



Gaza Ophthalmic Centre

27.3.1 CEREBELLUM Part 1 Neurosciences I

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Gaza Ophthalmic Centre

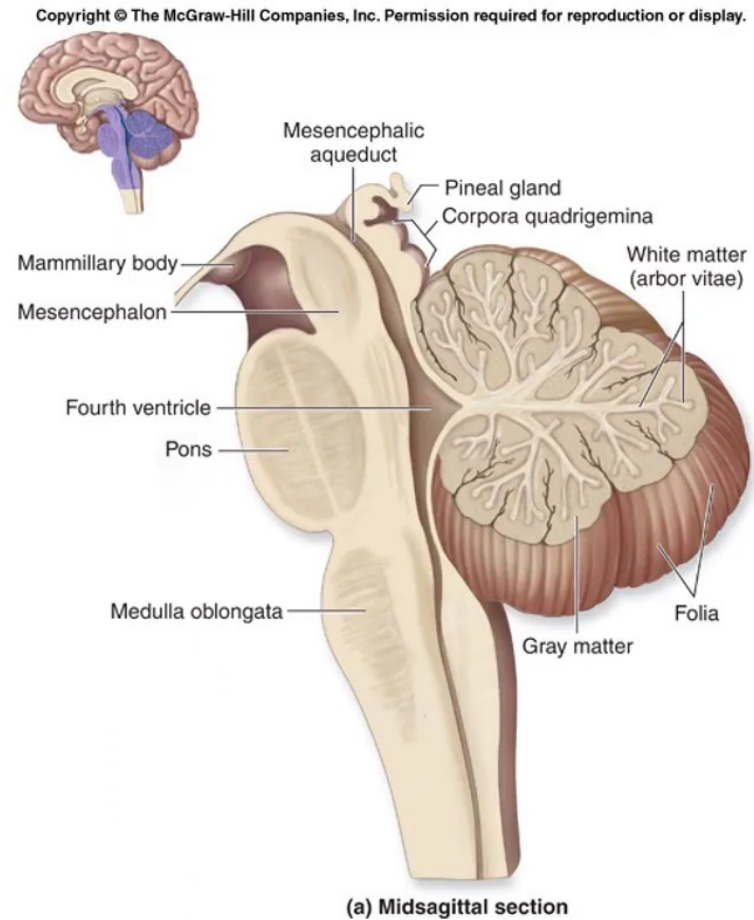
Dr. Maged Awni Abu-Ramadan, MD, FRCSEd



The Cerebellum: General

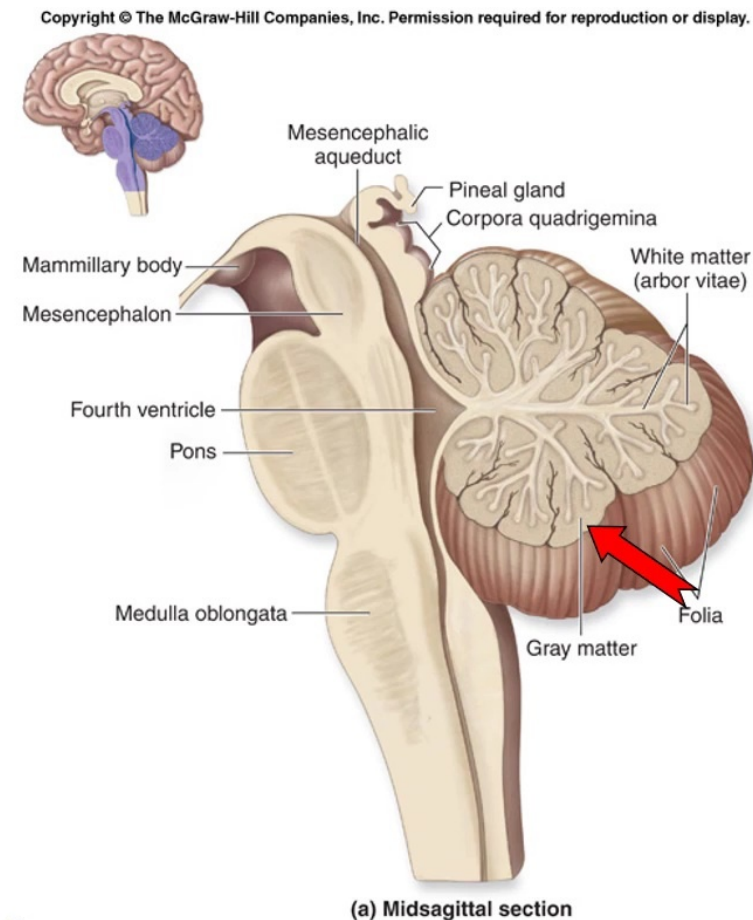
Located

- Dorsal to the
- Pons and
- Medulla



The Cerebellum: General

- Composed of
- Three regions
 - Cortex
 - Gray matter
 - Internal white matter
 - Deep cerebellar nuclei
 - deeply situated
 - gray matter



