ELECTROOCULOGRAPHY

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ELECTROOCULOGRAPHY

- Method for assesment of the eye movements employing the measurement of potential difference between cornea and retina
- This potential generates an electric dipole oriented in parallel with the optical axis of the eye

- The main goal of eye movements: to maintain and stabilize the object of interest at the point of the sharpest vision (yellow spot)

Types of eye movements

- **Sustaining (miniature) –** such as **fixation** - Looking into our eyes do not stray far away in space, but they are automatically fixed on a point in space (its visual field)
- **Smooth pursuit movements** - assist the macular stabilization of the observed object
- **Saccadic movements** – assist the transferring the view to a new object

- **Nystagmus** – rhythmic eye-bulb movements, with 2 components: slow deviation to one side and fast twitch to the opposite side (slow is vestibular, fast from brainstem structures)

- **Vestibulo-ocular reflex** – stabilization of the retinal image during sudden, non-uniform movements of the head
- **Optokinetic nystagmus** – regular eye movement stabilizing the view during slight movement of the head or when the object changes its position with respect to motionless head

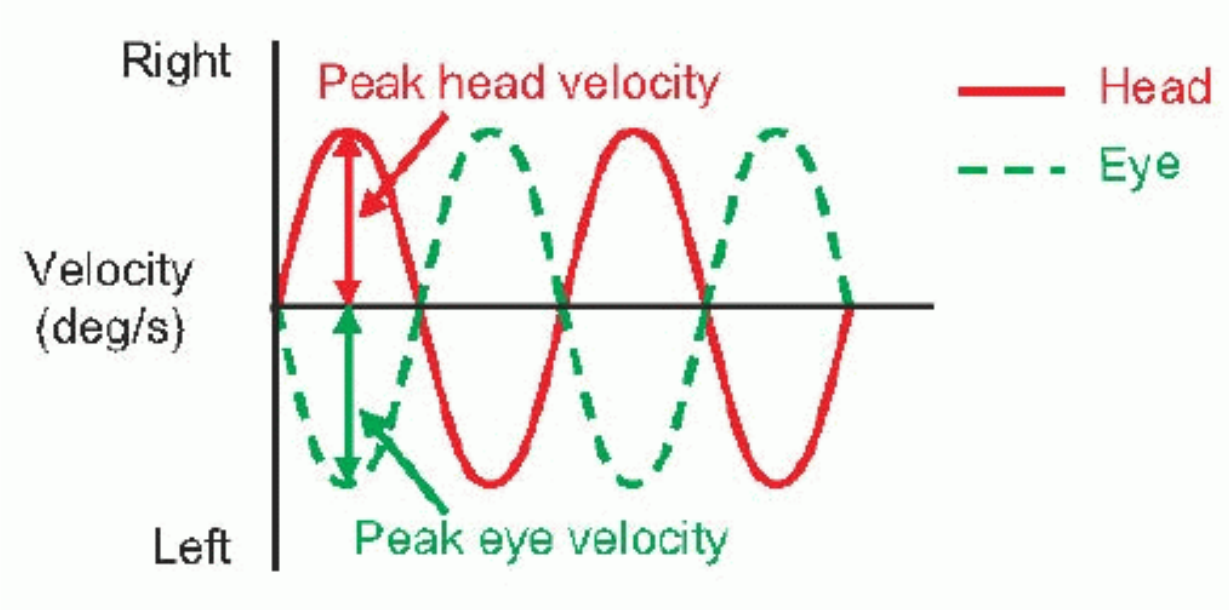
Eye Movement

Function of Eye Movement	Type of Eye Movement	
"Holding" (slow)	•Smooth Pursuit •Optokinetic Nystagmus (slow phase) •Vestibular Nystagmus	•Convergence •Divergence •Accommodative Vergence
"Catching" (fast)	•Saccades •Optokinetic Nystagmus (quick phase)	
"Sustaining" (miniature)	•Microsaccades	•Tremor •Drift
voluntary eye movement; involuntary eye movement		

The Vestibular Apparatus

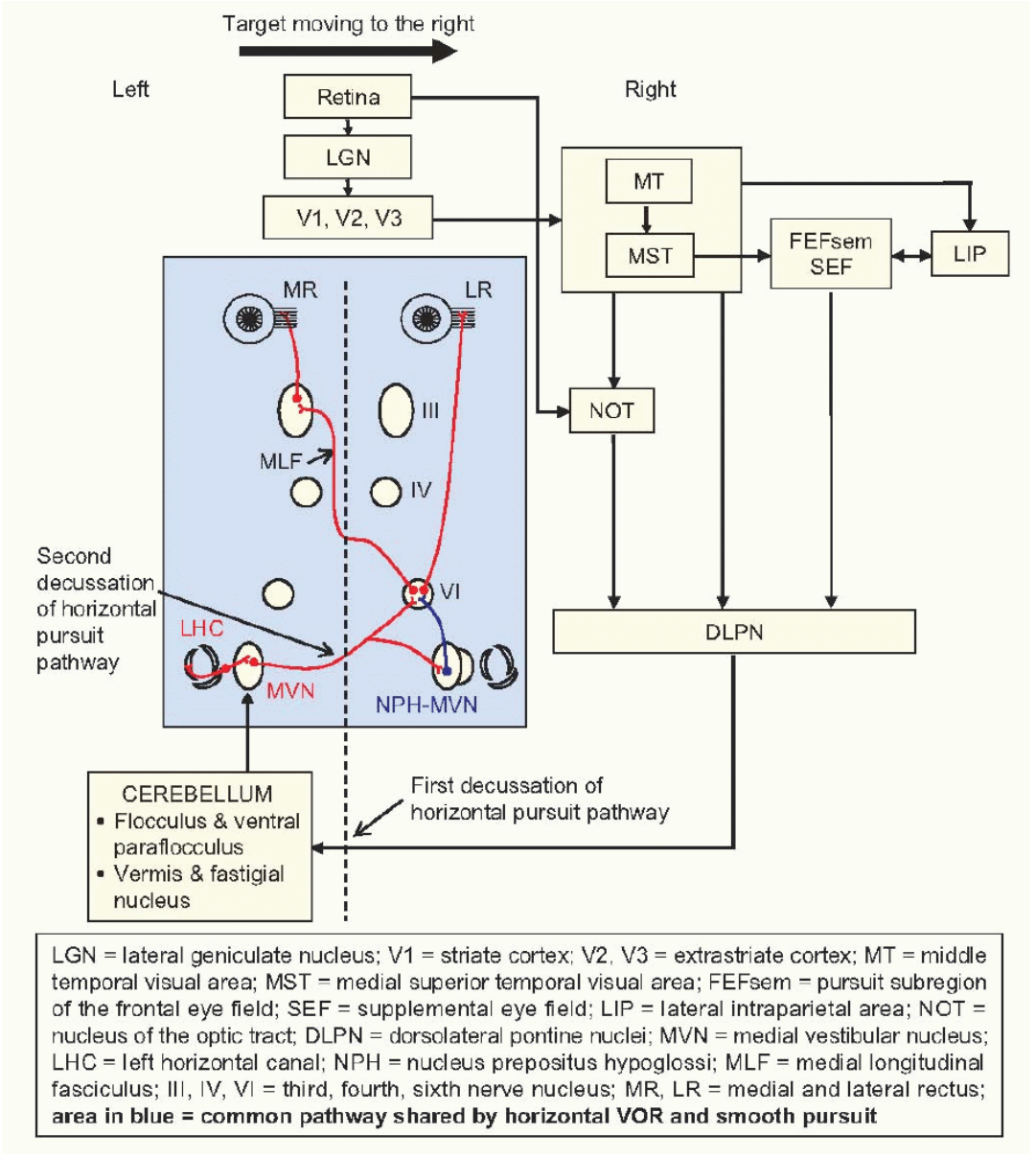
- The vestibulo-ocular and optokinetic reflexes are the earliest eye movements to appear phylogenetically
- The **vestibulo-ocular reflex (VOR)** stabilizes retinal images during head motion by counter-rotating the eyes at the same speed as the head but in the opposite direction

