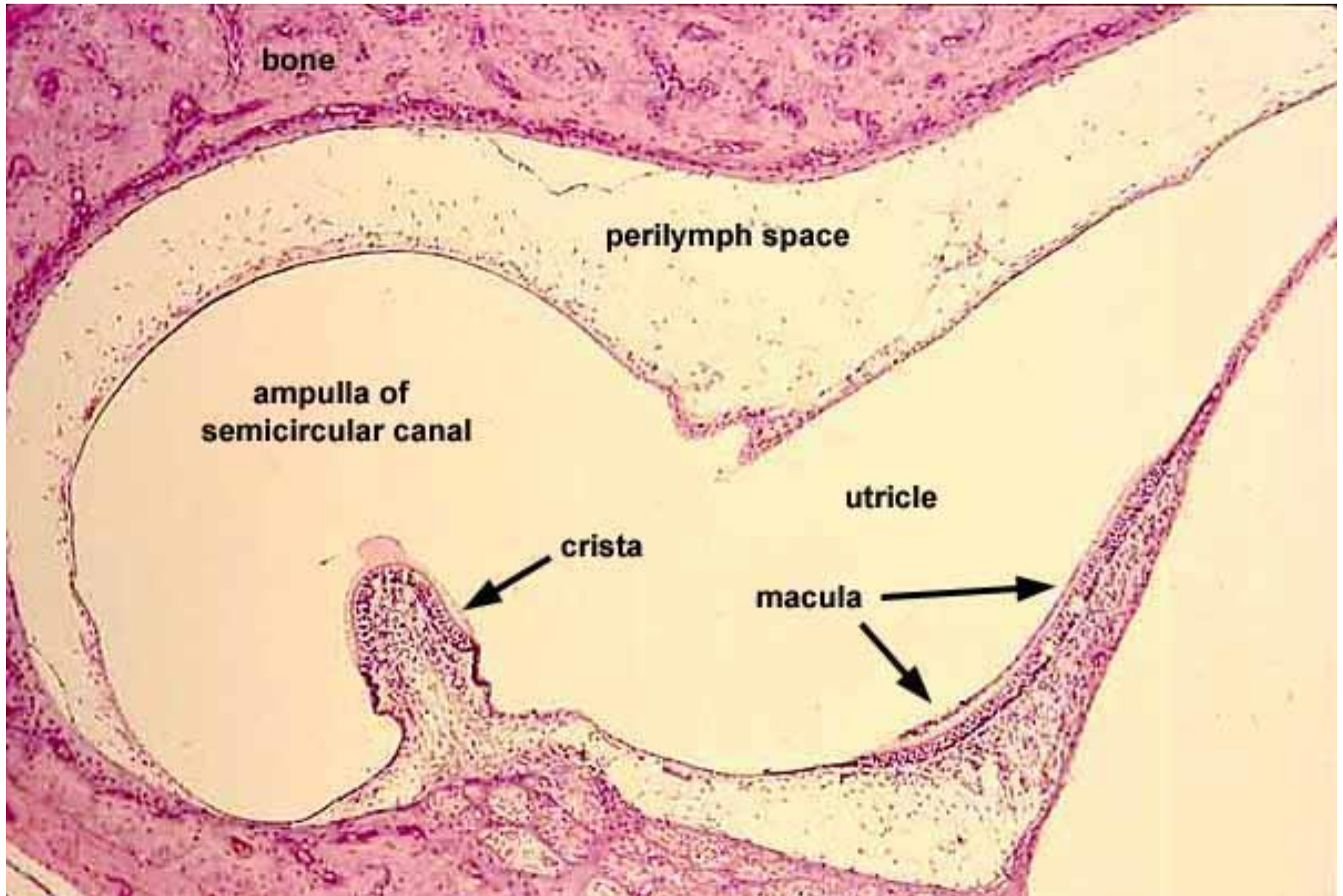
Spiral ganglion



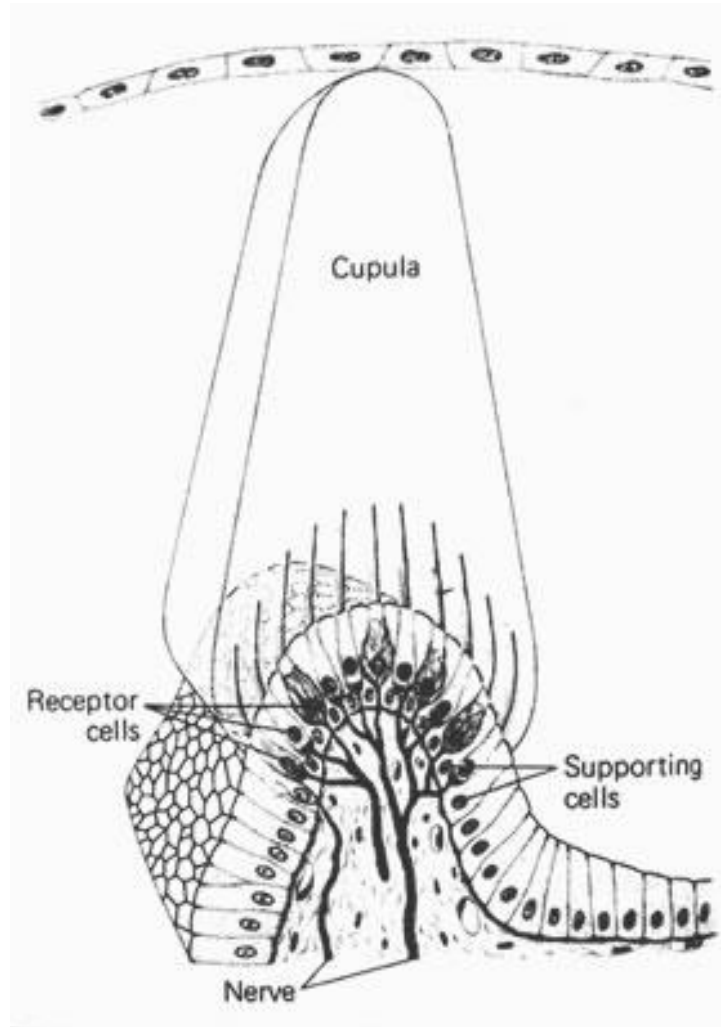
Vestibular apparatus



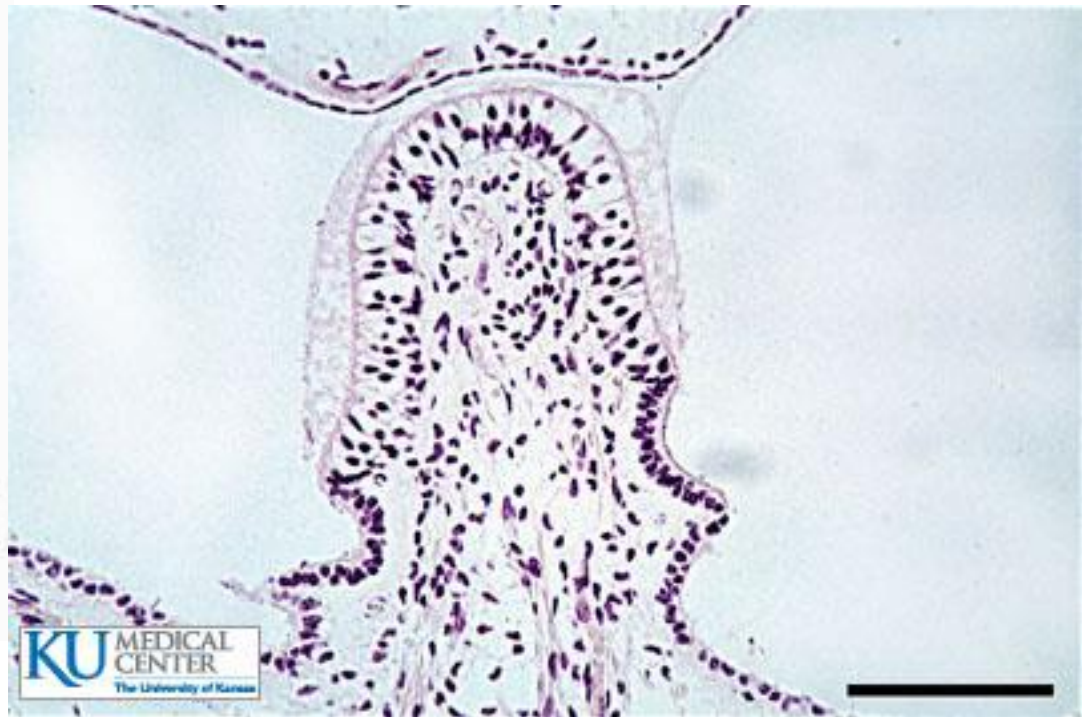
Membranous labyrinth



Ductus semicirculares