The Cerebellum: General

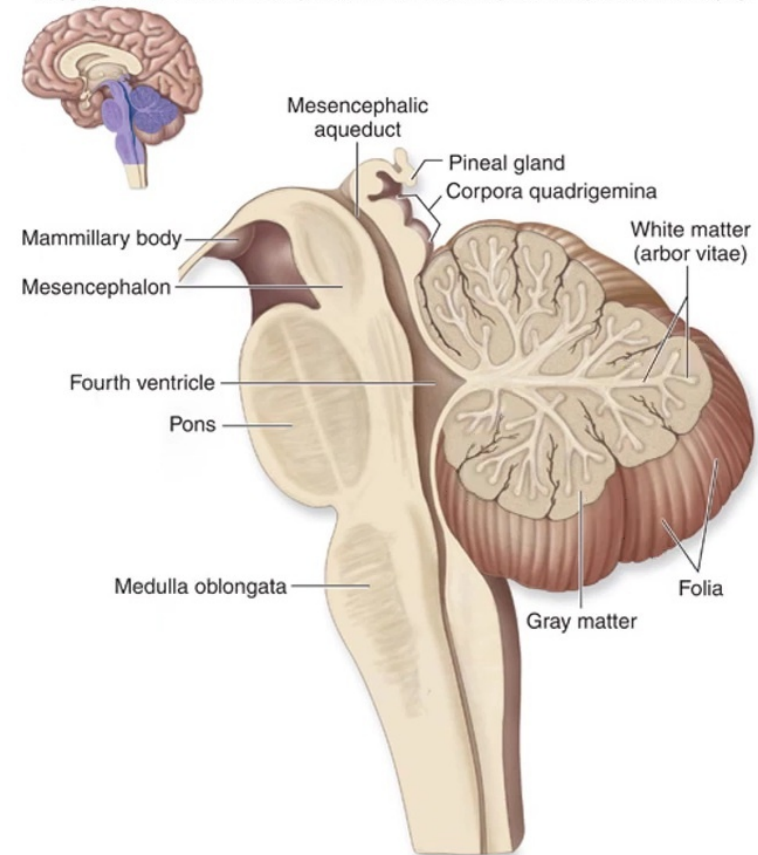
Smoothens and

- Coordinates
- Body movements

Helps

- Maintain
- Equilibrium

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(a) Midsagittal section



The Cerebellum: General

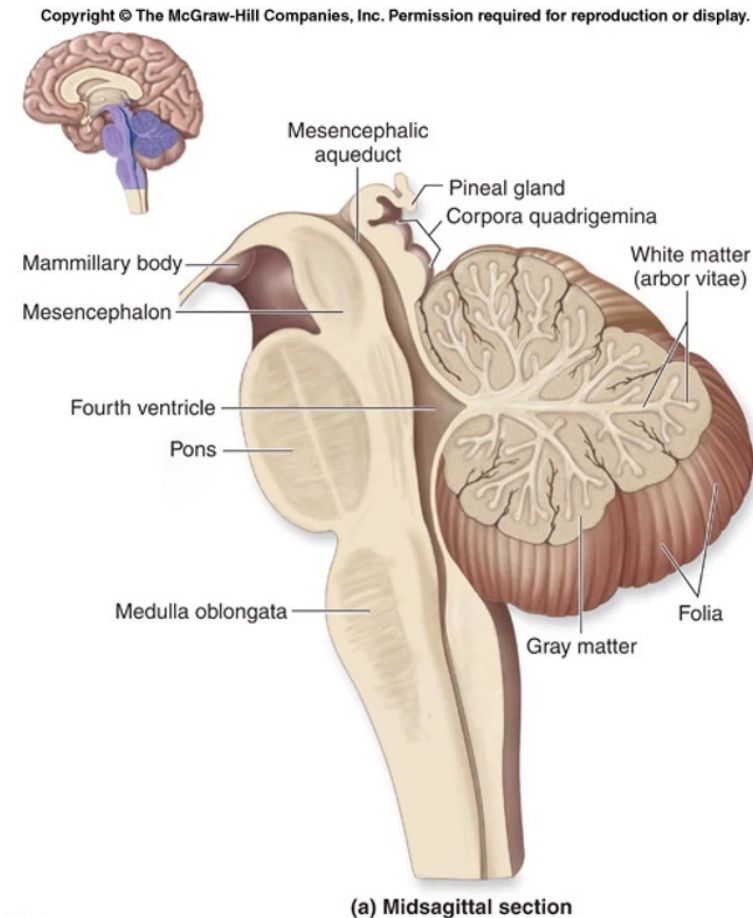
Cerebellum must

- Receive information on

1. Equilibrium
2. Current movements of
 1. Limbs
 2. Neck, and
 3. Trunk

From the

1. Cerebral cortex
2. Spinal cord



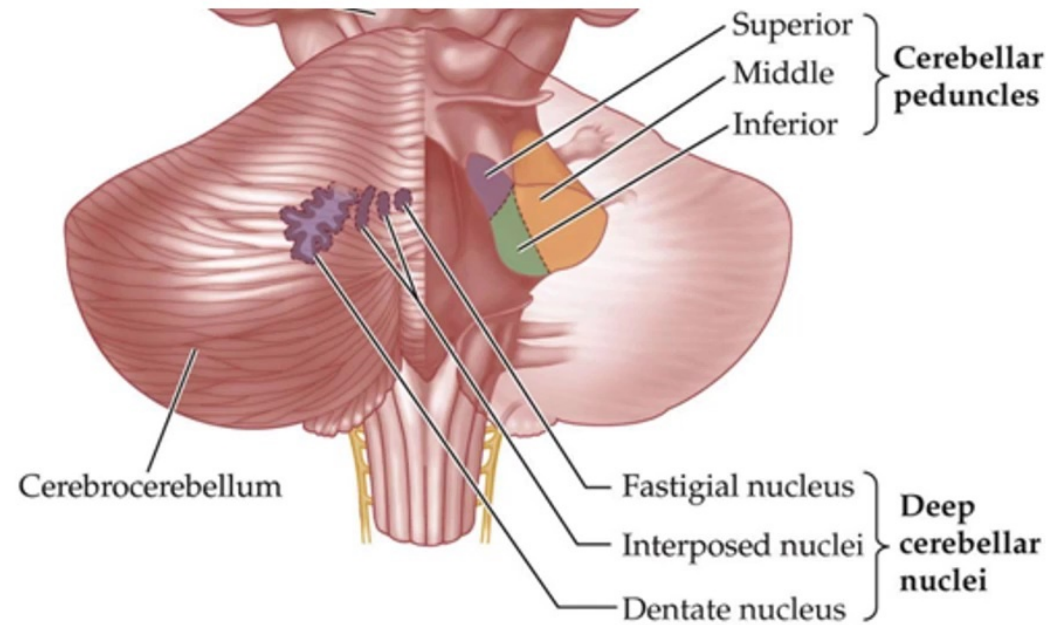
Cerebellum: General

Cerebellar nuclei are

- Three (4)
- Paired

Deep

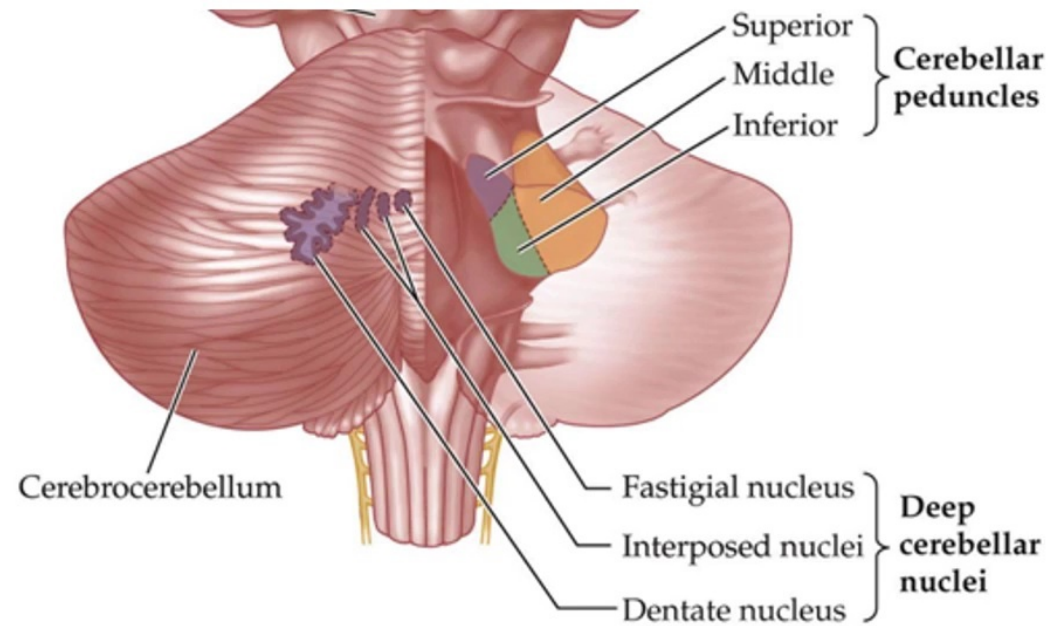
- Located
- within the
- White matter of the
- Cerebellum



Cerebellum: General

The fourth ventricle,

- Ventral to the
- Cerebellum,
- Mass lesions or
- Swelling of
- The cerebellum
- can cause
- **Obstructive**
- **Hydrocephalus**



Cerebellum: Divisions

A) Anatomical

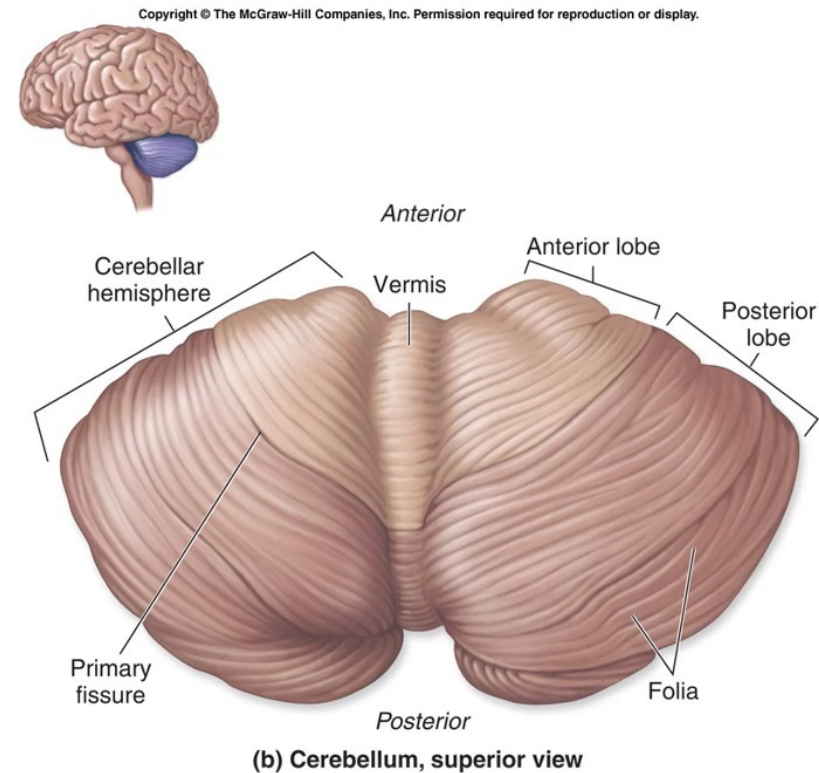
Central median vermis

2 lateral

- Cerebellar
- Hemispheres

Fissures →

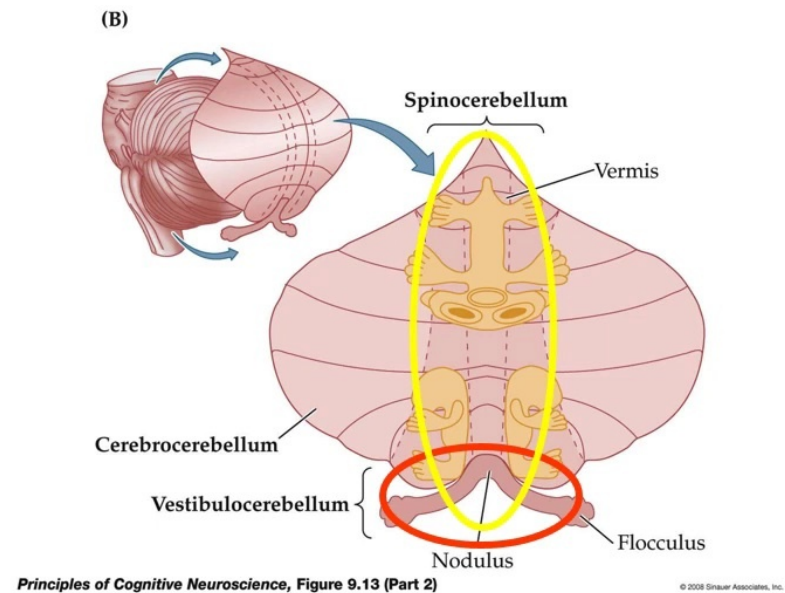
- Lobes
- Lobules



Cerebellum: Divisions

B) Functional

1. Vestibular part
2. Spinal part
3. Cerebral part



Cerebellum: External Features

Consists of

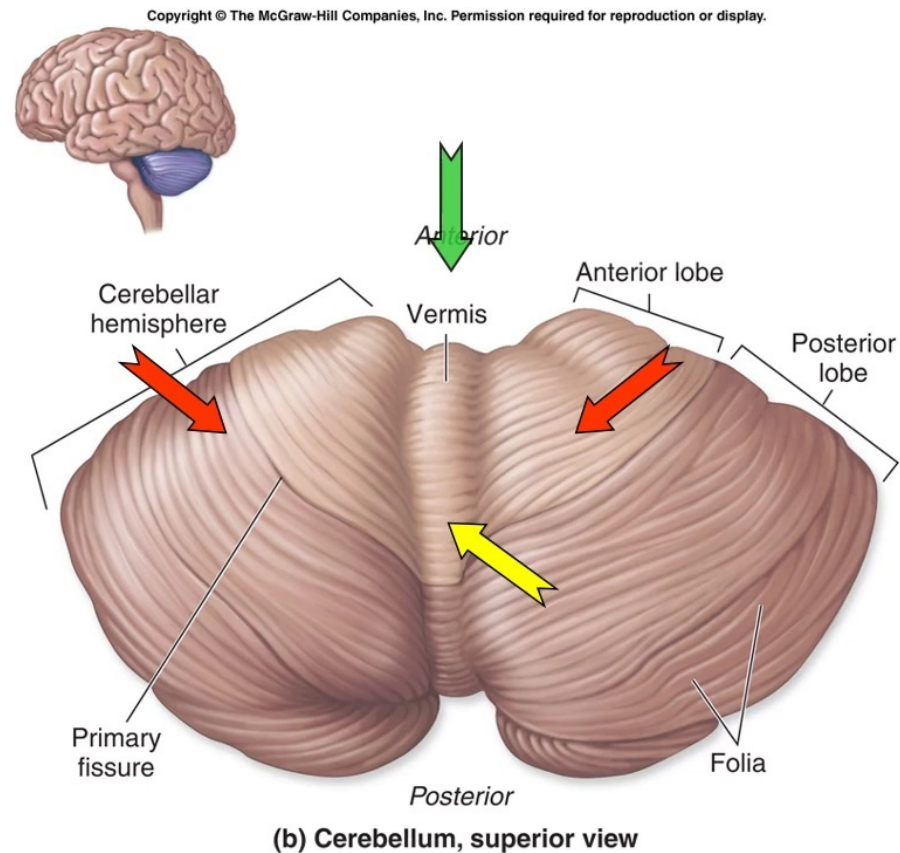
- 1) Two
 - Lateral
 - Cerebellar
 - Hemispheres

2) Midline vermis

1. Superior
2. Inferior

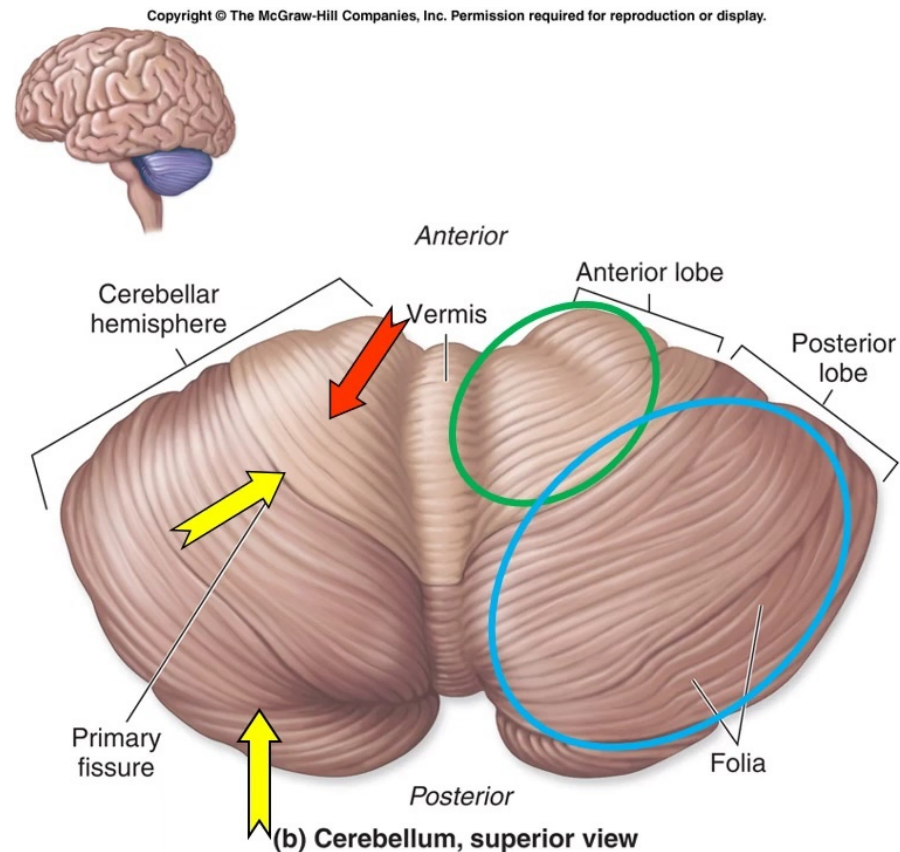
3) 2 Notches

1. Anterior
2. Posterior



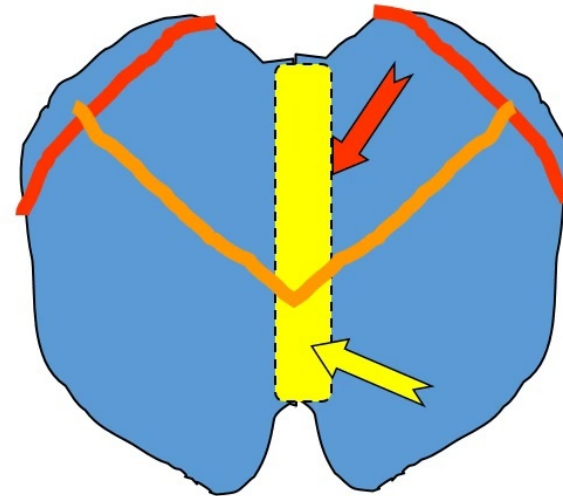
Cerebellum: External Features

- Surface folded into
 1. Ridges called **folia**
 2. Separated by **fissures**
- Hemispheres subdivided into:
 1. Anterior lobe
 2. Posterior lobe