Characteristics of the VOR



The VOR stabilizes retinal images during brief head movements by counter-rotating the eyes at the same speed as the head but in the opposite direction

Summary of Central Control of Pursuit Eye Movement



Vertigo
Nystagmus

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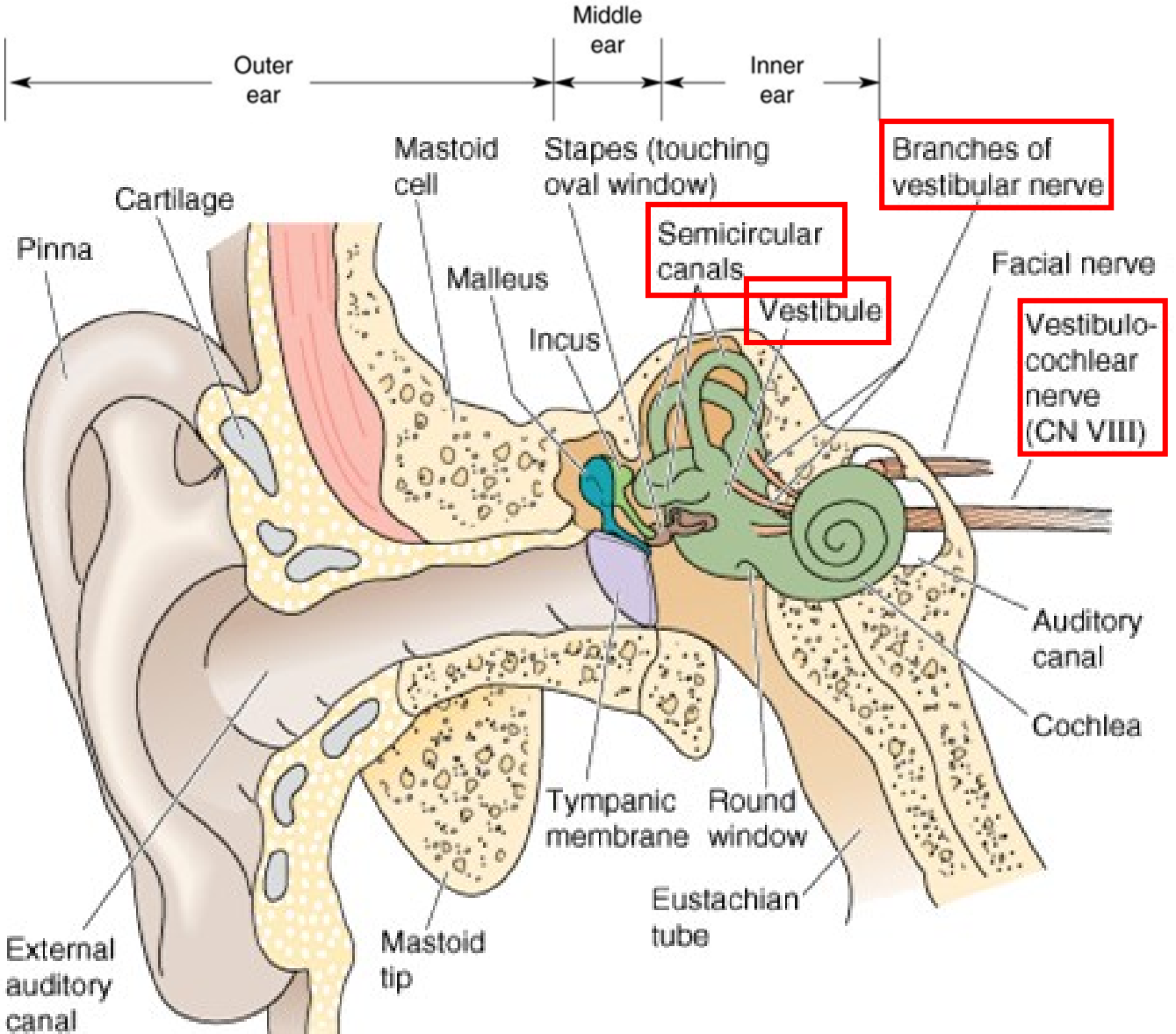
Vertigo

