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**QUESTION**

Discuss the physiology of balance

**ANSWER**

**THE PHYSIOLOGY OF BALANCE: VESTIBULAR FUNCTION**

The vestibular system is the sensory apparatus of the inner ear that helps the body maintain its postural equilibrium. The information furnished by the vestibular system is also essential for coordinating the position of the head and the movement of the eyes. There are two sets of end organs in the inner ear, or labyrinth: the semicircular canals, which respond to rotational movements (angular acceleration); and the utricle and saccule within the vestibule, 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. Functionally these organs are closely related to the cerebellum and to the reflex centres of the spinal cord and brainstem that govern the movements of the eyes, neck, and limbs.

Although the vestibular organs and the cochlea are derived embryologically from the same formation, the otic vesicle, their association in the inner ear seems to be a matter more of convenience than of necessity.

The sense of balance or equilibrioception is the perception of balance and spatial orientation. It helps prevent humans and nonhuman animals from falling over when standing or moving. Equilibrioception is the result of a number of sensory systems working together: the eyes (visual system), the inner ears (vestibular system), and the body's sense of where it is in space (proprioception) ideally need to be intact.

The vestibular system, the region of the inner ear where three semicircular canals converge, works with the visual system to keep objects in focus when the head is moving. This is called the vestibulo-ocular reflex (VOR).

**VESTIBULAR SYSTEM**

In the vestibular system, equilibrioception is determined by the level of a fluid called endolymph in the labyrinth, a complex set of tubing in the inner ear.

The body’s balance system works through a constant process of position detection, feedback and adjustment using communication between the inner ear, eyes, muscles, joints and the brain.

Deep inside the ear, positioned just under the brain, is the inner ear. While one part of the inner ear enables hearing, another part, called the vestibular system, is designed to send information about the position of the head to the brain’s movement control centre, the cerebellum.

**DYSFUNCTION**

When the sense of balance is interrupted it causes dizziness, disorientation and nausea. Balance can be upset by Ménière's disease, superior canal dehiscence syndrome, an inner ear infection, by a bad common cold affecting the head or a number of other medical conditions including but not limited to vertigo. It can also be temporarily disturbed by quick or prolonged acceleration, for example riding on a merry-go-round. Blows can also affect equilibrioreception, especially those to the side of the head or directly to the ear.

**SYSTEM OVERVIEW**

* MECHANICAL

There are five sensory organs innervated by the vestibular nerve; three semicircular canals (Horizontal SCC, Superior SCC, Posterior SCC) and two otolith organs (Saccule and Utricle). Each semicircular canal (SSC) is a thin tube that doubles in thickness briefly at a point called osseous ampullae. At their center-base each contains an ampullary cupula. The cupula is a gelatin bulb connected to the stereocilia of hair cells, affected by the relative movement of the endolymph it is bathed in.

Since the cupula is part of the bony labyrinth, it rotates along with actual head movement, and by itself without the endolymph, it cannot be stimulated and therefore, could not detect movement. Endolymph follows the rotation of the canal, however, due to inertia its movement initially lags behind that of the bony labyrinth.

* NEURAL

First order vestibular nuclei (VN) project to IVN, MVN, and SVN.

The inferior cerebellar peduncle is the largest center through which balance information passes. It is the area of integration between proprioceptive, and vestibular inputs to aid in unconscious maintenance of balance and posture.

Inferior olive nucleus (also known as the olivary nucleus) aids in complex motor tasks by encoding coordinating timing sensory info; this is decoded and acted upon in the cerebellum.

**THE BRAIN’S MOVEMENT CONTROL CENTRE**

The cerebellum is a small part of the brain positioned at the back of the head, where it meets the spine, which acts as the body’s movement and balance control centre. It receives messages about the body’s position from the inner ear, eyes, muscles and joints, and sends messages to the muscles to make any postural adjustments required to maintain balance. It also coordinates the timing and force of muscle movements initiated by other parts of the brain.

**POSITION FEEDBACK FROM THE INNER EAR**

The vestibular system in each inner ear is made up of three semi-circular canals and two pockets, called the otolith organs, which together provide constant feedback to the cerebellum about head movement.

**POSITION FEEDBACK FROM EYES, SKIN, MUSCLES AND JOINTS**

The vestibular system (inner ear balance mechanism) works with the visual system (eyes and the muscles and parts of the brain that work together to let us ‘see’) to stop objects blurring when the head moves. It also helps us maintain awareness of positioning when, for example, walking, running or riding in a vehicle. In addition, sensors in the skin, joints and muscles provide information to the brain on movement, the position of parts of the body in relation to each other, and the position of the body in relation to the environment.