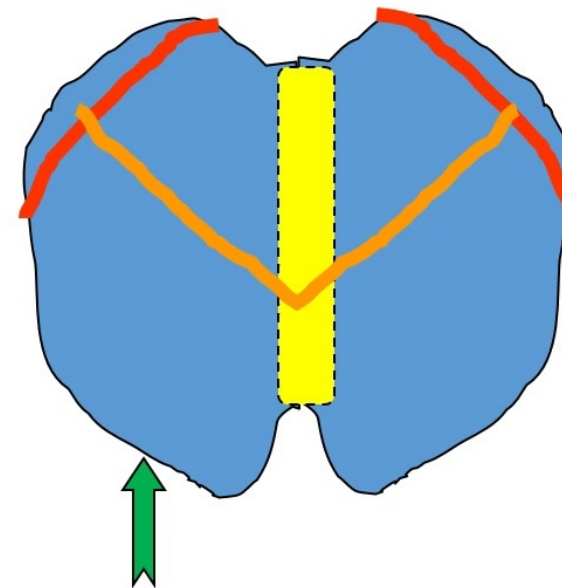
Cerebellum: Superior Surface

- Not clearly demarcated
 - from the
 - Vermis
- The Sup Vermis →
 - Slightly elevated AP ridge



Cerebellum: Superior Surface

- HZ Fissure
 - Separates the
 - Superior surface
 - Inferior surface
- Primary Fissure
 - V shaped
 - Separates the
 - Anterior &
 - Middle Lobes



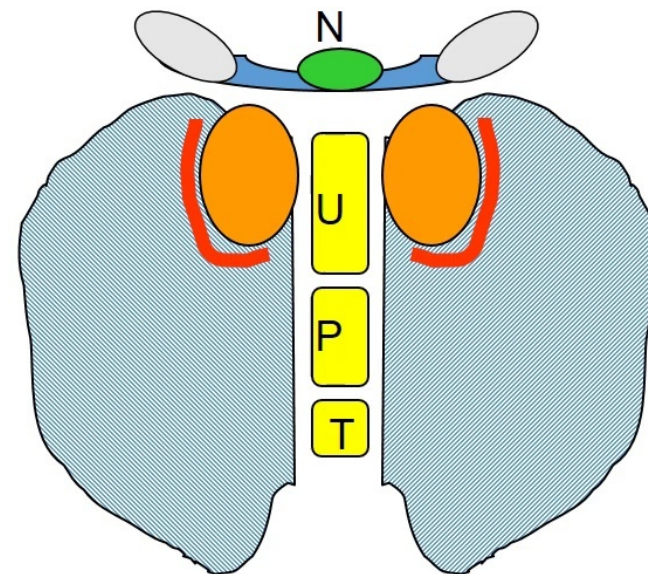
Cerebellum: Inferior Surface

- Convex
- 2 hemispheres

Separated by

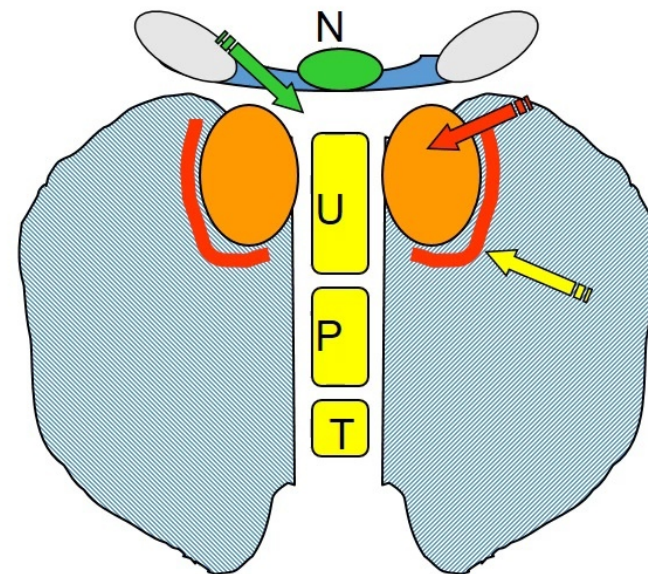
- Deep hollow
- (Valecula)

- → Contains
 - Inferior Vermis
 - Medulla ~ Anterior part
 - Falx Cerebelli ~ Posterior part



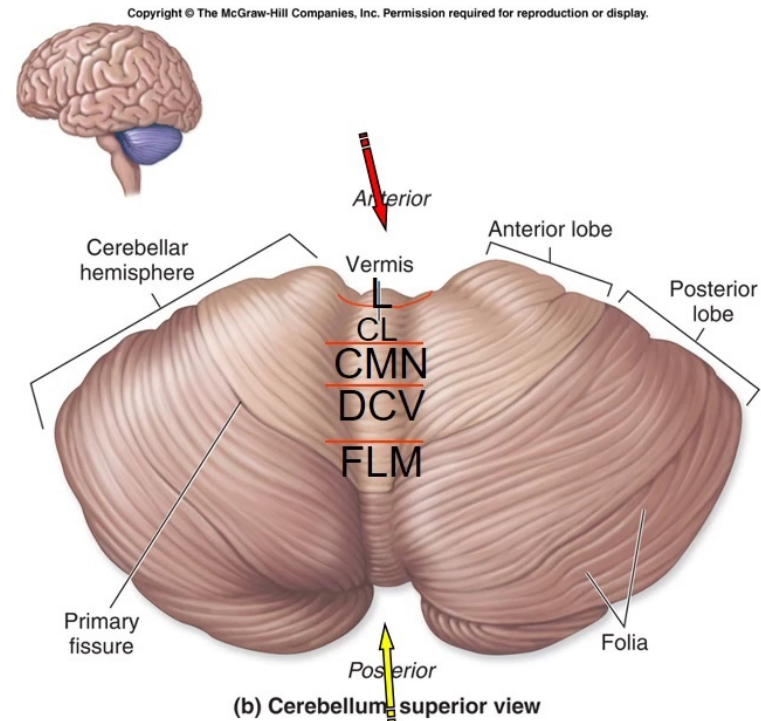
Cerebellum: Inferior Surface

- 2 Tonsils
 - On both sides of the Vermis
 - Retro tonsillar fissure
- Posterolateral Fissure
 - Between Nodule & Uvula
 - Extends laterally behind the Flocculus



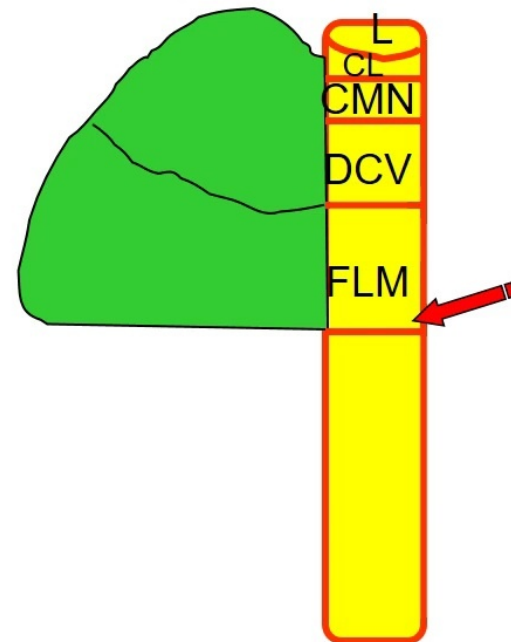
Cerebellum: Vermis I

- Anterior Notch
 - In the Roof of V4
- Posterior Notch
 - Occupied by Falx Cerebelli



Cerebellum: Vermis 2

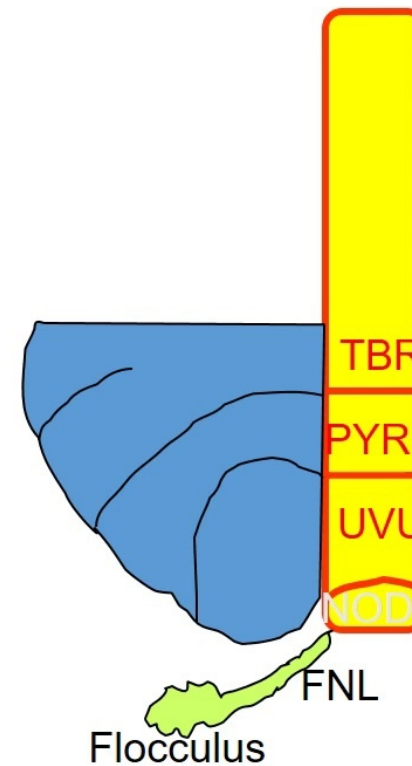
- Superior Vermis
 - Continuous with cerebellar hemispheres
1. Lingula
 2. Central lobule
 3. Culmen
 4. Declive
 5. Folium vermis



Cerebellum: Vermis 2

- Inferior Vermis

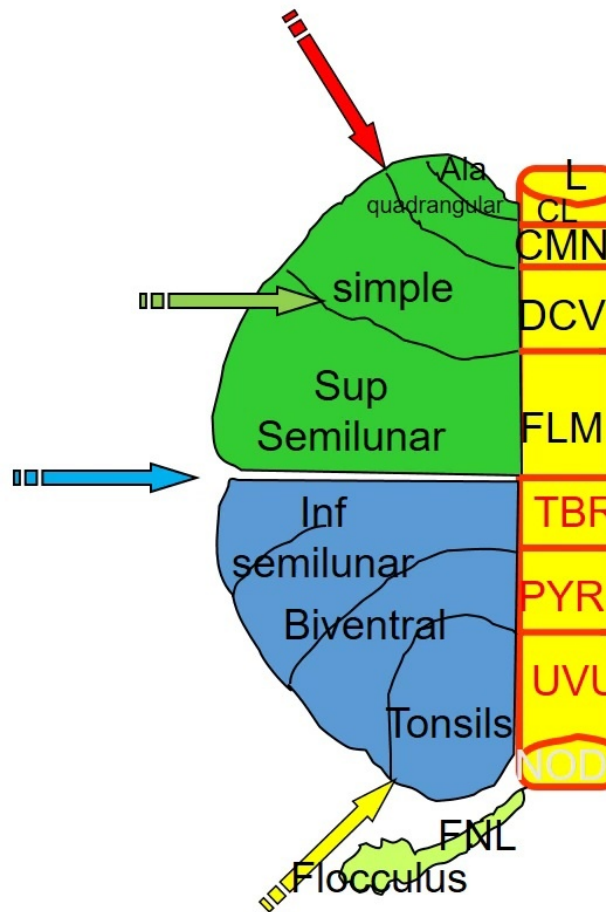
- Paramedian sulcus
 - separates it from cerebellar hemispheres
1. Tuber vermis
 2. Pyramid
 3. Uvula → tonsils
 4. Nodule → + flocculi → flocculo nodular lobe