- Vertigo (dizziness)– subjective loss of stability in space, rotation of surrounding space or rotation of body in space
- connected with objective symptoms – disturbances of equilibrium and nystagmus – by stimulation of the labyrinths
- semicircular canals are stimulated by:
  - rotation - post-rotational vertigo
  - Caloric (application of external auditorial tube either with cold=27°C or warm=47°C water
  - electric current - galvanic vertigo

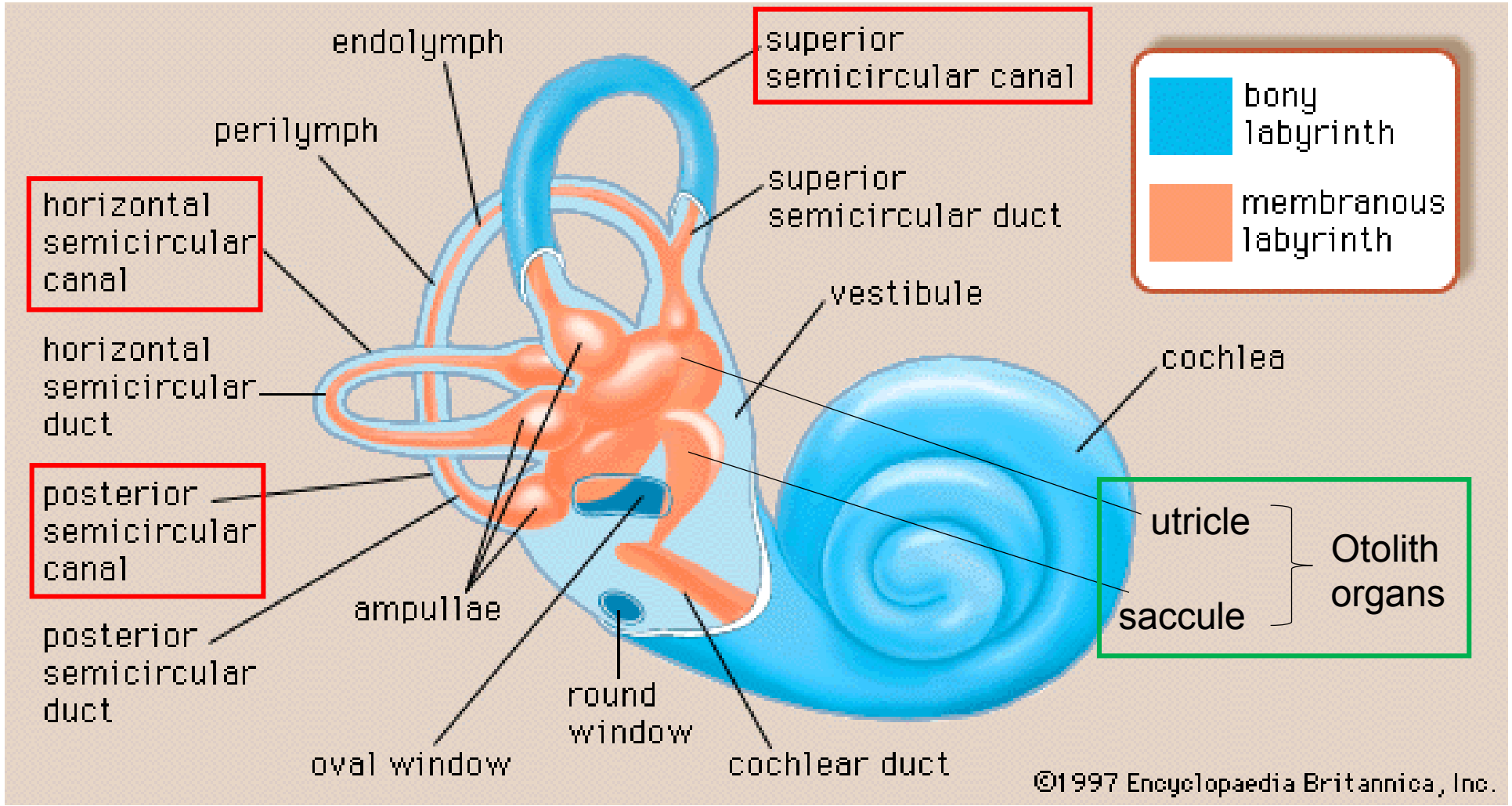
Nystagmus

- rhythmic eye-bulb movements, 2 components: slow deviation to one side and fast twitch to the opposite side
- slow is vestibular, fast from brainstem structures
- Nystagmus at rest – vestibular system is affected by some pathological process or cerebellum

