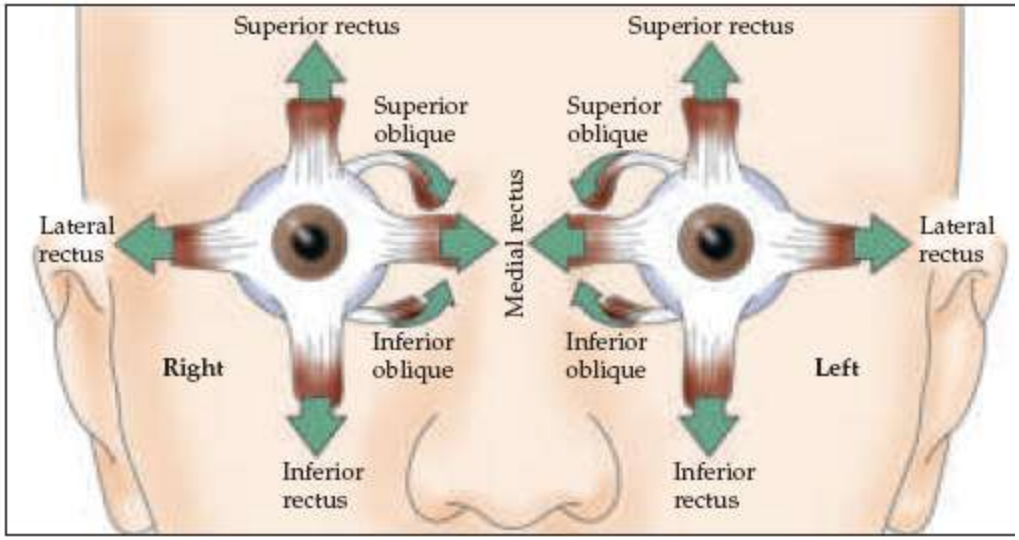
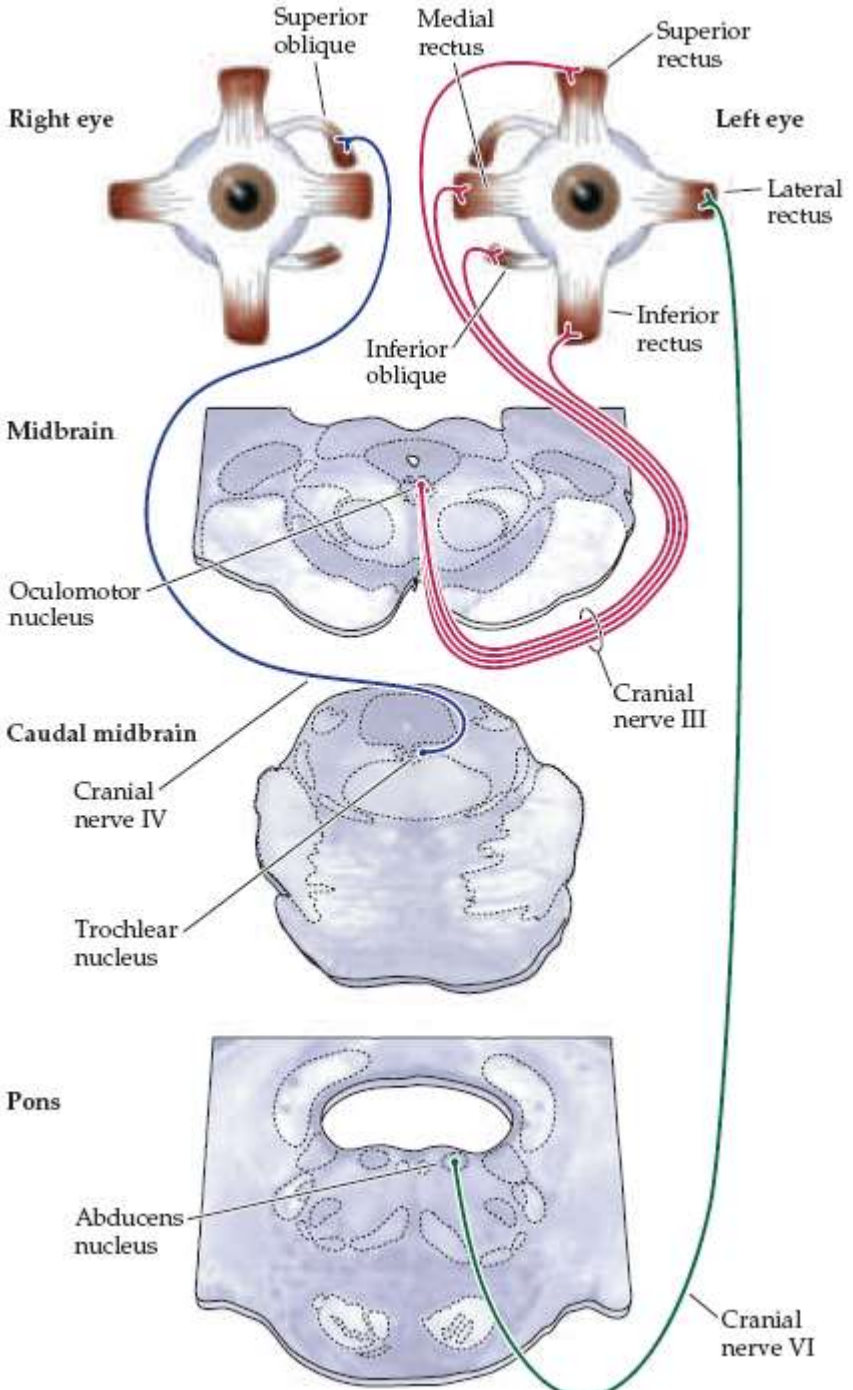
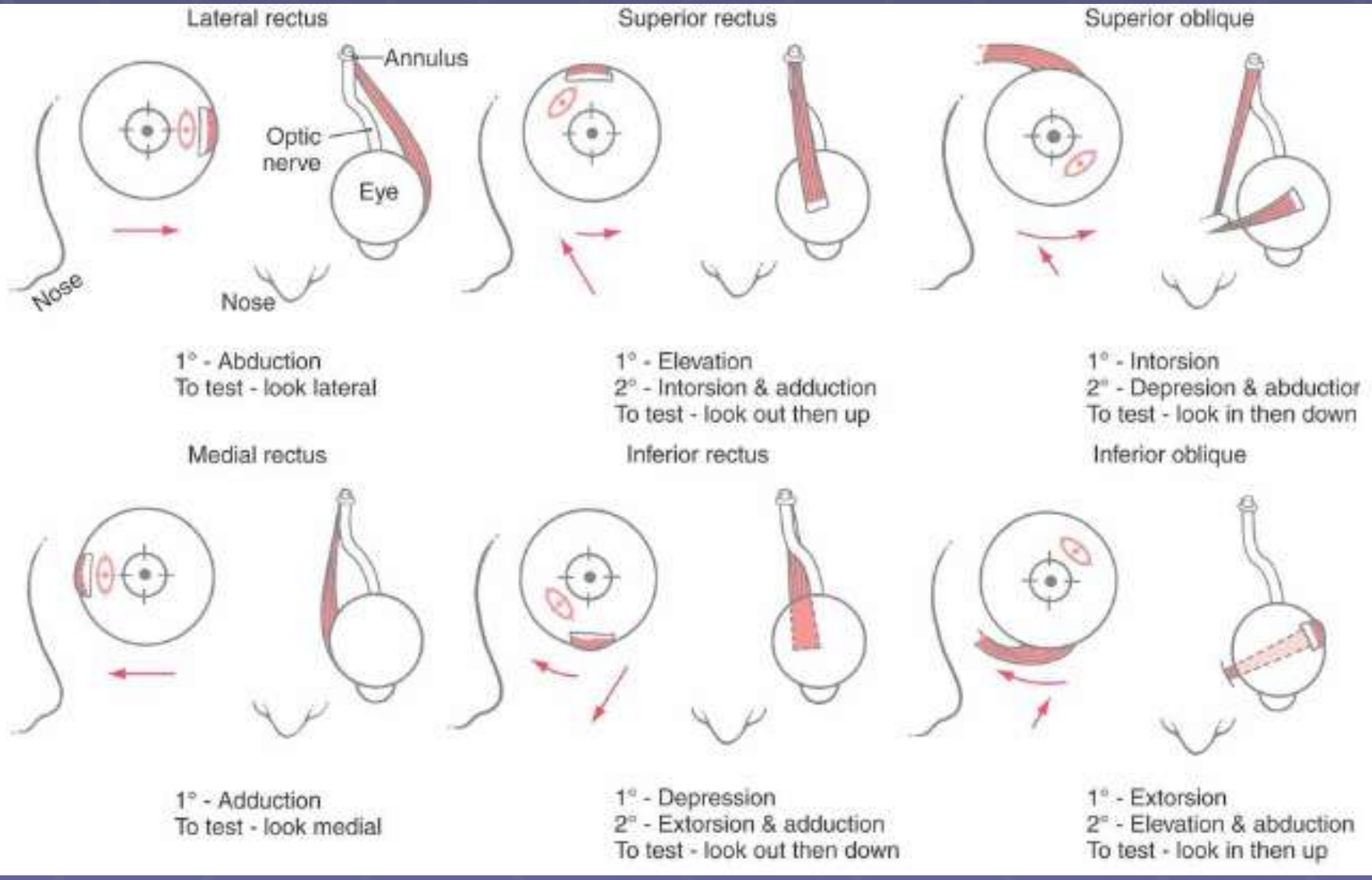
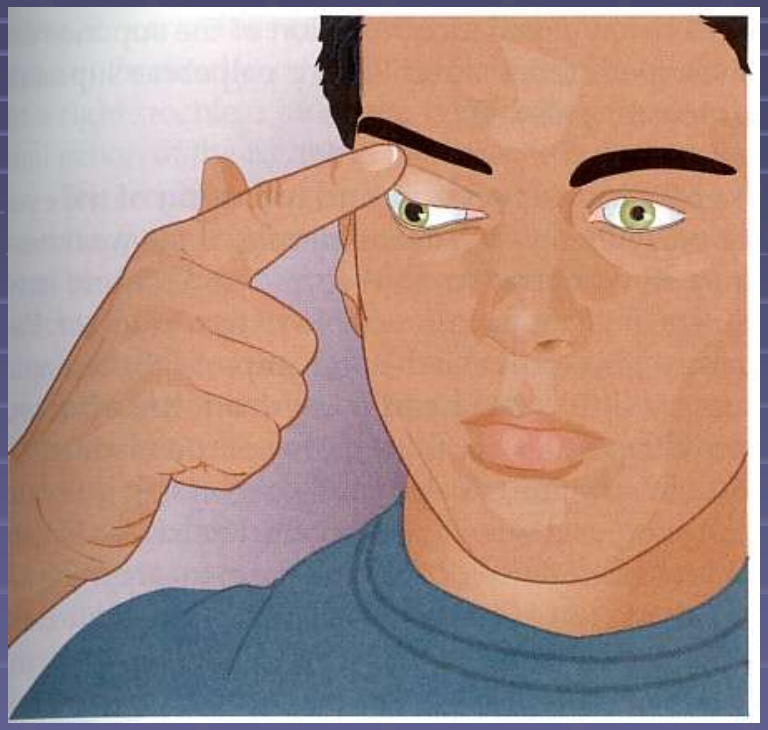
Control of eye movement


Superior rectus
Superior rectus
Superior oblique
Superior oblique
Lateral rectus
Medial rectus
Lateral rectus
Inferior oblique
Inferior oblique
Right
Left
Inferior rectus
Inferior rectus


Superior oblique
Medial rectus
Superior rectus
Right eye
Left eye
Lateral rectus
Inferior rectus
Inferior oblique
Midbrain
Oculomotor nucleus
Cranial nerve III
Caudal midbrain
Cranial nerve IV
Trochlear nucleus
Pons
Abducens nucleus
Cranial nerve VI

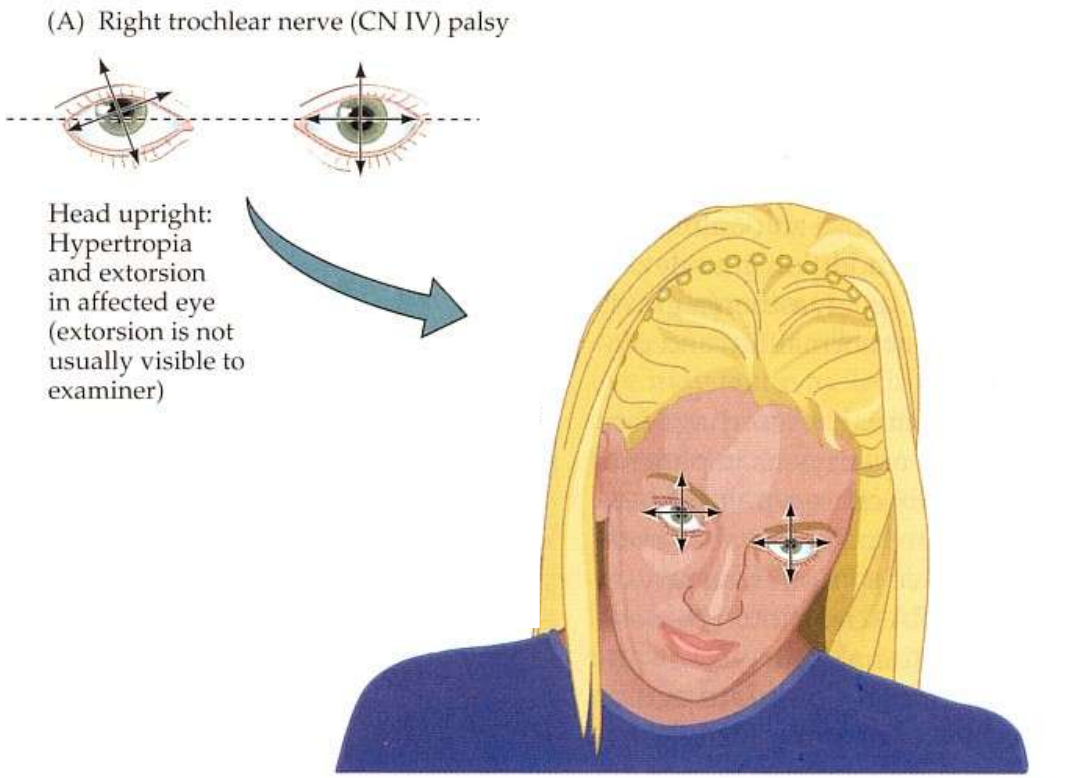

Lateral rectus
Annulus
Optic nerve
Eye
Nose
Nose
1° - Abduction
To test - look lateral
Superior rectus
1° - Elevation
2° - Intorsion & adduction
To test - look out then up
Superior oblique
1° - Intorsion
2° - Depresion & abductior
To test - look in then down
Medial rectus
1° - Adduction
To test - look medial
Inferior rectus
1° - Depression
2° - Extorsion & adduction
To test - look out then down
Inferior oblique
1° - Extorsion
2° - Elevation & abduction
To test - look in then up

Third Nerve Palsy



Eye “down and out”

Trochlear Nerve Palsy



Note: Right eye

- Instead of intorsion and depression action of superior oblique
- See extorsion and elevation

Observe how the axes over the right eye shift when patient generates a compensatory head movement

Attempted Correction:

- Patient tilts head to her left
- Tucks chin to foveate on object
- Left eye will align accordingly

Abducent nerve injury

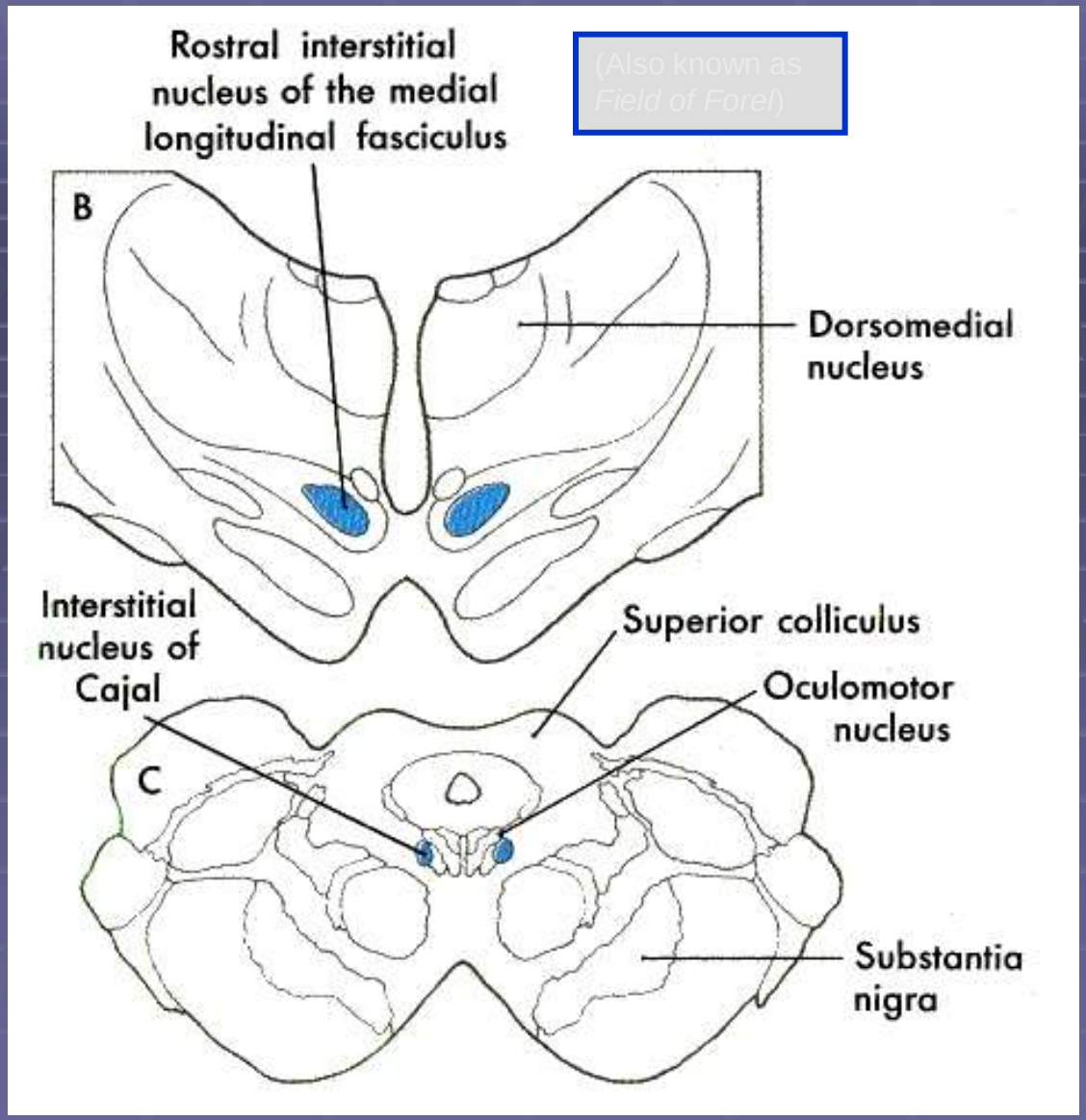
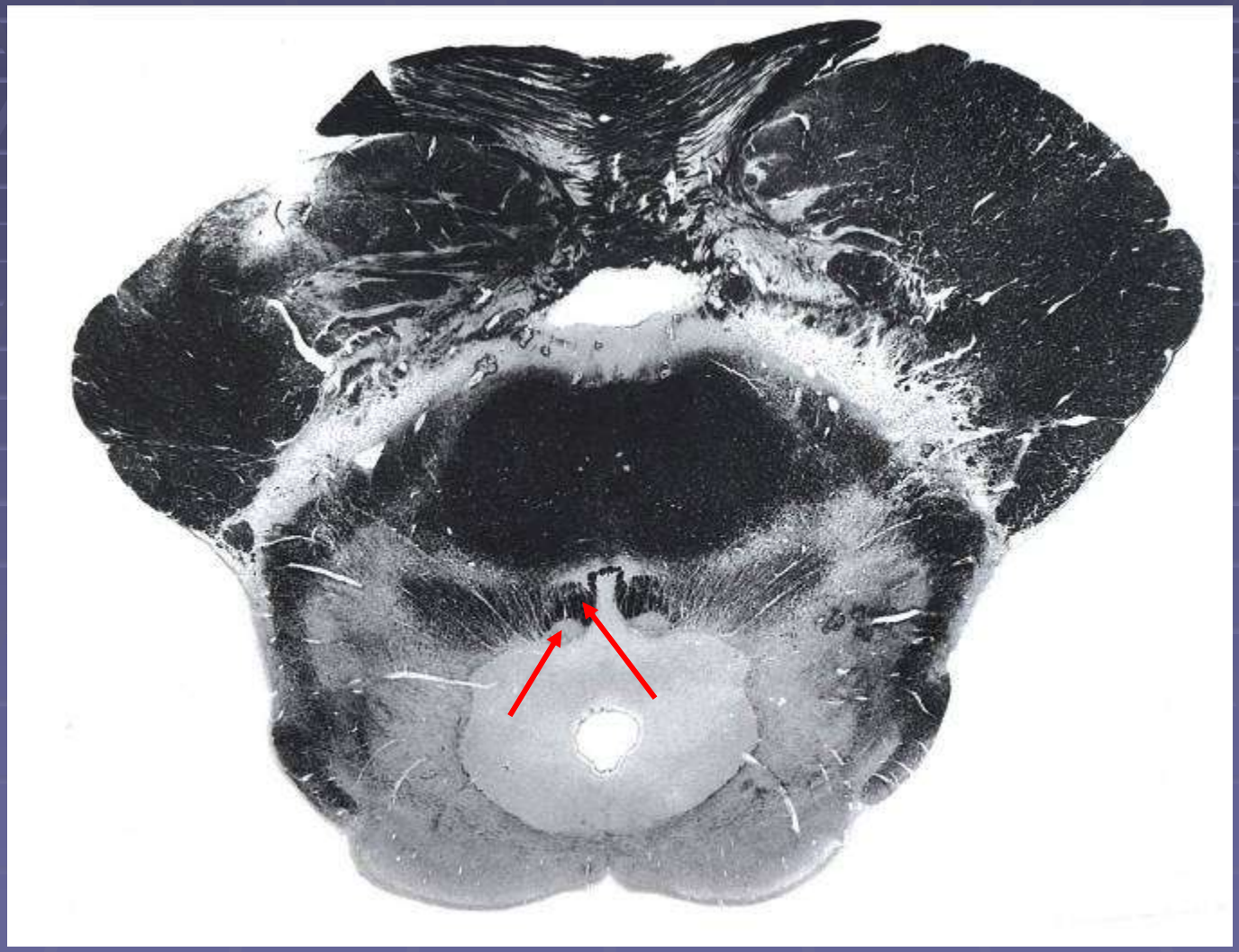