Cerebellum: Vermis 2

- R&L Cerebellar Hemispheres

- Superior surface
- Inferior surface
- Folia
- Fissures



Cerebellum: Vermis 3

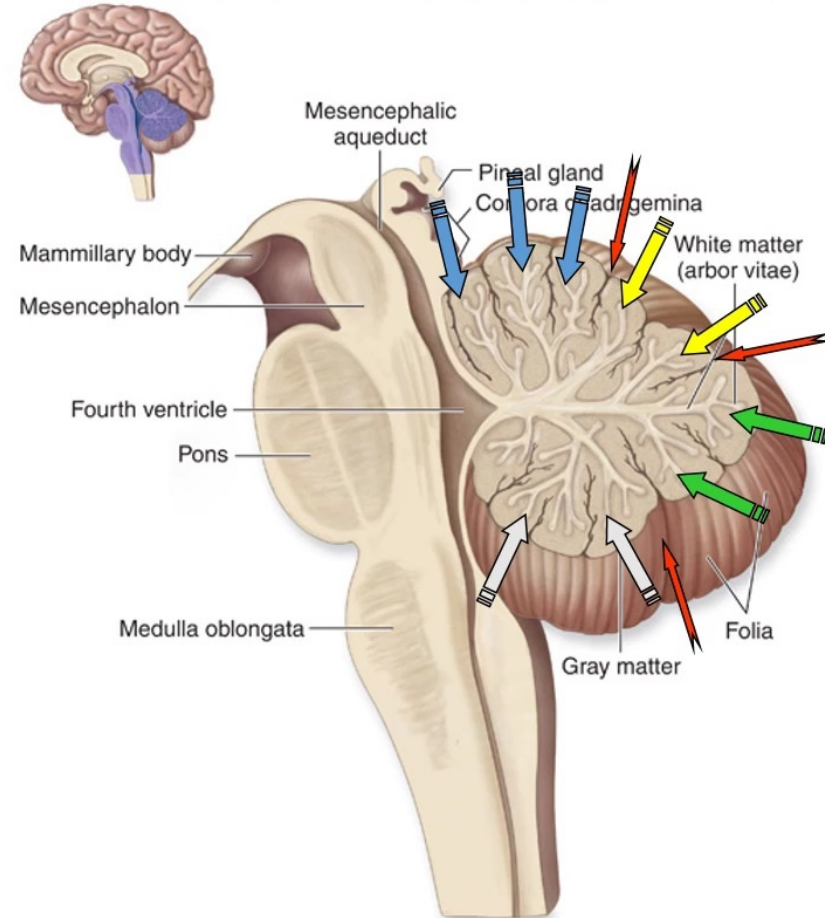
- SUPERIOR VERMIS

- LINGULA
- CENTRAL LOBULE
- CULMEN
- PRIMARY FISSURE
- DECLIVE
- FOLIUM
- HORIZONTAL FISSURE

- INFERIOR VERMIS

- TUBER
- PYRAMID
- POSTEROLATERAL FISSURE
- UVULA
- NODULE

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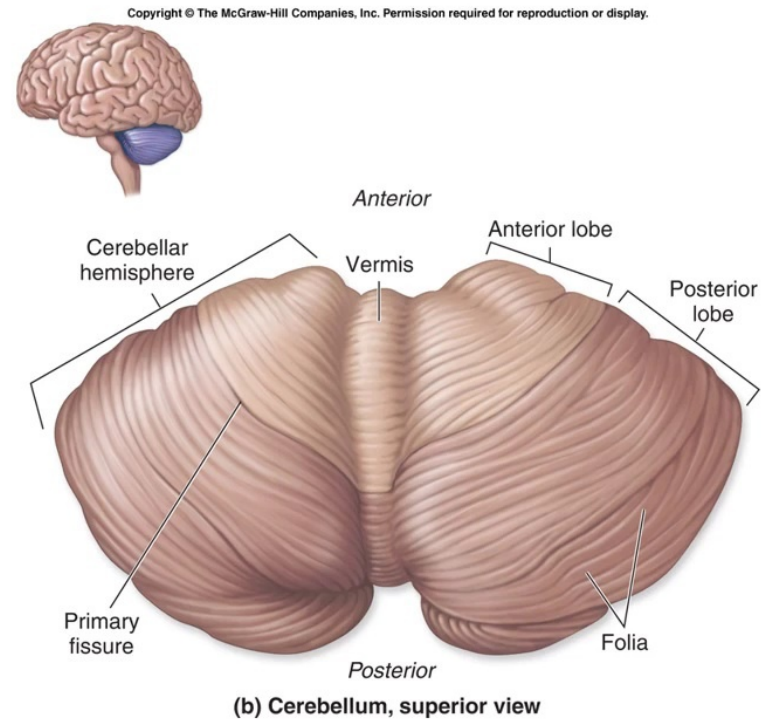


(a) Midsagittal section



Cerebellum: Fissures

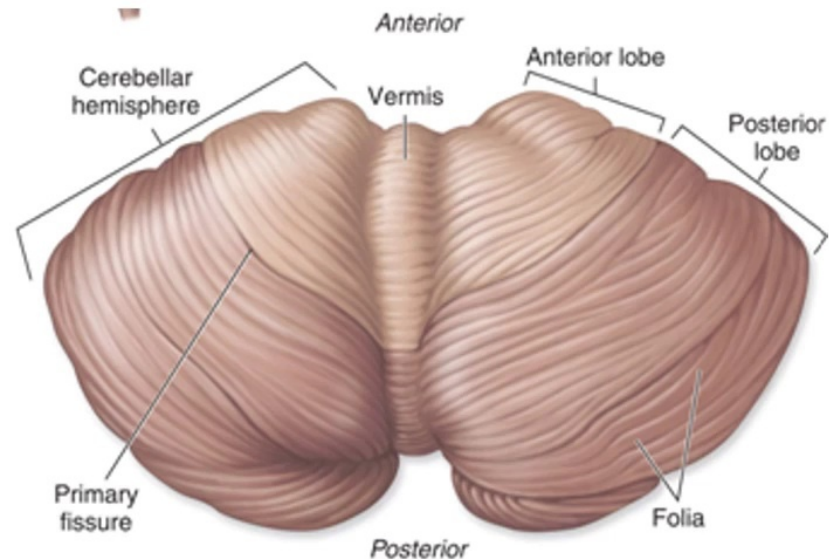
- 3 Important Fissures
 1. Primary Fissure
 2. Posterolateral Fissure
 3. Horizontal Fissure



Cerebellum: Fissures

*** Deep transverse fissures

- Cut the vermis transversely
- Extends laterally into the hemispheres
- Cerebellum divided into lobes
- Each lobe has
 - A median part (Vermis)
 - 2 lateral extensions (Hemispheres)



Cerebellum: Fissures

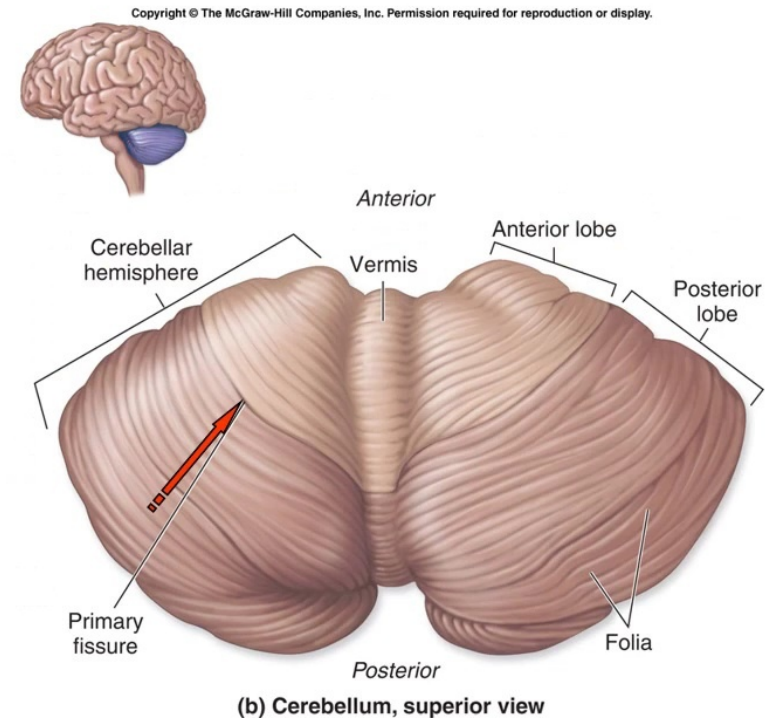
Primary Fissure

- Superior surface



1. Anterior &
2. Posterior

- Anatomical Lobes



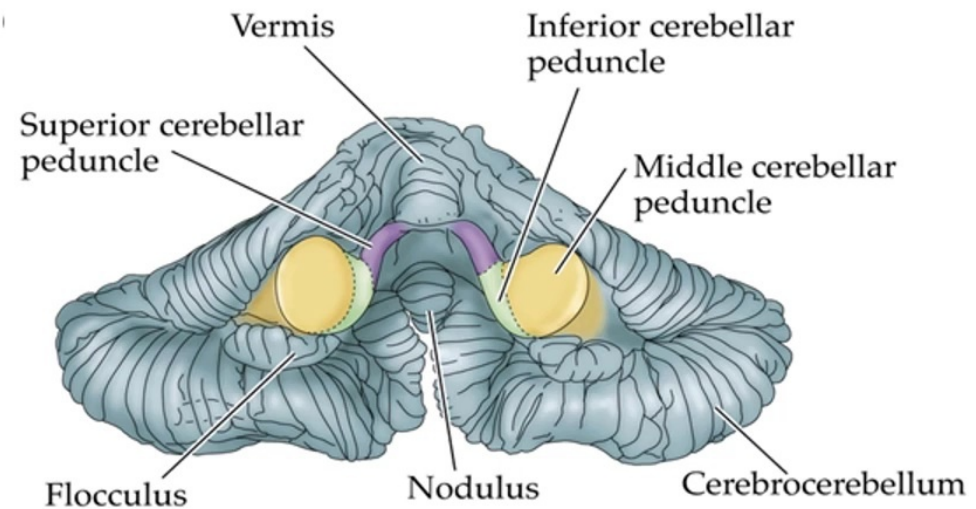
Cerebellum: Fissures

Posterolateral Fissure

Inferior surface



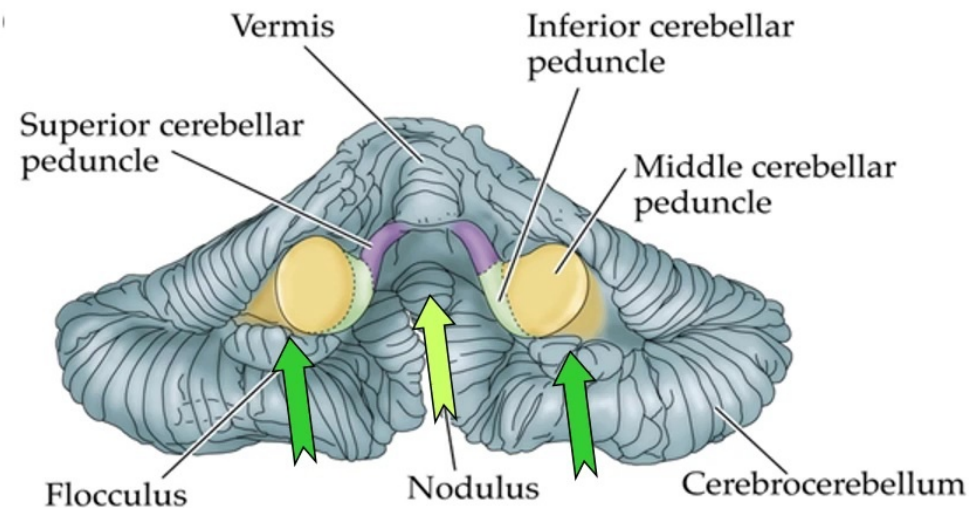
1. Posterior lobe &
2. Flocculonodular Lobe



Cerebellum: Fissures

Posterolateral Fissure

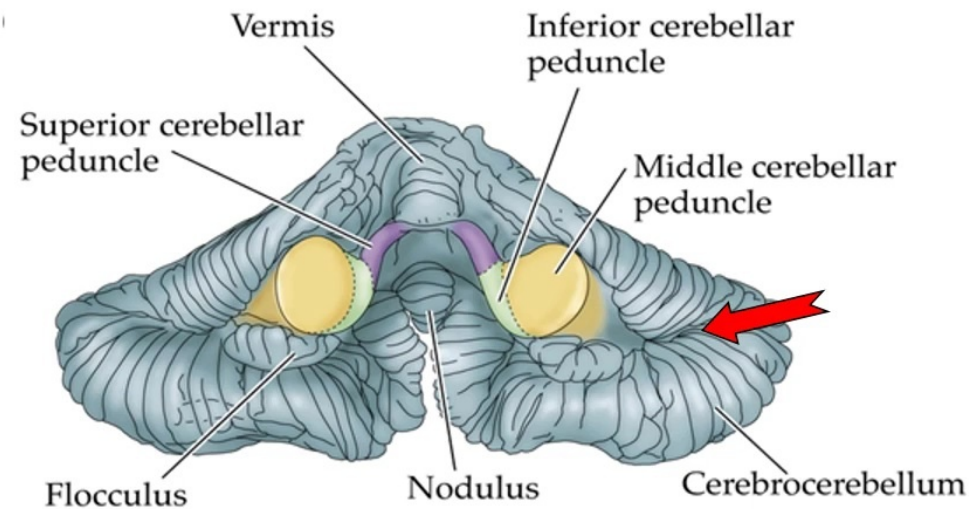
- Separates the
 - Main part of
 - Cerebellum from
- Flocculonodular lobe
 1. Nodule in the middle
 2. Flocculus on either side



