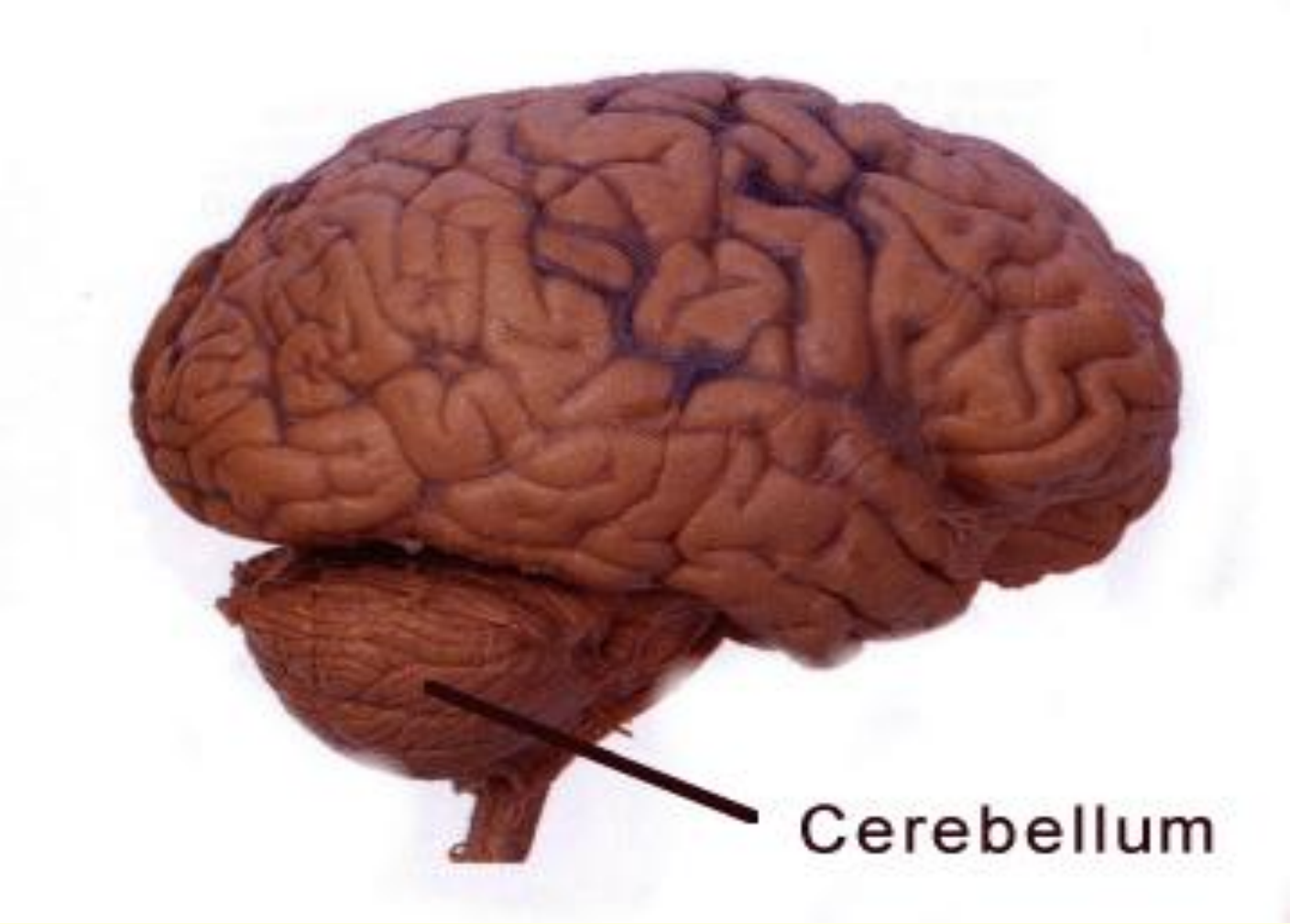
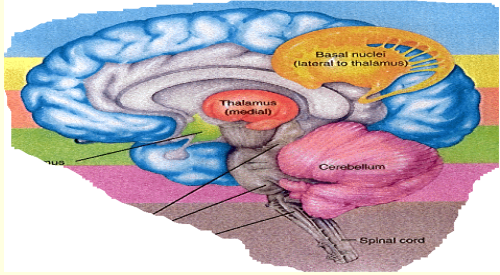
CEREBELLUM AND VESTIBULOCOCHLEAR NERVE

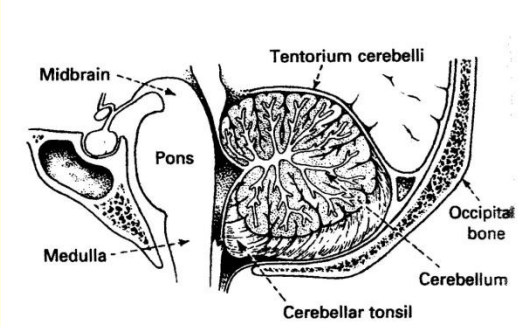


CEREBELLUM

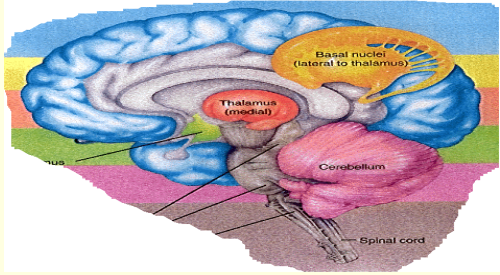


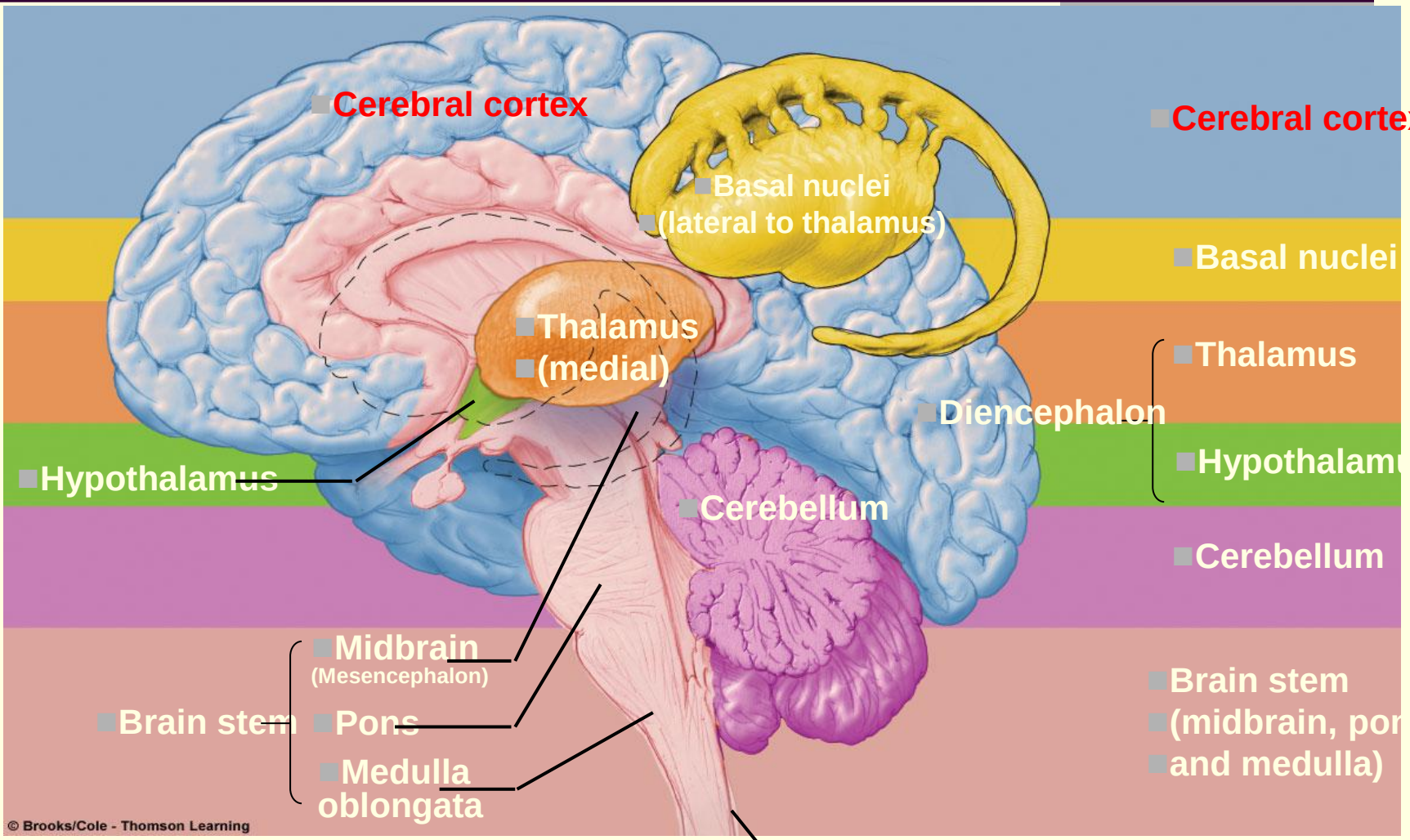
CEREBELLUM: Cerebellum is derived from a Latin word means "little brain.“ Cerebellum is the largest part of the hind brain, lies behind the pons and medulla Oblongata.

- Shape: Oval shaped, with an approximate weight is 150 gm
- Location: Cerebellum is situated in the posterior cranial fossa
- Anteriorly: 4th ventricle, pons, and medulla oblongata
- Superiorily: Covered by tentorium cerebelli
- Inferiorly: Squamous occipital

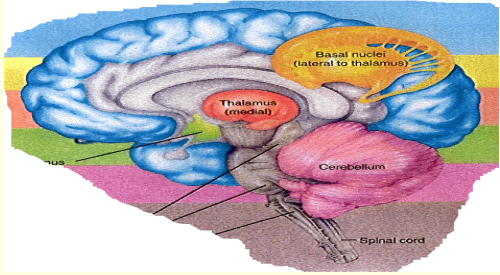


CEREBELLUM


Basal nuclei
(lateral to thalamus)
Thalamus
(medial)
Cerebellum
Spinal cord


Cerebral cortex
Basal nuclei
(lateral to thalamus)
Thalamus
(medial)
Hypothalamus
Cerebellum
Midbrain
(Mesencephalon)
Brain stem
Pons
Medulla
oblongata
Spinal cord
© Brooks/Cole - Thomson Learning
Cerebral cortex
Basal nuclei
Thalamus
Diencephalon
Hypothalamu
Cerebellum
Brain stem
(midbrain, por
and medulla)

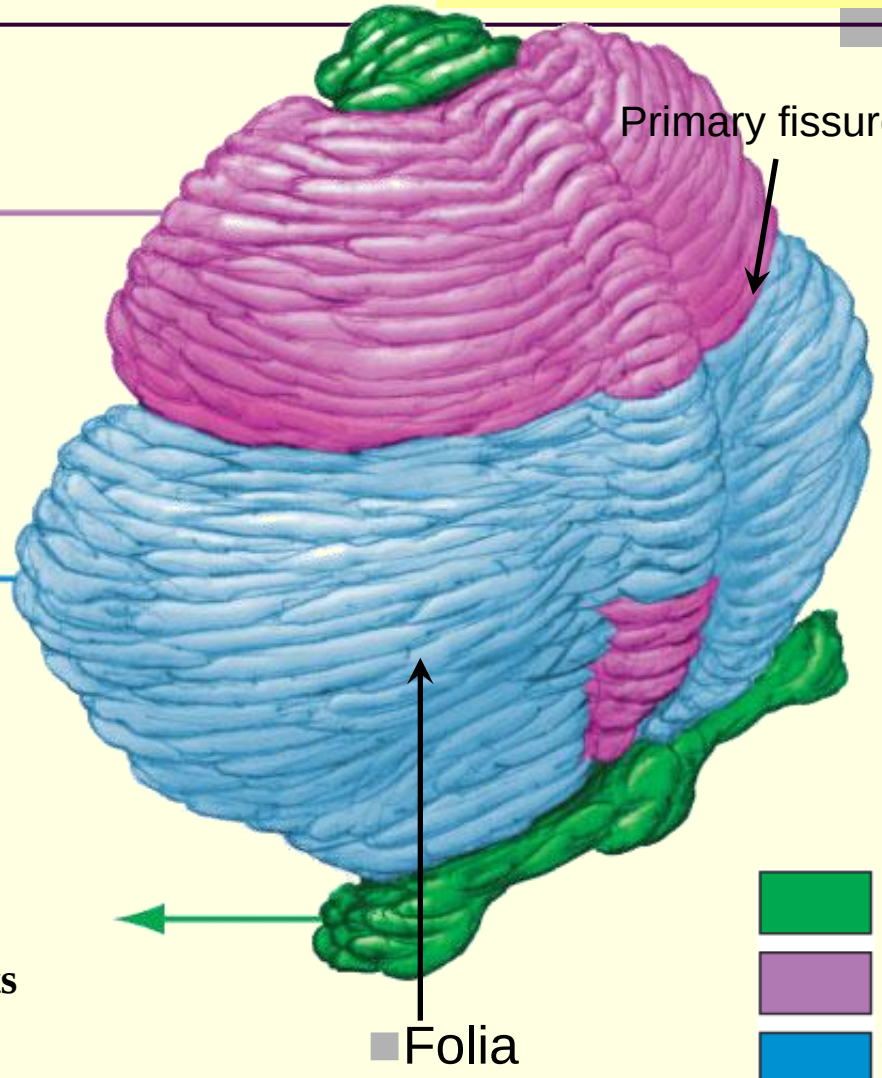
CEREBELLUM



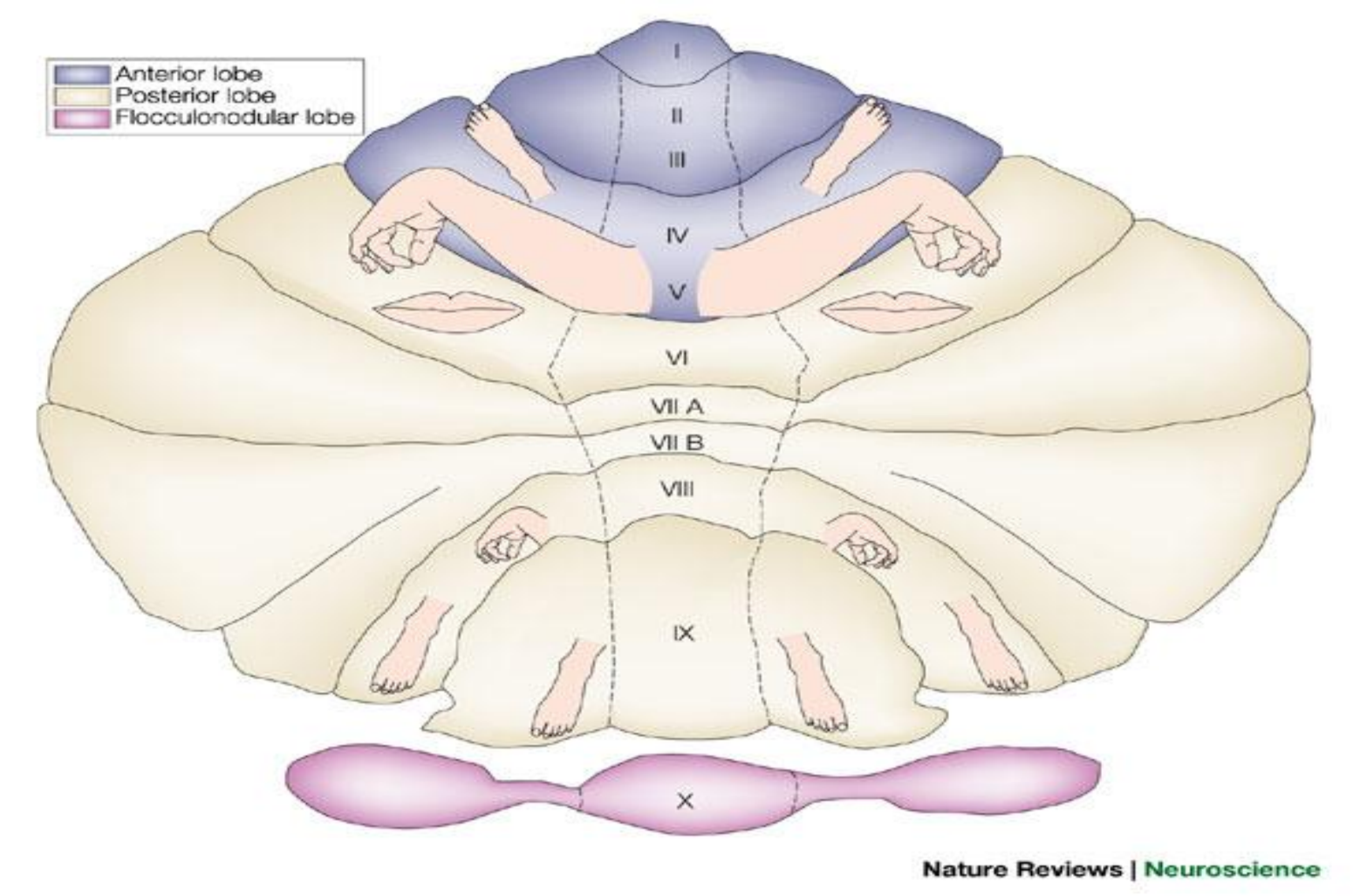
The cerebellum is anatomically and physiologically divided into three parts:

