**THE EAR**

**Anatomy of the ear**

The ear is divided to External, Middle and Inner ear.

**The external ear:**

* It composed of **auricle** (pinna) and the **external auditory meatus**.
* It’s function is to collect and transmit sound to the tympanic membrane.

**The auricle** is composed of cartilage covered with perichondrium to which the skin are very closely adherent.

The lateral surface has characteristic prominences and depressions which are different in every individuals even identical twins. the curved rim is ***helix***, anterior and parallel to it is another prominence, ***antihelix***. Superiorly this divided into two crura, between which is the ***triangular fossa***, above the two crura is the **scaphoid fossa**. In front of antihelix, and partly encircled by it, is the ***concha***  Below the crus of the helix and overlapping the external auditory meatus is the ***tragus***. Opposite to it at the inferior limit of antihelix is the ***antitragus***, below the antitragus is soft area composed of fibrous and adipose tissue called ***lobule***.

**The external auditory meatus**:  
 The outer third is cartilaginous, the inner two thirds are bony , the outer cartilagenous portion is covered with skin that contain hair follicles, sebaceous glands and cerminous glands which secrete wax.While these structures are lost in the inner bony meatus where the skin is thin and hair-free.

Owing to the tight union of cartilage and skin any inflammatory process will be extremely painful . The EU canal extends from the concha of the auricle to the TM is approximately 2.4 cm. The diameter of the canal varies greatly between individuals and between different races.

**The Tympanic membrane**

The tympanic membrane or ear drum is oval in shape and measures about 1cm in diameter and supported around its periphery by a fibrous thickening (the annulus).This fibrous annulus fits in turn into a slot in the tympanic bone.

Ther is small deficiency superiorly,called the **notch of Rivinus**.

Tne ear drum consists of ***three layers***:

**The outer layer**  is epithelial layer continous with the skin.   
**The middle layer**  which is fibrous layer  
**The inner layer** which is mucous layer continuous with the lining with tympanic cavity

The tympanic membrane is divided into two parts:  
**Pars tensa** and **pars flaccida**  
Pars flaccida is the most superior part occupying the notch of Rivinus and its medial layer is comprised of irregular elastic fibers hence the flaccidity, it is small sometime difficult to see, it called some time (attic),perforation in this area are potentially unsafe.

**The middle ear**  
 The middle ear is an air-containing cavity in petrous part of the temporal bone lined with mucous membrane ,it contain the auditory ossicles, it is narrow, oblique, slit like cavity whose long axis lies approximately parallel to the plane of tympanic membrane.   
It divided into:  
●Epitympanum→ upper most portion or attic above the level of the malleolar folds.  
●Mesotympanum→ middle portion  
●Hypotympanum→ lower portion

**Function of the middle ear**

Transmit sounds, which reach the TM in the form of air pressure waves ,to the inner ear where a liquid wave is set up.

The sound energy is transmitted across the middle ear by a chain of three bones malleus, incus and stapes called ossicles the ossicular chain together with the ear drum amplifies the sound energy

The middle ear has six portions:  
Roof  
Floor  
Anterior wall  
Posterior wall

Lateral wall  
Medial wall

**The roof**   
 Formed by a thin plate of bone, the tegmen tympani, which is part of petrous temporal bone. It separate the tympanic cavity from the meninges and temporal lobe of the brain in the middle cranial fossa.  
**The floor:**  
 Formed by a thin plate of bone, which may be deficient and may be replaced partly by fibrous tissue. It separate the tympanic cavity from the superior bulb of the internal jugular vein.

**The anterior wall:**  
 Is formed below by a thin plate of bone that separate 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 of these leads into the auditory tube (eustachian tube),and the upper and smaller is the entrance into the canal for the tensor tympani muscle,these canals are separated by a thin boney septum

**The posterior wall:**

Has in its upper part a large, irregular opening called the aditus to the mastoid antrum. Below this is a small, hollow, conical projection, the pyramid ,from whose apex emerges the tendon of the stapedius muscle.

**The medial wall:**  
 Is formed by the lateral wall of the inner ear. The greater part of the wall shows a rounded projection called the promontory, which result from the underlying first turn of the cochlea.  
 Above and behind the promontory lies the **fenestra vestibuli**, which is oval shaped and closed by the foot plate (base) of stapes.(oval window) ,on the medial side of this window is the prilymph of scala vestibule of the inner ear.  
 Below the posterior end of the promontory lies the **fenestra cochleae**. which is round and closed by the secondary tympanic membrane.(round window), on the medial side of this window is the prilymph of the blind end of scala tympani.

