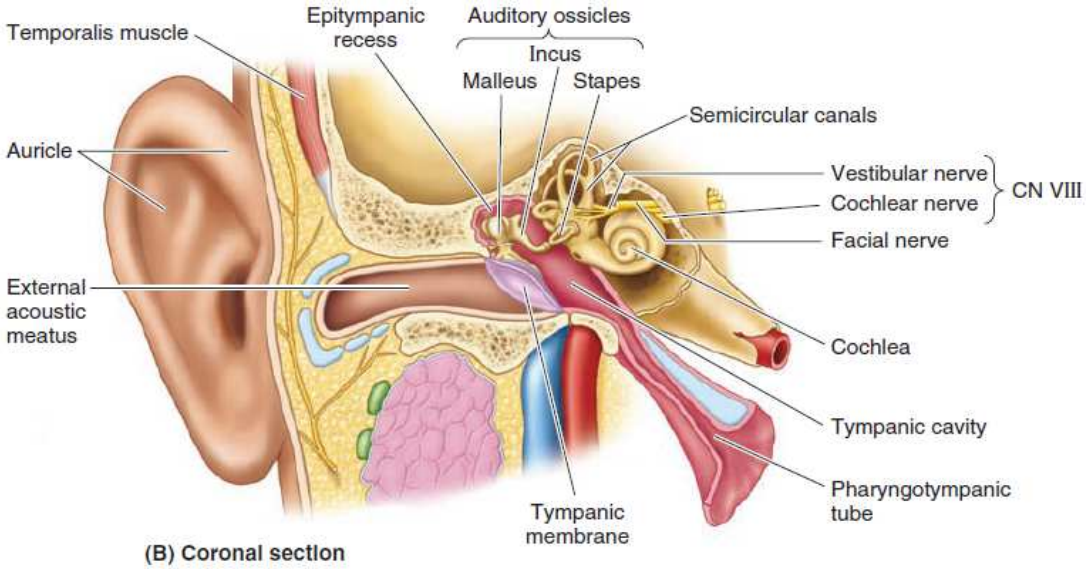
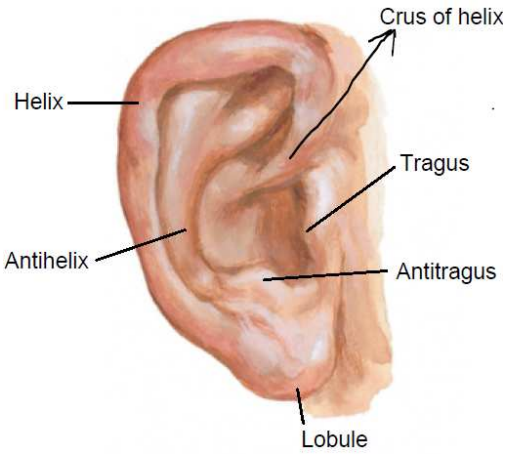
# L8 Ear

## A. External Ear

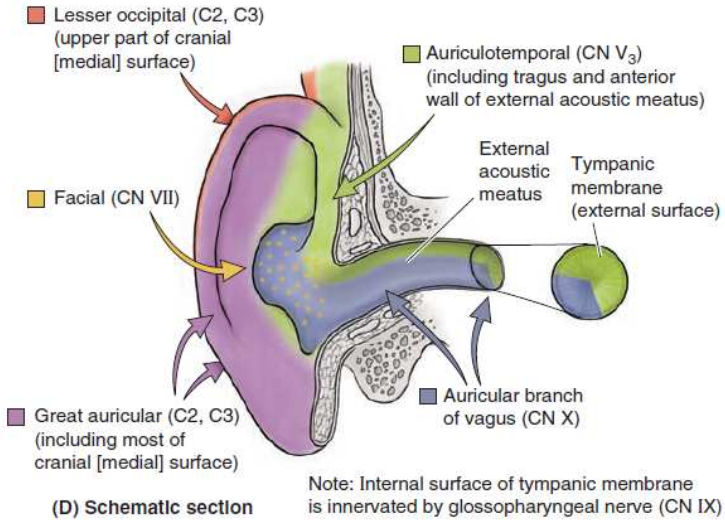



- **External ear** consists of **auricle** and **external acoustic meatus**
- **Auricle**:
  - Supported by yellow <u>elastic cartilage</u> except **lobule**
  - **Tragus** over opening of external acoustic meatus
  - Can be moved a little by <u>extrinsic</u> and <u>intrinsic muscles</u> supplied by **facial n.**

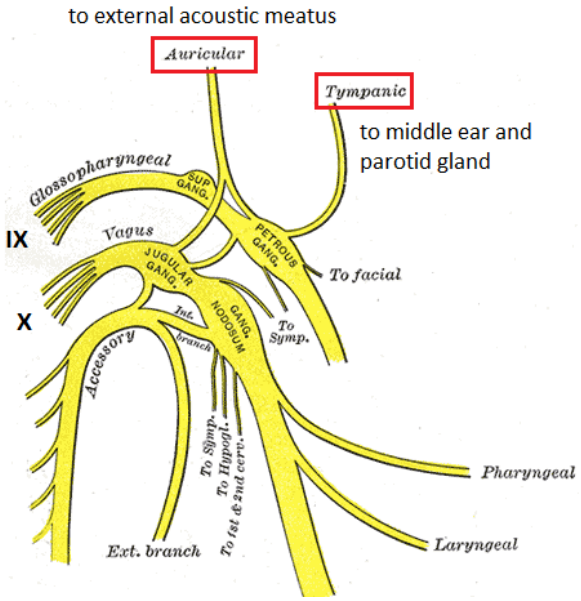



- **External acoustic meatus**: passage through which vibrating air can be transmitted to **tympanic membrane**
  - Adult: ~3cm long
    → Much shorter in infants
  - Support:
    → Outer 1/3 by cartilage
    → Inner 2/3 by temporal bone
  - <u>NOT</u> even in diameter → **isthmus** (narrowest part) close to tympanic membrane
  - Lined by sensitive skin with **ceruminous (wax-producing) glands** (esp in cartilaginous part

