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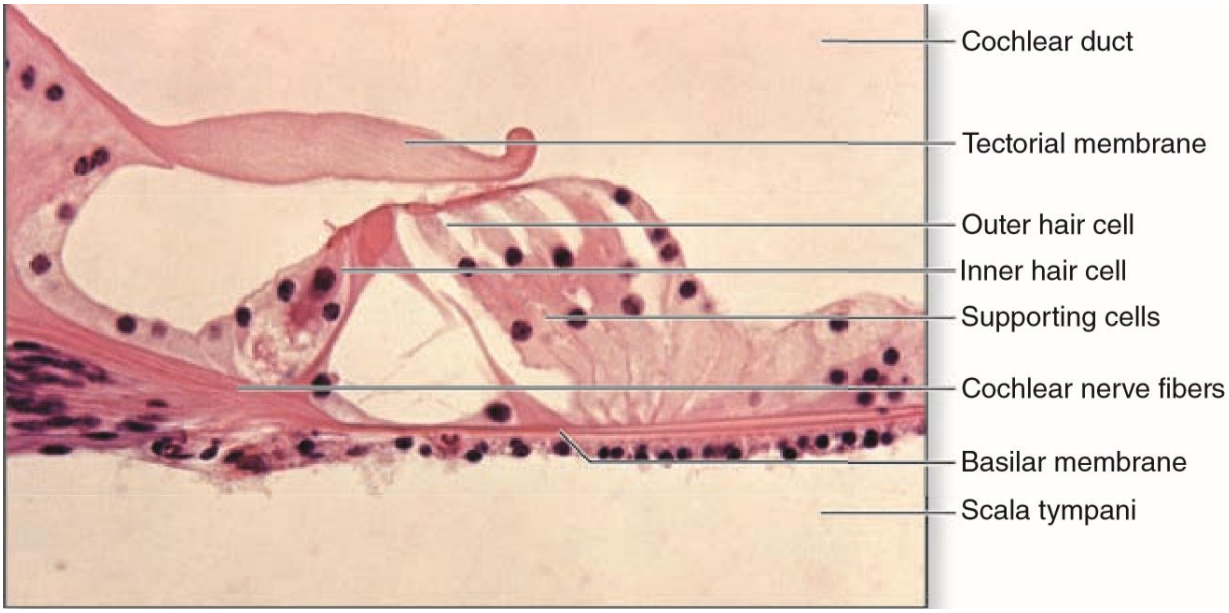
HISTOLOGY OF THE ORGAN OF CORTI (Spiral Organ)

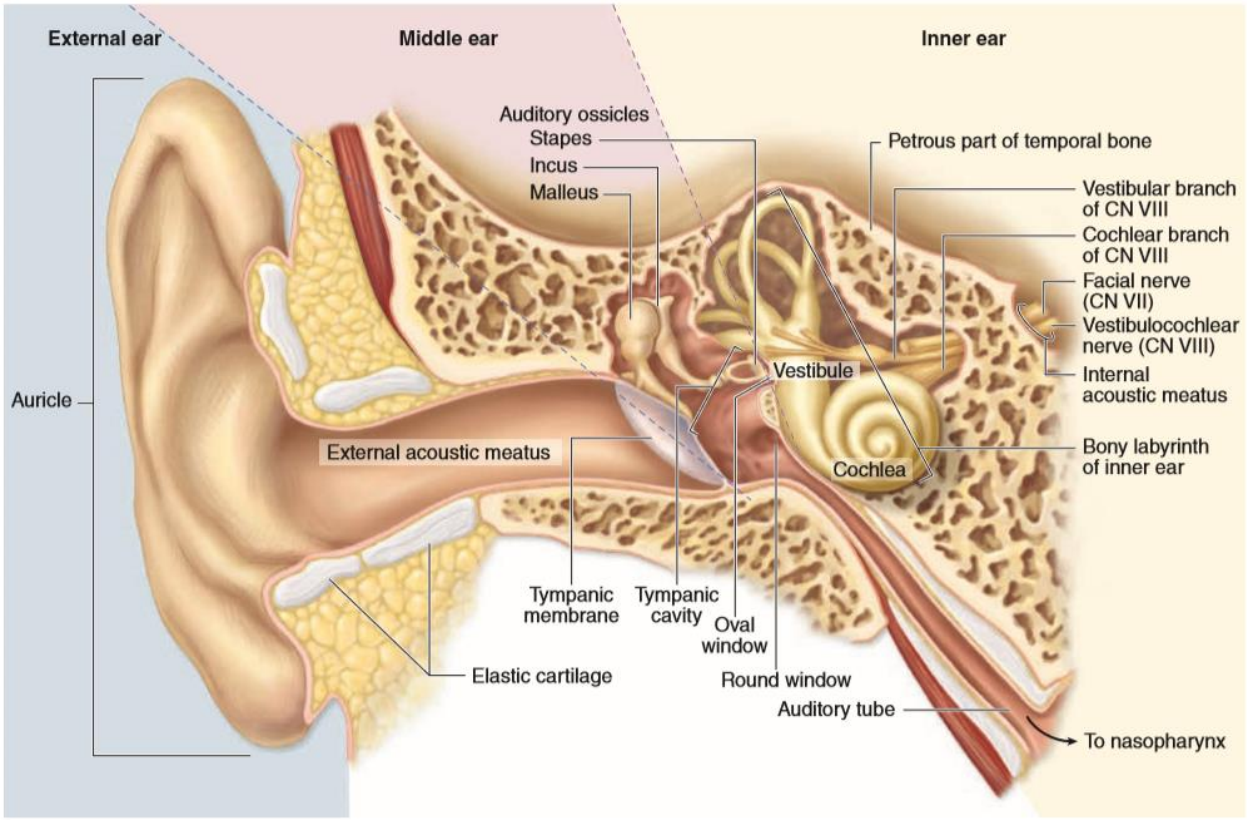
The Organ of Corti is a part of the cochlea; a part of the inner ear, and it mediates the sense of hearing transducing pressure waves to action potentials. This structure is localized in the cochlear duct (scala media) and it is formed by a series of hair cells, nervous terminations of spiral ganglion and supporting cells. They are arranged in the basilar layer of the cochlear duct.



