

far out of it and any danger to the inner ear from violent movements of the drum head is impossible.

We have now led a sound wave through the meatus to the drum head, across the malleus incus and stapes to the oval window. Through that opening the domain of the inner ear is reached.

Two little sacs, the utricle and saccule, are the first bodies upon which the impulses imparted by the stapes are received. The former communicates with the semi-circular canals; the latter with the cochlea. Of course the impulses from the stapes are communicated through the fluid of the vestibule. Now as these two sacs are imbedded in bone, it follows that, as the fluid of the vestibule would be practically incompressible, no vibrations or movements could be transmitted. Here is the use of the foramen rotundum, a round opening in the osseous wall of the vestibule, covered with an elastic membrane. When the base of the stapes presses into the vestibule, the membrane of the round window bulges outwards, and vice-versa. In this way a to and fro movement of the liquid is allowed, which may be communicated to the sacs and tubes. On the wall of the utricle directly in front of the oval window there are neither nerve endings nor modified epithelium; but on its back wall is a ridge of long cells with stiff hair-like points directly towards the base of the stapes. In front of the cells and lying among their long points are the otoliths or ear stones. Now when an impulse is transmitted by the stapes, either of two things results.

The otoliths, being movable, may oscillate among the hair-like endings of the cells and thus convey the excitation to those cells, or the membrane bearing the cells may readily move with the force given by the base of the stapes: as these cells are of small mass the motion would soon die out and hence the purpose of the otoliths,—being slow to move on account of their greater mass but capable of continuing that motion longer,—their purpose may be to keep up the excitation of the nerve cells. In whichever way, nevertheless, at this point some of the sound waves are in contact with filaments of the auditory nerve. So much for sound waves in the vestibule. In the semi-circular canals, at the end of the ampullae we have nerve endings of the kind described in the utricle. The ampullae being wide cavities with narrow exits into the canals proper are capable, when the fluid is put in motion in them, of forming eddies such as may be seen when water is allowed to run out of an ordinary sink basin. This circular motion of the liquid will stimulate the nerve end-