Anatomy of the Ear

The ear is divided into three parts:

1- External ear, consisting of auricle & external auditory canal.
2- Middle ear.
3- Inner ear, consisting of vestibule, semicircular canals & cochlea.

External Ear

Auricle

The auricle or pinna is a fibro-cartilaginous sheet attached to the side of the skull. Its lateral surface is concave & presents a number of features. The rim of the auricle is called the helix. The crest which is just in front of & parallel to the helix is called the antihelix. Between them, the helix & antihelix enclose a depression, called the scaphoid fossa. The upper end of the antihelix is bifurcated to hold the triangular fossa. The big depression in the auricle is the concha. Tragus guards the concha anteriorly. Antitragus bounds the concha posteriorly. Between the tragus & antitragus, there is a notch, called the inter-tragic notch. Lobule (composed only of fat & fibroareolar tissue) which hangs the lower end of the auricle.

Blood Supply: The auricle is supplied by the superficial temporal artery, posterior auricular artery, & twigs from the occipital artery.

The auricular veins drain into the veins accompanying the auricular arteries.

Nerve supply: The greater auricular nerve (C2&C3) supplies sensations to the lower end third of the lateral surface & to the lower tow thirds of the medial surface of the auricle. The surface is sub- rest of the lateral served by the lesser occipital nerve (C2).

External Auditory Canal

The external auditory canal, an inch in length, extends from the concha to the eardrum & consist of two parts. The outer one third is made of cartilage & called cartilaginous part. The inner two thirds is made of bone & called the bony part. During its course, it describes a sigmoid course. Its outer third goes medially, forwards & slightly upwards. Its middle third courses medially, backwards, & slightly upwards. Its inner third traverses medially, forwards & downwards. The cross-section of the canal is oval with its long axis directed downwards & backwards & measures 9-10 mm. This is, however, reduced considerably at the isthmus, a point which is half a centimeter from the ear drum. And also at the junction of the cartilaginous & bony parts.

Lining: It is lined by the skin which differs in detail in its two parts. While the hair-follicles & sebaceous glands occur in abundance in the cartilaginous part, they are absent from the bony part. Moreover, the skin of the cartilaginous part is more closely adherent to the underlying tissues than that of the bony part.

Blood Supply: It is supplied by the anterior, posterior & deep auricular vessels.

Lymph Drainage: It drains into the anterior, posterior & inferior auricular lymph glands.

Nerve Supply: The sensations from its anterior half are carried by the auriculo-temporal nerve. Those from its posterior half are conducted in the auricular branch of the vagus nerve (Arnold's nerve).

Middle Ear

The middle ear is like a match box with six sides, namely:

1- The roof is formed by the tegmen tympani which separates it from the temporal lobe of the brain.

2- The floor is formed by the upper aspect of the fossa for the superior bulb of the internal jugular vein.

3- Anterior wall: The lower half of the anterior wall is related to the internal carotid artery in the carotid canal & is perforated by the caroticotympanic arteries. In its upper half, it has two openings. The upper opening is the opening of the canal for tensor tympani muscle. The lower opening is the tympanic orifice of the auditory tube.

4- Posterior wall: separates the middle ear from the mastoid bone. It contains the aditus which leads to the mastoid antrum.

5- Medial wall: In it there are two openings, the upper of which is the oval window & the lower is the round window which is closed by the secondary tympanic membrane. In front of & between these two windows lies the promontory (basal turn of the cochlea). The surface of it is grooved for the nerve fibers of the tympanic plexus. The horizontal portion of the facial nerve is enclosed in a bony canal(Fallopian canal), which is sometimes deficient, & which crosses the medial wall above the oval window. Situated just above the bend of this canal is the eminence of the lateral semicircular canal.

6- Lateral wall: is the partly membranous (tympanic membrane) & partly bony which is the outer attic wall.

The tympanic membrane represents the first closing membrane of the embryo. It separates the external auditory canal from the middle ear cleft. The tympanic membrane is thin & when examined with an auriscope has a pearly grey colour with a triangular bright area, the cone of light, extending from the center (umbo) downwards & forwards. Its dimensions are 8rnrnx9rnmx0.1. It is placed obliquely so much so that it makes an angle of 45 degree with the floor of the external auditory canal.

Short process of the malleus is a small knuckle in the middle of the upper part of the ear drum. Anterior & posterior malleolar folds run forwards & backwards from it. Handle of the malleus descends downwards & backwards from it. That part of the tympanic membrane which is situated above the two malleolar folds is flaccid & called the pars flaccida. The rest of the ear drum is tense & known as pars tensa. The ear drum is made of three layers

1- Outer layer of squamous epithelium continuous with that of the meatus.

2- Middle layer of fibrous tissue which has radiating & circular fibers which is absent in pars flaccida.

3- Inner layer of mucous membrane continuous with the lining of the tympanic cavity.

The middle ear contains

1- Air

2- Muscles (tensor tympani & stapedius)

3- Bones (ossicles)

a- Malleus b- Incus c- stapes

Blood Supply: The middle ear is supplied by the deep auricular branch of the maxillary artery, branches from stylomastoid, middle meningeal, ascending pharyngeal & internal carotid arteries. The veins drain into the pterygoid plexus & the superior petrosal sinus.

Lymph Drainage: The lymphatics mainly drain into the retropharyngeal & parotid glands.