Cerebellum: Fissures

Horizontal Fissure

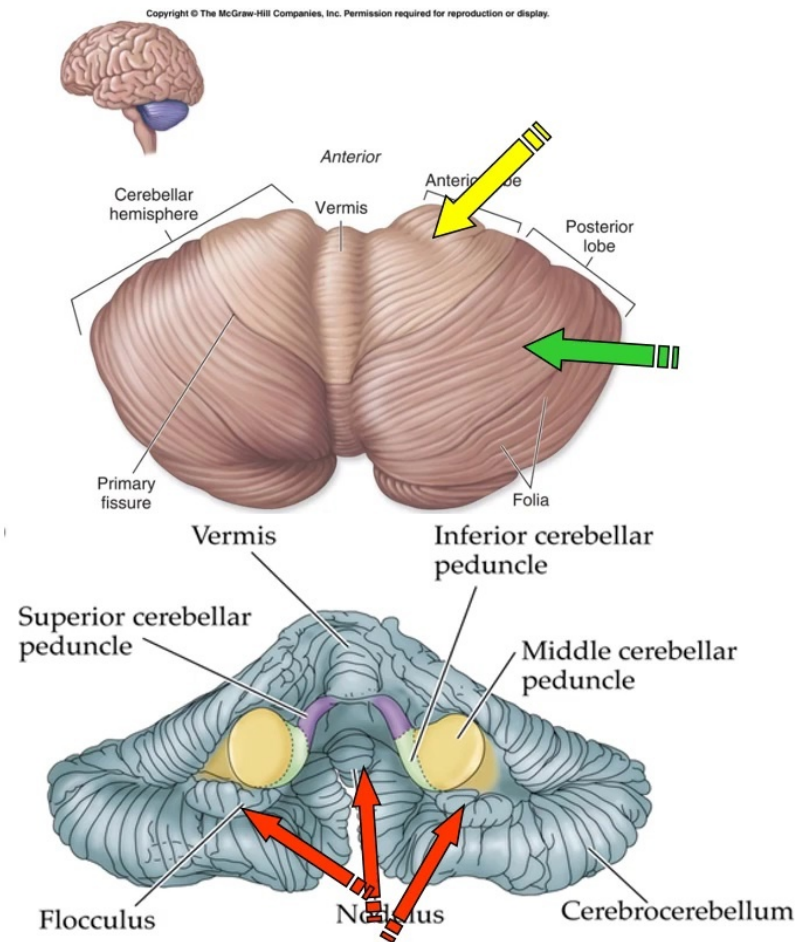
- Extends between the
- MCP of
- Both sides
- $\leftrightarrow$
- Superior &
- Inferior Surfaces
- Runs through the
- Posterior lobe



Cerebellum: Anatomical Lobes

- 3 Anatomical Lobes

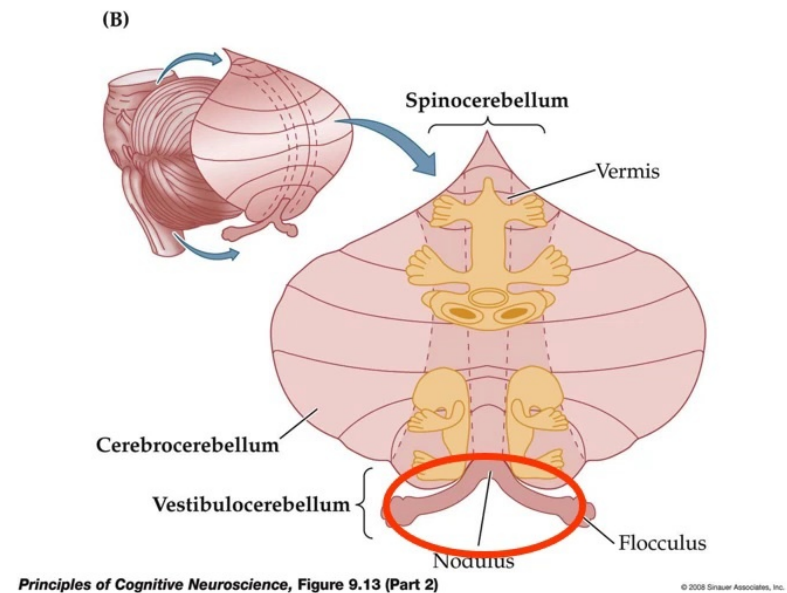
1. Flocculonodular Lobe
 - Nodule + R & L Flocculi
 - Limited posteriorly by the Posterolateral Fissure
2. Anterior Lobe
 - On the Superior Surface
 - Limited posteriorly by the Primary Fissure
3. Posterior Lobe
 - The rest of the cerebellum
 - $\leftrightarrow$ Primary & Posterolateral fissures



Cerebellum: Functional Lobes

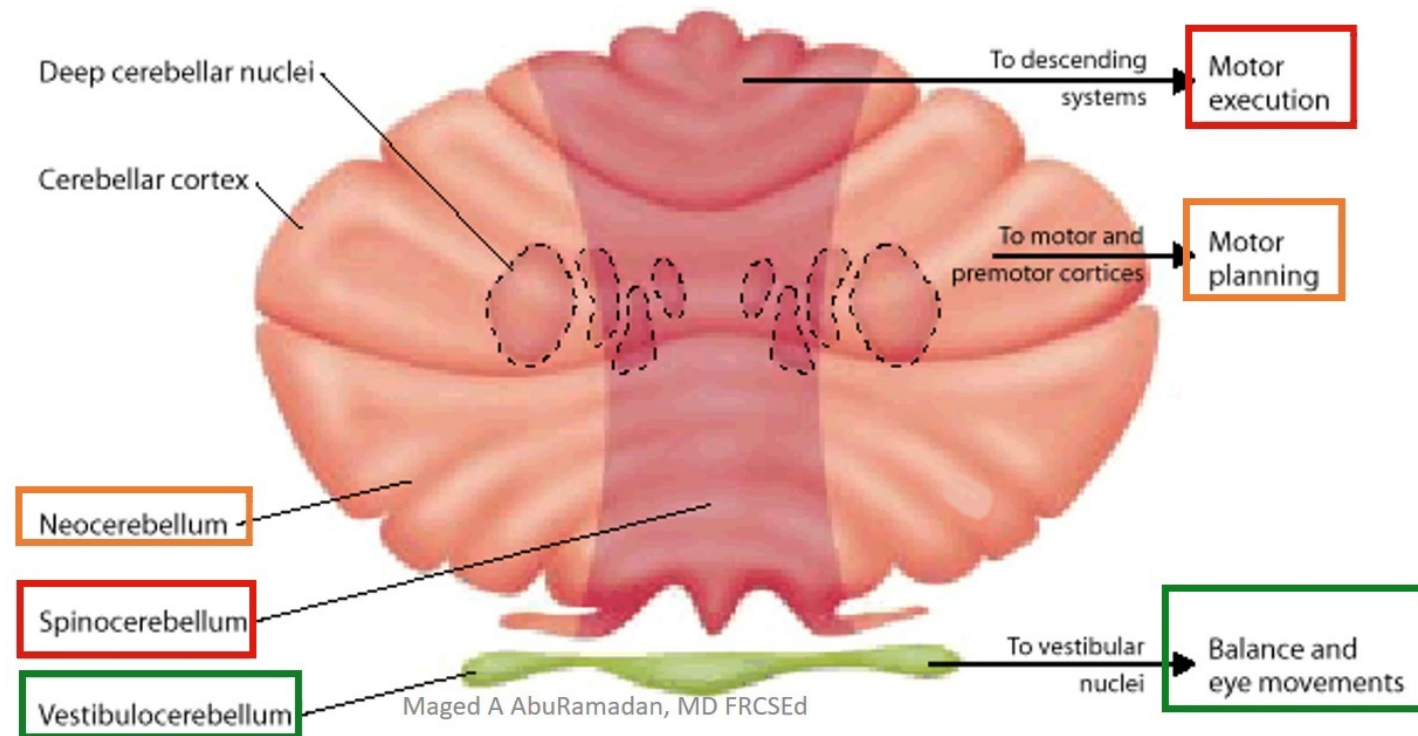
- 3 Functional Lobes

1. Vestibulo Cerebellum
2. Spino Cerebellum
3. Cerebro Cerebellum



Cerebellum: Functional Lobes

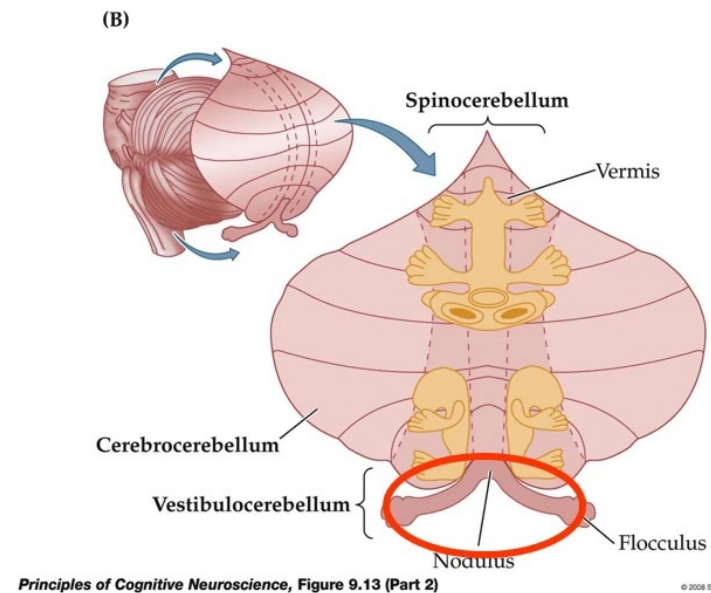
- Three main systems



Cerebellum: Functional Lobes

1) Vestibulo Cerebellum

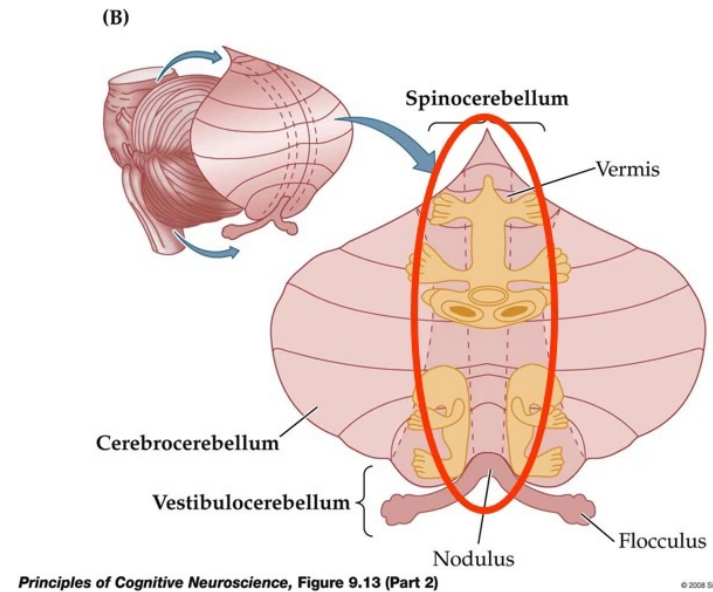
- Archicerebellum
- = Flocculonodular lobe
- Connection with
- Vestibular Nuclei
- Phylogenetically the oldest part
- Equilibrium



