

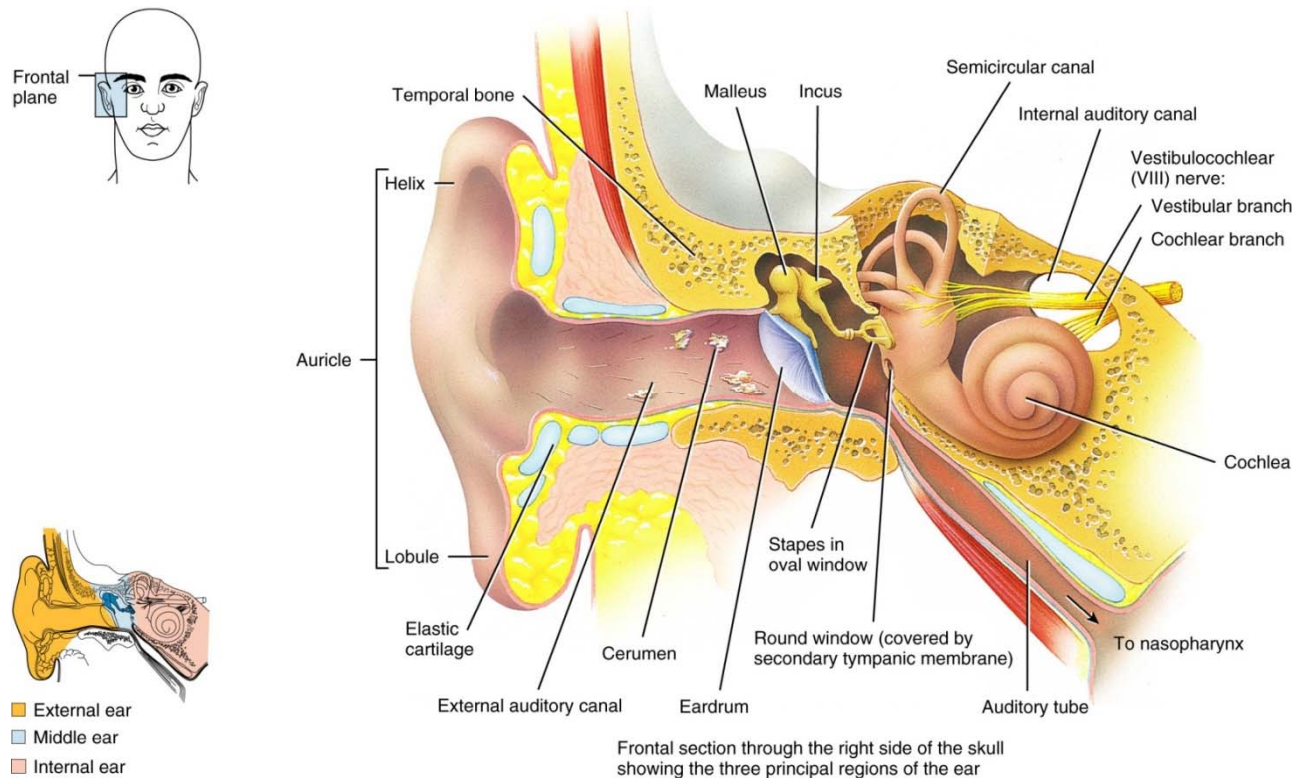
Ear

Lecture Objectives

- Make a list of structures making the external, middle, and internal ear.
- Discuss the features of the external auditory meatus and tympanic membrane.
- Describe the shape, position, boundaries and content of the middle ear.
- Describe the auditory tube, its openings and structure.
- Describe the mastoid air cells and their connection to the middle ear.
- Note how structures fit each other.
- Describe the bony labyrinth.
- Explain how the membranous labyrinth fits the bony one.
- Describe the hearing and balance receptors.

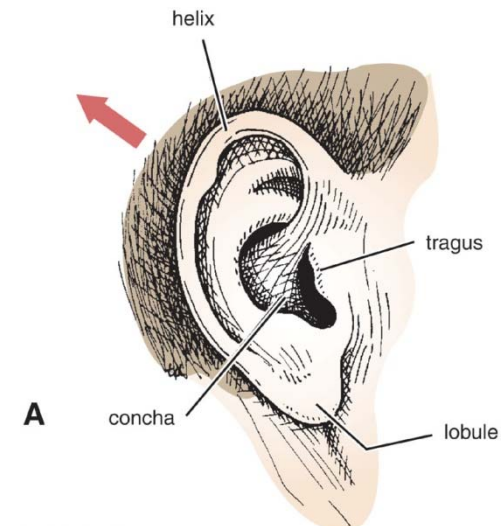
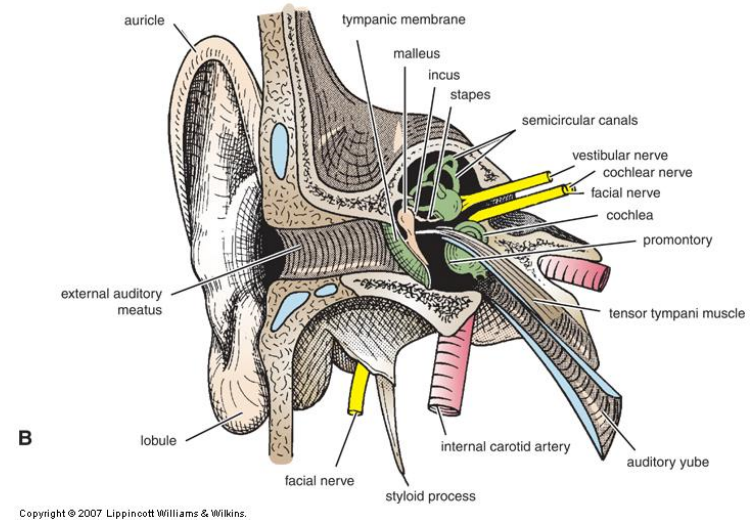
Anatomy of the Ear Region

- External ear
- Middle ear
- Internal ear



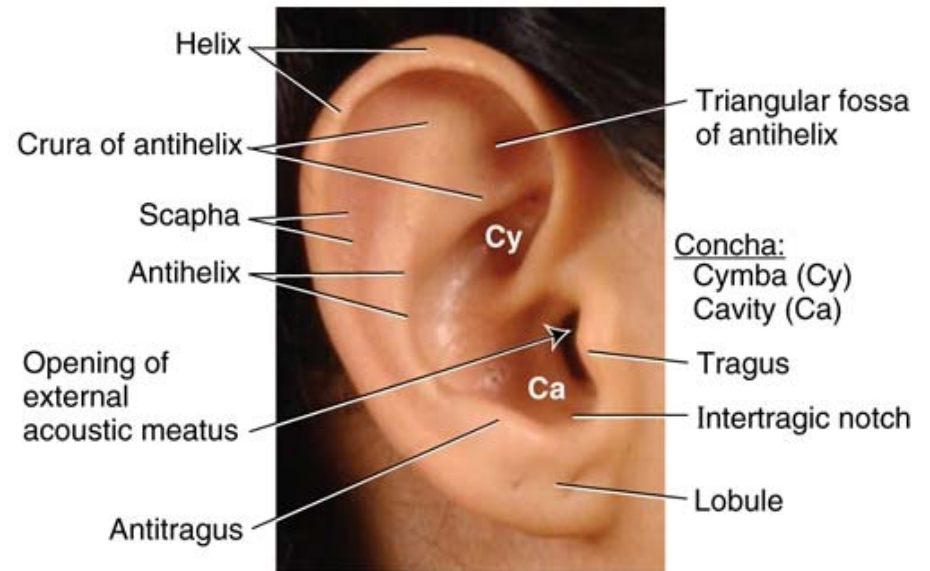
External Ear

- Function = collect sounds
- Structures
 - auricle or pinna
 - elastic cartilage covered with skin
 - external auditory canal
 - curved 1" tube of cartilage & bone leading into temporal bone
 - ceruminous glands produce cerumen = ear wax
 - tympanic membrane or eardrum
 - epidermis, collagen & elastic fibers, simple cuboidal epith.

