LMU DeBusk College of Osteopathic Medicine
LINCOLN MEMORIAL UNIVERSITY

Anatomy of the Ear, Nasal Cavity, Pharynx and Larynx

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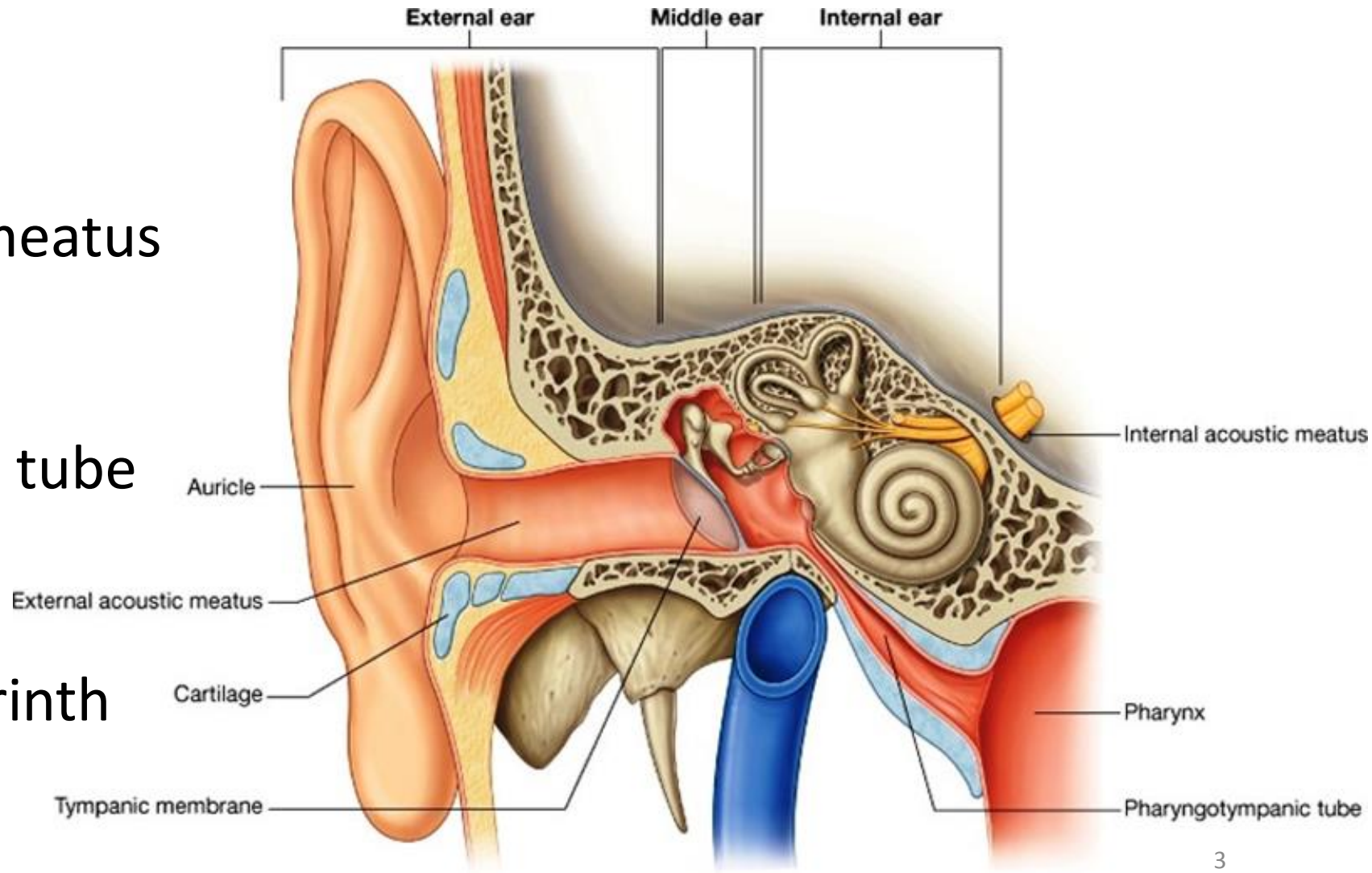
Objectives

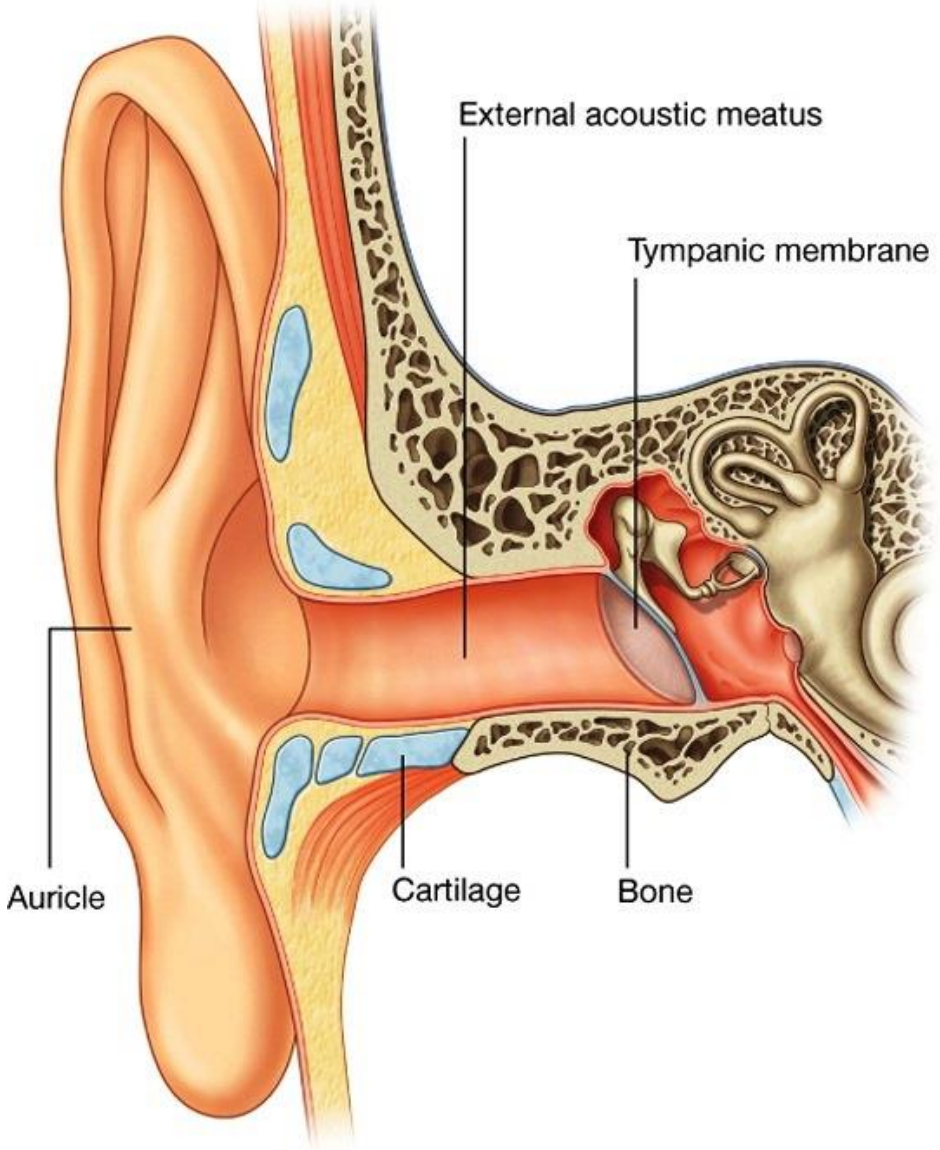
1. Describe the nasal cavity, its general morphology including the walls, openings, nasal septum, conchae, and meatuses.
2. Describe and identify the named portions of the pharynx, and important anatomical features of each.
3. Describe the important anatomical features and innervation of the external, middle, and inner ear.
4. Describe the sensory innervation of the nasal cavity, and the sensory and motor innervation of the glossopharyngeal and vagus nerves related to the pharynx and larynx.

The Ear

- **External**
  - Auricle
  - External acoustic meatus
- **Middle**
  - Tympanic cavity
  - Pharyngotympanic tube
- **Internal**
  - Bony labyrinth
  - Membranous labyrinth



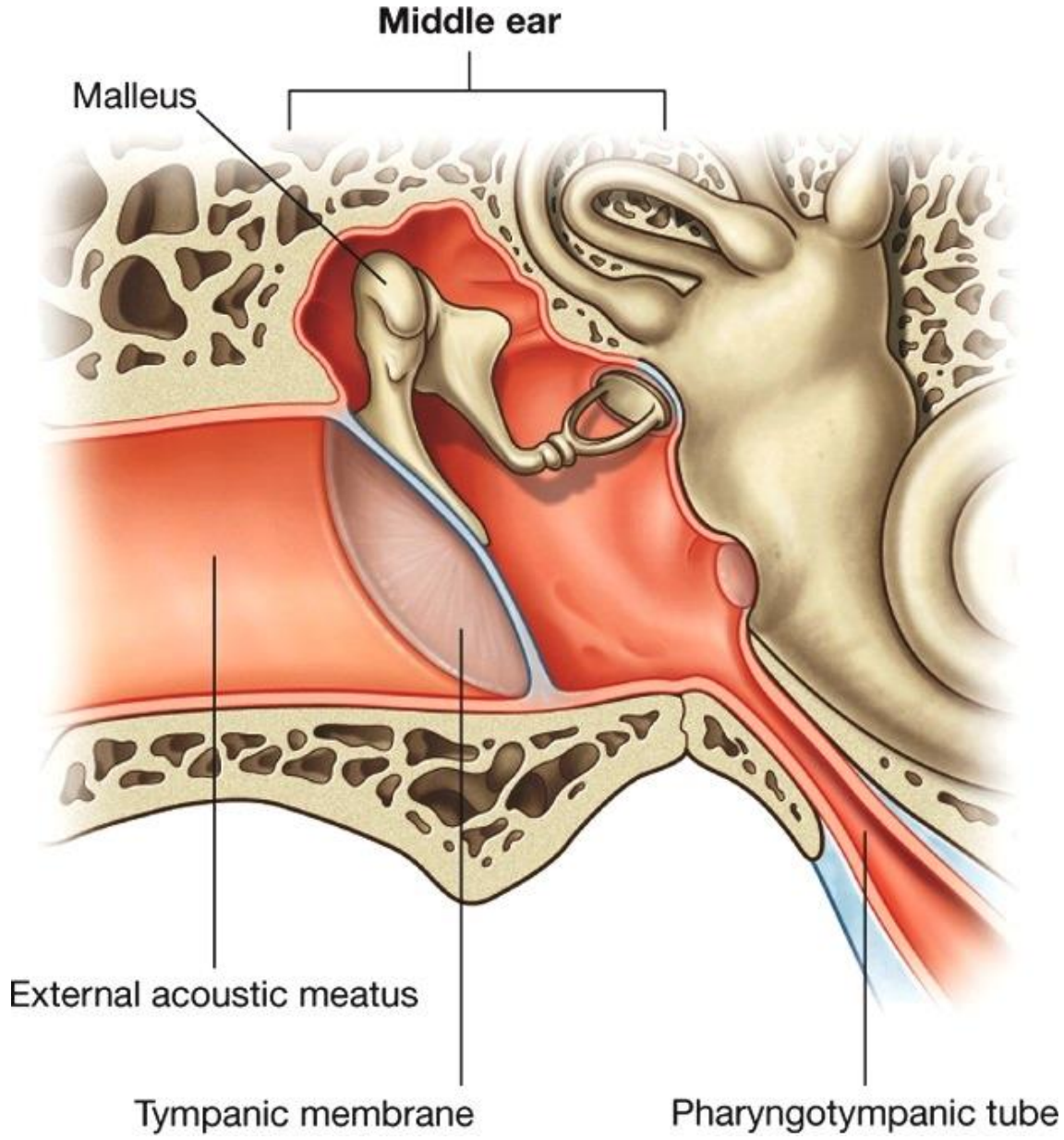
External Acoustic Meatus



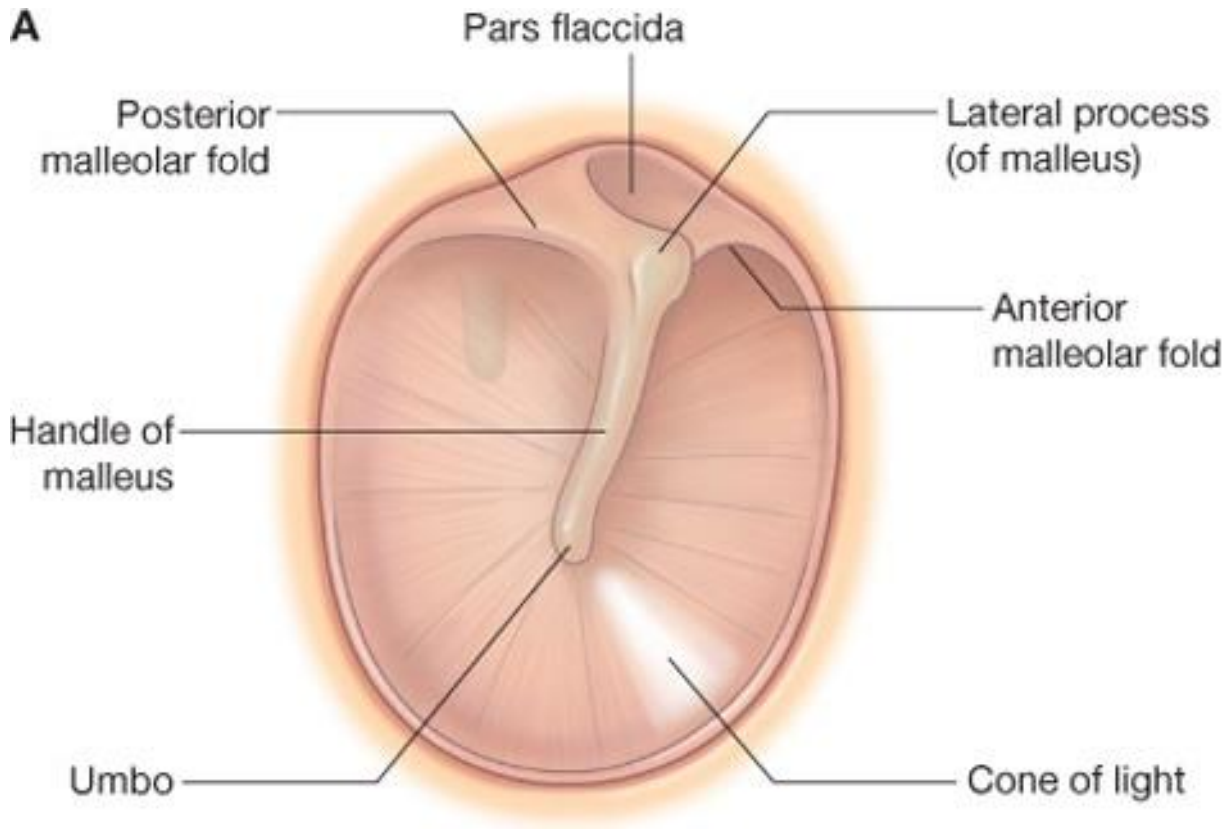
- **Extends from auricle to tympanic membrane**
- **Length ≈ 1 inch (2.5 cm)**
- **Cartilage externally (⅓), then bone (⅔)**
- **Ceruminous (modified sweat glands) glands secrete *cerumen***
- **Not straight in adults**
- **Need to pull ear superiorly, posteriorly, and laterally**
- **Sensory – auriculotemporal n.(CN V_3) and vagus (CN X)**

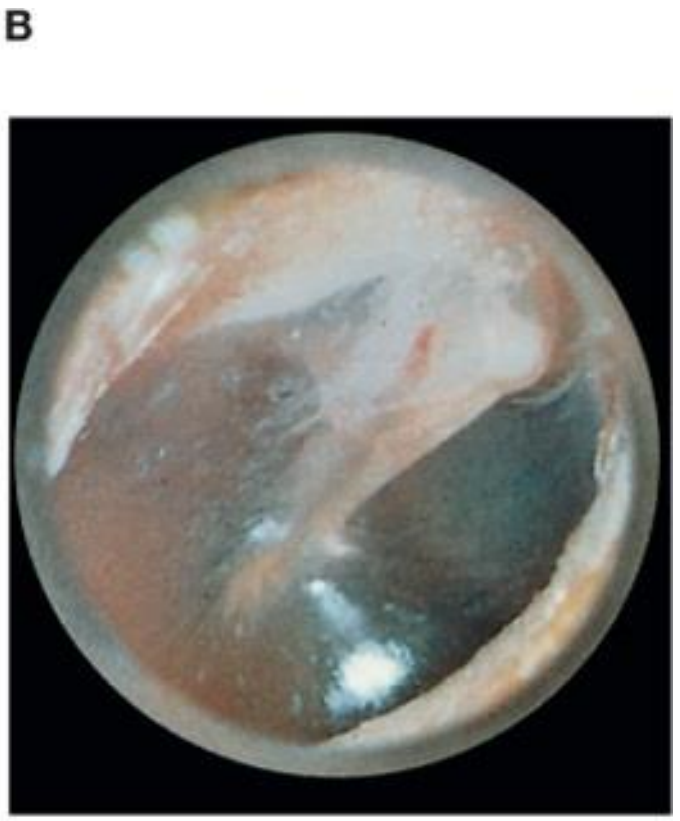
Tympanic Membrane

- **Tilted anteriorly and inferiorly**
- **Skin (stratified squamous epithelium) on outside**
- **Mucous membrane (simple cuboidal) on inside**
- **Handle of malleolus is attached to inner surface**

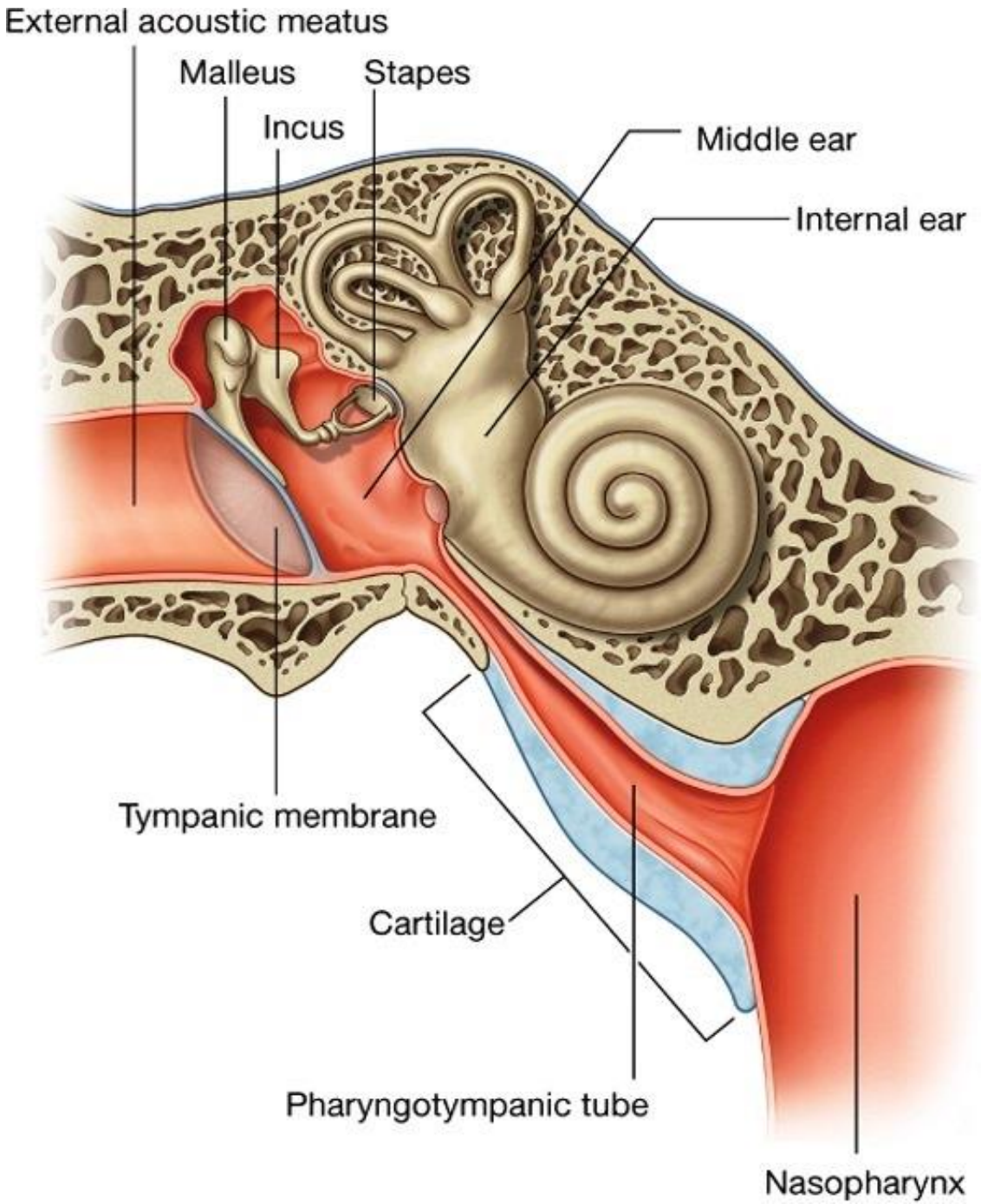


Tympanic Membrane





- **Flaccid area superiorly**
- **Sensory innervation of surfaces:**
  - **Outer – auriculotemporal (V_3), facial (VII), and vagus (X)**
  - **Inner – Glossopharyngeal (IX)**



