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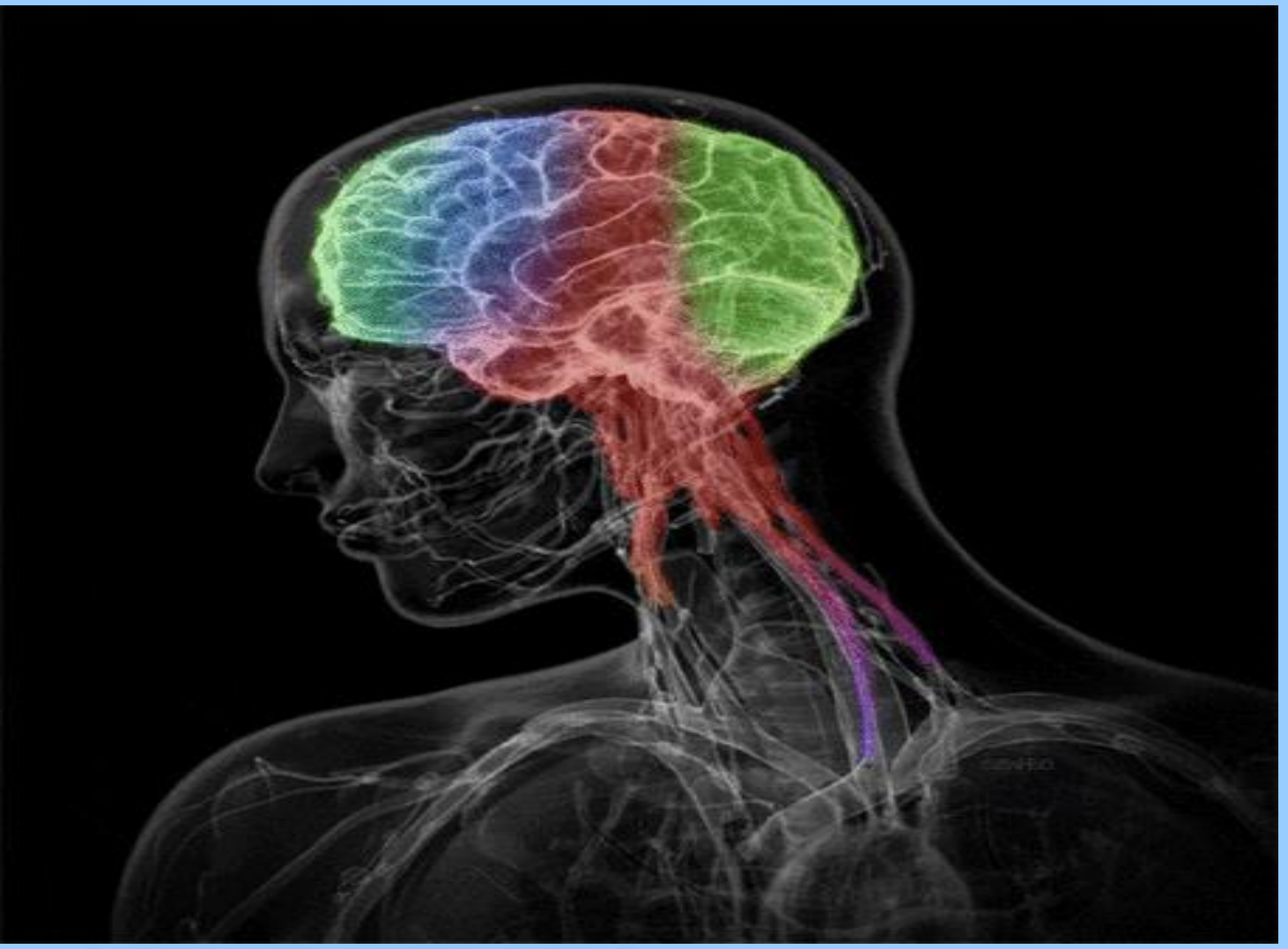
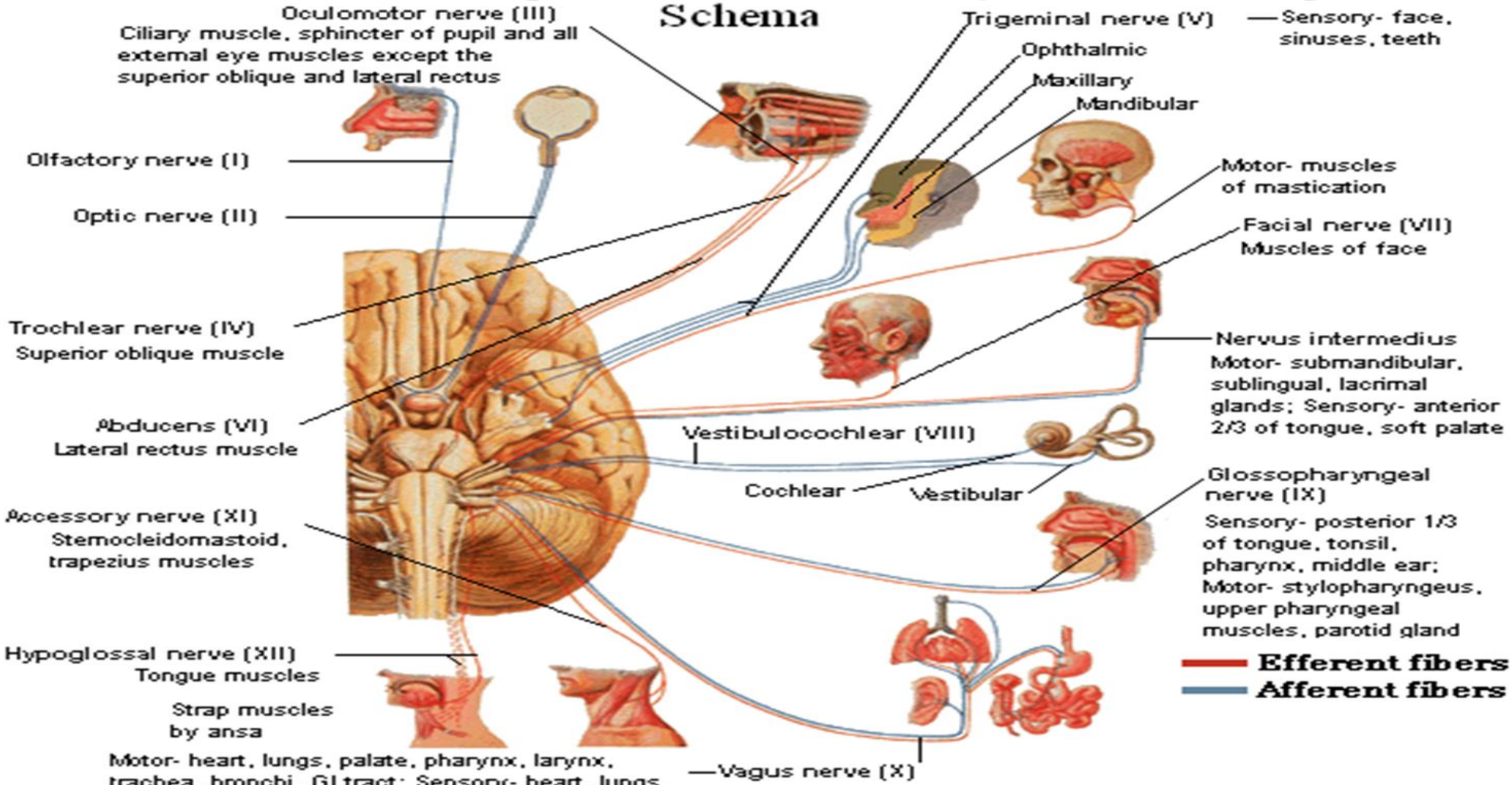


CRANIAL NERVES. SENSORY ORGANS.

Associate professor, PhD, Hordiichuk Daria

Cranial Nerves [Motor and Sensory Distribution]

Schema



Introduction to Cranial Nerve

- There are 12 pairs of cranial nerves which emerge from the brain itself. The first two olfactory and optic nerves are derived from the forebrain, whereas the remainder originate along the brain stem. These carry both efferent (motor) and afferent (sensory) fibres between the brain and the structures of the head and neck. In contrast to spinal nerves, cranial nerves exit through the cranium and are coated in a derivative of cranial meninges.

- The cranial nerves are:
- CN I - Olfactory Nerve
- CN II - Optic Nerve
- CN III - Oculomotor Nerve
- CN IV - Trochlear Nerve
- CN V - Trigeminal Nerve
- CN VI - Abducens Nerve
- CN VII - Facial Nerve
- CN VIII - Vestibulocochlear Nerve
- CN IX - Glossopharyngeal Nerve
- CN X - Vagus Nerve
- CN XI - Accessory Nerve
- CN XII - Hypoglossal Nerve

I Olfactory

Smell

II Optic

Vision

III Oculomotor

Upward
Medial
Downward
Up and In

IV Trochlear

Down and In

V Trigeminal

Touch Forehead and Cheek

Clench Teeth

VI Abducens

Look Side to Side

VII Facial

Taste for the Anterior 2/3 of Tongue

Smile

VIII Acoustic

Hearing

Equilibrium

IX Glossopharyngeal

Posterior 1/3 of the Tongue

Speech

X Vagus

Defecation

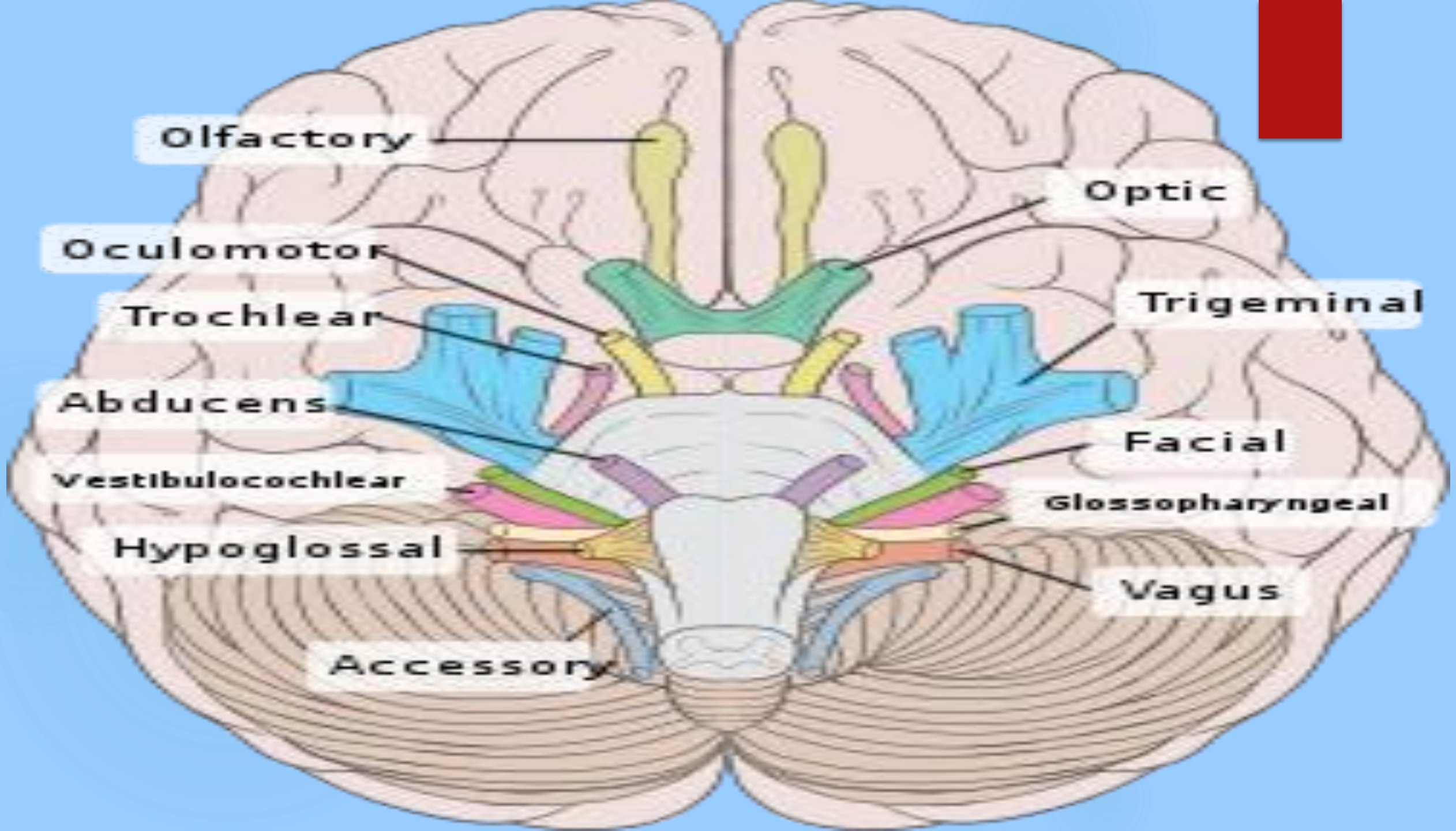
Slowed Heart Rate

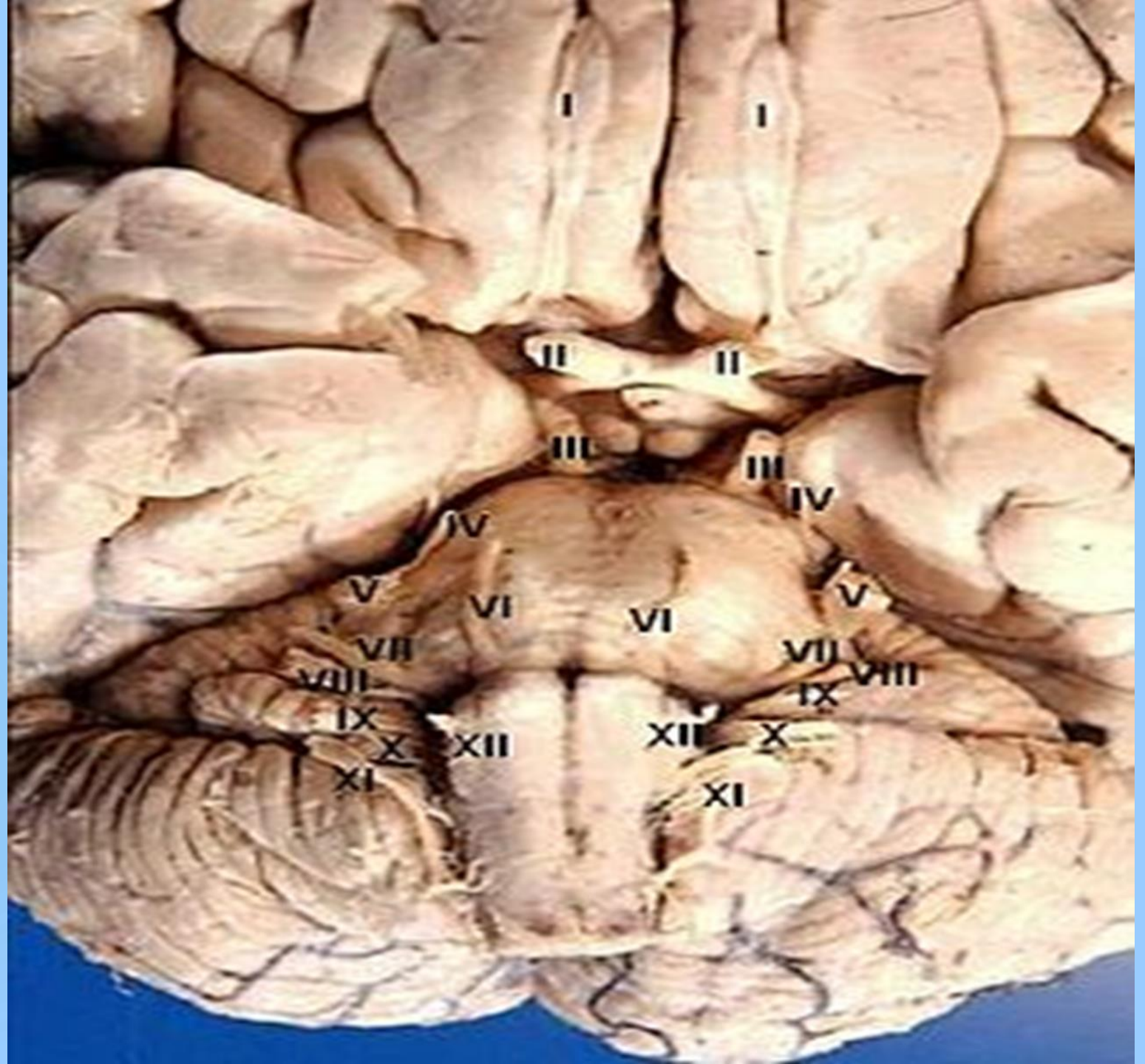
XI Spinal Accessory

Shoulder Shrug

XII Hypoglossal

Tongue Movement


Olfactory
Optic
Oculomotor
Trochlear
Trigeminal
Abducens
Facial
Vestibulocochlear
Glossopharyngeal
Hypoglossal
Vagus
Accessory


I
I
II
II
III
III
IV
IV
V
V
VI
VI
VII
VII
VIII
VIII
IX
IX
X
X
XI
XI
XII
XII

Classification of the Cranial Nerves

- It is possible to describe a cranial nerve in terms of its function and embryological origin, initially cranial nerves can be subdivided into being either:
- **Motor** (efferent)
- **Sensory** (afferent)
- And from there further categorization can occur.
- **Motor (efferent) Cranial nerves**
- **-Somatic motor (general somatic efferent)**
- (III, IV, VI, XII)
- These cranial nerves are so called because they innervate muscles derived from the occipital somites, such as the extra ocular and extrinsic tongue muscles.

- -**Branchial motor (special visceral efferent)**
- (V, VII, IX, X, XI)
- These are described as branchial because they specifically innervate muscles which are derived from the branchial arches during development (muscles of mastication, larynx, facial expression, pharynx and middle ear)
- - **Parasympatheic (general visceral efferent)**
- (III, VII, IX, X)
- These nuclei do not innervate striated muscle like the branchial and somatic, they instead provide preganglionic parasympathetic fibers to innervate glands, smooth muscle and cardiac muscle within the head, heart, lungs and digestive tract above the splenic flexure.

- **Sensory (afferent) cranial nerves**
- **-Visceral sensory**
- **special visceral afferent- (**VII, IX, X)
- **general visceral afferent-** (IX, X)
- The name is related to the fact that it detects sensation from visceral organs.
- They are divided into special visceral, referring to the rostral portion of the nucleus which contributes to the special sensation of taste. Whilst the general visceral portion is named as such due to this caudal portion receiving general sensory impulses such as cardiac, respiratory .
- **- General somatic sensory (general somatic afferent)**
- (V, VII, IX, X)
- These nuclei detect general sensation, such as touch, pain, vibration from the face, sinuses and meninges
- **- Special somatic sensory (special somatic)**
- (VIII)
- This carries information from the special sensation of hearing and balance.

- **4) CN IV (Trochlear nerve) Somatic motor** - Control of the superior oblique muscle leading to depression and intorsion (inward rotation of the upper pole) of the eye.

- **5) CN V (Trigeminal nerve) - General somatic sensory** - Sensation of touch, pain, proprioception and temperature for the face, mouth, nasal passages, anterior 2/3s of the tongue and part of the meninges (supratentorial dura mater).
- **Branchial motor** - It also innervates the muscles of mastication (masseter, temporalis, lateral pterygoid, medial pterygoid) and tensor tympani.

- **6) CN VI (Abducens nerve)** - **Somatic motor** - Controls the lateral rectus, leading to abduction of the eye.

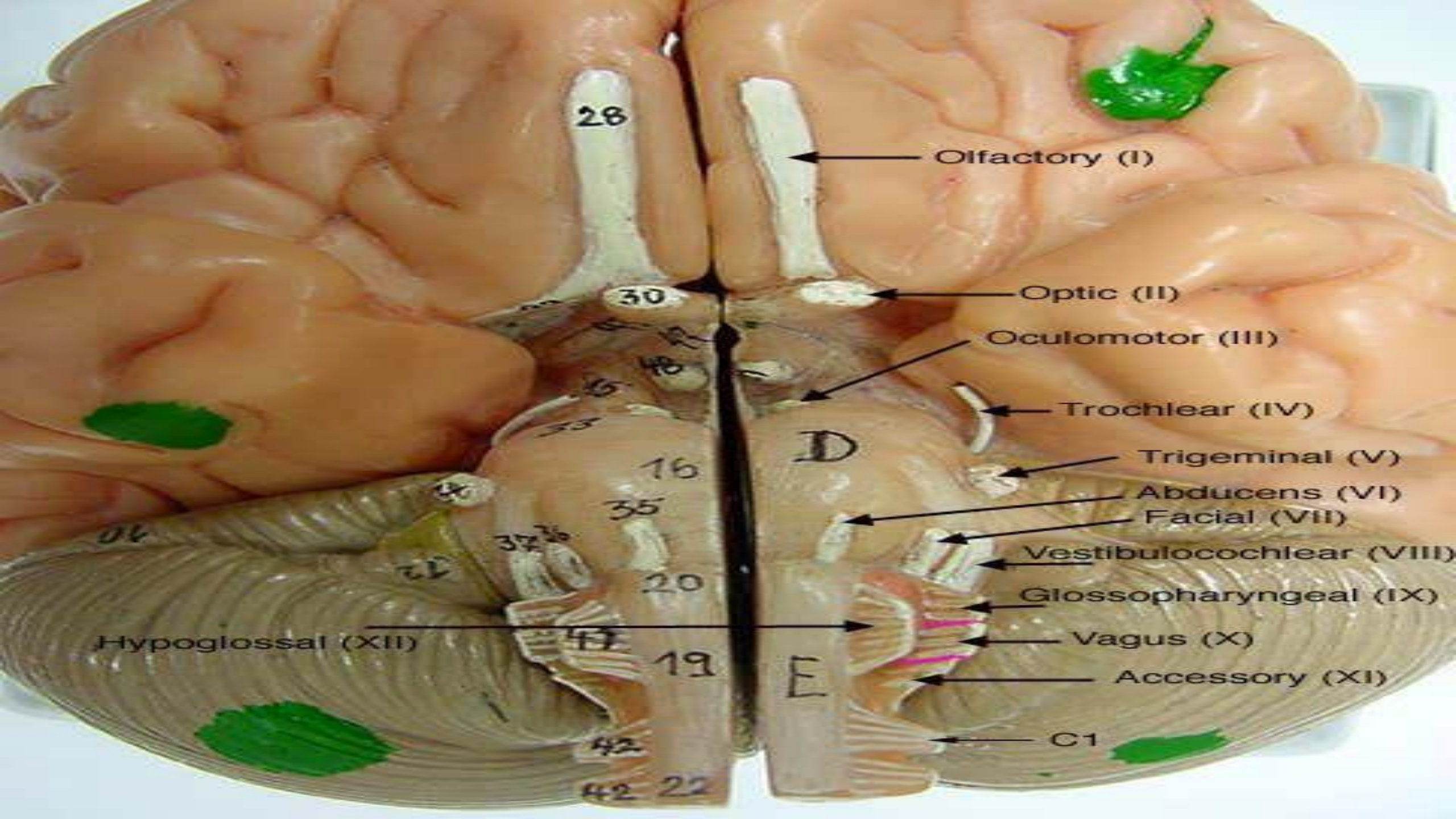
- **7) CN VII (Facial nerve)**
- **Branchial motor** - Innervates the muscles of facial expression as well as the stapedius and digastric muscle.
- **Parasympathetic** - Stimulates the lacrimal, sublingual, submandibular and other salivary glands (except parotid).
- **Special visceral sensory** - Senses taste on the anterior 2/3 of the tongue.
-
- **8) CN VIII (Vestibulocochlear nerve)**
- **Special somatic sensory** - Controls the sensation of hearing and balance
-
- **9) CN IX (Glossopharyngeal Nerve)**
- **Branchial motor** - innervates the stylopharyngeus
- **Parasympathetic** - stimulates the parotid gland
- **General somatic sensory** - detects sensation from the middle ear, near the External acoustic meatus (EAM), pharynx and posterior 1/3 of the tongue.
- **Special visceral sensory** - sensation of taste on the posterior 1/3 of the tongue.
- **General visceral sensory** - innervates chemo and baroreceptors on the carotid bodies.

- **10) CN X (Vagus nerve)**
- **Branchial motor** - Innervates the muscles of the pharynx and larynx for swallowing and speech.
- **Parasympathetic** - innervation of the heart, lungs and digestive tract down to the splenic flexure.
- **General somatic sensory** - provides general sensation to the pharynx, meninges (posterior fossa) and a small region .
- **Special visceral sensory** - taste from the epiglottis and pharynx
- **General visceral sensory** - chemo and baroreceptors of the aortic arch
-
- **11) CN XI (Spinal Accessory nerve)**
- **Branchial motor** - innervation of the sternocleidomastoid and upper part of trapezius muscle
-
- **12) CN XII (Hypoglossal nerve)**
- **Somatic motor** - The intrinsic muscles of the tongue

Cranial nerves&function

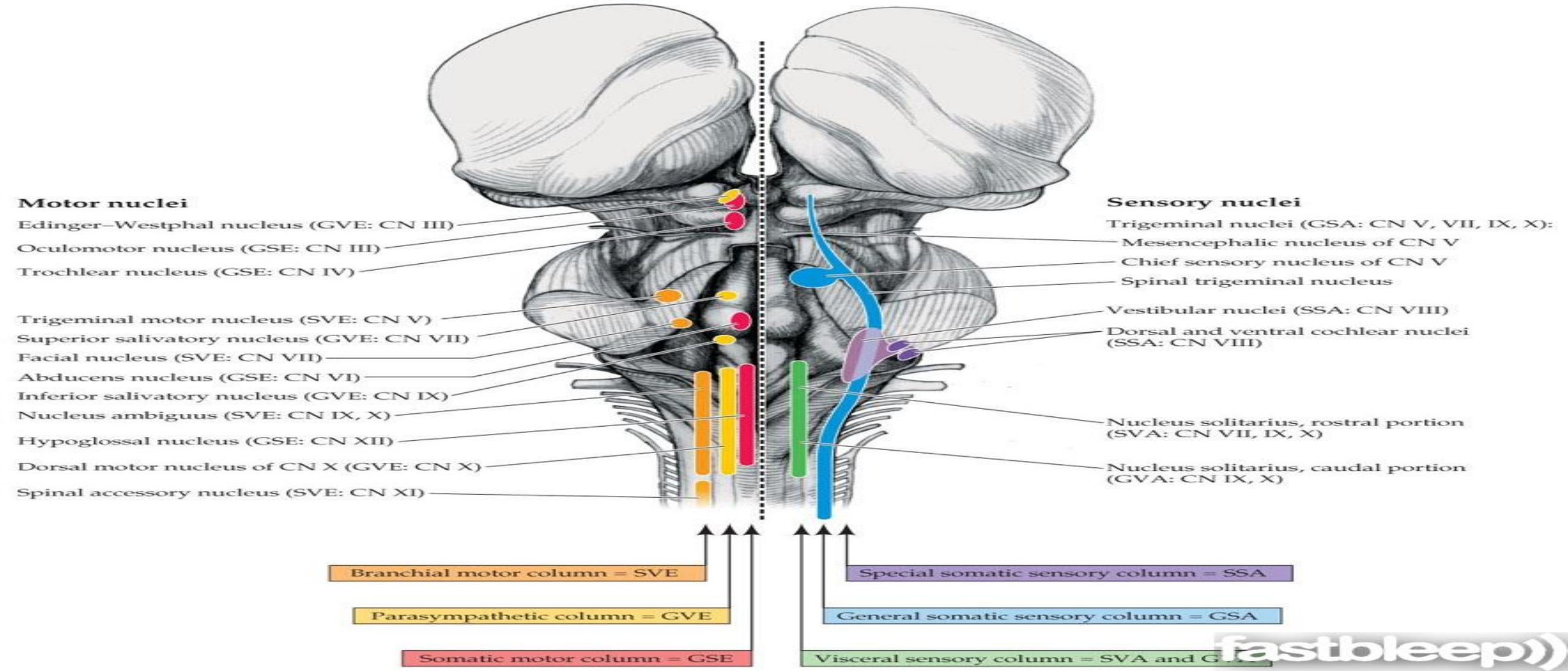
S-SENSORY
M-MOTOR
B-(BOTH MOTOR & SENSORY)

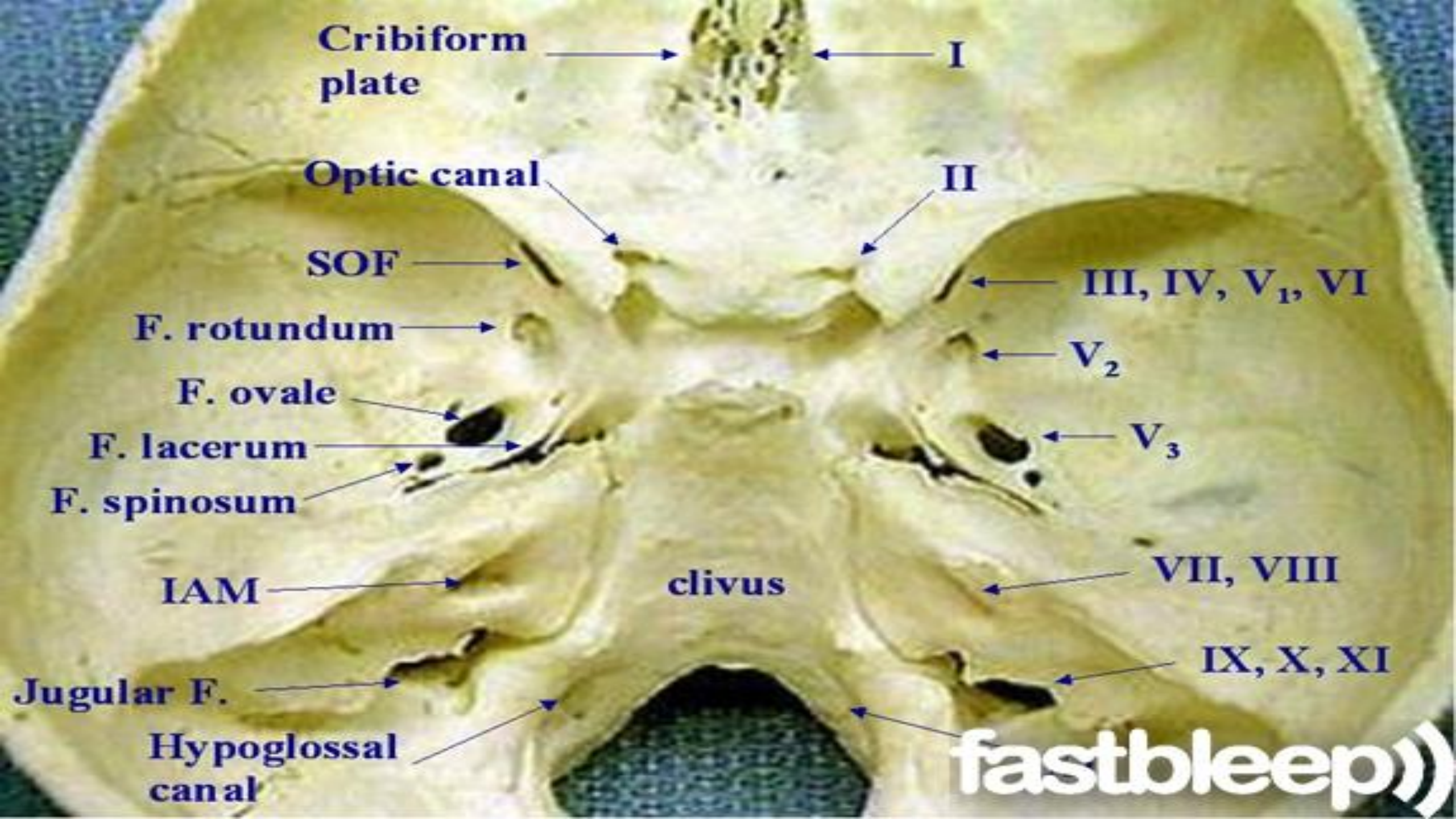
some-1
say-2
marry-3
money-4
but-5
my-6
brother-7
says-8
big-9
brains-10
matter-11
most-12


Olfactory (I)
Optic (II)
Oculomotor (III)
Trochlear (IV)
Trigeminal (V)
Abducens (VI)
Facial (VII)
Vestibulocochlear (VIII)
Glossopharyngeal (IX)
Vagus (X)
Accessory (XI)
C1
Hypoglossal (XII)
D
E
28
30
16
35
20
19
42
42
22

BRAINSTEM NUCLEI

The cranial nerves originate from pairs of nuclei (motor or sensory) within the brainstem, where like in the spinal cord, the motor nuclei are located ventrally whilst sensory nuclei are found dorsally along the brainstem. 3 motor and 3 sensory columns run the length of the brainstem.

