



# Macroscopic anatomy of the eye and ear

Dr. Sándor Katz Ph.D.

## Parts of the visual organ



Eyeball (bulbus oculi)

Optic nerve, central apparatus (nervus opticus, tractus opticus, apparatus opticus centralis)

Auxiliary organs (organa accessoria)

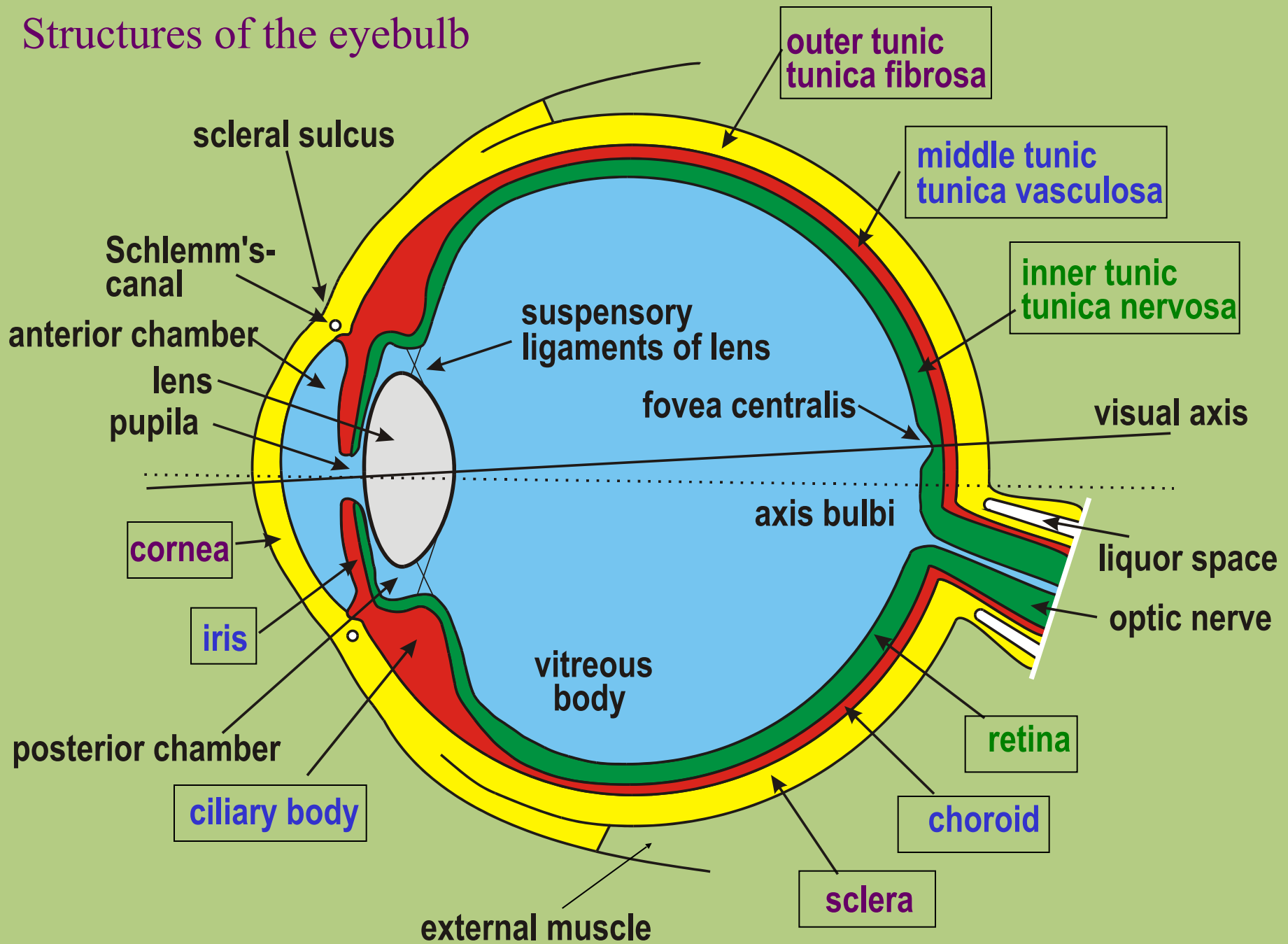
External muscles of the eye (musculi bulbi)

Adipose tissue (corpus adiposum orbitae)

Protective organs (palpebrae et tunica conjunctiva)

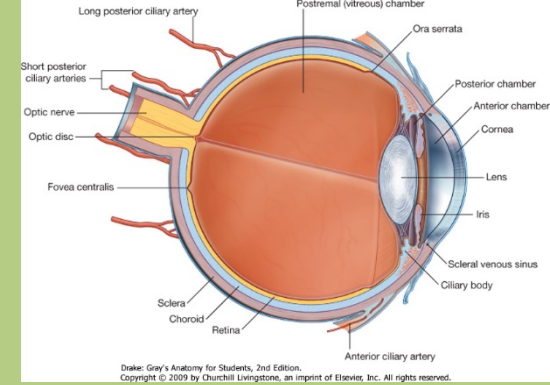
Lacrimal organs (apparatus lacrimalis)

# Structures of the eyeball





# Fibrous tunic – cornea

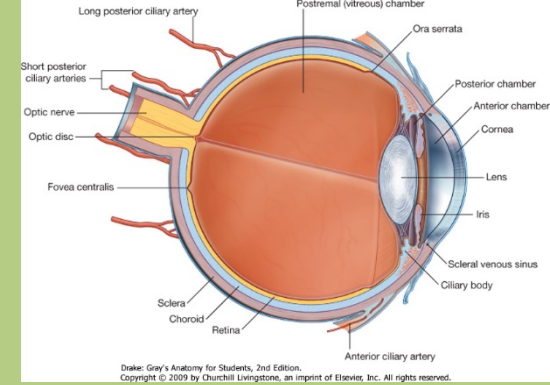


- **Corneal epithelium:**
- non-keratinized stratified squamous epithelium;
- microvilli present at the surface
- numerous free nerve endings

**NOTE: THE CORNEA IS AVASCULAR.**



# Fibrous tunic – cornea



Outer aspect of cornea

Tear layer

Stratified squamous epithelium

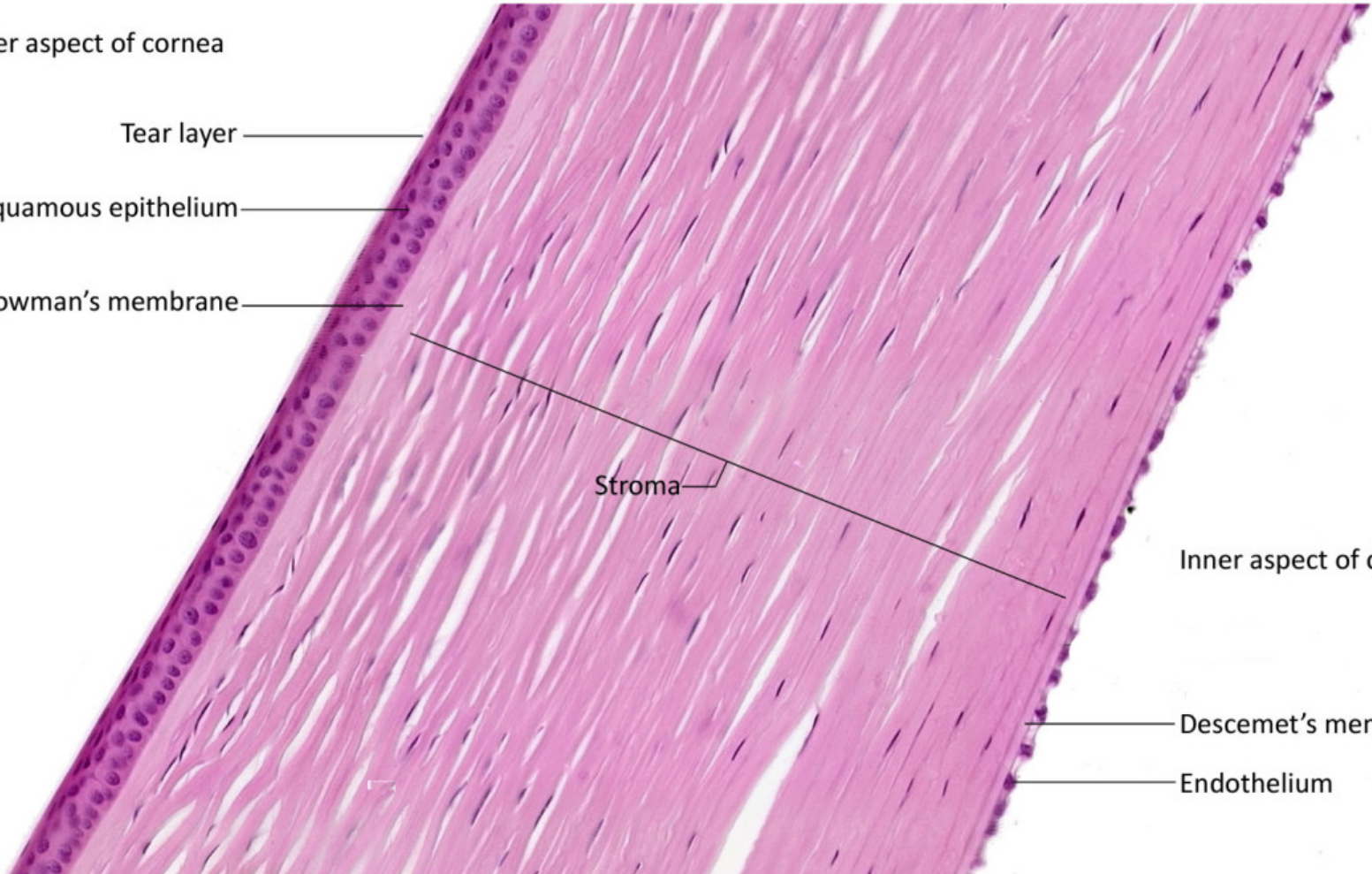
Bowman's membrane

Stroma

Inner aspect of cornea

Descemet's membrane

Endothelium



## Why is the cornea transparent ?

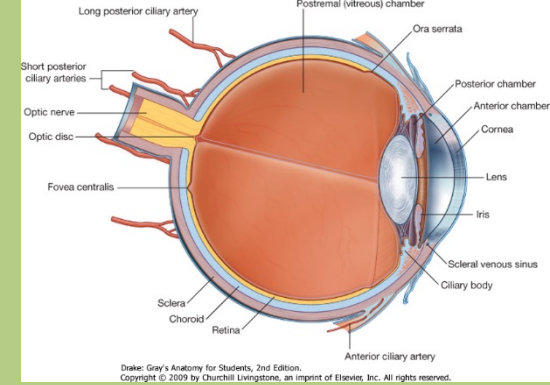
Structural regularity (sclera lacks the almost crystalline organisation)

Sandwich-like arrangement of stroma between epithelium and endothelium (sclera is sandwiched between acellular layers; episclera and lamina fusca)

No vessels, no melanocytes (vascularization after inflammation causes opacity)

Strong degree of dehydration (damage to epithelium [tight junctions] or endothelium [ion-pump] causes water-uptake and opacity)

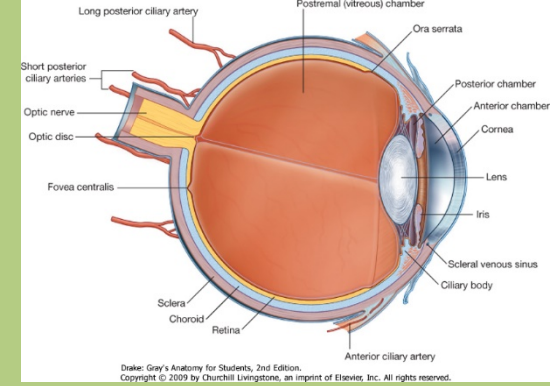
# Fibrous tunic – sclera



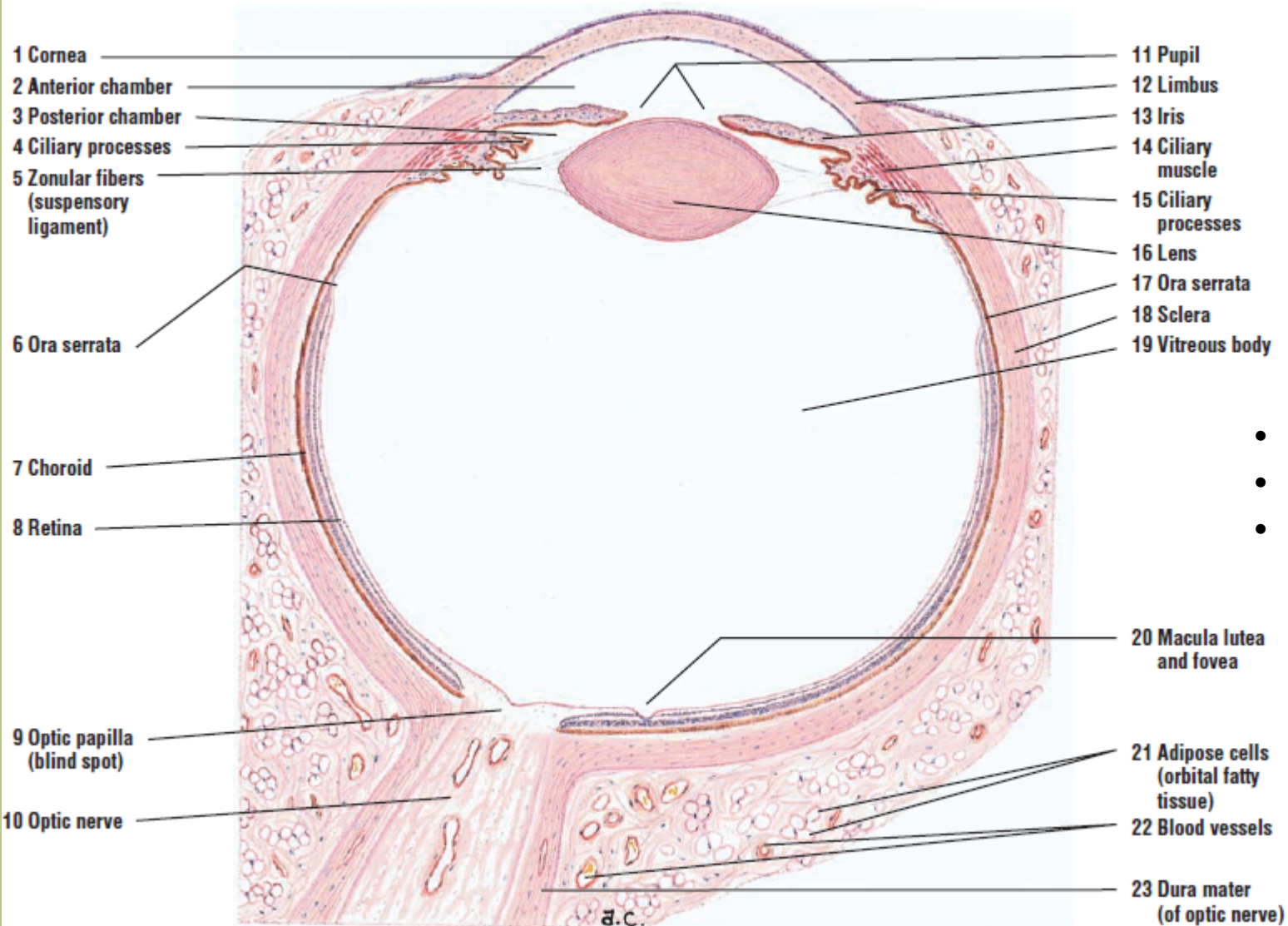
- adjacent to the choroid
- fibroblasts, melanocytes and macrophages
- collagen and elastic fibers



