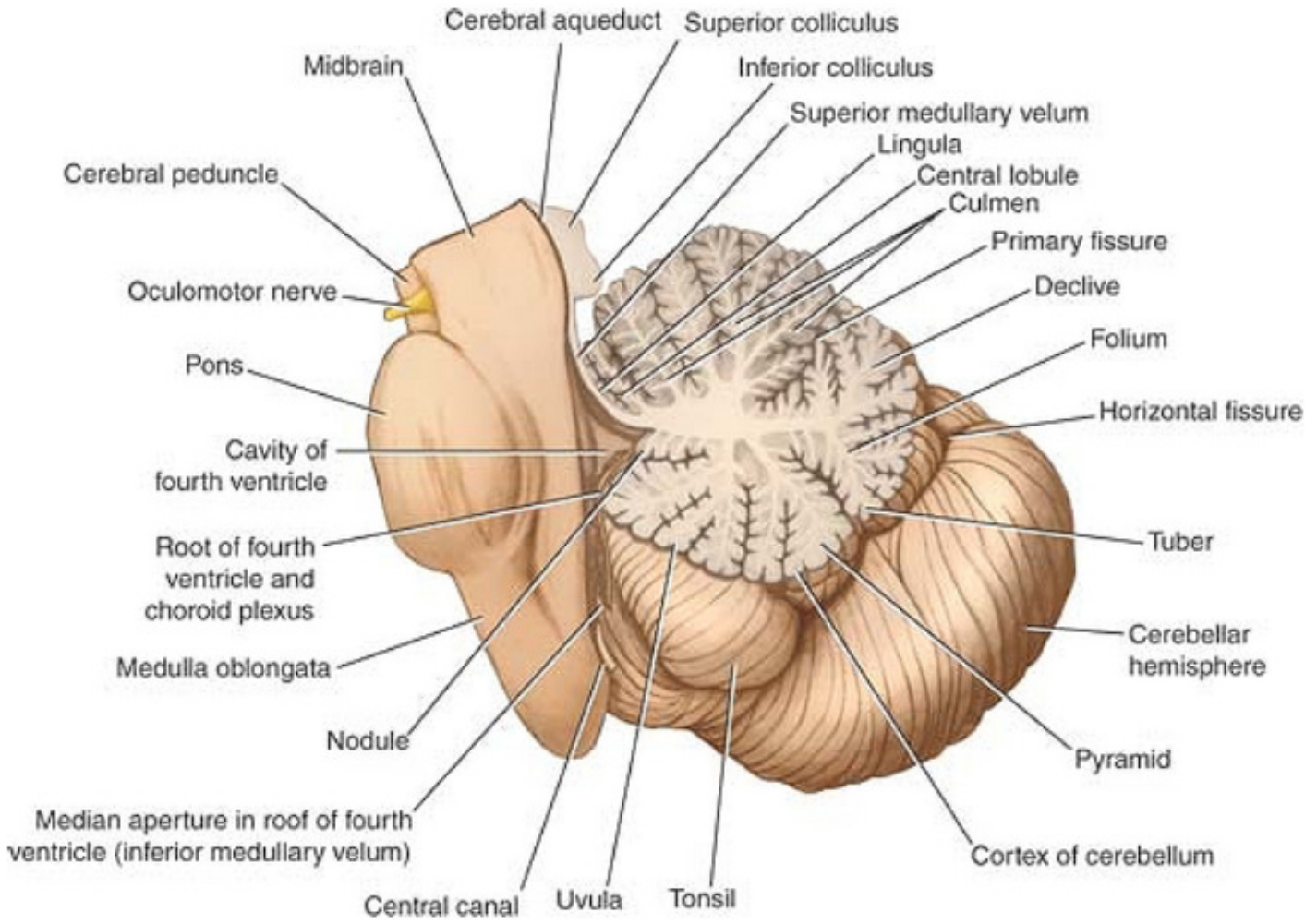
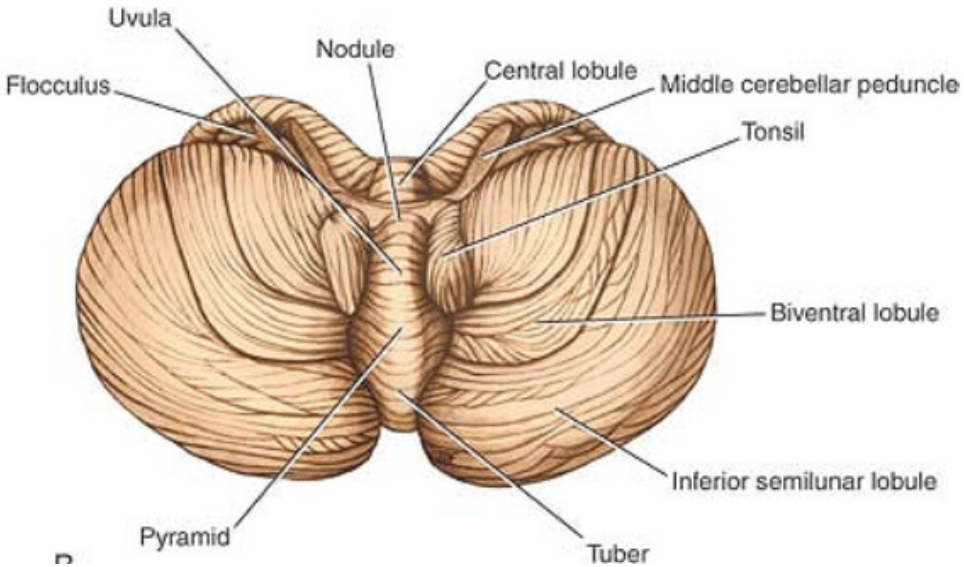
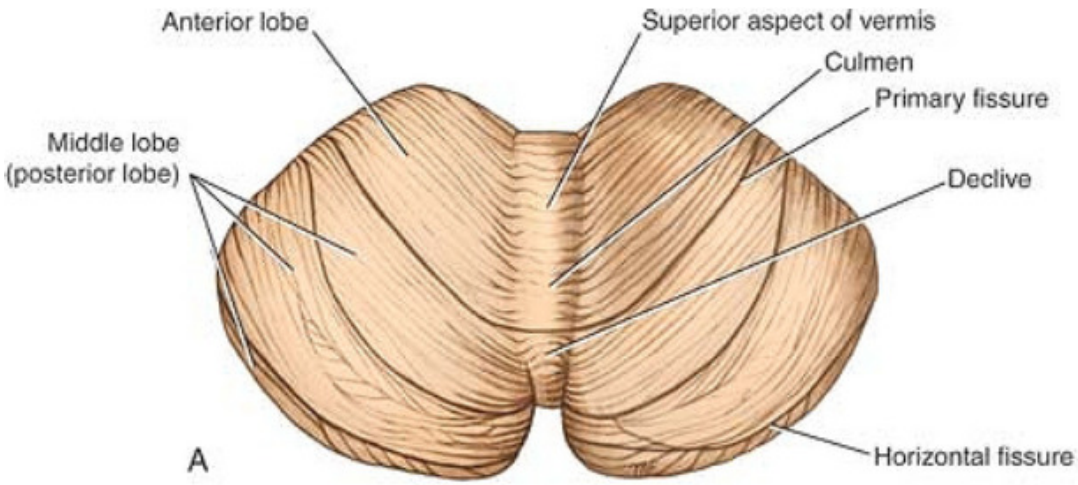
Cerebellum

- Located below tentorium cerebelli within posterior cranial fossa.
- Formed of 2 hemispheres connected by the vermis in midline.
- Gray matter is external.
- White matter is internal, contain several deep nuclei with the largest is the dentate nucleus.

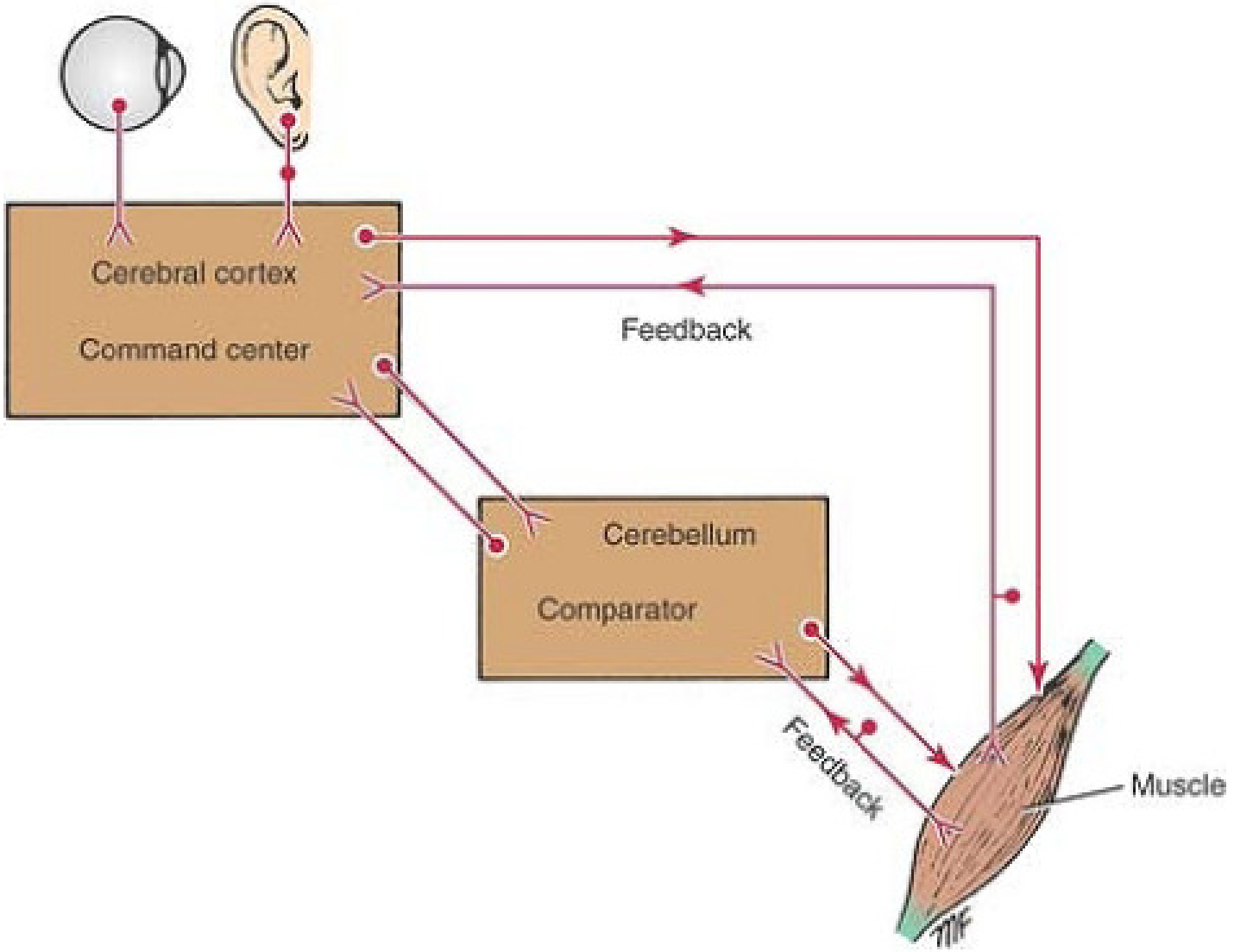






Functions of Cerebellum

- Maintenance of posture and balance.
- Maintains muscle tone.
- Coordinates voluntary motor action.