Middle Ear

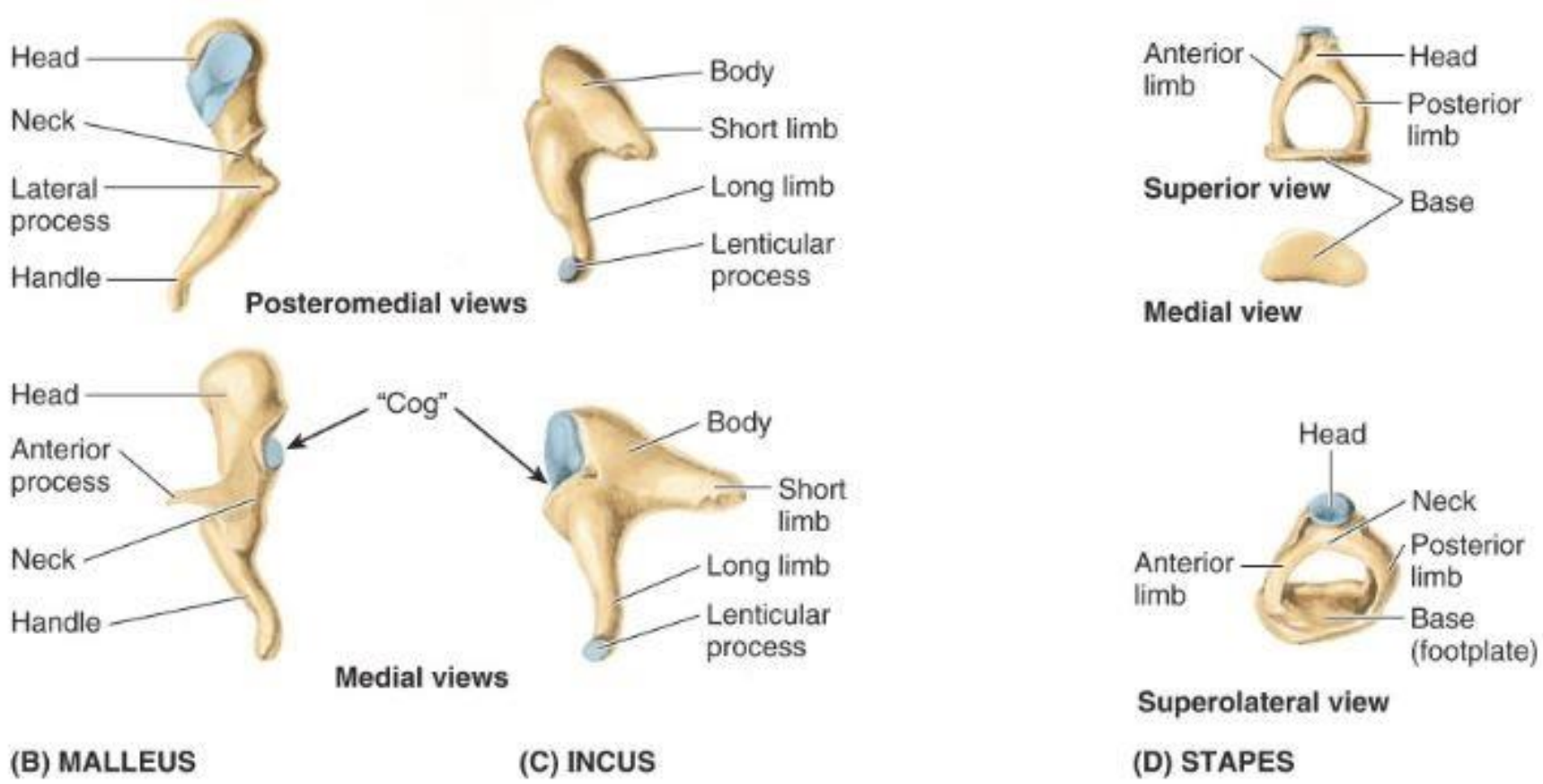
Auditory Ossicles

- **Malleus – attached to tympanic membrane**
- **Incus**
- **Stapes – footplate attached to oval window**

Pharyngotympanic Tube

- **AKA auditory tube, Eustachian canal**
- **Connects anterior part of middle ear cavity with nasopharynx**

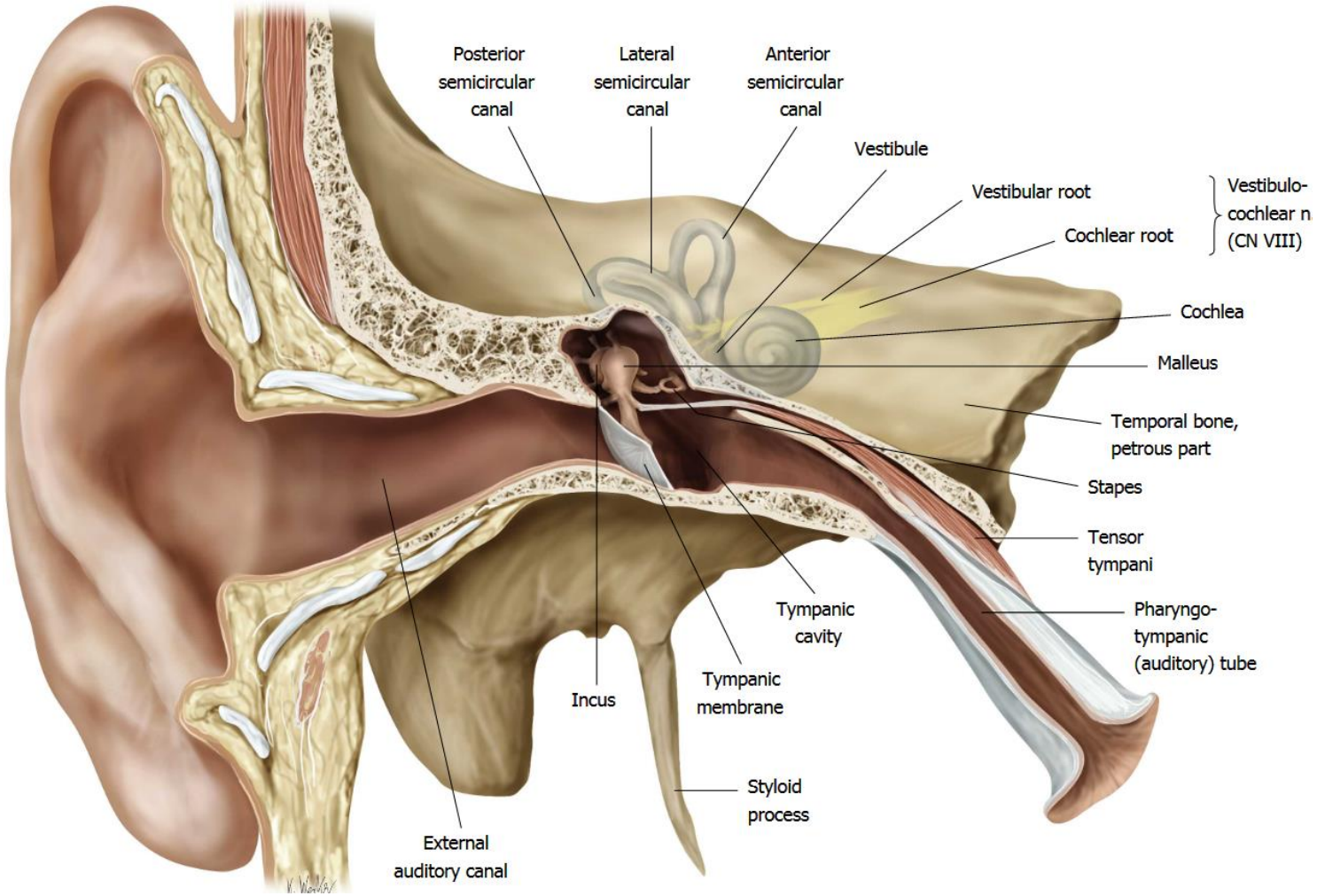
Middle Ear Ossicles



Moore Fig 7.116

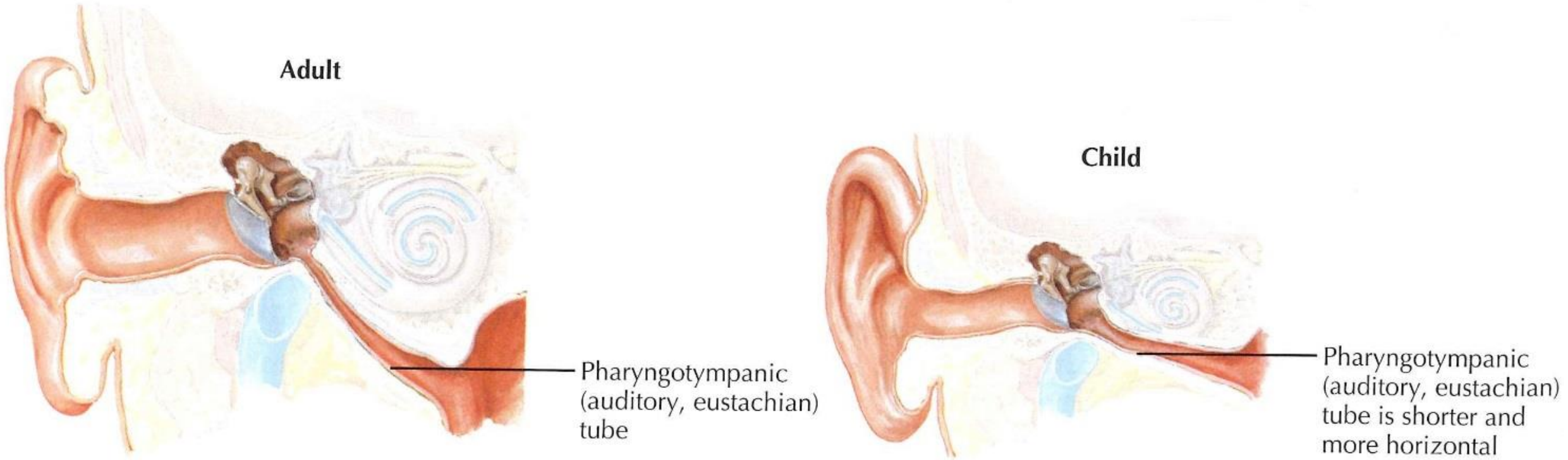
- Ossicles are suspended from walls of tympanic cavity by ligaments
- Ossicles articulate with each other through synovial joints
- Footplate of stapes articulates with temporal bone at the oval window – stabilized by the **annular ligament**

Pharyngotympanic Tube



- Connects tympanic cavity with nasopharynx
- Lateral ⅓ – bony; medial ⅔ – cartilaginous
- Lined by mucous membrane
- Enables middle ear cavity to equalize pressure with atmospheric pressure

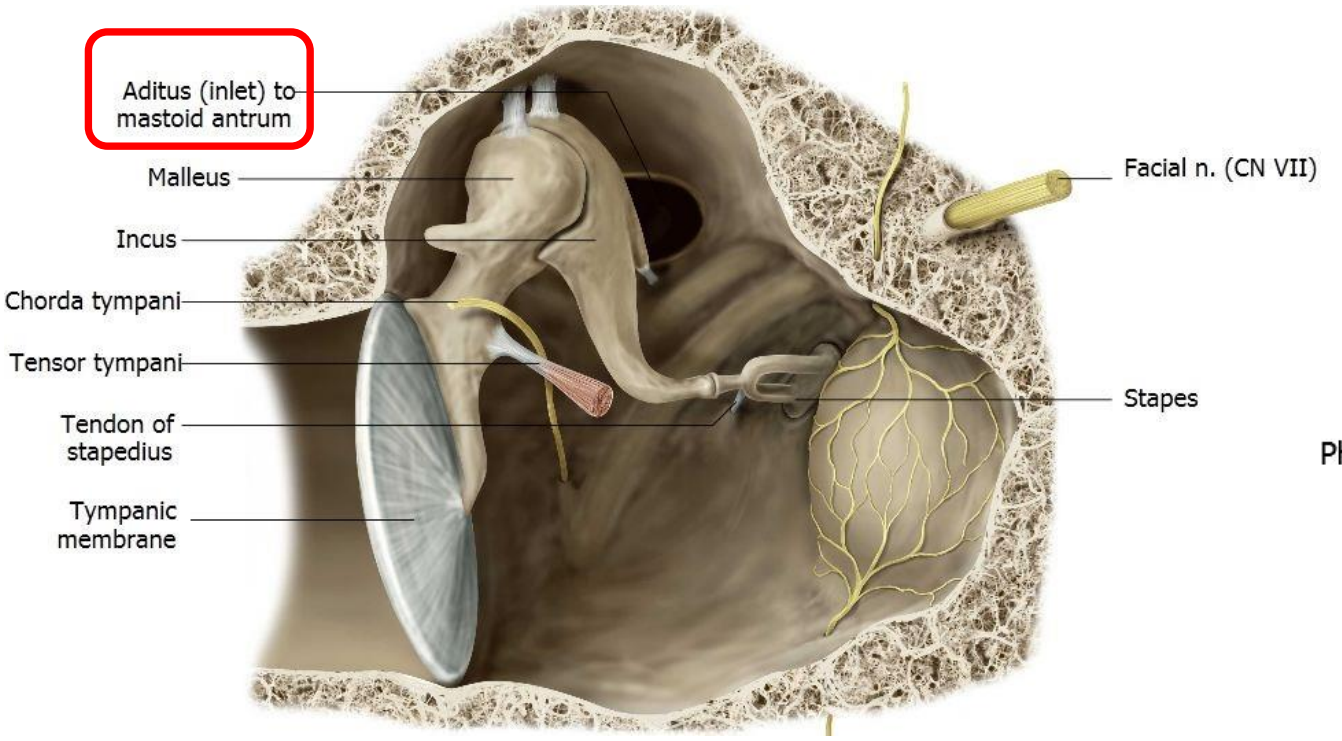
Middle Ear Canal



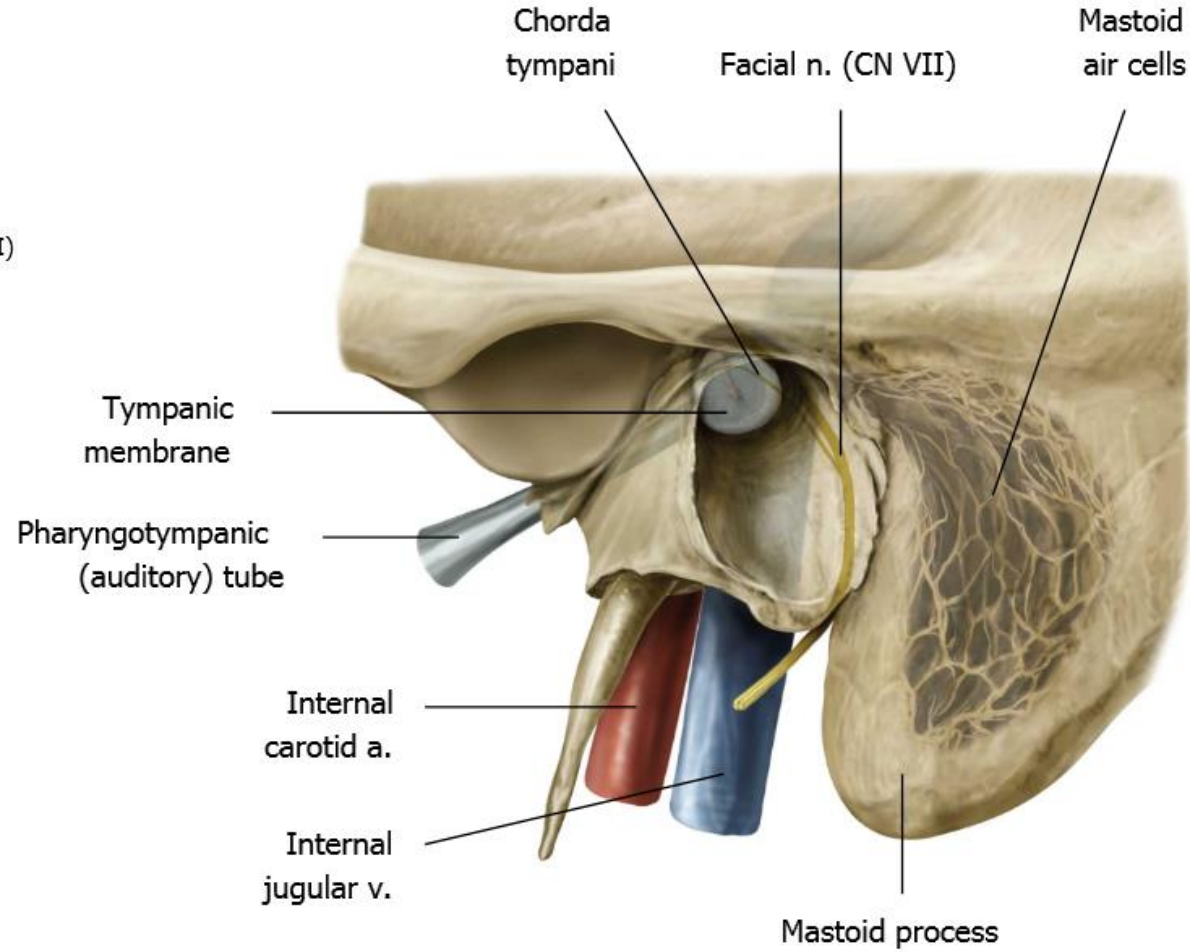
Children more prone to middle ear infections (Otitis Media)

- Thought to be due to auditory tube being shorter and in a more horizontal position
- Fluids from nasopharynx can more easily flow into tympanic cavity