# Fibrous tunic – sclera



# Vascular tunic (uvea)



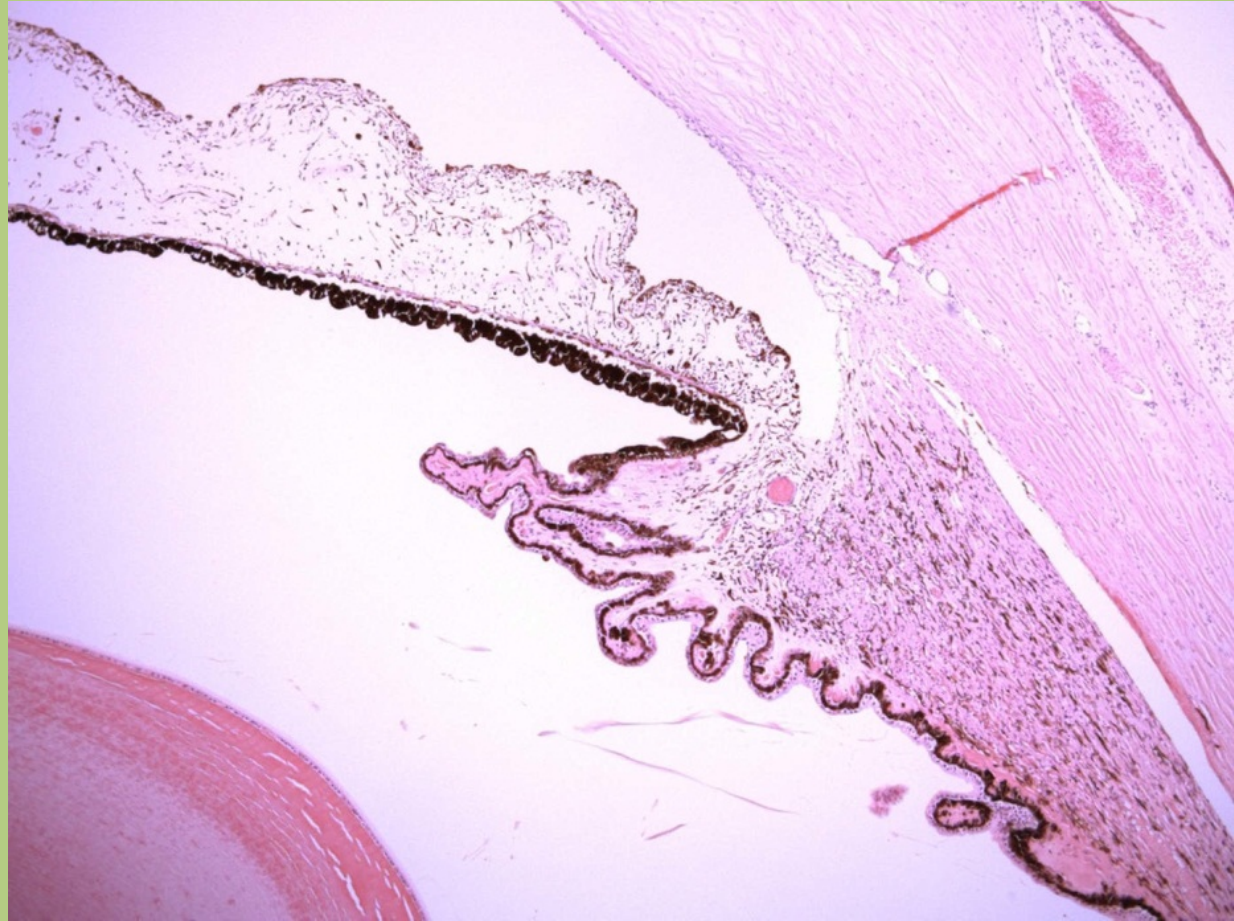
- **Choroid**
- **Ciliary body**
- **Iris**



# Vascular tunic – ciliary body

- **Lens's suspension**
- **Accommodation of the eye**
- **Production of the aqueous humor**

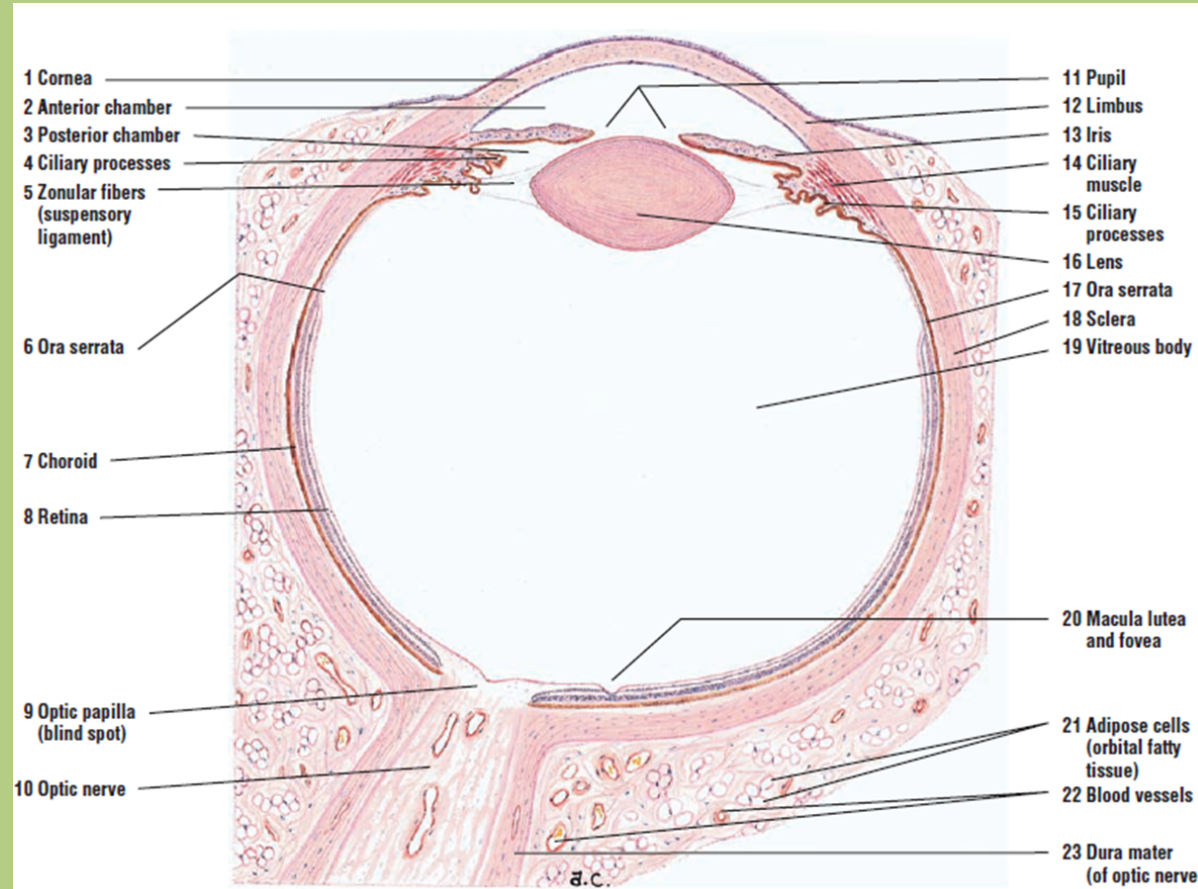
The anterior third of the ciliary body has about **75 ciliary processes**. The **zonular fibers** arise from the grooves between the processes.





# Vascular tunic – iris

- **Forms a contractile diaphragm in front of the lens.**

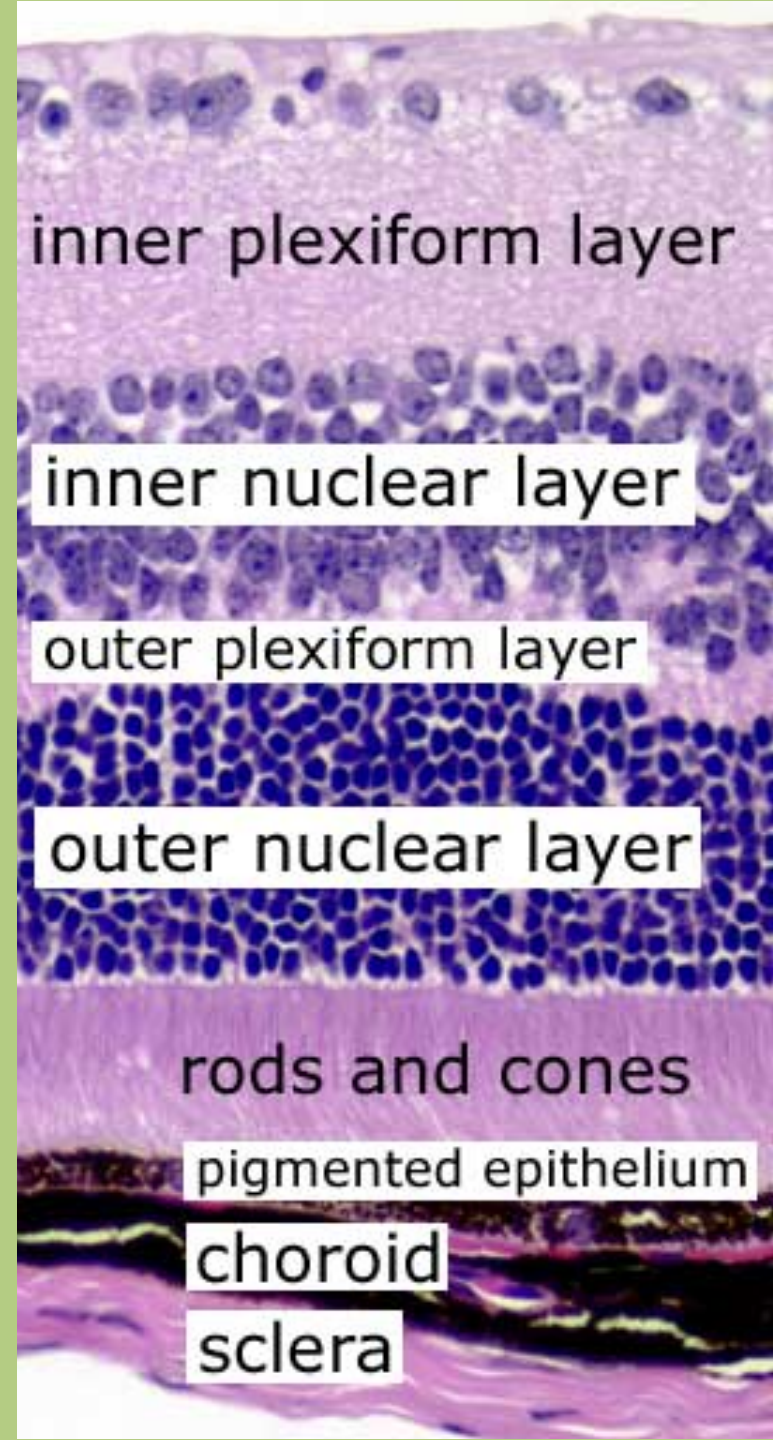


# Inner tunic: Photosensitive retina

- **Photoreceptor cells:** *rods and cones*
- **Conducting neurons:** *bipolar and ganglionic cells*
- **Associating neurons:** *horizontal, amacrine, centrifugal and interplexiform cells*
- **Supporting (glial) cells:** *Müller's cells, microglial cells and astrocytes*

# Photoreceptors: rods and cones

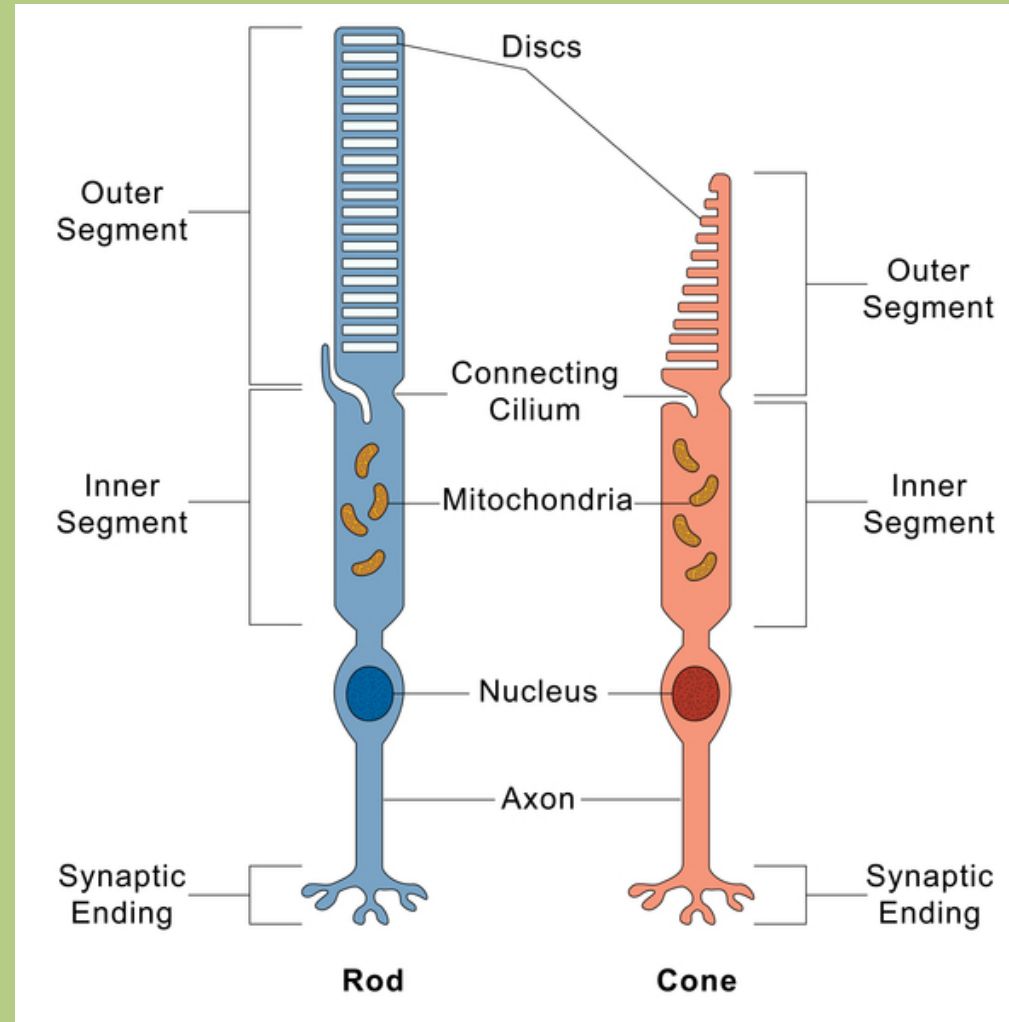
- *The retina contains approx. 120 million rods and 7 million cones.*
- *The light first passes through all of the layers of the retina before it reaches the photoreceptors.*

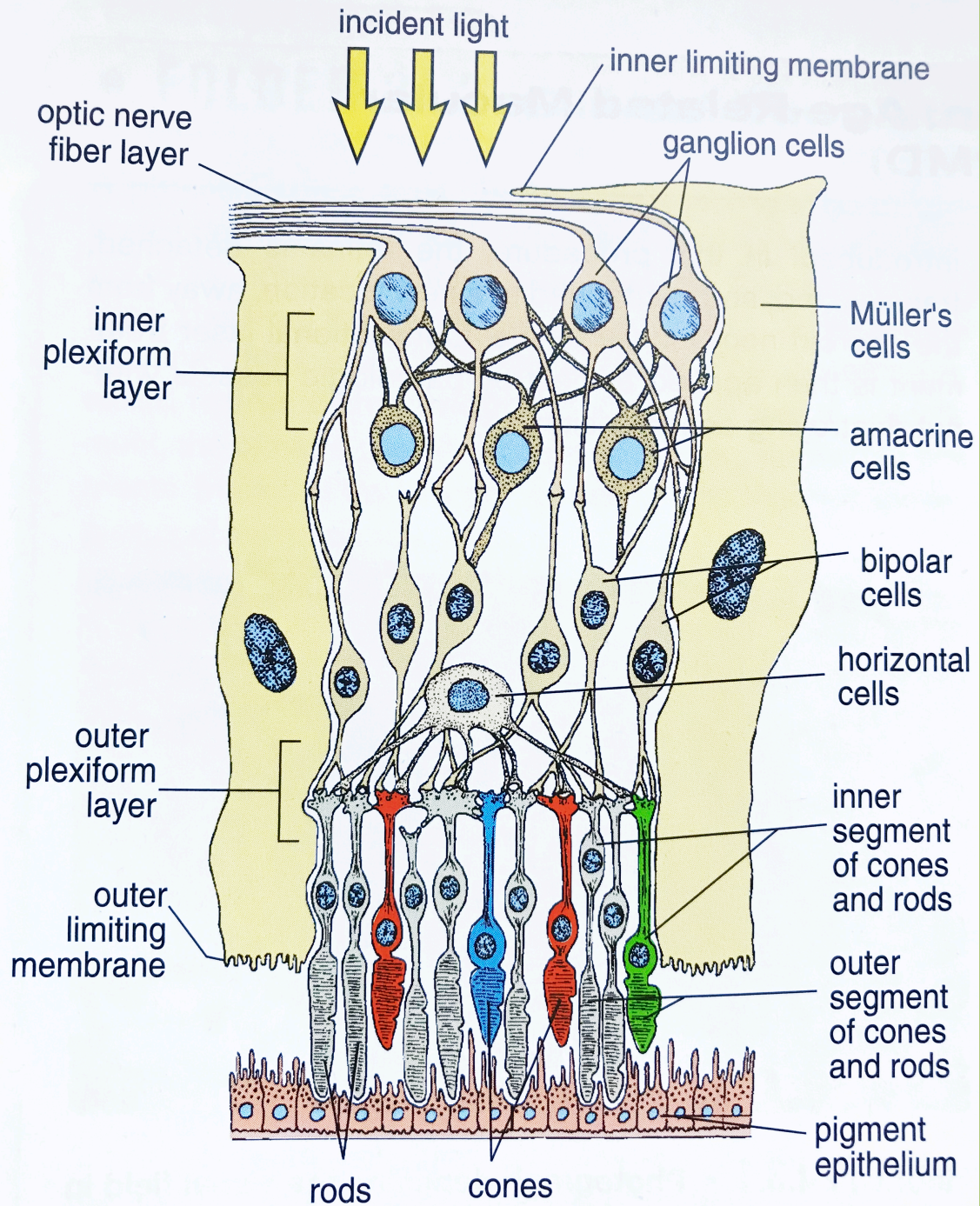




## Layer II.: Photoreceptors: rods and cones

- The *rods are more sensitive to light* and are the receptors used during periods of low light intensity (e.g. at dusk or at night).
- The *cones are less sensitive to low light but more sensitive to red, green and blue* regions of the visual spectrum.
- Cones provide a visual image composed of color by mixing the appropriate proportion of red, green and blue.
- Visual pigments: *rods: rhodopsin, cones: iodopsin.*





## Specialized regions of the retina - fovea centralis

- *Small shallow depression on the posterior pole of the eye.*
- Most of the layers of the retina are reduced, except photoreceptors.
- *Only cones are presented.*
- In this area, the retina is specialized for *discrimination of details and color vision.*
- *Retinal vessels are absent,* allowing light to pass unobstructed into the cones.