Figure 28-11

Vertical eye movements

Atlas 6-23



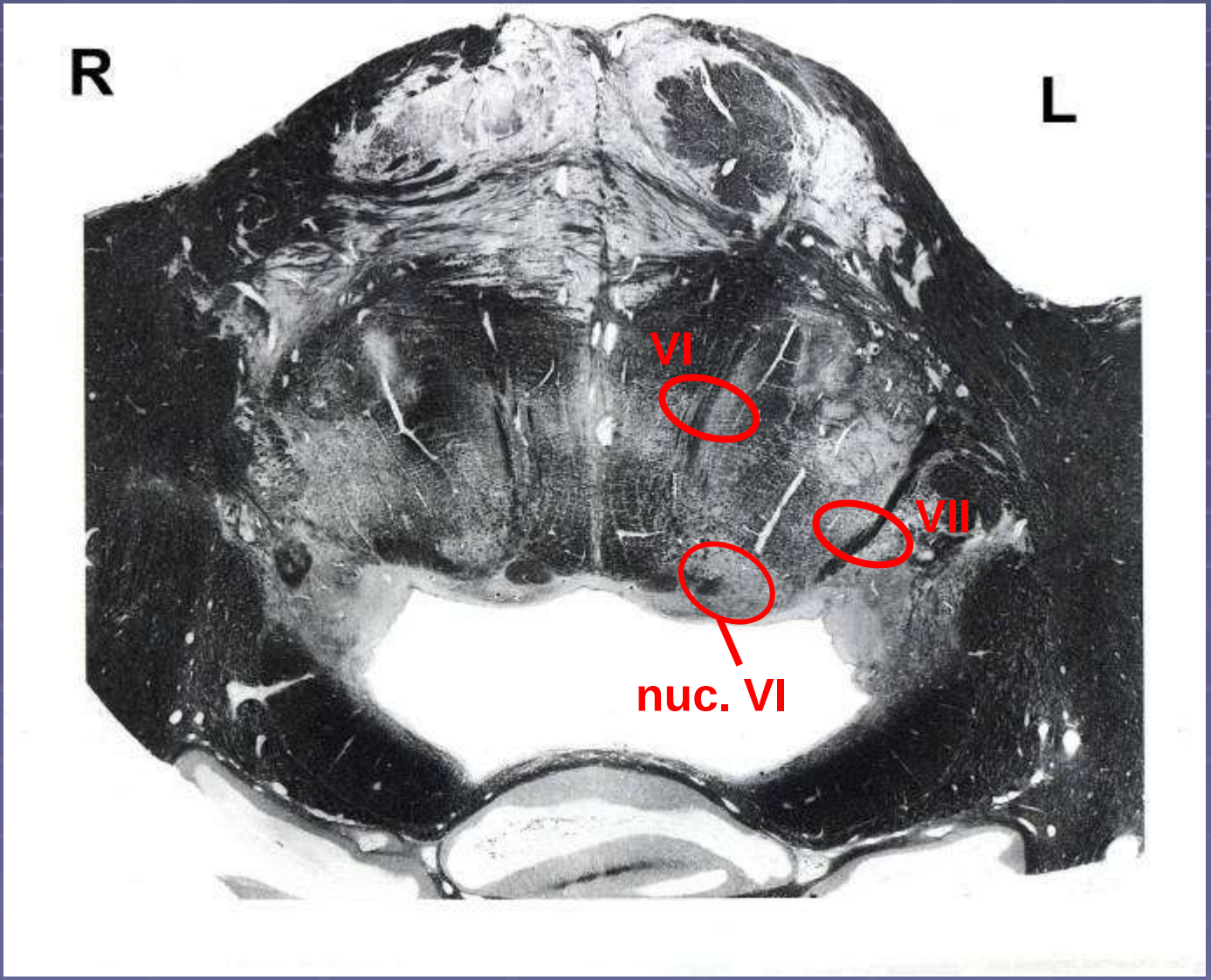
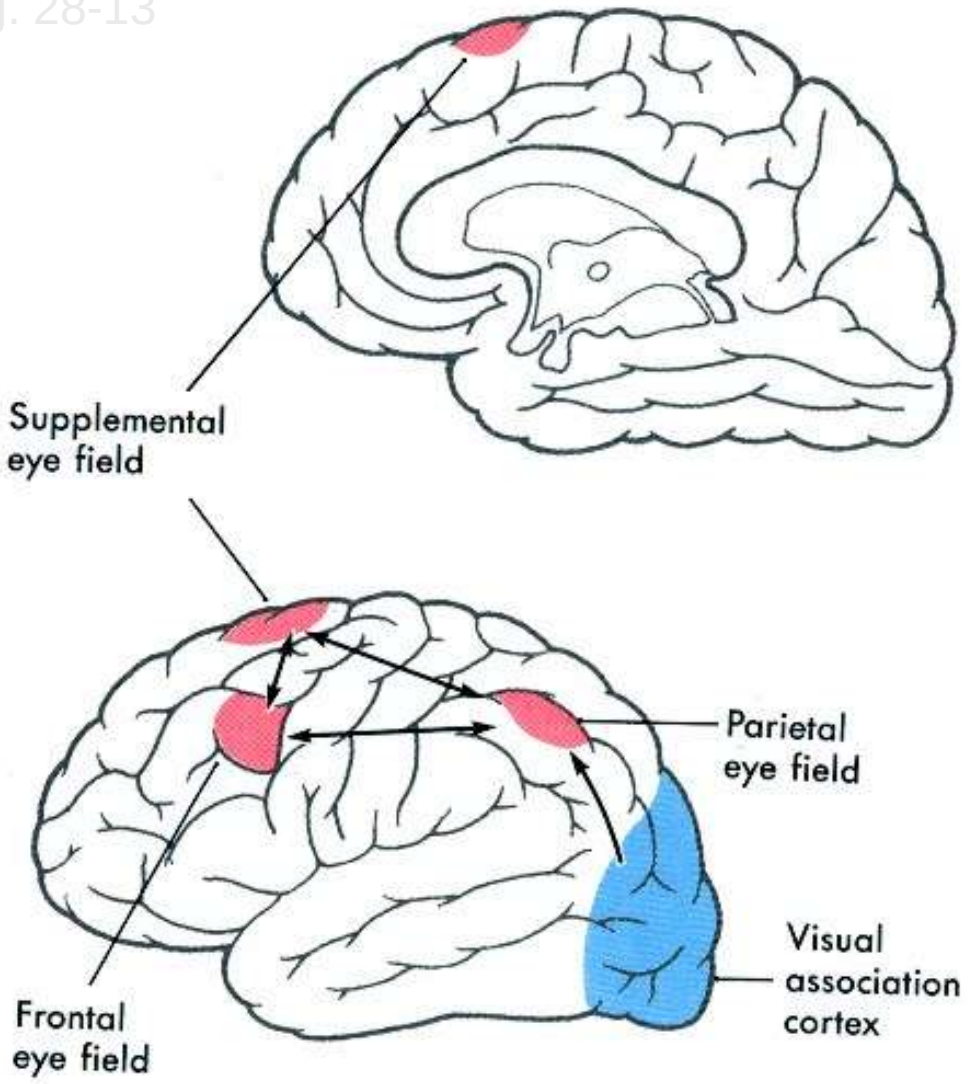
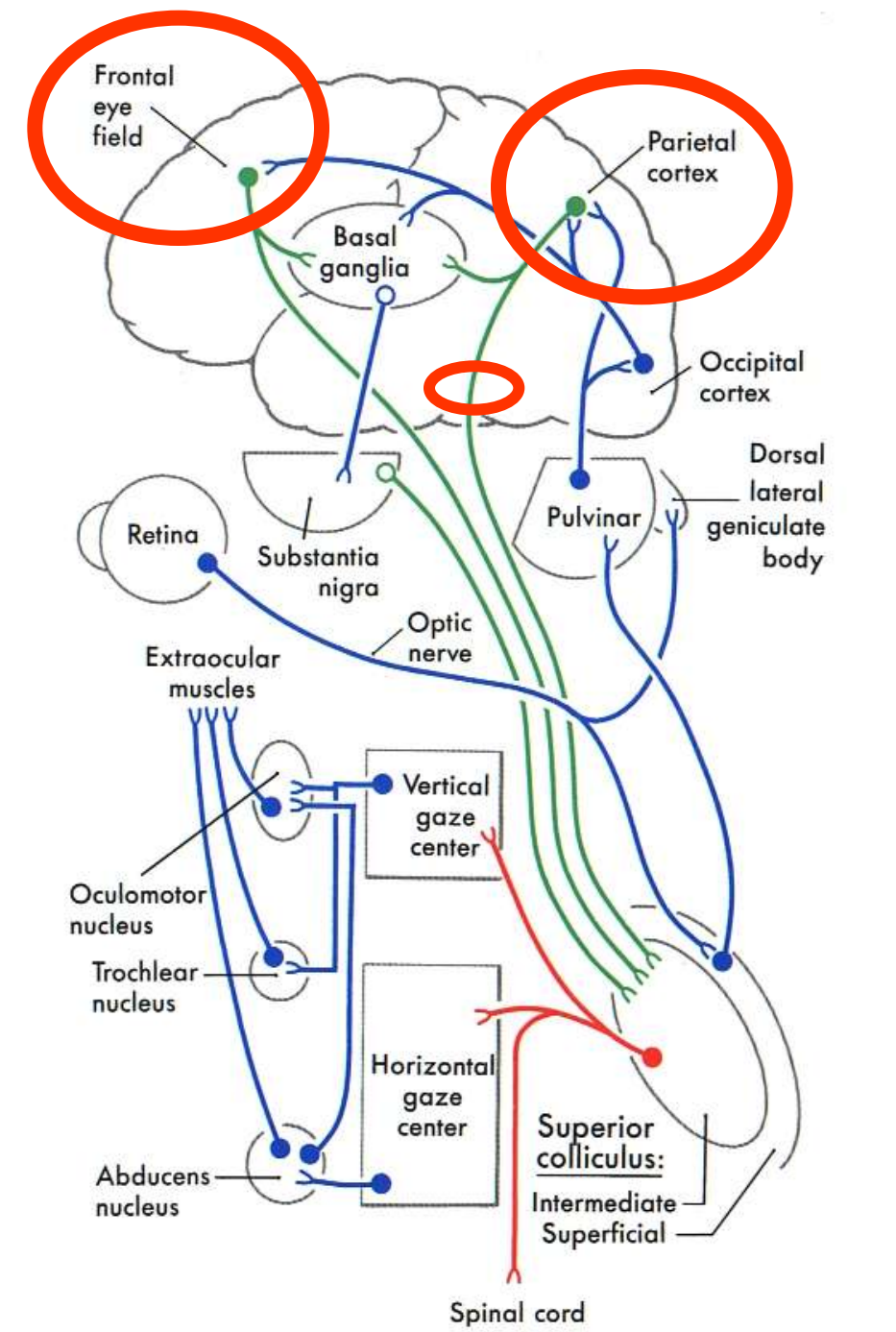

R
L
VI
VII
nuc. VI

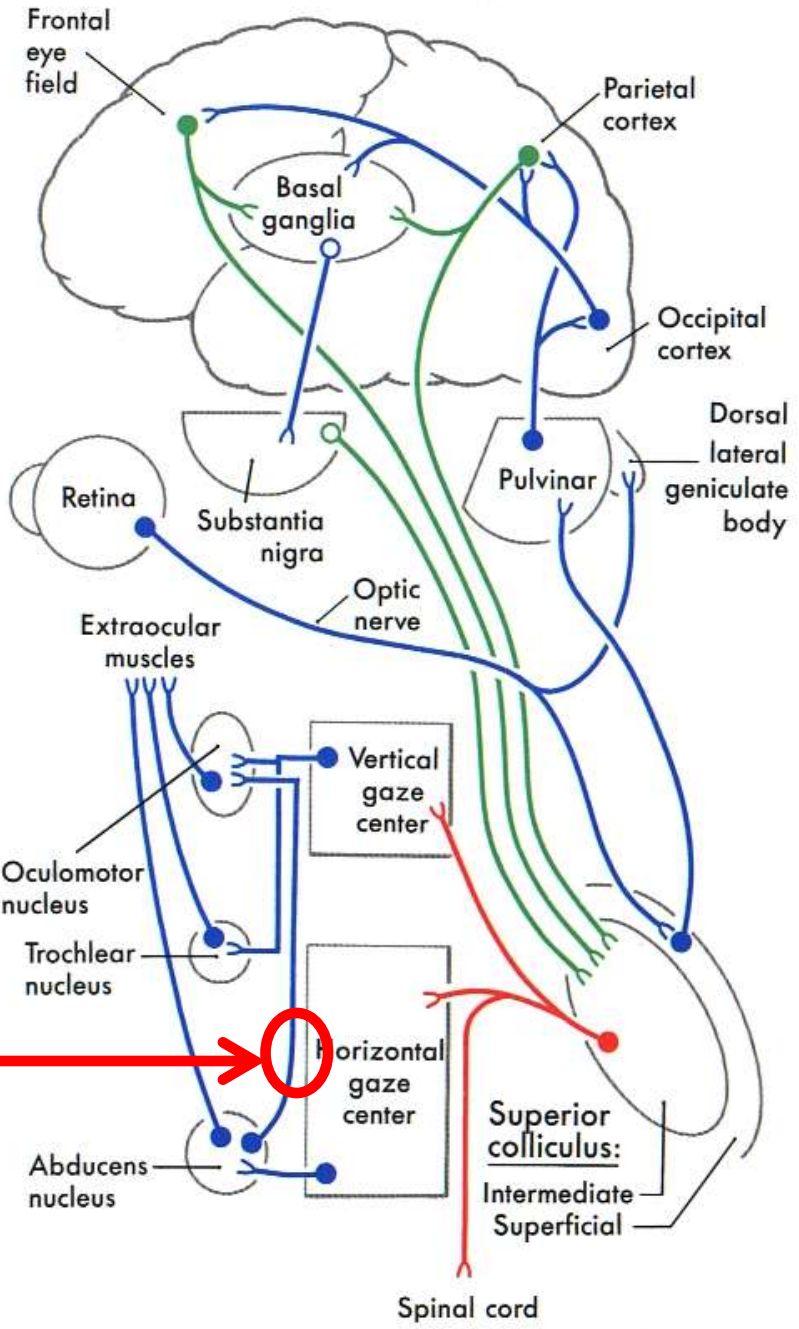
Fig. 28-13

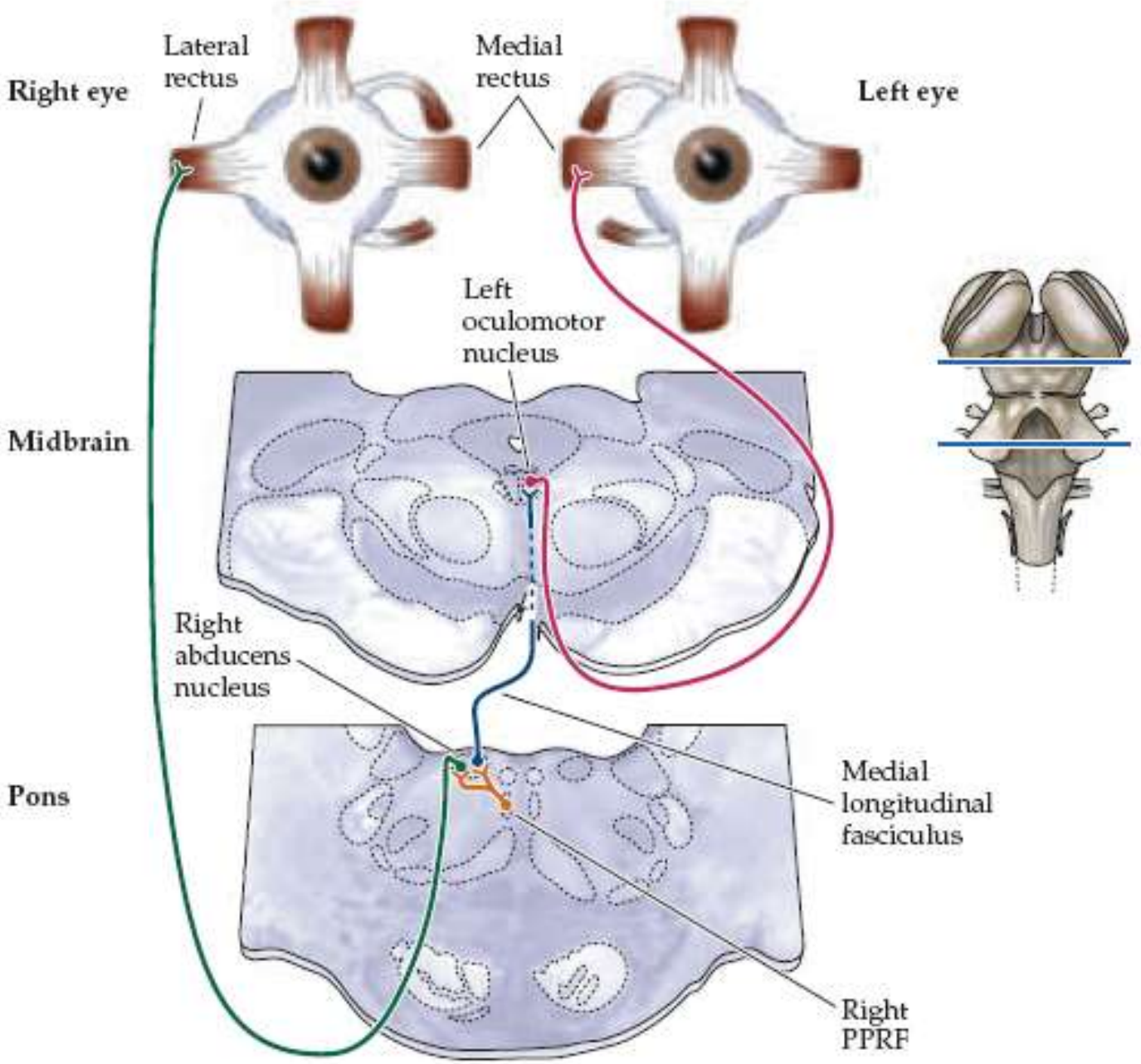

Supplemental
eye field
Parietal
eye field
Visual
association
cortex
Frontal
eye field

