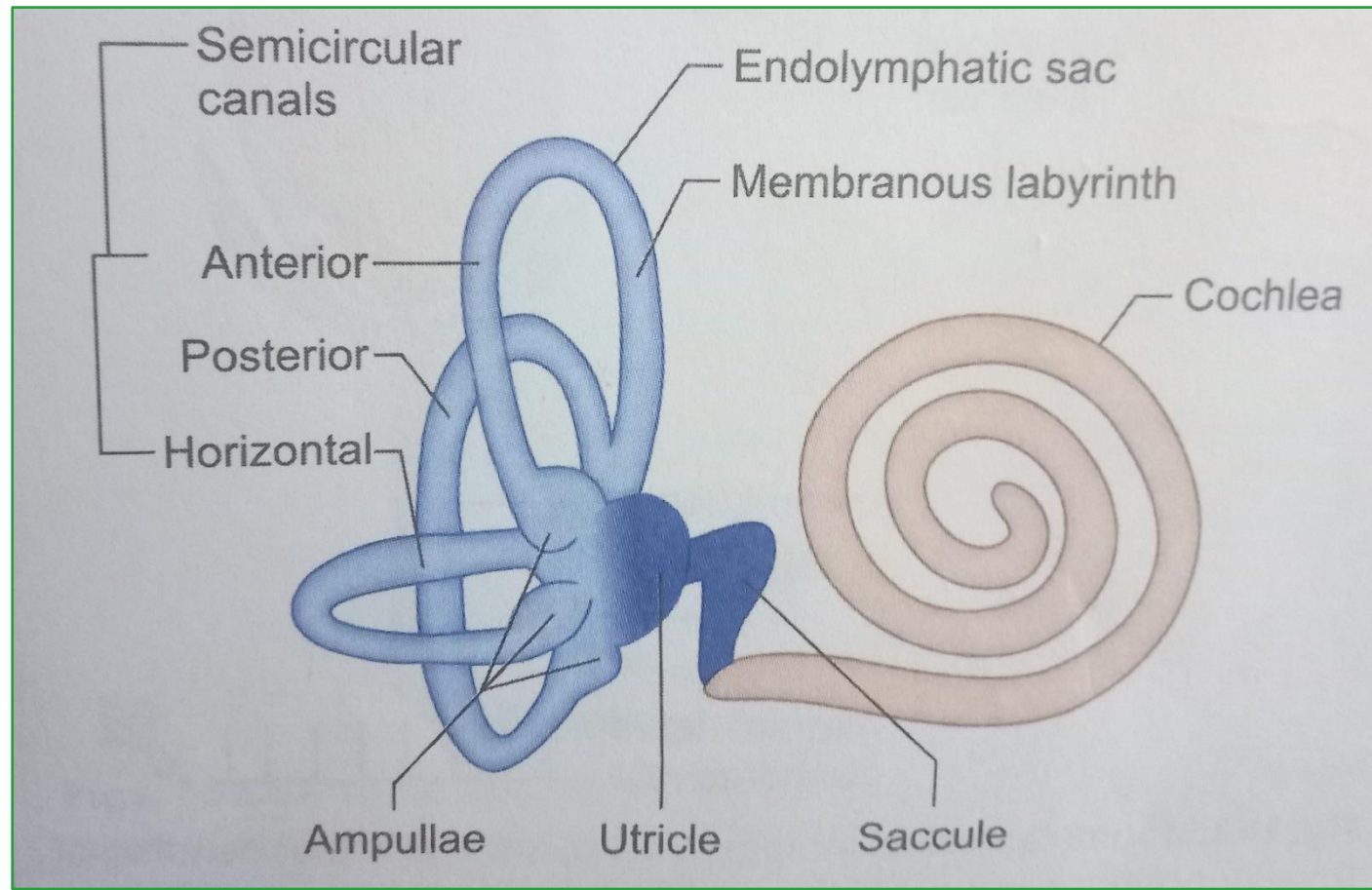


Vestibular Apparatus

VESTIBULAR APPARATUS

- Located in the bony labyrinth of inner ear.
- Maintenance of balance at rest & balance during movement.
- VA consists of semicircular canals & otolith organs.
- The receptors are hair cells. They detect the sense of position & motion of head.
- Vestibular receptors are stimulated by linear & angular acceleration.
- Linear acceleration stimulate otolith organs and angular acceleration stimulate semicircular canals.
- Vestibular apparatus maintain equilibrium & balance by activating postural & ocular reflexes