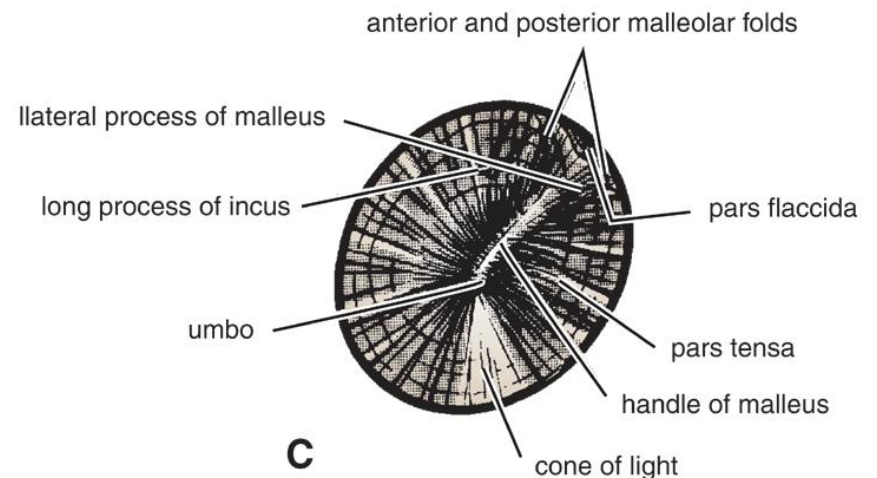


External Ear

- Auricle parts:
 - Helix & antihelix
 - Tragus & antitragus
 - Lobule
 - Sacphoid fossa
 - Triangular fossa
 - Concha
- Tympanic membrane parts:
 - Flaccid part (superiorly)
 - Between the anterior & posterior malleolar folds
 - Tense part



Copyright © 2010 Wolters Kluwer Health | Lippincott Williams & Wilkins



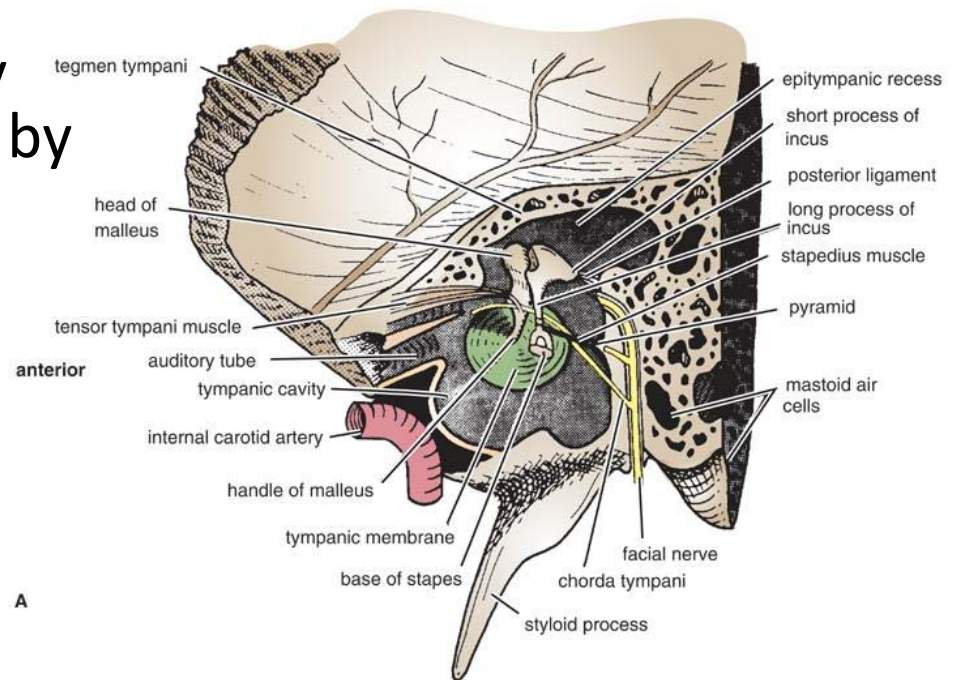
Copyright © 2007 Lippincott Williams & Wilkins.

External Ear

- Sensory innervation:
 - Great auricular n. - auricle
 - Auriculotemporal n. (V3) - auricle, external auditory canal & eardrum (outer)
 - Auricular branch of vagus - external auditory canal & eardrum (outer)
 - Glossopharyngeal n. – eardrum (inside)
- Lymph drainage: superficial parotid, mastoid & superficial cervical
- Perforated eardrum (hole is present)
 - at time of injury (pain, ringing, hearing loss, dizziness)
 - caused by explosion, scuba diving, or ear infection

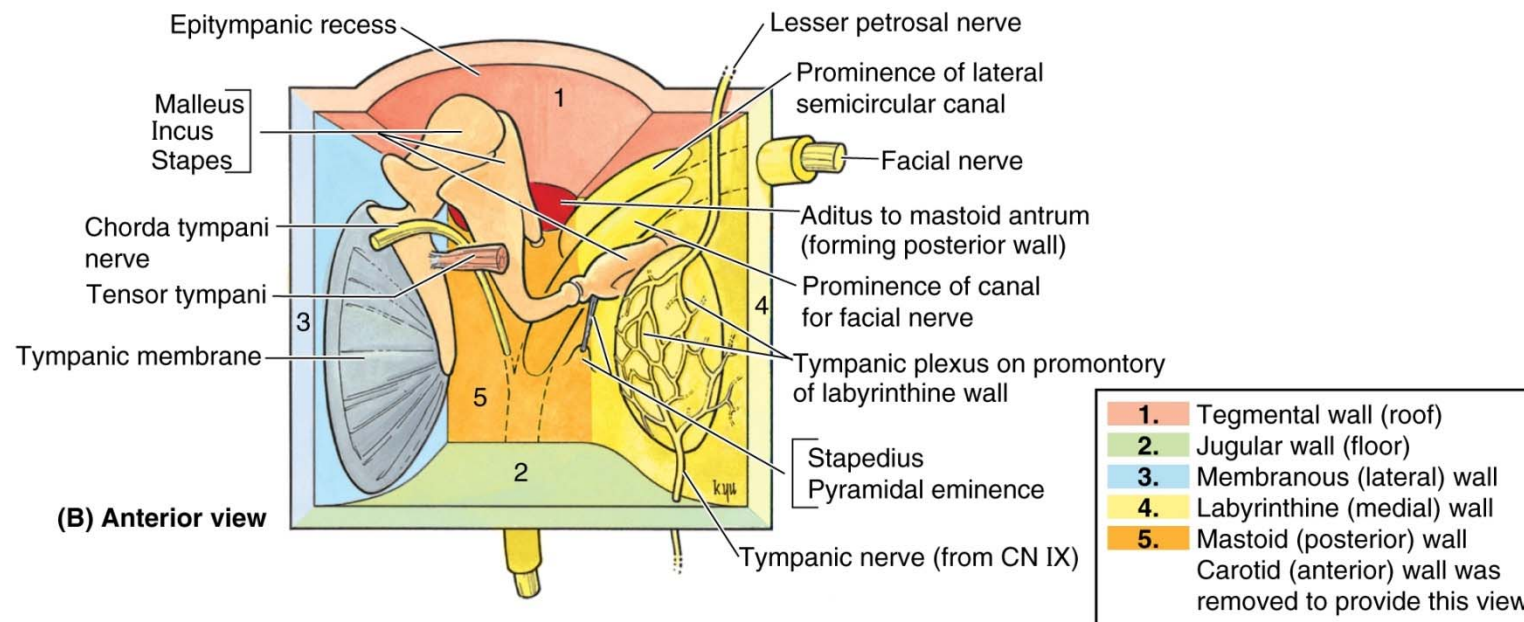
Middle Ear Cavity

- Air filled cavity in the temporal bone
- Lined with mucus membrane
- Separated from external ear by eardrum and from internal ear by oval & round windows
- Connected anteriorly with nasopharynx via auditory (pharyngotympanic) tube
- Connected posteriorly with mastoid air cells via mastoid antrum
- Parts
 - Epitympanic recess (superiorly)
 - Tympanic cavity proper