GROSS ANATOMY

The cochlear duct is located between scala tympani and scala vestibuli and it is filled with **endolymph**. This structure is delimited by the basilar membrane inferiorly and Reissner's membrane superiorly. The Organ of Corti covers the basilar membrane and it is under the **tectorial membrane**, an acellular gelatinous mass extending over the organ of Corti from the connective tissue around the **modiolus**, into which hair cell stereocilia are immersed. The tectorial membrane consists of fine bundles of collagen (types II, V, IX, and XI) associated with

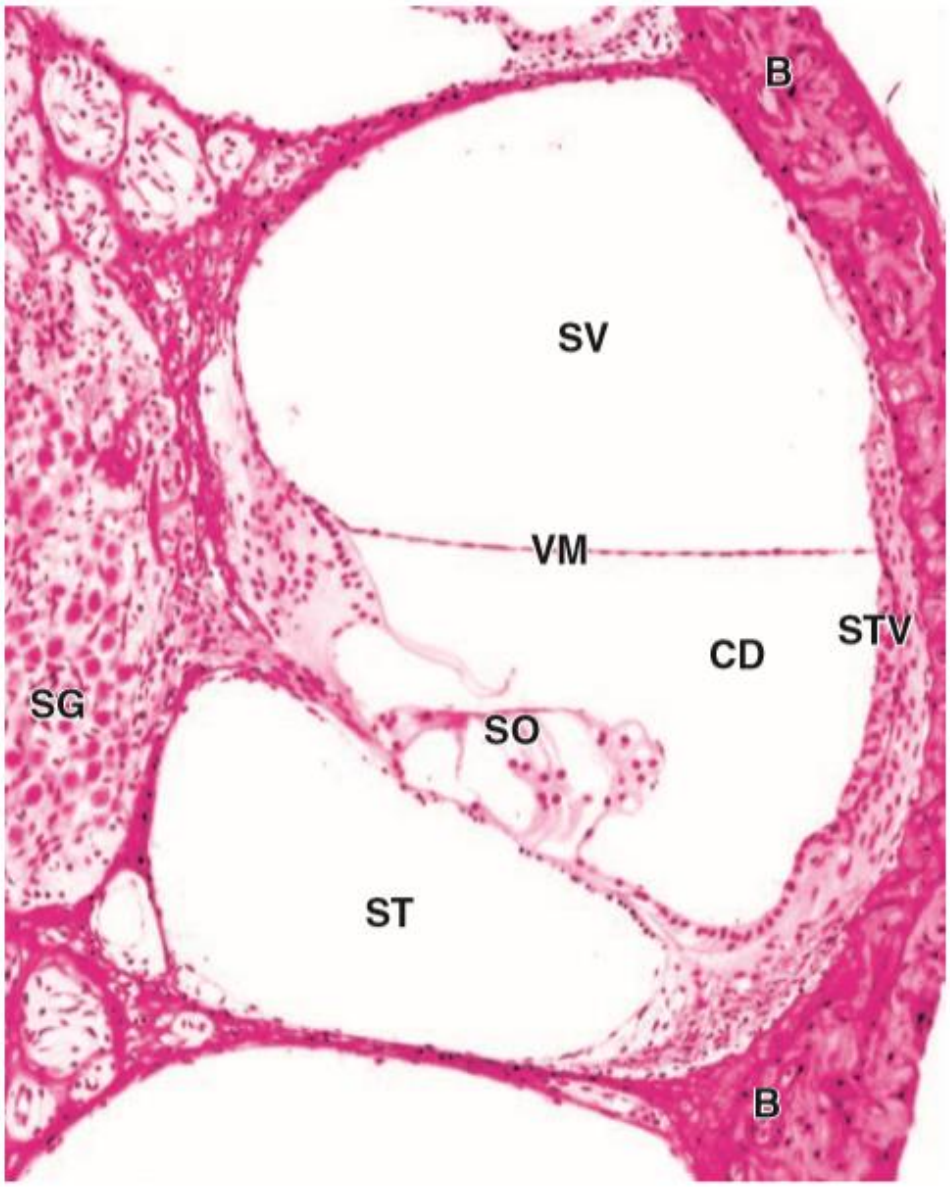
proteoglycans and forms during the embryonic period from secretions of cells lining this region. The peripheral process of acoustic nerve fibers provides synaptic connections between hair cells and cochlear nucleus.
The lateral wall of the cochlear duct is formed by the **stria vascularis**, which contains numerous capillary loops and small blood vessels and produces endolymph.