- Innervation:
  - External ear: mainly by **cervical plexus**
  - External auditory meatus:
    - → Main supply: **auriculotemporal n.** ($V_3$)
    - → **Auricular branch of vagus**
    - → Branches from **facial n.**
  - Clinical relevance: pain from lower teeth can be referred to external acoustic meatus (esp children) → earache may mean a large cavity in a lower tooth

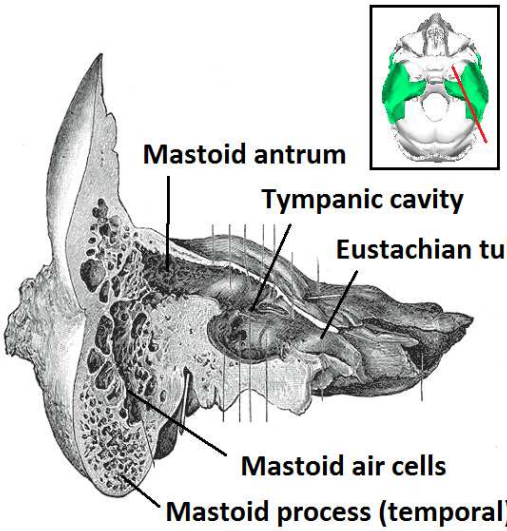



- Blood supply: unimportant
- Lymphatic drainage: mainly to **superficial cervical LNs** along EJV
- Clinical relevance:
  - External auditory meatus NOT straight → clinicians straighten it by pulling auricle upwards and backwards to see the tympanic membrane with an otoscope
  - **Otitis externa**: infections of external acoustic meatus

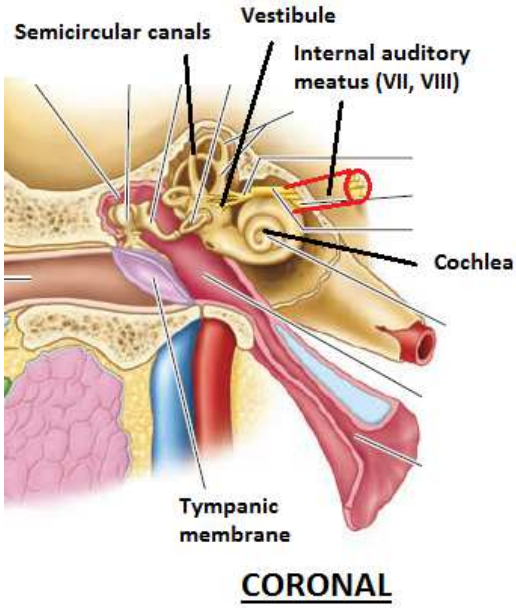



**Note that **auricular br. of vagus (X)** is joined by a segment from **CN IX** and therefore CN IX have minor contributions to innervation of external auditory meatus. **Tympanic n.**, the pretrematic n. from IX back to 2nd arch, is solely contributed by **CN IX**.*

# B. Middle Ear

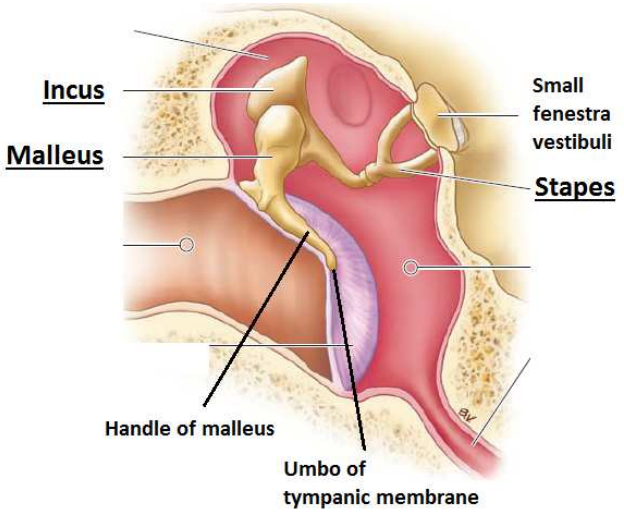


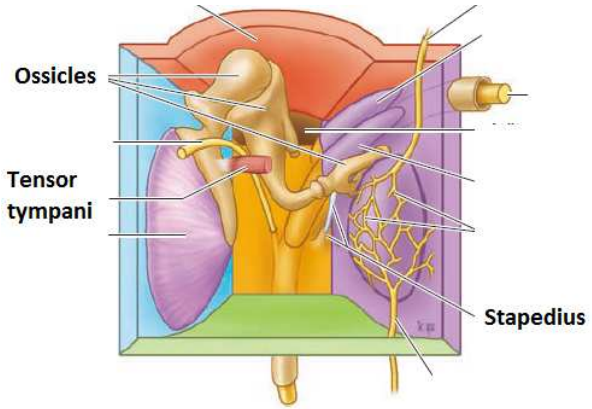

- **Middle ear (tympanic cavity)**: an air chamber lined by **mucosa**
  - Mucosa continuous with:
    - → Anterior: auditory tube and nasopharynx
    - → Posterior: **mastoid antrum (sinus)** and **mastoid air cells**
  - Medial: **inner ear**
    - → Anterior: cochlea
    - → Posterior: semicircular canals
    - → **Vestibule** in between
    - → **Internal acoustic meatus** superior to vestibule leading CN VII and VIII into inner ear
  - Lateral:
    - → **Tympanic membrane**
    - → **External acoustic meatus**