Cerebellum: Functional Lobes

2) Spino Cerebellum

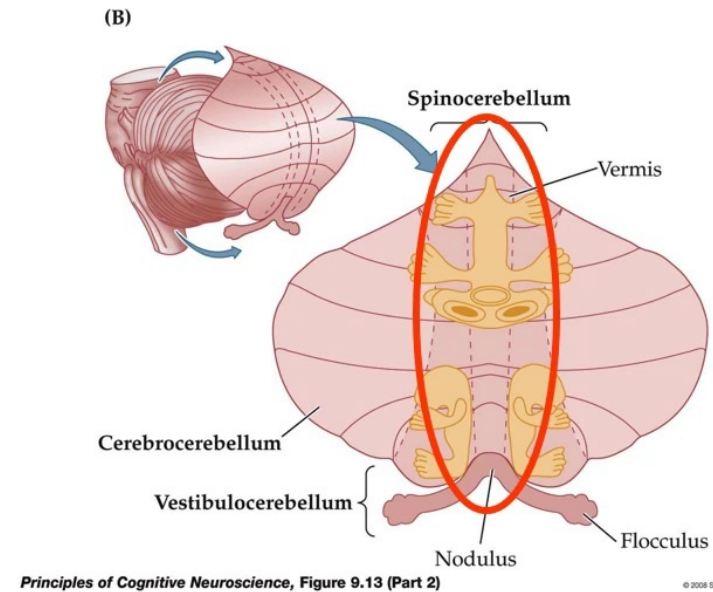
- Paleocerebellum
 - Vermal zone
 - Midline vermis
 - Paravermal zone
 - Part of cerebellar hemisphere



Cerebellum: Functional Lobes

2) Spino Cerebellum

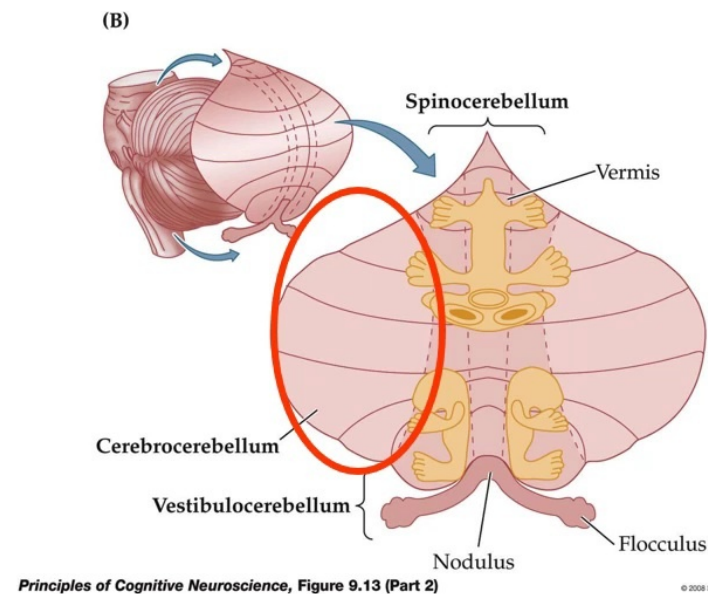
- Connection with
 - Spinal &
 - BS Nuclei
- **Receives**
 - Proprioceptor input
 - Copy of motor plan
- → coordination of movement



Cerebellum: Functional Lobes

3) Cerebro Cerebellum

- Neocerebellum
- Large lateral zone of the cerebellar hemispheres
- Connection with the Cerebral Hemispheres
- Phylogenetically the newest
- Planning & programming of movements

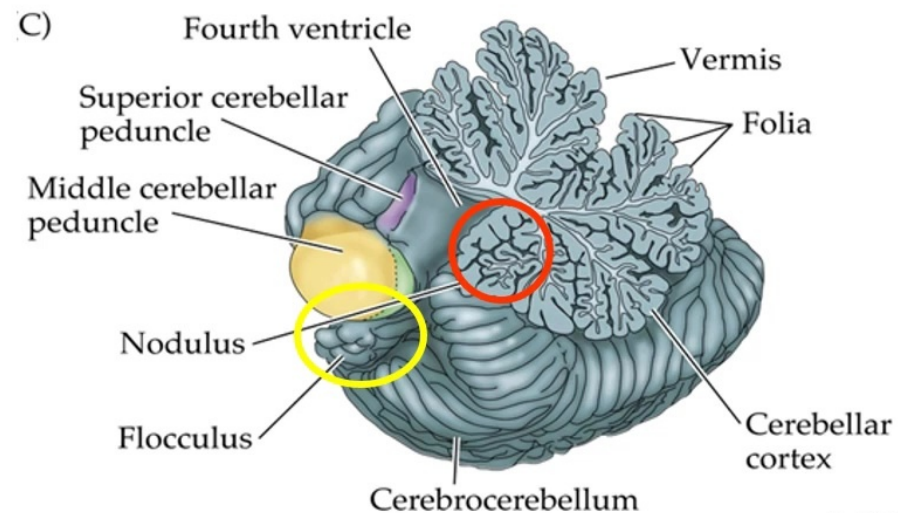
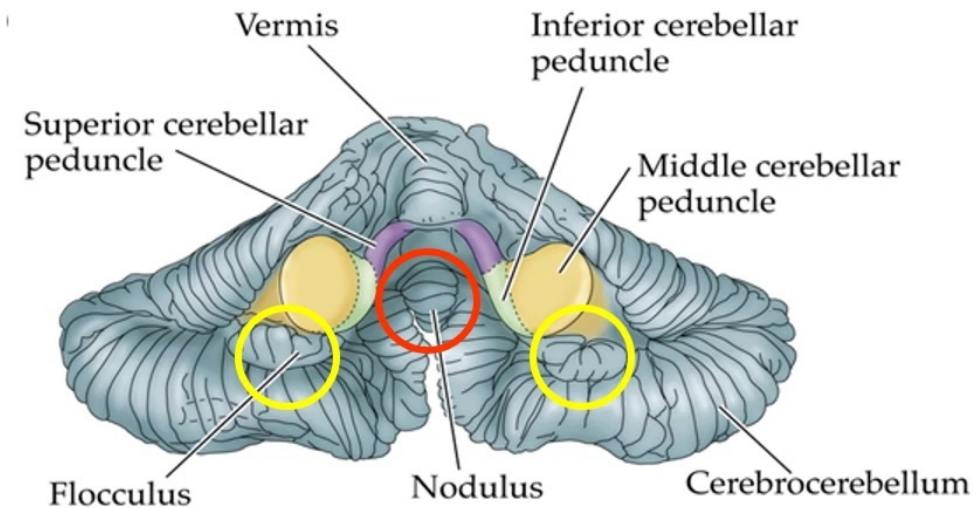


Cerebellum: Vestibular part

Archicerebellum

1. 2 floccules
2. Nodule of the vermis

- Receives input from
- Inner ear

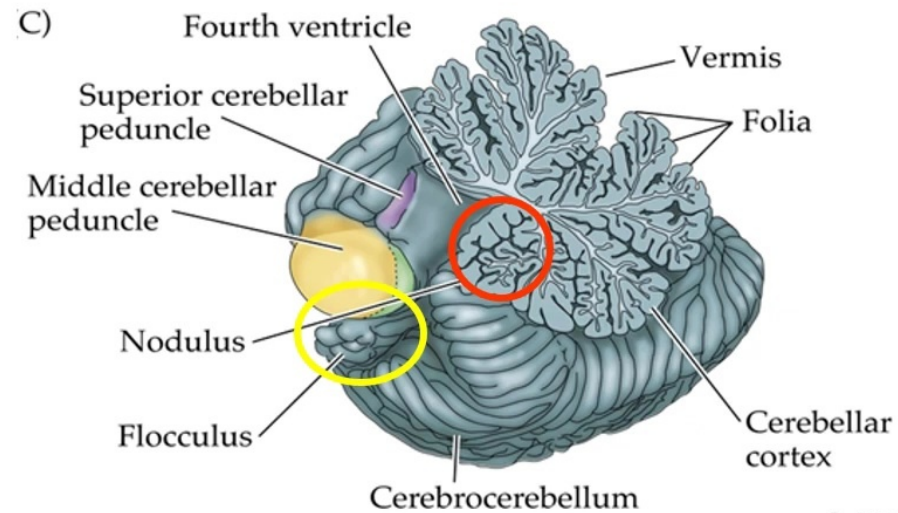
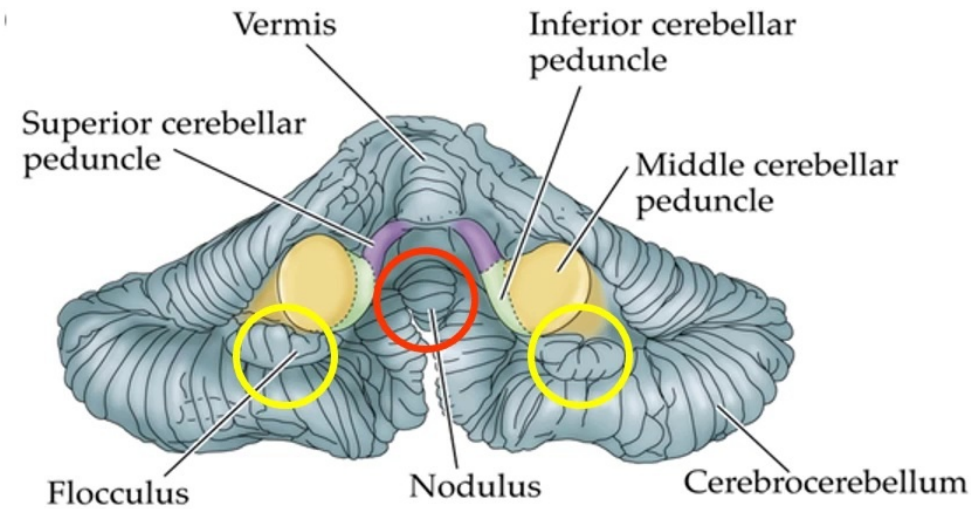


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Cerebellum: Vestibular part

- Afferent Tracts
 - Vestibulo-cerebellar tracts →
- Flocculonodular lobe
 1. Direct
 2. Indirect
- Organs
 1. 3 semicircular canals
 2. Utricle
 3. Saccule



© 2001



Cerebellum: Vestibular part

- Efferents

- Purkinje neurons



- Inhibitory axons

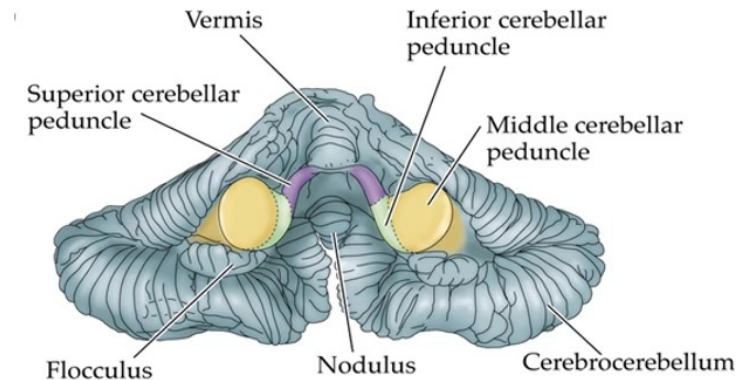
- Direct to

- IL

- Vestibular Nuclei

- Function

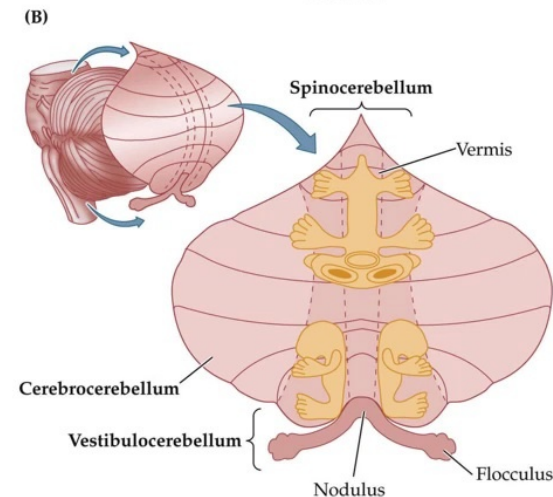
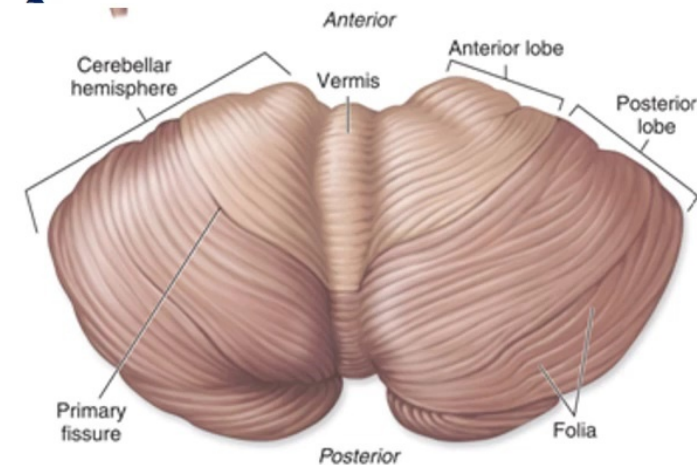
- Maintains
- Balance &
- Equilibrium



