



MED437
KING SAUD UNIVERSITY



Anatomy of Cerebellum and Relevant Connections

Lecture (14)

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هذا العمل مبني بشكل أساسي على عمل دفعة ٤٣٦ مع المراجعة والتدقيق وإضافة الملاحظات ولا يغني عن المصدر الأساسي للمذاكرة

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

{وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ}

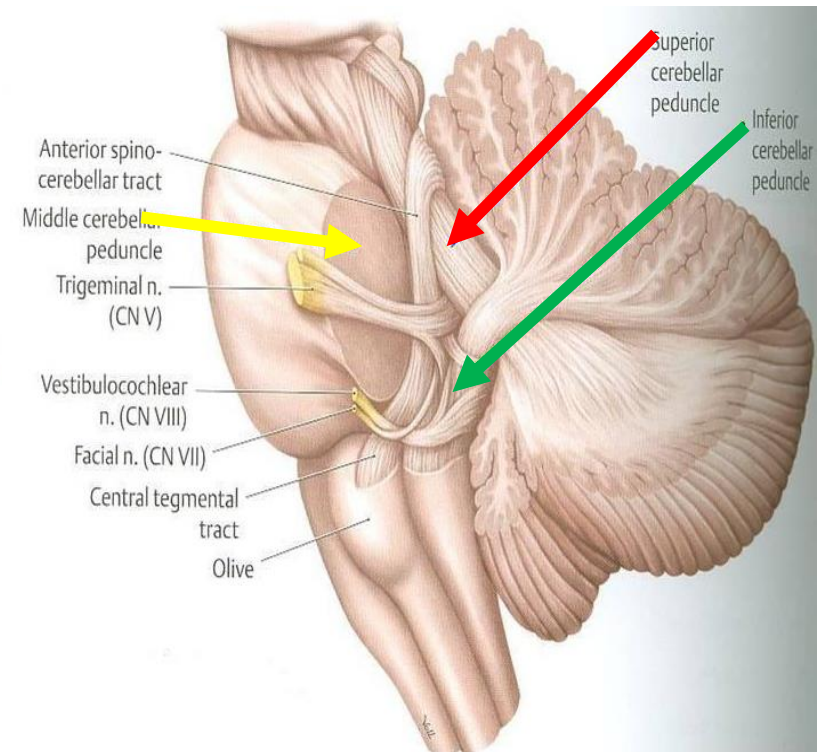
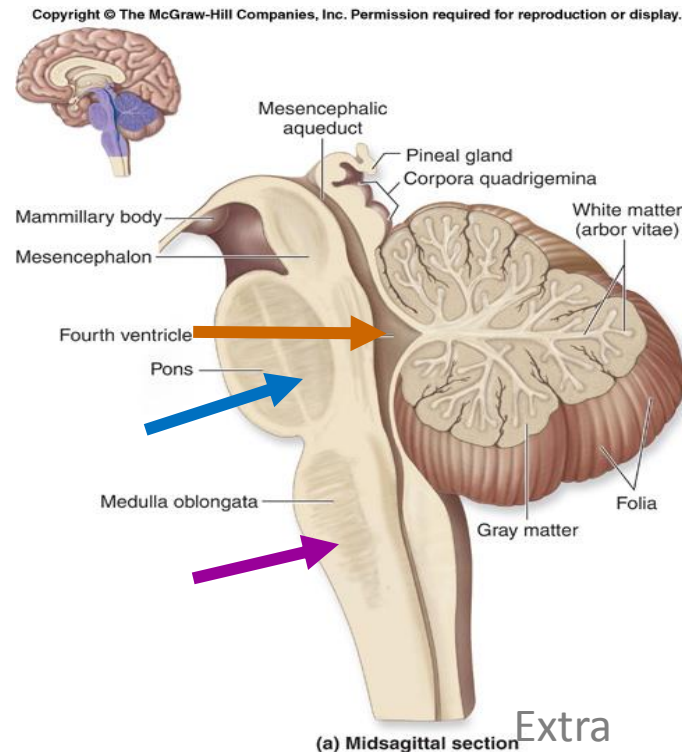
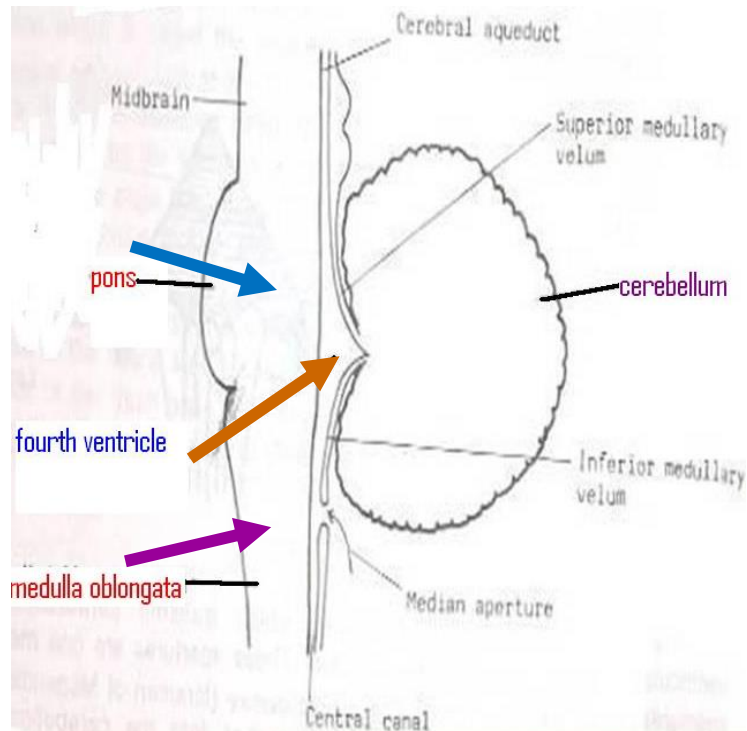
■ Objectives

At the end of the lecture, students should be able to:

- ✓ 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

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



Cerebellum

External Features

Cerebellum has 3 fissures:

- 2 main (primary) fissures (related to lobes): primary and secondary (posterolateral)
- Horizontal fissure (largest/deepest) and not related to lobes

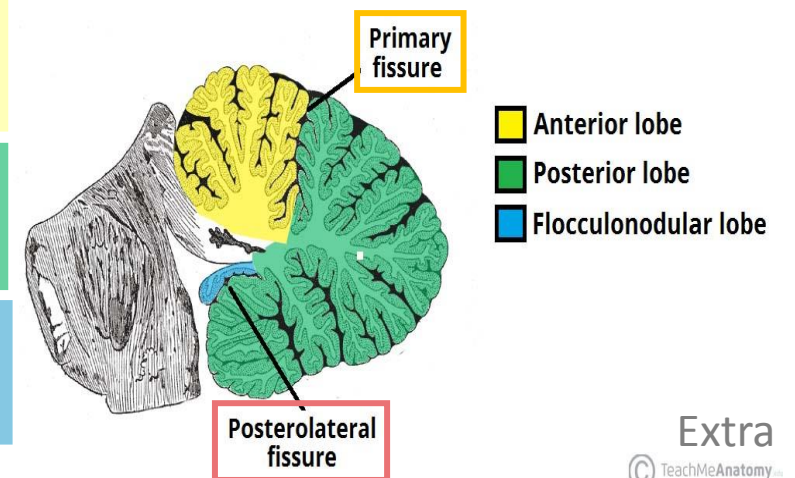
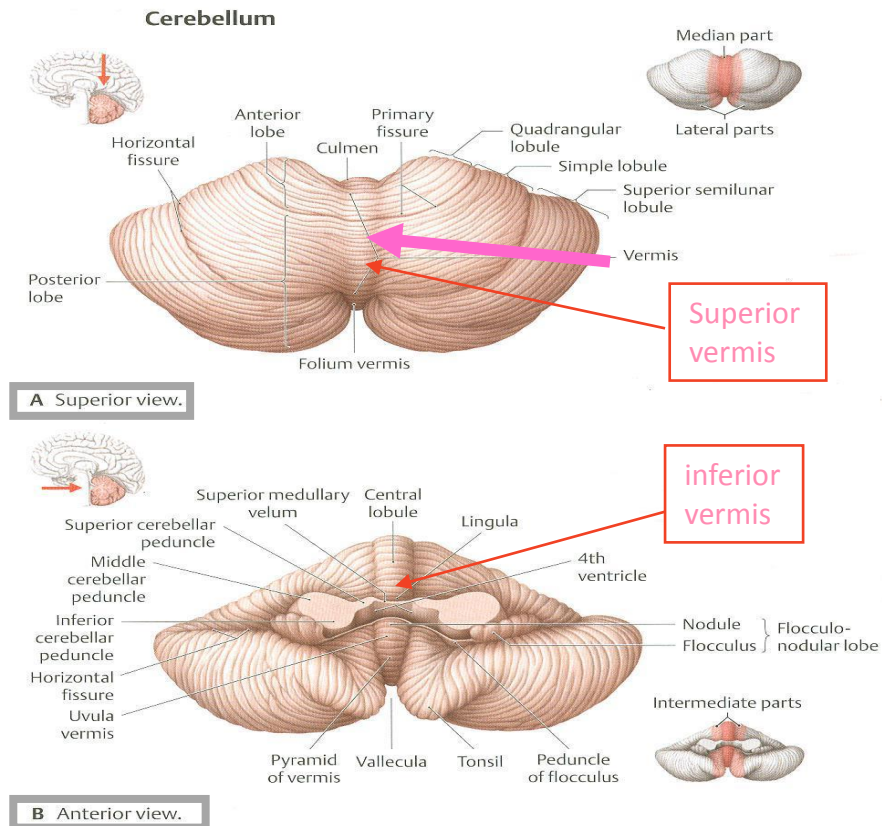
- It consists of **two Cerebellar Hemispheres** joined in midline by the **Vermis**. and paravermis (intermediate zone) is between vermis and hemisphere
- Its surface is highly convoluted forming **Folia** (like gyri), separated by **Fissures** (like sulci).