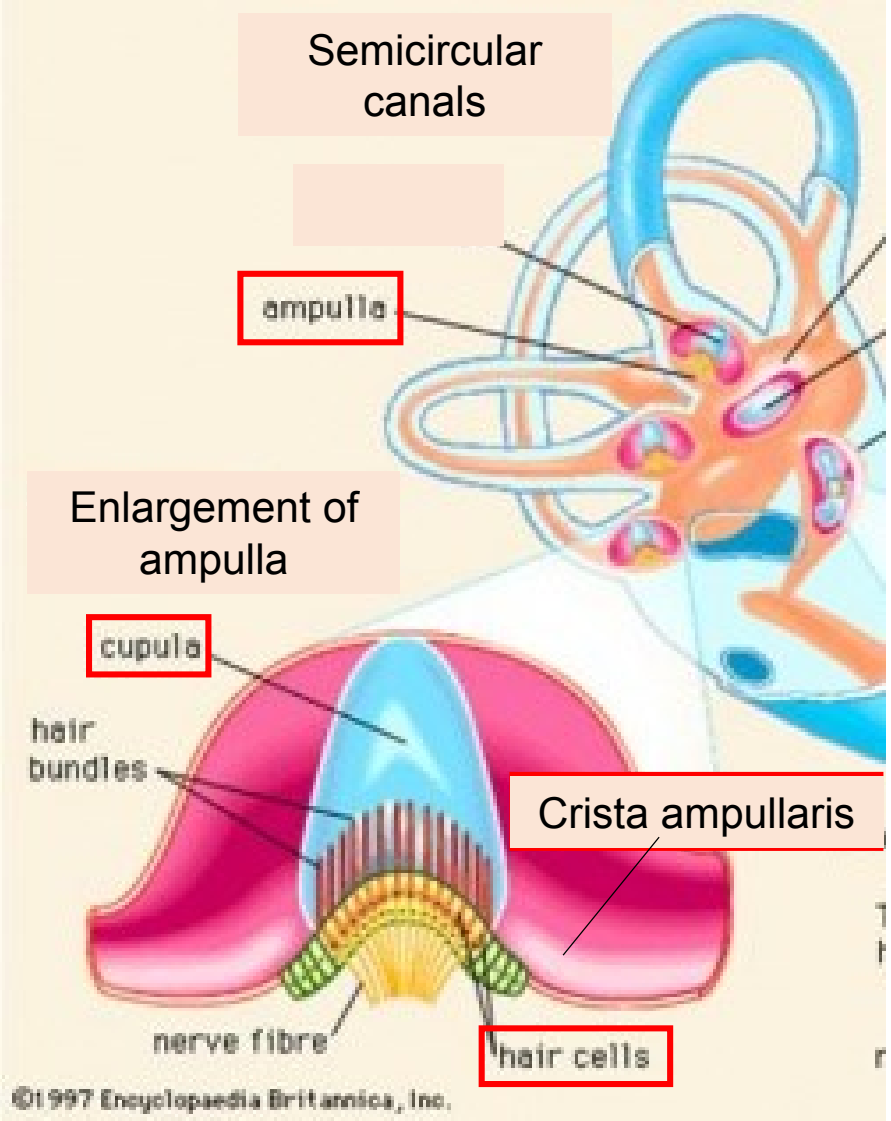
Vestibular System: Structure



Vestibular System: Structure



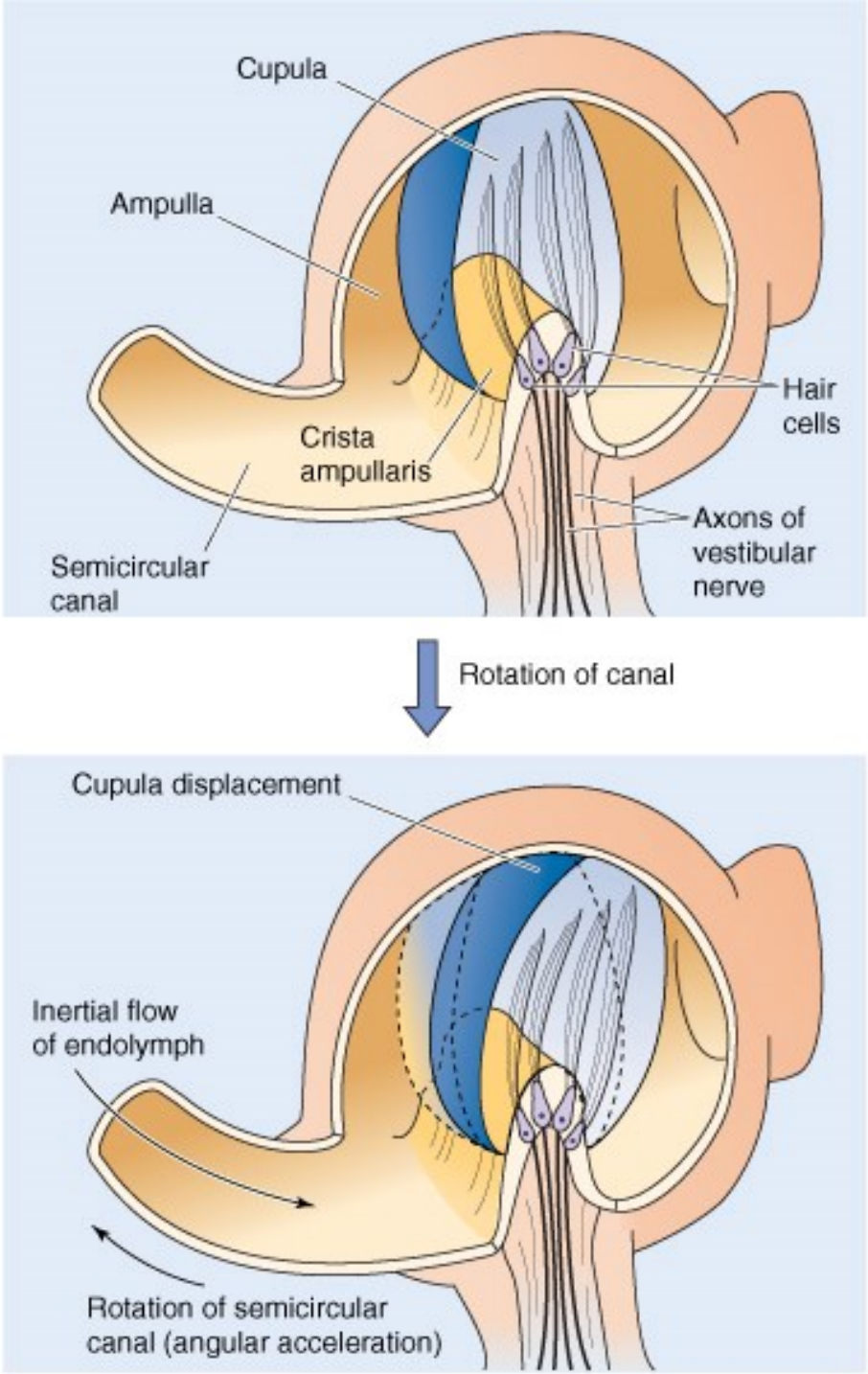
Semicircular canals: structure



- each semicircular canal contains an ampulla
  - Contains hair cells embedded in sensory epithelium called crista ampullaris
  - Cilia of hair cells project into gelatinous cap called cupula