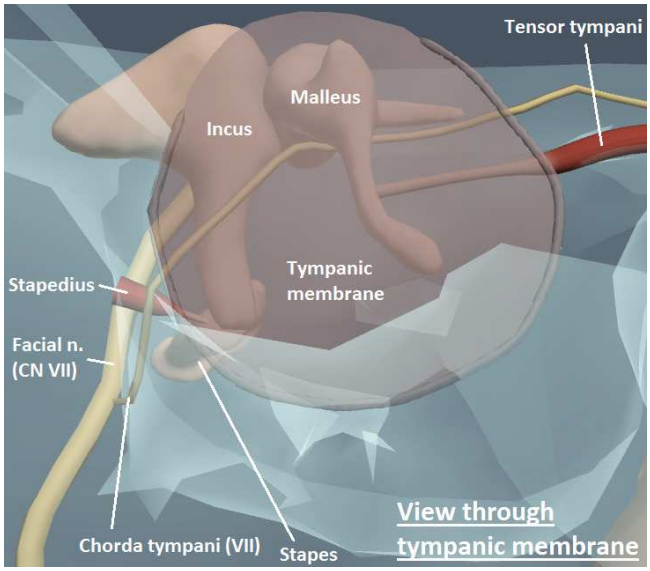



# 1. Ossicles

- **Ossicles**: three small bones within middle ear
  - **Malleus**, **incus** and **stapes** (lateral to medial)
  - Joined by synovial joints
- **Malleus** attached by its **handle** to **umbo** (centre) of tympanic membrane
- **Stapes** with **base** attached to **small fenestra vestibuli** (much smaller than tympanic membrane)
- Vibrations of tympanic membrane transmitted by a lever system formed by the three ossicles
  - → ↓displacement + ↑pressure
  - → vibration magnified
- **Ligaments** present to stabilize ossicles anteriorly and posteriorly
- Two muscles dampen movements of ossicles
- **Tensor tympani**:
  - Origin: Eustachian tube (anteromedial)
  - Insertion: neck of malleus
  - Action: tense tympanic membrane + ↓amplitude of vibration (protective)
  - Innervation: CN $V_3$



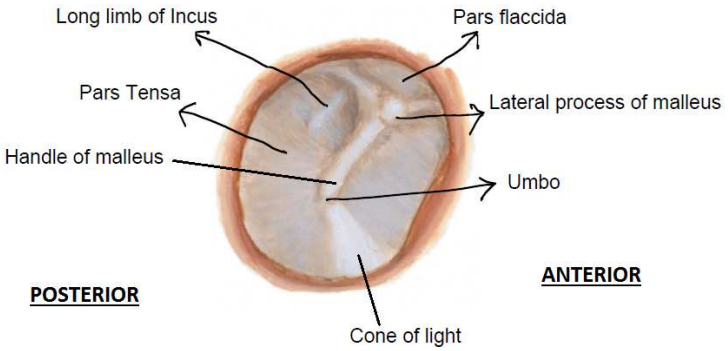



- **Stapedius**: body's smallest muscle
  - Origin: pyramid eminence on posterior wall of tympanic cavity
  - Insertion: neck of stapes
  - Action: dampen loud sounds (protective)
  - Innervation: CN VII

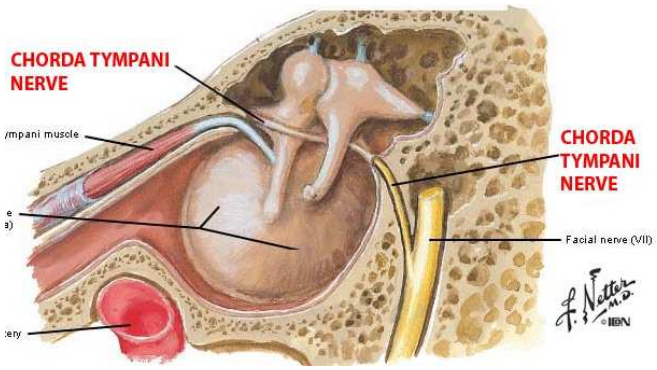
# 2. Walls of Tympanic Cavity

## a. Lateral Wall – Tympanic Membrane

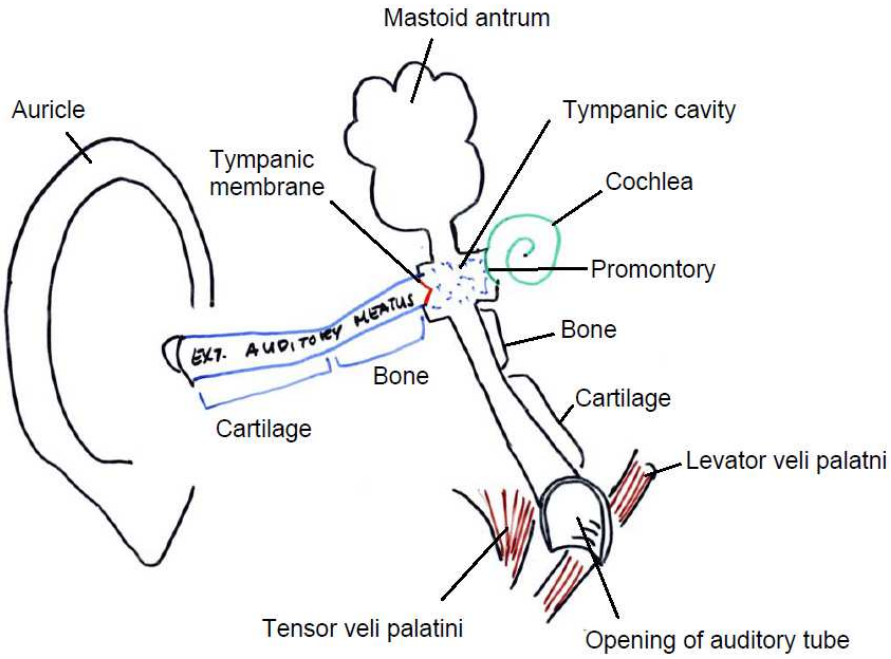
- **Lateral wall** almost entirely occupied by the **tympanic membrane**
  - Separates tympanic cavity from external acoustic meatus
- Lining:
  - External: skin
  - Medial: mucosa
- Divided into:
  - **Pars flaccida**: thin membrane superior to attachment of lateral process of malleus
  - **Pars tensa**: thick tense membrane in other parts of tympanic membrane