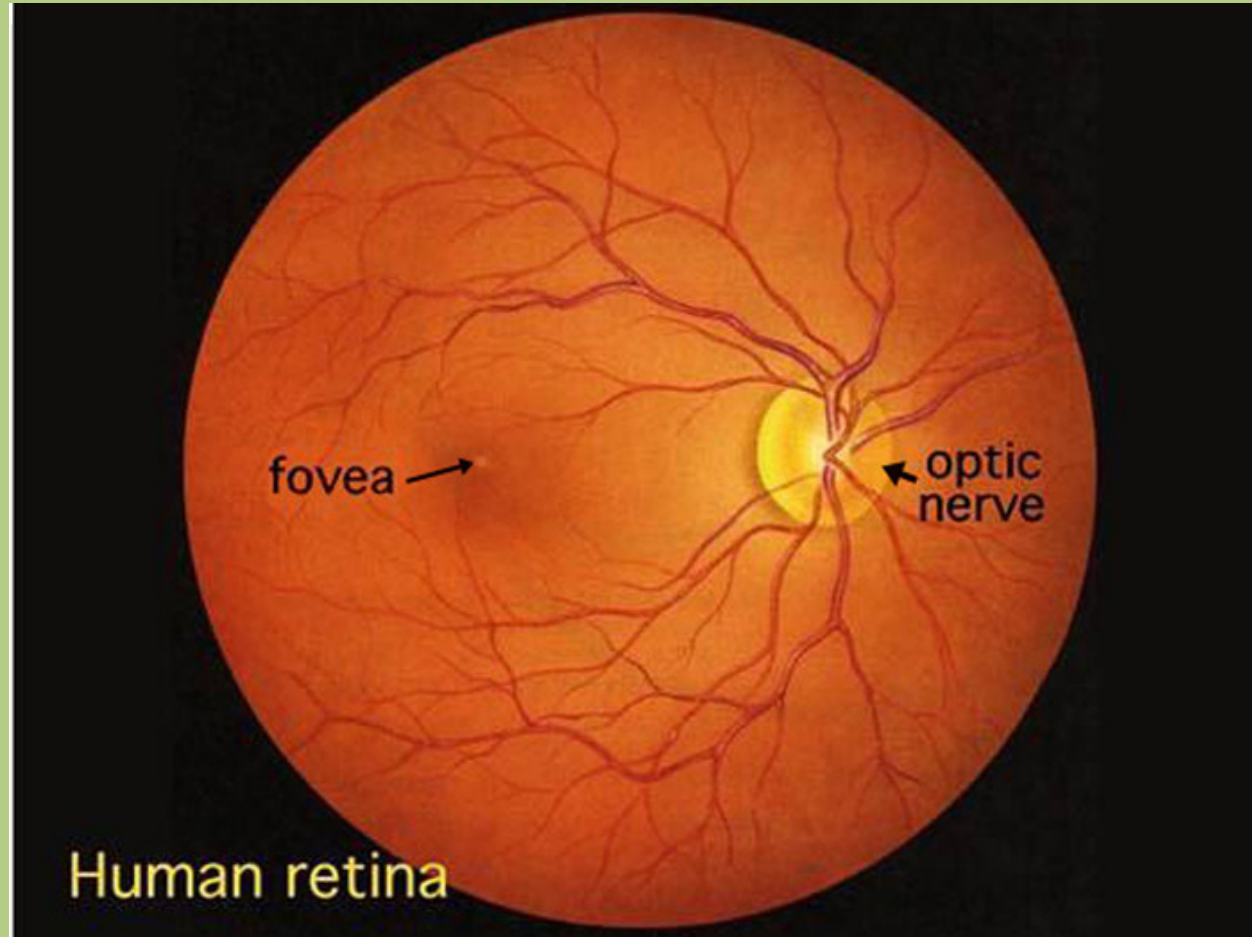
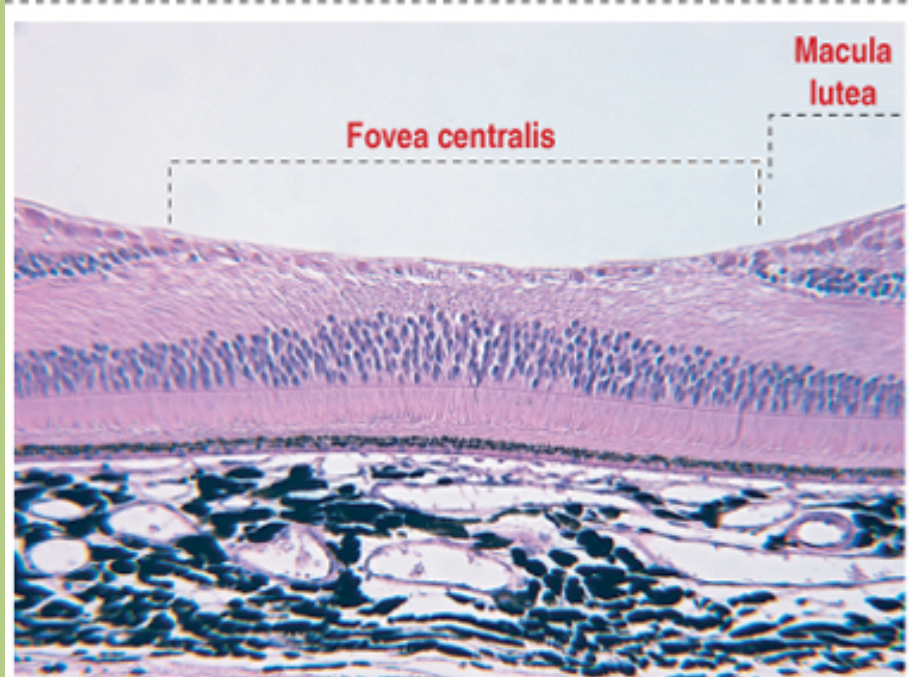


Figure 1. A view of the retina seen through an ophthalmoscope.

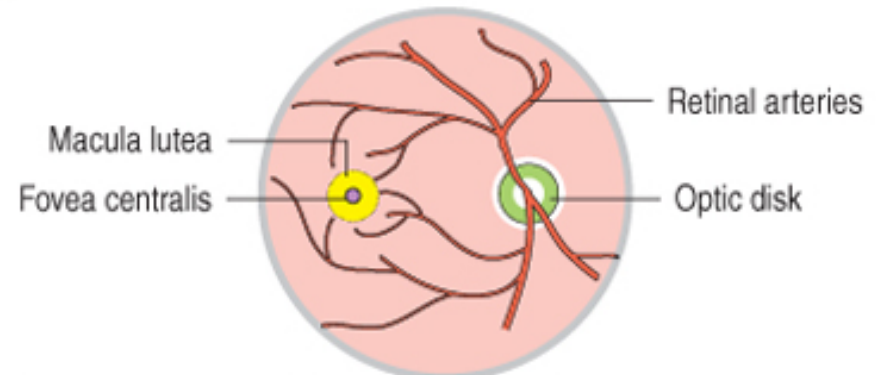


# Specialized regions of the retina - macula lutea

- *Surrounds the fovea*
- It is yellowish because of the presence of *yellow pigments (xanthophyll)*.
- *Cones are concentrated in the middle.*
- *Retinal vessels are absent.*

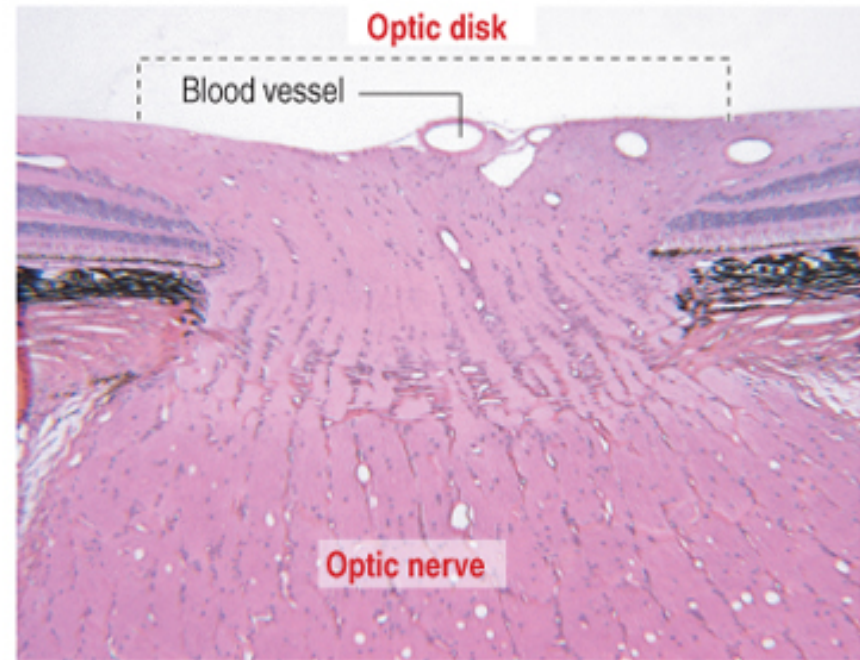


The **macula lutea**—yellow spot produced by **xanthophyll pigments** within retinal cells, which may absorb short wavelength light—provides for central vision. In its center, the **fovea** is for high quality vision. The rest of the retina is for peripheral vision. **Cones** are concentrated in the macula and are responsible for acute vision and color distinction. **Rods** are for vision in dim light and for movement detection.



# Specialized regions of the retina - optic disk

- It presents *neither rods nor cones = blind spot.*
- *Axons of the ganglion cells are leaving the eye ball here.*
- *Central retinal artery and vein are presented.*



The axons of the ganglion cells turn into the **optic nerve** at the **optic disk**, which lacks photoreceptors and corresponds to the **blind spot** of the retina.

The optic disk has a central depression, the **optic cup**, that is pale in comparison to the surrounding nerve fibers. A loss of nerve fibers in glaucoma results in an increase in the optic cup area.

**Retinal blood vessels** can be visualized with an ophthalmoscope. When **intraocular pressure increases**, the disk of the optic nerve appears **concave**. The disk becomes swollen (**papilledema**) and the veins are dilated when intracranial pressure increases.

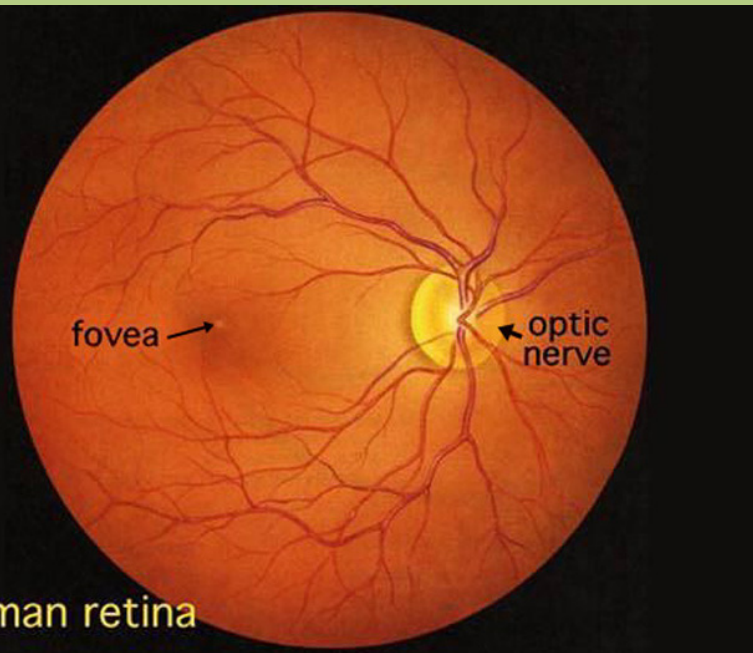
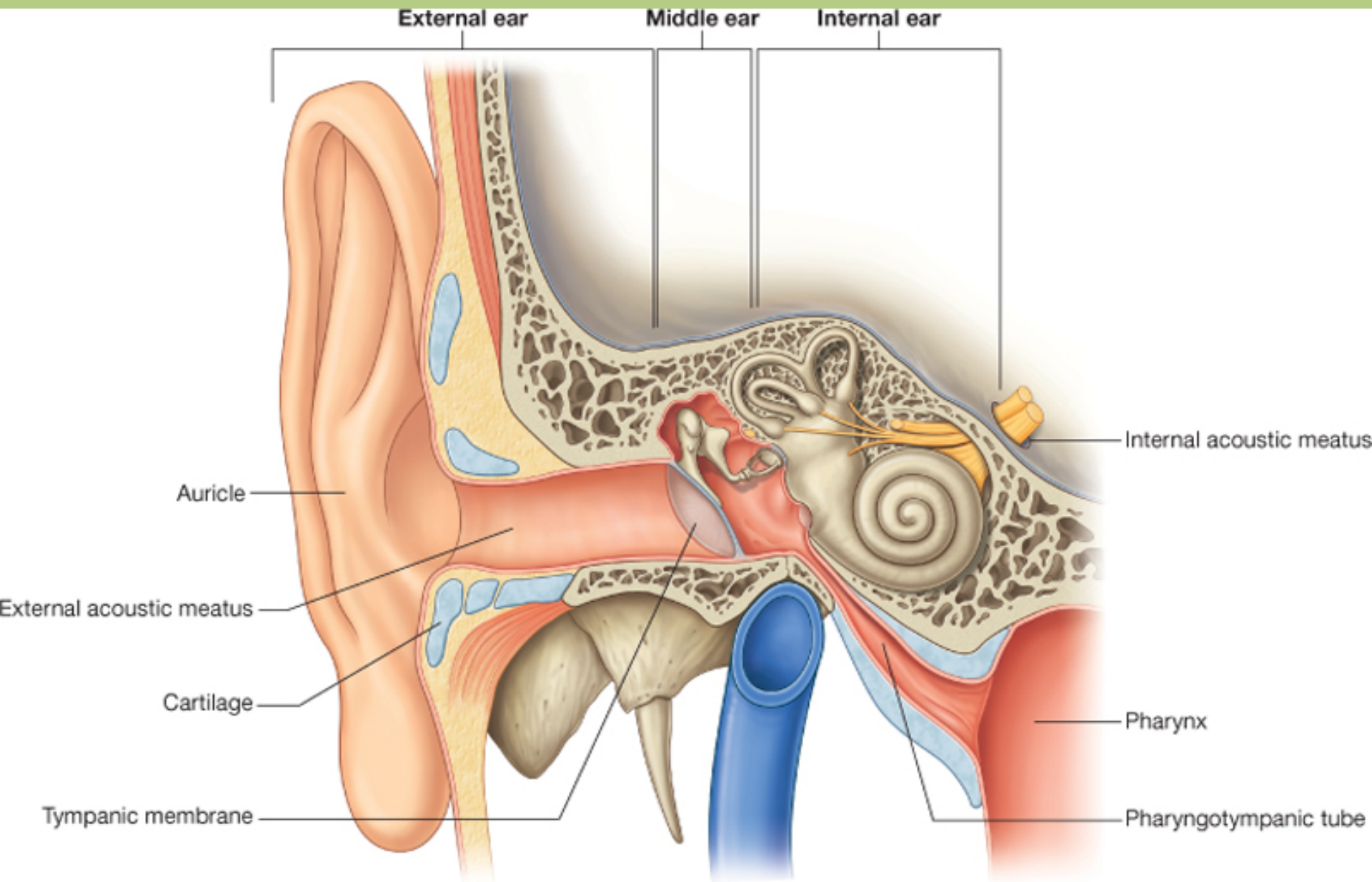
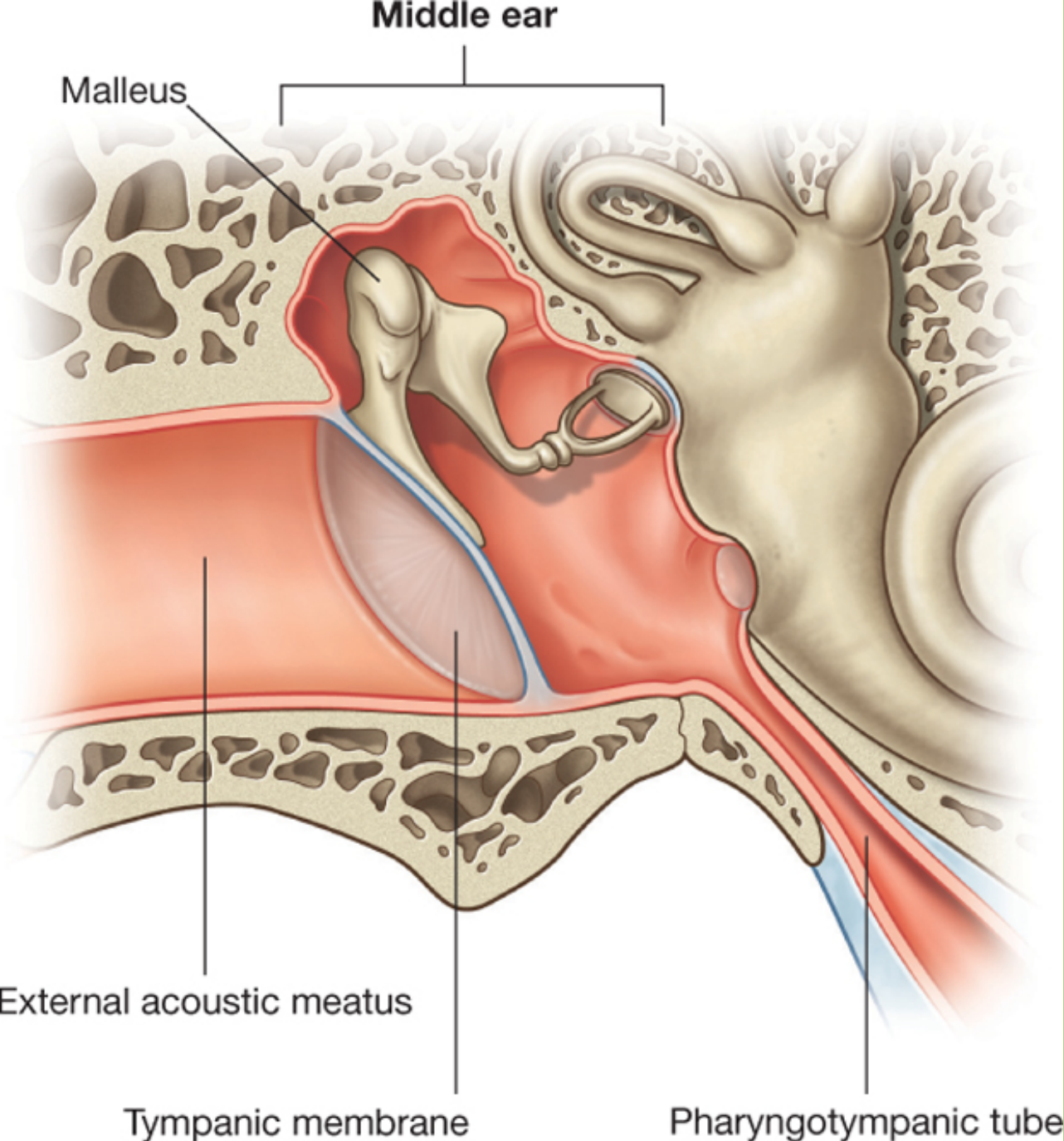