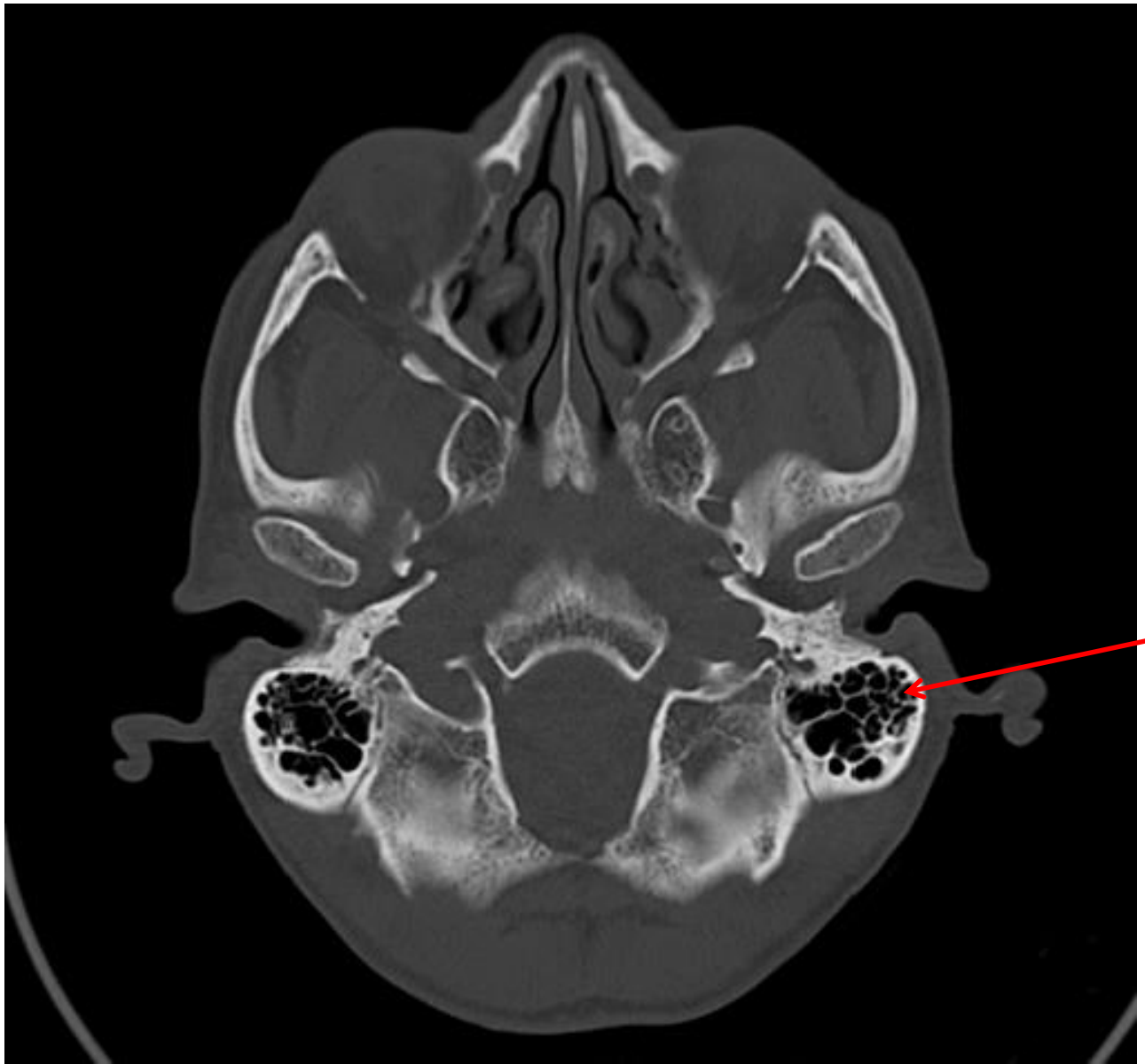
Middle Ear Cavity



Mastoid Air Cells

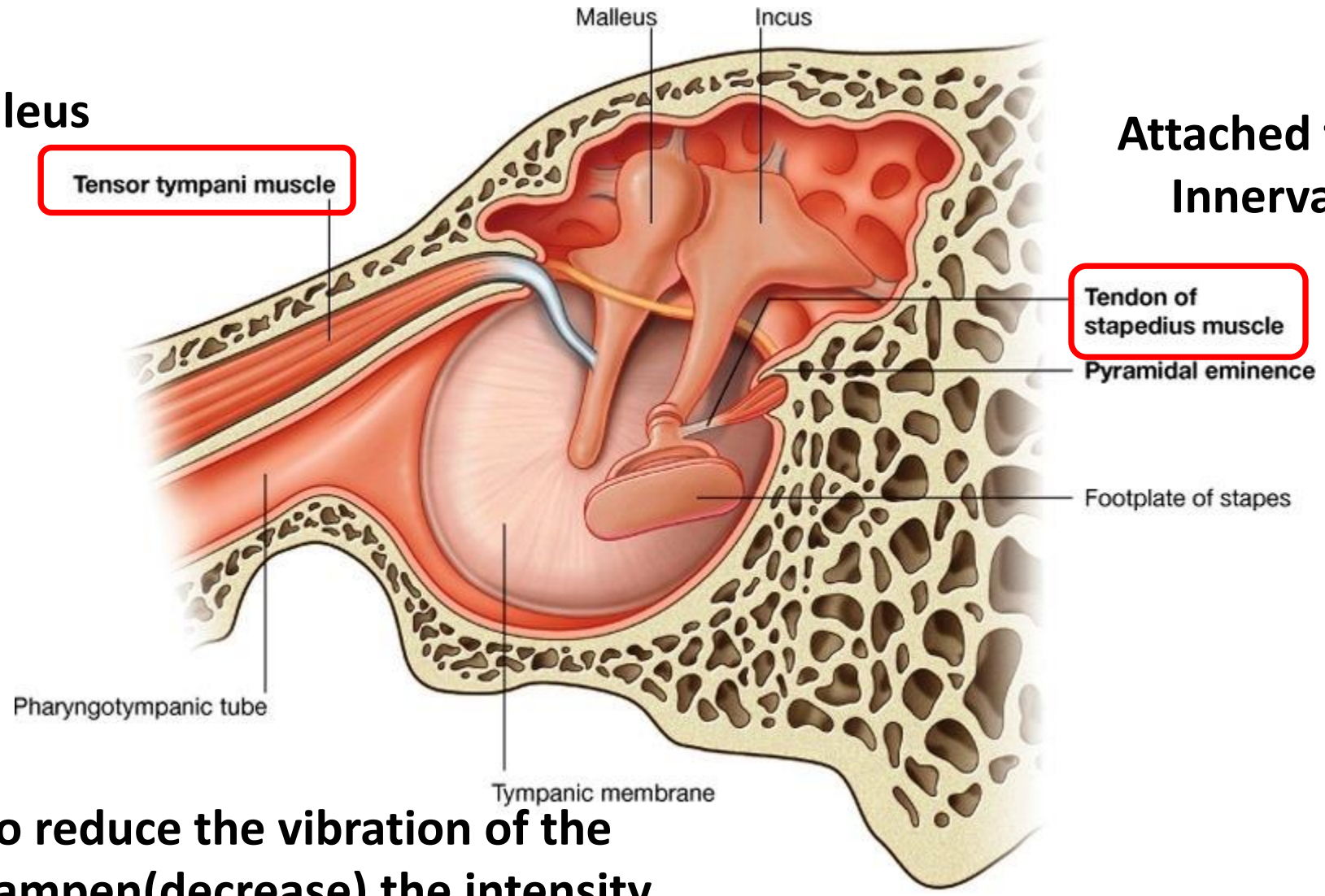


Mastoid Air Cells



Middle Ear Muscles

Attached to malleus
Innervation - V_3

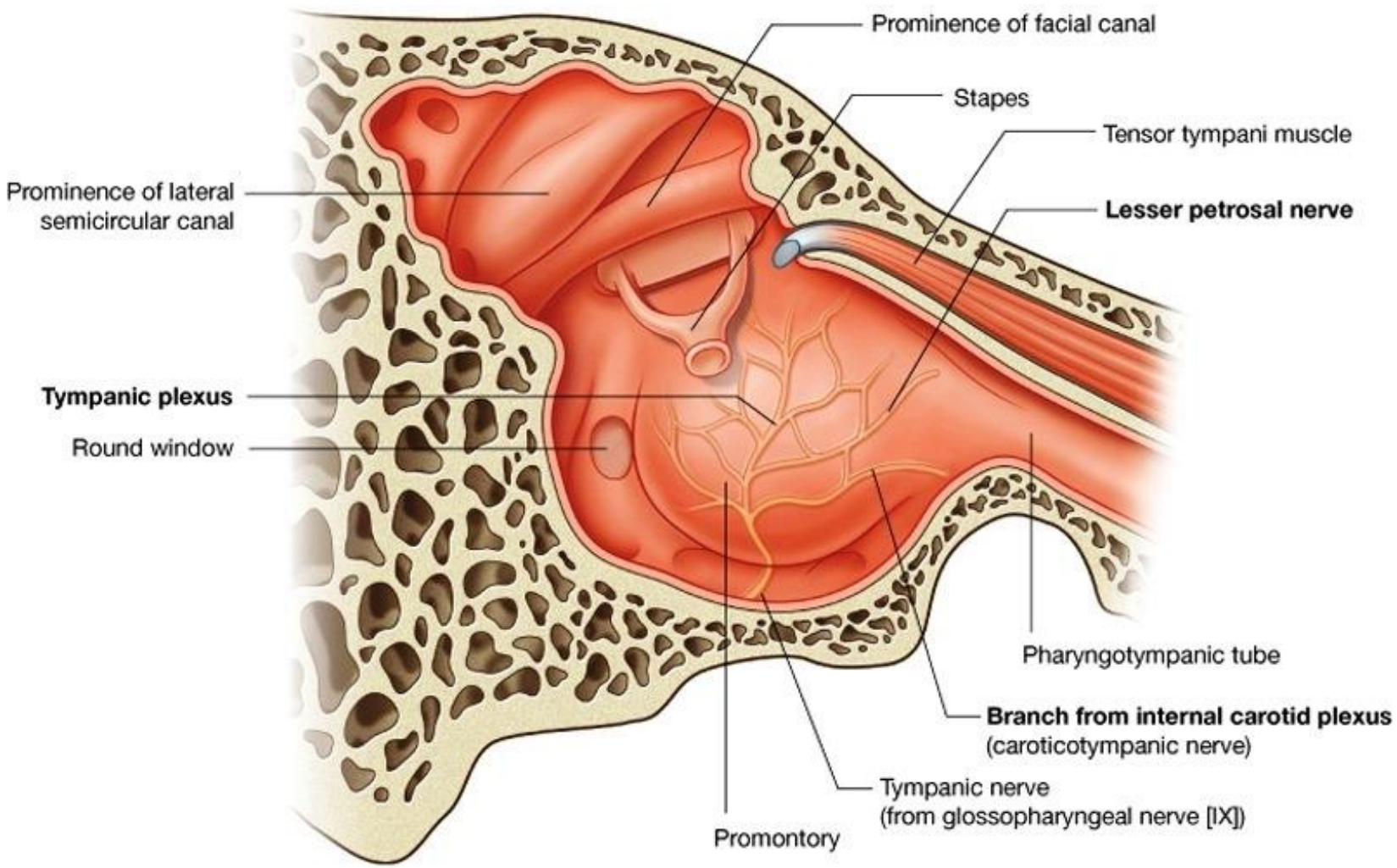


Attached to stapes
Innervation - VII

Function is to reduce the vibration of the ossicles to dampen(decrease) the intensity of the pressure waves going to the inner ear

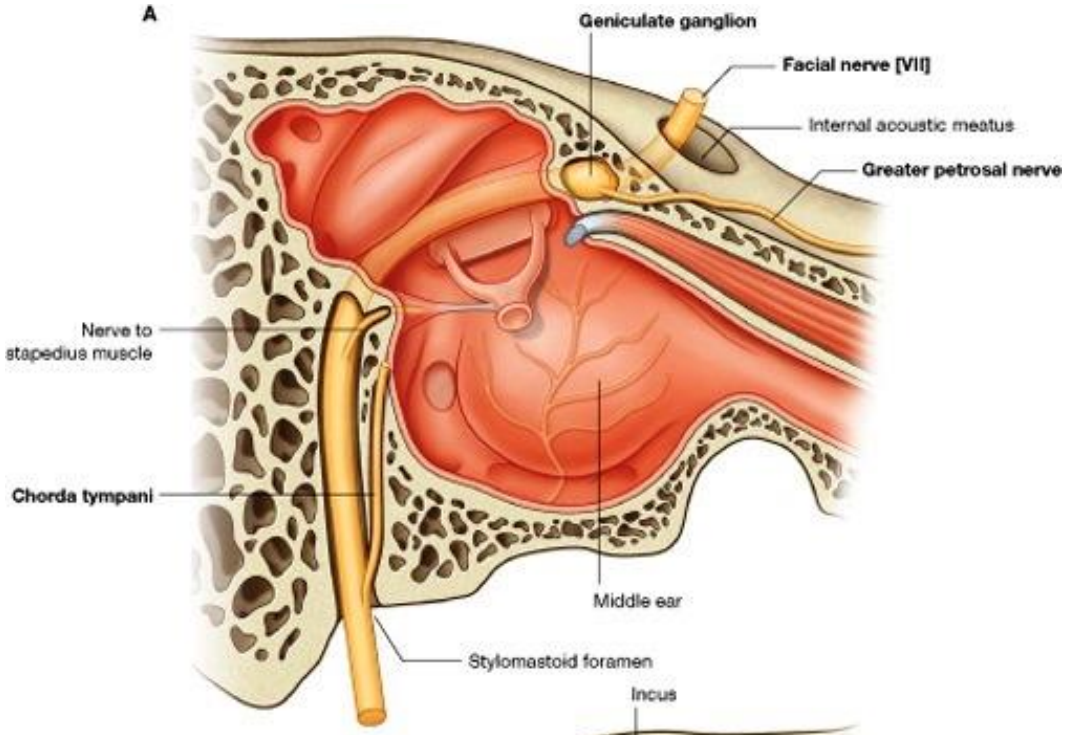
Middle Ear Innervation

- **Tympanic branch of CN IX enters floor of middle ear**
- **Forms plexus on medial wall – *tympanic plexus***
- **Innervates all the mucous membrane of middle ear, mastoid air cells, pharyngotympanic tube**
- ***Lesser petrosal n.*** **leaves cavity to provide parasympathetic innervation of parotid gland**



Facial Nerve (CN VII) Relationship to Ear

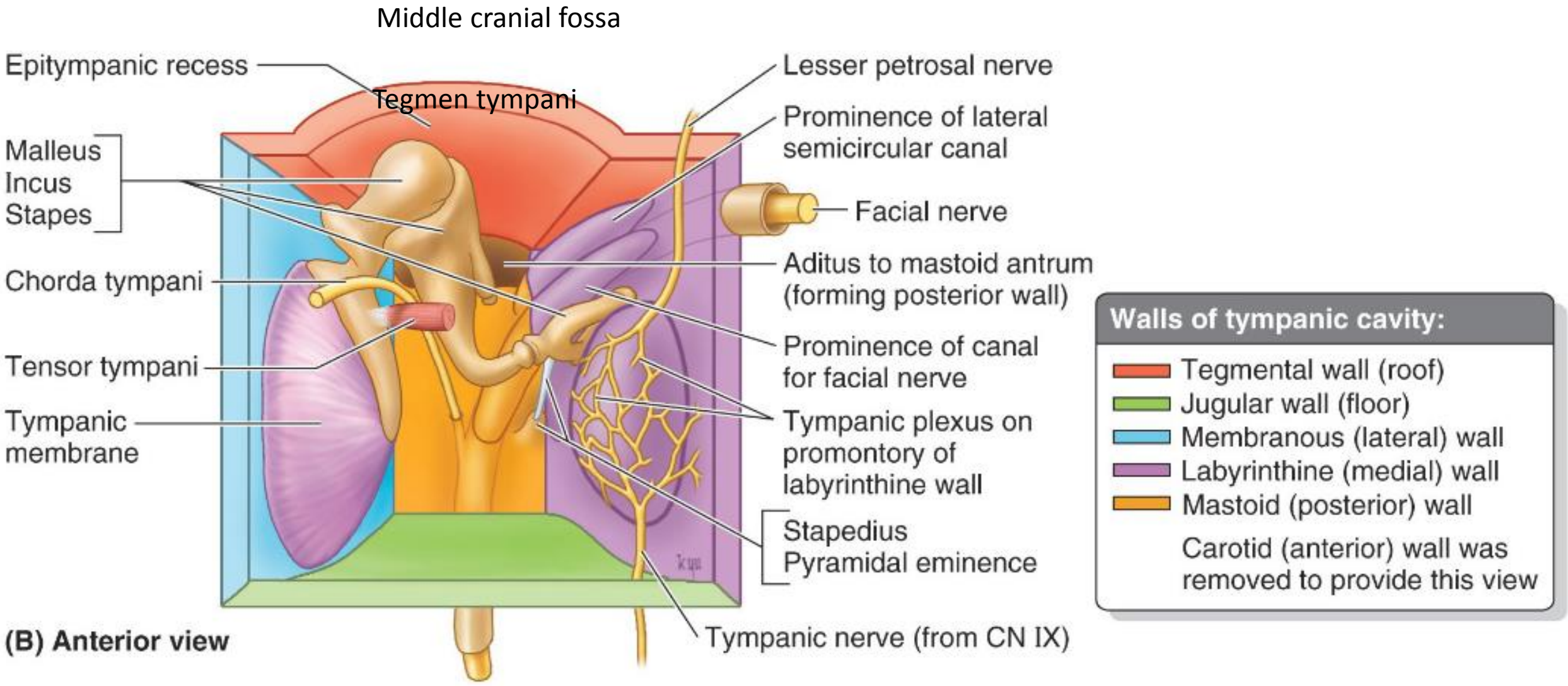
- **Facial n. travels in bony canal between middle and inner ear**
- **Gives off *greater petrosal n.* – parasympathetic to lacrimal gland**
- **Gives off *branch to stapedius m.***
- **Gives off *chorda tympani n.***
- **Chorda tympani n. travels through middle ear cavity**
  - **Parasympathetic to salivary glands**
  - **Taste from anterior 2/3 tongue**
- **Exits skull through stylomastoid foramen**



Chorda tympani

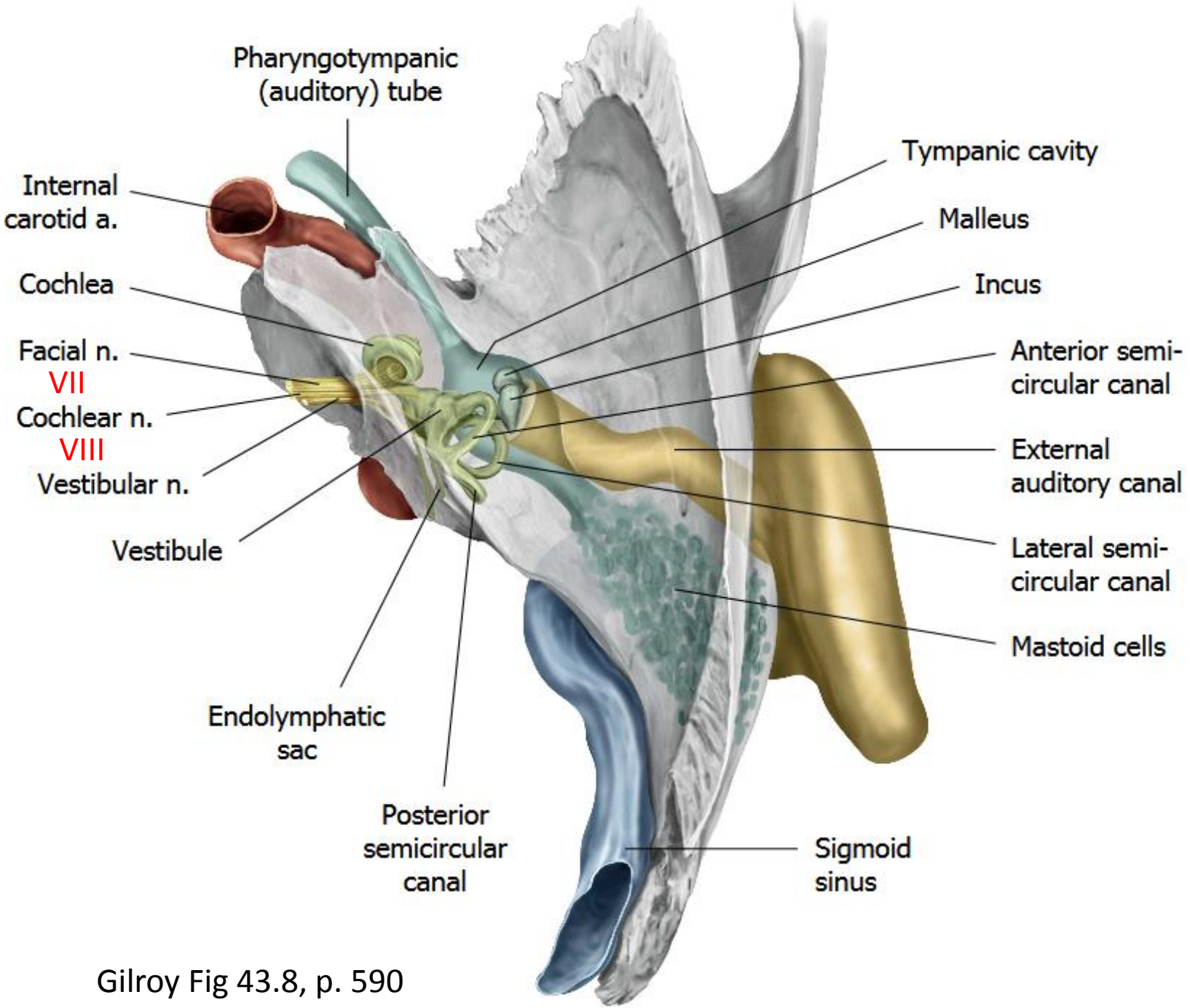
Stylomastoid foramen

Middle Ear Cavity



Moore Fig 7.114

Inner Ear

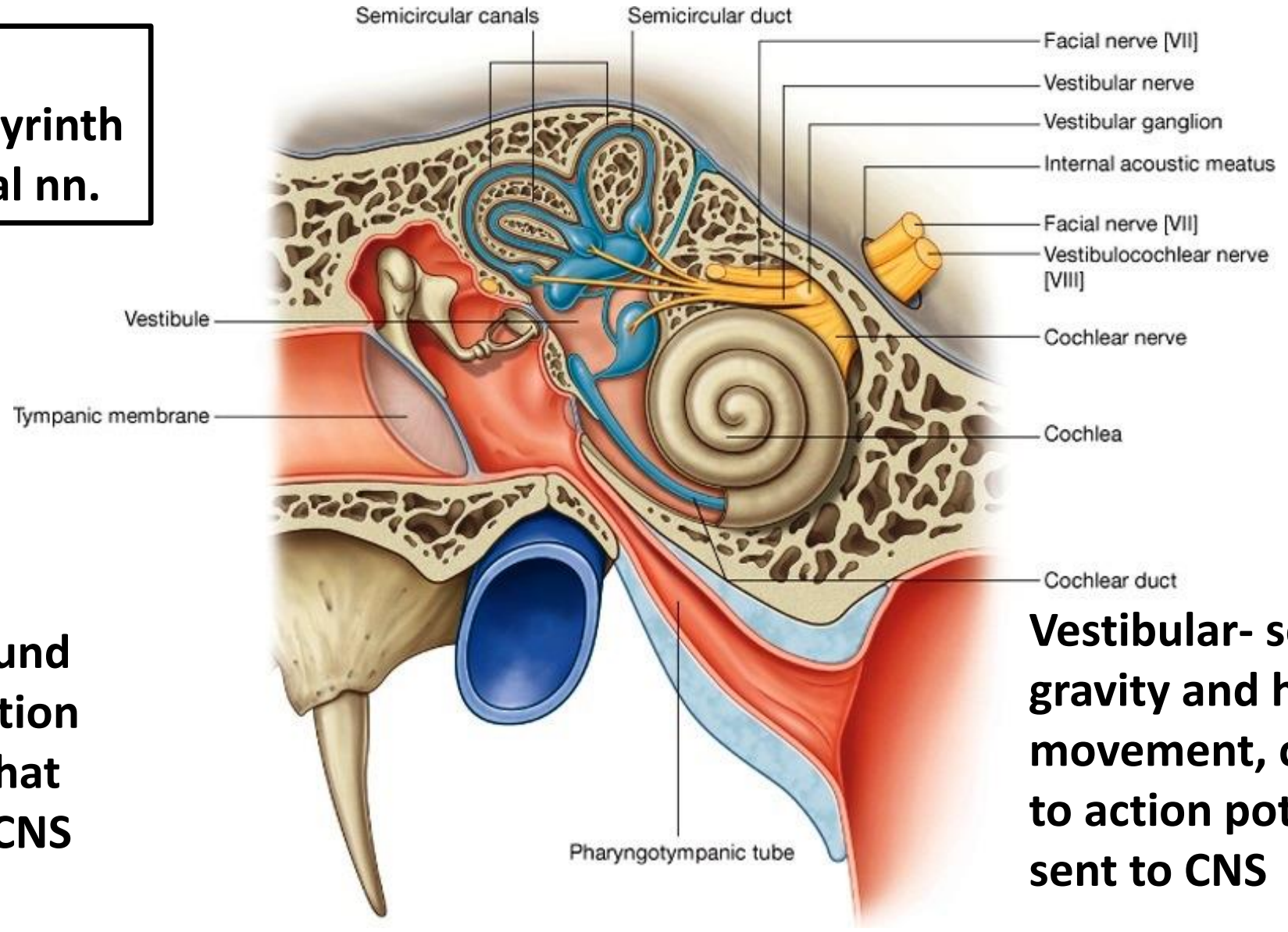


Gilroy Fig 43.8, p. 590

Located in petrous portion of temporal bone, lateral and posterior to internal acoustic meatus

Inner Ear

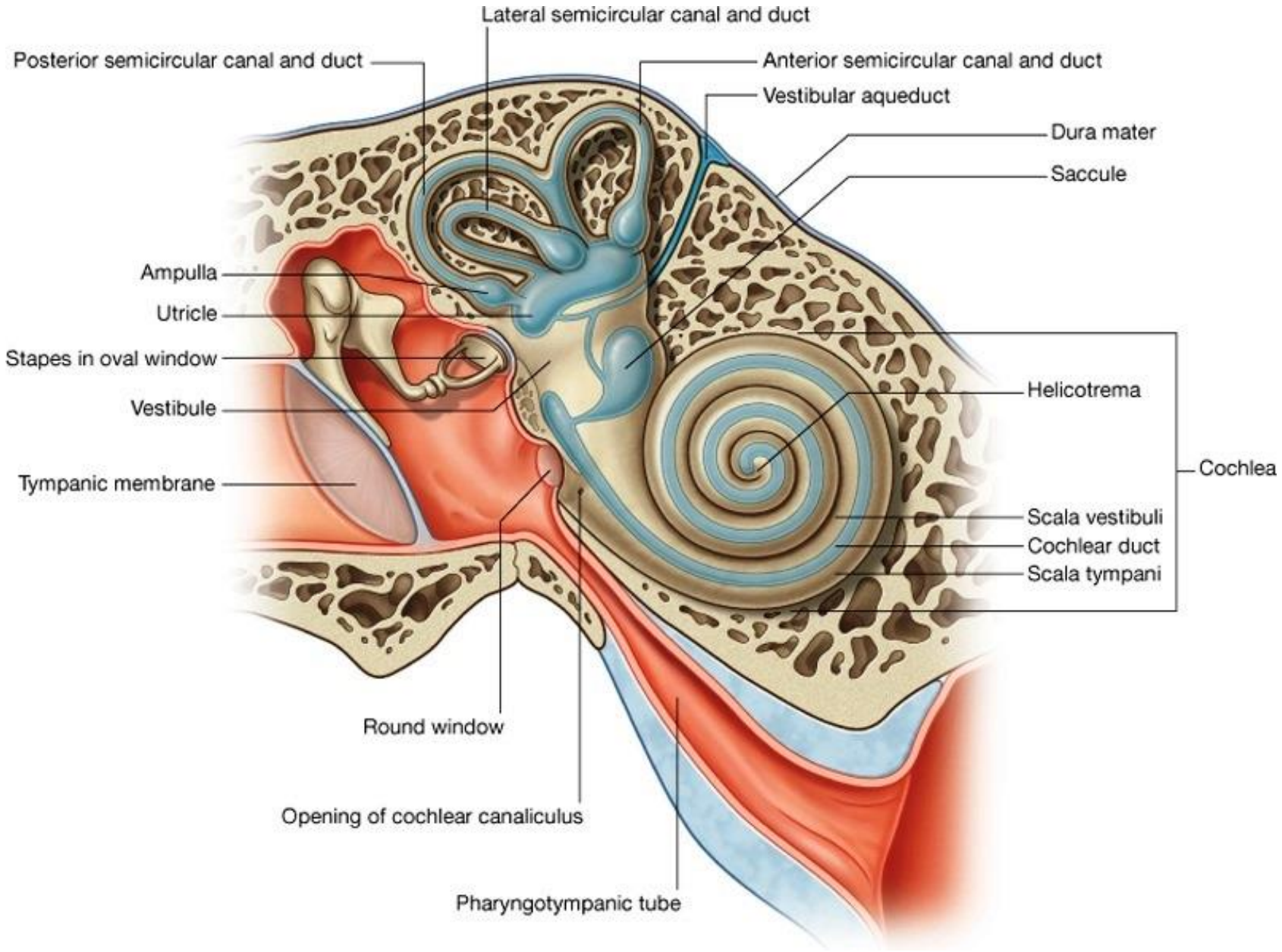
- **Bony labyrinth**
- **Membranous labyrinth**
- **VII and VIII cranial nn.**



