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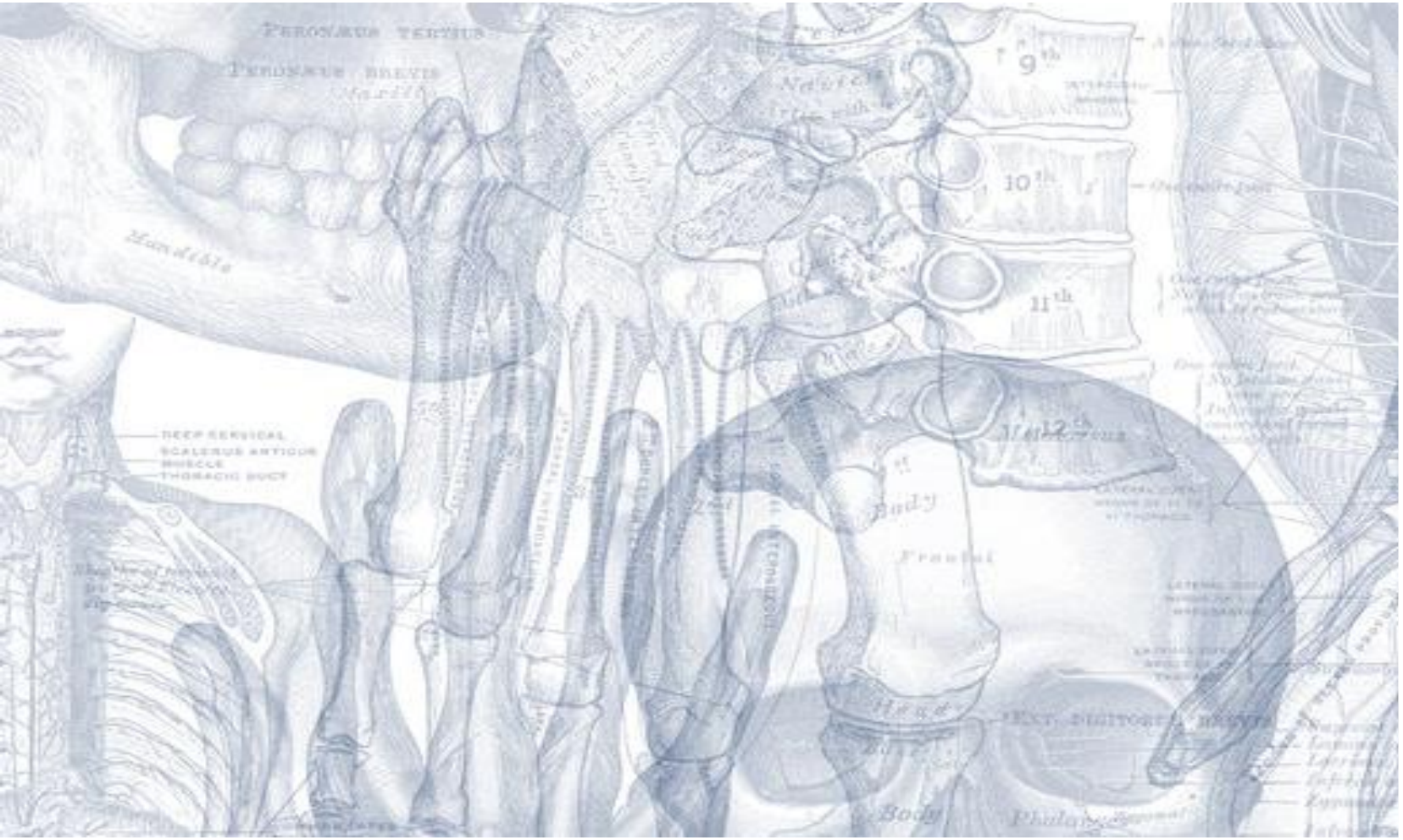


ANATOMY
TEAM 436

436
MEDICINE
KING SAUD UNIVERSITY

تمت المراجعة
شوق الأحمري & عبدالعزيز العنقري

Anatomy of Cerebellum and Relevant Connections

Please view our Editing File before studying this lecture to check for any changes.

Color Code

- **Important**
- **Doctors Notes**
- **Notes/Extra explanation**

Objectives

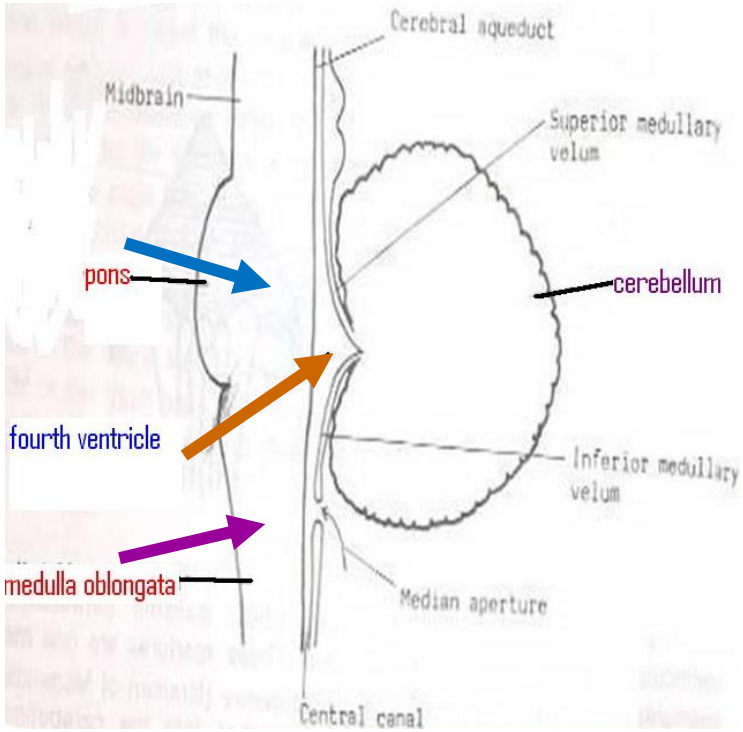
At the end of the lecture, students should:

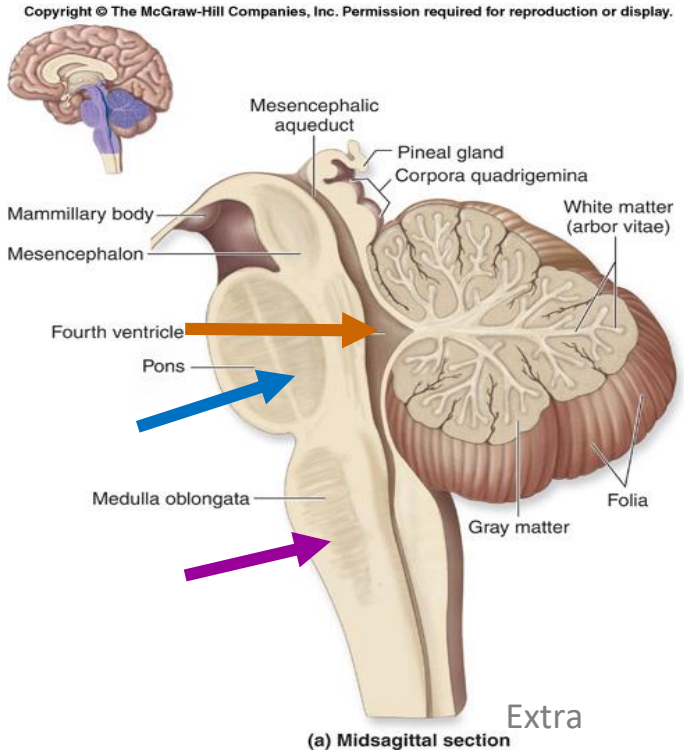
- ✓ Describe the External features of the cerebellum (lobes, fissures).
- ✓ Describe briefly the Internal structure of the cerebellum.
- ✓ List the name of Cerebellar Nuclei.
- ✓ Relate the Anatomical to the Functional Subdivisions of the cerebellum.
- ✓ Describe the Important connections of each subdivision.
- ✓ Describe briefly the Main Effects in case of lesion of the cerebellum.

Cerebellum

Playlist

- *Origin*: from **Hindbrain**.
- *Position*: lies **behind** Pons & Medulla Separated from them by **Fourth ventricle**.
- *Connections:* to the **brainstem** by Inferior, Middle & Superior **Cerebellar Peduncles**.
  (medulla) (pons) (midbrain)