Figure 1. A view of the retina seen through an ophthalmoscope.

# Gross anatomy of the ear



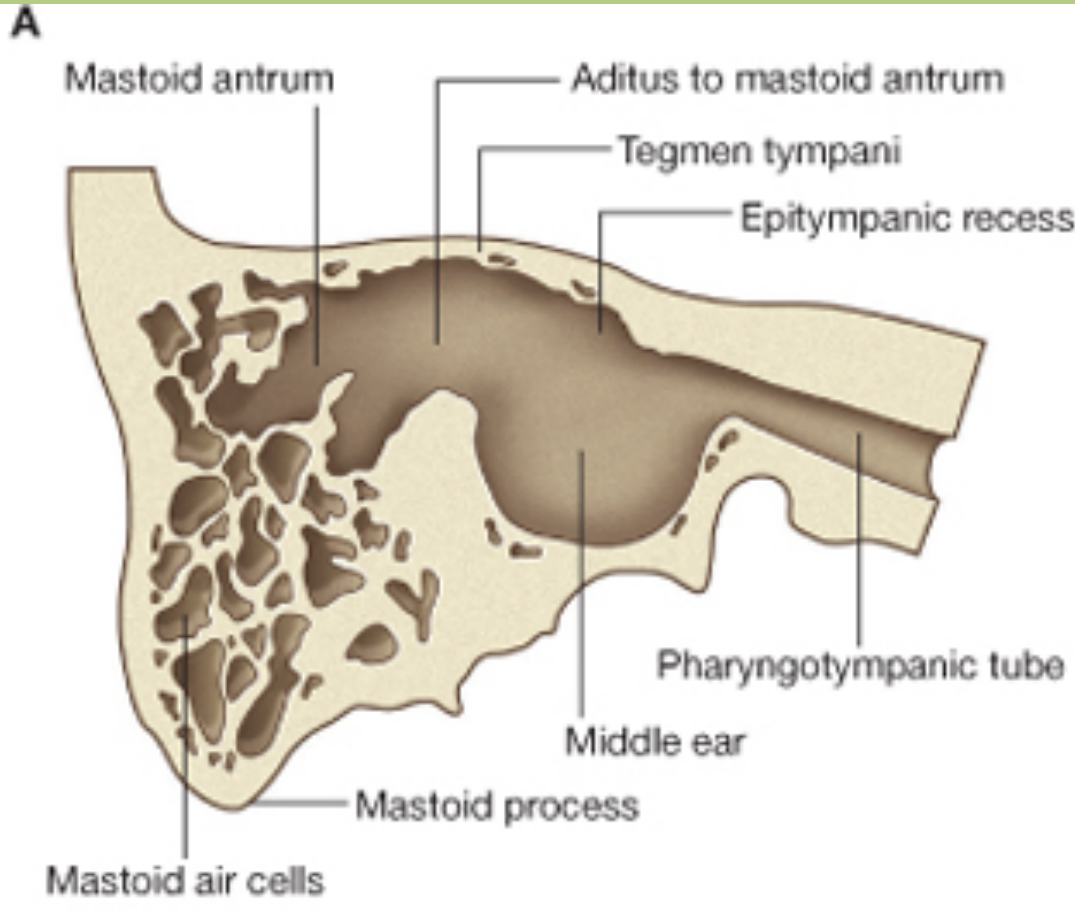




## Tympanic (middle ear) cavity

It is lined with mucous membrane and *filled with air*, which reaches it from the nasopharynx via the E u s t a c h i a n (pharyngotympanic) tube. It contains three small bones, the malleus, incus and stapes (*auditory ossicles*). They form an articulated chain connecting the lateral and medial walls of the cavity, and which *transmits and accelerates the vibrations of the tympanic membrane across the cavity to the cochlea.*

# Tympanic Cavity: posterior wall

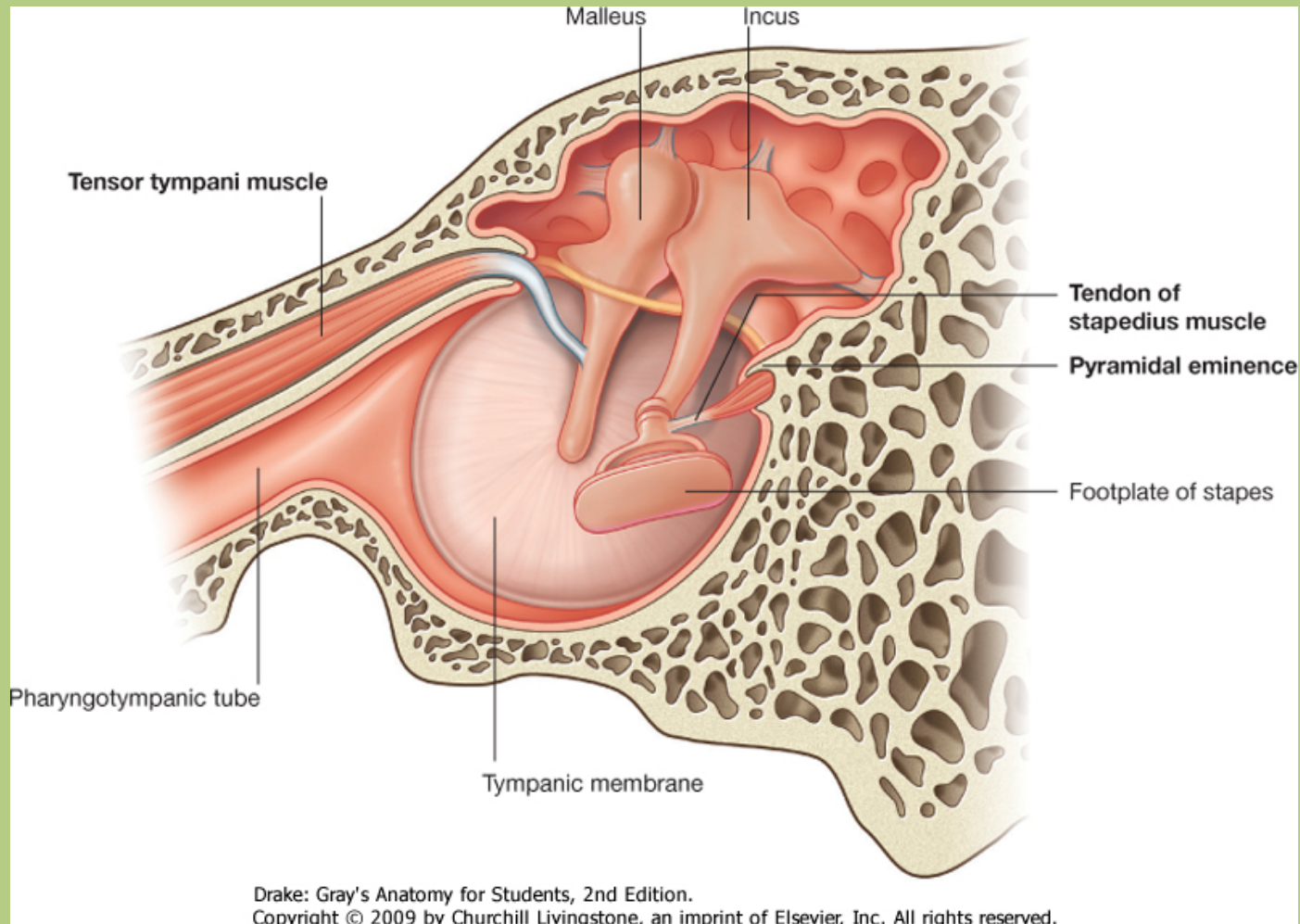


**Aditus to the mastoid antrum:** large irregular aperture which leads back from the epitympanic recess into the upper part of the mastoid antrum. The mastoid antrum is an air sinus in the temporal bone representing mastoid air cells. They interconnect and communicate with the middle ear cavity.



# Carotid (anterior) wall

It is a thin lamina and forms the posterior wall of the carotid canal. It represents the **caroticotympanic canaliculi** for penetrating structures: the caroticotympanic nerves (sympathetic fibers) and tympanic branches of the internal carotid artery. Above them two bony canals are presented: **(semi)canal for the Eustachian tube** and **(semi)canal for the tensor tympani muscle**. They are separated by a bony septum. These (semi)canals are parts of the musculotubarian canal.

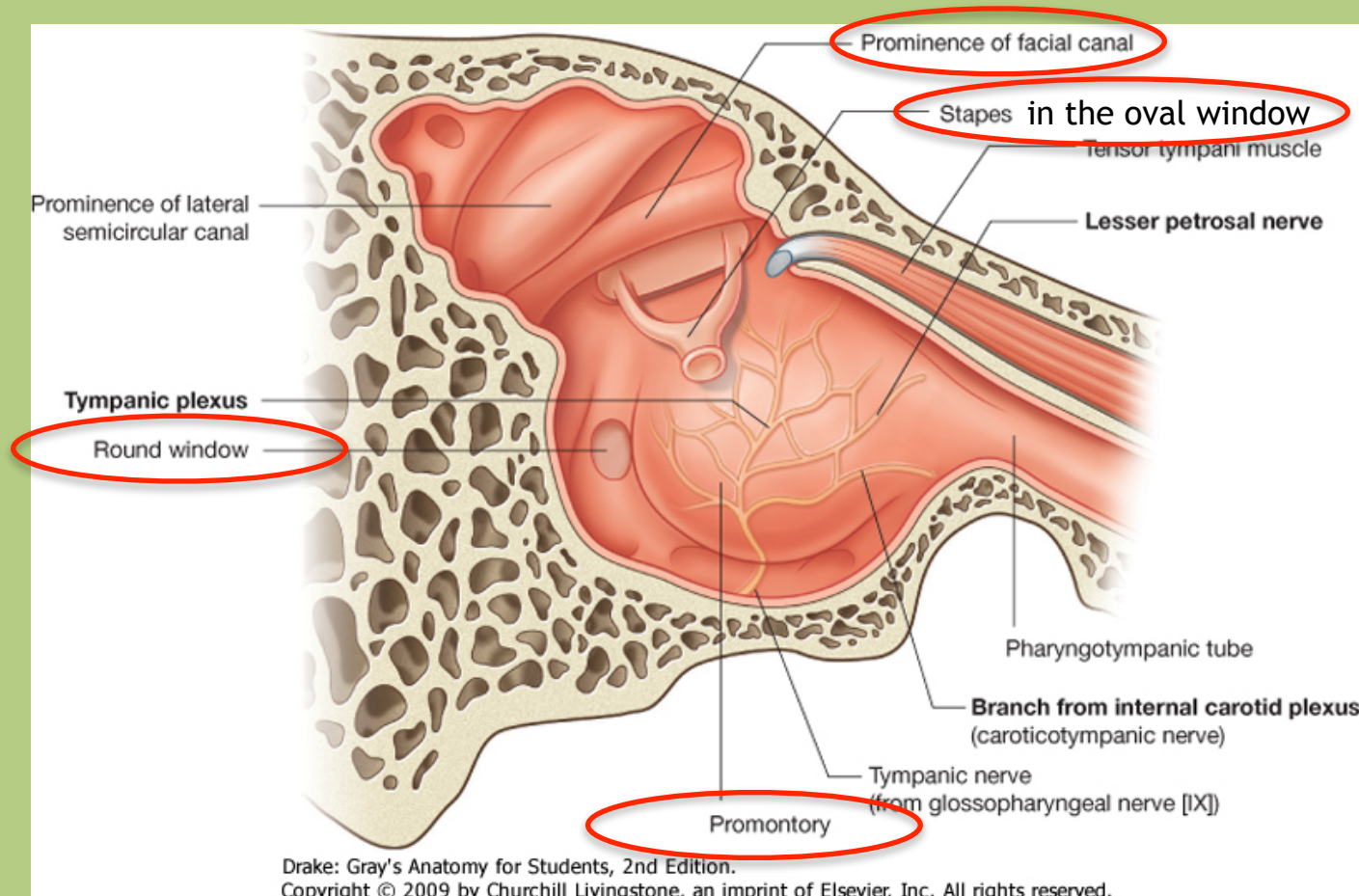


# Labyrinthine (medial) wall

It forms the lateral boundary of the inner ear. The **promontory** is the projection of the basal turn of the cochlea and represents the tympanic plexus.

