Larynx & Middle Ear
喉部與中耳

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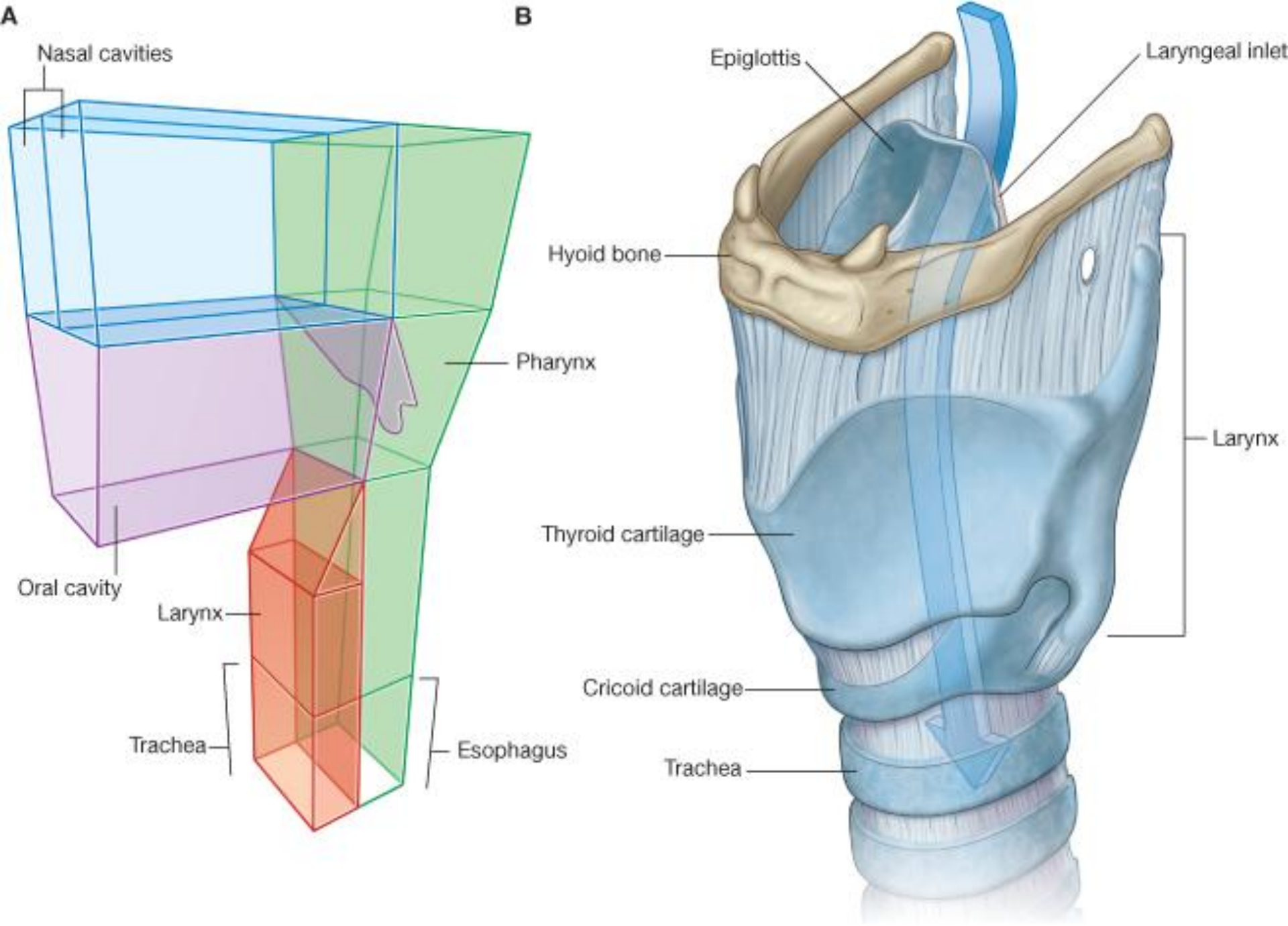
Outline:

- Cartilages and ligaments of larynx
- Muscles, blood vessels and nerves of larynx



Larynx

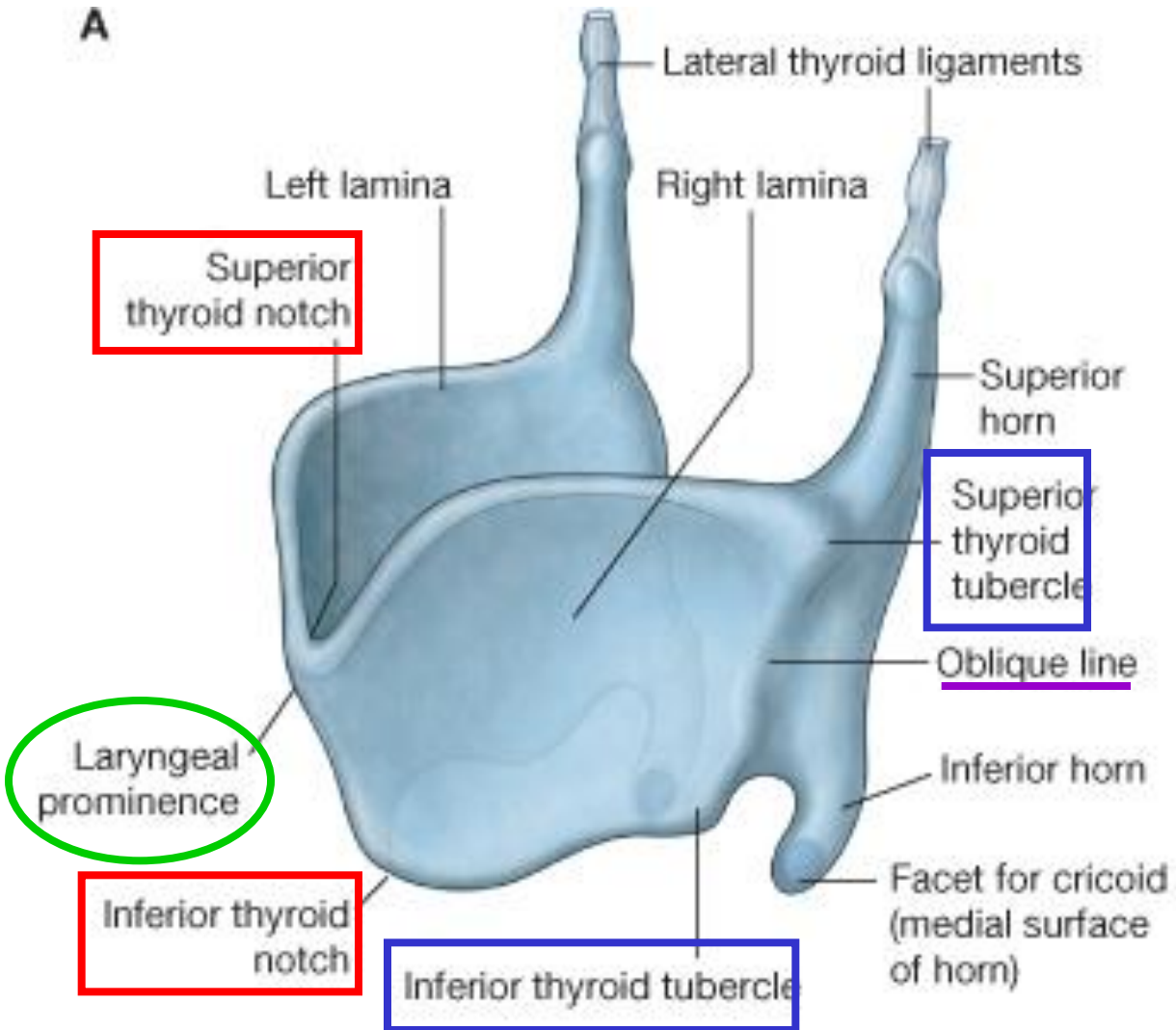
Position: C3-C6
Function: voice production (vocalization)

Laryngeal skeleton: (9 cartilages)

- **Thyroid cartilage**
- **Cricoid cartilage**
- **Arytenoid cartilages**
- **Epiglottic cartilage**
- **Corniculate cartilages**
- **Cuneiform cartilages**

Thyroid cartilage – laryngeal prominence (***Adam's apple***), sup. & inf. thyroid notch; horn; tubercles, ***oblique line***

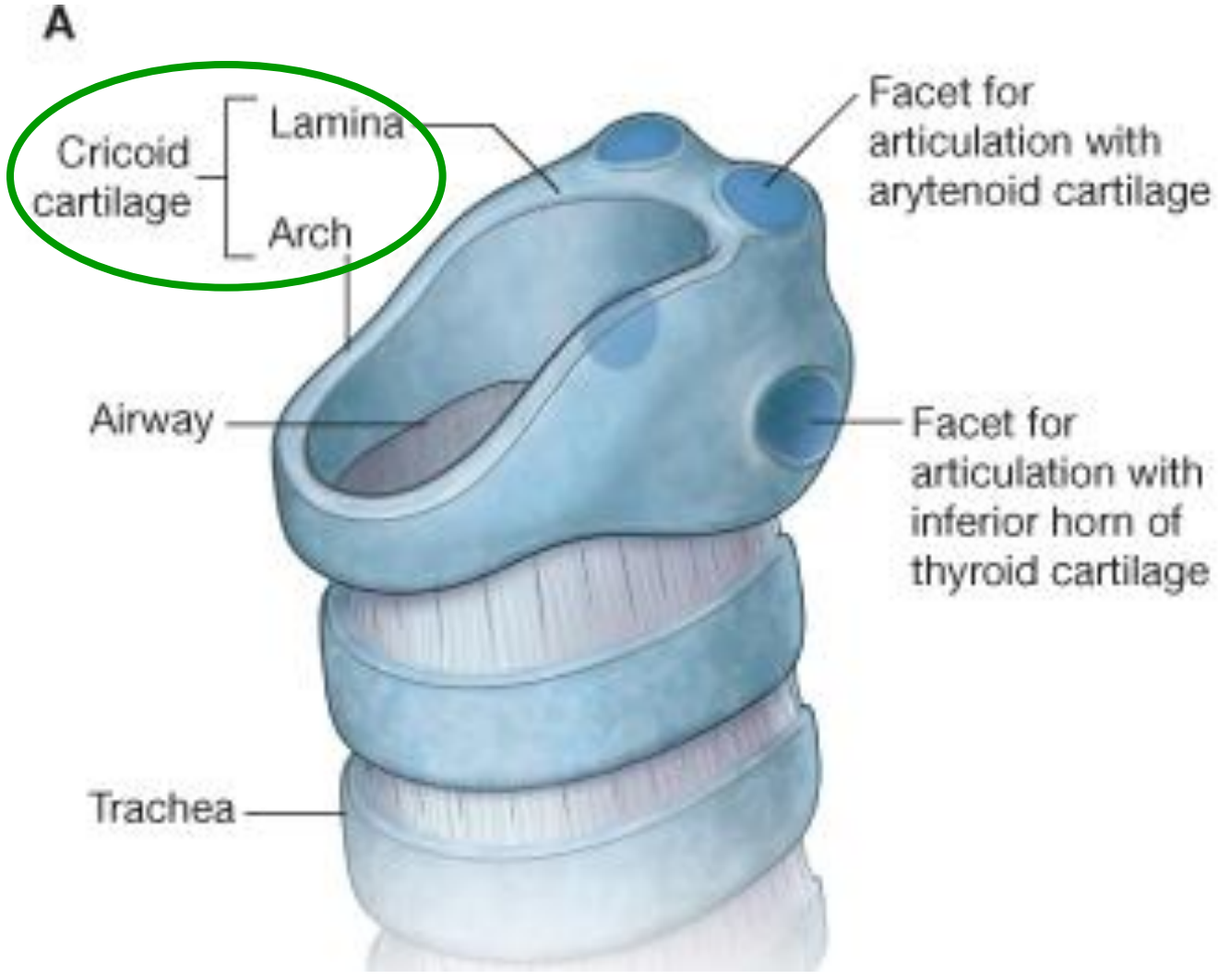
facet for cricoid cartilage



Cricoid cartilage – **lamina** and **arch**,

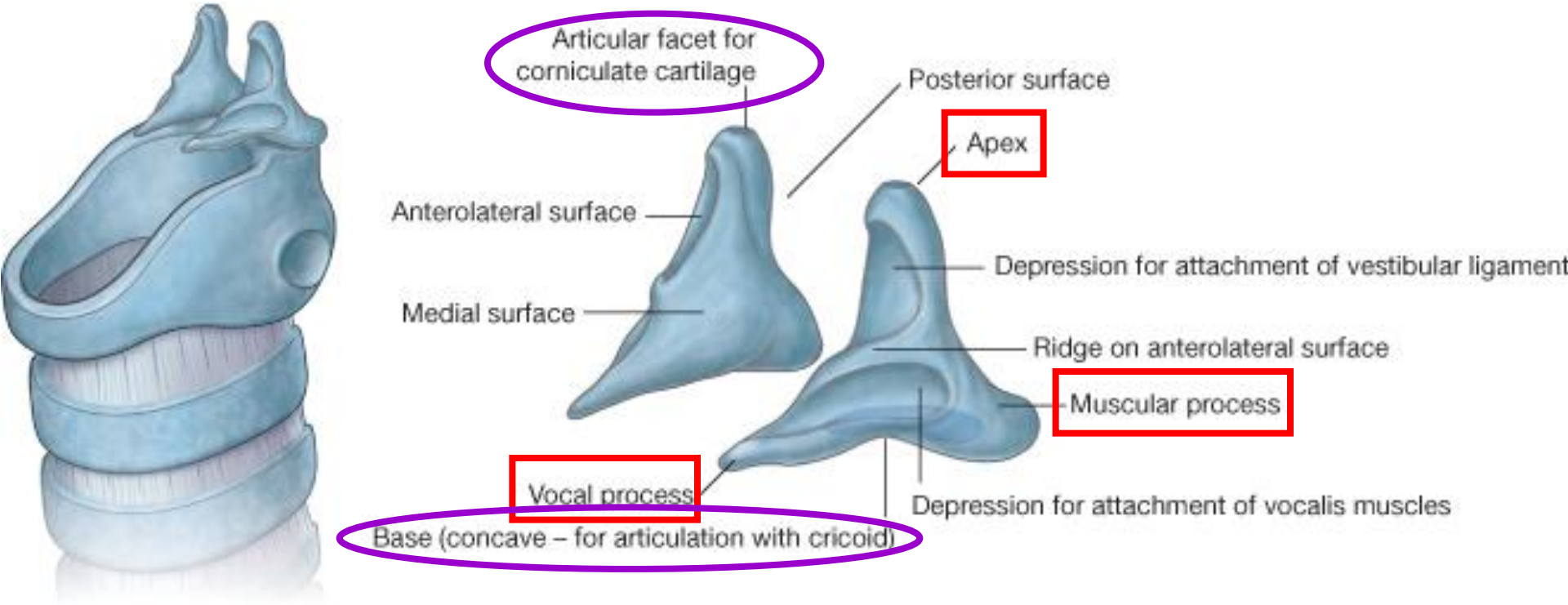
facet for inferior horn of thyroid cartilage

facet for arytenoid cartilage

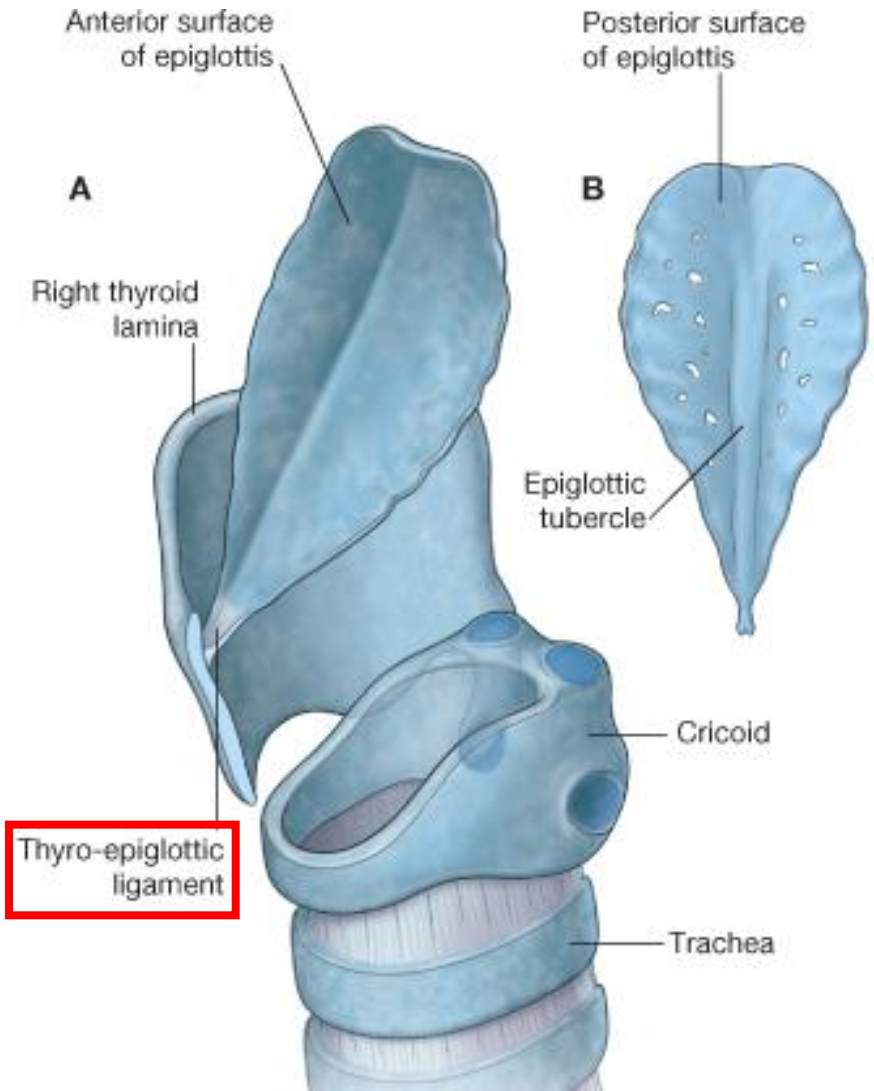


Arytenoid cartilages – three-sided pyramids (apex, vocal process and muscular process)

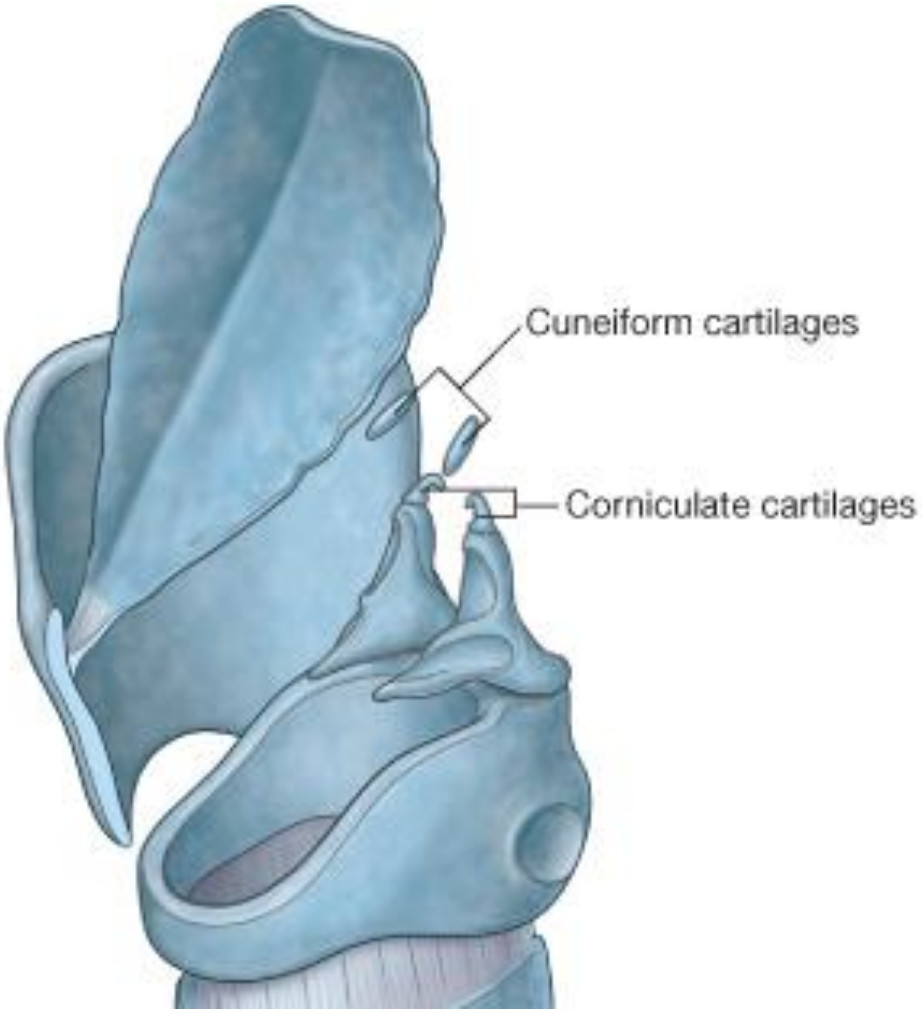
crico-arytenoid joints



Epiglottic cartilage – "leaf-shaped"
– post. to tongue & hyoid bone, ant. to laryngeal inlet
thyro-epiglottic lig.



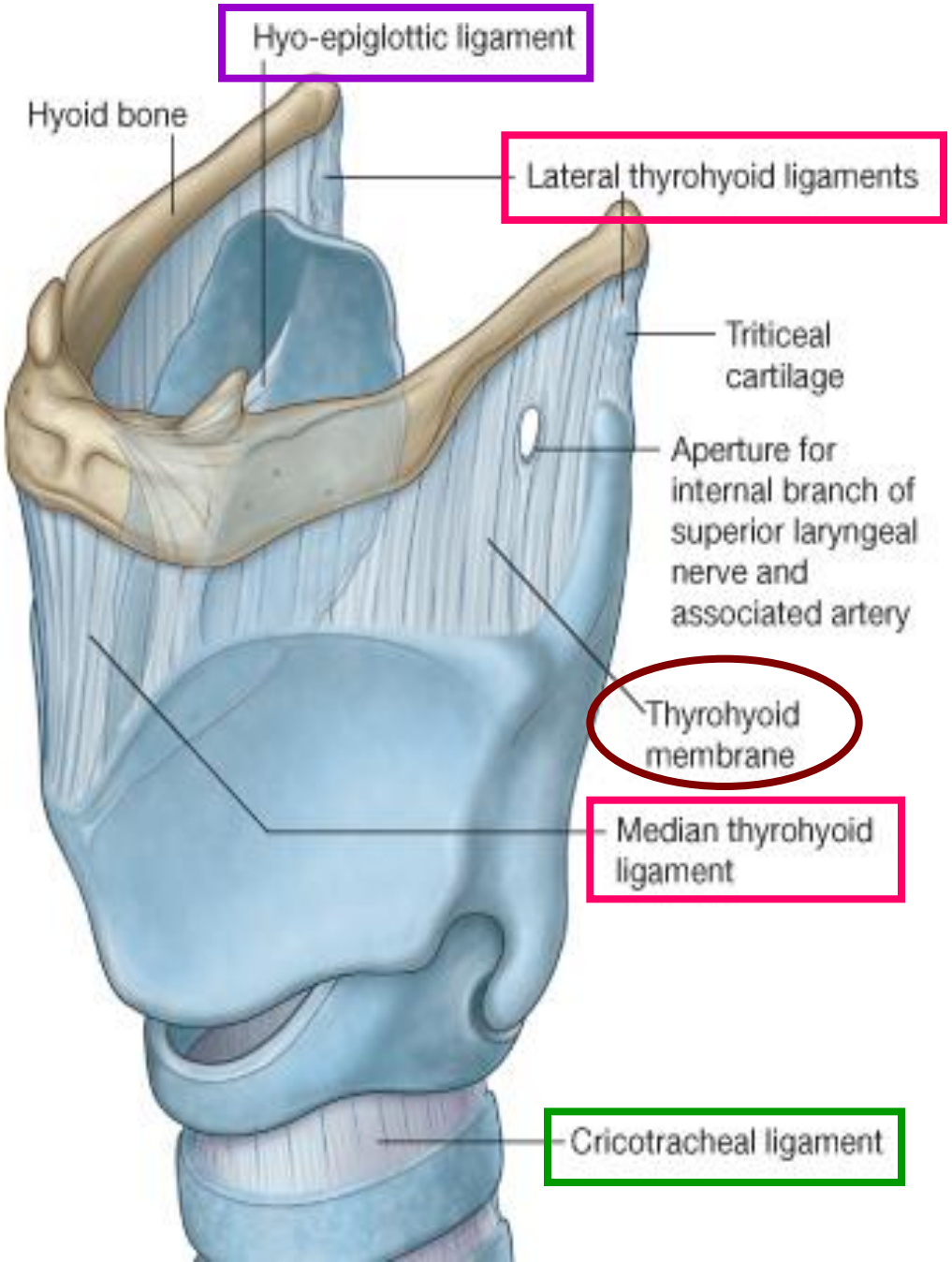
Corniculate cartilages
– attach to the apex of arytenoid cartilage
Cuneiform cartilages
– do not directly attach to other cartilage



Extrinsic ligaments of larynx

- **Thyro-hyoid membrane**

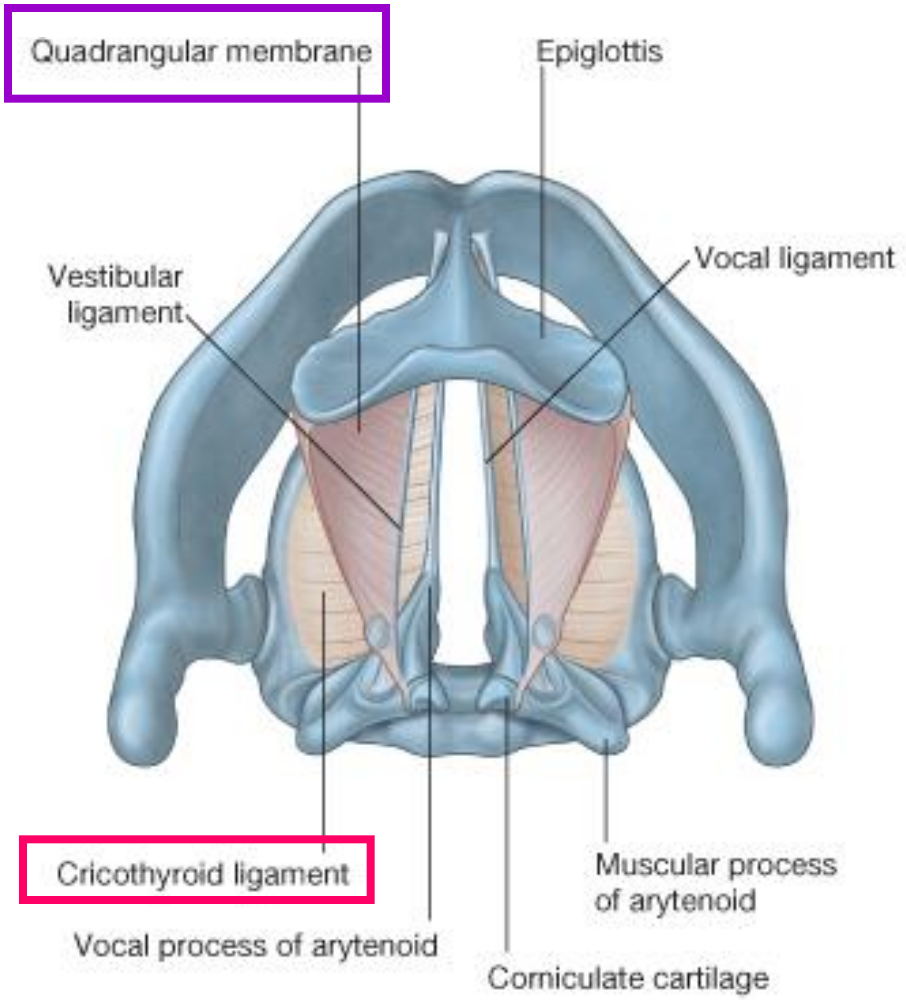
  median & lateral thyro-hyoid **ligaments**
- **Hyo-epiglottic ligament**
- **Crico-tracheal ligament**