- **Auditory – converts sound waves to action potentials that are sent to CNS**

Vestibular- senses gravity and head movement, converts to action potentials sent to CNS

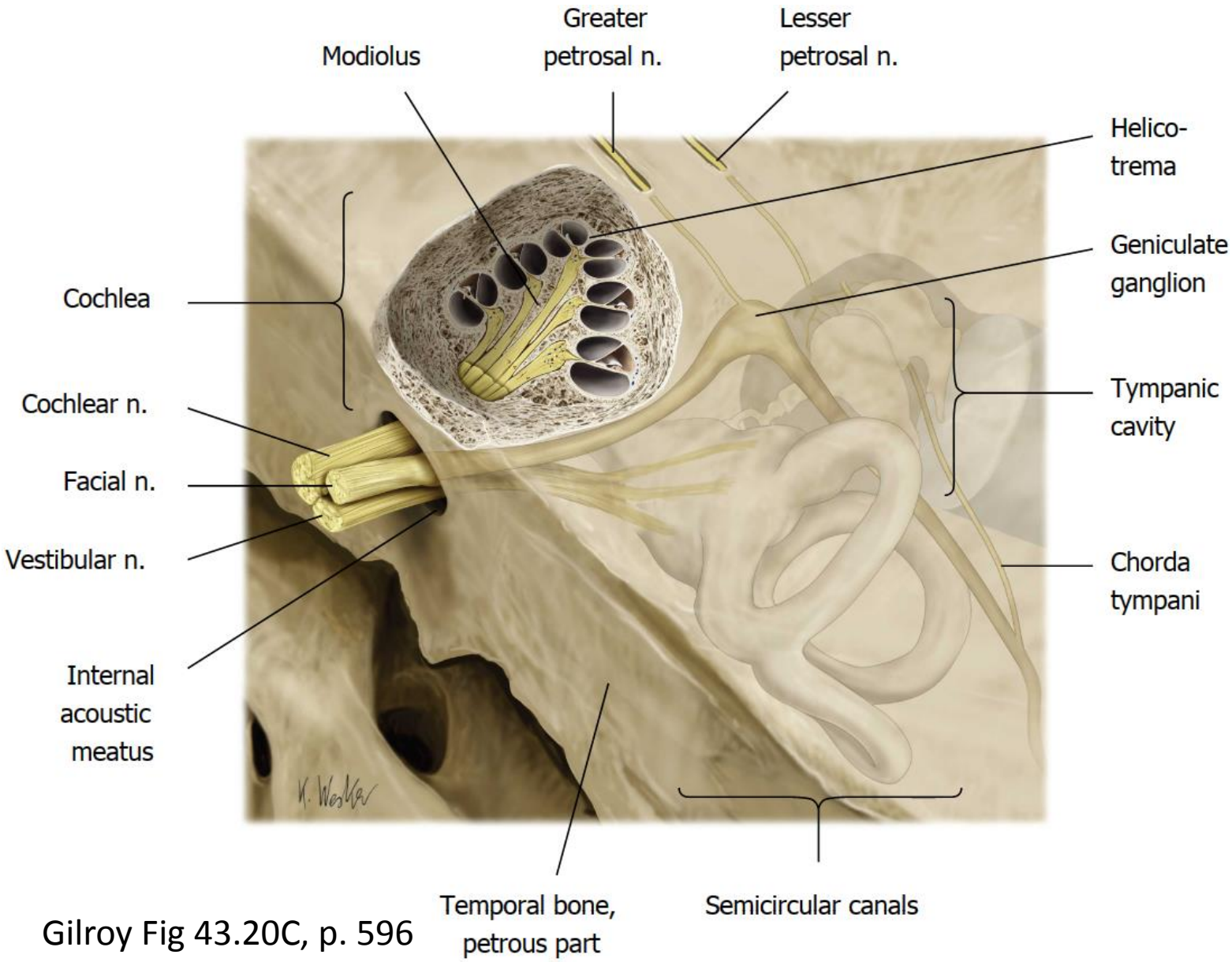
Bony Labyrinth



Hollowed-out areas of temporal bone
Contains membranous labyrinth

- **Semicircular canals**
  - **Semicircular ducts**
- **Vestibule**
  - **Utricle**
  - **saccule**
- **Bony cochlea**
  - **Cochlear duct**

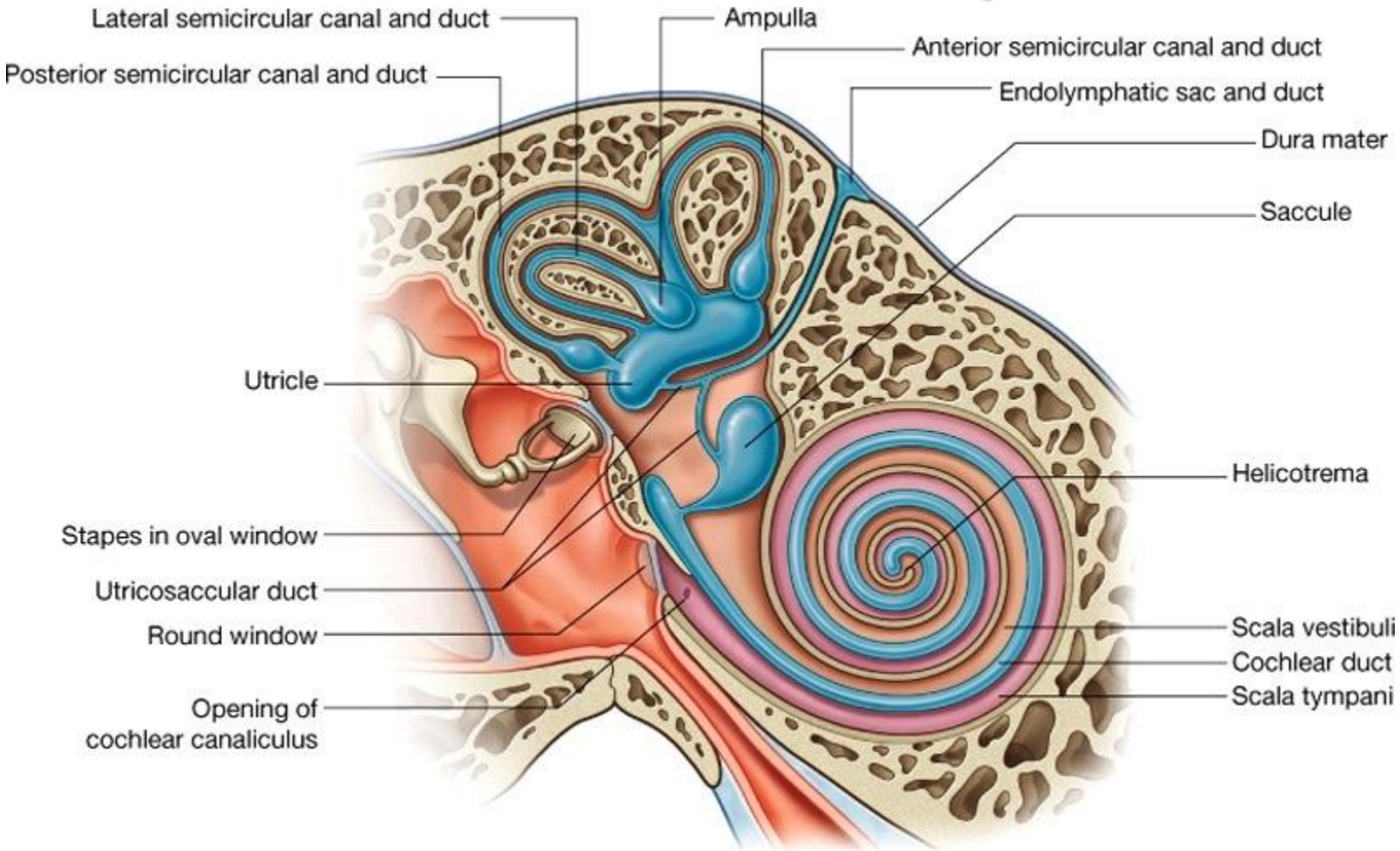
Bony Cochlea



Gilroy Fig 43.20C, p. 596

Located in the petrous portion of the temporal bone

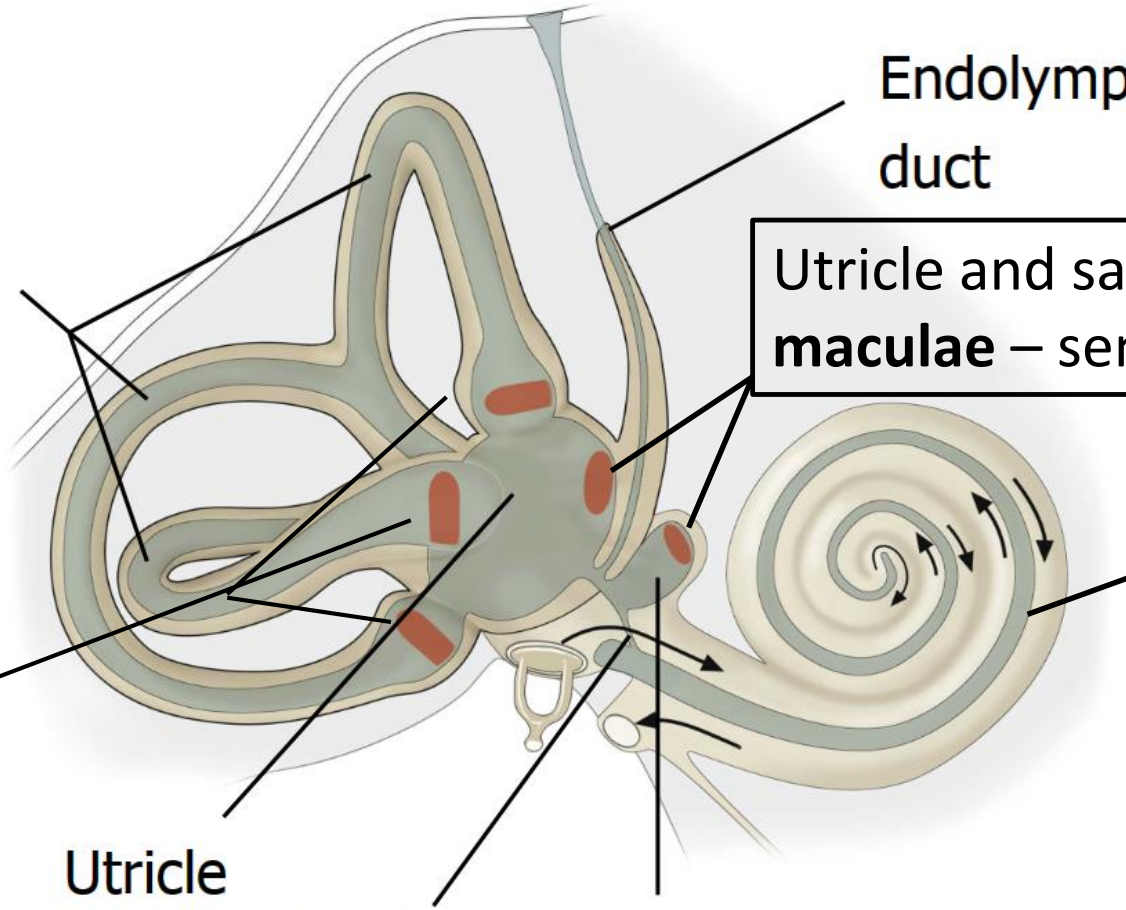
Membranous Labyrinth



Semicircular ducts connected to utricle; utricle connected to saccule; saccule connected to cochlear duct – contains *endolymph*

***Perilymph* is in bony cavity surrounding membranous labyrinth**

Membranous Labyrinth - Vestibular



- Ampullae are swellings in semicircular ducts
- Ampullae contain **cristae** – sensory receptors

Utricle and saccule contain **maculae** – sensory receptors

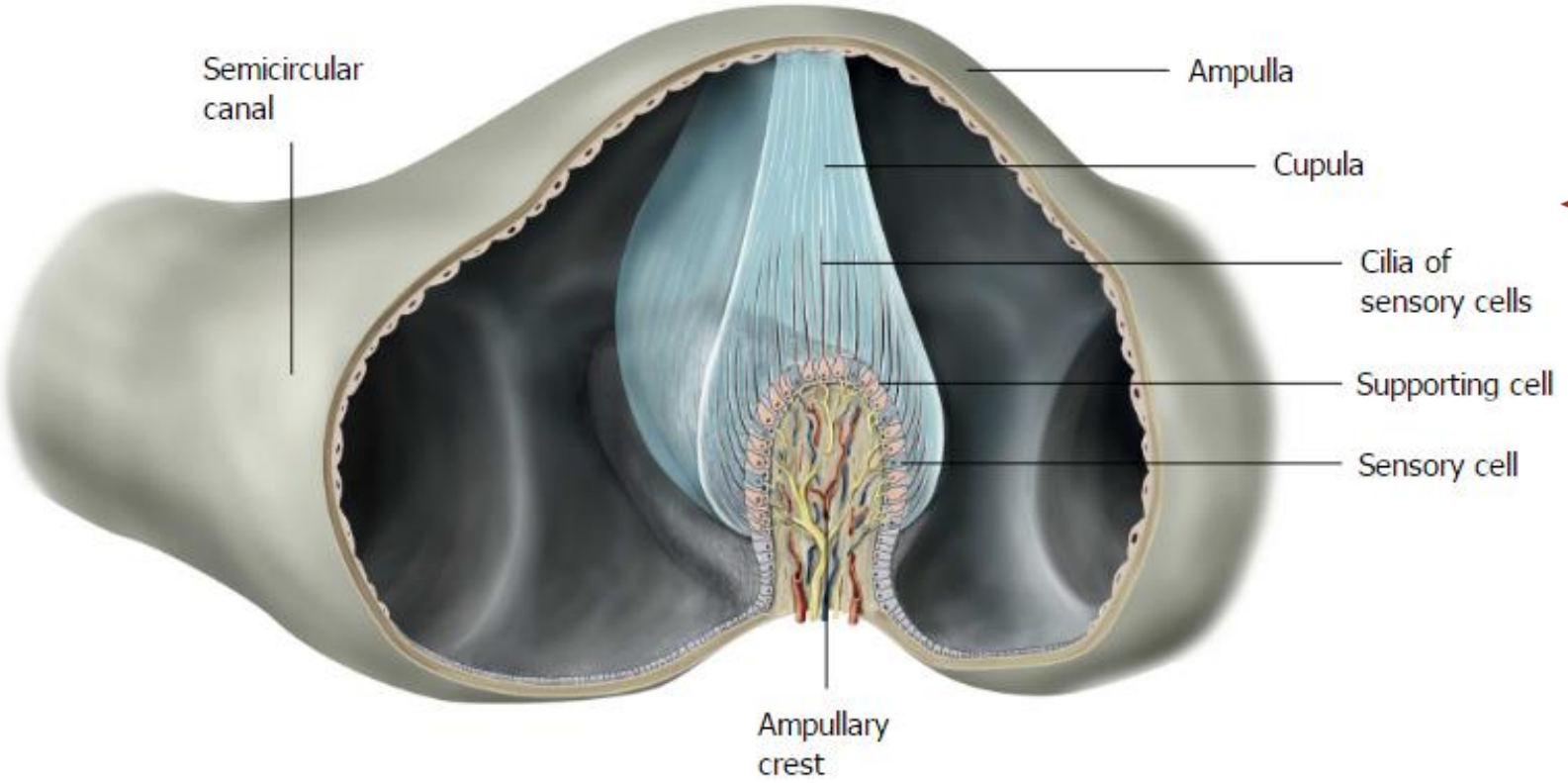
Gilroy Fig 43.20A, p. 596

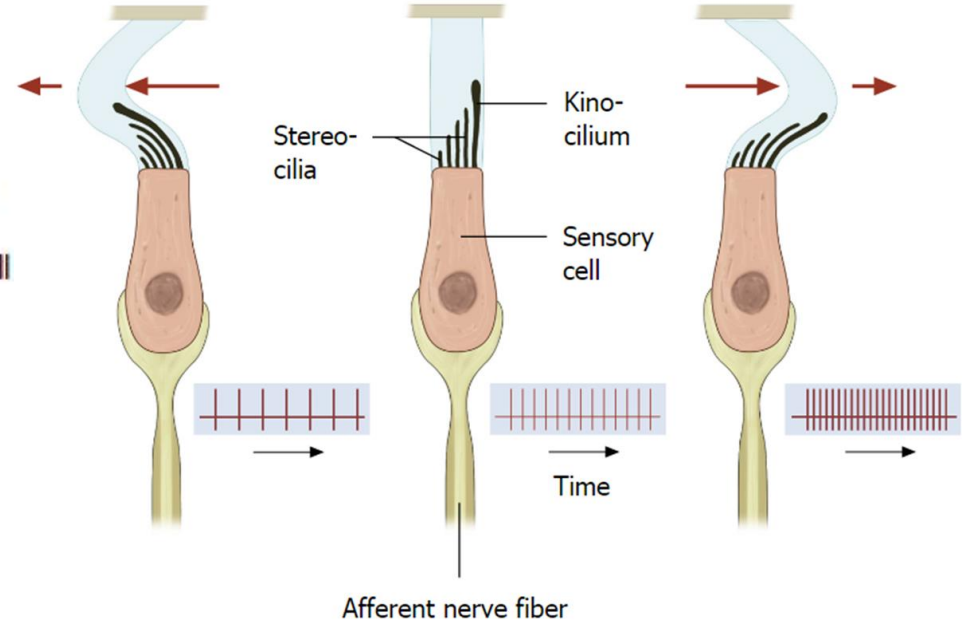
Vestibular Inner Ear

Two sets of sensory receptors:

- Semicircular Ducts (3) – sense rotation of head in all planes
  - Receptors – cristae
- Utricle and Saccule – sense linear acceleration and deceleration of the head, sensitive to force of gravity
  - Receptors - maculae

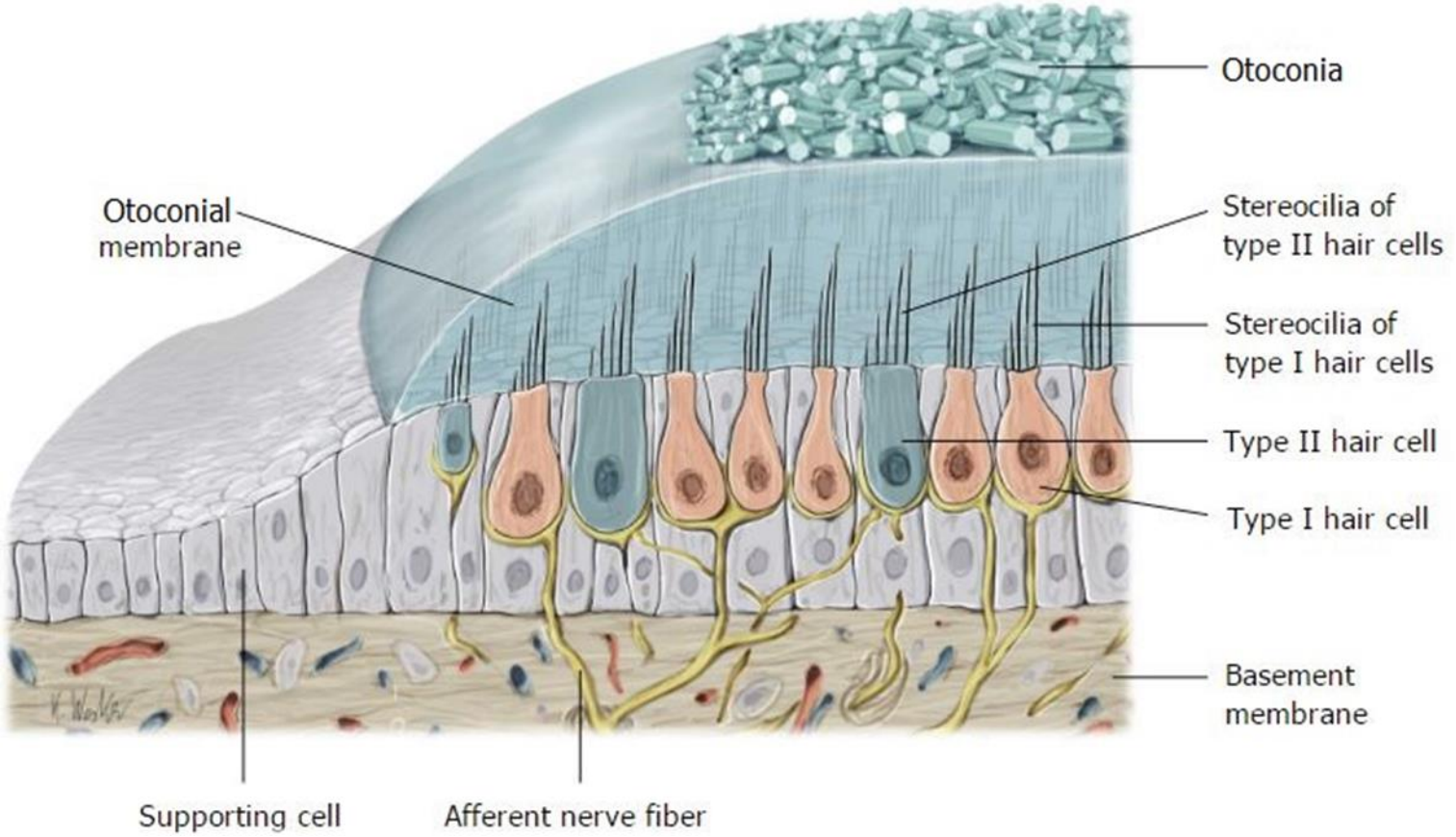
Vestibular Receptors - Cristae





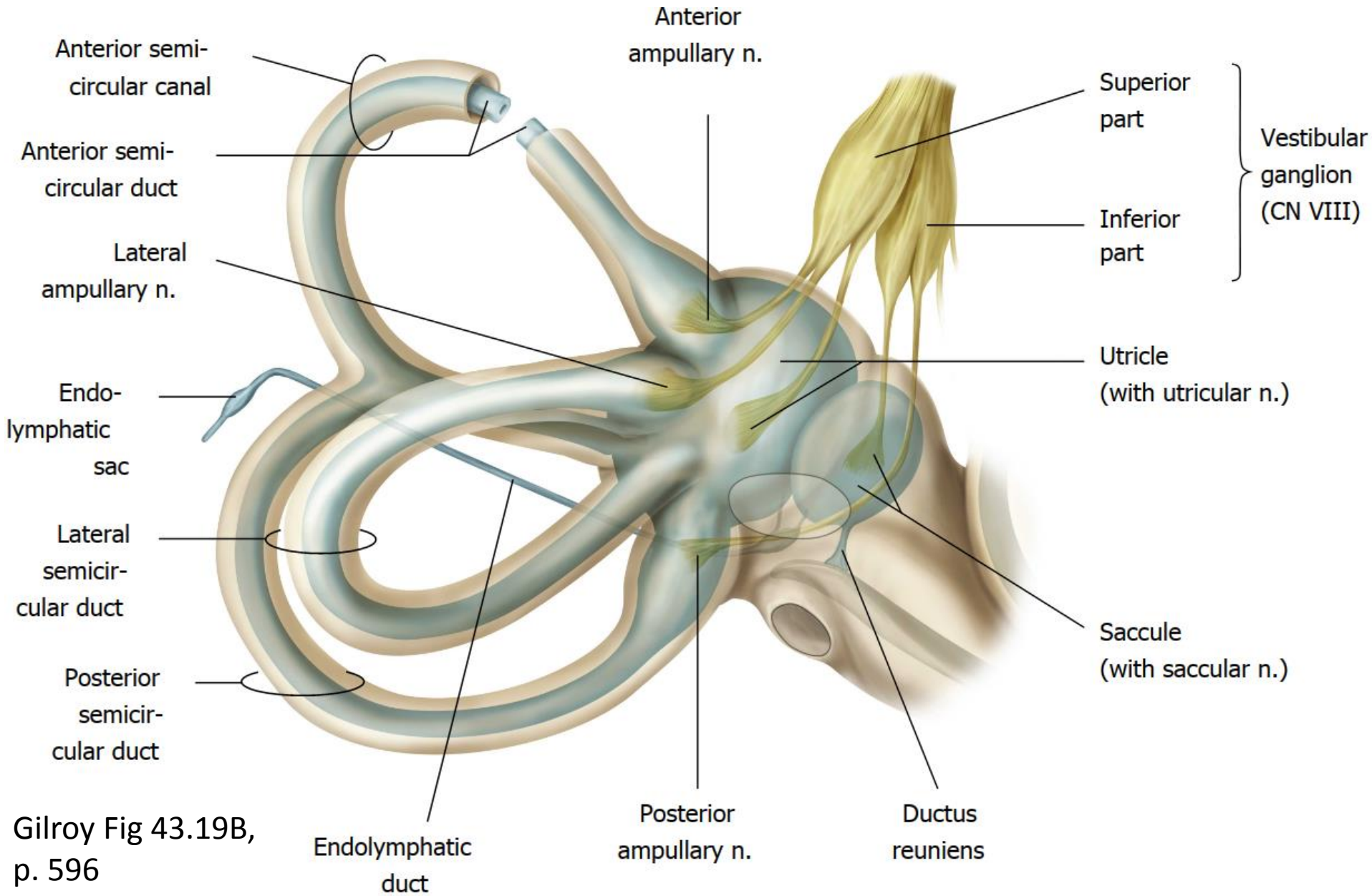
- Ampullary crest (crista) contains hair cells with cilia embedded in gelatinous cupula attached to roof of duct
- Head movement causes fluid (endolymph) to push against cupula, which is deformed like a sail
- Movement of cupula bends cilia on hair cells