Anatomical Subdivision

1. **Anterior lobe:** in front of primary fissure, on the superior surface.

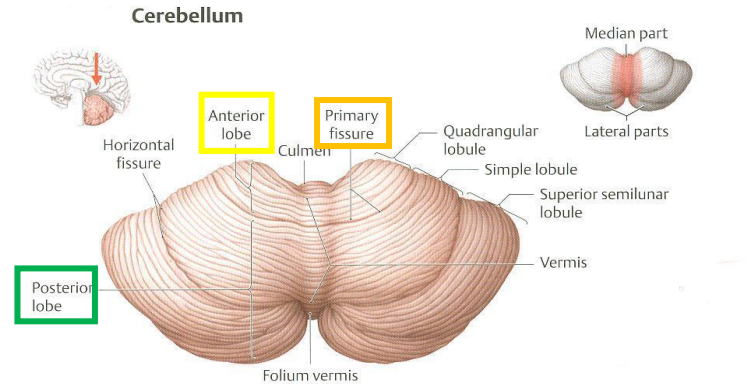
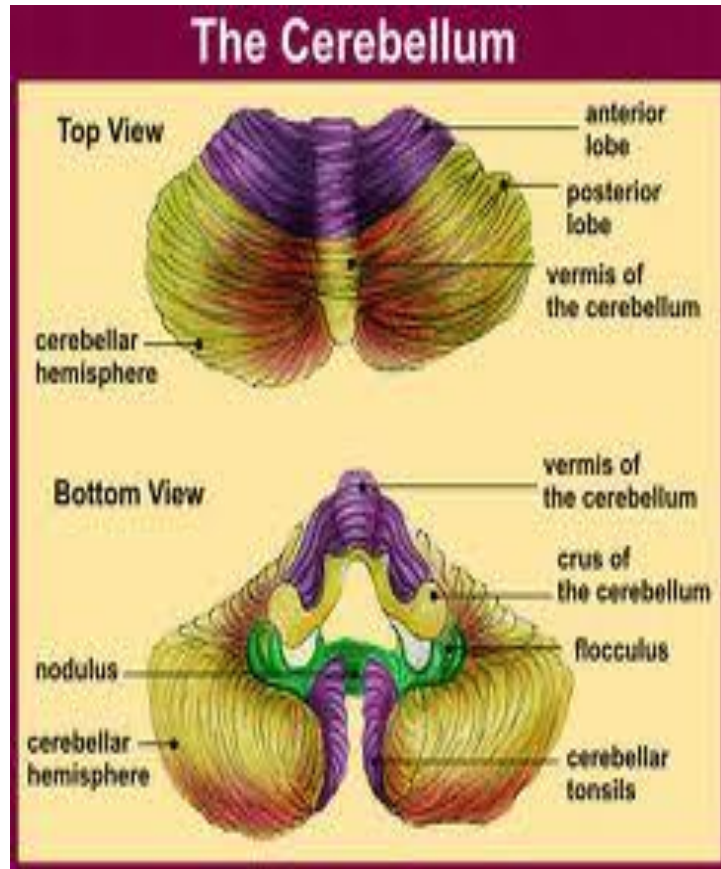
2. **Posterior (middle) lobe:** behind primary fissure (Between Primary & Secondary/posterolateral fissures).

3. **Flocculonodular lobe:** in front of secondary (Posterolateral) fissure, on the inferior surface .