Hyo-epiglottic ligament
Hyoid bone
Lateral thyrohyoid ligaments
Triticeal cartilage
Aperture for internal branch of superior laryngeal nerve and associated artery
Thyrohyoid membrane
Median thyrohyoid ligament
Cricotracheal ligament

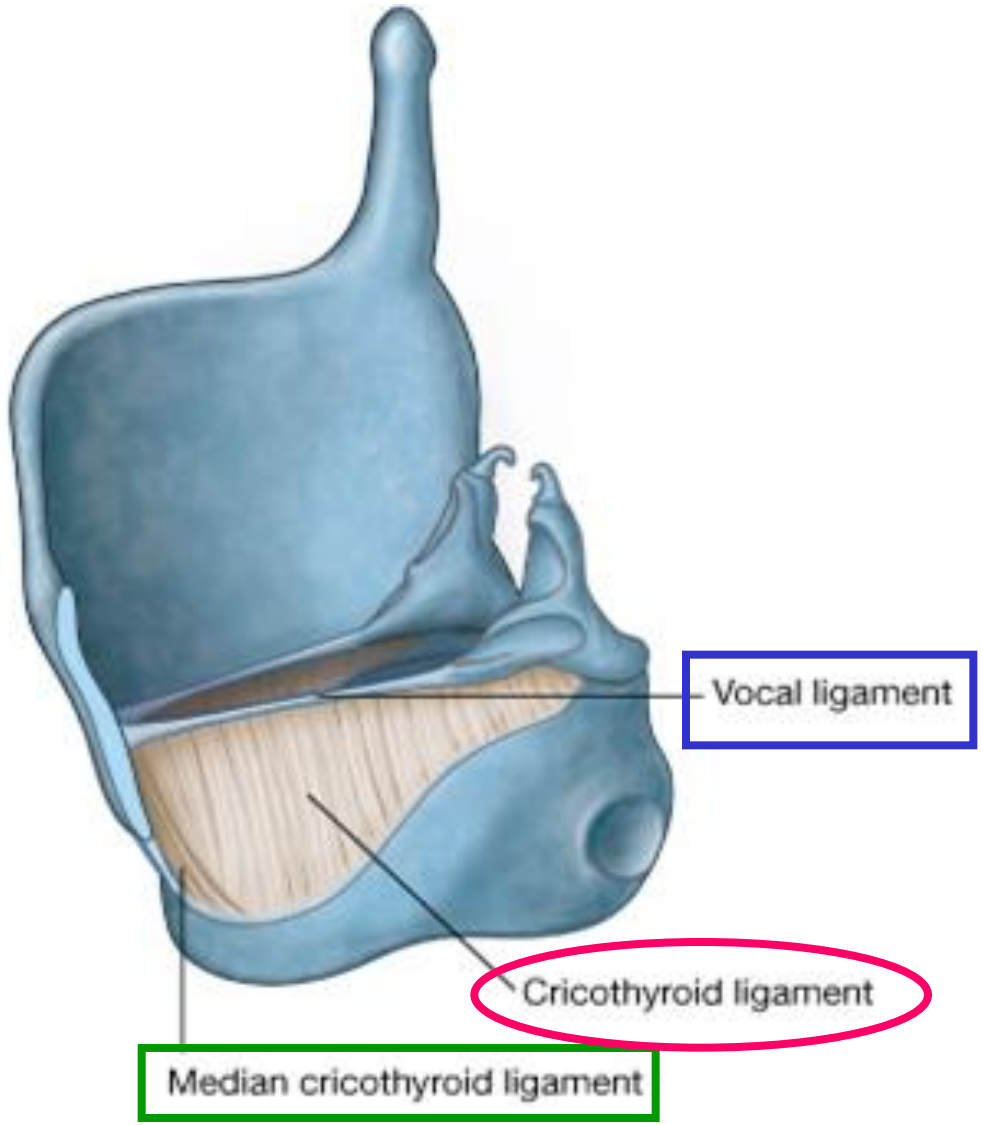
Intrinsic ligaments of larynx (fibro-elastic membrane of larynx)

Crico-thyroid ligament

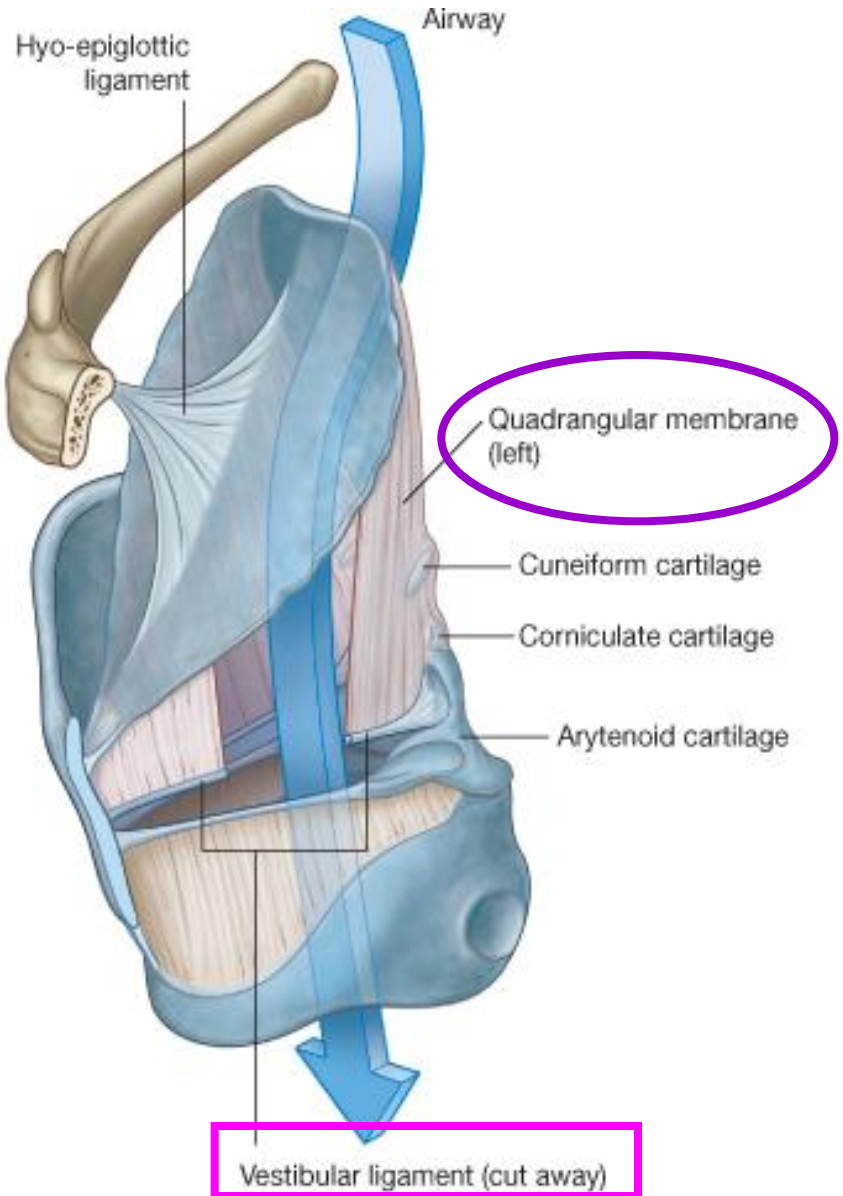
Quadrangular membrane



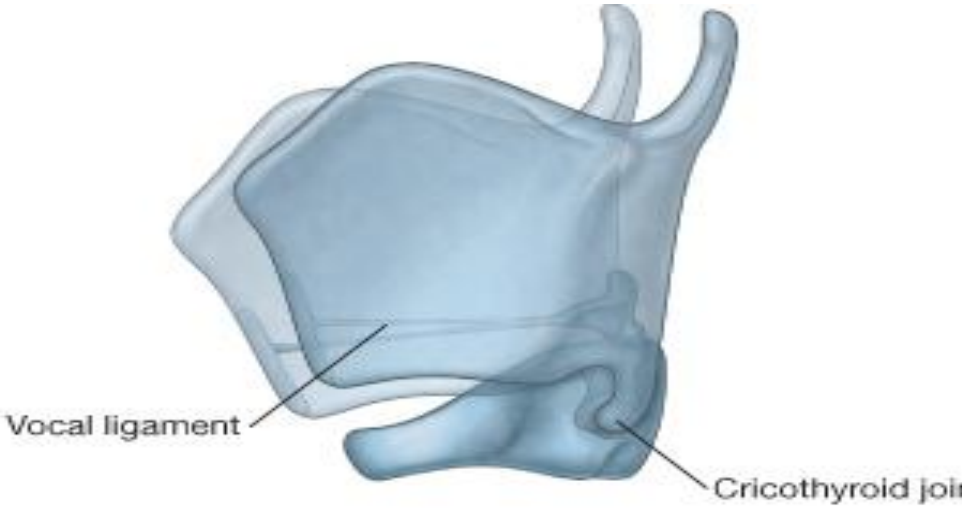
Crico-thyroid membrane (ligament)
(crico-vocal membrane)



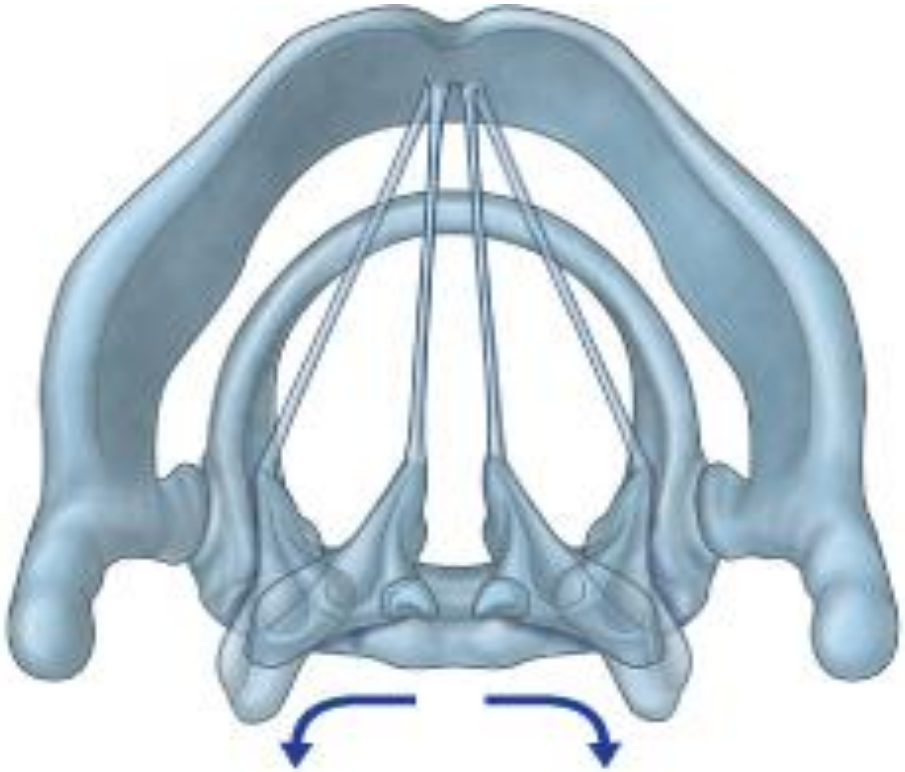
Quadrangular membrane



Laryngeal joints



crico-thyroid joint



crico-arytenoid joint

Cavity of the larynx

Vestibule

– superior to the **vestibular fold** (false vocal fold)

Ventricle & saccule

– between the **vestibular folds** and **vocal folds**

Infraglottic space

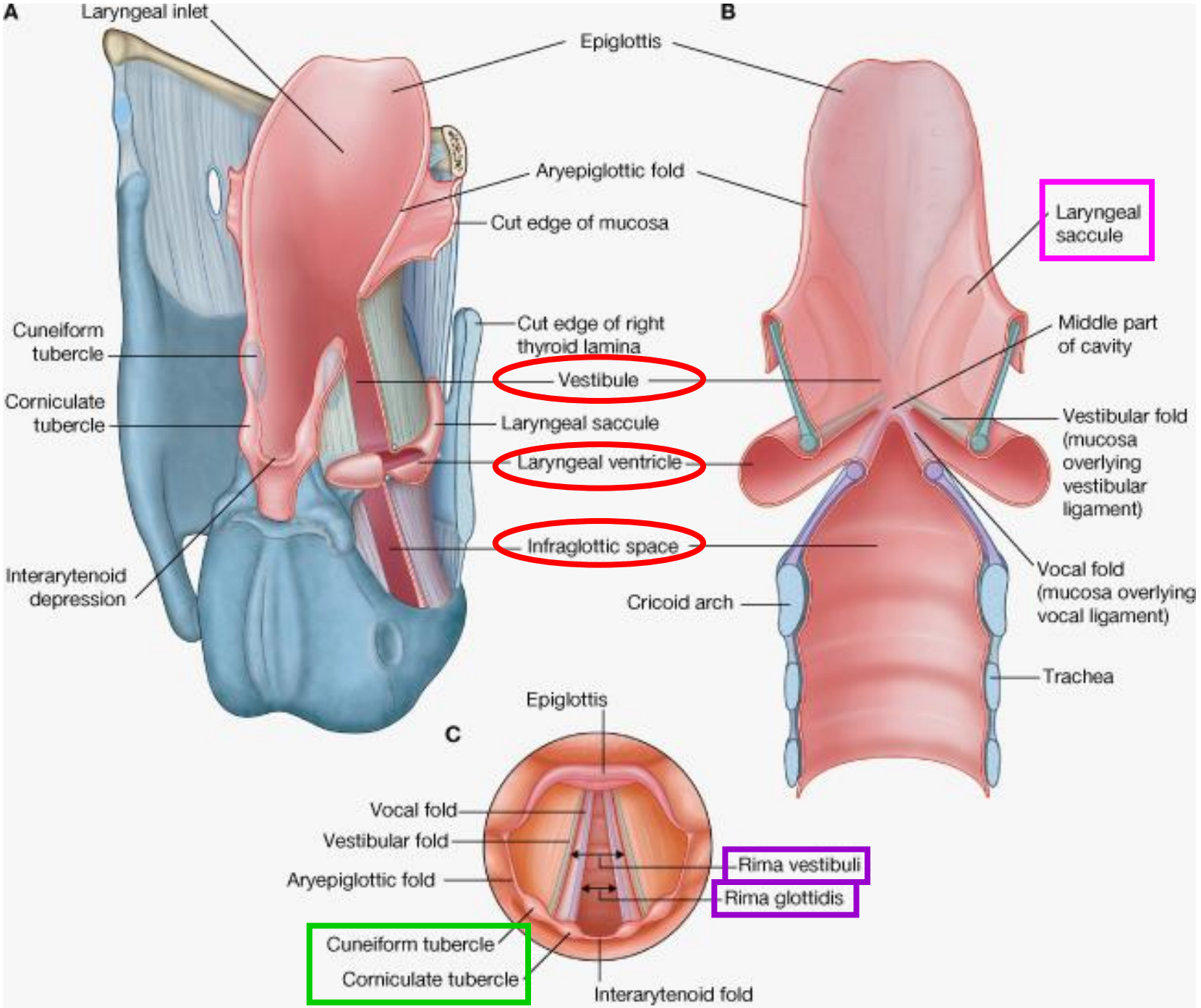
– from vocal fold to the border of cricoid cartilage

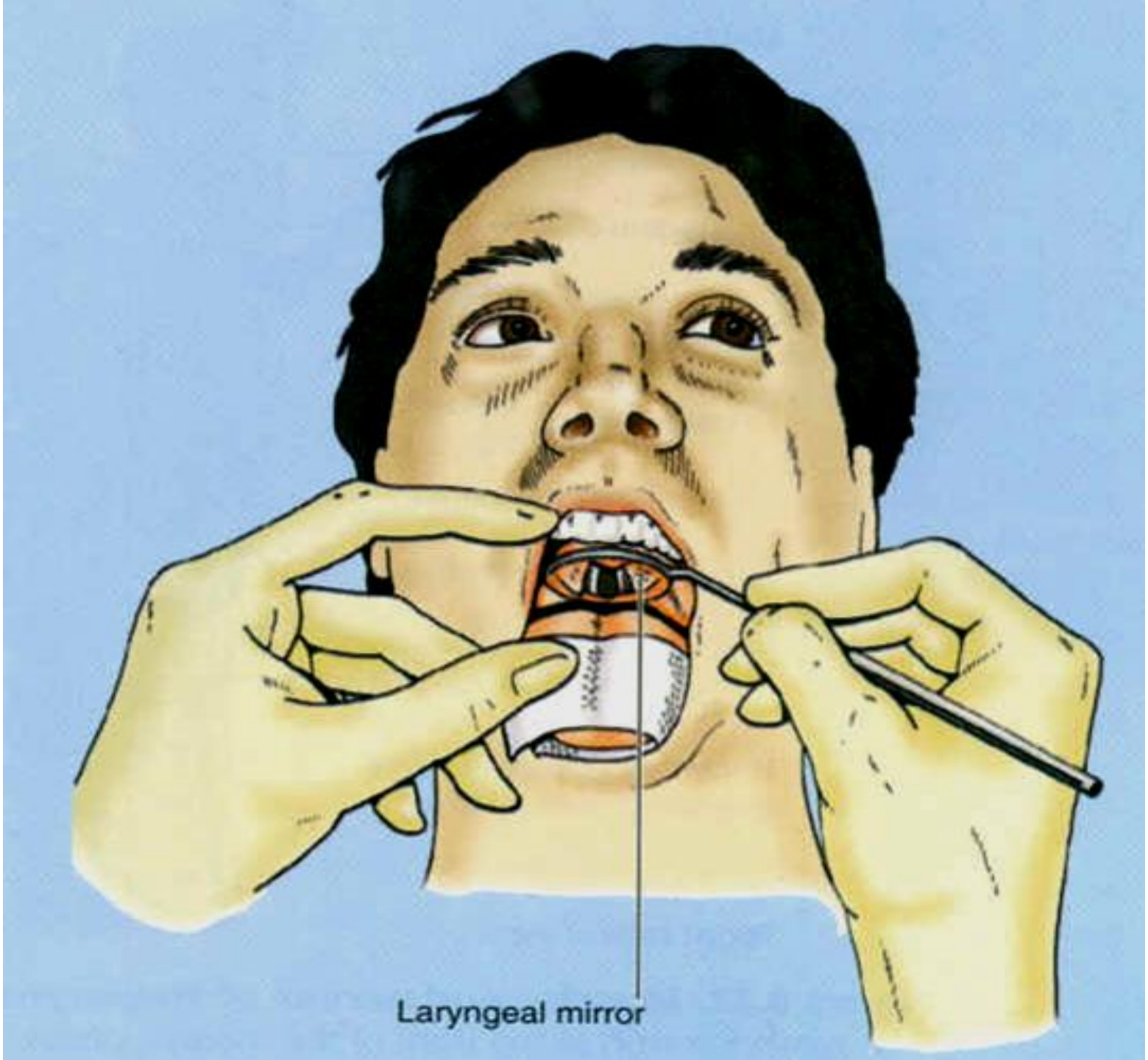
Glottis (the vocal apparatus of the larynx)

Rima glottidis – the aperture between the **vocal folds**

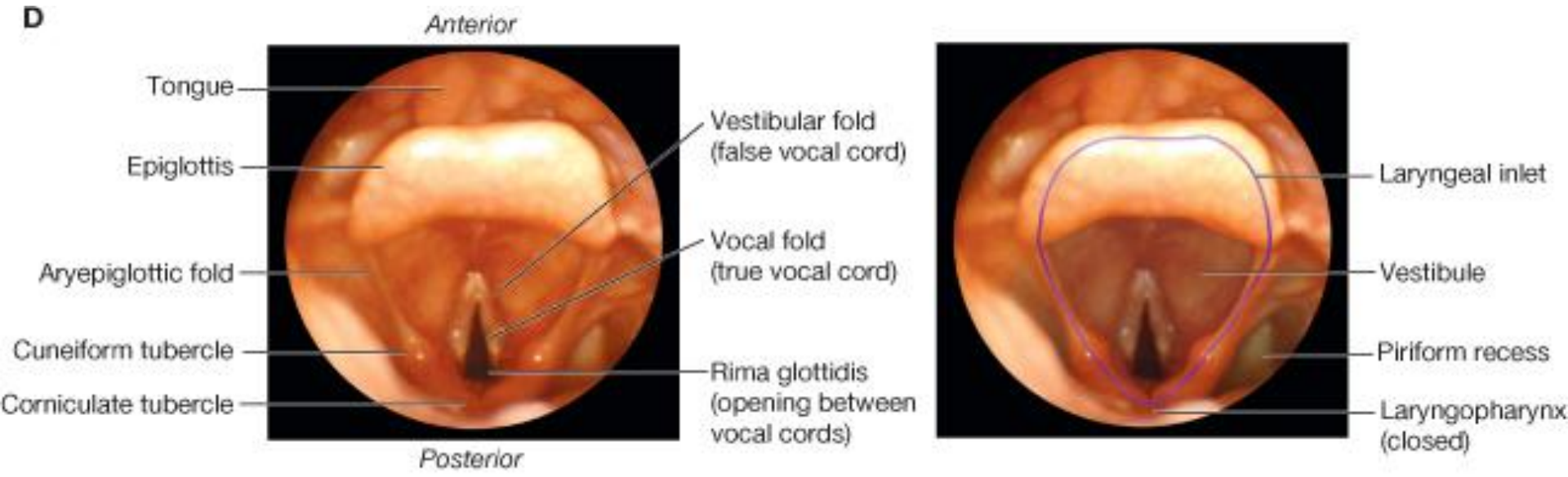
Rima vestibuli – the aperture between the **vestibular folds**

Greater length of the vocal folds in man




Laryngeal mirror

Laryngeal cavity



Laryngeal muscles

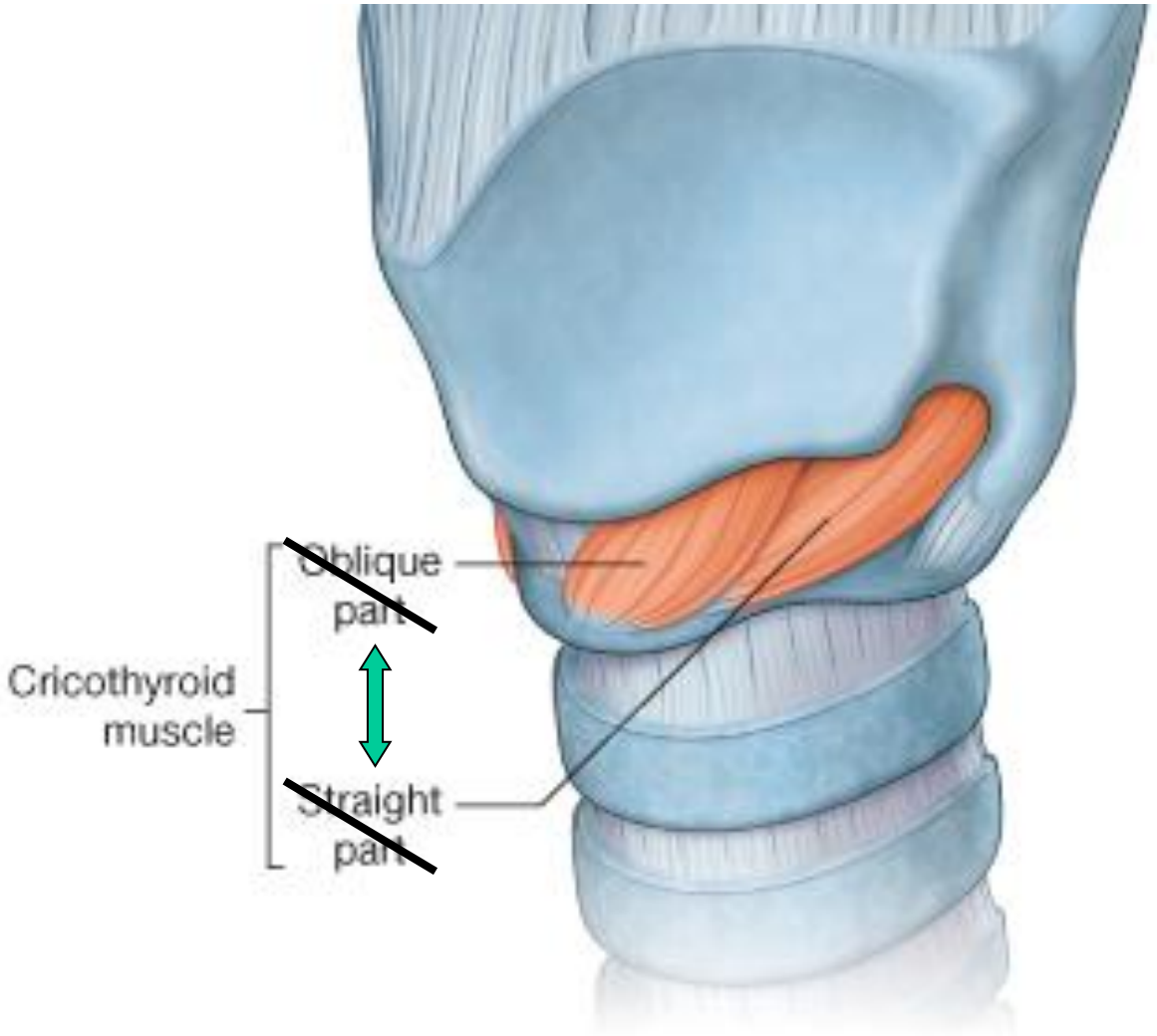
Extrinsic laryngeal muscles: *move the larynx as a whole*

infra-hyoid m. (depressor),
supra-hyoid and **stylopharyngeus m.** (elevators)