Vestibular Receptors - Maculae



- **Maculae are the specialized portion of the wall of utricle and saccule**
- **Cilia of hair cells project into gelatinous otoconial membrane**
- **Small calcium crystals (otoconia) on surface of the membrane**
- **Sense gravity and linear movements of head**

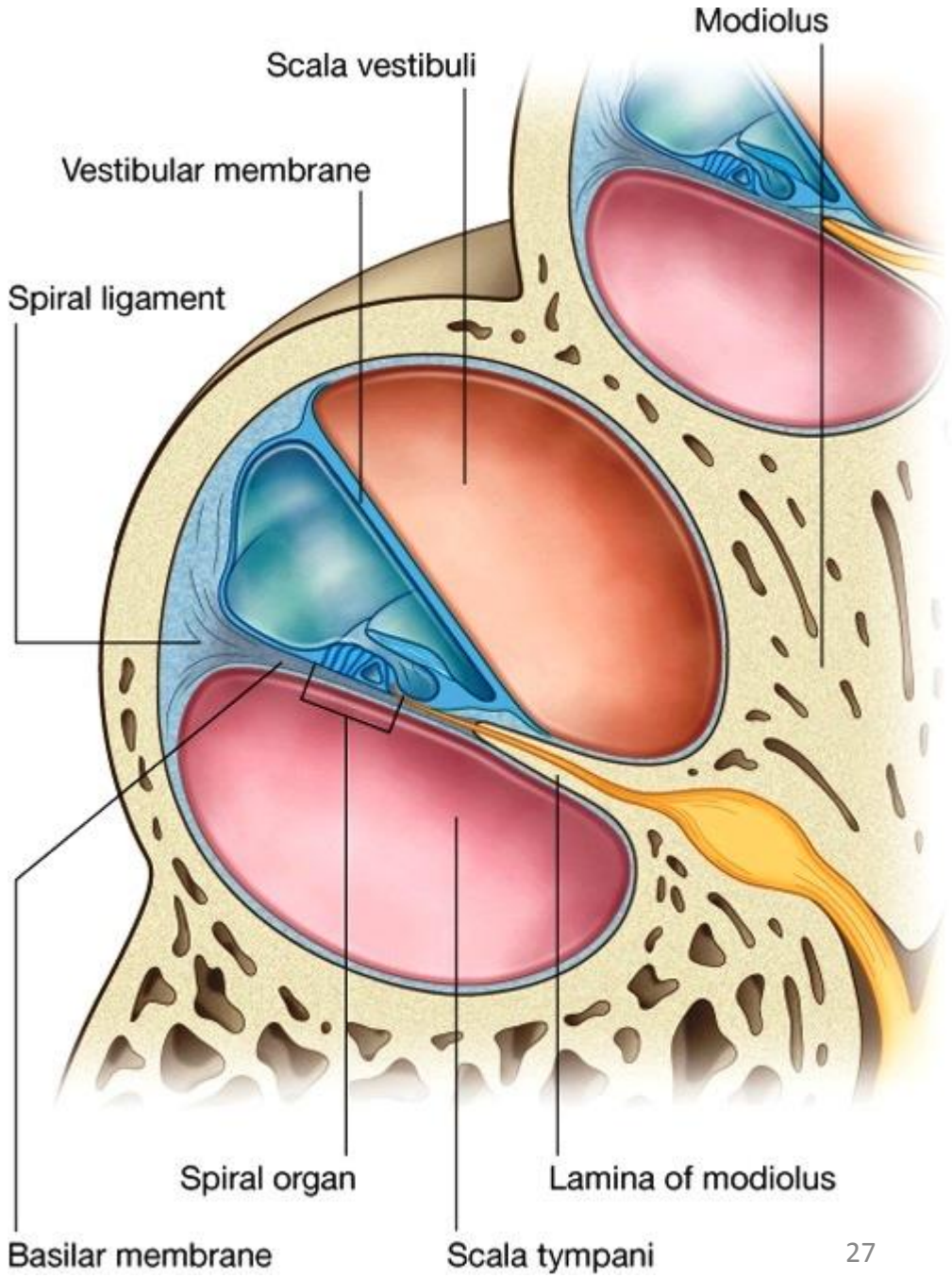
Vestibular Nerve



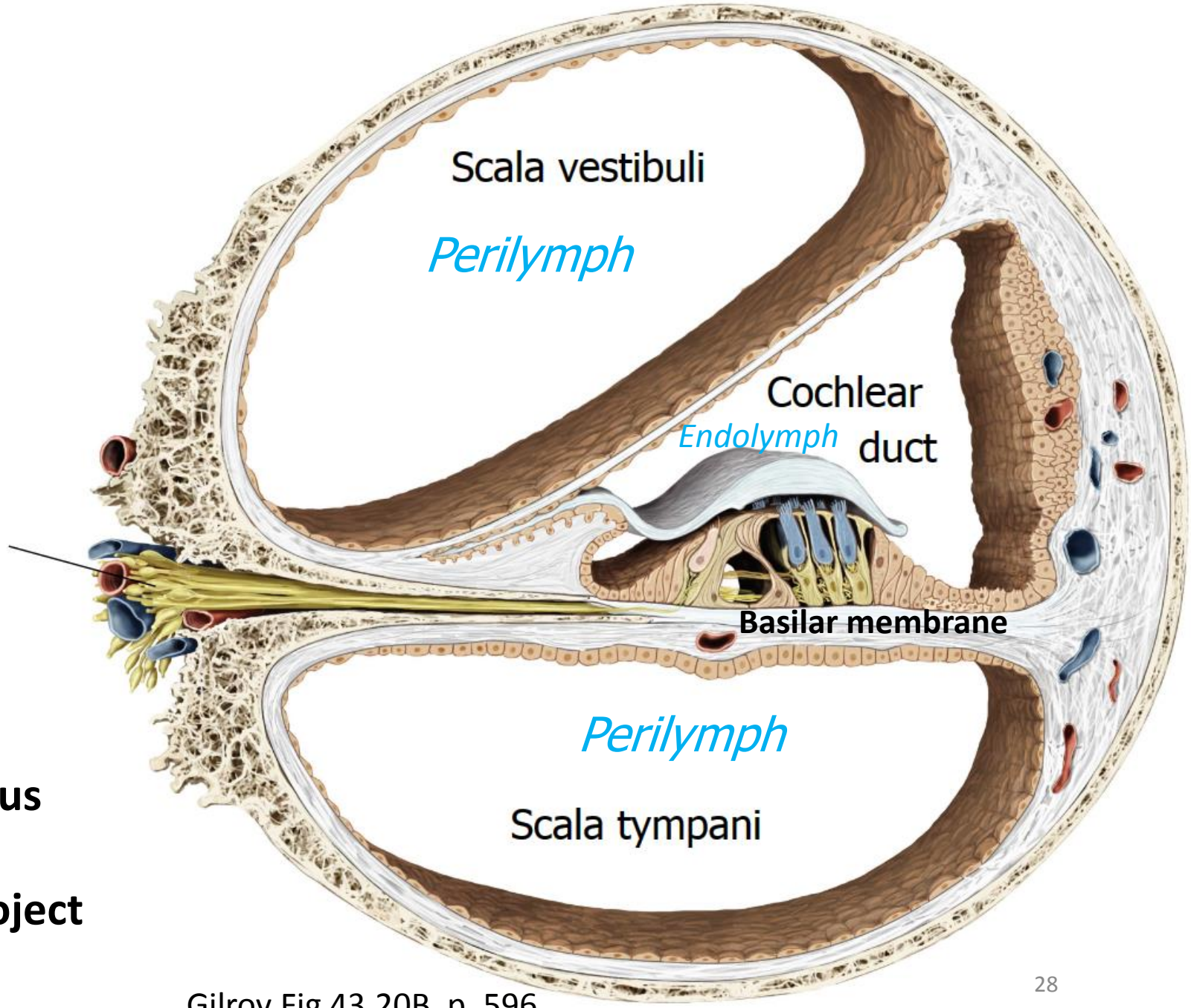
Gilroy Fig 43.19B, p. 596

Cochlear Duct

- **Contains endolymph**
- **Lies between scala tympani and scala vestibuli**
- **Pressure waves travel up and down the scala and vibrate the basilar membrane**
- **Organ of Corti (spiral organ) sits on basilar membrane**



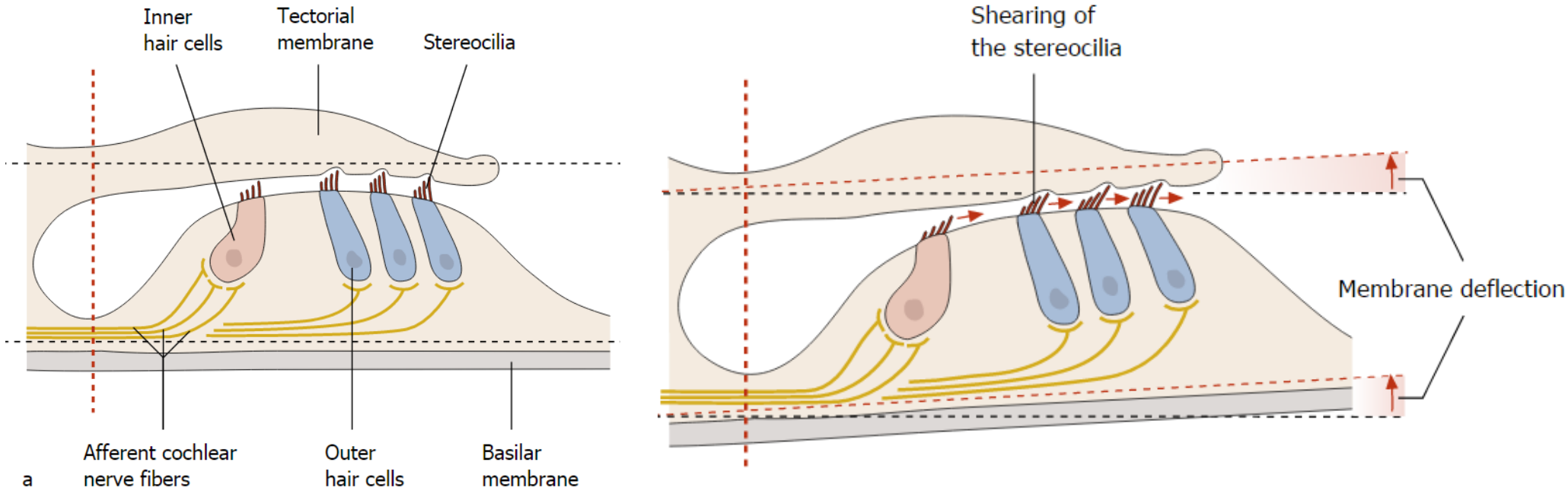
Inner Ear Cross Section



- **Organ of Corti sits on basilar membrane**
- **Tectorial membrane – gelatinous membrane over hair cells**
- **Cilia on surface of hair cells project into tectorial membrane**

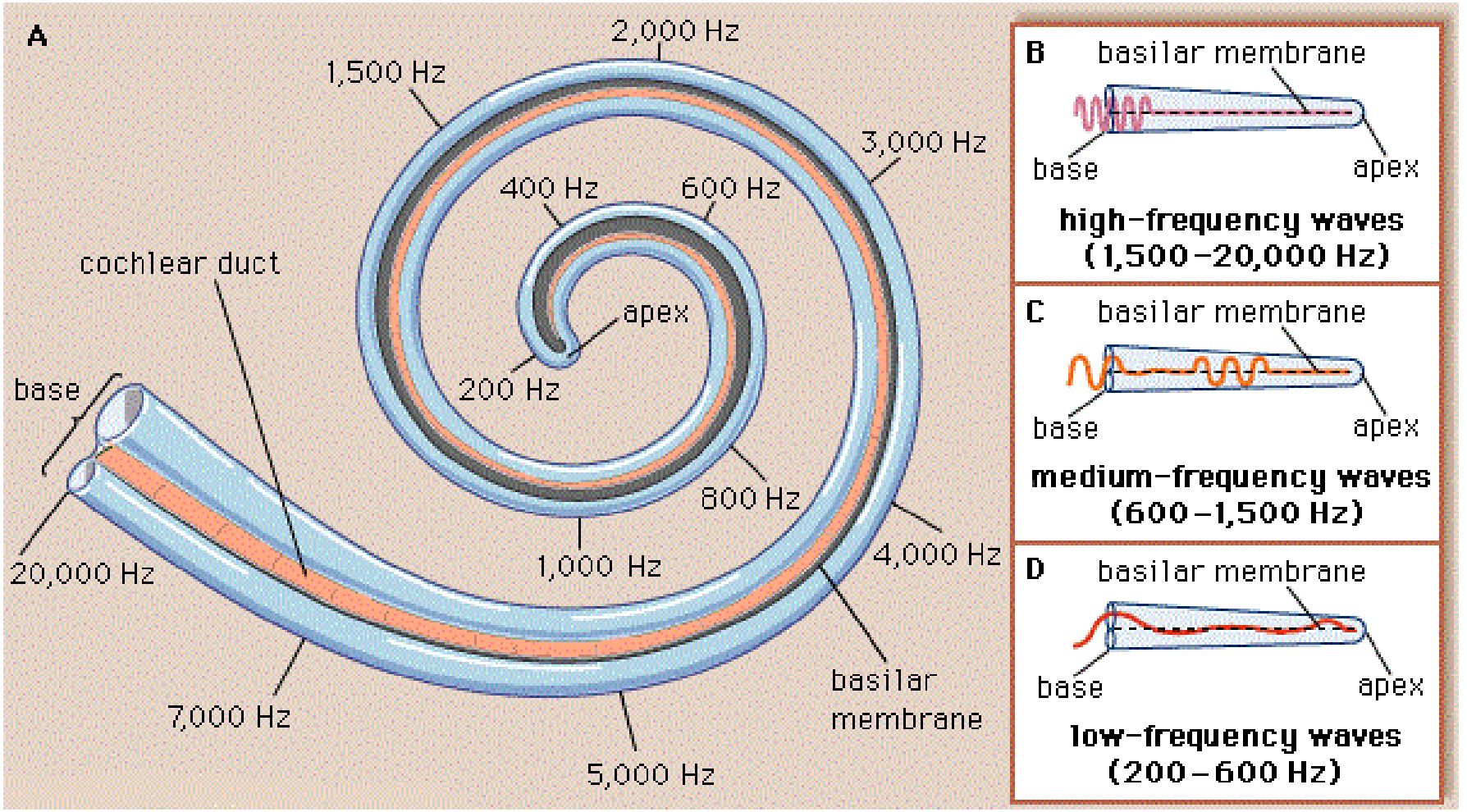
Gilroy Fig 43.20B, p. 596

Cochlear Function



- Vibration of basilar membrane causes stereocilia to bend on hair cells
- Deflection of stereocilia initiates receptor potential in hair cells
- Hair cells depolarize cochlear nerve endings on hair cells
- Action potential sent to brainstem cochlear nuclei

Organ of Corti Frequency Sensitivity



Highest frequency sounds – vibrate <u>base</u> of basilar membrane

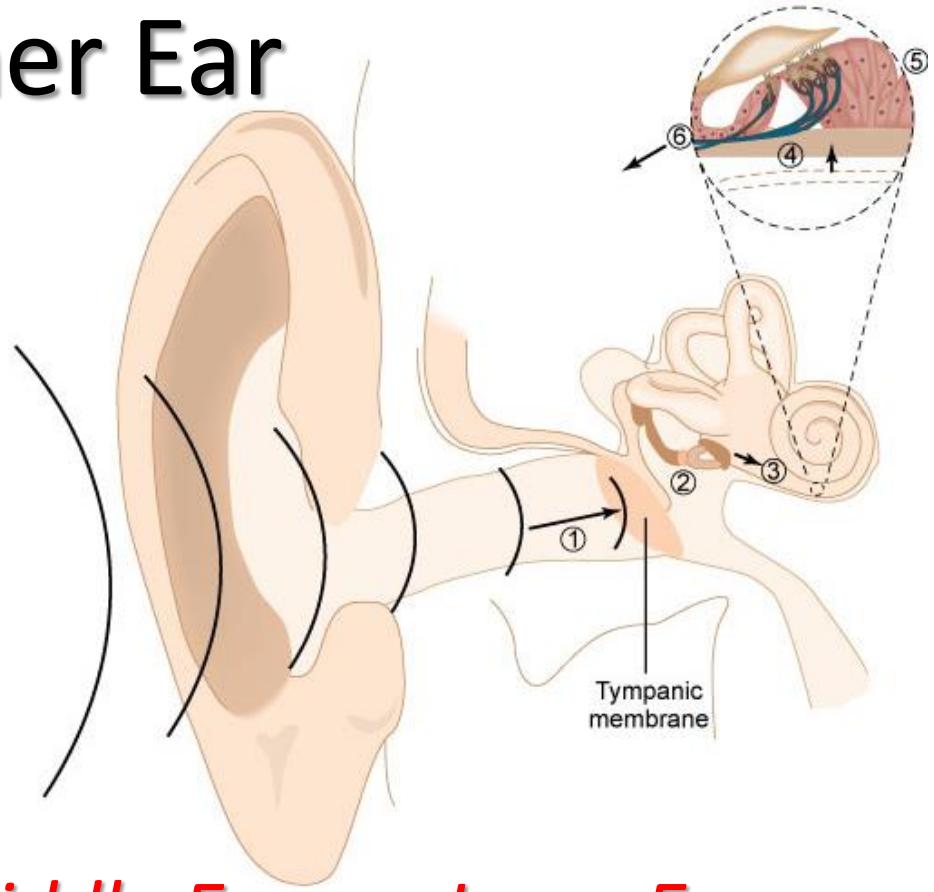
Lowest frequency sounds – vibrate <u>apical</u> region of membrane

Sound Conduction to Inner Ear

External Ear-collects sound waves

Middle Ear-converts to vibrations

Inner Ear- converts vibrations to action potentials



Middle Ear *Inner Ear*

① Sound waves strike tympanic membrane (ear drum)

② Ossicles (small bones) move, causing vibration of membrane at opening of upper chamber

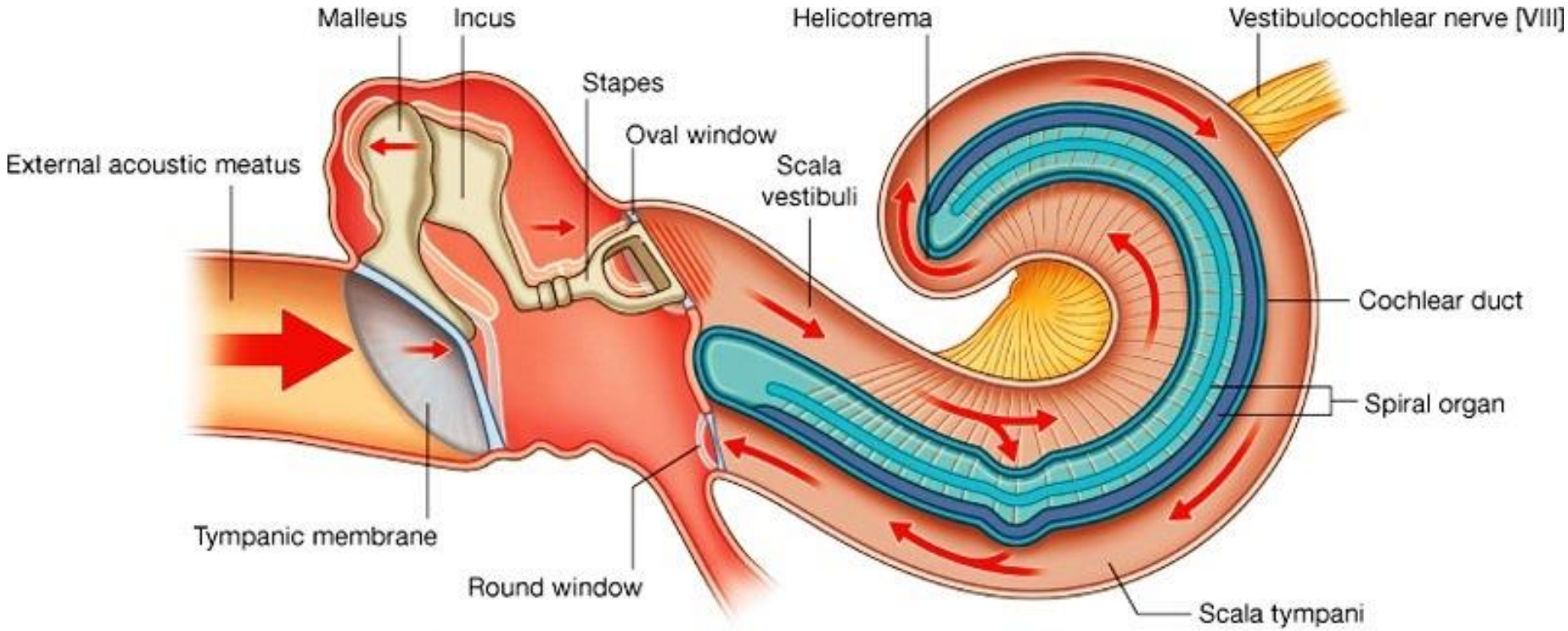
③ Movement of fluid in upper chamber

④ Vibration of basilar membrane and attached hair cells

⑤ Hairs bend because the tips are embedded in the immobile tectorial membrane. Hair cells depolarize