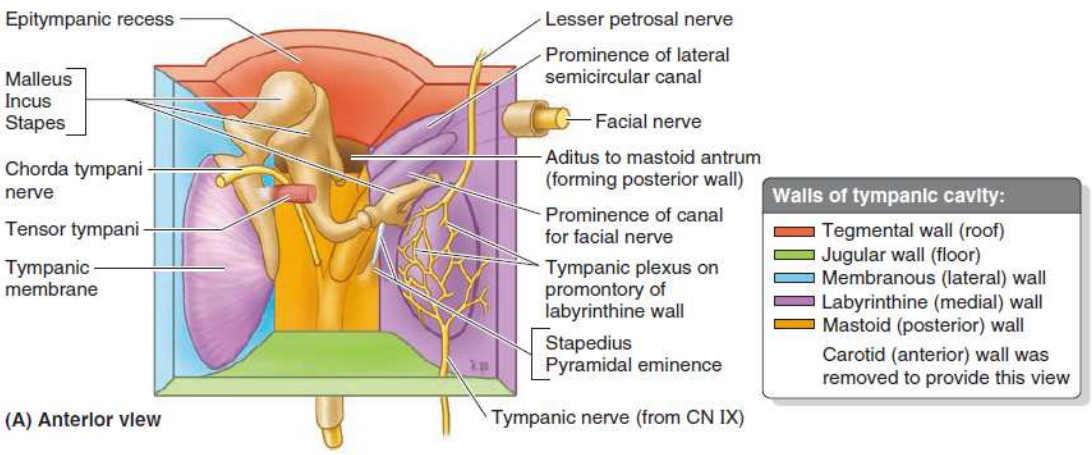



- **Umbo**: conical depression pulled towards the centre by handle of malleus
- **Cone of light**: located anteroinferiorly
  - Note that tympanic membrane does not stand vertically
  - Leans over into external acoustic meatus sloping <u>downward</u> and <u>forward</u>
  - When viewed by otoscope, light is reflected downward and forward (i.e. anteroinferiorly) → **cone of light**
  - Clinical importance: reflects the <u>integrity</u> of tympanic membrane → 5% people without this is normal → must investigate
- **Chorda tympani**:
  - Branches off CN VII in posterior wall
  - Travels along medial side of tympanic membrane and **neck** of malleus (but deep to the mucosa)
  - Projects anteriorly to join **lingual n.** ($V_3$)

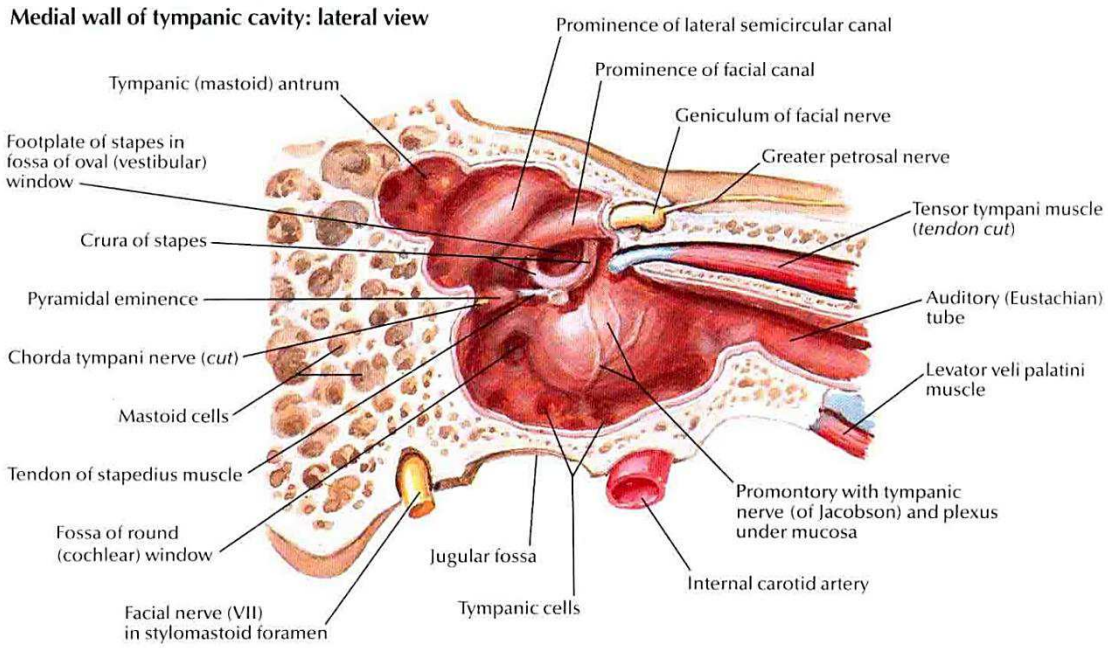


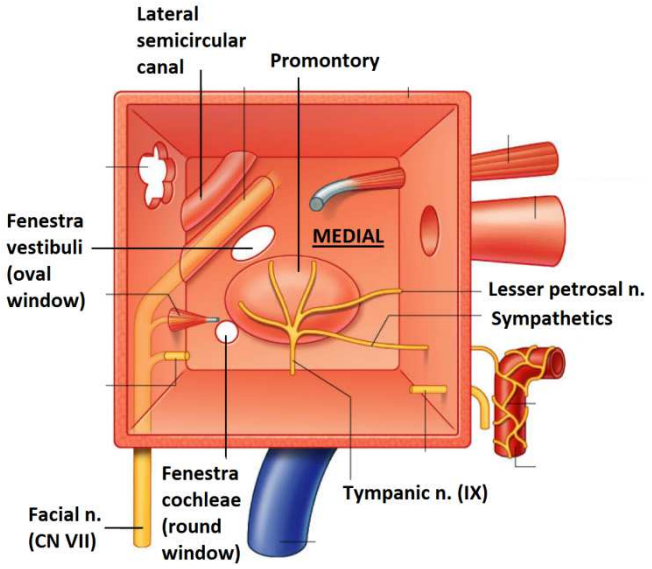

- <u>Posteroinferior</u> quadrant of membrane may be incised safely in middle ear operations


