The Ear

Dr. Heba Kalbouneh
Associate Professor of Anatomy and Histology
The ear consists of the external ear; the middle ear (tympanic cavity); and the internal ear (labyrinth), which contains the organs of hearing and balance.

Sound is captured by the external ear

Mechanical signals in the middle ear

The internal ear converts the mechanical signals into electrical signals to transfer information to the brain

The internal ear also contains receptors that detect motion and position
The auricle has a characteristic shape
- It collects air vibrations
- It consists of a thin plate of elastic cartilage covered by skin

The external auditory meatus is a curved tube that leads from the auricle to the tympanic membrane
- It conducts sound waves from the auricle to the tympanic membrane
1. **Helix.**
2. Crus of helix
3. Auricular tubercle.
4. **Antihelix.**
5. Crura of antihelix.
6. Triangular fossa.
7. Scaphoid fossa.
8. **Concha of auricle.**
9. **External acoustic meatus.**
10. **Tragus.**
11. **Antitragus.**
12. Intertragic notch.
13. **Lobule of auricle.**

**Anotia** is complete absence of the external ear, and is most likely caused by a developmental disturbance between the seventh and eighth gestational week.

Prominent ears (also known as ‘bat’ ears) are caused by the absence or inadequacy of an antihelical fold.

The cartilage of the auricle is arranged in a pattern of elevations and depressions.
Note that the Auricular branches of vagus and facial supply deeper parts of the auricle.
The external auditory meatus

- The framework of the outer third of the meatus is elastic cartilage, and the inner two thirds is bone
- The meatus is lined by skin
- The outer third is provided with hairs and sebaceous and ceruminous glands

Ceruminous glands are modified sweat glands that secrete a yellowish brown wax (cerumen = earwax)

The hairs and the wax provide a sticky barrier that prevents the entrance of foreign bodies
Otoscopic examination of the tympanic membrane is facilitated by first straightening the external auditory meatus by gently pulling the auricle upward and backward in the adult.

Move the mobile part to make meatus straight.

Outer third is directed upward and backward.

Inner two thirds are directed downward and forward.
In the adult the external meatus is about 1 in. (2.5 cm) long and is narrowest about 0.2 in. (5 mm) from the tympanic membrane.
The Tympanic membrane (ear drum)

Is a thin, fibrous membrane

Is formed of:
1- Outer layer:
   Skin
2- Middle layer:
   Fibrous tissue
3- Inner layer:
   Mucous membrane

✓ It is concave laterally
✓ Umbo is small depression produced by the tip of the handle of the malleus

The membrane is obliquely placed, facing downward, forward, and laterally

The inner surface of tympanic membrane is fixed to handle of Malleus
Remember that the middle fibrous layer is present in the major parts of the ear drum which called **pars tensa**

However, this layer is **absent** in the upper part of the ear drum which is called **pars flaccida** (Shrapnell's membrane) (Rivinus’ ligament)

The pars tensa and flaccida are separated from each other by two folds called **the anterior and posterior malleolar folds**

The tympanic membrane is extremely sensitive to pain
Otoscopic Examination
When the membrane is illuminated through an otoscope, the concavity produces a cone of light, which radiates anteriorly and inferiorly from the umbo.
The antero-inferior quadrant of the ear drum is called the cone of light (because it reflects the light coming from the otoscope).
Otitis media
Middle Ear (Tympanic Cavity)

- Is an air-containing cavity in the petrous part of the temporal bone
- Is lined with mucous membrane
- It contains the auditory ossicles, whose function is to transmit the vibrations of the tympanic membrane (eardrum) to the inner ear

The middle ear has

- ROOF
- FLOOR
- ANTERIOR WALL
- POSTERIOR WALL
- LATERAL WALL
- MEDIAL WALL
Tympanic cavity (middle ear) is a narrow, oblique, slitlike cavity whose long axis lies approximately parallel to the plane of the tympanic membrane.
Walls of middle ear

- Roof
- Medial wall
- Anterior wall
- Posterior wall
- Floor
It separates the tympanic cavity from the **internal jugular vein**

It separates the tympanic cavity from the **meninges and the temporal lobe** of the brain in the middle cranial fossa.

**Floor**  
**JUGULAR WALL**

It separates the tympanic cavity from the **internal jugular vein**
Tegmen tympani
Is formed below by a thin plate of bone that separates the tympanic cavity from the internal carotid artery.

At the upper part of the anterior wall are the openings into two canals. The lower and larger leads into the auditory tube. The upper and smaller is the entrance into the canal for the tensor tympani muscle.
EUSTACHIAN TUBE:

It connects the anterior wall of the tympanic cavity to the nasopharynx.

It serves to equalize air pressures in the tympanic cavity and the nasopharynx.