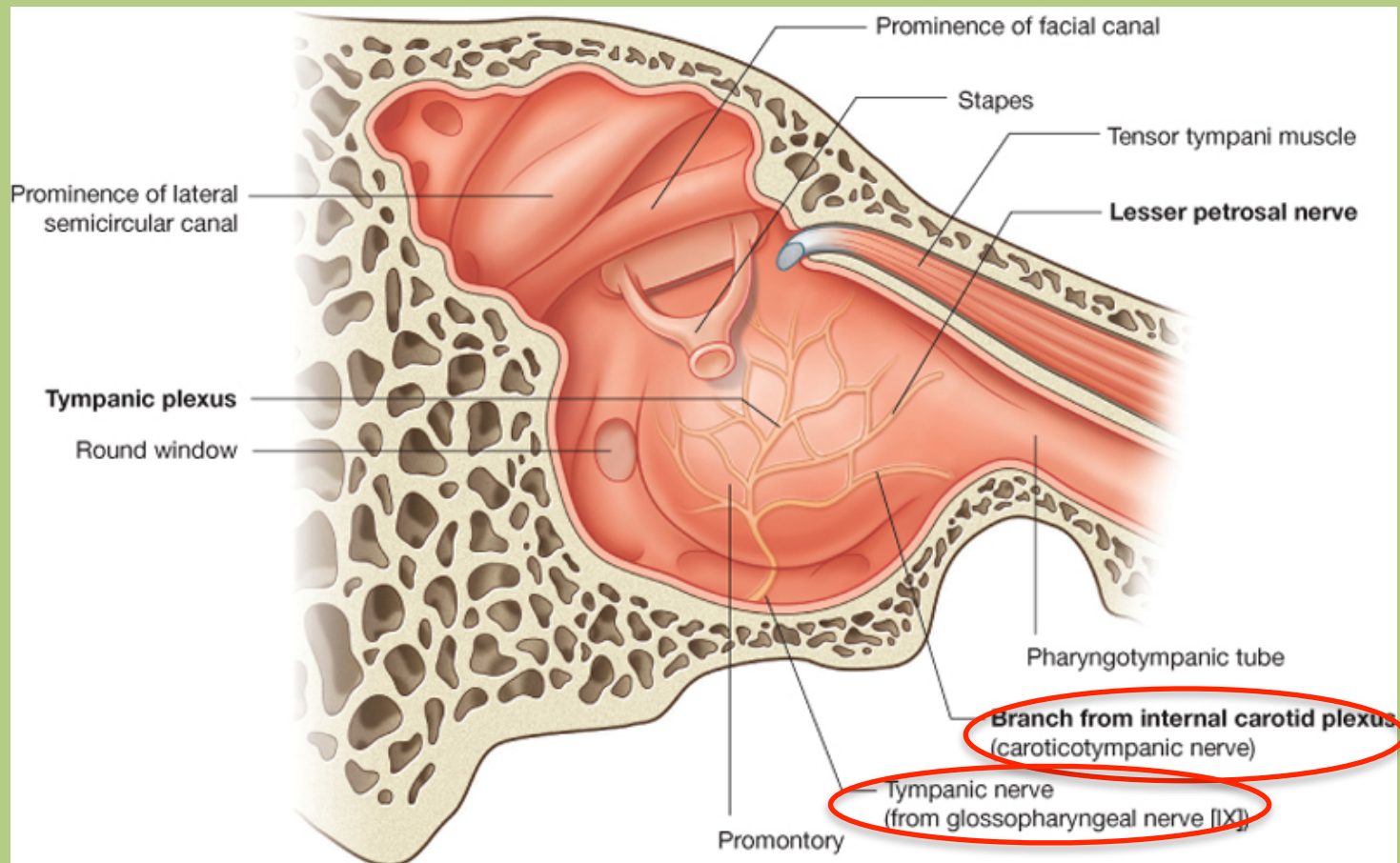
The **oval window** (fenestra vestibuli) is a kidney-shaped opening situated above the promontory, and leading from the tympanic cavity to the vestibule of the inner ear. It is occupied by the footplate of the stapes, which is attached to the margin by an annular ligament.

The **round window** (fenestra cochleae) is situated below and a little behind the oval window. In dried specimens it opens into the scala tympani of the cochlea, but in life it is closed by the *secondary tympanic membrane*. The **prominence of the facial nerve** crosses the medial wall from the cochleariform process to the posterior wall. It contains the facial nerve.

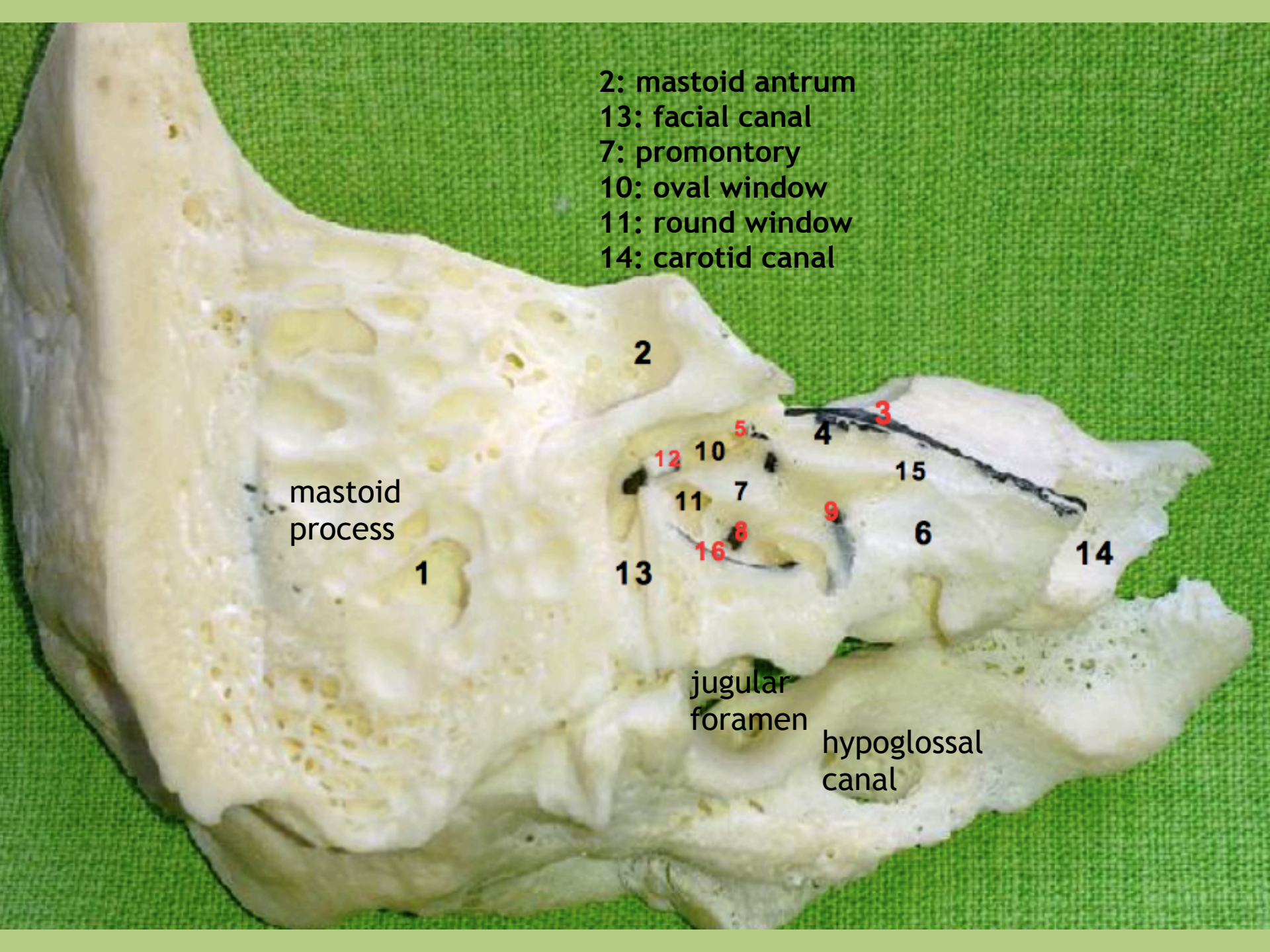


# Tympanic plexus

Is formed by the **tympanic nerve**, **caroticotympanic nerves** and a **communicating branch of the facial nerve**. The tympanic plexus supplies the mucosa of the tympanic cavity, Eustachian tube and mastoid air cells. The secretomotor fibers of the tympanic plexus leave the cavity (hiatus of the lesser petrosal nerve) and become the **lesser petrosal nerve** which leaves the skull through the foramen lacerum to join the **otic ganglion**. Postganglionic secretomotor fibers leave this ganglion in the **auriculotemporal nerve** to innervate the **parotid gland**.







- 2: mastoid antrum
- 13: facial canal
- 7: promontory
- 10: oval window
- 11: round window
- 14: carotid canal

mastoid process

jugular foramen

hypoglossal canal

1

2

13

12

10

5

11

7

16

8

4

3

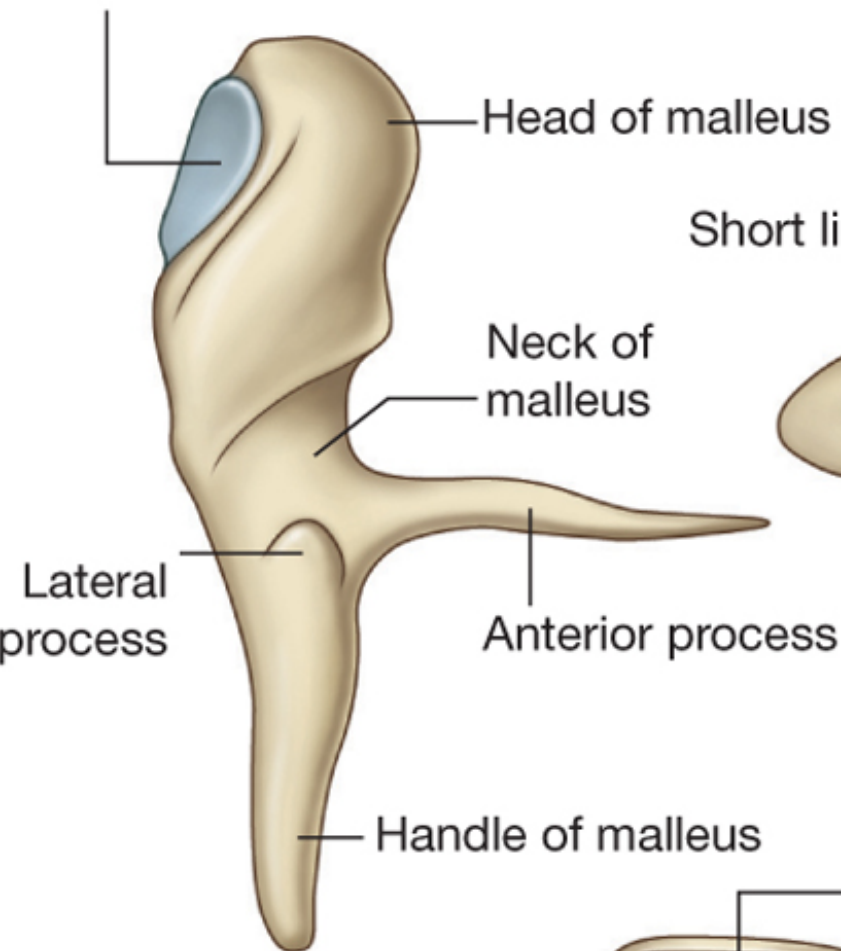
9

15

6

14

# A Incus articulation



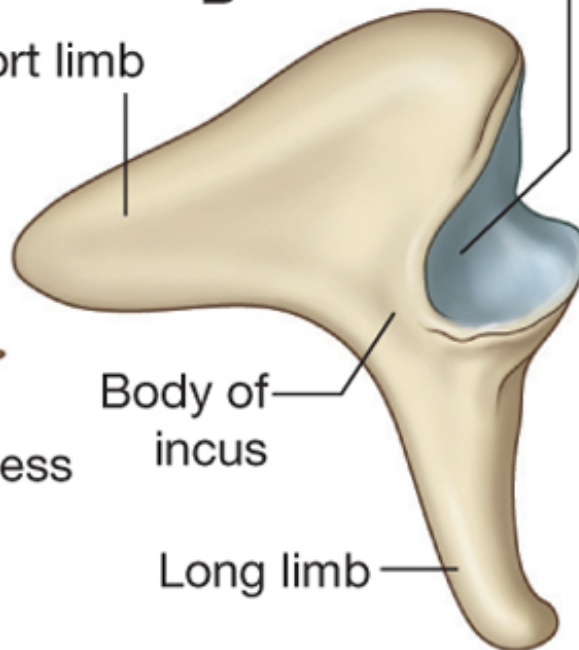
# Malleus articulation

**B**

Short limb

Body of incus

Long limb



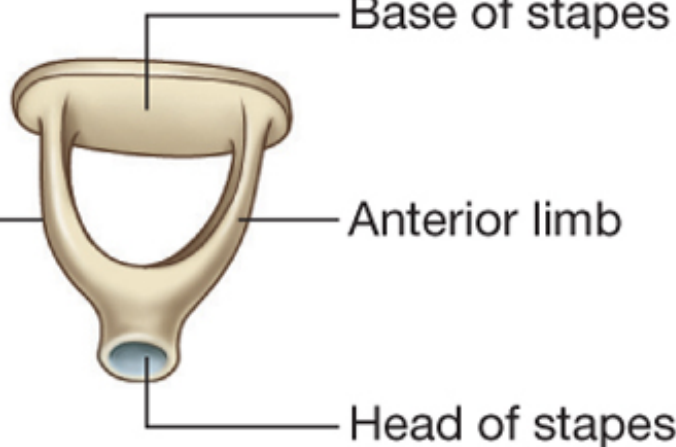
**C**

Base of stapes

Posterior limb

Anterior limb

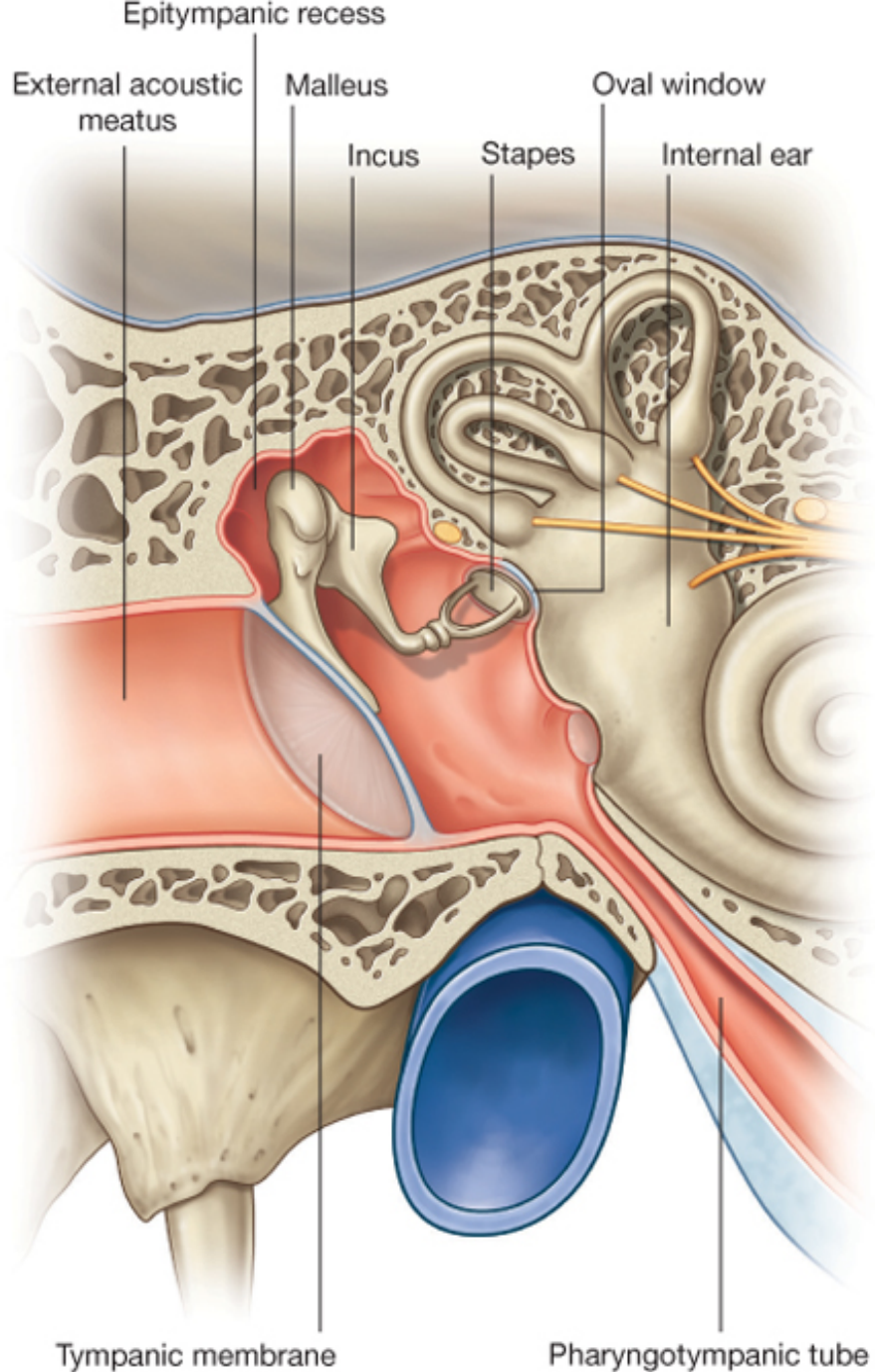
Head of stapes



## Ossicular chain:

- **malleus** (hammer)
- **incus** (anvil)
- **stapes** (stirrup)