- **Paleocerebellum:** Anterior lobe [Spinocerebellum]
- **Neocerebellum:** Posterior lobe [Cerebrocerebellum]
- **Archicerebellum:** Flocculonodularlobe [Vestibulocerebellum]

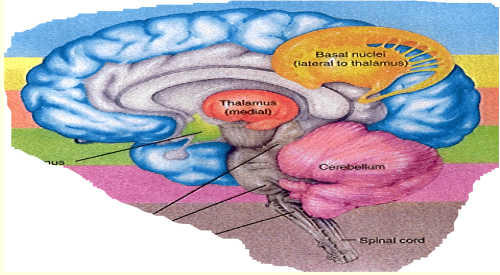
CEREBELLUM

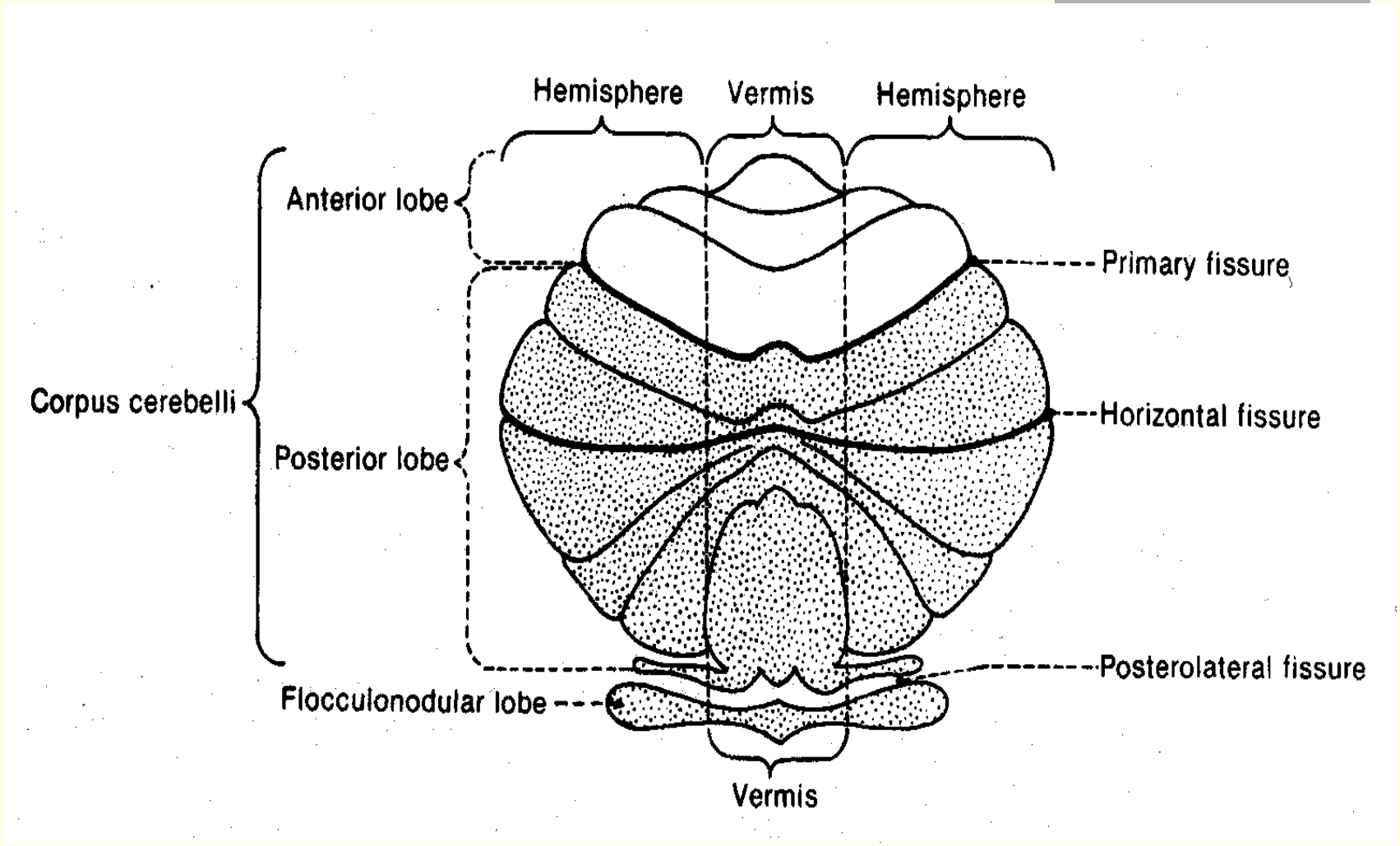

Primary fissure
Anterior Lobe
Posterior Lobe
Flocculo-Nodular Lobe (FN lobe)
Regulation of muscle tone, coordination of skilled voluntary movement
Planning and initiation of voluntary activity
Maintenance of balance, control of eye movements
Folia
Vestibulocerebellum
Spinocerebellum
Cerebrocerebelum

CEREBELLUM

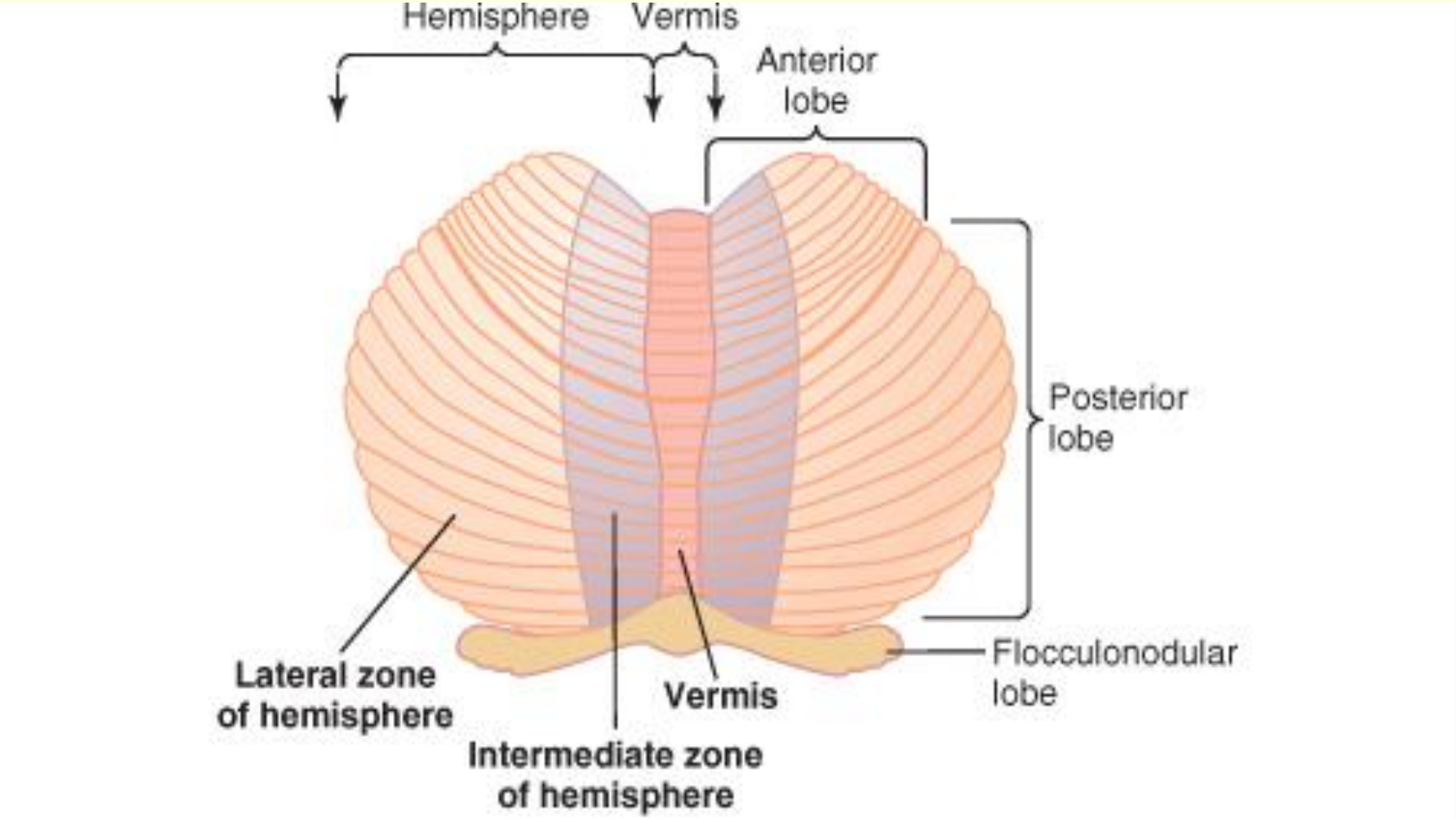

Anterior lobe
Posterior lobe
Flocculonodular lobe
I
II
III
IV
V
VI
VII A
VII B
VIII
IX
X
Nature Reviews | Neuroscience

PHYSIOLOGICAL ANATOMY OF THE CEREBELLUM

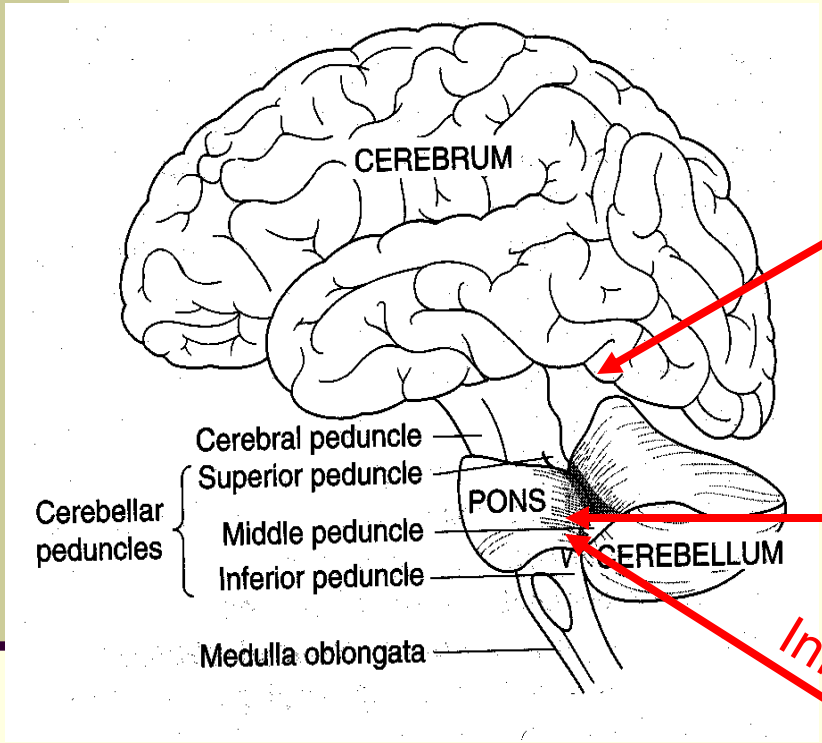




PHYSIOLOGICAL ANATOMY OF THE CEREBELLUM



CEREBELLAR PEDUNCLES: CARRY AFFERENTS FROM WHERE?