⑥ Cochlear nerve endings activated

Transmission of Sound

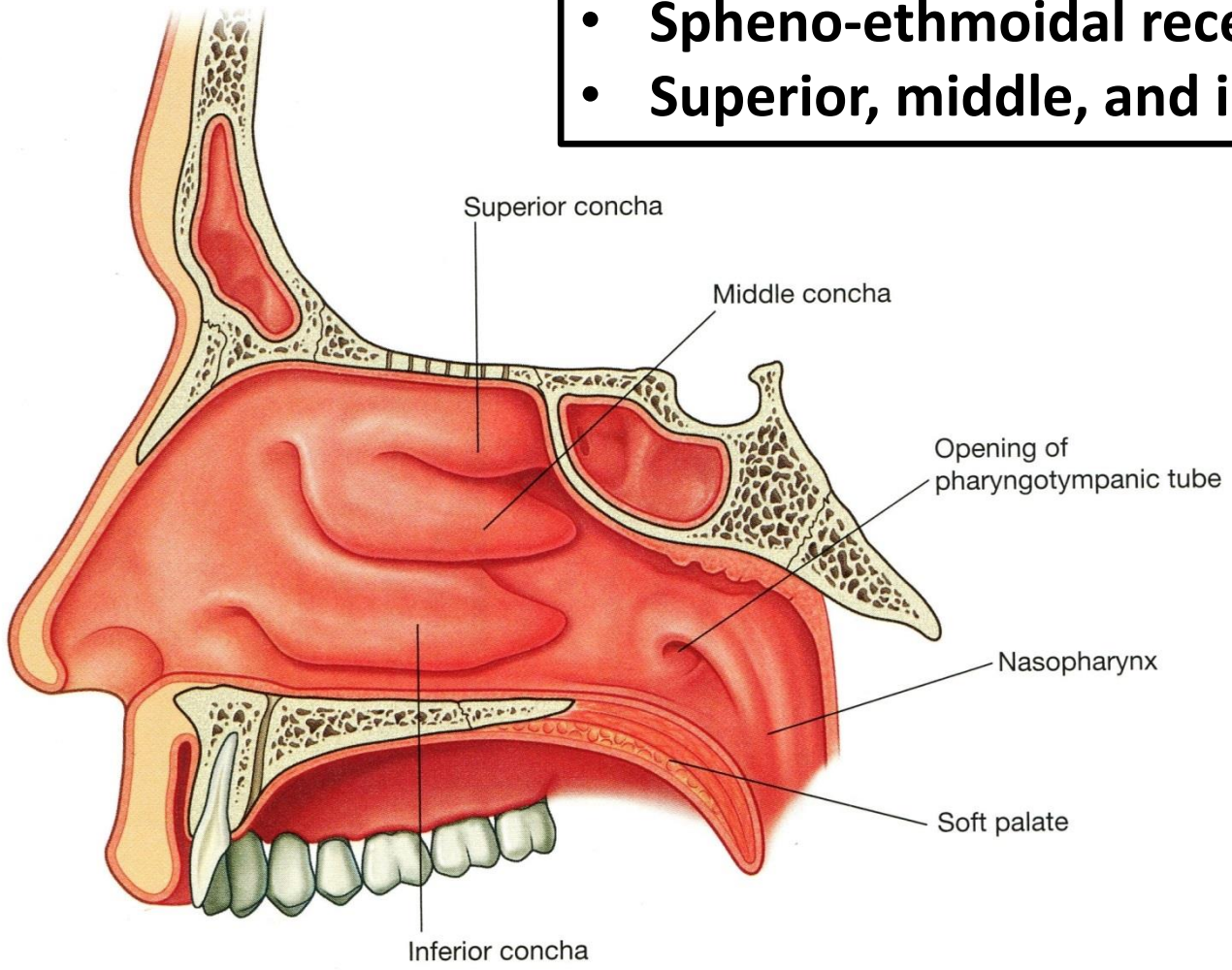


- **Stapes moves in and out at oval window**
- **Sound waves transmitted up scala vestibuli toward helicotrema**
- **Frequency of sound wave causes specific portion of basilar membrane to vibrate**
- **Hair cells at that location create action potentials**
- **Pressure wave travels down scala tympani and pressure released at round window**

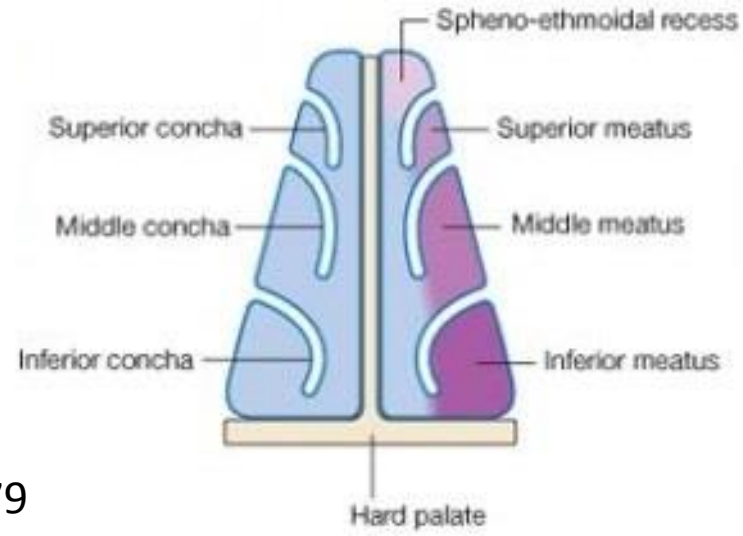
Nasal Cavity – Nasal Conchae

Conchae divide each nasal cavity into 4 air channels:

- **Spheno-ethmoidal recess**
- **Superior, middle, and inferior meatuses**

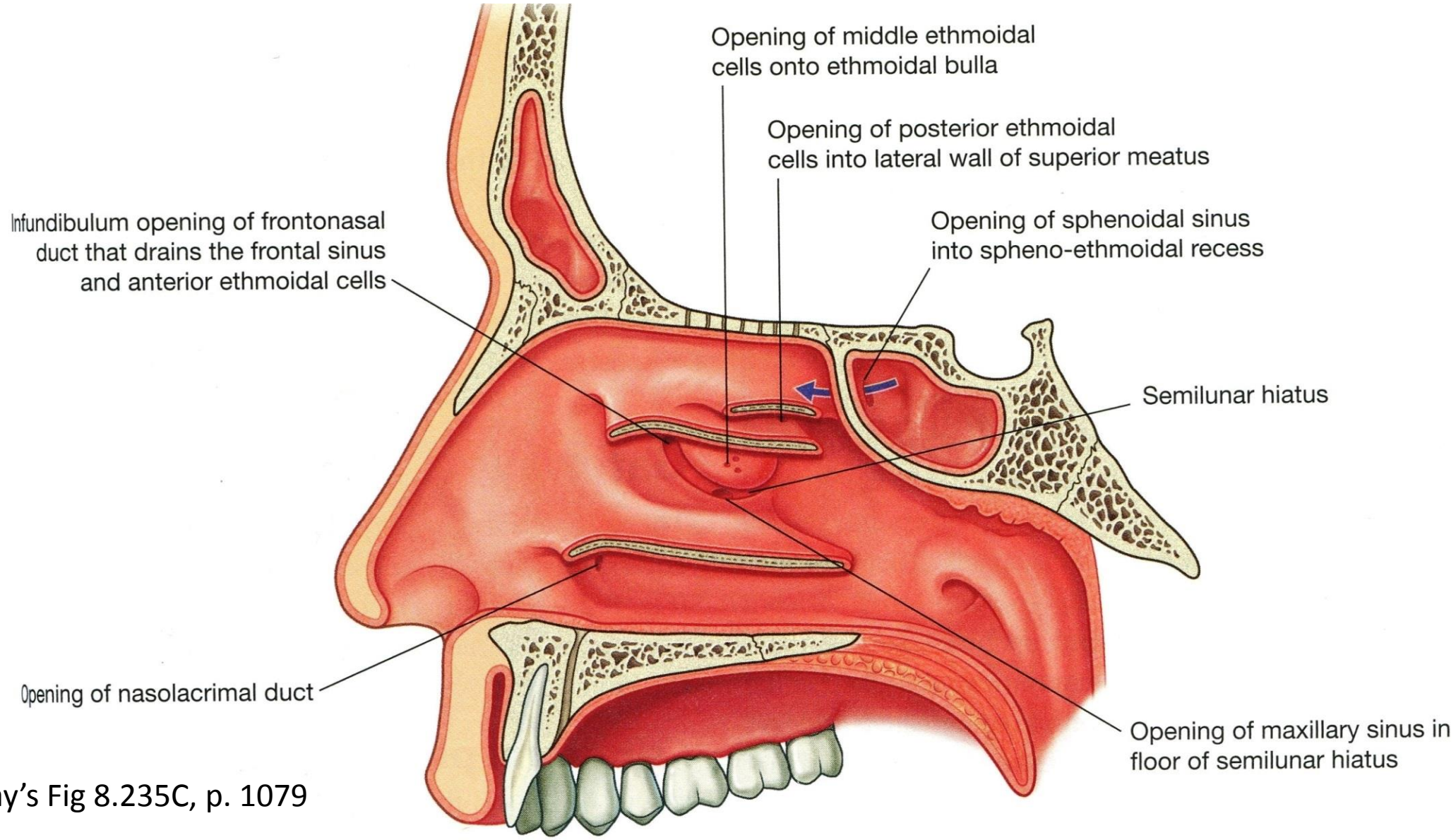


All sinuses and nasolacrimal duct open into these recesses



Gray's Fig 8.235B, p. 1079

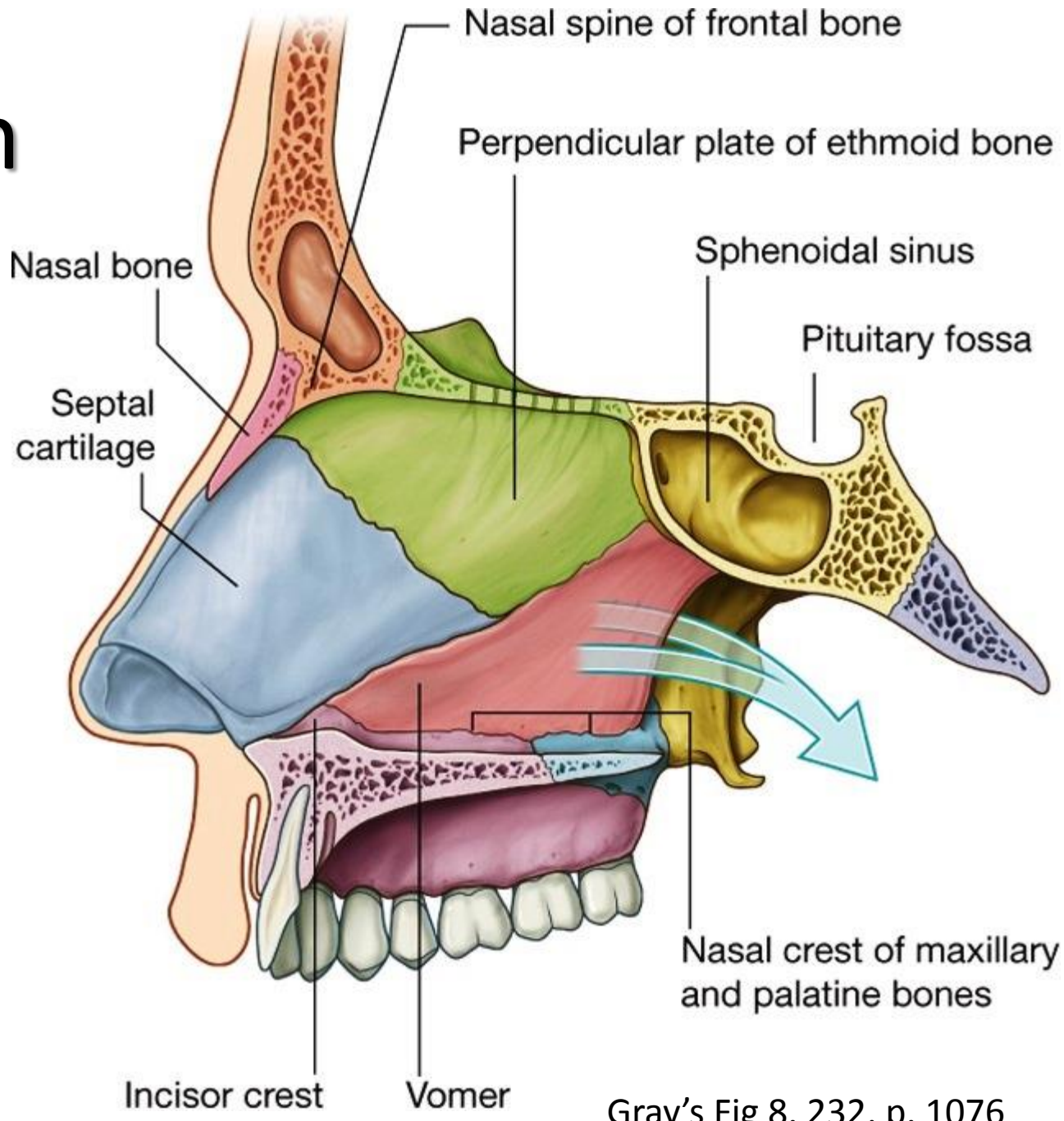
Nasal Cavity – Sinus Openings



Gray's Fig 8.235C, p. 1079

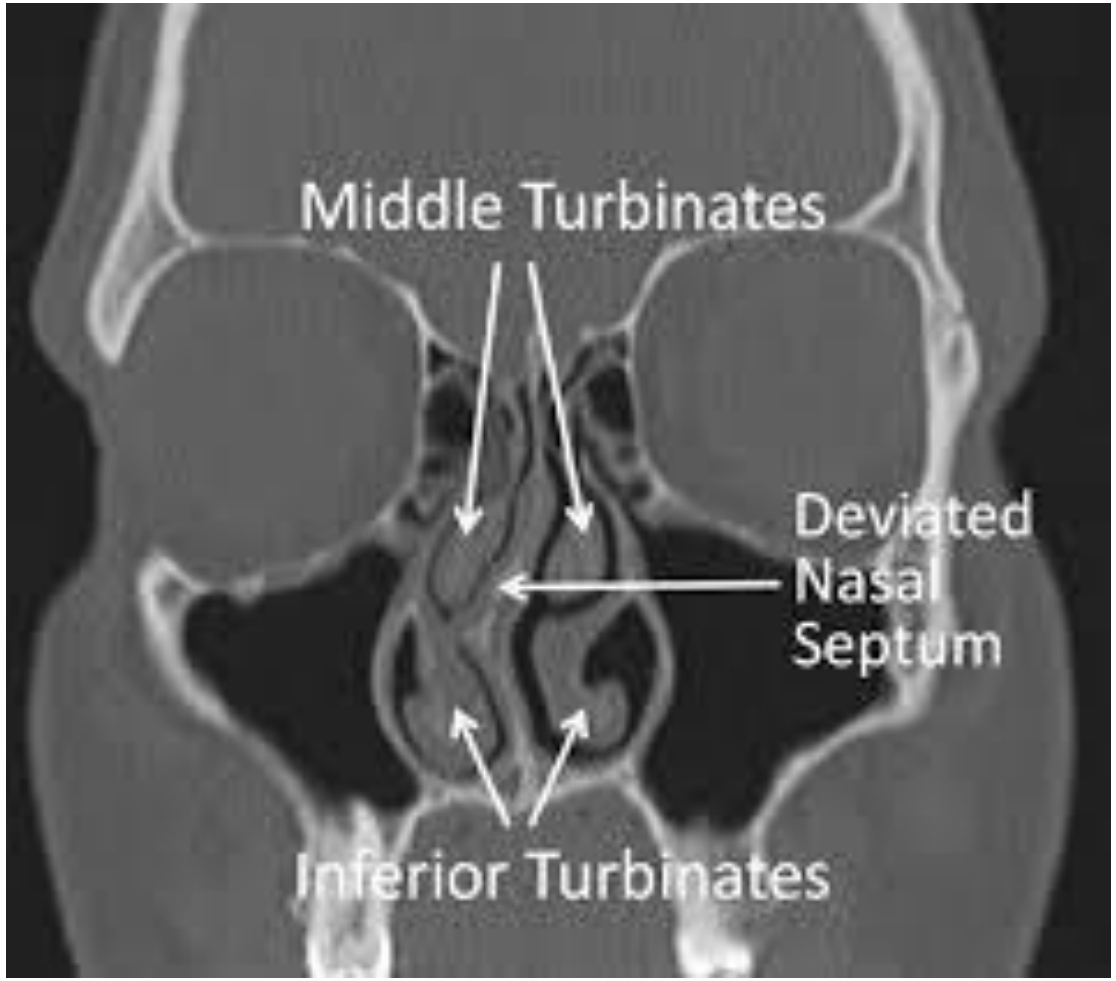
Nasal Septum

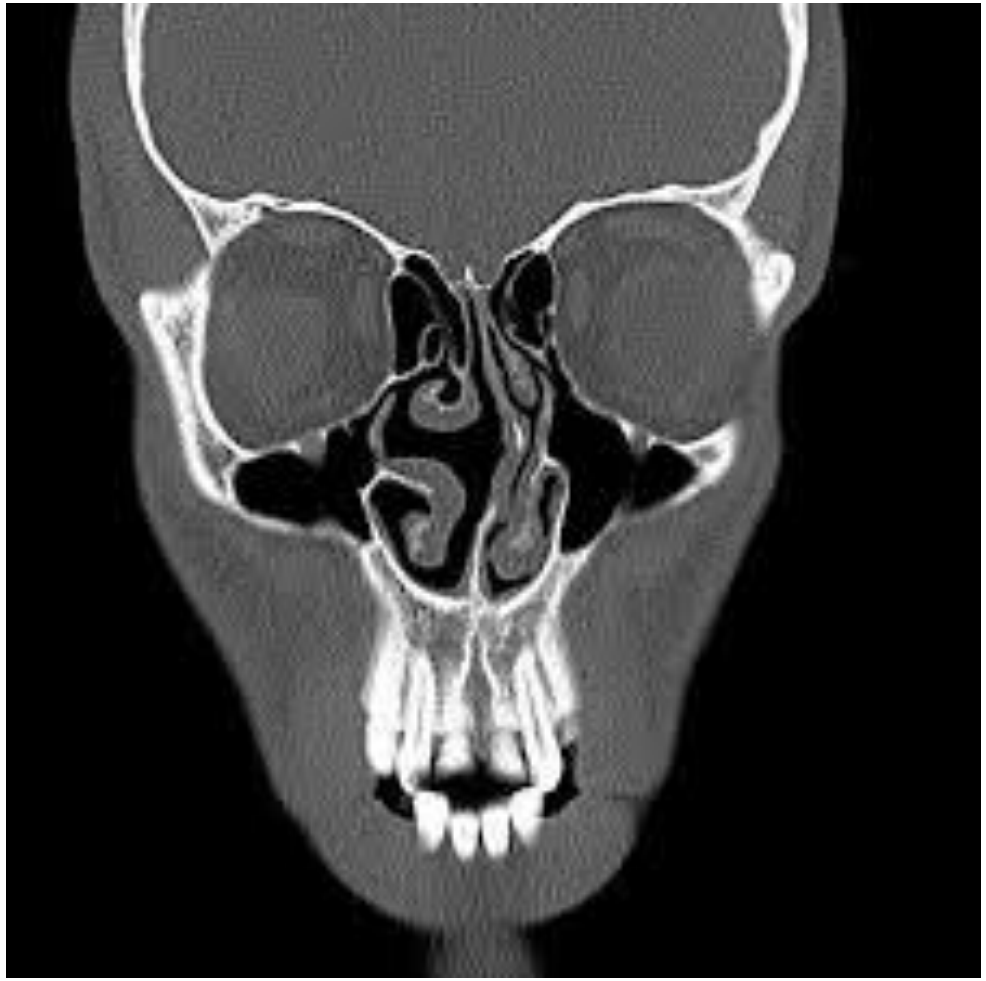
- **Separates nasal cavity into two equal parts**
  - **Septal cartilage**
  - **Perpendicular plate of ethmoid bone**
  - **Vomer bone**
- **Covered with mucous membrane**