Mastoid antrum
Auricle
Tympanic cavity
Tympanic membrane
Cochlea
Promontory
EXT. AUDITORY MEATUS
Bone
Bone
Cartilage
Cartilage
Levator veli palatni
Tensor veli palatini
Opening of auditory tube

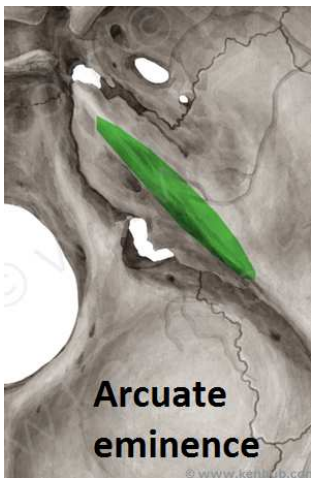

Epitympanic recess
Malleus
Incus
Stapes
Chorda tympani nerve
Tensor tympani
Tympanic membrane
Lesser petrosal nerve
Prominence of lateral semicircular canal
Facial nerve
Aditus to mastoid antrum (forming posterior wall)
Prominence of canal for facial nerve
Tympanic plexus on promontory of labyrinthine wall
Stapedius
Pyramidal eminence
Tympanic nerve (from CN IX)
(A) Anterior view
Walls of tympanic cavity:
Tegmental wall (roof)
Jugular wall (floor)
Membranous (lateral) wall
Labyrinthine (medial) wall
Mastoid (posterior) wall
Carotid (anterior) wall was removed to provide this view

## b. Medial Wall



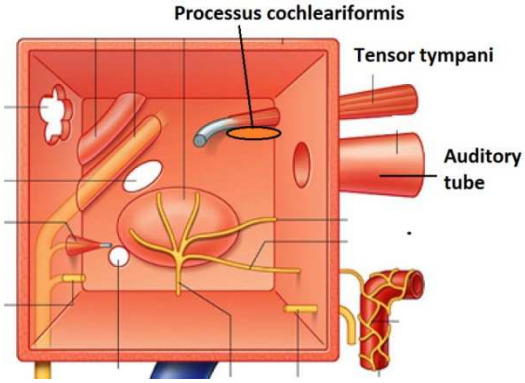



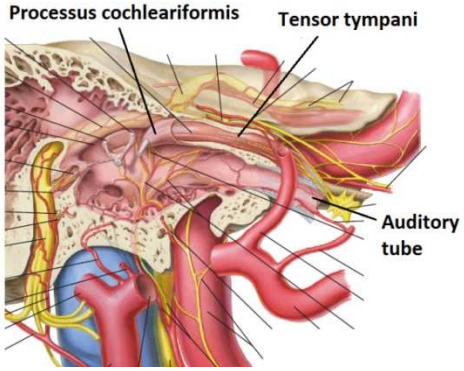

- Medial wall separates tympanic cavity from the inner ear
- **Promontory**: prominent bulge caused by basal turn of cochlea
- **Tympanic plexus**: submucosal plexus on promontory with fibres from
  - **Tympanic nerve of CN IX** (through **tympanic canaliculus**)
  - **Sympathetics** from ICA
- **Lesser petrosal n.** carries autonomic fibres from tympanic n. (IX) to **otic ganglion** → secretomotor to **parotid gland**
- Two membranes closing
  - **Fenestra vestibuli (oval window)** → stapes via **annular ligament**
  - **Fenestra cochleae (round window)** → pressure release
- Two bony bulges due to two structures just deep to medial wall:
  - **Facial nerve** turning posteriorly at the end of **internal acoustic meatus** after forming **geniculate ganglion**
  - **Lateral semicircular canal**
- **Arcuate eminence**: small superior projection of petrous temporal bone into cranial cavity above
  - Marks position of **anterior semicircular canal**



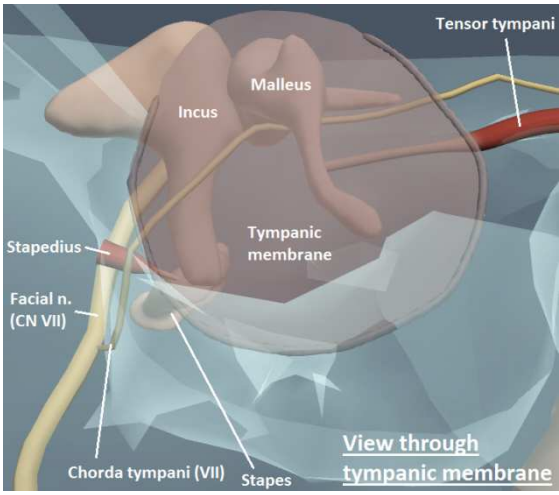

**Note that **promontory** and **umbo** are in fact quite close to each other.*

## c. Anterior Wall



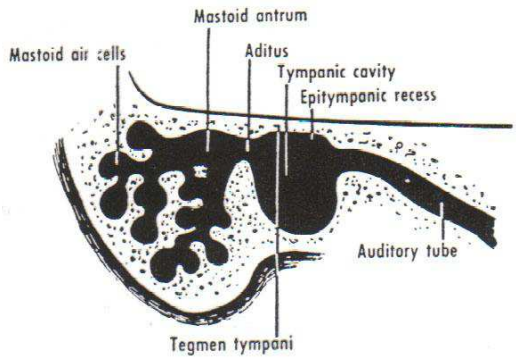




- Anterior wall contains:
  - Opening of **auditory tube**
  - **Tensor tympani** muscle
- **Tensor tympani**:
  - Origin: cartilage of auditory tube
  - Tendon turns laterally around a minute spike of bone **processus cochleariformis**
  - Insertion: neck of malleus
- **Auditory tube** directed downwards and medially
  - Runs from middle ear to nasopharynx