Superior Cerebellar Peduncle

Inputs to the Cerebellum from the cerebrum

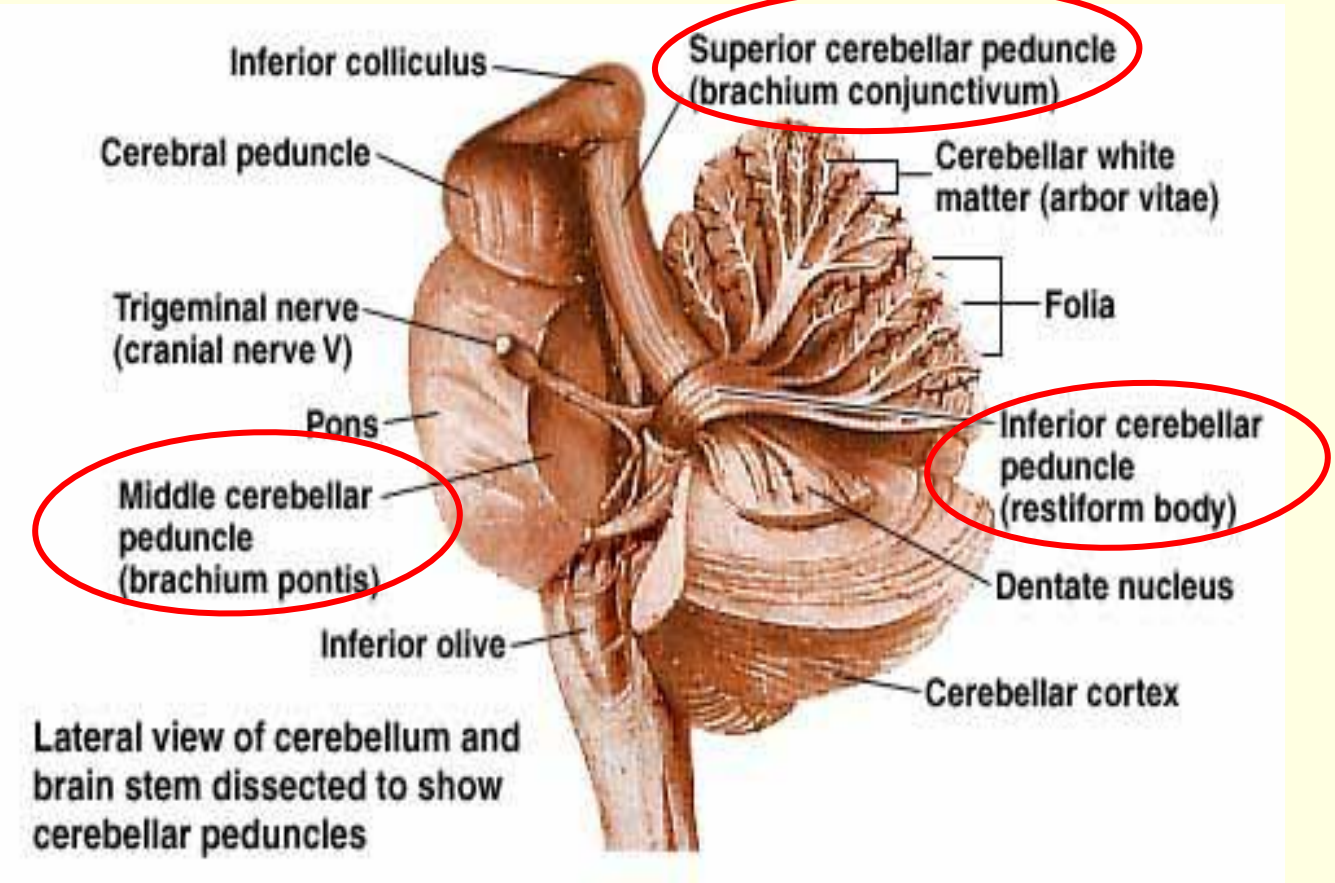
Middle Cerebellar Peduncle

Inputs to the Cerebellum from from the Pons

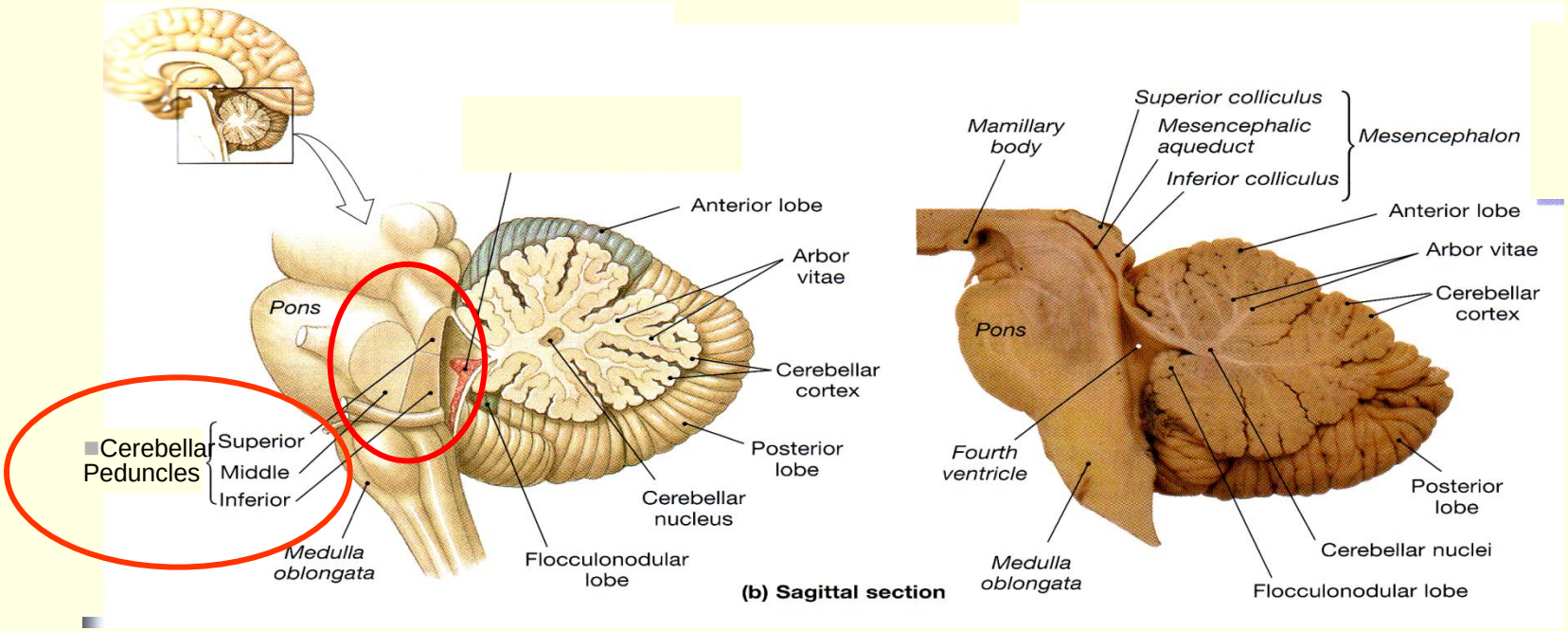
Inferior Cerebellar Peduncle

Inputs to the Cerebellum from the Medulla Oblongata

CEREBELLAR PEDUNCLES: CARRY AFFERENTS FROM WHERE?



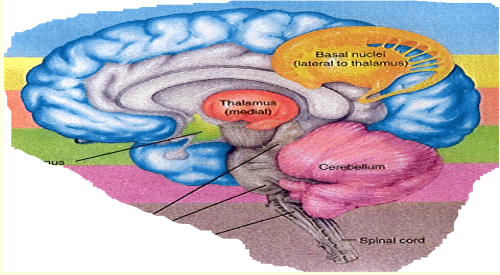
CEREBELLAR PEDUNCLES: CARRY AFFERENTS FROM WHERE?

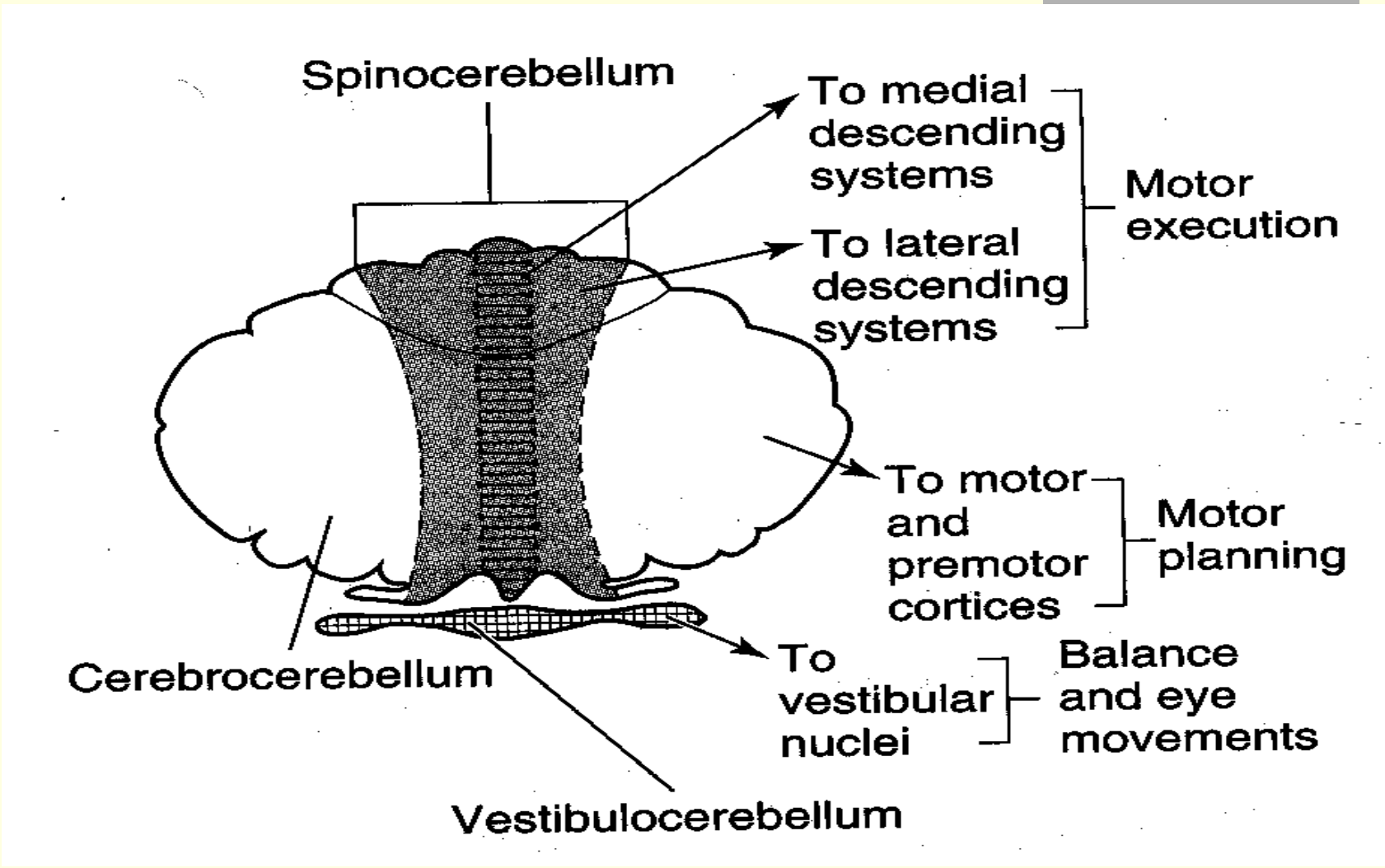


Three paired fiber tracts connect the cerebellum to the brainstem:

- Superior peduncles connect the cerebellum to the cerebrum
- Middle peduncles connect the cerebellum to the pons
- Inferior peduncles connect the cerebellum to the medulla

FUNCTIONAL DIVISION OF THE CEREBELLUM





CEREBELLUM: THE RULE OF 3

3 lobes	**•Floculonodular Lobe** **•Anterior lobe** **•Posterior lobe**
3 Cortical Layers	**•Molecular layer** **•Purkinje cell layer** **•Granular layer**
3 purkinje's cells afferent paths	**•Mossy fibers** **•Climbing fibers** **•Aminergic fibers**
3 pairs of deep nuclei	**•Fastigial** **•Interposed(globose & emboliform)** **•Dentate**
3 pairs of peduncles	**•Superior (pri.output)** **•Middle (pri.Input)** **•Inferior (pri.Input)**
3 functional division	**•Vestibulocerebellum** **•Spinocerebellum** **•Cerebrocerebellum**

CEREBELLUM LAYERS

The cerebellum has an external cerebellar cortex separated by white matter from the deep cerebellar nuclei as follows:

Cerebellar Cortex

- Molecular Layer
- Purkinje Cell Layer
- Granular Layer

Cerebellar Nuclei

- Dentate Nucleus
- Globose Nucleus
- Emboliform Nucleus
- Fastigial Nuclei

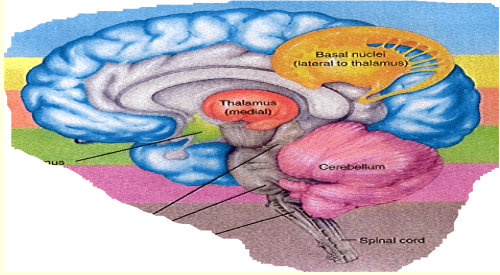
- Purkinje cells
- Basket cells
- Stellate cells
- Golgi cells

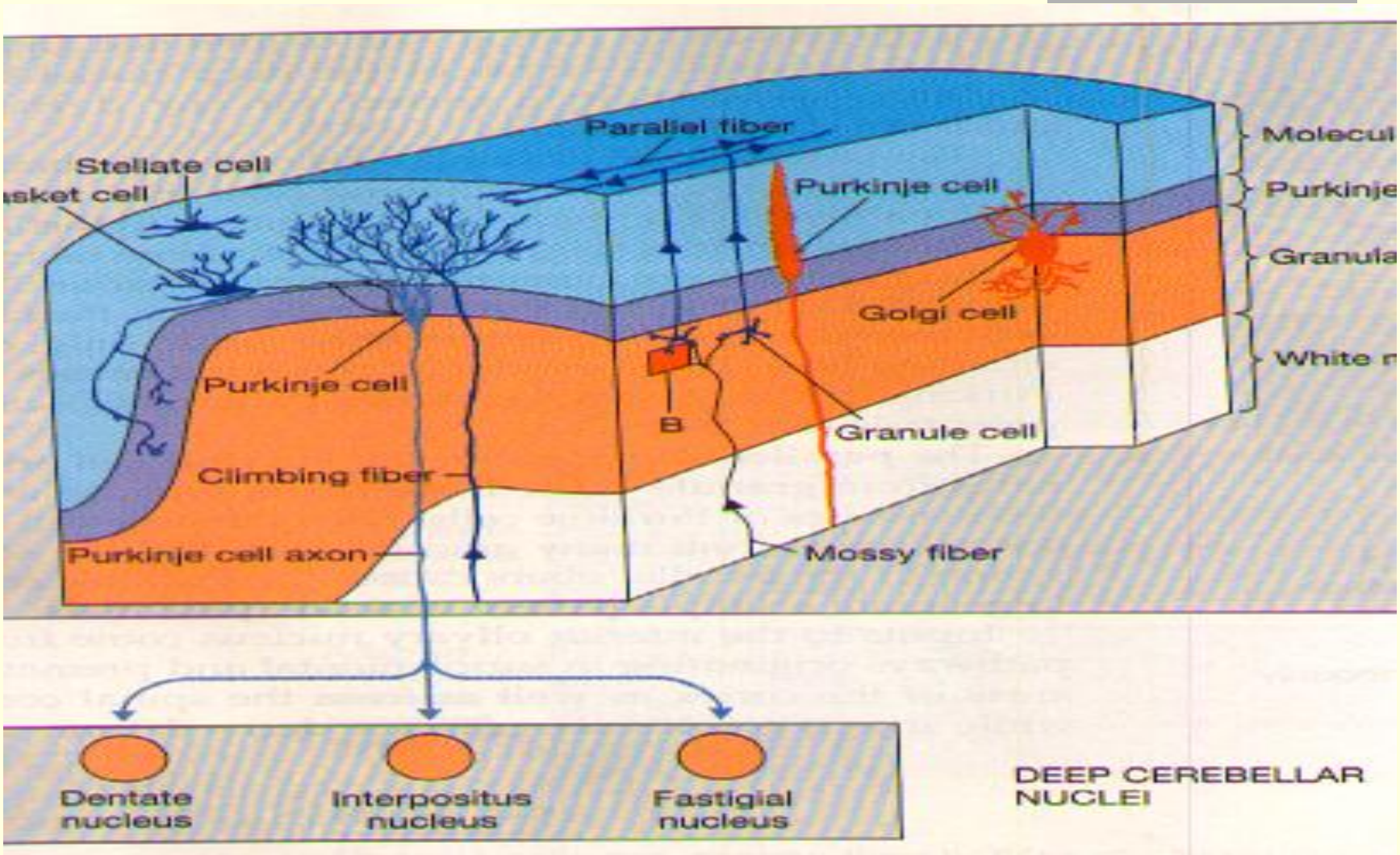
→ GABA

- Granule cells → Glutamate

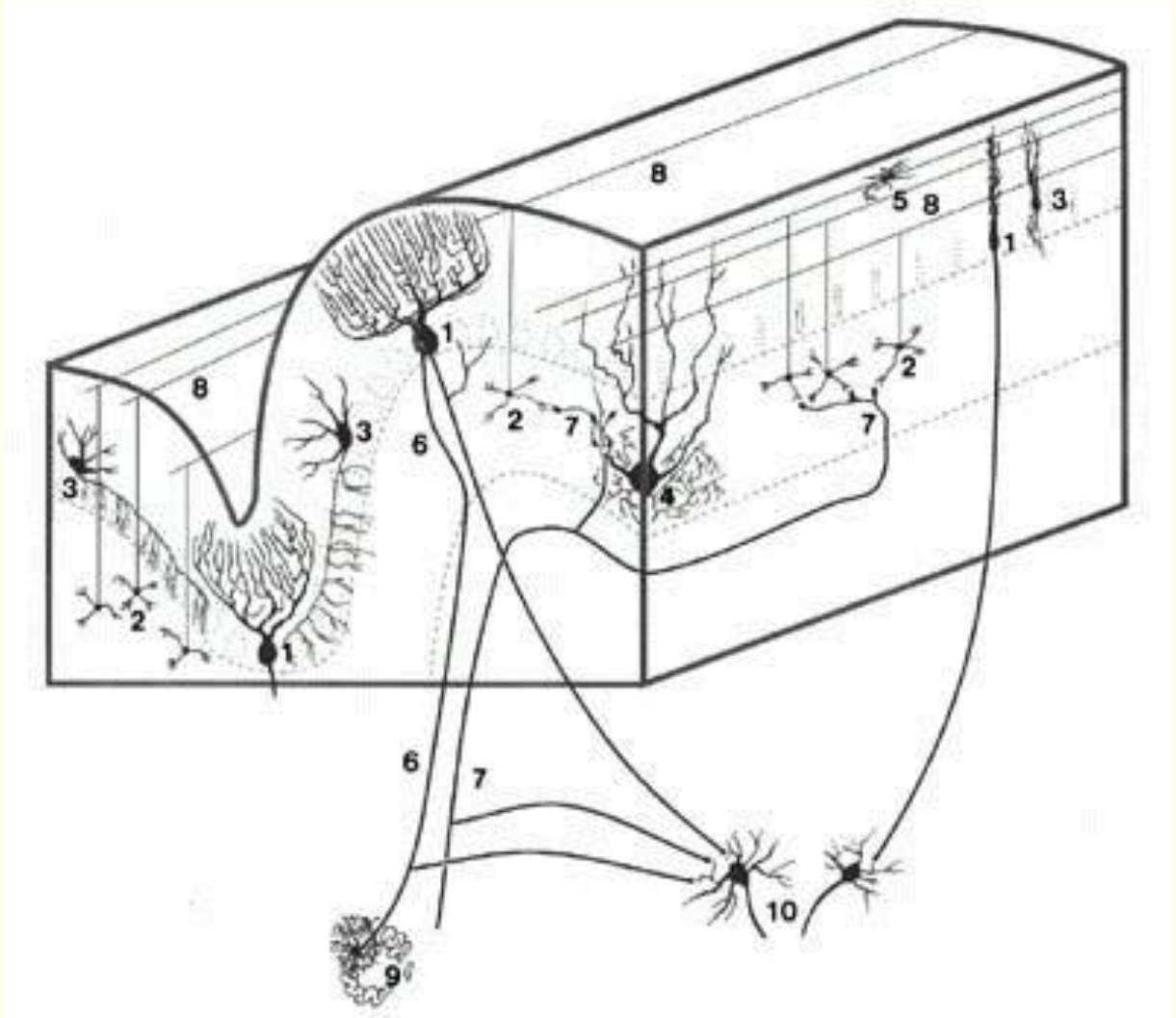
Note: [Globose and Emboliform also known as interpositus nucleus

TYPES OF THE CELLS INTHE CEREBELLUM





TYPES OF THE CELLS INTHE CEREBELLUM



- 1. Purkinje cell
- 2. granule cell
- 3. basket cell
- 4. Golgi cell
- 5. stellate cell
- 6. climbing fiber
- 7. mossy fiber
- 8. parallel fiber
- 9. inferior olivary nucleus
- 10. deep cerebellar nuclei