Intrinsic laryngeal muscles: *regulation of the tension of* **vocal folds** *and the size of* **rima glottidis**

cricothyroid m. (ext. laryngeal n.)
post. cricoarytenoid m. (recurrent laryngeal n.)
lat. cricoarytenoid m.
transverse & oblique arytenoid m.
vocalis m.
thyroarytenoid m.

cricothyroid m. (stretches and tenses vocal fold)
– **external laryngeal nerve**



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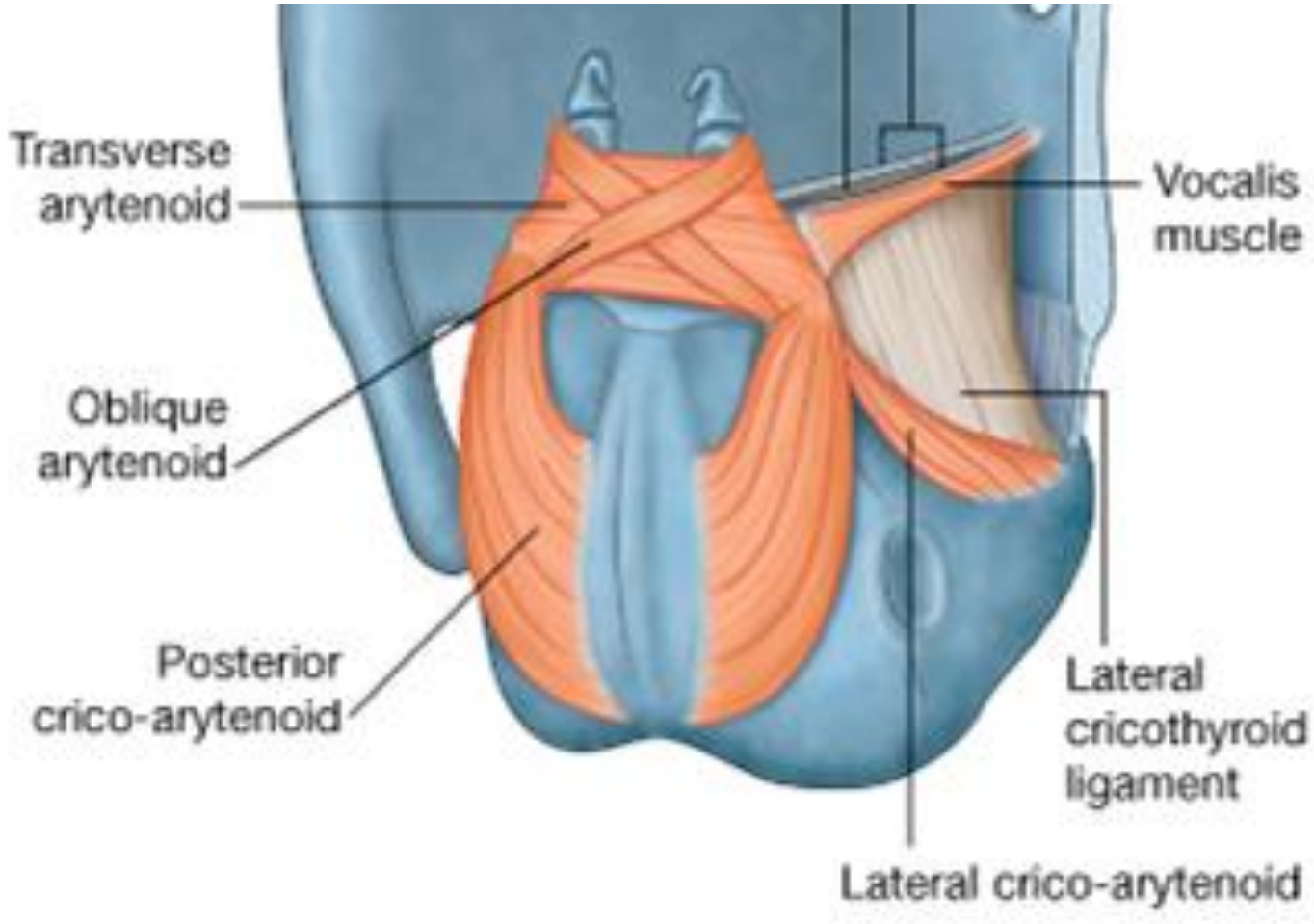
posterior cricoarytenoid m. (open)
lateral cricoarytenoid m. (close)
transverse arytenoid m. (close)
oblique arytenoid m. (close of laryngeal inlet)
vocalis m. (adjust tension in vocal fold)



oblique arytenoid m. (aryepiglottic part)
(sphincter of laryngeal inlet)
thyroarytenoid m. (thyroepiglottic part)
(sphincter of vestibule and laryngeal inlet)

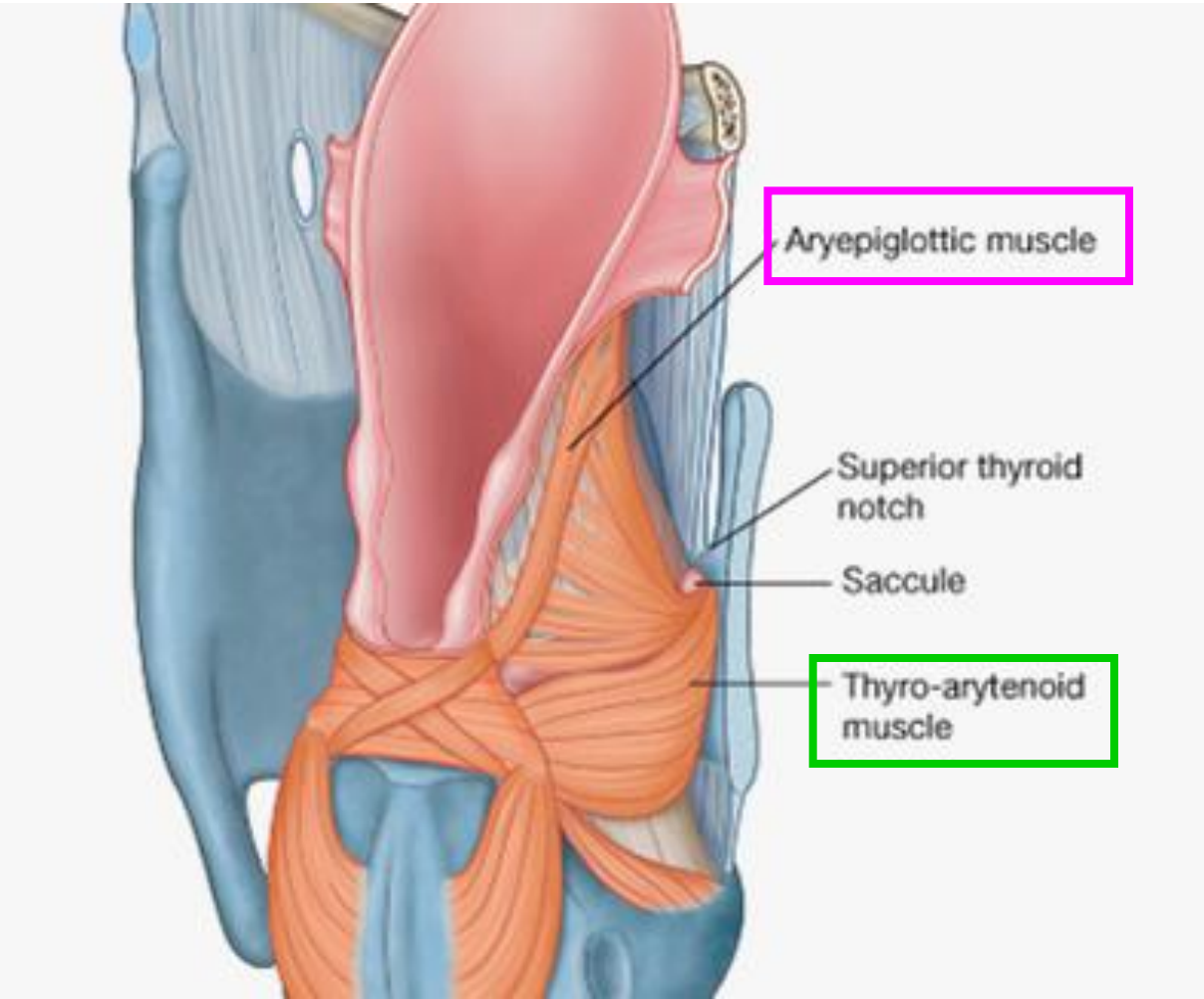
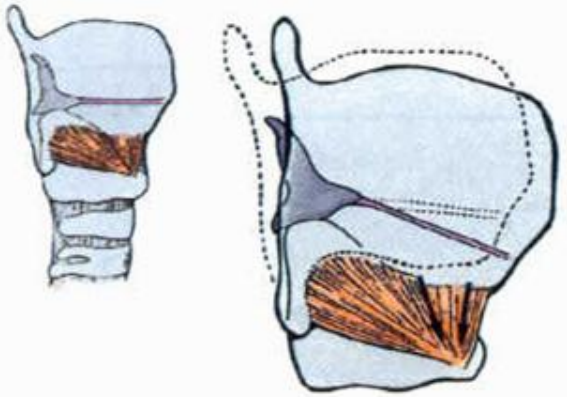
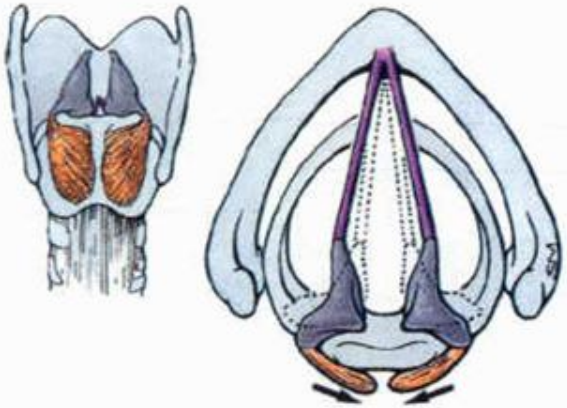


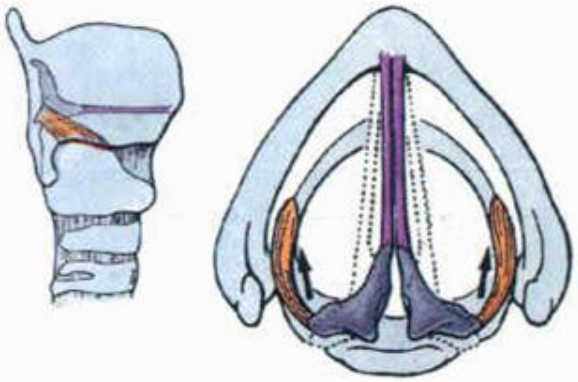
Table 8.5. Actions of Laryngeal Muscles



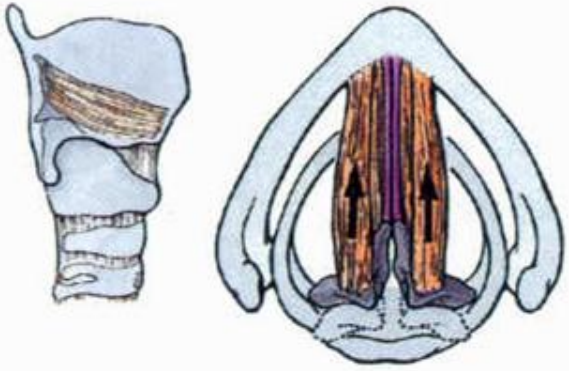
Lateral view
Cricothyroid



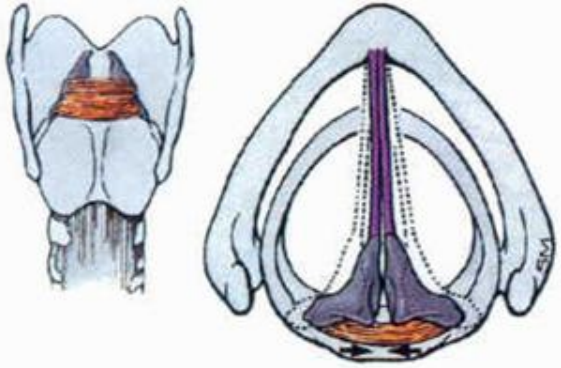
Superior view
Posterior cricoarytenoid



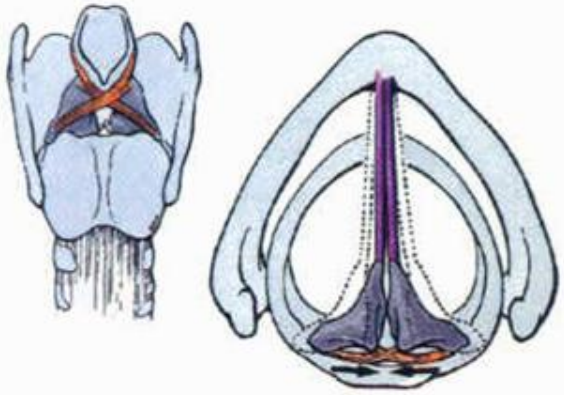
Superior view
Lateral cricoarytenoid



Superior view
Thyroarytenoid



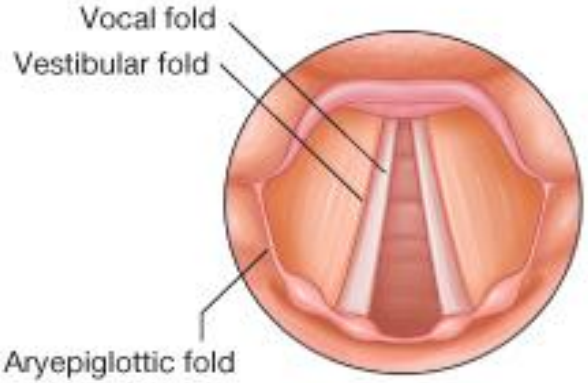
Superior view
Transverse arytenoid



Superior view
Oblique arytenoid

A

Quiet respiration



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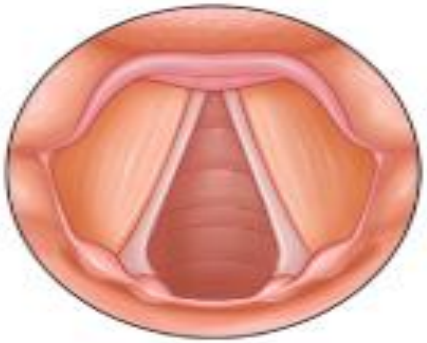
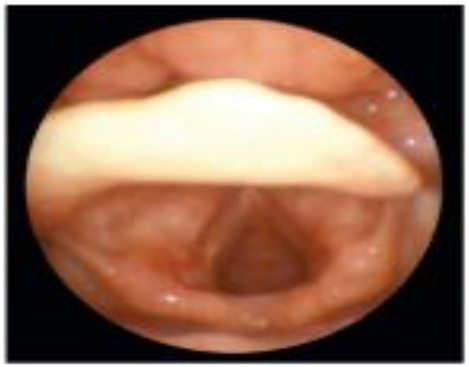
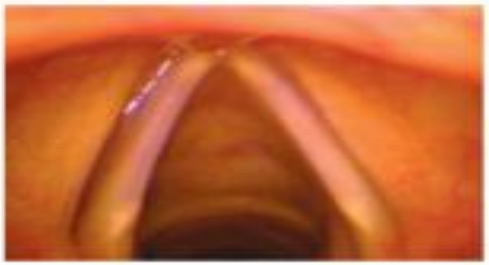
B

Forced inspiration

- vocal folds abducted and rima glottidis wide open
- vestibule open







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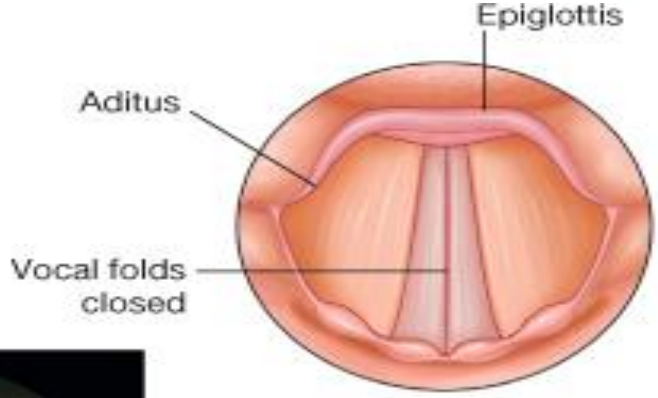
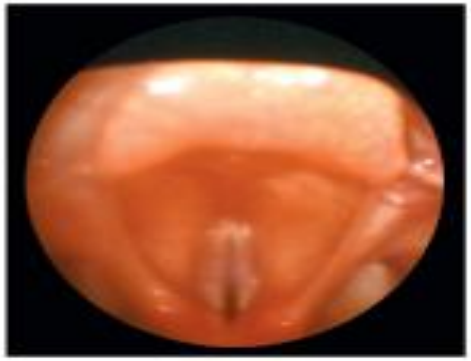
C

Phonation

- vocal folds adducted and stridulating as air is forced between them
- vestibule open





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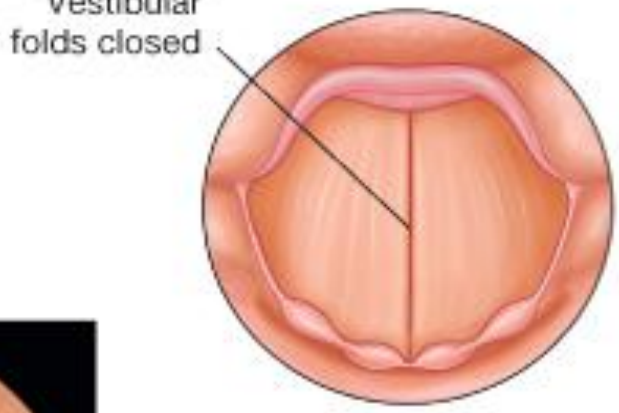
D

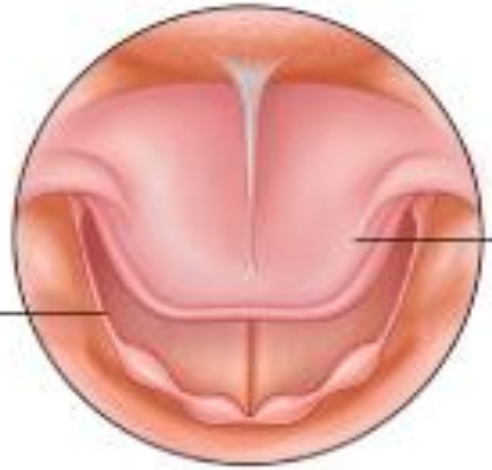
Effort closure

- vocal folds and vestibular folds adducted
- rima glottidis and vestibule closed



E

Swallowing

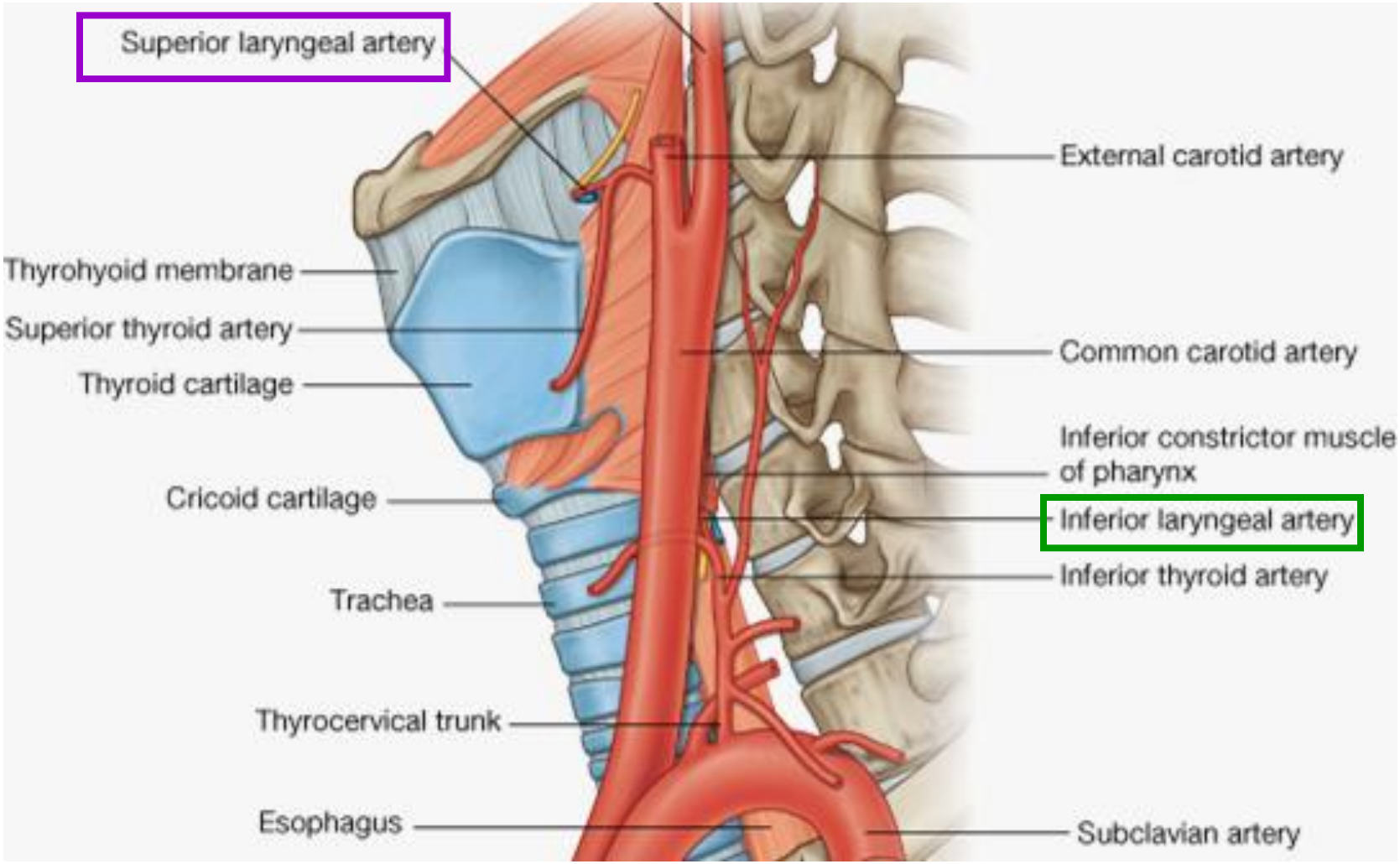


Vessels of the larynx

Arteries:

Sup. laryngeal artery (branches of sup. thyroid artery)

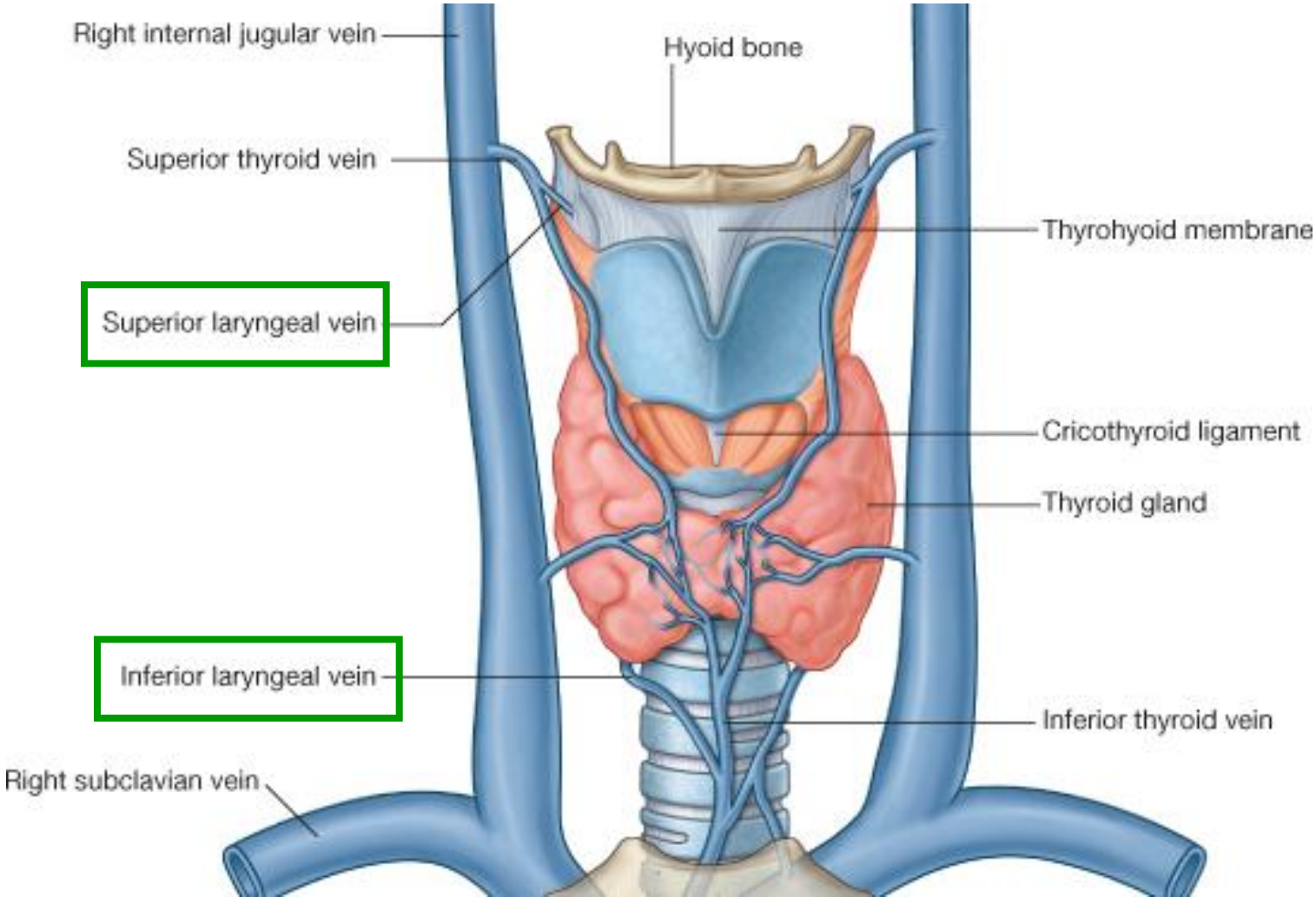
Inf. laryngeal artery (branches of inf. thyroid artery)



Veins: accompany the laryngeal arteries

Sup. laryngeal vein → sup. thyroid vein → IJV

Inf. laryngeal vein → inf. thyroid vein
→ left brachiocephalic v.