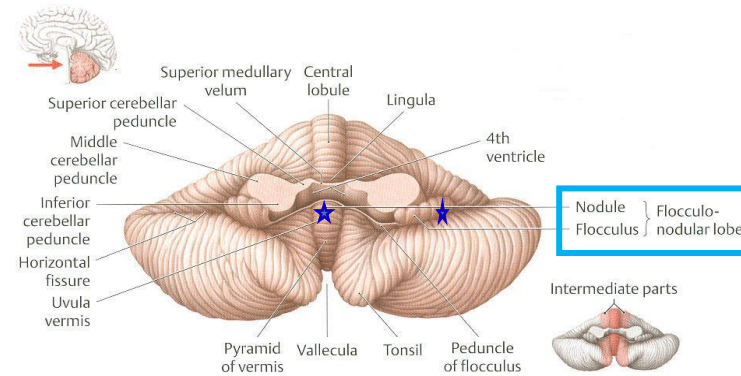


Cerebellum

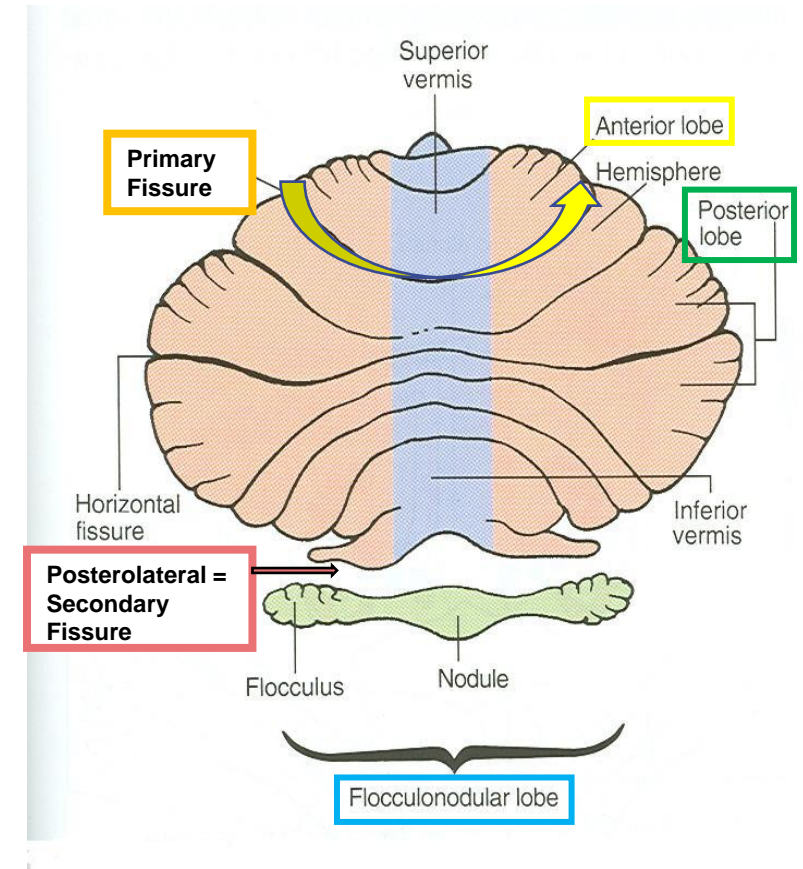
Anatomical Subdivision



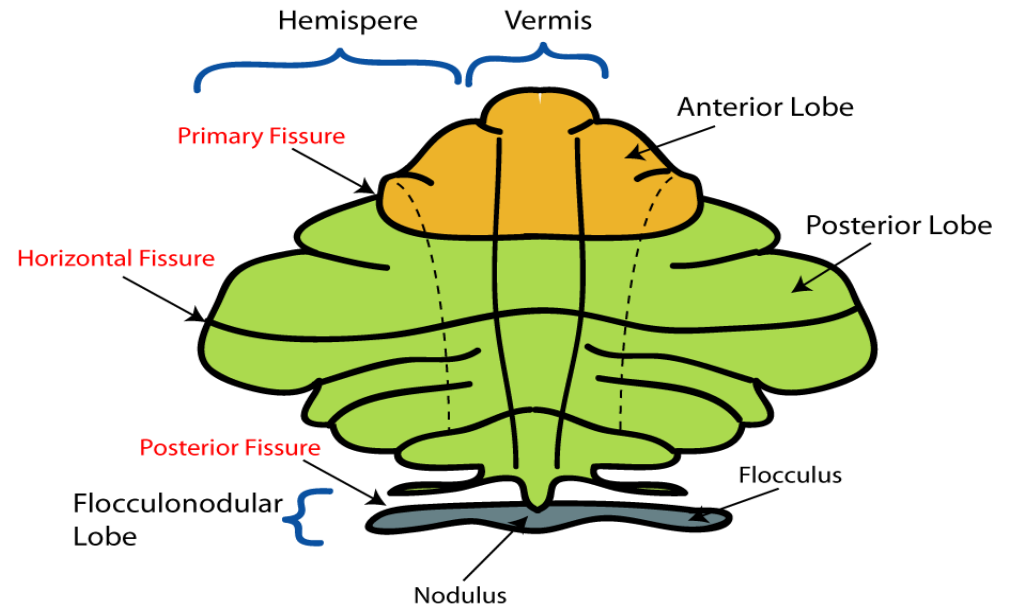
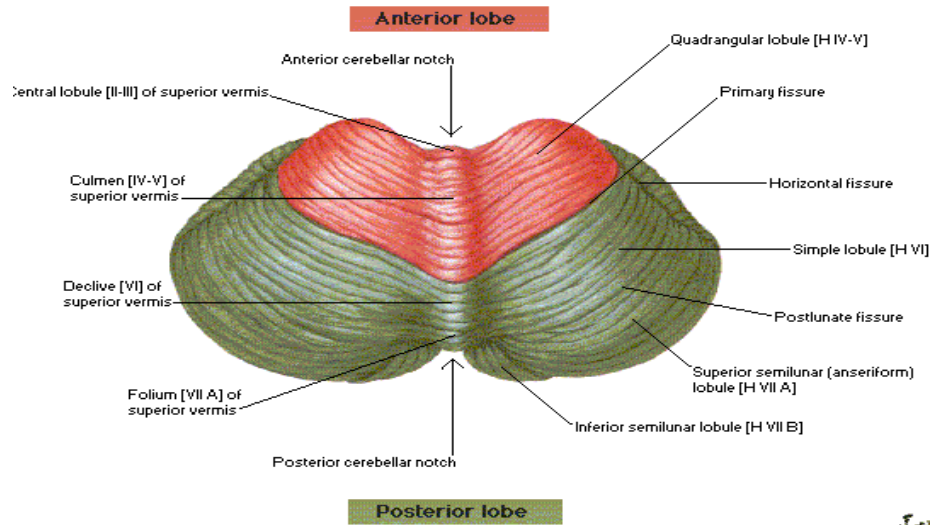
A Superior Surface



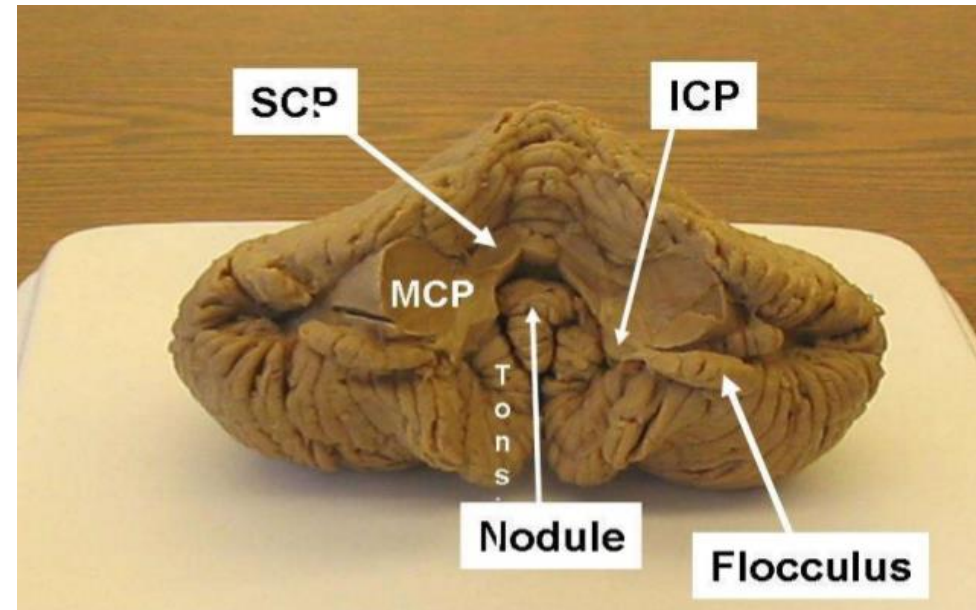
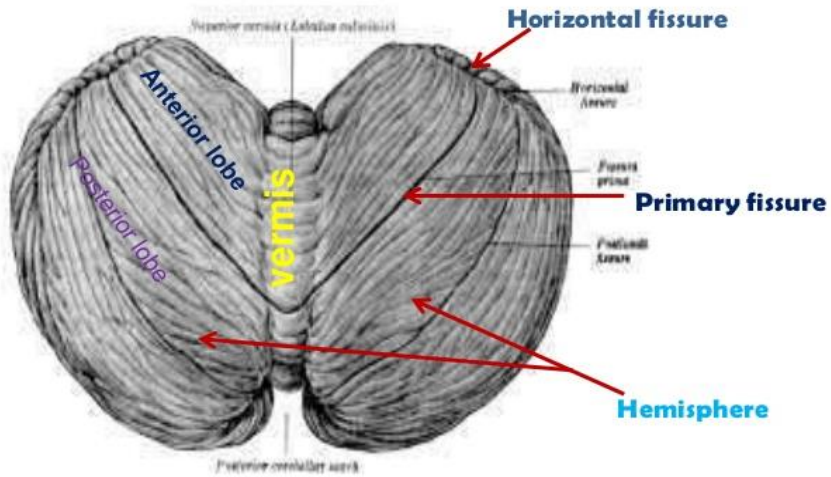
B Anteroinferior Surface