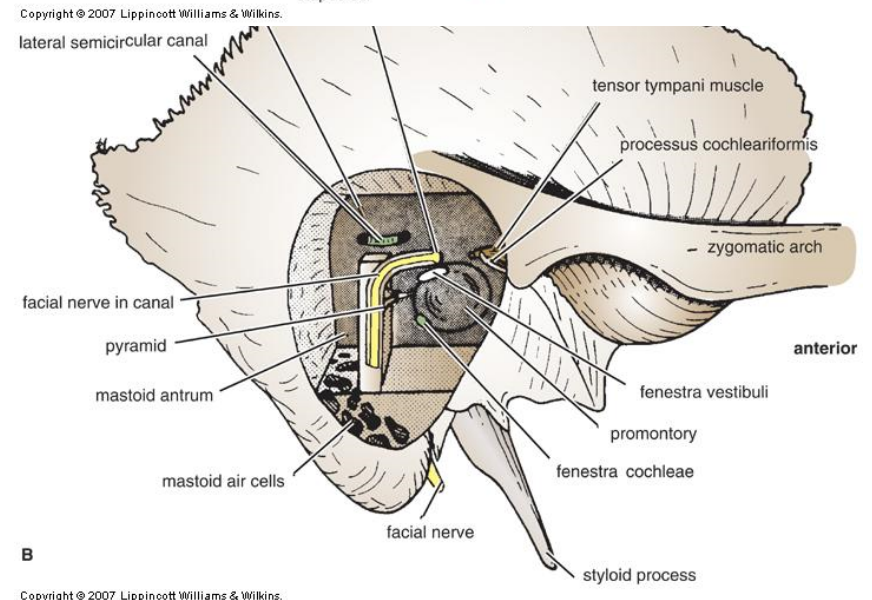
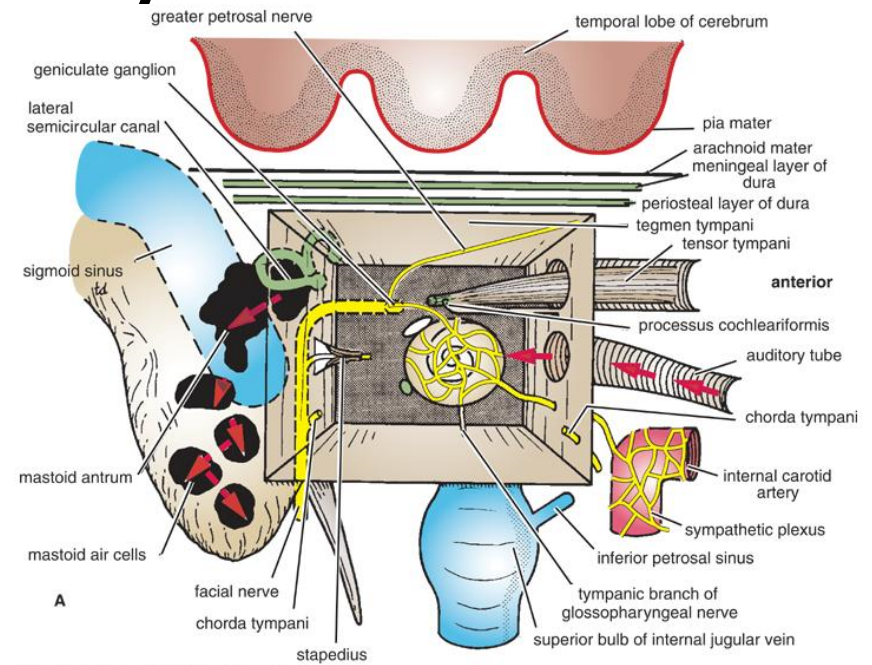
Middle Ear Cavity Content

- Auditory ossicles - connected by synovial joints
 - **malleus** (attached to eardrum), **incus** & **stapes** (attached by foot plate to membrane of oval window)
- Stapedius & tensor tympani mm.
- Chorda tympani n.
- Tympanic plexus of nerves



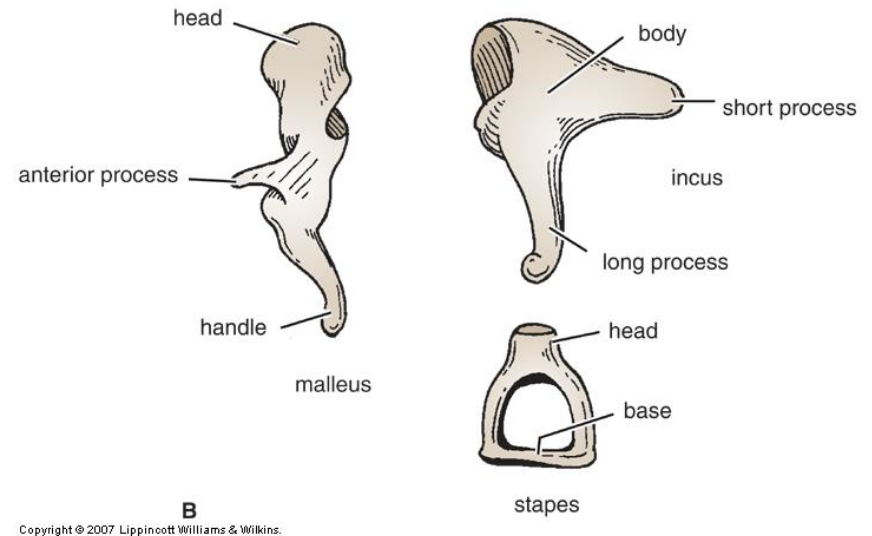
Middle Ear Cavity Walls

- **Roof** (tegmen tympani of petrous portion)
- **Floor**- separated from internal jugular vein
- **Anterior wall**- separated from internal carotid a.
 - Opening to auditory tube
 - Opening of a canal for tensor tympani m.
- **Posterior wall**
 - Opening to mastoid antrum
 - Pyramid (pony projection): attachment of stapedius m.
- **Lateral wall** (eardrum)
- **Medial wall**- Separated from inner ear
 - Promontory (round projection by cochlea)
 - Oval window (fenestra vestibuli)
 - Closed by base of stapes
 - Round window (fenestra cochleae)
 - Closed by secondary tympanic membrane