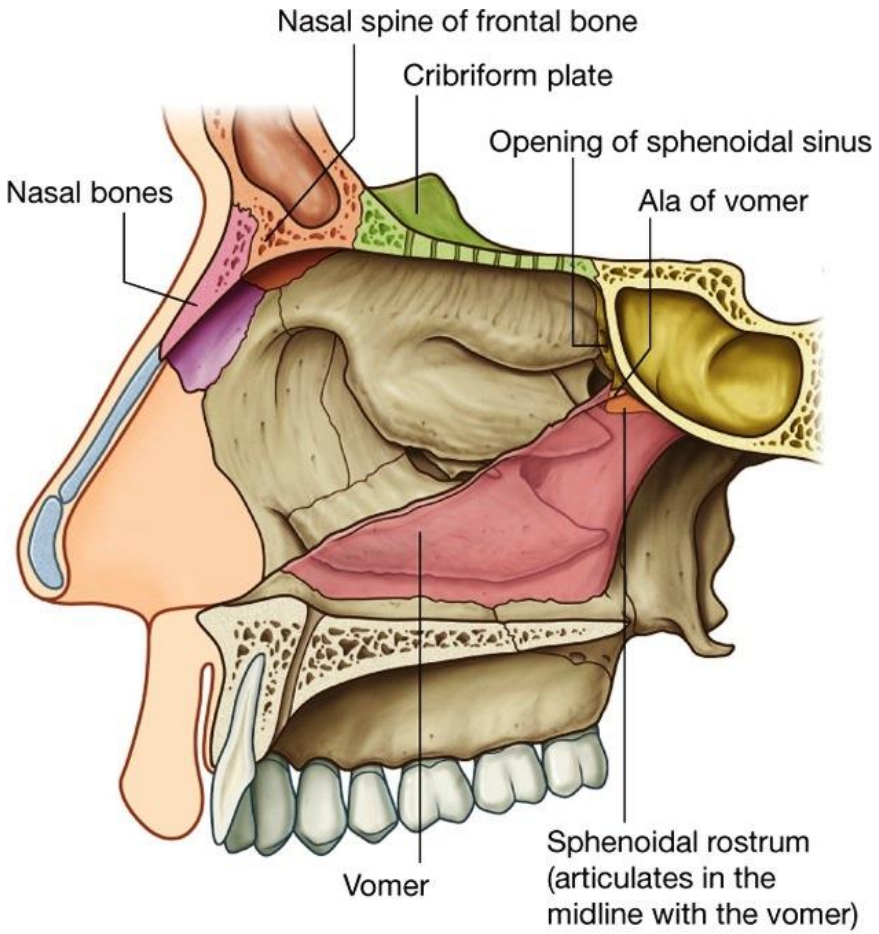
Gray's Fig 8. 232, p. 1076

Deviated Nasal Septum



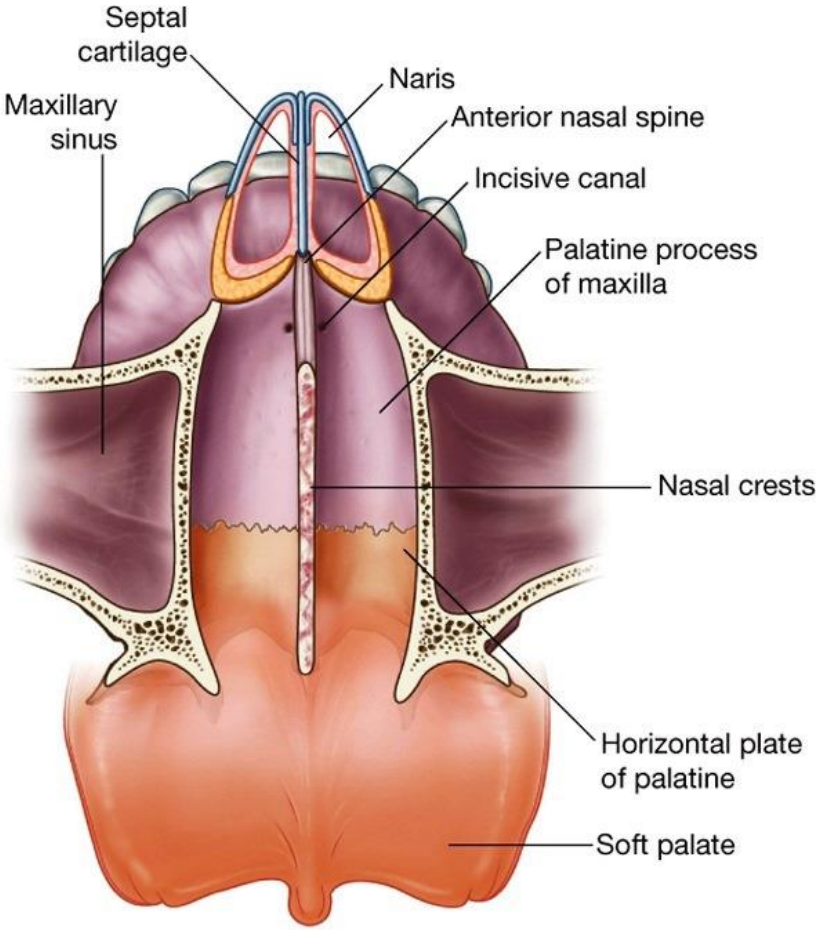


Roof and Floor of Nasal Cavity



Nasal, frontal, ethmoid, sphenoid bones

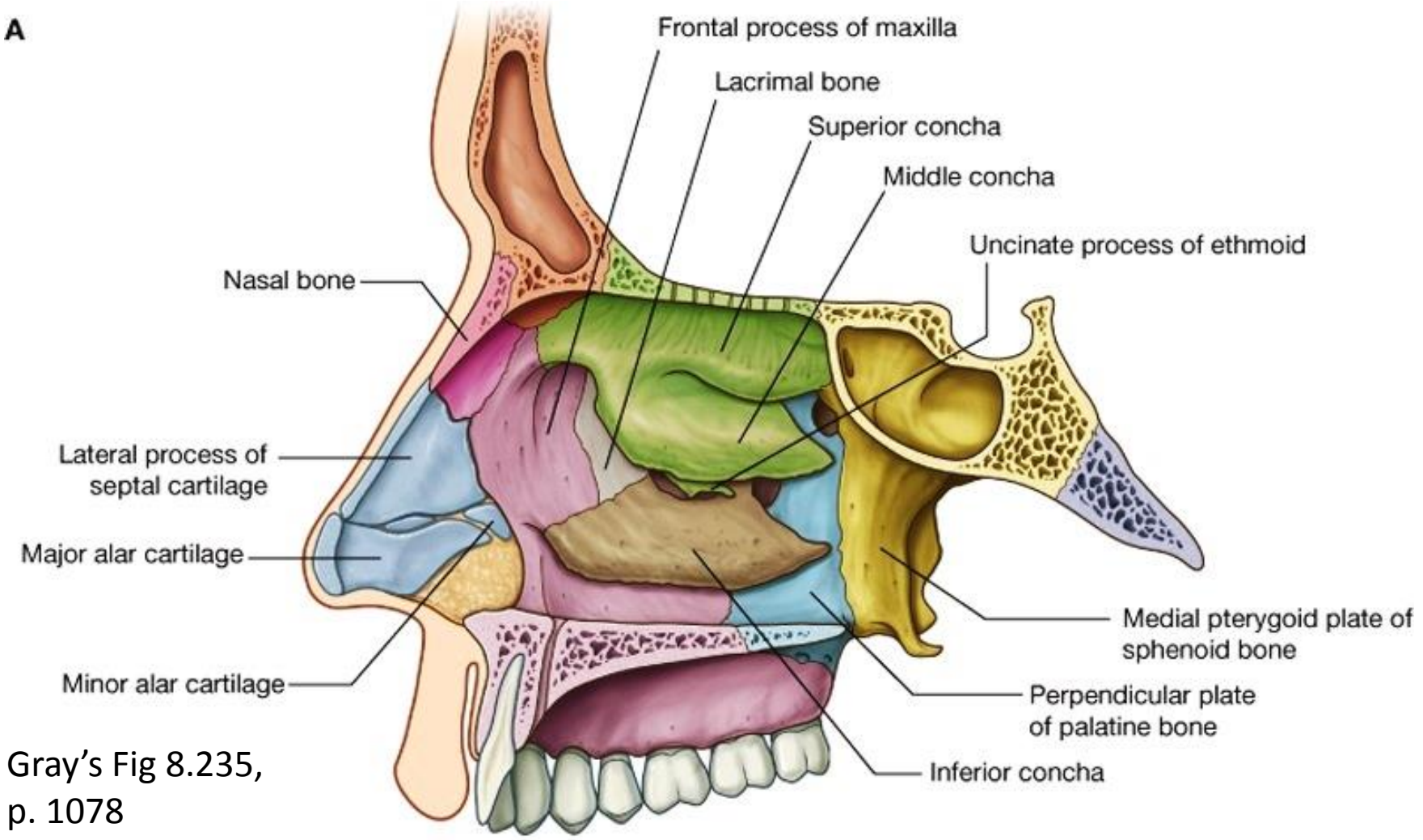
Gray's Fig 8.234, p. 1077



- **Maxillary and palatine bones**
- **Soft palate**

Gray's Fig 8.233, p. 1077

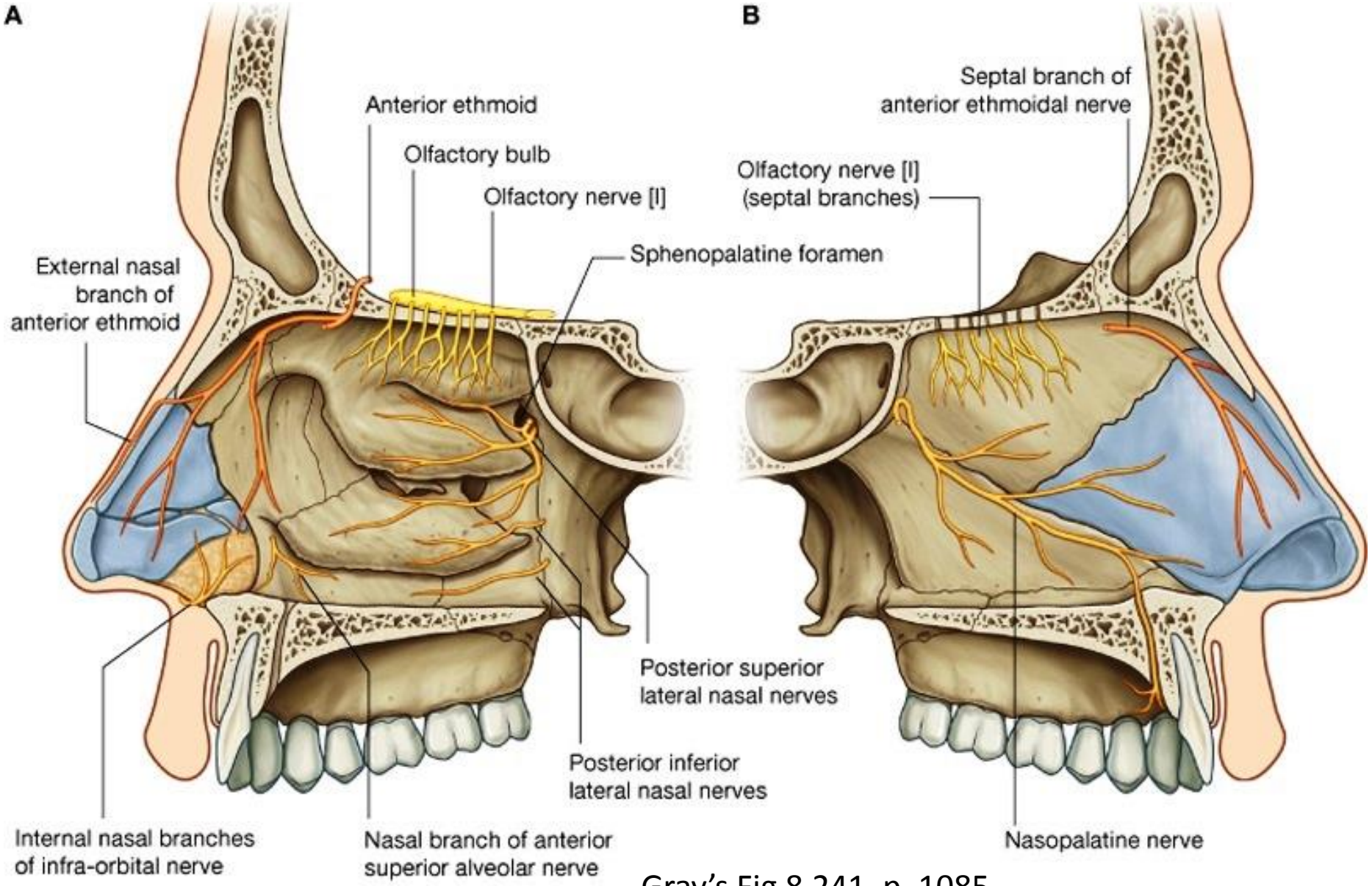
Lateral Walls of Nasal Cavity



Gray's Fig 8.235, p. 1078

Three nasal conchae: Superior and middle (ethmoid bone); Inferior nasal concha – AKA turbinate bones

Innervation of Nasal Cavity

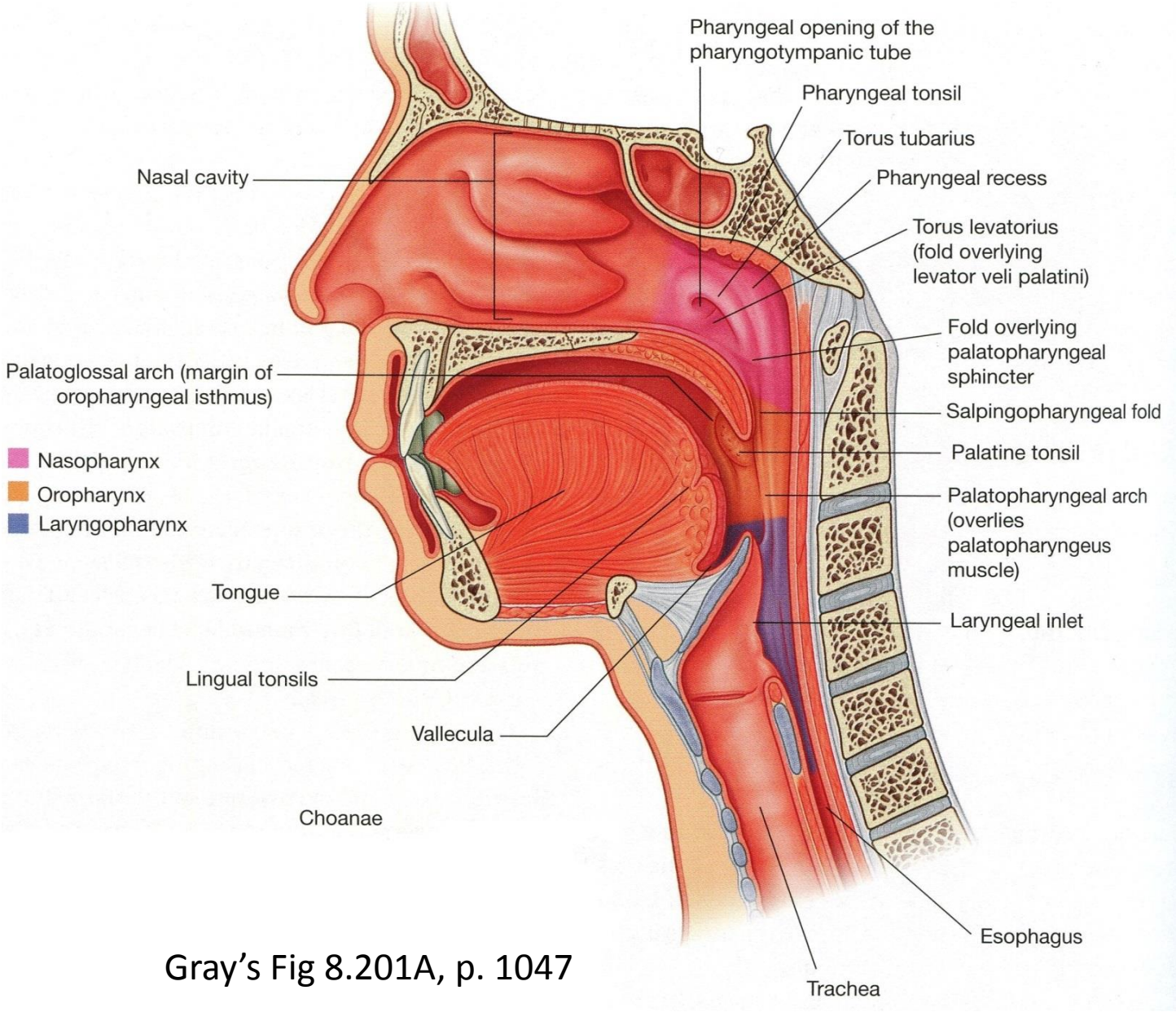


Gray's Fig 8.241, p. 1085

Pharynx – Mid-sagittal

Divisions:

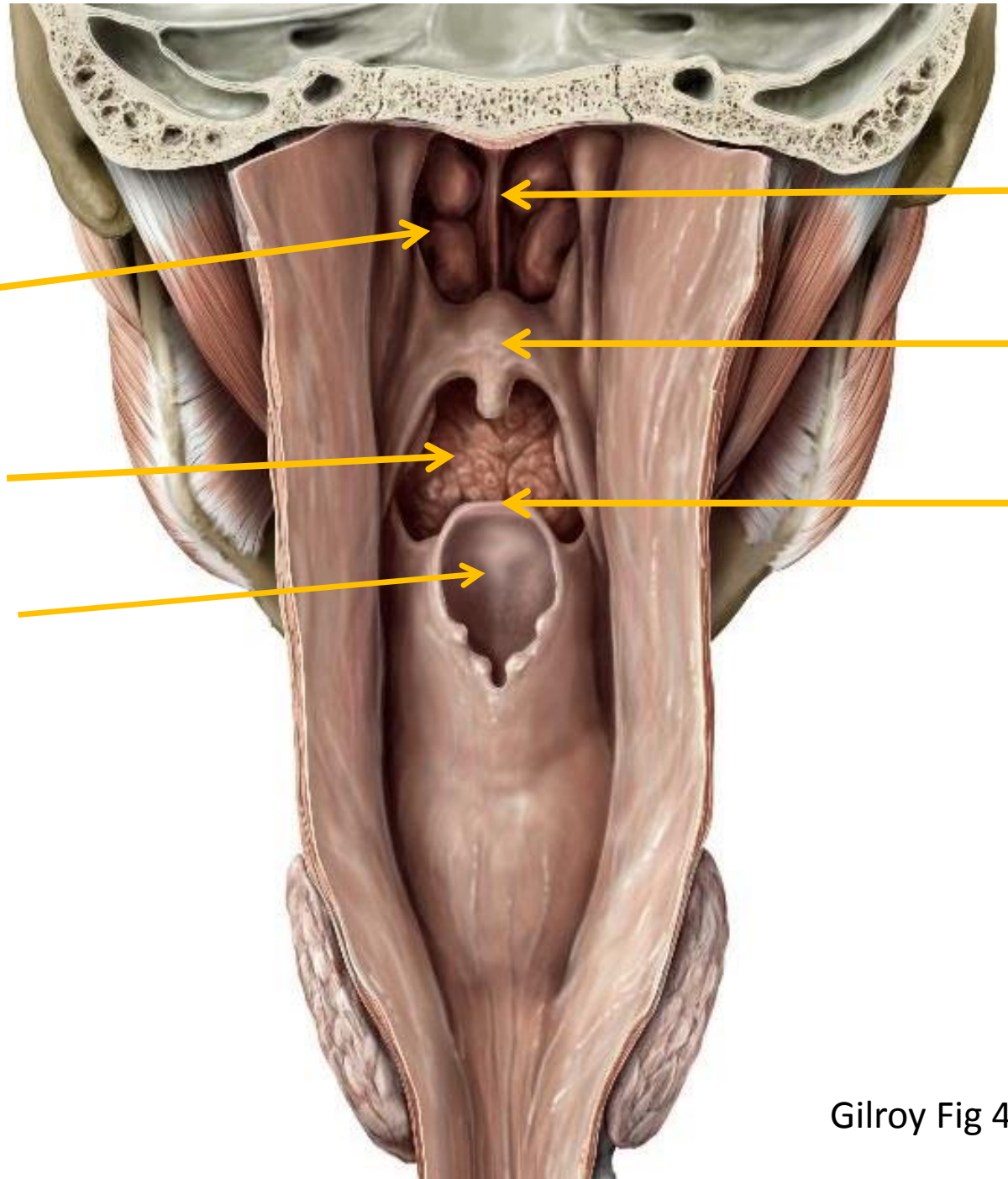
- ***Naso*- posterior apertures of nasal cavity (choanae) to edge of soft palate**
- ***Oro* – soft palate to tip of epiglottis**
- ***Laryngo*- epiglottis to lower edge of cricoid cartilage**