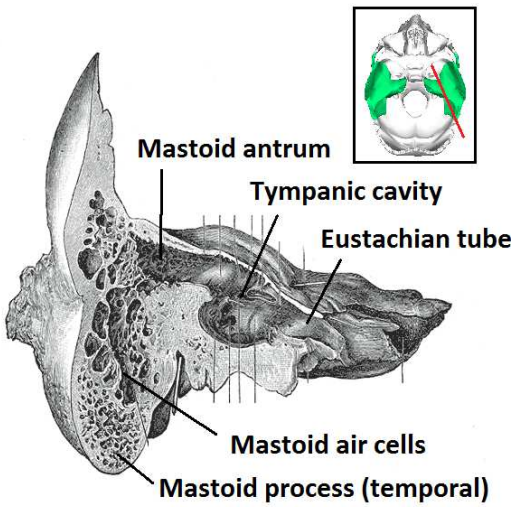



## d. Posterior Wall

- **Aditus ad antrum**: opening to mastoid antrum (sinus) on posterior wall
- **Antrum (mastoid sinus)**: air-filled space in petrous temporal below posterior cranial fossa
  - Almost full-size at birth
  - Greatly enlarged by growth of mastoid process after birth
  - Mastoid process develops air cells that communicates with mastoid antrum

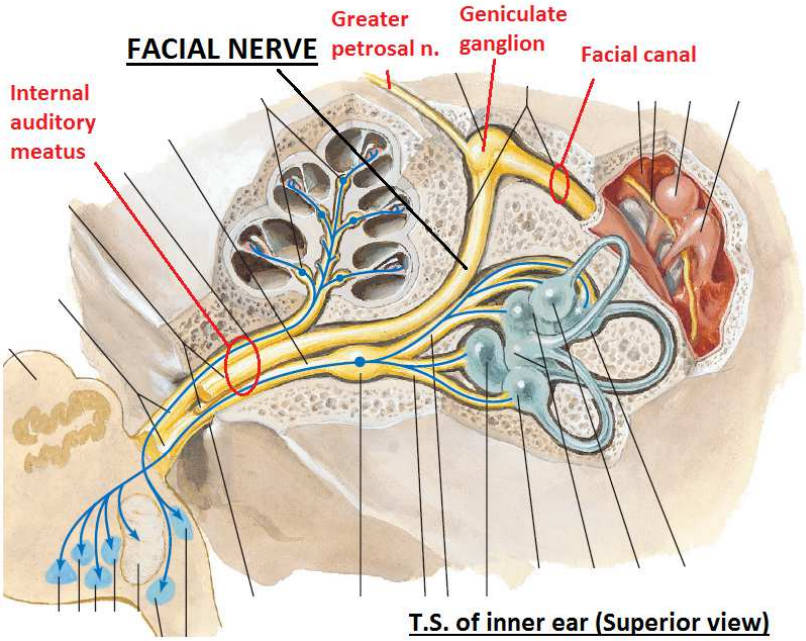



- **Mastoid air cells**
  - Function: regulates temperature and pressure of the middle ear
  - Performed by changes in blood flow and rate of air resorption
- **Pyramid**: bony spike on posterior wall projecting into tympanic cavity
  - Fibres of **stapedius** inside pyramid
  - Tendon of **stapedius** runs from tip of pyramid to neck of stapes