NUCLEI OF THE CEREBELLUM

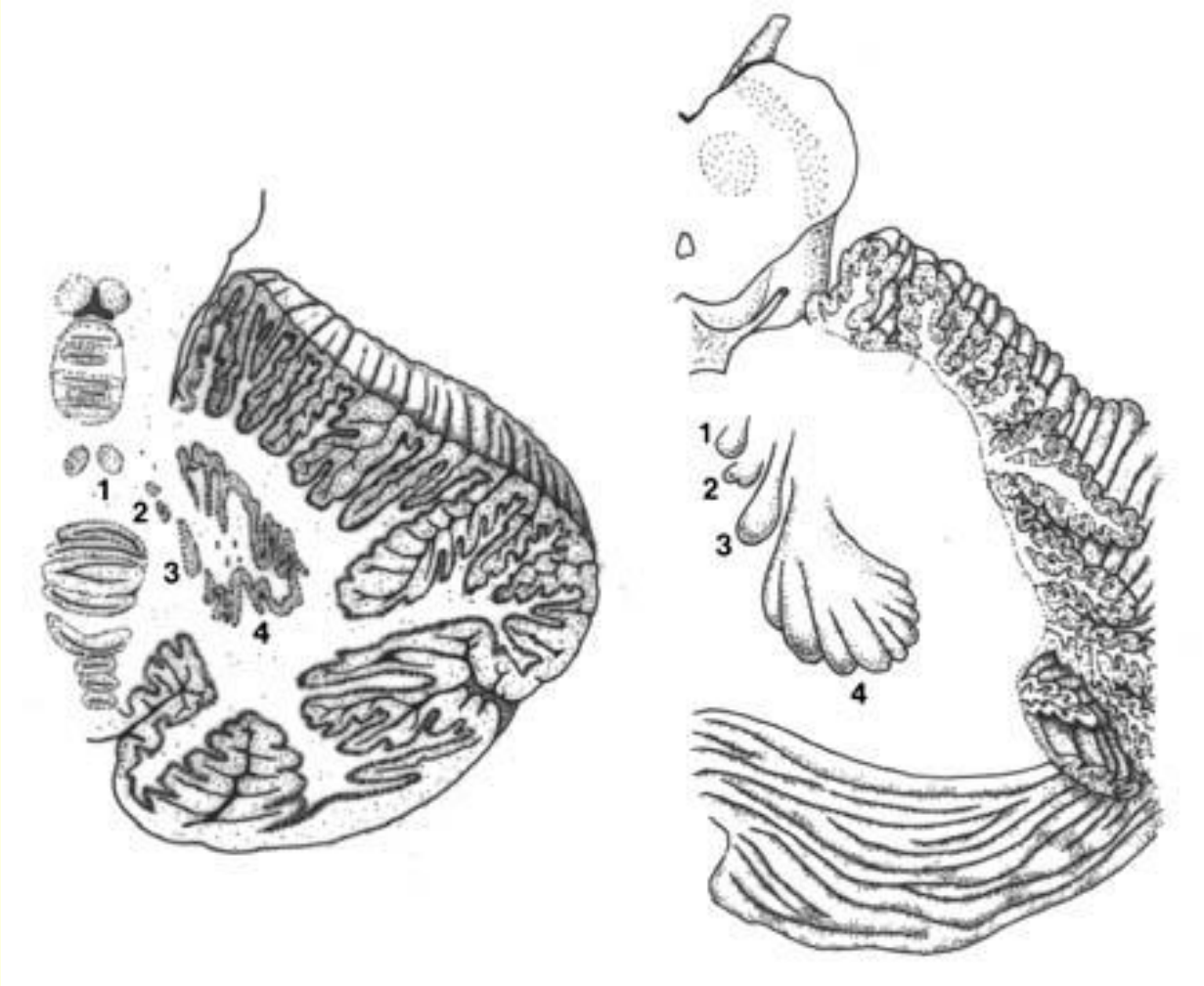
DEEP NUCLEI

1. Fastigial nucleus

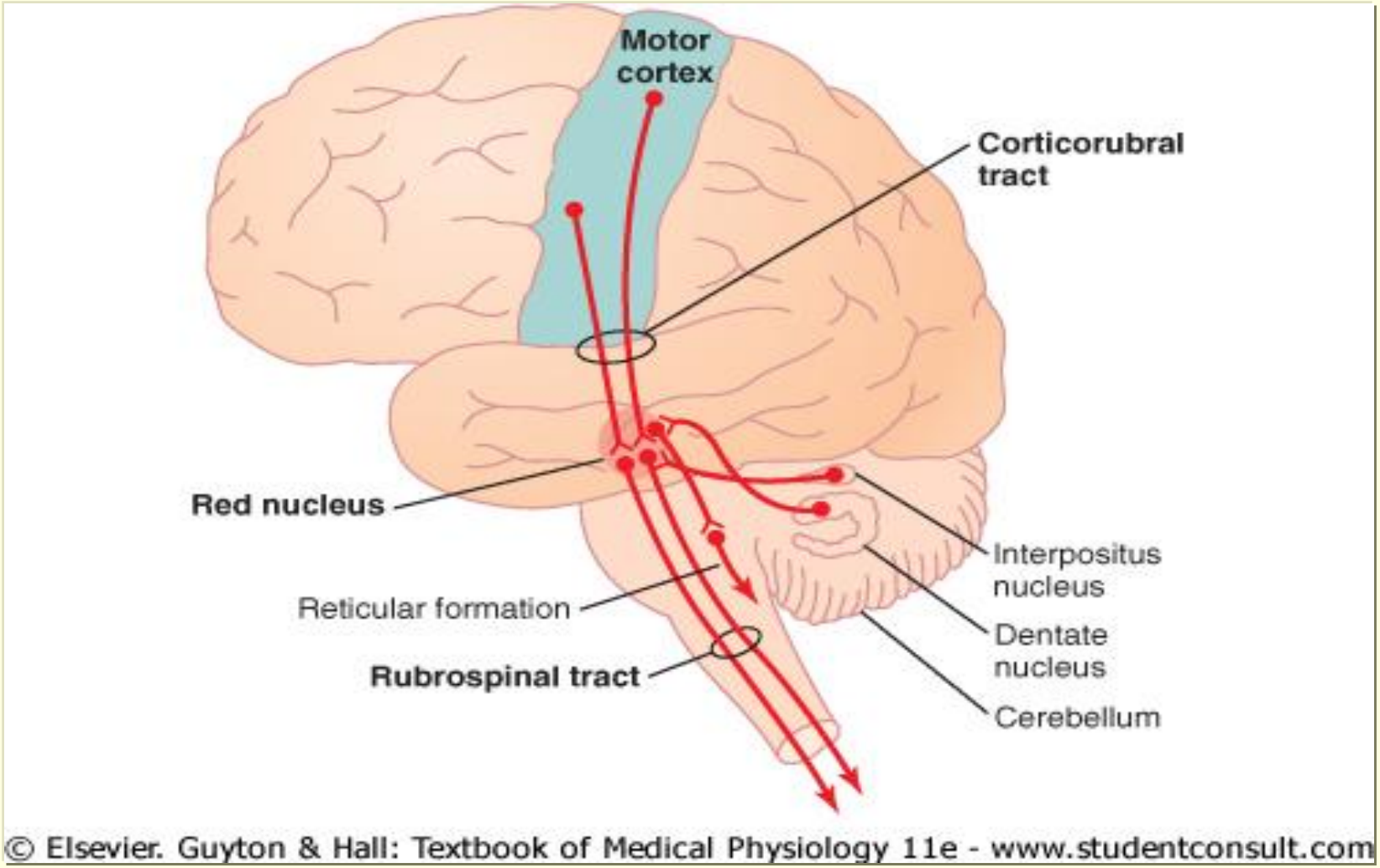
2. Globose nucleus

3. Emboliform nucleus

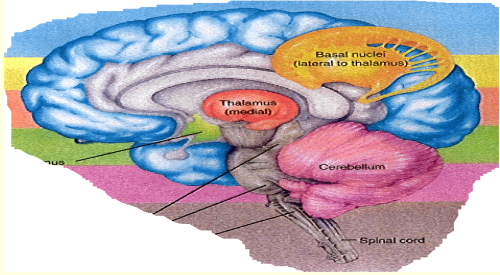
4. Dentate nucleus



NUCLEI OF THE CEREBELLUM



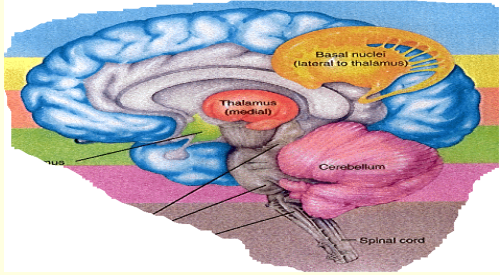
CELL TYPES INTHE CEREBELLUM



1 Molecular Layer

- *Stellate Cell* --- taurine (inhibitory)
- afferent: *parallel fiber*
- efferent: Purkinje cell dendrite
- *Basket Cell* - GABA (inhibitory)
- afferent: *parallel fiber*
- efferent: Purkinje cell soma
- *Parallel Fiber* granule cell axon *Purkinje Cell Dendrite*

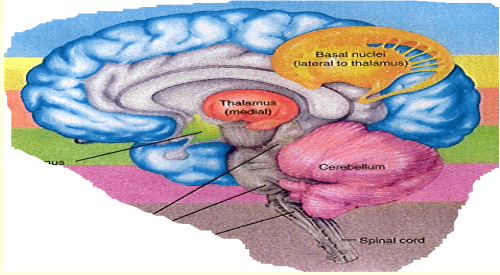
CELL TYPES INTHE CEREBELLUM



II. Purkinje Cell Layer

- *Purkinje Cell*
- 15,000,000 in number
- GABA (inhibitory)
- afferent: *parallel fiber* , *climbing fiber*
- stellate cell, basket cell
- efferent: deep cortical nuclei

CELL TYPES INTHE CEREBELLUM



Granular Layer :

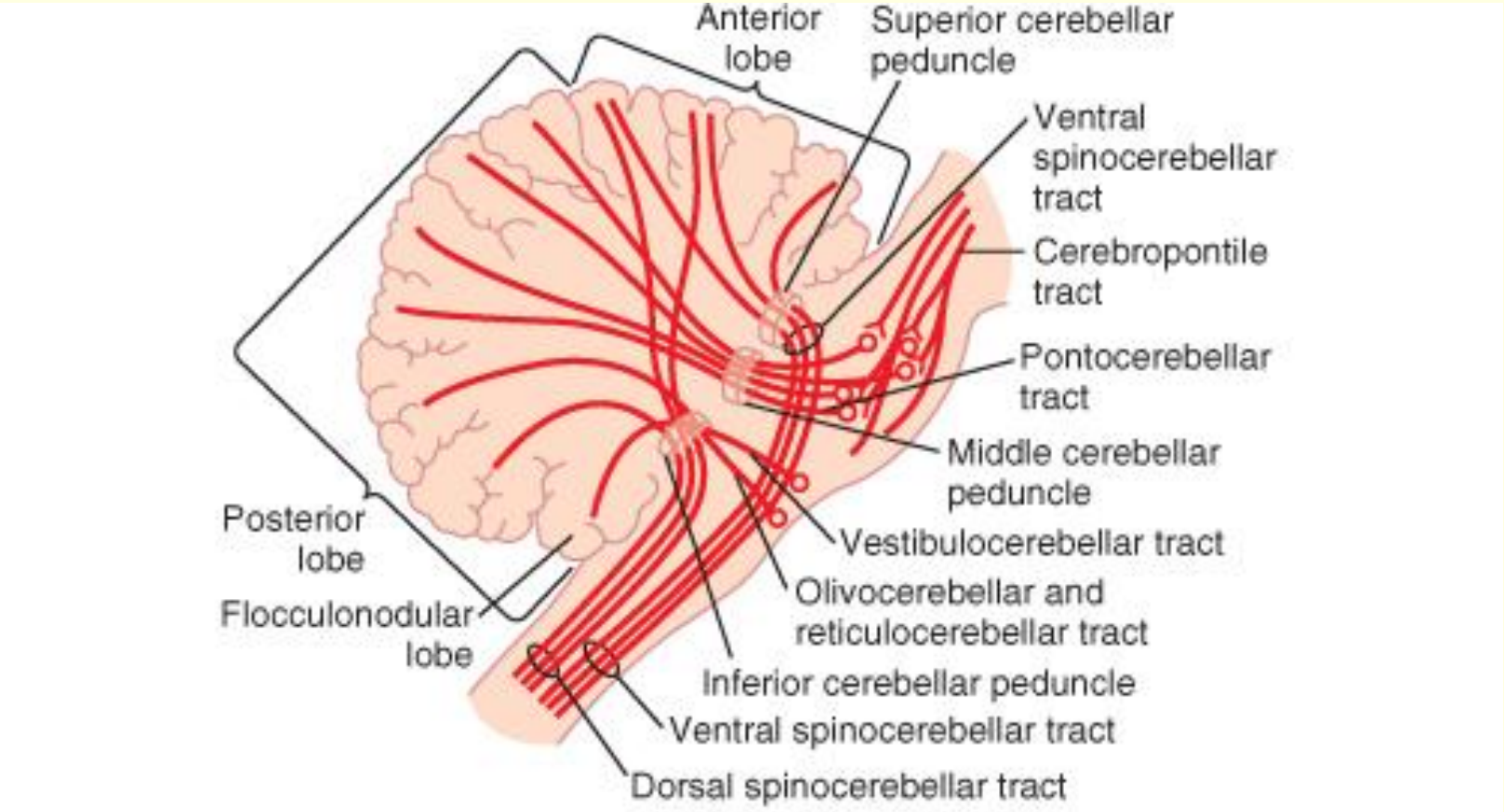
Granular Cell

- glutamic acid (excitatory)
- afferent: *mossy fiber*
- efferent: *Purkinje cell dendrite*
- basket cell, stellate cell, Golgi cell

Golgi Cell

- GABA (inhibitory)
- afferent: parallel fiber, mossy fiber rosette
- efferent: granule cell dendrite

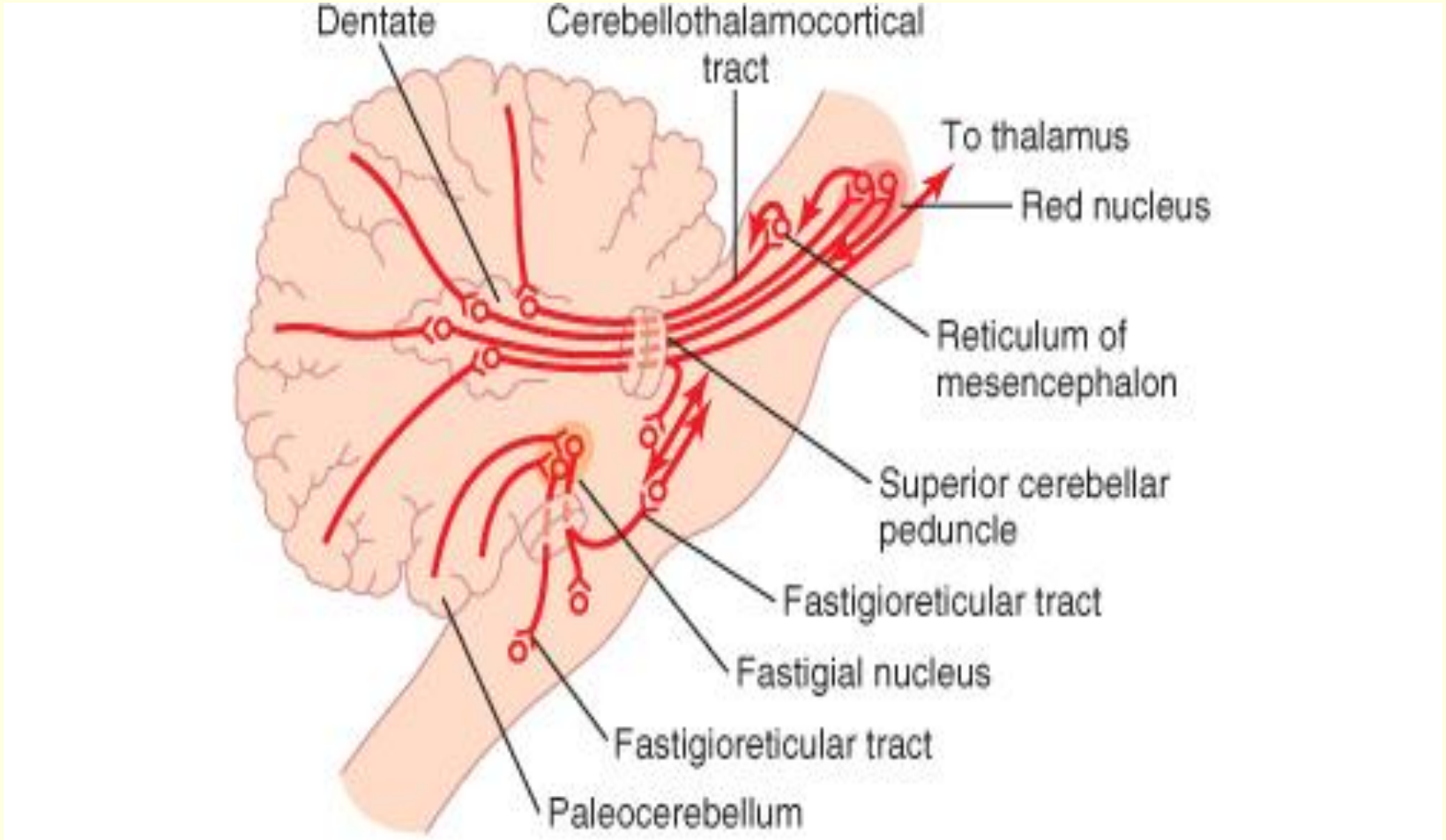
PRINCIPAL AFFERENT TRACTS TO THE CEREBELLUM