Cerebellum: Spinal part

Paleocerebellum

- Vermis of the
 - Anterior lobe
 - Uvulas
 - Pyramid
-
- Receives input from
 - Proprioceptives



Principles of Cognitive Neuroscience, Figure 9.13 (Part 2)

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Cerebellum: Spinal part

- **Afferent Tracts**

1. **Spinocerebellar tracts →**

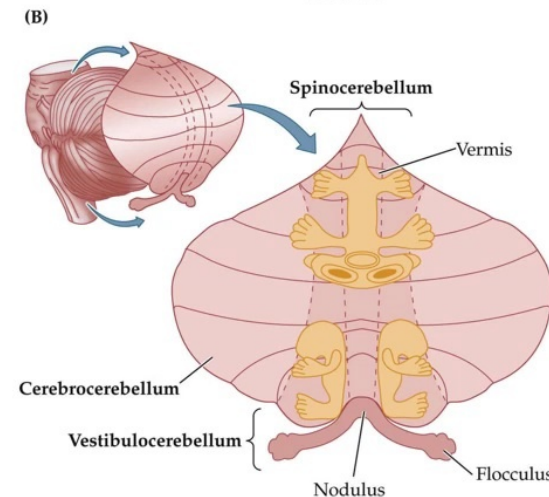
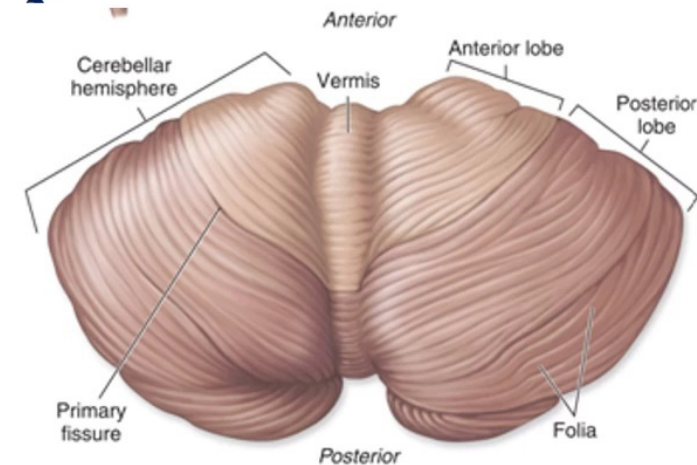
- Spinal cerebellum
- Dorsal & ventral

2. **External arcuate fibres →**

- Spinal cerebellum
- D&V

- **Organs**

1. **Muscle spindles**
2. **Tendon spindles**
3. **Pacinian corpuscles**



Principles of Cognitive Neuroscience, Figure 9.13 (Part 2)

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Cerebellum: Spinal Part

- **Efferents**

- 1) **Vermal zone**

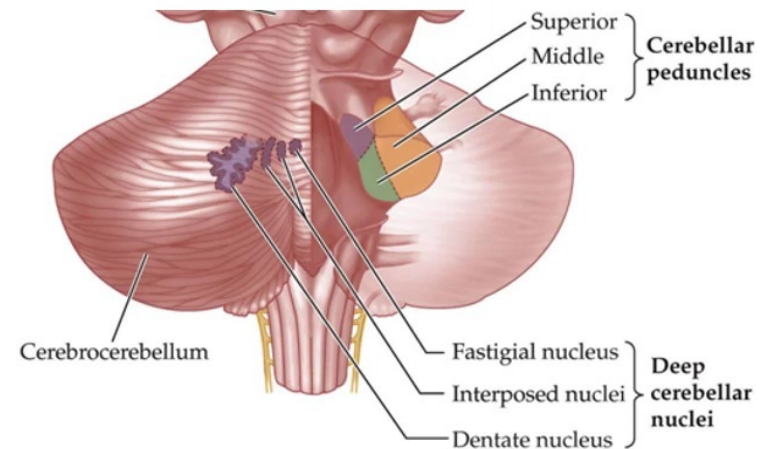
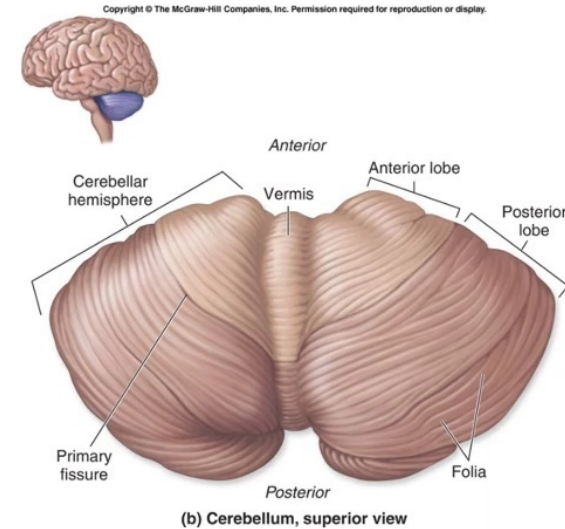
1. **Purkinje neurons**
 - → inhibitory axons
 - Direct to
 - IL Fastigial Nuclei

2. **Fastigial**

- → excitatory axons
- → Bilateral Nc
- → axial & proximal muscle controlling nuclei

- **Function**

- Bilateral regulation of
- muscle tone &
- posture of
- Proximal M



Cerebellum: Spinal Part

- **Efferents**

- 2) **Paravermal zone**

- 1. **Pyramidal neurons**

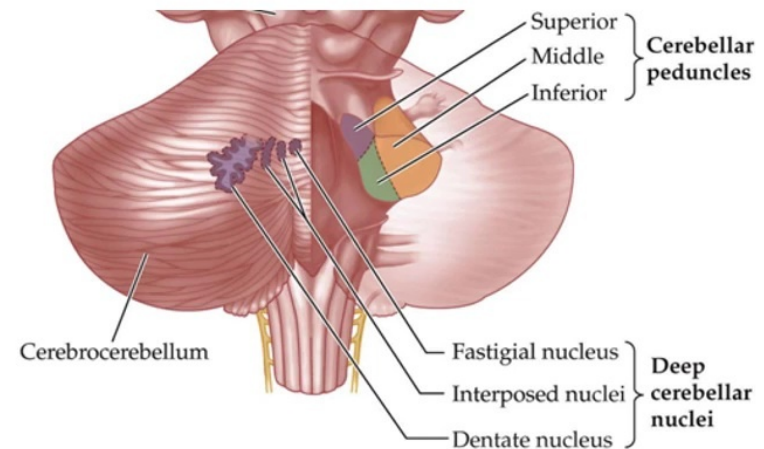
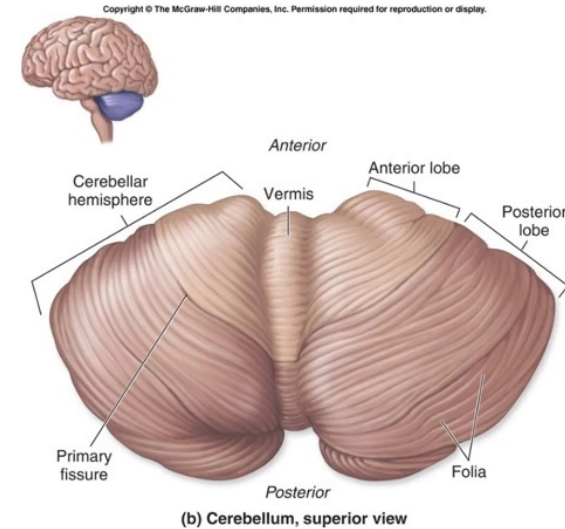
- → inhibitory axons
 - Direct to
 - IL Interpose Nuclei

- 2. **Interpose**

- → excitatory axons
 - → CL Nc
 - → Distal muscle controlling nuclei

- **Function**

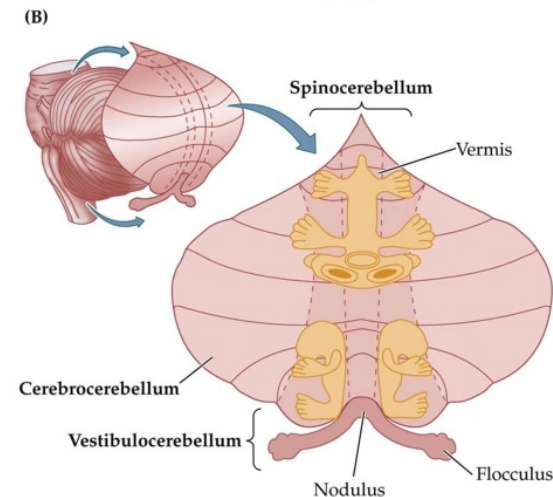
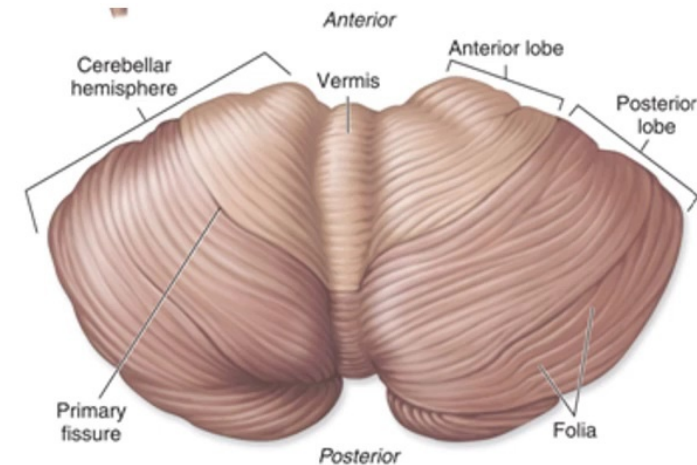
- CL regulation of
 - muscle tone &
 - coordination of
 - Distal M



Cerebellum: Cerebral Part

Neocerebellum

- The largest part
 - 2 cerebellar hemispheres
 - Middle part of vermis
-
- Receives impulses from
 - Cerebral cortex
 1. Cerebro-pontine cerebellar pathway →
 - MCP →
 - Neocerebellum
 2. Cerebro-pallido-olivo-cerebellar pathway →
 - ICP →
 - All parts of the cerebellum



Principles of Cognitive Neuroscience, Figure 9.13 (Part 2)