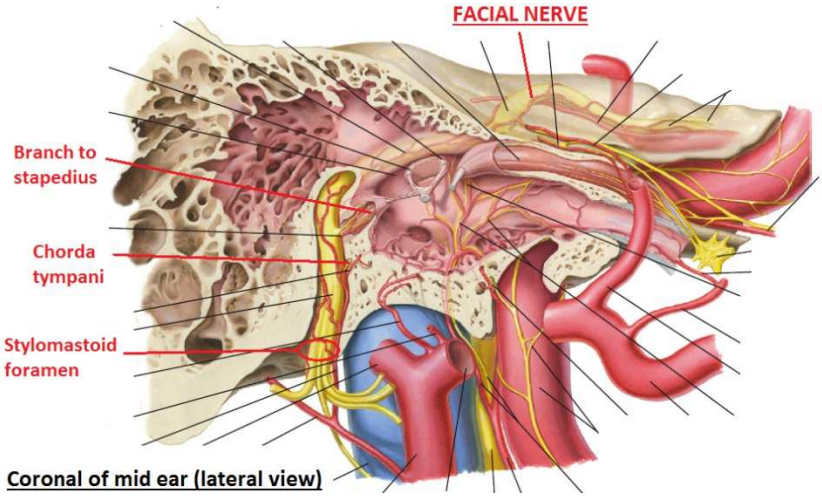


## i. Course of Facial Nerve

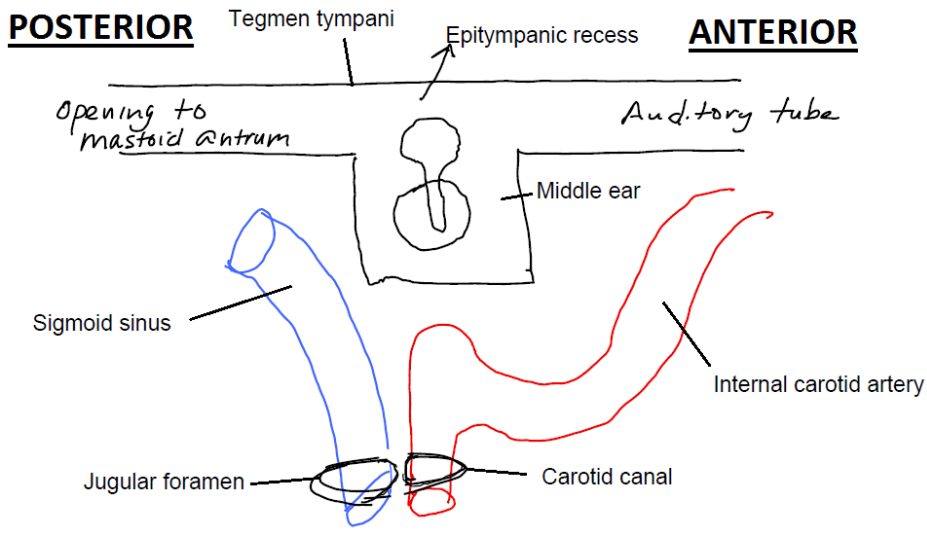
- Arises from pontomedullary junction as **motor** and **sensory roots**
- Runs along **internal auditory meatus** into **inner ear** between cochlea (anterior) and semicircular canals (posterior)
- Proceeds a short distance anteriorly within temporal bone then turns sharply posteriorly at **geniculate ganglion** (where sensory fibres synapse)
- **Greater petrosal n.** projects anteriorly to **pterygopalatine ganglion** (near $V_2$) to innervate oronasal cavities and lacrimal gland
- Facial nerve continues to runs posteriorly along the <u>medial wall</u> of tympanic cavity within **facial canal**, making a bulge as it do so
- Gives two branches at <u>posterior wall</u> of tympanic cavity:
  - **Nerve to stapedius**
  - **Chorda tympani** to cross tympanic membrane (lateral wall) and joins **lingual n.** ($V_3$) via **petrotympanic fissure** (anterior to tympanic membrane)
- Exits temporal at **stylomastoid foramen**
  - Birth: no mastoid process → stylomastoid foramen very superficial → easy damage by forceps that grip the head in **assisted forceps delivery**



T.S. of inner ear (Superior view)



Coronal of mid ear (lateral view)




## e. Roof

- Thin layer of bone
- Formed by **tegmen tympani** of petrous temporal
- **Epitympanic recess**: space in tympanic cavity above the level of tympanic membrane
- Superior to roof → **middle cranial fossa** with meninges and temporal lobe
- Clinical significance: thinnest part of petrous temporal
  → paediatric otitis media may result in **meningitis** due to spread

## f. Floor

- Also thin
- **Carotid canal** lies anterior to the floor
- **Jugular foramen** lies posteroinferior to the floor
  - Enlarged **superior bulb of IJV** lies directly under tympanic cavity
- Surgical significance in ENT surgery:
  over-aggressive scraping of tympanic cavity floor
  → punctures ICA → invariable death (cannot clamp ICA ∵ in carotid canal)

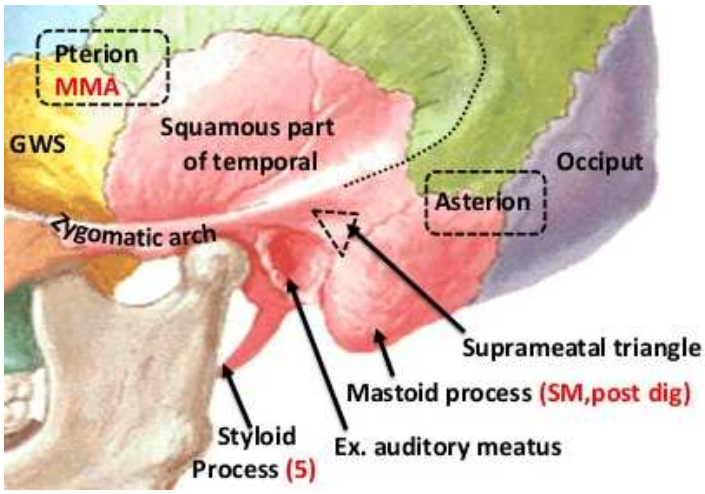
# 3. Neurovascular Supply of Tympanic Cavity

- Arterial supply: small arteries from several branches of external carotid artery
- Venous drainage: mostly by **pterygoid venous plexus**
- Nerve supply: **tympanic branch of glossopharyngeal n. (CN IX)**
- Lymphatic drainage:
  - Parotid (preauricular) nodes
  - Upper deep cervical lymph nodes

**Some textbooks also say that CN 7 provides some supply to tympanic plexus but this is questionable.*

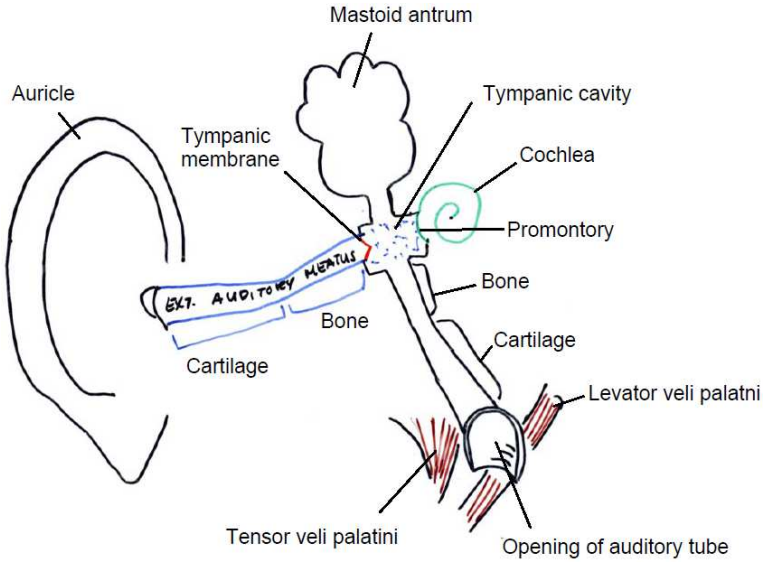
# 4. Clinical Relevance

- **Otitis media**: infection of middle ear
  - Usually caused by infections from pharynx reaching middle ear via auditory tube
  - Young children (<10y/o) particularly susceptible
  - May be detected by observing the bulging of tympanic membrane into external acoustic meatus using an otoscope
    → May also be indicated by colour of membrane
  - Consequences of untreated otitis media:
    → Damage hearing
    → Spread to mastoid antrum
    → Damage any of the structures deep to the walls (eg. facial n.)
  - May spread to cranial cavity (middle or posterior cranial fossae) by resorbing bone
    → spread to brain
  - Pre-antibiotic era: necessary to drain of mastoid antrum by drilling into it
    → Surface landmark: **suprameatal triangle** above and posterior to external acoustic meatus