Semicircular canals: function

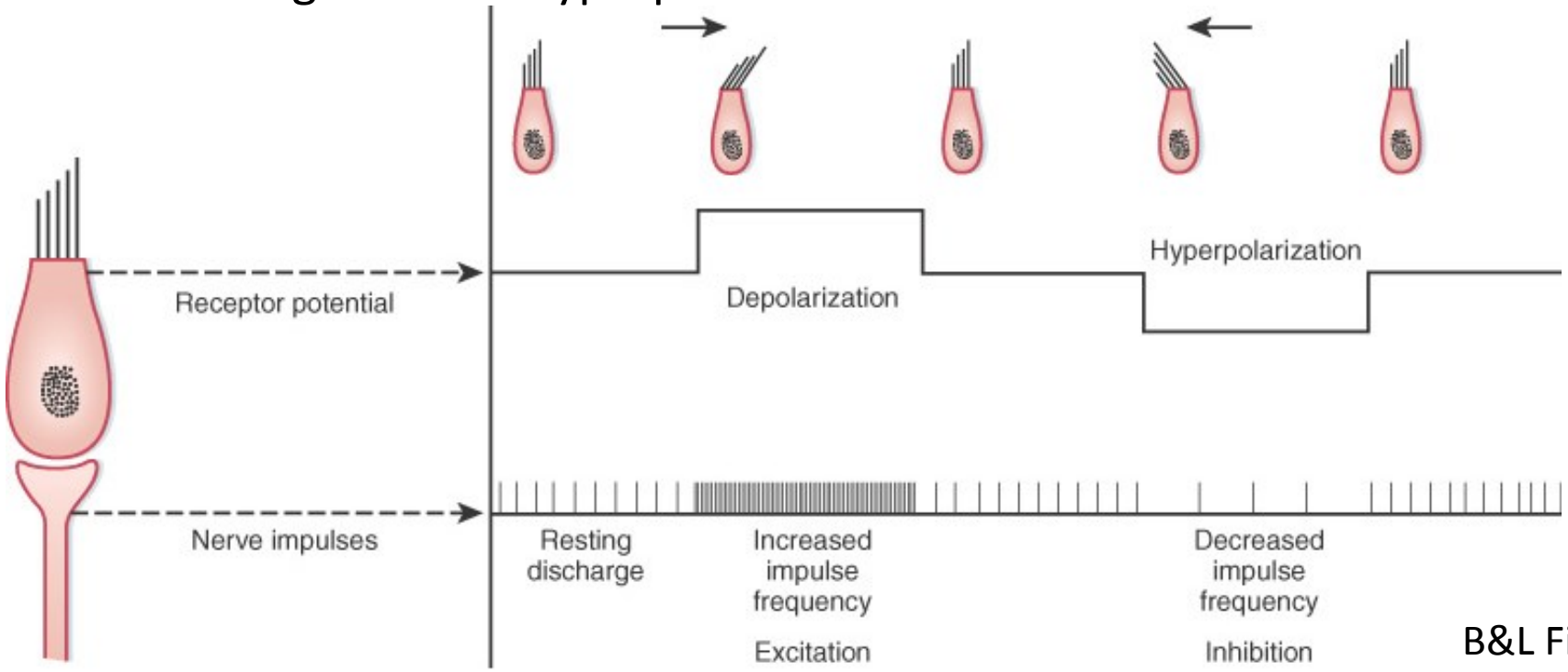
- Specialized for responding to **rotational acceleration** of the head
  - Head rotation results in the movement of endolymph in opposite direction
  - Bends cupula which bends hair cells
    - Same mechanical/electrical coupling as in auditory hair cells



B&B Figure 13-18

Semicircular canals: sensory transduction

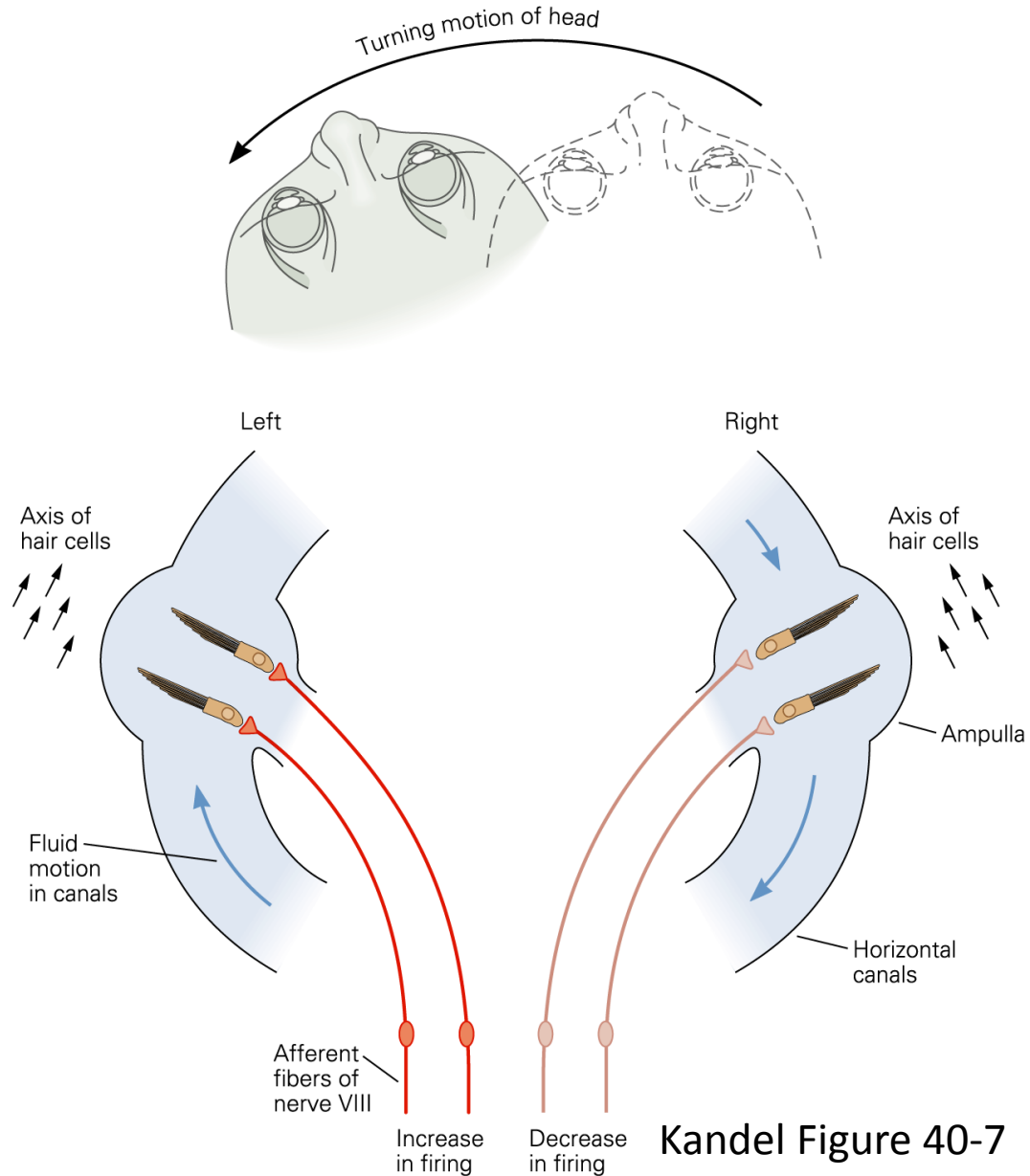
- Steriocilia maintain directionality on both sides of the head
  - Bending towards kinocilium → opens mechanically gated cation channels → K^+ influx → depolarization
  - Bending away from kinocilium → closes channels that are open during resting state → hyperpolarization