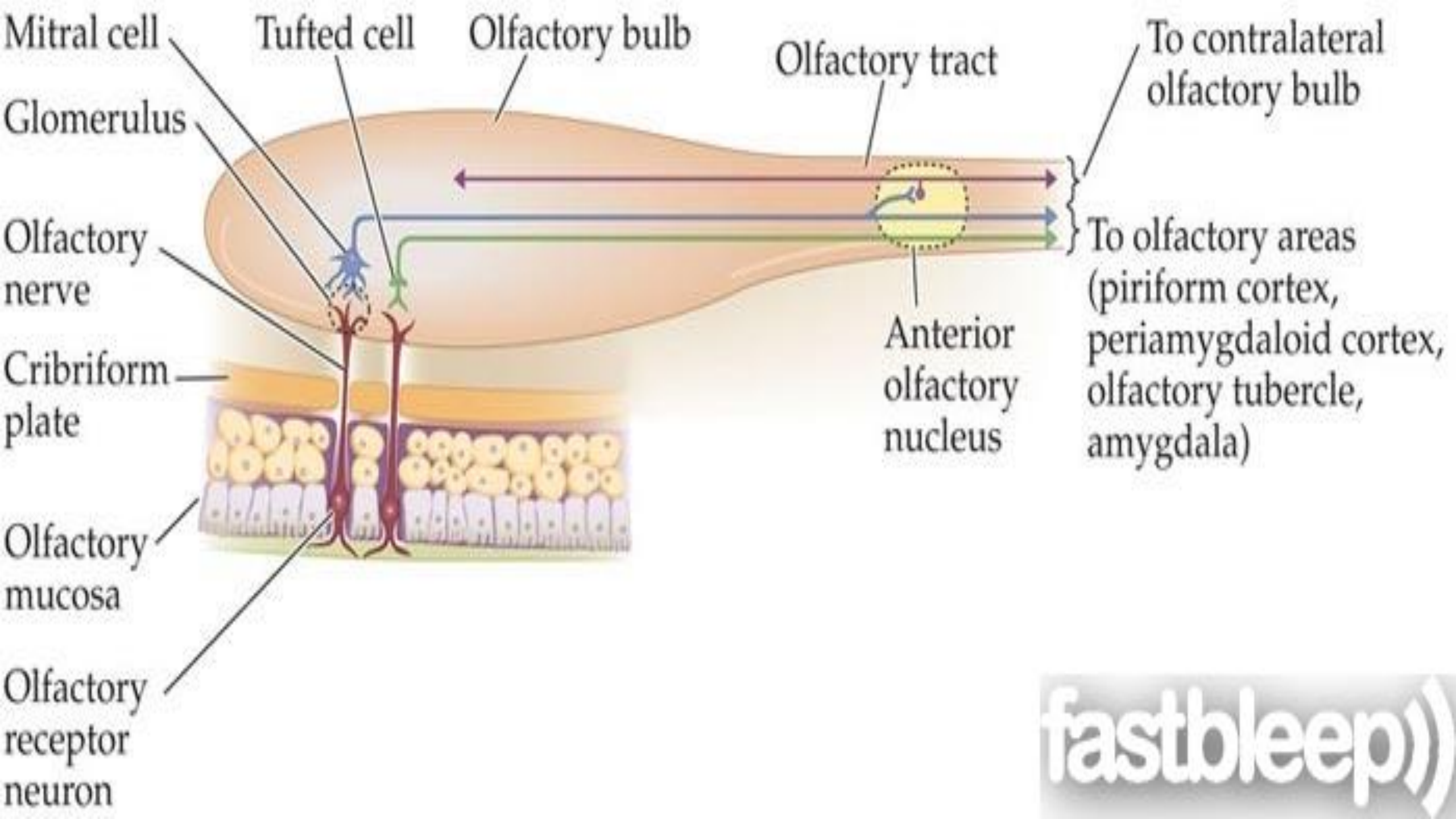



Cribiform plate
I
Optic canal
II
SOF
III, IV, V1, VI
F. rotundum
V2
F. ovale
V3
F. lacerum
F. spinosum
IAM
clivus
VII, VIII
IX, X, XI
Jugular F.
Hypoglossal canal

CN I

- Olfactory receptor neurones are found in the roof of the nasal cavity, the nasal septum and medial wall of superior nasal concha. These ciliated neurones are stimulated by aerosolised odour molecules dissolved in the surrounding mucus. On either side of the nasal septum, these receptor neurones pass through the cribriform plate of the ethmoid bone by forming 20 olfactory nerves to reach the olfactory bulb found on the orbital surface of the frontal lobe, within the anterior cranial fossa.
- These olfactory nerves synapse onto mitral and tufted cells at the glomerulus of the olfactory bulb, which form the olfactory tract. These tracts form the anterior olfactory nucleus along its route, which can then form medial and lateral striae.

- The lateral stria projects to the primary olfactory cortex, formed of the piriform cortex and periamygdaloid cortex which is found near the medial tip of the temporal lobe. From here connections to the amygdala (involved in emotional olfaction) and entorhinal cortex (memory aspect of olfaction) exist.
- The medial stria projects through the anterior commissure to the contralateral olfactory bulb and cortex.


Mitral cell
Tufted cell
Olfactory bulb
Olfactory tract
To contralateral olfactory bulb
Glomerulus
Olfactory nerve
Cribriform plate
Anterior olfactory nucleus
To olfactory areas (piriform cortex, periamygdaloid cortex, olfactory tubercle, amygdala)
Olfactory mucosa
Olfactory receptor neuron

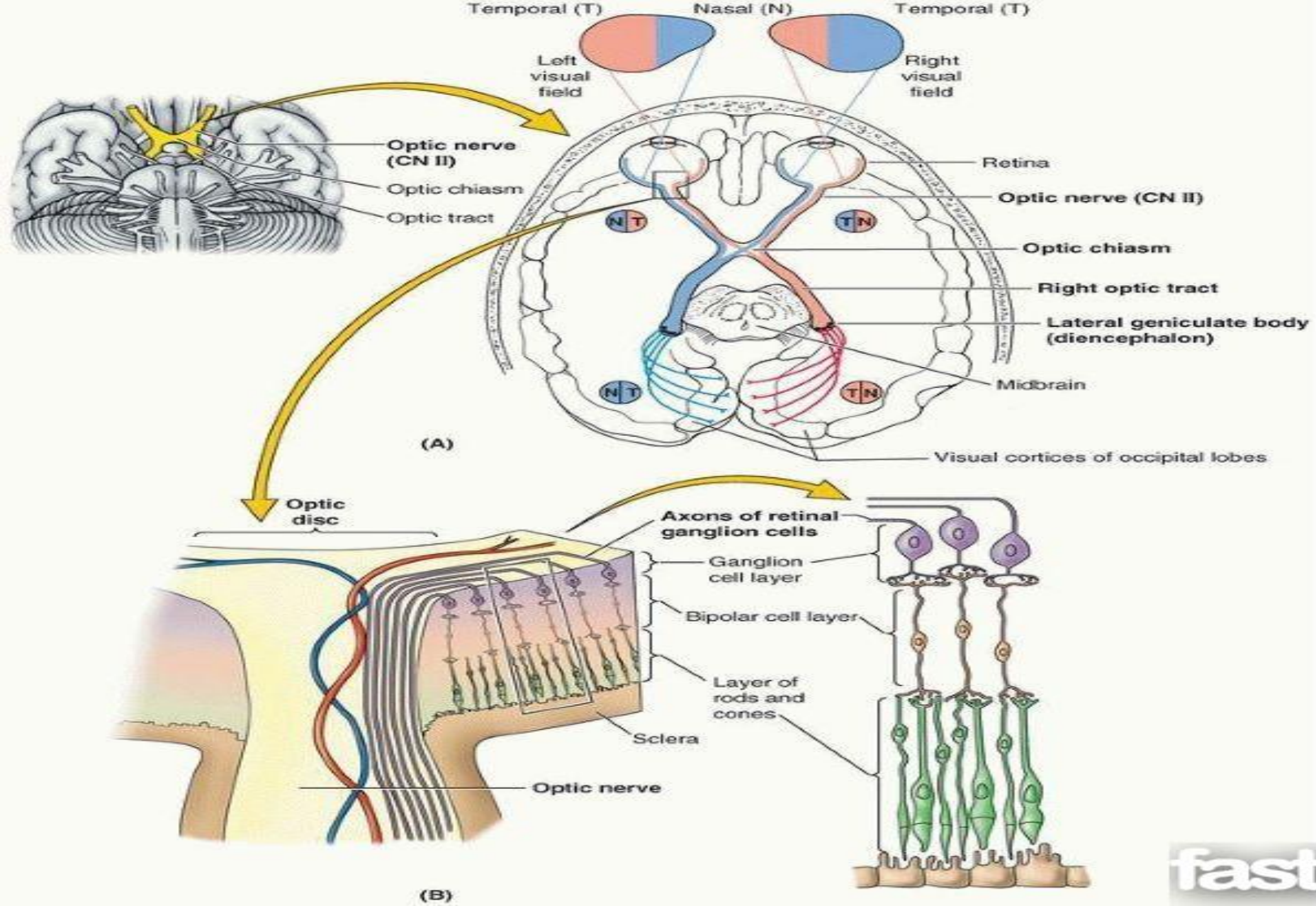
Clinical Correlation - Anosmia

- Usually patients with unilateral anosmia are unaware of their condition due to the contralateral nostril compensating. This is why each nostril must be tested individually.
- An important sign of bilateral anosmia is a loss of taste, due to the importance of olfaction to the sensation of flavour.
- Differential diagnosis of Anosmia:
- Head trauma - These can damage the olfactory nerves as they pass through the cribriform plate.
- Viruses - damage the olfactory neuroepithelium
- Obstruction
- Parkinson's/Alzheimer's - this is believed to be due to atrophy of the anterior olfactory nucleus.

- Intracranial lesions such as meningioma, metastases, meningitis or sarcoidosis when manifested on the frontal lobe cause anosmia. This is important, as frontal lobe lesions are usually difficult to detect and may produce no symptom other than anosmia.
- Temporal lobe epilepsy sometimes manifests with olfactory hallucinations, due to irritation of the lateral olfactory area.

CN II

- Embryologically CNII is derived from the diencephalon, so is formed of oligodendrocytes rather than schwann cells, hence CNII is considered a tract of the CNS not a nerve. CNII is unique in that it is covered with meninges.
- CNII begins where the unmyelinated axons of the retinal ganglion cells pierce the sclera and form the optic disc.
- These nerves enter the middle cranial fossa, by exiting the optic canal posteromedially where the optic chiasm is formed. Here decussation occurs, whereby the nasal (medial) fibres of the retina cross to join the uncrossed temporal (lateral) fibres to form the optic tract.
- Most of these fibres terminate in the lateral geniculate body of the thalamus, whereby the axons pass through two seperate loops (Baum & Meyer) to enter the occipital cortex, the part of the cerebral hemisphere involved in visual processing.
- Some fibres enter the pre-tectal nucleus, through the brachium of the superior colliculus, and act as the afferent limb of the pupillary light reflex and control eye movements.
- Some other fibres enter the suprachiasmatic nucleus controlling circadian rhythmns.

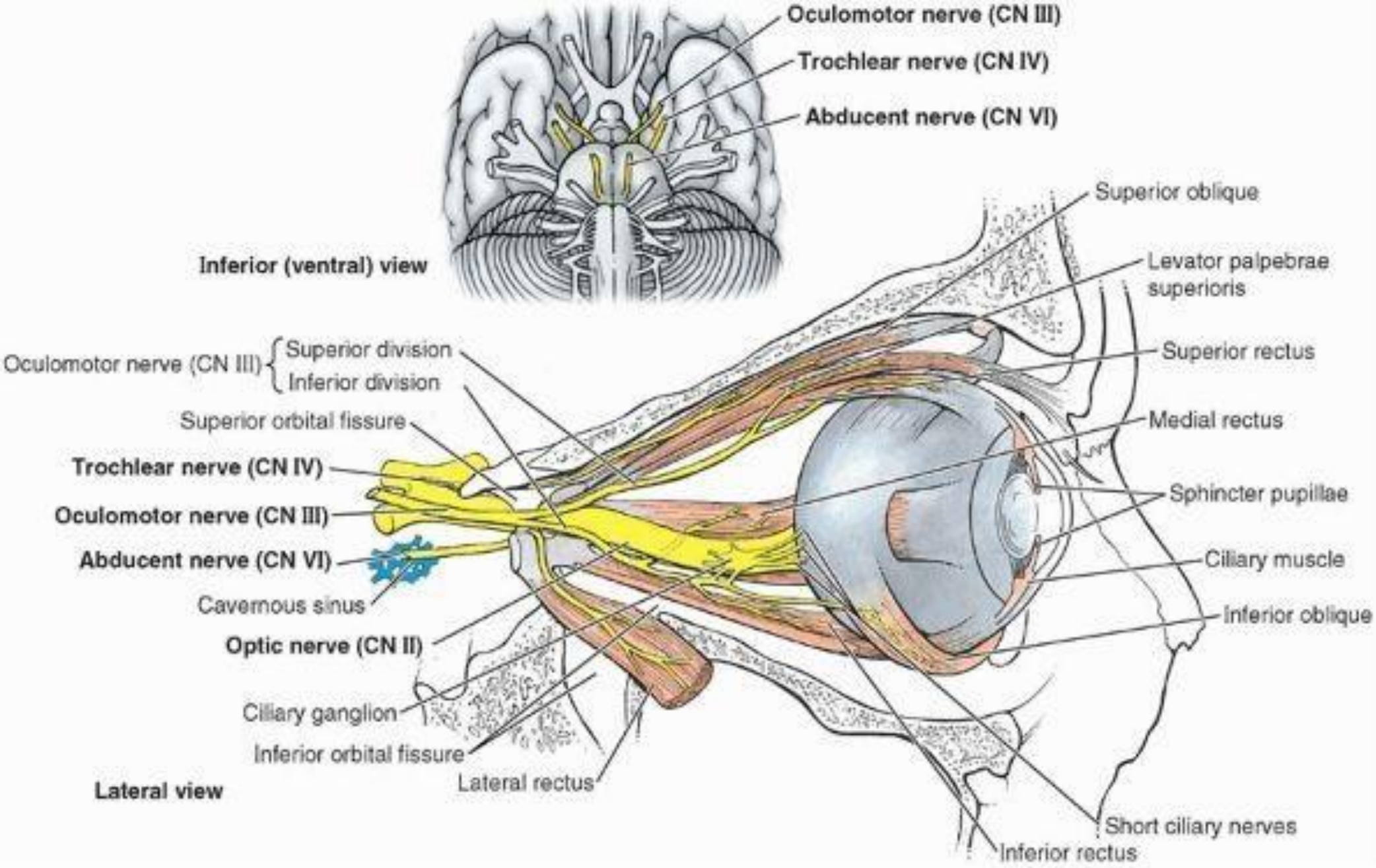

Temporal (T)
Nasal (N)
Temporal (T)
Left visual field
Right visual field
Optic nerve (CN II)
Optic chiasm
Optic tract
Retina
Optic nerve (CN II)
Optic chiasm
Right optic tract
Lateral geniculate body (diencephalon)
Midbrain
Visual cortices of occipital lobes
(A)
Optic disc
Axons of retinal ganglion cells
Ganglion cell layer
Bipolar cell layer
Layer of rods and cones
Sclera
Optic nerve
(B)

Clinical Correlation of CNII

- Multiple sclerosis, which normally spares the PNS, affects the optic nerve, due to the fact it is a CNS tract rather than a PNS nerve. This results in optic neuritis, leading to loss of visual acuity/peripheral vision. Toxic substances such as alcohol or other inflammatory disorders may also precipitate this condition.
- Visual field defects can occur due to different lesions that occur along the length of the visual pathway. These lesions can obstruct the transfer of retinal information along the pathway and lead to a loss of a portion of the respective visual field that it was transmitting. This can commonly occur due to berry aneurysms or pituitary gland tumors.
- Quite commonly during a transient ischemic attack, occlusion of the retinal artery can occur by an emboli from a carotid stenosis which causes loss of vision in one eye for a brief period of time. This is a warning sign for impending retinal or cerebral infarcts.

CN III

- CNIII leaves the midbrain between the posterior cerebral and superior cerebellar arteries and pierces the sellar diaphragm over the hypophysis. Subsequently upon piercing the cavernous sinus, it enters the superior orbital fissure.
- CNII then forms two divisions:
- Superior division - innervates the superior rectus and levator palpebrae superioris.
- Inferior division - innervates the inferior and medial rectus and inferior oblique.
- Within the inferior division the **ciliary ganglion** is formed from parasympathetic fibres; these form short ciliary nerves to innervate the ciliary body and sphincter pupillae. This pre-ganglionic parasympathetic branch is derived from the Edinger-Westphall nucleus, and serves as the efferent (motor) limb of the pupillary light reflex.


Oculomotor nerve (CN III)
Trochlear nerve (CN IV)
Abducent nerve (CN VI)
Inferior (ventral) view
Superior oblique
Levator palpebrae superioris
Superior rectus
Medial rectus
Sphincter pupillae
Ciliary muscle
Inferior oblique
Short ciliary nerves
Inferior rectus
Oculomotor nerve (CN III)
Superior division
Inferior division
Superior orbital fissure
Trochlear nerve (CN IV)
Oculomotor nerve (CN III)
Abducent nerve (CN VI)
Cavernous sinus
Optic nerve (CN II)
Ciliary ganglion
Inferior orbital fissure
Lateral rectus
Lateral view

Clinical Correlation of CNIII

- Due to the close proximity of CNIII with the superior cerebellar, posterior cerebral and posterior communicating artery, any aneurysms here can lead to CNIII palsy. However due to the more medial and superficial aspects of CNIII carrying the parasympathetics, these are more likely to be compressed.
- Fractures of the cavernous sinus and a herniating uncus can also lead to CNIII palsy.
- Any loss of CNIII manifests with dilated pupils due to loss of parasympathetic constriction and absence of pupillary light reflex will be observed as the efferent limb is carried by CNIII. Ptosis may occur due to loss of levator palpebrae superioris. The eye will turn down and out due to overaction of CN IV and VI.


Ipsilateral ptosis
-Superior palpebrae superioiris, Meuller's


Restricted upward gaze
-Superior rectus

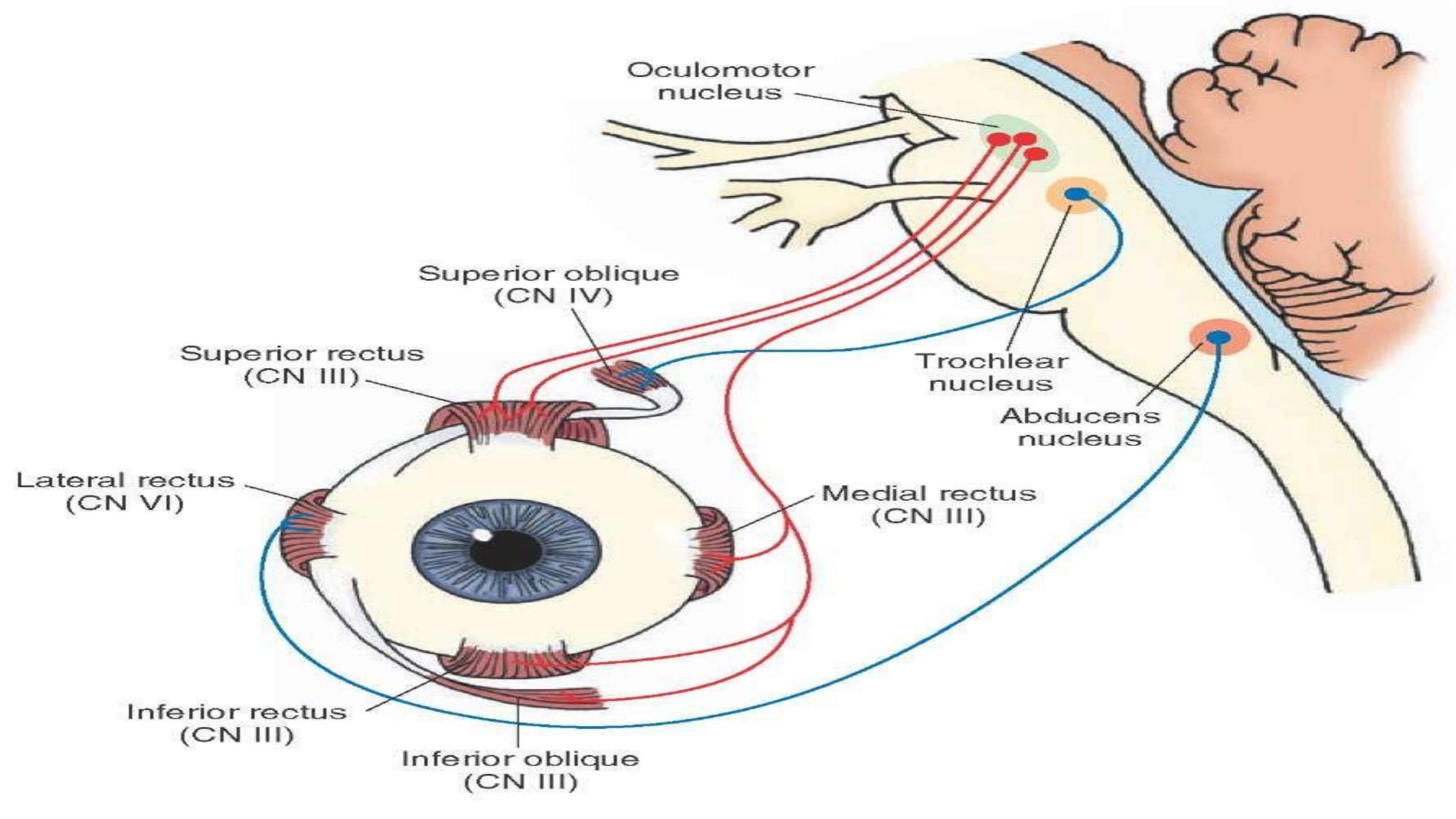

Restricted downward gaze
-Inferior rectus


Normal lateral gaze
-Abducencs nerve is intact


Restricted medial gaze
-Medial rectus

CN IV

- **CN IV** is unique in that it is the only cranial nerve to arise from the dorsal brain stem. It loops around the brainstem and passes anteriorly within the subarachnoid space. It, like CNIII, passes between the superior cerebellar and posterior cerebral arteries, and pierces the dura at the tentorium cerebelli and enters the cavernous sinus. After it does this, it passes through the superior orbital fissure into the orbital fissure to innervate the superior oblique.

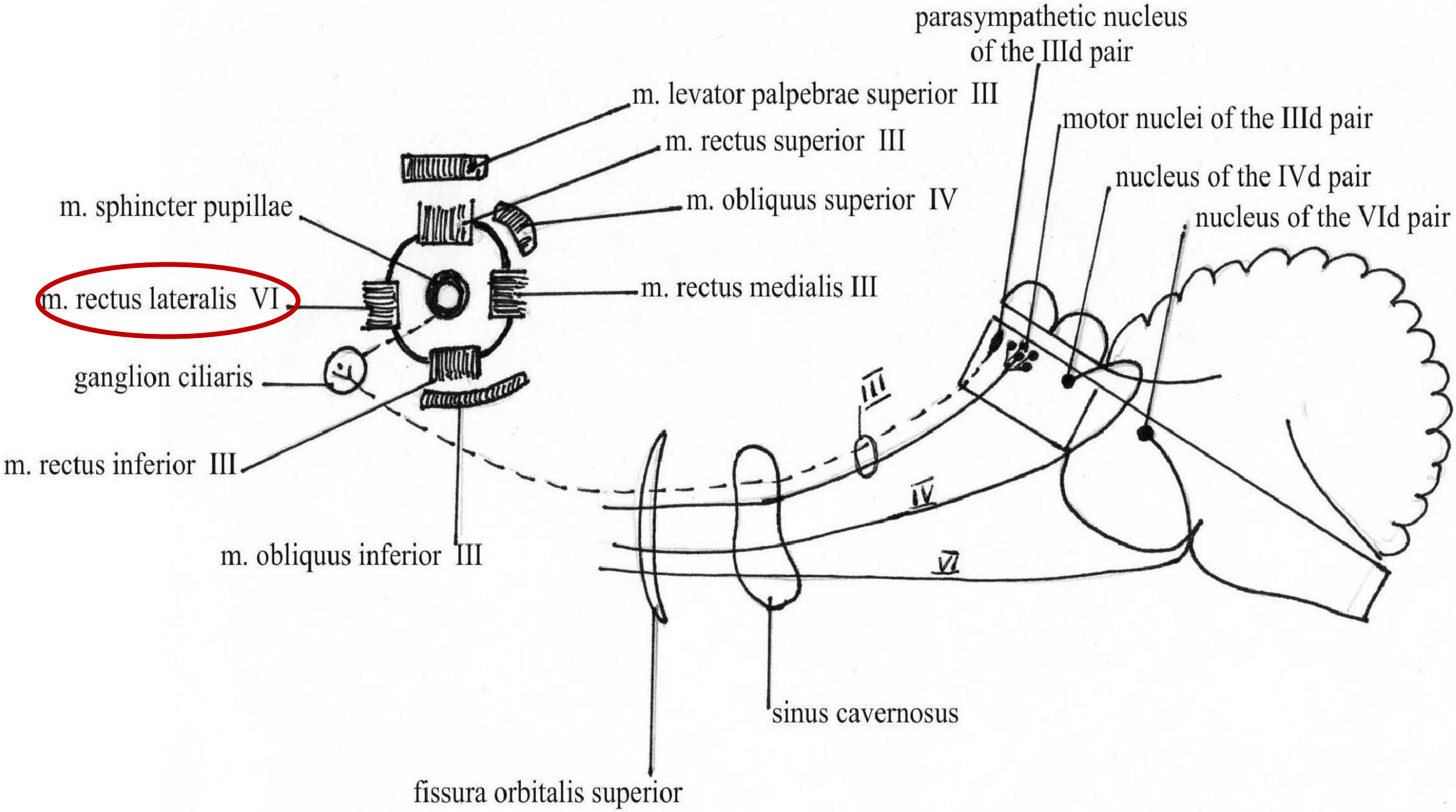

Oculomotor nucleus
Superior oblique (CN IV)
Superior rectus (CN III)
Trochlear nucleus
Abducens nucleus
Lateral rectus (CN VI)
Medial rectus (CN III)
Inferior rectus (CN III)
Inferior oblique (CN III)

CLINICAL CORRELATION

- Due to its crossed method of exiting the brainstem, CNIV is susceptible to cerebellar tumour compression.
- Due to CNIV being thin and having such a long intracranial course it is easily damaged by the shear injury of head trauma.
- Symptoms manifest as vertical diplopia, which worsens when the patient looks down and medially, due to the superior oblique normally depressing the pupil and causing intorsion. However the inferior oblique is unopposed in causing extorsion due to CN IV paralysis, which can also cause the eye to drift upward.

CN VI

- Upon leaving the brainstem at the pontomedullary junction of the pons, these fibres travel within the subarachnoid space between the pons and clivus straddling the basilar artery. Upon exiting the dura, CNVI enters Dorello's canal, where it runs between the skull and dura. It makes a sharp bend as it passes over the petrous temporal bone tip to enter the cavernous sinus. Through this it enters the superior orbital fissure to innervate the lateral rectus.


parasympathetic nucleus
of the IIId pair
m. levator palpebrae superior III
m. rectus superior III
motor nuclei of the IIId pair
nucleus of the IVd pair
m. obliquus superior IV
nucleus of the VId pair
m. sphincter pupillae
m. rectus lateralis VI
m. rectus medialis III
ganglion ciliaris
III
IV
VI
m. rectus inferior III
m. obliquus inferior III
sinus cavernosus
fissura orbitalis superior

CLINICAL CORRELATION OF CN VI

- Due to its long vertical course, CNVI is affected by raised intracranial pressures which act downward especially as it bends over the crest of the petrous tip of the temporal bone. Therefore CNVI palsy is an important sign of hydrocephalus, brain tumours, basilar artery aneurysm and intracranial lesions. Diabetes may cause this due to microvascular complications.
- Lesions lead to horizontal dipolpia, which causes improper abduction of the eye, and unopposed constant adduction.

CN VIII

- CN VIII leaves at the pontomedullary junction, lateral to the facial nerve. Upon traversing the subarachnoid space it enters the internal acoustic meatus alongside the facial nerve and labyrinthine artery, where it travels within the auditory canal of the petrous temporal bone. Within this it splits into the vestibular nerve and the cochlear nerve.
- Vestibular nerve - formed of the vestibular ganglion. This nerve attaches to the utricle and saccule and cristae of the ampullae, thereby sensing movement.
- Cochlear nerve - formed of the spiral ganglion. This extends around the cochlea to sense hearing.