HISTOLOGY

The organ of corti is made up of epithelial cells that are arranged in a complicated manner. The cells are divisible into the true receptor cells or hair cells, and supporting elements which are given different names depending on their location. Cells of the organ of corti include;

- Inner hair cells
- Outer hair cells
- Supporting cells



The spiral organ (**SO**) or organ of Corti lies within the cochlear duct (**CD**), or scala media. This duct is filled with endolymph produced in the stria vascularis (**STV**), an unusual association of epithelial cells and the capillaries in the periosteum of the bone (**B**). On either side of the cochlear duct are the scala vestibuli (**SV**) and scala tympani (**ST**), which are filled with perilymph and are continuous at the apex of the cochlea. The vestibular membrane (**VM**) separates perilymph in the scala vestibuli from endolymph in the cochlear duct. Cell bodies of bipolar neurons in the spiral ganglion (**SG**) send dendrites to the hair cells of the spiral organ and axons to the cochlear nuclei of the brain. (X25; H&E)

Supporting Cells

These cells are of four different types:

- Corti pillars (rod cells)
- Hensen cells
- Deiters cells (phalangeal cells)
- Claudius cells

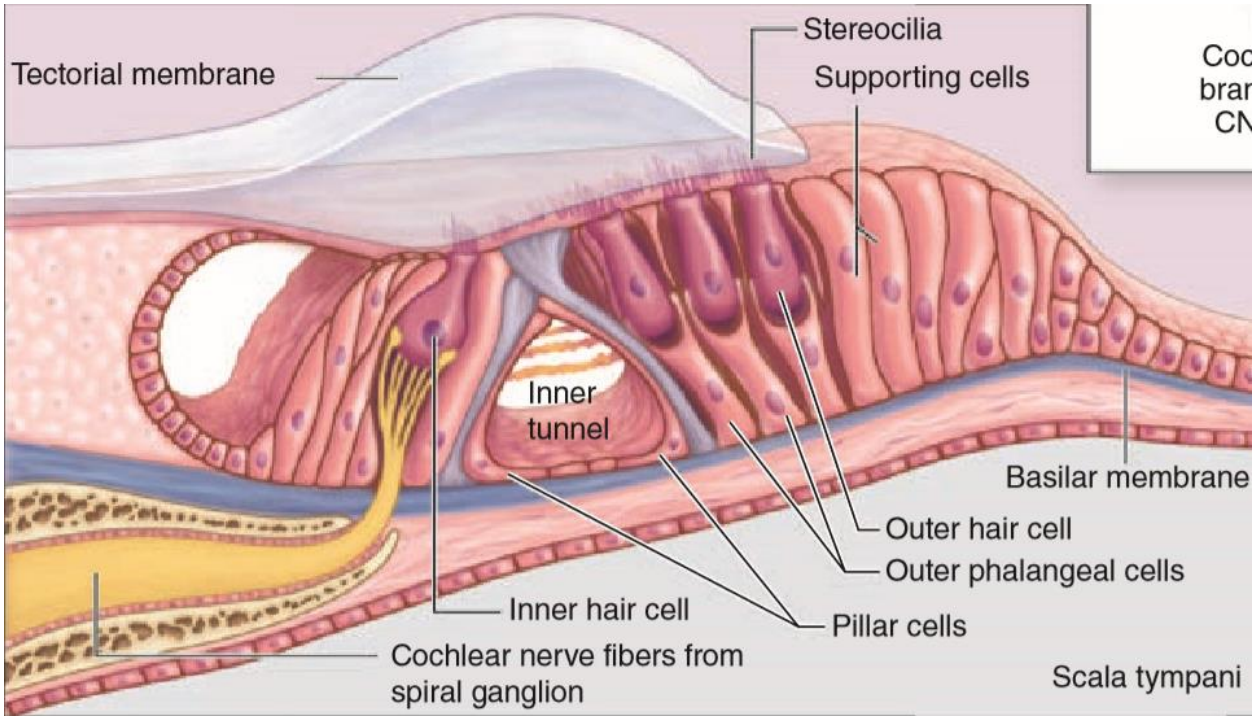
A V-shaped tunnel called the tunnel of Corti, is situated between the inner and outer **rod cells** and contains a fluid called cortilymph. The base of the tunnel lies over the basilar membrane. To the internal side of the inner rod cells there is a single row of inner hair cells. The inner