Nerves: branches of **vagus nerve**

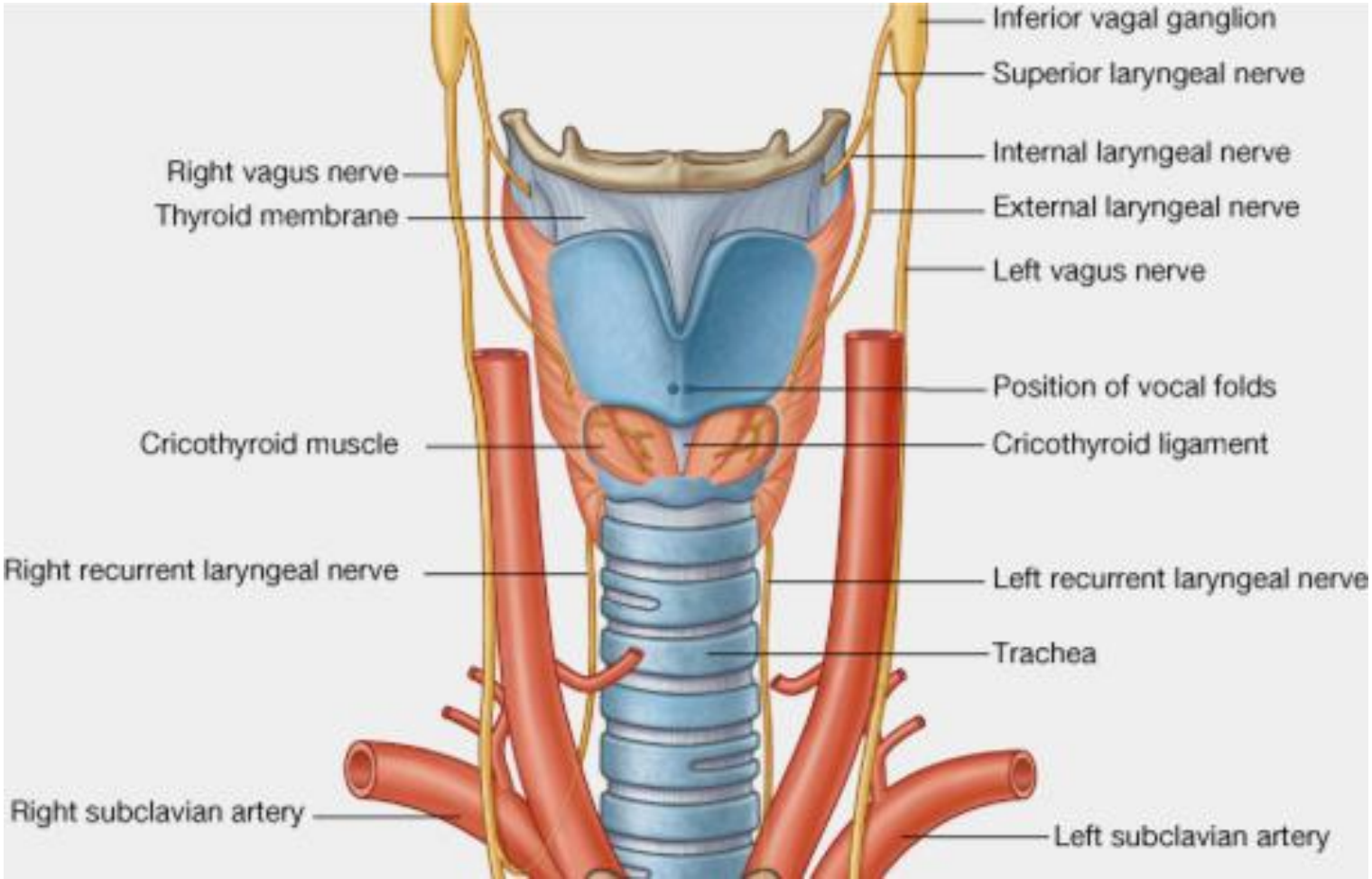
Sup. laryngeal nerve (from inf. vagal ganglion)

→ **internal laryngeal nerve** (sensory and autonomic)

external laryngeal nerve (motor)

Inf. laryngeal nerve

(terminal part of recurrent laryngeal n.– motor nerve)



Dissection of Larynx

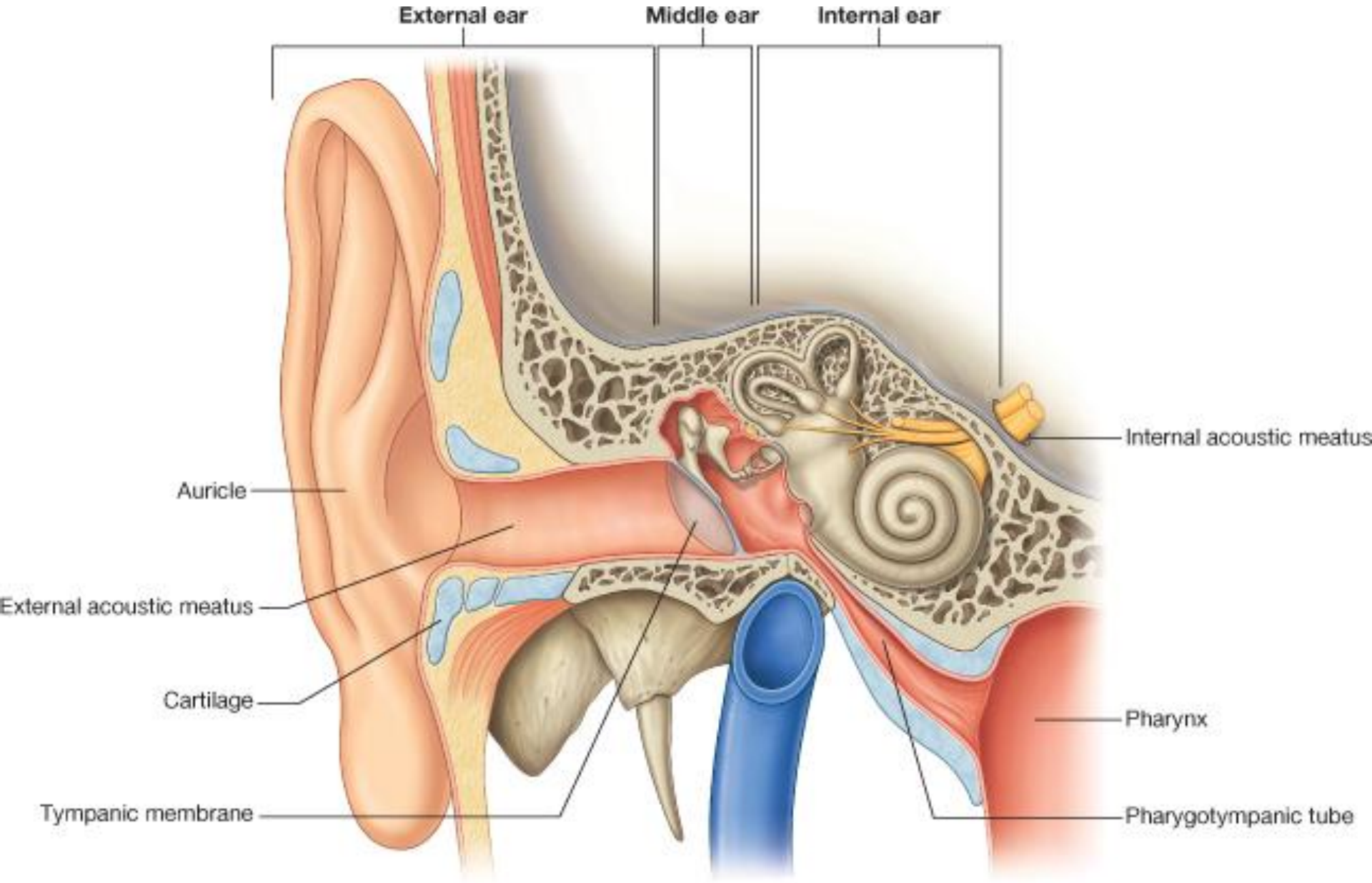
Larynx

1. Examine **thyroid, cricoid, arytenoid, epiglottic cartilages** and **vocal ligaments**.
2. Carefully trace the **internal laryngeal nerve** & **recurrent laryngeal nerve**.
3. Remove mucosa of **piriform recess** to expose **intrinsic laryngeal muscles**.
4. Identify **posterior cricoarytenoid muscles**, **arytenoid muscles** (***transverse & oblique fibers***).

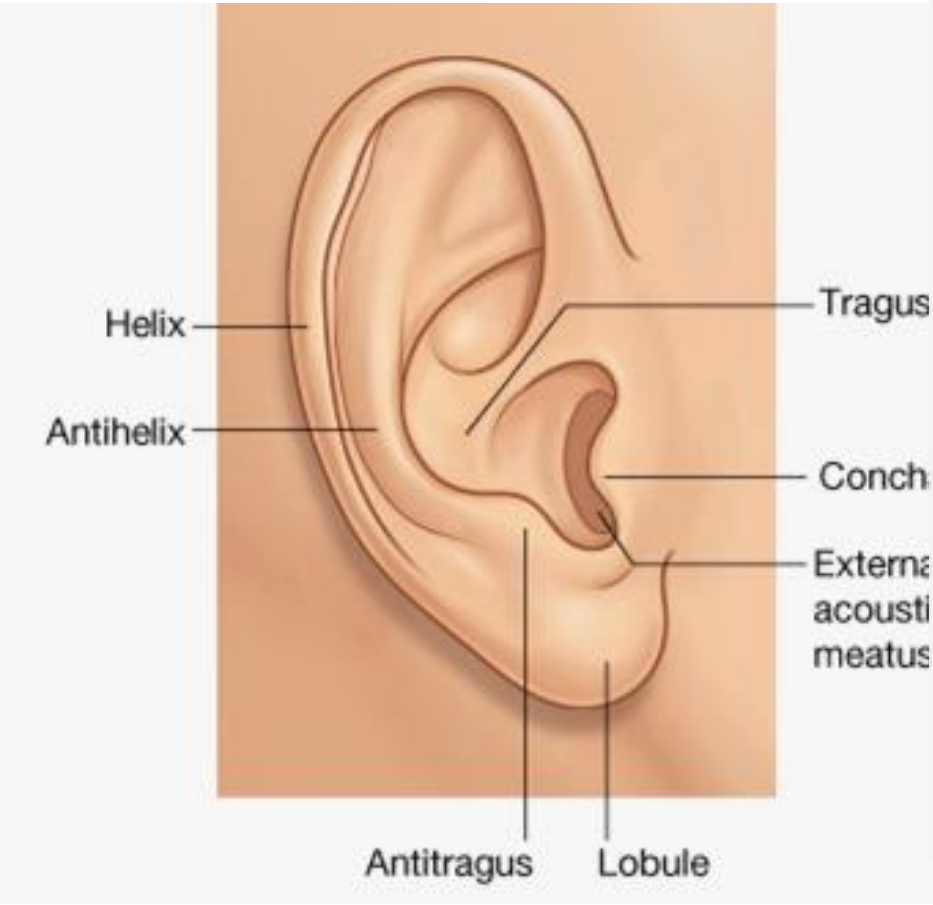
oblique fibers also called ***aryepiglotticus***.

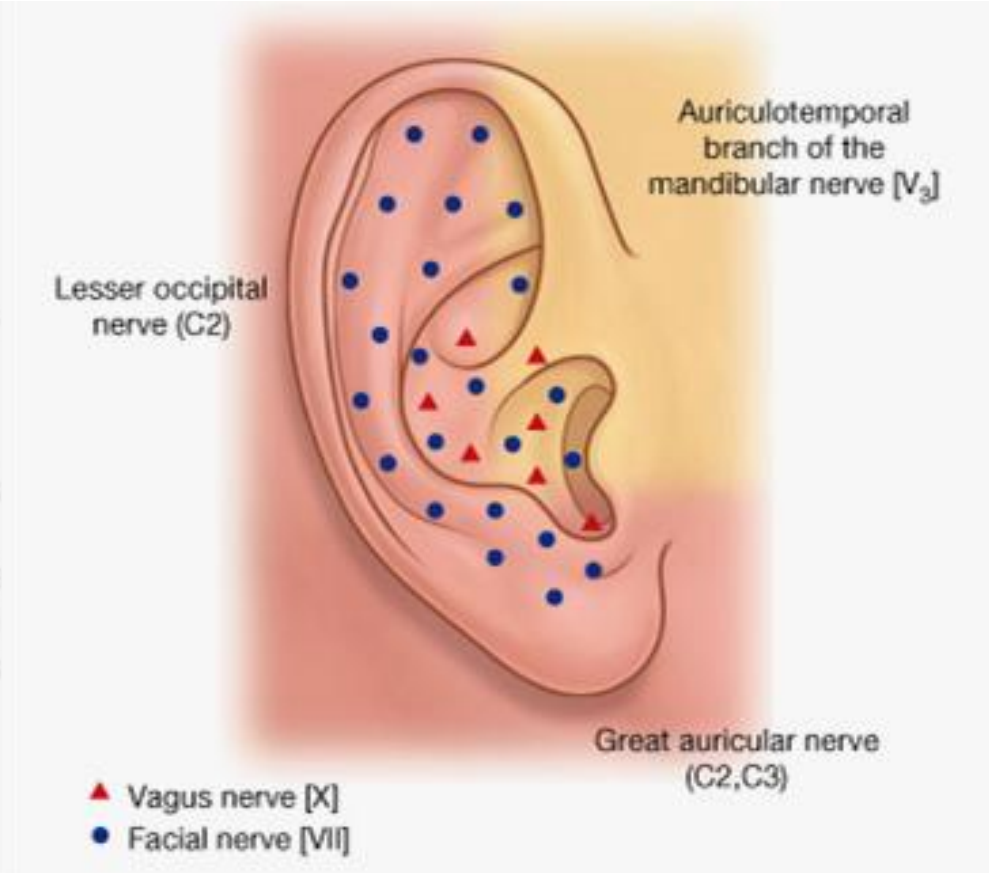
5. Define **cricothyroid joint**, just posterior to the joint run **recurrent laryngeal nerve**.
6. Cut lamina of thyroid cartilage about 8mm to the left of midline.
7. Reflect **thyroid lamina** inferiorly, **cricothyroid muscle** still attaches.
8. Identify **cricothyroid muscle, lateral cricoarytenoid, thyroarytenoid, vocalis & thyroepiglotticus**.
9. Examine **vestibular fold, vocal fold & ventricle**.

Middle Ear



Auricle


Helix
Antihelix
Tragus
Conch
Externa
acousti
meatus
Antitragus
Lobule

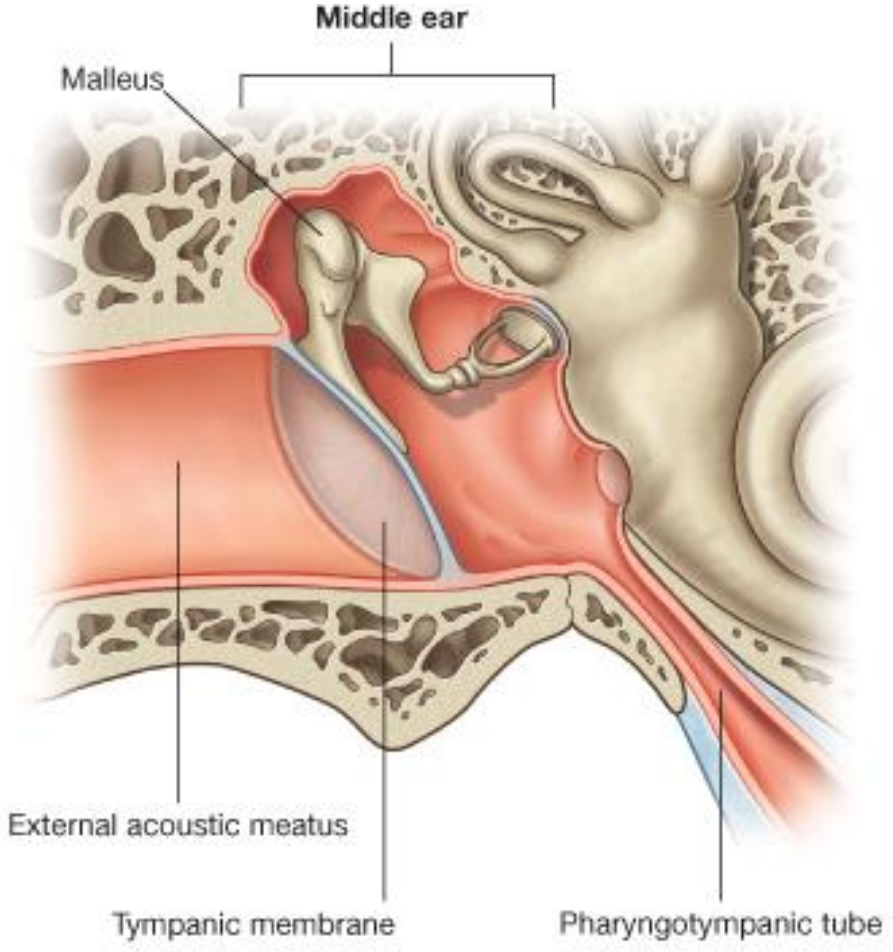

Auriculotemporal
branch of the
mandibular nerve [V3]
Lesser occipital
nerve (C2)
Great auricular nerve
(C2,C3)
Vagus nerve [X]
Facial nerve [VII]

Tympanic membrane

– fibrous membrane covered with thin skin (umbo)

External innervation: **auriculotemporal nerve (V3)**

Internal innervation: **glossopharyngeal nerve (IX**

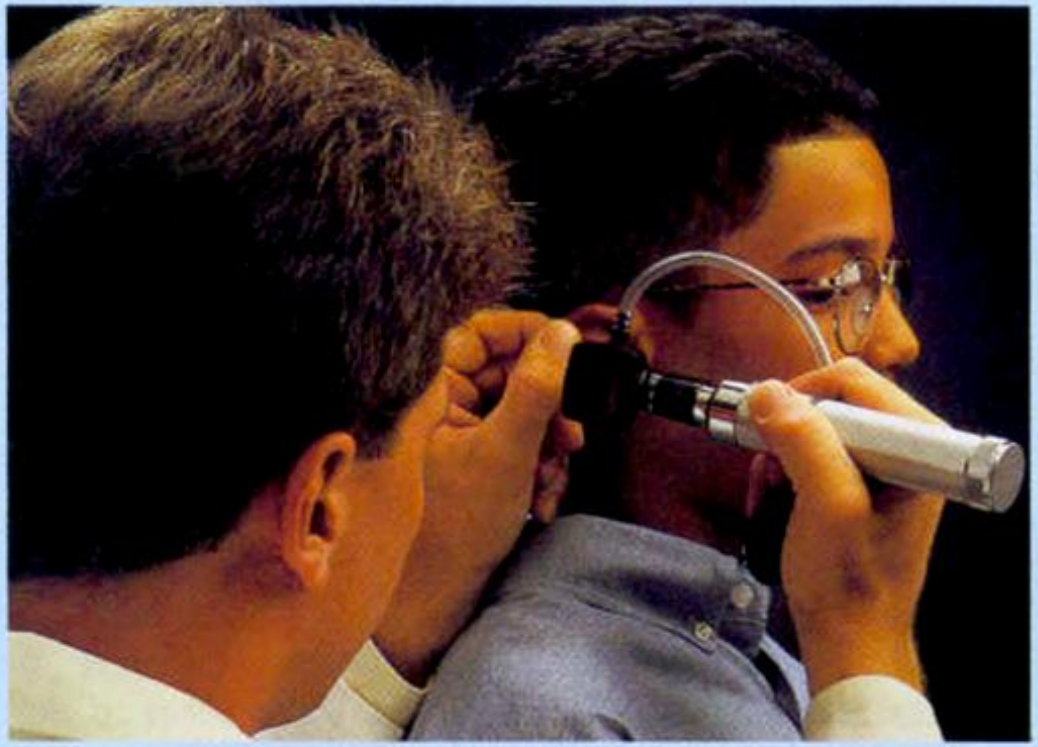


ernal Ear Injury

ding within the auricle resulting from trauma may uce an *auricular hematoma*. The localized collection ood forms between the perichondrium and auricular lage. As the hematoma enlarges it compromises the d supply to the cartilage. If untreated (e.g., by aspira-, fibrosis—formation of fibrous tissue—develops in verlying skin, forming a malformed auricle (e.g., the liflower ear" that occurs in some wrestlers).

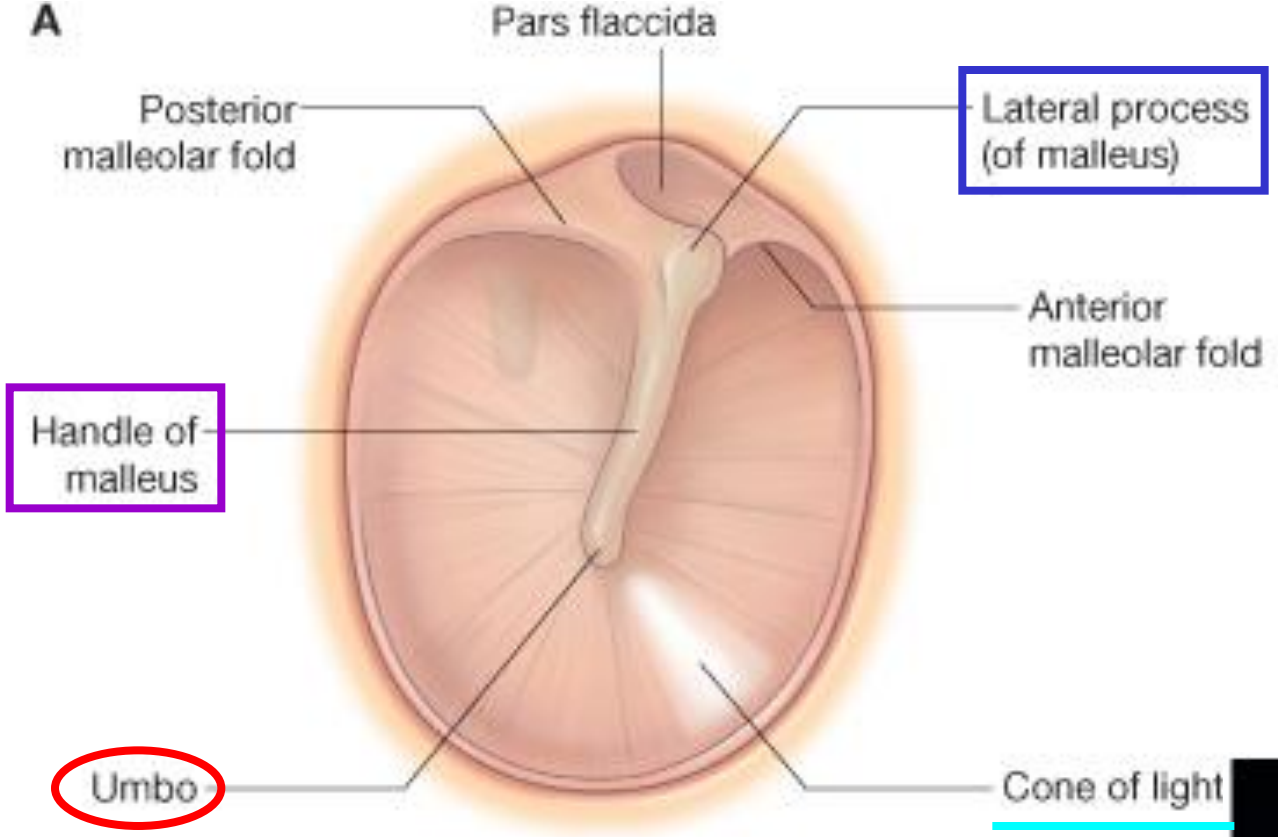
Otoscopic Examination

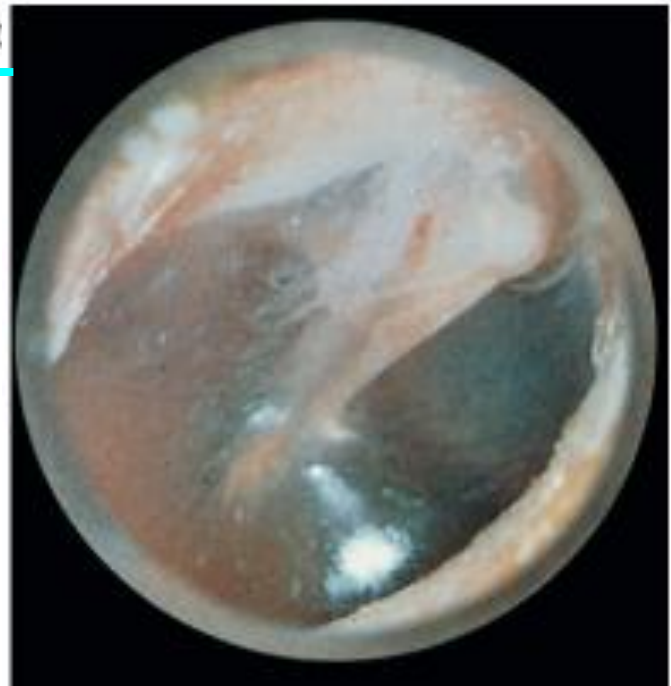
Examination of the external acoustic meatus and tymp membrane begins by straightening the meatus. In ad the helix is grasped and pulled posterosuperiorly (up, and back). These movements reduce the curvature of meatus, facilitating insertion of the *otoscope* (*A*). The ternal acoustic meatus is relatively short in infants; th fore, extra care must be exercised to prevent injury to tympanic membrane. The meatus is straightened b



(A) Otoscopic examination

(B) Normal tympanic membrane


A
Pars flaccida
Posterior malleolar fold
Lateral process (of malleus)
Anterior malleolar fold
Handle of malleus
Umbo
Cone of light