B&L Figure 8-26

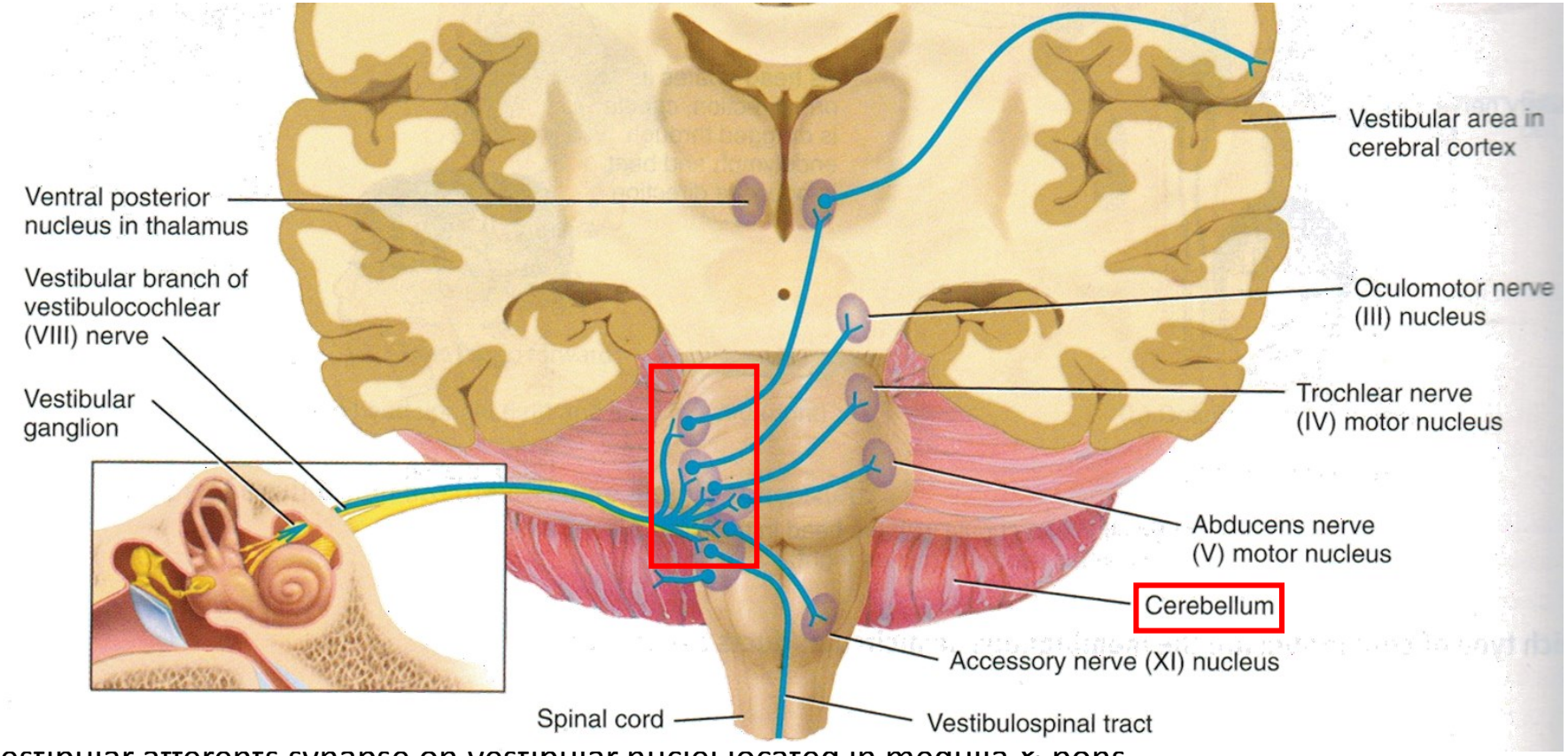
Semicircular canals: sensory transduction

- Paired canals work together to signal head movement
  - With turning of the head, hair cells on one side of the body send excitatory signals to the brain while hair cells on the opposite side are inhibited