hair cell is supported by tall columnar cells called inner **phalangeal cells**. On the outer side of each external rod cell there are three or four rows of outer hair cells. The outer hair cells do not lie directly on the basilar membrane, but are supported by the outer phalangeal cells (of Dieters) which rest on the basilar membrane. The uppermost parts of the heads of the phalangeal cells are expanded into horizontal plates called the phalangeal processes. These processes join similar processes of neighboring cells to form a continuous membrane called the **reticular lamina**. To the outer side of the outer hair cells and the phalangeal cells, there are tall supporting cells (**Hensen cells**). Still more externally the outer spiral sulcus is lined by cubical cells (**Claudius cells**).

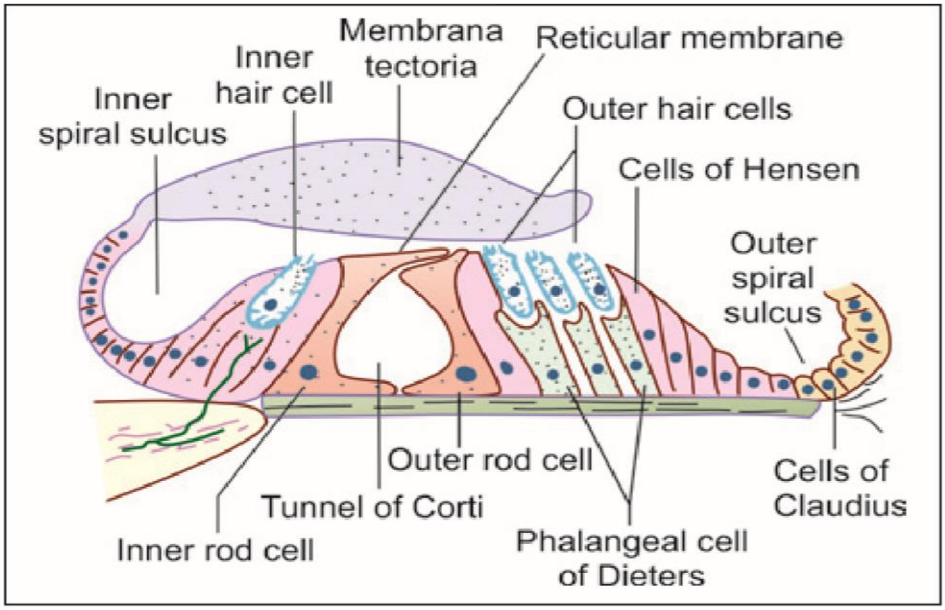
Hair Cells

These important receptor cells of hearing transduce sound energy into electrical energy. They possess hairs (stereocilia) on their apical surface. The hair cells are distinctly shorter than the rod cells. Their apices are at the level of the reticular lamina. Their lower ends (or bases) do not reach the basilar membrane. They rest on phalangeal cells. The plasma membrane at the base of each hair cell forms numerous synaptic contacts with the terminations of the peripheral processes of neurons in the spiral ganglion. Some efferent terminals are also present. The apical surface of each hair cell is thickened to form a cuticular plate the edges of which are attached to neighboring cells. There are two types of hair cells