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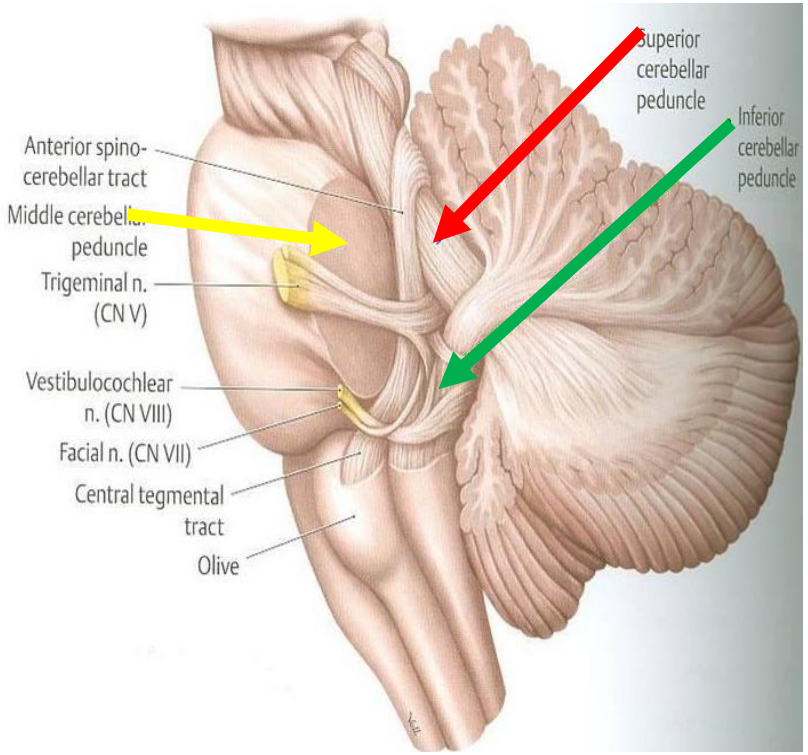
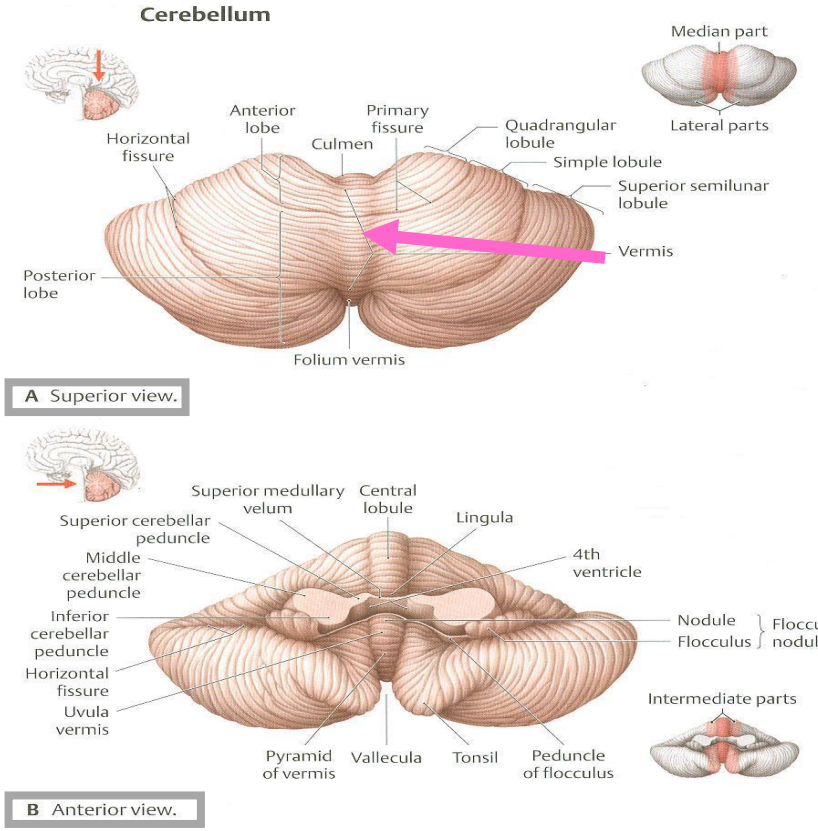


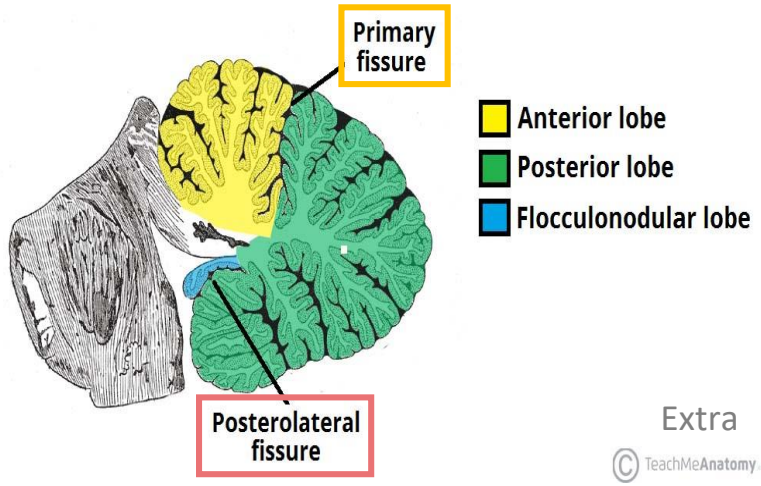
Cerebellum
External Features

- It consists of **two Cerebellar Hemispheres** joined in midline by the **Vermis**.
- Its surface is highly *convoluted* forming **Folia** (like gyri), separated by **Fissures** (like sulci).



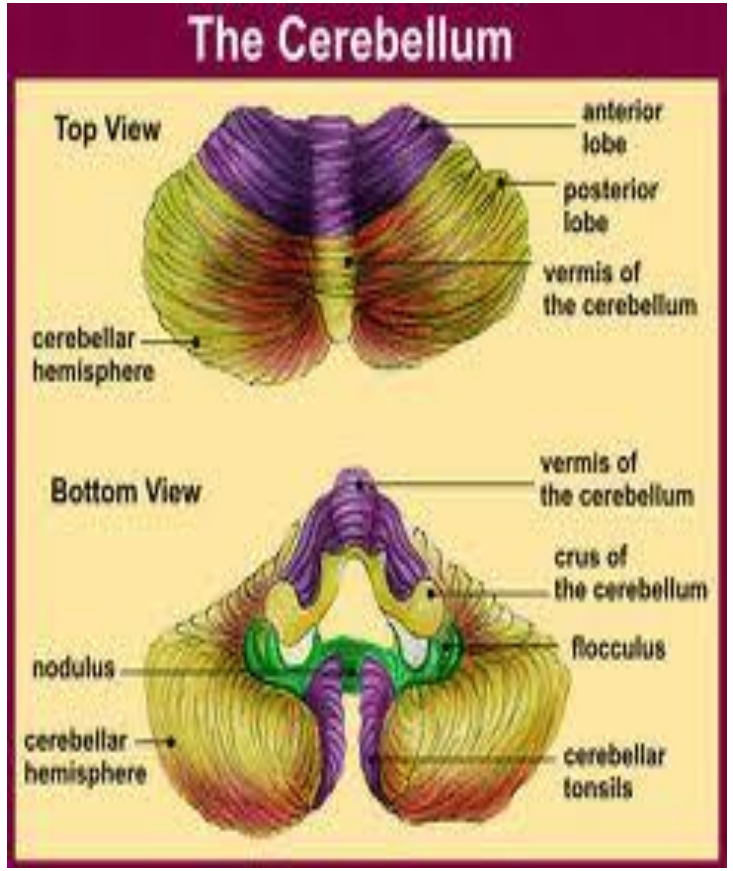
Anatomical Subdivision

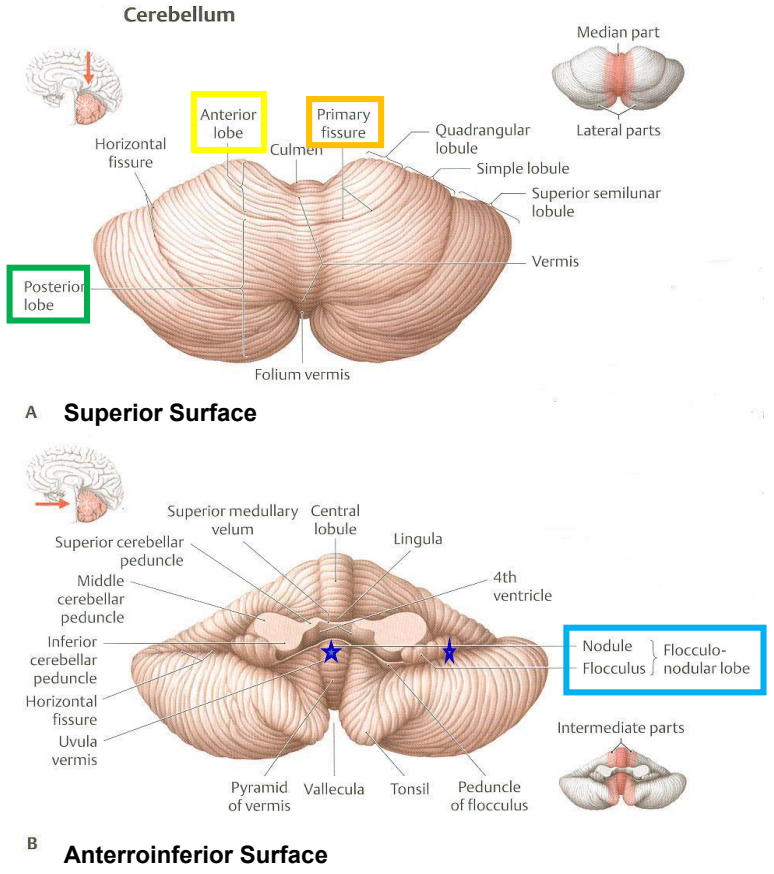
1. **Anterior lobe**: in front of *primary fissure*, on the superior surface.
2. **Posterior** (middle) **lobe**: behind *primary fissure* (Between Primary & Secondary/posterolateral fissures).
3. **Flocculonodular lobe**: in front of *secondary* (Posterolateral) *fissure*, on the inferior surface .