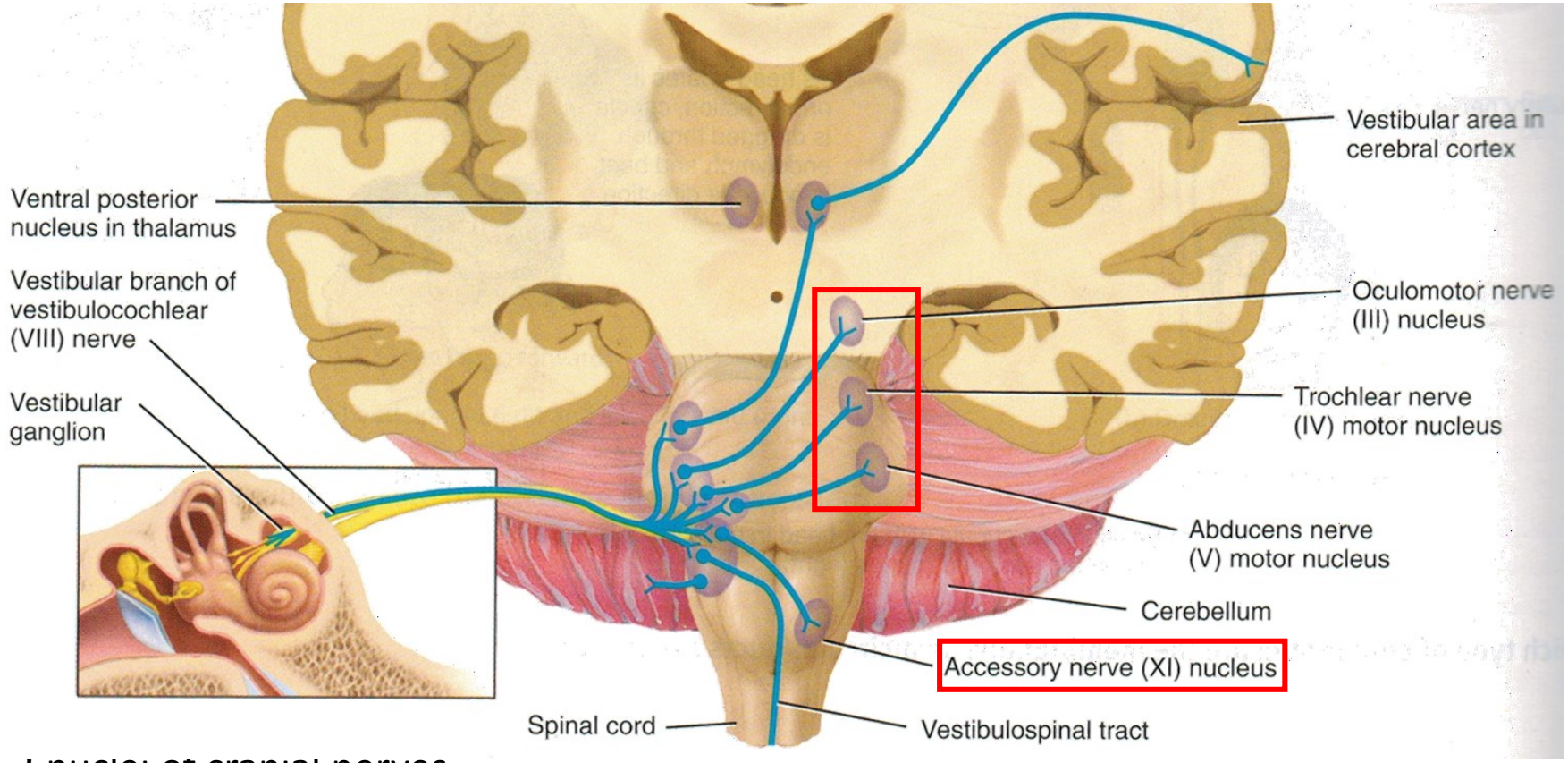
Kandel Figure 40-7

Vestibular Pathways



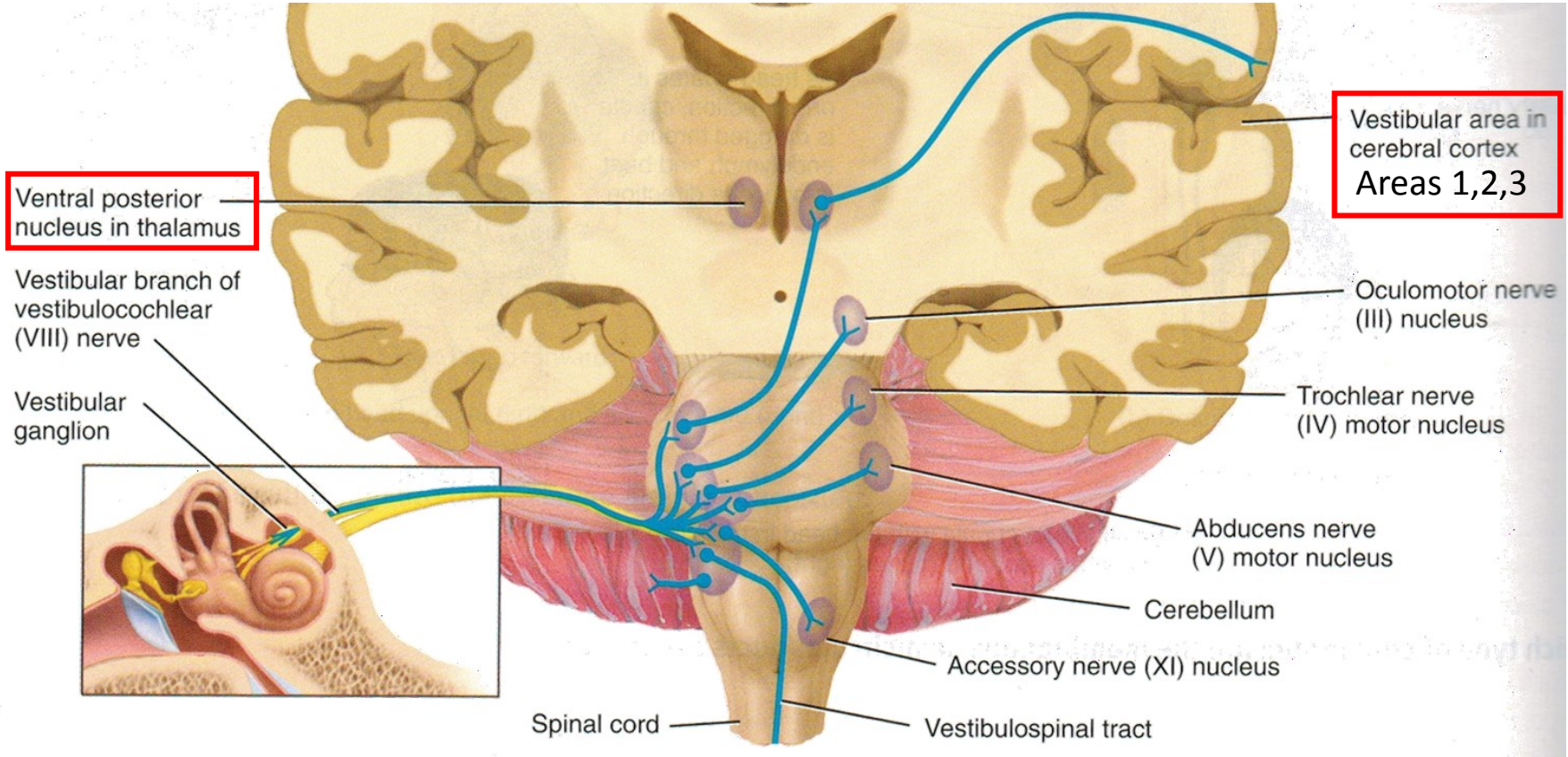
- vestibular afferents synapse on vestibular nuclei located in medulla & pons
  - Nuclei integrate information from vestibular, visual, and somatic receptors and send collaterals to
    - 1.cerebellum
      - Sends corrective adjustments to motor cortex: maintenance of balance and posture