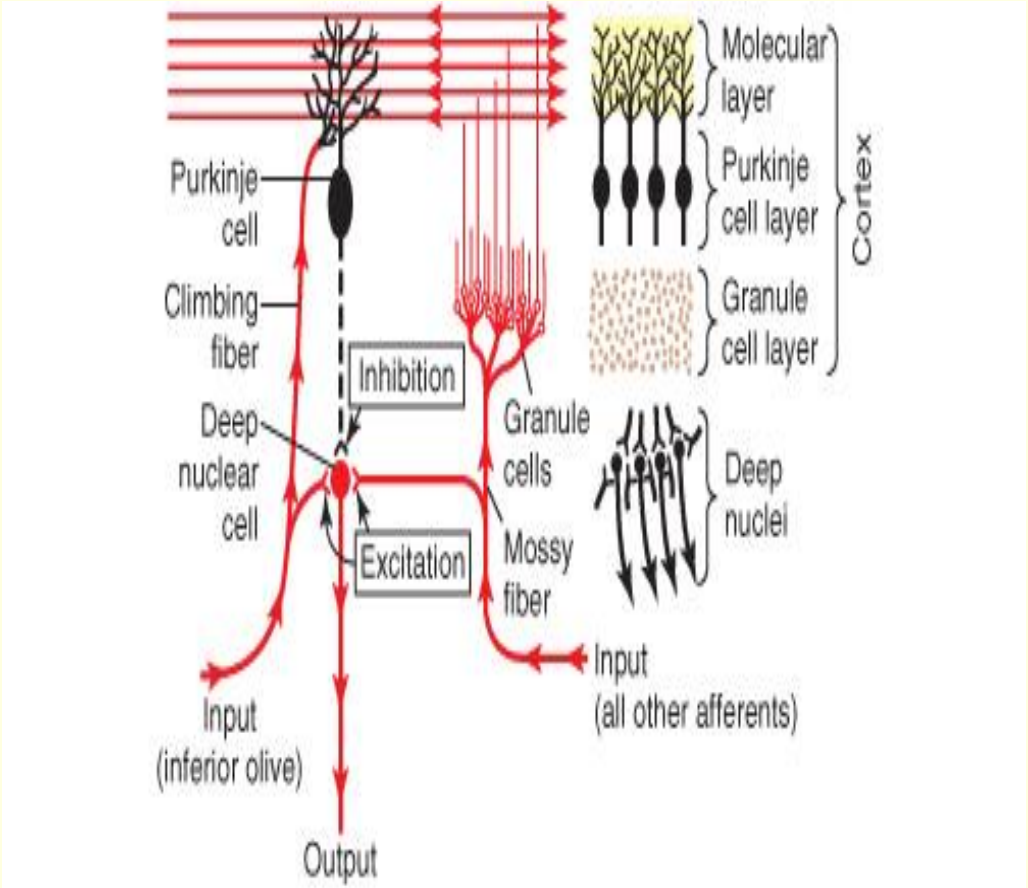
PRINCIPAL AFFERENT TRACTS TO THE CEREBELLUM

AFFERENT TRACTS	TRANSMITS
Vestibulocerebellar	Vestibular impulses from labyrinths, direct & via vestibular nuclei.
Dorsal Spinocerebellar	Prorioceptive & exteroceptive impulses from the body.
Ventral Spinocerebellar	Prorioceptive & exteroceptive impulses from the body.
Cuneocerebellar	Prorioceptive impulses, especially from the head and neck.
Tectocerebellar	Auditory & visual impulses via inferior and superior colliculi.
Pontocerebellar	Impulses from motor and other parts of cerebral cortex via pontine nuclei.
Olivocerebellar	Proprioceptive input from whole body via relay in inferior olive.

PRINCIPAL EFFERENT TRACTS TO THE CEREBELLUM



CEREBELLUM WITH EXCITATORY AND INHABITORY CONTROL

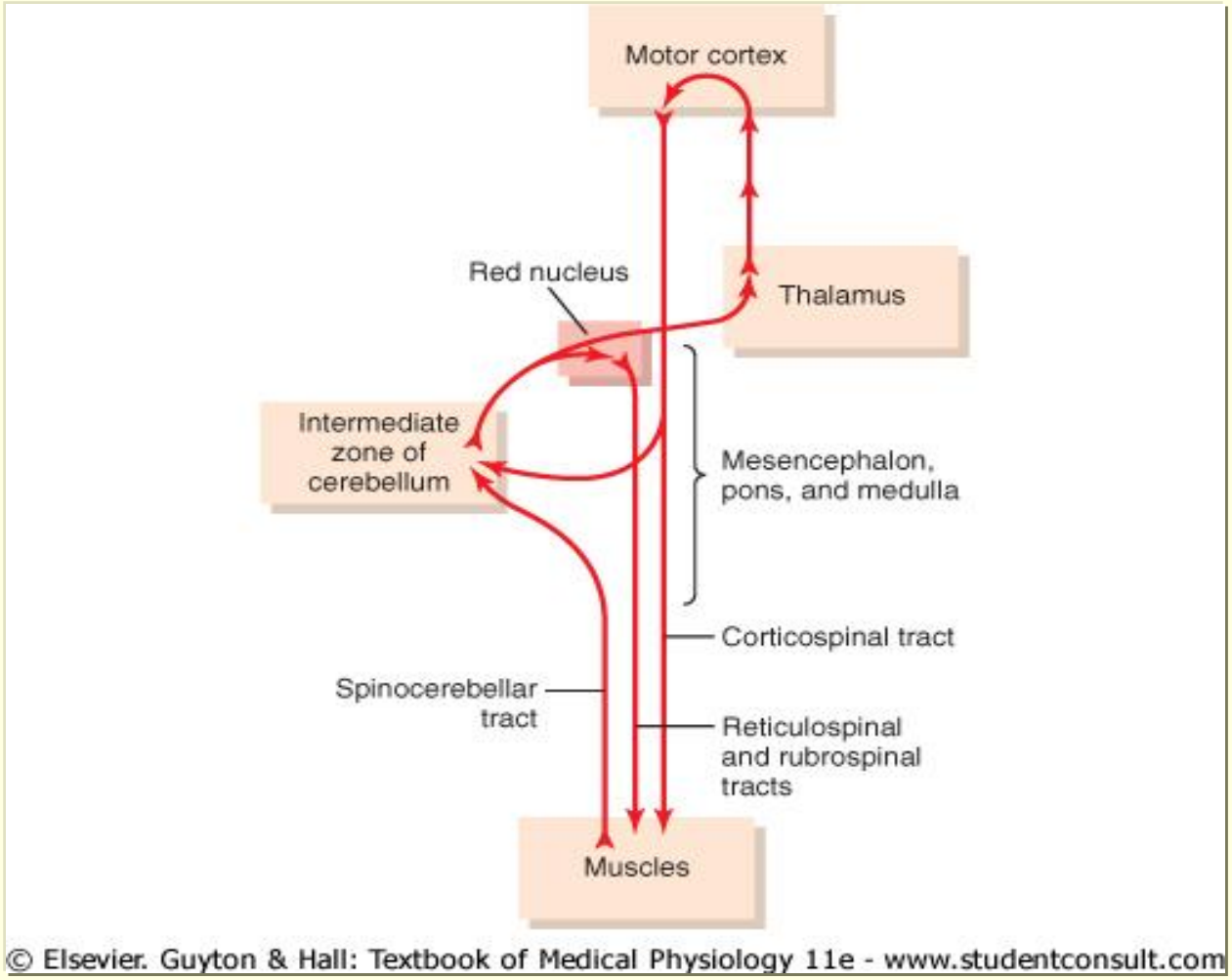


The left side of this figure shows the basic neuronal circuit of the cerebellum, with excitatory neurons shown in red

Purkinje cell (an inhibitory neuron) shown in black.

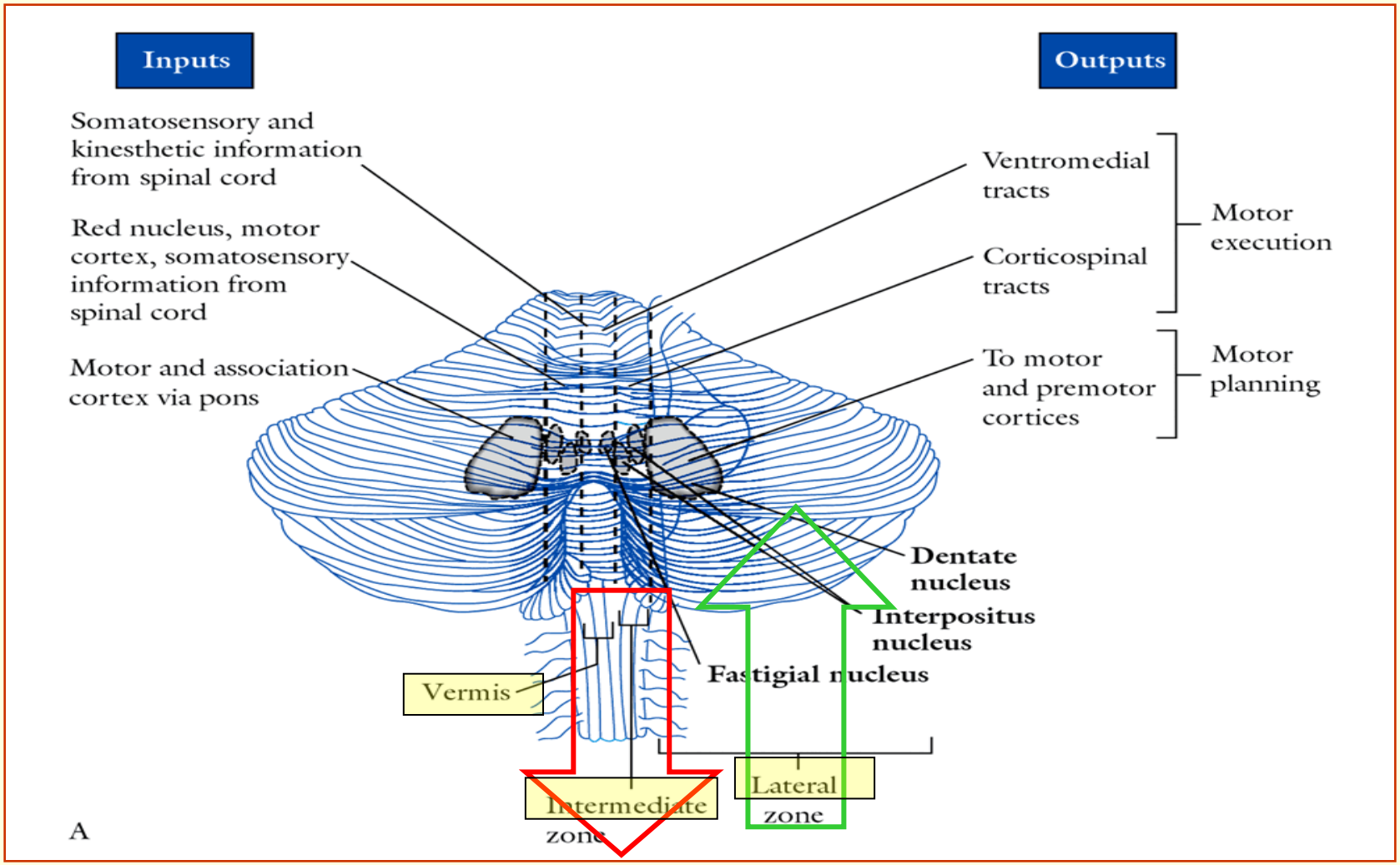
The physical relationship of the deep cerebellar nuclei to the cerebellar cortex with its three layers.

CEREBELLUM AND VOLUNTARY MOTOR CONTROL

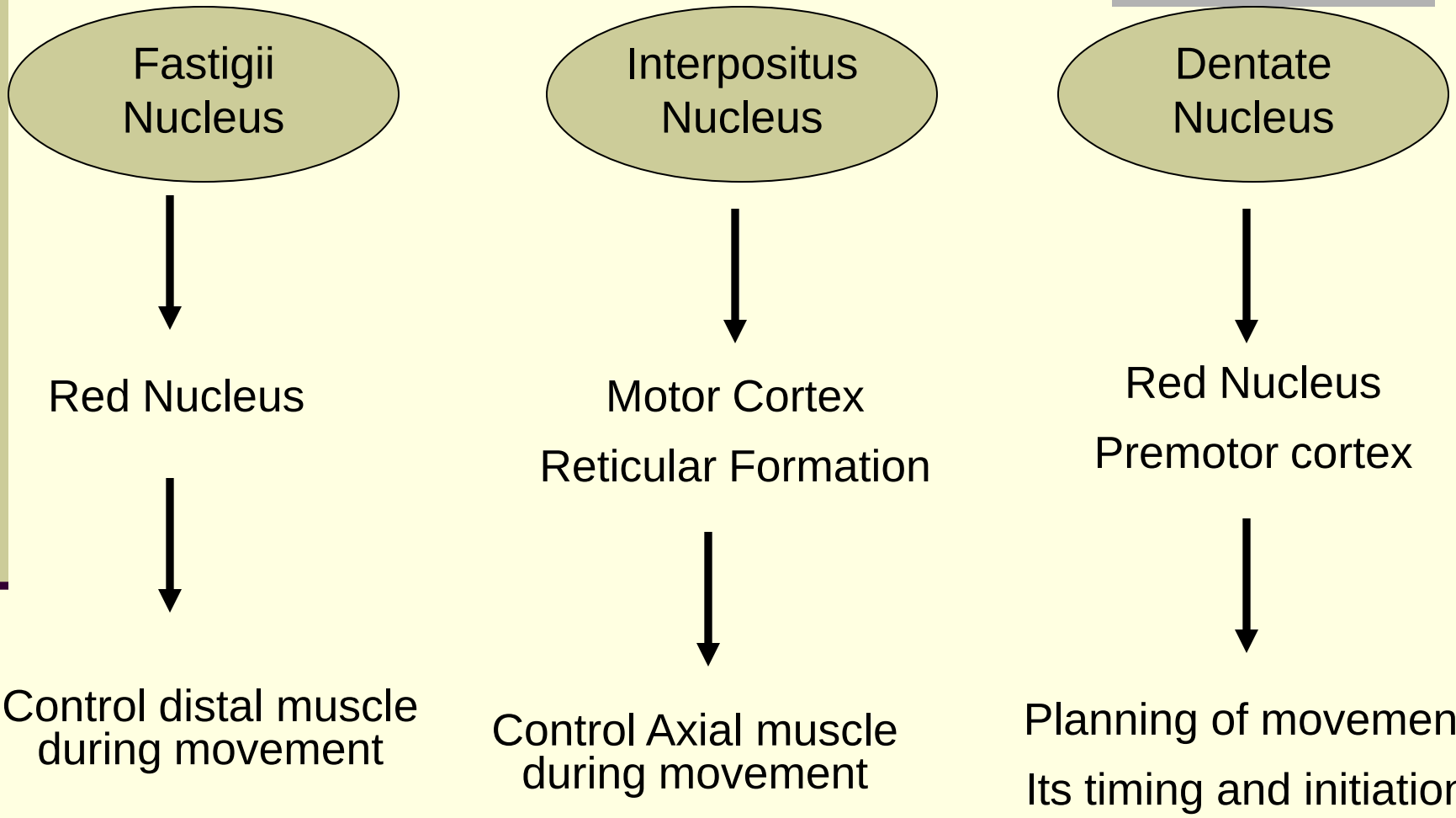


Cerebral and cerebellar control of voluntary movements, involving especially the intermediate zone of the cerebellum.