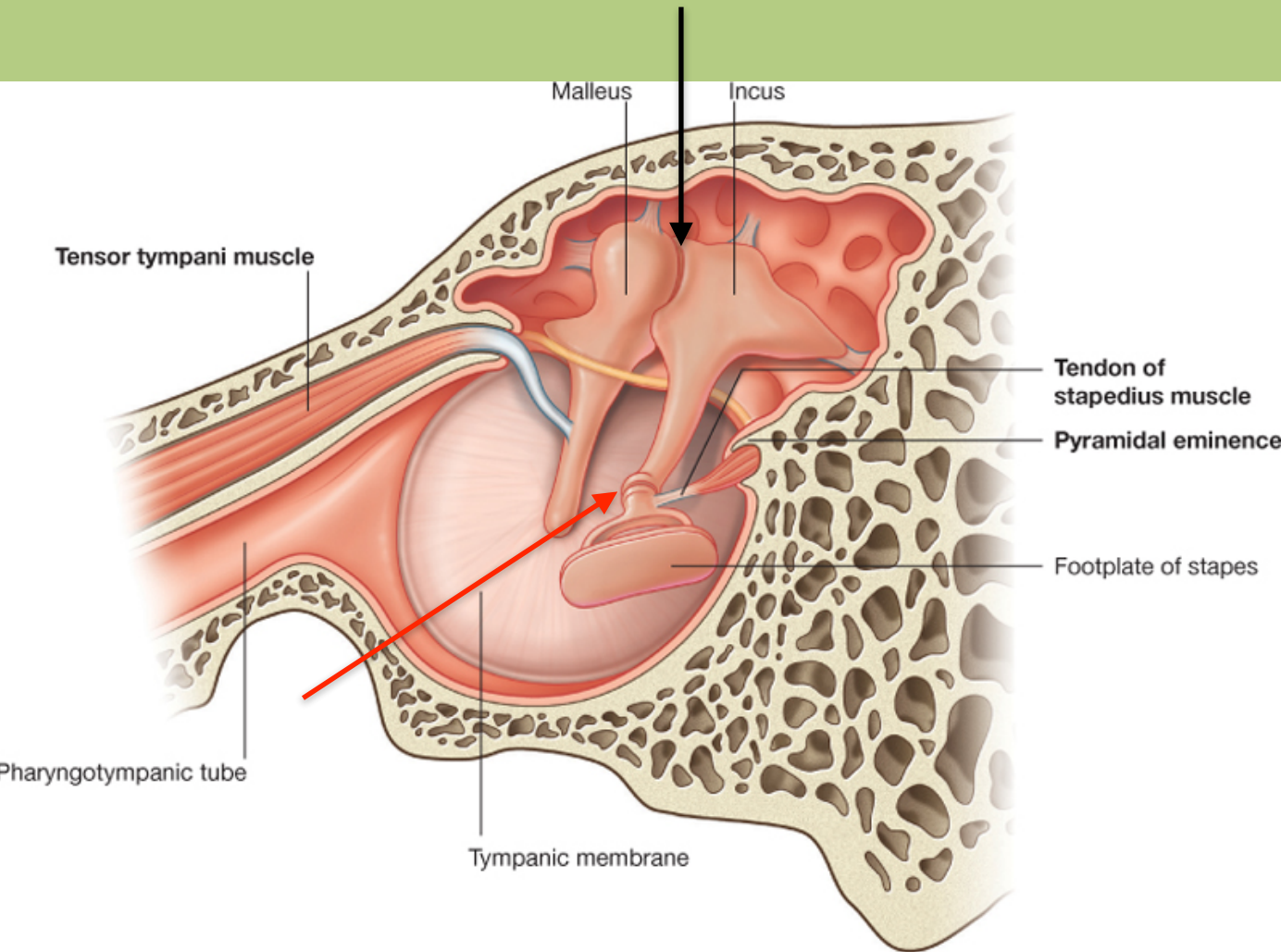




### **Ossicular chain:**

- **malleus** (hammer)
- **incus** (anvil)
- **stapes** (stirrup)





## Ossicular articulations

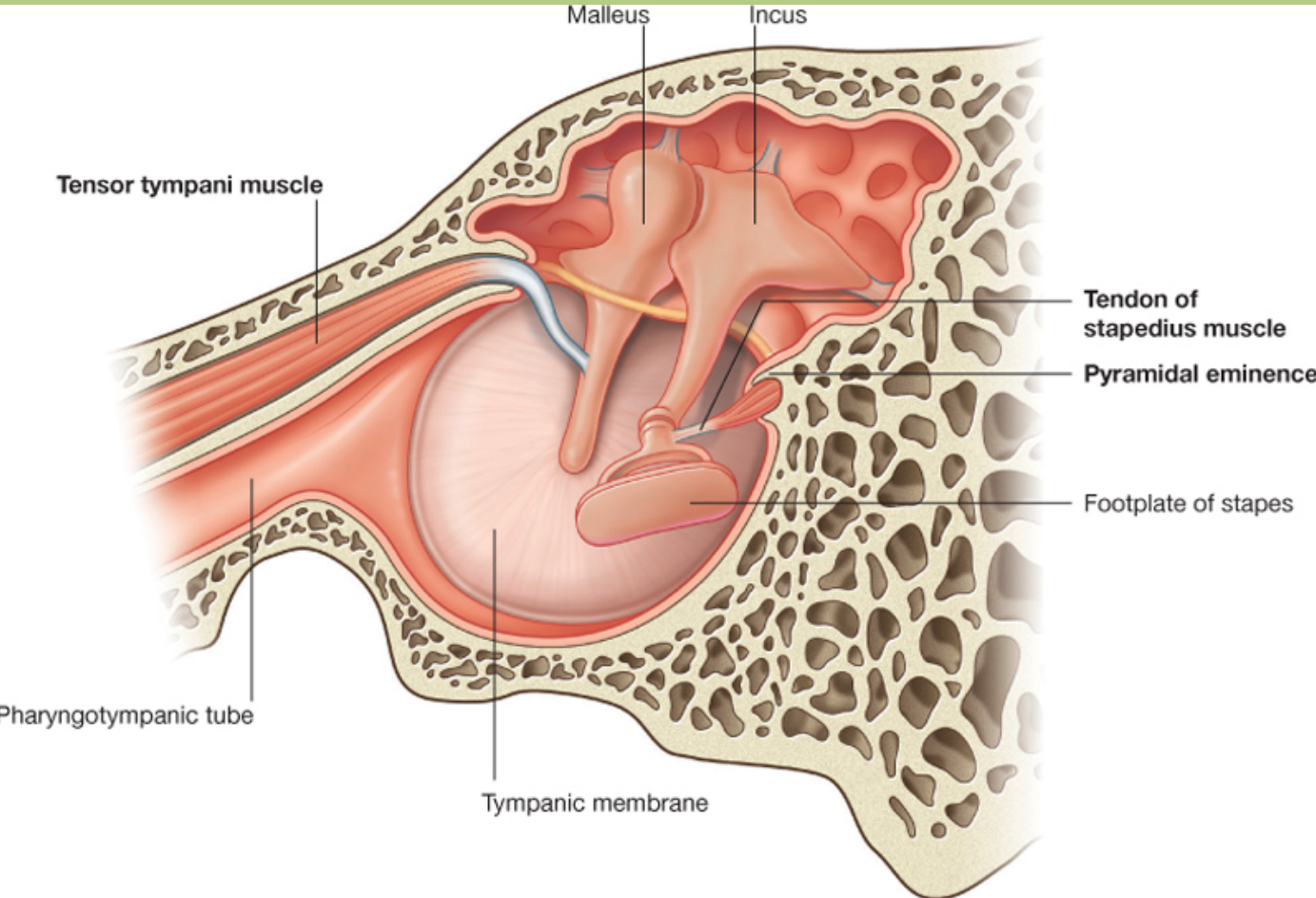
The *incudomalleolar joint* (black arrow) is saddle-shaped and the *incudostapedial joint* (red arrow) is ball and socket articulation. The articular surfaces are covered by articular cartilage, and each joint is enveloped by a capsule lined by synovial membrane.

## Muscles

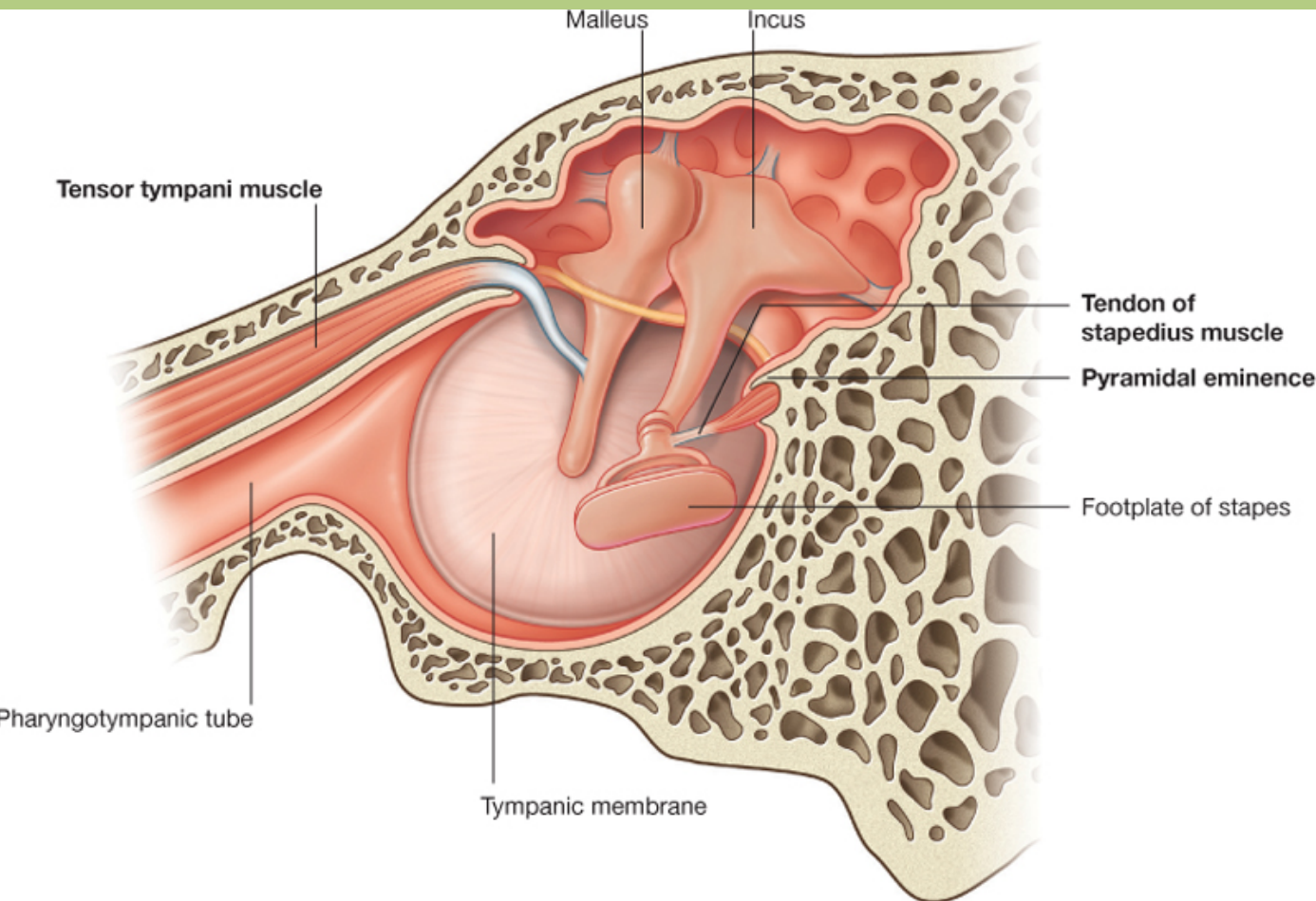
The **tensor tympani** occupies the bony canal above the osseous part of the Eustachian tube. It arises from the cartilaginous part of the tube and its tendon turns on the pulley-like cochleariform process and attaches to the handle of the malleus.

**Actions:** It draws the handle of the malleus medially and so tenses the tympanic membrane. Its action also pushes the footplate of the stapes more tightly into the oval window.

**Innervation:** V/3



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## Muscles

The **stapedius** arises from the wall of the cavity of pyramidal eminence and attaches to the neck of the stapes.

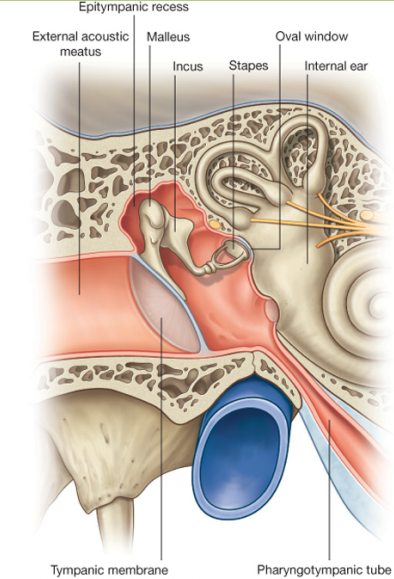
**Actions:** It helps to damp down the excessive sound vibration. It opposes the action of the tensor tympani.

**Innervation:** stapediaal nerve of CN VII

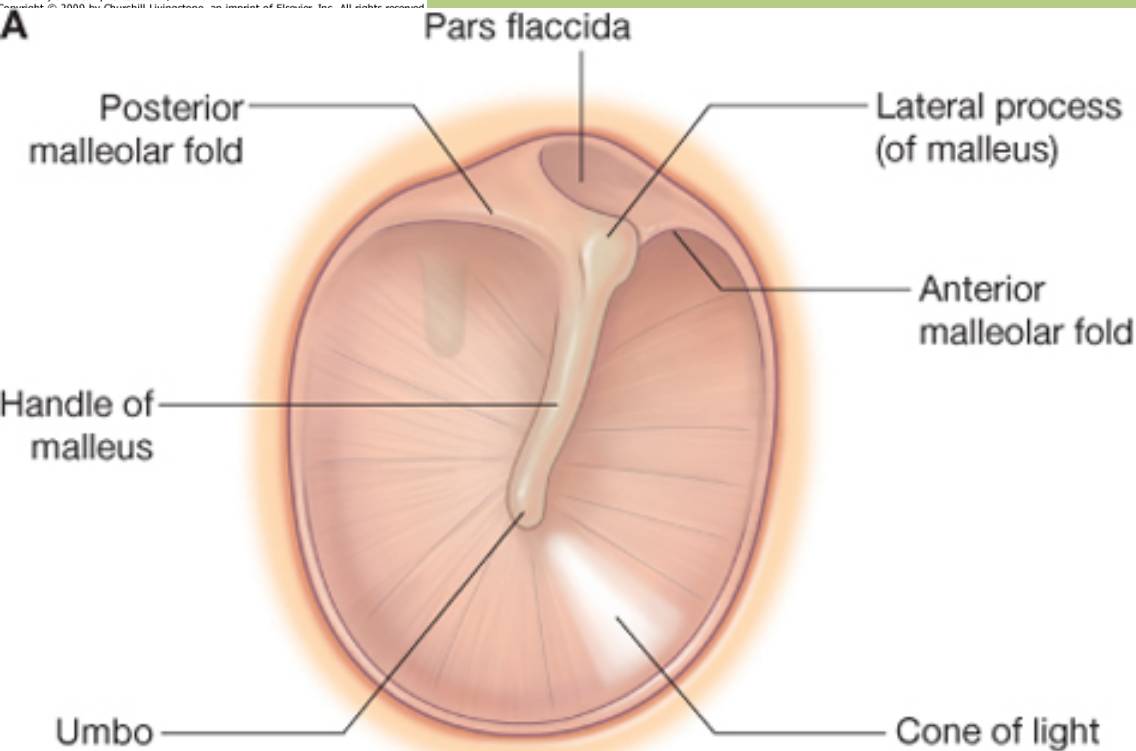


# Membranous (lateral) wall

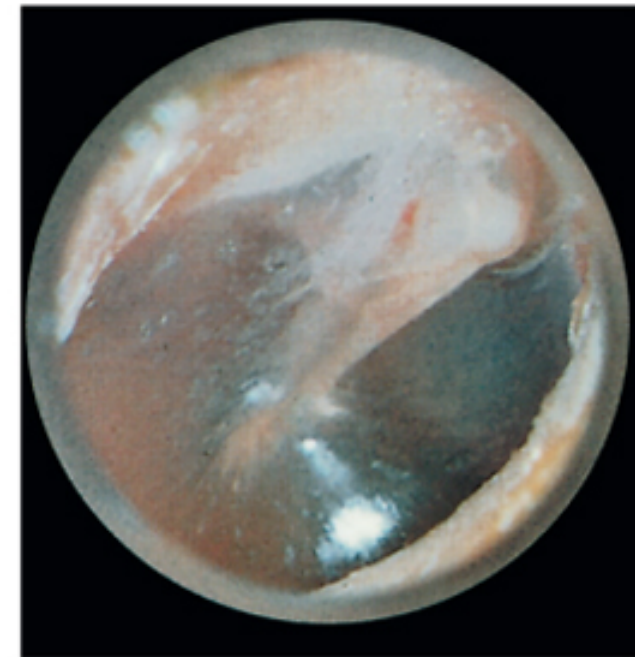
The lateral wall consists mainly of the **tympanic membrane** (*eardrum*) and ring of bone to which the membrane is attached. The tympanic membrane separates the tympanic cavity from the external acoustic meatus. It is thin, semi-transparent, and almost oval. Most of its circumference is a thickened fibrocartilaginous ring. Two bands, the **anterior and posterior malleolar folds** border a lax and thin part of the membrane (**pars flaccida**) but the majority of the membrane is taut (**pars tensa**). The handle of the malleus is firmly attached to internal surface of the membrane as far as its centre, which projects toward the tympanic cavity.