Its posterior inner third is **bony**

Its anterior two thirds are **cartilaginous**

**Pharyngo-tympanic tube**

**Auditory tube**

**Eustachian tube**

**Pharyngotympanic tube**

**Nasopharynx**

**External acoustic meatus**

**Middle ear**

**Internal ear**

**Malleus**

**Incus**

**Stapes**
Opening of Eustachian tube into nasopharynx
Medial wall

The horizontal part of the facial nerve arching above the promontory

Oval window:
Above and behind the promontory, oval shaped and closed by the base of the stapes (Fenestra vestibuli)

The medial wall is formed by the lateral wall of the inner ear.

Promontory is a rounded projection (results from the underlying first turn of the cochlea)

Round window:
Below the posterior end of the promontory, round and closed by the secondary tympanic membrane (Fenestra cochleae)
The base of stapes closes the oval window of the internal ear.
Mastoid process
Tympanic part of temporal bone
External acoustic meatus
Mastoid process
Tympanic part of temporal bone
External acoustic meatus
1-has in its upper part a large, irregular opening, the **aditus** to the mastoid
2-Below, a small conical projection, the **pyramid**, from its apex emerges the tendon of the stapedius muscle
3- The **vertical part of the facial nerve**
Mastoid Antrum
The mastoid antrum lies behind the middle ear in the petrous part of the temporal bone
It communicates with the middle ear by the aditus
The horizontal part of the facial nerve

Stylomastoid foramen

The vertical part of the facial nerve
The lateral wall is largely formed by the tympanic membrane (ear drum)
Infections and Otitis Media

The meninges and the temporal lobe of the brain lie superiorly meningitis and a cerebral abscess in the temporal lobe.

(acute mastoiditis)

Into the mastoid antrum

The posterior wall of the mastoid antrum is related to the **sigmoid venous sinus**. If the infection spreads in this direction, a thrombosis in the **sigmoid sinus** may take place.

Medial wall: A spread of the infection in this direction can cause a facial nerve palsy and labyrinthitis with vertigo.

through the auditory tube from the nasal part of the pharynx.
Groove for the **sigmoid sinus**
CONTENTS OF THE MIDDLE EAR

- It contains the auditory ossicles, whose function is to transmit the vibrations of the tympanic membrane (eardrum) to the perilymph of the internal ear.

A-3 Auditory Ossicles
B-2 muscles
C-2 nerves (tymppanic plexus and chorda tympani)
D-air
1-The malleus is the largest ossicle and possesses a head, a neck, a long process or handle, an anterior process, and a lateral process.

its head is rounded and articulates posteriorly with the **incus**

**The incus possesses:**

a large body and two processes:
- The body articulates with the head of the malleus.
- The long process articulates with the head of the stapes

**The stapes** has a head, a neck, two limbs, and a base

**The head** articulates with the long process of **the incus**.

The neck is narrow and receives the insertion of the **stapedius** muscle. The two limbs diverge from the neck and are attached to **the oval base** which closes **the oval window** of the internal ear
# Muscles of middle ear

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Nerve supply</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensor tympani</td>
<td>Mandibular division of trigeminal nerve</td>
<td>Dampens down vibrations of tympanic membrane</td>
</tr>
<tr>
<td>Stapedius</td>
<td>Facial nerve</td>
<td>Dampens down vibrations of stapes</td>
</tr>
</tbody>
</table>
Inner Ear
(labyrinth)
Internal acoustic meatus

Inner ear is situated in the petrous part of the temporal bone
The inner ear is divided into:
1- Bony labyrinth
2- Membranous labyrinth

The vestibule, the central part of the bony labyrinth
The membranous labyrinth is lodged within the bony labyrinth. It is filled with endolymph and surrounded by perilymph.
The duct of the cochlea lies within the bony cochlea.
Posterior semicircular canal
Posterior semicircular duct

Lodged within the canals are the semicircular ducts
Superior semicircular canal
Superior semicircular duct

Lodged within the canals are the semicircular ducts
Lateral semicircular canal
Lateral semicircular duct

Lodged within the canals are the semicircular ducts
Bony ampullae

Each canal has a swelling at one end called the **ampulla**
Membranous ampullae
Utricle

**Utricle and Saccule** are lodged in the bony vestibule
Utricle and Saccule are lodged in the bony vestibule
Vestibulo-cochlear nerve

Vestibular nerve  Cochlear nerve
Vestibular nerve originates from vestibule (saccule and utricle) and semicircular canals (ampullae)
Vestibular nerve carries impulses from the utricle, the saccule, and the ampullae of the semicircular ducts.
Cochlear nerve carries impulses from organ of Corti in cochlea (contains the sensory receptors for hearing)
Section through cochlea

- Scala vestibuli
- Cochlear duct (Scala media)
- Scala tympani
- Modiolus
- Lamina of modiolus
- Cochlear nerve
- Spiral ganglion
- Helicotrema
The auditory nerve (cochlear) carries the electrical signal to the brain, which turns it into a sound that we recognize and understand.
Transmission of sound

External acoustic meatus
Malleus
Incus
Helicotrema
Vestibulocochlear nerve [VIII]
Stapes
Oval window
Scala vestibuli
Cochlear duct
Spiral organ
Tympanic membrane
Round window
Scala tympani