**Name: Adeyemo Sannicolas Crystal**

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**Department: Medicine and surgery**

**Histology of the organ of Corti**

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**Diagram of the organ of Corti**

The Organ of Corti is an organ of the inner ear located within the cochlea which contributes to audition. The Organ of Corti includes three rows of outer hair cells and one row of inner hair cells. Vibrations caused by sound waves bend the stereocilia on these hair cells via an electromechanical force. The hair cells convert mechanical energy into electrical energy that is transmitted to the central nervous system via the auditory nerve to facilitate audition.

The primary function of the organ of Corti is the transduction of auditory signals. Sound waves enter the ear via the auditory canal and cause vibration of the tympanic membrane. Movement of the tympanic membrane causes subsequent vibrations within the ossicles, the three bones of the middle ear which transfer the energy to the cochlea through the oval window. As the oval window moves, waves transfer to the perilymph fluid inside the Scala tympani and then the Scala vestibule of the cochlea. When fluid moves through these structures, the basilar membrane (located between the Scala media and Scala tympani) shifts respectively to the tectorial membrane.

The organ of Corti is an organ of the inner ear contained within the Scala media of the cochlea. It resides on the **basilar membrane**, a stiff membrane separating the Scala tympani and Scala media. The Scala media is a cavity within the cochlea that contains endolymph which has a high (150 mM) K+ concentration. The endolymph helps to regulate the electrochemical impulses of the auditory hair cells.

The organ of Corti is composed of both supporting cells and mechanosensory hair cells. The arrangement of mechanosensory cells are into inner and outer hair cells along rows. There is a single row of inner hair cells and three rows of outer hair cells which are separated by the supporting cells. The supporting cells are also named Dieters or phalangeal cells.

**Diagram of organ of Corti showing inner hair cells and outer hair cells**

The hair cells within the organ of Corti have sterocilia that attach to the tectorial membrane. Shifts between the tectorial and basilar membranes move these sterocilia and activate or deactivate receptors on the hair cell surface. When cation channels open on the hair cells, potassium ions flow into the hair cells, the cells depolarize, and the depolarization causes voltage-gated calcium channels to open. The calcium influx results in glutamate release from the hair cells onto the auditory nerve. The auditory nerve then sends information about the sound wave to the brain.

**Inner hair cells** function primarily as the sensory organs for audition. They provide input to 95% of the auditory nerve fibres that project to the brain. The stiffness and size of the hair cell arrangement throughout the cochlea enable hair cells to respond to a variety of frequencies from low to high. Cells at the apex to respond to lower frequencies while hair cells at the base of the cochlea (near the oval window) respond to higher frequencies, which creates a tonotopic gradient throughout the cochlea.

While inner hair cells are the output centre of the cochlea, the **outer hair cells** are the input centre. They receive descending inputs from the brain to assist with the modulation of inner hair cell function (i.e., modulating tuning and intensity information). Unlike other regions of the brain, the modulation of inner hair cells by outer hair cells is not electrical but mechanical. Activation of outer hair cells changes the stiffness of their cell bodies; this manipulates the resonance of perilymph fluid movement within the Scala media and allows for fine-tuning of inner hair cell activation.

Inner and outer hair cells are distinctly different in structure. Both types of hair cells have stereocilia on the apical surface; however, the arrangement of sterocilia and their connection to the tectorial membrane are distinctly different. For both types of hair cells, the mechanical bending of the sterocilia opens potassium channels at the tips of the sterocilia that allow hyperpolarization of the cells. The tallest of the stereocilia of outer hair cells are embedded into the tectorial membrane. These stereocilia get displaced as the basilar membrane moves with the tectorial membrane. The stereocilia of inner hair cells are free-floating. Movement of the viscous perilymph fluid provides the mechanical force to open these channels.

Inner hair cell activation is much more complicated than outer hair cell activation. The movement of fluid within the Scala media relies on the resonance (vibration) of both the tectorial membrane and organ of Corti. Cells within the organ of Corti are much more flexible than cells within the basilar membrane. Alterations in the stiffness of these cells change the resonance of the organ of Corti and subsequently the movement of fluid within the Scala media.

The outer hair cells alter the stiffness of the organ of Corti through a motor protein, prestin, located on the lateral membrane of these cells. These proteins vary in shape in response to voltage changes. Depolarization of the outer hair cells causes prestin to shorten, shifting the basilar membrane and increasing the membrane deflection, thereby intensifying the effect on the inner hair cells.

**Blood supply**

The labyrinthine artery is the main supplier of oxygenated blood to the cochlea and therefore the organ of Corti. This artery is also known as the auditory artery or internal auditory artery. The labyrinthine artery most commonly originates from the anterior inferior cerebellar artery (AICA). AICA most commonly originates from the basilar artery. Occasionally, about 15% of the time, the auditory or labyrinthine artery, can branch off directly from the basilar artery. Less commonly, this artery may originate from the superior cerebellar or vertebral artery.

The labyrinthine artery follows the vestibulocochlear nerve from its point of origin into the internal acoustic meatus where it further divides into two branches, the anterior vestibular artery, and the common cochlear artery. The common cochlear artery will then divide into two more arteries, the proper cochlear artery, and the vestibulocochlear artery. The vestibulocochlear artery then gives off the vestibular ramus and the cochlear ramus.

**Nerves**

Inner hair cells are mechanoreceptor cells. They transmit information about acoustic stimuli directly to the type I spiral ganglion neurons (i.e., auditory nerve, radial afferents). These afferents synapse within the cochlear nucleus within the brain. Input from the inner hair cells to the type I spiral ganglion neurons can be altered by lateral olivocochlear efferent nerves that have axodendritic synapses onto these type I ganglion neurons. The lateral olivocochlear nerves do not synapse onto inner hair cells. They terminate on the auditory nerve fibres within the cochlea.

Outer hair cells have both efferent and afferent connections. They receive input from medial olivocochlear neurons directly onto their cell bodies, axosomatic synapses. These efferent connections form feedback loops that manipulate the stiffness of the Organ of Corti and therein the activity of the inner hair cells. The outer hair cells synapse onto type II spiral ganglion neurons. The function of these afferents is still unknown. These neurons do not respond to auditory stimuli.