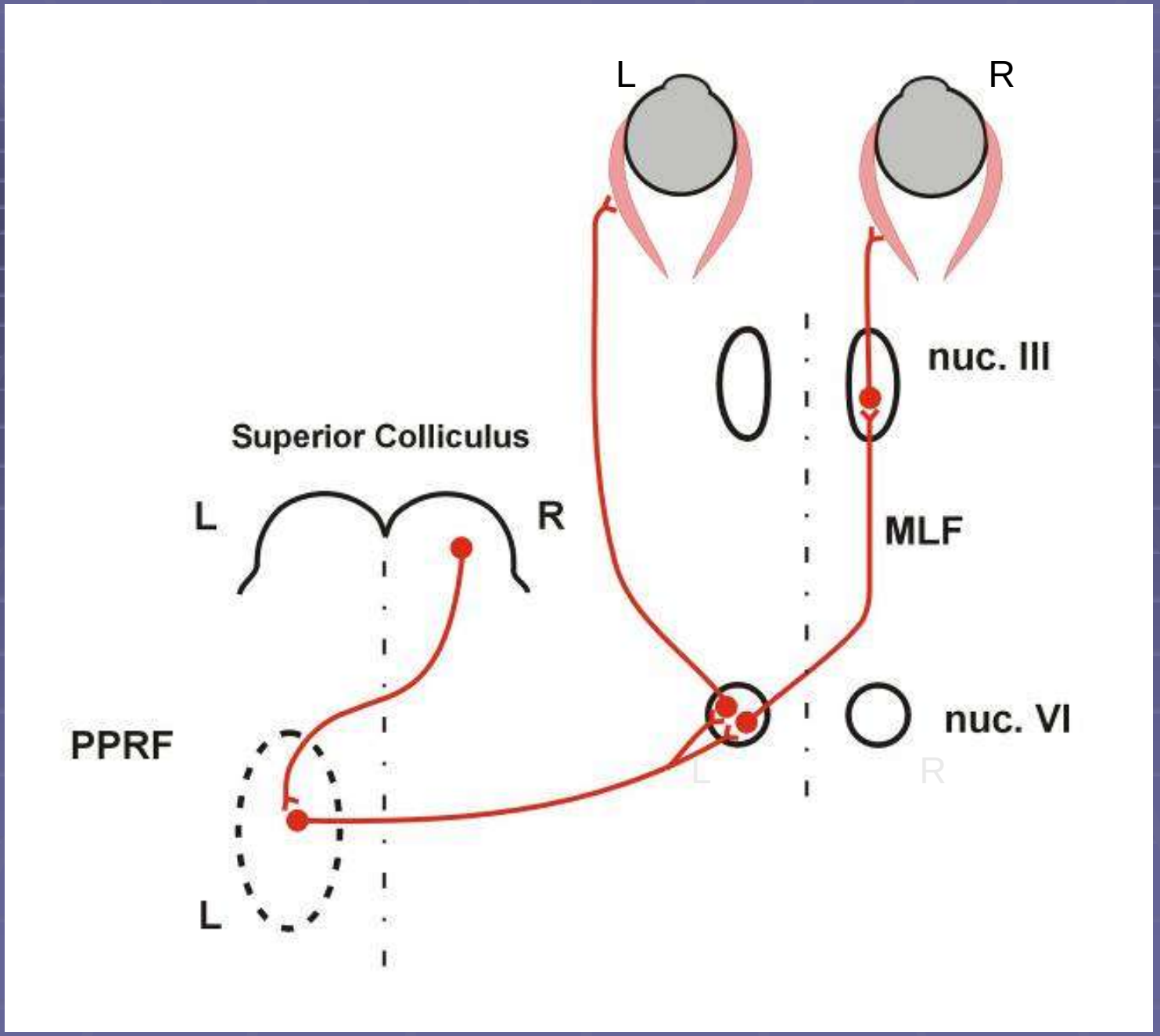
Basic pathway for controlling saccadic eye movements



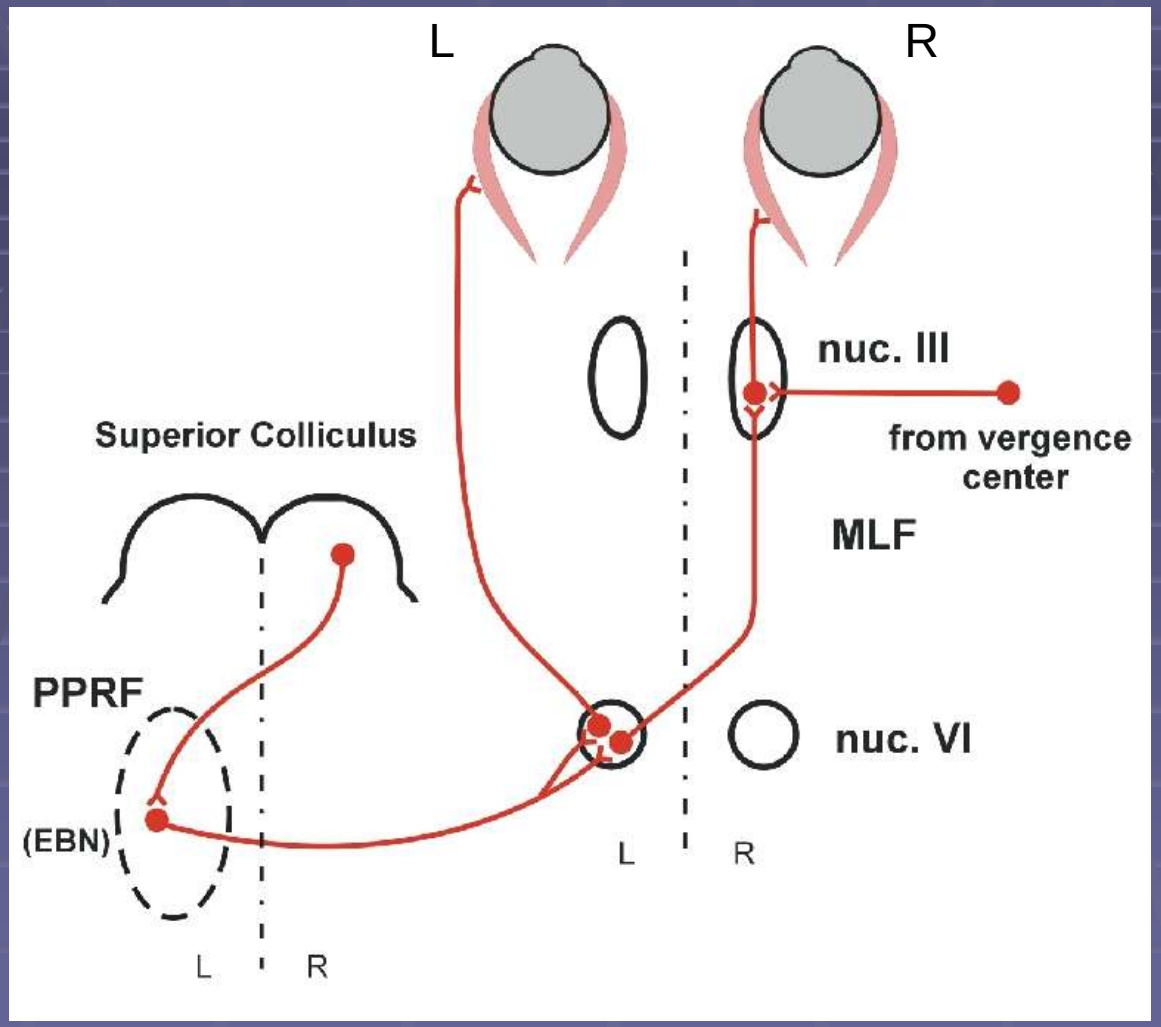
MLF


Frontal eye field
Parietal cortex
Basal ganglia
Occipital cortex
Dorsal lateral geniculate body
Pulvinar
Retina
Substantia nigra
Optic nerve
Extraocular muscles
Vertical gaze center
Oculomotor nucleus
Trochlear nucleus
Horizontal gaze center
Abducens nucleus
Superior colliculus:
Intermediate
Superficial
Spinal cord


Right eye
Lateral rectus
Medial rectus
Left eye
Left oculomotor nucleus
Midbrain
Right abducens nucleus
Pons
Medial longitudinal fasciculus
Right PPRF