Cerebellum

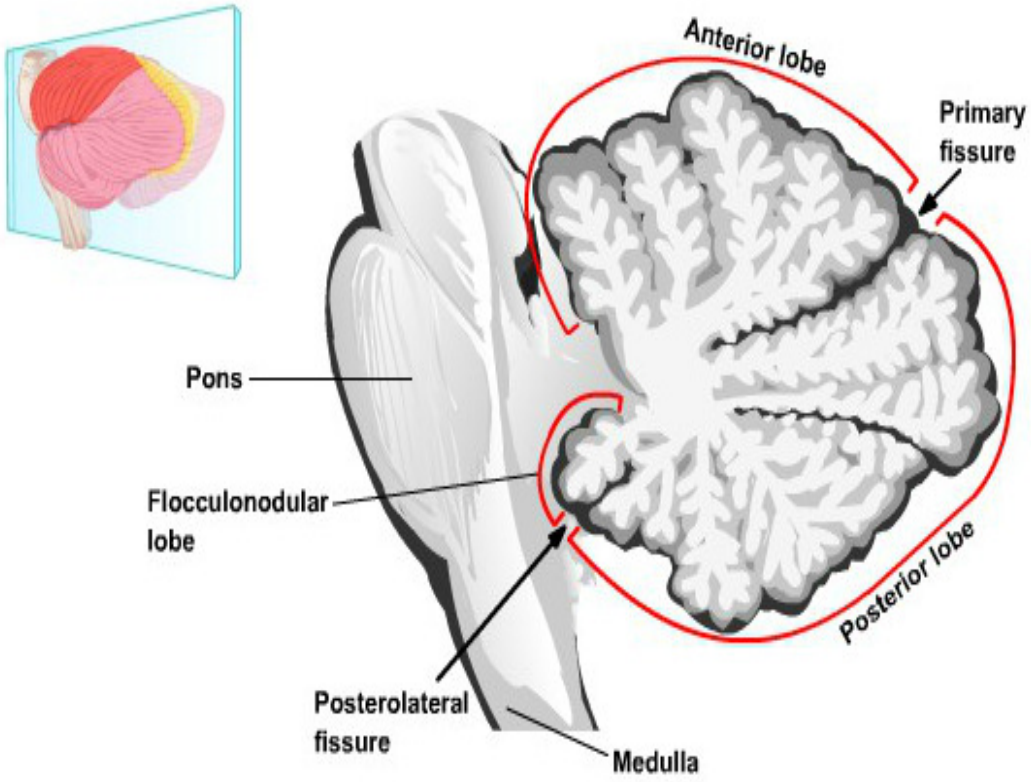
Three lobes

1. **Anterior lobe**
2. **Posterior lobe**
3. **flocculonodular lobe**

Two main fissures:

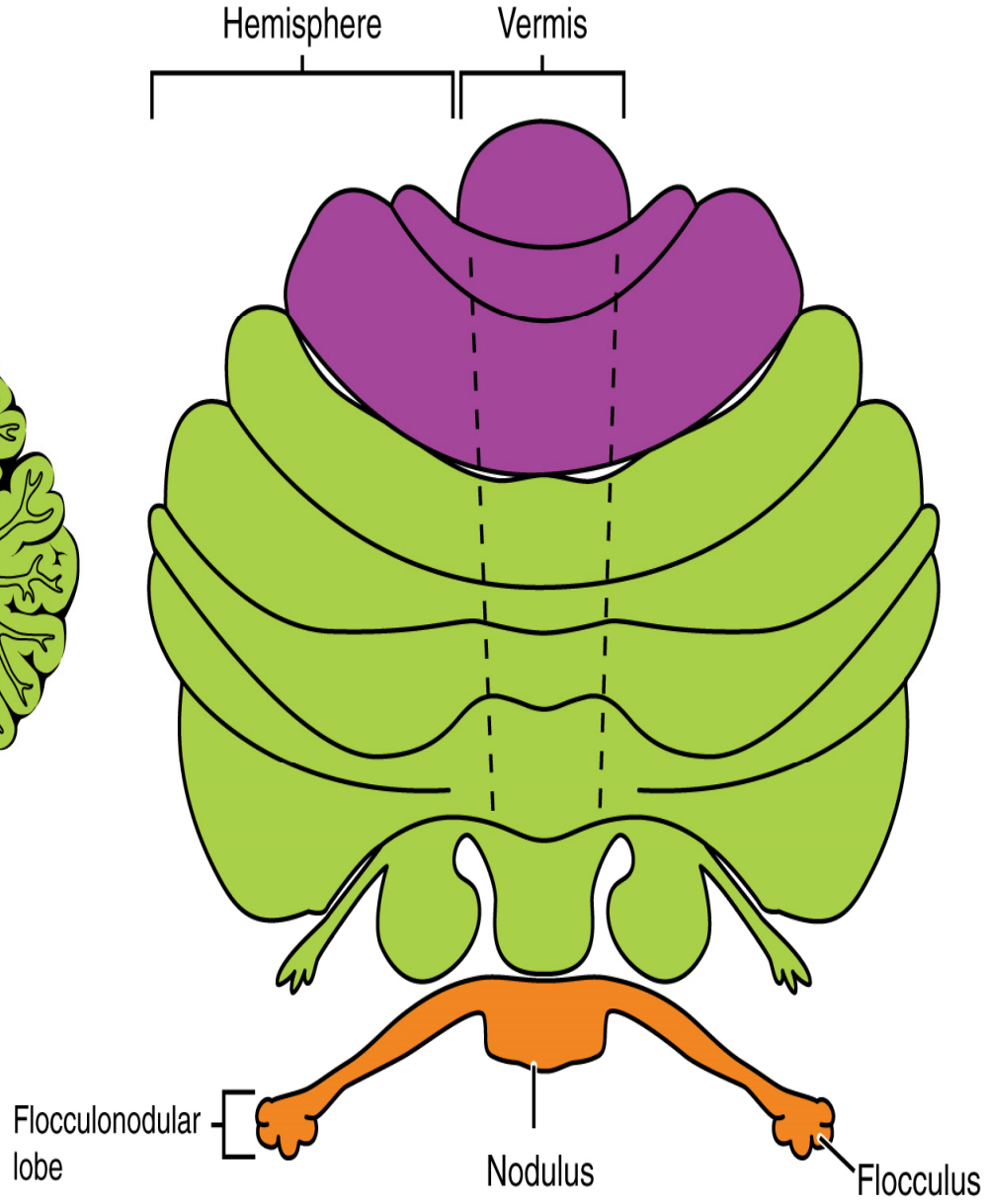
➢ **The primary fissure** separates the **posterior lobe** from the **anterior lobe**

➢The **posterolateral fissure (uvulonodular fissures)** separates the **flocculonodular lobe** from the **posterior lobe**



Midsaggital section of cerebellum

Superior view of an “unrolled” cerebellum

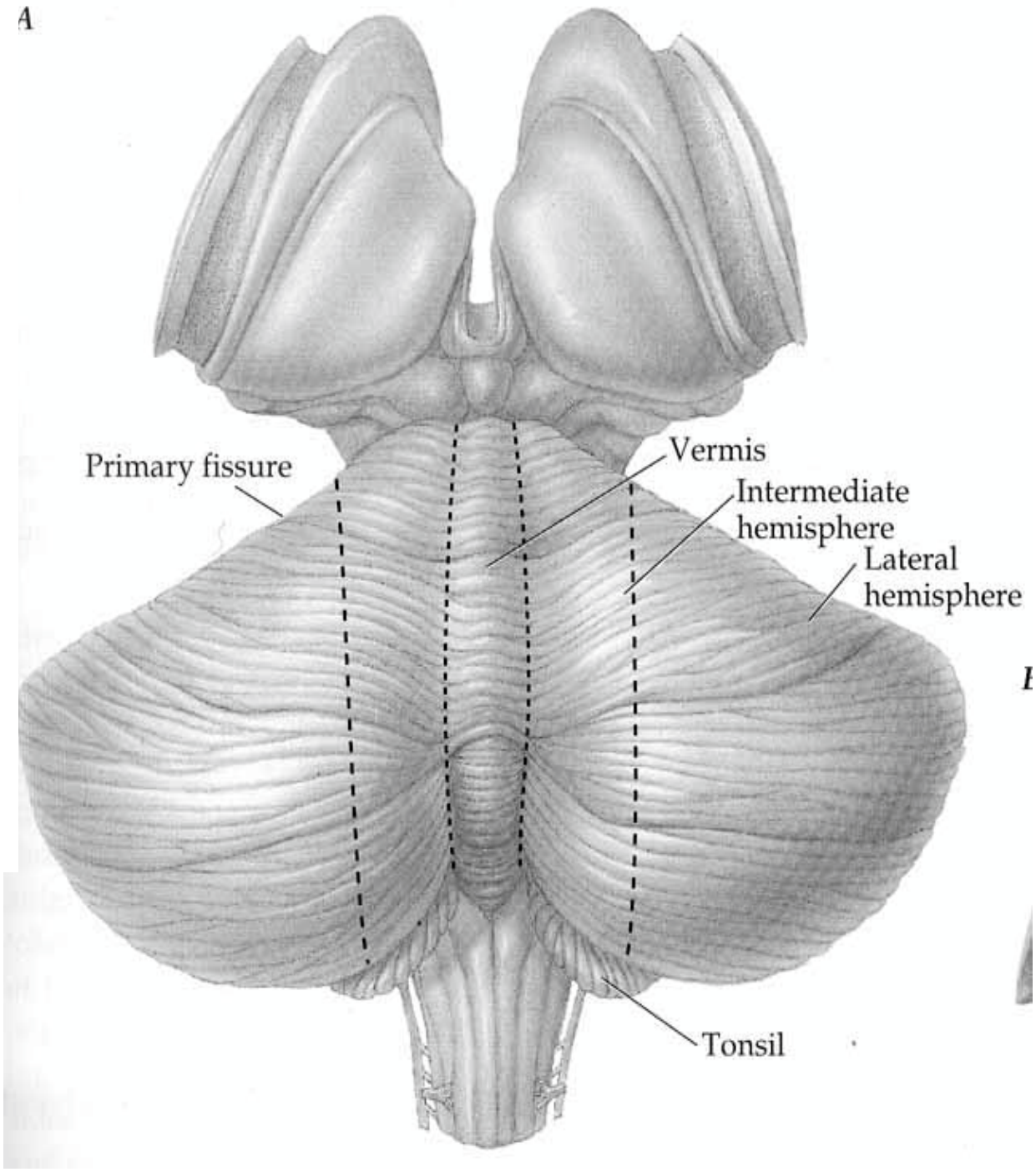


Cortex = organized into groups of folia = 10 lobules and 3 lobes,

Major anatomical divisions (reflecting functional regions

1. **vermis**
2. **intermediate zone**
3. **lateral hemispheres**

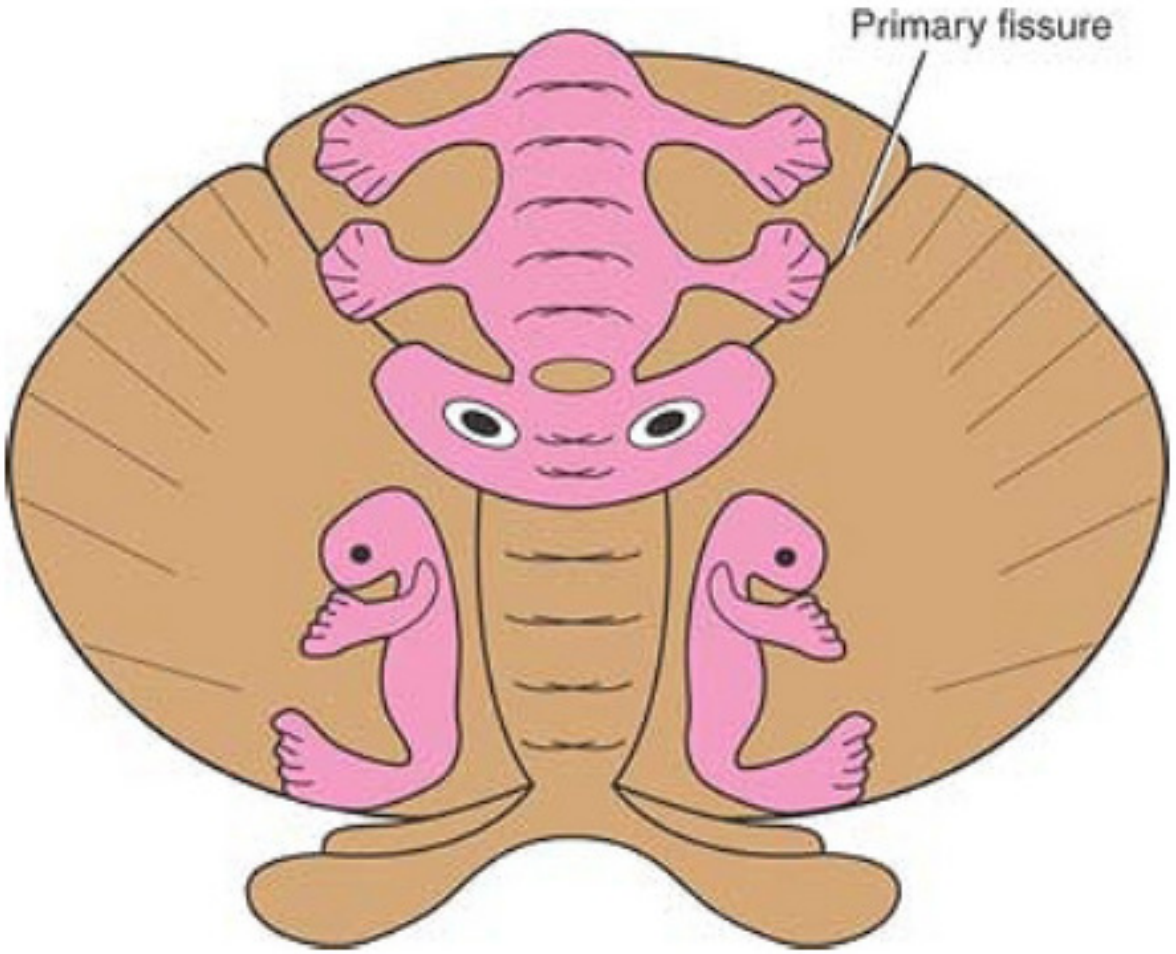
➢no clear morphological borders between the intermediate zone and the lateral hemisphere that are visible from a gross specimen.



