

## *The ear*

### **The external ear constitutes:**

- 1) The auricle (pinna).
- 2) The external auditory (acoustic) meatus.
- 3) The tympanic membrane (eardrum).

### ***The auricle***

- Is an oval cartilage attached to the side of the skull by anterior & posterior auricular ligaments.
- The skin is thin & well attached to the underlying perichondrium & prolonged inward into the external auditory meatus as far as the tympanic membrane.
- The cartilage is prolonged inward to be continuous with the a external 1 /3 of the EAM.
- Three auricular muscles are present to move the auricle' but their function is negligible in human.
- Vessels; posterior auricular & superficial temporal vessels.
- Nerves; great auncular, vagus and auriculotemporal nerves The supply of the auricle as mentioned.

### ***The eam :***

- Is 24 mm,in length
- Its lateral 1/3 is cartilagenous & directed upward & backward as it goes medially
- Its medial 2/3 is bony & directed downward & forward as it goes medially
- The bony canal is narrower than the cartilagenous
- The skin is adherent to the underlying bone & cartilage

- The narrowest part of the canal is the isthmus which is the junction between its two parts
- The skin of the cartilagenous part contains hair with sebaceous & ceruminous glands
- The EAM is bounded anteriorly by the TM joint & parotid gland & posteriorly by the mastoid process
- The inferior wall of the canal is 5 mm longer than the superior one due to the obliquity of the eardrum
- Vessels; as the auricle & deep auricular vessels.
- Nerves; auriculotemporal & auricular branch of the vagus nerves.

***The eardrum :***

- A nearly oval membrane 8X10 mm, set in a cone like shape whose concavity faces outward & its most concave point is its center "umbo"
- It is semitransparent, pearly grey in color
- It is applied in an oblique manner in the EAM so-that its lateral surface faces downward, forward & laterally making 55° angle with the floor
- Its circumference is a fibrocartilagenous ring set in the tympanic sulcus
- It is composed of three layers:
  - a) Outer layer of modified skin continuous with that of the EAM
  - b) Inner layer of m.m continuous with that of the middle ear
  - c) Intermediate fibrous layer formed of circular & radial fibers which is responsible for the strength of the membrane
- The upper 1/6 of the membrane lacks the intermediate layer so it is

lax & called pars flaccida, the rest of the membrane is called pars tensa

- The handle of the malleus is fused with the upper part of the membrane

### ***Applied anatomy :***

- In order to straighten the EAM in examination of the ear it should be pulled upward, backward & laterally in adults and downward, backward & laterally in children
- Wax of the external ear mostly affects the lateral 1/3 of the EAM
- In ear syringing, the nozzle should be directed forward at first then backward, upward & medially to avoid injury to the tympanic membrane
- Normal tympanic membrane is semitransparent & pearly grey with a cone of light in its antero-inferior part, a diseased membrane loses its shiny appearance & the cone of light'

### ***The middle ear :***

Is a small, six-walled cavity in the temporal bone where the sound waves are converted into mechanical waves

- The cavity is 15 mm in height, 15 mm in AP dimension but narrow from side to side where it is narrowest in the center (2 mm)but wider above & below (like a biconcave lens)
- The cavity communicates anteriorly with the nasopharynx via the Eustachian tube & posteriorly with the mastoid air cells through the aditus, their mucosal lining is continuous with each other & is respiratory in type

### **Parts :**

- a) Epitympanum "epitympanic recess OR attic"; the part of the cavity which extends above the level of the tympanic membrane
- b) Mesotympanum; the part of the cavity opposite to the eardrum
- c) Hypotympanum; the part below the level of the eardrum
  - Contents:
    - a) ONE nerve; chorda tympani
    - b) TWO muscles; tensor tympani & stapedius
    - c) THREE bones; incus, malleus & stapes

### ***Walls of the middle ear :***

#### **The roof :**

The roof of the tympanic cavity is formed by the thin plate of tegmen tympani which separates the ear from the cranial cavity "

#### ***The floor:***

- The floor of the middle ear separates the ear from the jugular fossa
- It is perforated by the tympanic branch of glossopharyngeal nerve

The lateral wall : (discussed)

#### **The medial wall :**

- The most prominent feature of the medial wall is the promontory of the internal ear which is the basal turn of the cochlea
- The promontory is grooved by branches of the tympanic plexus
- The oval window "fenestra vestibuli": is an oval opening above the promontory whose long axis is horizontal & maximum convexity is superior, it is closed in life by the footplate of the stapes
- The round window "fenestra cochleae"; lies below & behind the promontory & closed in life by the secondary tympanic membrane

- The facial canal seen in the medial wall as a prominence of bone above the oval window which then curves inferiorly & nearly vertically behind the promontory, the bone may be so thin in this area
- The prominence of the lateral semicircular canal sometimes a prominent ridge above the facial canal

