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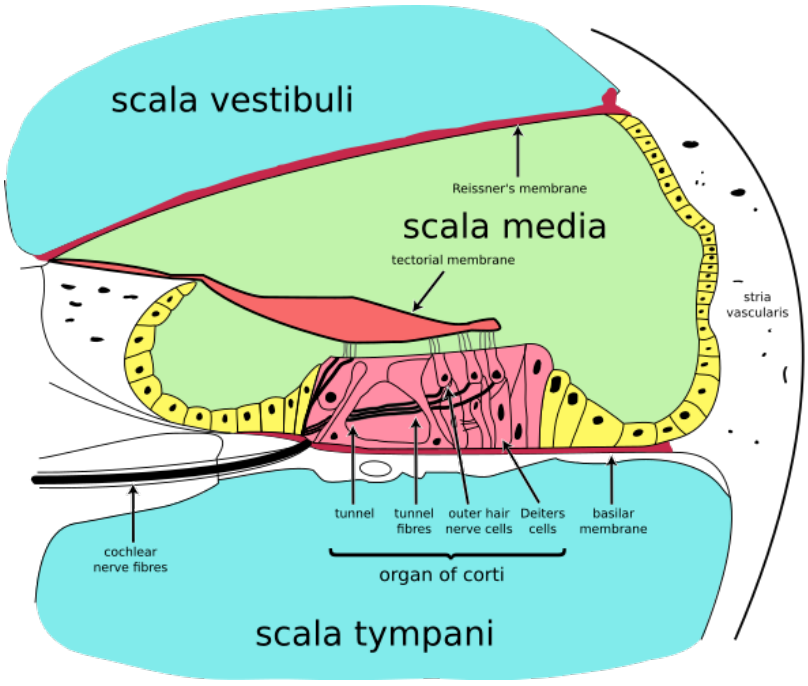
Question

With the aid of a diagram, write an essay on the histology of an organ of Corti

HISTOLOGY OF THE ORGAN OF CORTI



The organ of Corti, or spiral organ, is the specialised receptor organ for hearing and is located in the cochlea. This highly varied strip of epithelial cells allows for transduction of auditory signals into nerve impulses' action potential. Transduction occurs through vibrations of structures in the inner ear causing displacement of cochlear fluid and movement of hair cells at the organ of Corti to produce electrochemical signals.

STRUCTURE

The organ of Corti is located in the scala media of the cochlea of the inner ear between the vestibular duct and the tympanic duct. The organ of Corti contains:

-A single row of inner hair cells

-Three rows of outer hair cells that have stereocilia (but no kinocilium) on their apical border

-Supporting cells: (Pillar cells, Phalangeal cells, Border cells, Cells of Hensen)

Strategically positioned on the basilar membrane of the organ of Corti are three rows of elongated cylindrical outer hair cells and one row of short inner hair cells. Projecting from the tops of the hair cells are tiny finger like projections called stereocilia, which are arranged in a graduated fashion with the shortest stereocilia on the outer rows and the longest in the center, this allows the sensory cells superior tuning capability. The inner hair cells are synapsed with afferent fibers of the cochlear portion of the vestibulocochlear nerve. The outer hair cells are in contact with a gelatinous mass called the tectorial membrane rich in tectorin and their

basal portions are synapsed with afferent and efferent fibers of the cochlear portion of the vestibulocochlear nerve. Separating these hair cells are supporting cells, which includes:

-Phalangeal cells(outer and inner), separates and support both the outer hair cells and the inner hair cells.

Outer phalangeal cells: are tall columnar cells that are attached to basilar membrane, their apical portions are cup-shaped to support the basilar portions of outer hair cells along with efferent and afferent nerve fibers, they do not reach the free surface of the organ of corti

Inner phalangeal cells: are located deep to the innel pillar cells, they completely surround the inner hair cells

-Inner and outer pillar cells: These are tall cells with wide bases and apical ends that are attached to basilar membrane, their central portions are deflected to form the walls of inner tunnel and their apical portion contact each other.

-Border cells: Are slender cells that support the inner aspects of the organ of Corti, they also outline the inner border of the organ of Corti.

-Cells of Hensen: They define the outer border of the organ of Corti and are located between the outer phalangeal cells and the cells of Claudius.

If the cochlea were uncoiled, it would roll out to be about 33 mm long in women and 34 mm in men, with about 2.28 mm of standard deviation for the population. The cochlea is also tonotopically organized, meaning that different frequencies of sound waves interact with different locations on the structure. The base of the cochlea, closest to the outer ear, is the most stiff and narrow and is where the high frequency sounds are transduced. The apex of the cochlea is wider and much more flexible and loose and functions as the transduction site for low frequency sounds.

FUNCTION

The function of the organ of Corti is to change (transduce) auditory signals and minimise the hair cells' extraction of sound energy.

-Auditory transduction: In normal hearing, the majority of the auditory signals that reach the organ of Corti in the first place come from the outer ear. Sound waves enter through the auditory canal and vibrate the tympanic membrane, also known as the eardrum, which vibrates three small bones called the ossicles. As a result, the attached oval window moves and causes movement of the round window, which leads to displacement of the cochlear fluid. However, the stimulation can happen also via direct vibration of the cochlea from the skull.The basilar membrane on the tympanic duct presses against the hair cells of the organ as perilymphatic pressure waves pass. The stereocilia atop the inner hair cells move with this fluid displacement and in response their cation, or positive ion selective, channels are pulled open by cadherin structures called tip links that connect adjacent stereocilia.

The organ of Corti, surrounded in potassium rich fluid endolymph, lies on the basilar membrane (made up of zona arcuata and zona pectinata) at the base of the scala media, it extends from the spiral lamina at modiolus to the lateral wall. Under the organ of Corti is the scala tympani and above it, the scala vestibuli (composed of squamous epithelium). Both structures exist in a low potassium fluid called perilymph. Because those stereocilia are in the midst of a high concentration of potassium, once their cation channels are pulled open, potassium ions as well as calcium ions flow into the top of the hair cell. With this influx of positive ions the inner hair cells becomes depolarized, opening voltage-gated calcium channels at the basolateral region of the hair cells and triggering the release of the neurotransmitter glutamate. An electrical signal is then sent through the auditory nerve and into the auditory cortex of the brain as a neural message.

-Cochlear amplification: The organ of Corti is also capable of modulating the auditory signal. The outer hair cells can amplify the signal through a process called electromotility where they increase movement of the basilar

and tectorial membranes and therefore increase deflection of stereocilia in the inner hair cells.

CLINICAL SIGNIFICANCE

-Hearing loss: The organ of Corti can be damaged by excessive sound levels, leading to noise-induced impairment. The most common kind of hearing impairment, sensorineural hearing loss, includes as one major cause of the reduction of function in the organ of Corti. Specifically, the active amplification function of the outer hair cells is very sensitive to damage from exposure to trauma from overly-loud sounds or to certain ototoxic drugs. Once outer hair cells are damaged, they do not regenerate, and the result is a loss of sensitivity and an abnormally large growth of loudness (known as recruitment) in the part of the spectrum that the damaged cells serve.

-Conductive hearing loss involves various problems in the middle ear which can reduce conduction of vibrations by the chain of ossicles from the tympanic membrane to the oval window.