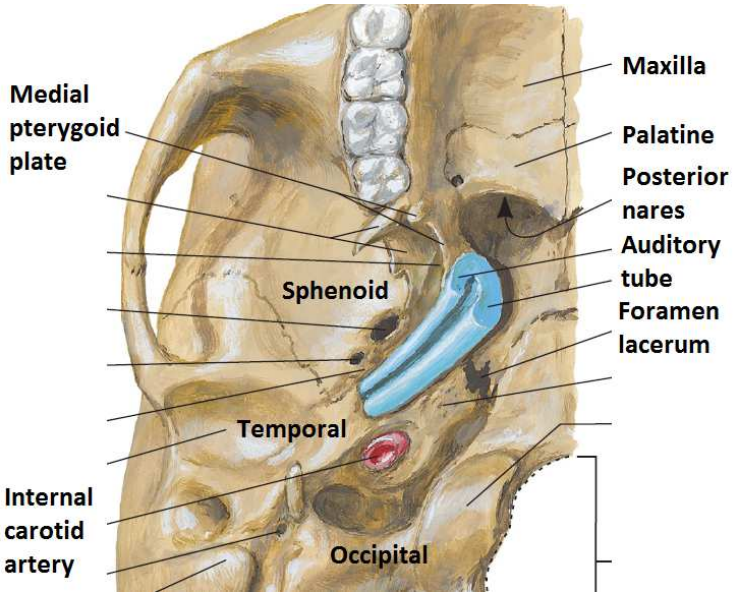


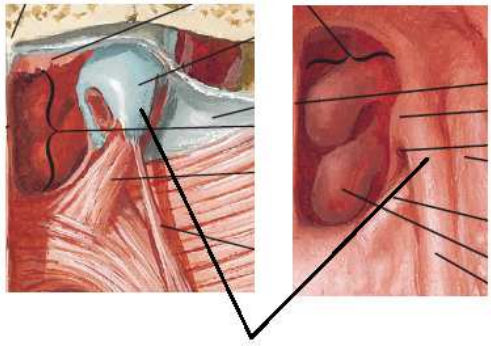

# C. Auditory Tube

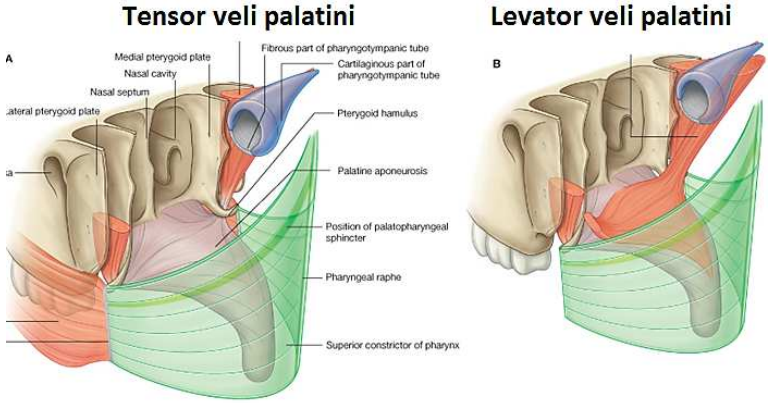
- **Auditory tube** connects nasopharynx to middle ear
- Function: supply air to middle ear
- ~3.5cm long
- Runs inferomedially from anterior wall of tympanic cavity
  - More horizontally in the young
- Divided into:
  - Posterolateral 1/3: **bony part** in petrous temporal bone
  - Anteromedial 2/3: **cartilaginous part**
- **Isthmus**: narrowest part at junction between bony and cartilaginous parts



- Bony part:
  - Lining: thin mucosa without glands
  - Kept wet by evaporation from blood vessels
- Cartilaginous part:
  - Cartilage shaped like an 'inverted J' completed by fibrous tissue
  - Exits petrous temporal near its junction with sphenoid bone
  - Lining: respiratory epithelium with lots of mucous gland
  - Opens wide into nasopharynx just behind base of **medial pterygoid plate**
  - **Tubal eminence**: cartilage opening into nasopharynx raises mucosa superiorly and posteriorly
  - Two muscles insert (in part) onto cartilage here:
    - → **Tensor veli palatini** from lateral part of cartilage to round hamulus and <u>tense</u> soft palate
    - → **Levator veli palatini** from medial part of cartilage to <u>raise</u> soft palate
    - → Also pull on cartilage
      - → open the tube
      - → introduce air into middle ear to replace the air reabsorbed into blood vessels there
- Arterial supply:
  - **Ascending pharyngeal aa.** from external carotid a.
  - **Middle meningeal aa.** from branches of **maxillary a.** that pass into skull through foramen spinosum (just lateral to auditory tube)
- Venous drainage: **pterygoid plexus**



- Clinical relevance:
  - Obstruction of auditory tube often accompanies middle ear infections
    → pain + hearing loss (if not cleared)
  - Young children have shorter, more horizontal and wider auditory tubes
    → Easy infection from nasopharynx or even to mastoid antrum (unless checked with antibiotics)
    → Result: immediate (temporary) hearing loss
    → Frequency subsides >10y