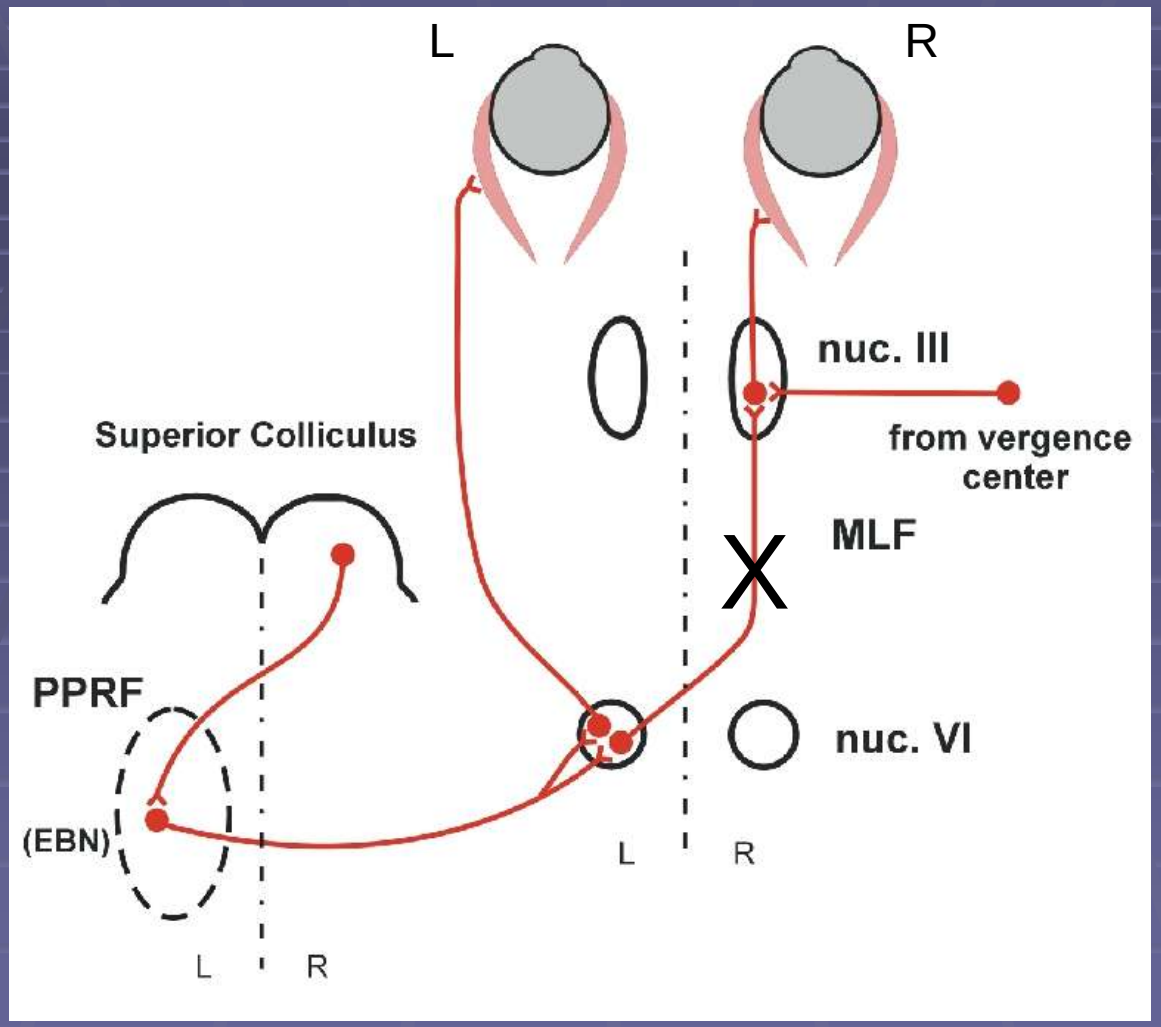

L
R
nuc. III
Superior Colliculus
L
R
MLF
PPRF
nuc. VI
L
R
L

Conjugate eye movements



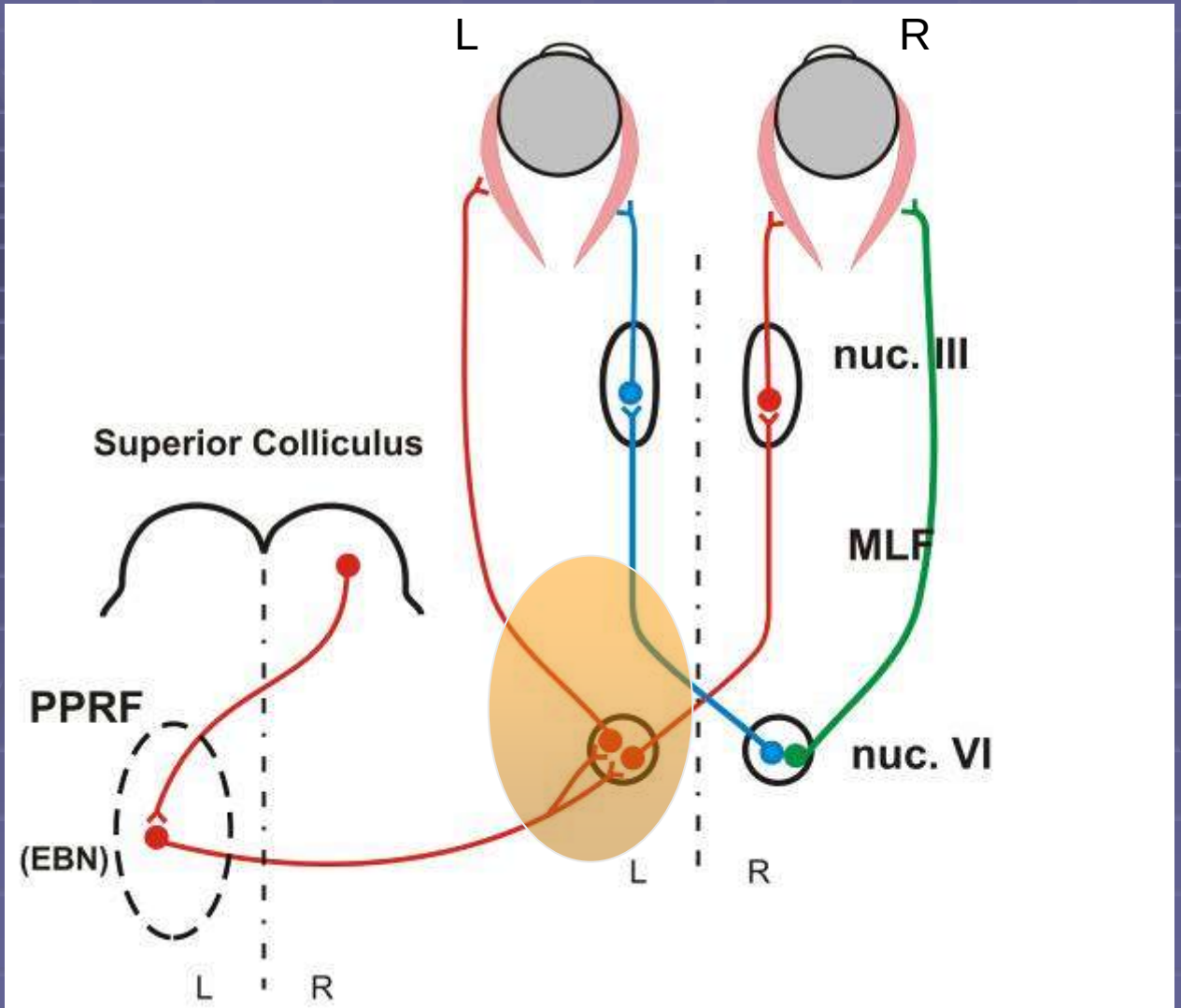
Disconjugate eye movements

Conjugate eye movements



Disconjugate eye movements

Internuclear Ophthalmoplegia

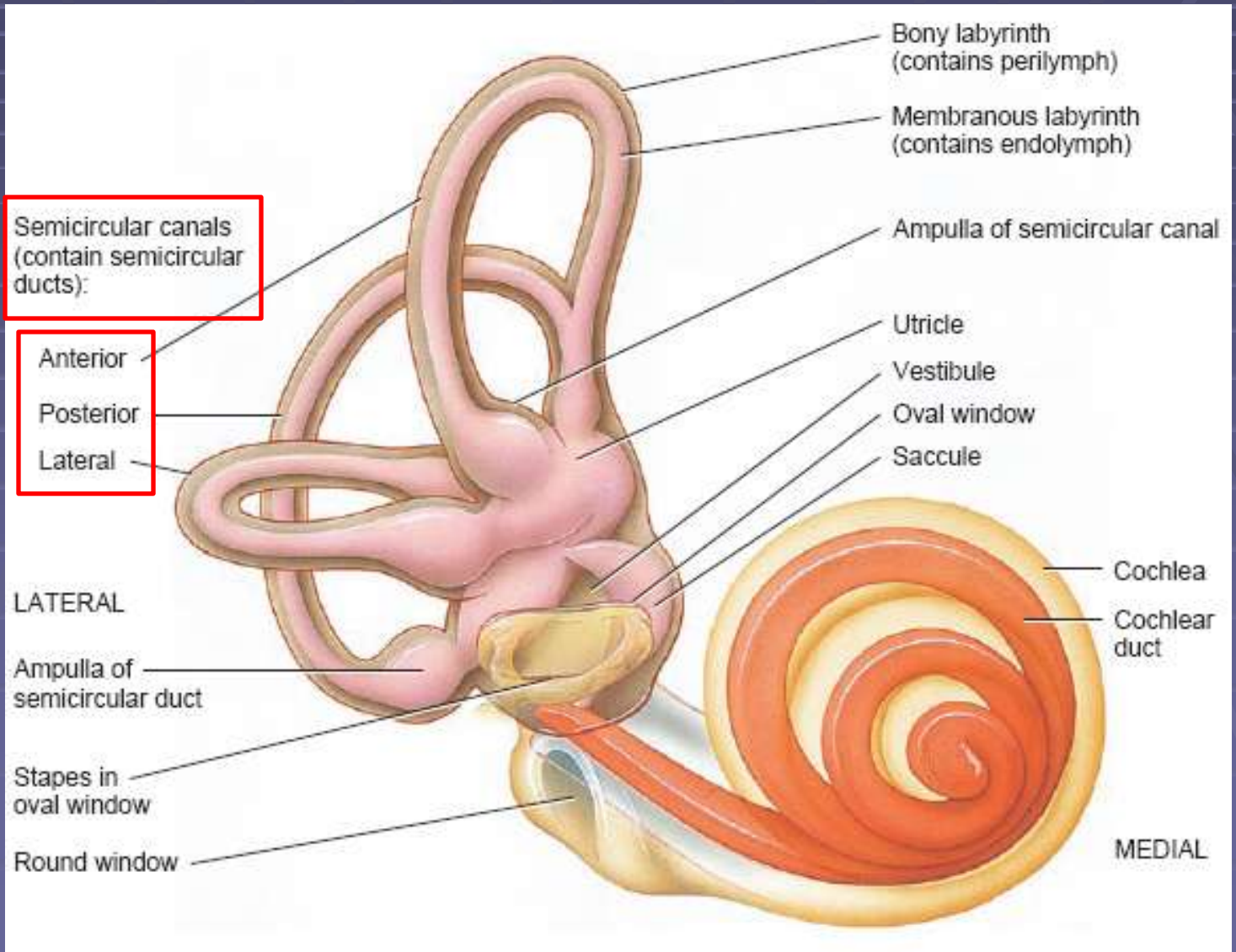


ONE-AND-A-HALF SYNDROME

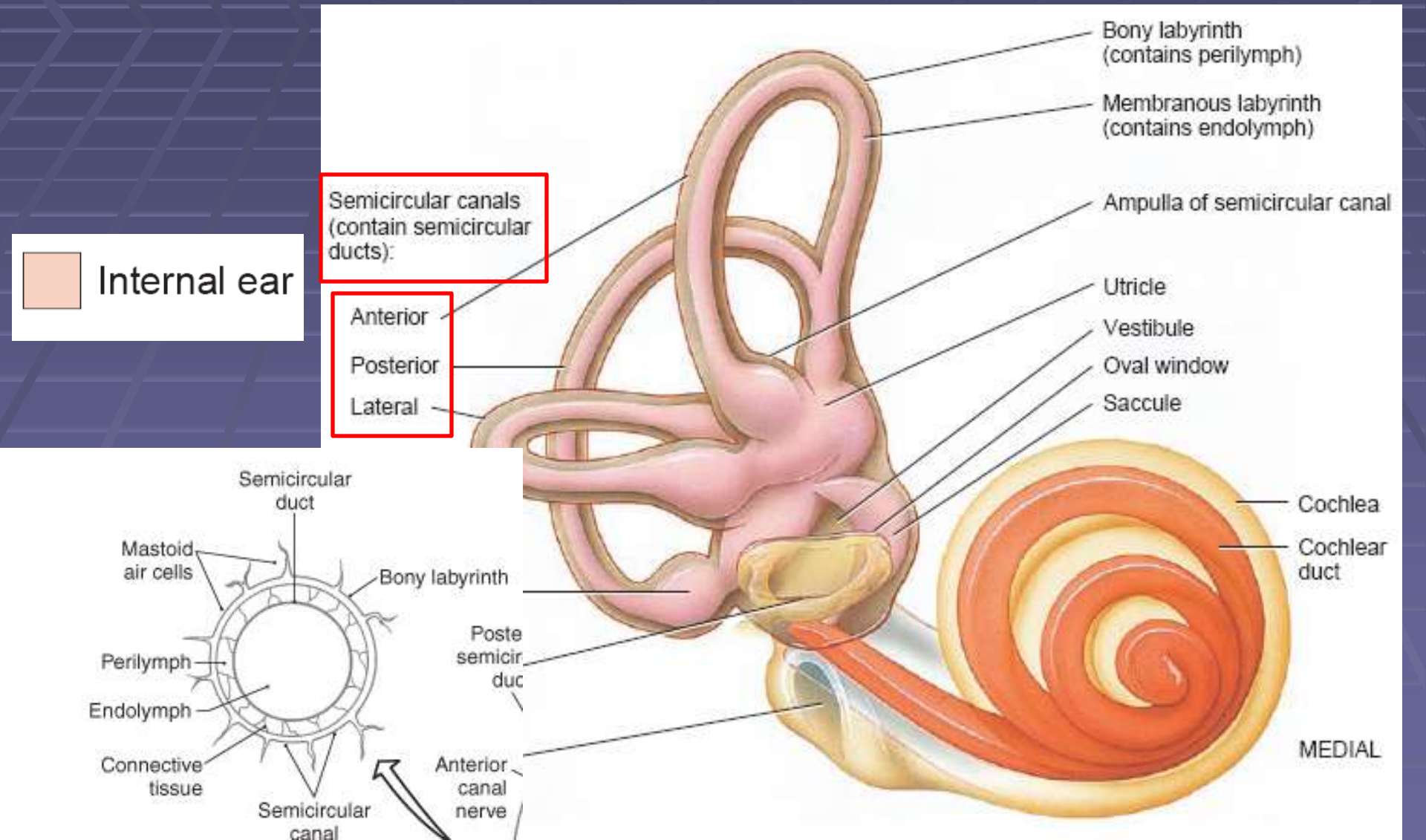
The Vestibular System

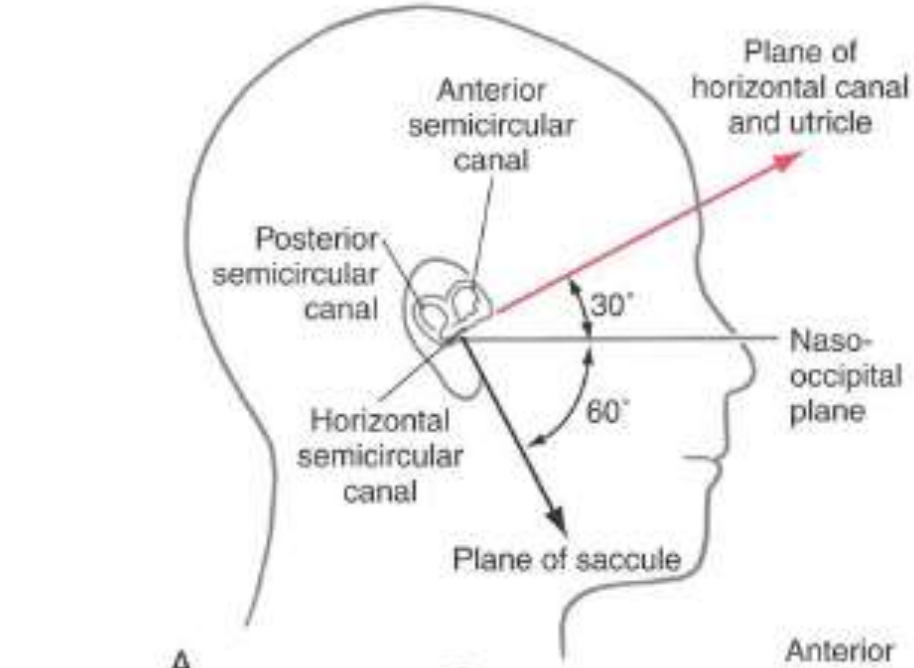
Anatomy of the ear

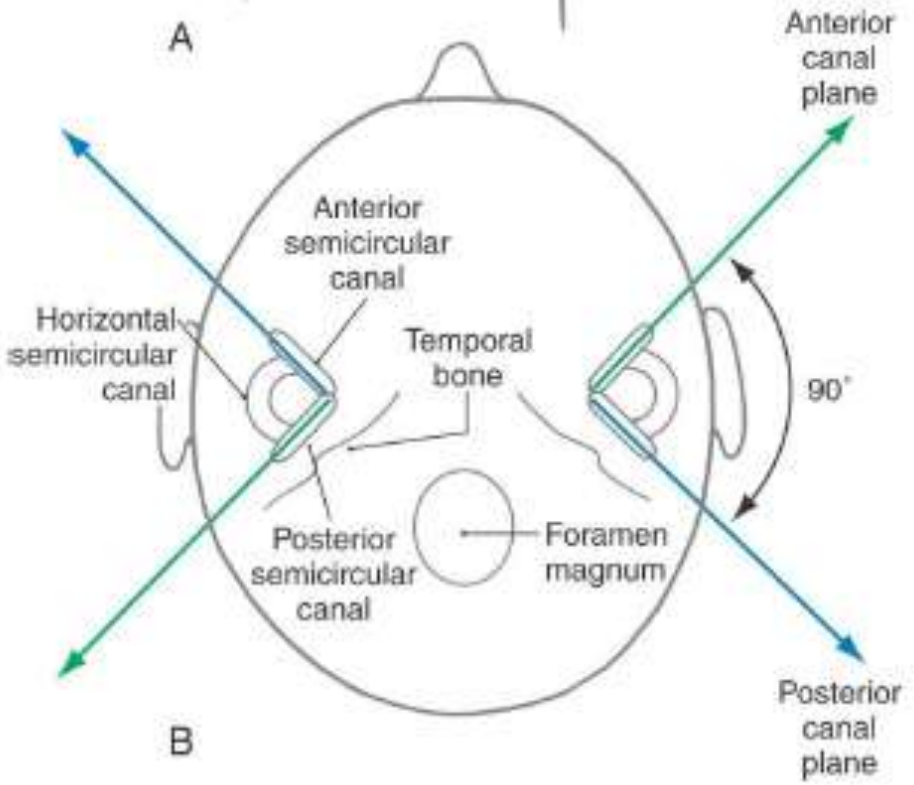
Internal ear

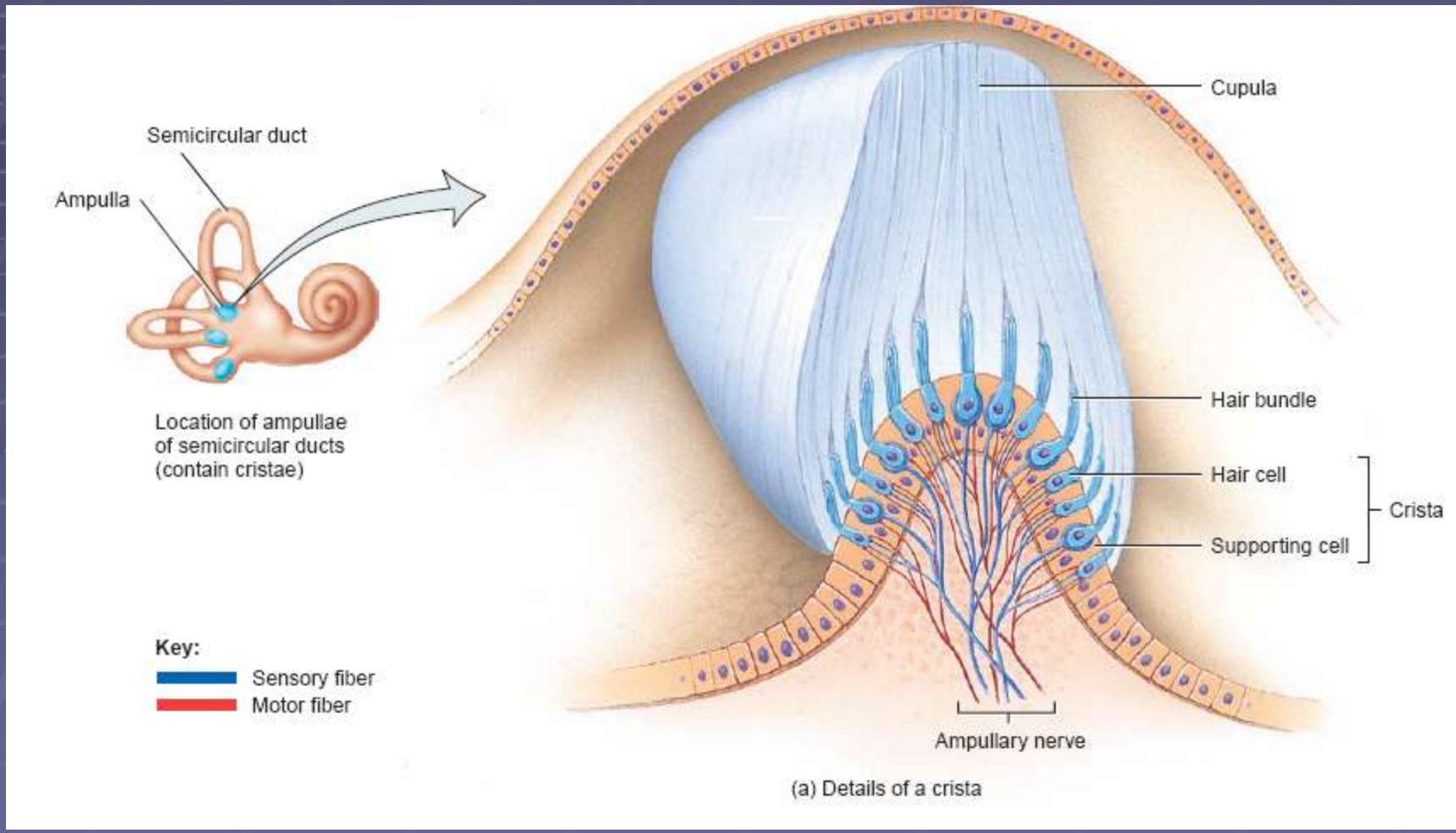


Anatomy of the ear



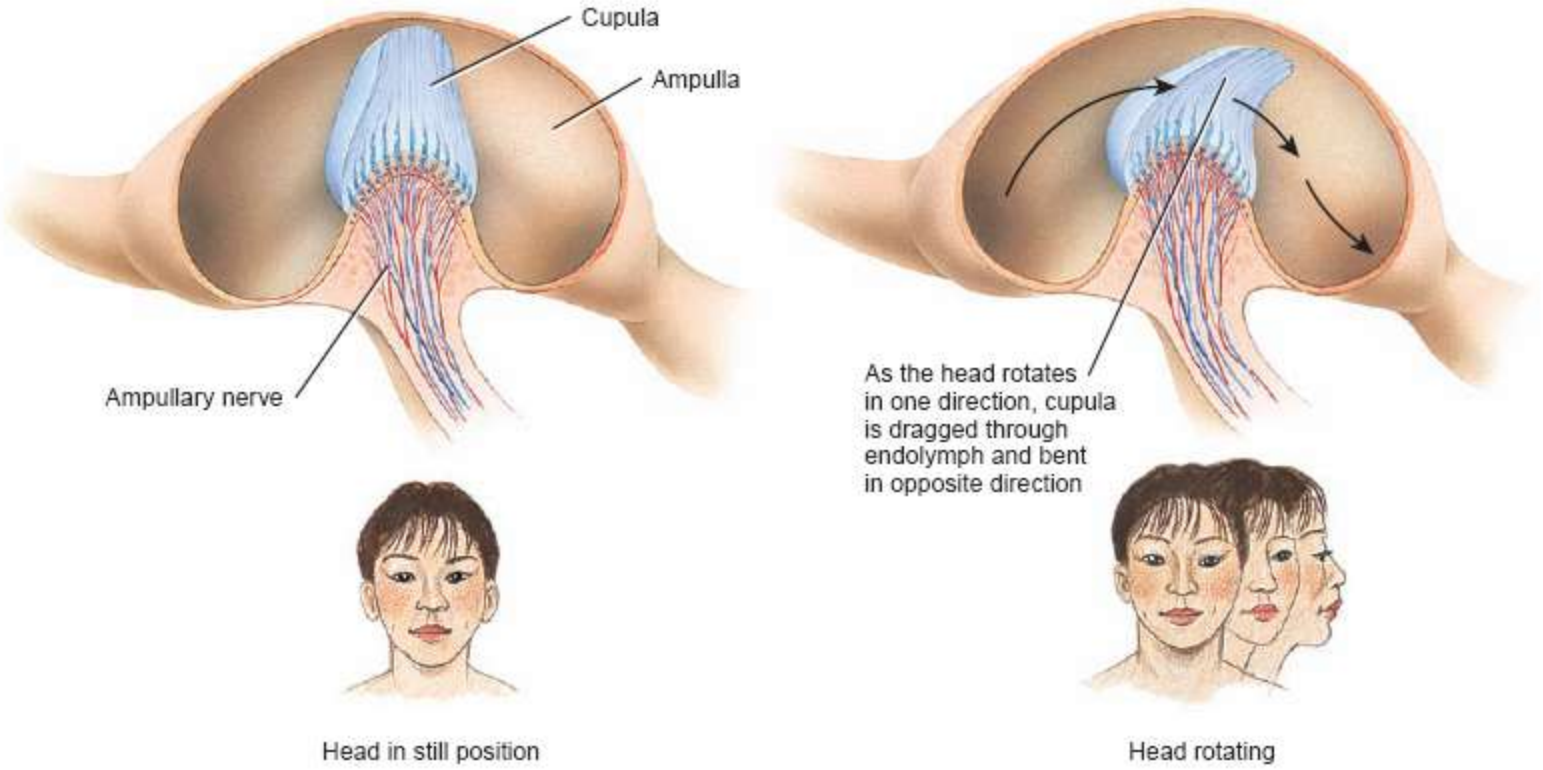

Plane of horizontal canal and utricle
Anterior semicircular canal
Posterior semicircular canal
30°
Naso-occipital plane
60°
Horizontal semicircular canal
Plane of saccule
A


Anterior canal plane
Anterior semicircular canal
Horizontal semicircular canal
Temporal bone
90°
Posterior semicircular canal
Foramen magnum
Posterior canal plane
B