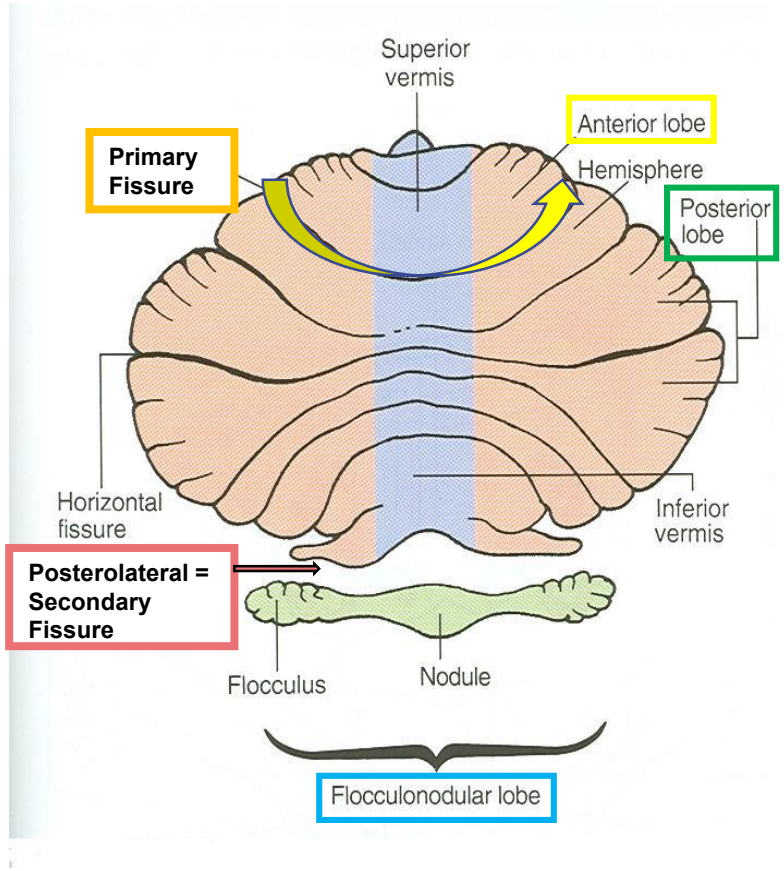


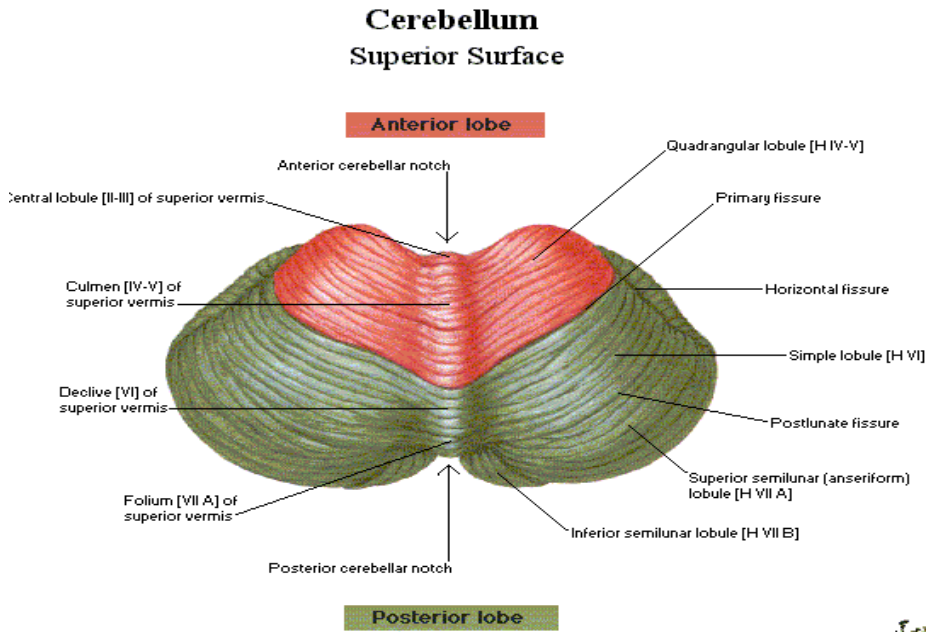
Extra

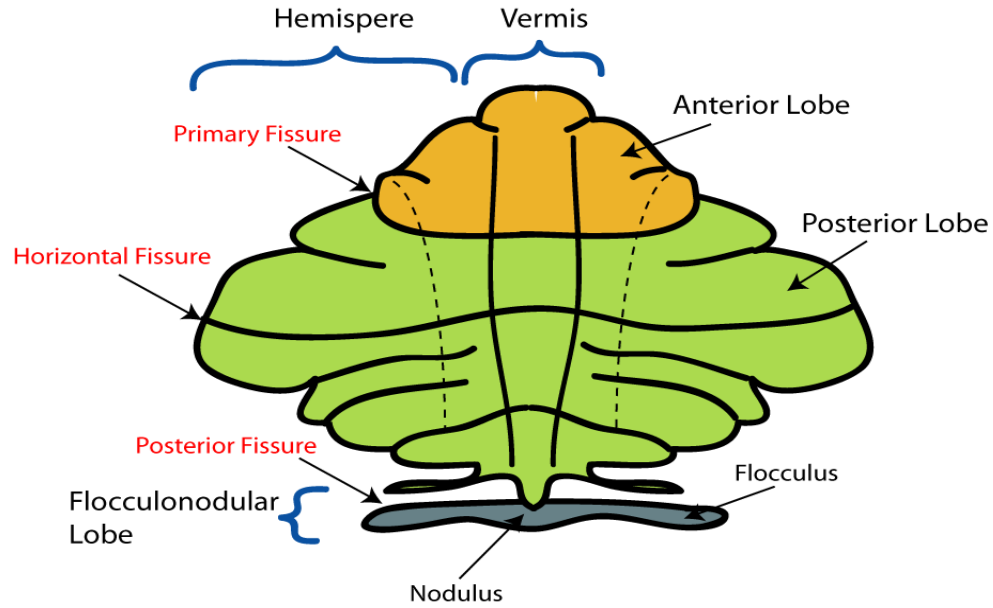
Cerebellum
Anatomical Subdivision

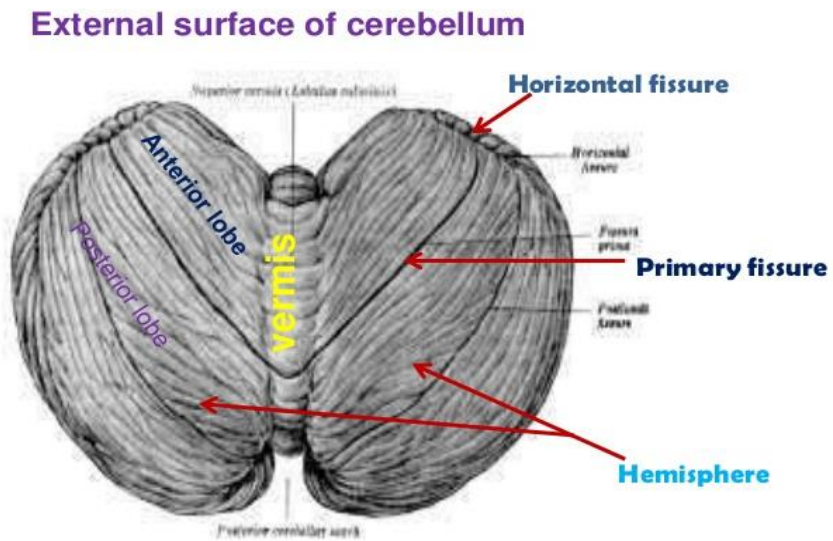


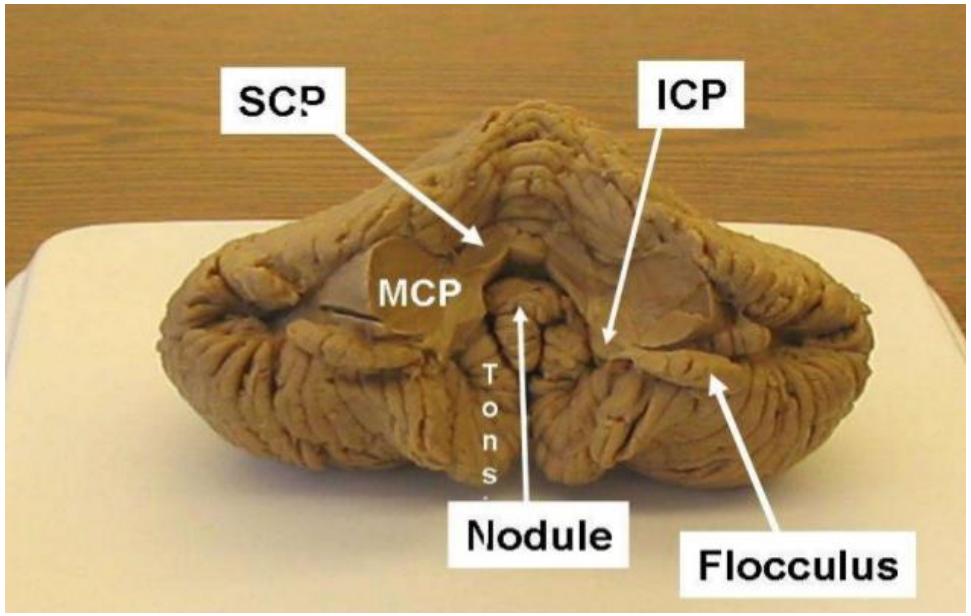





Cerebellum
Superior Surface
Anterior lobe
Anterior cerebellar notch
Quadrangular lobule [H IV-V]
Primary fissure
Central lobule [II-III] of superior vermis
Culmen [IV-V] of superior vermis
Horizontal fissure
Simple lobule [H VI]
Declive [VI] of superior vermis
Postlunate fissure
Superior semilunar (anseriform) lobule [H VII A]
Folium [VII A] of superior vermis
Inferior semilunar lobule [H VII B]
Posterior cerebellar notch
Posterior lobe


Hemispere
Vermis
Anterior Lobe
Primary Fissure
Posterior Lobe
Horizontal Fissure
Posterior Fissure
Flocculus
Flocculonodular Lobe
Nodulus


External surface of cerebellum
Horizontal fissure
Anterior lobe
Posterior lobe
vermis
Primary fissure
Hemisphere