Vestibular Pathways



- 2.<u>nuclei of cranial nerves</u>
  - Control coupled movements of the eyes, maintain focus and visual field
- 3.<u>nuclei of accessory nerves</u>
  - Control head movement and assist with equilibrium

Vestibular Pathways



- 4.<u>ventral posterior nucleus of thalamus</u> and <u>vestibular area in cerebral cortex</u> (part of primary somatosensory cortex)
  - Conscious awareness of the position and movement of head

Vestibular Reflexes

Vestibulospinal Reflexes

- Senses falling/tipping
  - contracts limb muscles for postural support

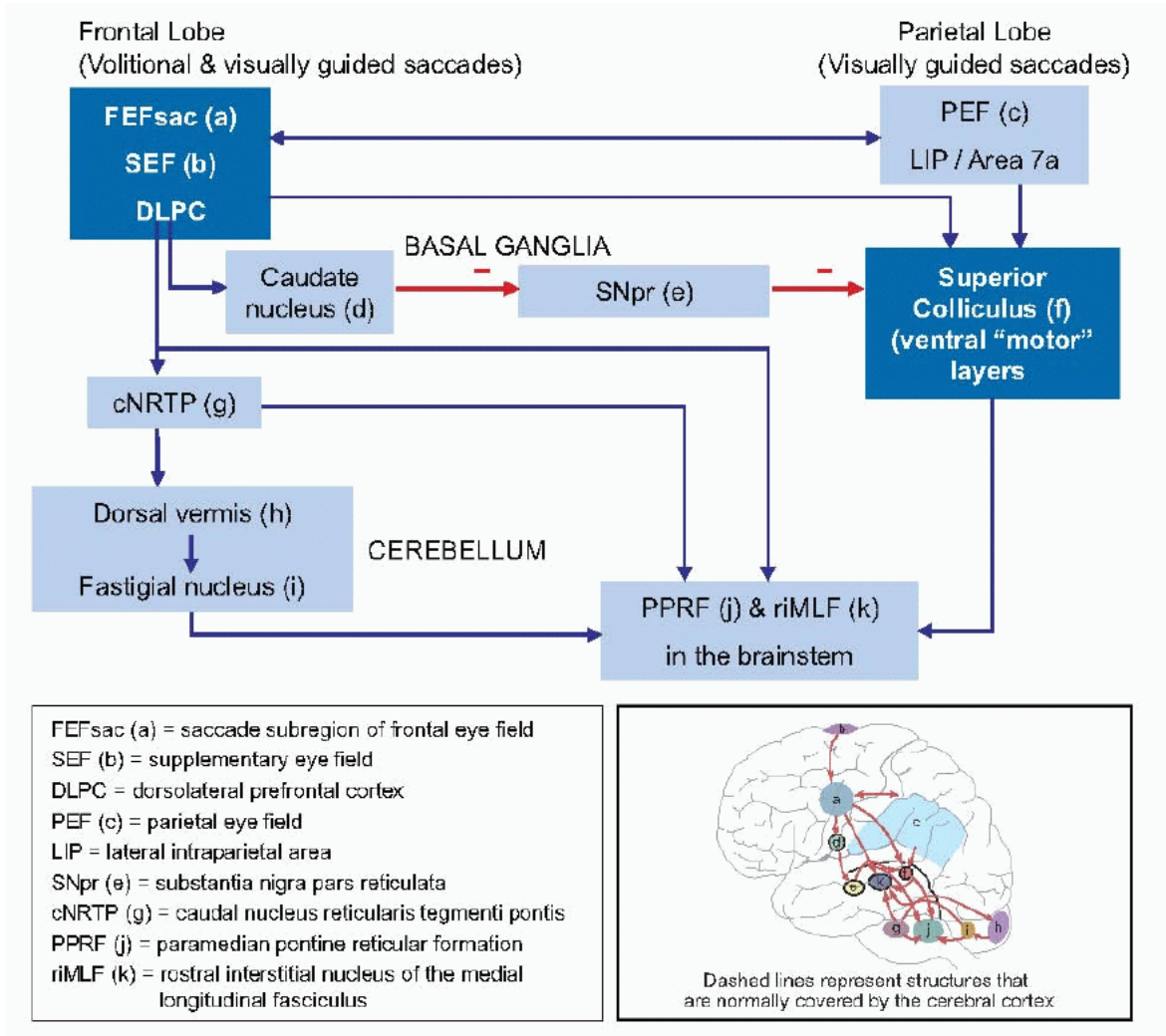
Vestibulocollic Reflexes

  - acts on the neck musculature to stabilize the head if body moves

Vestibulo-ocular Reflexes

- stabilizes visual image during head movement
  - causes eyes to move simultaneously in the opposite direction and in equal magnitude to head movement

Summary of Central Control of Saccades



Redrawn from Leigh RJ, Zee DS. The Neurology of Eye Movements. 3rd ed. New York: Oxford University Press; 1999. With permission of Oxford University Press.

- Activation of the frontal eye field (FEFsac) and superior colliculus (SC) on one side generates contralateral horizontal saccades.
- Simultaneous activation of FEFsac on both sides or SC on both sides generates vertical and torsional saccades.