INPUTS AND OUTPUTS OF THE CEREBELLUM



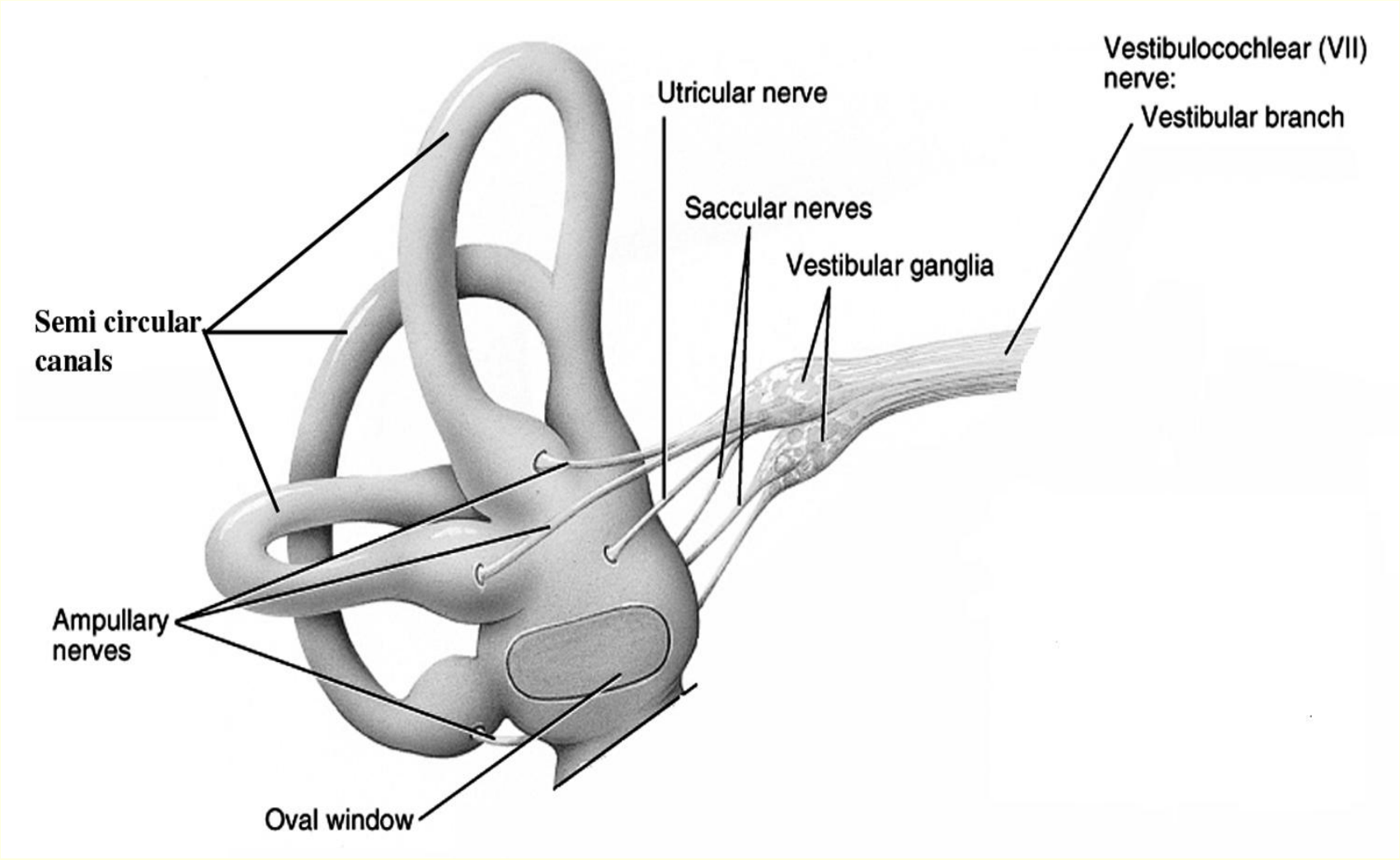
OUTPUT FROM DEEP CEREBELLAR NUCLEI



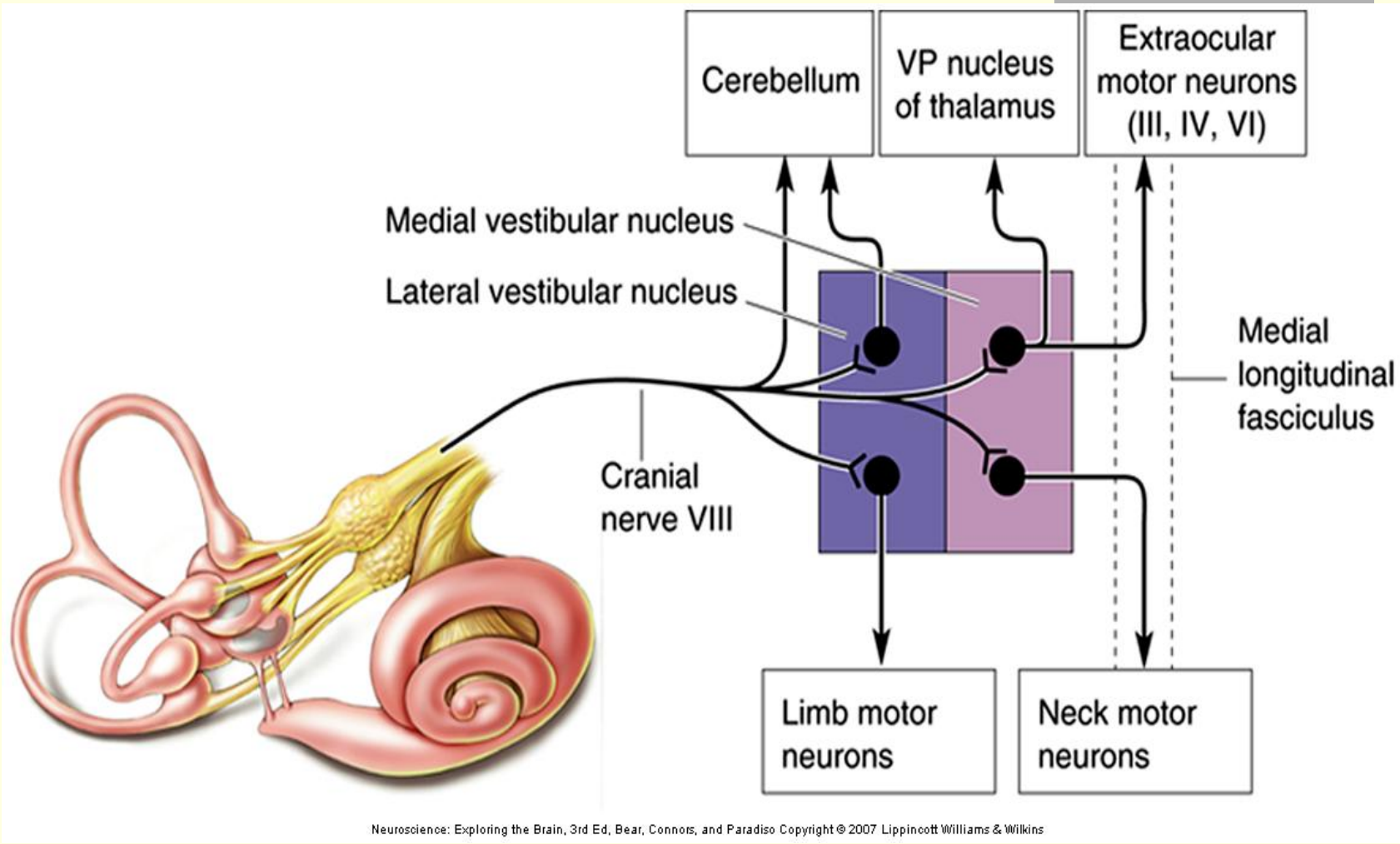
VESTIBULO COCHLEAR NERVE

- The vestibulo cochlear nerve conducts hearing (audition) and balance (vestibular).
- The receptor cells are located in the membranous labyrinth which is embedded in the petrous part of the temporal bone.
- There are two specialized organs in the bony labyrinth, the cochlea and the vestibular apparatus.
- The vestibular apparatus senses head position changes relative to gravity. Movement causes fluid vibration resulting in hair cell displacement that activates the vestibular part of the eighth nerve.