### **The anterior wall :**

- This wall separates the middle ear from the carotid canal
- It is perforated by the coroticotympanic nerves which leaves the carotid plexus around the ICA to enter the tympanic plexus over the promontory
- In the upper end of the anterior wall lies the opening of the Eustachian tube
- Above the auditory tube opening lies the semicanal for tensor tympani muscle
- Tensor tympani, a 2cm long muscle which arises from the septum between the auditory tube & its canal & from the cartilagenous part of the tube gives rise to a slender tendon which hooks around the processus & then directed laterally to insert into the handle of the malleus, its contraction tenses the tympanic membrane by pulling the handle of the malleus medially resulting in dampening of its vibrations

### ***The auditory (Eustachian) tube :***

- This 3.5 cm long tube connects the cavities of the middle ear & nasopharynx
- Its tympanic 1/3 is osseous & pharyngeal 2/3 is cartilagenous
- The direction of the tube from the ear to the nasopharynx is downward, forward & medially making 45° angle with the sagittal

plane & 35° angle with the horizontal plane

- The mucosa of the middle ear therefore is continuous with that of the nasopharynx through the tube
- Mucous glands are present in the cartilagenous part whose pharyngeal end is surrounded by the tubal tonsils
- The tube is shorter, wider & more horizontal in children

### **The posterior wall**

- The upper part of the posterior wall is open to the mastoid antrum through the aditus ad antrum which is a large irregular opening leading from the middle ear to the mastoid antrum
- Fossa incudis lies below the opening of the mastoid antrum,- it lodges the short process of the incus
- The vertical facial canal lies medially in the posterior wall
- The pyramidal eminence;projects from the posterior wall in front of the facial canal, it is hollow structure whose walls give rise to stapedius muscle
- Stapedius arises from the pyramidal eminence, its tendon is inserted into the posterior part of the neck of the stapes, its contraction tilts the footplate of the stapes resulting in dampening of its effect on the internal ears (protective function)

### ***The mastoid air cells :***

- These are small bony cavities communicating with each other located within the mastoid process
- The first cell is the largest & called mastoid antrum which lies immediately behind the attic with which it communicates through the aditus ad antrum

- The size & number of mastoid air cells vary considerably, sometimes only few small cells are present within the mastoid & called sclerotic mastoid
- The mastoid process develop into a definite elevation only at the age of 2 years
- The lining mucosa is continuous with that of the tympanic cavity
- Three bones, the incus, malleus & stapes united by true synovial joints form a lever system which convert the vibrations of the tympanic membrane into mechanical energy represented by the pressure of the footplate of stapes on the oval window
- The fixation of these bones in the tympanic cavity is provided by:
  - 1) The attachment of the malleus handle to the eardrum
  - 2) The attachment of the stapedial footplate to the oval window
  - 3) The anterior & posterior ligaments of the bones

### **The malleus :**

- The bone's name is derived from its resemblance to a hammer
- The rounded head of the bone lies in the epitympanic recess
- The long handle is fused with the upper half of the tympanic membrane
- The head shows a posterior oval concavity which receives the incus in the incudo-malleal joint which is of the saddle variety
- The short anterior process is connected to the petro-tympanic fissure' of the anterior wall by a ligament

### **The incus :**

- The anterior part of the body of the incus has a concavo-convex facet for articulation with the malleal head
- The short process (posterior crus) extends posteriorly to lie in the

fossa incudis

- The long process (inferior crus) descends vertically parallel to the handle of the malleus to end in a rounded structure, the lenticular process which is received by the head of stapes in the incudostapedial joint which is of ball & socket variety

### **The stapes :**

- The head of stapes is hollowed for reception of the lenticular process of the incus
- The narrow neck receives posteriorly the insertion of stapedius
- Two crura diverge from the neck to attach the footplate
- The footplate closes the oval window to which it is attached by a ring like ligament

### ***Blood supply of the middle ear :***

#### **The arterial supply :**

- The main artery of the eardrum is the anterior tympanic branch of maxillary artery
- The main artery of the tympanic cavity, mastoid antrum & mastoid air cells is the stylomastoid branch of posterior auricular branch of the ECA together with the anterior tympanic branch of the maxillary artery
- Smaller branches from the ascending pharyngeal artery, middle meningeal artery, artery of pterygoid canal share in the supply of the middle ear



### ***The veins :***

- Are parallel to" arteries & drain to:

- 1) Superior petrosal sinus
- 2) Pterygoid plexus

### ***Nerve supply of the middle ear:***

The tympanic cavity, the deep surface of the tympanic membrane & mastoid air cells are supplied by the tympanic plexus.