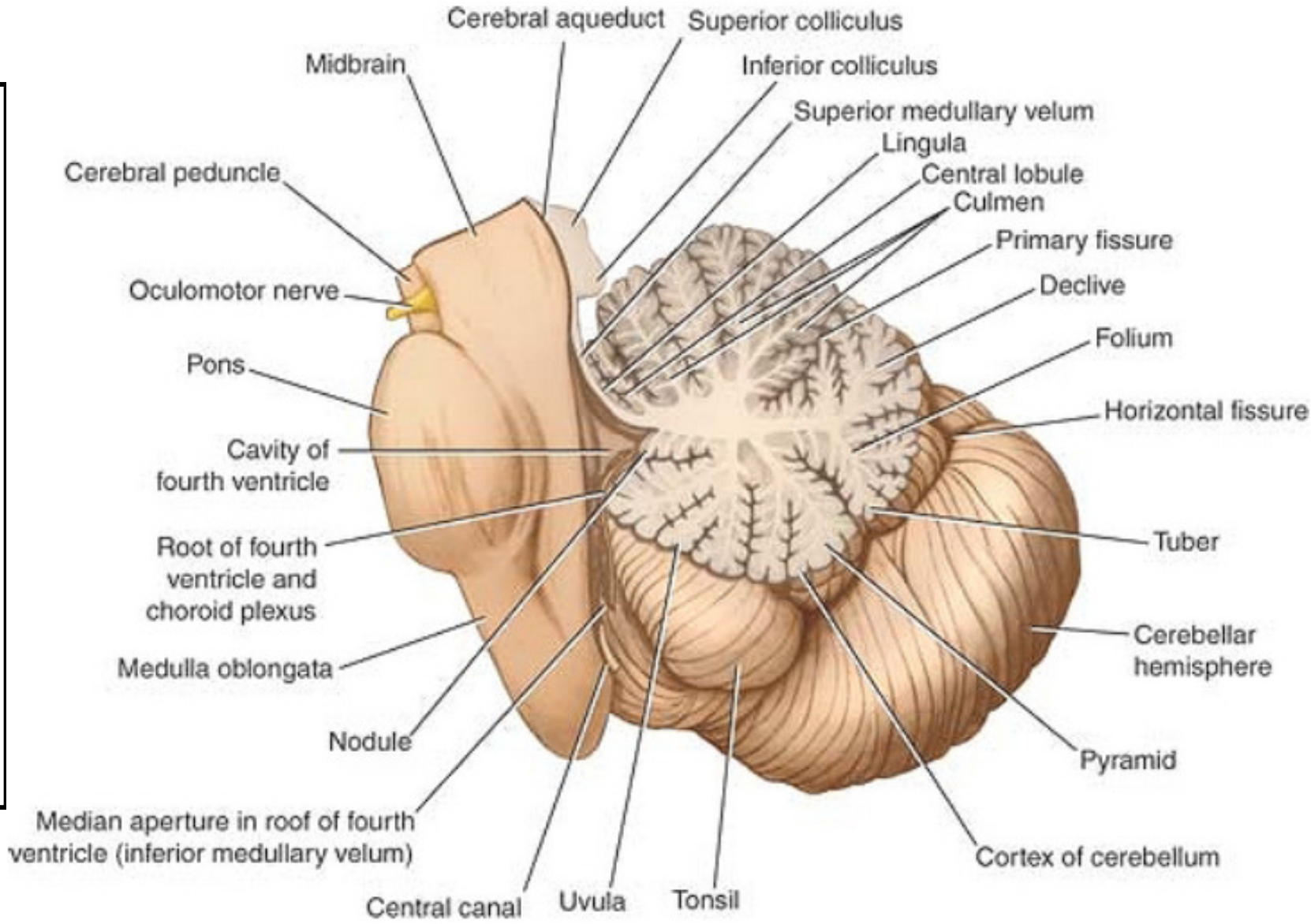
Vermis : influences the movements of the long axis of the body
(neck, shoulders, thorax, abdomen and hips)

Intermediate zone: control muscles of the distal parts of the limbs
(hand and feet)

Lateral zone: concerned with planning of sequential movements of the entire body

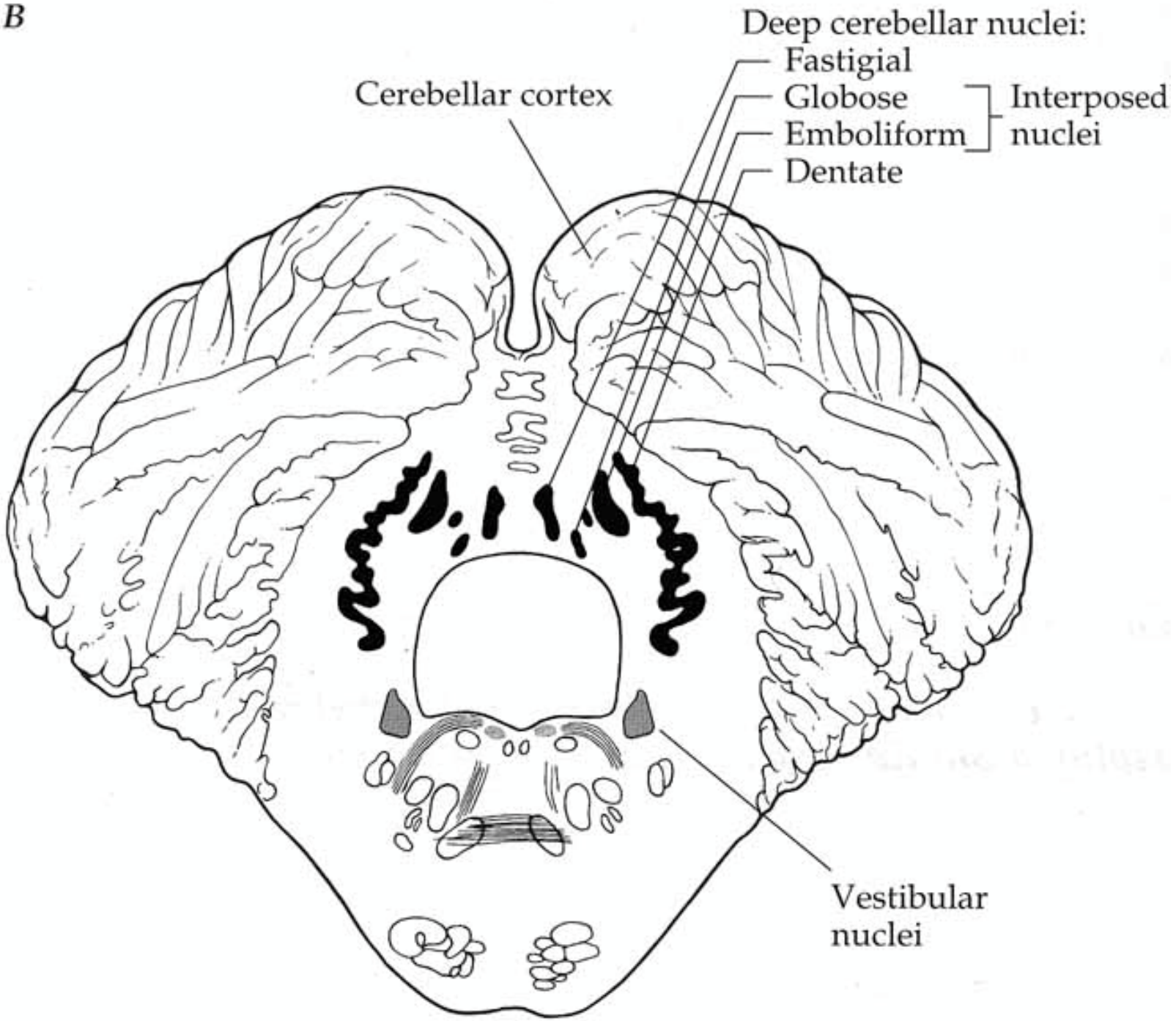


The cerebellum is composed of an outer covering of gray matter called the **cortex** and inner white matter Embedded in the white matter of each hemisphere three
masses of gray matter forming the **intracerebellar nuclei**



Each ridge or gyrus in cerebellar cortex is called a **folium,** with a branched appearance called the **arbor vitae** (white matter)

Deep cerebellar Nuclei



Structure of cerebellar cortex

1- molecular layer

- stellate cell

-basket cell

-consisting of axons of granule cells (parallel fibers) and dendrites of Purkinje cells

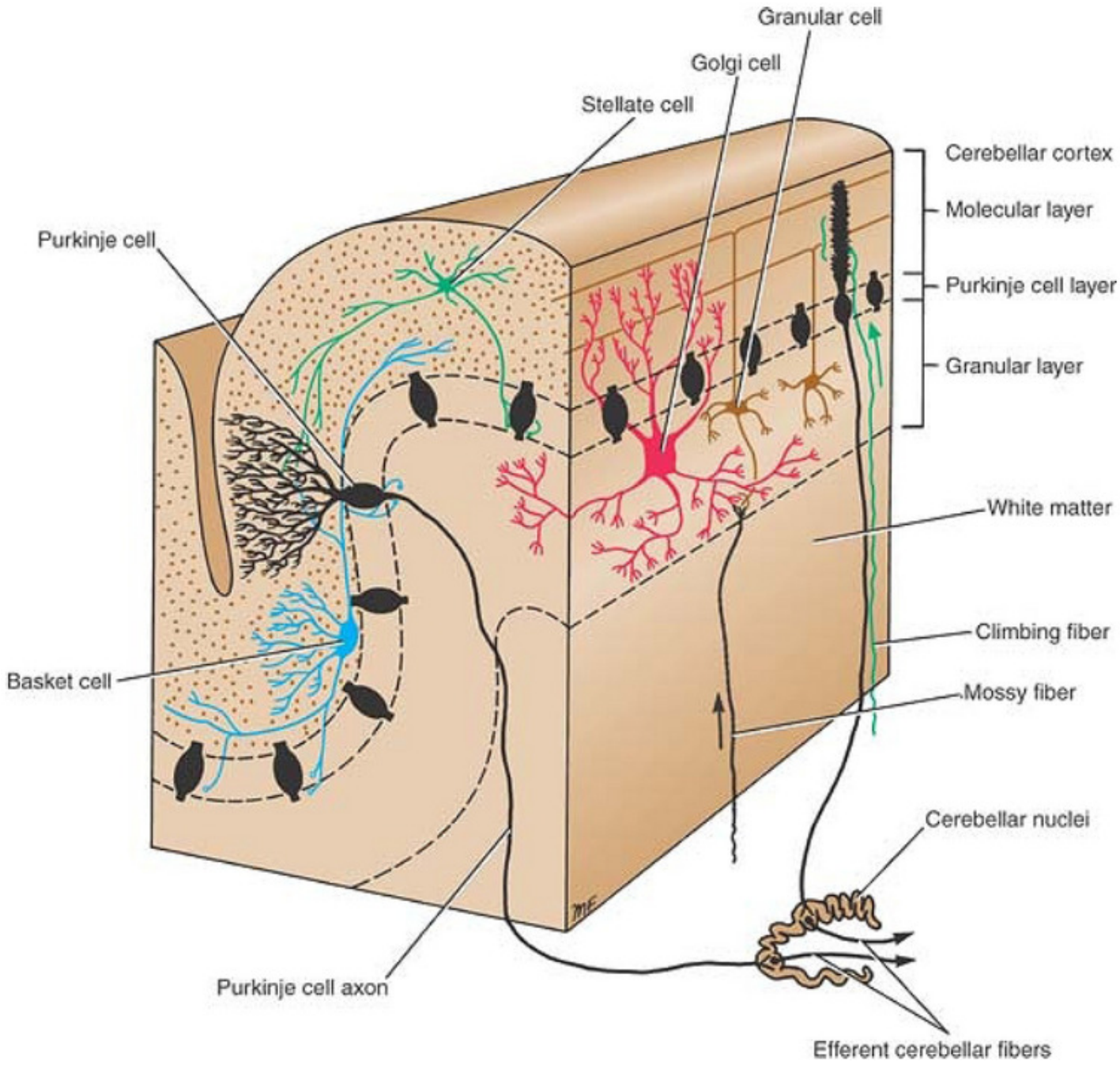
2- Purkinje cell layer

large neuronal cell bodies (Purkinje cells) Flask shaped cells

3- granular layer

-small neurons called granular cells

- Golgi cells: (Inhibitory)