CN 8

Vestibulo-Cochlear Nerve

Cochlear division- Hearing

From organ to Corti in cochlea

Hair cells to cell bodies in spiral ganglion (in modiolus)

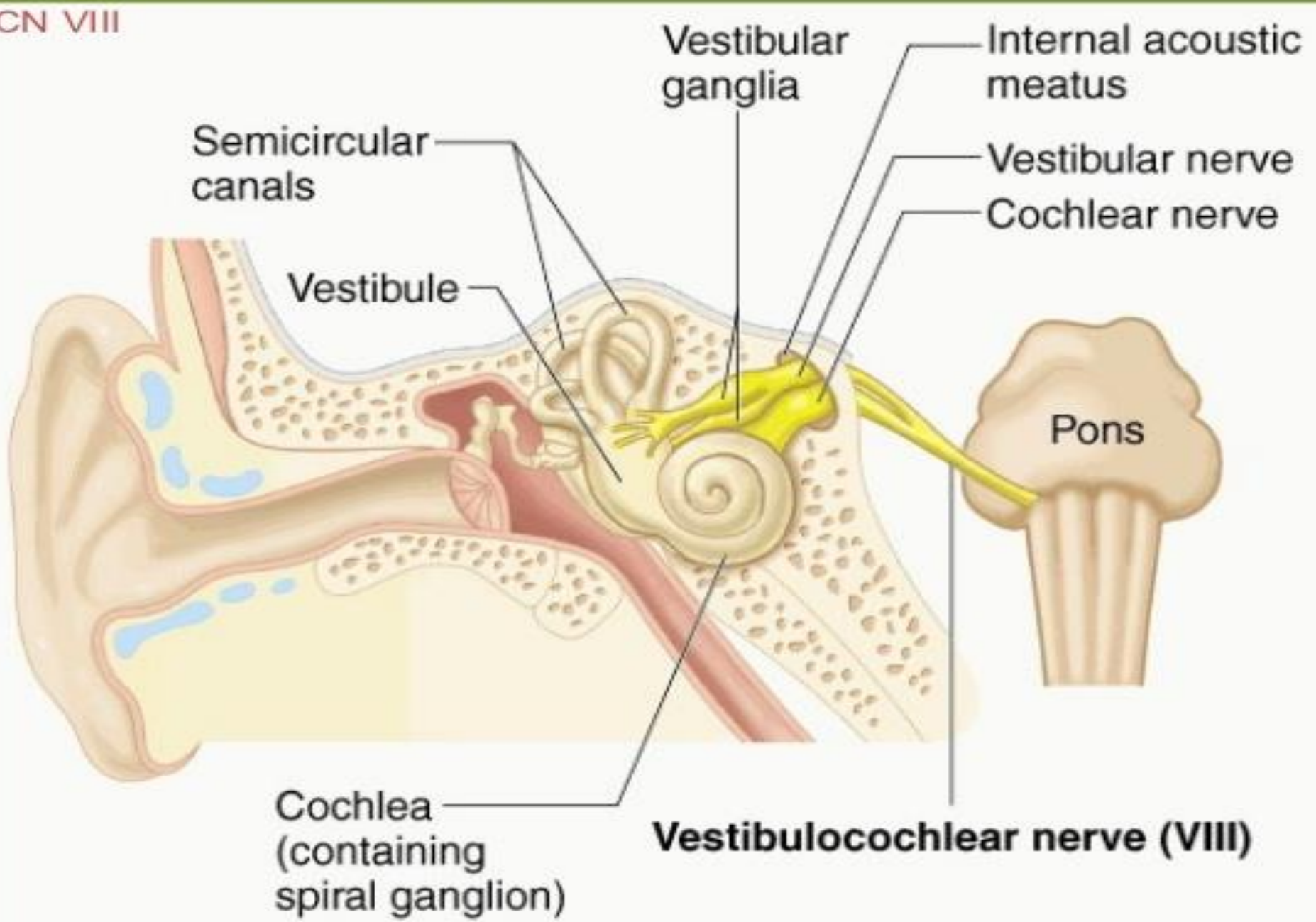
To 2 cochlear nuclei (ventral & dorsal)

Vestibular division – Balance

From semicircular canals, utricle & saccule

Cell bodies in vestibular ganglion in outer part of internal acoustic meatus

To 4 vestibular nuclei (medial, lateral, superior, inferior)



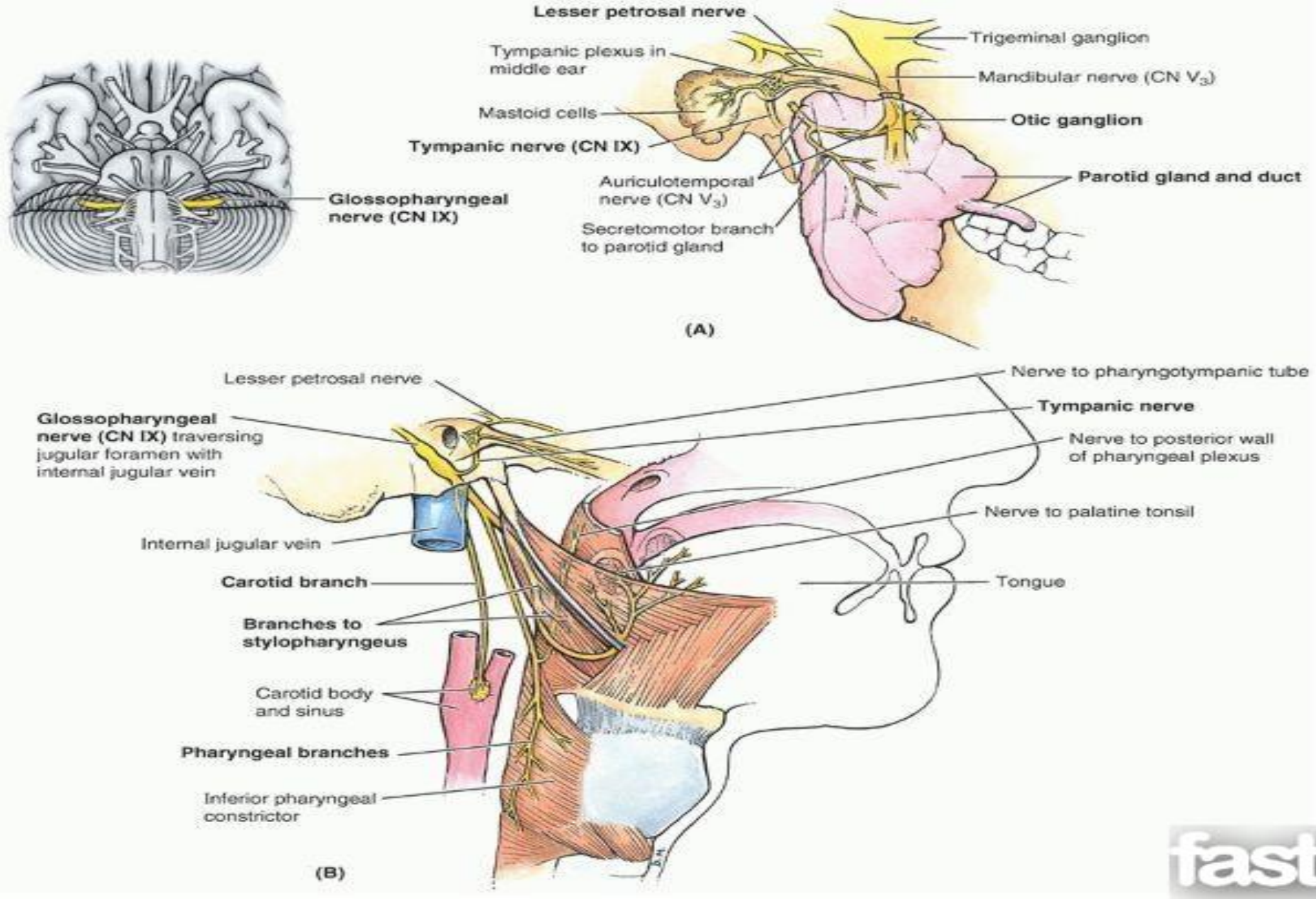
Clinical Correlation of CNVIII

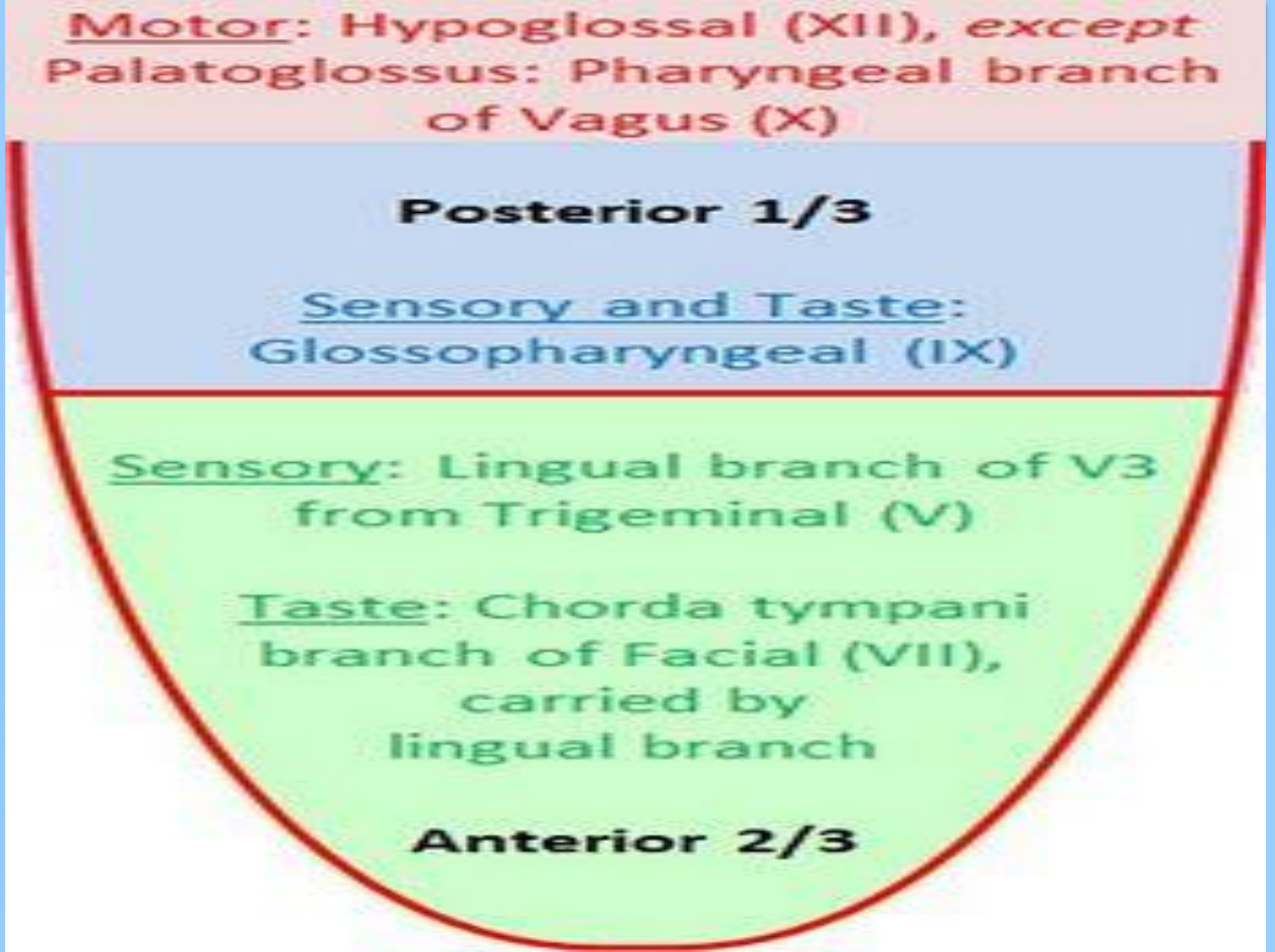
- Due to the close relationship of the vestibular nerve and cochlear nerve, lesions of one usually affect the other, leading to both tinnitus, vertigo and impaired hearing. Infact usually the cause of vertigo after head trauma is a peripheral vestibular nerve lesion.
- There are two forms of hearing loss:
- Conductive hearing loss - CNVIII is working but bone conduction of sound is impaired, due to the external auditory canal/middle ear not transmitting soundwaves.
- Sensorineural hearing loss - physical ear structures are preserved, however there is damage to the cochlea or neurone that is impairing hearing.

- Acoustic neuromas are the most common tumors of this region and grow within the auditory canal on the surrounding schwann cells of CNVIII. This tumor can lead to loss of hearing and commonly disequilibrium and tinnitus. This can eventually affect CN V, leading to facial pain and sensory loss and CNVII damage causing facial weakness.

CN IX

- Also called "a poor man's facial nerve", it is very similar to CNVII.
- Upon leaving the ventrolateral medulla below CNVIII, it traverses the subarachnoid space to exit via the jugular foramen.
- Upon exiting, it forms two sensory ganglions, where afferent general sensation, touch and pain of the tongue, pharynx and middle ear are relayed, alongside taste.
- The only muscle it innervates is the stylopharyngeus, and so it follows its course eventually reaching the tongue. It passes further inferiorly to convey inputs to the baro and chemoreceptors in the carotid body.
- Parasympathetic fibres leave via the tympanic nerve to join the lesser petrosal to synapse with the otic ganglion (associated with CNV3), innervating the parotid gland.


Glossopharyngeal nerve (CN IX)
Lesser petrosal nerve
Tympanic plexus in middle ear
Mastoid cells
Tympanic nerve (CN IX)
Auriculotemporal nerve (CN V3)
Secretomotor branch to parotid gland
Trigeminal ganglion
Mandibular nerve (CN V3)
Otic ganglion
Parotid gland and duct
(A)
Lesser petrosal nerve
Glossopharyngeal nerve (CN IX) traversing jugular foramen with internal jugular vein
Internal jugular vein
Carotid branch
Branches to stylopharyngeus
Carotid body and sinus
Pharyngeal branches
Inferior pharyngeal constrictor
Nerve to pharyngotympanic tube
Tympanic nerve
Nerve to posterior wall of pharyngeal plexus
Nerve to palatine tonsil
Tongue
(B)


Motor: Hypoglossal (XII), except Palatoglossus: Pharyngeal branch of Vagus (X)
Posterior 1/3
Sensory and Taste: Glossopharyngeal (IX)
Sensory: Lingual branch of V3 from Trigeminal (V)
Taste: Chorda tympani branch of Facial (VII), carried by lingual branch
Anterior 2/3

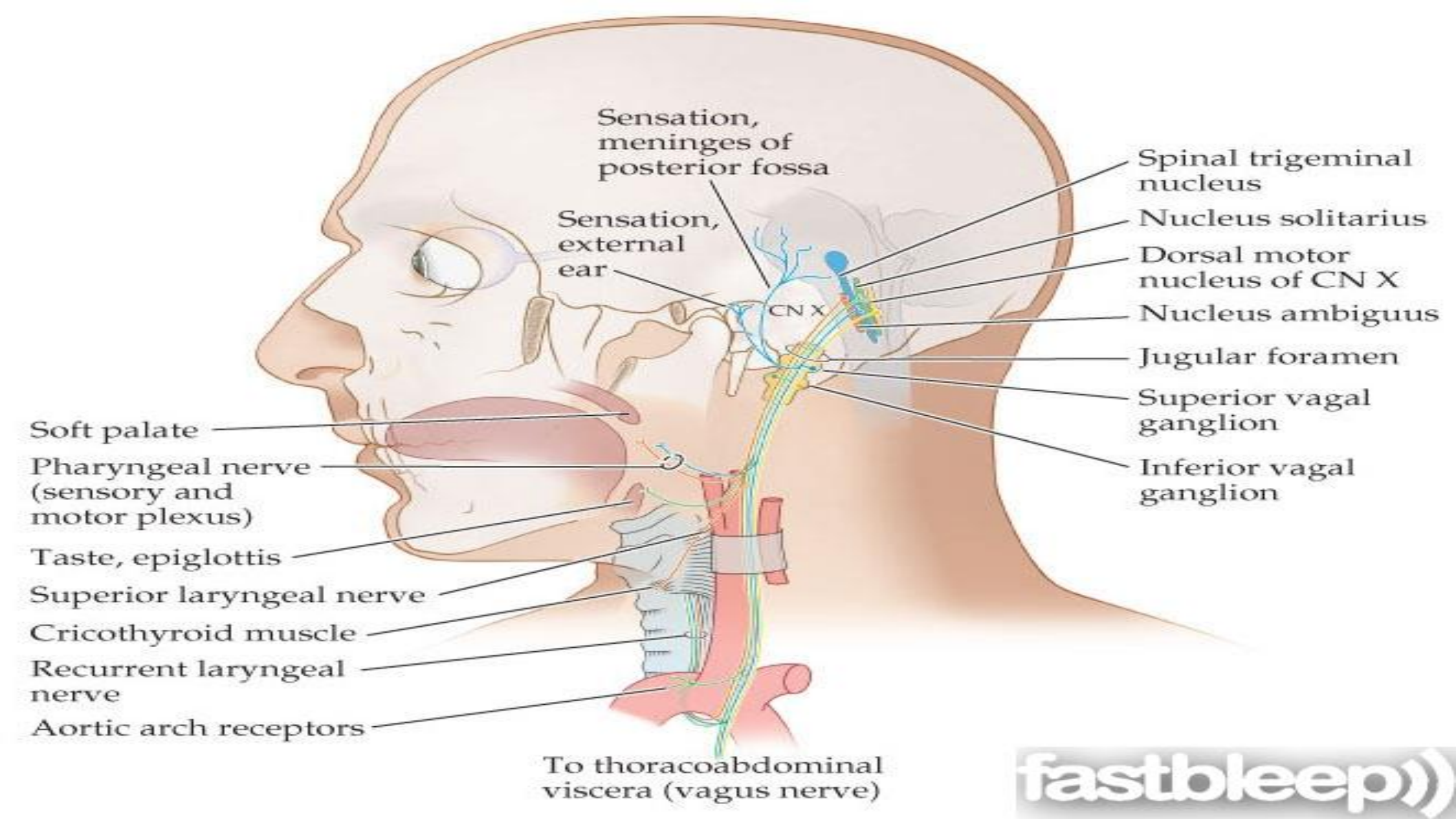
CLINICAL CORRELATION OF CN IX

- Usually isolated lesions of CNIX are fairly uncommon. However when they occur, taste is absent on the posterior 1/3 of the tongue, alongside an absence of the gag reflex (as the afferent limb is derived from CNIX). However, due to roughly 25% of the population having an absent gag reflex, this is usually not alone a diagnostic marker.
- Due to the fact that CNIX, X and XI all exit via the jugular foramen, it is common for tumours, infection or trauma to involve these adjacent cranial nerves. Infact tumours in this region cause "jugular foramen syndrome" leading to cranial nerve palsies.
- Glossopharyngeal neuralgia is very similar to trigeminal neuralgia, but limited to the throat and ear and worsens during eating by sensory stimulation, usually initiated by swallowing.

CN X

- The vagus nerve is named after the latin for wanderer, due to it having the longest course and extensive distribution.
- CNX leaves as several rootlets below CNIX on the ventrolateral medulla, crossing the subarachnoid space and exiting the cranium through the jugular foramen between CN IX and XI.
- Upon exiting, CNX forms 2 ganglions:
- the superior ganglion of vagus nerve- synapses with CNIX and the superior cervical ganglion. It is responsible for general sensation.
- the inferior ganglion of the vagus nerve- responsible for taste and chemoreceptors from aortic arch.

- As it descends CNX supplies all pharyngeal, laryngeal and upper oesophageal muscles.
- CNX continues inferiorly within the carotid sheath; from here it extends into the thorax, supplying parasympathetic sensation to the heart, lungs and bronchi.
- Upon reaching the eosophageal hiatus, it passes through with the eosophagus entering the abdomen. From here it innervates the oesophagus, stomach and intestines up to the colic flexure.


Sensation, meninges of posterior fossa
Sensation, external ear
CN X
Spinal trigeminal nucleus
Nucleus solitarius
Dorsal motor nucleus of CN X
Nucleus ambiguus
Jugular foramen
Superior vagal ganglion
Inferior vagal ganglion
Soft palate
Pharyngeal nerve (sensory and motor plexus)
Taste, epiglottis
Superior laryngeal nerve
Cricothyroid muscle
Recurrent laryngeal nerve
Aortic arch receptors
To thoracoabdominal viscera (vagus nerve)

Clinical Correlation of CN X

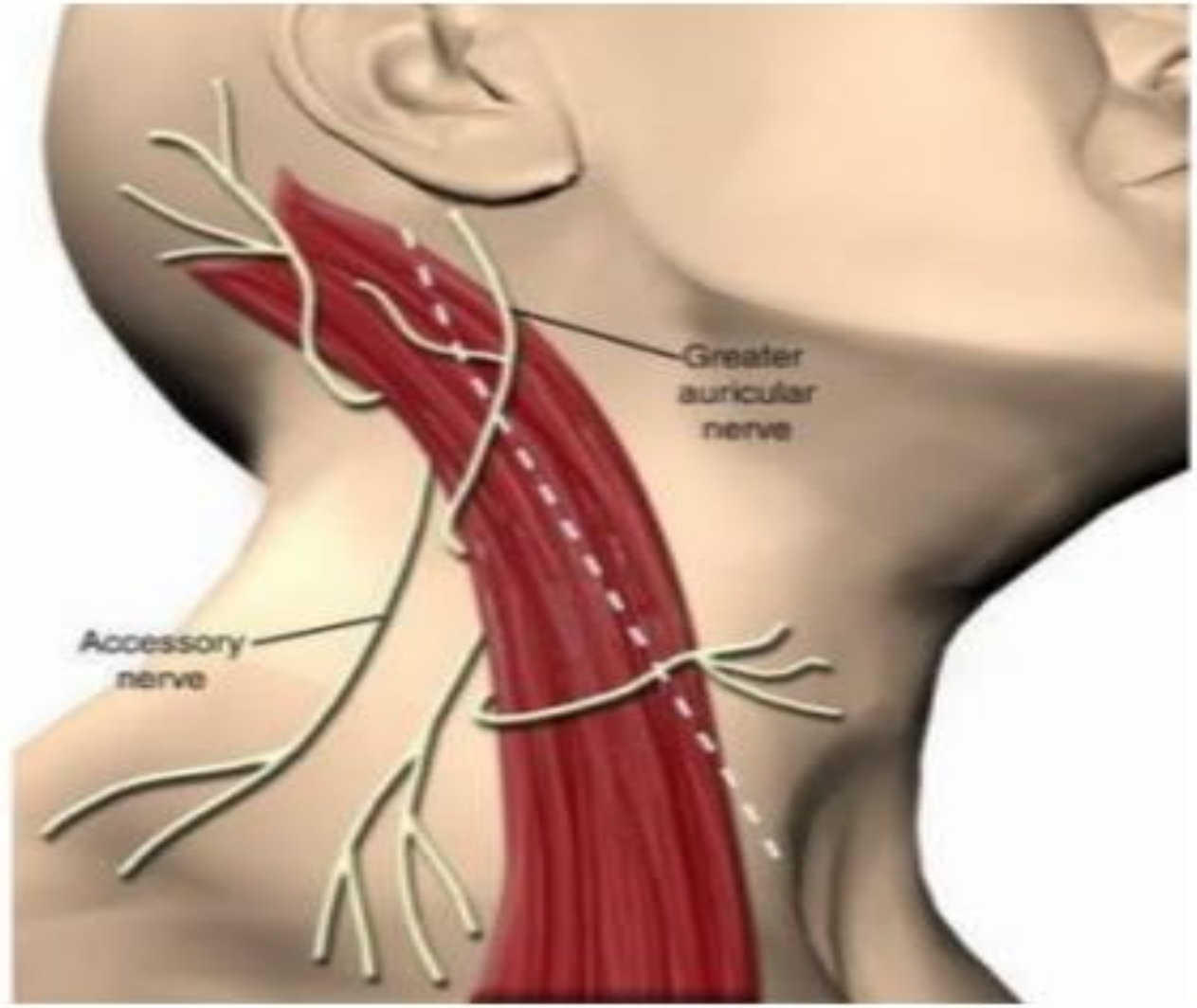
- Isolated lesions are very uncommon, however CNX damage to the pharyngeal branches can lead to dysphagia, and aphonia can develop due to paralysis of the laryngeal muscles.
- The recurrent laryngeal nerve (CNX branch) commonly occurs with surgery of the neck. thyroid surgery and carotid endarterectomy, or cardiac surgery due to the recurrent laryngeal looping around the arch of aorta on the left side. Aortic aneurysms and apical lung cancers can also damage the recurrent laryngeal. Damage to the recurrent laryngeal leads to loss of voice and inspiratory stridor.
- An abnormal gravelly voice is common in Parkinson's disease due to interference of basal ganglia dysfunction with articulation.
- Usually dysphagia and dysarthria occur together and can be caused by infarcts, cerebellar/brainstem lesions and alcohol. Commonly any dysphagia can lead to aspiration pneumonia due to impaired swallowing in an individual, and is frequently a cause of death.

CN XI

- This cranial nerve does not arise from the brainstem, rather from C1-5.
- These rootlets leave the spinal accessory nucleus between the dorsal and ventral nerve roots and ascend through the foramen magnum. Upon entering the cranium it exits the cranium via the jugular foramen by descending alongside the internal carotid artery. It eventually supplies the sternocleidomastoid (SCM) and the upper portion of the trapezius muscle. As it is leaving the cranium, some rootlet fibres from the nucleus ambiguus in the medulla join CNXI briefly before leaving immediately and rejoining CNX to form the recurrent laryngeal nerve. It is mentioned within literature that there are cranial contributions from the medulla, these fibers however do not connect with the spinal component and only travel with CNXI for a few cm, so functionally these fibers can be assumed still part of CNX.

CN XI - SPINAL ACCESSORY NERVE

- **ORIGIN:** Medulla
- **INNERVATION:** Sternocleidomastoid & trapezius muscles
- **FUNCTION:** Motor function Sternocleidomastoid & trapezius
- **DYSFUNCTION:** Muscle weakness.



CLINICAL CORRELLATION OF CNXI

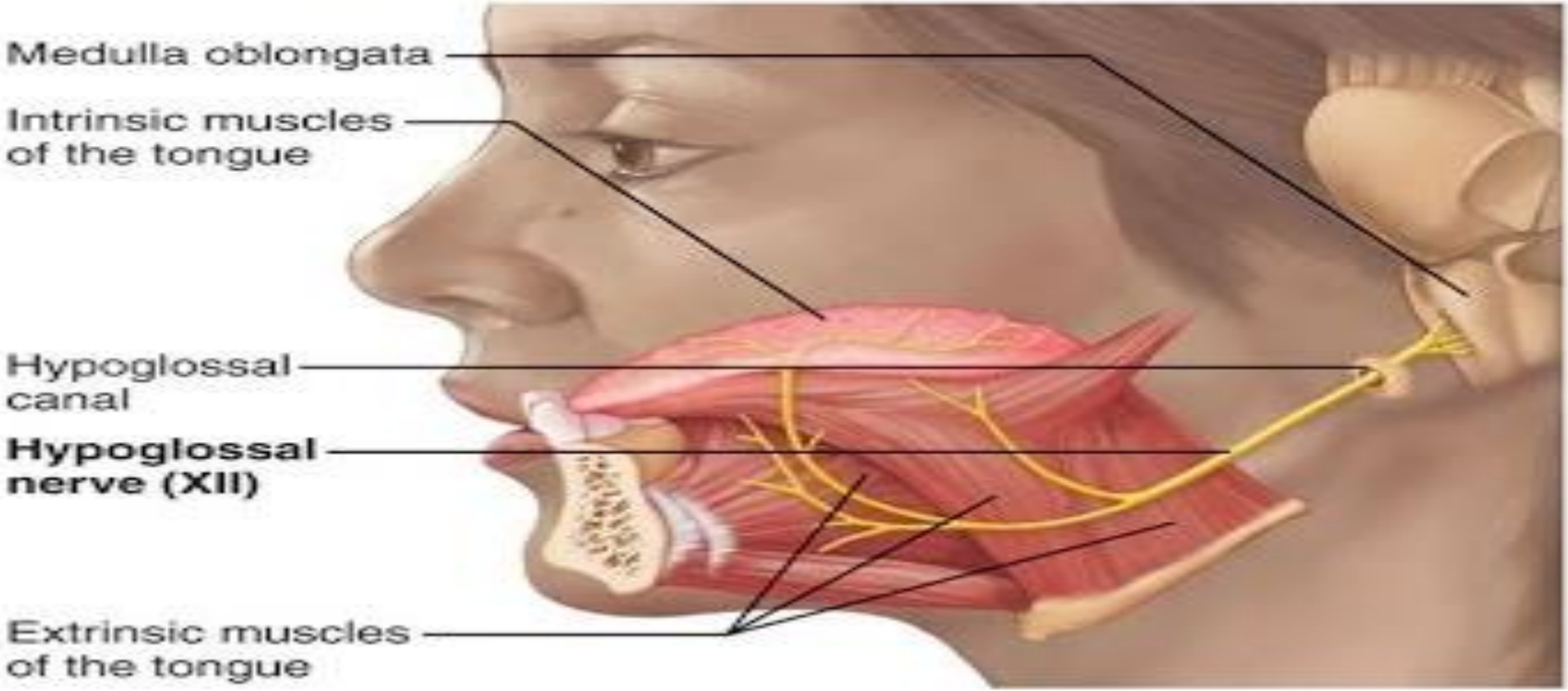
- lesions of CNXI cause ipsilateral weakness of the shoulder shrug due to trapezius damage and a weakness of the head turning away from the lesion, this is due to the left SCM turning the head right (and vice versa).
- Due to a tendency of other neck muscles to compensate for the SCM, it is essential to palpate the SCM to detect its contraction.
- Due to its very superficial course through the cervical region, it is very commonly damaged in surgery, especially lymph node biopsies, internal jugular vein cannulation and carotid endarterectomy.

CN XII

- Arising from several rootlets from the ventral medulla it leaves the cranium via the hypoglossal canal.
- Upon leaving the hypoglossal canal, it is joined by branches of the cervical plexus which use CNXII to reach the hyoid muscles.
- Upon reaching the angle of the mandible it travels anteriorly to innervate all intrinsic and extrinsic muscles of the tongue (except the palatoglossus).