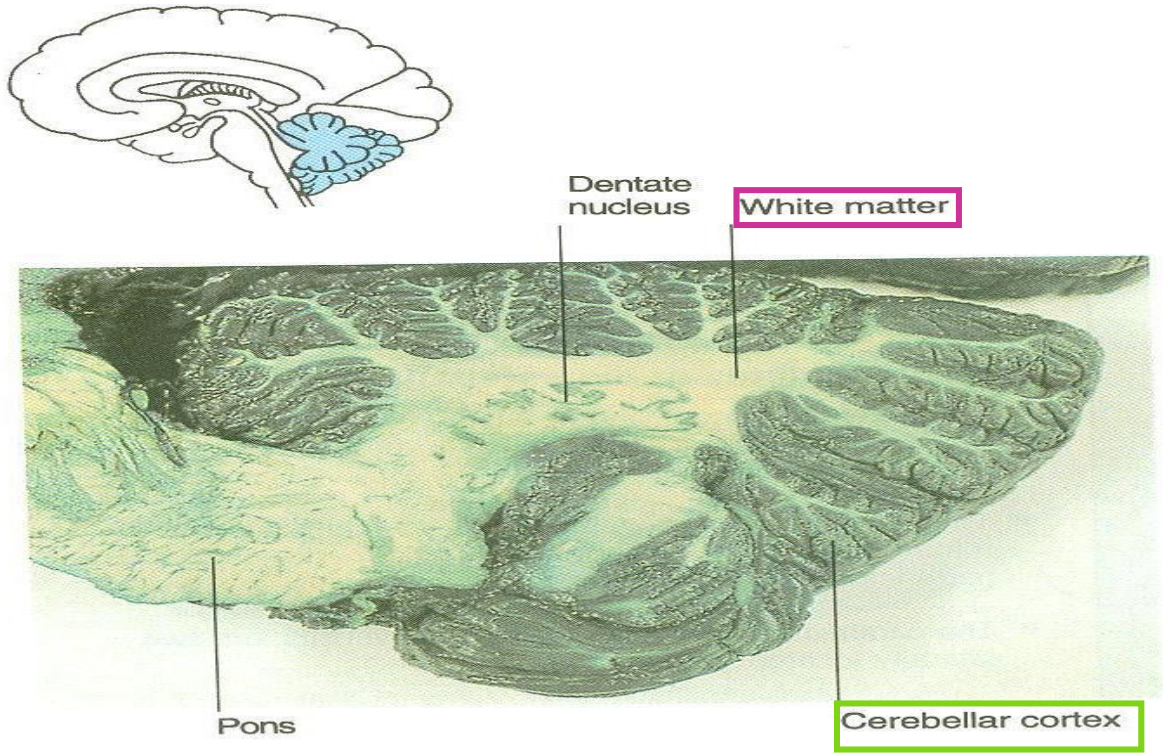

SCP
ICP
MCP
Tonsil
Nodule
Flocculus

Cerebellum

Constituents (Internal Structure and Nuclei of Cerebellum)

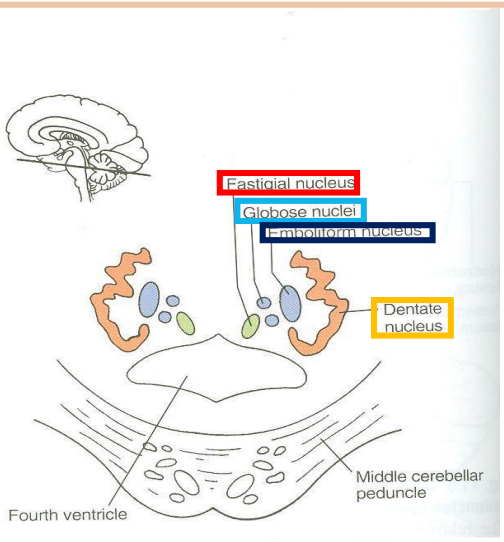
Outer grey matter: cerebellar cortex

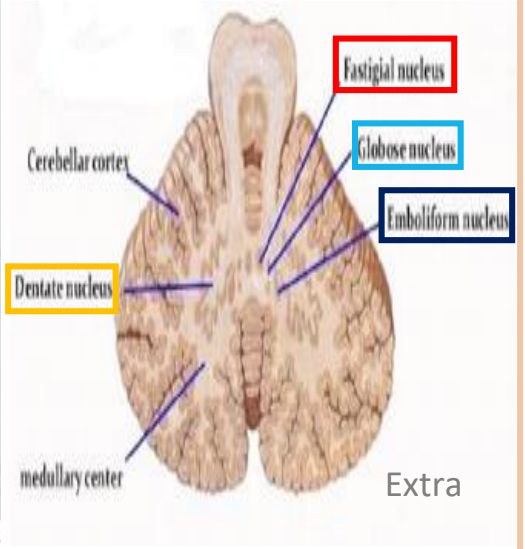
Inner white matter: cerebellar medulla



Deeply seated nuclei in white matter:
from medial to lateral:

- Fastigial nucleus: smallest one
- Globose nucleus.
- Emboliform nucleus.
- Dentate nucleus: **largest** one.



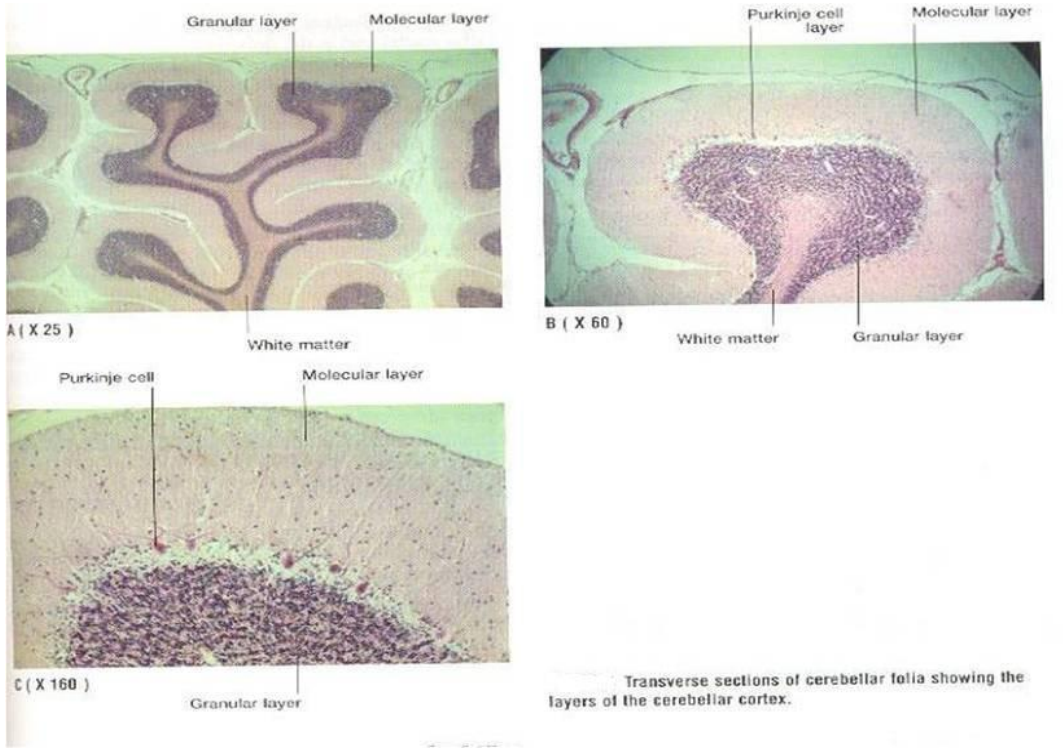


Extra

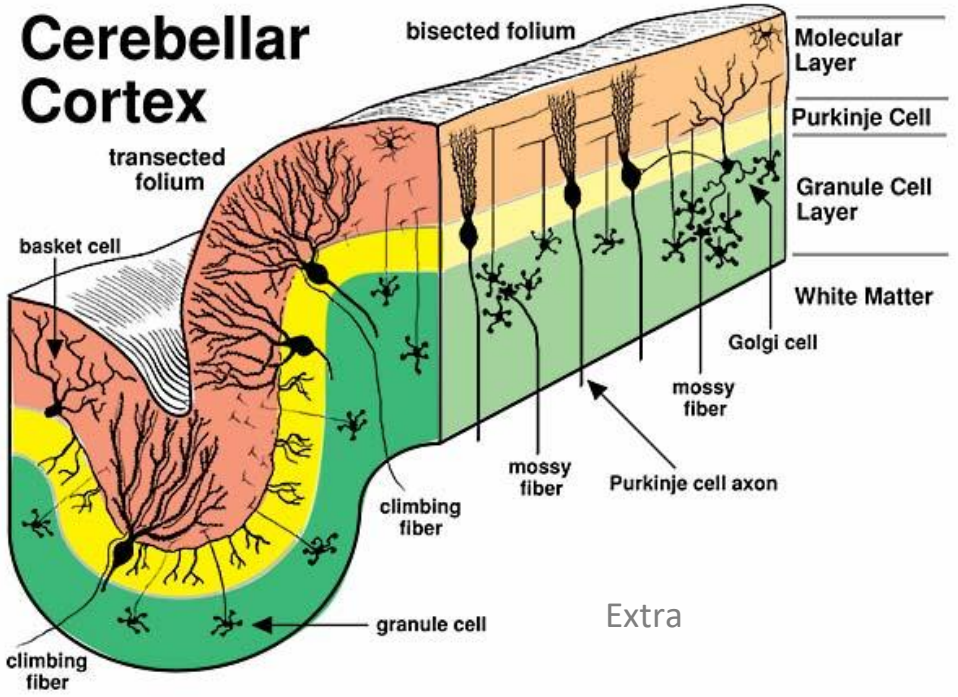
Cerebellum
Cerebellar Cortex

The cerebellar cortex is divided into **3 layers**:

1. **Outer molecular layer**
2. **Intermediate Purkinje cell layer**
3. **Inner granular layer**



Transverse sections of cerebellar folia showing the layers of the cerebellar cortex.