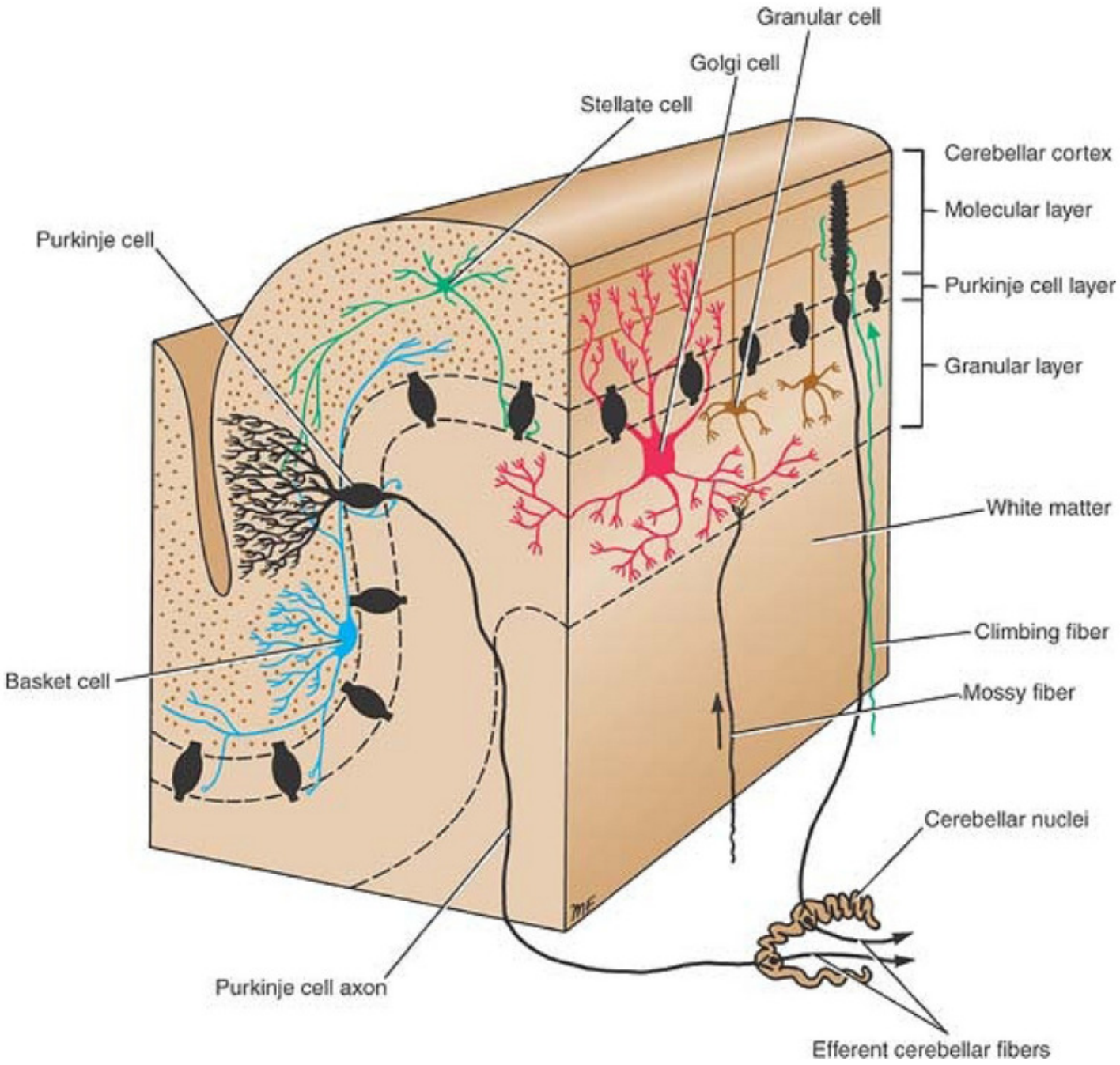
Cerebellar cortical mechanisms

Input to the cerebellar cortex:

1- Climbing fibers: terminal fibers of the olivocerebellar tracts

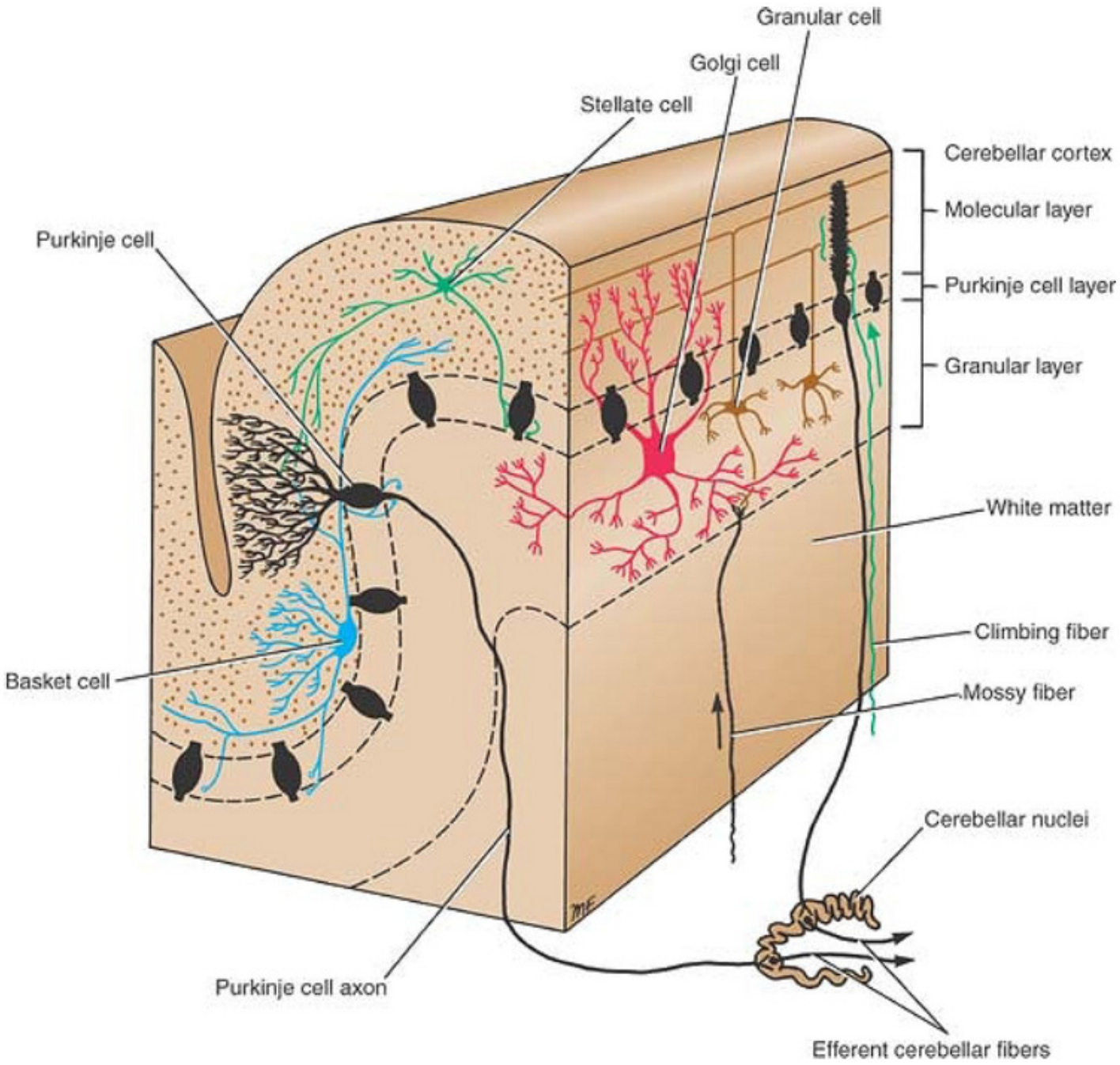
2- Mossy fibers: terminal fibers of all other cerebellar afferent tracts

Both are **excitatory** to purkinje cells



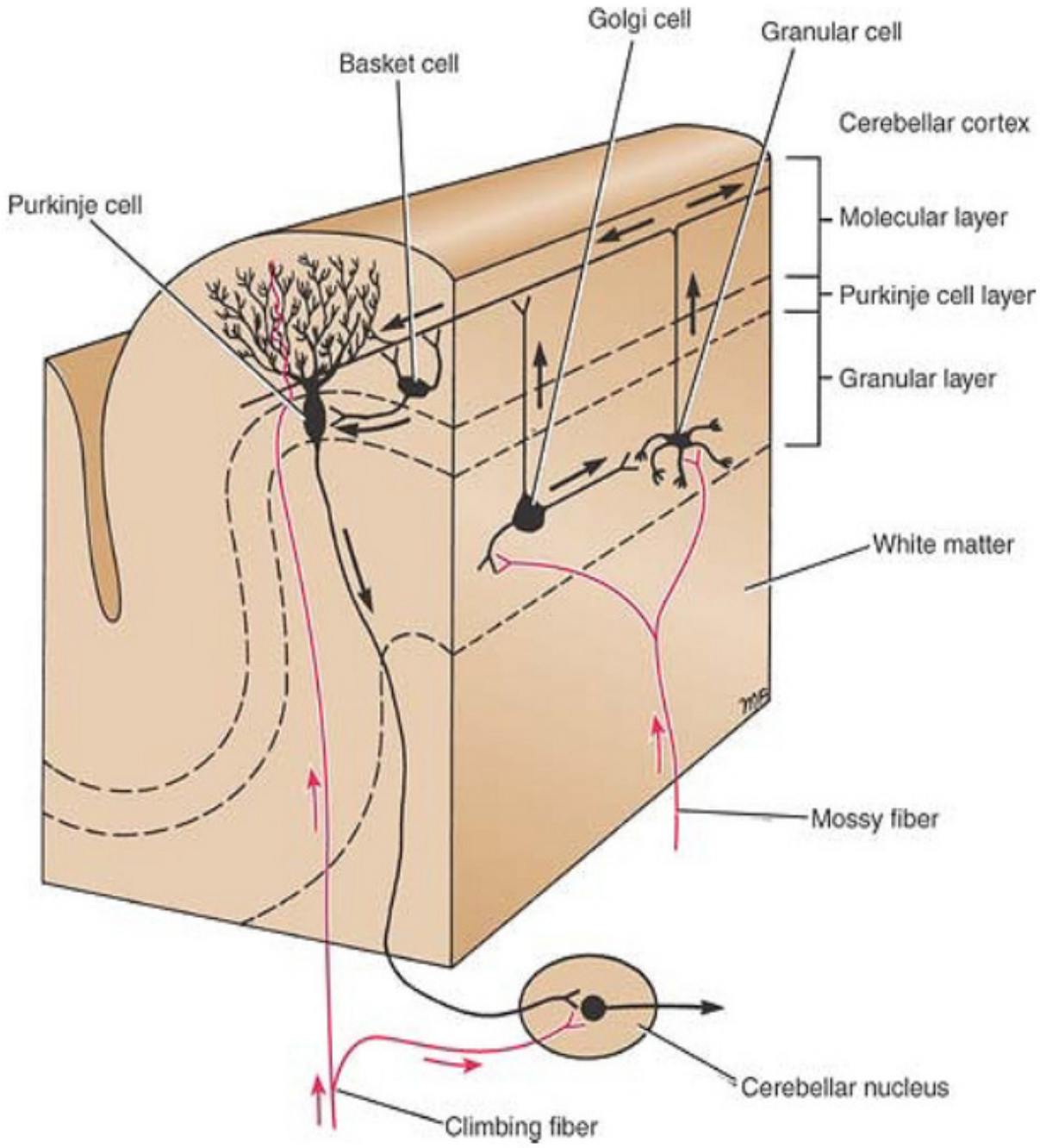
Cerebellar cortical mechanisms

- a single purkinje neuron makes synaptic contact with only one climbing fiber
- one climbing fiber makes contact with one to ten purkinje neurons
- a single mossy fiber may stimulate thousands of purkinje cells through the granule cells
- Granule cells receive input from mossy fibers and project to the Purkinje cells