VESTIBULAR APPARATUS



VESTIBULAR APPARATUS

FUNCTIONAL ANATOMY

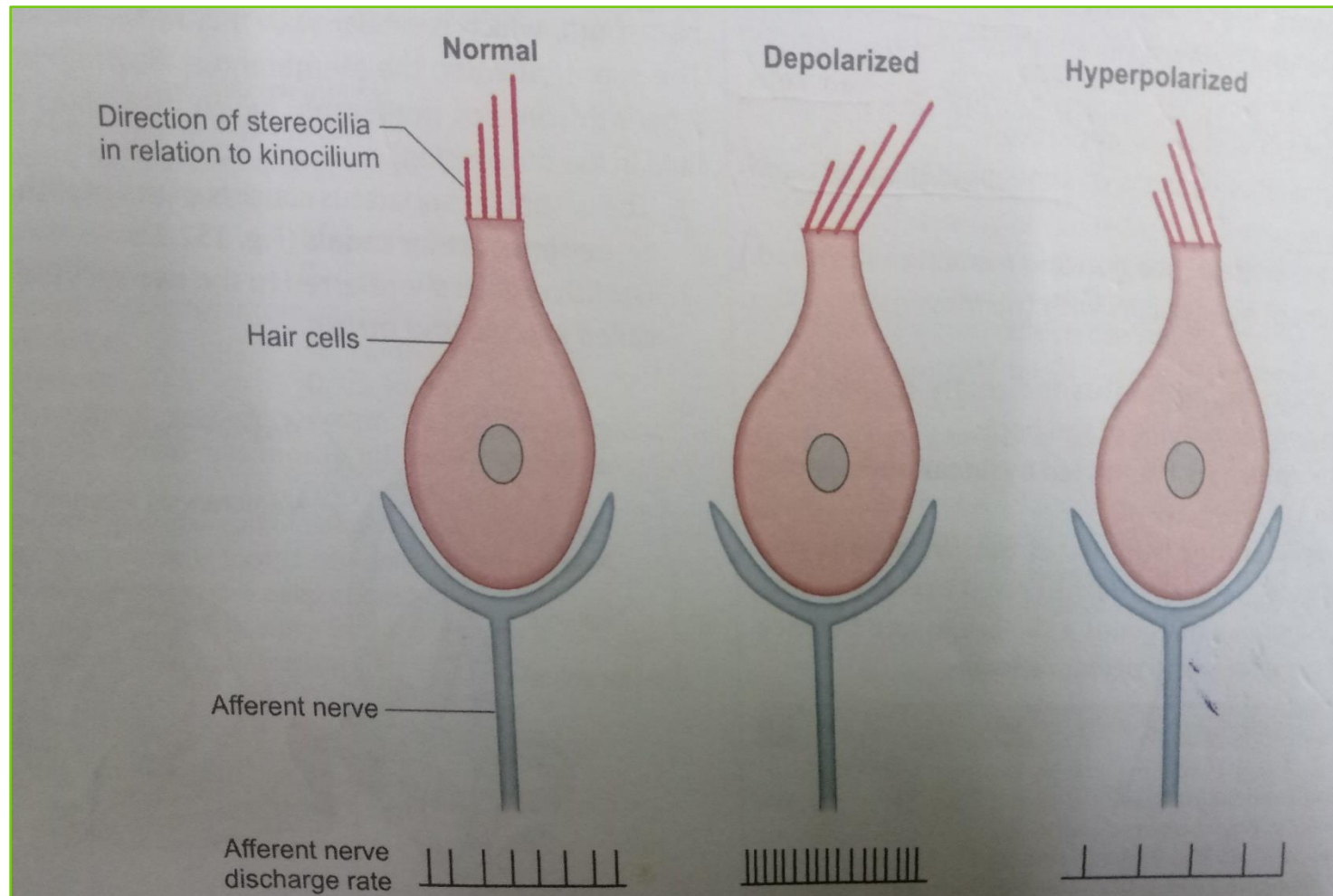
- ◆ VA is also known as membranous labyrinth.
- ◆ It contain endolymph.
- ◆ The space between the membranous labyrinth & bony labyrinth contain perilymph.
- ◆ Otolith organs are 2 sac like structures called saccule & utricle. Contain calcium carbonate crystals.-crystals of ear(otolith)
- ◆ Semicircular canal-Horizontal, anterior, posterior.

