

The inner ear

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The inner ear comprises the cochlea and vestibular labyrinth (sacculle, utricle and semicircular canals). These structures are - embedded in dense bone called the otic capsule. The cochlea is a coiled shell of two and three-quarter turns. Within the cochlea is a spiral structure called the cochlear duct (Figure 51.3), which contains endolymph that is partitioned by Reissner's membrane from the perilymph of the scala ves - tib uli and the basilar membrane from the perilymph of the scala tympani. The perilymph sits uninterrupted from the oval window and stapes footplate at the start of the scala vestibuli in continuity with the round window membrane at the end of the scala tympani (Figur e 51.4). The endolymph has a high concentration of potassium, similar to intracellular fluid, and (b) the perilymph has a high sodium concentration and communicates with the cerebrospinal fluid (CSF). Maintenance of the ionic gradients is an active process and is essential for neuronal activity . Bartolomeu Eustachio (Eustachius) , 1513-1574, Professor of Anatomy , appointed physician to the Pope in 1547. Alfonso Giacomo Gaspare Corti , 1822-1876, Italian anatomist. There are approximately 15 /uni00A0 500 hair cells in the human cochlea. They are arranged in rows of 3500 inner and 12 /uni00A0 000 outer hair cells. Movement of the stapes footplate causes a pres - sure wave through the perilymph, resulting in vibration of the basilar membrane and a shearing motion between the tops of the hair cells and the tectorial membrane. The inner hair cells act as mechanoelectric transducers, converting the acoustic signal into an electric impulse. The outer hair cells contain contractile proteins and serve to tune the basilar membrane on which they are positioned. Each inner hair cell responds - to a particular frequency of vibration. When stimula ted, it depolarises and passes an impulse to the cochlear nuclei in the brainstem.

Short process of malleus The majority of the ossicles lie out of Long sight in the attic process of incus Pars /f_l accida Oval Handle of malleus window Pars tensa Stapes Anterior bulge of ear canal Round window Light re /f_l ex niche Figure 51.1 (a) Right tympanic membrane and (b) diagram to illustrate the anatomy of the tympanic membrane and ossicles (courtesy of Dr Christian Deguine). Scala vestibuli Scala media Inner hair cell nerves Cochlear nerve /f_i bres Figure 51.3 The cochlear duct. Posterior Antrum cranial fossa Attic Mastoid M ET TM Hypotympanum Stylomastoid Medial foramen VII Anterior Posterior Lateral Figure 51.2 Diagram of the right ear to show the relationships of the middle ear. ET, Eustachian tube; M, malleus; TM, tympanic membrane; VII, facial nerve (courtesy of Dr Christian Deguine). Reissner's membrane Stria vascularis Tectorial membrane Organ of Corti Tunnel Outer hair cell nerve Tunnel Basilar /f_i bres membrane Scala tympani

The vestibular labyrinth consists of the semicircular canals, utricle and sacculle and their central connections. The three semicircular canals are arranged in the three planes of space at right angles to each other. Like the auditory system, hair cells are present. In the lateral canals, the hair cells are embedded in a gelatinous cupula. Shearing forces, caused by angular move ments of the head, produce hair cell movements and generate action potentials. In the utricle and sacculle the

hair cells are embedded in an otoconial membrane, which contains particles of calcium carbonate. These respond to changes in linear acceleration and the pull of gravity. Impulses are carried centrally by the vestibular nerve and connections are made to the spinal cord, cerebellum and external ocular muscles. Its function is to record the position and movements of the head.

Oval window Stirrup (stapes) Anvil (incus) Hammer (malleus) Eardrum (tympanum) Air Air Ear canal
Endolymph Round window Perilymph Eustachian tube Inner ear Middle ear

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