Cerebellar cortical mechanisms

1. Purkinje Cells - the only output neuron from the cortex utilizes GABA to inhibit neurons in deep cerebellar nuclei
2. Granule Cells- intrinsic cells of cerebellar cortex; use glutamate as an excitatory transmitter; excites Purkinje cells via axonal branches called “parallel fibers”
3. Basket Cells and stellate cells- inhibitory interneuron; utilizes GABA to inhibit Purkinje cells

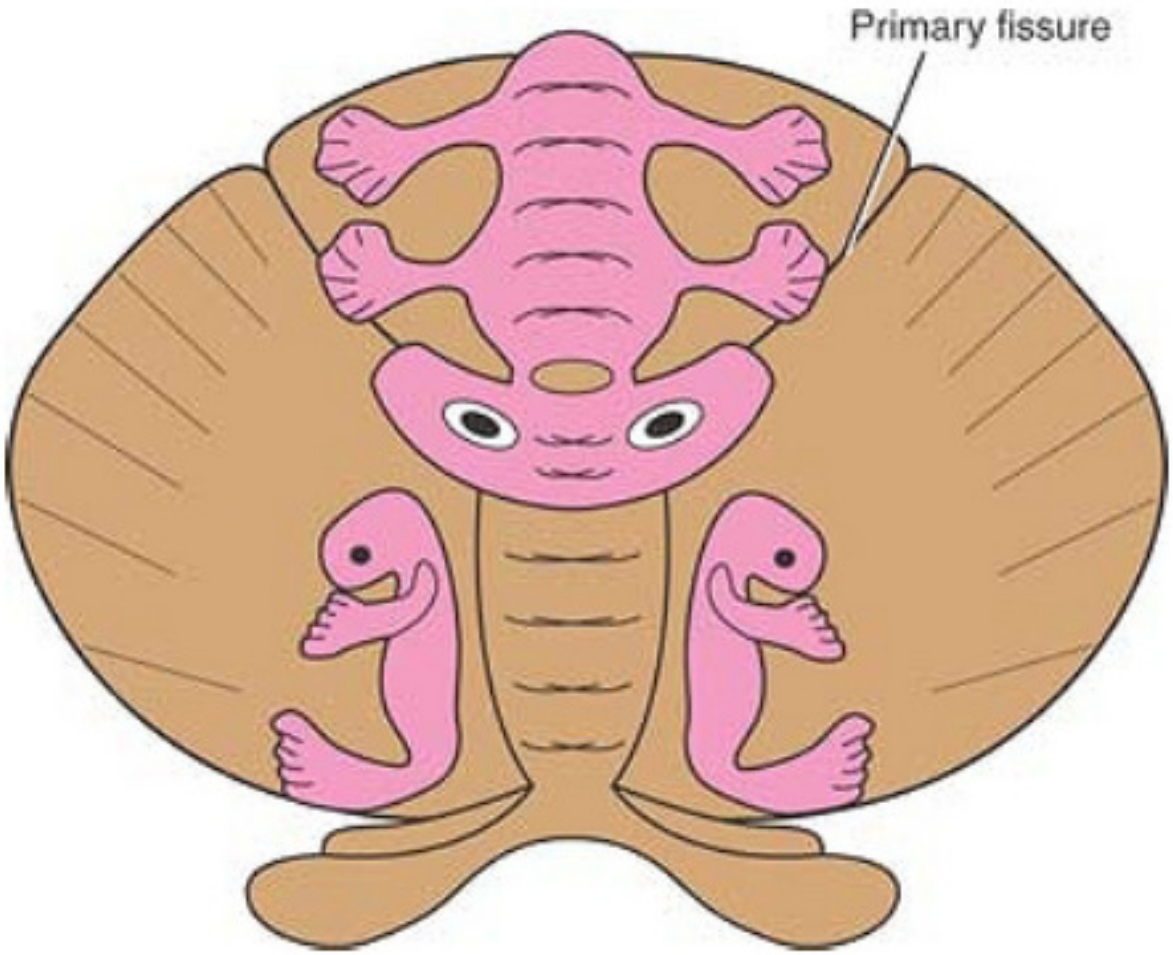


Functional anatomy

A. Spinocerebellum

B. Cerebrocerebellum

C. Vestibulocerebellum



Spinocerebellum

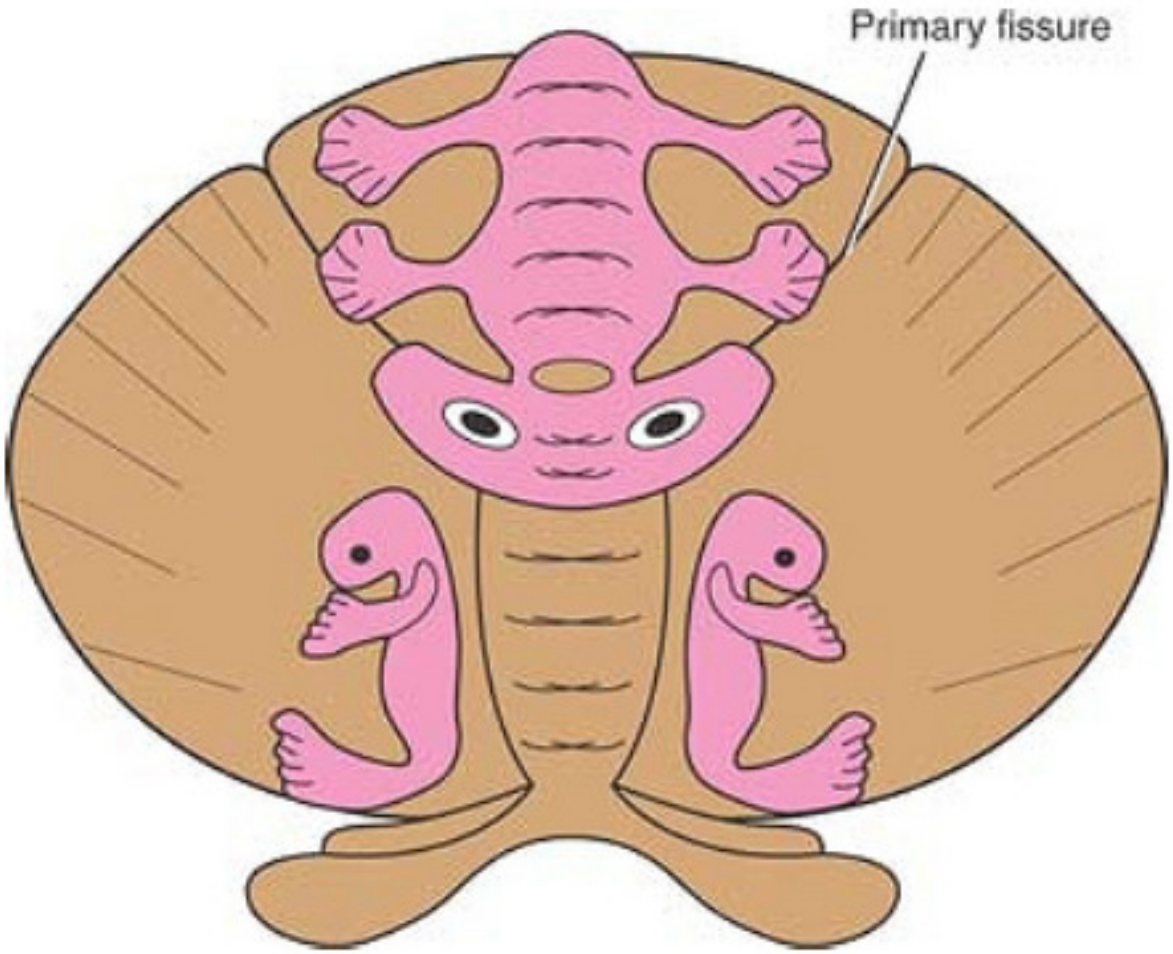
➢ most of the vermis of the posterior and anterior cerebellum plus the adjacent intermediate zones on both sides of the vermis.

Cerebrocerebellum

➢lateral zones of the cerebellar hemispheres, lateral to the intermediate zones

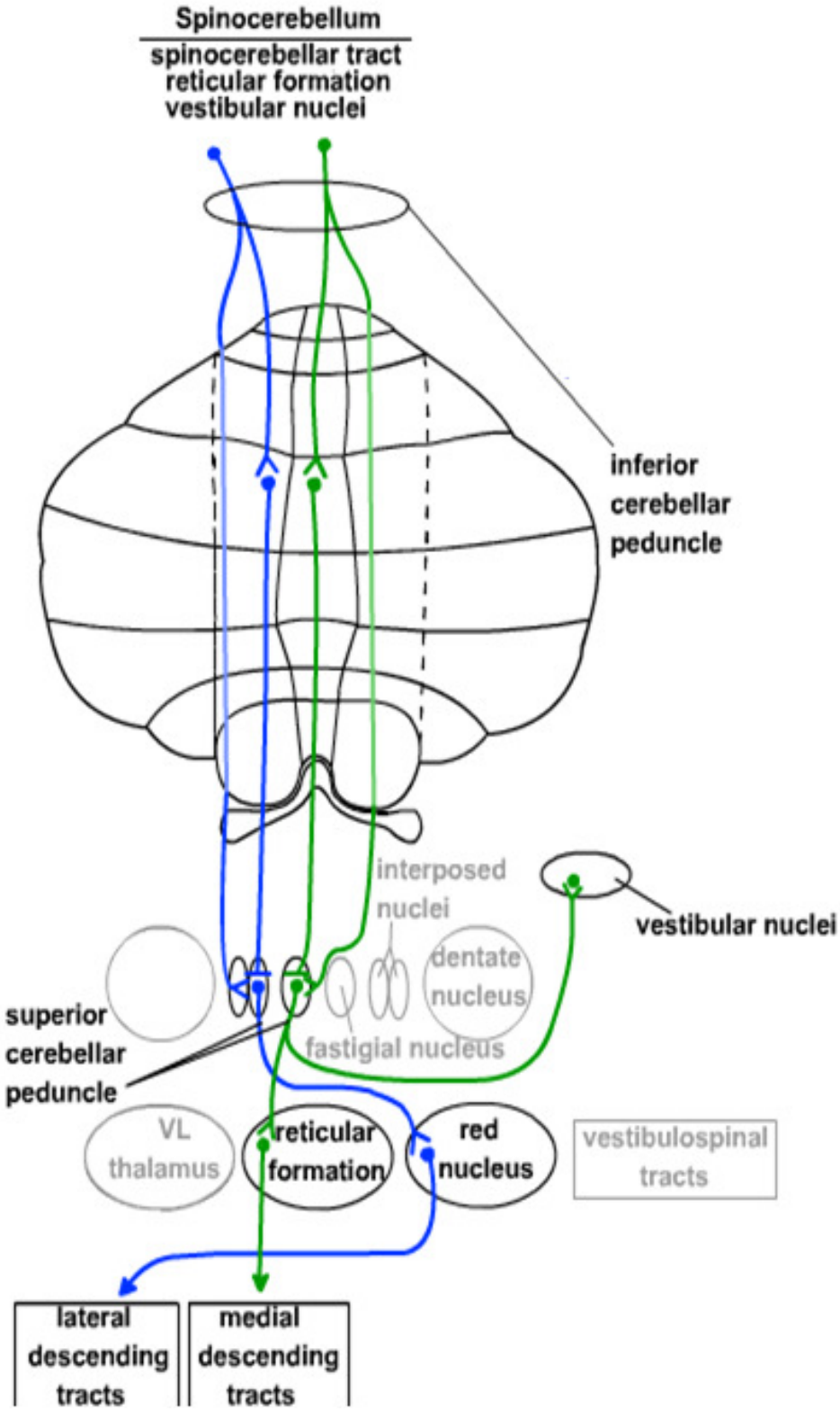
Vestibulocerebellum

➢ small flocculonodular cerebellar lobes and adjacent portions of the vermis



Spinocerebellum

- comprises the vermis + intermediate hemisphere of the cerebellar cortex, as well as the **fastigial** and **interposed nuclei**.
- projects through fastigial and interposed nuclei.
- has a somatotropic organization.
- it receives major inputs from the spinocerebellar tracts.
- Its output projects to rubrospinal, vestibulospinal, and reticulospinal tracts
- It is involved in the integration of sensory input with motor commands to produce adaptive motor coordination
- controls posture and movement of trunk and limbs.



Spinocerebellum

the **vermis** will send efferents through fastigial n.