Cerebellum Superior Surface



External surface of cerebellum



Cerebellum

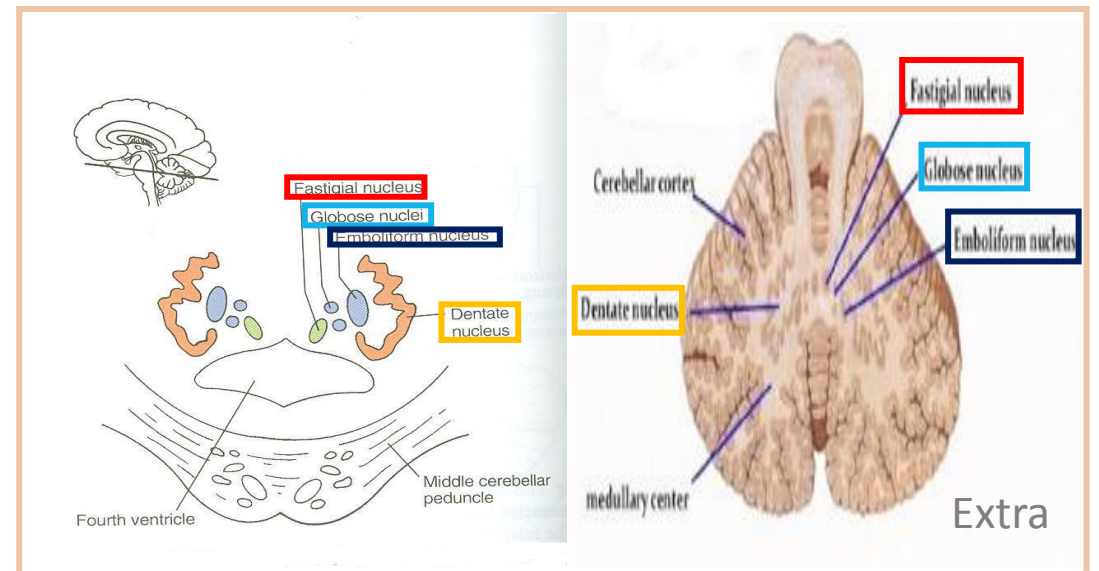
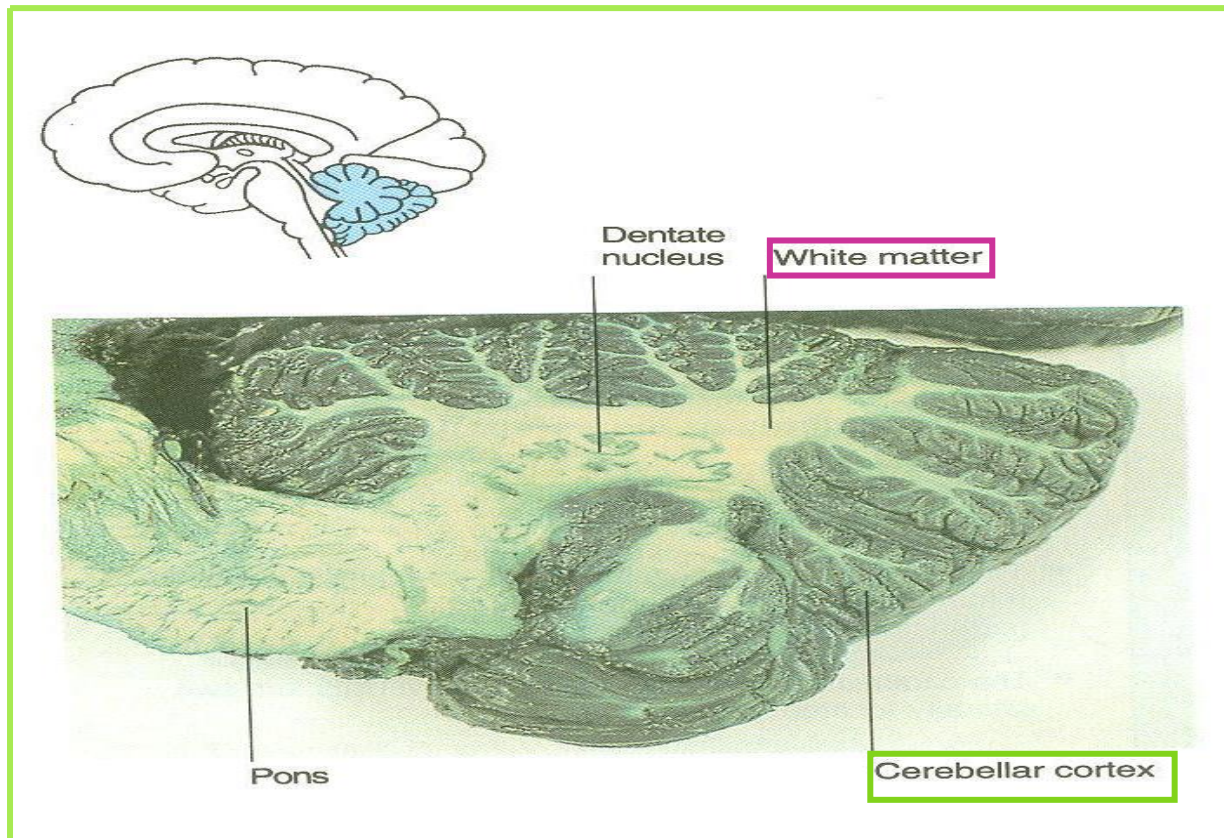
Constituents (Internal Structure and Nuclei of Cerebellum)

Outer grey matter:
cerebellar cortex

Inner white matter:
cerebellar medulla

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

- Fastigial nucleus: smallest one (most medial)
- Globose nucleus.
- Emboliform nucleus. } They have related functions
- Dentate nucleus: largest one.



Cerebellum

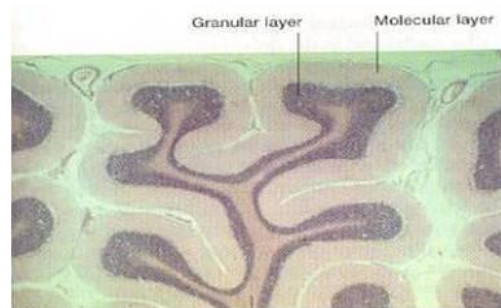
Cerebellar Cortex

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

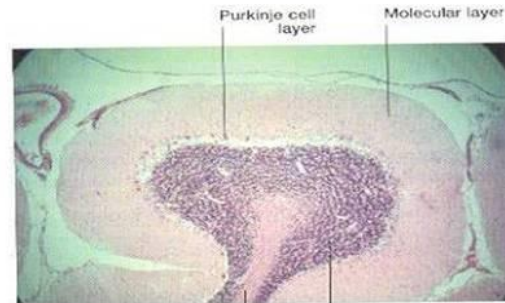
1. Outer molecular layer

2. Intermediate Purkinje cell layer

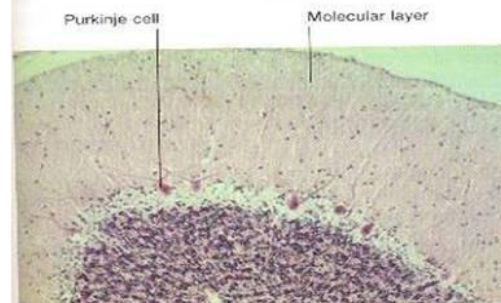
3. Inner granular layer



A (X 25)

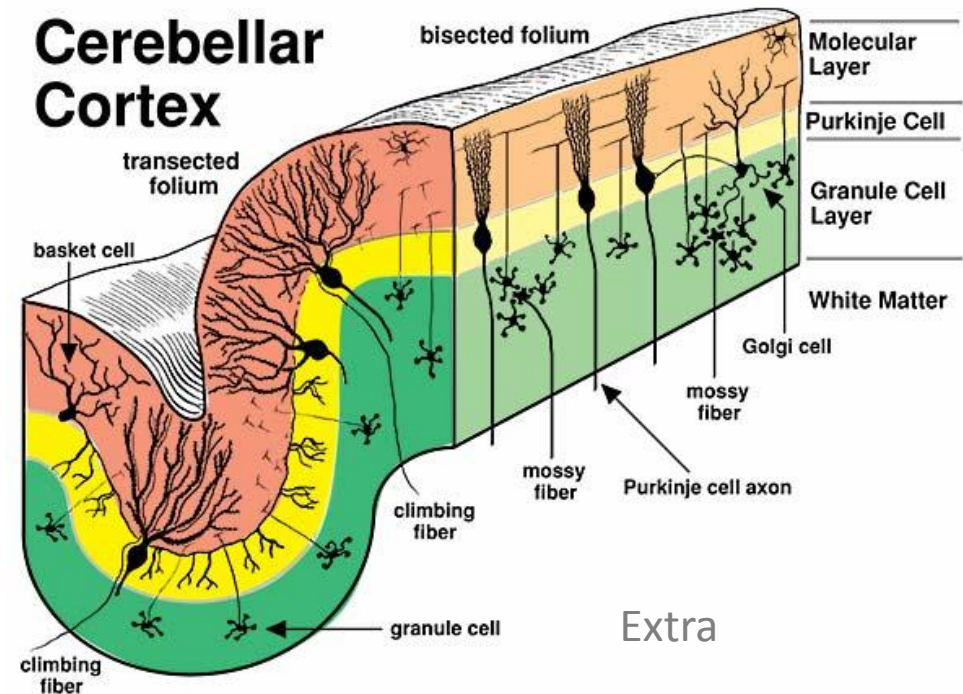


B (X 60)