VESTIBULAR APPARATUS

Hair Cells

- ◆ The hair cells are receptors in vestibular apparatus,
- ◆ Hair cells have large number of cilia arranged according to their length.
- ◆ The longest cilium is the kinocilium,
- ◆ Other cilia are called stereocilia,
- ◆ When cilia bend toward the kinocilium , hair cells are depolarized, and when cilia bend away from the kinocilium hair cells are hyperpolarized,
- ◆ Hair cell activity is conveyed to the higher centers through the eighth cranial nerve.

HAIR CELL



VESTIBULAR APPARATUS

Otolith Organs

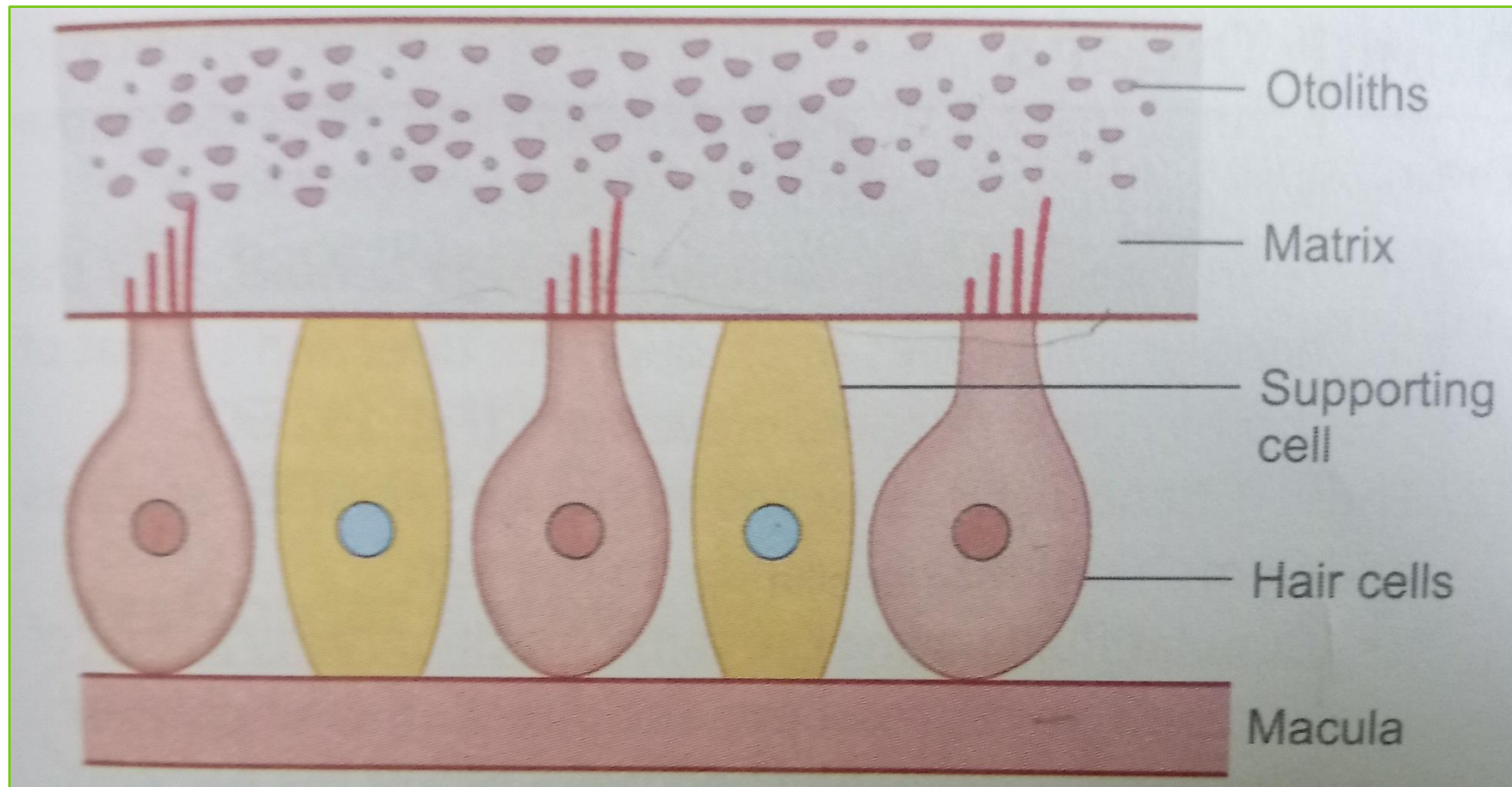
- ◆ Hair cells in saccule or utricle are located in the macula, the sensory epithelium,
- ◆ The macular hair cells are covered with an otolith membrane which is gelatinous mass containing crystals of calcium carbonate known as otoliths or otoconia.
- ◆ The cilia of the hair cells project into the gelatinous mass,
- ◆ The macula of saccule is oriented vertically and macula of the utricle is oriented horizontally,
- ◆ Hair cells of otolith organs are stimulated by linear acceleration,
- ◆ They also detect change in head position.

