

EAR

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I. Overview - specialized for sound detection

A. Outer ear - funnel shaped structure of cartilage and skin that leads to Tympanic membrane; directs sound toward Tympanic membrane; helps detect source of sound.

B. Middle ear - air filled chamber that contains bones (ossicles) that link Tympanic membrane to cochlea; also contains muscles that dampen sounds; middle ear is linked to Nasopharynx by auditory tube which allows for equilibration of air pressure on inner side of Tympanic membrane.

C. Inner ear - fluid filled chamber in petrous part of temporal bone; inner ear contains Cochlea (hearing) and Vestibular apparatus for gravity detection (both innervated by CN VIII).

Clinical Note: Functioning of inner ear can be tested independently by vibrations transmitted directly through bone (Weber test: tuning fork on calvarium is perceived as sound); **CONDUCTIVE HEARING LOSS** - damage to middle ear (tympanic membrane, auditory ossicles); **SENSORINEURAL HEARING LOSS** - damage to inner ear (cochlea, CN VIII).

II. Outer Ear - composed of two parts:

A. Auricle (pinna) - elastic cartilage covered with skin; functions to reflect sound waves. Parts: helix, antihelix, tragus and lobule.

Decorative Note: Cartilage does not extend into Lobule; Lobule can be readily pierced to provide support for decorative metal objects.

B. **External auditory meatus** - tube from auricle to the Tympanic membrane; posterior to Parotid gland and TMJ (Temporomandibular joint); located anterior to mastoid process. Outer third consists of elastic cartilage; contains hairs, sebaceous glands and ceruminous glands (produce cerumen = ear wax); serves to protect Tympanic membrane; Inner two thirds is composed of bone lined with skin.

Clinical note: External auditory meatus is curved anteriorly in adults, is straight in children; in adults, auricle is pulled up and back to insert otoscope.

Clinical note: sensory innervation of Outer Ear is complex and derived from CN V, VII, IX and X; patient's with Bell's palsy can have sensation of ear ache.

III. **Middle Ear (Tympanic cavity)** - cavity in the petrous portion of the temporal bone that is hard to visualize; lies below middle cranial fossa

A. Boundaries

1. Roof - tegmen tympani (thin plate of petrous part of temporal bone) separates Tympanic cavity from middle cranial fossa.
2. Floor - Jugular foramen lies below cavity; rupture of the internal jugular vein can result in hemorrhaging into the Tympanic cavity.
3. Anterior wall - has opening of Auditory tube (posterior 1/3 of tube is in bony canal, anterior 2/3 is cartilage); Auditory tube links middle ear with nasopharynx for equilibration of pressure; anterior wall also has bony canal containing tensor tympani muscle.
4. Posterior wall - leads to mastoid air cells in mastoid process (opening is called aditus); canal for Facial nerve (CN VII) courses in posterior wall (after passing from medial wall).
5. Medial wall - is lateral wall of inner ear; landmarks - **Oval window** (fenestra vestibuli) is **attachment for stapes**; Round window (fenestra cochlea) is other end of coiled cochlea; landmarks - promontory is bulge in wall from first turn of cochlea; prominence of facial nerve canal - horizontal ridge from underlying facial nerve.
6. Lateral wall - Tympanic membrane.

Clinical Note: Otitis media (middle ear infection) is common in children. Middle ear is functionally a dead end cavity that opens to nasopharynx. Infection can spread from upper respiratory system. Damage to auditory ossicles can cause hearing loss.

Prolonged infection in Tympanic cavity can spread through tegmen tympani to brain.

Clinical Note: Incidence of Otitis media declines rapidly after age of 5; growth is associated with a change in orientation of the auditory tube (from horizontal to angled inferiorly) and an increase in the size of its lumen; both factors may contribute to decreased incidence of Otitis media.

B. Auditory ossicles - from lateral to medial: **malleus** (hammer), **incus** (anvil) and **stapes** (stirrup); ossicles amplify effect of vibration; in addition, Tympanic membrane has 15-20 times greater area than footplate of stapes; this increases force per unit area and helps transmit sound vibrations from air to fluid in inner ear (impedance matching).

Otoscope view: Handle malleus is attached to upper half of Tympanic membrane; malleus is supported by ligaments linking it to wall of Tympanic cavity; part of Tympanic membrane surrounding handle is tense (pars tensa); upper end is less tense (pars flaccida)

C. Muscles

1. **Tensor tympani muscle** - origin - canal in anterior wall; insertion - handle of malleus; innervation - V3

2. **Stapedius muscle** - origin - posterior wall (landmark is pyramid); insertion - neck of stapes; innervation - VII

Actions - Both muscles act to dampen movements of ossicles (decrease intensity of sound); tensor also makes Tympanic membrane tighter; prevents damage to inner ear; **paralysis of muscles produces hyperacusia (sounds seem too loud, Bell's palsy).**

D. Innervation - **Tympanic nerve - Visceral Sensory** (GVA, imprecise sensation) branch of **IX** that enters Tympanic cavity). Nerve forms Tympanic plexus that also innervates mastoid air sinus and auditory tube; can give rise to Lesser Petrosal nerve (to Parotid Gland).

Clinical Note: Damage Chorda tympani (branch of VII) - Chorda tympani has no function in middle ear; it provides taste to anterior 2/3 of tongue, Parasympathetics to Submandibular ganglion; however, it leaves facial canal and passes through Tympanic cavity and crosses over upper end of handle of malleus before exiting via petrotympanic fissure; if Tympanic membrane is pierced, can damage Chorda tympani and lose taste to anterior tongue on that side; this fact may have baffled early physicians and patients.