Tympanic plexus:

An autonomic plexus formed at the promontory of the internal ear by contribution of :

- 1) The tympanic branch of glossopharyngeal nerve
- 2) Carotid sympathetic branches of the carotid sympathetic plexus

### ***Nerves in the middle ear:***

- 1) Facial nerve has part of its course in the medial & posterior walls of the tympanic cavity but this part does not contribute to ear supply
- 2) Chorda tympani traverses the tympanic cavity between its bones but also give no branch to the ear.

### ***Applied anatomy :***

- Communication between the nasopharynx & middle ear results in transmission of infections from the nose & pharynx to the ear so otitis media is one of the complications of upper respiratory tract infection which complicates children infections more than adults due to the shape of their tubes & the possibility of associated adenoids
- Communication between the middle ear & the mastoid air cells results in transmission of infection from the middle ear to the mastoid resulting in acute or chronic mastoiditis

- Facial nerve involvement may be associated with diseases of the middle ear (LMND), Bell's palsy
- The oblique position & concavity of eardrum is protective because it was vertical, it will be more susceptible to damage
- The sound waves are transmitted across the footplate of the stapes to the perilymph so it moves a membrane covered by nerve fibers leading to stimulation of the nerves & hearing
- \* Pars flaccida is more liable to damage than the rest
- \* When the footplate transmit the waves to the perilymph the excess pressure produced will be absorbed by secondary tympanic membrane
- \* Genuiculate nucleus lies at the angle of loop of facial nerve
- \* Chorda tympani at first run with facial n then it leaves it and pass through the cavity and leave it through the anterior wall
- \* Tendon of tensor tympani hooks ninety degrees from anterior wall to lateral wall of middle ear
- \* High intensity sound lead to reflex contraction of tensor tympani and elevation of footplate of stapes by contraction of stapedius
  - \* Tensor tympani protects middle ear
  - \* Stapedius protects inner ear

### **The inner ear :**

- The inner ear is the essential organ of hearing & equilibrium
- It consists of the membranous labyrinth which is filled with endolymph & located inside a similar bony structure, the bony labyrinth which is filled with perilymph
- The membranous labyrinth consists of the :
  - 1) Cochlear duct; is the snail like part of the inner ear responsible for

hearing

- 2) Interconnecting channels responsible for maintaining equilibrium:
  - a) The utricle & saccule; stimulated by linear acceleration
  - b) The semicircular ducts; stimulated by angular acceleration
  - c) The part of the bony labyrinth lodging the cochlear duct is named the cochlea
  - d) The part lodging the semicircular ducts is called the semicircular canals
  - e) The part lodging the utricle & saccule is called the vestibule

The bony labyrinth :

### ***The Cochlea***

- Resembles a snail shell formed of 2.5 turns & lies on its side
- It is the most anterior part of the bony labyrinth situated in front of the vestibule & internal acoustic meatus
- It is 0.5 cm in height & its basal turn measures 1 cm in diameter
- The central axis of it is called the modiolus' from which the spiral lamina arises & projects inside the cochlear turns & partially divides the cavity of the cochlea into scala vestibuli above the lamina & scala tympani below it
- The oval window opens into scala vestibuli & the fluid surge made by the 'pressure of the footplate of stapes' ascends to reach the summit of the cochlea (helicotrema) where it is transmitted to scala tympani which ends below in the secondary tympanic membrane occluding the round window
- Another opening in the basal turn of the cochlea opens to the inferior surface of the petrous bone called the cochlear aqueduct

### ***The Vestibule :***

- It is the middle part of the inner ear bounding the middle ear medially
- In its lateral wall the oval window opens to the tympanic cavity from which the stapedial footplate closes this window
- Vibration of the footplate of the stapes results in fluid surge in the perilymph of the vestibule

### ***The Semicircular Canals :***

- Are three, anterior (superior), posterior & lateral
- They lie above & behind the vestibule & behind the internal acoustic meatus
- Each canal describes a greater part of a circle whose diameter is 1 mm & has a dilatation in one end called the ampulla
- The canals are perpendicular to each other, the superior is vertical & lies transverse to the long axis of the petrous bone, the posterior, also vertical, lies in the long axis of the bone while the lateral lies horizontally so its convexity lies laterally making a bony bulge in the medial wall of the middle ear
- Only five opening. of the SCC opens into the vestibule since the posterior end of the anterior canal opens in the posterior SCC in the crus commune
  - The sensory organ of the cochlear duct is the spiral organ of Corti
  - The sensory organ of the SCC is the crista
  - The sensory organ of the utricle & saccule is the macula
  - The specialized cells in each sensory organ are the hair cells

***Arteries of the labyrinth :***

- The main artery is the labyrinthine branch of the basilar artery
- The stylomastoid branch of the posterior auricular artery supplies some of the blood

***Veins of the labyrinth :***

Similar to arteries & drain to the inferior petrosal sinus