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## PHYSIOLOGY OF BALANCE

The vestibular system is the sensory apparatus of the inner ear that helps the body maintain its postural equilibrium. Balance is coordinated through the vestibular system, the nerves of which are composed of axons from the vestibular ganglion that carries information from the utricle, saccule, and semicircular canals. The system contributes to controlling head and neck movements in response to vestibular signals. An important function of the vestibular system is coordinating eye and head movements to maintain visual attention. Most of the axons terminate in the vestibular nuclei of the medulla. Some axons project from the vestibular ganglion directly to the cerebellum, with no intervening synapse in the vestibular nuclei. The cerebellum is primarily responsible for initiating movements on the basis of equilibrium information.

Neurons in the vestibular nuclei project their axons to targets in the brain stem. One target is the reticular formation, which influences respiratory and cardiovascular functions in relation to body movements. A second target of the axons of neurons in the vestibular nuclei is the spinal cord, which initiates the spinal reflexes involved with posture and balance. To assist the visual system, fibers of the vestibular nuclei project to the oculomotor, trochlear, and abducens nuclei to influence signals sent along the cranial nerves. These connections constitute the pathway of the vestibulo-ocular reflex

(VOR), which compensates for head and body movement by stabilizing images on the retina. Finally, the vestibular nuclei project to the thalamus to join the proprioceptive pathway of the dorsal column system, allowing conscious perception of equilibrium.

Balance is mediated by the vestibular nuclei in the brain stem. The labyrinth (a part of the inner ear), is a major organ of our vestibular (balance) system. The three semicircular canals of the labyrinth is associated with sensing rotary motion. The brain senses the direction and speed of rotation of the head by the movement of fluid in the semicircular canals.

Balance is maintained by the interactions between the labyrinth and other systems in the body, such as the visual and skeletal systems. The main inputs into the balance system are the: vestibular labyrinths, visual system (eyes), somatosensory system, especially proprioception.

The main outputs from the vestibular nuclei are:

1. Vestibulo-ocular: permitting reflex eye movements related to posture.
2. Vestibulo-spinal which supply: anti-gravity muscles in the lower limbs, reflex arcs which control gait