The Hypoglossal Nerves - XII

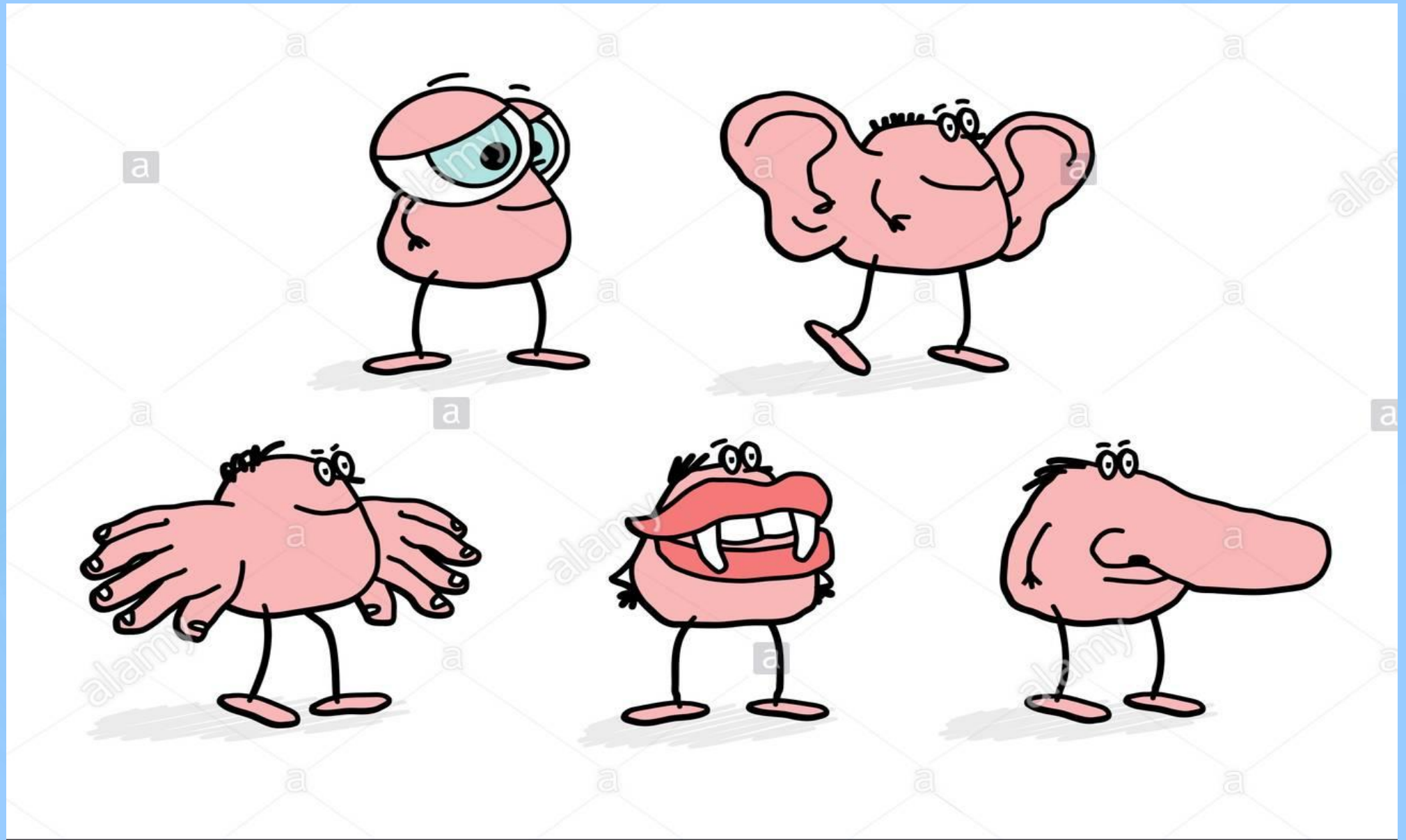
- Runs inferior to the tongue
  - Innervates the tongue muscles



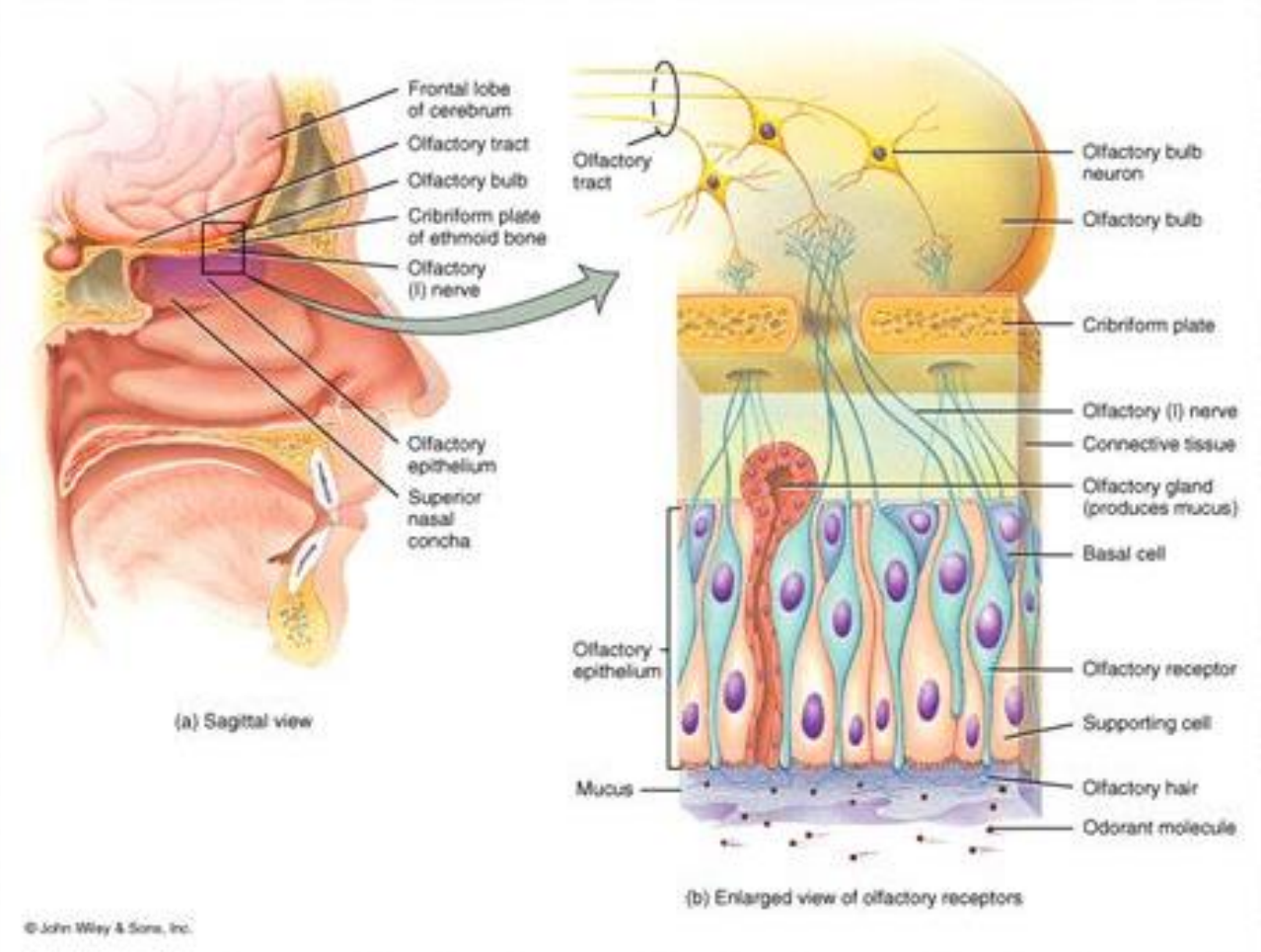
CLINICAL CORRELATION OF CNXII

- Upper motor neurones that control tongue movement decussate within the corticobulbar tracts before arriving at the hypoglossal nuclei. This means lesions of the primary motor cortex/internal capsule cause contralateral weakness of the tongue, whereas lesions of the hypoglossal nuclei cause ipsilateral weakness of the tongue.
- Tongue weakness causes the tongue upon protrusion to deviate towards the weak side due to overactive compensatory action of the other hypoglossal nerve. CNXII damage also causes tongue muscles to atrophy.

SENSORY ORGANS



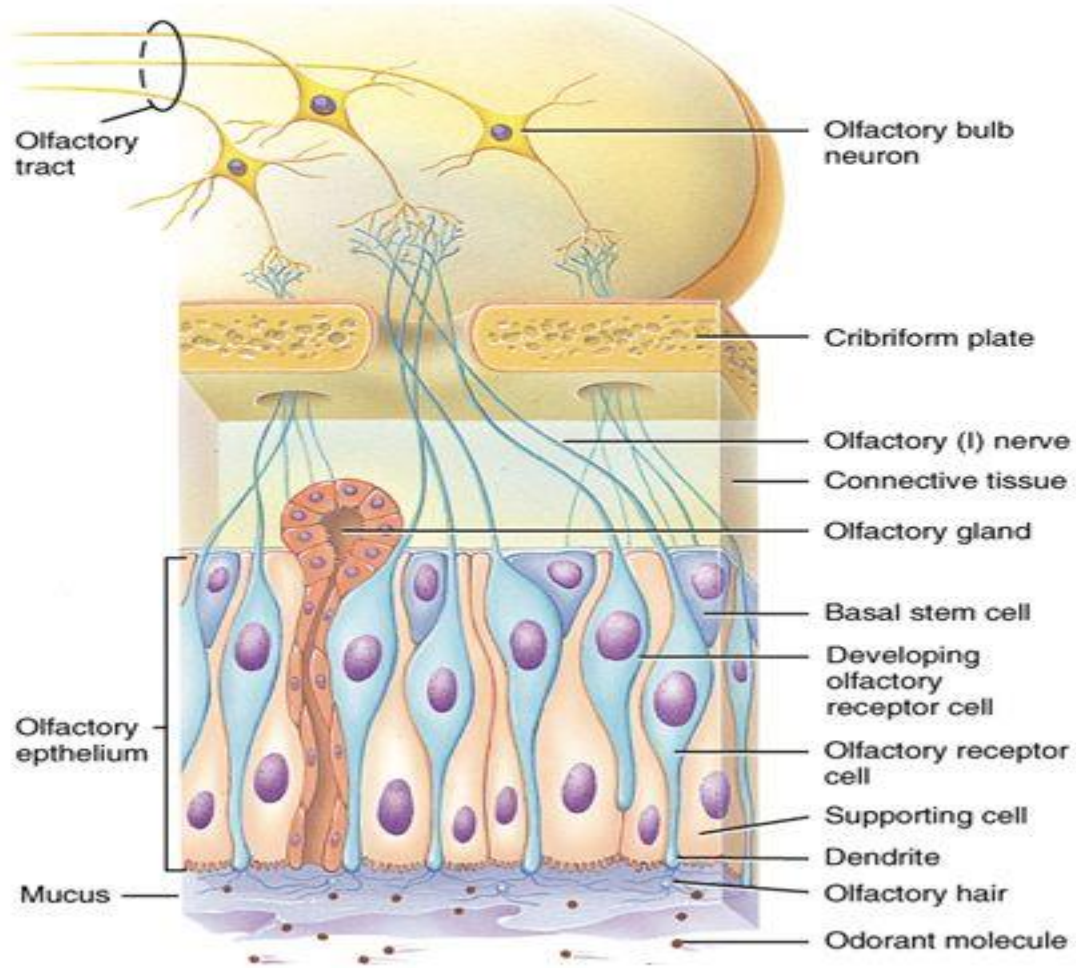
Chemical Senses: Smell

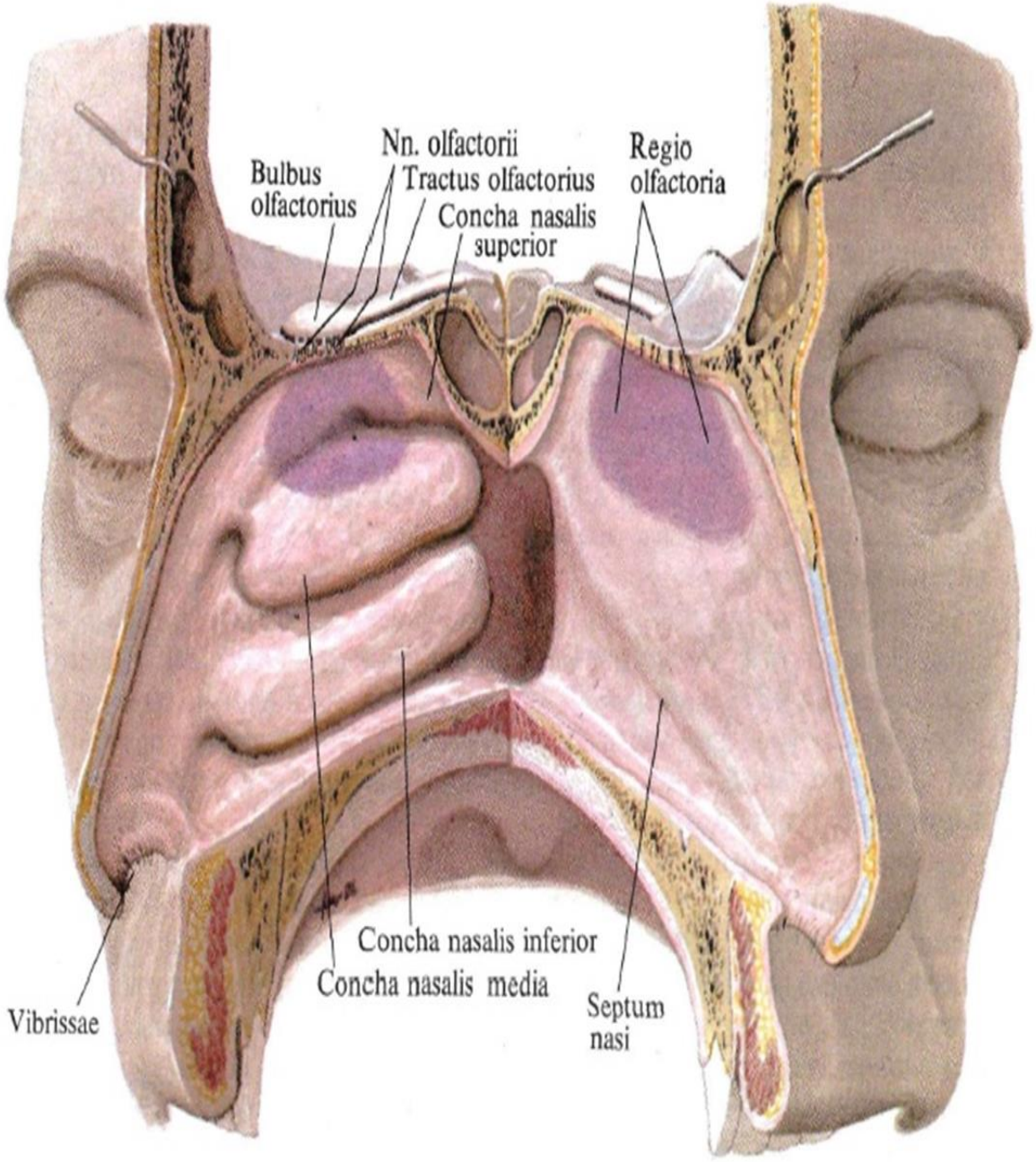


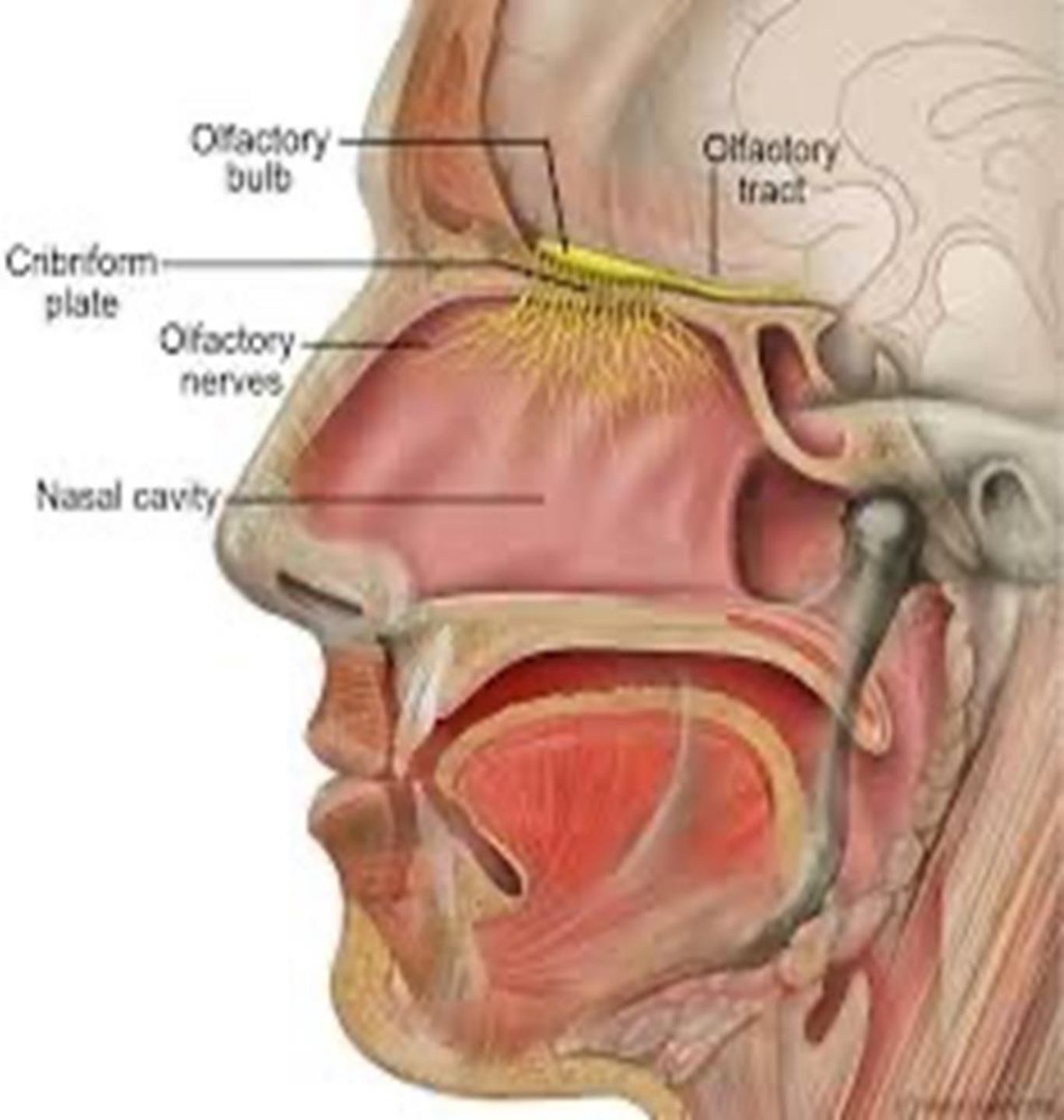
- The olfactory cortex of the brain is tied to the emotional part of the brain, thus many smells with trigger memories and emotions
- The receptors are quickly triggered, but also quickly adapt to smells

Cells of the Olfactory Membrane

- Olfactory receptors
  - bipolar neurons with cilia or olfactory hairs
- Supporting cells
  - columnar epithelium
- Basal cells = stem cells
  - replace receptors monthly
- Olfactory glands
  - produce mucus
- Both epithelium & glands innervated cranial nerve VII (facial nerve)



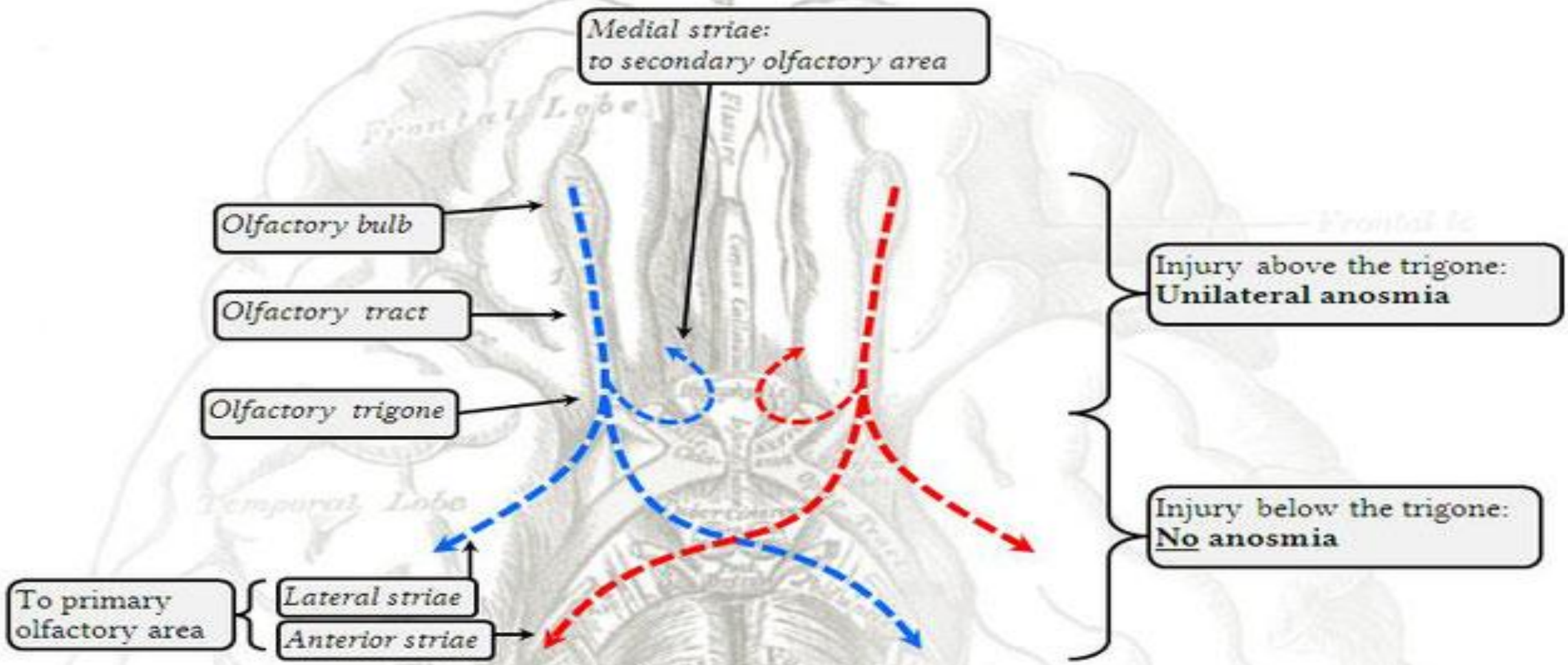

Bulbus olfactorius
Nn. olfactorii
Tractus olfactorius
Concha nasalis superior
Regio olfactoria
Concha nasalis inferior
Concha nasalis media
Septum nasi
Vibrissae


Olfactory bulb
Olfactory tract
Cribriform plate
Olfactory nerves
Nasal cavity

- **The lateral stria** projects to the primary olfactory cortex, formed of the piriform cortex and periamygdaloid cortex which is found near the medial tip of the temporal lobe. From here connections to the **uncus, amygdala (involved in emotional olfaction) and parahypocampal gyrus (III neurons).**

- **The medial stria** penetrate through the anterior perforated substance to the **contralateral olfactory bulb and cortex (III neurons).**

- **The intermedial stria** penetrate through the anterior perforated substance, projects through the anterior commissure to the subcallous region then reach gyrus dentatus, fasciolaris, uncus.

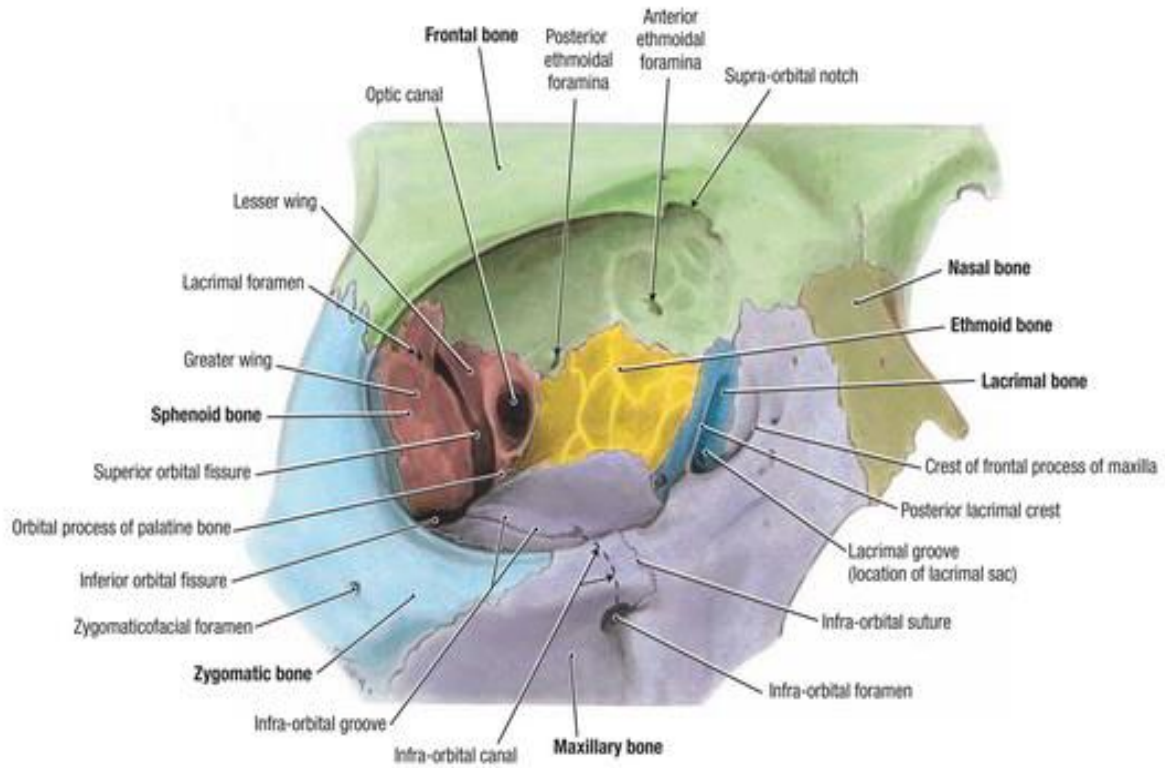

Medial striae:
to secondary olfactory area
Olfactory bulb
Olfactory tract
Olfactory trigone
To primary olfactory area
Lateral striae
Anterior striae
Injury above the trigone:
Unilateral anosmia
Injury below the trigone:
No anosmia

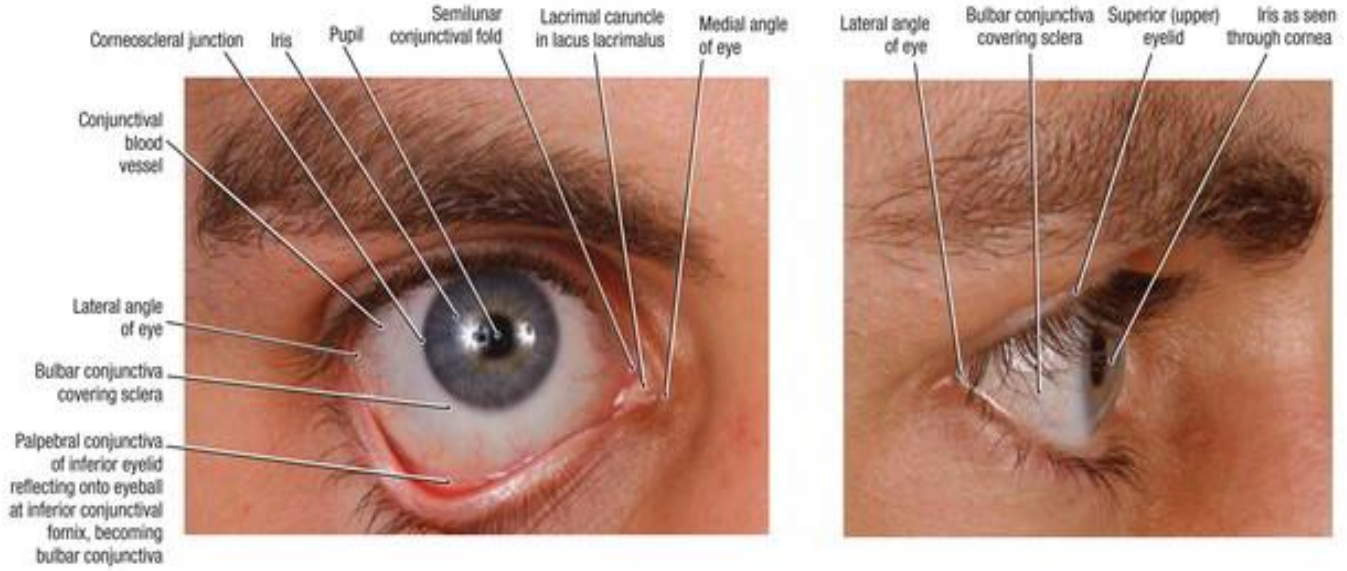
The organ of vision

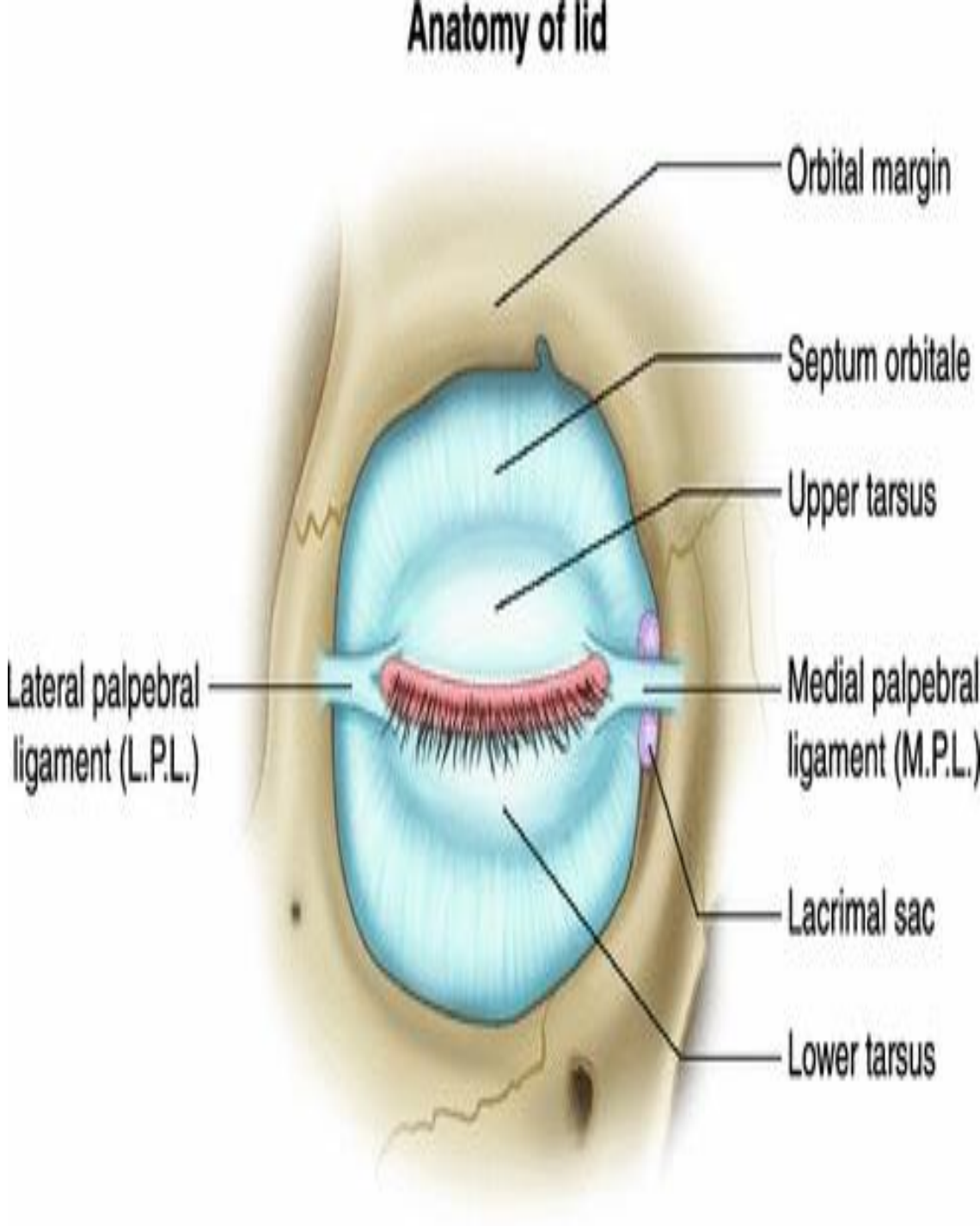
- I.The accessory visual apparatus:
- the eyelids, the lachrymal apparatus,
- and motor apparatus.
- II. Eyeball.

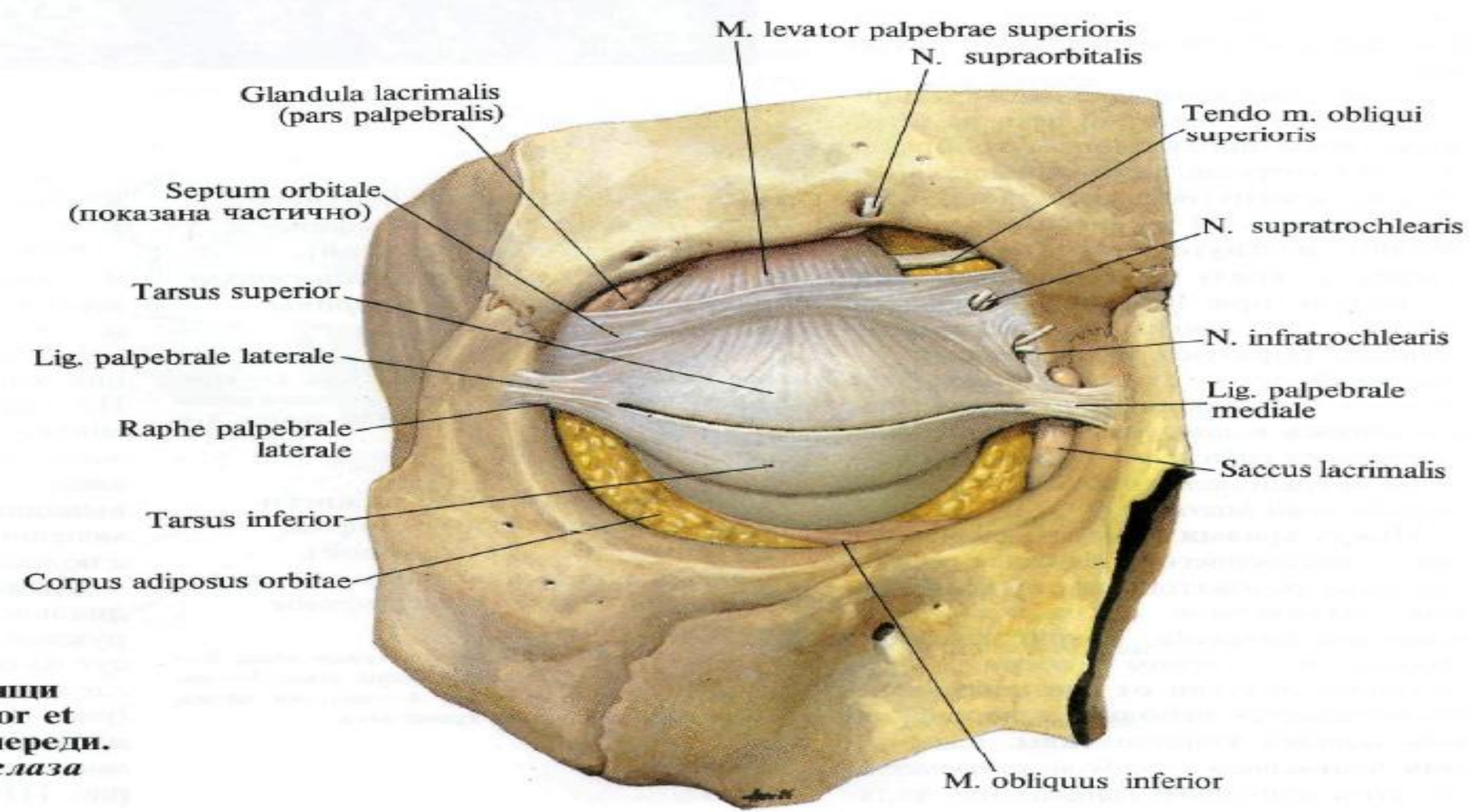
The organ of vision.
The accessory visual apparatus.