Extra

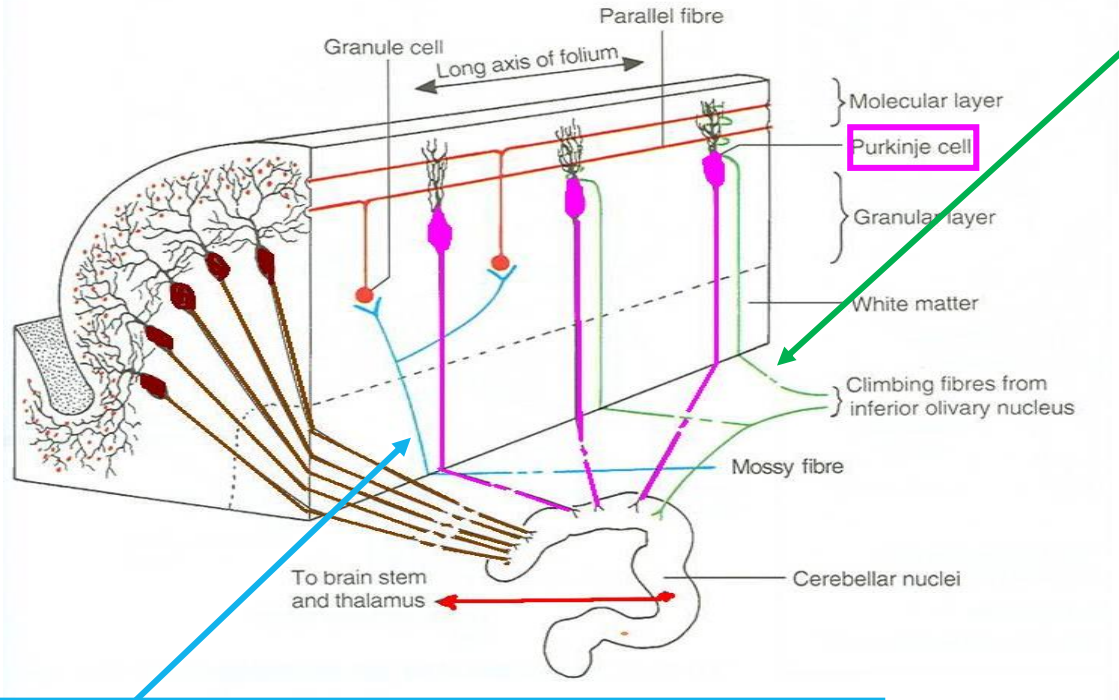
Cerebellum

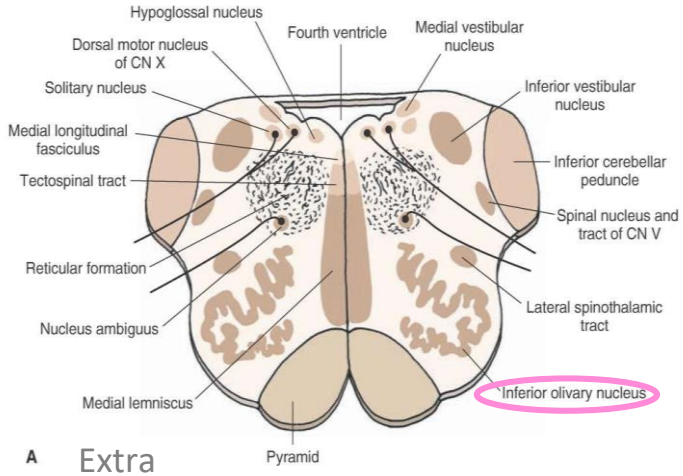
Cerebellar Medulla

Afferent fibers:

Fibers coming into the cerebellum
They are of two types:
mossy and climbing

Climbing fibres:
from *inferior olivary nucleus*, relay to *purkinje cells*





Mossy fibres: rest of fibres:

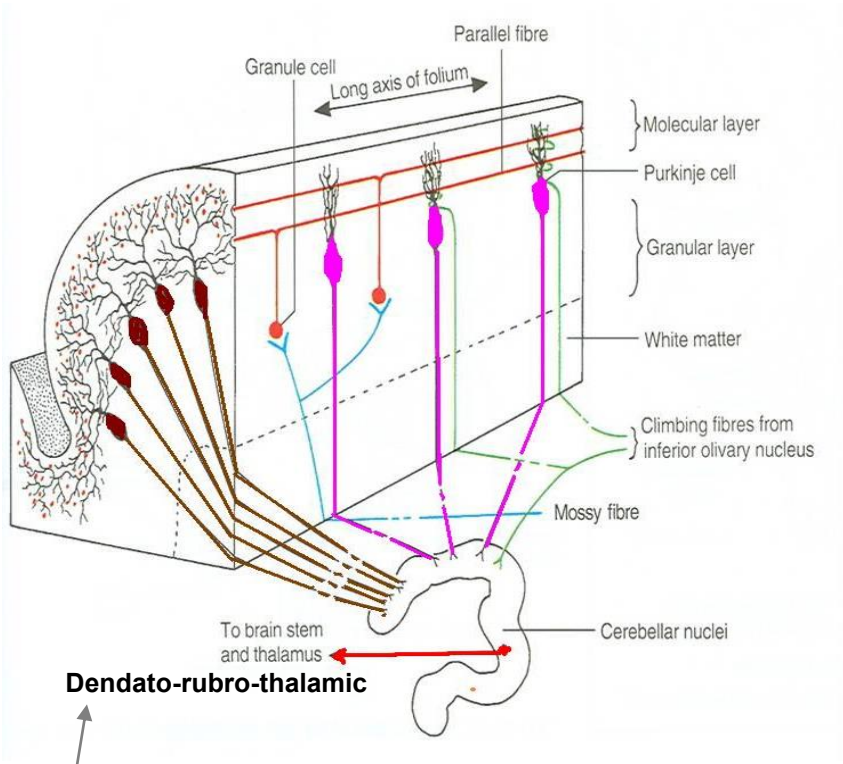
1. From *vestibular nuclei*
2. From *spinal cord*
3. From *pons*

They relay to *granule cells* which in turn relay to *purkinje cells*.

Finally all afferent fibers passing through the medulla relay to **purkinje cells in the cortex.**

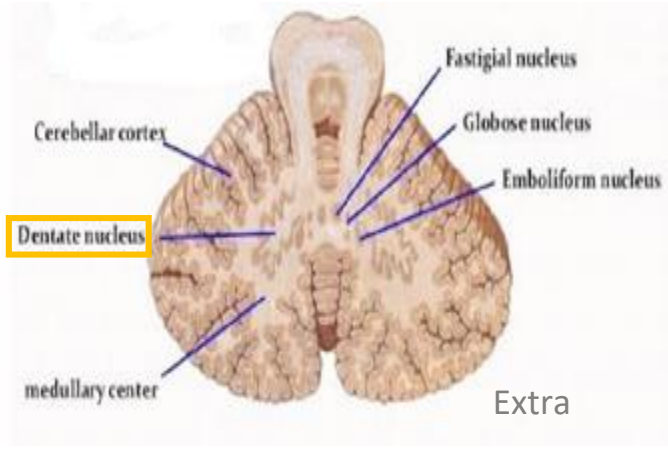
Cerebellum
Cerebellar Medulla

- **Axons of Purkinje Cells are the only axons to leave the cortex to medulla**:
  1. The great majority of axons <u>do not leave</u> cerebellum & end in *deep cerebellar nuclei*, specially **<u>Dentate nucleus</u>**.
  2. Some of axons <u>leave</u> cerebellum **as efferent fibres**.



Efferent Fibres:

- Most of efferent fibres are *axons of deep cerebellar nuclei*.
- Main Efferents go to:
  1. **Vestibular nuclei** (cerebello-vestibular tract).
  2. **Red nucleus** (Dendato-rubro-thalamic tract).
  3. **Ventral lateral nucleus of thalamus** (Dendato-thalamic).