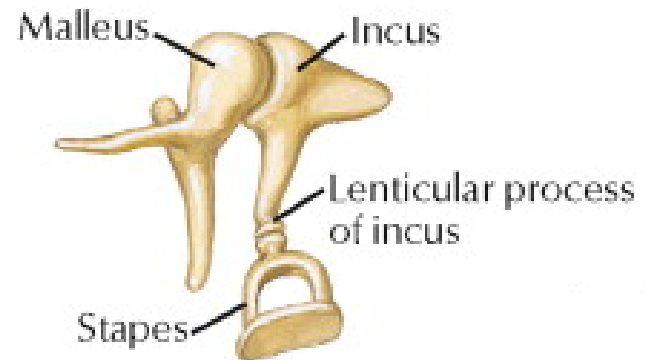


Auditory Ossicles

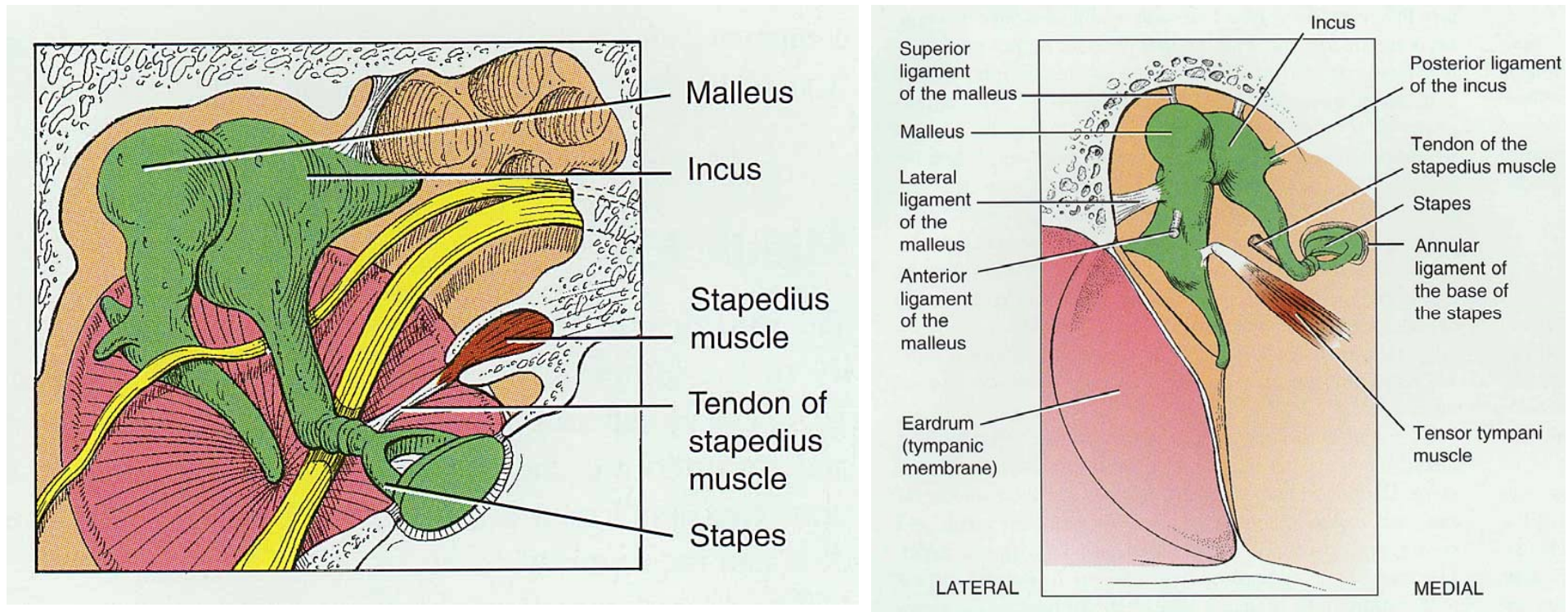
- **Malleus**
 - Handle (for eardrum & tensor tympani m.)
 - Anterior (for ligament) & lateral (for malleolar folds) processes
 - Neck
 - Head (for incus)
- **Incus**
 - Body (for malleus)
 - Long process (for stapes)
 - Short process (for ligament)
- **Stapes**
 - Head (for incus)
 - Neck (stapedius m.)
 - Limbs
 - Base (for oval window)



Ossicles articulated: medial view



Muscles of the Ear



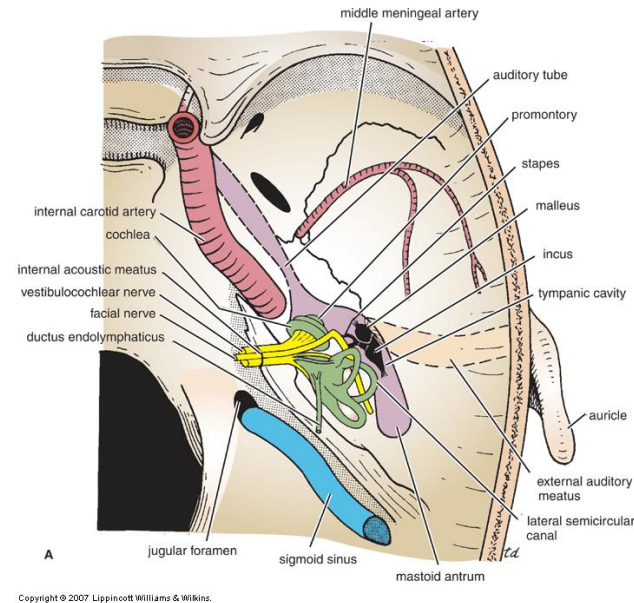
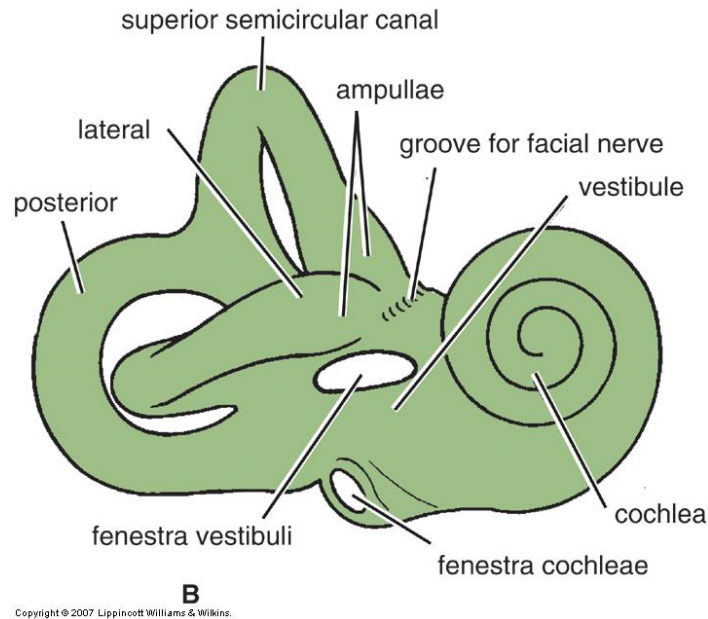
- Stapedius m. inserts onto stapes
 - prevents very large vibrations of stapes from loud noises
 - Facial nerve
- Tensor tympani attaches to malleus
 - limits movements of malleus & stiffens eardrum to prevent damage
 - Mandibular branch of trigeminal nerve

Table 18-2**Muscles of the Middle Ear**

Muscle	Origin	Insertion	Nerve Supply	Action
Tensor tympani	Wall of auditory tube and wall of its own canal	Handle of malleus	Mandibular division of trigeminal nerve	Dampens down vibrations of tympanic membrane
Stapedius	Pyramid (bony projection on posterior wall of middle ear)	Neck of stapes	Facial nerve	Dampens down vibrations of stapes

From Snell RS: Clinical Anatomy. 7th Ed. Philadelphia: Lippincott Williams & Wilkins, 2004, p. 839.

Inner Ear---Bony Labyrinth

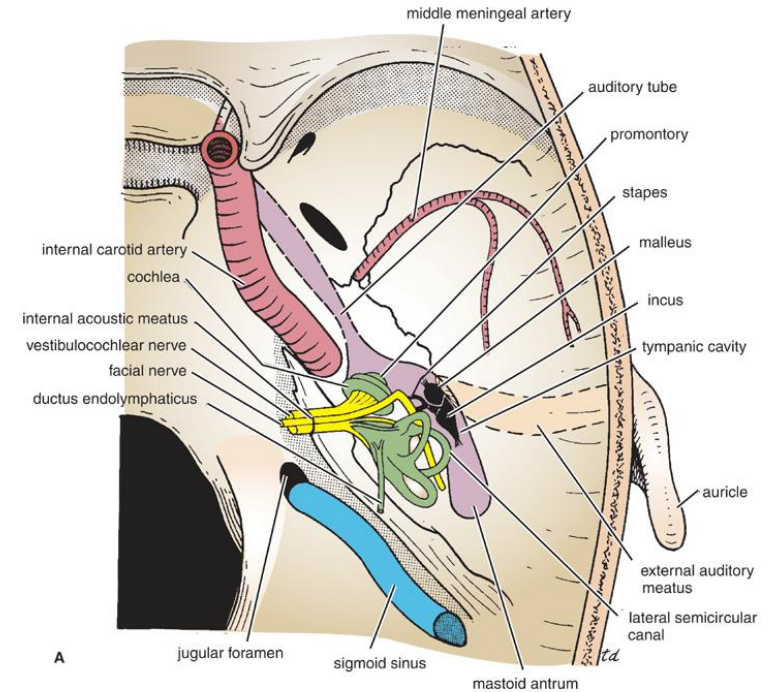
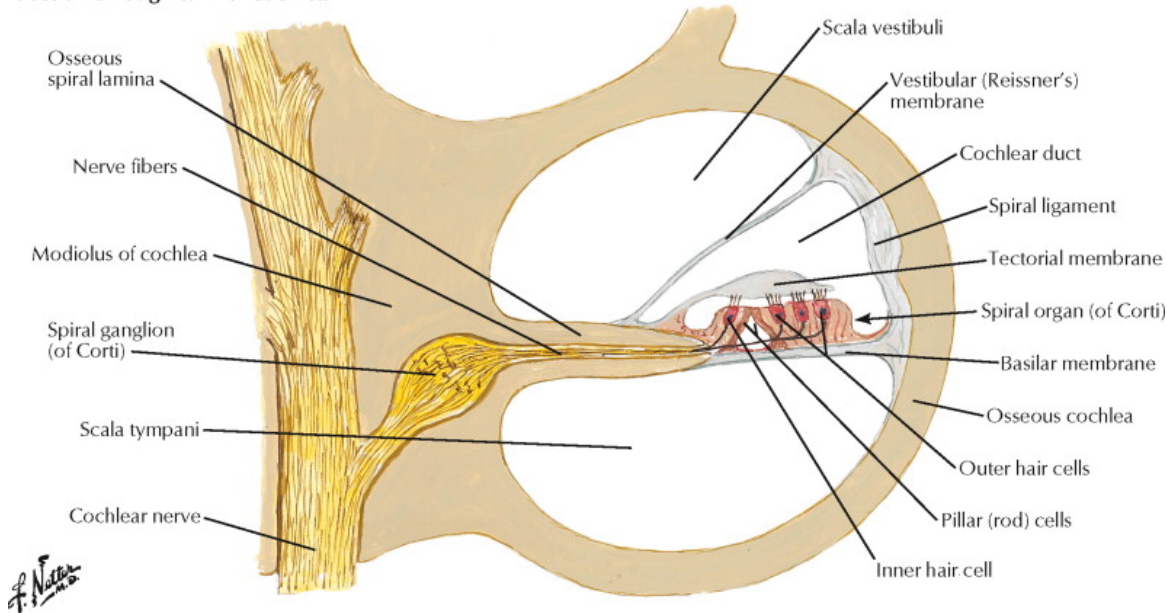