- 1- two eyelids: skin, orbicularis oculi muscle, tarsus (tarsal glands), conjunctiva (palpebral and ocular parts, superior and inferior fornices).
- 2- the lachrymal apparatus: lachrymal glands, lachrymal streams, lachrymal lake, lachrymal canaliculi, lachrymal sac, nasolachrimal duct.
- 3- the motor apparatus: four recti mm., two oblique mm., mm. levator palpebral superiorioris.


Frontal bone
Posterior ethmoidal foramina
Anterior ethmoidal foramina
Optic canal
Supra-orbital notch
Lesser wing
Lacrimal foramen
Nasal bone
Ethmoid bone
Greater wing
Lacrimal bone
Sphenoid bone
Crest of frontal process of maxilla
Superior orbital fissure
Posterior lacrimal crest
Orbital process of palatine bone
Lacrimal groove (location of lacrimal sac)
Inferior orbital fissure
Infra-orbital suture
Zygomaticofacial foramen
Zygomatic bone
Infra-orbital foramen
Infra-orbital groove
Infra-orbital canal
Maxillary bone


Corneoscleral junction
Iris
Pupil
Semilunar conjunctival fold
Lacrimal caruncle in lacus lacrimalus
Medial angle of eye
Conjunctival blood vessel
Lateral angle of eye
Bulbar conjunctiva covering sclera
Palpebral conjunctiva of inferior eyelid reflecting onto eyeball at inferior conjunctival fornix, becoming bulbar conjunctiva
Lateral angle of eye
Bulbar conjunctiva covering sclera
Superior (upper) eyelid
Iris as seen through cornea


Anatomy of lid
Orbital margin
Septum orbitale
Upper tarsus
Lateral palpebral ligament (L.P.L.)
Medial palpebral ligament (M.P.L.)
Lacrimal sac
Lower tarsus



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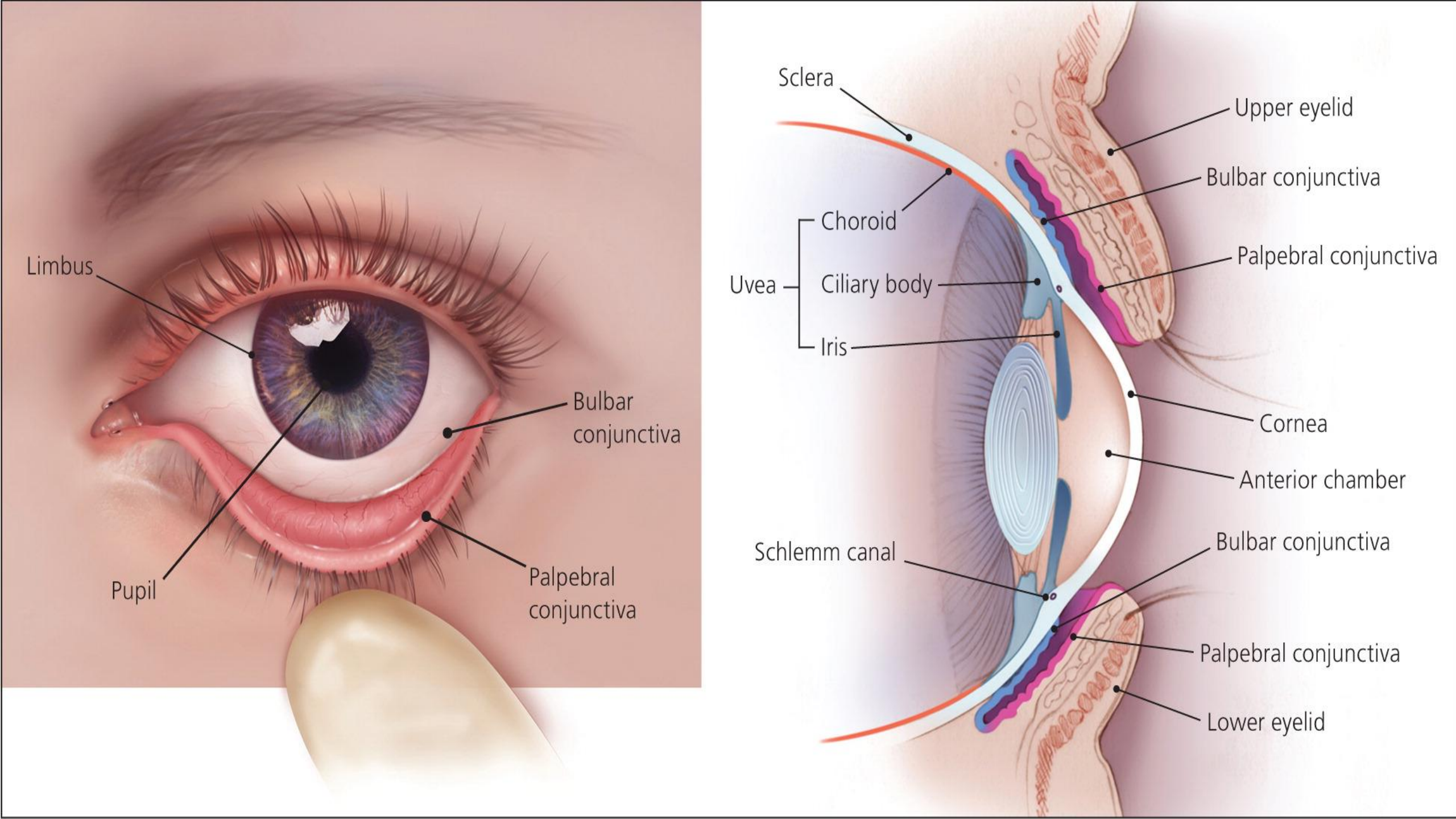
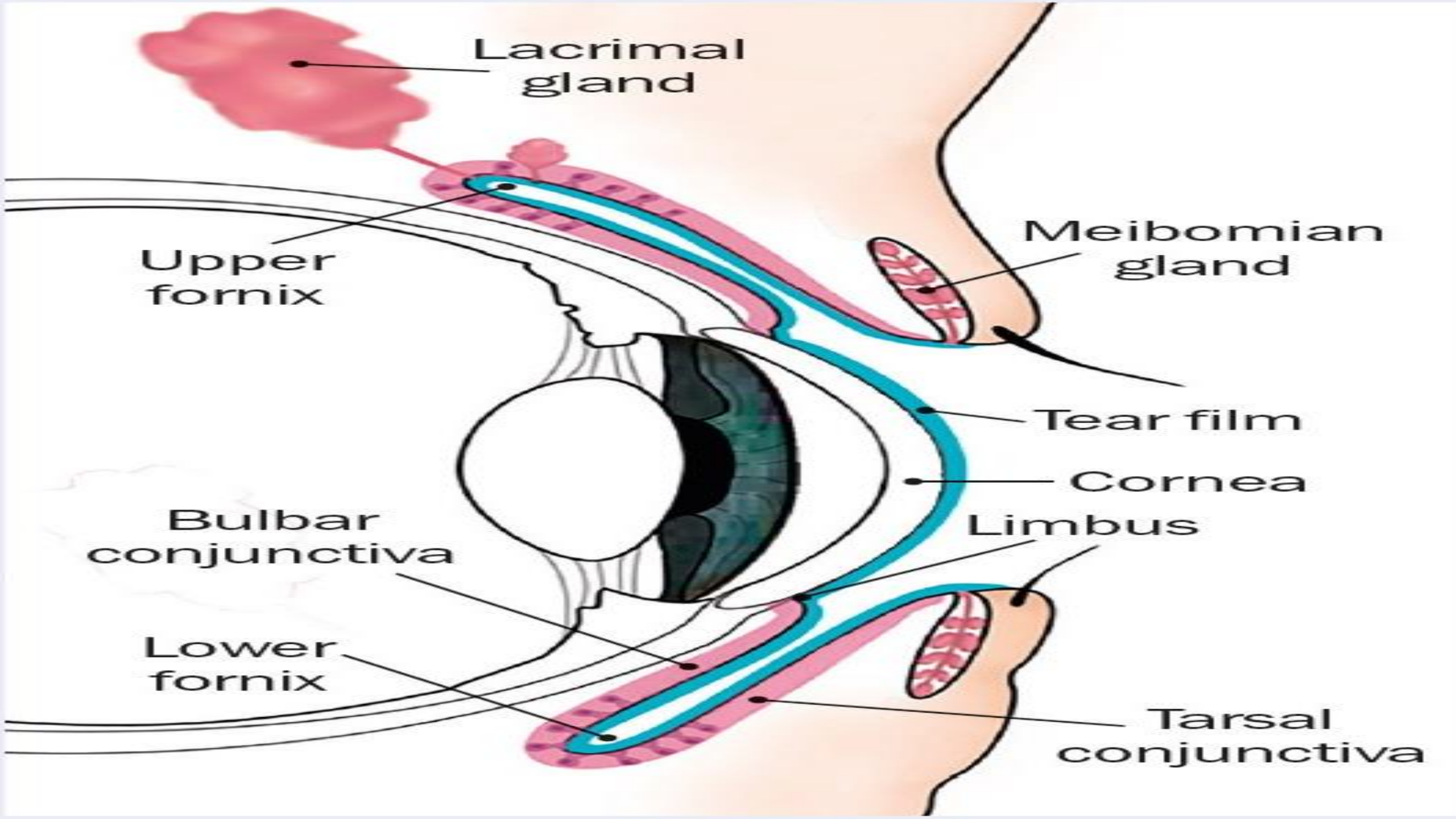
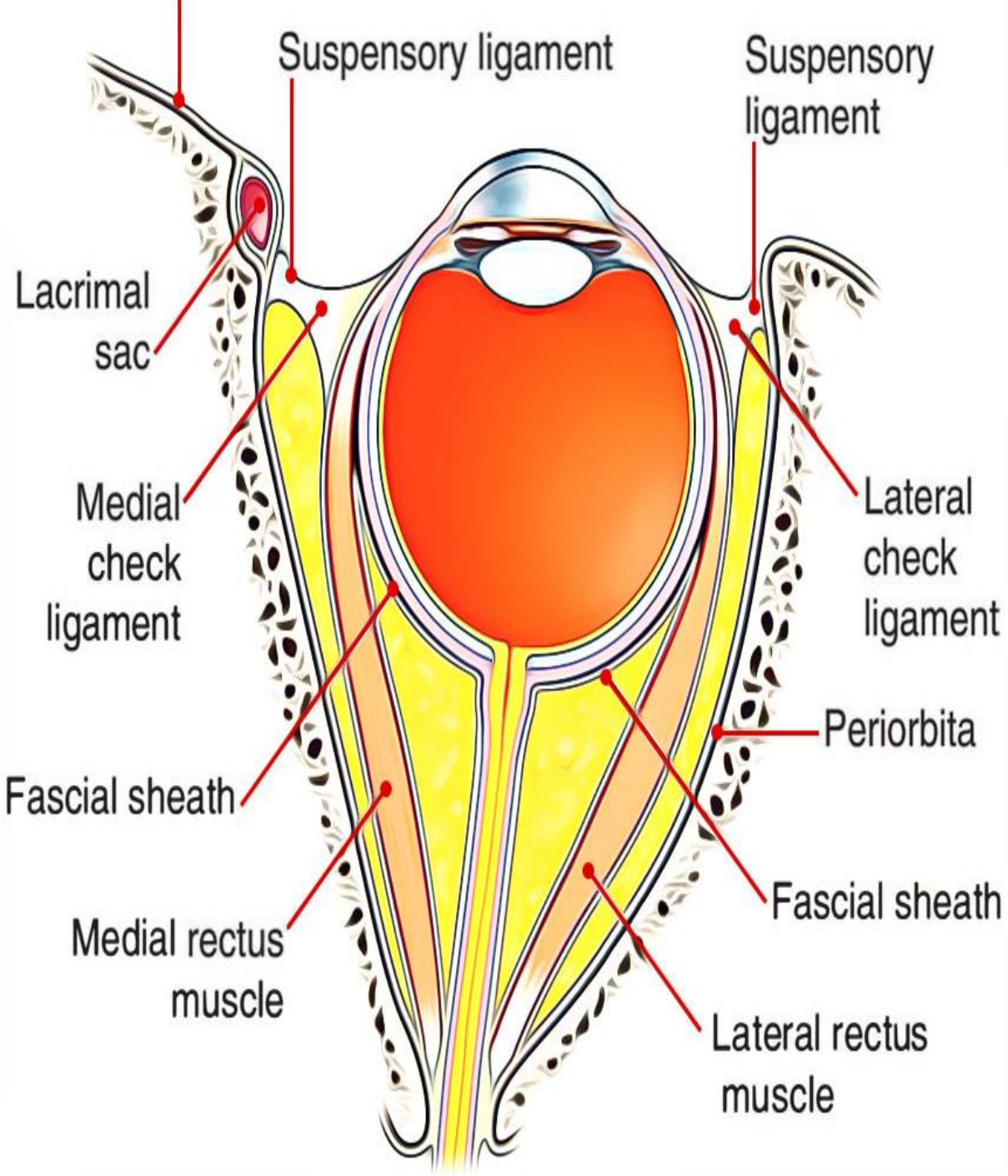
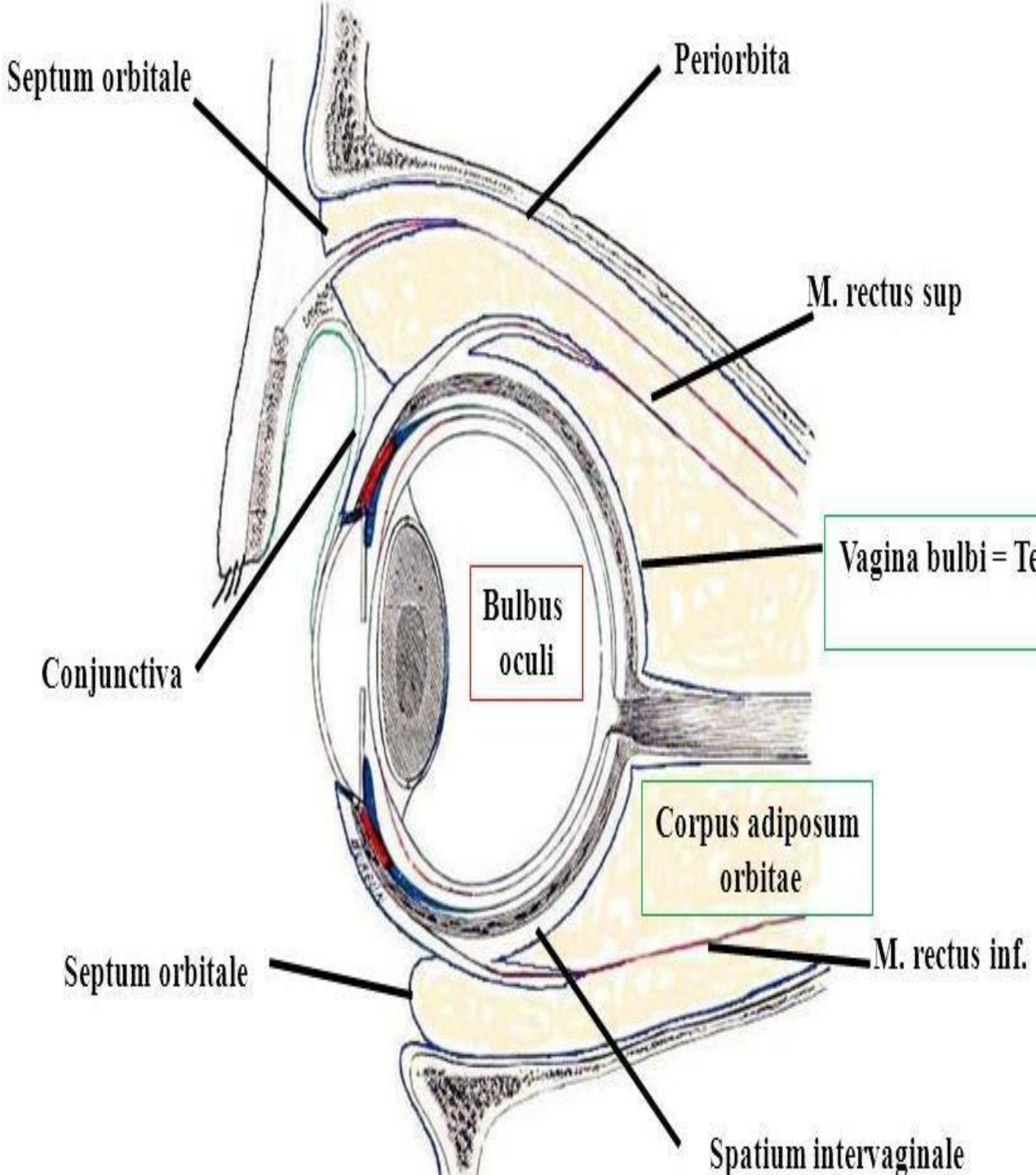
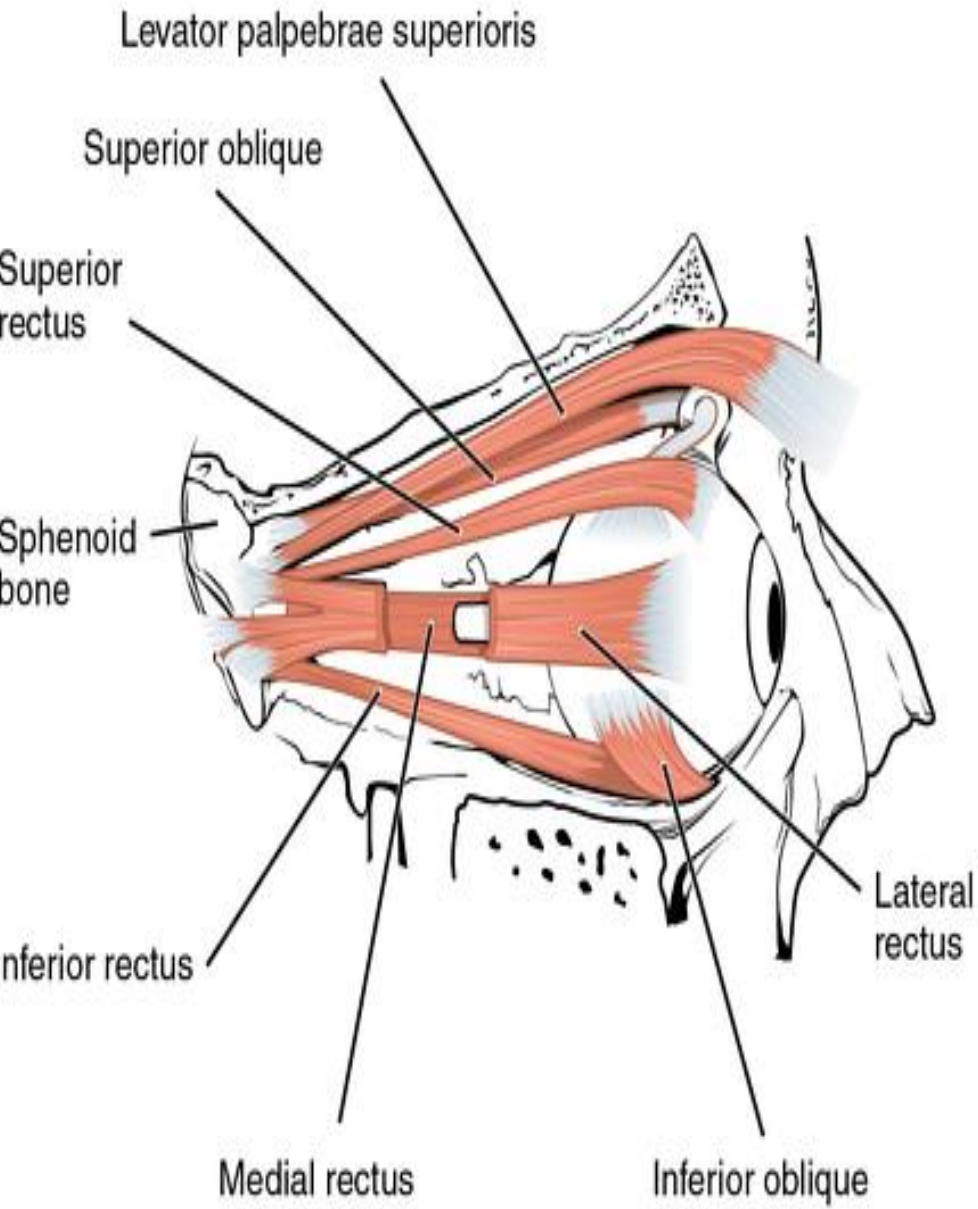
Meibomian glands

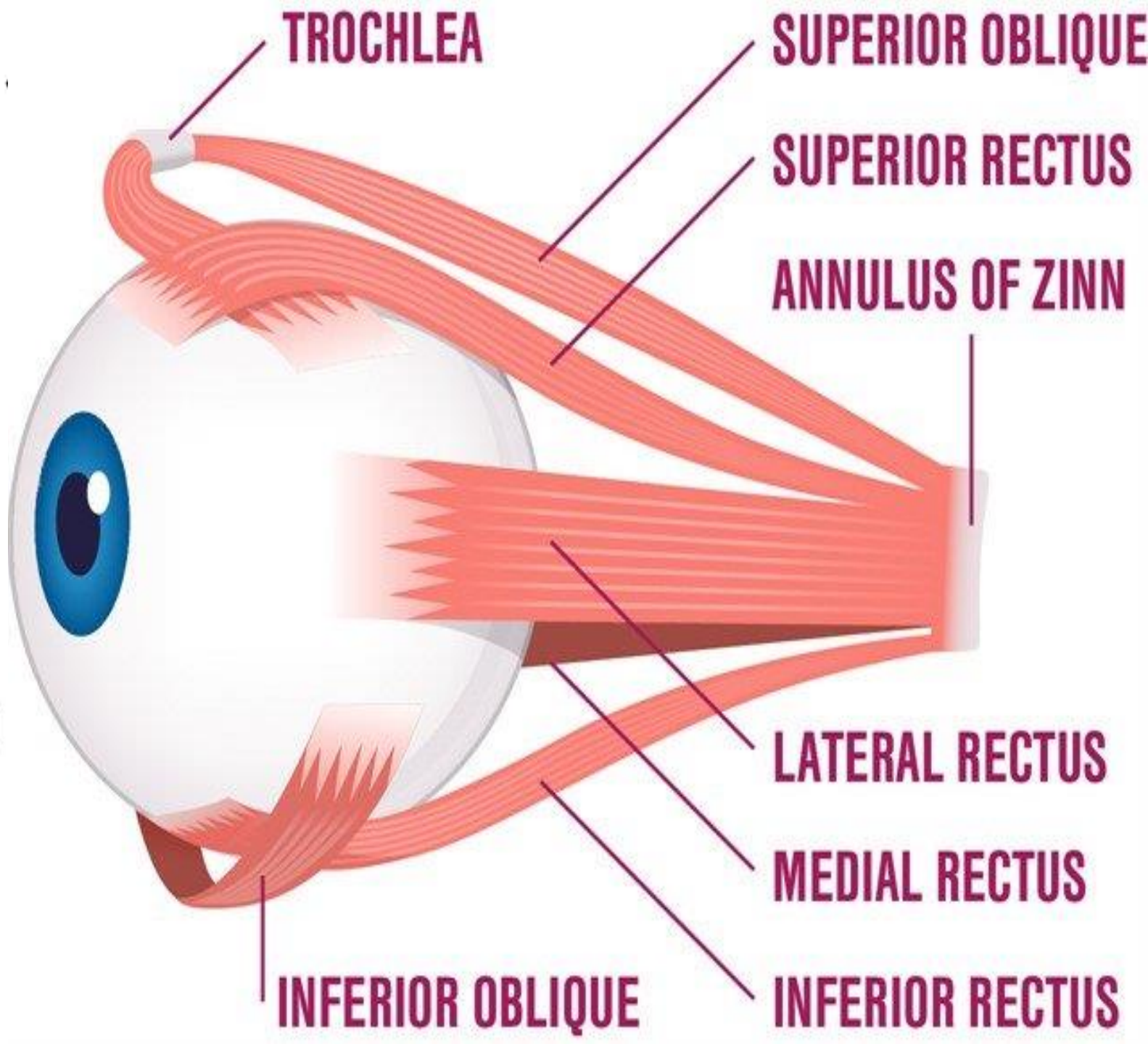

Limbus
Bulbar conjunctiva
Pupil
Palpebral conjunctiva
Sclera
Upper eyelid
Bulbar conjunctiva
Choroid
Palpebral conjunctiva
Uvea
Ciliary body
Iris
Cornea
Anterior chamber
Schlemm canal
Bulbar conjunctiva
Palpebral conjunctiva
Lower eyelid

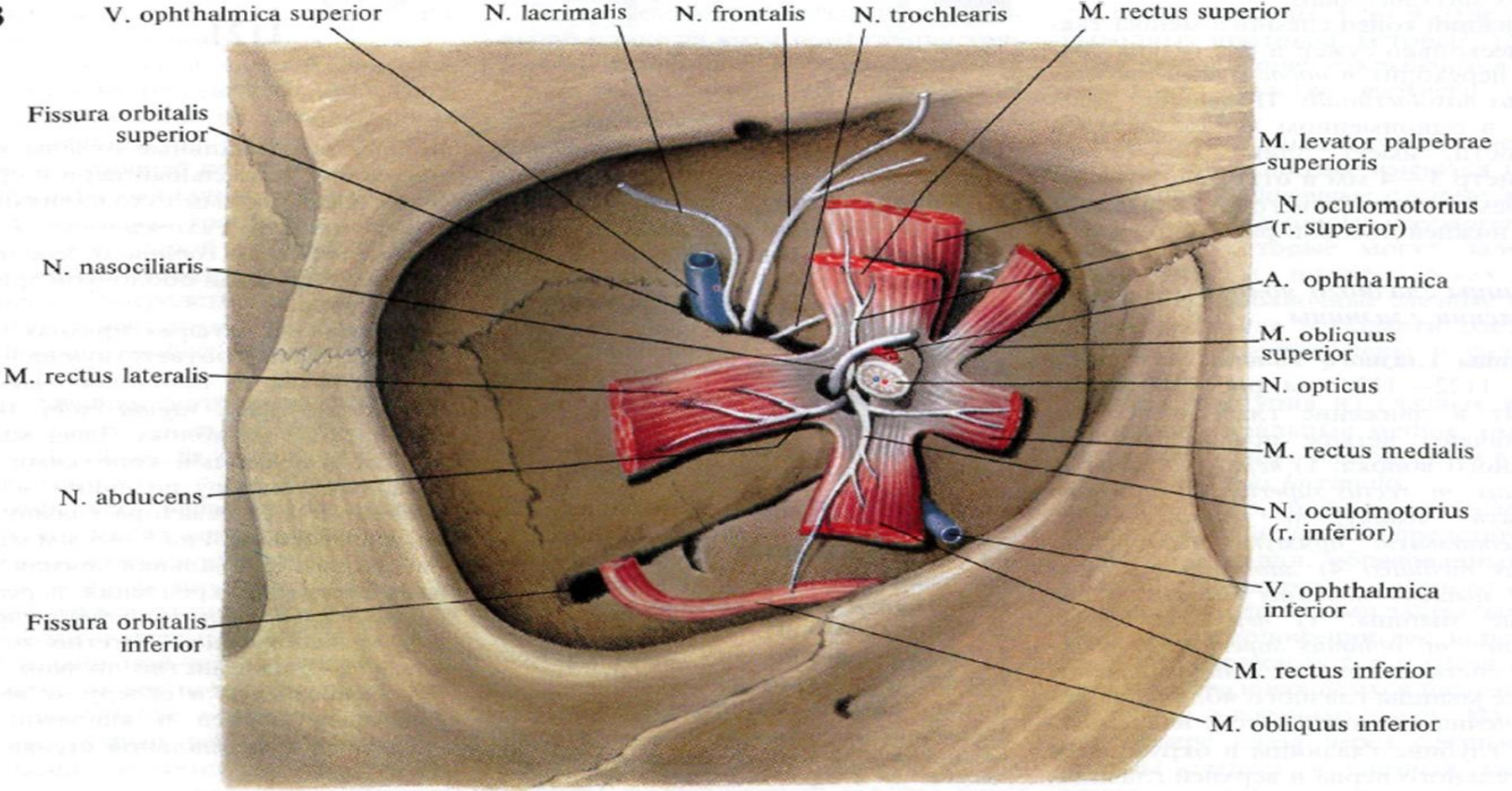

Lacrimal gland
Upper fornix
Meibomian gland
Tear film
Cornea
Limbus
Bulbar conjunctiva
Lower fornix
Tarsal conjunctiva