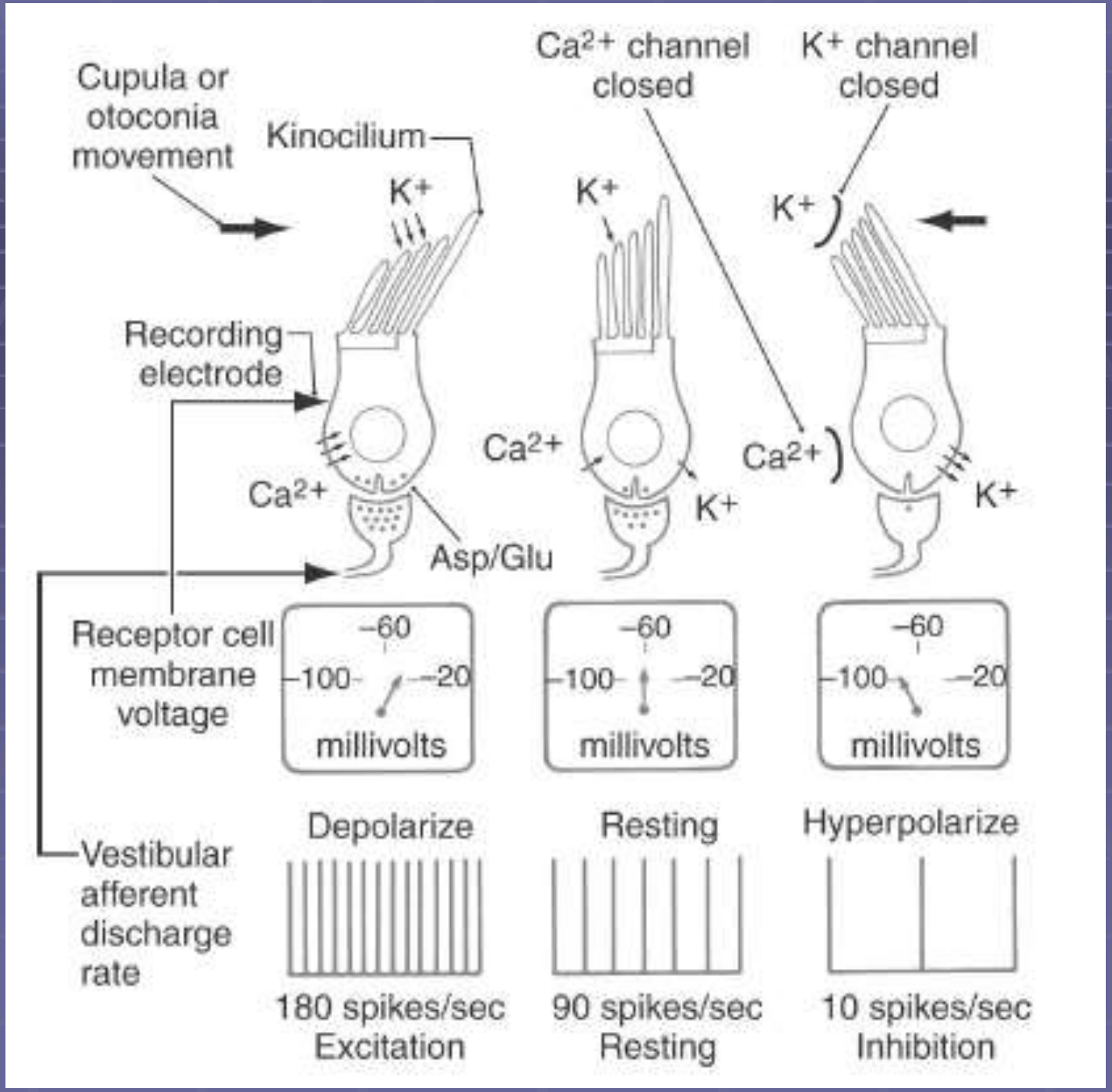


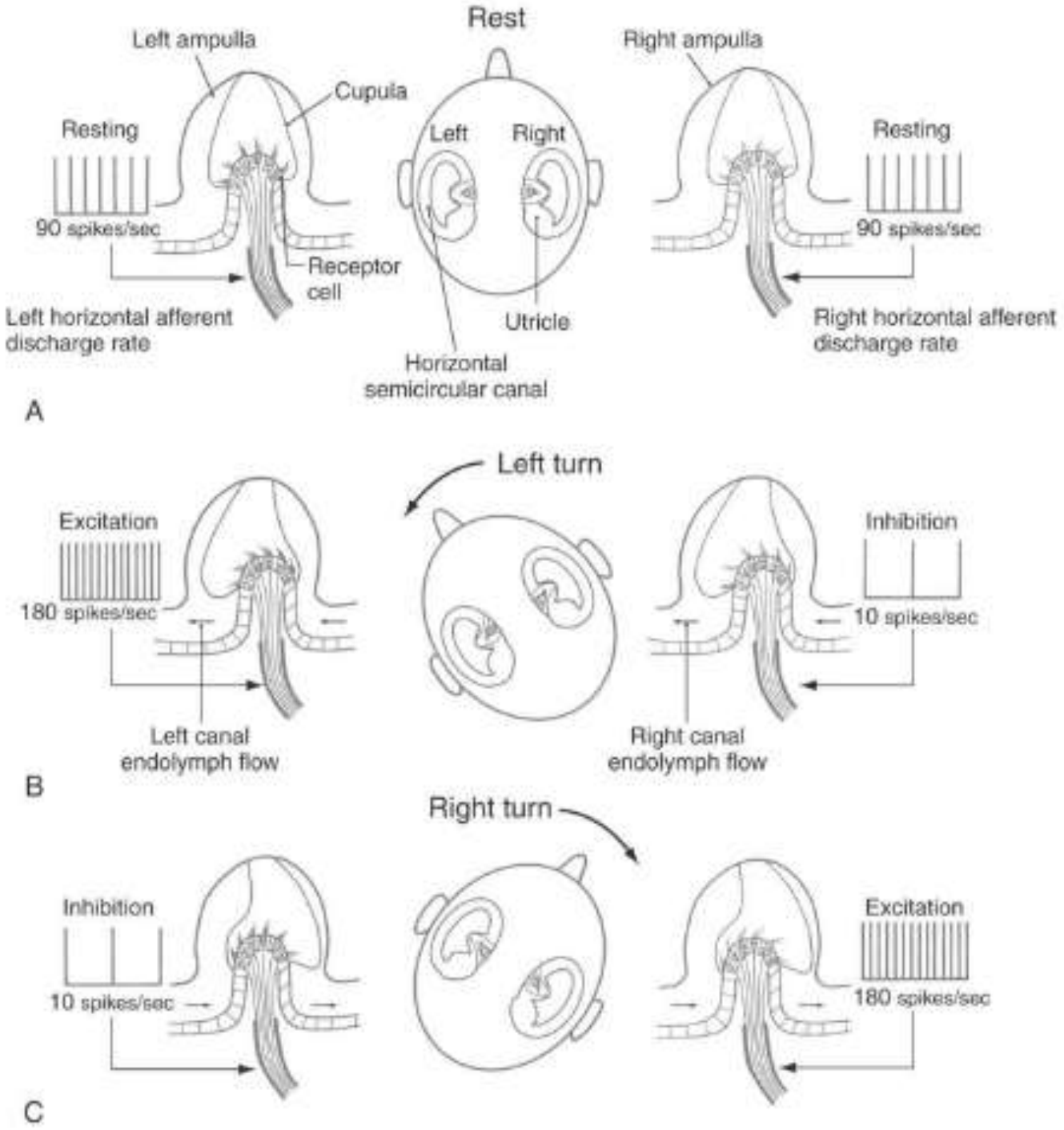
(a) Details of a crista

Ampulla of Semicircular canal



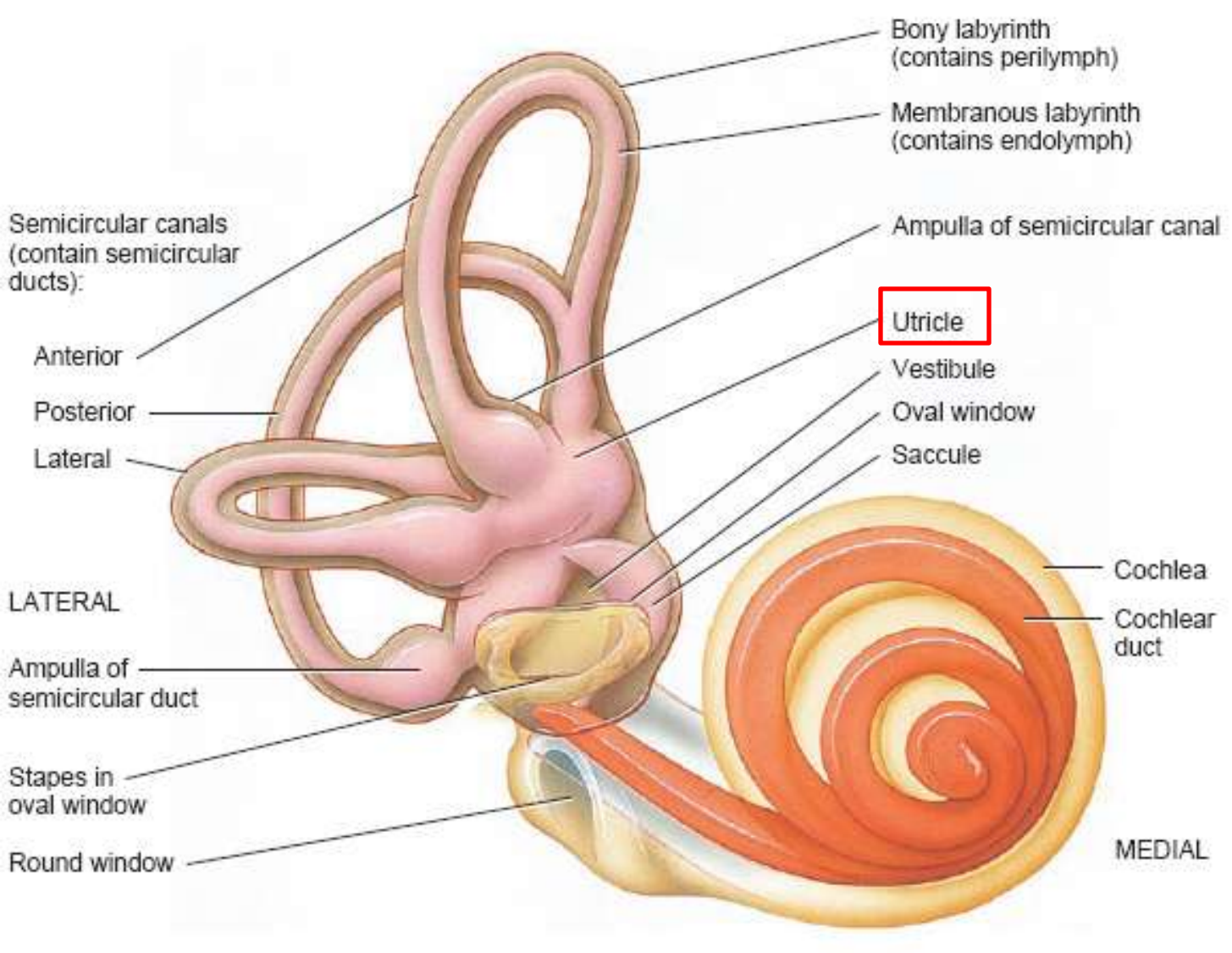
(b) Position of a cupula with the head in the still position (left) and when the head rotates (right)


Cupula or otoconia movement
Kinocilium
K+
Recording electrode
Ca2+
Asp/Glu
Ca2+ channel closed
K+
Ca2+
K+
K+ channel closed
K+
Ca2+
K+
Receptor cell membrane voltage
−60
−100
−20
millivolts
−60
−100
−20
millivolts
−60
−100
−20
millivolts
Vestibular afferent discharge rate
Depolarize
Resting
Hyperpolarize
180 spikes/sec
Excitation
90 spikes/sec
Resting
10 spikes/sec
Inhibition


Rest
Left ampulla
Cupula
Resting
90 spikes/sec
Receptor cell
Left horizontal afferent discharge rate
Left
Right
Utricle
Horizontal semicircular canal
Right ampulla
Resting
90 spikes/sec
Right horizontal afferent discharge rate
A
Left turn
Excitation
180 spikes/sec
Left canal endolymph flow
Inhibition
10 spikes/sec
Right canal endolymph flow
B
Right turn
Inhibition
10 spikes/sec
Excitation
180 spikes/sec
C

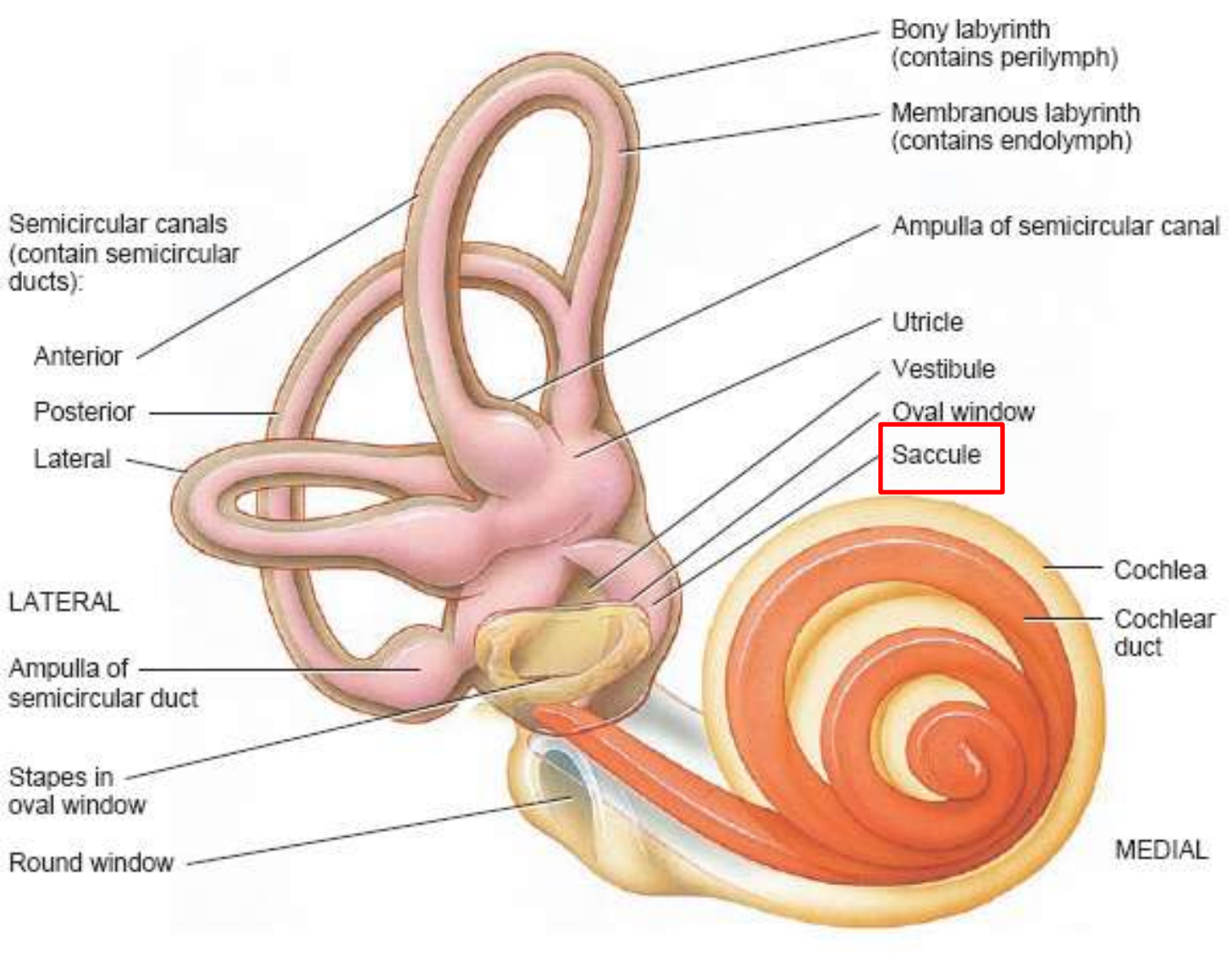
Anatomy of the ear

Internal ear



Anatomy of the ear

Internal ear



Macula and otolith organ

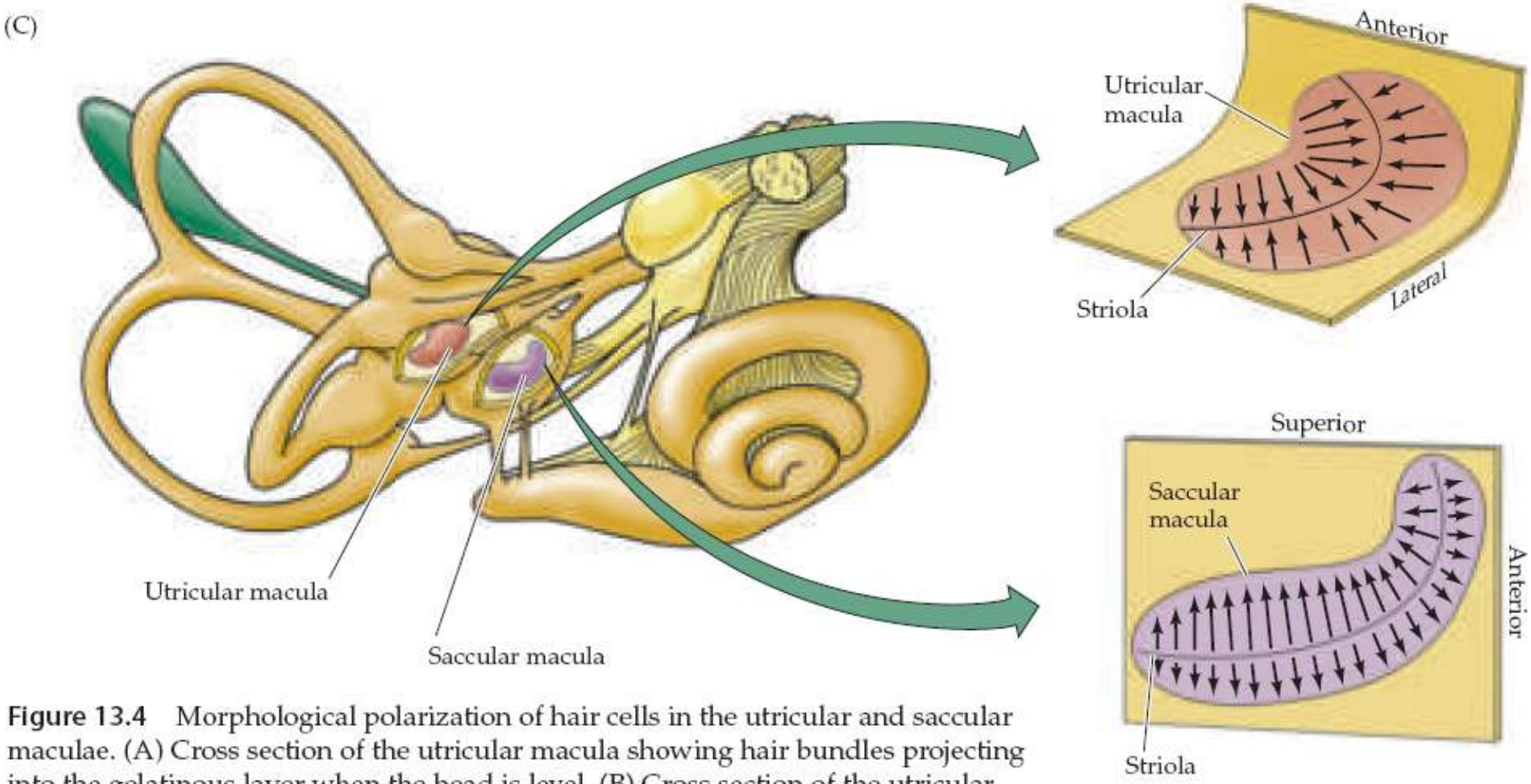
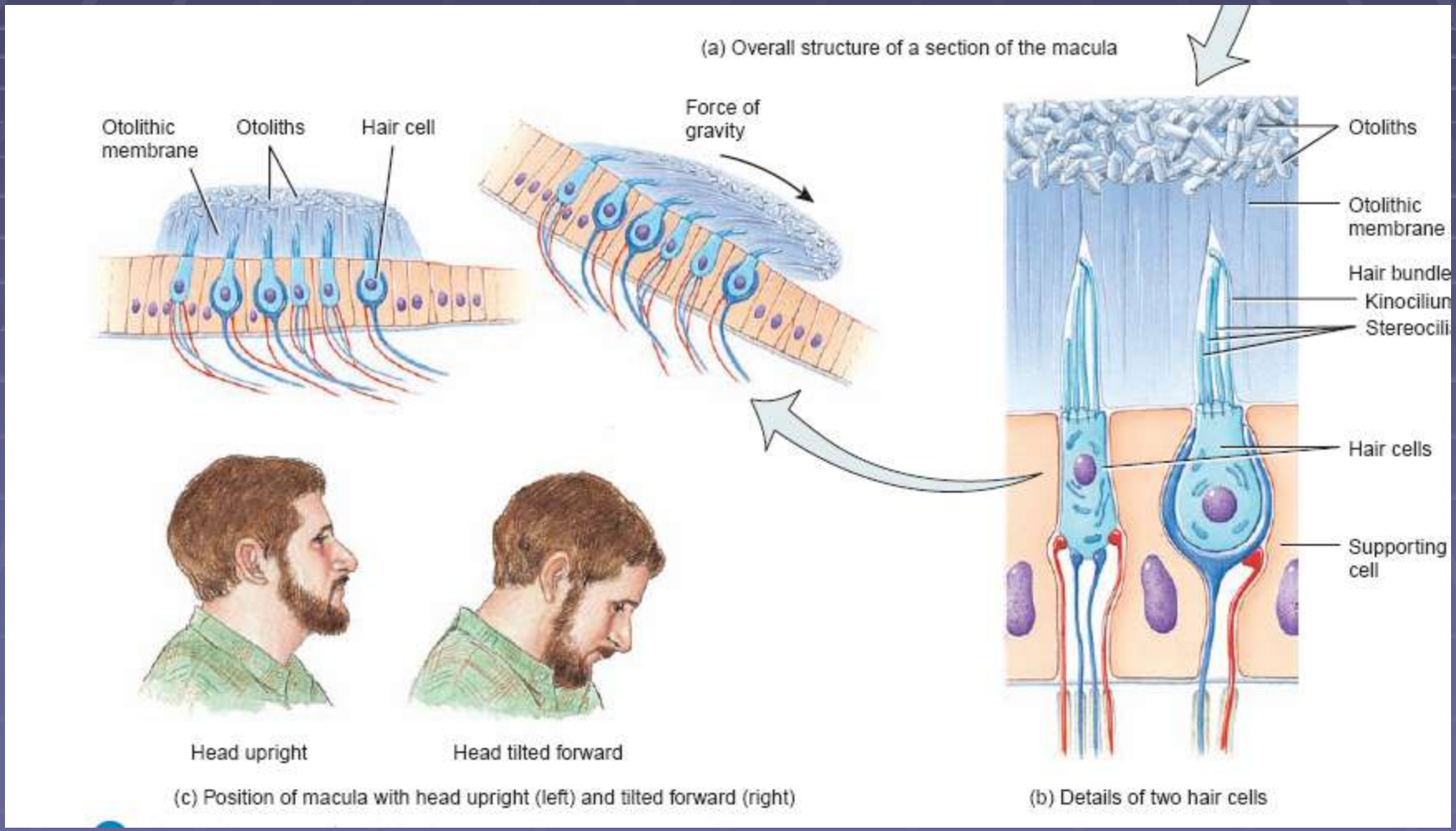
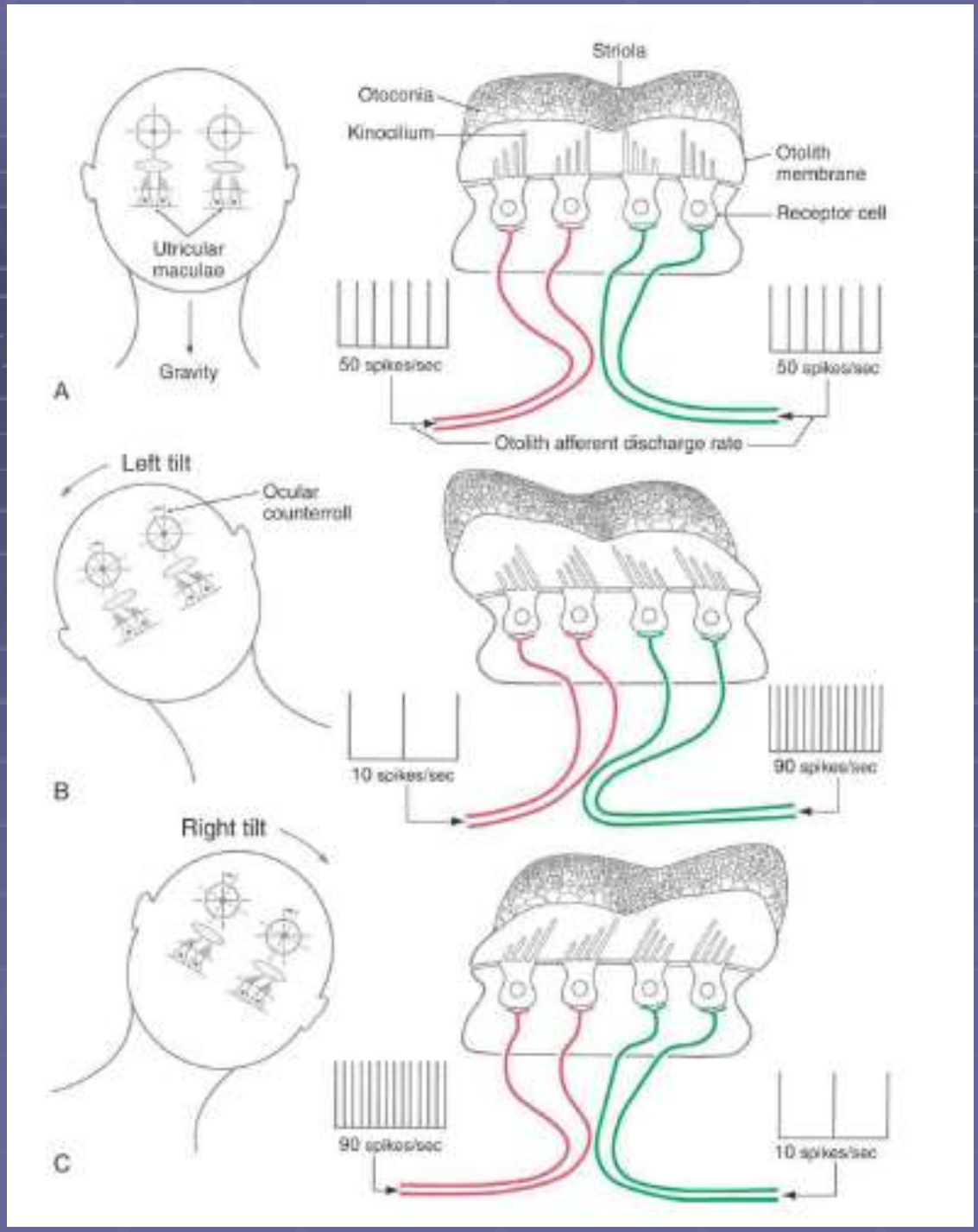
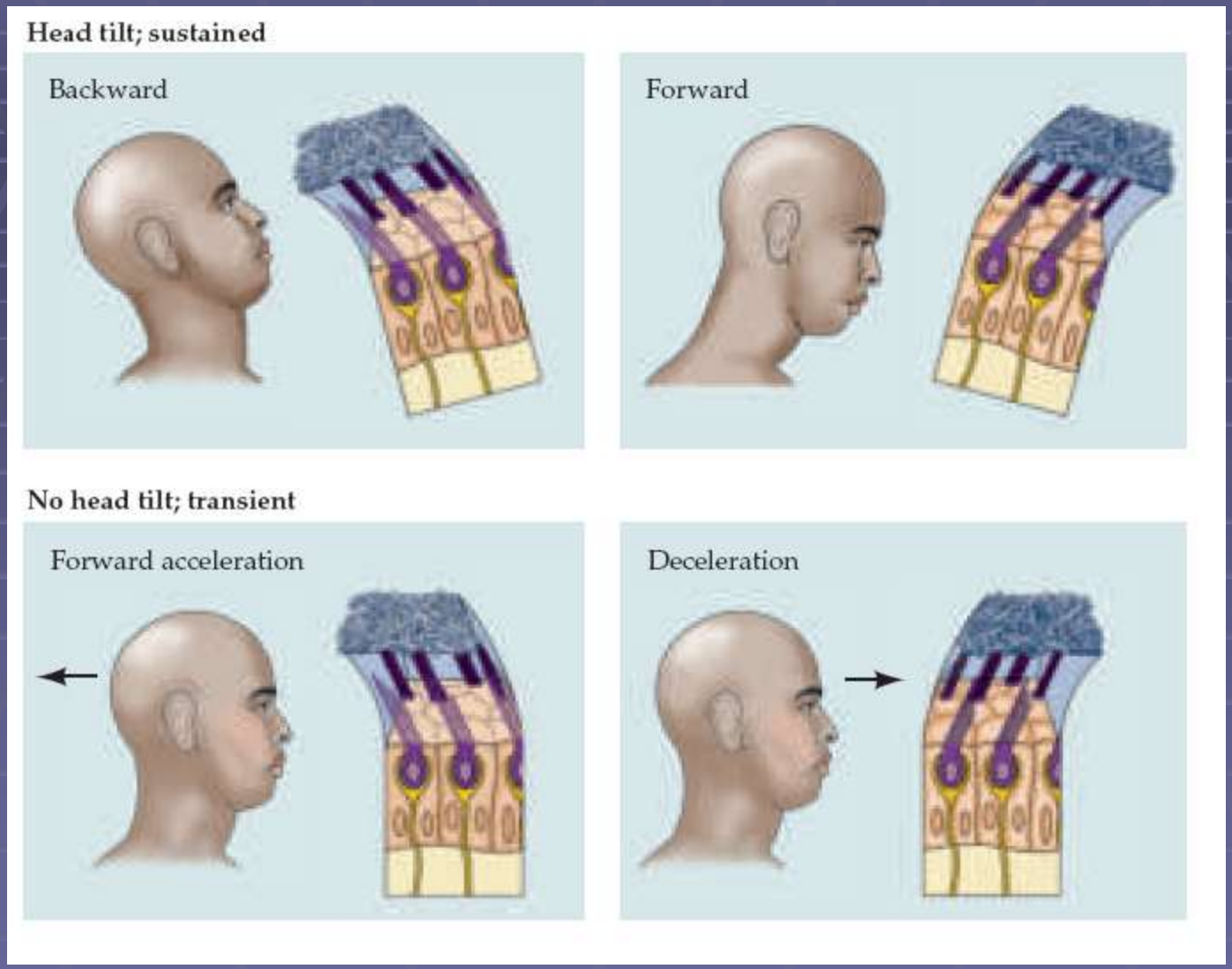