**The Ossicles**  
The auditory ossicles are: Malleus , Incus , Stapes

**The malleus** is largest ossicle, had a head, a neck, a handle or long process, an anterior process, and alateral process  
The head is rounded and articulate posteriorly with the incus. The neck is constricted part below the head.  
The handle passes downward and backward and firmly attach to the medial structure of the tympanic membrane, it can be seen through the tympanic membrane on otoscopic examination.

**The incus**  posses a large body and two processes  
 The body is rounded and articulates anteriorly with the head of malleus  
The long process descends behind and parallel to the handle of malleus. Its lower end bends medially and articulates with head of stapes. Its shadow on T.M can sometime be seen on otoscopic examination.

**The stapes** has a head, a neck, two limbs (crura) and a base (foot plate)   
 The head is small and articulates with the long process of incus.  
 The neck is narrow and receives the insertion of stapedius muscle  
 The two limbs diverge from the neck and attached to the oval base or foot plate  
 The foot plate is 3mm x1.4mm and it lies in the oval window.

**The Eustachian tube**   
 The auditory tube extends from the anterior wall of tympanic cavity downwards, forwards, and medially to the nasopharynx.  
Its posterior third is bony, its anterior two-third is cartilaginous.  
It serves to equalize pressure of air in tympanic cavity and nasopharynx.

**The inner ear:**

Called also the labyrinth, it consists of bony capsule that is almost embedded in the petrous part of temporal bone , ***it consists of***:

**Bony labyrinth**, comprising a series of cavities within the bone

**Membranous labyrinth**, comprising of series of membranous sacs and ducts contained within the bony labyrinth

**Bony labyrinth :** It consists of three parts :

1-The vestibule

2-The semicircular canals

3-The cochlea

They are lined by endosteum and contain a clear fluid called the perilymph

***The vestibule*** is the central part of the bony labyrinth .In its lateral wall is the fenestra vestibule (oval window) which is closed by the base of stapes, and the fenestra cochleae (round window) which is closed by secondary tympanic membrane. Logged within the vestibule are the saccule and utricle of the membranous labyrinth.

There are three ***semicircular canals***, superior, posterior and lateral-----open in posterior part of the vestibule by five orifices .The superior and posterior are vertical while the lateral semicircular canal is set in horizontal position

***The cochlea*** resembles a snail shell, it opens in the anterior part of the vestibule .It consists of a central pillar (the modiolus) around which a tube makes two and one half spiral turn. The cochlea is divided by a membrane into scala vestibule above and scala tympani below.

**Membranous labyrinth:** logged within the bony labyrinth and filled with endolymph and surrounded by perilymph and consists of utricle and saccule which are logged in the bony vestibule, also contain three semicircular ducts which lie within the bony semicircular canals, also contain the duct of cochlea which lie within the bony cochlea.

**Physiology of hearing**

Airborne sound consists of vibration of the atmosphere and the purpose of auditory apparatus is to convert this vibrations in air to vibrations in the inner ear fluid, and then to nerve impulses to be transmitted along the auditory nerve to the higher centers of hearing.

The auricle collect sound waves to some extent, then pass along the external auditory meatus to the tympanic membrane, the vibration of tympanic membrane are transmitted to the malleus, incus and stapes.

Then the sound transmitted to the oval window, causing the vibration to be set up in the endolymphatic and prilymphatic compartments of the inner ear, so the middle ear structure convert the sound from air to fluid.

The tympanic membrane is at its most efficient when the air pressure in the external auditory meatus and the middle ear is equal, and this equalization is achieved by the Eustachian tube.

Then the vibration transmitted to the inner ear produce displacement of the basilar membrane and shearing movement between the hair cell and tectorial membrane of the organ of Corti which initiates nerve impulse in the fibers of auditory nerve.

**Physiology of balance:**

The balance of the body is maintained by coordination of information from three systems;

1.proprioception. i.e sensations from muscles, joints, tendons and ligaments

2.the eyes

3.the vestibular system

The vestibular system consists of the semicircular canals, the utricle and the saccule. The semicircular canals respond to angular (rotatory) acceleration while the utricle and saccule respond to linear acceleration.