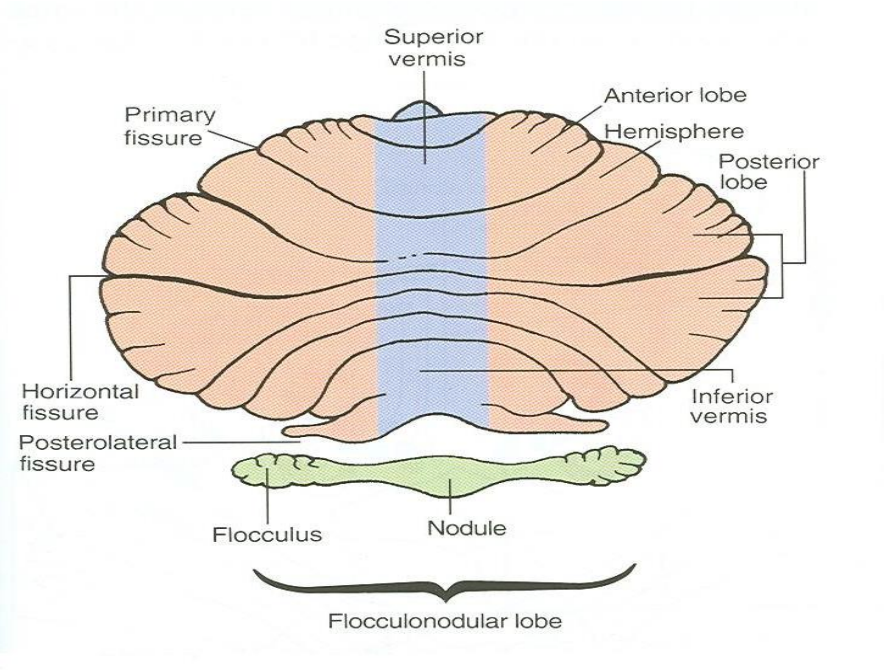


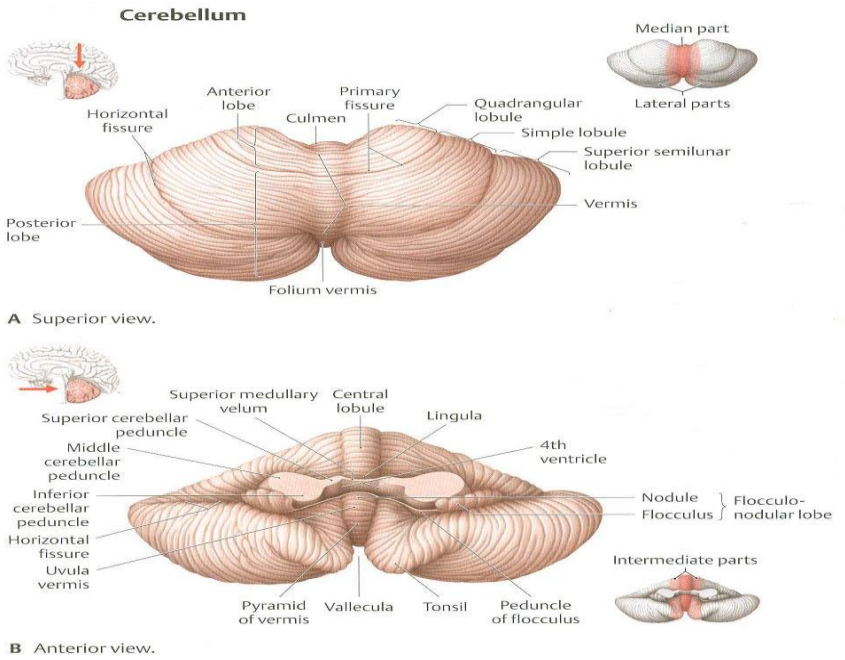
Extra

Cerebellum
Functional Subdivisions

Cerebellum is divided according to function into 3 parts:

1. **Archi**cerebellum	2. **Paleo**cerebellum	3. **Neo**cerebellum
Vestibular Part of cerebellum: **Flocculonodular** lobe.	Spinal Part of cerebellum: **Vermis** & **Paravermis**	Cerebral Part of cerebellum: **Rest of Cerebellum**.





Cerebellum
Functional Subdivisions

SCP = superior cerebellar peduncle
MCP = middle cerebellar peduncle
ICP = inferior cerebellar peduncle

	Archicerebellum	**Paleocerebellum**	**Neocerebellum**
Nuclei Related	Fastigial	Globose & Emboliform	Dentate
Afferents	from **Vestibular** nuclei (*Vestibulocerebellar* fibres), (through ICP)	from **spinal cord** (dorsal *spinocerebellar* tracts through ICP & ventral *spinocerebellar* tract through SCP)	from **Pons** (*Pontocerebellar* fibres) (through MCP)
Efferents	cortical (purkinje cell) Fibres project : to **Fastigial nucleus**, which projects to **vestibular nuclei** (through ICP) + to **Reticular** formation	to globose & embliform nuclei which project to **red nucleus** (through SCP)	to **Red nucleus** but mostly to **Ventral Lateral Nucleus of Thalamus** (through SCP) then to **motor cortex**
Function	1. controls body **Balance** (via vestibulospinal & reticulospinal tracts). 2. Control of eye movement (via VO vestibulo-ocular reflex)	controls **posture & muscle tone** (via Rubrospinal tract).	**coordination of voluntary movements** (via descending corticospinal & corticobulbar tracts or rubrospinal tract).

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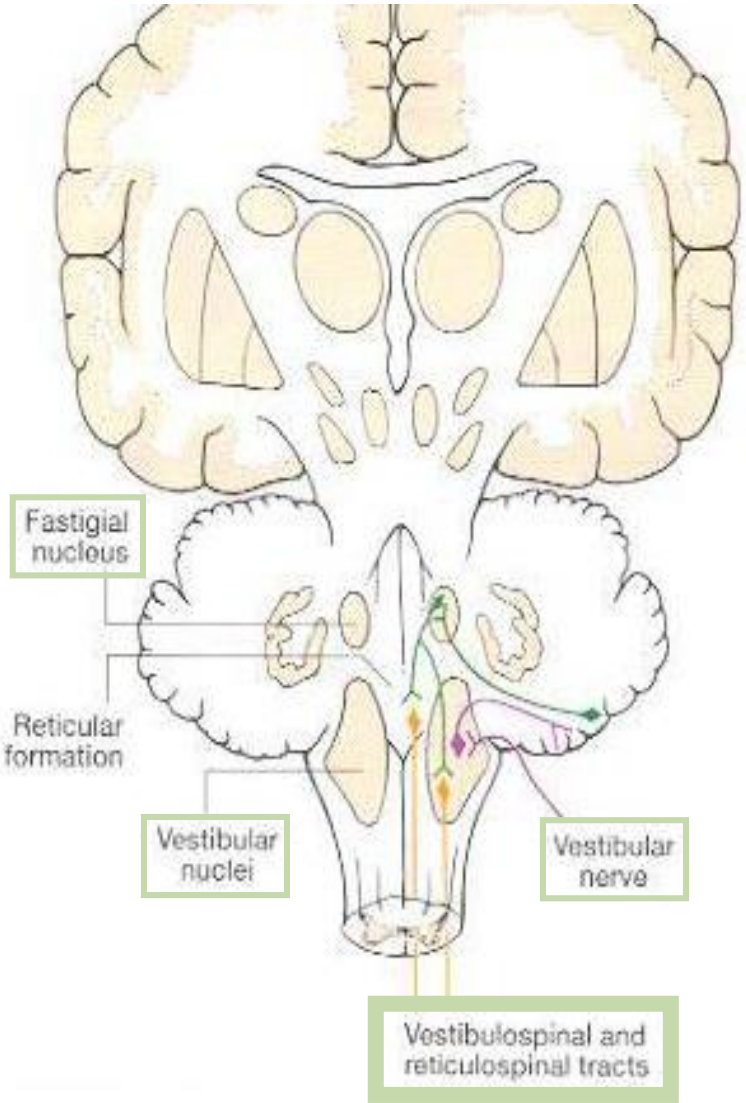