- Bony labyrinth = set of tube-like cavities in temporal bone
 - lined with periosteum & filled with perilymph
 - surrounds & protects Membranous Labyrinth
 - **Semicircular canals** (superior (anterior), lateral & posterior) opens anteriorly into vestibule
 - Orientation
 - **Vestibule** contains laterally the oval & round windows
 - **Cochlea** open posteriorly into vestibule

Cochlea Structure

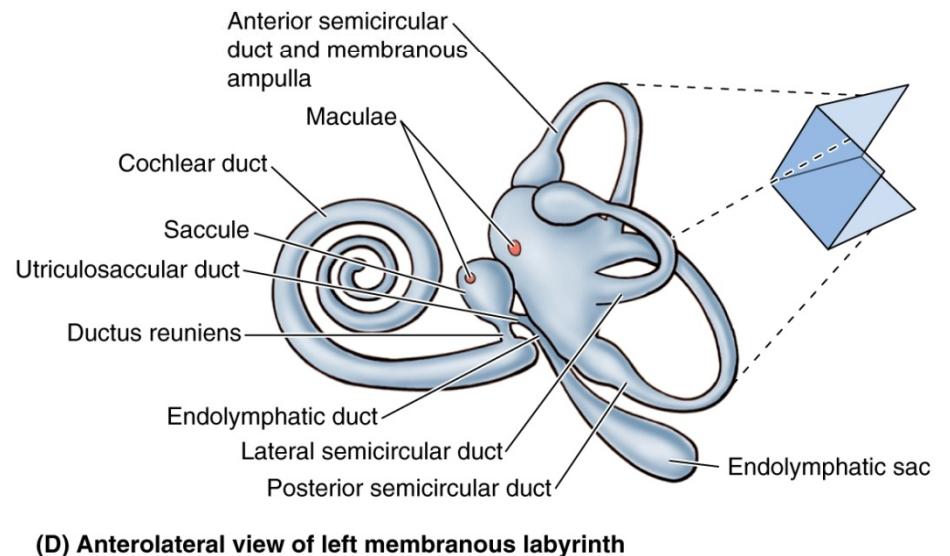
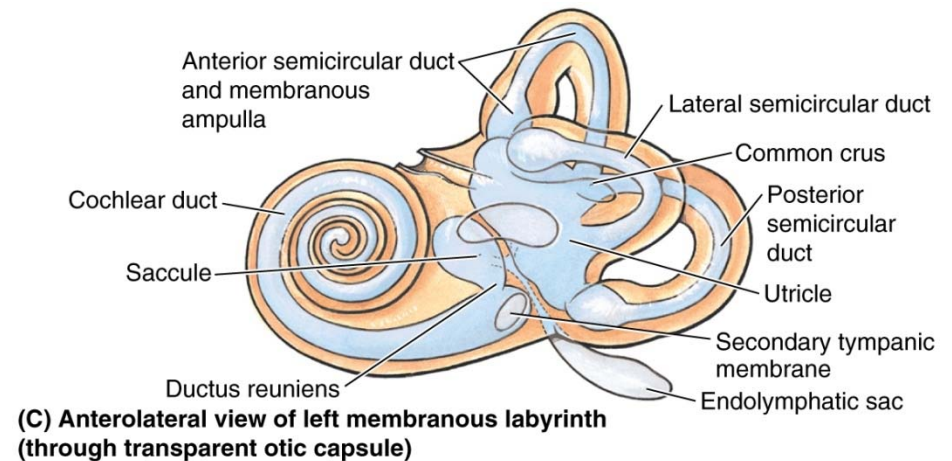
- Modiolus (central part) pierced at the base by the cochlear nerve
- Cochlear canal
 - Spiral lamina
 - Basilar membrane
 - Parts
 - Scala vestibuli (begins at oval window)
 - Scala tympani (ends at round window)

Section through turn of cochlea

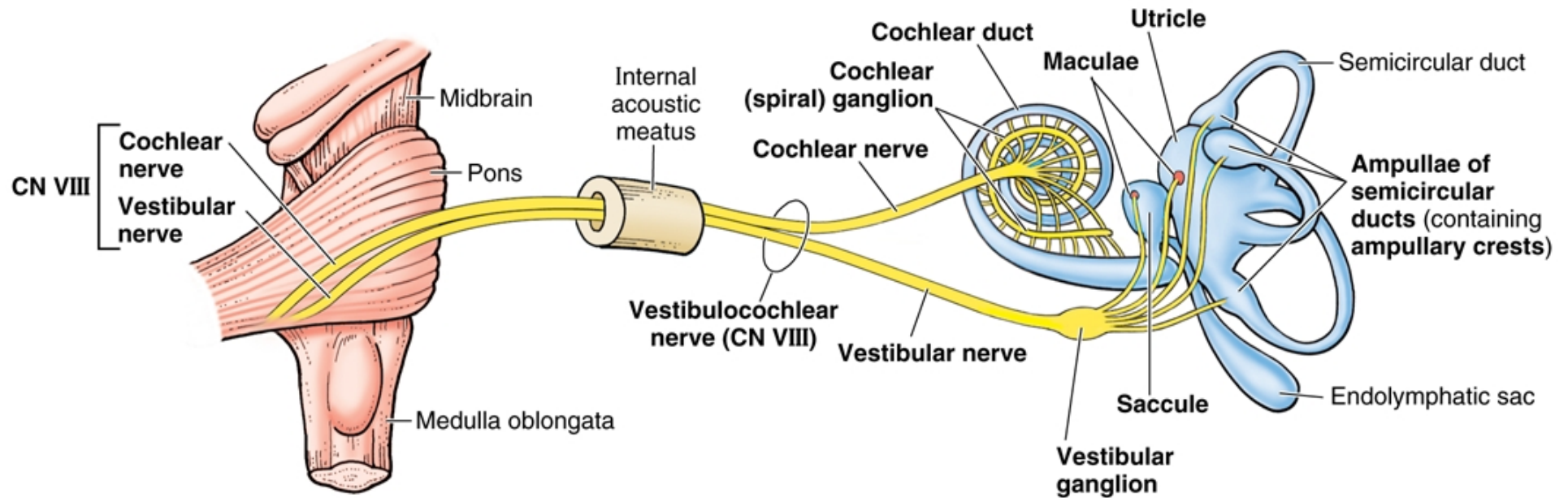


Inner Ear---Membranous Labyrinth

- Membranous labyrinth = set of membranous tubes containing sensory receptors for hearing & balance and filled with endolymph
 - Utricle & saccule in the vestibule
 - Connected to each other and to the endolymphatic sac by a utriculosaccular duct
 - Semicircular ducts in semicircular canals
 - Cochlear duct in cochlea
 - Connected to saccule by ductus reuniens
 - Contains organ of Corti