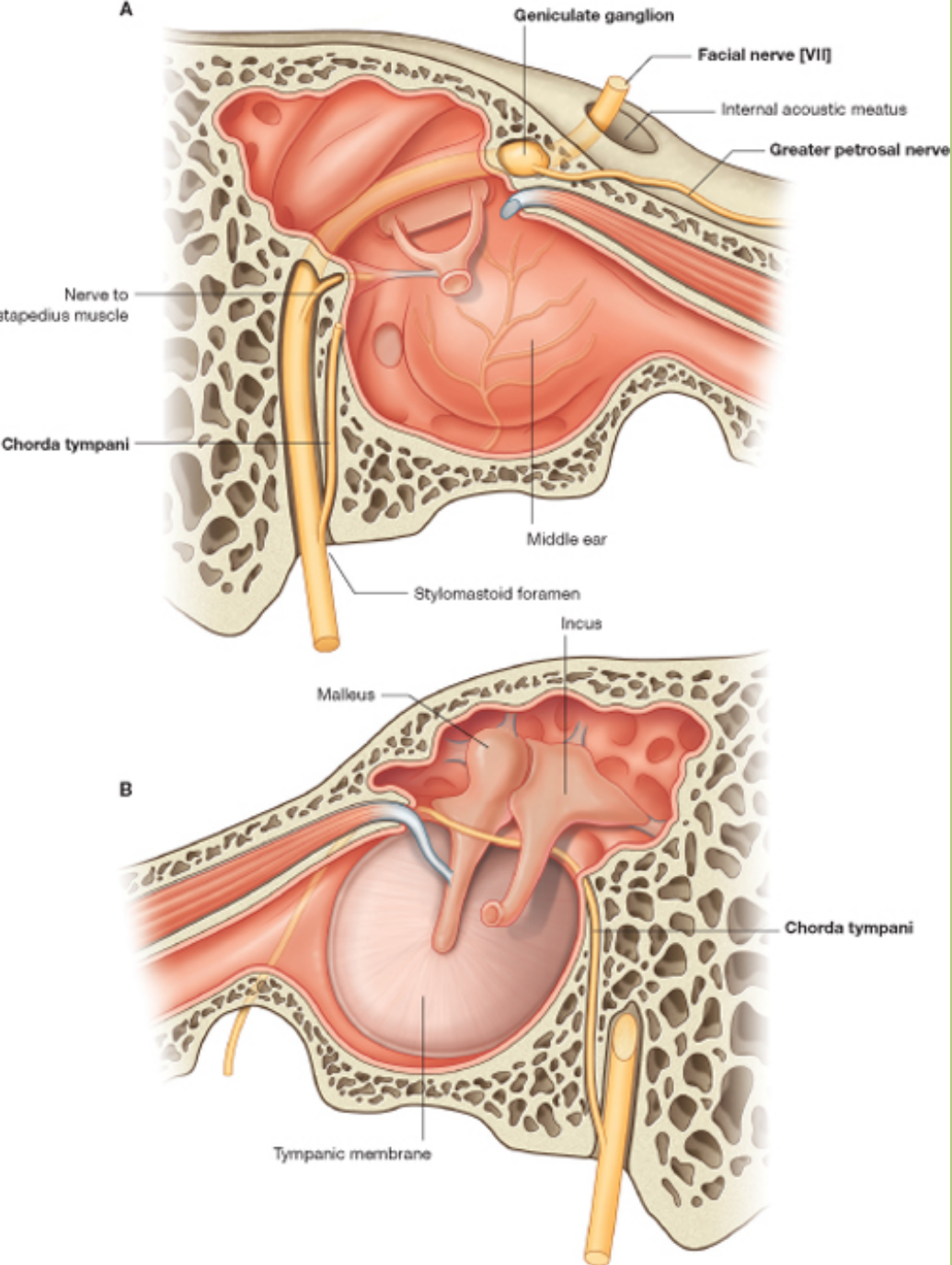


A



B





## Chorda tympani

It enters the tympanic cavity via the *posterior canaliculus close to the tympanic membrane*, then *crosses medial to the upper part of the handle of the malleus*. On the anterior tympanic wall, it *enters the anterior canaliculus*.

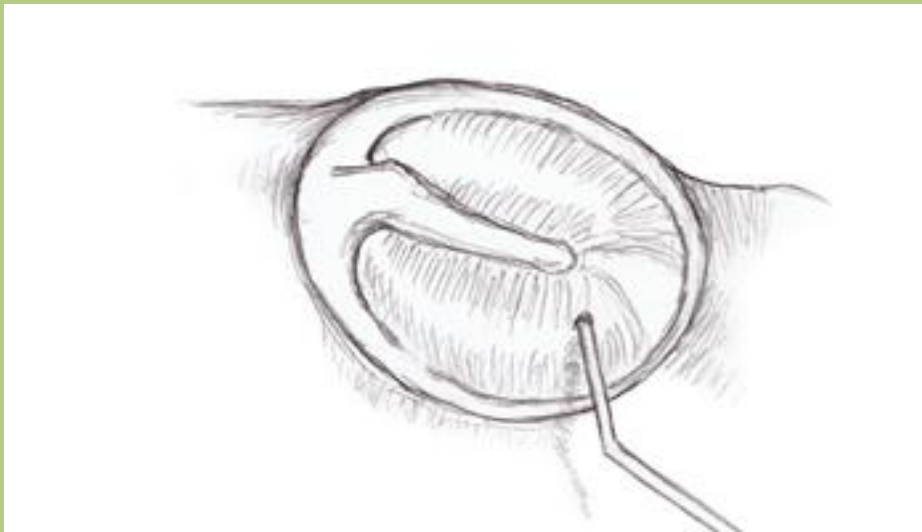
It exits the skull at the *petrotympanic fissure*.

It contains **parasympathetic fibers** which supply the submandibular and sublingual glands via the submandibular ganglion and **taste fibers** from the anterior two-thirds of the tongue.

# Otitis media

*Infection of the middle ear cavity.* A mixture of factors predispose to otitis media, but *Eustachian tube dysfunction or obstruction is thought to be one of the most important factors.* Congenital palate defects, host immunity, and viral or bacterial infection may all be contributing factors.

*Tympanocentesis* is a minor surgical procedure that refers to puncture of the tympanic membrane with a needle in order to aspirate fluid from the middle ear cleft or to provide a route for administration of intratympanic medications. It is used mainly for the management of complex cases that have not responded to antibiotic therapy.

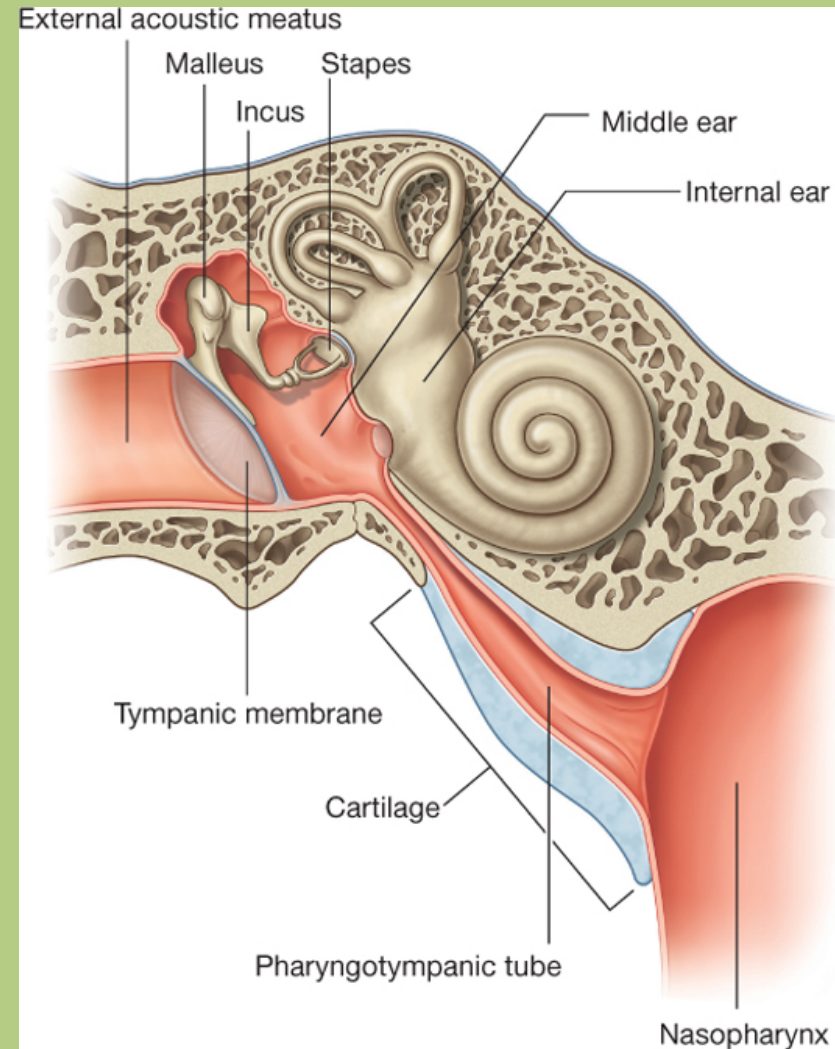
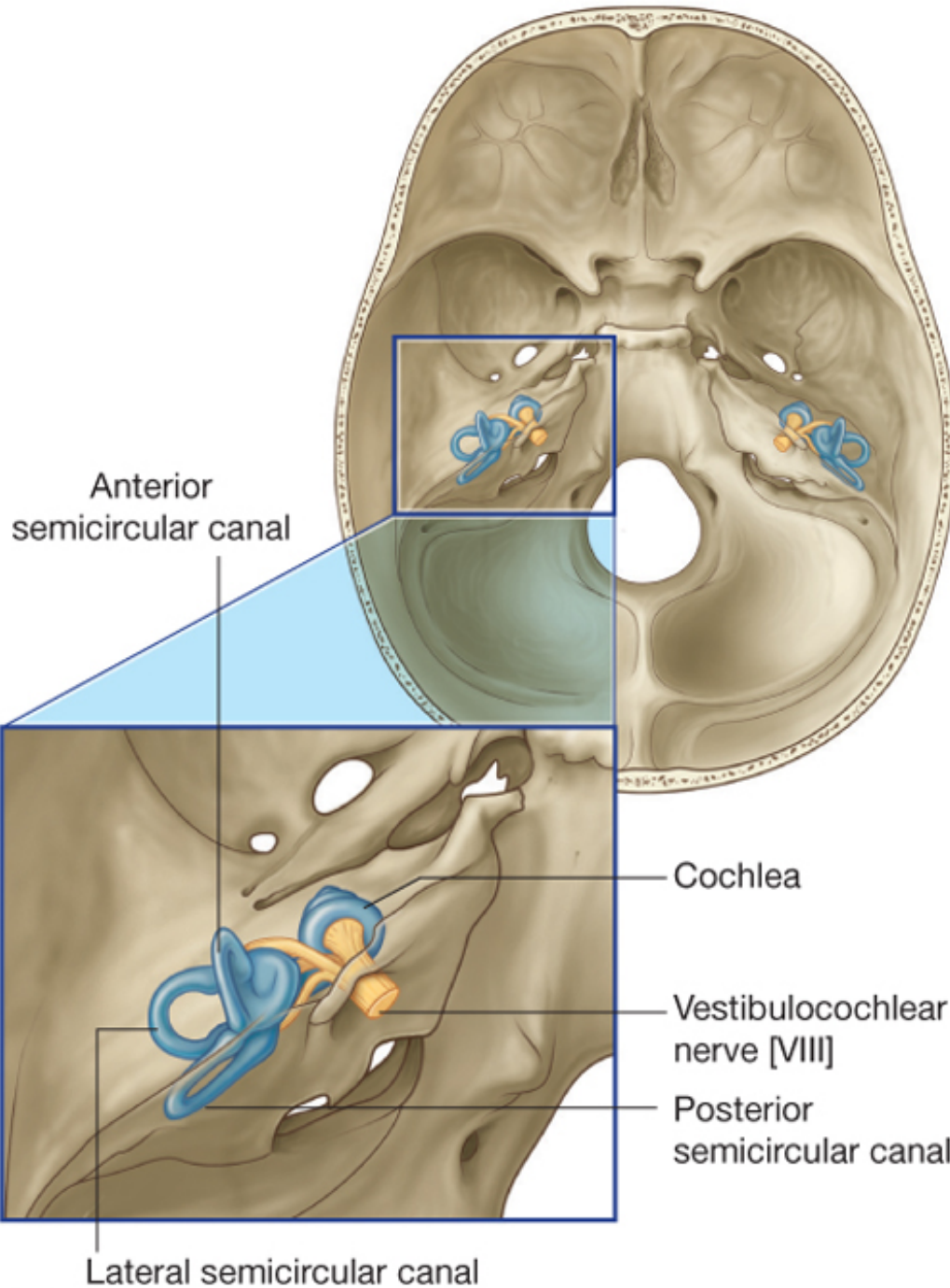


tympanocentesis

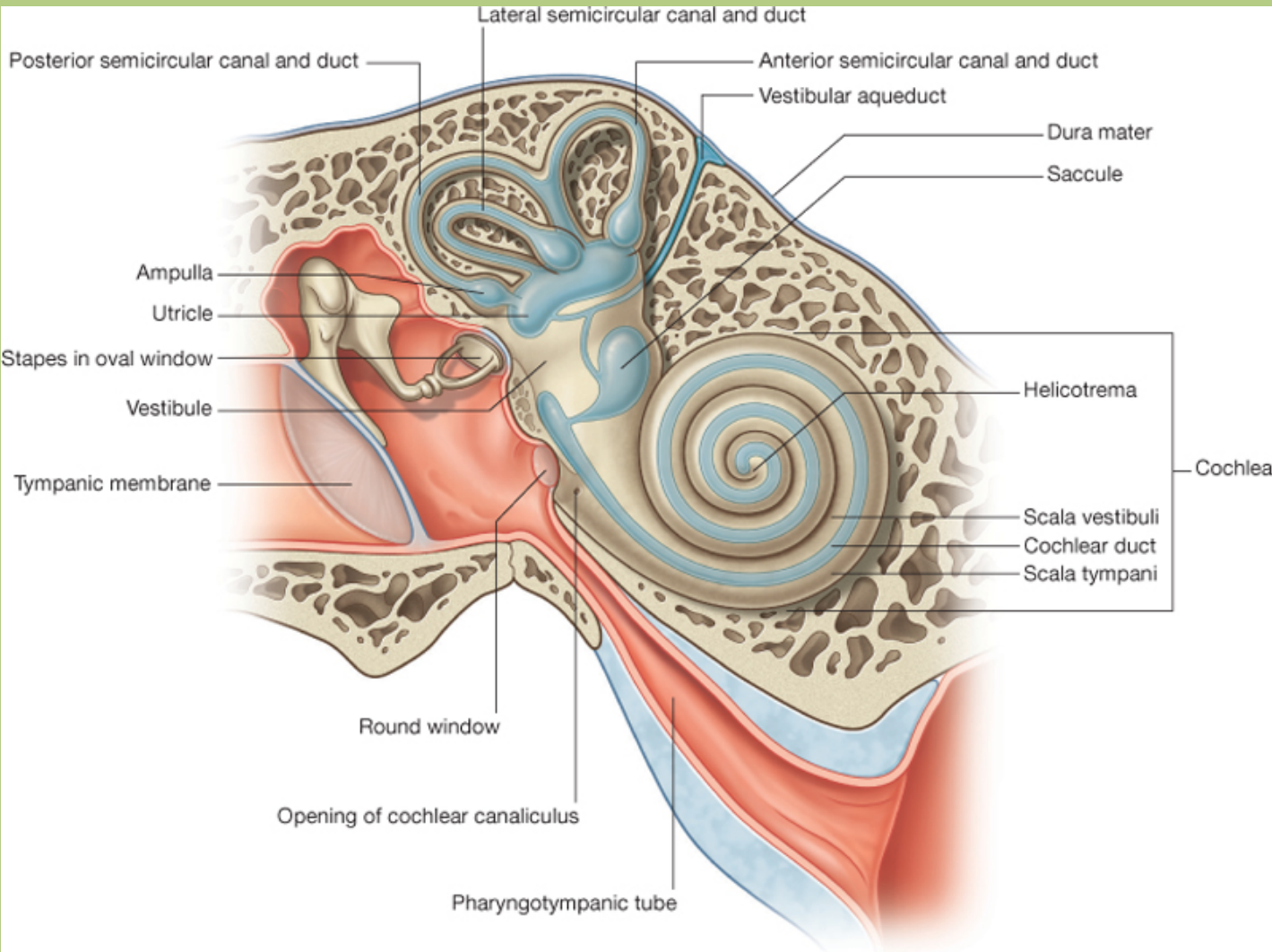


# Inner ear

It contains the organ of hearing, the **cochlea**, and the organs of balance, the **utricle**, **sacculle** and **semicircular canals**.