crista ampullaris

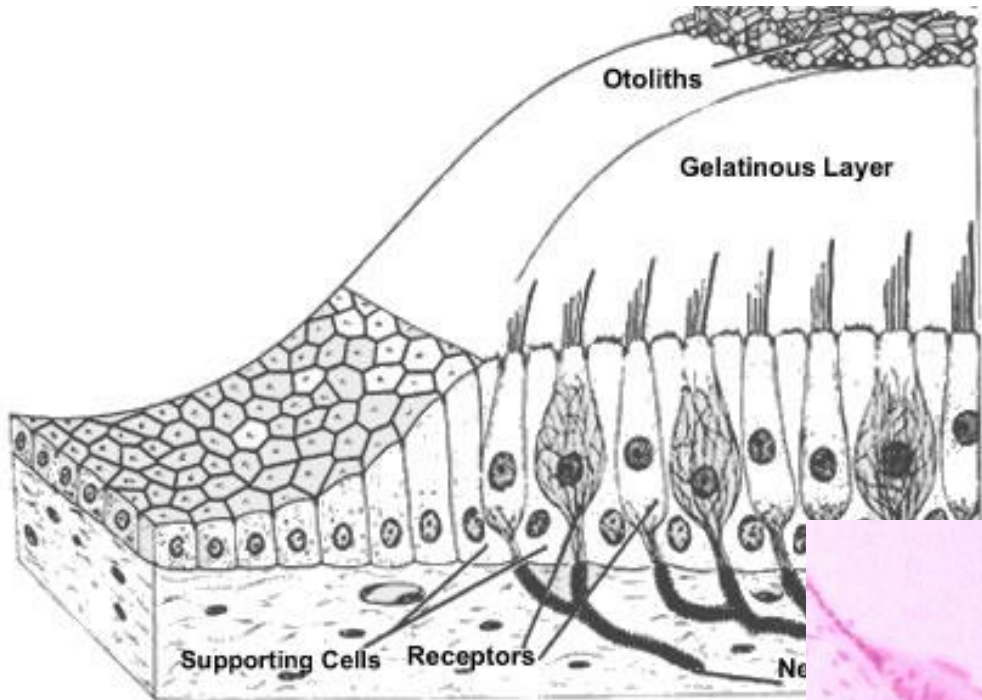


acceleration

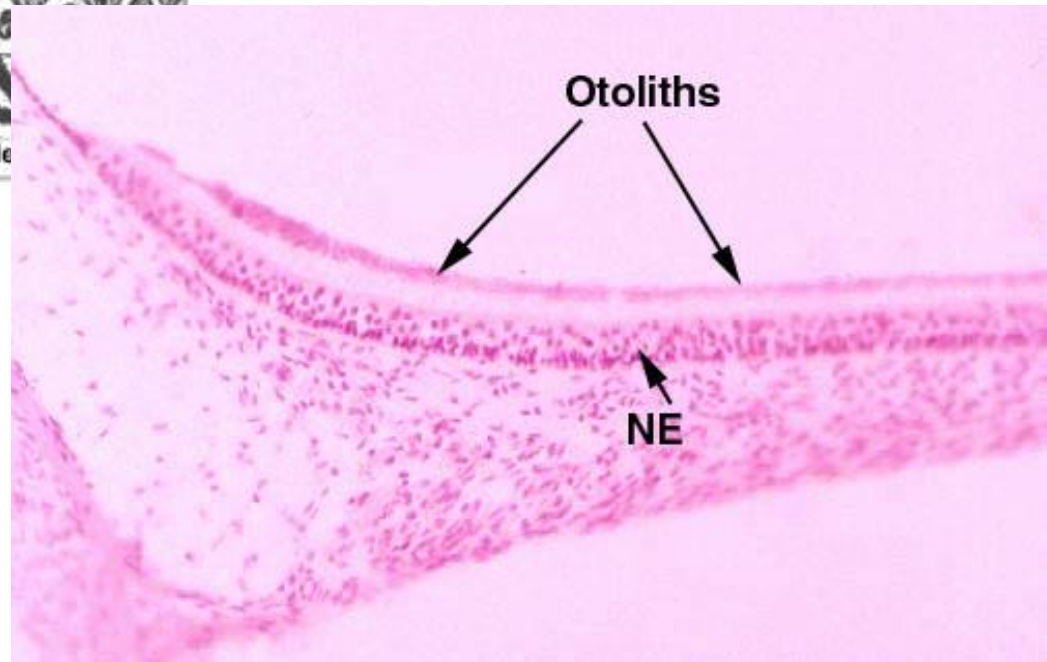
Crista ampullaris



Utriculus a sacculus



- macula statica



position

Slides – eye, ear

- 88. Anterior eye segment
- 89. Posterior eye segment
- 90. Fasciculus opticus
- 91. Palpebra
- 92. Glandula lacrimalis

- 93. Cochlea
- 94. Auricula



Alfonso Corti

1822-1876

Recherches sur l'organ de l'ouïe des mammiferes

1851