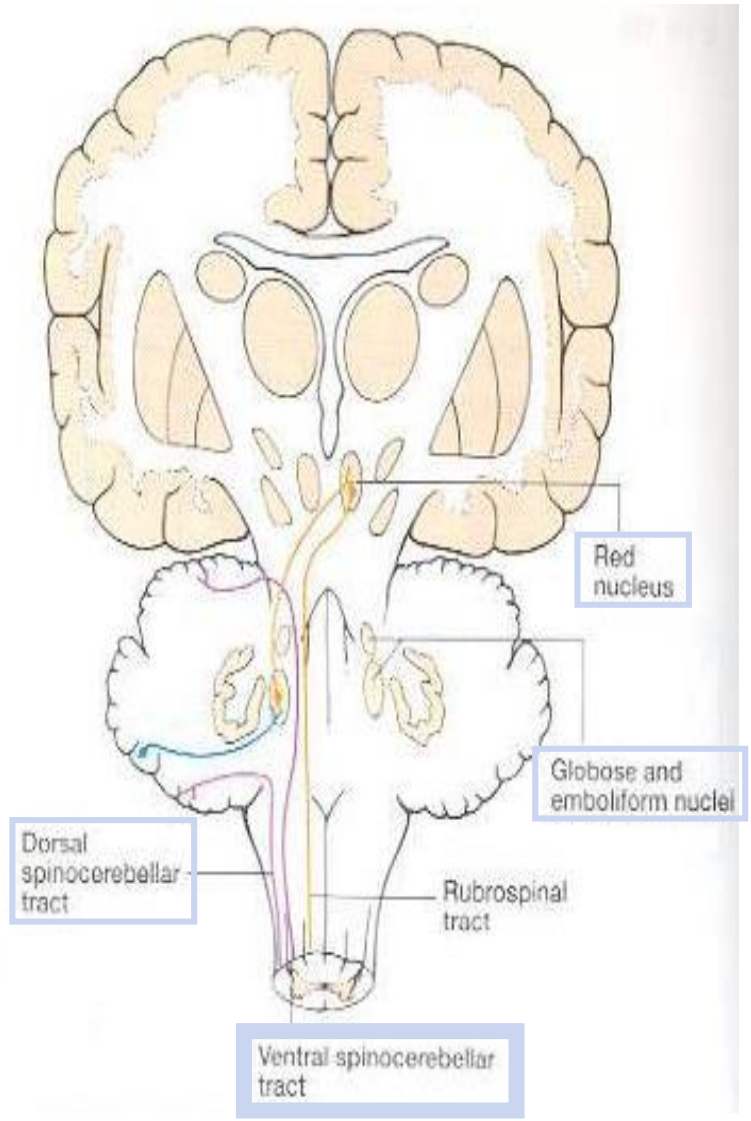

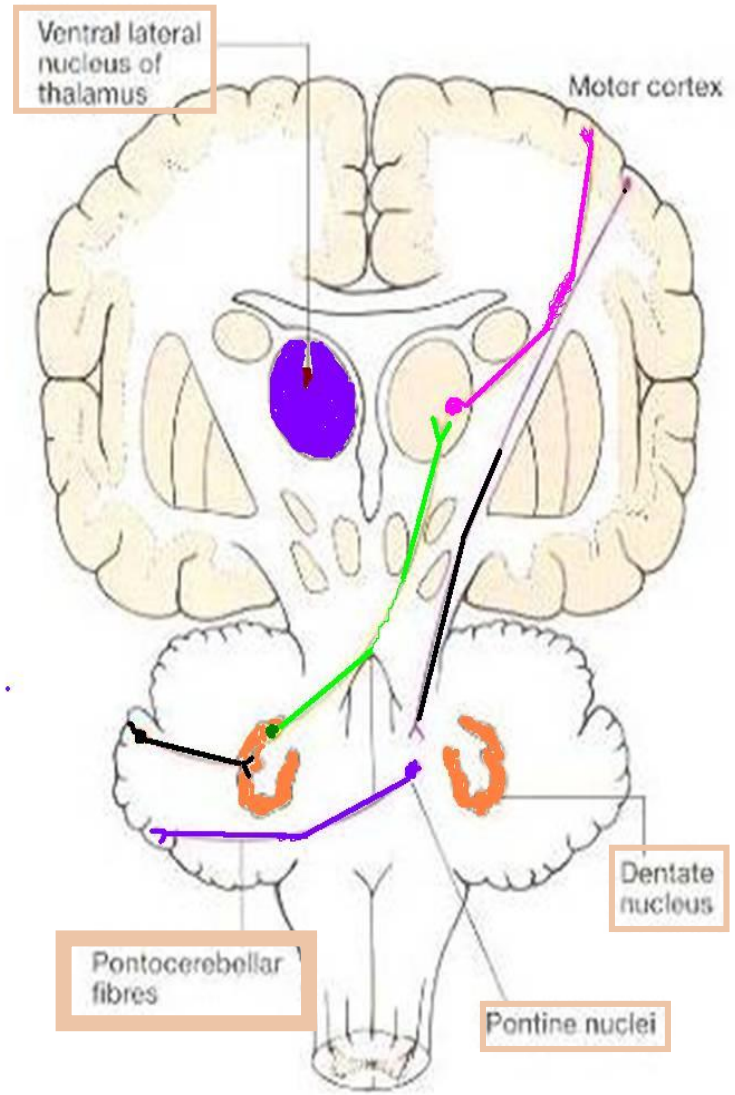

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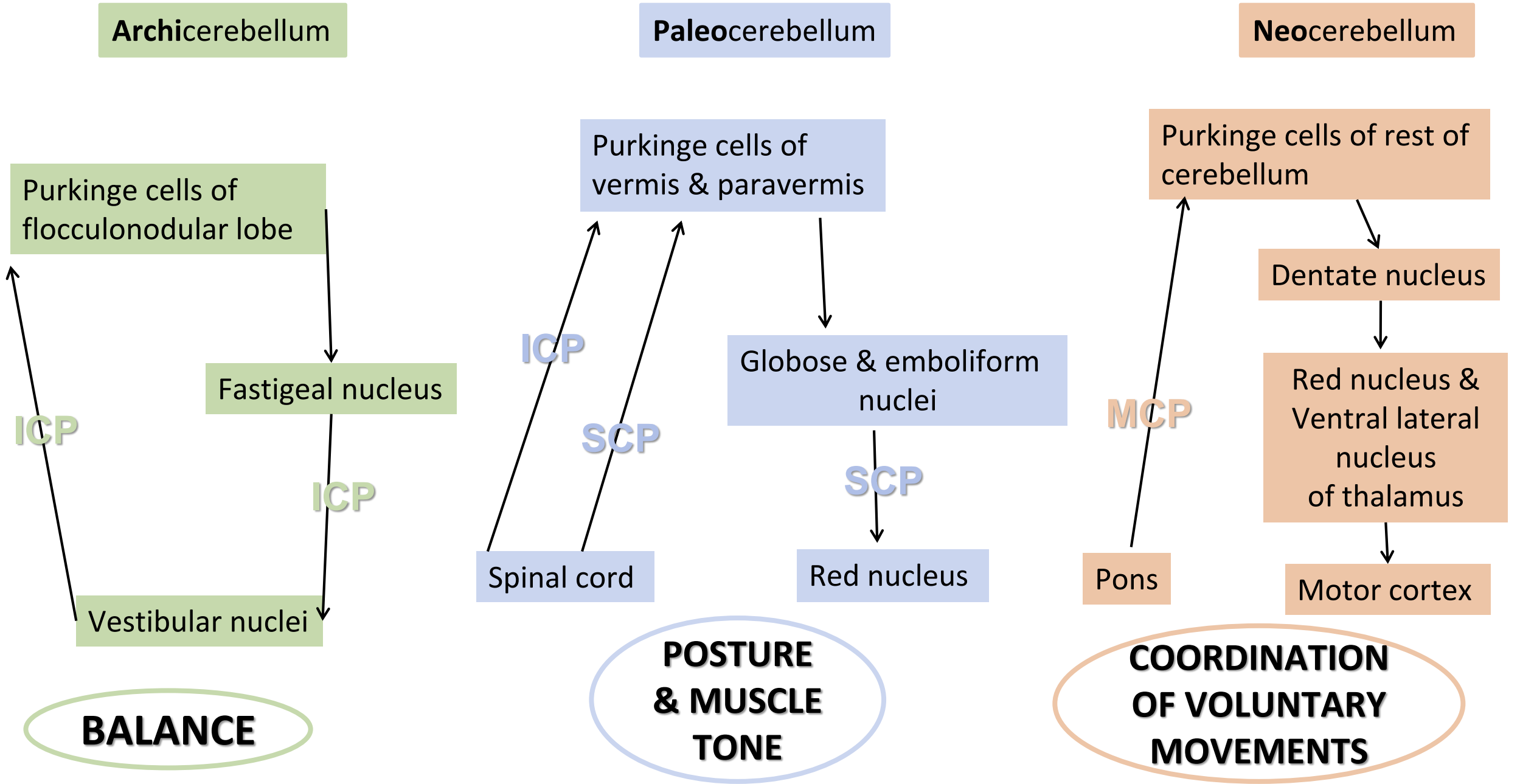
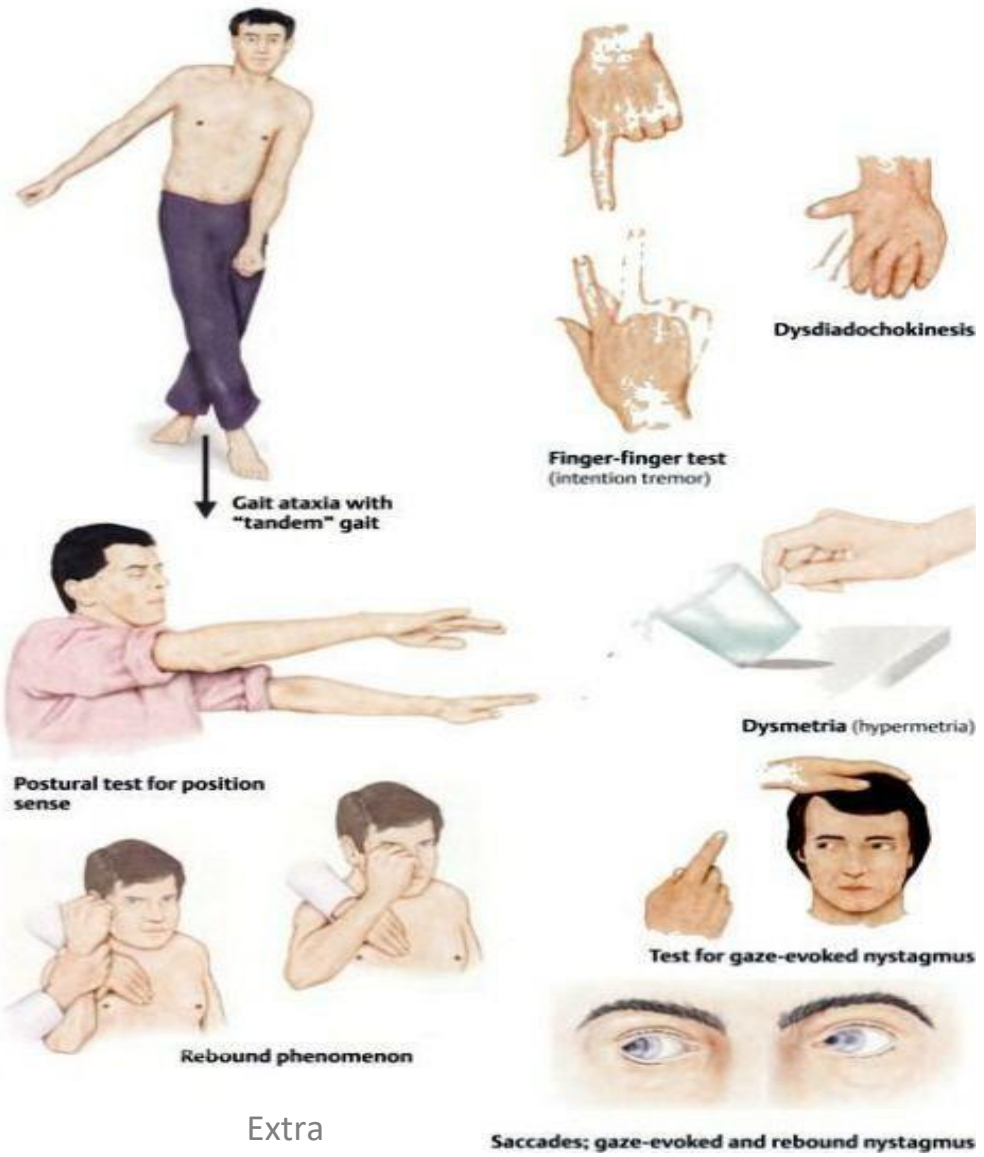


Cerebellum
Cerebellar Lesions

- MIDLINE LESION: Loss of postural control.
- UNILATERAL LESION: "Cerebellar ataxia" causes *ipsilateral*:
  1. Incoordination of arm: **intention tremors** (on performing voluntary movements)
  2. Incoordination of leg: **unsteady gait**
  3. Incoordination of eye movements: **nystagmus**
  4. Slowness of speech: **dysarthria** (difficulty of speech)



Extra

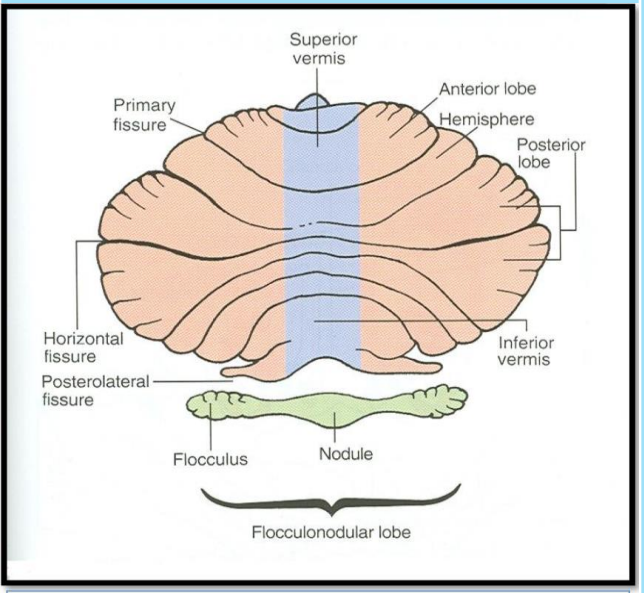
Summary

- Anatomically, the cerebellum is divided into:
  anterior, **posterior** & **flocculonodular** lobes.
- Developmentally & functionally, it is divided into:
  archi- paleo- & **neocerebellum**.