Inferior cerebellar peduncles

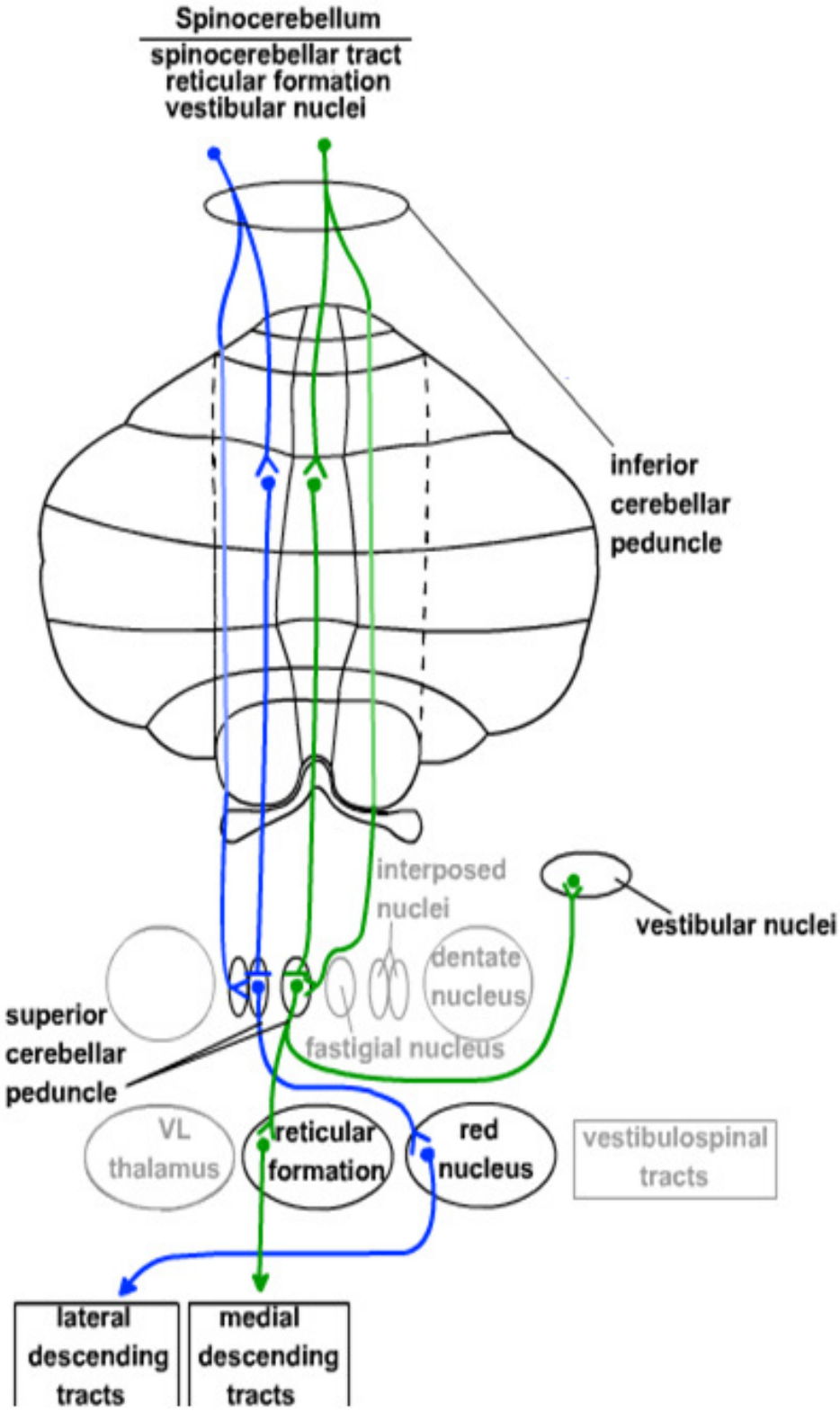
Medial descending pathways:
(Anterior column)
A-fastigial vestibular pathway
(vestibulospinal tract)

B-fastigial reticular pathway
(reticulospinal tract)

VL

1° motor ctx descends

Medial (anterior) Corticospinal tract



Spinocerebellum

The **intermediate hemisphere** will send efferents through interposed n.

Superior cerebellar peduncle

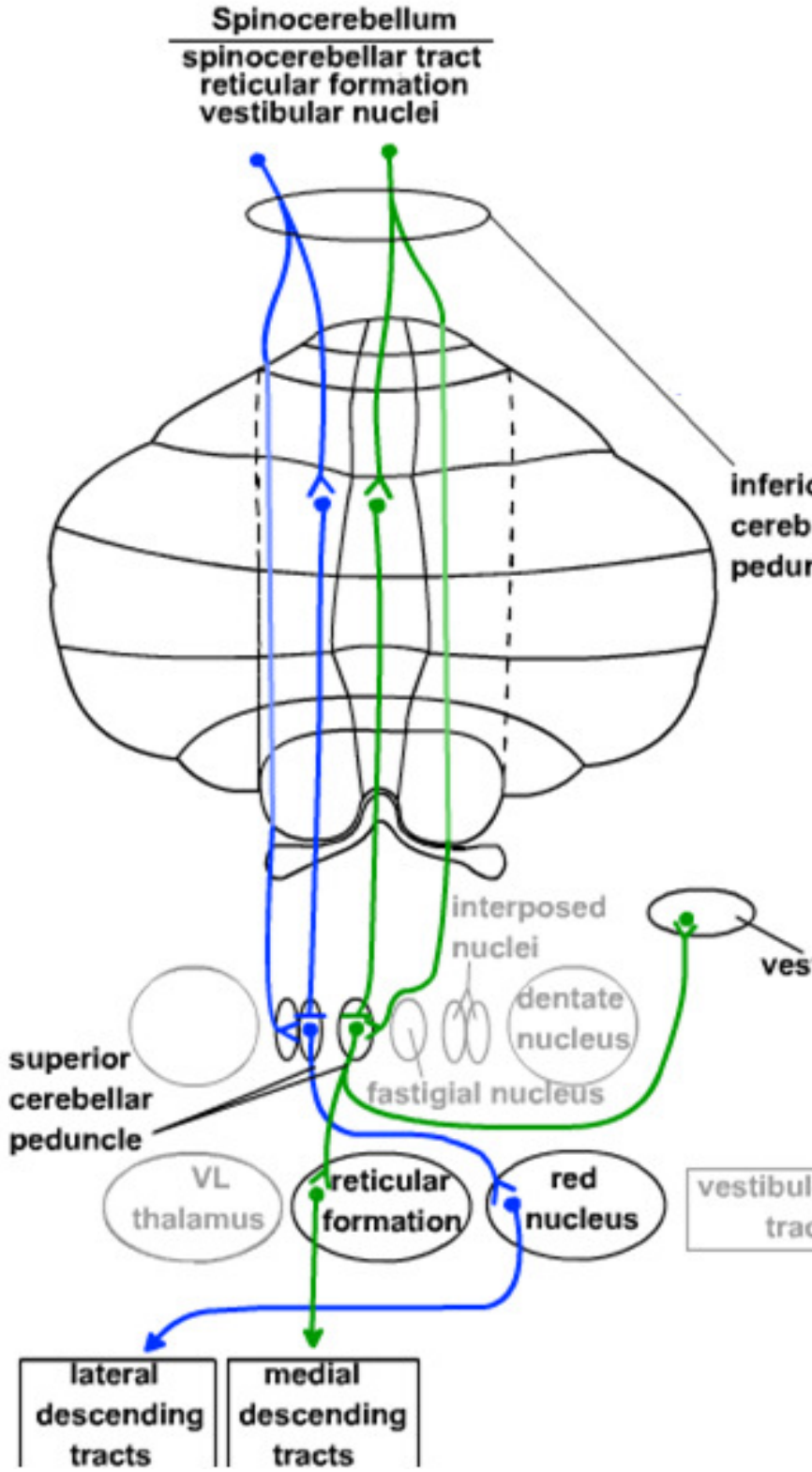
Red nucleus

Globose-emboliform-rubral pathway
(Rubrospinal tract)

VL

1° motor ctx descends

Lateral cortico-spinal tract



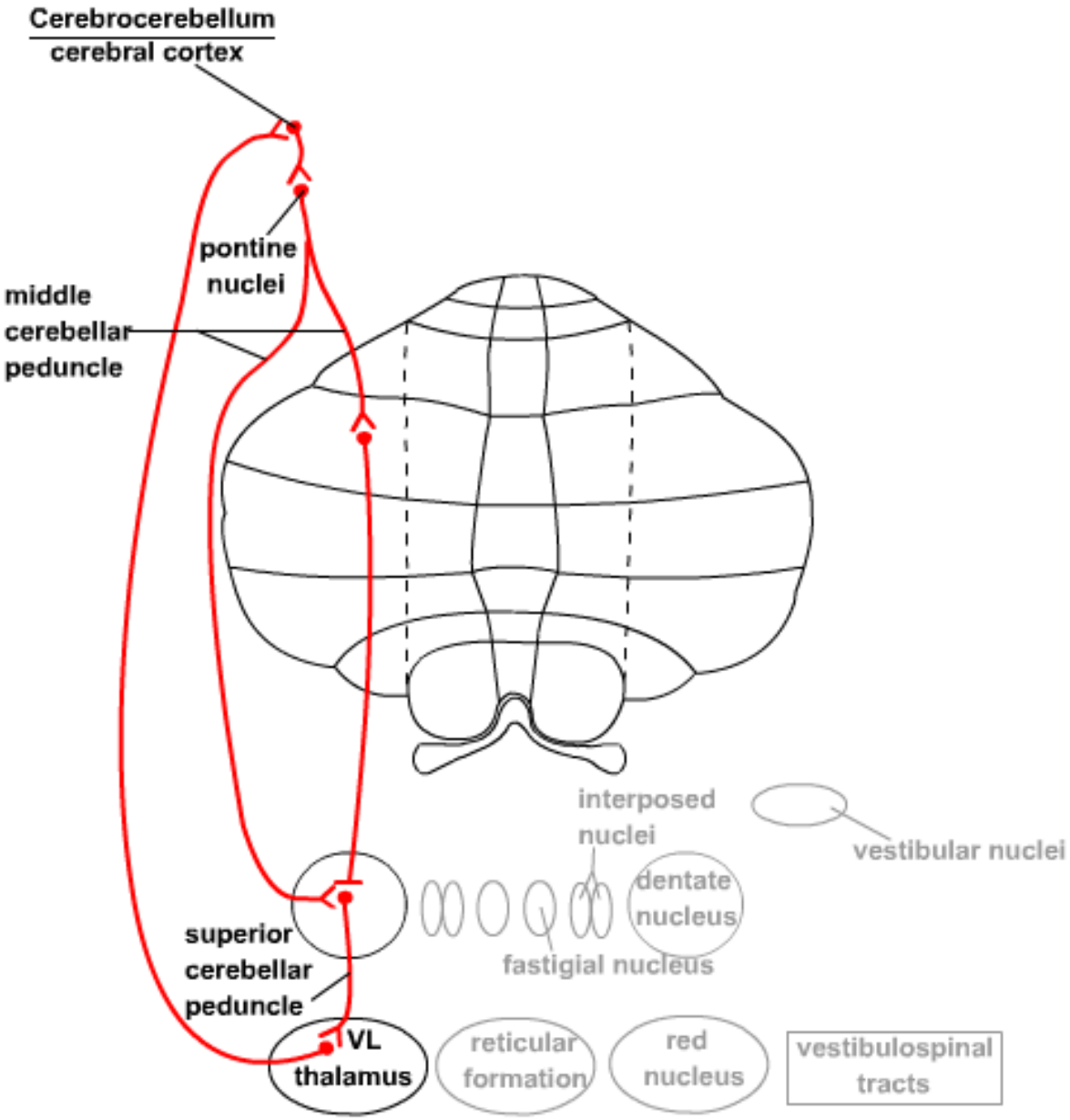
Cerebrocerebellum

comprising the **lateral hemispheres** and the **dentate nuclei**

- participates in the planning of movement
- located in the lateral hemisphere
- projects to the dentate nucleus
- from its extensive connections with the cerebral cortex, via the pontine nuclei (afferents) and the VL thalamus (efferents). It is involved in the planning and timing of movements.

-- Afferent input : from entire contralateral cerebral cortex

-- Efferent pathway : thalamus



Cerebrocerebellum

Contralateral cerebral ctx

↓

pontine nuclei.

↓

Middle cerebellar peduncle

↓

Contralateral cerebellar cortex

Efferent pathway

↓

Dentate n.