Gray's Fig 8.201A, p. 1047

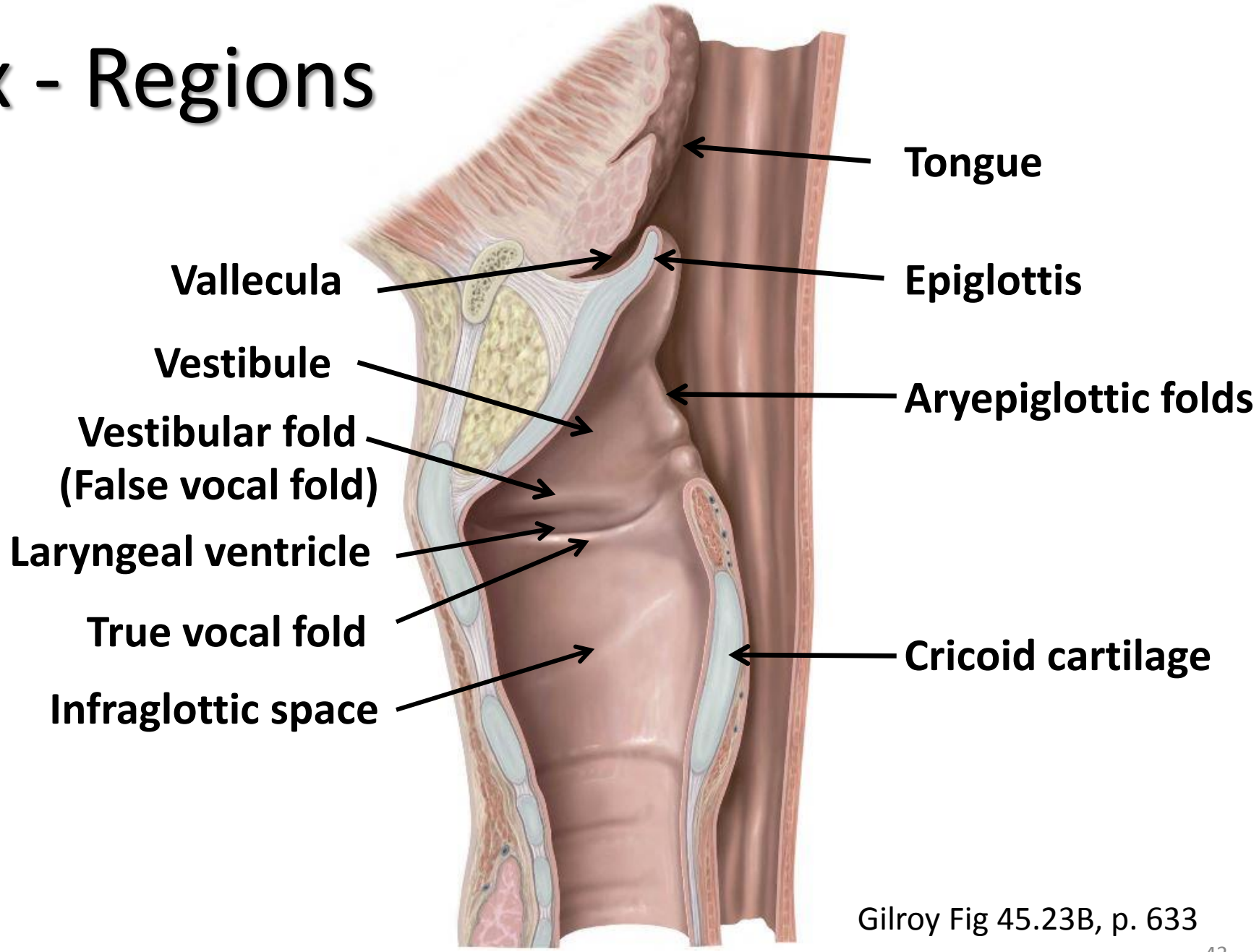
Floor of Nasal Cavity

Pharynx Posterior



Gilroy Fig 44.27, p. 613

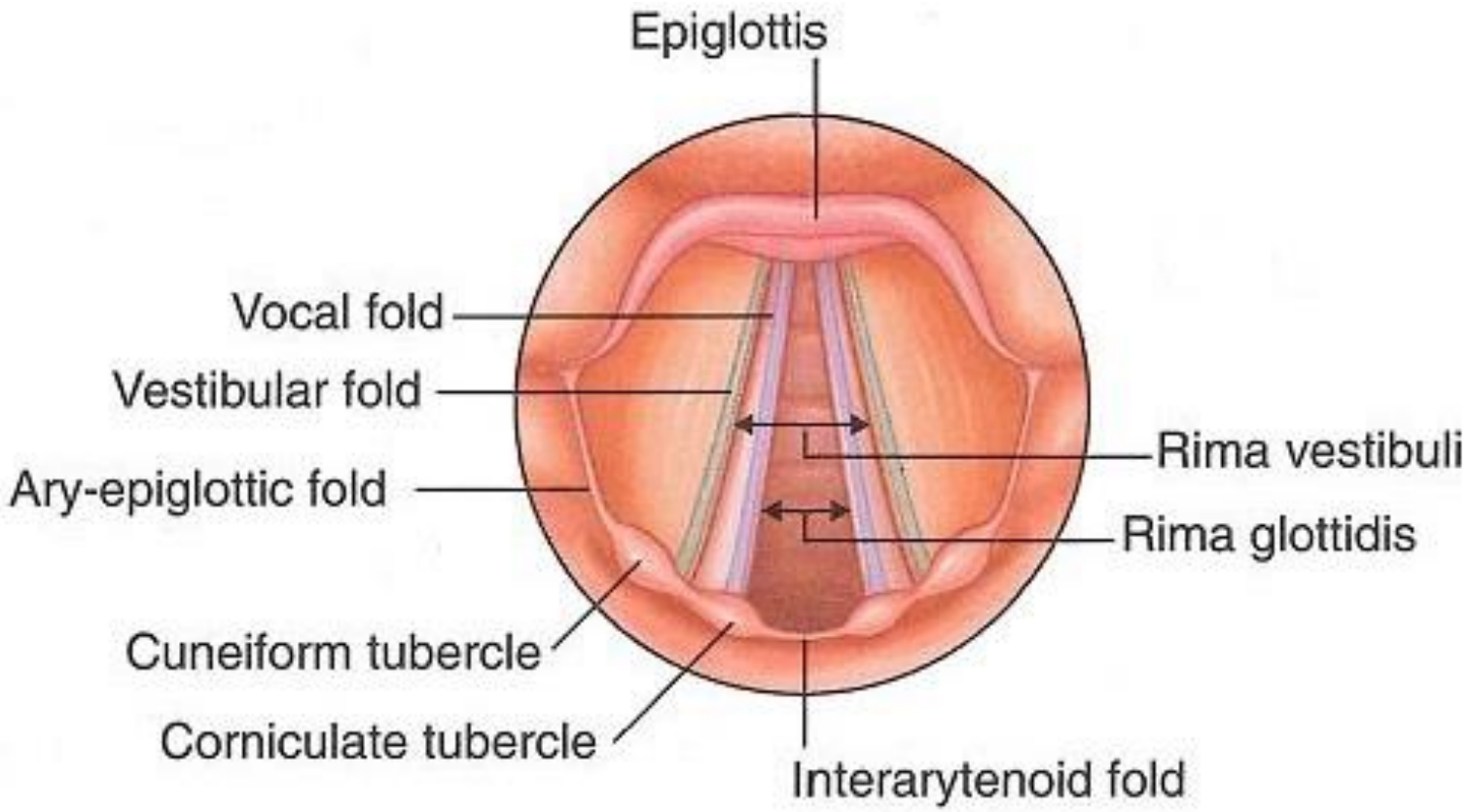
Larynx - Regions



Gilroy Fig 45.23B, p. 633

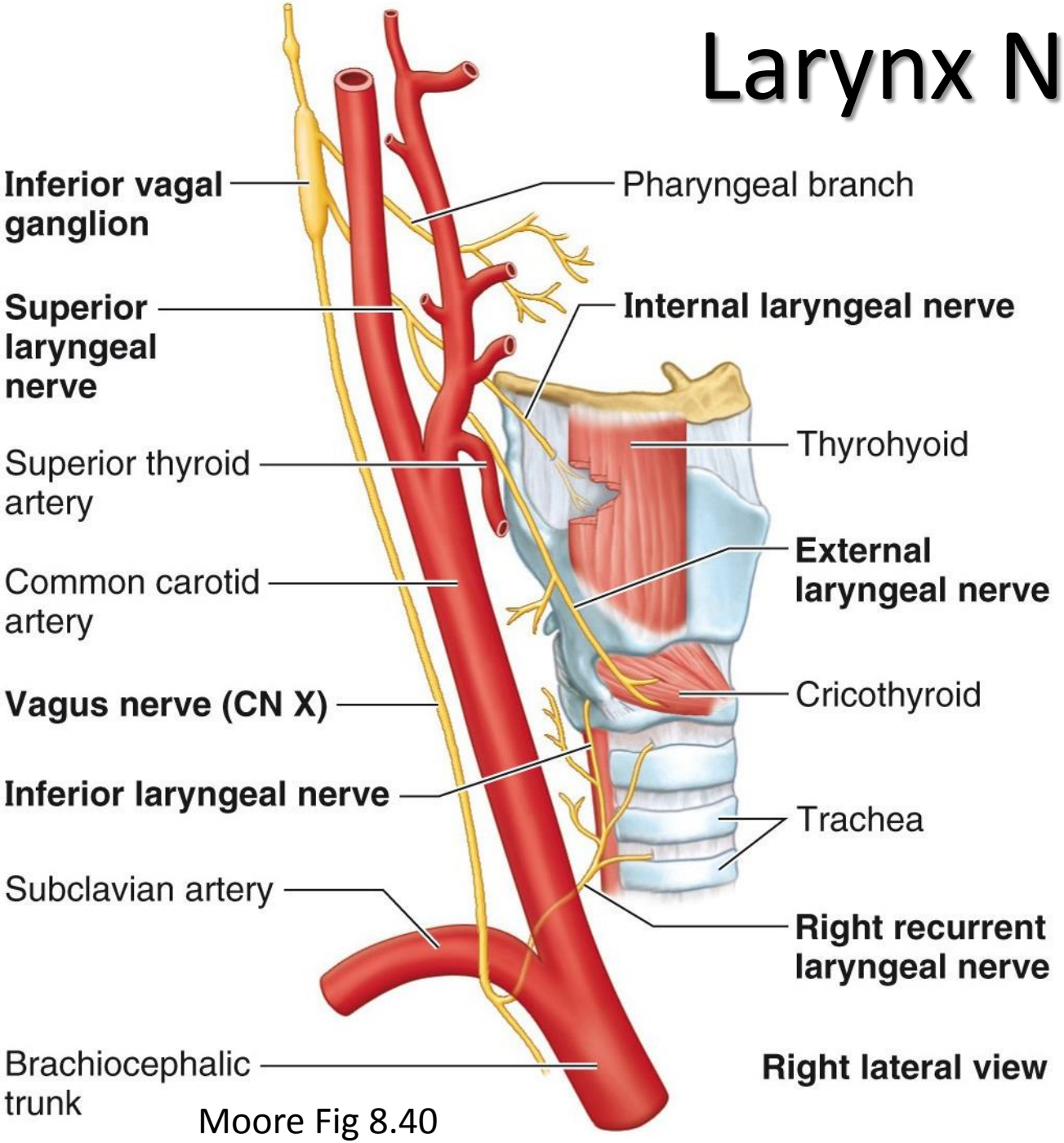
Larynx – Regions

Superior



- **Rima vestibuli – triangular opening between vestibular folds**
- **Rima glottidis – triangular opening between vocal folds**

Larynx Nerve Supply



Moore Fig 8.40

All innervation is by branches of Vagus n. (CN X)

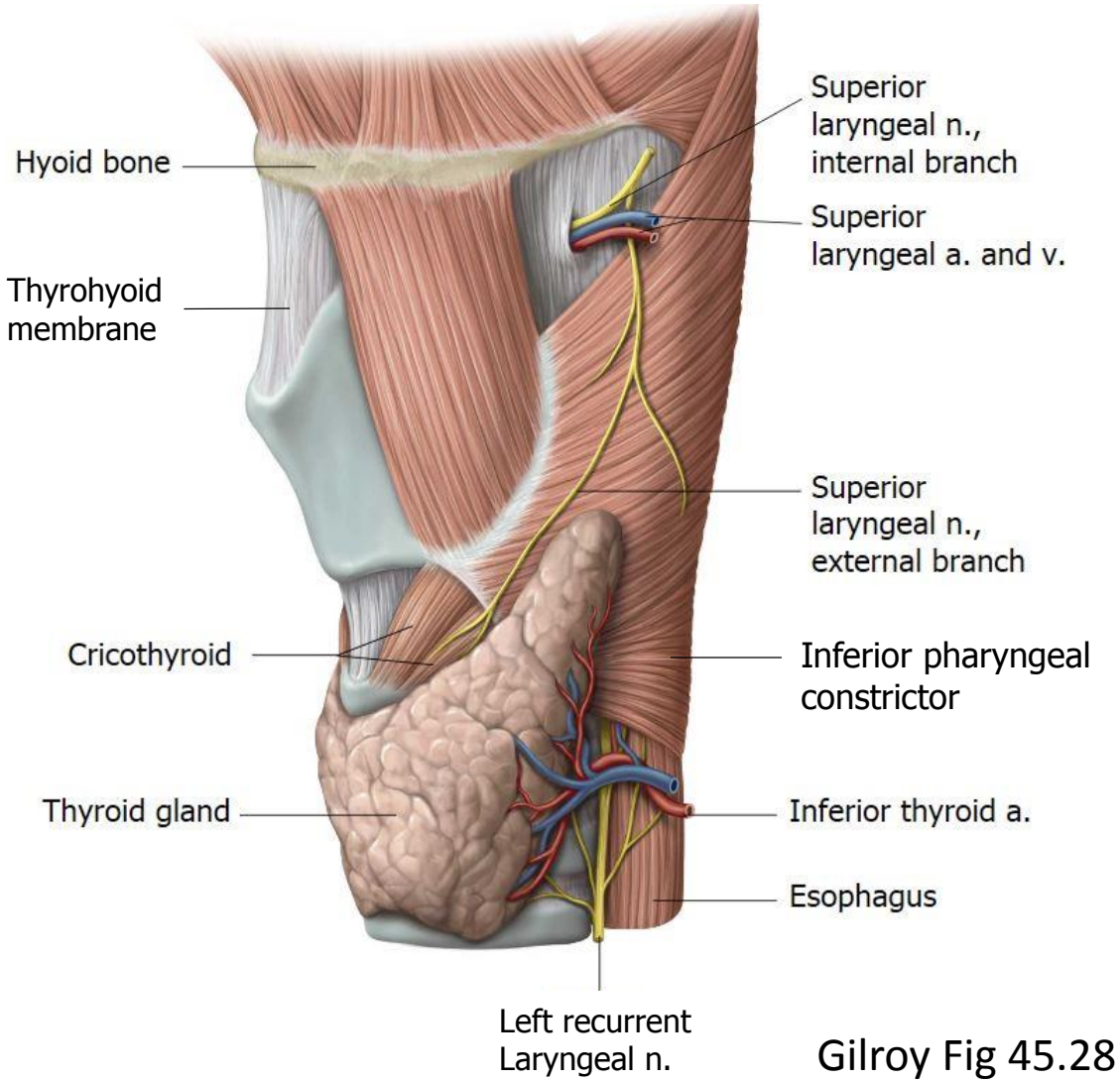
Superior laryngeal n.

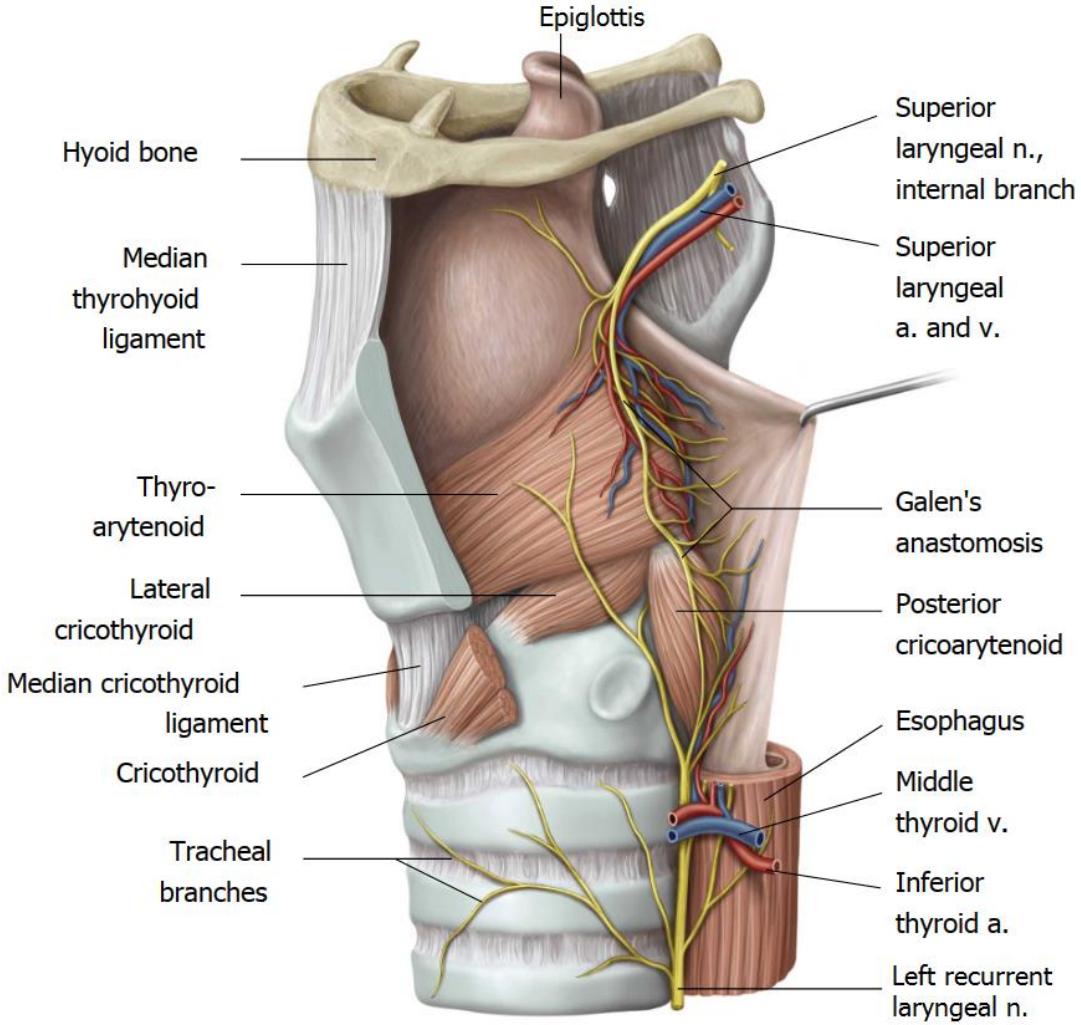
- ***Internal br.*** **– sensory innervation of larynx above vocal folds**
- ***External br.*** **– motor to cricothyroid m.**

Recurrent laryngeal n.

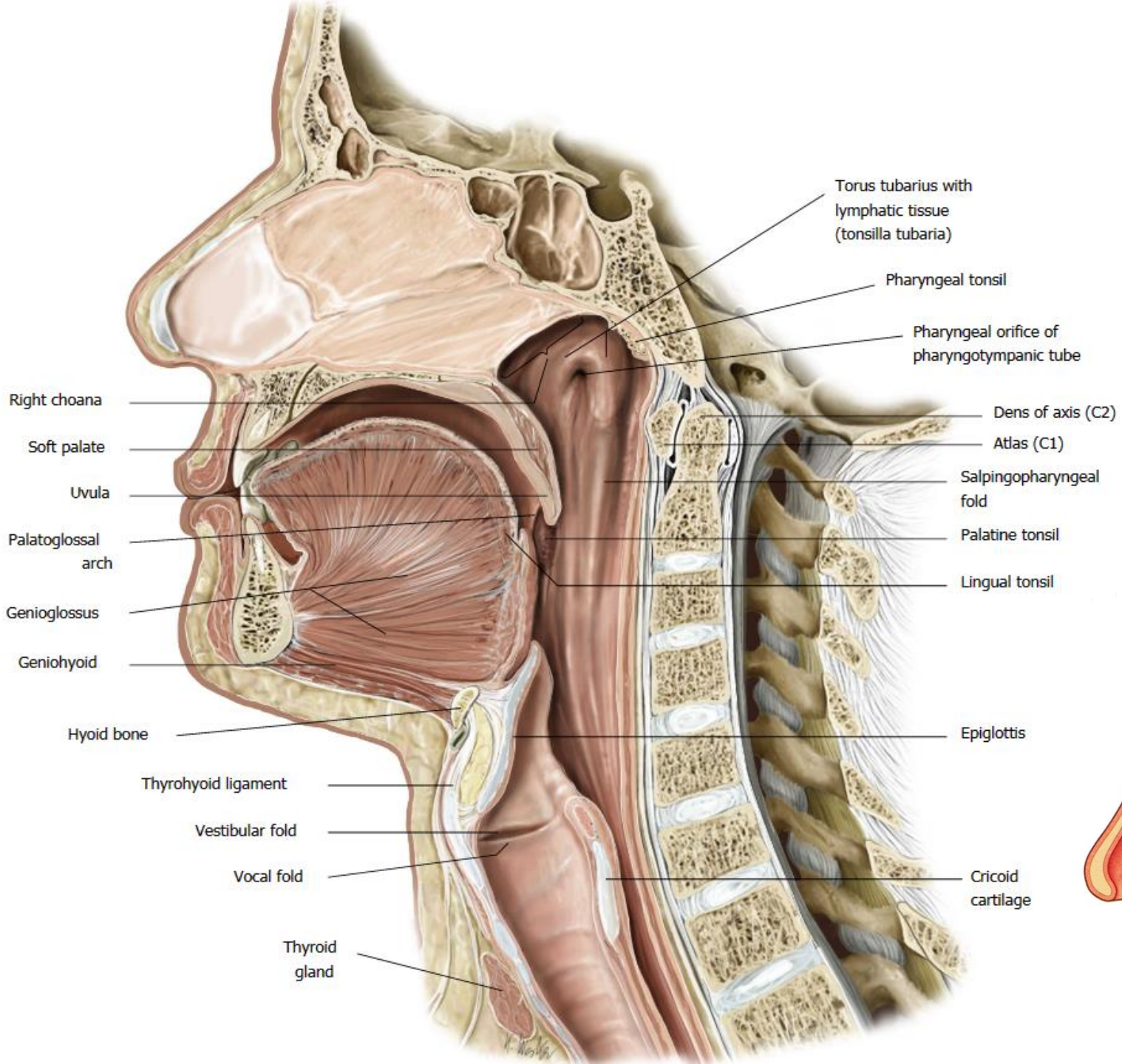
- ***Sensory*** **to larynx inferior to vocal folds**
- ***Motor*** **to all other intrinsic muscles**
- **May be referred to as inferior laryngeal n.**

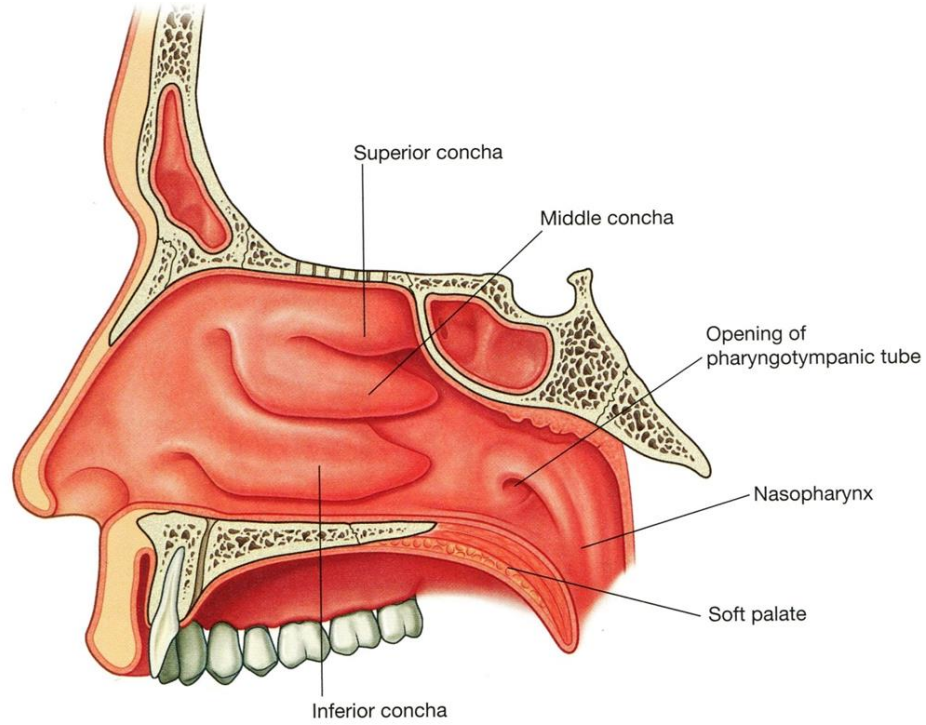
Larynx Nerve Supply





Gilroy Fig 45.28 A & B, p. 635


Torus tubarius with lymphatic tissue (tonsilla tubaria)
Pharyngeal tonsil
Pharyngeal orifice of pharyngotympanic tube
Right choana
Soft palate
Uvula
Palatoglossal arch
Genioglossus
Geniohyoid
Hyoid bone
Thyrohyoid ligament
Vestibular fold
Vocal fold
Thyroid gland
Dens of axis (C2)
Atlas (C1)
Salpingopharyngeal fold
Palatine tonsil
Lingual tonsil
Epiglottis
Cricoid cartilage


Superior concha
Middle concha
Opening of pharyngotympanic tube
Nasopharynx
Soft palate
Inferior concha