- ***Inner hair cells***: Inner hair cells form a single row and are richly supplied by afferent cochlear fibers. These are flask-shaped cells and relatively short. They are very important in the transmission of auditory impulses. Their nerve fibers are mainly afferent.
- ***Outer hair cells***: Outer hair cells are arranged in three or four rows and mainly receive efferent innervation from the olivary complex. These are long cylindrical cells which modulate the function of inner hair cells. Their nerve fibres are mainly efferent. The lower end of each outer hair cell fits into a depression on the upper end of a phalangeal

cell, but the inner hair cells do not have such a relationship. The ‘hair’ of the outer hair cells are somewhat longer and more slender than those on inner hair cells.

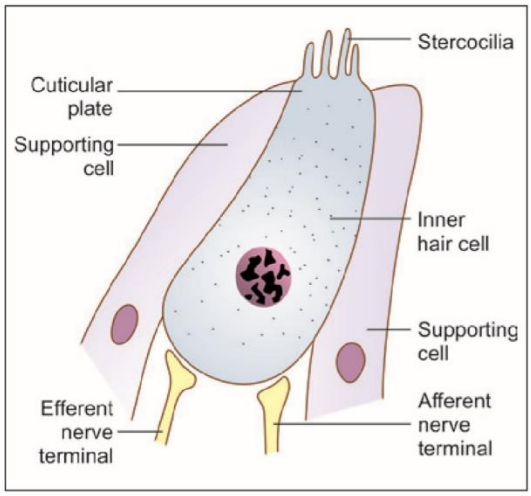




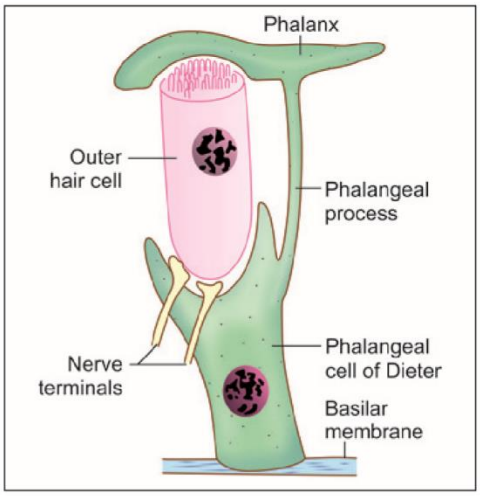
Organ of Corti

Difference between inner hair cells and outer hair cells

	Inner hair cells	Outer hair cells Cells
Numbers	3500	12000
Rows	One	Three or four
Shape	Flask	Cylindrical
Nerve supply	Mainly afferent fibres	Mainly efferent fibres
Development	Early	Late
Function	Transmit auditory stimuli	Modulate function of inner hair cells
Ototoxicity	More resistant	More sensitive and easily damaged
High intensity noise	More resistant	More sensitive and easily damaged
Generation of otoacoustic emissions	No	Yes



Inner hair cell



Outer hair cell

FUNCTION OF THE ORGAN OF CORTI

During the process of hearing, movements of the basilar membrane produces forces that result in friction between the 'hairs' of hair cells against the tectorial membrane. This friction leads to bending of the 'hairs'. This bending generates nerve impulses that travel through the cochlear nerve to the brain. The presence of efferent terminals on the hair cells probably controls the afferent impulses reaching the brain. It can also lead to sharpening of impulses emanating from particular segments of the spiral organ by suppressing impulses from adjoining areas. It has to be remembered that the transverse length of the basilar membrane is not equal in different parts of the cochlear canal. The membrane is shortest in the basal turn of the cochlea, and longest in the apical turn (quite contrary to what one might expect). Different segments of the membrane vibrate most strongly in response to different frequencies of sound thus providing a mechanism for differentiation of sound frequencies. Low frequency sounds are detected by hair cells in the organ of Corti lying near the apex of the cochlea, while high frequency sounds are detected by hair cells placed near the base of the cochlea.