EAR

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Specialized for hearing and equilibrium. It consists of three parts:

**External ear:** receives the sound waves.

**Middle ear:** transmits the waves from air to bone, and by bone to the inner ear.

**Internal ear:** the vibrations are transduced to specific nerve impulse which pass through the acoustic nerve to the C.N.S.
EXTERNAL EAR

Auricle (Pinna):
Irregular shaped plate of elastic cartilage, covered by tightly adherent skin on all sides. There is a large number of fat cells present in the subcutaneous tissue of the lower part of the lobe of auricle.

External auditory meatus:
Flattened canal extends from the surface into the temporal bone, and its internal limit is the tympanic membrane. It is lined by stratified seq. epith., (skin) which is thick in the outer part of the canal, and contains hair, sebaceous glands, and ceruminous glands in the sub mucosa. The inner part of the canal has thin skin, with no hair or glands.
Ceruminous glands
are modified apocrine sweat glands, coiled tubular glands, produce a brownish semisolid mixture of fat and wax; the cerumen(ear wax). The wall of the external auditory meatus is supported by elastic cartilage in its outer third, while the inner part is supported by the temporal bone.
Tympanic membrane (ear drum):
An oval membrane that lies at the deep end of the external auditory meatus. Its external surface is covered by a thin layer of epidermis, while the inner surface is lined by simple cuboidal epith. Between these two epith. coverings, is a tough C.T. layer composed of collagen and elastic fibers and fibroblasts.
The anterior upper quadrant of the tympanic membrane is more transparent because the C.T. layer is much thinner. Tympanic membrane transmits sound vibrations to the ossicles of the middle ear.
MIDDLE EAR (TYMPANIC CAVITY)

It lies inside the temporal bone, as an irregular space between the tympanic membrane and the boney surface of the internal ear. It communicates anteriorly with the pharynx by the auditory tube (Eustachian tube), where the epith. change into pseudostratified columnar epith., and posteriorly with the air filled cavities of the mastoid process of the temporal bone.

Middle ear is lined by simple seq. epith., resting on the thin lamina propria strongly adherent to the periosteum.
Eustachian tube (pharyngotympanic tube) opens during the process of swallowing to balance the pressure of air in the middle ear with atmospheric pressure. It has narrow lumen, and surrounded at the tympanic end by bone, and supported for the rest of its course by hyaline cartilage. It is lined by columnar ciliated epith. in the boney part, then change into stratified ciliated with goblet cells at the pharyngeal part. The stroma contains lymphocytes, mucous and serous glands.
**Round window:** an opening at the medial wall of the tympanic cavity, at its lower part. It is closed by thin C.T. membrane, covered on the tympanic side by mucous membrane, and on the cochlear side by single seq. cell layer. It separates the tympanic cavity from scala tympani of the cochlea.

**Oval window:** an opening at the upper part of the medial wall of the tympanic cavity. It is closed by the foot plate of the stapes. It separates the tympanic cavity from scala vestibule of the cochlea.

**Ossicles:** three small bones; **malleus, incus, and stapes.** They transmit mechanical vibrations from tympanic membrane to the inner, ear. Malleus is inserted to the tympanic membrane by its handle, incus head is articulated with the head of the malleus, These, bones are articulated by synovial joints, and covered by simple seq. epith.
INTERNAL EAR
Composed of two labrynthhs:

1- **Boney labyrinth**: a series of spaces within the petrous temporal bone, includes:

Vestibule, semicircular canal, and cochlea.