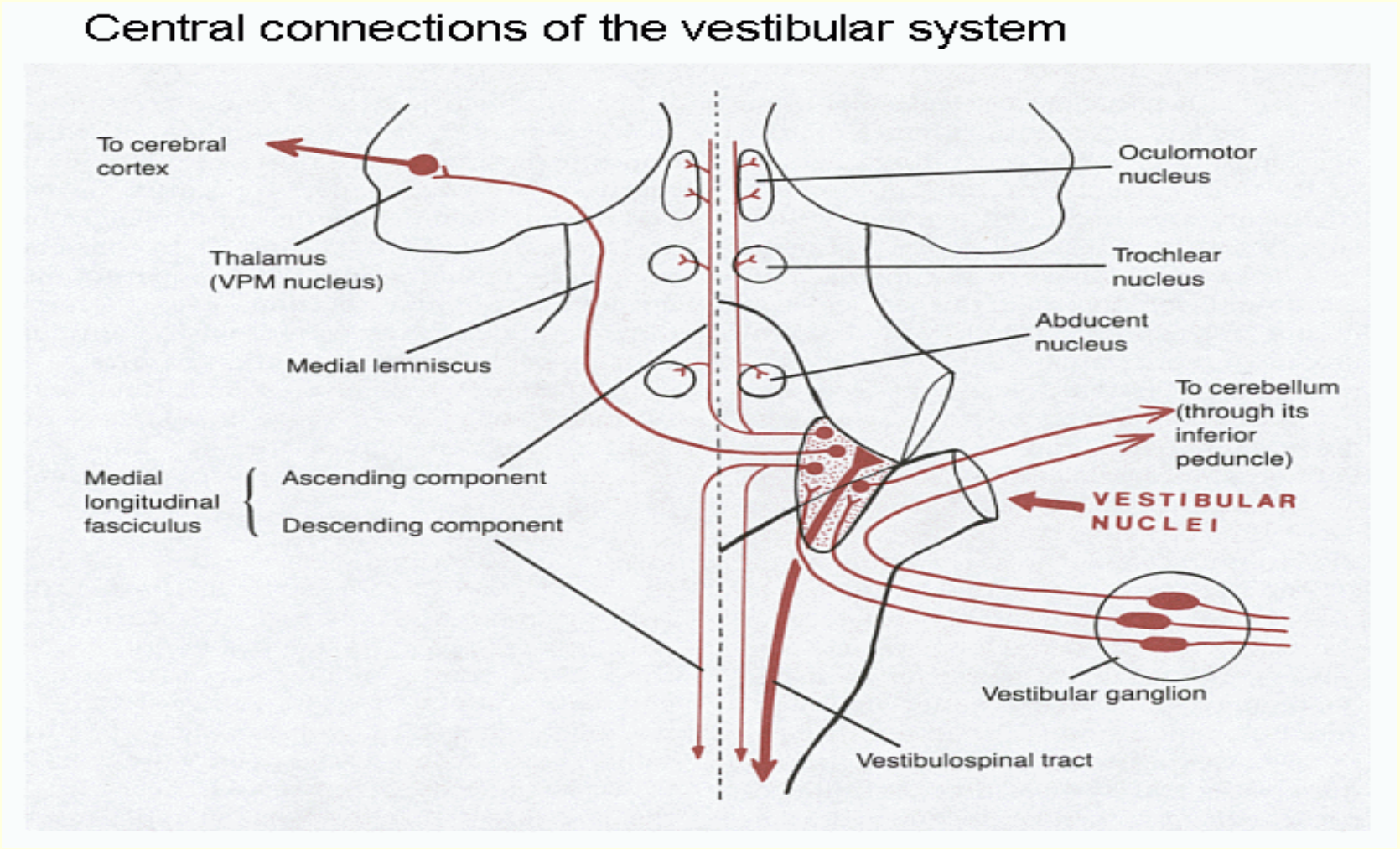
VESTIBULOCOCHLEAR NERVE



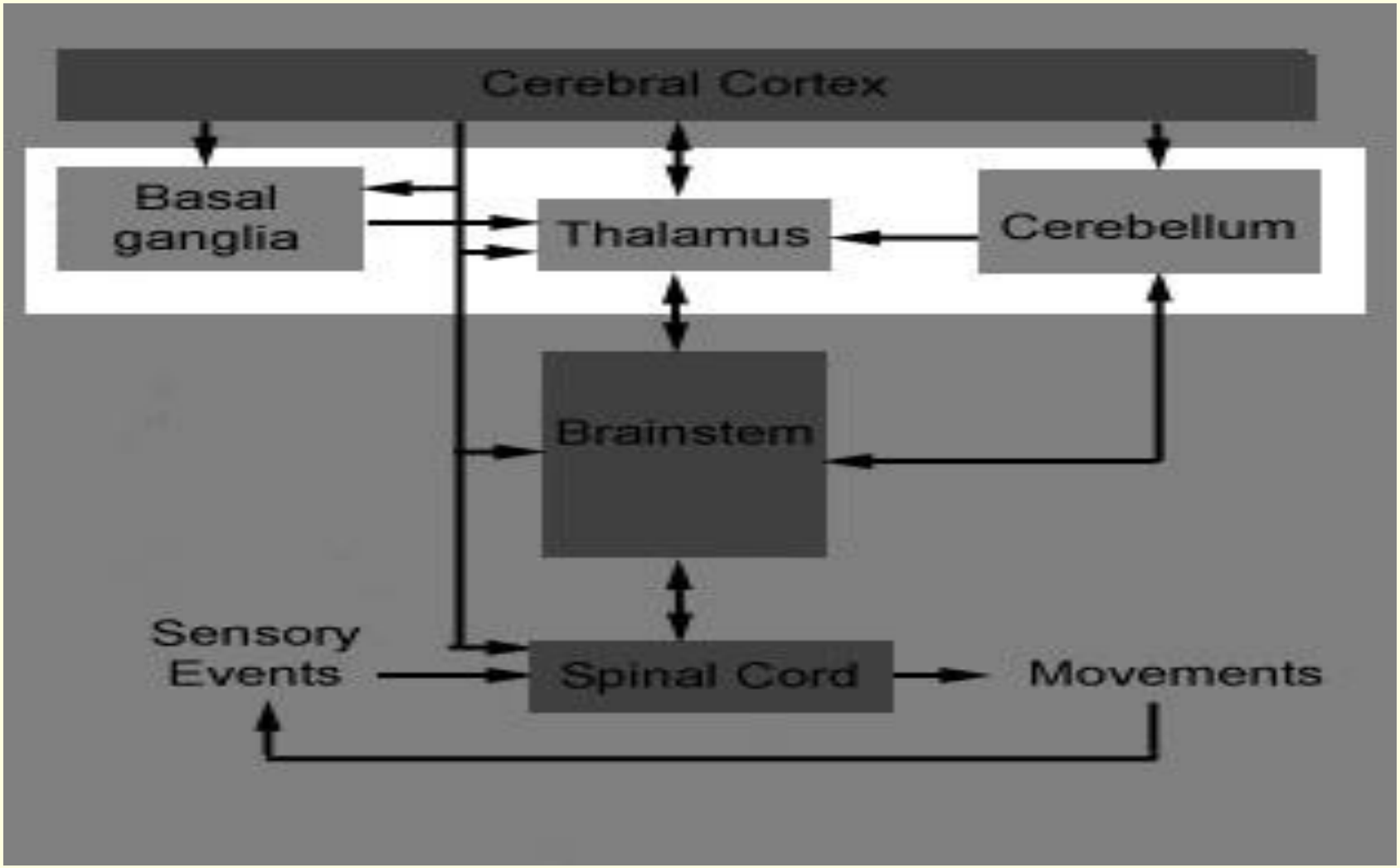
VESTIBULOCOCHLEAR NERVE



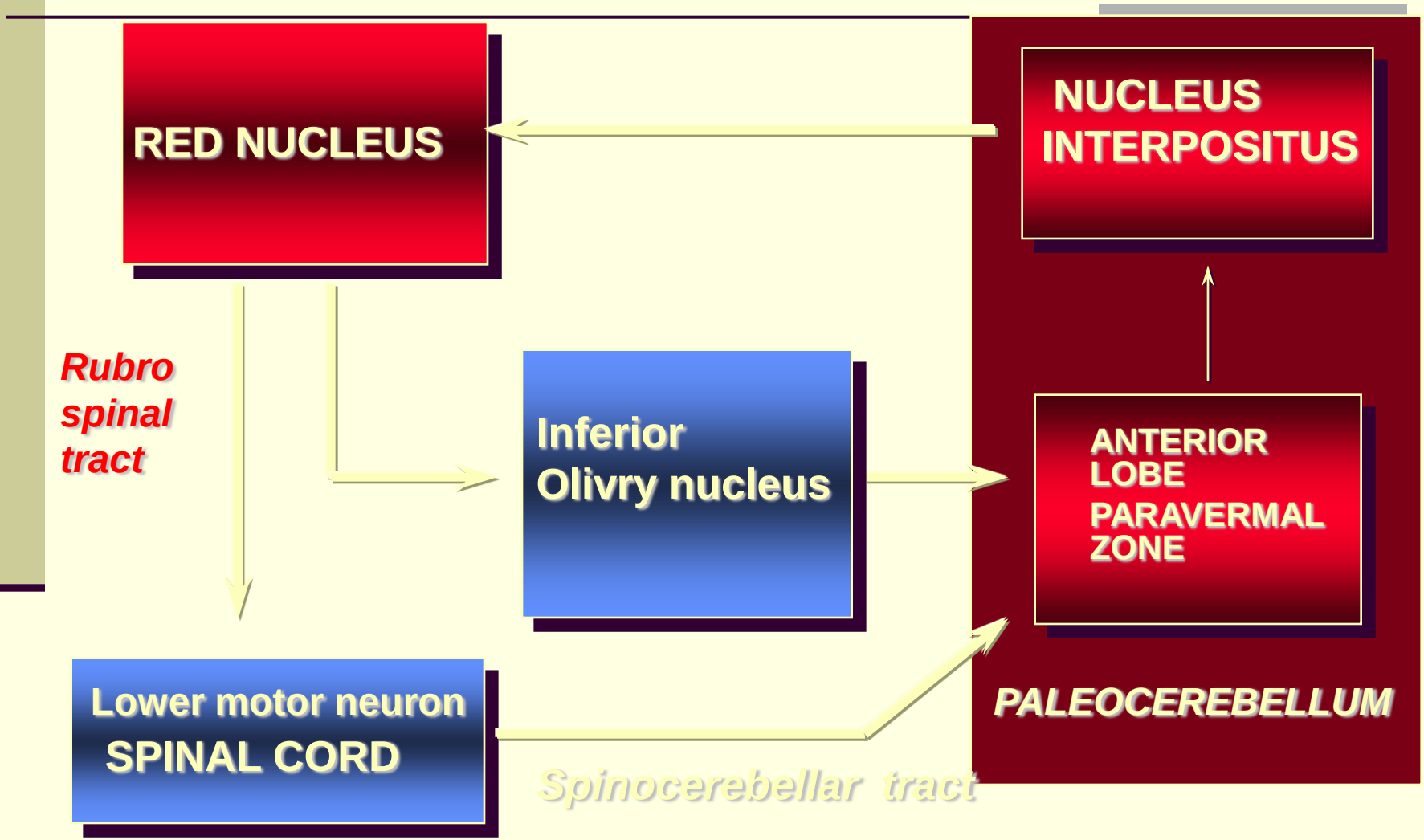
VESTIBULOCOCHLEAR NERVE



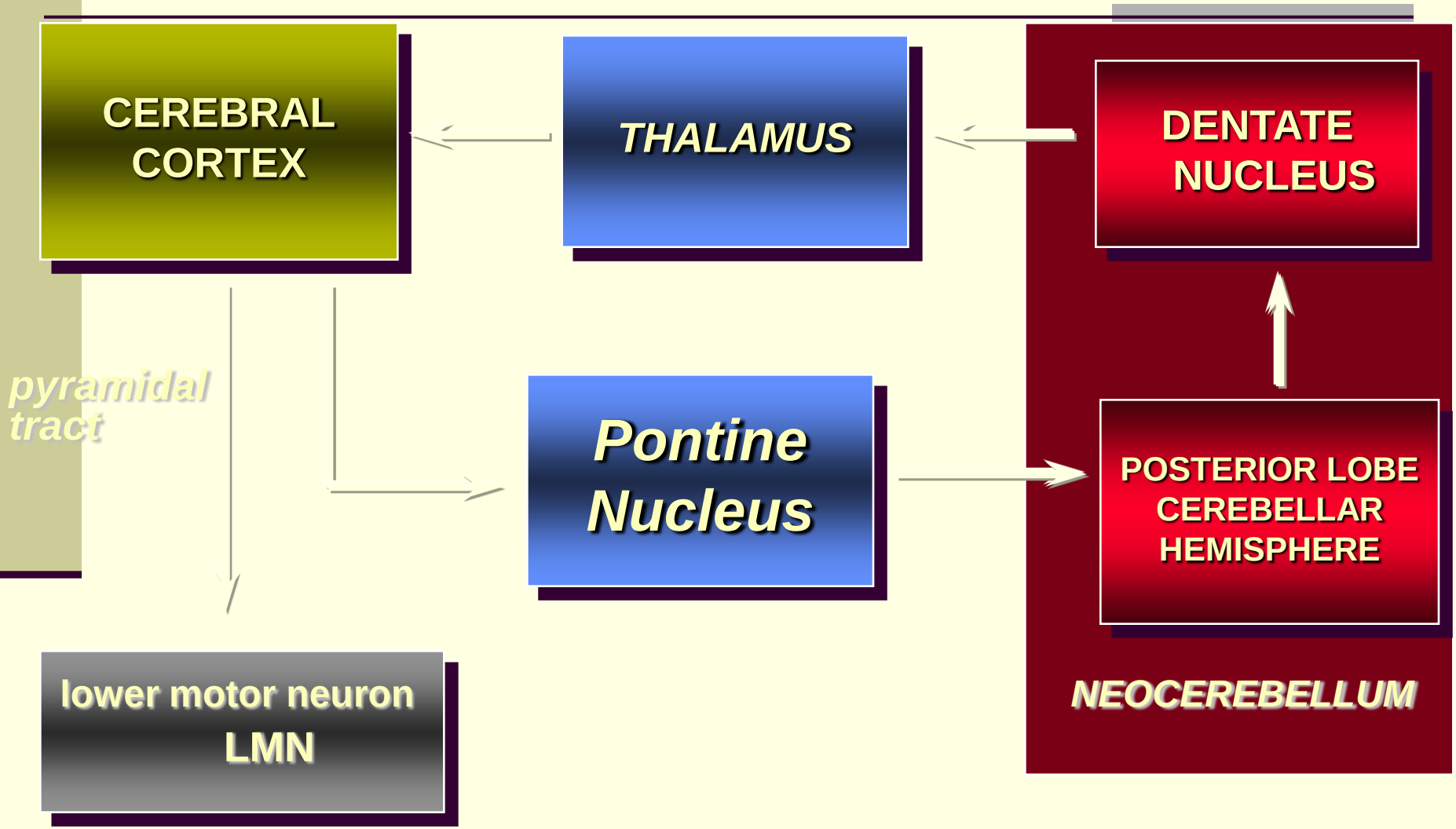
CONNECTIONS OF THE CEREBELLUM



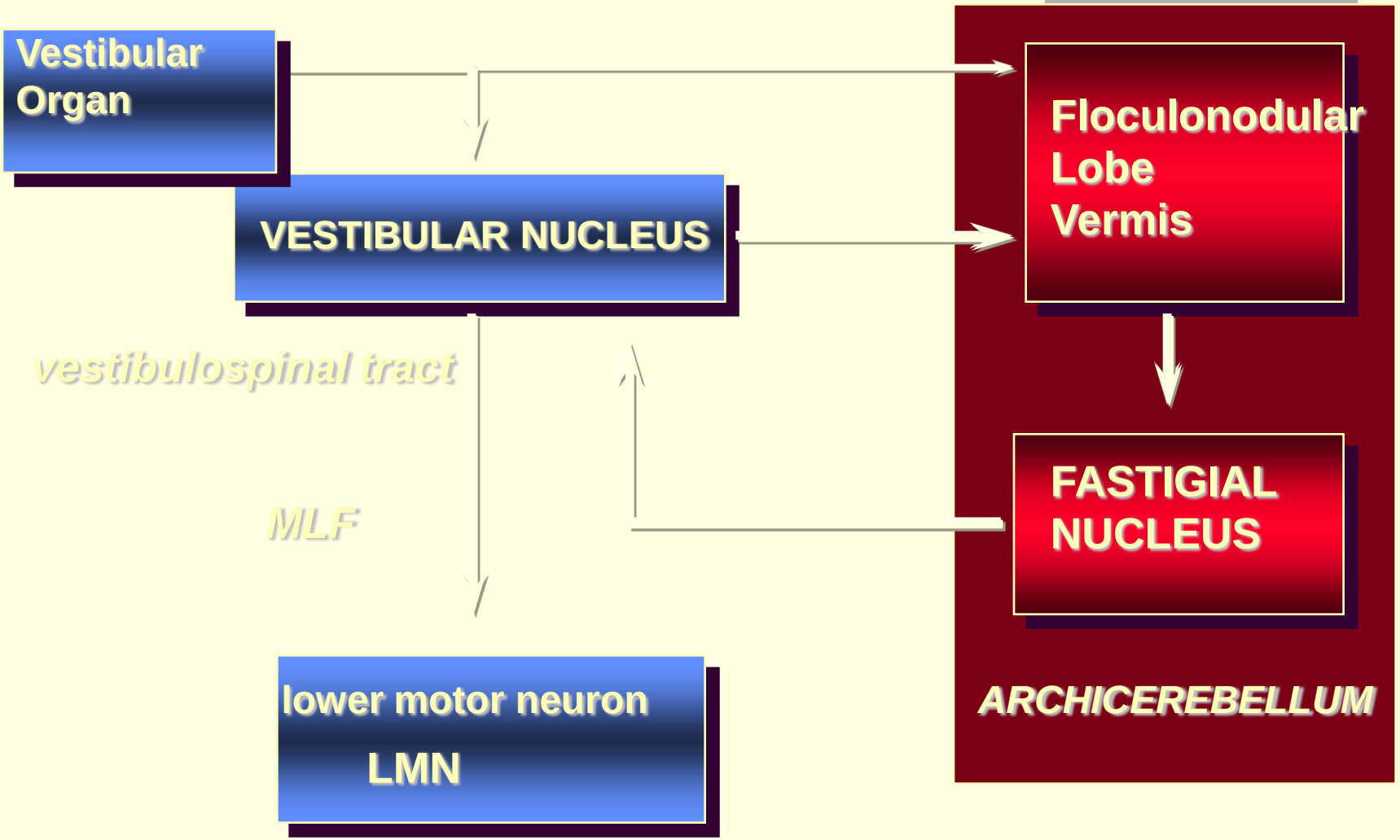
MAIN CONNECTIONS OF THE PALEOCEREBELLUM



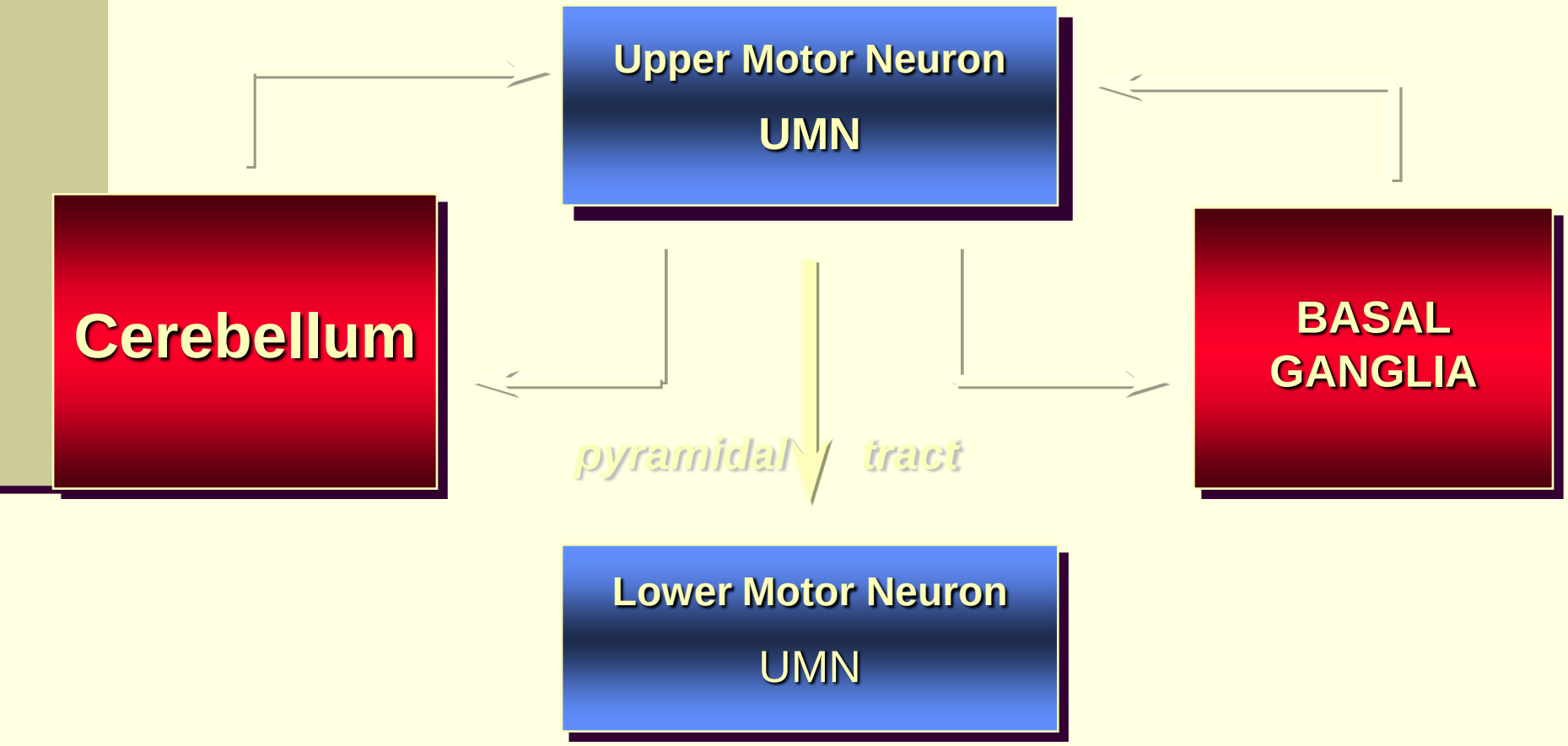
MAIN CONNECTIONS OF THE NEOCEREBELLUM



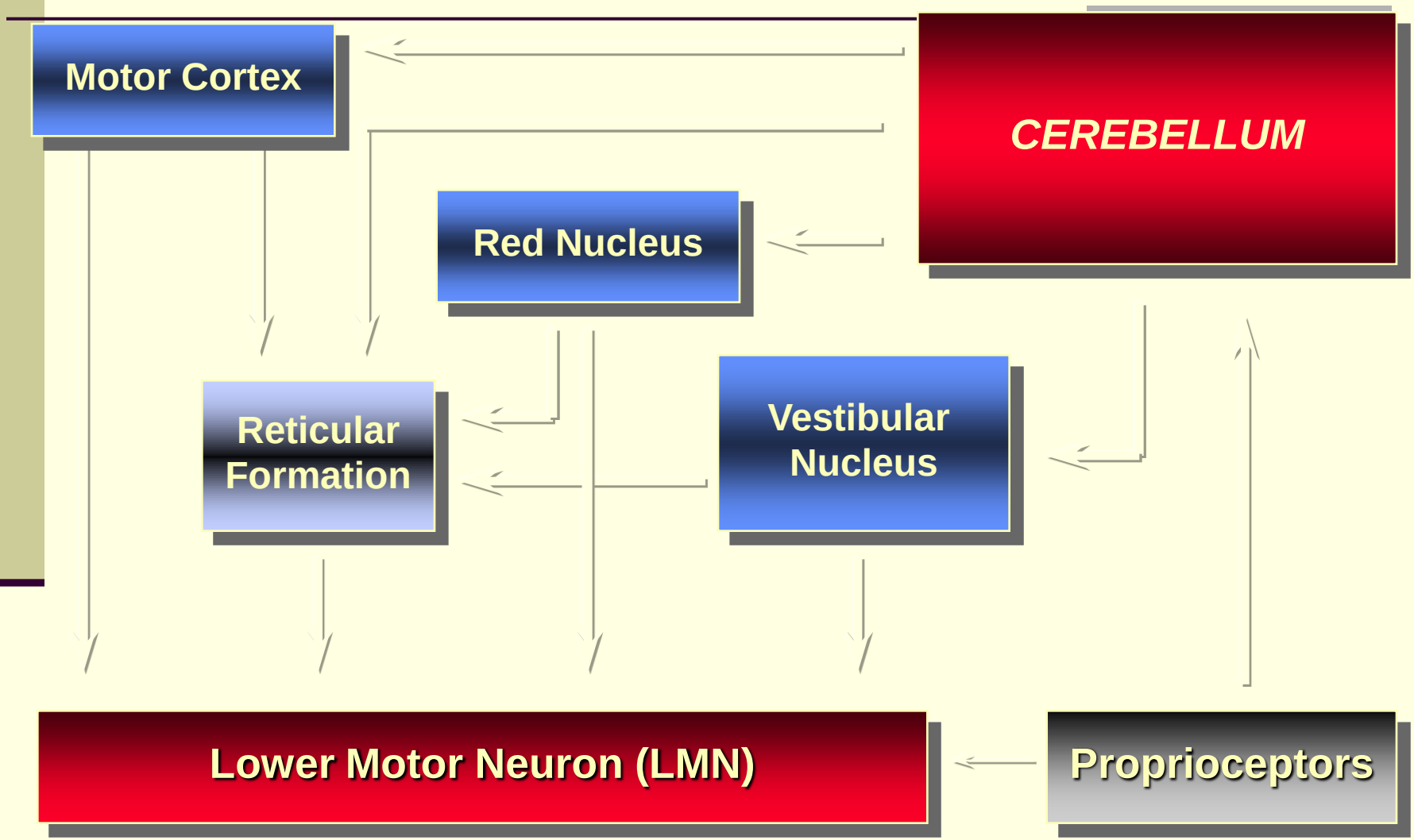
MAIN CONNECTIONS OF THE VESTBULOCEREBELLUM



