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# The Vestibular System

The vestibular apparatus, which is responsible for the sense of balance or sense of equilibrium, is located in the inner ear along with the cochlea. It consists of 3 semicircular ducts and 2 otolith organs, which together facilitate spatial orientation and registration of movements.

# Structure of the Vestibular Apparatus

The structure of the vestibular apparatus is similar to that of the cochlea. The ducts of the vestibular apparatus are also filled with endolymph, and the sensory cells are also hair cells. However, unlike the hair cells of the cochlear, these develop cilia and several stereocilia that are connected via tip links.

They are covered by a gelatinous mass. Inside the semicircular ducts, this mass, which contains mucopolysaccharide, is called the cupula. In addition, this mass contains small calcium carbonate crystals inside the otolith organ and is, therefore, called the otolithicmembrane.

## Transduction of the vestibular apparatus

The tough cupula/otolithic membrane is shifted against the sensory cells through acceleration, deceleration, or rotating of the head. Just like inside the cochlea, the shifting leads to shear movement and a deflection of cilia and stereocilia and causes a receptor potential.

The transduction process is the same in the semicircular ducts and the otolith organs. However, because of their anatomic differences, the 2 organs measure different movements.

**Translational motion:** Otolith organs measure acceleration and deceleration. Macula sacculi measure vertical translational motions, and macula utriculi measure horizontal motions.

**Rotational motion:** The endolymph in the semicircular ducts is usually arranged circularly. Because of inertia, the fluid is shifted against the sensory epithelium during rotations, and thus the cilia of the cells are deflected. Cilia are built in a way that, if deflected medially toward the utricle, they will cause a potential. This means that when the head is rotated to the left side, the fluid in the horizontal semicircular ducts shifts to the right, which leads to activity in the left semicircular ducts and afferent nerves.

Vestibular pathway

The generated potentials are transferred from the first neuron as part of the **vestibulocochlear nerve** to the **vestibular nuclei** inside the rhombencephalon and to the second neuron. From this point on, the crossed and uncrossed pathways continue on to the **nucleus ventralis posterior** of the thalamus. The impulses are then transmitted to the vestibular areas of the cerebrum.

## The central vestibular system

The information from the vestibular apparatus is continuously offset by somatosensory information from the brain and neck area, as well as from other joints, for the central nervous system to acquire information about the posture of the entire body.

The 4 vestibular nuclei involved are the nucleus superior of Bechterew, nucleus inferior of Roller, nucleus medalis of Schwalbe, and nucleus laterals of Deiters. This is also true for muscular reflexes activated to maintain body balance.

Particularly interesting are the vestibulo-ocular reflexes, which connect the vestibular apparatus with the eye muscles. This is, for instance, important for rotational movements. Vestibular nystagmus is a slow, vestibular-induced eye movement followed by a fast return movement.

 SORRY FOR THE LATE SUBMISSION MA, WE HAVEN’T HAD LIGHT IN 3 WEEKS