VESTIBULAR APPARATUS

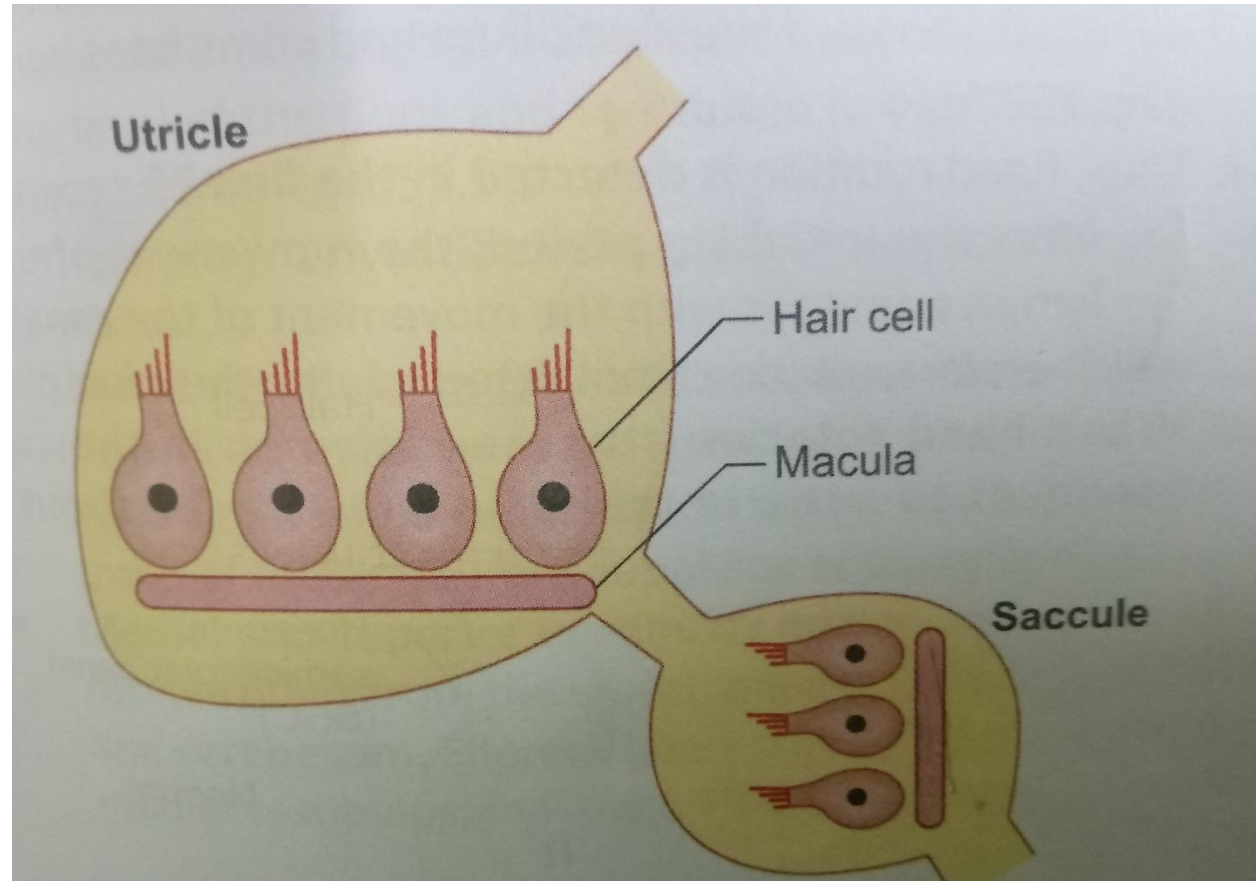
Mechanism of Action

- ◆ Otoliths are heavier than endolymph
- ◆ A change in the direction of the gravitational pull exerted on the otolith membrane bends the cilia of hair cells,
- ◆ Otolith organs detect change in head position and linear acceleration.

STRUCTURE OF OTOLITH ORGANS



STRUCTURE OF OTOLITH ORGANS



VESTIBULAR APPARATUS