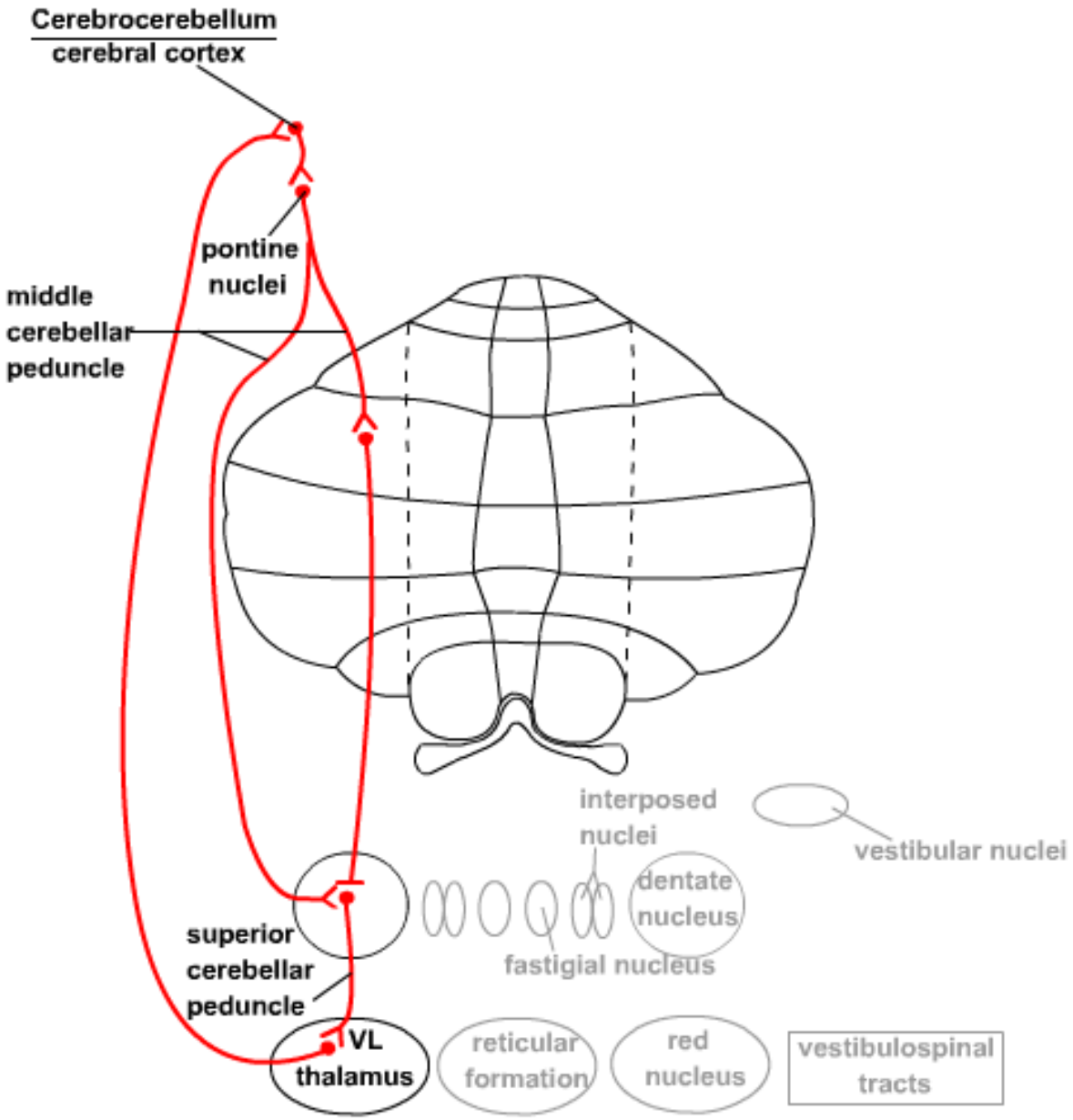
Dentothalamic pathway

↓

superior cerebellar peduncles
Decussation of SCP

↓

VL → 1° motor ctx and premotor ctx + prefrontal ctx → cortico-spinal tract



Vestibulocerebellum

comprises the **flocculonodular lobe** and its connections with the **lateral vestibular nuclei**

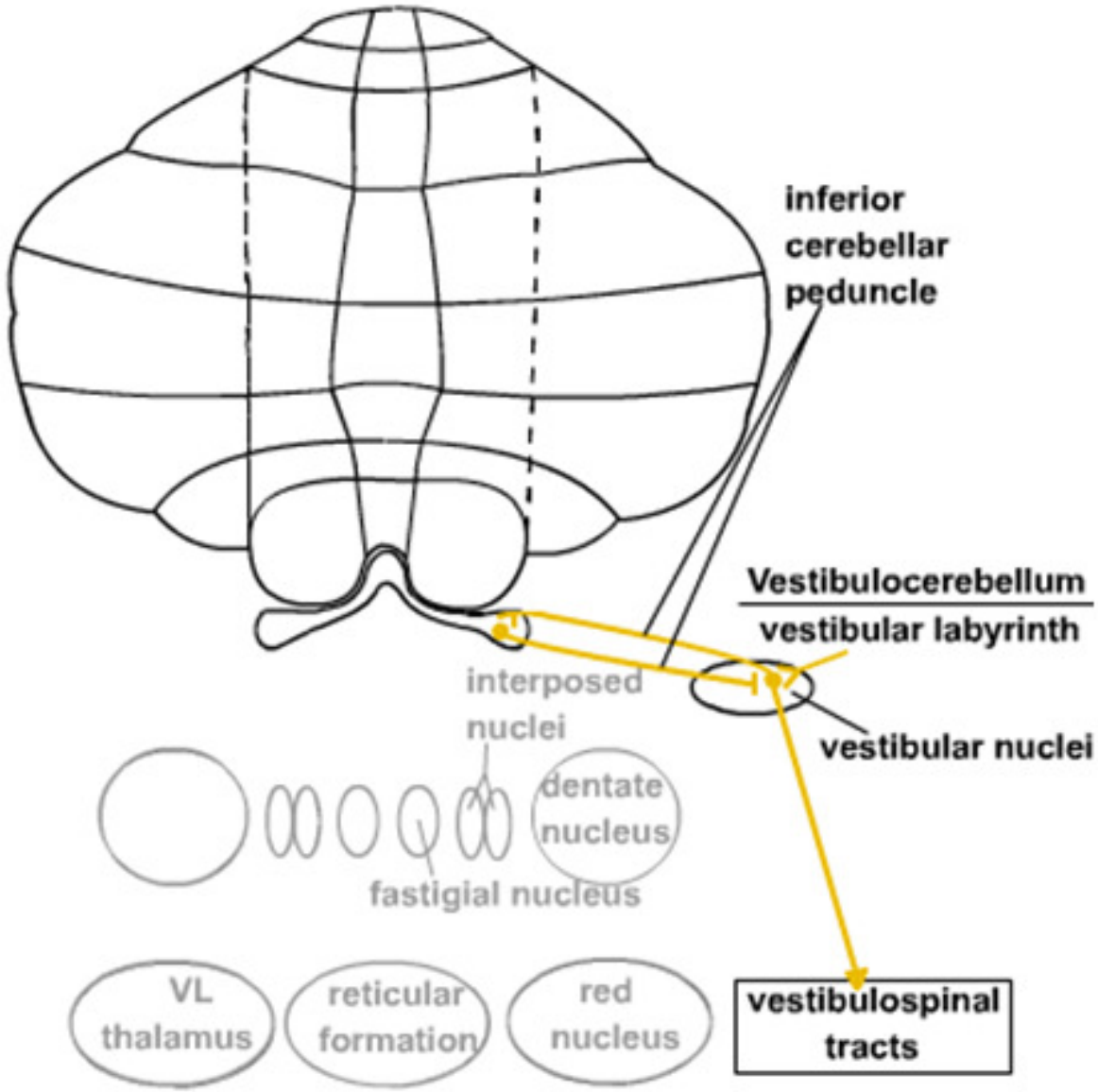
- functions in maintaining balance and controlling head and eye movements.
- located in flocculonodular lobe.
- projects to vestibular nuclei.
- it is involved in vestibular reflexes (such as the vestibuloocular reflex) and in postural maintenance.

<u>Afferent input</u>:

vestibular nerve and vestibular nuclei.

<u>Efferent path</u>

vestibular nuclei



Vestibulocerebellum

Vestibular cerebellar
Cortex (flocculonodular lobe)