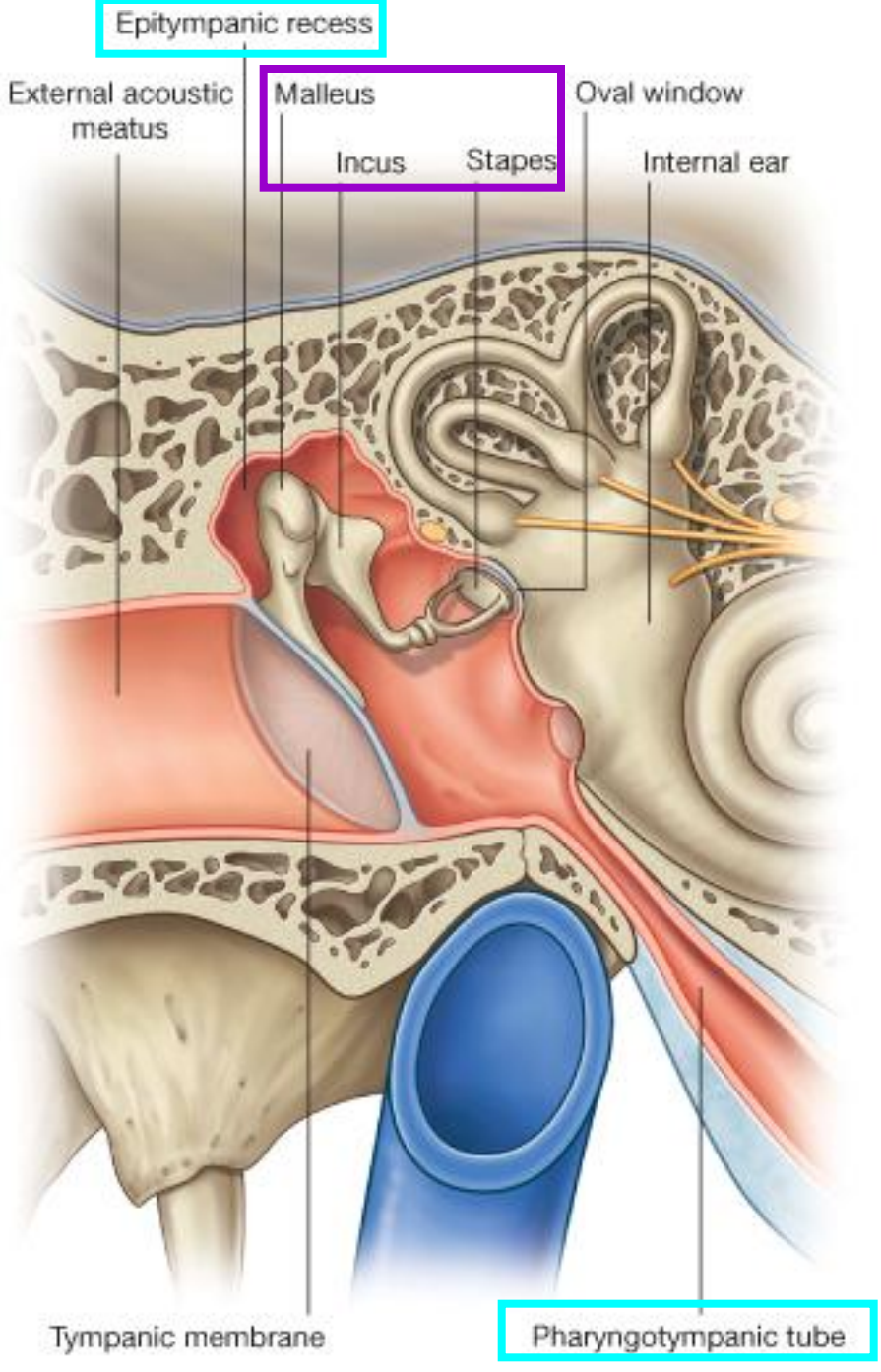
Middle ear

Include: **tympanic cavity** & **epi-tympanic recess**

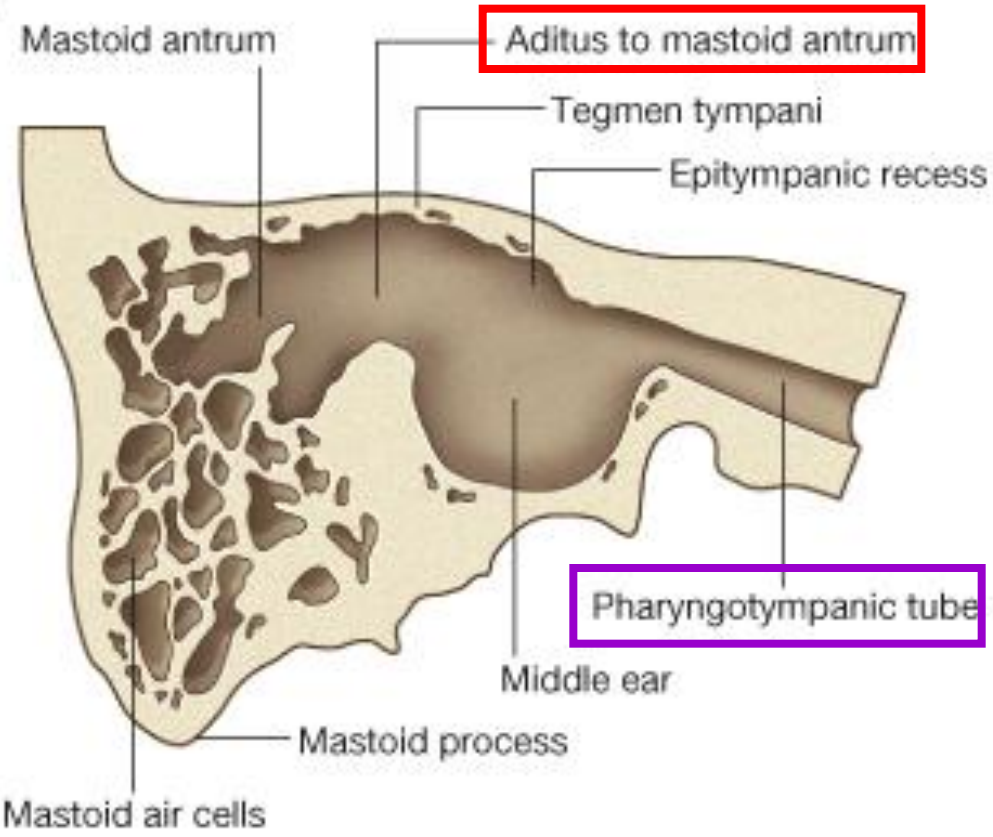
Connect: **pharyngo-tympanic tube** &
mastoid antrum

Contents:

auditory ossicles (malleus, incus & stapes)
stapedius & **tensor tympani** muscles
chorda tympani nerve (CN VII) &
tympanic plexus of nerve (CN IX)



A



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Walls of the tympanic cavity

roof: plate of bone

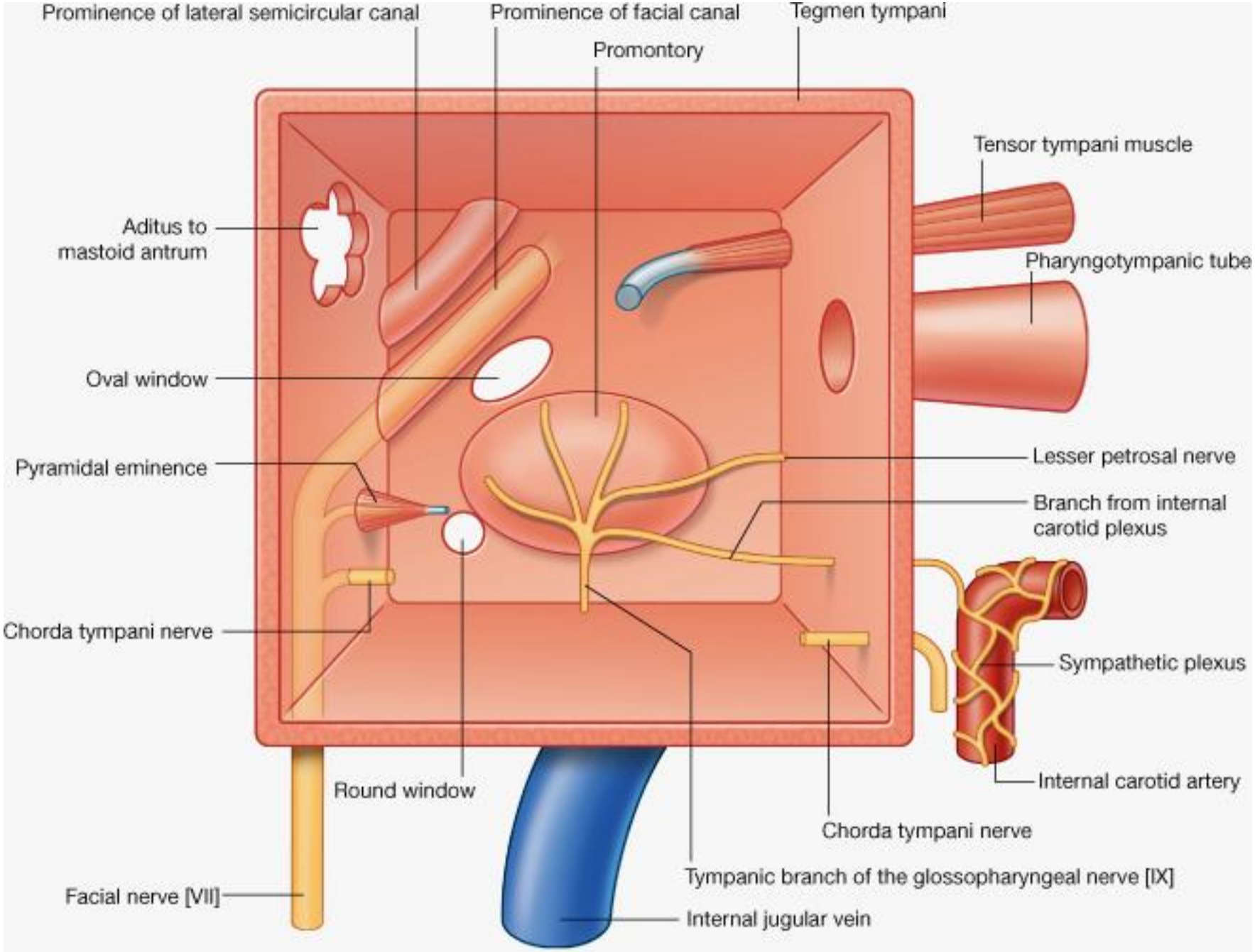
floor: near superior bulb of the IJV

lateral wall: tympanic membrane

medial wall :
promontory – basal turn of the cochlea,
tympanic plexus
oval window & round window

anterior wall : opening for **auditory tube** &
canal for **tensor tympani m.**

posterior wall : aditus to **mastoid antrum**
origin of **stapedius** (pyramid eminence),
chorda tympani nerve



Auditory ossicles

(1) **malleus** (2) **incus** (3) **stapes**

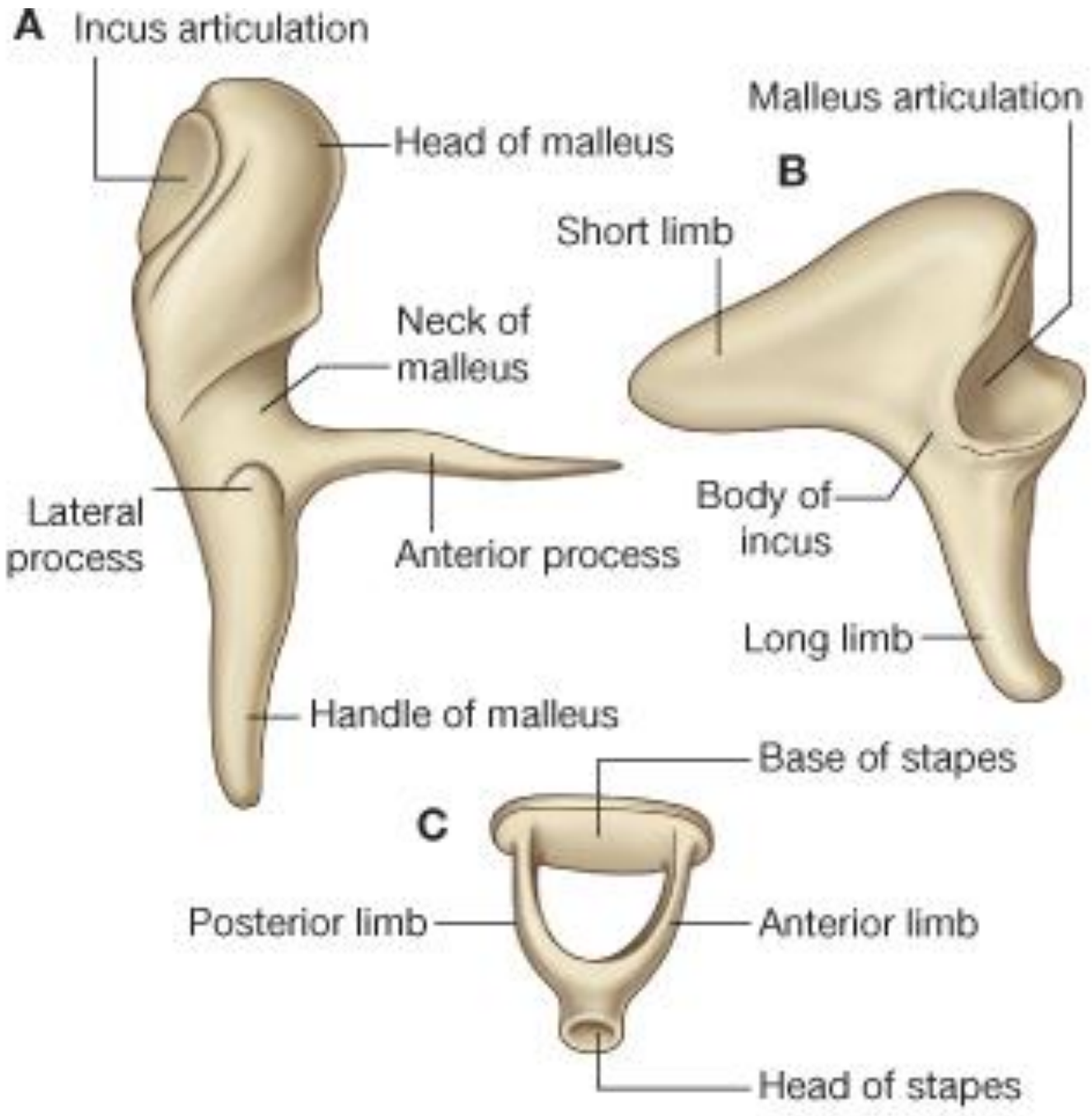
Muscles associated with the ossicles

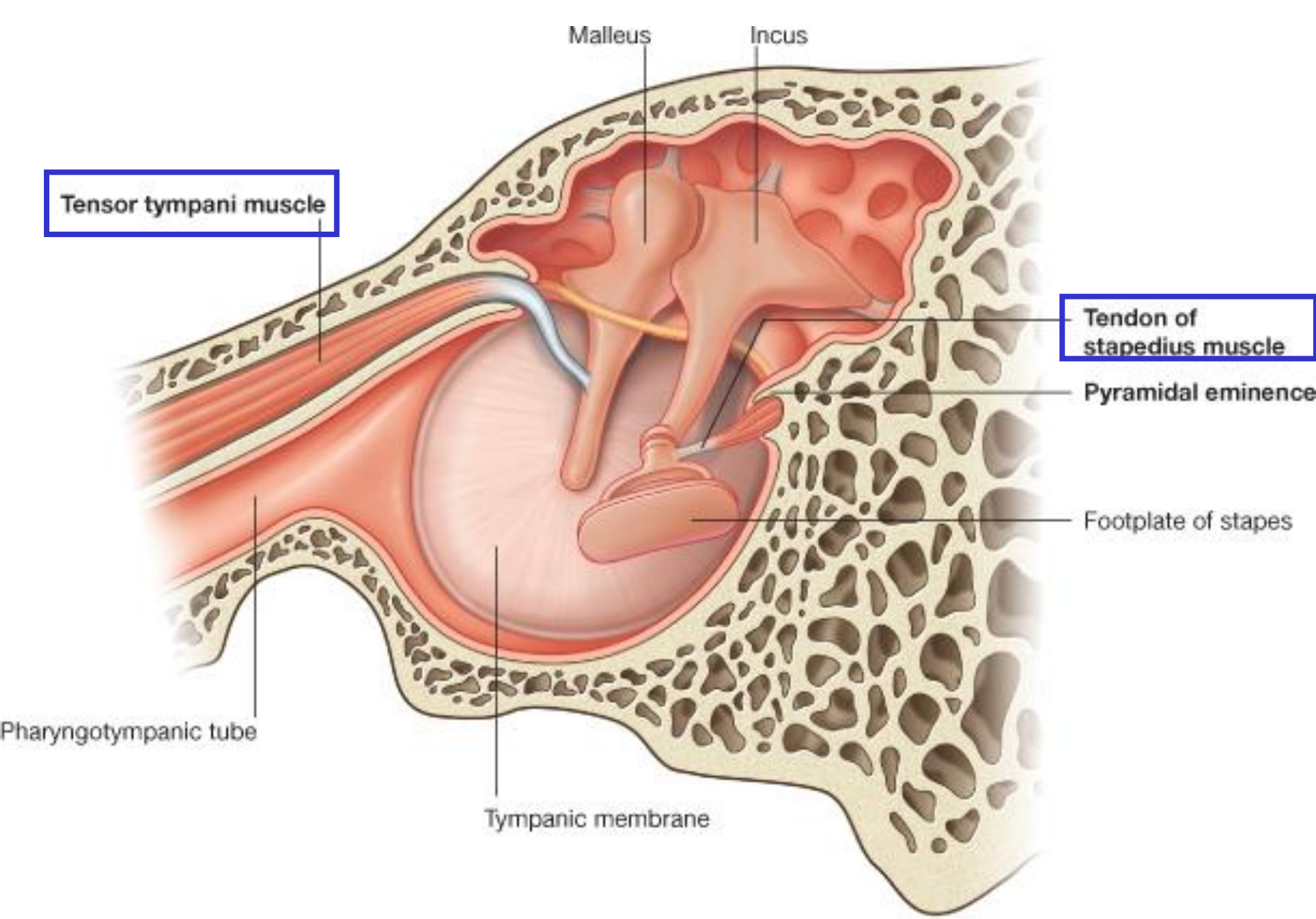
(1) **tensor tympani**:

origin –cartilaginous part of auditory tube
insertion – handle of malleus
nerve: **mandibular nerve (CN V3)**

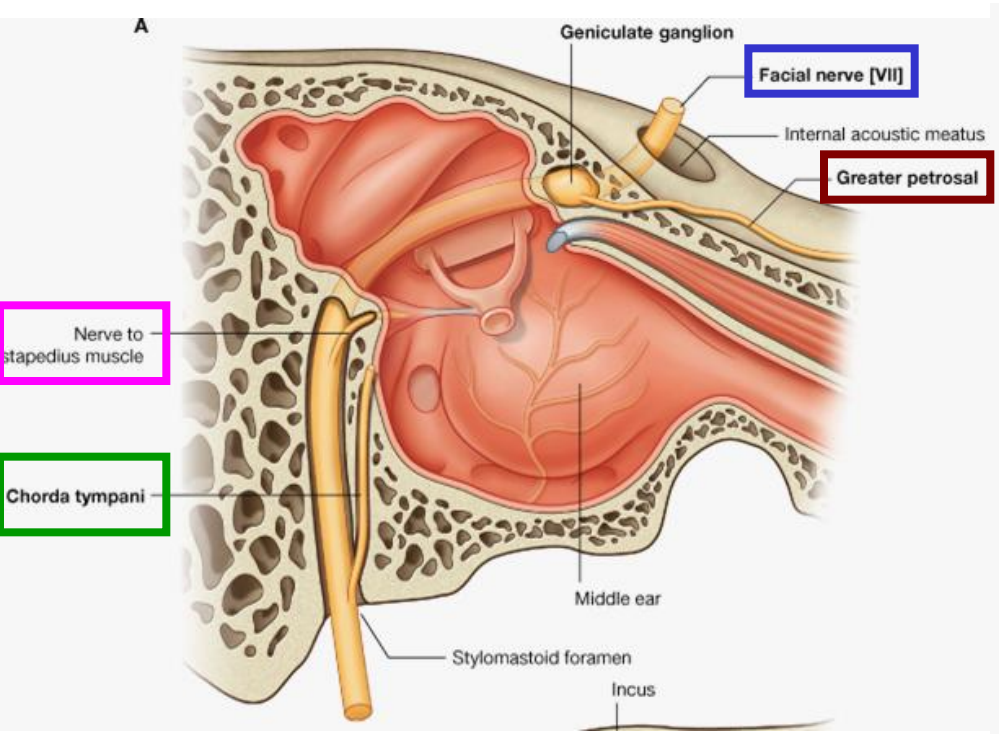
(2) **stapedius**:

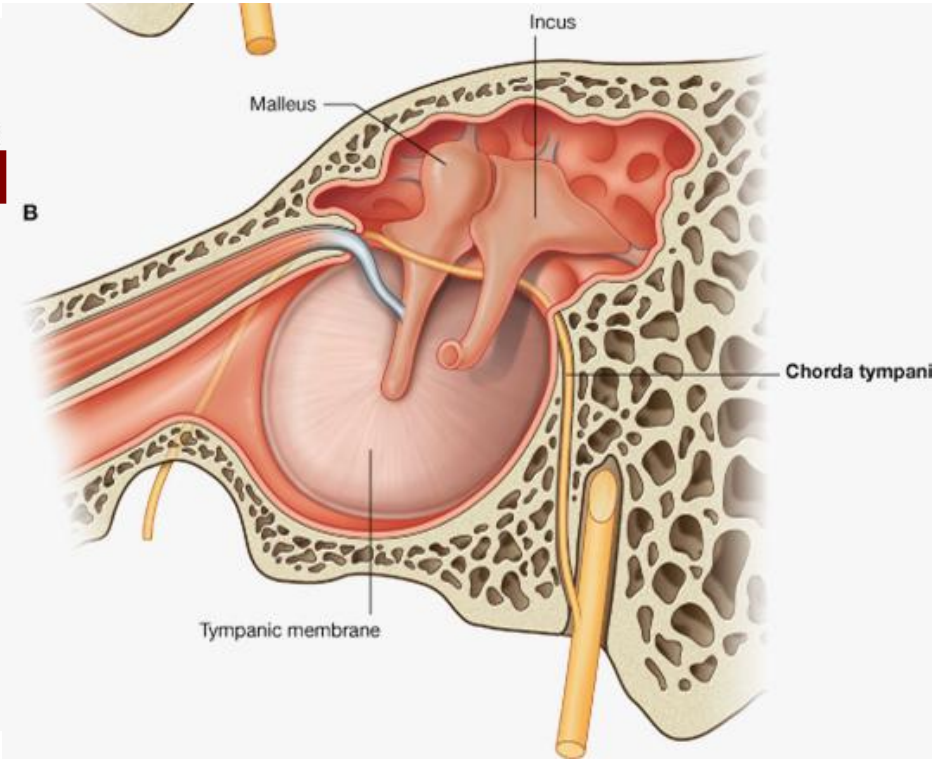
origin – pyramid eminence
insertion – neck of stapes
nerve: **facial nerve (CN VII)**



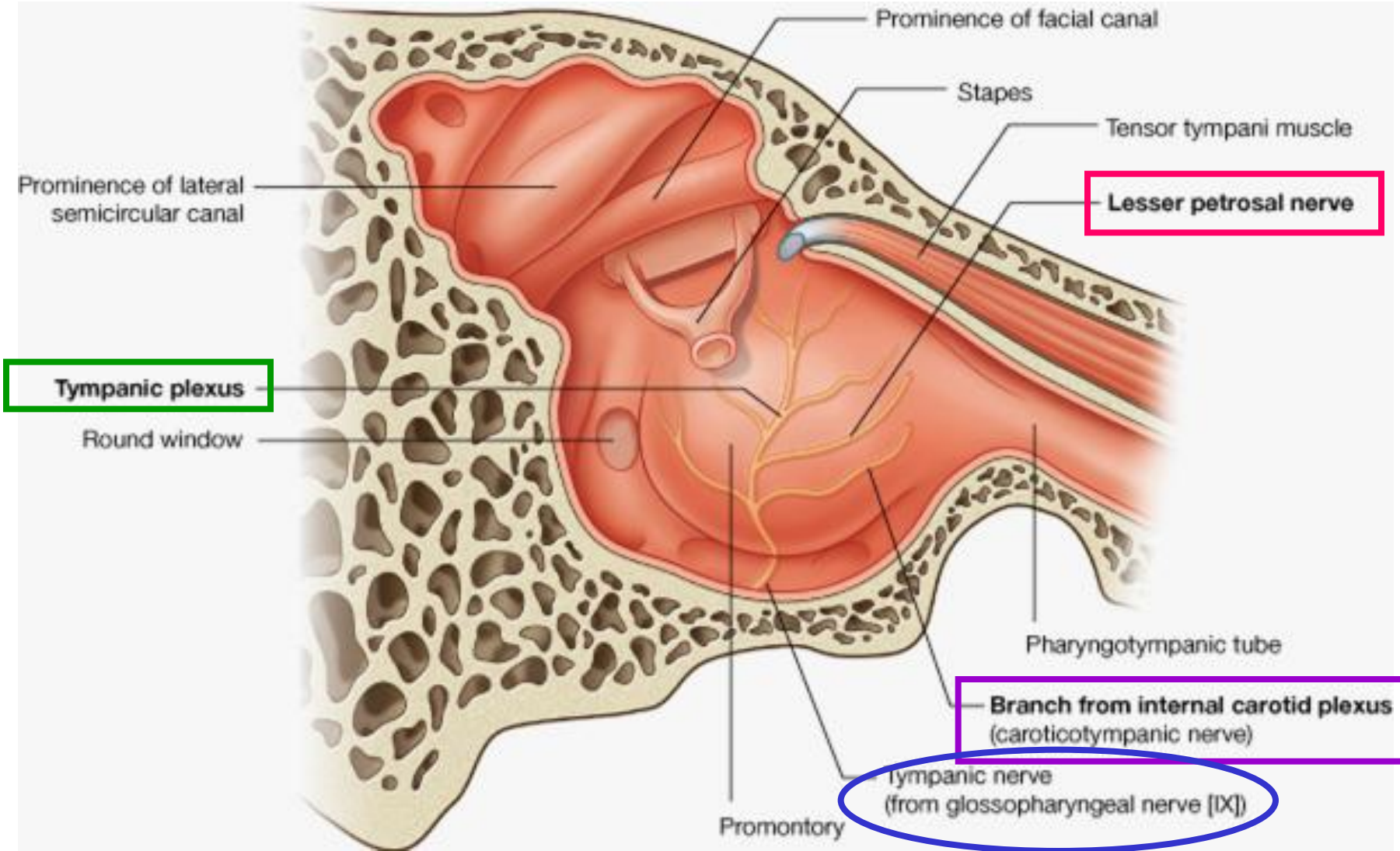


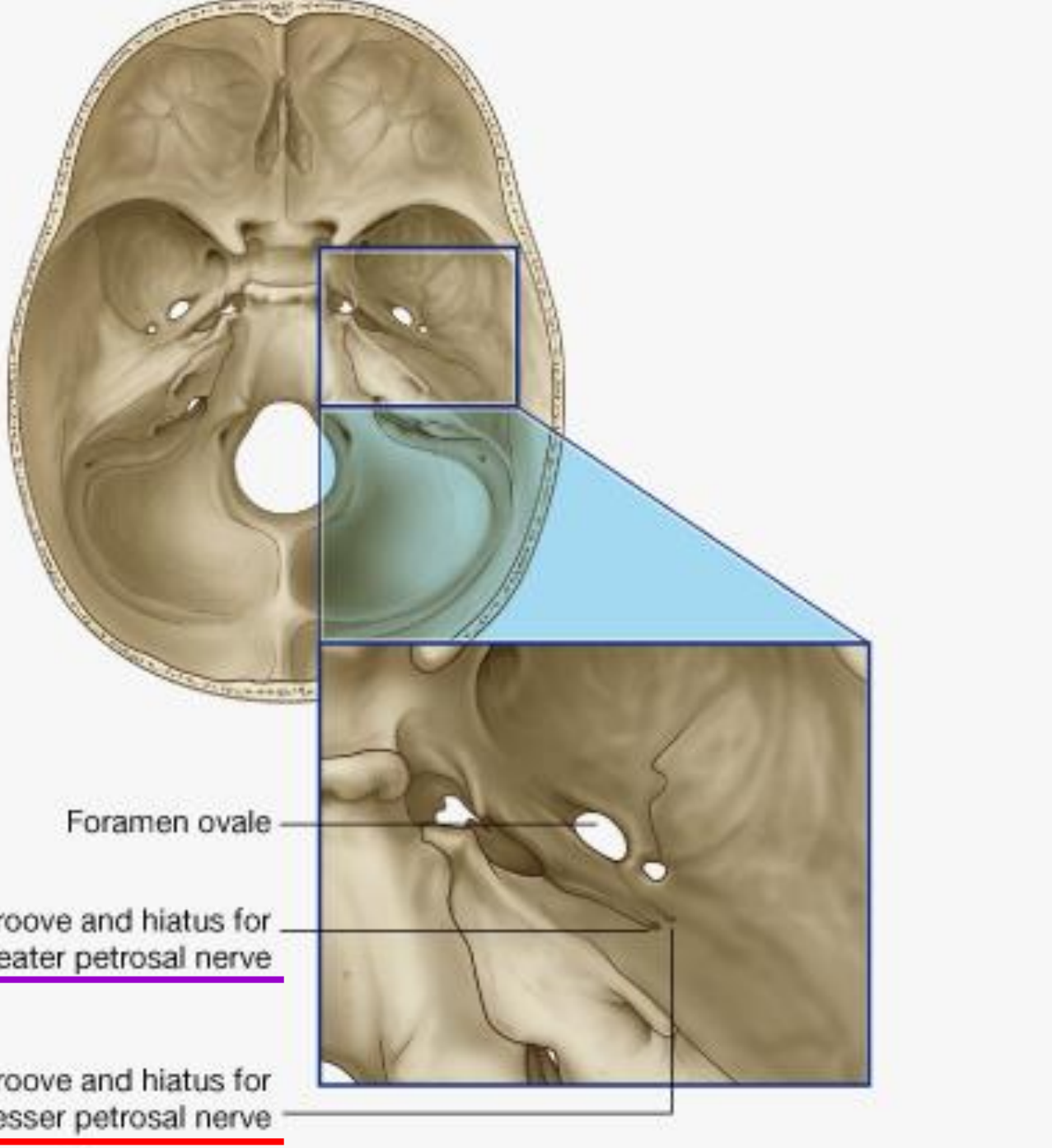
Facial nerve (CN VII) in the temporal bone