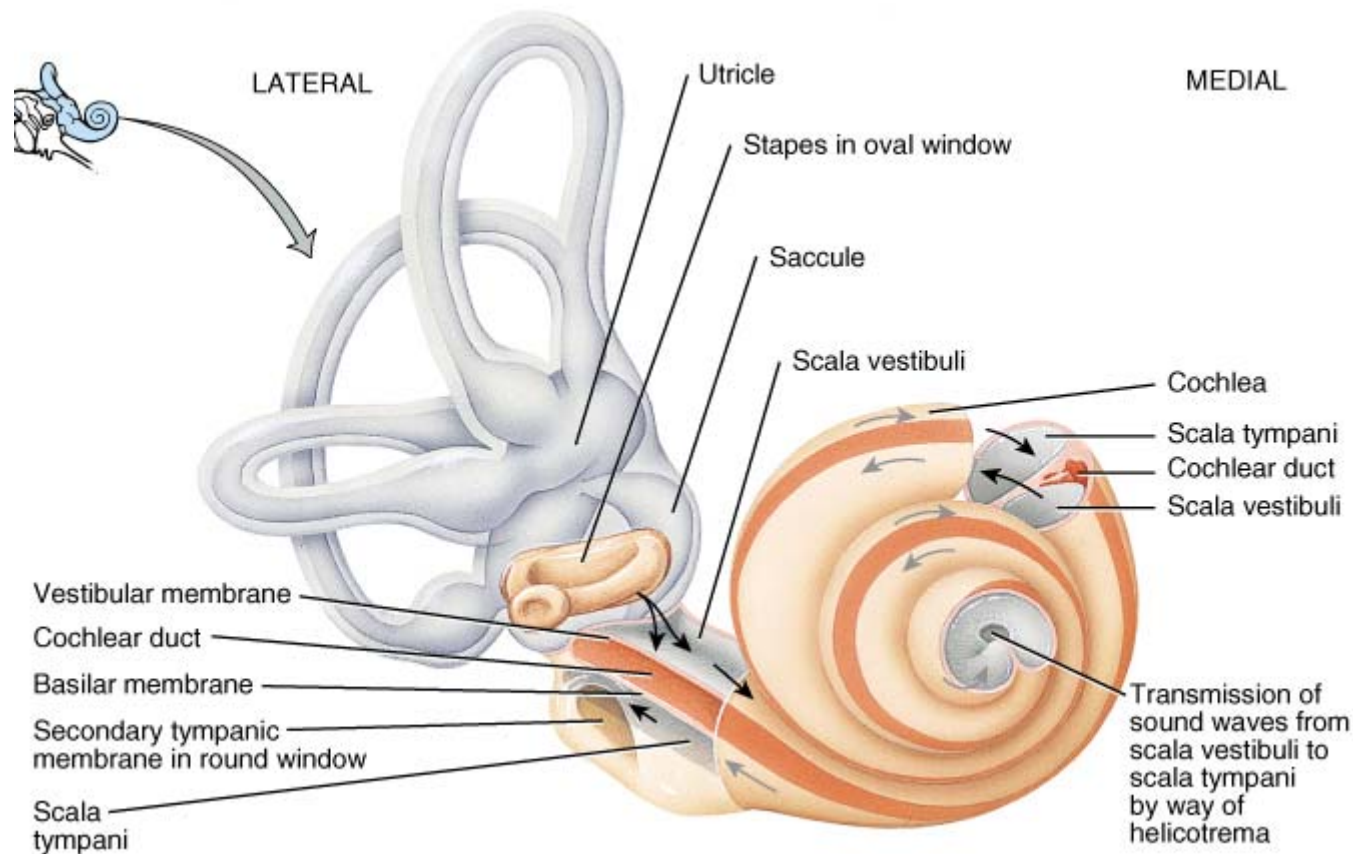
Cranial nerves of the Ear Region



Copyright © 2010 Wolters Kluwer Health | Lippincott Williams & Wilkins

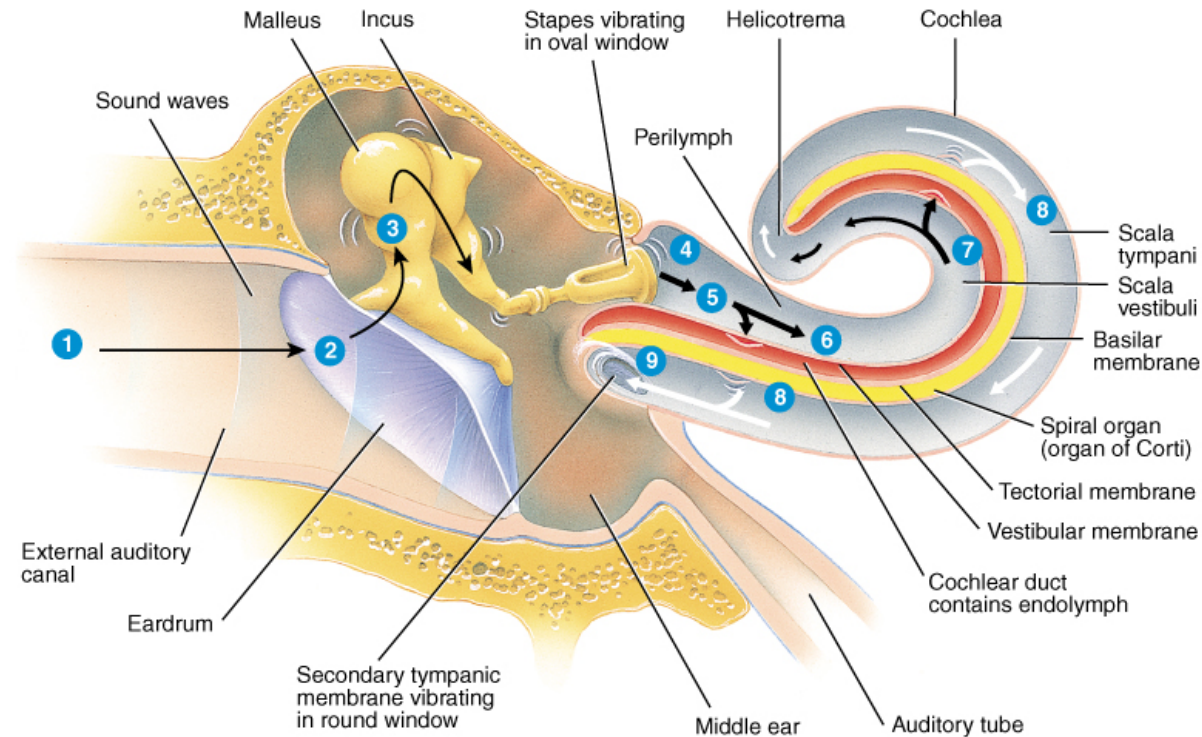
- Vestibulocochlear nerve = CN VIII
 - ampullary, utricular & saccular brs. form **vestibular branch**
 - Vestibular ganglion
 - **cochlear branch** has spiral ganglion in bony modiolus