2- **Membranous labyrinth**: a continuous epith. lined series of cavities found within the boney labyrinth, include:

Utricle and sacule: enclosed within the vestibule.
Semicircular ducts: within the semicircular canals
Cochlear duet: within the cochlea.
The boney labyrinth is filled with perilymph, which is similar in ionic composition to the extra cellular fluid, with very low protein contents. The membranous labyrinth contains the endolymph, with low Na+ and high K+ contents, and low protein concentrations.
Membranous labyrinth

Saccule and Utricle:
A thin sheath of C.T. lined by simple seq. epith. In the wall of the sacule and utricle, a small regions; the maculae, represents a differentiated neuroepith. Cells that innervated by branches of the vesibular nerve. The macula of the sacule lies in the floor, while that of the utricle lies at the lateral wall.
The macula is a thickening in the wall, which consists of the following cells:

1- **Receptor cells**: flask shaped with the nucleus in the expansion area. They have tuft of microvilli; 40-80, and one cilium on the free surface. The cilium is immotile. These cells have dense terminal web, numerous mitochondria, well developed Golgi apparatus, and large numbers of S.E.R. Receptor cells are of two types; type I, and type II cells. Both types have efferent nerve endings of the inhibitory type.
2- **Supporting cells:** they are dispersed in between hair cells, columnar in shape, where the nucleus lies at the base, and microvilli on the apical part.

The neuroepithelium cells are covered by thick gelatinous glycoprotein layer that secreted by supporting cells, with surface deposits of crystals made of calcium carbonate (otolith), or otoconia.
Semicircular ducts:

Have the same structure of the boney labyrinth. The receptor area present in their ampulla, have an elongated ridge like form called **cristae ampullaris**. The ridge is oriented perpendicularly to the long axis of the duct. Cristae are structurally similar to maculae, but their glycoprotein layer is thicker, and has a conical form called **cupula**, and not covered by otolith. The cupula extends from ampullae in contact with its opposite wall.
**Cochlear duct:**

A diverticulum of the saccule, 35mm long, surrounded by specialized perilymphatic spaces. The cochlea (boney labyrinth) is divided into three spaces:

**Scala vestibule:** above.

**Scala media**(cochlear duct).

**Scala tympani:** bellow.
The cochlear duct which contains endolymph, ends blindly at the apex of cochlea. The other two scalae contain perilymph. They are really one long tube, beginning at the oval window and terminating at the round window. They communicate at the apex of the cochlea through an opening called helicotrema.
Hisotology of the cochlear duct:

Vestibular (Reissners ) membrane: consists of two layers of seq. epith.; one derived from cochlear duct, and the other is derived from lining of scala vestibule.

Stria vascularis: a vascularised epith. at the lateral wall of the cochlear duct, consists of three types of cells; marginal, interniediate, and basal cells.
Organ of Corti: consists of hair cells which respond to different sound frequencies. It rests on a thick layer of amorphous ground substance; the basilar membrane, which contains keratin fibers. Hair cells are arranged as 3-5 rows outer hair cells, which have W shaped arrangement of stereo cilia, and one row of inner hair cells, with a linear arrangement of stereo cilia..
A basal body is found in the cytoplasm, adjacent to the tallest cilia. The apical cytoplasm contains numerous fine filaments, which give stiffness to the cell. The tip of the tallest cilia of the inner hair cells are embedded in the tectorial membrane; a glycoprotein rich secretion of certain cells of spiral limbus. **Pillar cells** are one type of supporting cells that contains large number of microtubules, they outline a triangular space between outer and inner hair cells called the **inner tunnel**
Endolymphatic duct and sac:
The duct initially lined by simple seq. epith. then gradually become columnar cells of two types: one with microvilli on its apical surface, with many pinocytotic vesicles, and vacules, for absorption of endolymph and endocytosis of foreign materials, and cellular remnants in endolymph.

Boney labyrinth
Spaces in the temporal bone. There is a central, irregular cavity; the vestibule hosting the saccule and utricle. Posteriorly, the three semicircular canal and anteriorly , the cochlea.
The cochlea is about 35mm in total length, with 2.5 turns around a boney core; the **modioulus**.

The modioulus has spaces within it containing blood vessels, and cell bodies of **spiral ganglia** and its fibers. The boney wall of vestibule and semicircular canals is lined by several layers of flattened C.T. cells, forming the mesothelium. From this layer, a thin trabeculae of fibers and fibroblasts extend to the outer wall of utricle, saccule and semicircular, ducts to support them. Blood vessels are also found in this C.T.