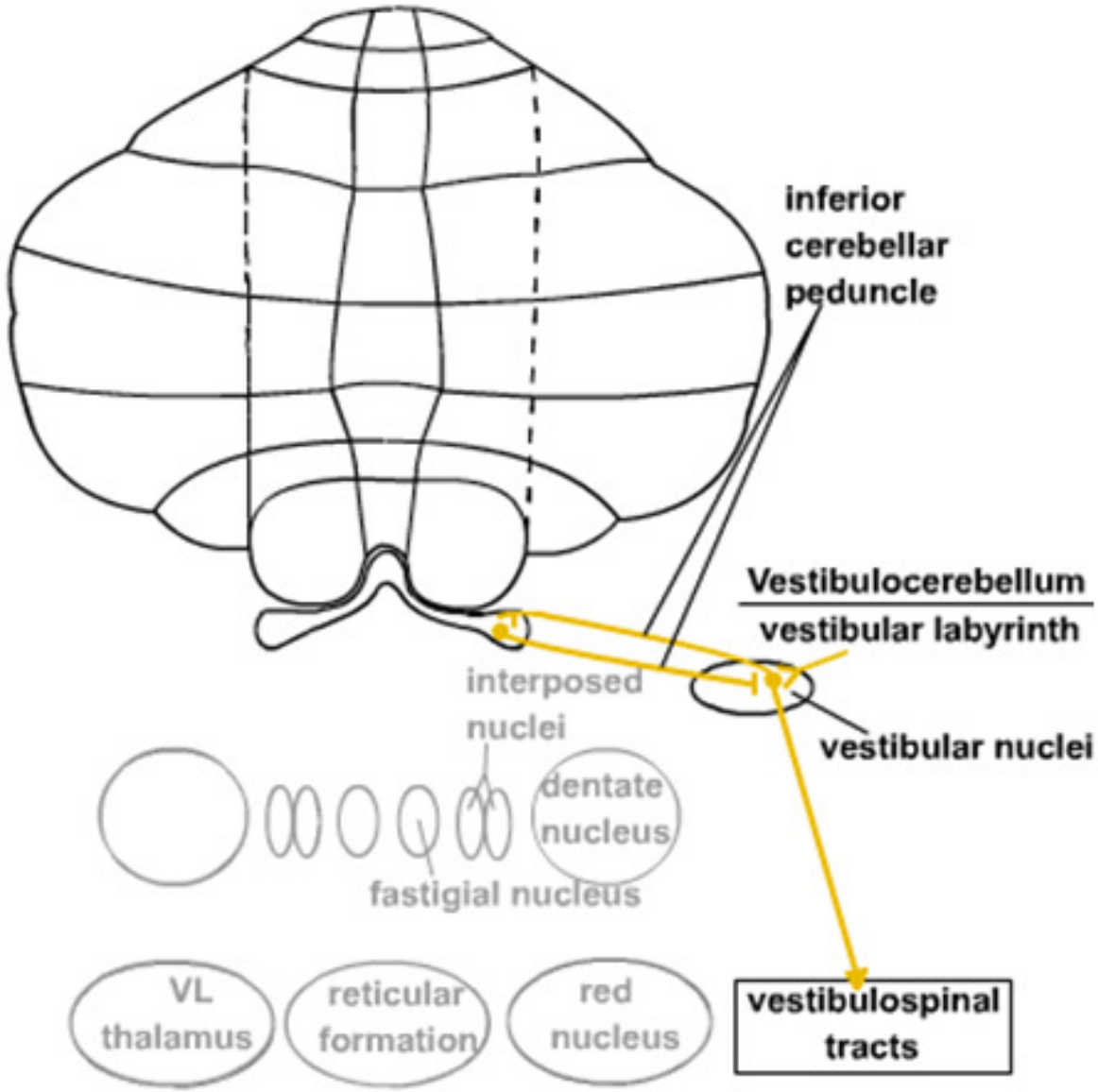
↓

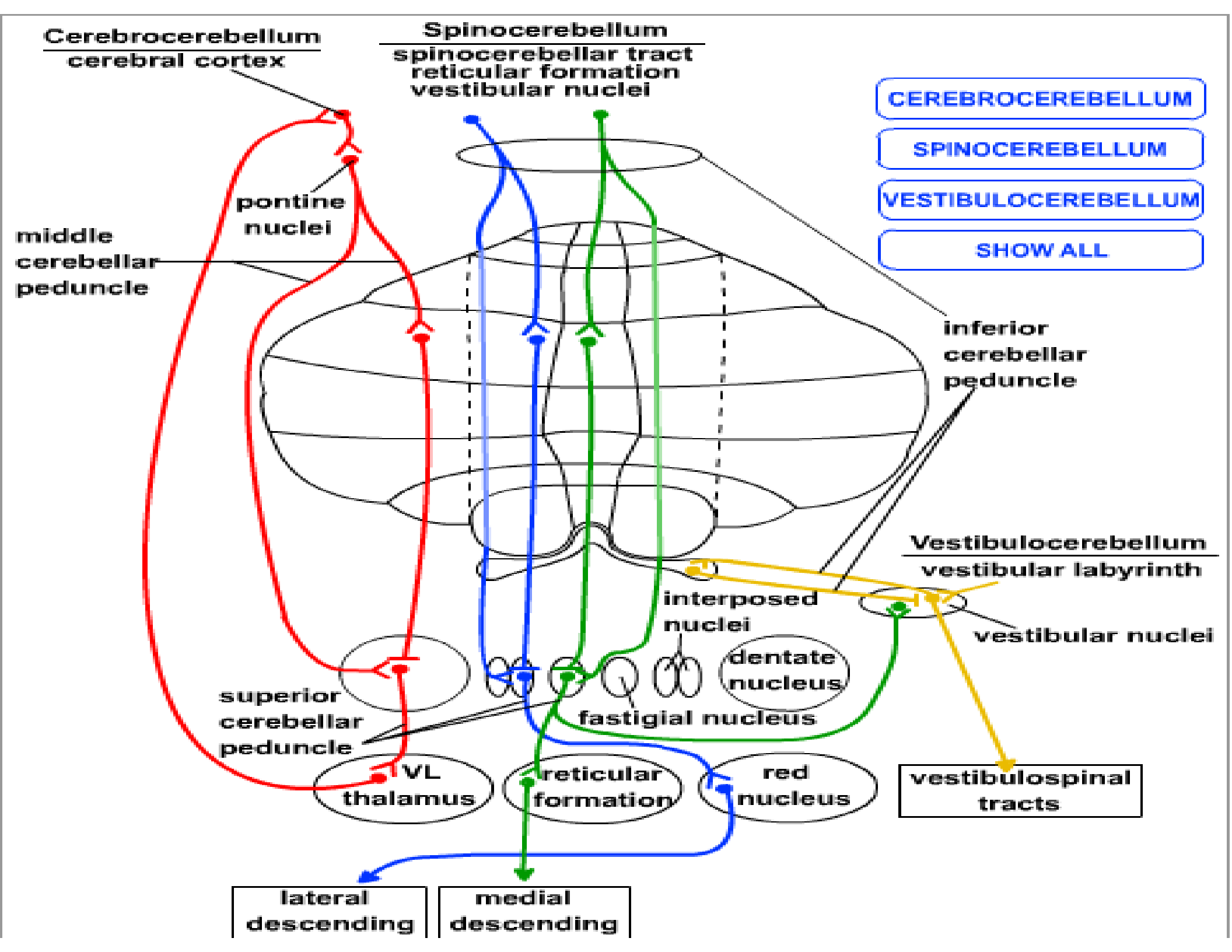
Vestibular nuclei

↙ ↘

VS tract

Med
longitud
Fasciculus
(eyes, head)




Cerebrocerebellum
cerebral cortex
Spinocerebellum
spinocerebellar tract
reticular formation
vestibular nuclei
CEREBROCEREBELLUM
SPINOCEREBELLUM
VESTIBULOCEREBELLUM
SHOW ALL
pontine nuclei
middle cerebellar peduncle
inferior cerebellar peduncle
Vestibulocerebellum
vestibular labyrinth
interposed nuclei
vestibular nuclei
dentate nucleus
fastigial nucleus
superior cerebellar peduncle
VL thalamus
reticular formation
red nucleus
vestibulospinal tracts
lateral descending
medial descending

Cerebellar afferent fibers

➢**From cerebral cortex**

1. Corticopontocerebellar pathway
2. Cerebro-olivocerebellar pathway
3. Cerebroreticulocerebellar pathway

➢**From spinal cord**

1. Anterior spinocerebellar tract
2. Posterior spinocerebellar tract
3. Cuneocerebellar tract

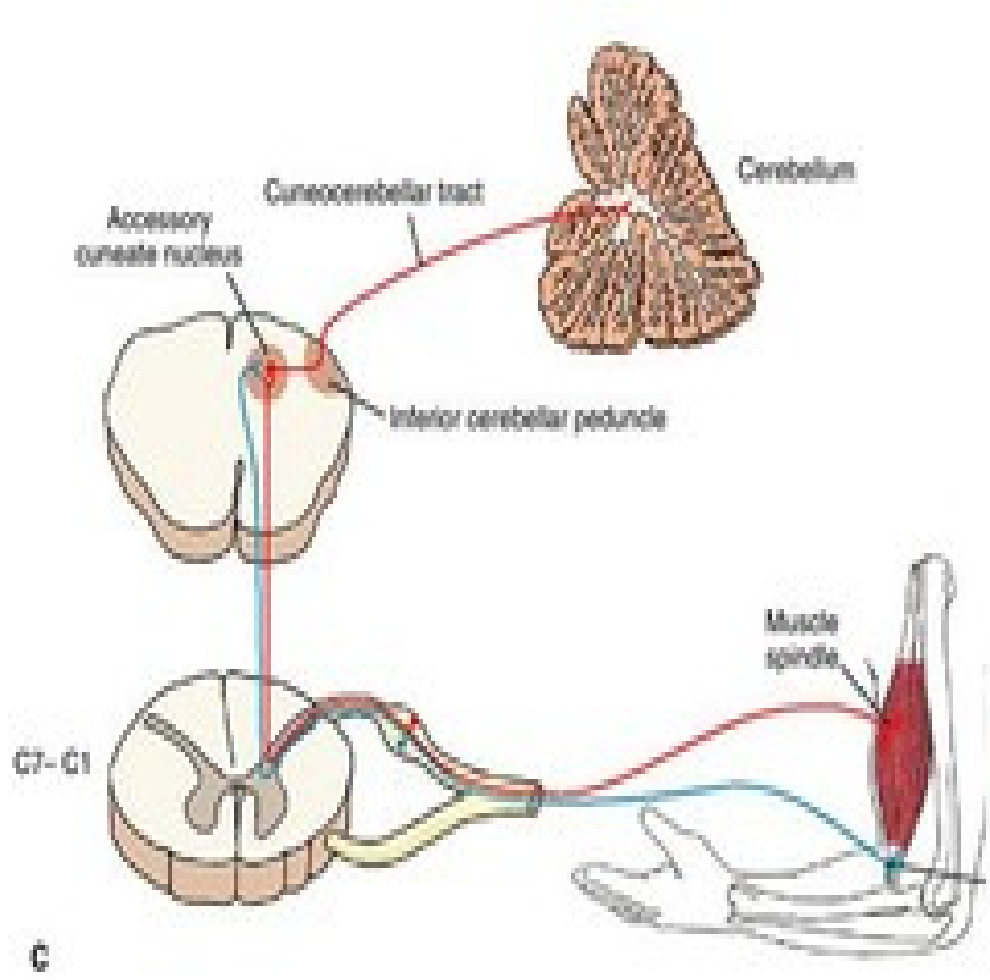
➢**From vestibular nerve**

➢**Other afferents**

1. Red nucleus
2. Tectum

Cuneocerebellar tract

- Originate in nucleus cuneatus of medulla oblongata
- Enter the ICP (ipsilateral)
- Receives proprioception (muscle-joint sensations) from the upper limb and upper part of thorax



Cerebellar efferent fibers

- Dentothalamic pathway
- Globose-emboliform-rubral pathway
- Fastigial vestibular pathway
- Fastigial reticular pathway

The **inferior cerebellar peduncle:** primarily contains **afferent** fibers from the medulla, as well as **efferents** to the vestibular nuclei.

The **middle cerebellar peduncle:** primarily contains **afferents** from the pontine nuclei.

The **superior cerebellar peduncle:** primarily contains **efferent** fibers from the cerebellar nuclei, as well as some afferents from the spinocerebellar tract.

Signs and symptoms of cerebellar disease

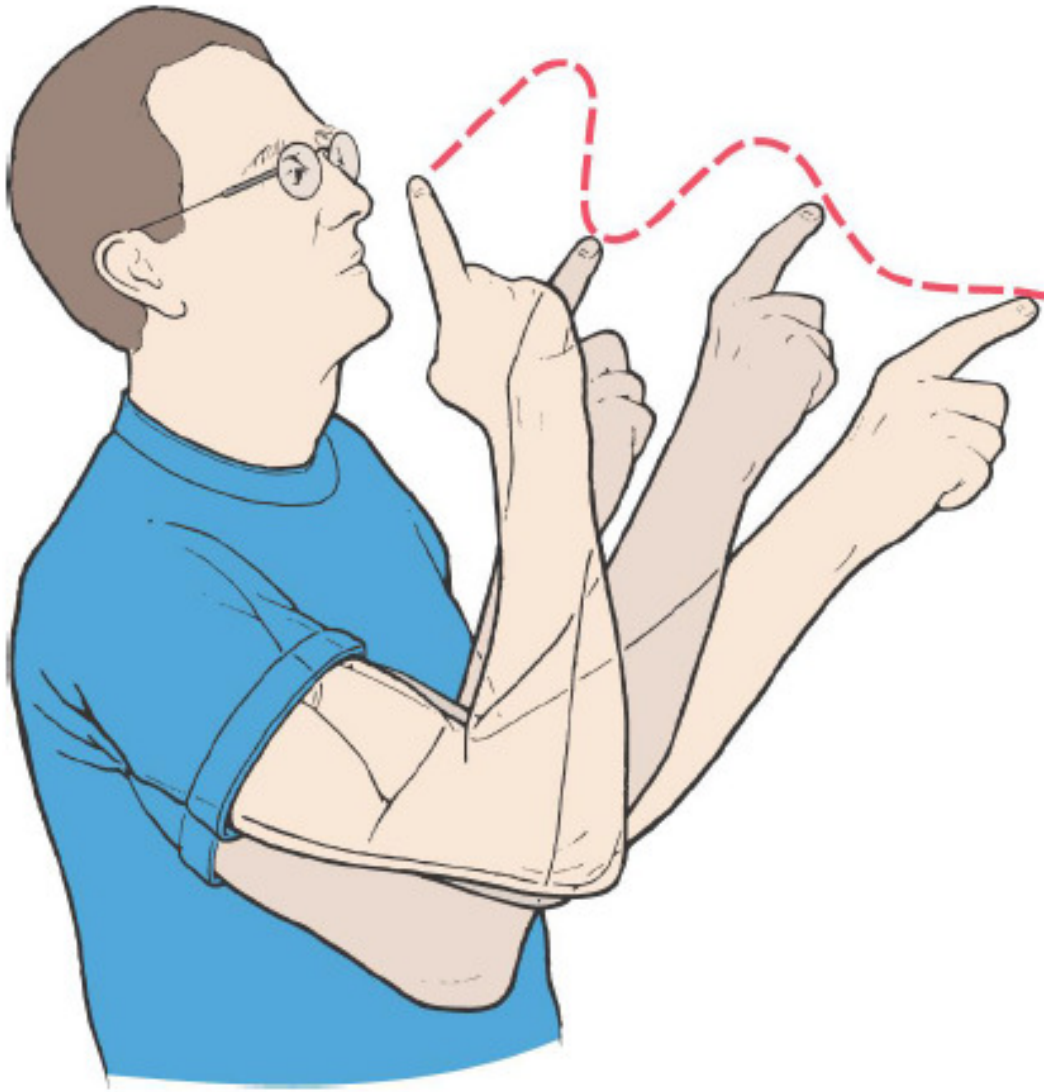
➢A lesion in one cerebellar hemisphere gives rise to signs and symptoms that are limited to the ***same side*** of the body

➢ **Hypotonia**: decrease in muscle tone: (Loss of the deep cerebellar nuclei, particularly of the interposed nuclei)

➢**Dysmetria** (past pointing): movements ordinarily overshoot their intended mark; then the conscious portion of the brain overcompensates in the opposite direction for the succeeding compensatory movement.

➢**Ataxia** (inaccuracy and disturbances of voluntary movement)

➢**Tremors**: involuntary oscillations of limbs ("intention tremor"), results from cerebellar overshooting and failure of the cerebellar system to "damp" the motor movements



Signs and symptoms of cerebellar disease

Postural changes and alteration of gait (wide-based gait) to compensate for loss of muscle tone

➢ **Failure of Progression**

- **Dysdiadochokinesia** (difficulty performing rapid alternating movements) due to failure to predict where the different parts of the body will be at a given time during rapid motor movements.
- **Dysarthria:** Disorders of speech

Nystagmus: rhythmic oscillations of the eyes. It occurs especially when the flocculonodular lobes of the cerebellum are damaged;