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**MATRIC NUMBER; 18/MHS02/028**

**COURSE CODE; PHS212**

**DEPARTMENT; NURSING**

**THE PHYSIOLOGY OF BALANCE**

The [vestibular system](https://www.britannica.com/science/vestibular-system) is the sensory apparatus of the [inner ear](https://www.britannica.com/science/inner-ear) that helps the body maintain its postural [equilibrium](https://www.britannica.com/science/proprioception). The information furnished by the vestibular system is also essential for coordinating the position of the [head](https://www.britannica.com/science/head-anatomy) and the movement of the eyes. There are two sets of end organs in the inner ear, or labyrinth: the [semicircular canals](https://www.britannica.com/science/semicircular-canal), which respond to [rotational](https://www.britannica.com/science/rotation-physics) movements (angular acceleration); and the [utricle](https://www.britannica.com/science/utricle) and [saccule](https://www.britannica.com/science/saccule) within the [vestibule](https://www.britannica.com/science/vestibule-ear), which respond to changes in the position of the head with respect to gravity (linear acceleration). The information these organs deliver is proprioceptive in character, dealing with events within the body itself, rather than exteroceptive, dealing with events outside the body, as in the case of the responses of the cochlea to [sound](https://www.britannica.com/science/sound-physics). Functionally these organs are closely related to the cerebellum and to the reflex centres of the [spinal cord](https://www.britannica.com/science/spinal-cord) and [brainstem](https://www.britannica.com/science/brainstem) that govern the movements of the eyes, neck, and limbs

Because the three [semicircular canals](https://www.britannica.com/science/semicircular-canal)—superior, posterior, and horizontal—are positioned at right angles to one another, they are able to detect movements in three-dimensional space. When the head begins to [rotate](https://www.britannica.com/science/rotation-physics) in any direction, the inertia of the endolymph causes it to lag behind, exerting pressure that deflects the [cupula](https://www.britannica.com/science/cupula) in the opposite direction. This deflection stimulates the [hair cells](https://www.britannica.com/science/hair-cell) by bending their stereocilia in the opposite direction.

The gravity receptors that respond to linear acceleration of the head are the maculae of the [utricle](https://www.britannica.com/science/utricle) and [saccule](https://www.britannica.com/science/saccule). The left and right [utricular maculae](https://www.britannica.com/science/macula-utriculi) are in the same, approximately horizontal, plane and, because of this position, are more useful in providing information about the position of the head and its side-to-side tilts when a person is in an upright position. The [saccular maculae](https://www.britannica.com/science/macula-sacculi) are in parallel vertical planes and probably respond more to forward and backward tilts of the head.

These sensory organs, particularly the utricle, have an important role in the righting [reflexes](https://www.britannica.com/science/reflex-physiology) and in reflex control of the muscles of the [legs](https://www.britannica.com/science/leg-anatomy), trunk, and [neck](https://www.britannica.com/science/neck-anatomy) that keep the body in an upright position.

The relation between the vestibular apparatus of the two ears is [reciprocal](https://www.merriam-webster.com/dictionary/reciprocal). When the head is turned to the left, the discharge from the left horizontal canal is decreased, and vice versa. Normal posture is the result of their acting in cooperation and in opposition. When the vestibular system of one ear is damaged, the unrestrained activity of the other causes a continuous false sense of turning ([vertigo](https://www.britannica.com/science/vertigo)) and rhythmical, jerky movements of the eyes ([nystagmus](https://www.britannica.com/science/nystagmus)), both toward the uninjured side. When the vestibular hair cells of both inner ears are injured or destroyed, as can occur during [treatment](https://www.britannica.com/science/ototoxic-drug) with the [antibiotics](https://www.britannica.com/science/antibiotic) gentamicin or [streptomycin](https://www.britannica.com/science/streptomycin), there may be a serious disturbance of posture and gait ([ataxia](https://www.britannica.com/science/ataxia)) as well as severe vertigo and disorientation. In younger persons the disturbance tends to subside as reliance is placed on vision and on proprioceptive impulses from the muscles and joints as well as on cutaneous impulses from the soles of the feet to compensate for the loss of information from the semicircular canals. Recovery of some injured hair cells may occur.