C (X 160)

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



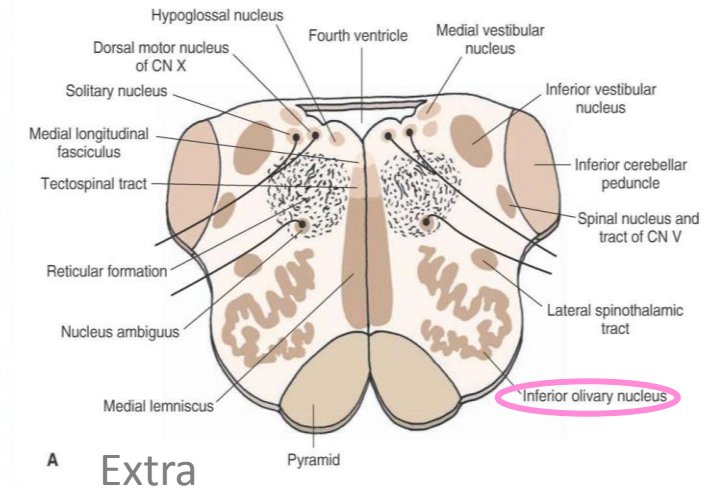
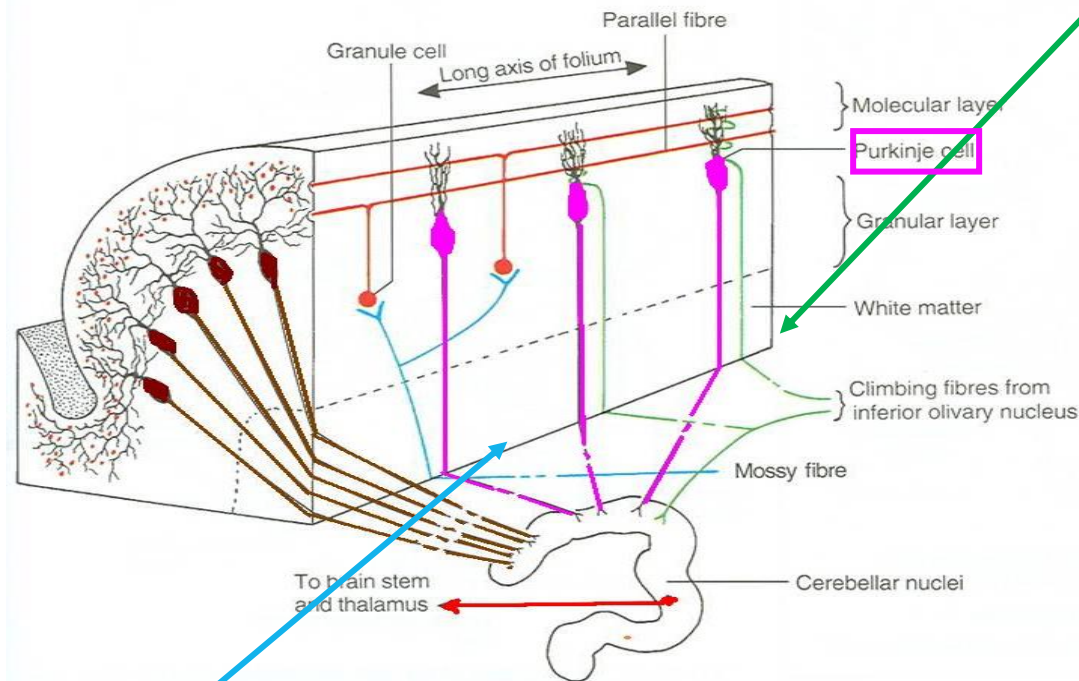
Cerebellum

Cerebellar Medulla

Climbing fibers:
from inferior olivary nucleus, relay to purkinje cells

Afferent fibers:

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



Mossy fibers: rest of fibers:

1. From vestibular nuclei
2. From spinal cord
3. From pons recall : corticopontocerebellar

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

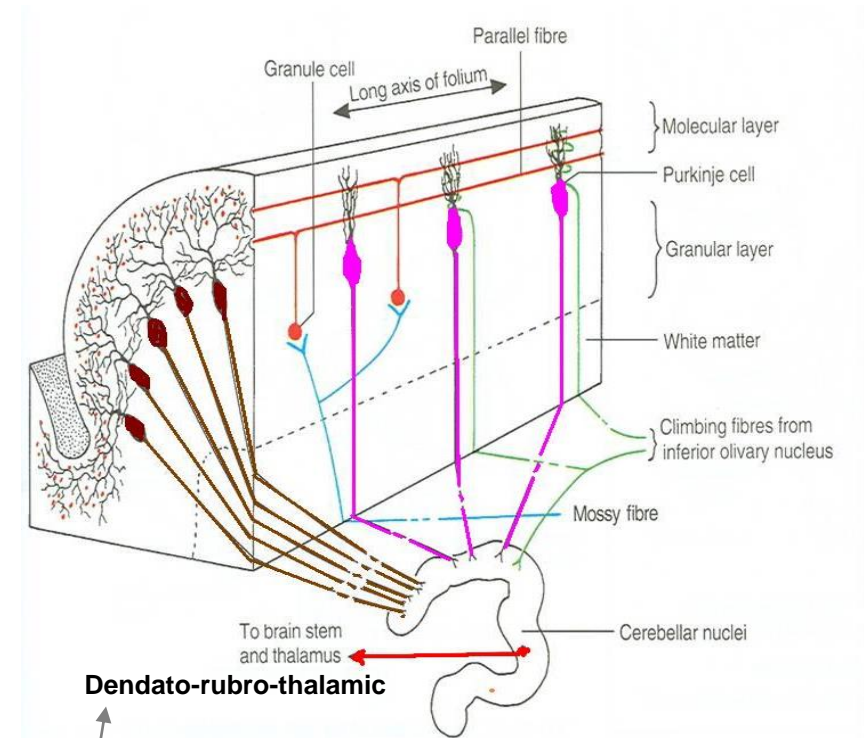
Finally all afferent fibers passing through the medulla relay to purkinje cells in the cortex.

Cerebellum

Cerebellar Medulla

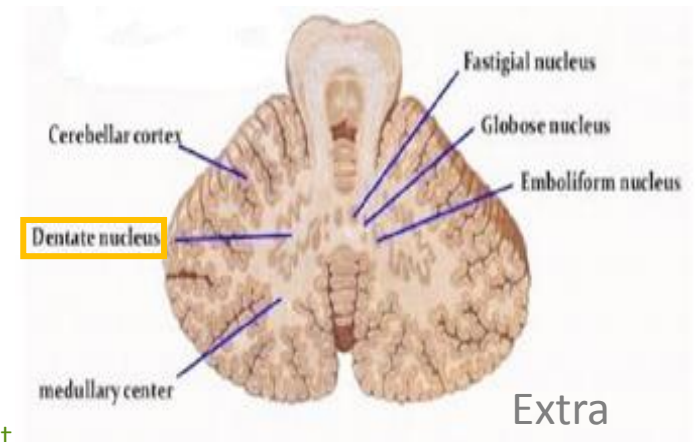
- Axons of Purkinje Cells are the only axons to leave the cortex to medulla:
 1. The great majority of axons do not leave cerebellum & **end in deep cerebellar nuclei, specially Dentate nucleus**.
 2. Some of axons (of deep cerebellar nuclei) leave cerebellum as **efferent fibers**.

Note that the axons of purkinje cells have to go to the cerebellar nucleus



Efferent Fibers:

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



Cerebellum

Functional Subdivisions

Cerebellum is divided according to function into 3 parts:

1. Archicerebellum

Vestibular Part of cerebellum:
Flocculonodular lobe.