Glossopharyngeal nerve (CN IX) in the temporal bone





Pharyngo-tympanic tube (auditory tube)

Opening: posterior to the inferior meatus of nasal cavity

Function: ***equalize pressure in middle ear***

Arteries: **ascending pharyngeal artery** (external carotid artery)

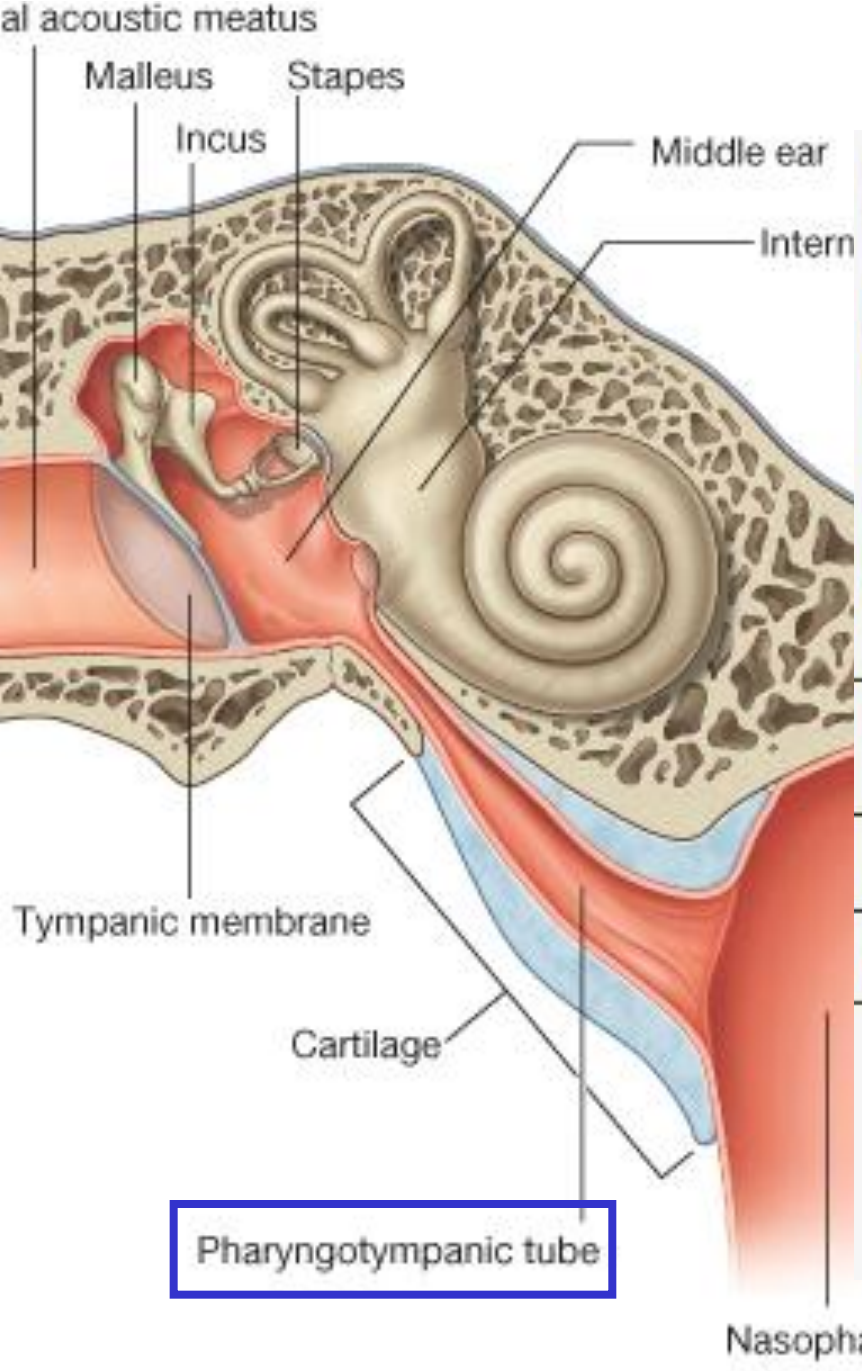
middle meningeal artery &

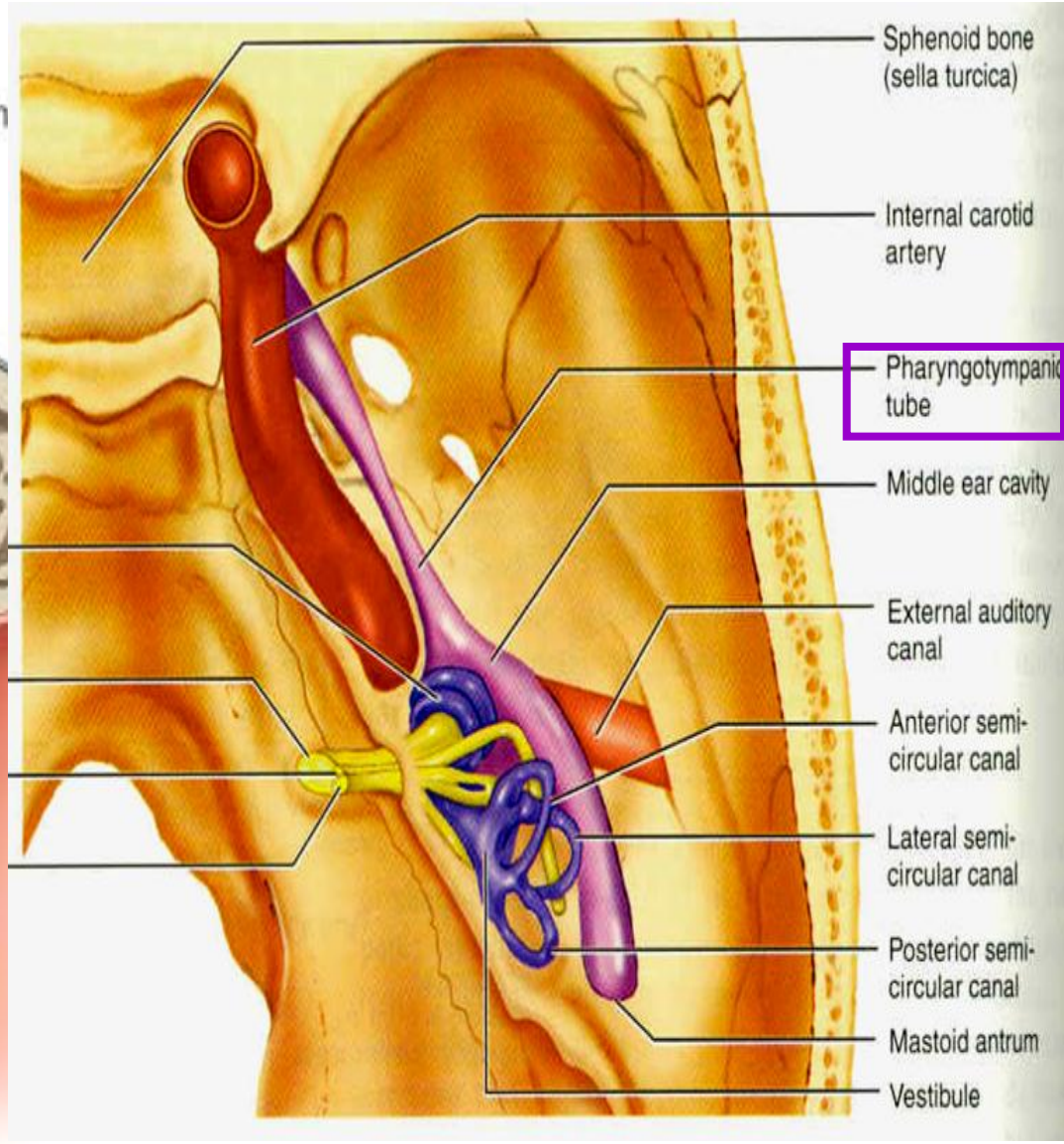
artery of pterygoid canal (maxillary artery)

Veins: drain into **pterygoid venous plexus**

Nerves: **tympanic plexus** &

nerve fibers of pterygopalatine ganglion


al acoustic meatus
Malleus
Stapes
Incus
Middle ear
Intern
Tympanic membrane
Cartilage
Pharyngotympanic tube
Nasopharynx


Sphenoid bone (sella turcica)
Internal carotid artery
Pharyngotympanic tube
Middle ear cavity
External auditory canal
Anterior semi-circular canal
Lateral semi-circular canal
Posterior semi-circular canal
Mastoid antrum
Vestibule

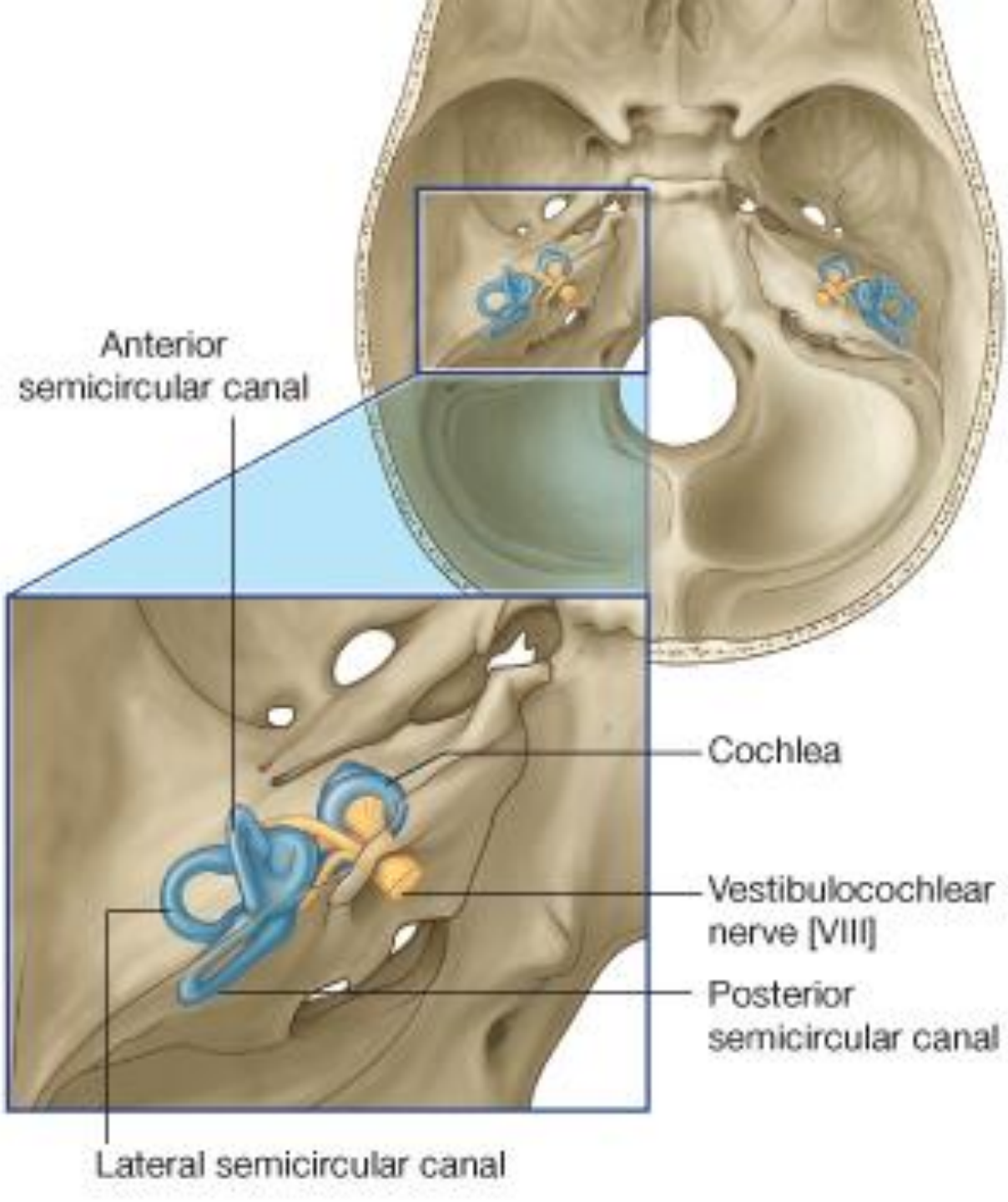
Internal ear (contains **vestibulocochlear organ**)

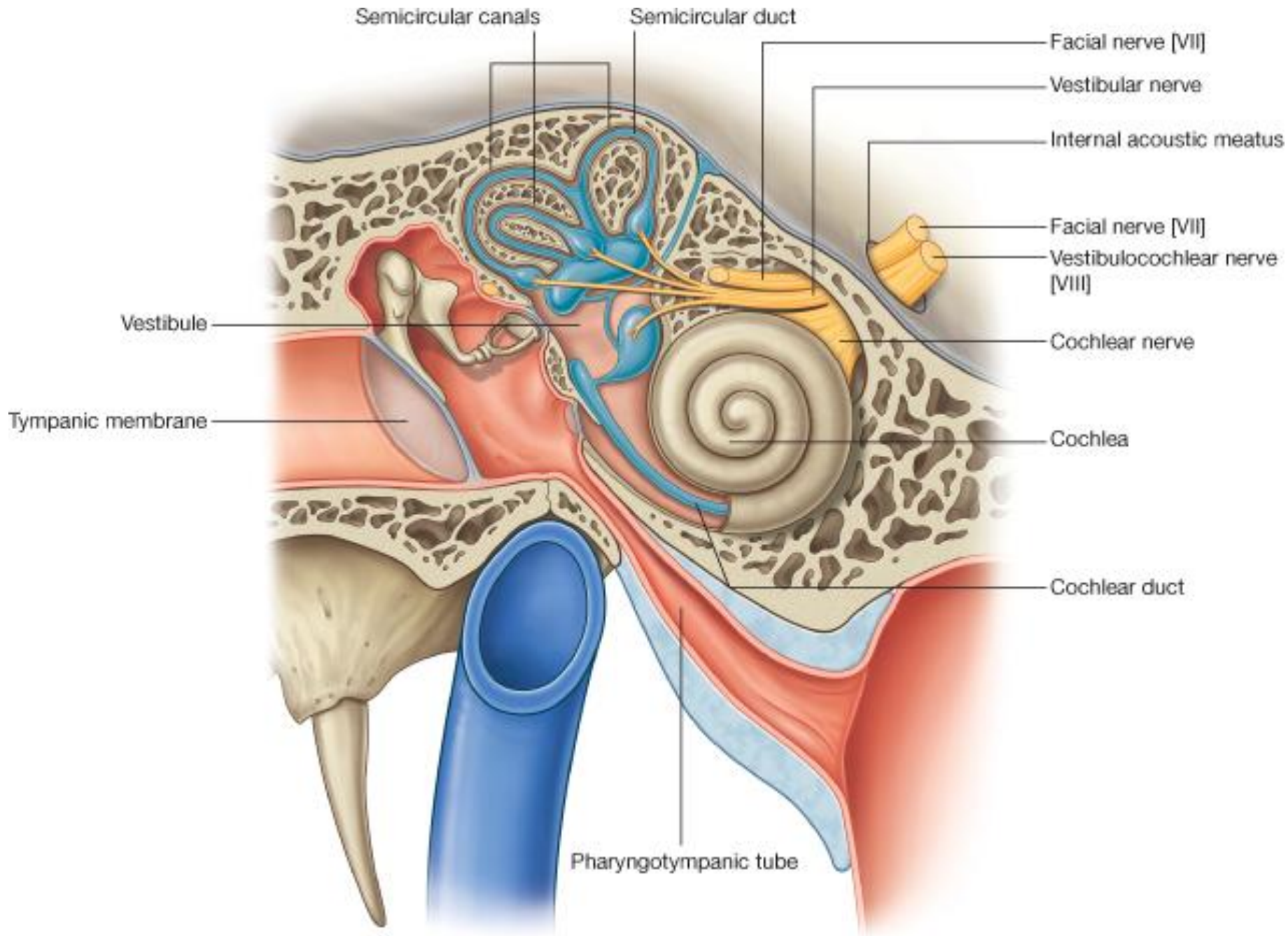
Bony labyrinth – **perilymph**

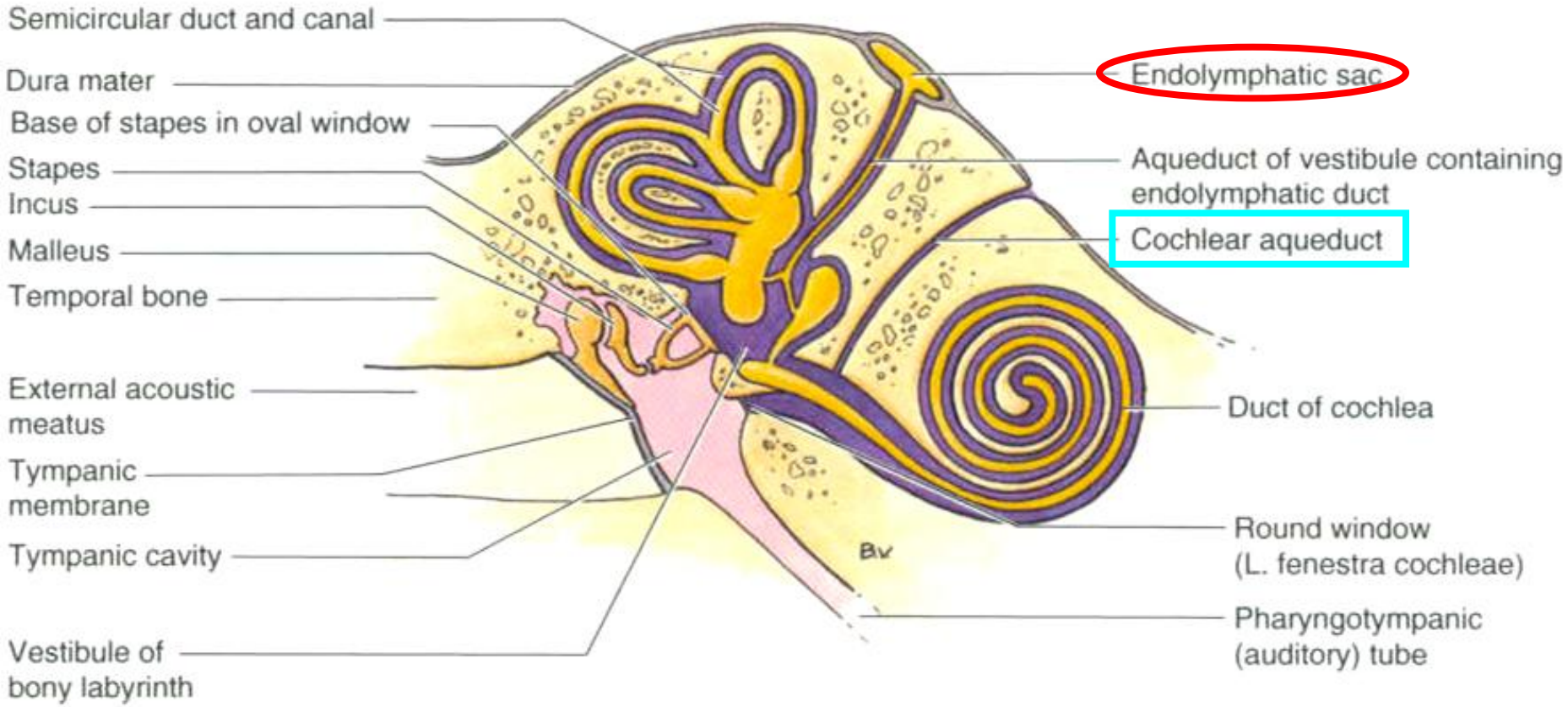
(1) **cochlea** : modiolus (a bony core for vessels & nerves)
cochlear canaliculus (aqueduct)
– communicates with subarachnoid space

(2) **vestibule** : contains **utricle** and **saccule**
(balancing apparatus)
vestibule aqueduct
(contains endolymphatic duct)

(3) **semicircular canals**: ant., post. and lateral semicircular canals
ampulla – end swelling


Anterior
semicircular canal
Cochlea
Vestibulocochlear
nerve [VIII]
Posterior
semicircular canal
Lateral semicircular canal





(B)

Figure 7.76. *(Continued)* **B.** The middle and internal parts of the ear. The *middle ear* (tympanic cavity)

Membrane labyrinth – **endolymph**

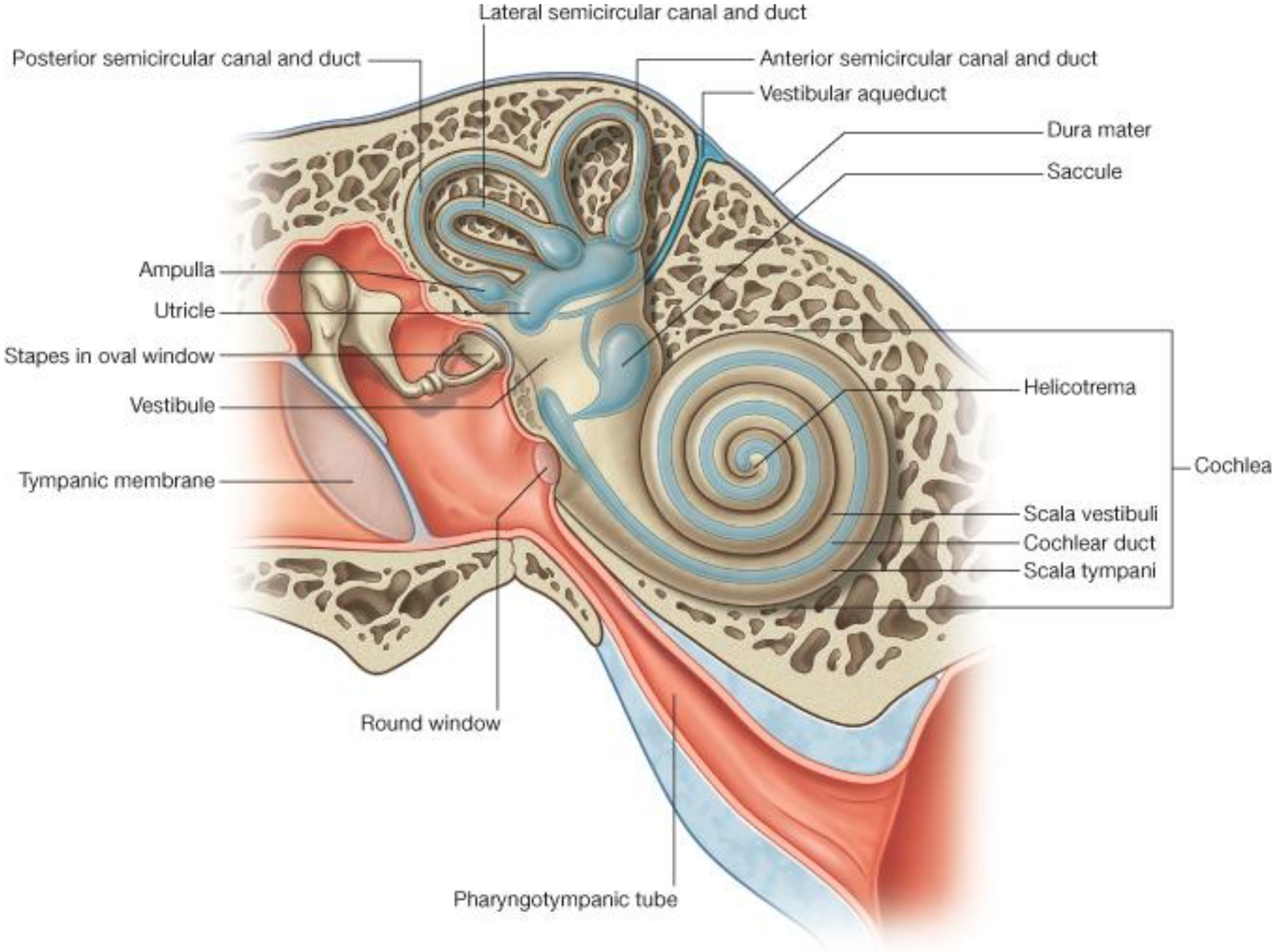
(1) **cochlear duct** in cochlea
(is fixed by **spiral ligament**)