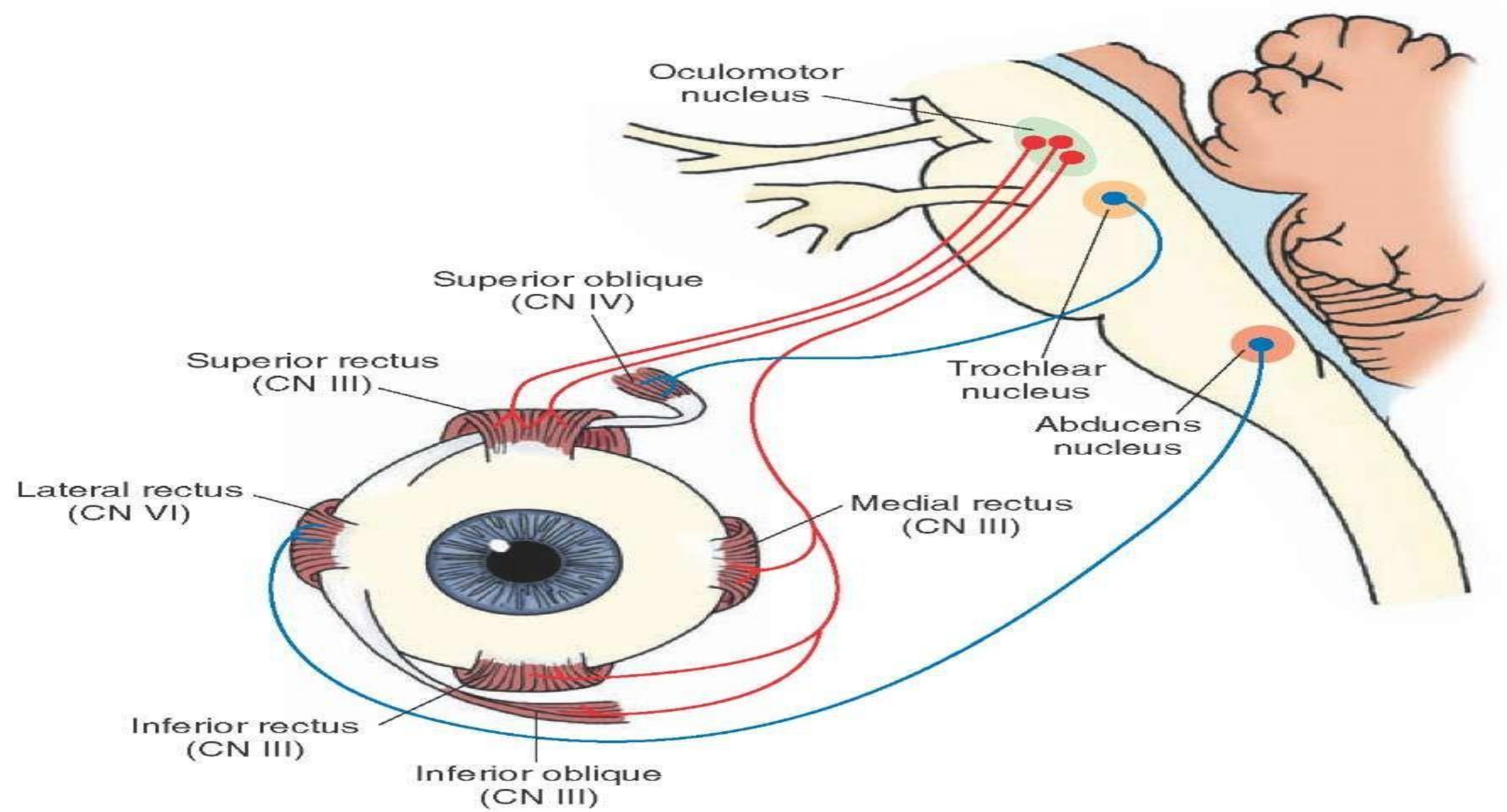

Suspensory ligament
Suspensory ligament
Lacrimal sac
Medial check ligament
Lateral check ligament
Periorbita
Fascial sheath
Fascial sheath
Medial rectus muscle
Lateral rectus muscle

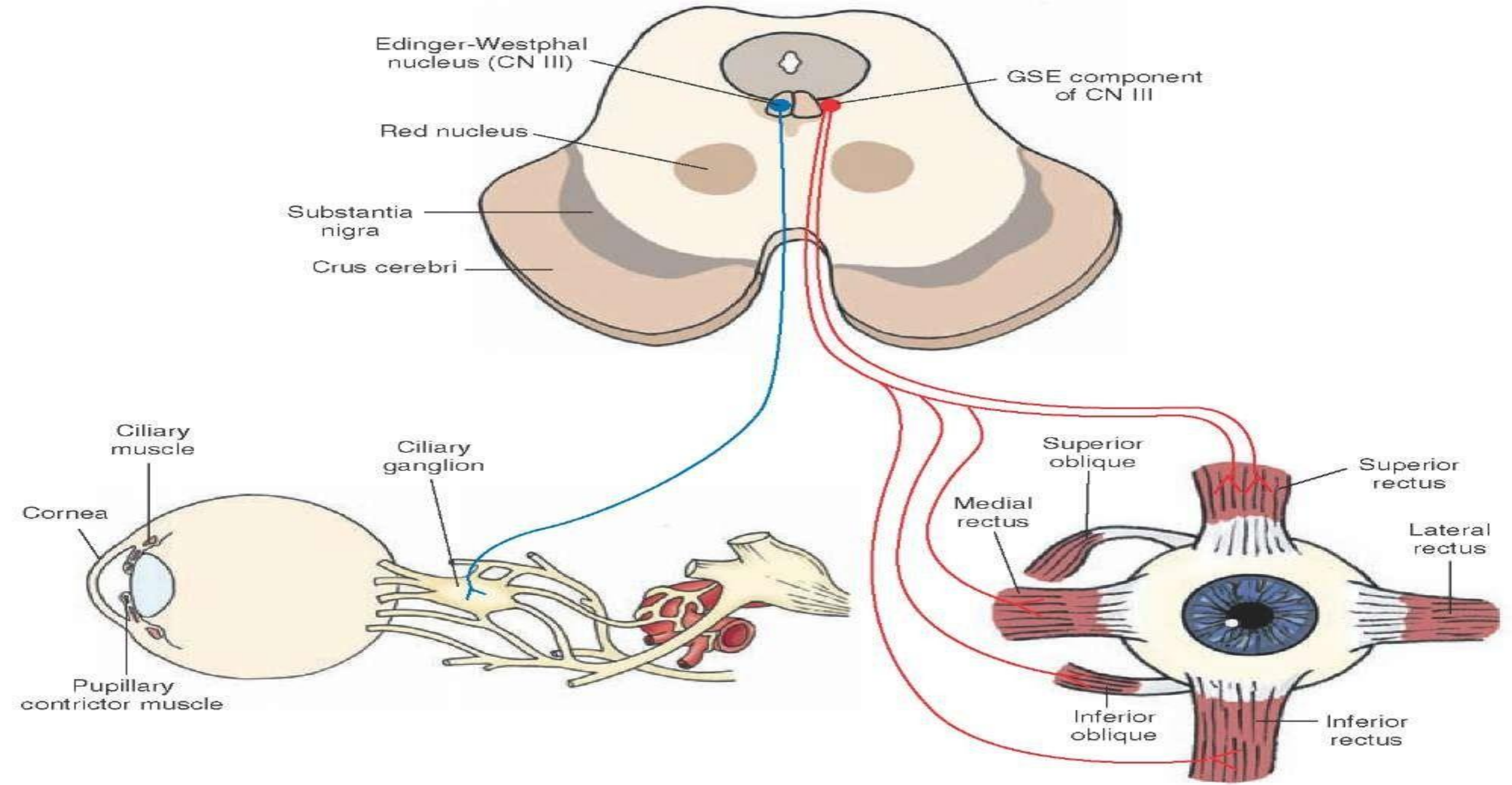

Septum orbitale
Periorbita
M. rectus sup
Vagina bulbi = Te
Bulbus oculi
Conjunctiva
Corpus adiposum orbitae
Septum orbitale
M. rectus inf.
Spatium intervaginale


Levator palpebrae superioris
Superior oblique
Superior rectus
Sphenoid bone
Lateral rectus
Inferior rectus
Medial rectus
Inferior oblique


TROCHLEA
SUPERIOR OBLIQUE
SUPERIOR RECTUS
ANNULUS OF ZINN
LATERAL RECTUS
MEDIAL RECTUS
INFERIOR OBLIQUE
INFERIOR RECTUS


V. ophthalmica superior
N. lacrimalis
N. frontalis
N. trochlearis
M. rectus superior
Fissura orbitalis superior
N. nasociliaris
M. rectus lateralis
N. abducens
Fissura orbitalis inferior
M. levator palpebrae superioris
N. oculomotorius (r. superior)
A. ophthalmica
M. obliquus superior
N. opticus
M. rectus medialis
N. oculomotorius (r. inferior)
V. ophthalmica inferior
M. rectus inferior
M. obliquus inferior


Oculomotor nucleus
Superior oblique (CN IV)
Superior rectus (CN III)
Lateral rectus (CN VI)
Trochlear nucleus
Abducens nucleus
Medial rectus (CN III)
Inferior rectus (CN III)
Inferior oblique (CN III)


Edinger-Westphal nucleus (CN III)
GSE component of CN III
Red nucleus
Substantia nigra
Crus cerebri
Ciliary muscle
Ciliary ganglion
Cornea
Pupillary contrictor muscle
Superior oblique
Superior rectus
Medial rectus
Lateral rectus
Inferior oblique
Inferior rectus

The coats of the eyeball

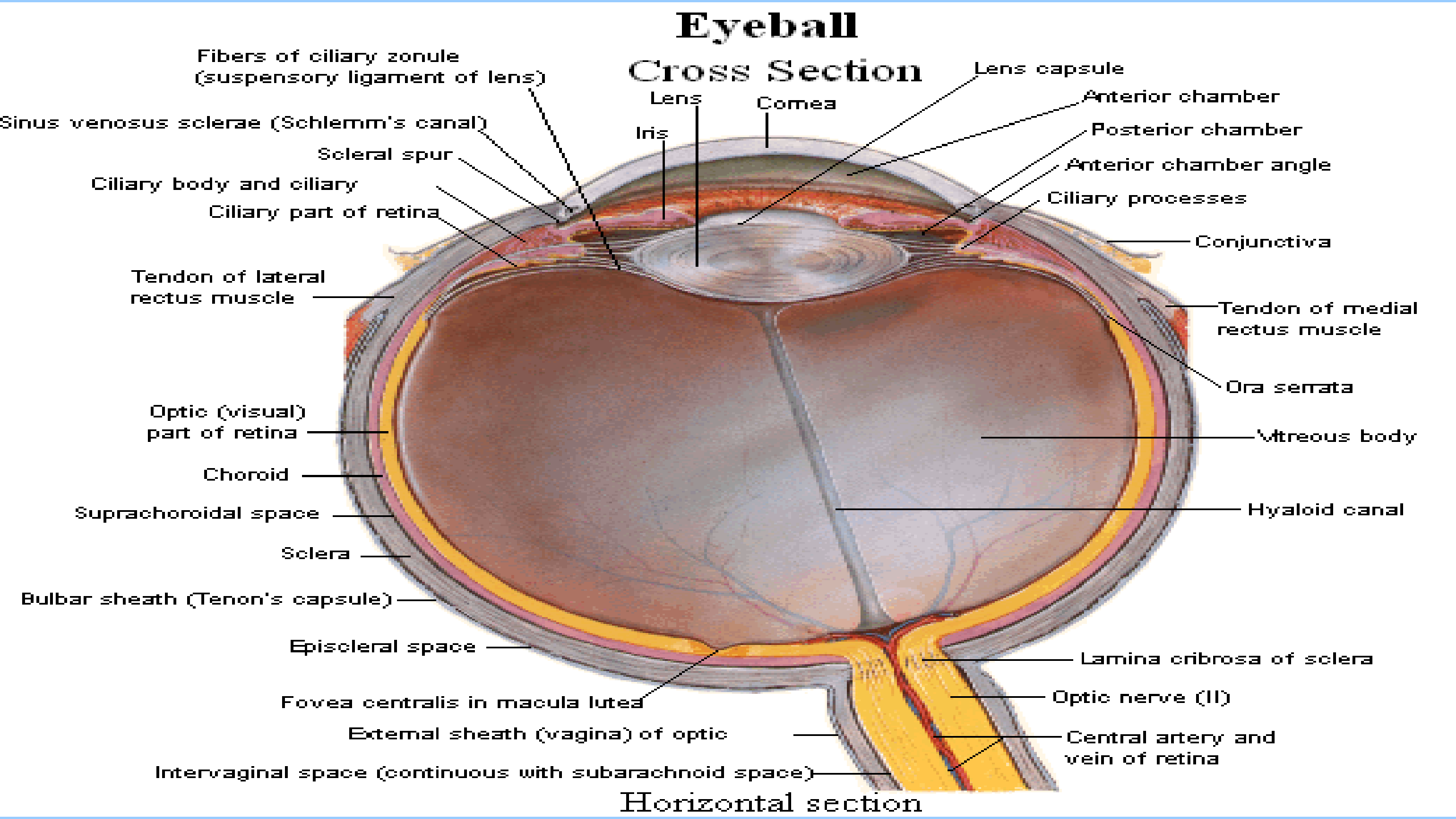
- 1.The fibrous coat (the sclera, the cornea)
- 2.The vascular coat (the choroid, the ciliary body, the iris).
- 3.The retina.

Organ of vision:
The coats of the eyeball

- **Three coats**:
- 1 – **fibrous coat**: sclera, limbus cornea, cornea.
- 2 **– vascular coat**: chorioidea, corpus ciliare: (m.ciliaris, ciliary ring, ciliary processes and folds), iris: (mm.sphincter and dilator pupilla).
- 3 **– nervous coat** (retina):optic and blind parts.
  The refracting media or inner nucleus of the eye: vitreous body, lens, fluid (aqueous humour).

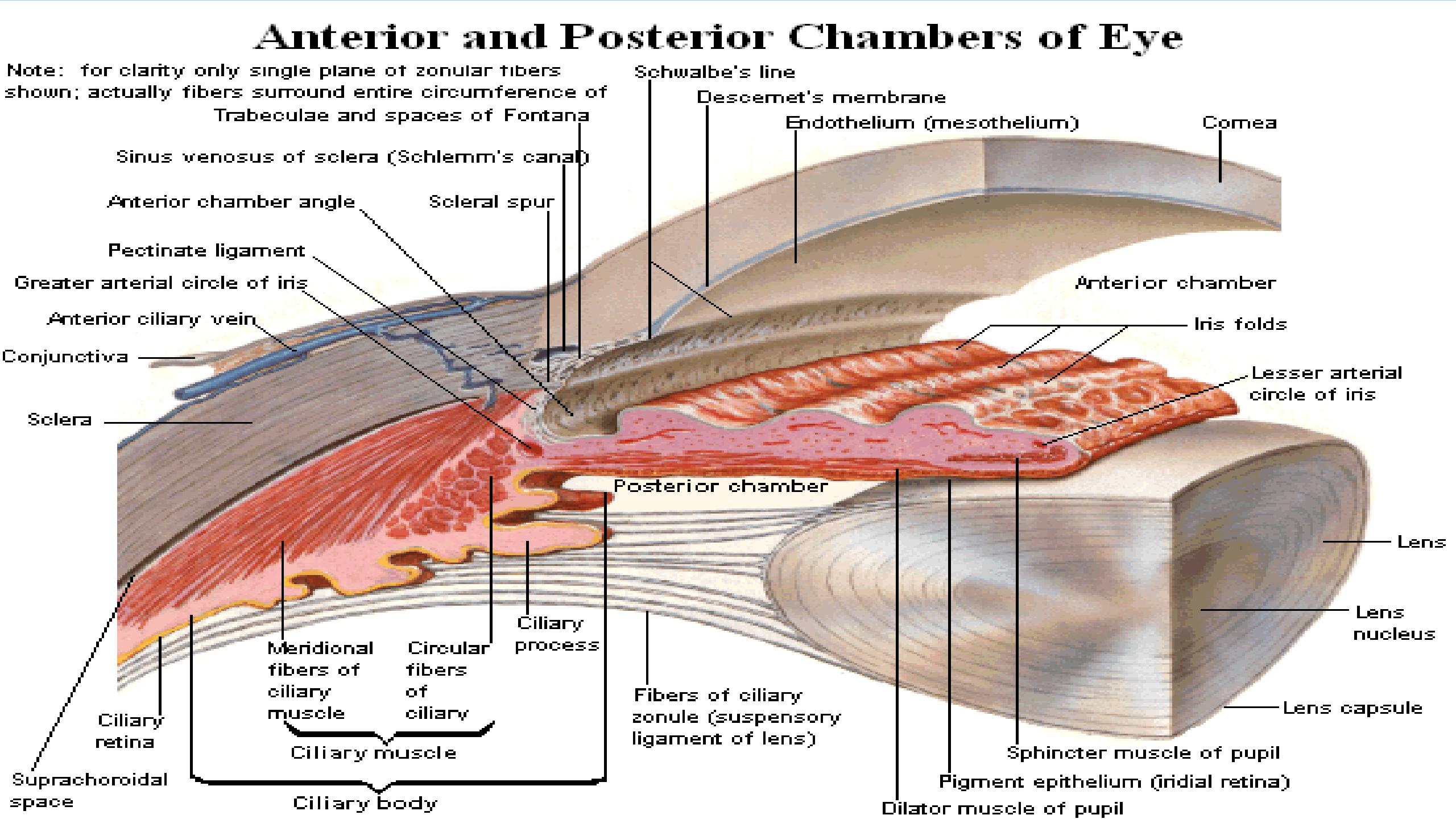
Eyeball

Cross Section



Horizontal section

Anterior and Posterior Chambers of Eye

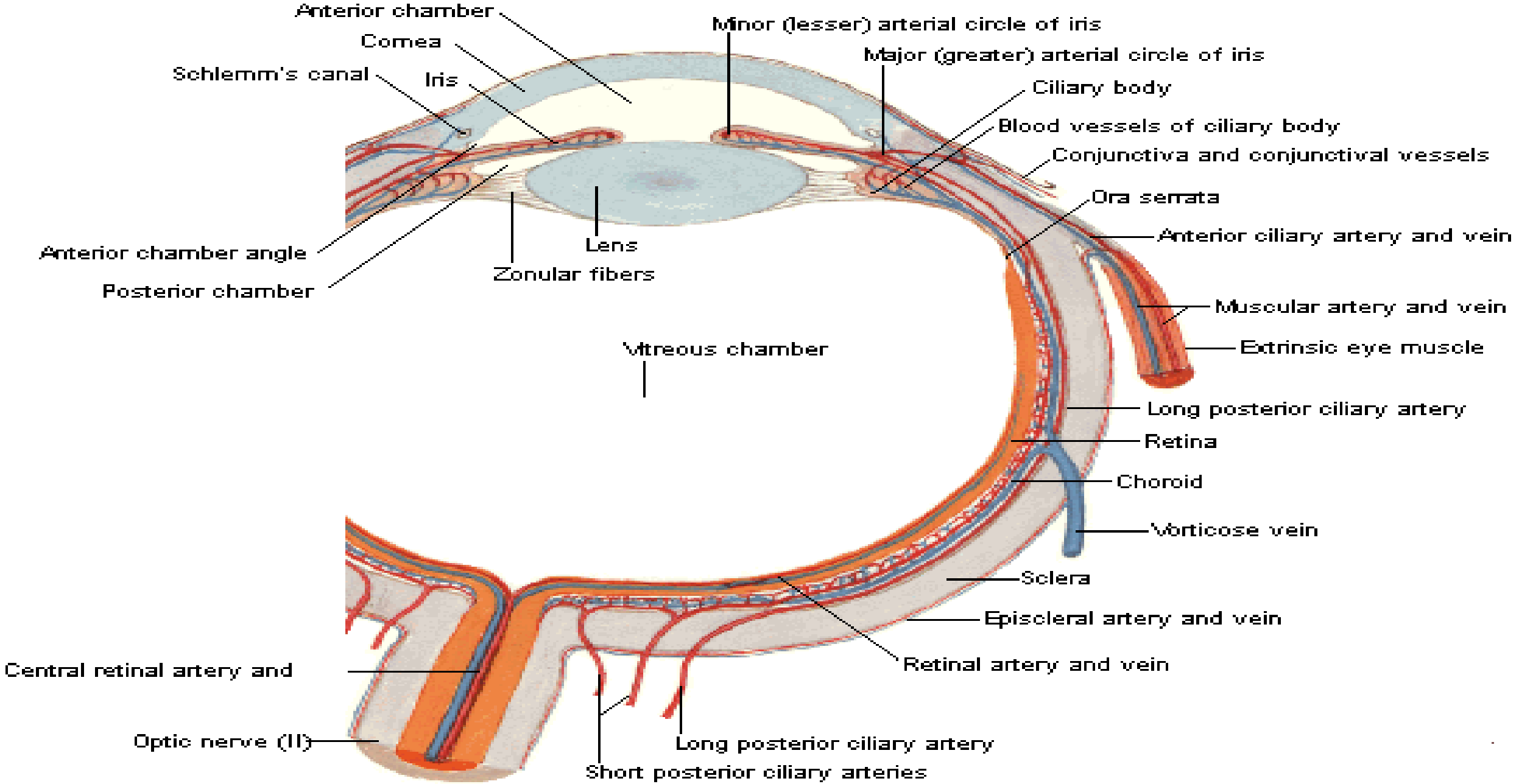


The refracting media of the eye

- The vitreous body
- The lens
- The chambers of the eye (they are filled with aqueous humor)

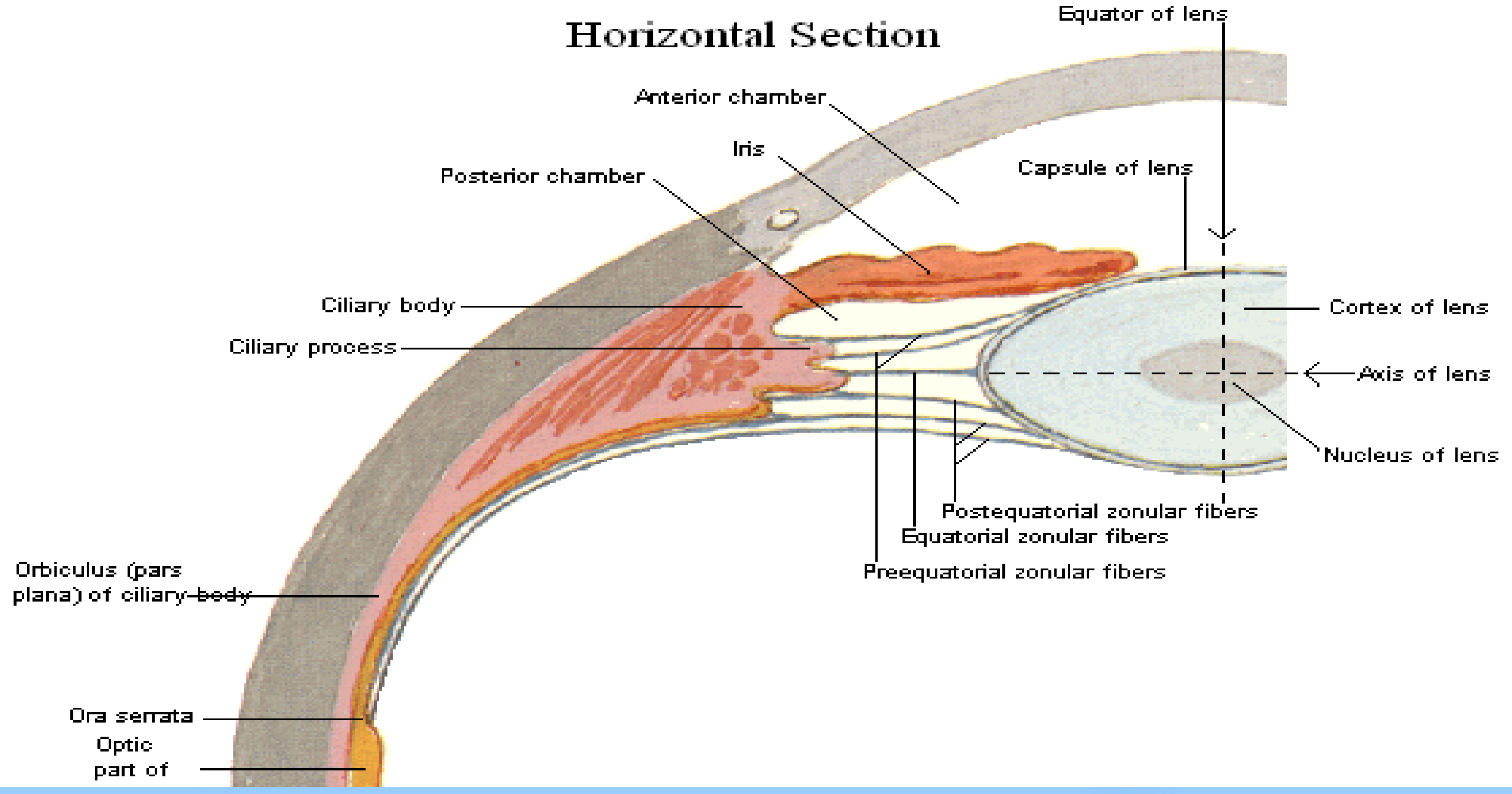
Intrinsic Arteries and Veins of Eye

Horizontal Section

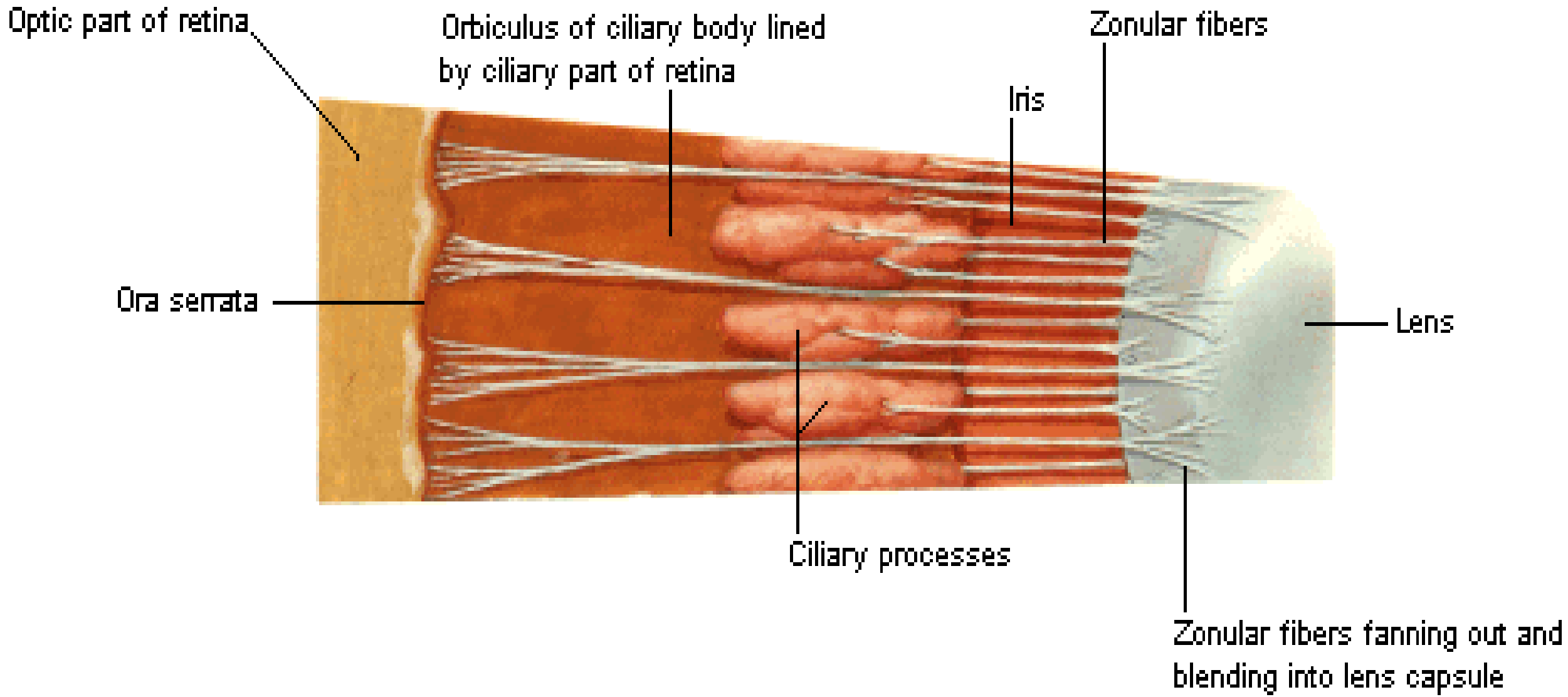


Lens and Supporting Structures

Horizontal Section

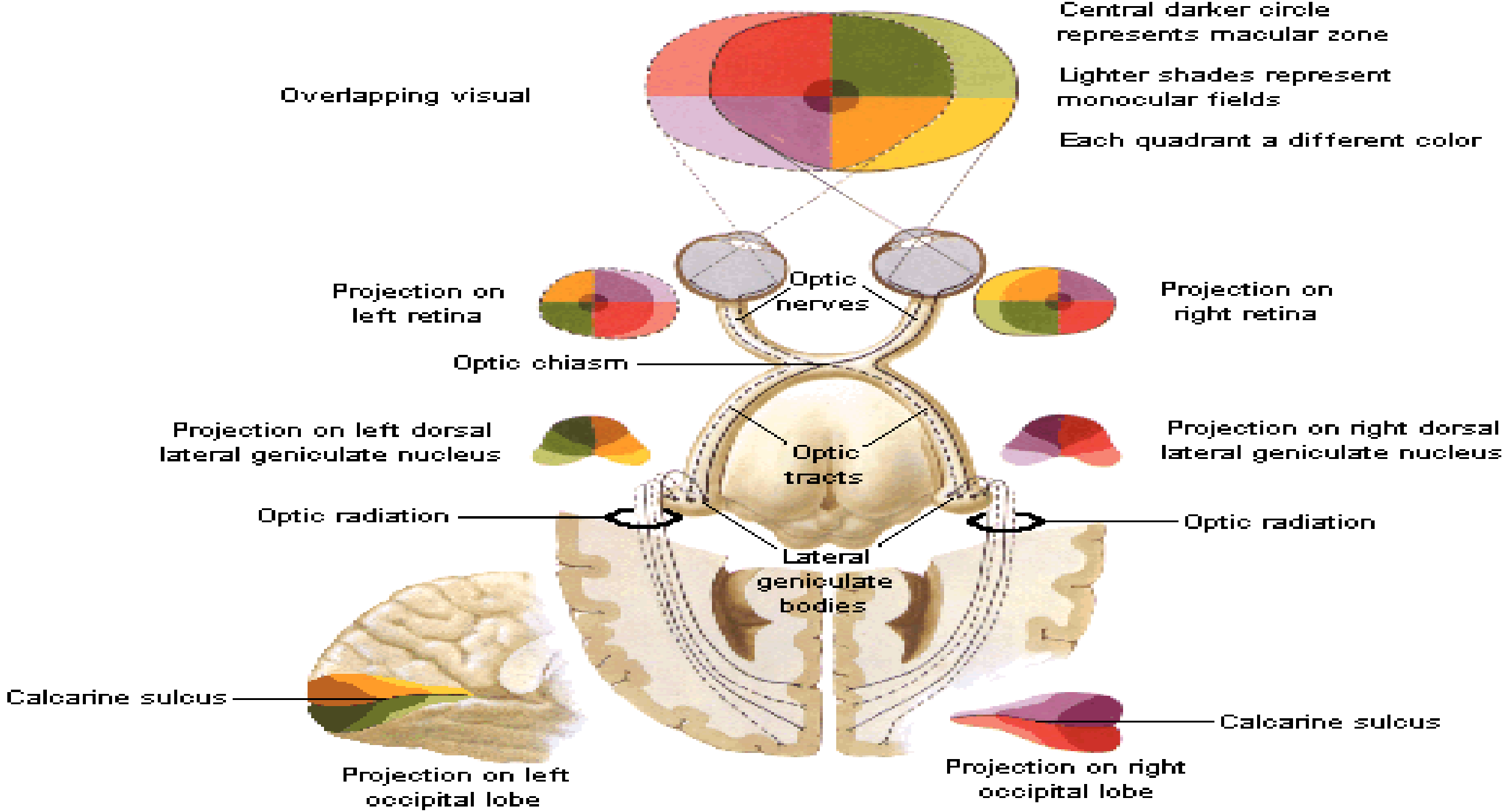


Lens and Supporting Structures



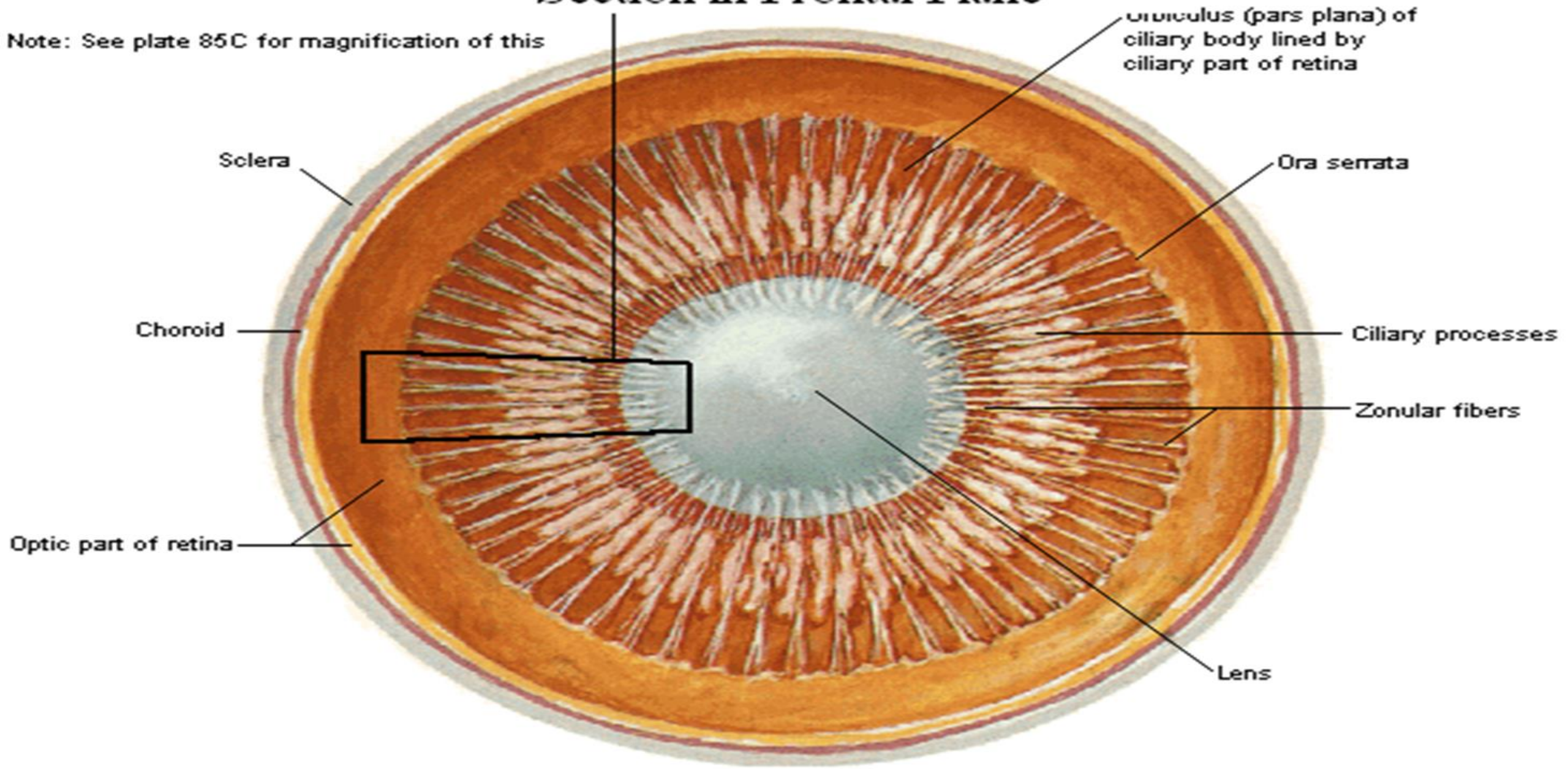
Magnified to ultramicroscopic scale (semischematic)