Nerve Supply: The main sensory nerve of the middle ear is the tympanic branch of the glossopharyngeal nerve.

Eustachian tube (auditory tube)

It is 36mm long, divided into an outer bony third & an inner cartilaginous two thirds. It extends from the anterior wall of the middle ear to the lateral wall of the nasopharynx. Its only function is to equalize the air pressure on the two sides of the ear drum.

Mastoid Air Cells

Are tiny air containing compartments in the mastoid temporal bone. These are divided into a number of topographical groups, such as

1- Antrum
2- Mastoid tip cells
3- Zygomatic cells
4- Squamous cells
5- Petrous apex cells
6- Perisinus cells
7- Perilabyrinthine cells
8- Retrofacial cells
9- Subdural cells

Inner Ear

The inner ear lies in the temporal bone. It is called the labyrinth (from its complexity)& consist of:

Osseous labyrinth

A series of cavities in the petrous part of the bone. There are three main parts:

1- Vestibule

Placed between the medial wall of the middle ear & the lateral end of the internal auditory canal. A small aperture in the posterior part of the medial wall of the vestibule leads into the aqueduct of the vestibule, a canal which passes backwards to the posterior surface of the petrous bone, where it opens under the dura. The fenestra ovali, in the lateral wall of the vestibule, is closed to the middle ear by the footplate of the stapes & its annular ligament.

2- Bony Semicircular Canals

Three in number on each side.

a- Superior Canal. Lies almost transverse to the long axis of the petrous. b- Posterior Canal. Lies in a plane parallel to the posterior surface of the petrous. c- Horizontal Canal. Lies in the angle between the superior & posterior canals.

3- Bony Cochlea

Lies in front of the vestibule. It resembles a snail shell in shape, & has 2.5 turns in the human. It has a central axis, the modiolus, which forms the inner wall of the bony canal of the cochlea, which is wound spirally round it. The osseous spiral lamina projects from the modiolus into the canal.

The osseous labyrinth contains perilymph in which the membranous labyrinth is situated. The composition of the perilymph is very similar to that of extracellular fluids.

Membranous Labyrinth

A continuous series of communicating sacs & ducts within the bony cavities. It consists of:

1- Saccule & Utricle, in the vestibule.

2- Membranous Semicircular ducts, in the bony semicircular canals.
3- Cochlear Duct (scala media) in the bony cochlea.

The membranous labyrinth contains endolymph fluid. The endolymph contains a very high concentration of potassium & a low sodium content, similar to that of intracellular fluids.

The basilar membrane stretches from the free border of the osseous spiral lamina to the outer wall of the bony canal of the cochlea.

Reissner's membrane extends diagonally from the osseous spiral lamina to the outer wall of the bony cochlea.

Sensory cells concerned with hearing are contained in the cochlear duct (scala media), a portion of the membranous labyrinth which lies between Reissner's membrane & the basilar membrane & ends blindly at the helicotrema. The scala media contains endolymph.

The scala vestibule & scala tympani lie above the scala media respectively & both contain perilymph. They communicate with each other at the helicotrema.

The scala vestibuli communicates functionally with the middle ear through the oval window, the scala tympani through the round window.

Organ of Corti

Consists of a series of epithelial structures arranged along the inner edge of the basilar Membrane. A tunnel, composed of two rows of rods of Corti, & forming a triangle with the basilar membrane, divides the organ into inner & outer portions. The tunnel contains a fluid called cortilymph.

On the inner side of the inner rod there is a single row of hair cells, the hair of each cell consisting of 120 sterocilia. On the outer side of the outer rod there are 3-4 rows of hair cells, the outer hair cell contains 46-148 stereocilia.

The Tectorial membrane overhangs the organ of Corti. Outside the outer hair cells are the cells of Hensen(supporting cells). Lining the outside of the scala media is the stria vascularis. Thickened endosteum lining the outer wall of the bony canal of the cochlea is called the spiral ligament.

Cochlear Division of the Eighth Cranial Nerve

The terminal fibers end in contact with the hair cells. These fibers are of two types:Type l fibers, sparsely granulated & probably afferent: and Type 2 fibers, richly granulated & probably efferent. The fibers pass in the spiral lamina to the spiral ganglion in the modiolus, to become the auditory branch of the eighth cranial nerve.

Anatomy of the Vestibular Labyrinth

The vestibular labyrinth is situated behind the cochlea within the petrous bone. It consists of a system of membranous sacs & ducts within the bony vestibule and semicircular canals. The three semicircular ducts open into the utricle by five separate openings .

Membranous semicircular ducts open into the posterior part of the utricle, which communicates indirectly with the saccule through the endolymphatic duct. This duct occupies the bony aqueduct of the vestibule and divides into two branches, which separate to open into the saccule & utricle. The endolymphatic duct has an initial dilatation, the sinus before it narrows at the isthmus, to enter the bony aqueduct.

Vestibular Division of Eighth Cranial nerve

Vestibular Receptor Organs. These are the ampullary crista & utricular maculae (otolith organ). The axis cylinders of the nerve fibers ramify round the hair cells of the receptor

organs. The fibers are gathered together to form the vestibular nerve, which passes through the internal auditory canal.

Blood Supply of the Labyrinth

The blood supply of the labyrinth is derived principally from the internal auditory artery, which arises usually from the anterior inferior cerebellar artery, sometimes directly from the basilar artery.