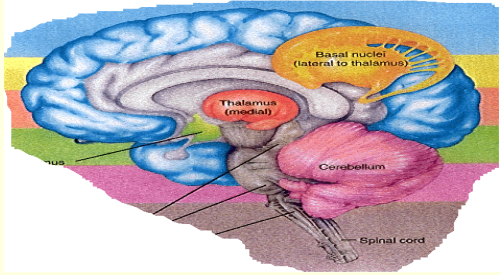
PYRAMIDAL TRACT AND ASSOCIATED CIRCUITS



CEREBELLUM AND AUTOMATIC MOTOR CONTROL

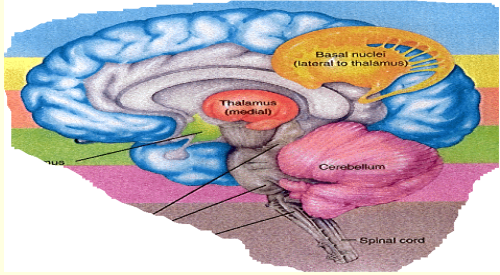


FUNCTIONS OF CEREBELLUM [ANTERIOR LOBE]



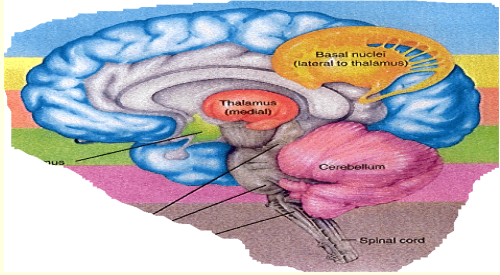
- The anterior lobe: Paleocerebellum [Spinocerebellum] : Concerned with regulation of muscle tone
- It receives inputs from muscle stretch receptors via a distinctive structure in the medulla known as the inferior olive.
- The inferior olive also receives inputs from a number of midbrain nuclei such as superior colliculus and the red nucleus
- The inferior olive sends outputs to the cerebellum through the inferior cerebellar peduncle

FUNCTIONS OF CEREBELLUM [ANTERIOR LOBE]



- It also receives a copy of the " Motor Plan" from the motor cortex, therefore by comparing plan with performance, it acts as a " comparator " and sends impulses back to the cortex to correct movement thereby it cordinates & smoothes ongoing body movements

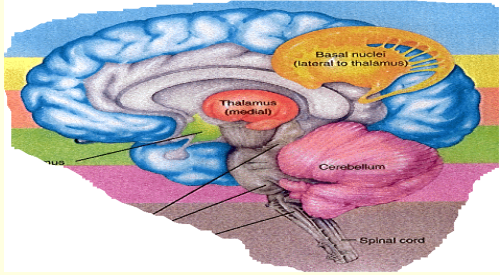
FUNCTIONS OF CEREBELLUM [POSTERIOR LOBE]



The posterior lobe / Neocerebellum [Cerebrocerebellum]: The Neo-cerebellum is the largest part of the cerebellum

- It receives inputs from the cerebral cortex via the pontine nuclei in the base of the pons
- Axons from the pontine nuclei enter the cerebellum through the middle cerebellar peduncles
- The major output tract of the cerebellum is the superior cerebellar peduncle, which primarily sends signals to the motor cortex and the supplementary motor area.

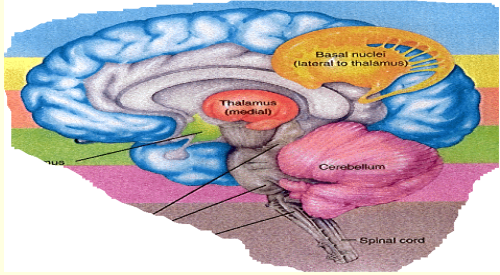
FUNCTIONS OF CEREBELLUM [POSTERIOR LOBE]



- The Neocerebellum is involved in conjunction of the cerebral cortex in planning & execution of voluntary body movements.
- It coordinate movements particularly of the distal limb muscles (hand) which are employed in skilful movement.
- The vemis projects to the brainstem & control the movement of axial and proximal limb muscle.

FUNCTIONS OF CEREBELLUM

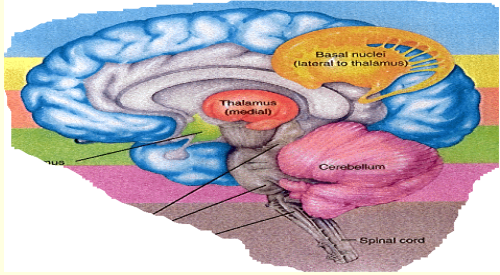
[FLOCULONODULAR LOBE]



Floculonodular lobe / Archicerebellum [Vestibulocerebellum]:

- The archicerebellum is the oldest part of the cerebellum from an evolutionary point of view
- It has connections to the vestibular nuclei and it is part of the vestibular system concerned with balance and equilibrium.

SUMMARY: FUNCTIONS OF CEREBELLUM



Cerebellum Lobe	Deep Nuclei	Cortex	Inputs	Outputs	Function
Paleocerebellum	Interposed; Fastigial	Vermis & Medial portions of Cerebellar hemispheres	Spinal and brainstem paths	SCP to Red Nucleus; Fastigial to RF	Muscle tone, posture & coordination of movements
Neo-cerebellum	Dentate	Lateral portions of Cerebellar Hemisphere	Corticopontine/ pontocerebellar	SCP	Planning and executive of voluntary & skilledhand movements
Archi cerebellum	Fastigial	Flocculonodular	Vestibular nuclei	Vestibular nuclei; RF	Balance, equilibrium & VOR

CLINICAL FEATURES / TESTS RELATED TO CEREBELLUM

Ataxia	Reeling, wide-based gait
Decomposition of movement	Inability to correctly sequence fine, coordinated acts
Dysarthria	Inability to articulate words correctly, with slurring and inappropriate phrasing
Dysdiadochokinesia	Inability to perform rapid alternating movements
Dysmetria	Inability to control range of movement
Hypotonia	Decreased muscle tone
Nystagmus	Involuntary, rapid oscillation of the eyeballs in a horizontal, vertical, or rotary direction, with the fast component maximal toward the side of the cerebellar lesion
Scanning speech	Slow enunciation with a tendency to hesitate at the beginning of a word or syllable
Tremor	Rhythmic, alternating, oscillatory movement of a limb as it approaches a target (intention tremor) or of proximal musculature when fixed posture or weight bearing is attempted (postural tremor)

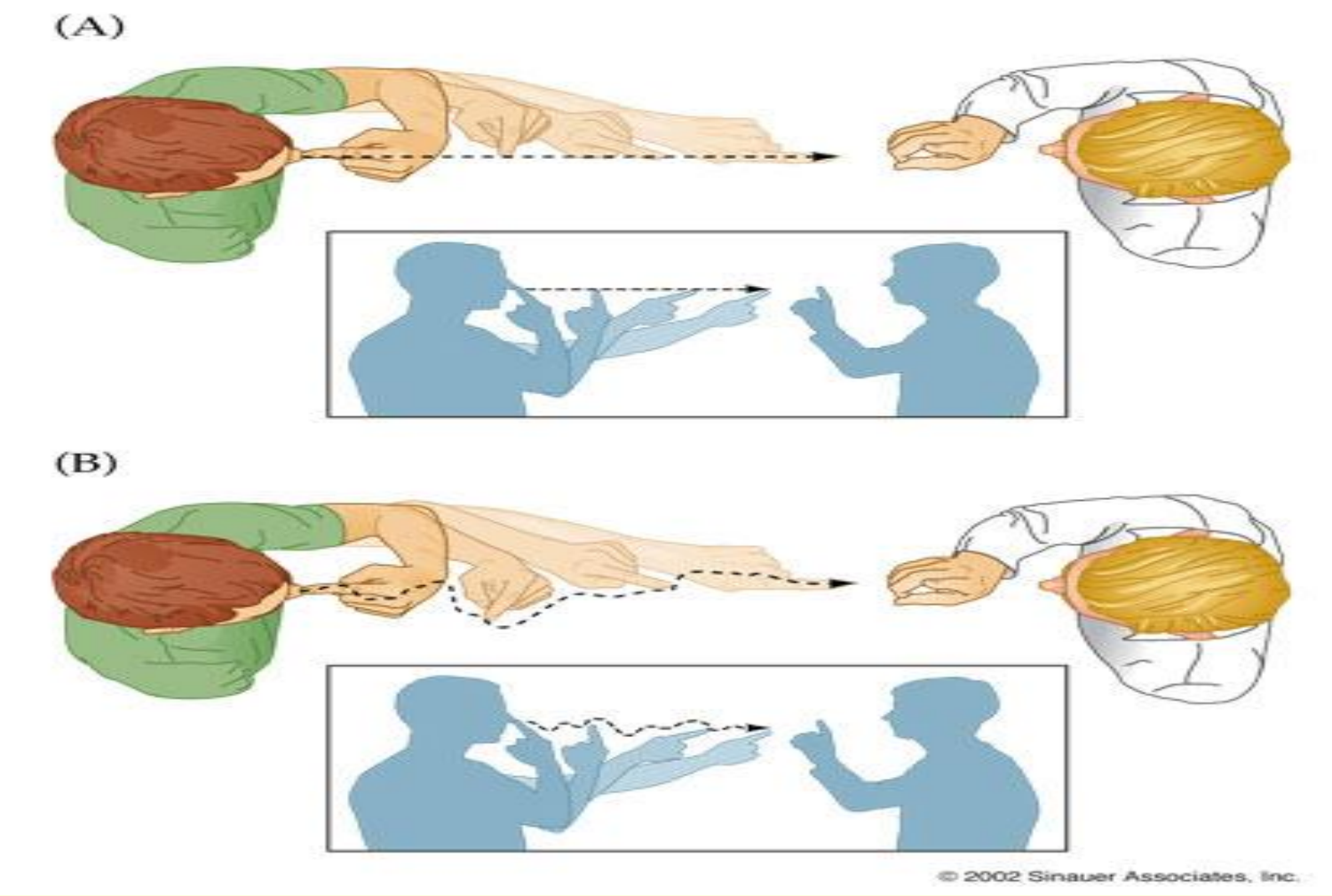
FINGER NOSE TEST

While the examiner holds his finger at arm's length from the patient. Patient touches her nose and then touches the examiner's finger. After several sequences, the patient is asked to repeat the exercise with her closed eyes.

A patient with a cerebellar disorder tends to miss the target.

FINGER NOSE TEST

FINGER NOSE TEST



DYSDIADOCHOKINESIS: RAPIDLY ALTERNATING MOVEMENTS

Dysdiadochokinesis: Inability to perform rapidly alternating movements. Is called dysdiadochokinesia. It is usually caused by multiple sclerosis in adults and cerebellar tumors in children. Patients with other movement disorders (e.g. Parkinson's disease) may have abnormal rapid alternating movement testing secondary to akinesia or rigidity, thus creating a false impression of dysdiadochokinesia.

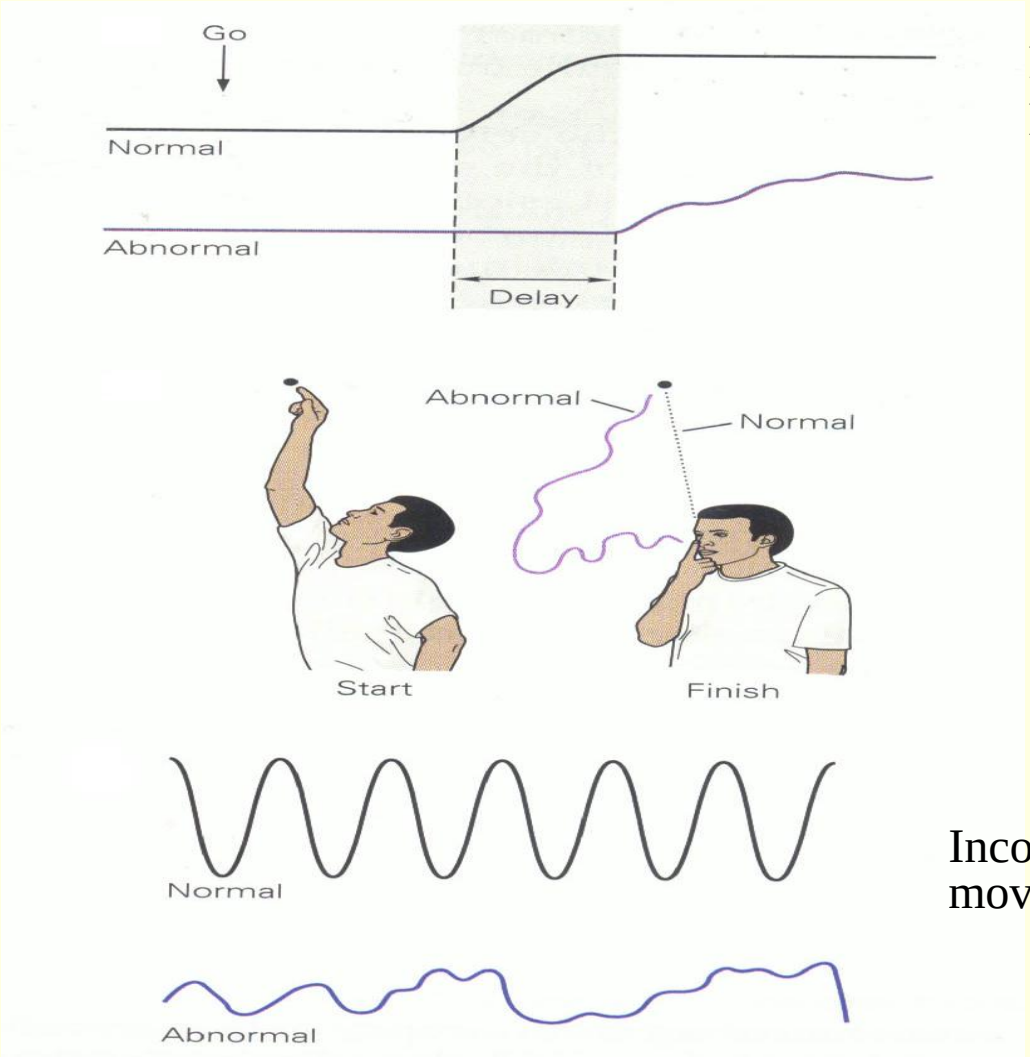
DYSDIADOCHOKINESIS: RAPIDLY ALTERNATING MOVEMENTS

HEEL TO SHIN TEST

The heel to shin test is a measure of coordination and may be abnormal if there is loss of motor strength, proprioception or a cerebellar lesion.

If motor and sensory systems are intact, an abnormal, asymmetric heel to shin test is highly suggestive of an ipsilateral cerebellar lesion.

CEREBELLAR SIGNS



Response delays
Hypometria &

Ataxia

Incoordination/ rapid alternating movements (disdiadocho kinesia)

THANK YOU