Semicircular Canals

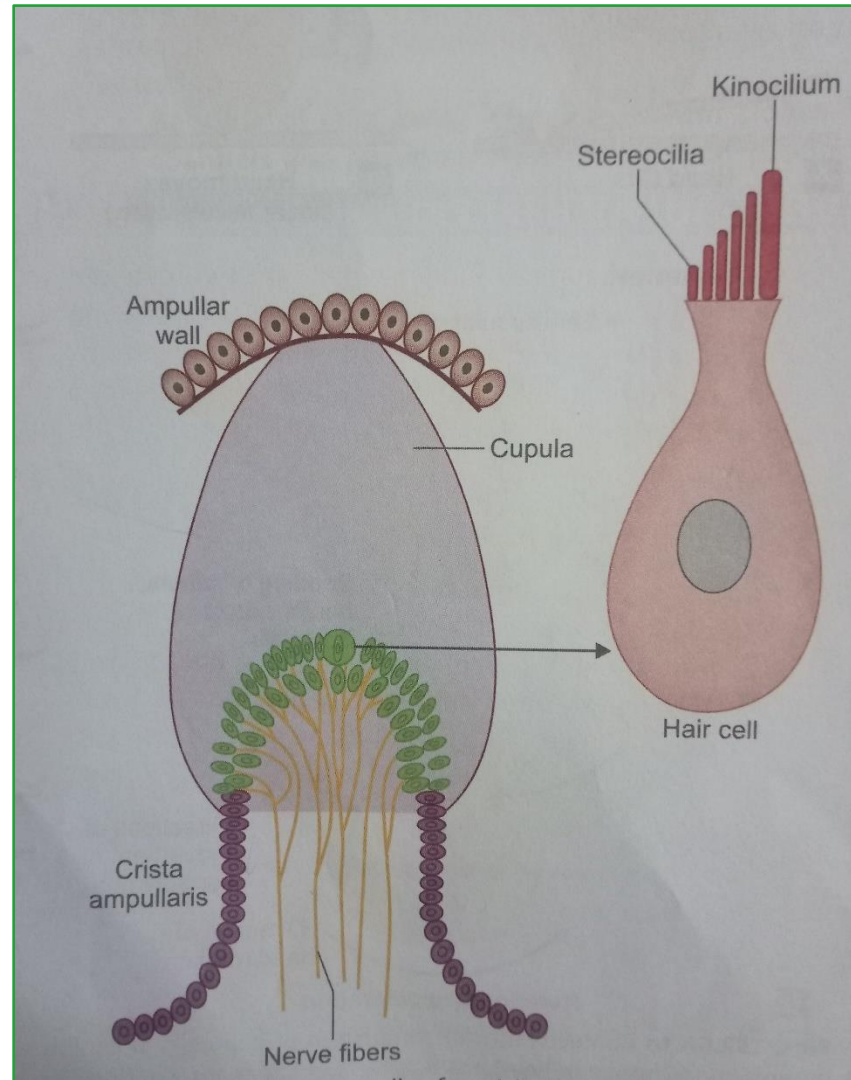
- In semicircular canals hair cells are located in ampulla, the dilated end of the canal.
- The ampulla open into the utricle.
- Ampulla contain CRYSTA AMPULLARIS. Hair cells are present on it.
- Cilia are embedded in a gelatinous mass known as CUPULA.
- No otolith present.
- Specific gravity of cupular fluid is same as that of endolymph.