1. **Archicerebellum** (flocculonodular lobe) is the oldest part of cerebellum, related to **fastigial** nucleus, connected to **vestibular** nuclei & concerning for *control of body balance.*
2. **Paleocerebellum** (vermis & paravermis) is related to **globose** & **emboliform** nuclei, connected to **spinal cord** & **red nucleus** & concerned with *regulation of posture & muscle tone.*
3. **Neocerebellum** (most of human cerebellum) is related to **dentate** nucleus, connected to **pons**, **thalamus**. Its final destination is to **motor cortex**. It is *concerned with coordination of voluntary movements.*

- **Cerebellar lesions lead to ipsilateral incoordination** (ataxia).

Characteristics	Cerebellum		
Origin	From **hindbrain**		
Position	Lies behind the pons and medulla, separated from them by **4th ventricle**		
External structures	Consists of two **cerebellar hemispheres** joined in the midline by **vermis**	Its surface is highly convoluted forming **folia**, separated by **fissures**	
Internal structures	Outer grey matter: **cerebellar cortex** Inner white matter: **cerebellar medulla**	Deep seated nuclei in white matter: (from medial to lateral) 1. **Fastigial nnucles** 2. **Globose nucleus** 3. **Emboliform nucleus** 4. **Dentate nucleus**	
Anatomical subdivisions	**Anterior lobe:** In front of primary fissure	**Posterior (middle) lobe:** Between primary and secondary (postero-lateral) fissures	**Flocculonodular lobe:** In front of secondary fissure

Characteristics	Cerebellum		
Functional subdivisions  Green = Archi-cerebellum, Blue= Paleo-cerebellum. Pink= Neo-cerebellum.	**Archicerebellum**: Fastigial nucleus relation **Afferent:** from vestibular nuclei *(vesttibulocerebellar fibers)* through ICP **Efferent:** cortical *(purkinje cell)* fibers project to fastigial which project to vestibular nuclei ± reticular formation **Function:** Control body balance and eye movement	**Paleocerebellum:** Globose and emboliform nuclei relation **Afferent:** from spinal cord *(ventral and dorsal spinocerebellar tracts through ICP and SCP respectively)* **Efferent:** to globose and emboliform nuclei which projects to red nucleus *(through SCP)* **Function:** Control posture and muscle tone	**Neocerebellum:** Dentate nucleus relation **Afferent:** from pons *(pontocerebellar tract)* through MCP **Efferent:** to red nucleus but mostly to ventral lateral nucleus of thalamus through SCP then to motor cortex **Function:** Coordination of voluntary movements

Cerebellar lesions

MIDLINE LESION: *Loss of postural control.*
UNILATERAL LESION: *"Cerebellar ataxia"*
causes *ipsilateral* :

1. **Incoordination of arm:** *intention tremors (on performing voluntary movements)*
2. **Incoordination of leg:** *unsteady gait*
3. **Incoordination of eye movements:** *nystagmus*
4. **Slowness of speech:** *dysarthria (difficulty of speech).*

Questions

1. _____ Climbing and mossy fibers relay to: _____
   A. Afferent, Inner granular layer
   B. Efferent, Inner granular layer
   C. Afferent, purkinje cells
   D. Efferent, purkinje cells

Answer: C

2. To which of the following do main efferents go to:
   A. Red nucleus
   B. Ventral posterior nucleus of thalamus
   C. Globose nucleus
   D. Emboliform nucleus

Answer: A

3. The nuclei related to paleocerebellum are:
   A. Globose & Dentate
   B. Emboliform & Fastigial
   C. Dentate & Fastigial
   D. Globose & Emboliform

Answer: D

4. The cerebellum originates from the dorsal aspect of the brain stem and overlies the _____ ventricle.
   A. Lateral ventricle
   B. Midline ventricle
   C. Third ventricle
   D. Fourth ventricle

Answer: D

5. Neocerebellum coordinate voluntary movements via:
   A. Vestibulospinal & reticulospinaltracts
   B. Descending corticospinal & corticobulbar tracts
   C. Descending corticospinal & reticulospinaltracts
   D. Vestibulospinal & corticobulbar tracts

Answer: B

6. Archicerebellum controls:
   A. Body Balance
   B. Posture
   C. Memory and speech
   D. All of the above

Answer: A

7. Damage to the cerebellum does not cause disorders of:
   A. Movement
   B. Equilibrium
   C. Motor learning
   D. Posture

Answer: C

8. List the effects of unilateral cerebellar lesion:

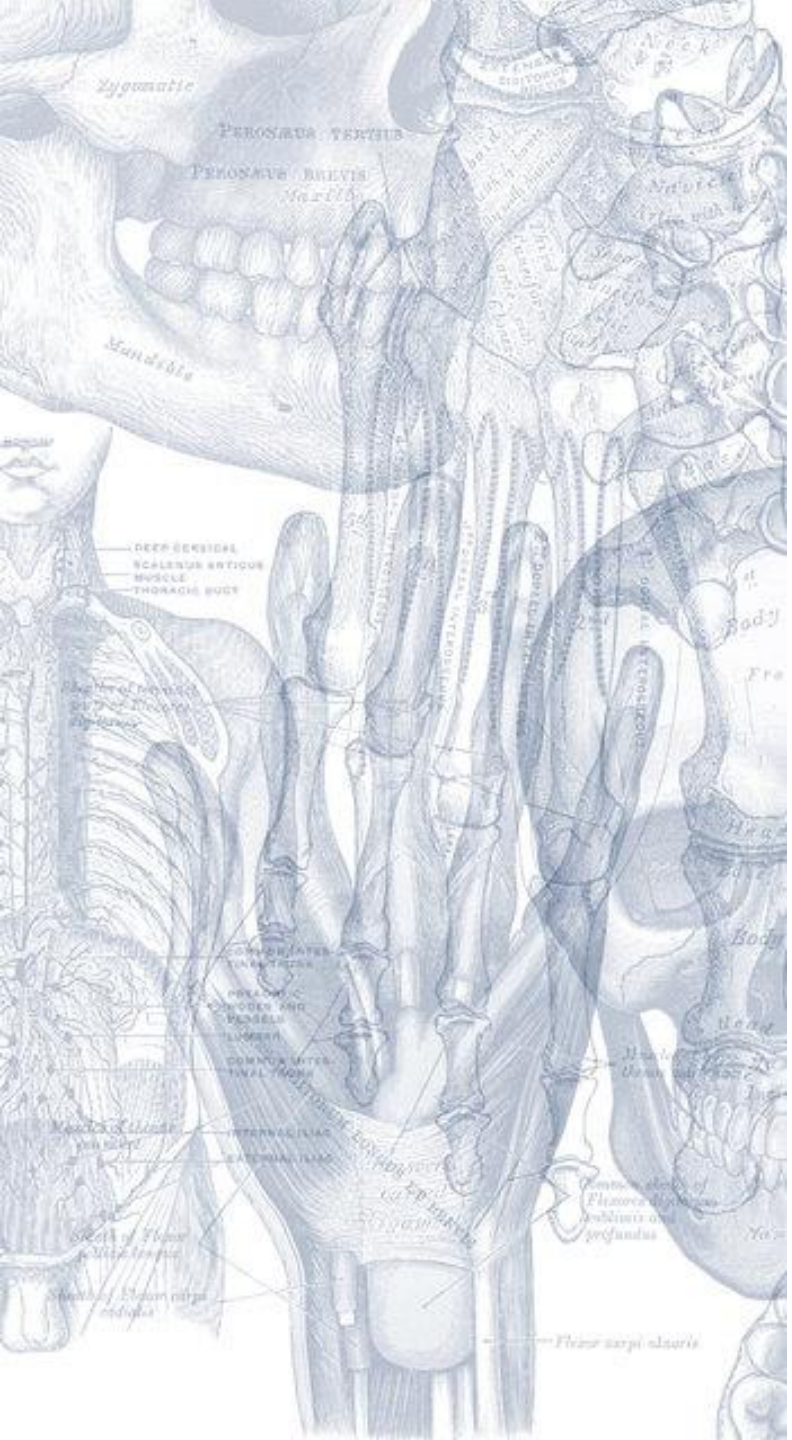
Answer: intention tremors, unsteady gait, nystagmus, dysarthria.

9. Name the three layers of the Cerebellum's cortex:

Answer: Molecular, Purkinje, and Granular

10. Damage to the cerebellum results in effects on which side of the body?

Answer: ipsilateral



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Anatomy Team

References:

1- Girls' & Boys' Slides

2- Greys Anatomy for Students

3- TeachMeAnatomy.com