Optic Nerve [Visual Pathway]



Lens and Supporting Structures

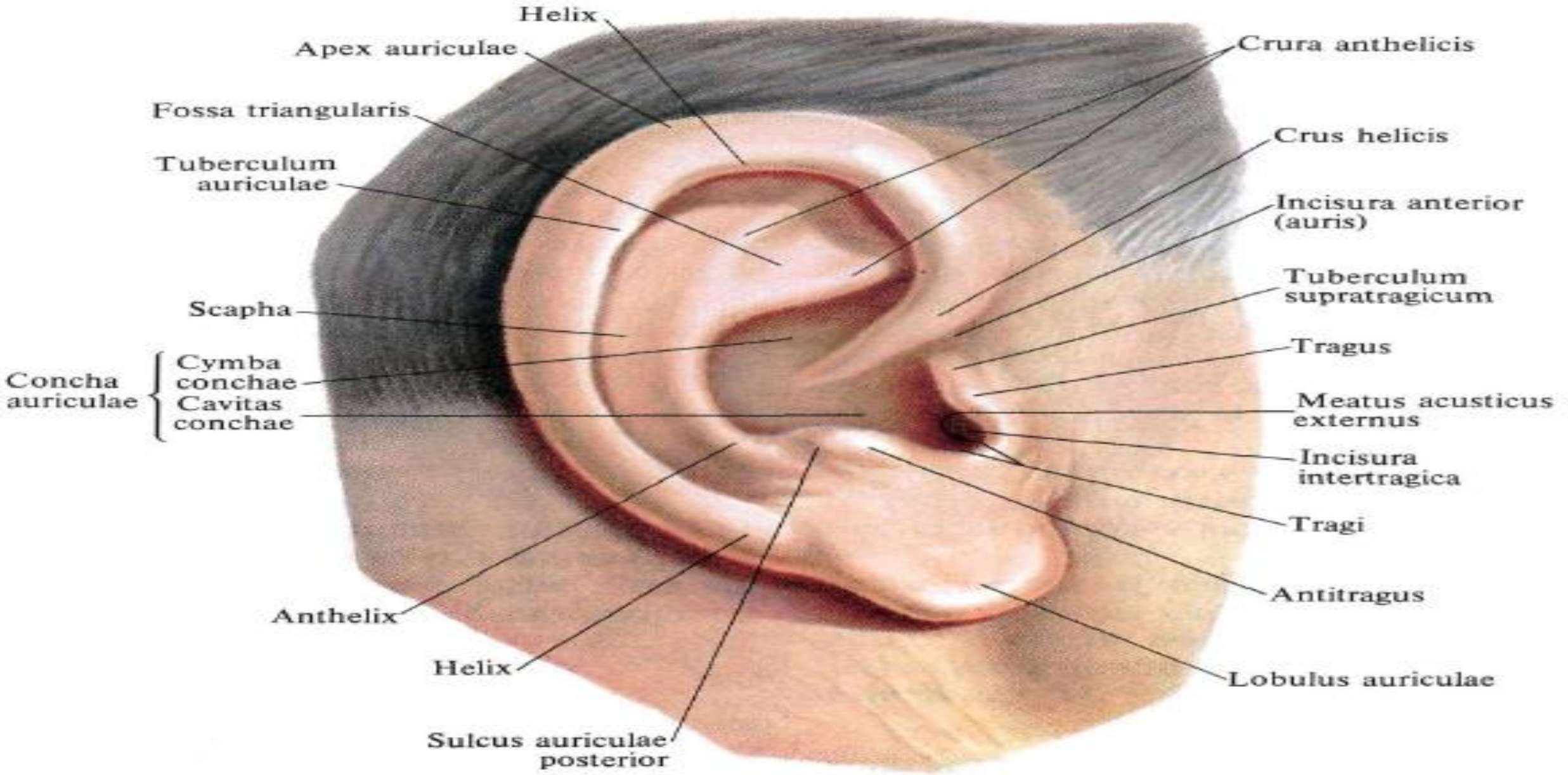
Section in Frontal Plane

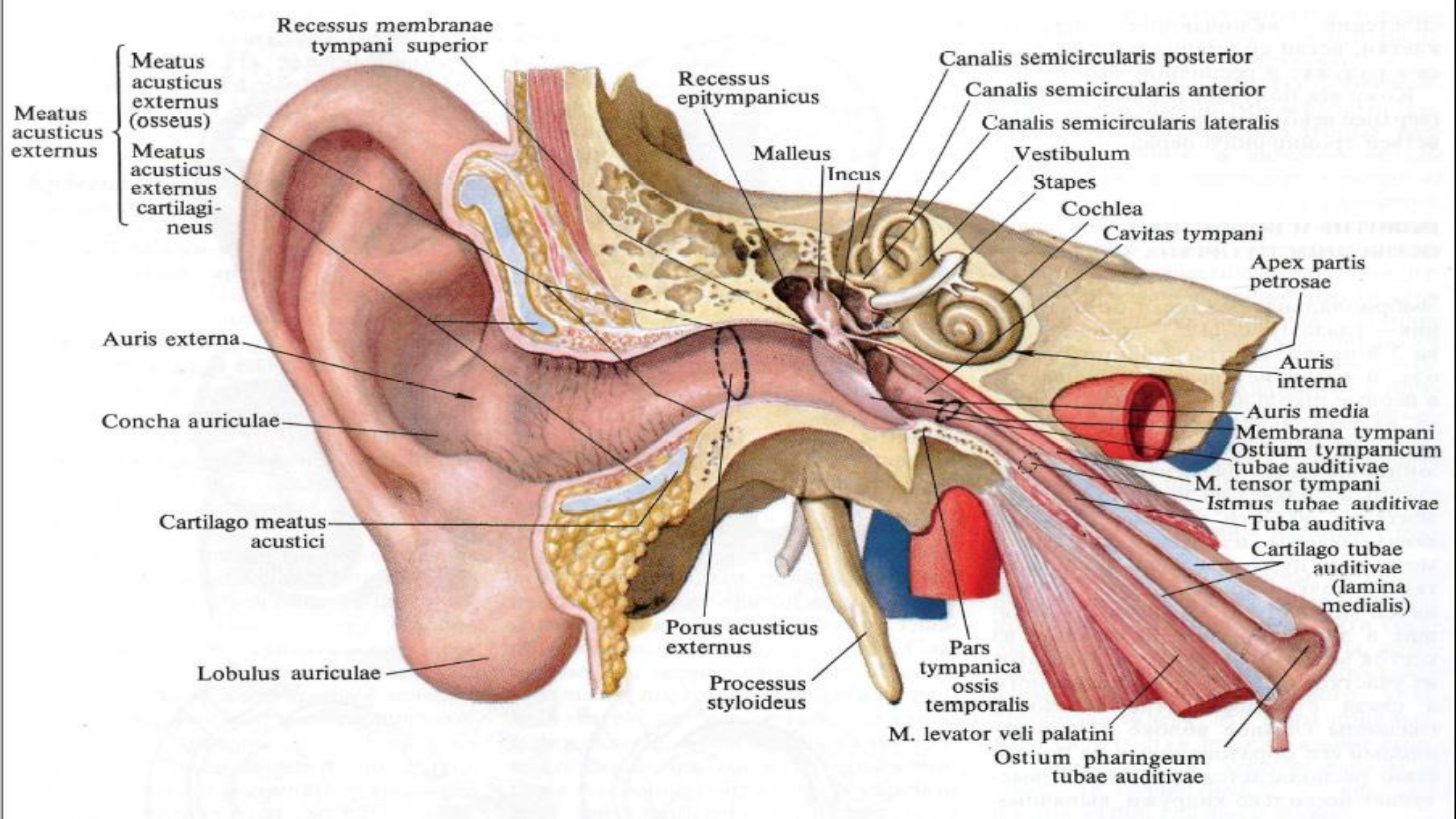


Bulb of eye: anterior segment viewed from behind

THE ORGAN OF HEARING AND GRAVITATION.

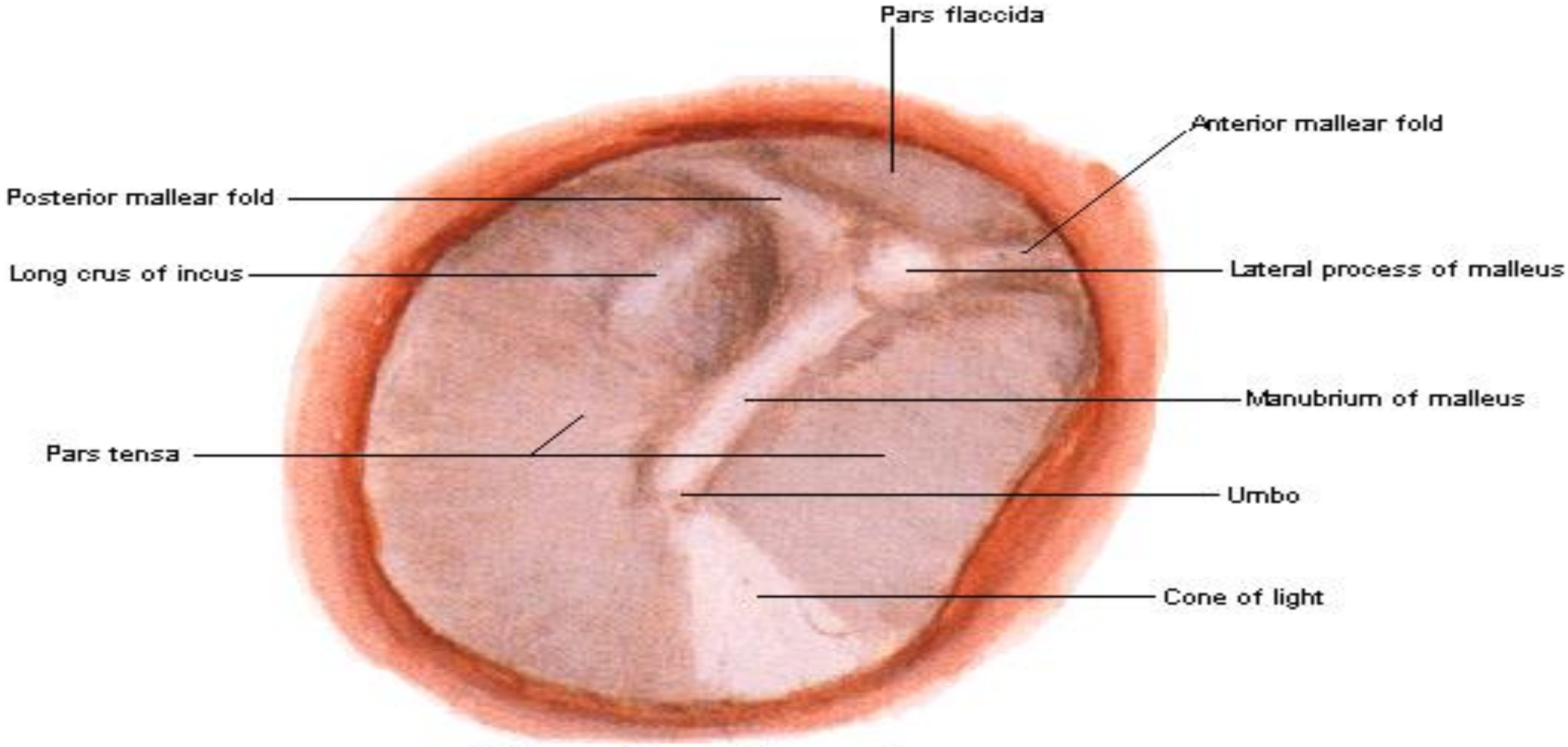
- **THE EXTERNAL EAR :** 1 – the auricle (ear).
- 2 – the external auditory meatus ("S"-shaped- cartilaginous and bony parts). The tympanic membrane— skin, fibrous tissue, mucous. Umbo, tensed and flaccid parts .
- **THE MIDDLE EAR :** 1 – the tympanic cavity (6 walls, 3 openings, 3 auditory ossicles: malleus-hammer, incus-anvil, stapes-stirrup). 2 – the auditory tube (bony and cartilaginous parts).
- **THE INTERNAL EAR :** 1 - the bony labyrinth (the vestibule, 3 semicircular canals, cochlea). 2 – the membranous labyrinth (vestibule –utricle,saccule; 3 semicircular ducts, cochlear duct).


Helix
Apex auriculae
Fossa triangularis
Tuberculum auriculae
Scapha
Concha auriculae
Cymba conchae
Cavitas conchae
Anthelix
Helix
Sulcus auriculae posterior
Crura anthelicis
Crus helicis
Incisura anterior (auris)
Tuberculum supratragicum
Tragus
Meatus acusticus externus
Incisura intertragica
Tragi
Antitragus
Lobulus auriculae


Meatus acusticus externus
Meatus acusticus externus (osseus)
Meatus acusticus externus cartilagi-neus
Recessus membranae tympani superior
Recessus epitympanicus
Canalis semicircularis posterior
Canalis semicircularis anterior
Canalis semicircularis lateralis
Malleus
Incus
Vestibulum
Stapes
Cochlea
Cavitas tympani
Apex partis petrosae
Auris externa
Auris interna
Concha auriculae
Auris media
Membrana tympani
Ostium tympanicum tubae auditivae
M. tensor tympani
Istmus tubae auditivae
Tuba auditiva
Cartilago meatus acustici
Cartilago tubae auditivae (lamina medialis)
Porus acusticus externus
Pars tympanica ossis temporalis
Lobulus auriculae
Processus styloideus
M. levator veli palatini
Ostium pharingeum tubae auditivae

External Ear

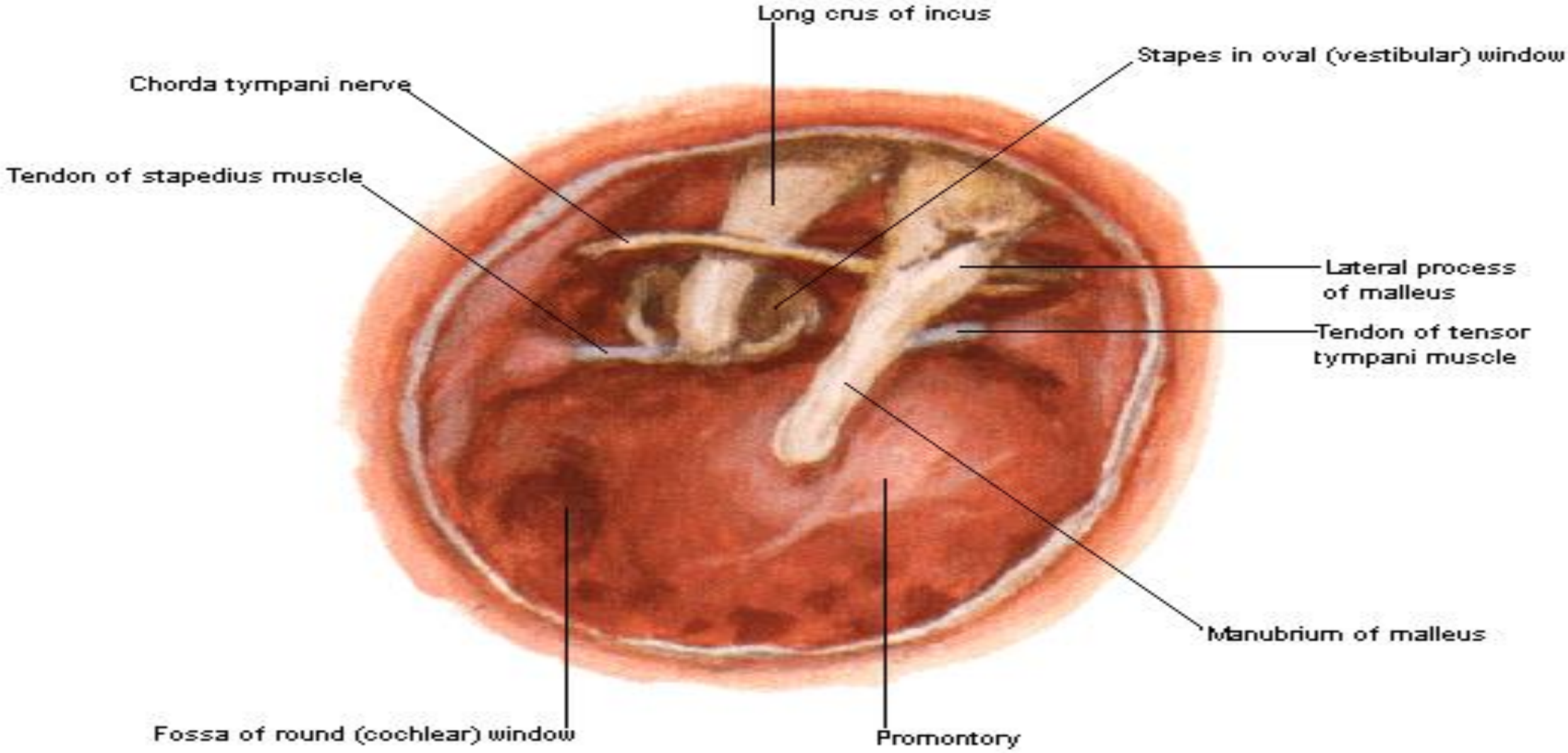
Right Tympanic Membrane



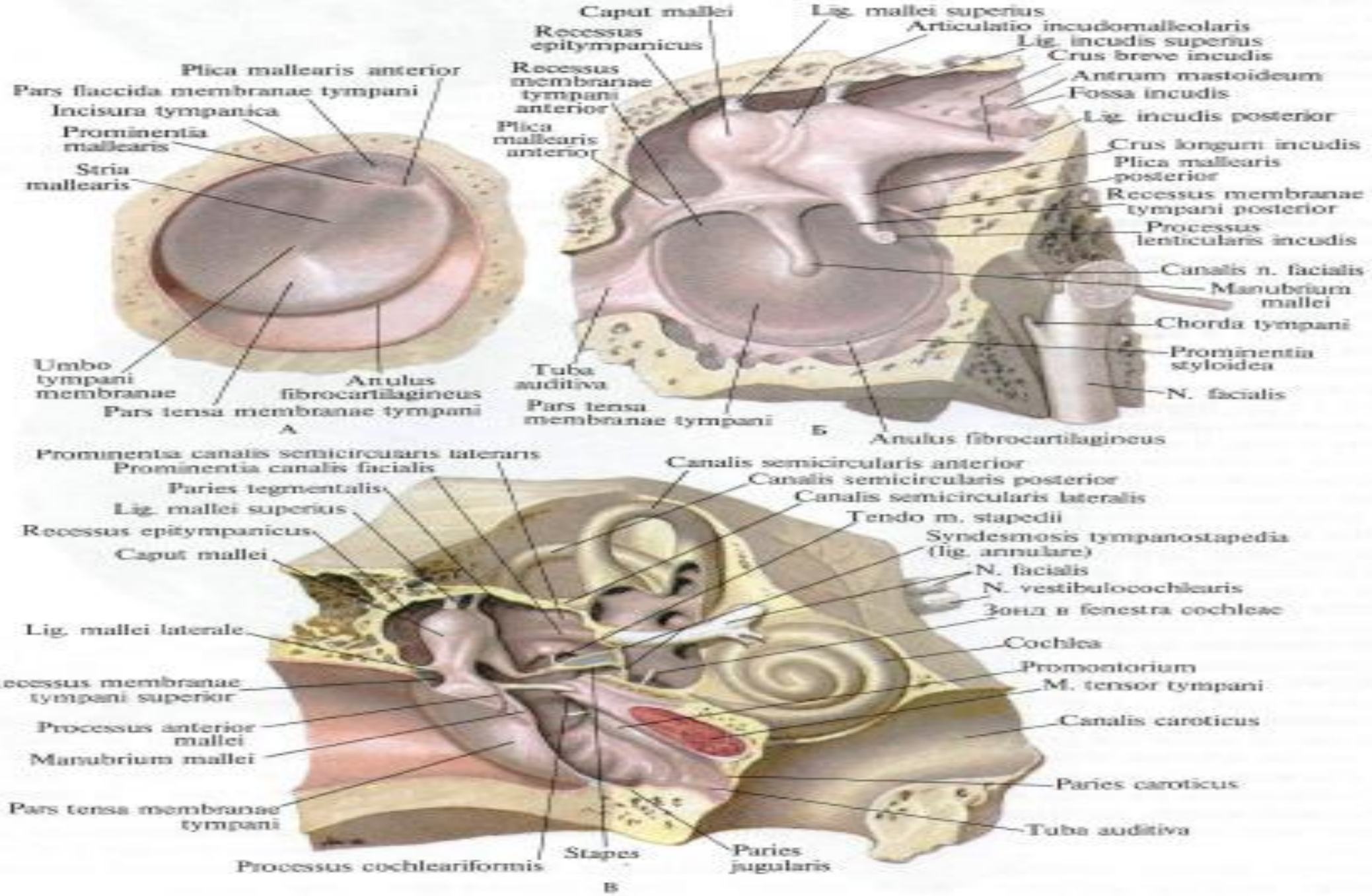
Viewed through speculum

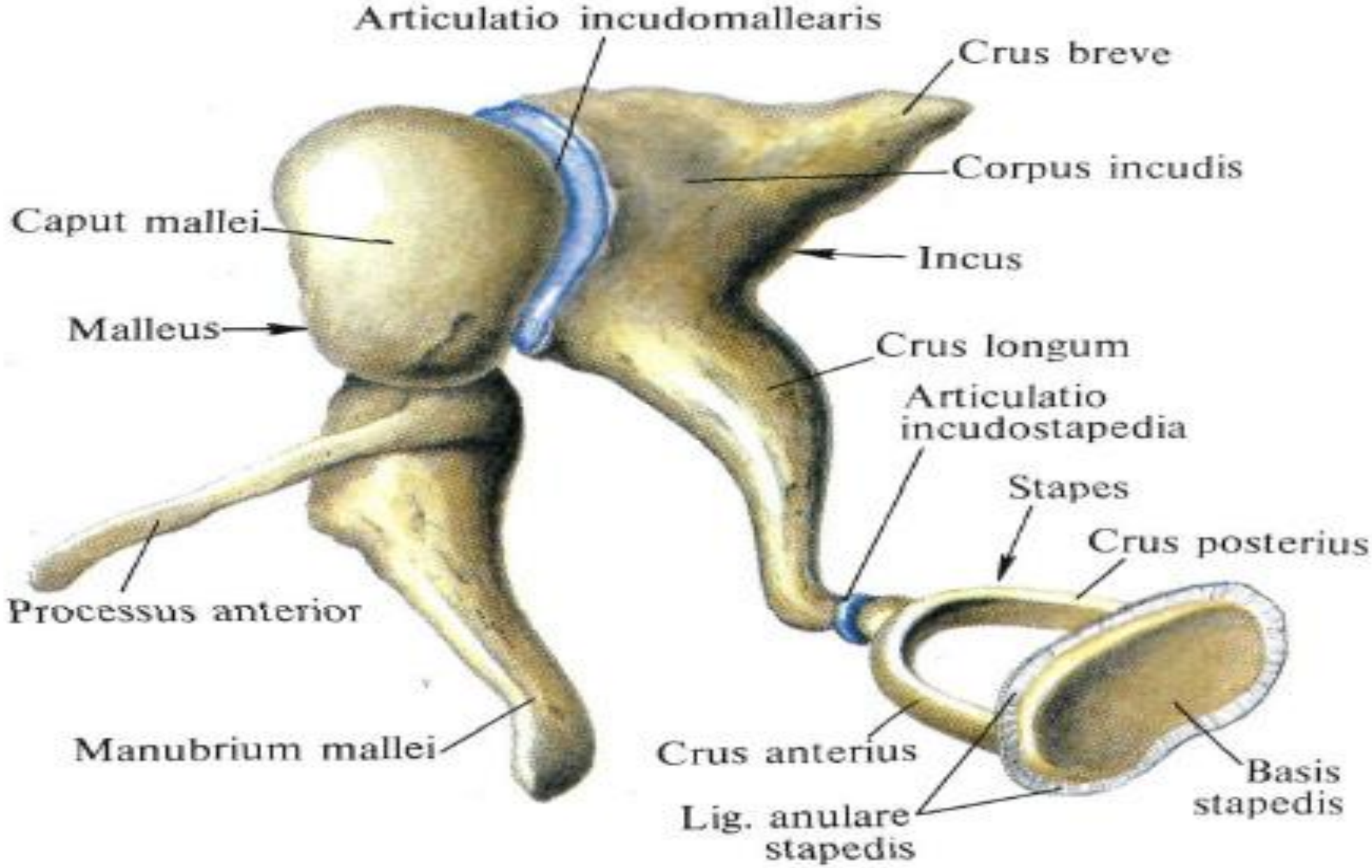
Tympanic Cavity

Viewed from External Acoustic Meatus



Tympanic Membrane Removed

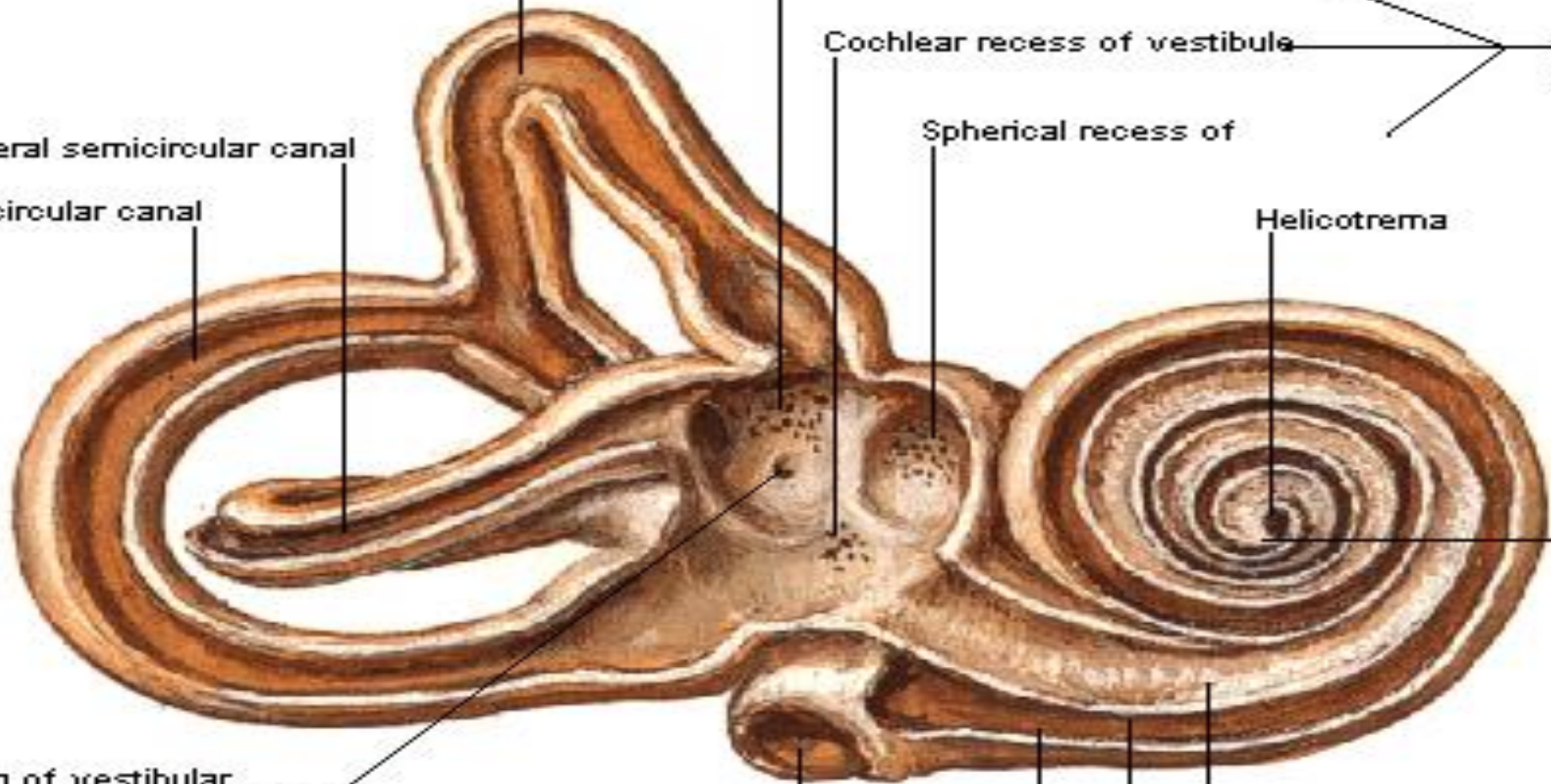

Plica mallearis anterior
Pars flaccida membranae tympani
Incisura tympanica
Prominentia mallearis
Stria mallearis
Umbo tympani membranae
Anulus fibrocartilagineus
Pars tensa membranae tympani
A
Caput mallei
Lig. mallei superius
Recessus epitympanicus
Articulatio incudomalleolaris
Lig. incudis superius
Crus breve incudis
Recessus membranae tympani anterior
Antrum mastoideum
Fossa incudis
Lig. incudis posterior
Plica mallearis anterior
Crus longum incudis
Plica mallearis posterior
Recessus membranae tympani posterior
Processus lenticularis incudis
Canalis n. facialis
Manubrium mallei
Chorda tympani
Prominentia styloidea
N. facialis
Tuba auditiva
Pars tensa membranae tympani
Б
Anulus fibrocartilagineus
Prominentsa canalis semicircusaris latenans
Prominentia canalis facialis
Paries tegmentalis
Lig. mallei superius
Recessus epitympanicus
Caput mallei
Canalis semicircularis anterior
Canalis semicircularis posterior
Canalis semicircularis lateralis
Tendo m. stapedii
Syndesmosis tympanostapedia (lig. annulare)
N. facialis
N. vestibulocochlearis
Зона в fenestra cochleae
Lig. mallei laterale
Cochlea
Promontorium
Recessus membranae tympani superior
M. tensor tympani
Processus anterior mallei
Canalis caroticus
Manubrium mallei
Paries caroticus
Pars tensa membranae tympani
Tuba auditiva
Stapes
Paries jugularis
Processus cochleariformis
B

