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their progress through the system. The second division reviews some of the basic characteristics of hearing. The final division, dealing with the interpretation of auditory sensations, discusses their attributes, the relation of these attributes to the characteristics of signals and also the reasons which may underlie the observed relationships. The emphasis in the following treatment of these subjects is on general background information and highlights. Further information is available in numerous books including References 1 to 18.

## 2. PHYSICAL ASPECTS OF AUDITORY SYSTEM

### a. Anatomy [8]

The auditory system, illustrated in part by Fig. 1, begins with the external ear and ends in the auditory receptive centers of the brain. The intervening parts comprise the middle ear, the inner ear or coch-

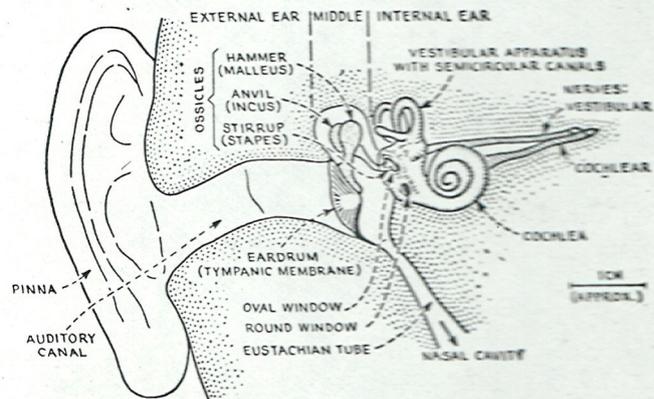


Fig. 1. Schematic diagram of human ear (adapted [65] from BRODEL [3]).

lea, and a neural network. Forming part of the external ear, the external auditory canal terminates in the eardrum. Resembling a shallow rigid cone, this organ is held in place in such a way that it acts, in its movements, more like a pendulum than as a stretched diaphragm [19]. Behind the drum, in the middle ear, is an air-filled cavity whose inner wall contains the oval and round windows of the cochlea. In this cavity is a chain of three ossicles (malleus, incus and stapes). Joined together and held in place by tissues and ligaments, these ossicles link the eardrum to the cochlea by way of the oval window. This window is occupied by the footplate of the stapes. The round window is closed by a thin membrane.

The cochlea (Figs. 1, 2) contains a canal which winds spirally about a bony axis called the modiolus. From this axis a bony shelf extends partway towards the outer wall of the canal; bridging the gap is the

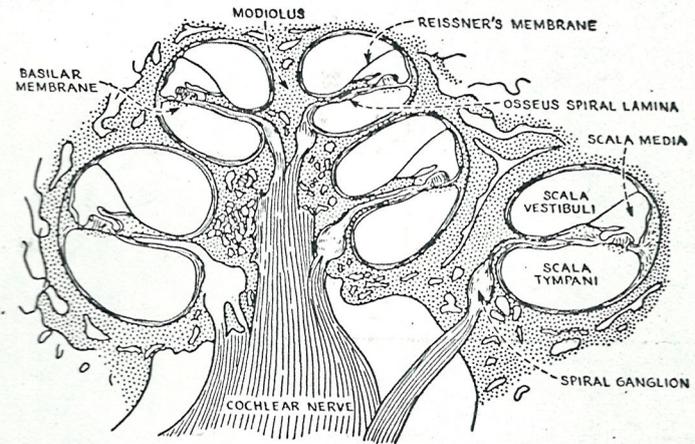


Fig. 2. A diagrammatic section through the human cochlea (adapted from GRAY'S Anatomy [8]).

basilar membrane. Shelf and membrane follow the spiral winding of the canal and subdivide it into two long channels (scala vestibuli and scala tympani). Just above the basilar membrane a second membrane (Reissner's) also extends from the bony shelf to the outer wall of the cochlea. Filled with a viscous fluid, the space between these two membranes is known as the scala media. Mounted on the basilar membrane, the pliable floor of the scala media, is the spiral organ of Corti (Fig. 3). It contains many neural elements called hair cells. These cells are arranged in several rows extending over nearly the full length of the membrane. Projecting from the top of each cell are hairlike processes whose upper ends appear to project into a

third membrane (tectorial)

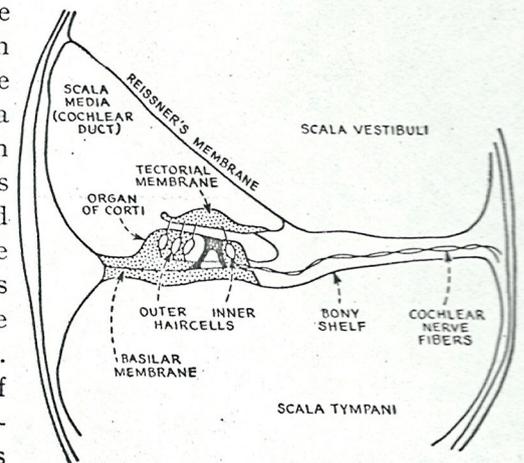


Fig. 3. A schematic section through a portion of the human cochlea (adapted [65] from STEVENS and DAVIS [15]).