VESTIBULAR APPARATUS

Semicircular Canals- Mechanism Of Action

- When head rotates to one side SSC also rotate to same side.
- The endolymph in the canals due to its natural inertia of a gelatinous fluid does not move immediately for about 20 seconds. So initially endolymph lags behind.
- Cupular fluid having same specific gravity moves along the direction of endolymph.
- After the initial lag period the movement of endolymph equalizes with the movement of canal. So rotation is not detected after the initial phase.
- When head rotation stops endolymph in the canal continues to move in the same direction for 20 seconds.

STRUCTURE OF AMPULLA OF SEMICIRCULAR CANAL

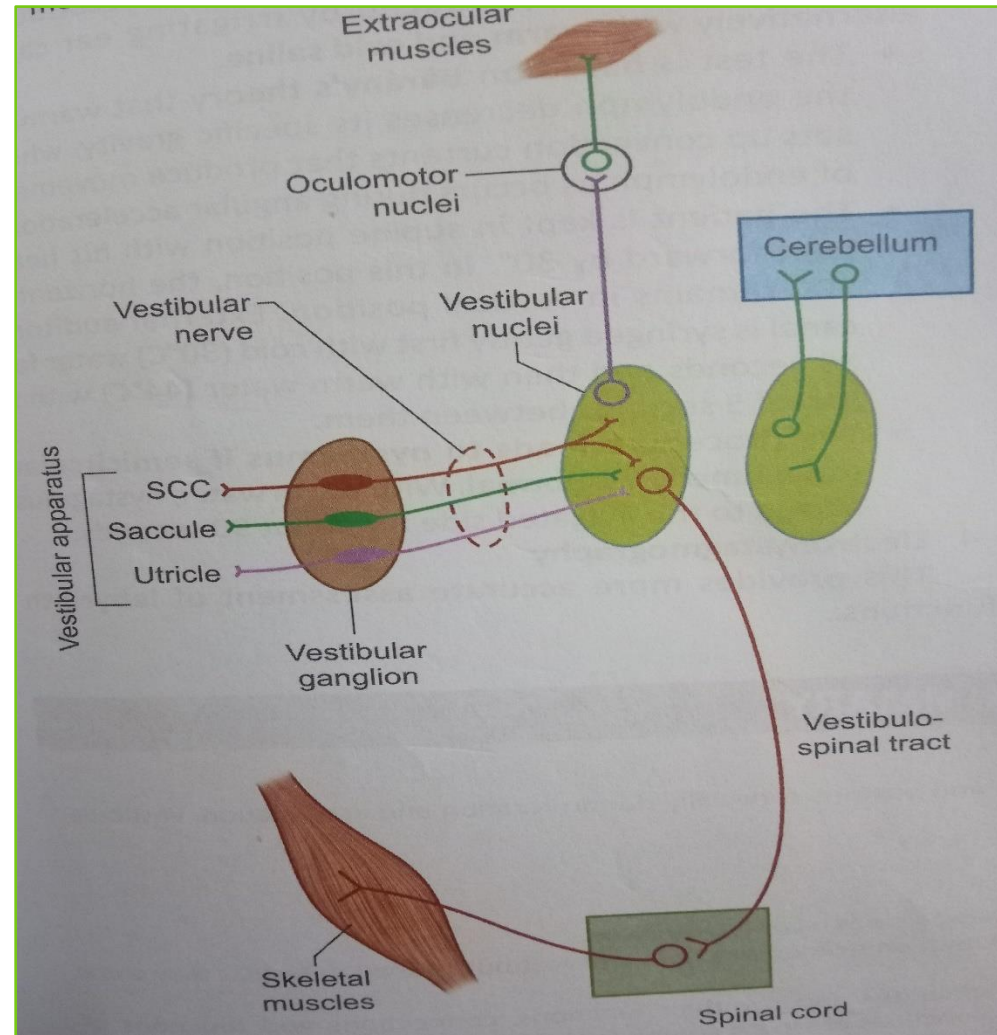


VESTIBULAR APPARATUS

VESTIBULAR PATHWAY

- Vestibular division of eighth cranial nerve-The cell bodies are located in the Scarpas ganglion(vestibular ganglion).
- These are bipolar neurons.
- The central axons travel in the 8th cranial nerve & terminate in the vestibular nuclei in the brainstem.
- There are 4 vestibular nuclei-Lateral, Medial, Superior & Inferior.
- Vestibular apparatus through vestibular nerve & nuclei convey information to Cerebellum, Oculomotor nuclei, and spinal cord motor neurons.

VESTIBULAR PATHWAY



VESTIBULAR APPARATUS

VESTIBULAR NUCLEI

1. Through cerebellar connections it maintains equilibrium & coordinates postural movements.
2. Through oculomotor nucleus, it regulates eye movements coordinated with bodily movements.
3. Through spinal motor neurons it controls postural reflexes.

VESTIBULAR APPARATUS

VESTIBULAR NUCLEI

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VESTIBULAR APPARATUS

VESTIBULAR REFLEXES

- POSTURAL REFLEXES-Provide postural stability for movement.
- VISUAL REFLEXES provide stability of visual images inspite of body movements.

POSTURAL REFLEXES-

- 1.Tonic labyrinthine reflex
- 2.Labyrinthine righting reflex
- 3.Vestibulocollic reflex.

VESTIBULAR APPARATUS

POSTURAL REFLEXES-

1. TONIC LABYRINTHINE REFLEXES:

- Help to maintain the tone of muscles especially in erect posture.
Receptors-in otolith organs.
- Stimulus-Action of gravity on the otolith organs as altered by change in body position.