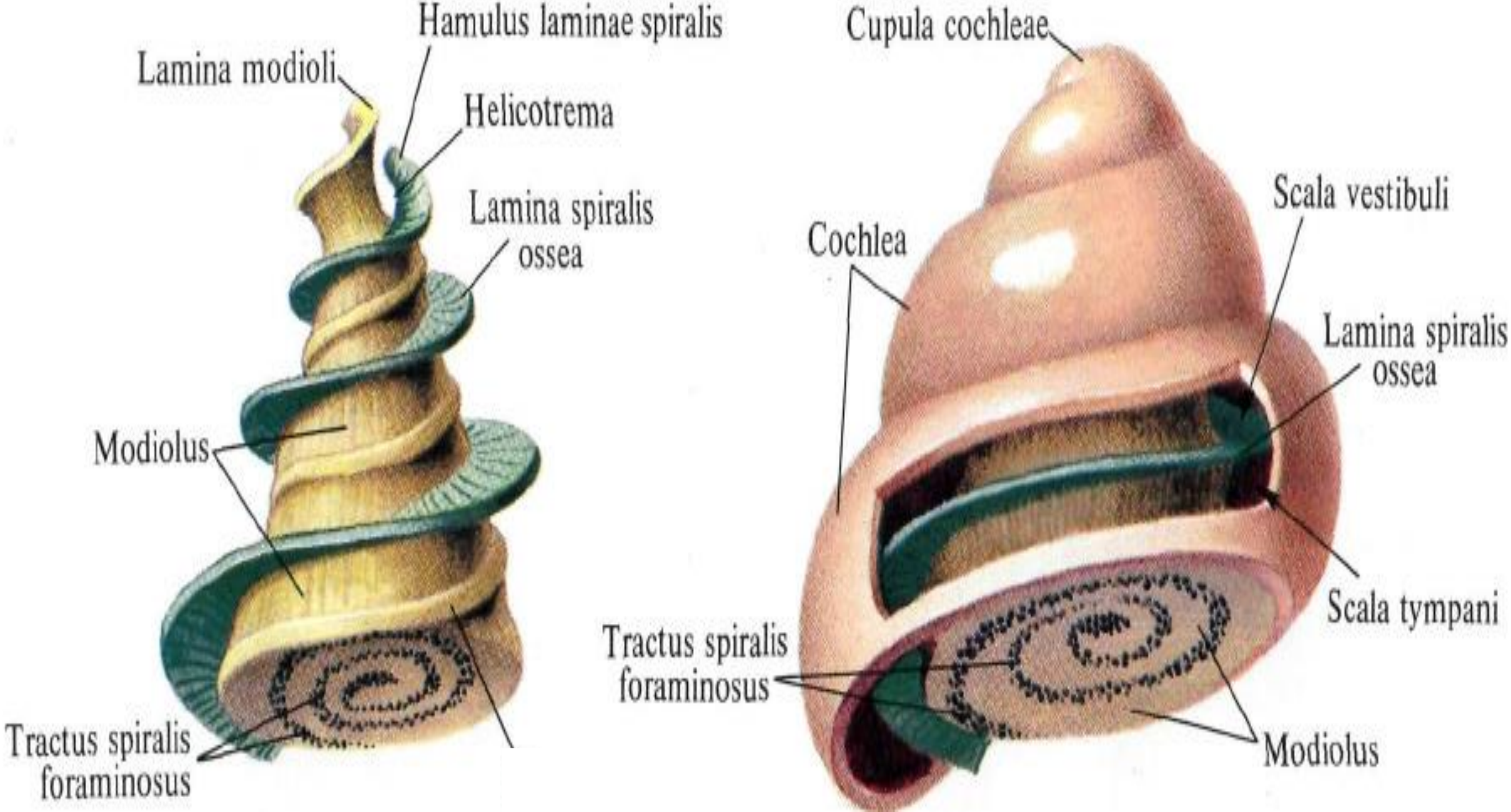

Articulatio incudomallearis
Crus breve
Corpus incudis
Caput mallei
Incus
Malleus
Crus longum
Articulatio incudostapedia
Stapes
Crus posterius
Processus anterior
Manubrium mallei
Crus anterius
Basis stapedis
Lig. anulare stapedis

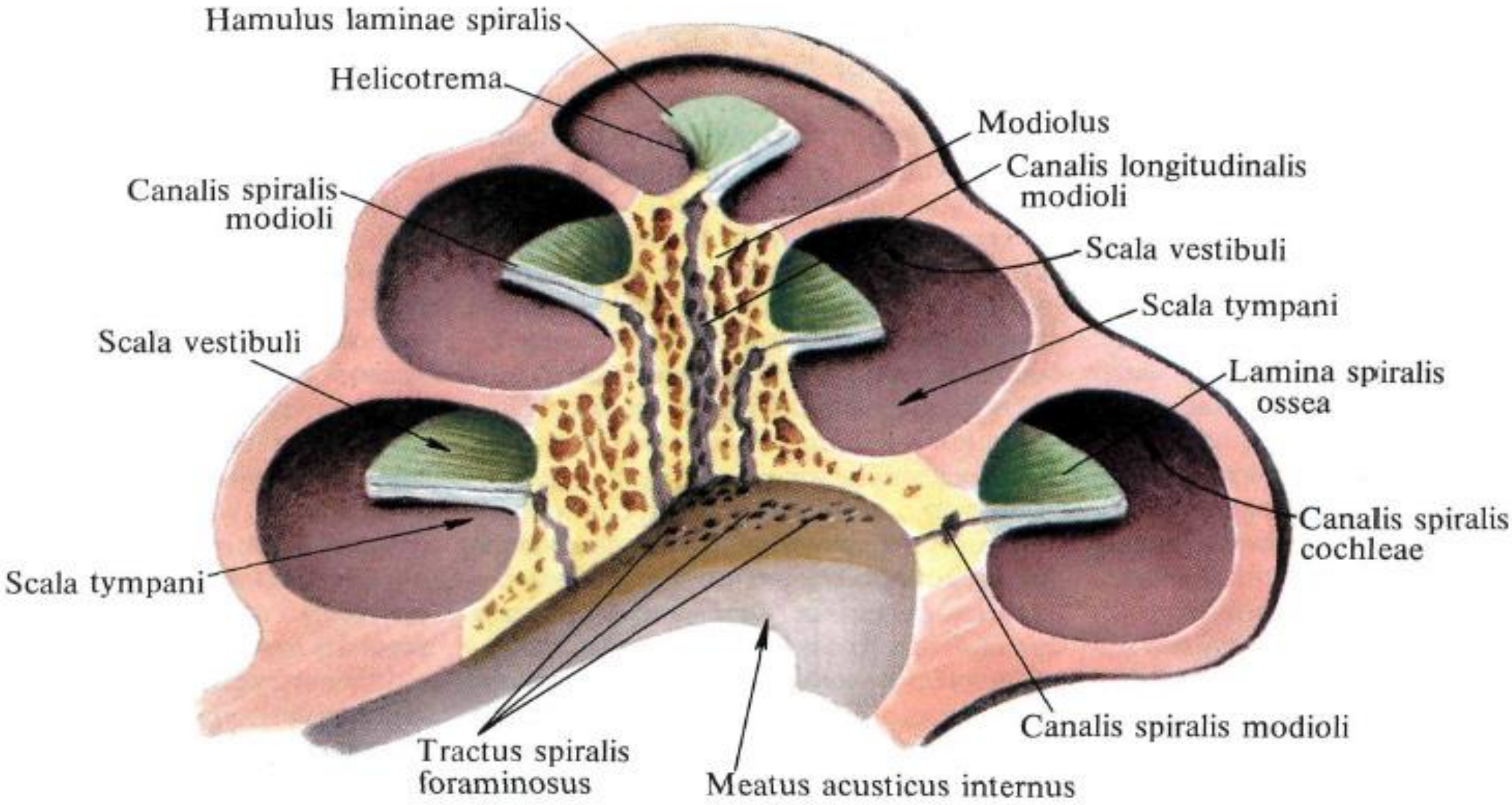
THE ORGAN OF HEARING AND GRAVITATION

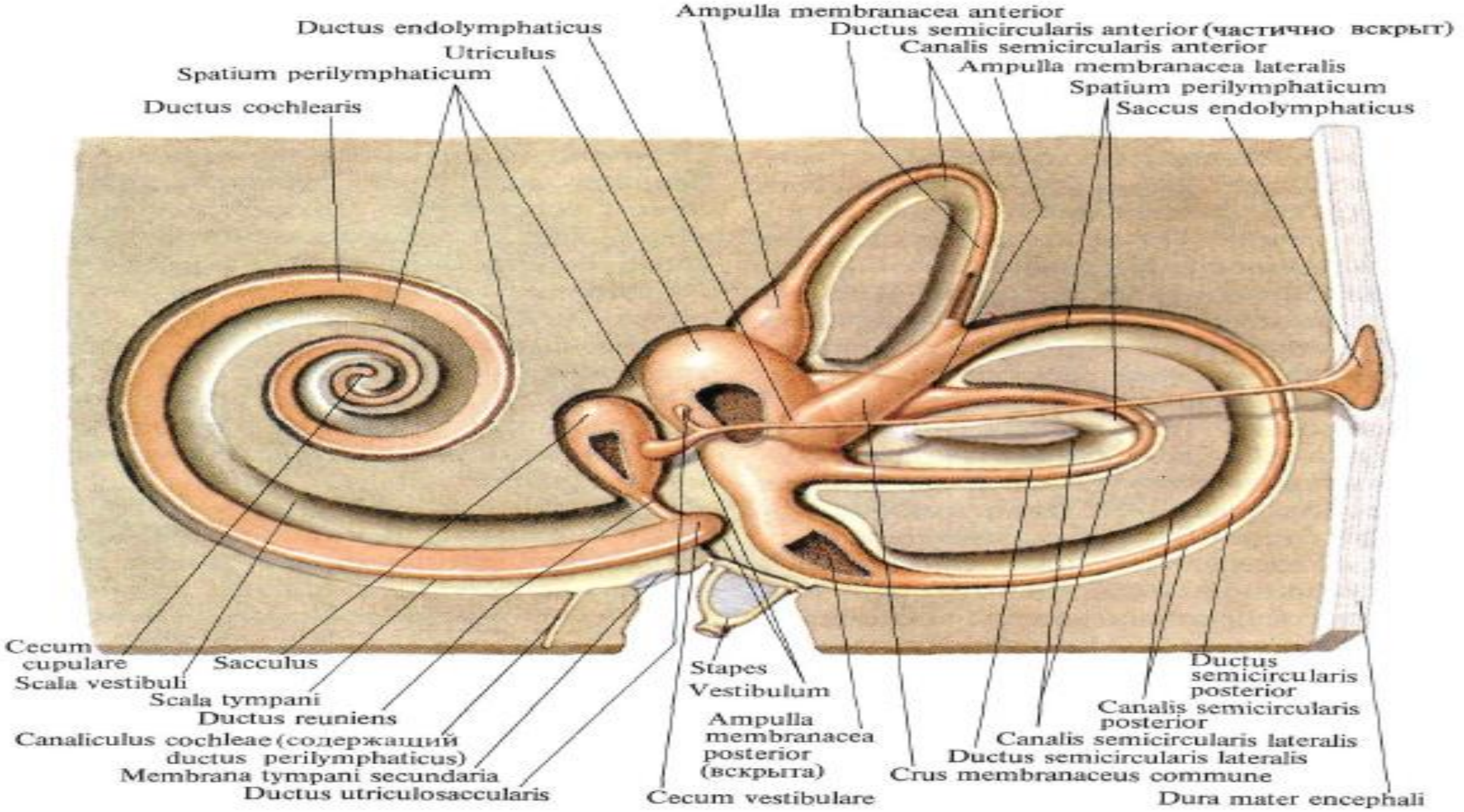
- ***3.The internal ear***
- **-bony labyrinth (the vestibule, the cochlea, the semicircular canals)**
- **-membranous labyrinth**

Right Osseous Labyrinth - Dissected
Membranous Labyrinth Removed



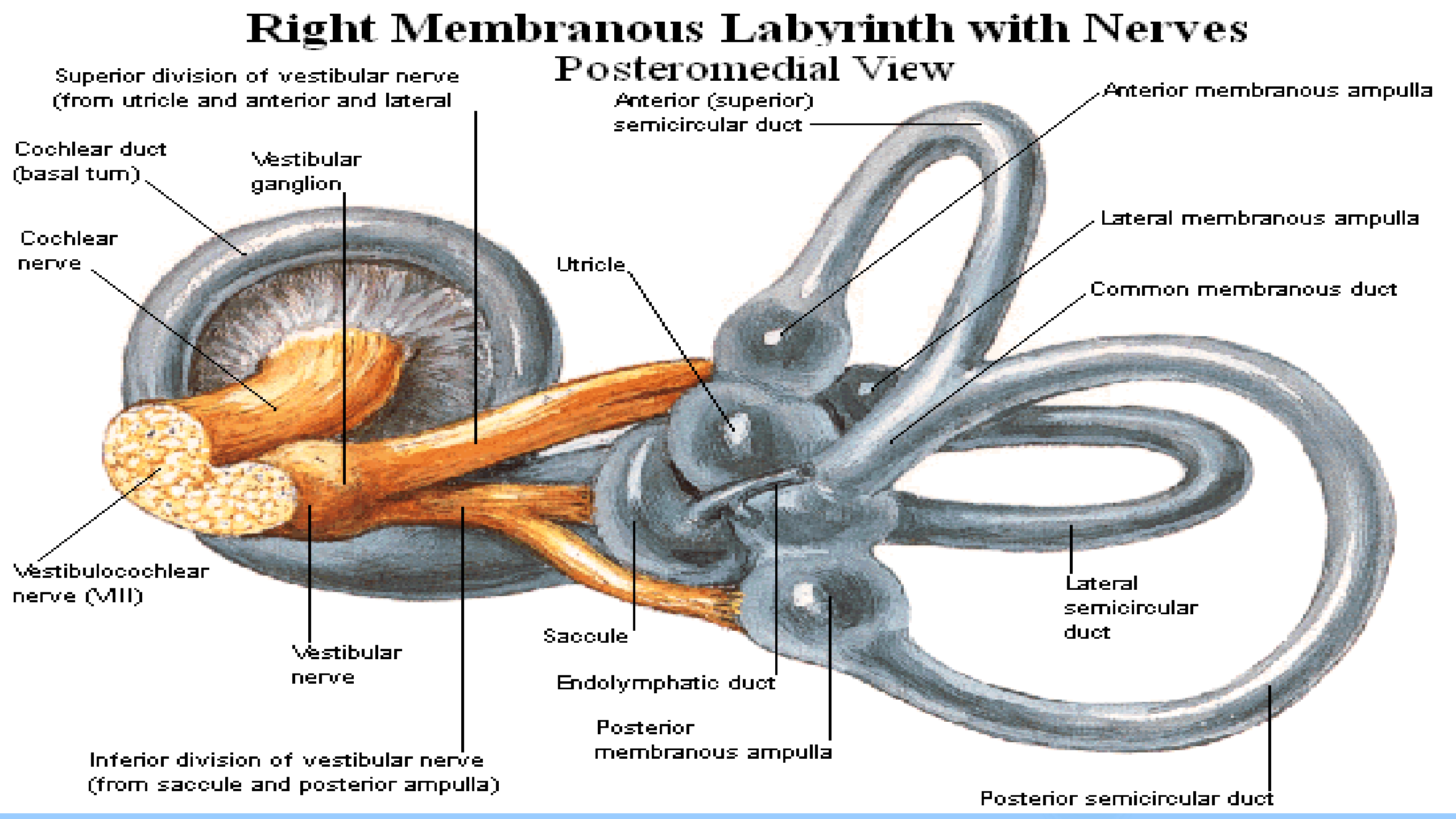

Hamulus laminae spiralis
Lamina modioli
Helicotrema
Lamina spiralis ossea
Modiolus
Tractus spiralis foraminosus
Cupula cochleae
Scala vestibuli
Cochlea
Lamina spiralis ossea
Scala tympani
Tractus spiralis foraminosus
Modiolus


Hamulus laminae spiralis
Helicotrema
Modiolus
Canalis longitudinalis modioli
Canalis spiralis modioli
Scala vestibuli
Scala tympani
Scala vestibuli
Lamina spiralis ossea
Canalis spiralis cochleae
Scala tympani
Canalis spiralis modioli
Tractus spiralis foraminosus
Meatus acusticus internus


Ductus endolymphaticus
Utriculus
Spatium perilymphaticum
Ductus cochlearis
Ampulla membranacea anterior
Ductus semicircularis anterior (частично вскрыт)
Canalis semicircularis anterior
Ampulla membranacea lateralis
Spatium perilymphaticum
Saccus endolymphaticus
Cecum cupulare
Scala vestibuli
Sacculus
Scala tympani
Ductus reuniens
Canaliculus cochleae (содержащий ductus perilymphaticus)
Membrana tympani secundaria
Ductus utriculosaccularis
Stapes
Vestibulum
Ampulla membranacea posterior (вскрыта)
Cecum vestibulare
Crus membranaceus commune
Ductus semicircularis lateralis
Canalis semicircularis lateralis
Canalis semicircularis posterior
Ductus semicircularis posterior
Dura mater encephali

Right Membranous Labyrinth with Nerves

Posteromedial View

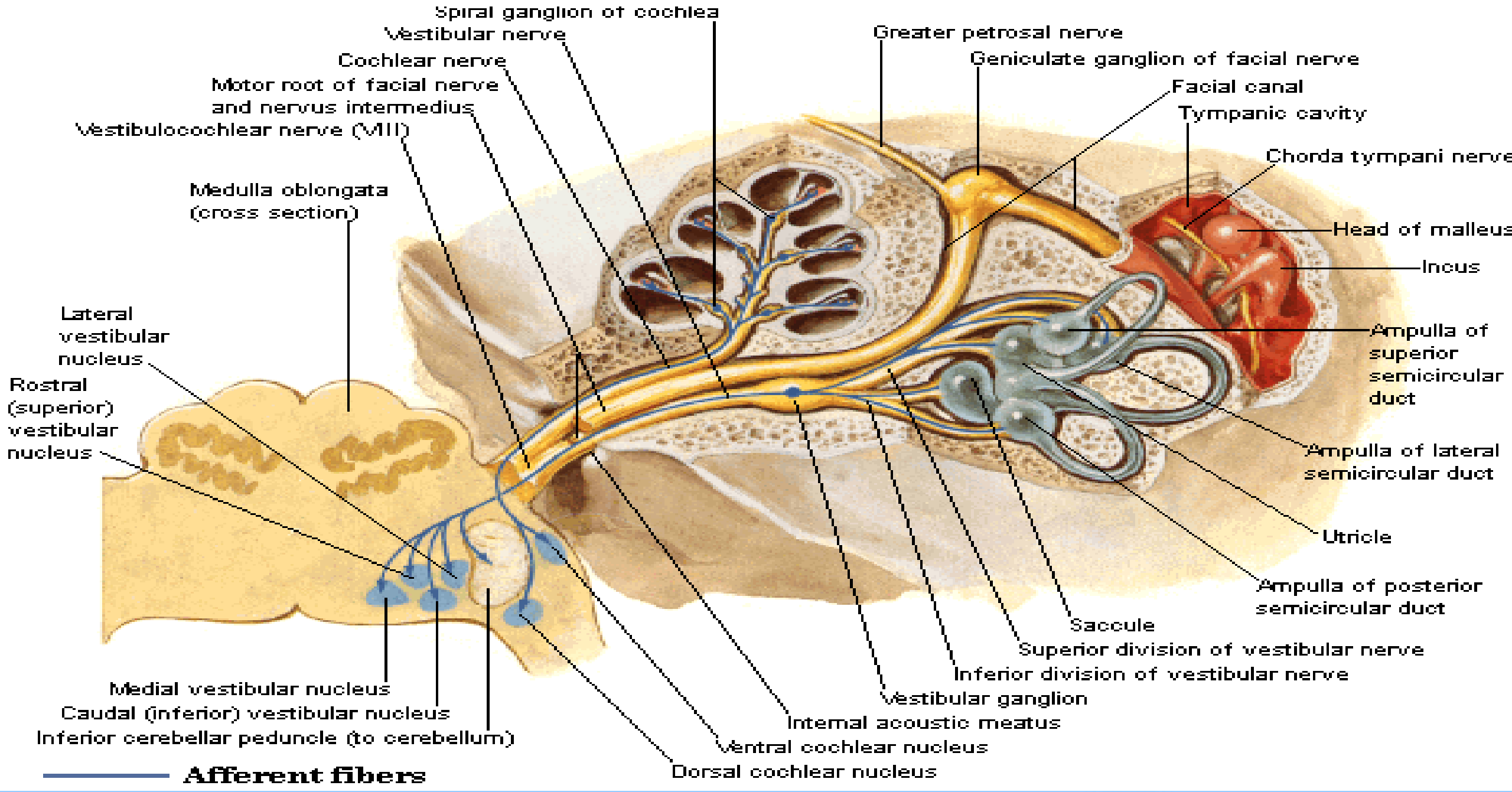


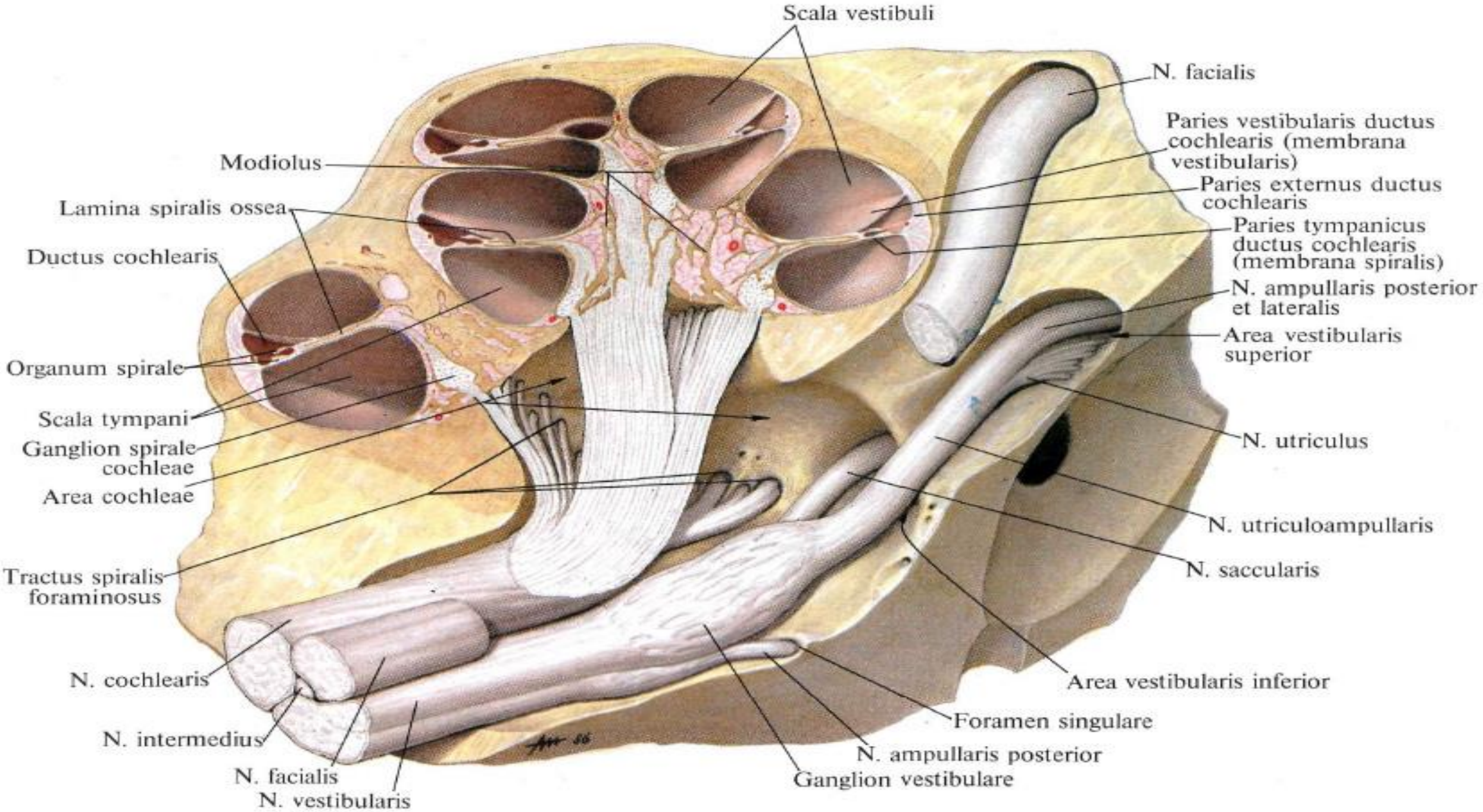
8-th(VIII) pair – the auditory (vestibulocochlear) nerve.

- **The vestibular nerve**: **receptors**-sensory cells of the utricle,saccule (receptors of static equilibrium) and of the semicircular canals (receptors of dynamic equilibrium).
- **I n.** – gang.vestibulare
- **II n.** -nuclei vestibulares
- **III n.-**opposite lateral thalamic nuclei. **Cortex** of the temporal and parietal lobes.

- **The cochlear nerve: receptors**-acoustic cells of the Corti organ on the walls of the membranous cochlear duct
- **I n.**- ganglia spirales
  II n.-nucleus dorsalis and ventralis of the pons
- **III n.**- opposite inferior colliculus of the midbrain and medial geniculate body.
- **Cortex** of the superior temporal gyrus.

Vestibulocochlear Nerve



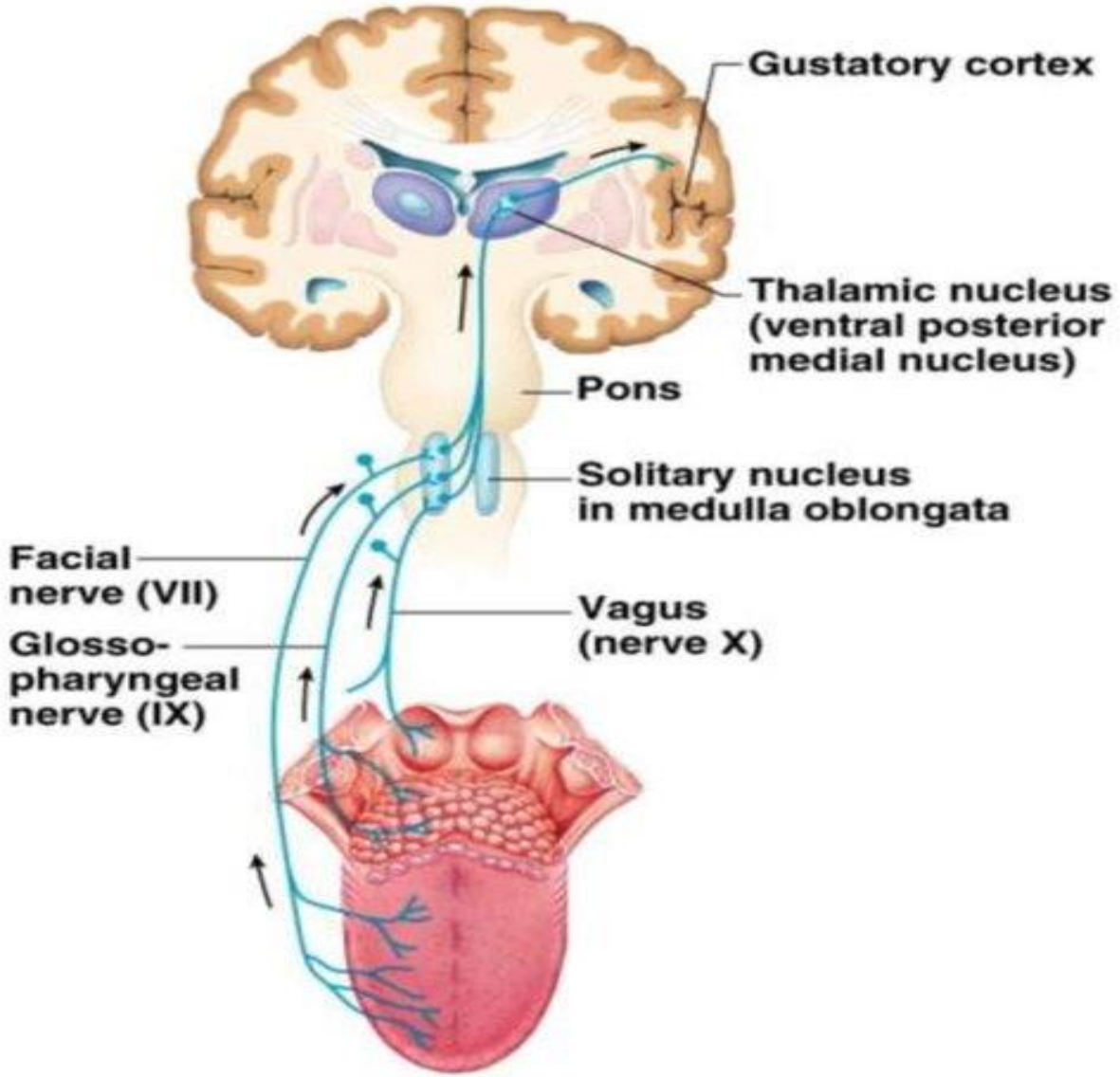

Scala vestibuli
N. facialis
Paries vestibularis ductus cochlearis (membrana vestibularis)
Modiolus
Paries externus ductus cochlearis
Lamina spiralis ossea
Paries tympanicus ductus cochlearis (membrana spiralis)
Ductus cochlearis
N. ampullaris posterior et lateralis
Area vestibularis superior
Organum spirale
Scala tympani
N. utriculus
Ganglion spirale cochleae
Area cochleae
N. utriculoampullaris
N. sacccularis
Tractus spiralis foraminosus
N. cochlearis
Area vestibularis inferior
Foramen singulare
N. intermedius
N. ampullaris posterior
N. facialis
Ganglion vestibulare
N. vestibularis

Taste (gustatory) pathway

- 1. Receptors Taste buds on tongue, lips, palatal arch and soft palate. Each "bud" contains several cell types in microvilli (taste hairs) that project through taste pore.
- Gustatory receptor cells communicate with cranial nerve axon endings to transmit sensation to brain.
- Cranial Nerves of taste
- Anterior 2/3 tongue: chorda tympani→ Facial nerve
- Posterior 1/3 tongue: Glossopharyngeal nerve
- Most posterior part of the tongue: Vagus nerve

Gustatory Pathway from Taste Buds

- Taste information reaches the cerebral cortex
  - Primarily through the facial (VII) and glossopharyngeal (IX) nerves
  - Some taste information through the vagus nerve (X)
  - Sensory neurons synapse in the medulla
    - Located in the solitary nucleus



Thx for your attention!!!!