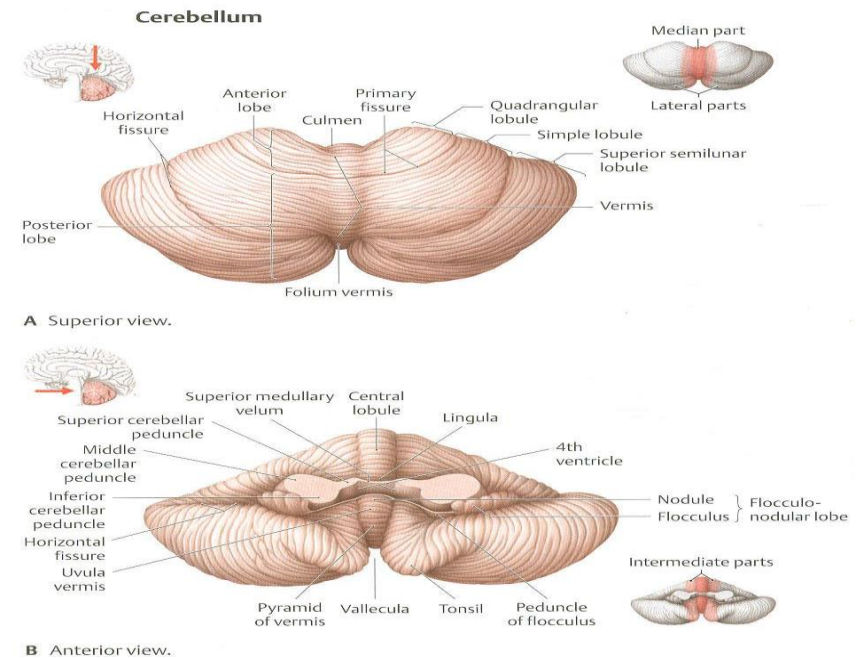
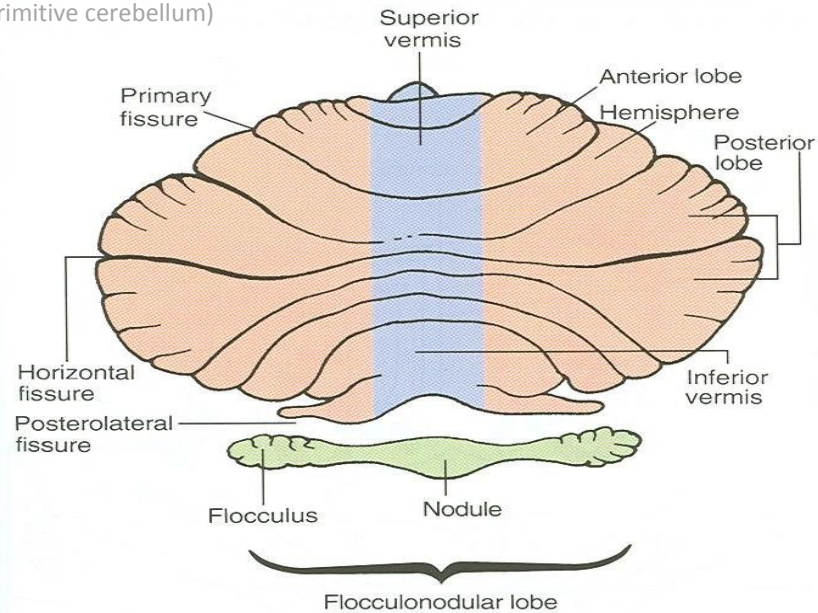
2. Paleocerebellum spinocerebellar

Spinal Part of cerebellum:
Vermis & Paravermis

3. Neocerebellum

Cerebral Part of cerebellum:
Rest of Cerebellum.

Archi = old
In all animals (primitive cerebellum)



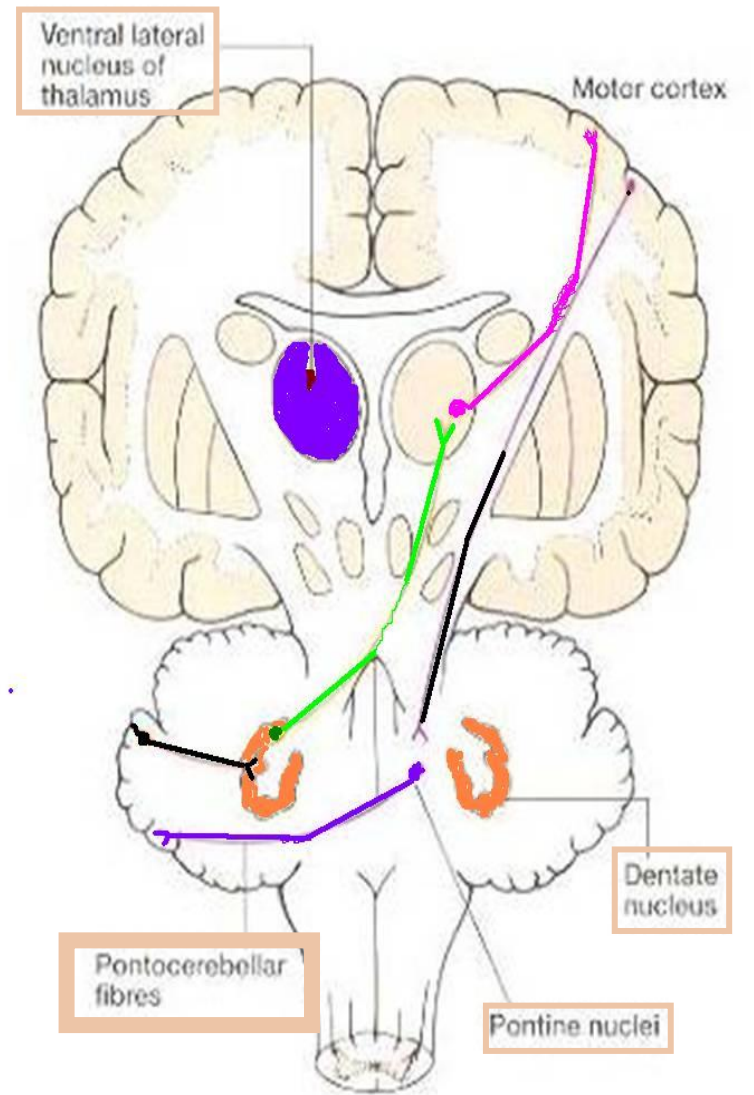
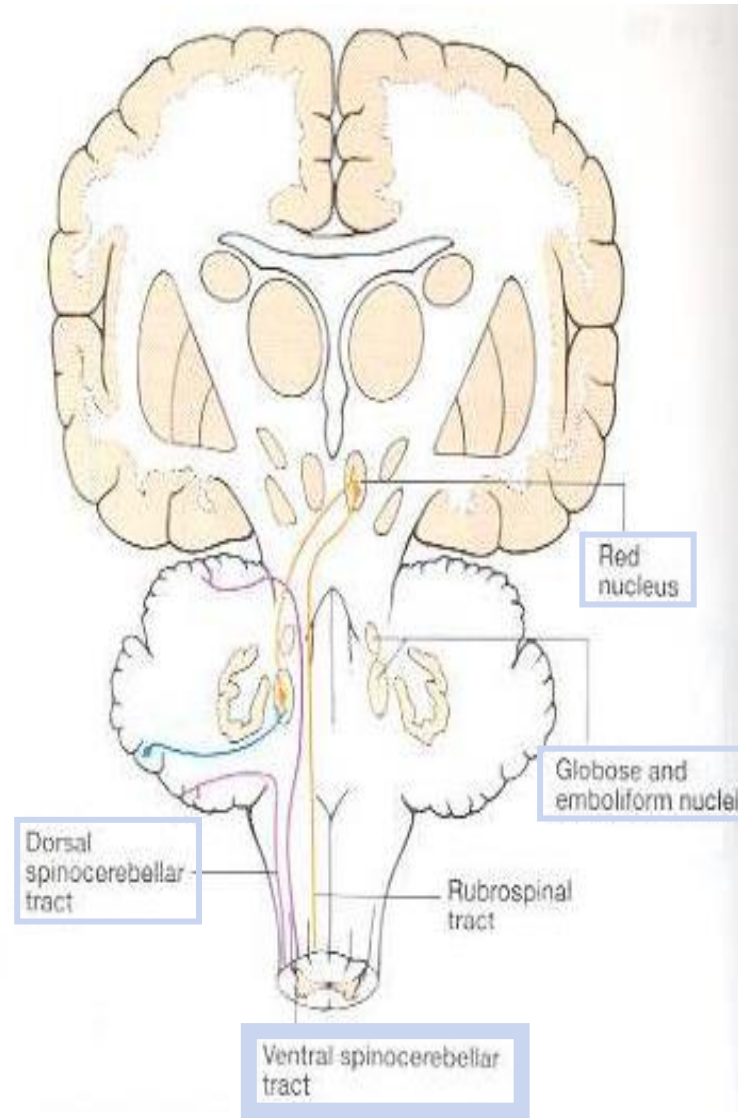
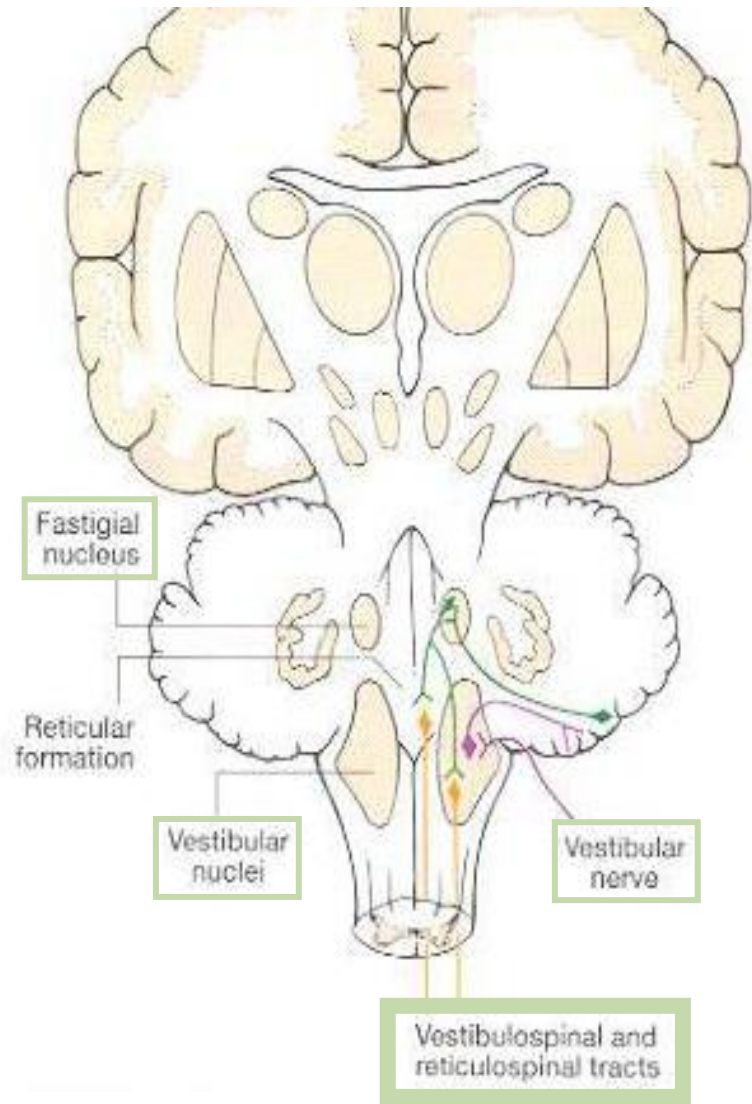
Cerebellum