- Pathway-The effects are mediated by vestibulospinal tracts.

VESTIBULAR APPARATUS

POSTURAL REFLEXES-

2. LABYRINTHINE RIGHTING REFLEX:

- When an animal is held by its body & tipped from side to side, the head stays in level due to activation of labyrinthine righting reflexes.
- Receptors-Hair cells in otolith organs.
- Stimulus -Tilting of head that stimulate otolith organs.
- Response-Contraction of neck muscles that keep the head level.

VESTIBULAR APPARATUS

POSTURAL REFLEXES-

3.VESTIBULOCOLLIC REFLEX:

Contraction of head & neck muscle in response to vestibular stimulation provide stability of head position during movement.

VESTIBULAR APPARATUS

VESTIBULO-OCULAR REFLEX (VOR)

- ◆ When head rotates, VOR helps to fix vision on the same object inspite of rotation of head.
- ◆ The visual fixation is an important component of postural regulation.
- ◆ When head rotates, eyes move in opposite direction so that visual image remains constant.
- ◆ When rotation exceeds 60° rapid movement of eyes occurs in the same direction to that of head rotation. Now the eye fixes on a new object. This slow movement of eyeball alternating with a rapid movement in opposite direction gives rise to nystagmus.
- ◆ The slow component of this reflexes is vestibular component, rapid component integrated in superior colliculi & prepontine reticular formation.

VESTIBULAR APPARATUS

PATHWAY FOR VESTIBULO-OCULAR REFLEX (VOR)

- First order neurons start from vestibular apparatus and terminate in the vestibular nuclei in brain stem.
- The second order neurons from vestibular nuclei to oculomotor nerve nuclei.
- The third order neurons originate from oculomotor nucleus to innervate extraocular muscles.

VESTIBULAR APPARATUS

APPLIED PHYSIOLOGY

- ❖ MOTION SICKNESS-Due to overstimulation of vestibular apparatus.
- ❖ VERTIGO-Illusion of motion ,usually rotation when actually no rotation take place. Vestibular system that senses position & rotation of head, when becomes abnormal vertigo occurs.
 - Physiological vertigo, central positional vertigo, labyrinthine vertigo, benign positional vertigo.