Figure 13.4 Morphological polarization of hair cells in the utricular and saccular maculae. (A) Cross section of the utricular macula showing hair bundles projecting into the gelatinous layer when the head is level. (B) Cross section of the utricular

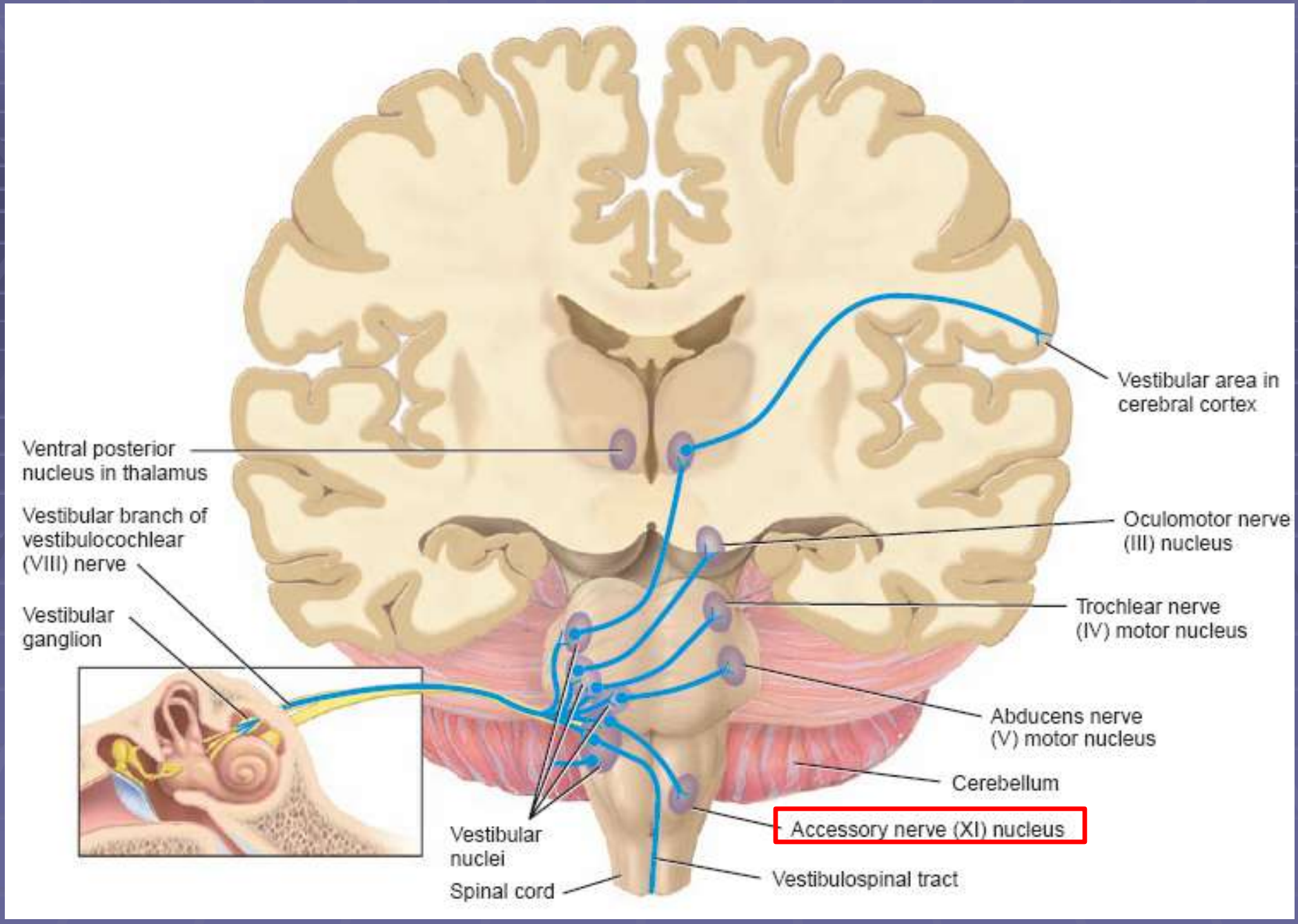
Macula and otolith organ

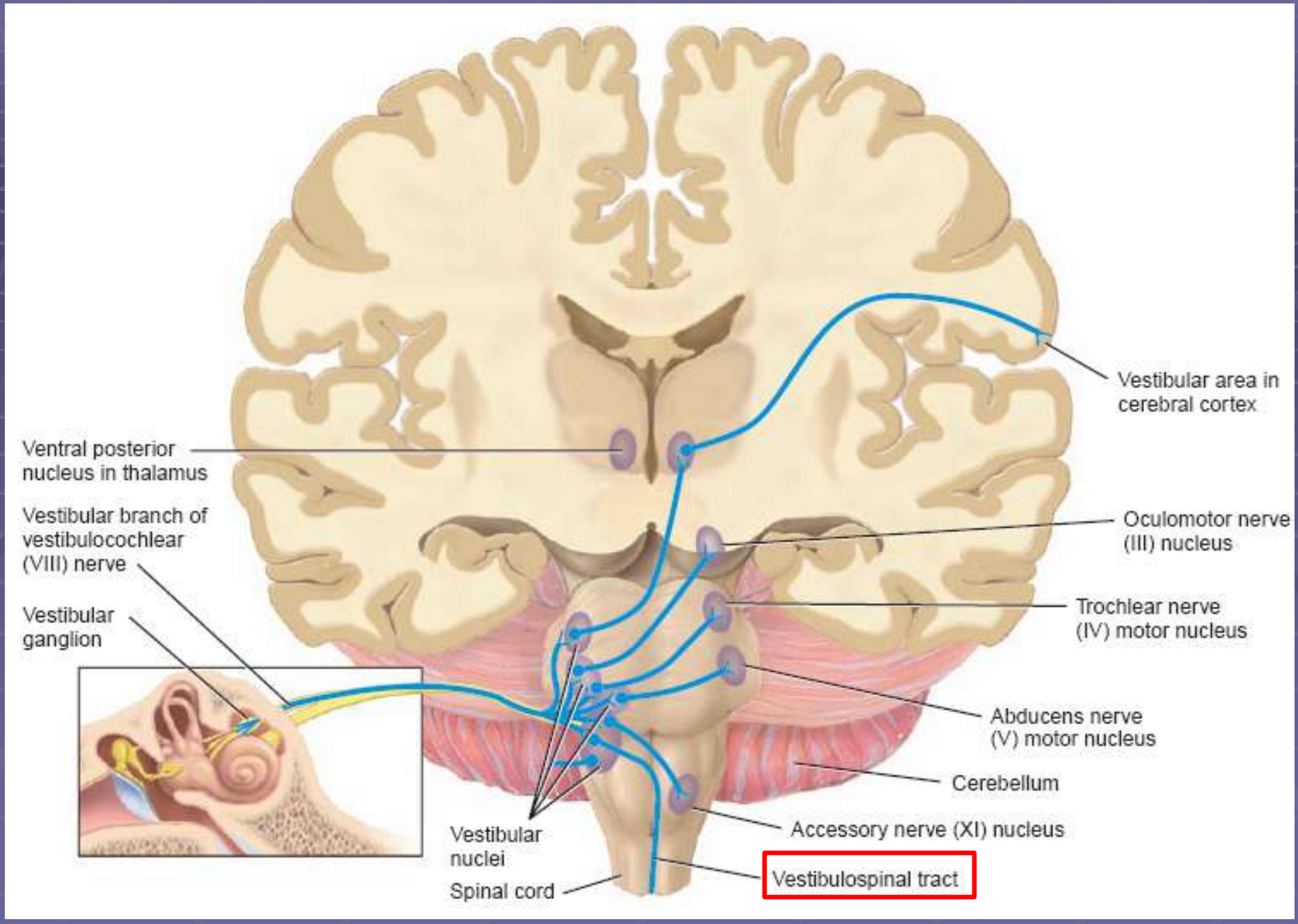


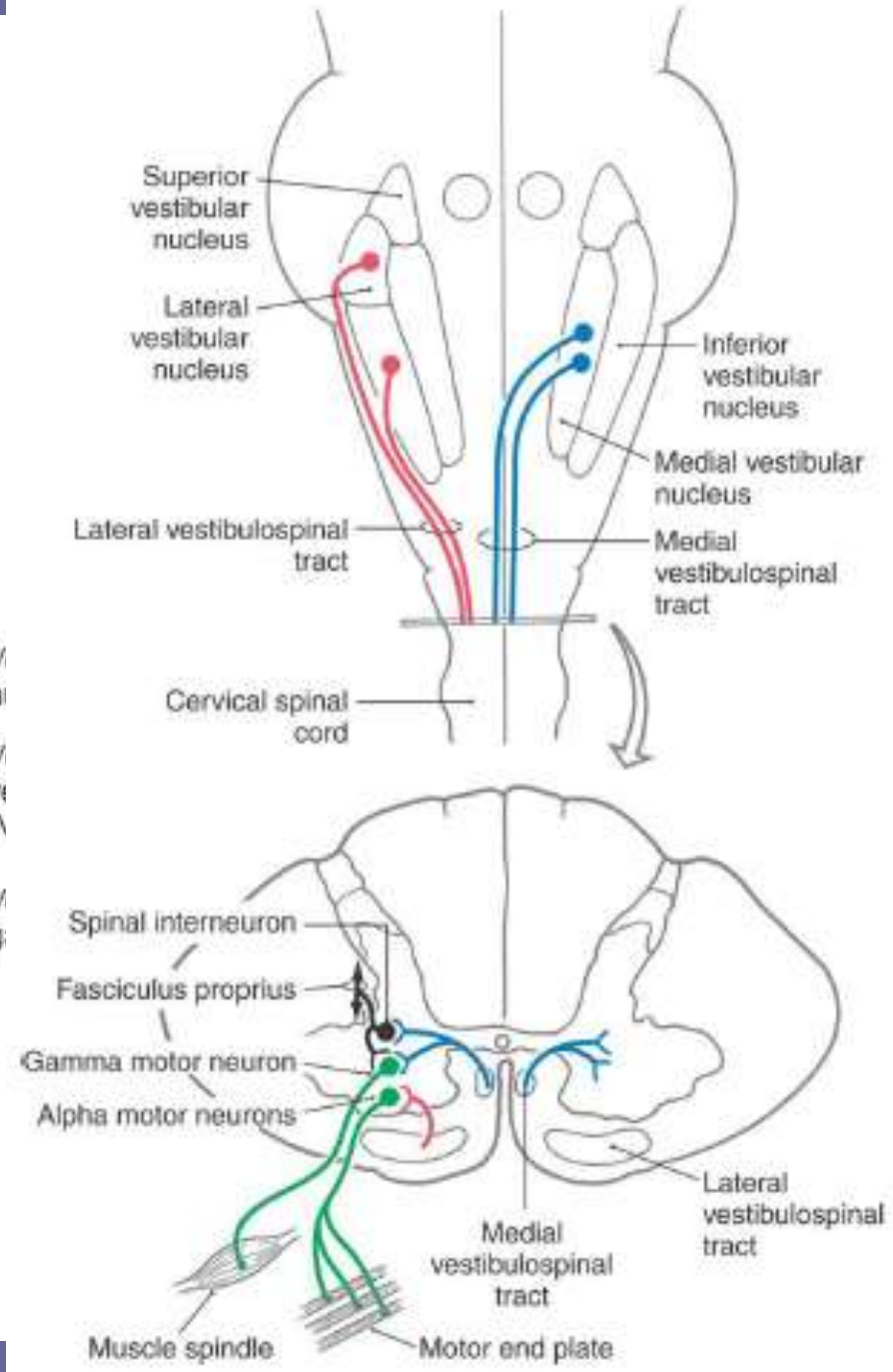

Striola
Otoconia
Kinocilium
Otolith membrane
Receptor cell
Utricular maculae
Gravity
A
50 spikes/sec
50 spikes/sec
Otolith afferent discharge rate
Left tilt
Ocular counterroll
B
10 spikes/sec
90 spikes/sec
Right tilt
C
90 spikes/sec
10 spikes/sec

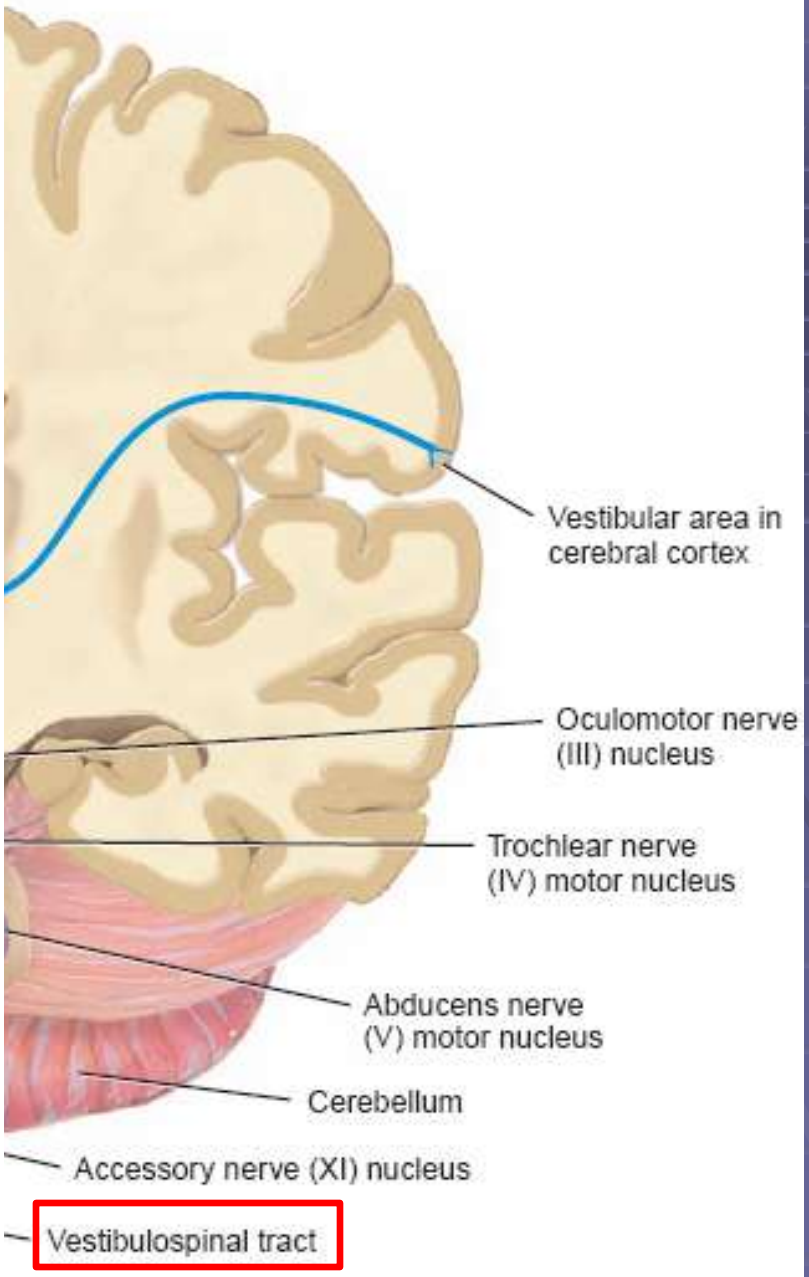

Head tilt; sustained
Backward
Forward
No head tilt; transient
Forward acceleration
Deceleration