Cochlear Anatomy



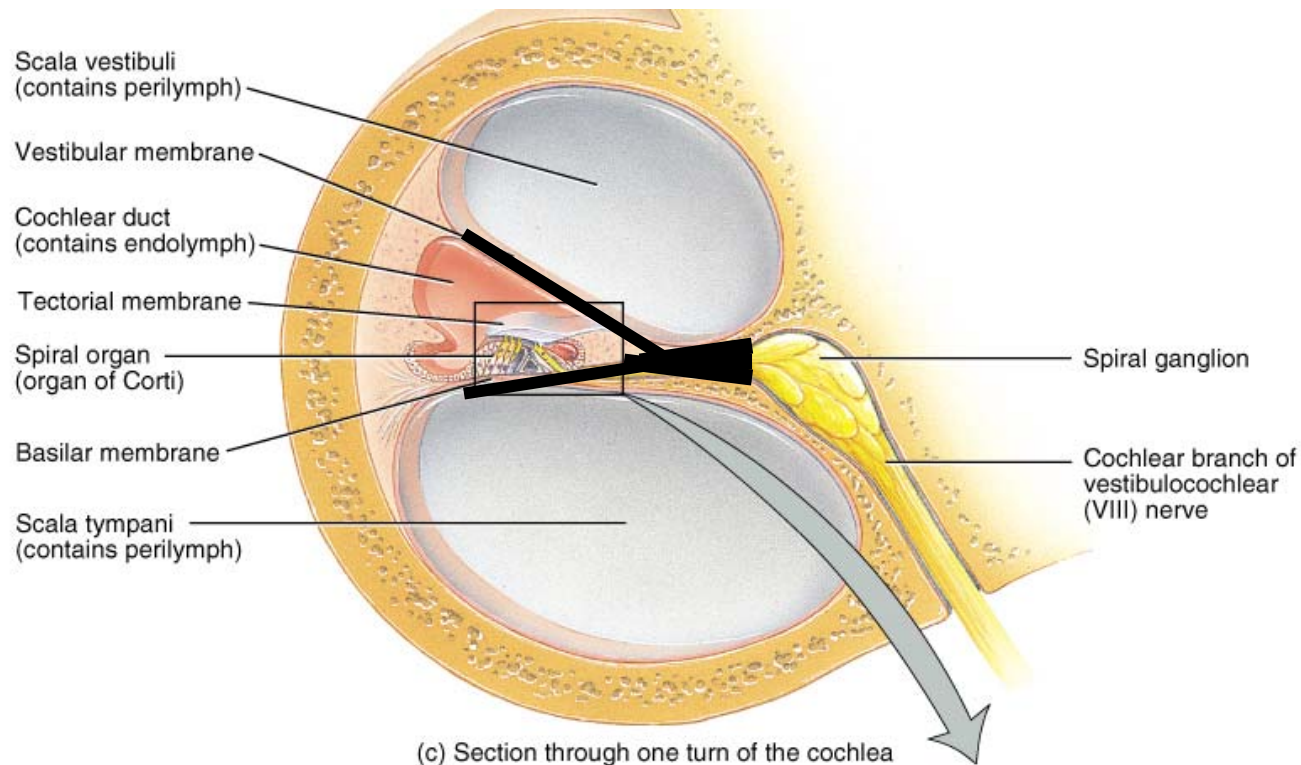
- 3 fluid filled channels found within the cochlea
 - scala vestibuli, scala tympani and cochlear duct
- Vibration of the stapes upon the oval window sends vibrations into the fluid of the scala vestibuli

Tubular Structures of the Cochlea



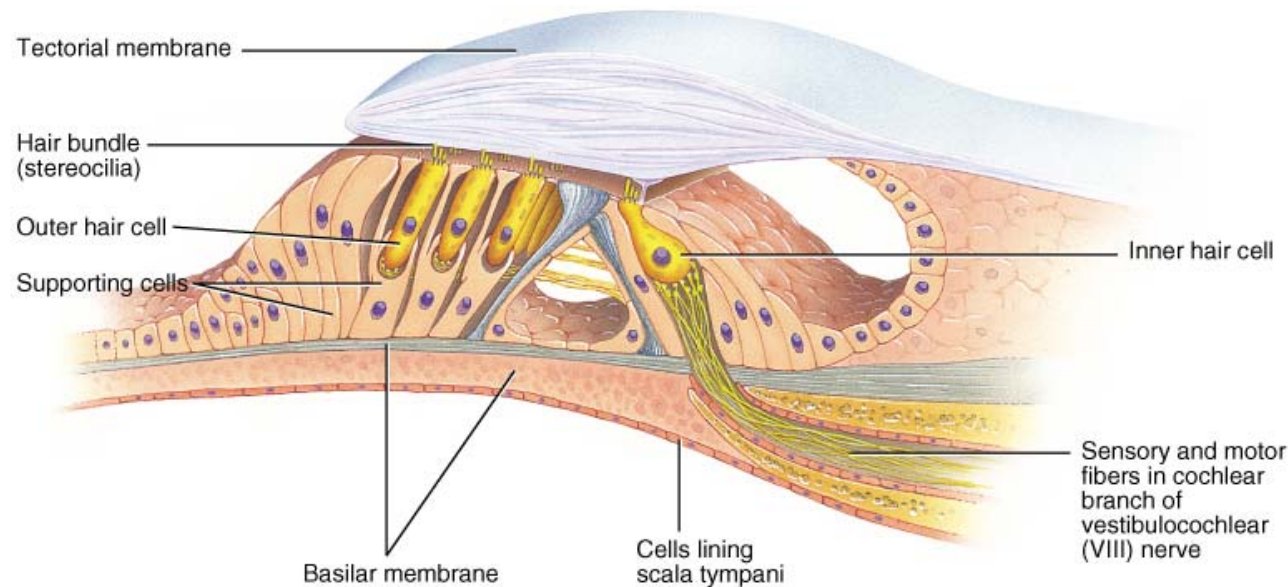
- Stapes pushes on fluid of scala vestibuli at oval window
- At helicotrema, vibration moves into scala tympani
- Fluid vibration dissipated at round window which bulges
- The central structure is vibrated (cochlear duct)

Section thru one turn of Cochlea

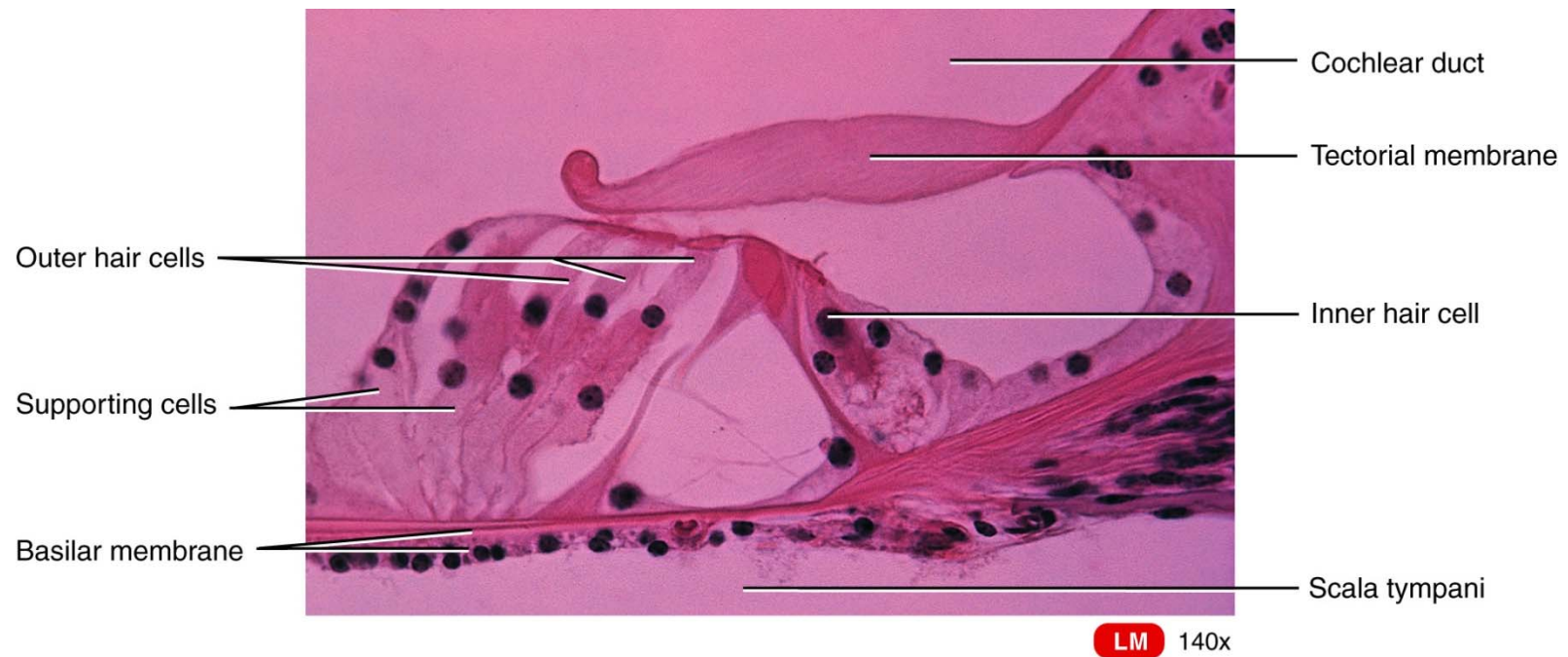


- Partitions that separate the channels are Y shaped
 - bony shelf of central modiolus
 - vestibular membrane above & basilar membrane below form the central fluid filled chamber (cochlear duct)
- Fluid vibrations affect hair cells in cochlear duct