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 & embiform 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 <u>vestibulospinal</u> & <u>reticulospinal</u> tracts). 2. Control of eye movement (via VO vestibulo-ocular reflex)	controls posture & muscle tone (via <u>Rubrospinal</u> tract).	coordination of voluntary movements (via <u>descending corticospinal</u> & <u>corticobulbar</u> tracts or <u>rubrospinal</u> tract).

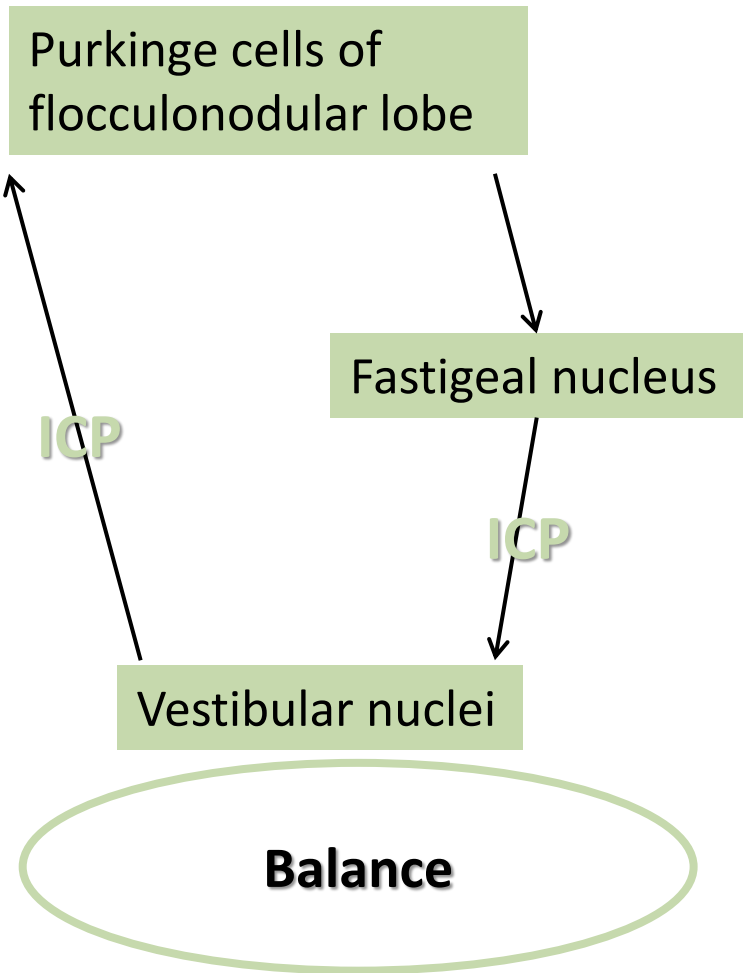
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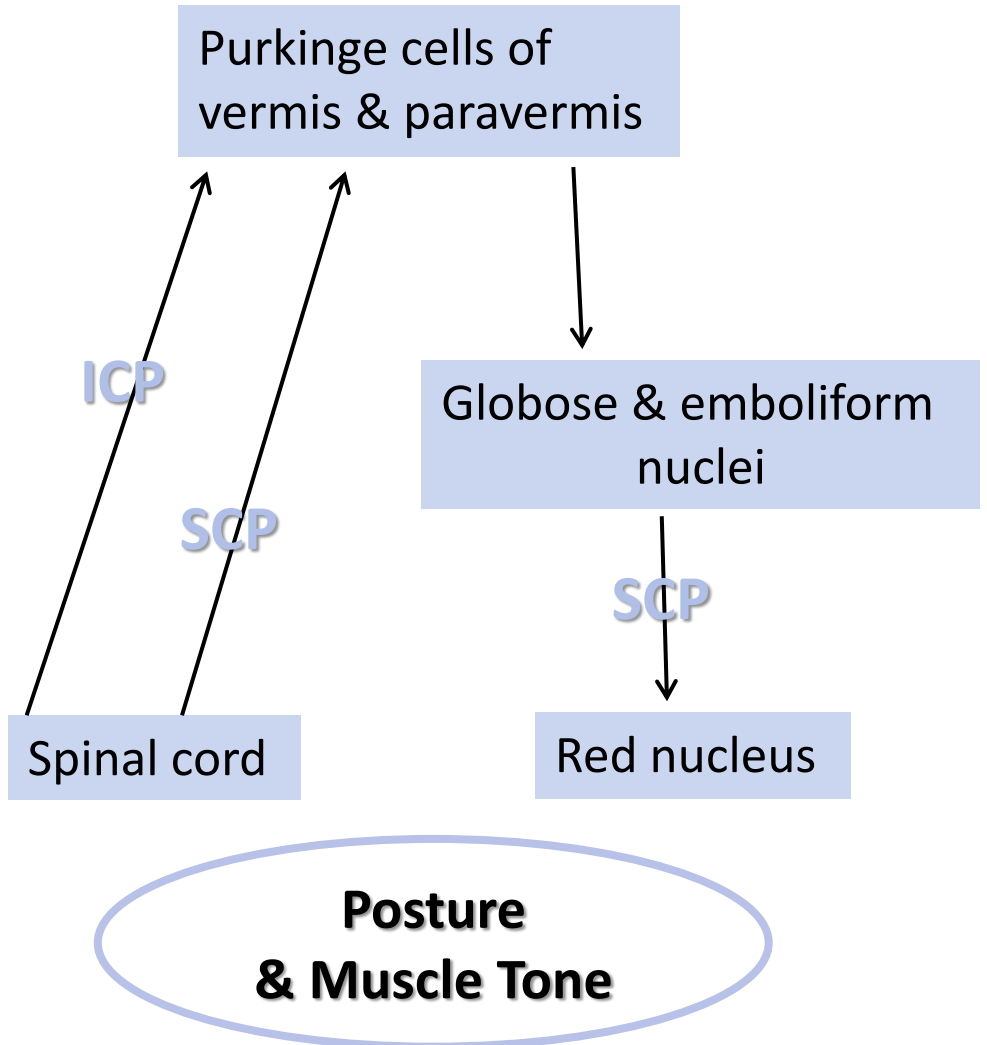
*In the PowerPoint presentation this slide is animated.