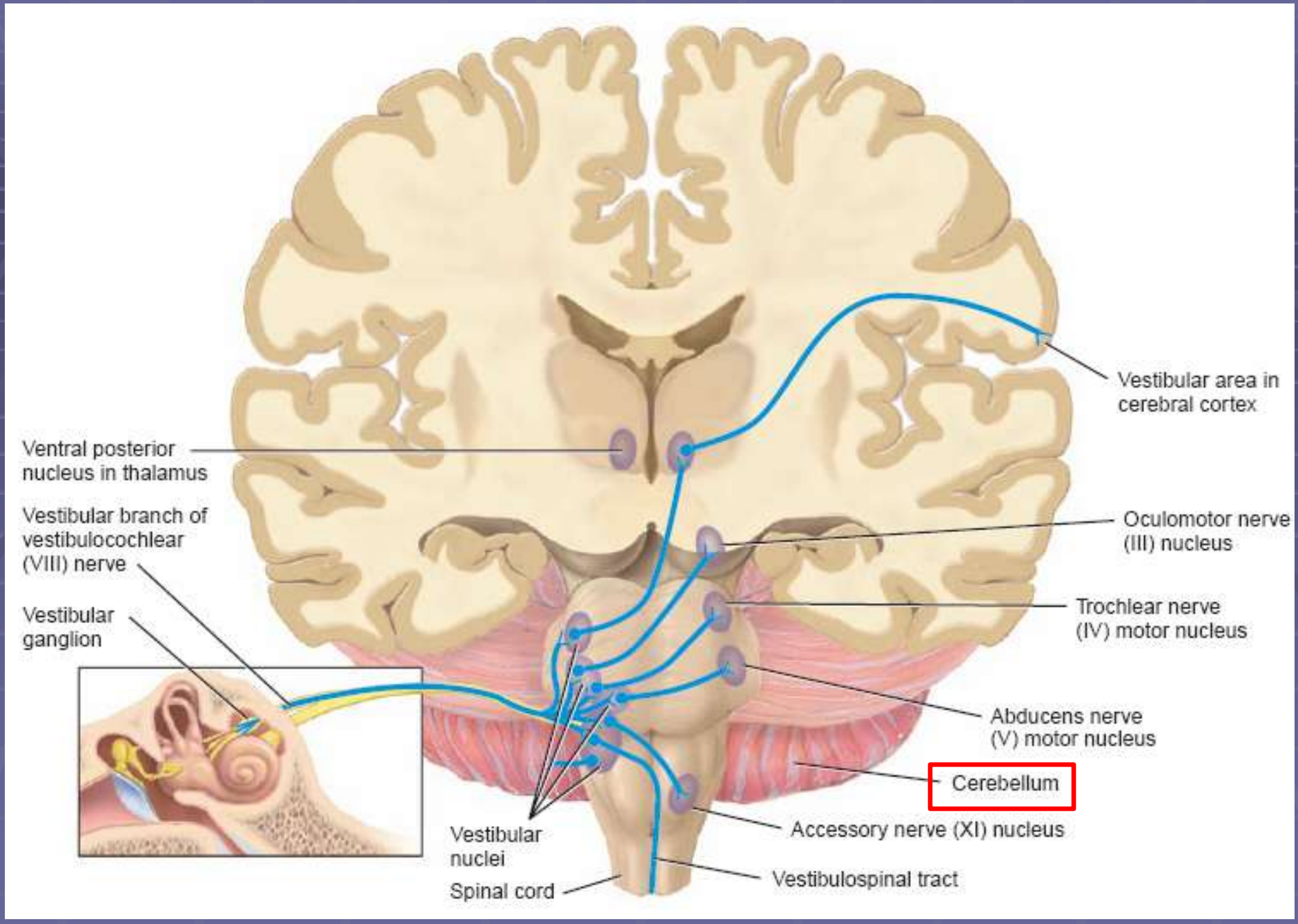
VESTIBULAR PATHWAY

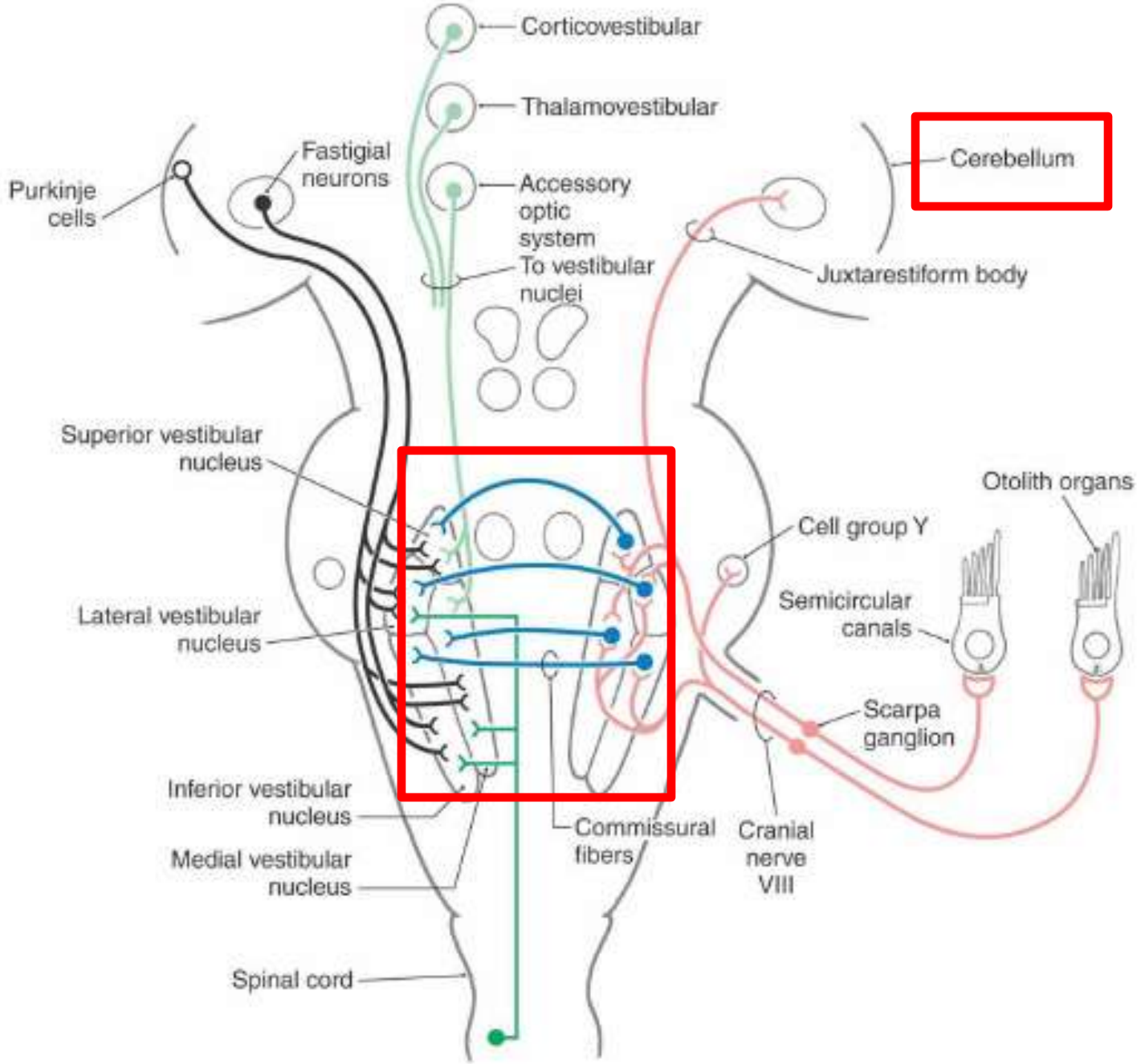

Vestibular area in cerebral cortex
Ventral posterior nucleus in thalamus
Vestibular branch of vestibulocochlear (VIII) nerve
Vestibular ganglion
Oculomotor nerve (III) nucleus
Trochlear nerve (IV) motor nucleus
Abducens nerve (V) motor nucleus
Cerebellum
Accessory nerve (XI) nucleus
Vestibular nuclei
Spinal cord
Vestibulospinal tract

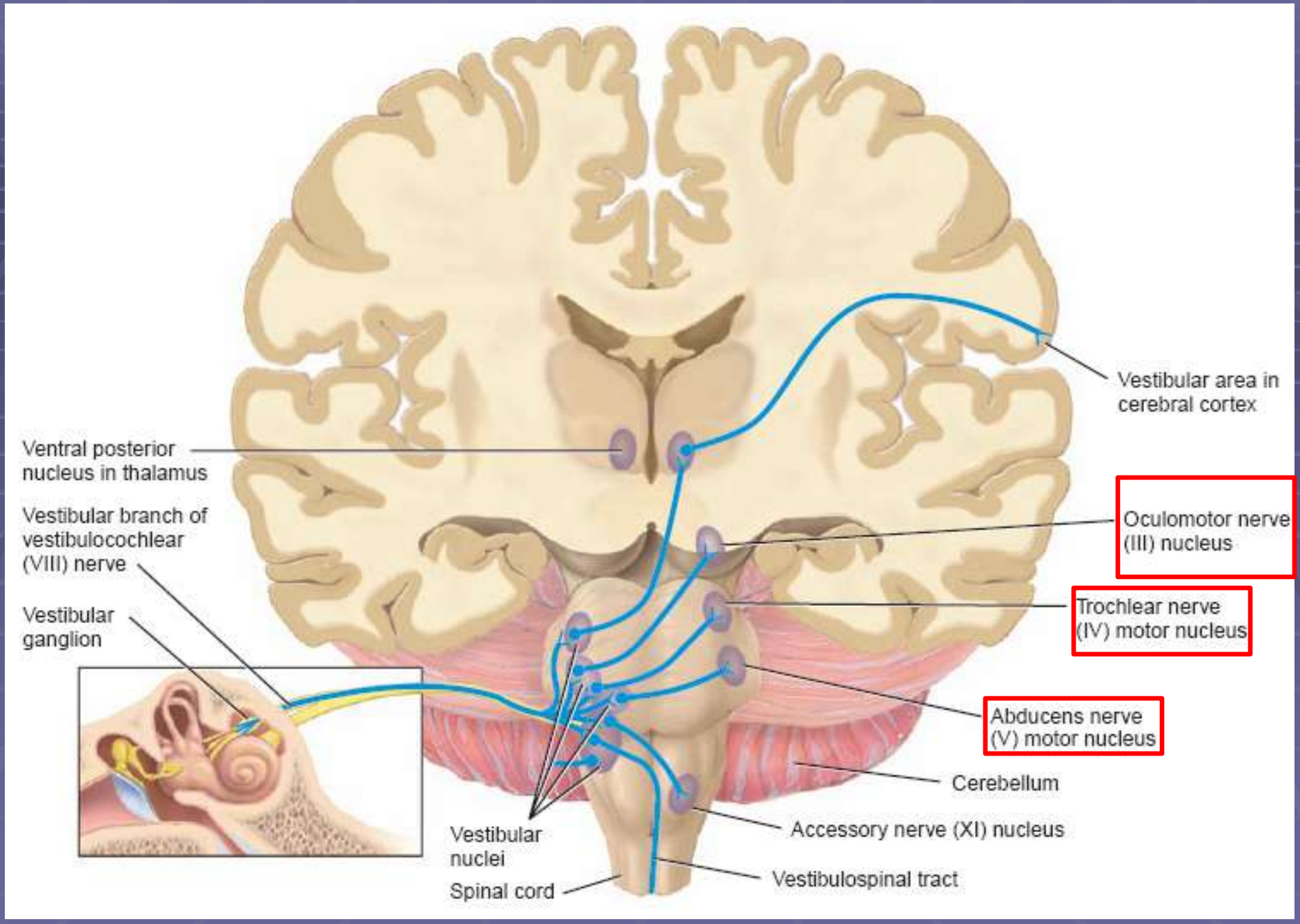

Vestibular area in cerebral cortex
Ventral posterior nucleus in thalamus
Vestibular branch of vestibulocochlear (VIII) nerve
Vestibular ganglion
Oculomotor nerve (III) nucleus
Trochlear nerve (IV) motor nucleus
Abducens nerve (V) motor nucleus
Cerebellum
Accessory nerve (XI) nucleus
Vestibular nuclei
Spinal cord
Vestibulospinal tract

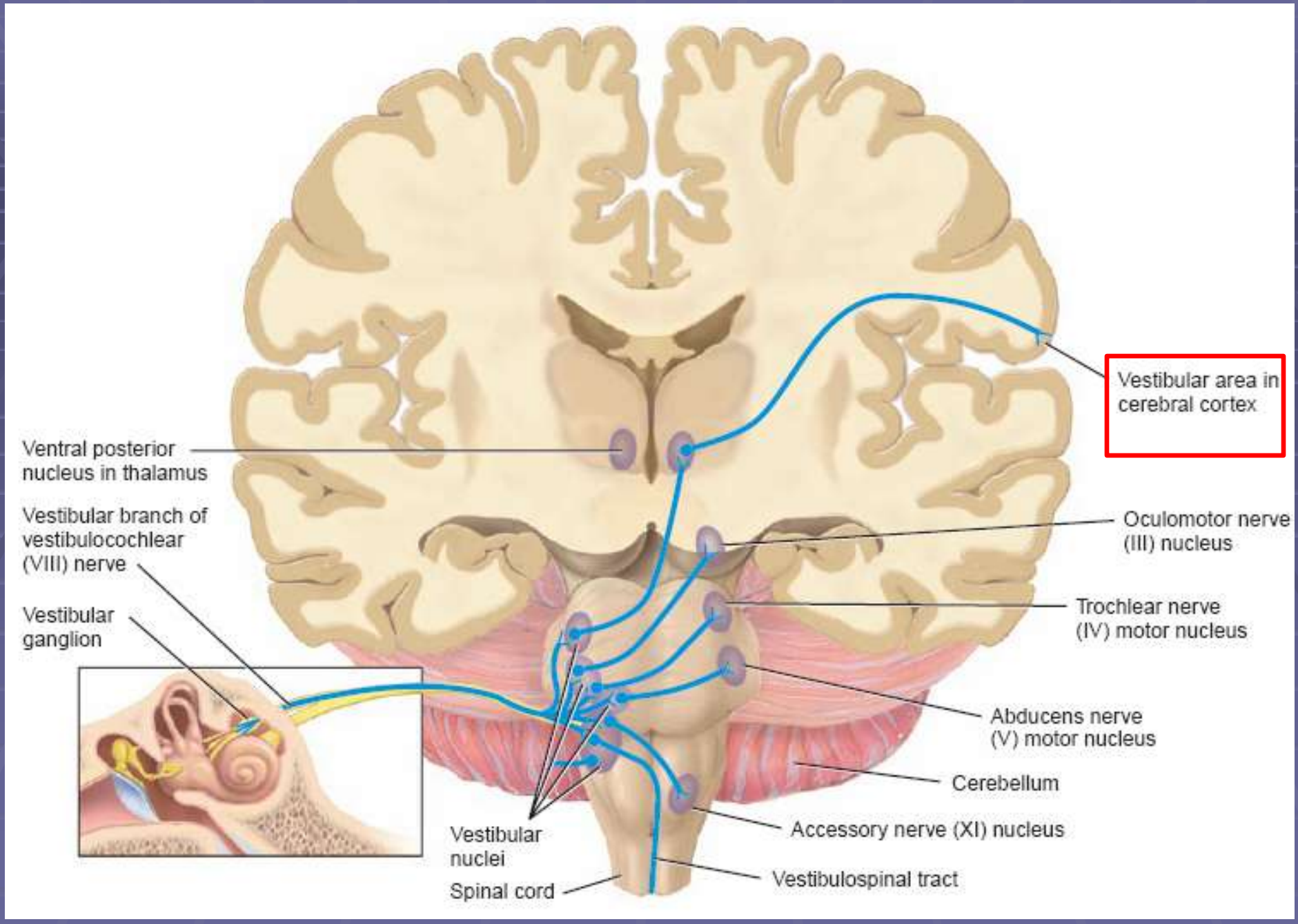

Superior vestibular nucleus
Lateral vestibular nucleus
Inferior vestibular nucleus
Medial vestibular nucleus
Lateral vestibulospinal tract
Medial vestibulospinal tract
Cervical spinal cord
Spinal interneuron
Fasciculus proprius
Gamma motor neuron
Alpha motor neurons
Lateral vestibulospinal tract
Medial vestibulospinal tract
Muscle spindle
Motor end plate

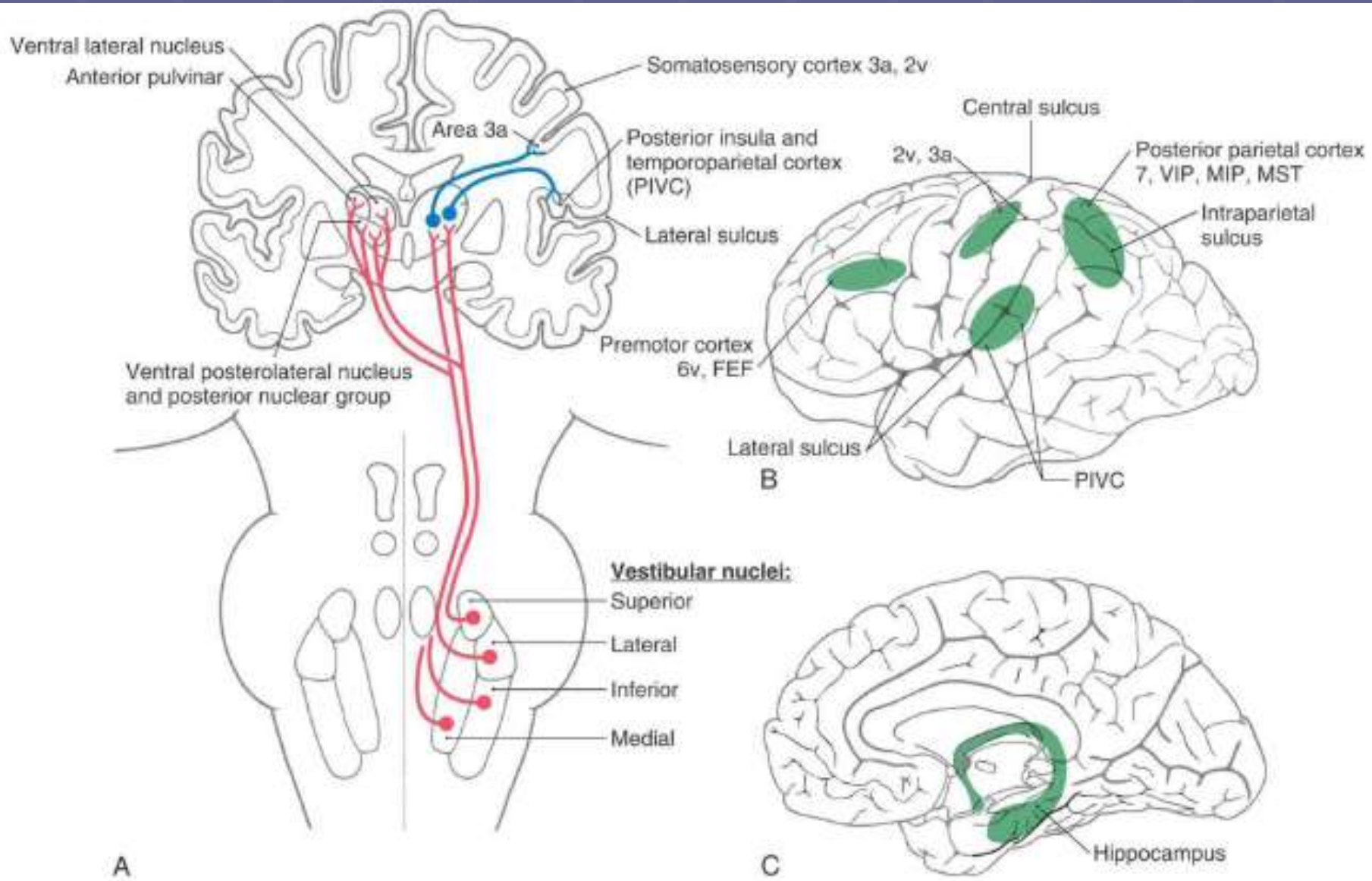

Vestibular area in cerebral cortex
Oculomotor nerve (III) nucleus
Trochlear nerve (IV) motor nucleus
Abducens nerve (V) motor nucleus
Cerebellum
Accessory nerve (XI) nucleus
Vestibulospinal tract


Vestibular area in cerebral cortex
Ventral posterior nucleus in thalamus
Vestibular branch of vestibulocochlear (VIII) nerve
Vestibular ganglion
Oculomotor nerve (III) nucleus
Trochlear nerve (IV) motor nucleus
Abducens nerve (V) motor nucleus
Cerebellum
Accessory nerve (XI) nucleus
Vestibular nuclei
Spinal cord
Vestibulospinal tract


Corticovestibular
Thalamovestibular
Fastigial neurons
Purkinje cells
Accessory optic system
To vestibular nuclei
Cerebellum
Juxtarestiform body
Superior vestibular nucleus
Otolith organs
Cell group Y
Semicircular canals
Lateral vestibular nucleus
Scarpa ganglion
Inferior vestibular nucleus
Commissural fibers
Cranial nerve VIII
Medial vestibular nucleus
Spinal cord

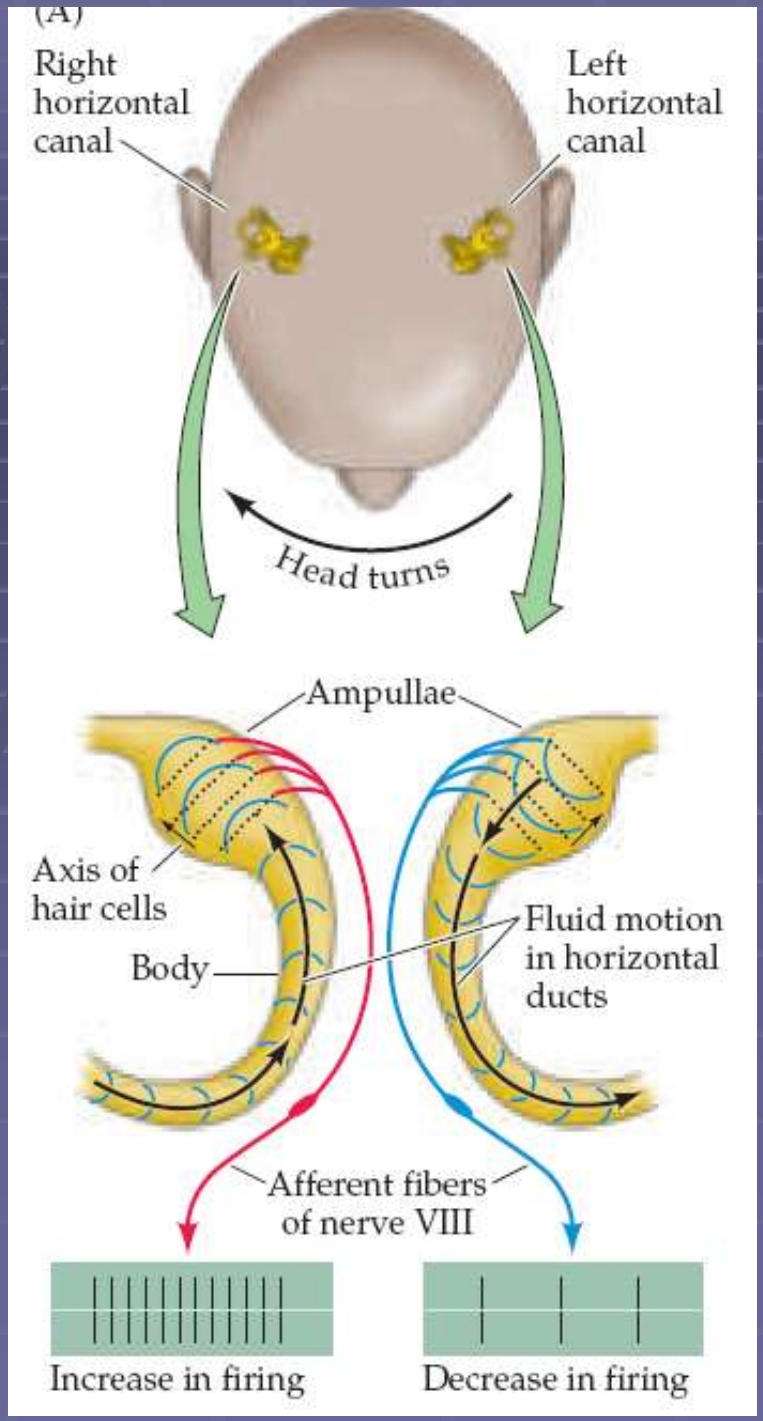

Vestibular area in cerebral cortex
Ventral posterior nucleus in thalamus
Vestibular branch of vestibulocochlear (VIII) nerve
Vestibular ganglion
Oculomotor nerve (III) nucleus
Trochlear nerve (IV) motor nucleus
Abducens nerve (V) motor nucleus
Cerebellum
Accessory nerve (XI) nucleus
Vestibular nuclei
Spinal cord
Vestibulospinal tract