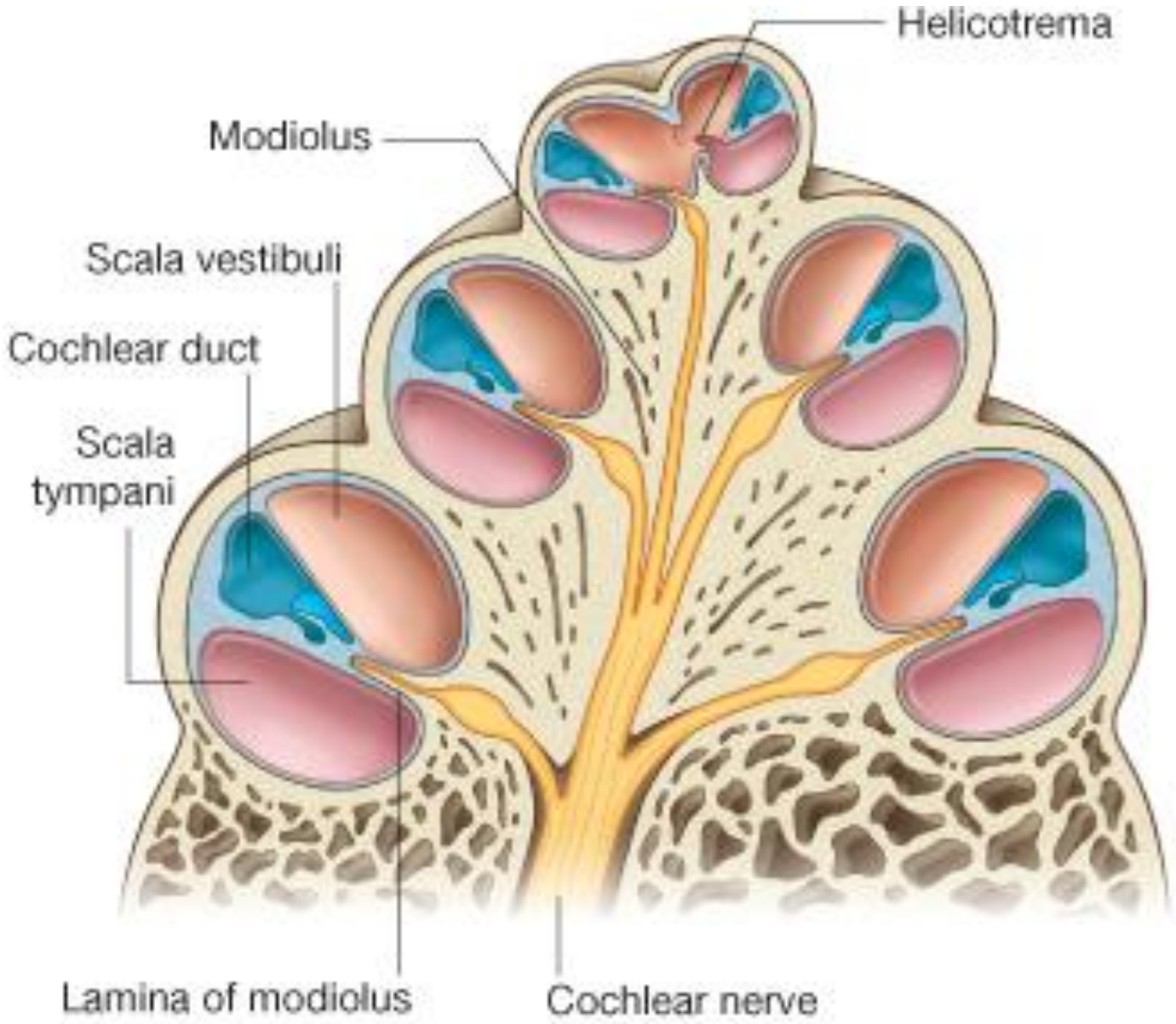
(2) **utricle** & **saccule** in vestibule
(**macula** – primary static organ)

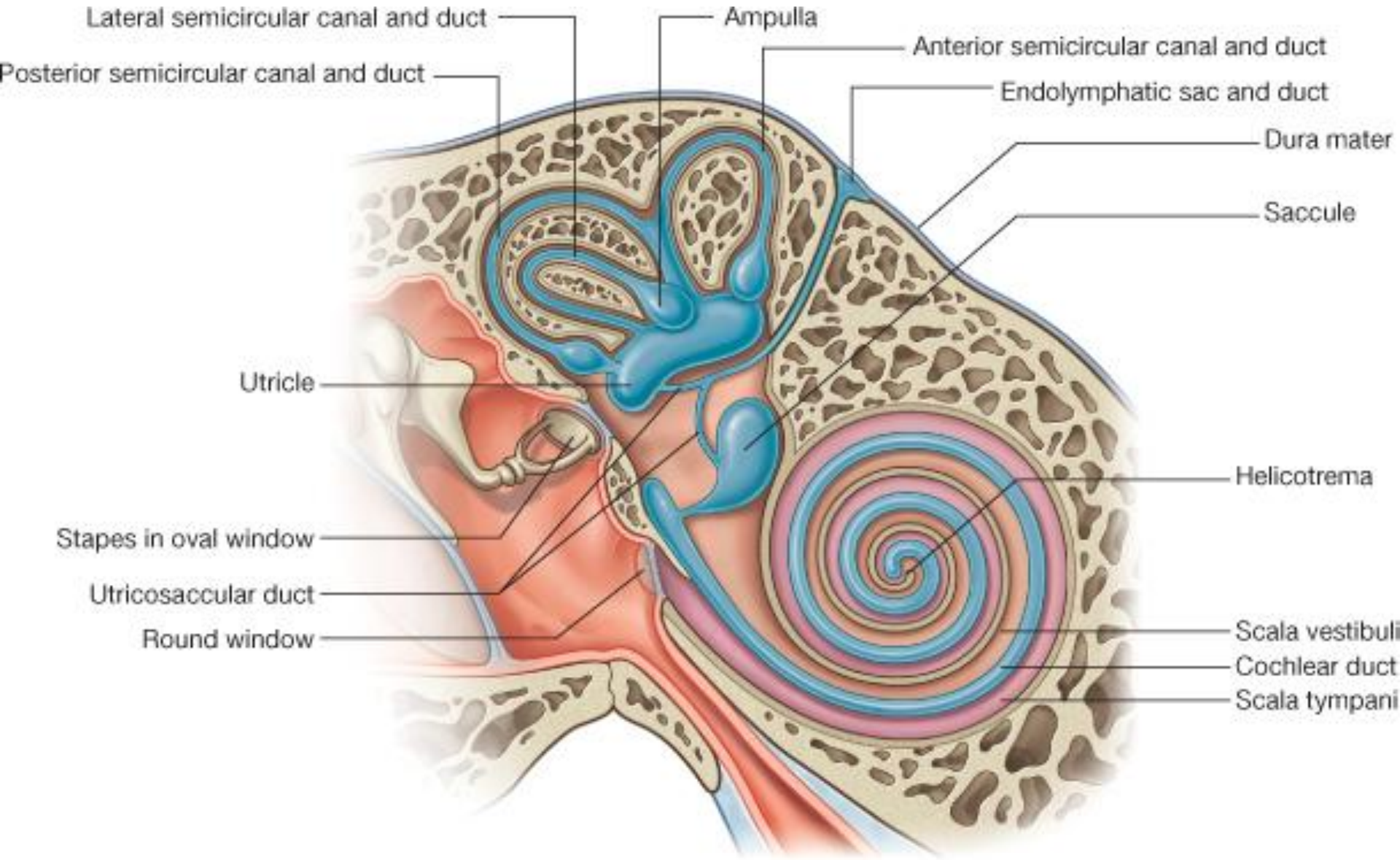
(3) **semicircular canals**
(**crista ampullaris** in ampulla)

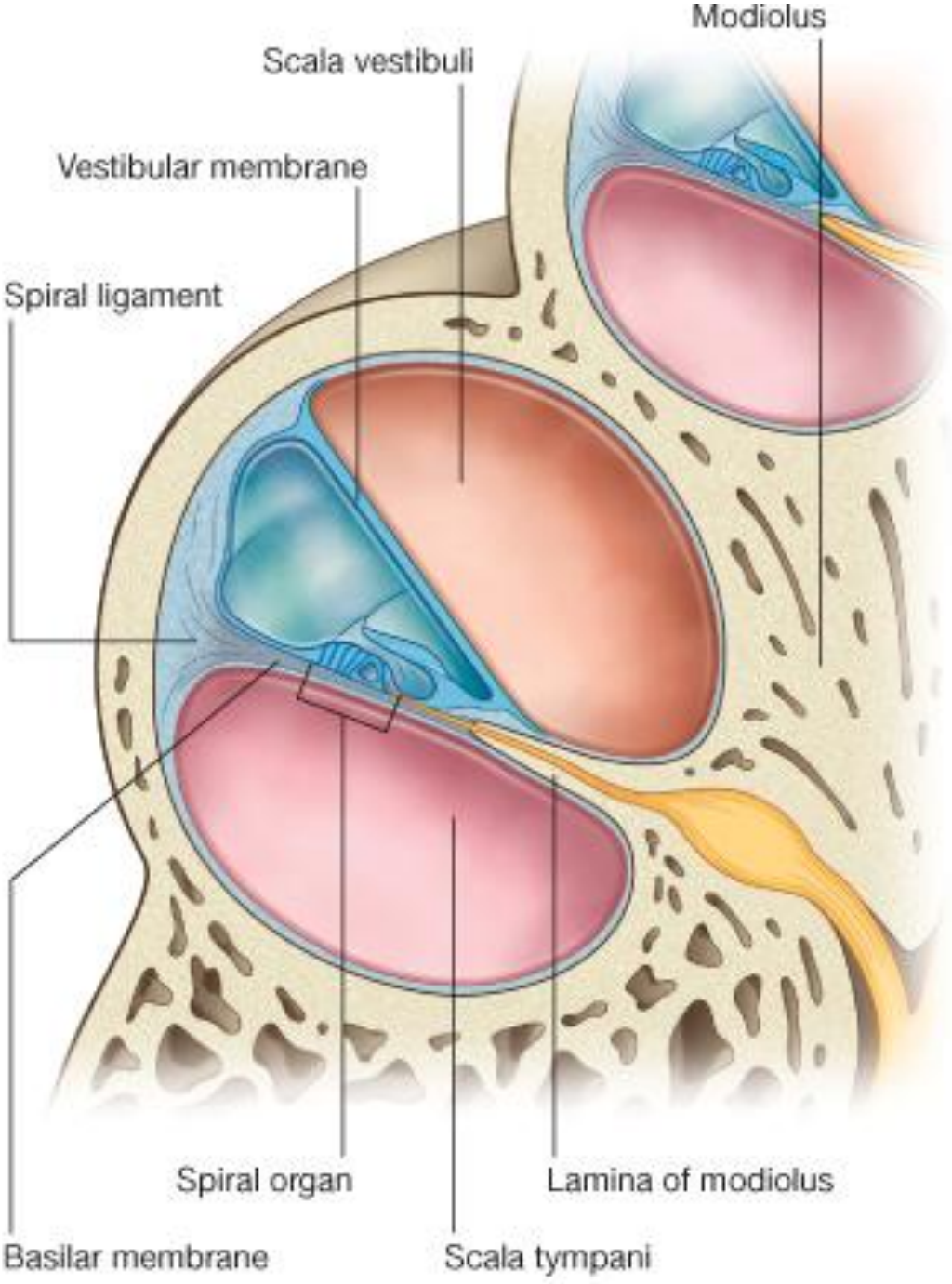
Ultrastructure of cochlear duct :

vestibular membrane, basilar membrane
scala vestibuli, cochlear duct, scala tympani
spiral ganglion,
organ of Corti – **tectorial membrane**



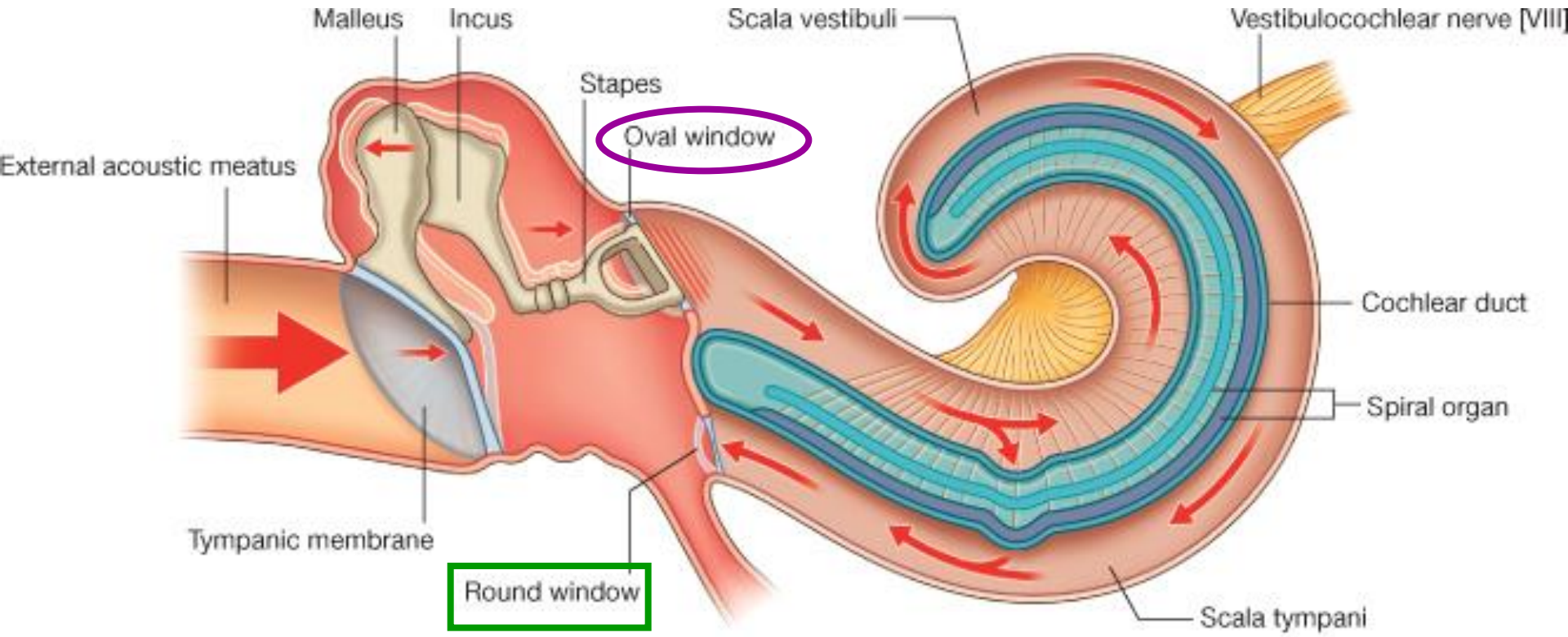






Pathway for conduction of sound

Sound waves collected by auricle
→ **tympanic membrane**
→ **auditory ossicles**
→ **perilymph** in oval window
→ **endolymph** in cochlear duct
→ ***tectorial membrane***
→ bending of hair cells
→ **spiral ganglion**
→ **cochlear nerve**
→ cochlear nuclei (in medulla oblongata)



Pathway for balance

Position of body

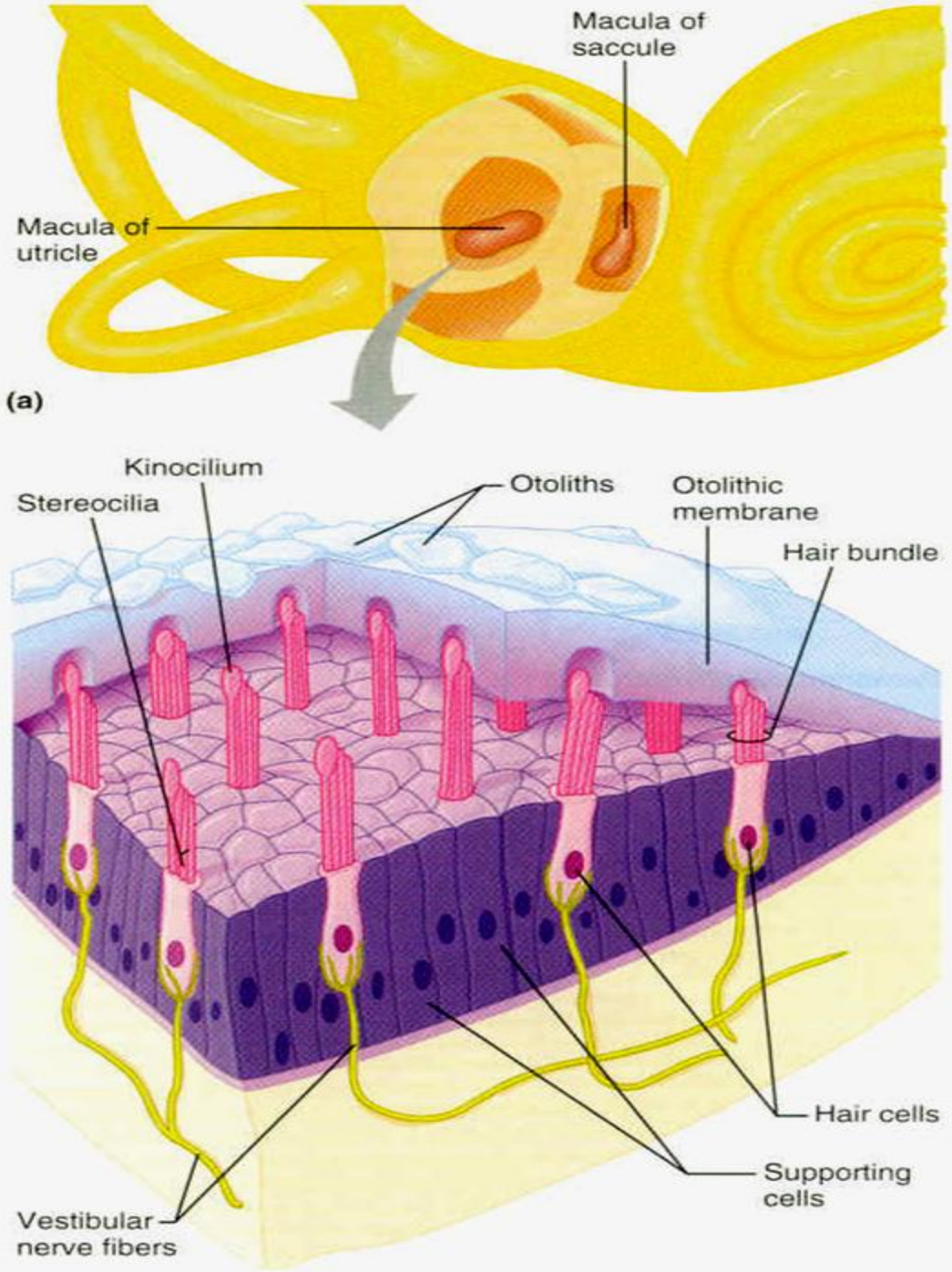
→ **macula utriculi**, **macula sacculi** &

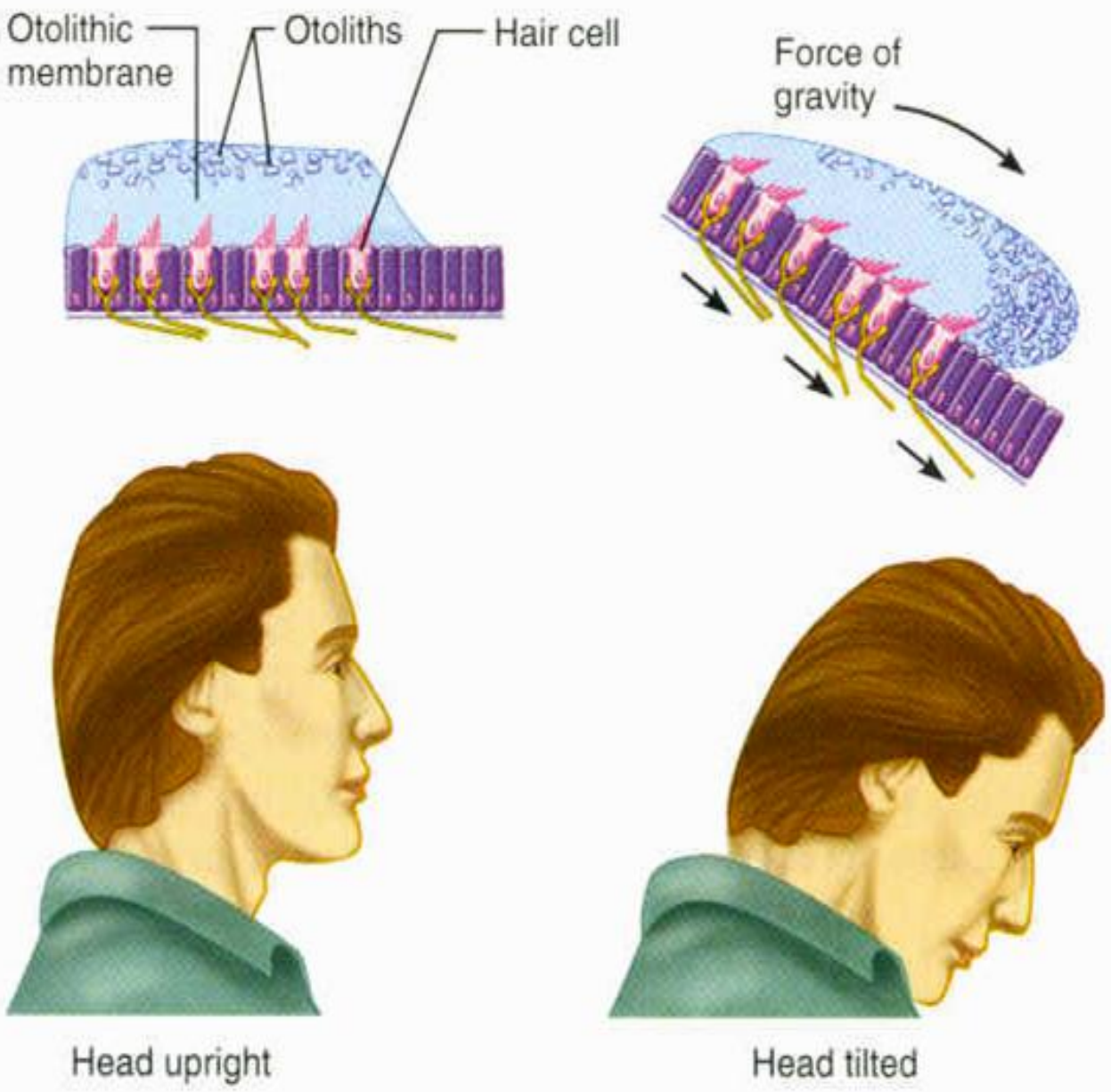
crista ampullaris

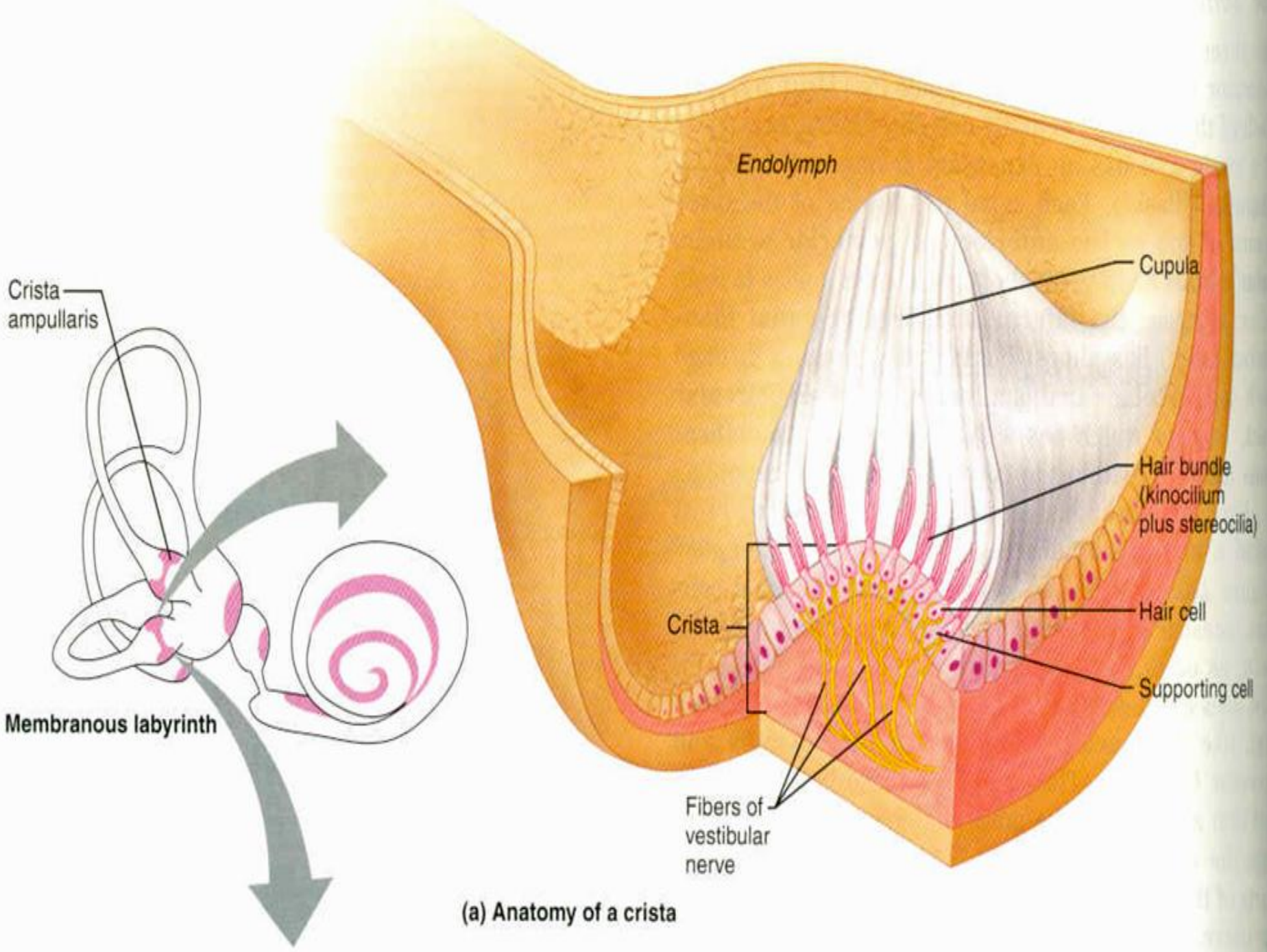
→ **vestibular ganglion**

→ **vestibular nerve**

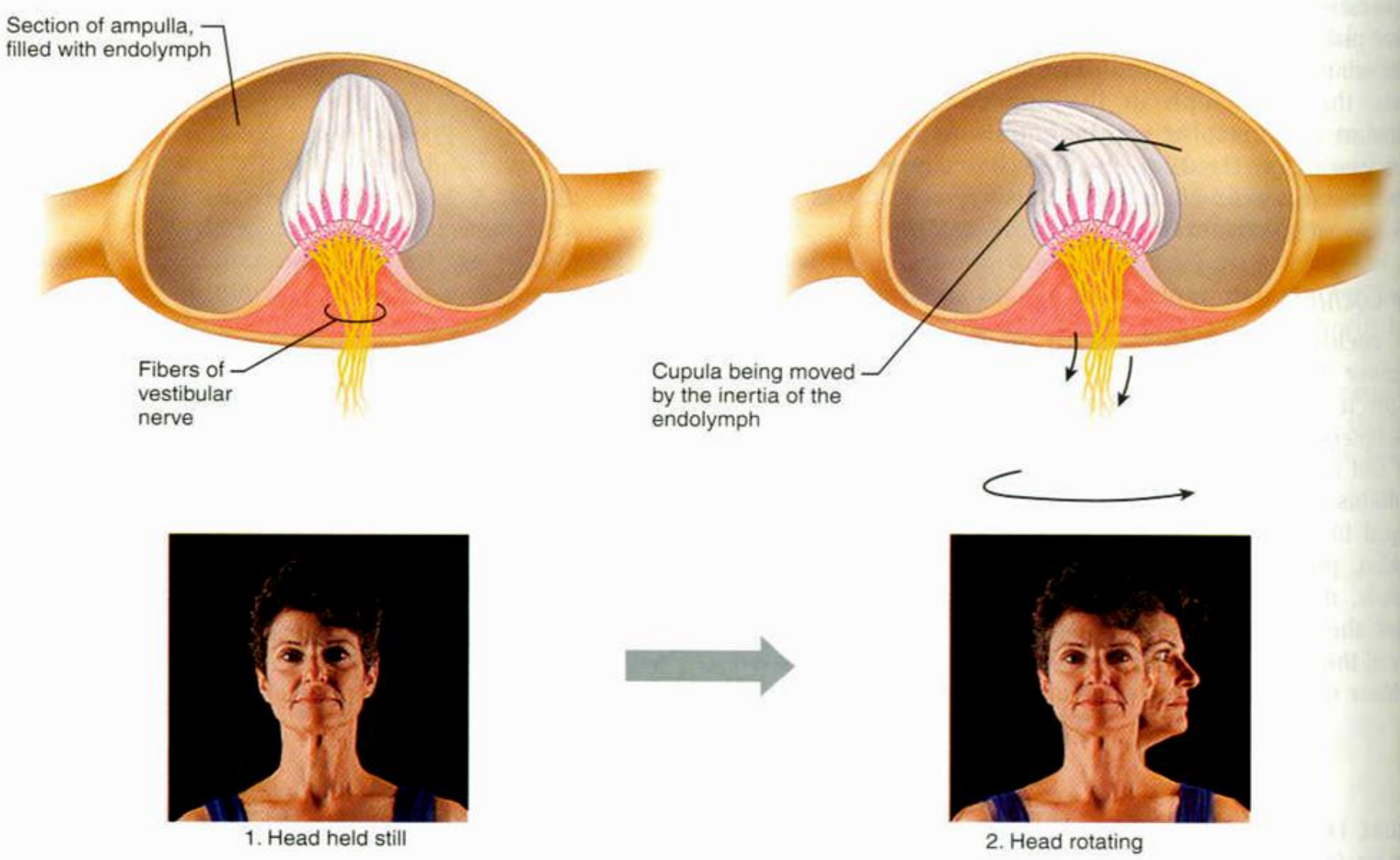
→ vestibular nuclei (in medulla oblongata)