# Inner ear



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It consists of the **bony (osseous) labyrinth**, a series of interlinked cavities in the petrous bone, and the **membranous labyrinth** of interconnected membranous sacs and ducts that lie within the bony labyrinth.

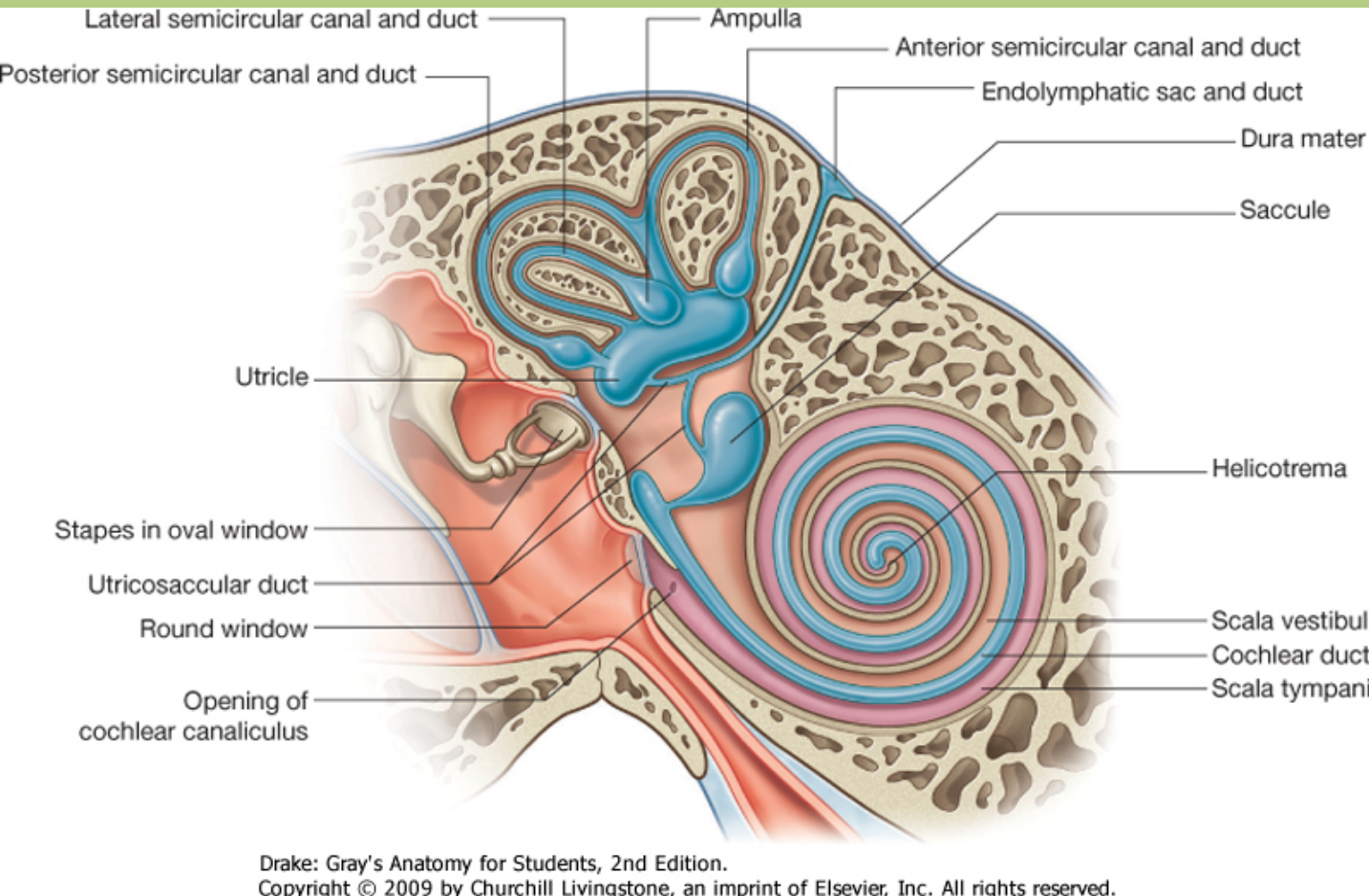
The oval window leads into the middle part of the osseous labyrinth, the **vestibule**.

The vestibule communicates anteriorly with the **bony cochlea** and posteriorly with the **bony semicircular canals**.

The osseous cochlea has two and half turns.

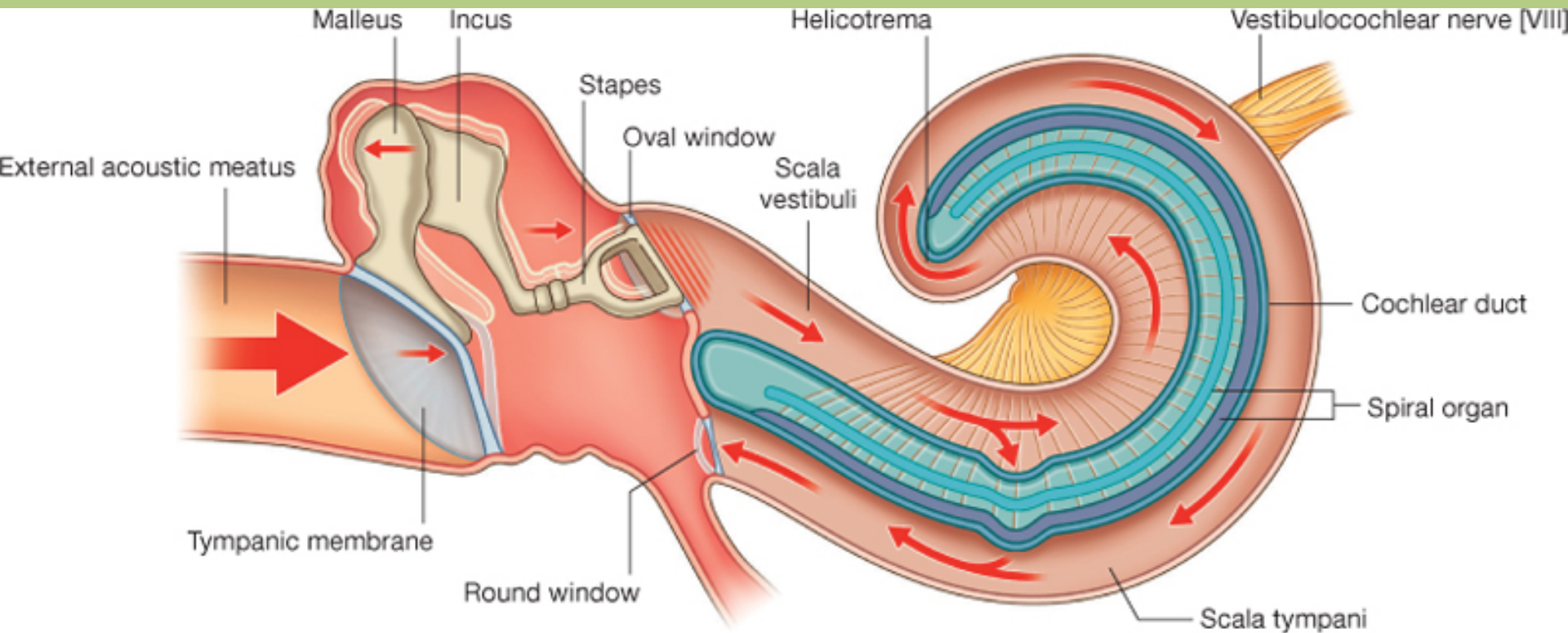


# Inner ear



The space between the bony and membranous labyrinths (purple) is filled by a clear fluid with an ionic composition similar to that of the other extracellular fluids, the **perilymph**. The membranous labyrinth contains **endolymph**, a fluid with an ionic composition more like that of cytosol (blue).

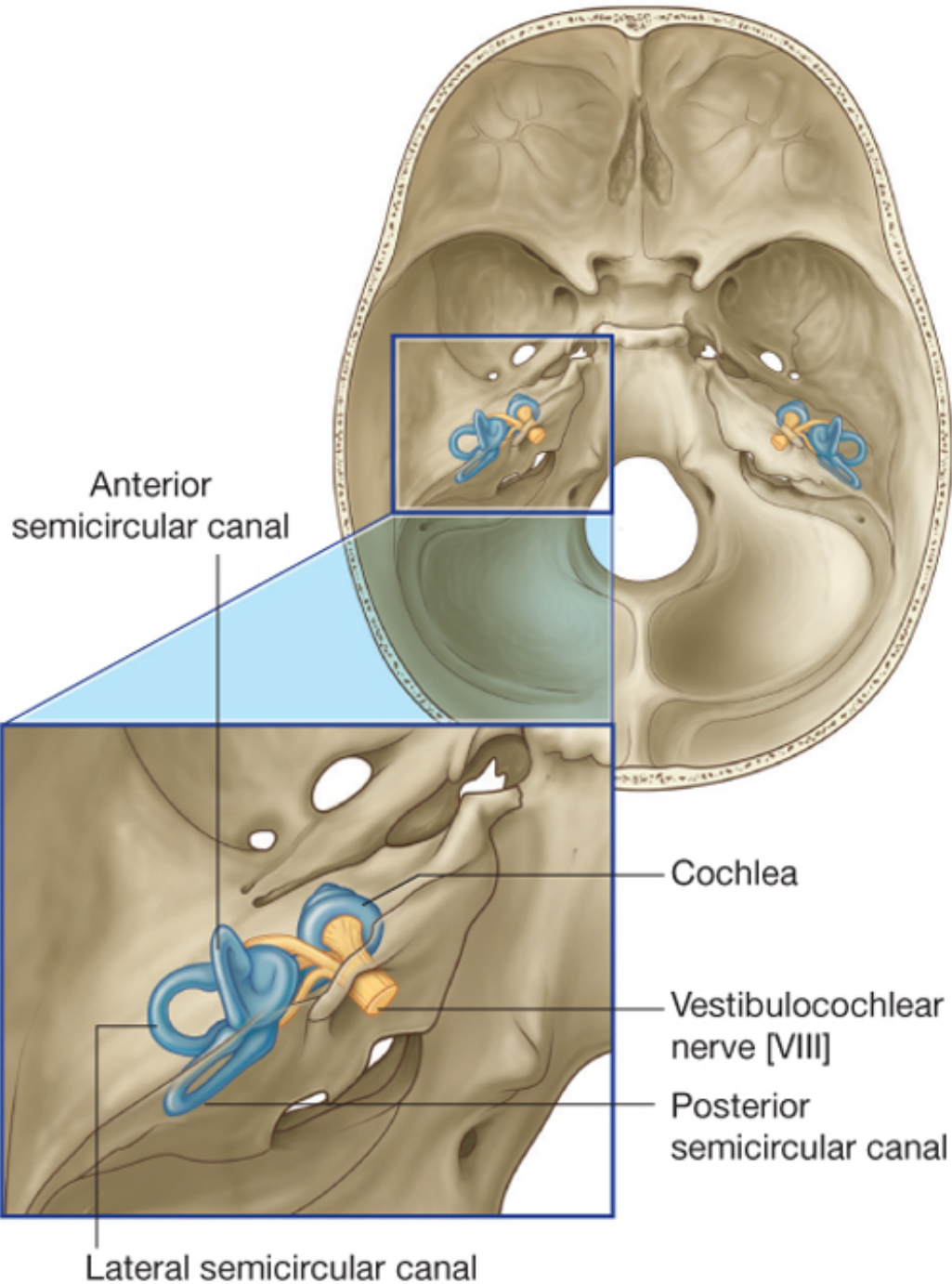




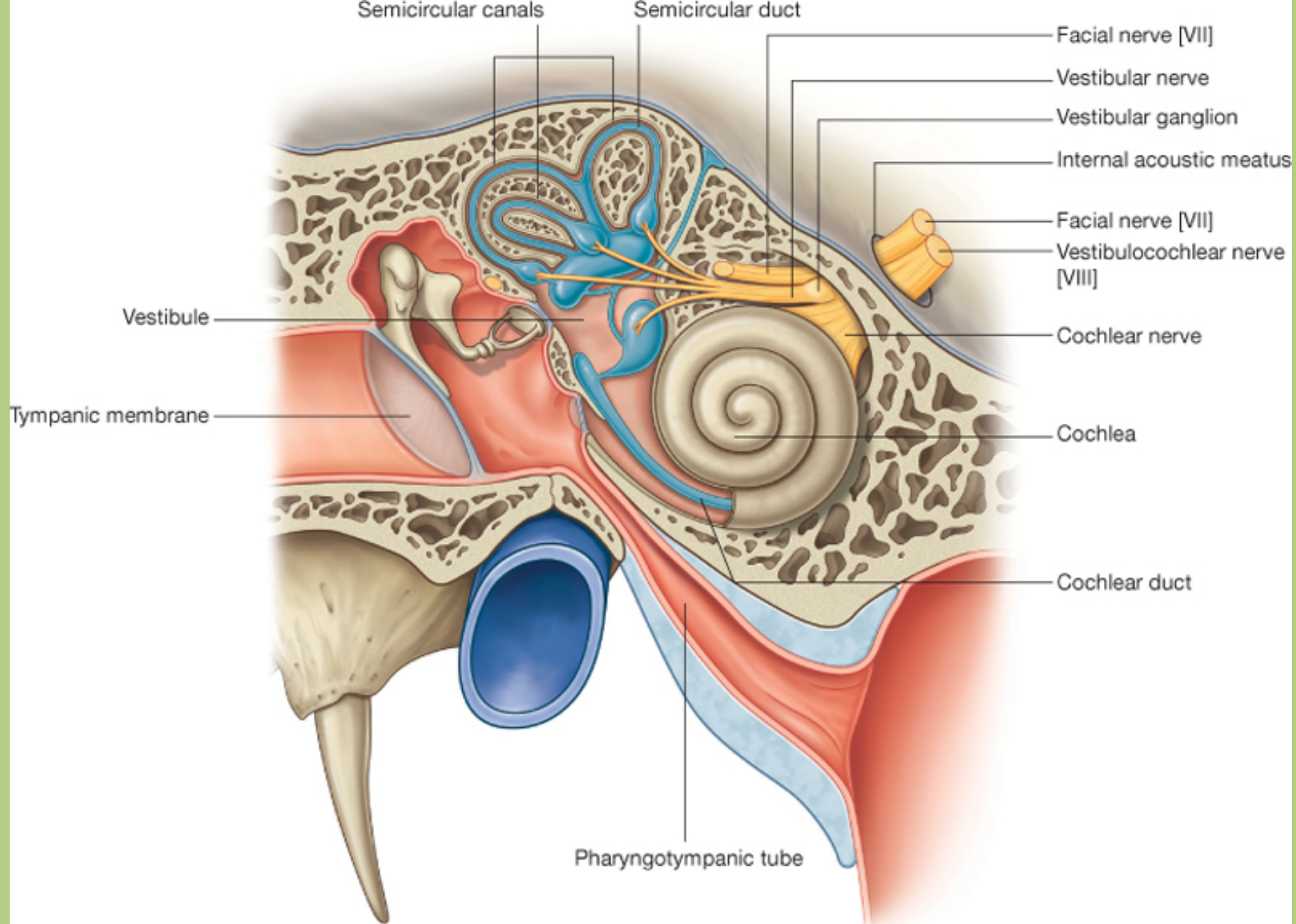
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The oscillations of sound waves are transmitted to the perilymph through the oval window via tympanic membrane and auditory ossicles. The resulting movements of the fluid ascend in the scala vestibuli and descend in the scala tympani to the round window, where the waves of movement are absorbed. Movements of the fluid lead to oscillations in the endolymphatic space at the sensory cells.

## Inner ear



The three semicircular ducts are arranged perpendicularly to each other. The **anterior semicircular duct** is oriented toward the surface of the pyramid, the **posterior semicircular duct** runs parallel to the posterior bony surface, and the **lateral semicircular duct** runs horizontally.





# Thank you for your attention.

References: Prof. Dr. Ágoston Szél's lectures (2006, 2007)

Gray's Anatomy for Students

Gray's Anatomy, The Anatomical Basis of Clinical Practice

Thieme, Atlas of Anatomy, Head, Neck and Neuroanatomy

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