Anatomy of the Organ of Corti



- 16,000 hair cells have 30-100 stereocilia (microvilli)
- Microvilli make contact with tectorial membrane (gelatinous membrane that overlaps the spiral organ of Corti)
- Basal sides of inner hair cells synapse with 1st order sensory neurons whose cell body is in spiral ganglion
- Shortening & lengthening of outer hair cells in response to signals from motor neurons change the responses of the inner hair cells



(e) Histology of the spiral organ (organ of Corti)

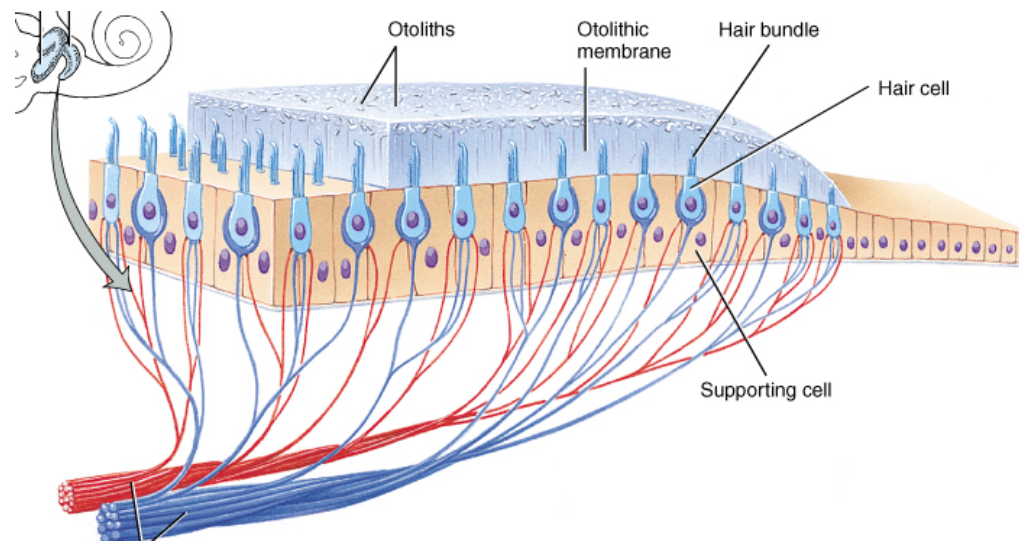
Deafness

- Nerve deafness
 - damage to hair cells from antibiotics, high pitched sounds, anticancer drugs
 - the louder the sound the quicker the hearing loss
 - fail to notice until difficulty with speech
- Conduction deafness
 - perforated eardrum
 - Otosclerosis (Hereditary disorder in which ossification of the labyrinth of the inner ear causes tinnitus and eventual deafness)

Physiology of Equilibrium (Balance)

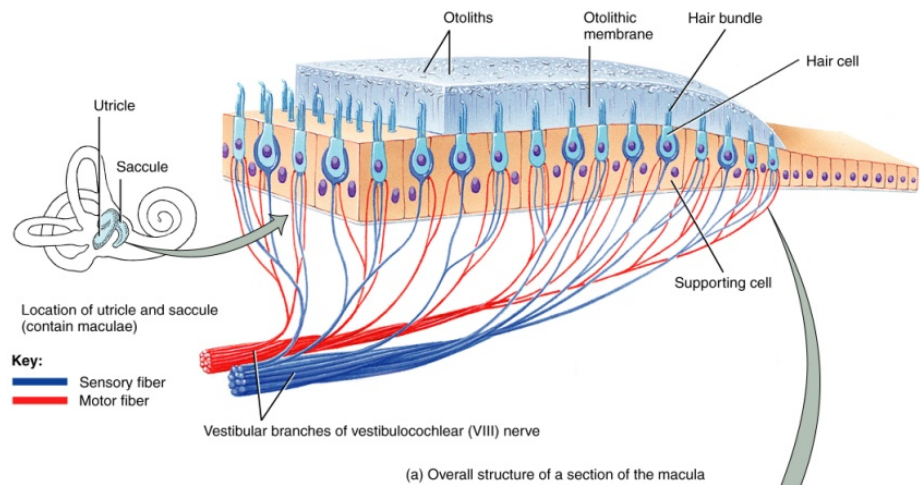
- Static equilibrium
 - maintain the position of the body (head) relative to the force of gravity
 - macula receptors within saccule & utricle
- Dynamic equilibrium
 - maintain body position (head) during sudden movement of any type--rotation, deceleration or acceleration
 - crista receptors within ampulla of semicircular ducts

Otolithic Organs: Sacculle & Utricle

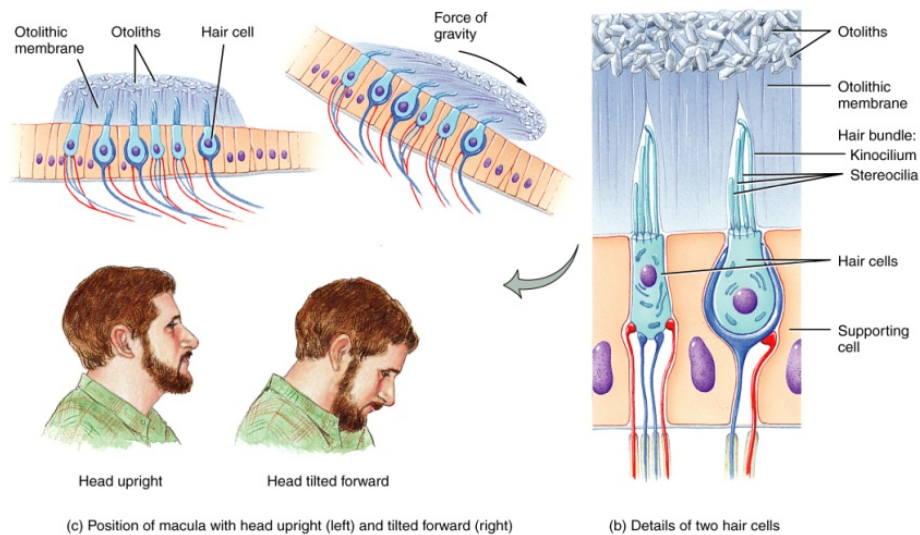


- Thickened regions called macula within the sacculle & utricle of the vestibular apparatus
- Cell types in the macula region
 - hair cells with stereocilia (microvilli) & one cilium (kinocilium)
 - supporting cells that secrete gelatinous layer
- Gelatinous otolithic membrane contains calcium carbonate crystals called otoliths that move when you tip your head

Detection of Position of Head



- Movement of stereocilia or kinocilium results in the release of neurotransmitter onto the vestibular branches of the vestibulocochlear nerve



Crista: Ampulla of Semicircular Ducts

- Small elevation within each of three semicircular ducts
 - anterior, posterior & horizontal ducts detect different movements
- Hair cells covered with cupula of gelatinous material
- When you move, fluid in canal bends cupula stimulating hair cells that release neurotransmitter