Only on the boy's slides

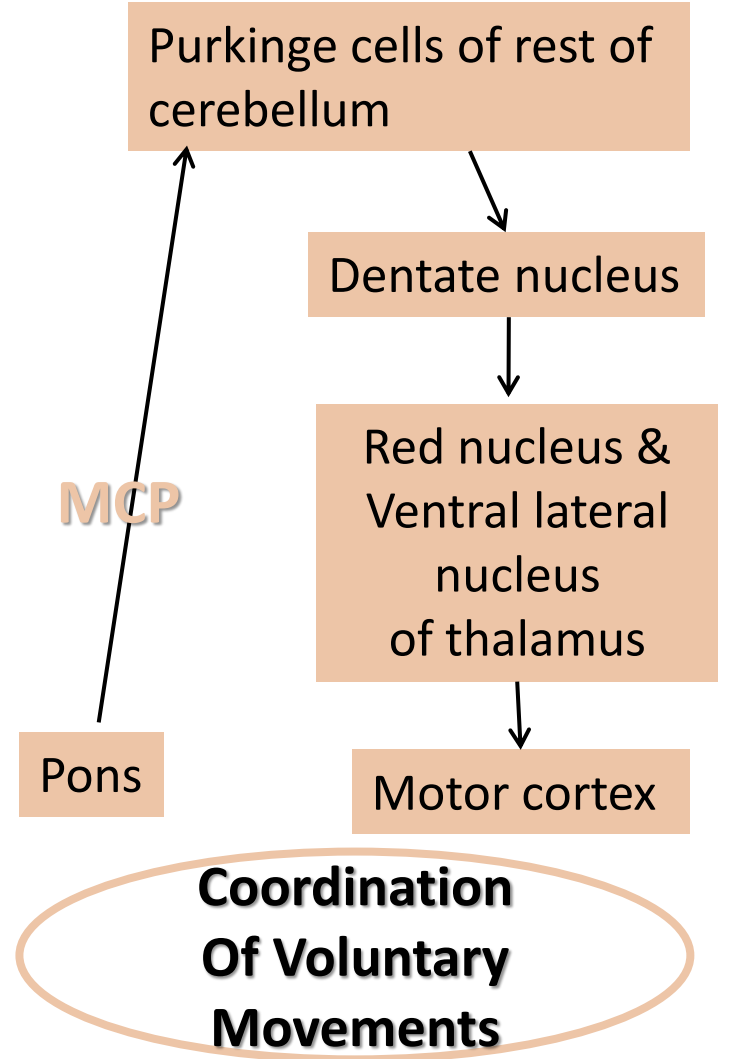
Archicerebellum



Paleocerebellum



Neocerebellum



Cerebellum

Cerebellar Lesions

- MIDLINE LESION: Loss of postural control.
- UNILATERAL LESION: “Cerebellar ataxia” causes ipsilateral:
 1. Incoordination of arm: **intention tremors** (not resting tremors as Parkinson's disease) **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)



Summary

Cerebellum function:

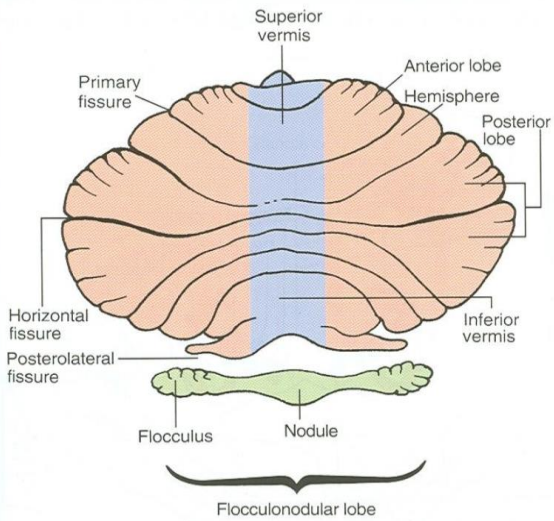
It acts like the maestro, and the muscles are like the musicians, and the cerebral order is like the note. So it coordinates the movement, just like when the maestro leads the musicians. And to do that it has to get information from spinal cord and the cerebrum.

- 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 nucleus 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

Functional subdivisions



Green = Archi-cerebellum,
Blue= Paleo-cerebellum.
Pink= Neo-cerebellum.

Cerebellum

Archicerebellum:

Fastigial nucleus relation

Afferent: from vestibular nuclei (*vestibulocerebellar fibers*) through ICP

Efferent: cortical (*purkinje cell*) fibers project to fastigial which project to vestibular nuclei \pm reticular formation

Function: Control body balance and eye movement

Paleocerebellum:

Globose and emboliform nuclei relation

Afferent: from spinal cord (*dorsal and ventral 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).*

MCQs

(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

(2) To which of the following do main efferent go to?

- A) Red nucleus
- B) Ventral posterior nucleus of thalamus
- C) Globose nucleus
- D) Emboliform nucleus

(3) The nuclei related to paleocerebellum are?

- A) Globose & Dentate
- B) Emboliform & Fastigial
- C) Dentate & Fastigial
- D) Globose & Emboliform

(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

(5) Neocerebellum coordinate voluntary movements via?

- A) Vestibulospinal & reticulospinal tracts
- B) Descending corticospinal & corticobulbar tracts
- C) Descending corticospinal & reticulospinal tracts
- D) Vestibulospinal & corticobulbar tracts

(6) Archicerebellum controls?

- A) Body Balance
- B) Posture
- C) Memory and speech
- D) All of the above

(7) Damage to the cerebellum does not cause disorders of?

- A) Movement
- B) Equilibrium
- C) Motor learning
- D) Posture

(8) ?

- A) B)
- C) D)


(9) ?

- A) B)
- C) D)

(10) ?

- A)
- B)
- C)
- D)

Answers



(1) C

(2) B

(3) D

(4) D

(5) B

(6) B

(7) A

(8) .

(9) .

(10) .



(1) List the effects of unilateral cerebellar lesion?

1. Intention Tremors
2. Unsteady Gait
3. Nystagmus
4. Dysarthria

(2) Name the three layers of the Cerebellum's cortex?

1. Molecular
2. Purkinje
3. Granular

(3) Damage to the cerebellum results in effects on which side of the body?

ipsilateral



Good luck
Special thank for team436 ❤️

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- References:
 1. Girls' & Boys' Slides
 2. Greys Anatomy for Students
 3. TeachMeAnatomy.com

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