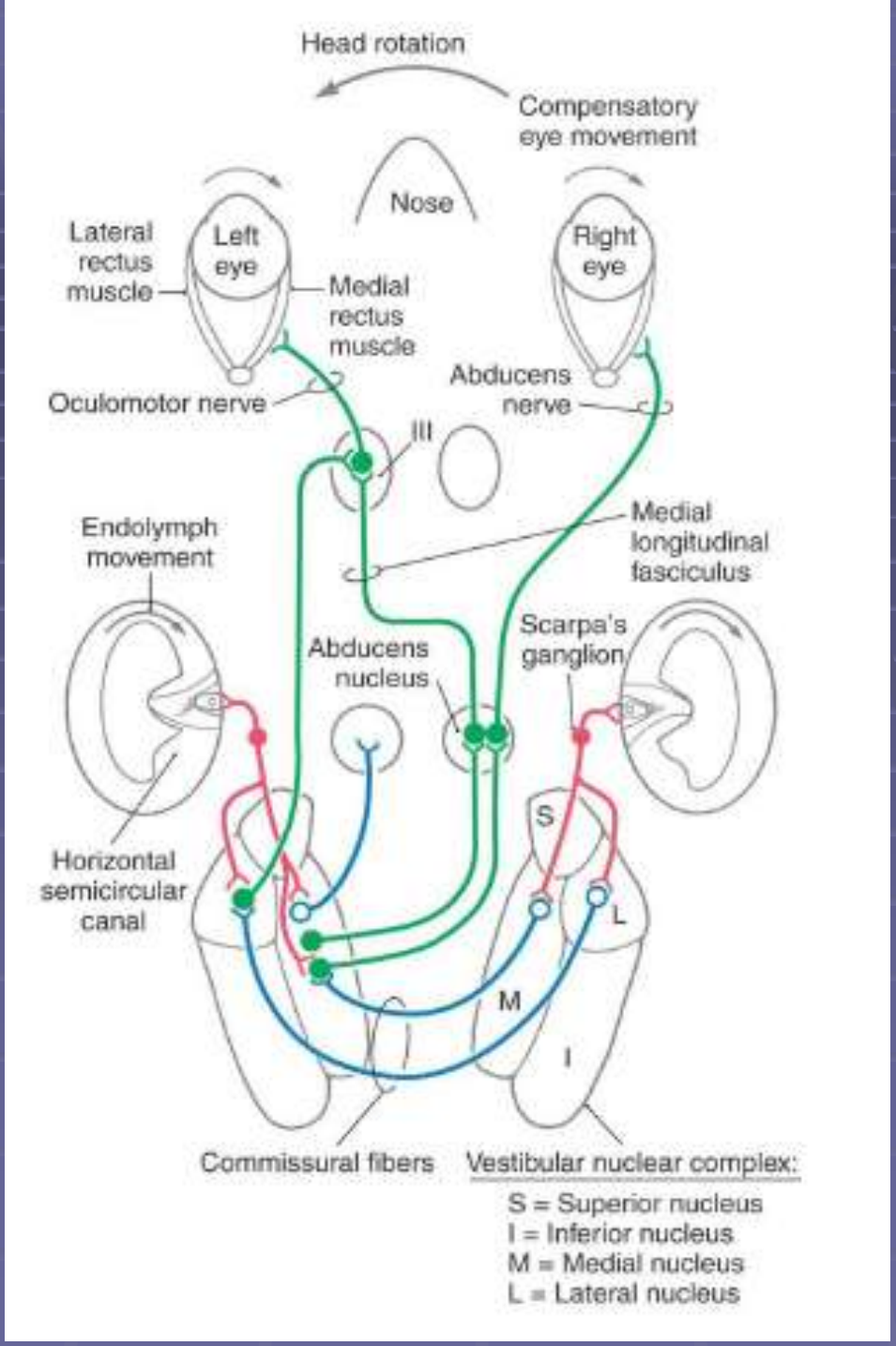

Vestibular area in cerebral cortex
Ventral posterior nucleus in thalamus
Vestibular branch of vestibulocochlear (VIII) nerve
Vestibular ganglion
Oculomotor nerve (III) nucleus
Trochlear nerve (IV) motor nucleus
Abducens nerve (V) motor nucleus
Cerebellum
Accessory nerve (XI) nucleus
Vestibulospinal tract
Vestibular nuclei
Spinal cord


Ventral lateral nucleus
Anterior pulvinar
Somatosensory cortex 3a, 2v
Area 3a
Posterior insula and temporoparietal cortex (PIVC)
Lateral sulcus
Ventral posterolateral nucleus and posterior nuclear group
Vestibular nuclei:
Superior
Lateral
Inferior
Medial
A
Central sulcus
2v, 3a
Posterior parietal cortex 7, VIP, MIP, MST
Intraparietal sulcus
Premotor cortex 6v, FEF
Lateral sulcus
PIVC
B
Hippocampus
C

VESTIBULOOCULAR REFLEX

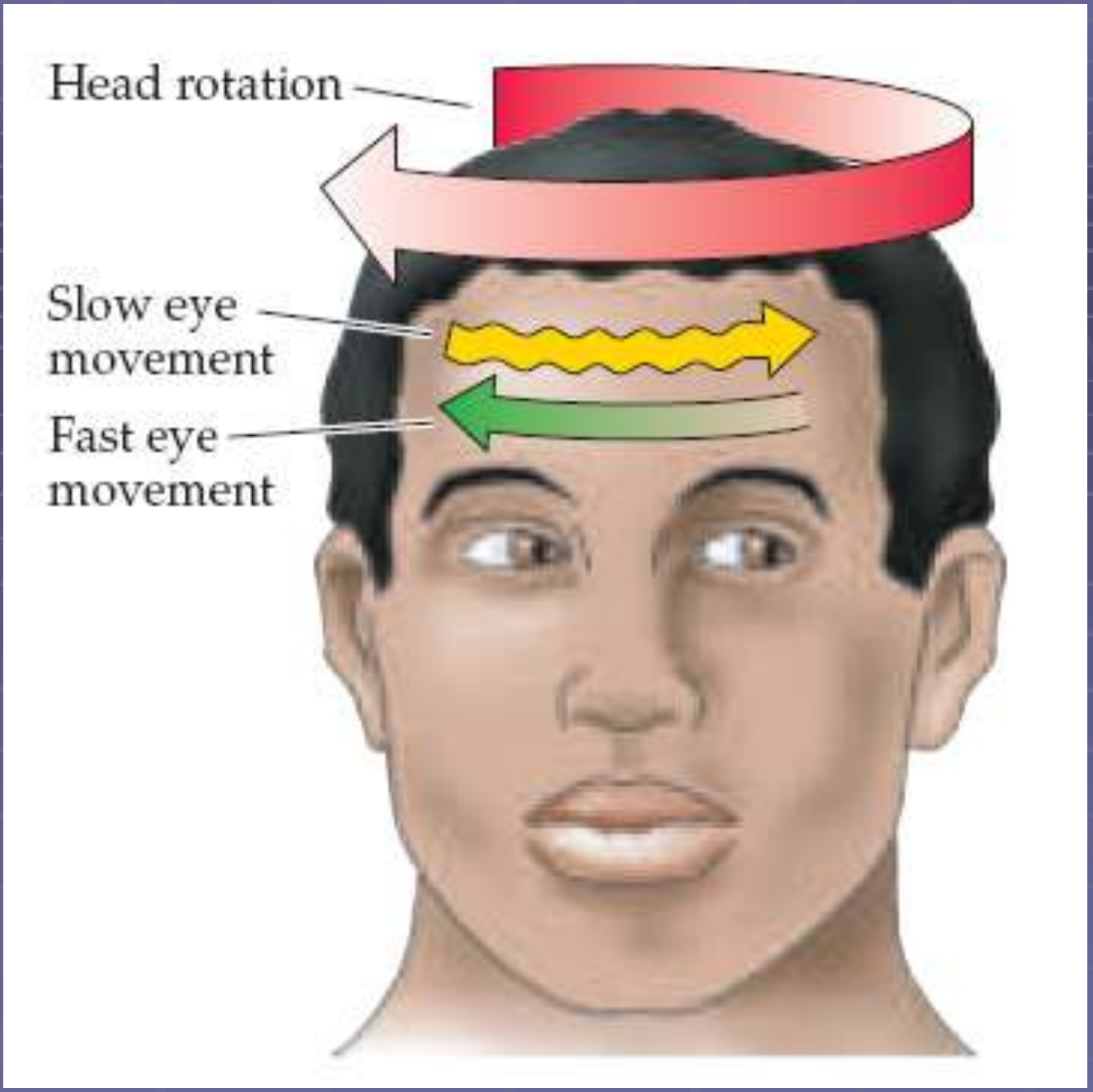
- **Compensatory for head movements**
  - ***Rotational Reflex***
  - ***Linear Reflex***


(A)
Right horizontal canal
Left horizontal canal
Head turns
Ampullae
Axis of hair cells
Body
Fluid motion in horizontal ducts
Afferent fibers of nerve VIII
Increase in firing
Decrease in firing

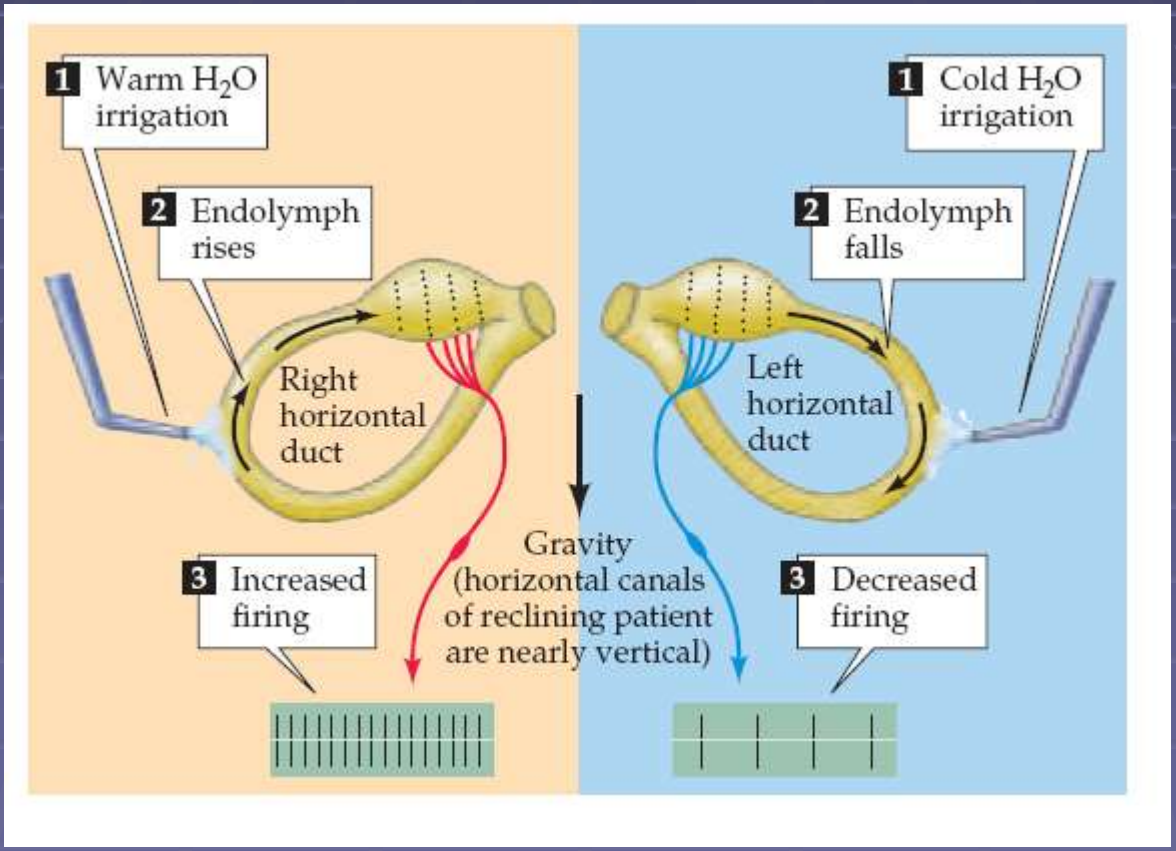

Head rotation
Compensatory eye movement
Nose
Lateral rectus muscle
Left eye
Right eye
Medial rectus muscle
Oculomotor nerve
Abducens nerve
III
Endolymph movement
Medial longitudinal fasciculus
Abducens nucleus
Scarpa's ganglion
S
L
M
I
Horizontal semicircular canal
Commissural fibers
Vestibular nuclear complex:
S = Superior nucleus
I = Inferior nucleus
M = Medial nucleus
L = Lateral nucleus

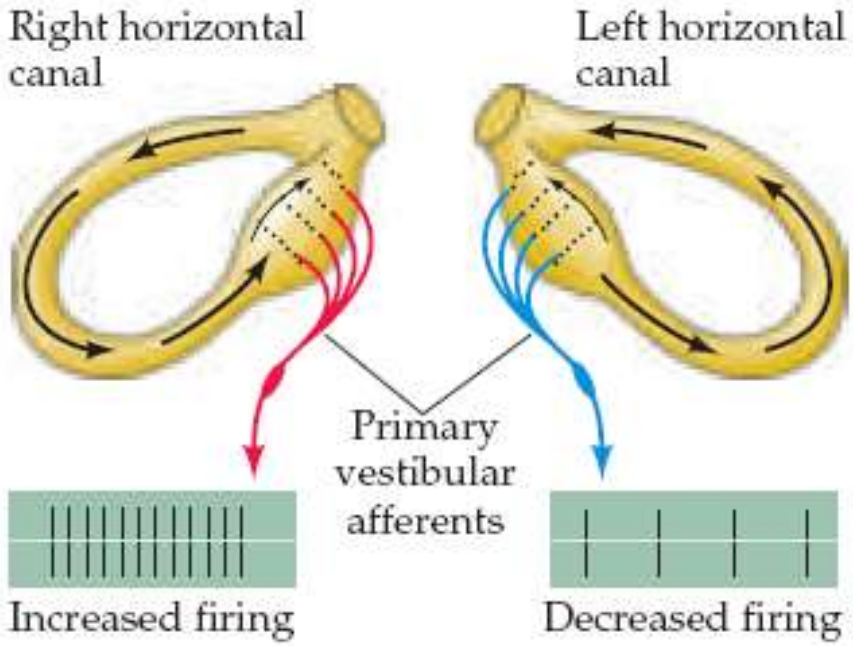
VESTIBULOOCULAR REFLEX

- **Compensatory for head movements**
  - ***Rotational Reflex***
  - ***Linear Reflex***
- ***Nystagmus***

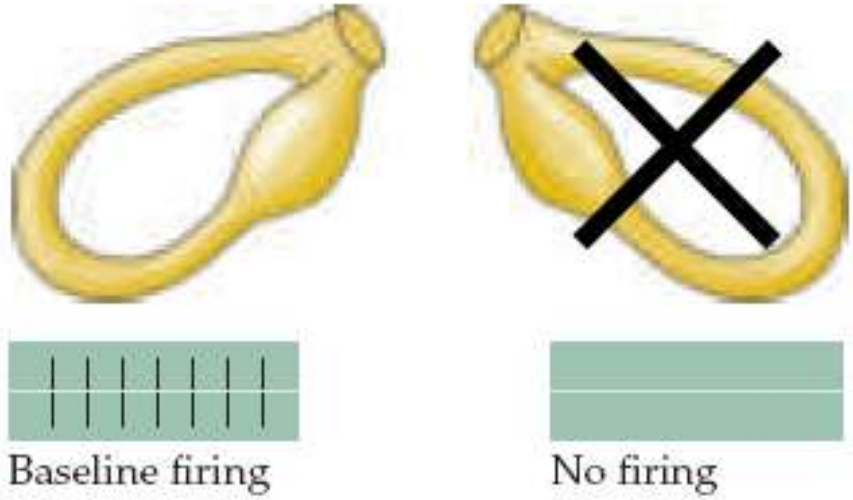

Head rotation
Slow eye movement
Fast eye movement

Caloric test





(2) **Spontaneous nystagmus**



Ménière Disease

Disease results from a disruption of normal endolymph volume

Symptoms include: Severe vertigo
Positional nystagmus (when head in a particular position)
Nausea

Affected individuals can also experience-unpredictable attacks of auditory & vestibular
symptoms: Vomiting
Tinnitus (ringing in ears)
Inability to make head movements
Inability to stand passively
Low frequency hearing loss

Treatment: administration of a diuretic (hydrochlorothiazide) & a salt restricted diet

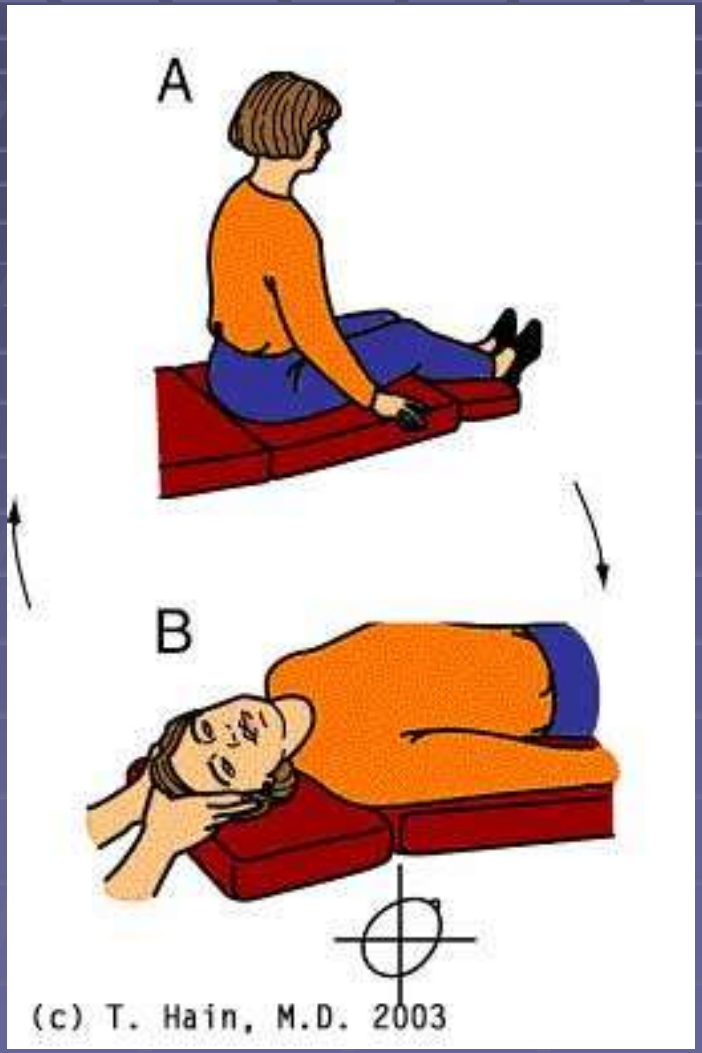
Persistent condition:shunt implantation into swollen endolymphatic sac, or delivery of a vestibulotoxic agents (gentamicin) into erilymph.

Benign Paroxysmal Positional Vertigo

- common clinical disorder.
- condition characterized by brief episodes of vertigo that coincide with particular changes in body position.
- pathophysiology poorly understood.
- posterior canal abnormalities are implicated.
- otoconia crystals in the utricle may separate from the otolith membrane and become lodged in the cupula, causing abnormal cupula deflections. AND/OR partial inflammation of cranial nerve VIII

Dix-Hallpike test

The definitive diagnostic test for benign paroxysmal positional vertigo



- Patient from sitting to supine position.
- Head turned 45^0 to one side and extended 20^0 backward.
- Observe eyes for nystagmus (30 sec.).
- Bring back to a sitting position.
- Small delay, test other side.
- A positive test consists of a burst of nystagmus.
- Posterior canal BPPV (more common) – eyes jump upward.

Dizziness: non-specific term.
generally means spatial disorientation.
may or may not involve feelings of movement.
may be accompanied by nausea or postural instability.
may be caused by factors other than vestibular dysfunction.

Vertigo: specific term.
perception of body motion.
spinning or turning sensation when no real motion is taking place.

Tinnitus Some of these causes include
high blood pressure,
diabetes,
listening to loud music,
a tumor,
thyroid conditions,
and medications / antidepressants, sedatives, antibiotics, anti-inflammatories, and aspirin.

Semicircular Canal Dehiscence (opening)

Temporal bone overlying the anterior or the posterior semicircular canal thins, creating an opening/dehiscence next to the dura.

Text Fig. 22-5

CT scan of the temporal bone projected into the plane of the left superior/anterior canal, in a patient with superior canal dehiscence syndrome.

The dehiscense exposes the bony labyrinth to the extradural space.

Symptoms: vertigo and oscillopsia in response to loud sounds (Tullio Phenomenon), or in response to maneuvers that change middle ear or intracranial pressure.

Nystagmus evoked by these stimuli aligns with the plane of the dehiscent superior canal.

Treatment: Surgical closure of the defect by bone replacement.

Vestibular Neuritis

- severe vertigo, nausea, vomiting
- no hearing loss or other CNS abnormalities
- possible edema of the vestibular nerve/ganglion.
- thought to be produced by acute viral infection.
- treated with anitemetics, vestibular suppressants, corticosteroids, & antiviral agents.