Macula of saccule
Macula of utricle
(a)
Kinocilium
Stereocilia
Otoliths
Otolithic membrane
Hair bundle
Hair cells
Supporting cells
Vestibular nerve fibers


Otolithic membrane
Otoliths
Hair cell
Force of gravity
Head upright
Head tilted
(c)



(a) Anatomy of a crista



(b) Function of the crista

FIGURE 16.22 Structure and function of the crista ampullaris in the inner ear. **(a)** Microscopic anatomy of the crista and cupula in the lateral semicircular duct, which has been cut in half. **(b)** Function of the crista: During rotational acceleration of the head, the endolymph in the semicircular duct lags, bending the cupula away from the direction of head movement and stimulating the hair cells.

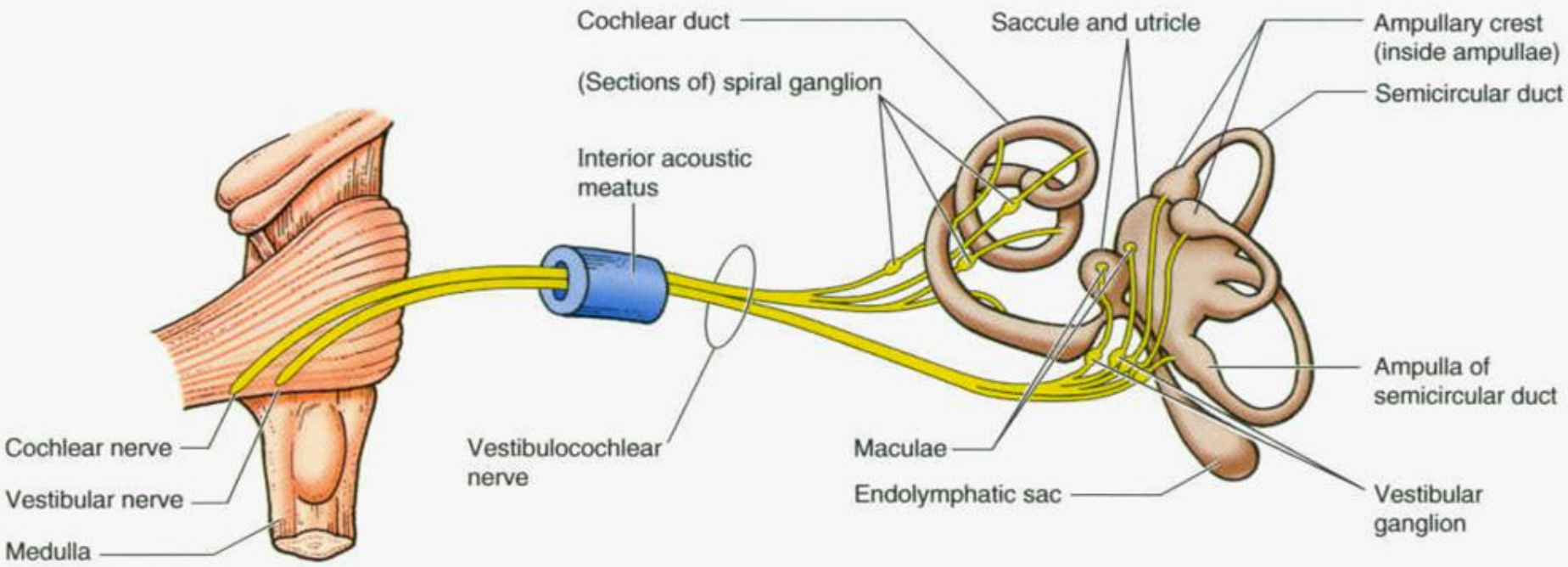


Figure 7.82. The vestibulocochlear nerve (CN VIII). Note that it has two parts: the cochlear nerve, or the nerve of hearing, and the vestibular nerve, or the nerve of balance. The cell bodies of the sensory fibers (only) that comprise the two parts of this nerve constitute the spiral and vestibular ganglia.

Dissection of Middle Ear

Middle Ear

1. Carefully remove **tegmen tympani,**
   examine facial nerve, geniculate ganglion,
   greater petrosal nerve, chorda tympani,
   vestibulo-cochlear nerve.
2. Identify **malleus, incus** (easy detached)**, stapes**
   and **semicircular canals**.

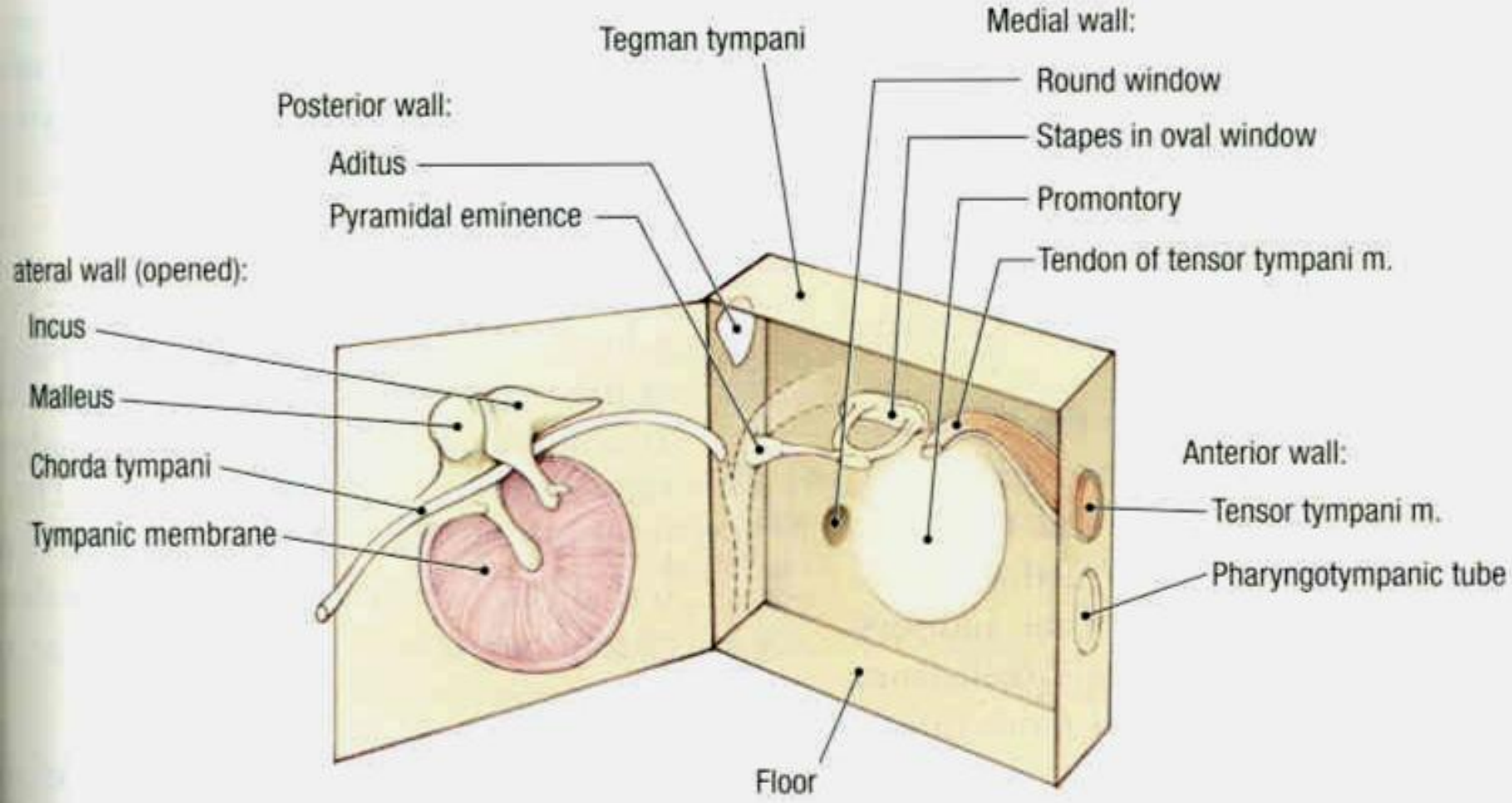
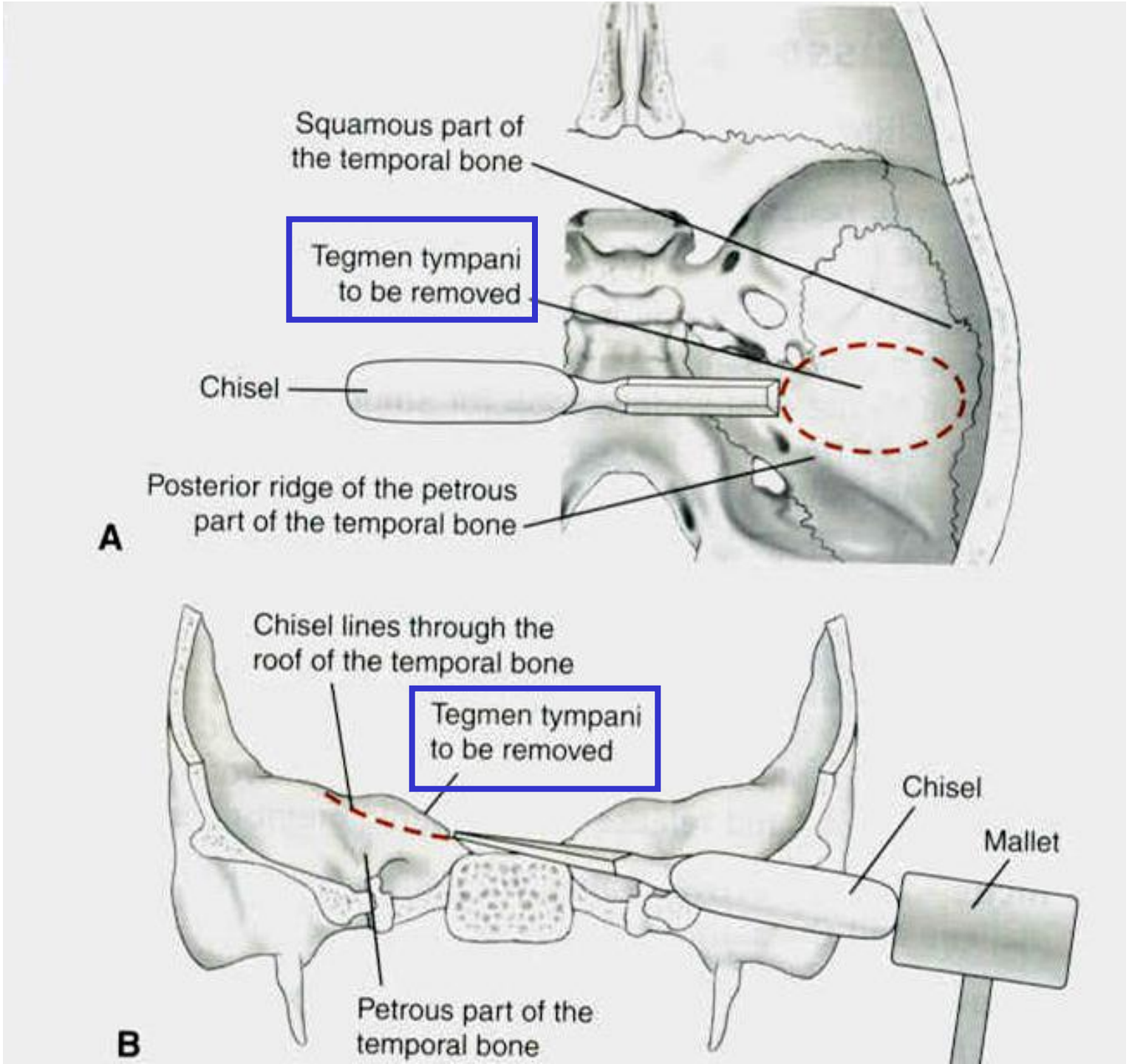
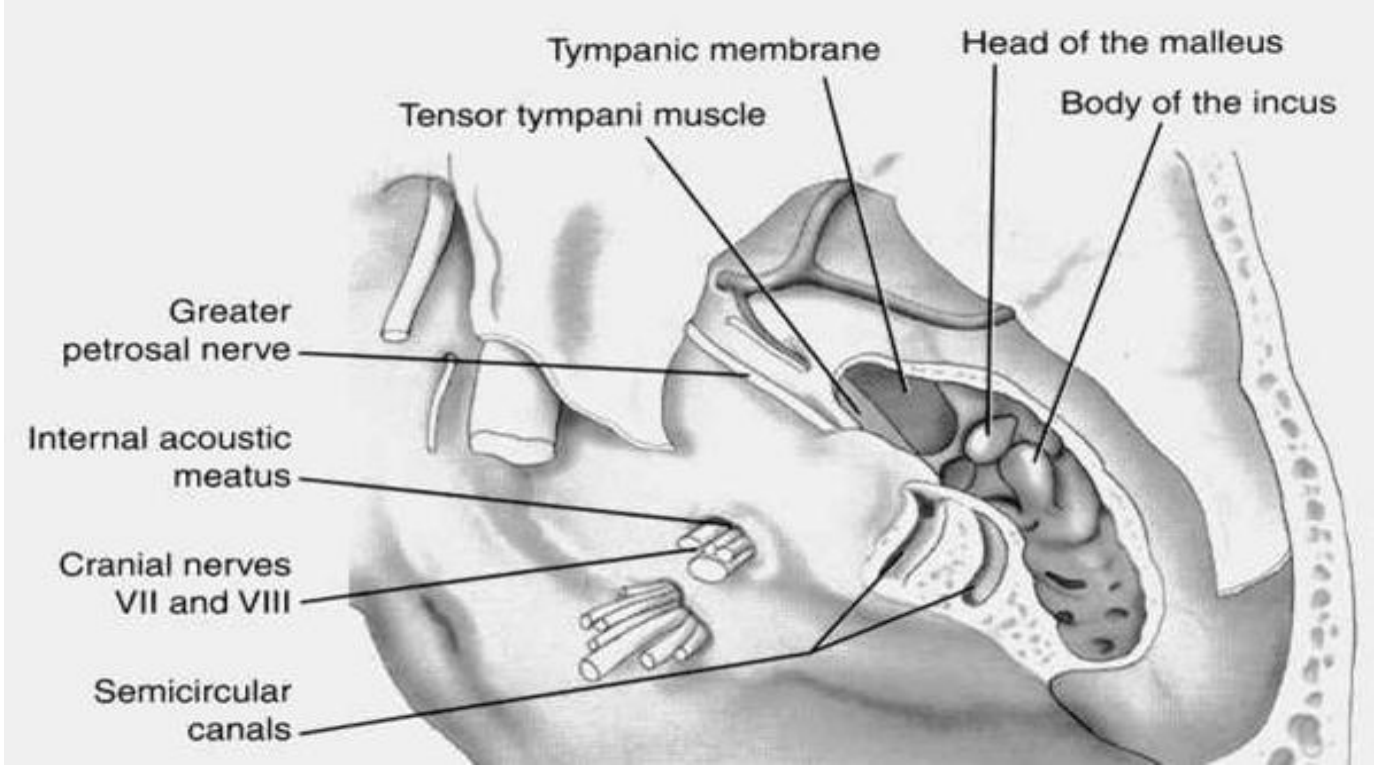
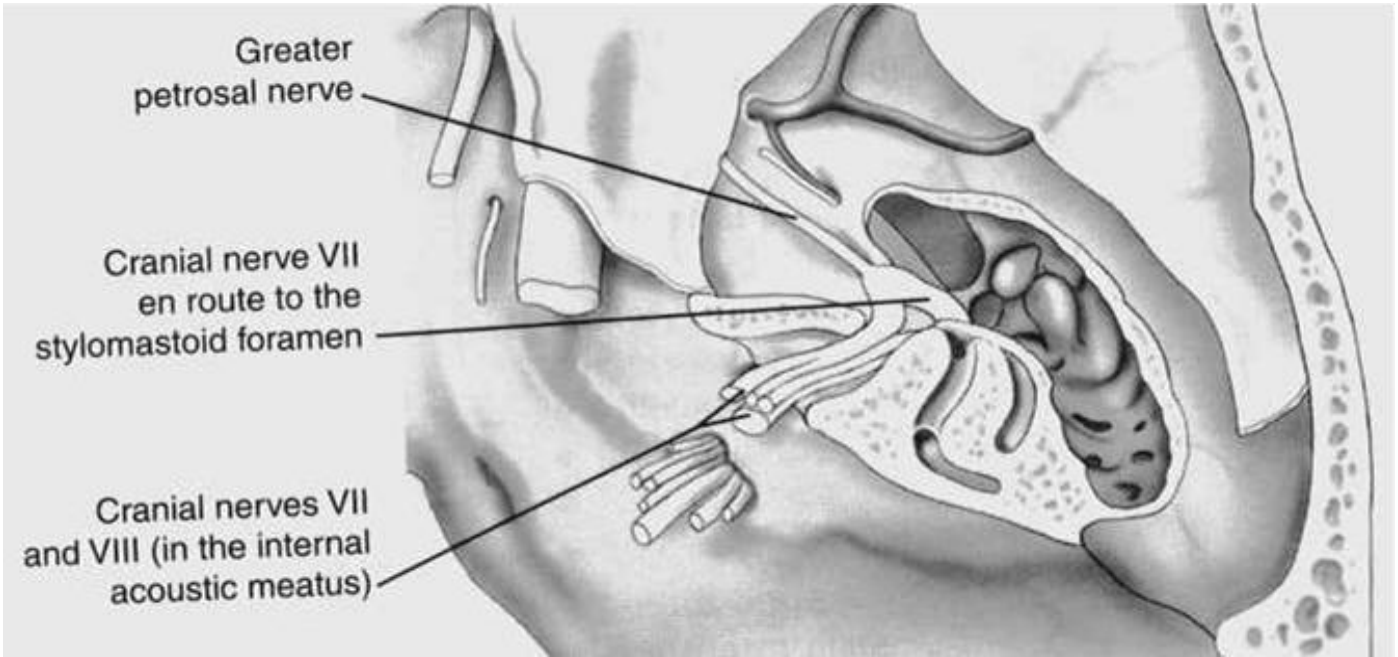
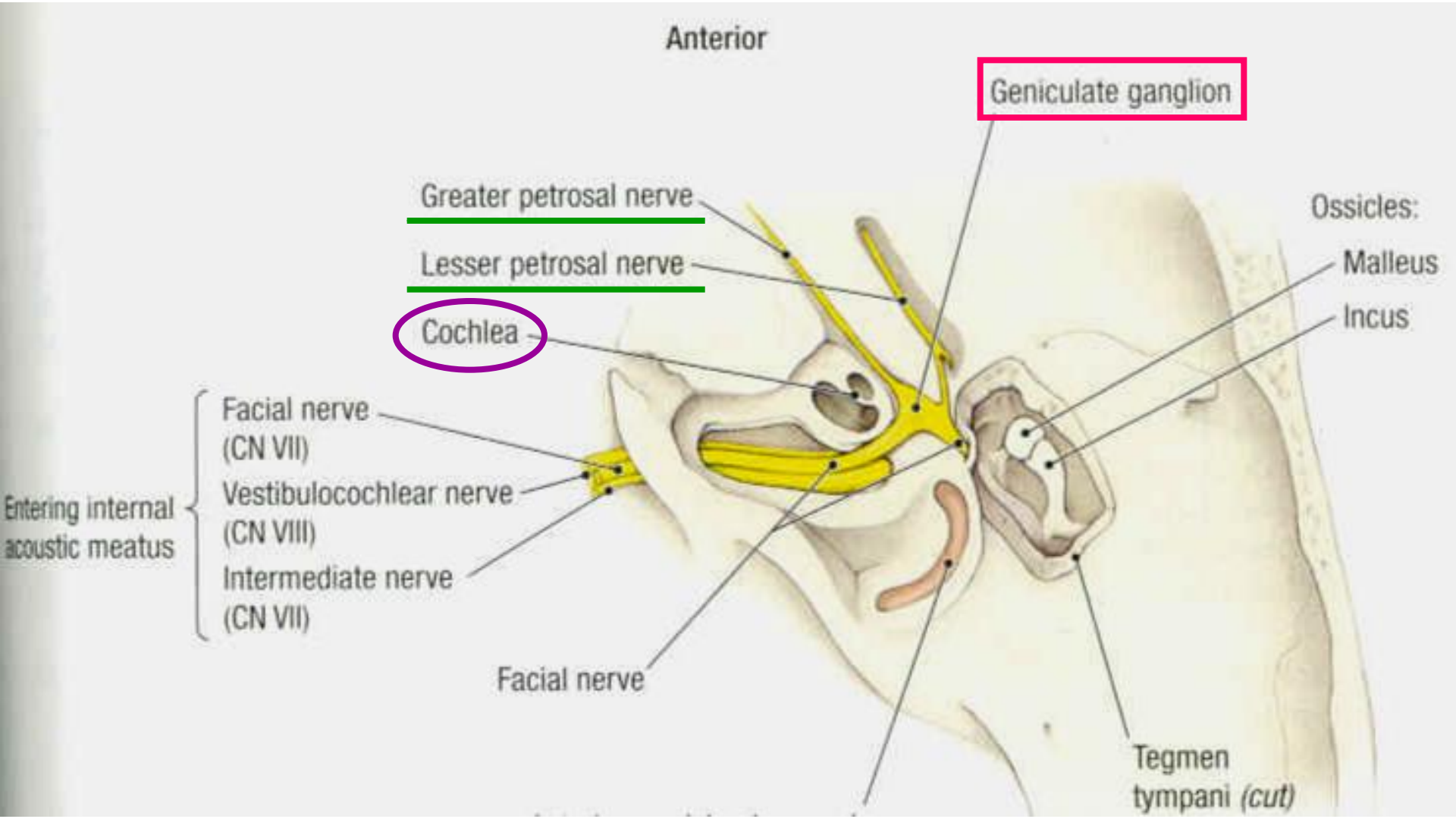


Figure 7.94. Schematic drawing of the walls of the tympanic cavity. Right ear in lateral view with the lateral wall opened.


Squamous part of the temporal bone
Tegmen tympani to be removed
Chisel
Posterior ridge of the petrous part of the temporal bone
A
Chisel lines through the roof of the temporal bone
Tegmen tympani to be removed
Chisel
Mallet
Petrous part of the temporal bone
B


Tympanic membrane
Head of the malleus
Tensor tympani muscle
Body of the incus
Greater petrosal nerve
Internal acoustic meatus
Cranial nerves VII and VIII
Semicircular canals


Greater petrosal nerve
Cranial nerve VII en route to the stylomastoid foramen
Cranial nerves VII and VIII (in the internal acoustic meatus)


Anterior
Geniculate ganglion
Greater petrosal nerve
Lesser petrosal nerve
Cochlea
Ossicles:
Malleus
Incus
Facial nerve
(CN VII)
Vestibulocochlear nerve
(CN VIII)
Intermediate nerve
(CN VII)
Entering internal acoustic meatus
Facial nerve
Tegmen tympani (cut)