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Cerebellum: Cerebral Part

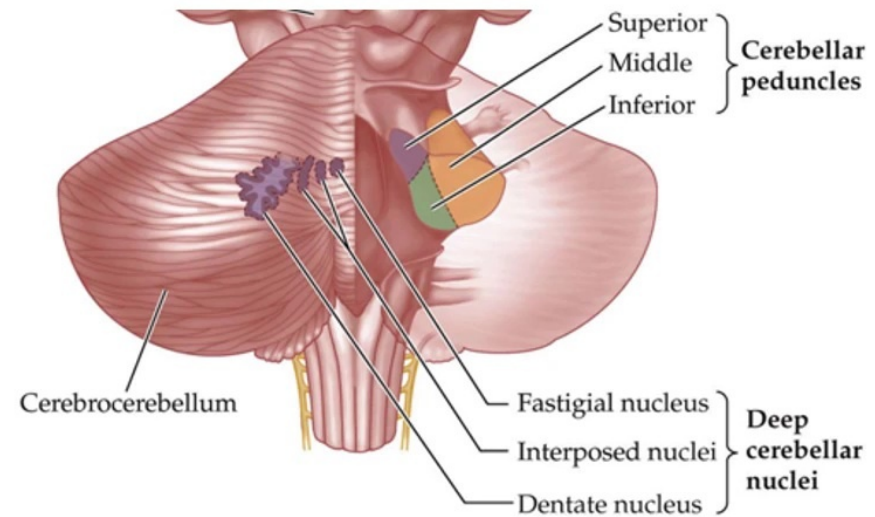
- **Efferents**

1. **Purkinje neurons**

- → inhibitory axons
- → IL Dentate Nuclei

2. **Dentate**

- → excitatory axons
- → CL Red Nc & Thalamus
- → Premotor Cortex



Cerebellum: Cerebral Part

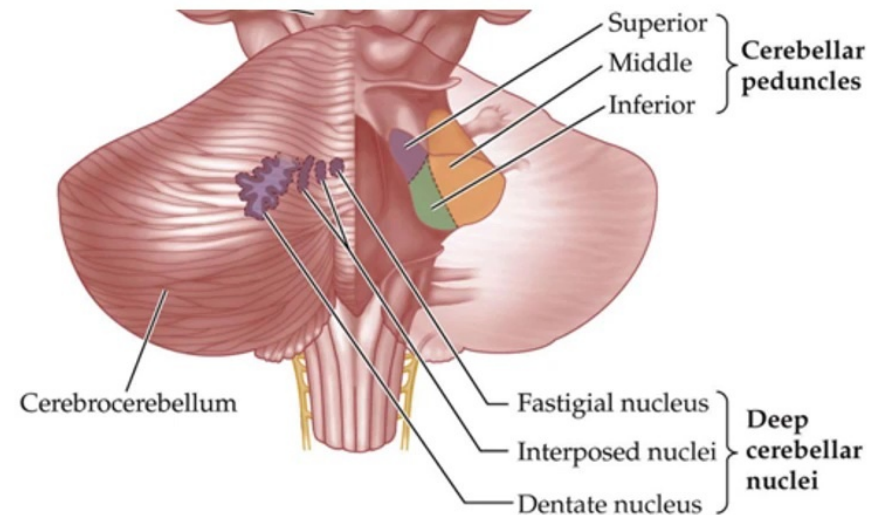
- **Function**

- 1) Motor learning of
 - new complex movements

- 2) Planning of
 - sequence of
 - intended movement

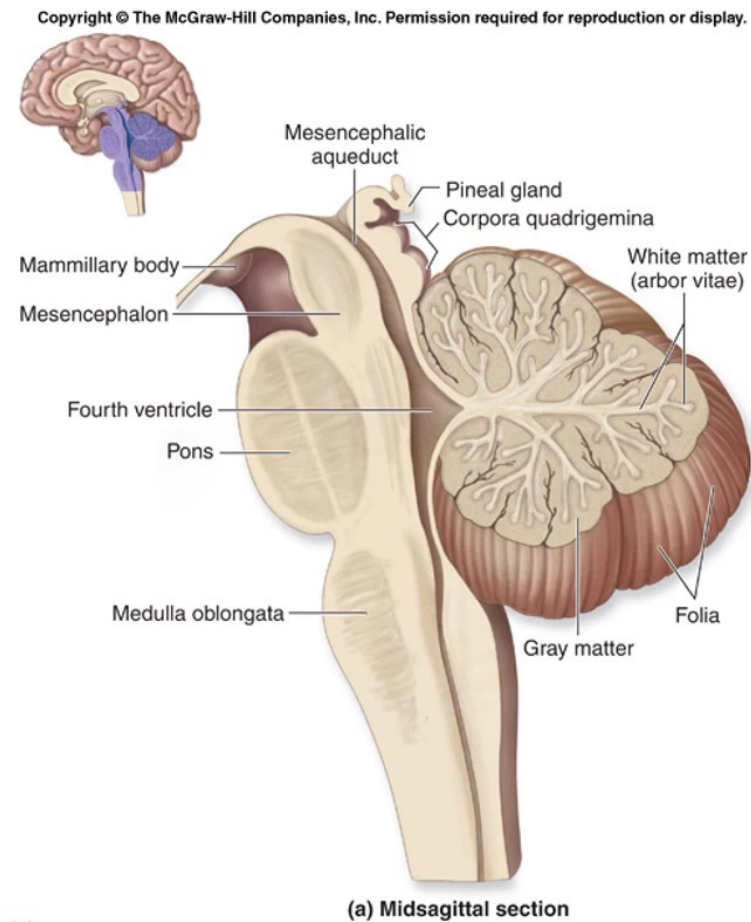
- 3) Anticipation function

- Connection with the
- Cerebral Hemispheres



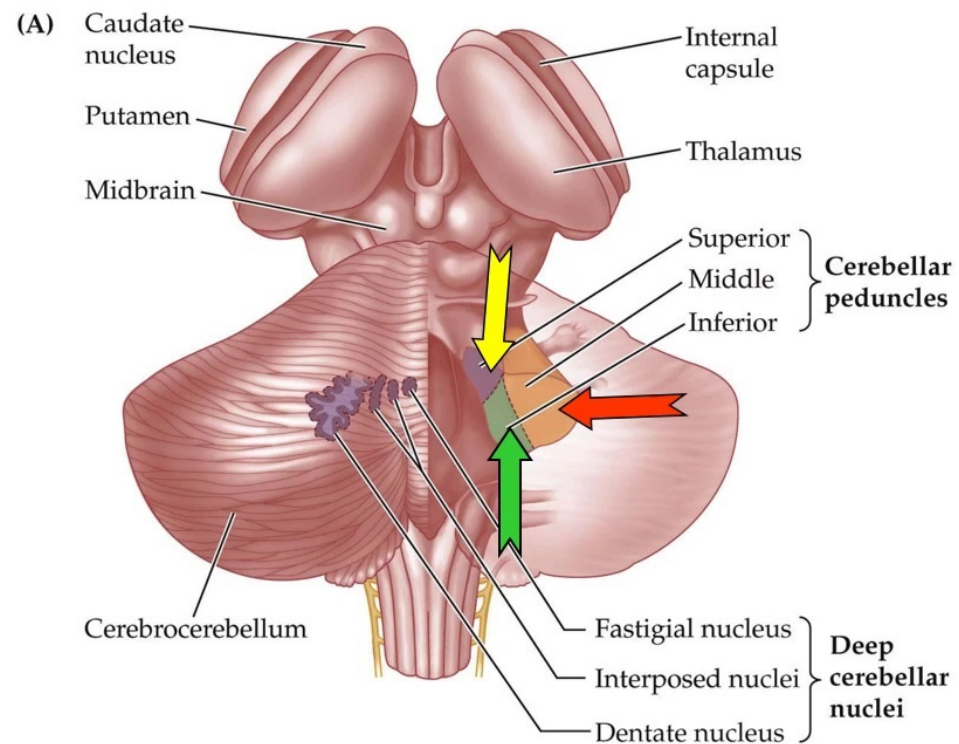
Cerebellum: Peduncles

- 3 Cerebellar Peduncles
 1. Inferior Cerebellar Peduncle
 - → Medulla
 2. Middle Cerebellar Peduncle
 - → Pons
 3. Superior Cerebellar Peduncle
 - → Midbrain



Cerebellar Peduncles

- **Ipsilateral** Fibers
 - to and from the Cerebellum
 - Run to and from the *Same side* of the body



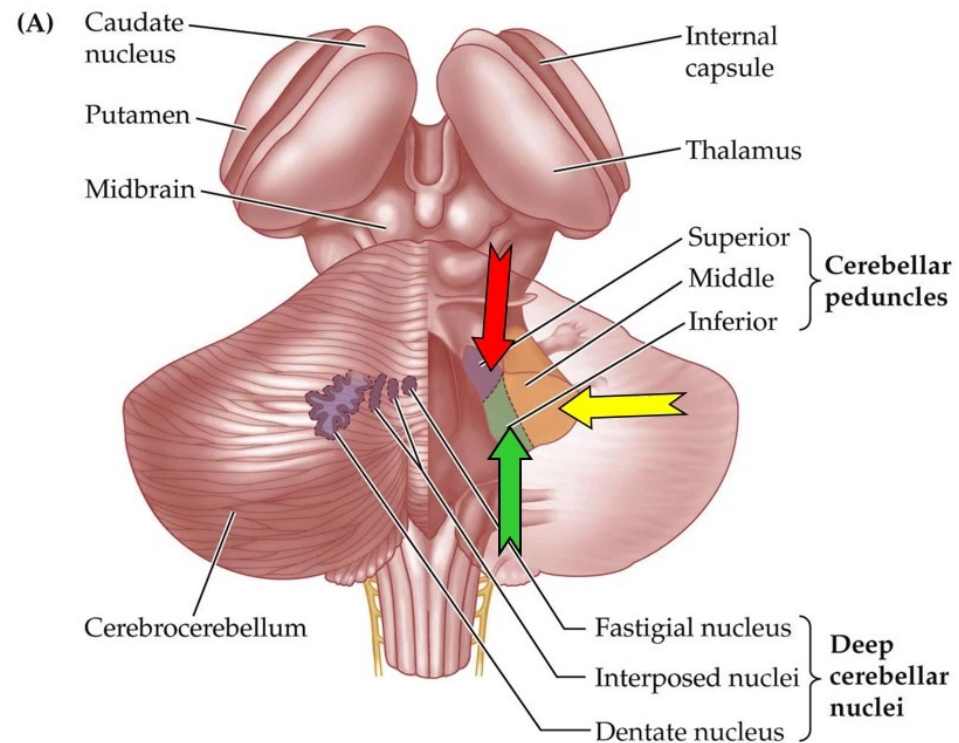
Principles of Cognitive Neuroscience, Figure 9.13 (Part 1)

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Cerebellar Peduncles

- Thick tracts
 - Connecting the
 - Cerebellum to the
 - Brain stem
1. Superior cerebellar peduncles
 2. Middle cerebellar peduncles
 3. Inferior cerebellar peduncles



Principles of Cognitive Neuroscience, Figure 9.13 (Part 1)

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Cerebellar Peduncles

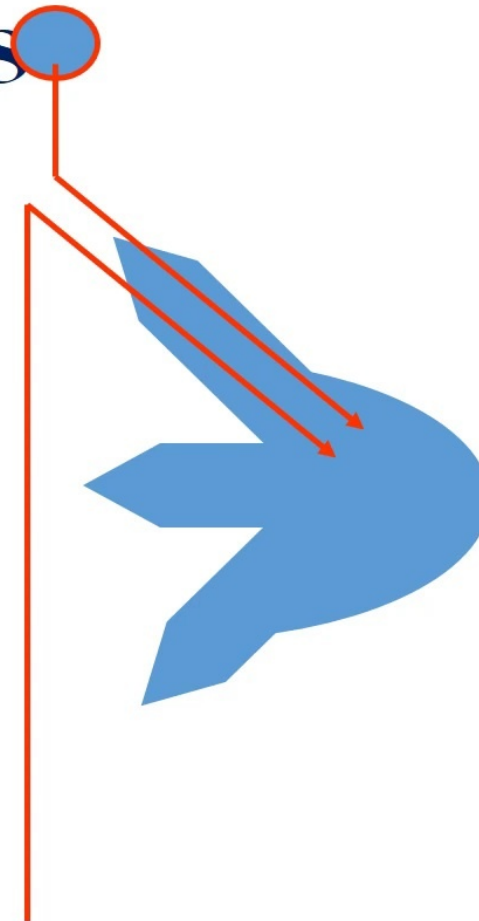
- SCP

- Aff

1. Ventral spino cerebellar
2. Tecto cerebellar

- Eff

1. Dentato rubro thalamic

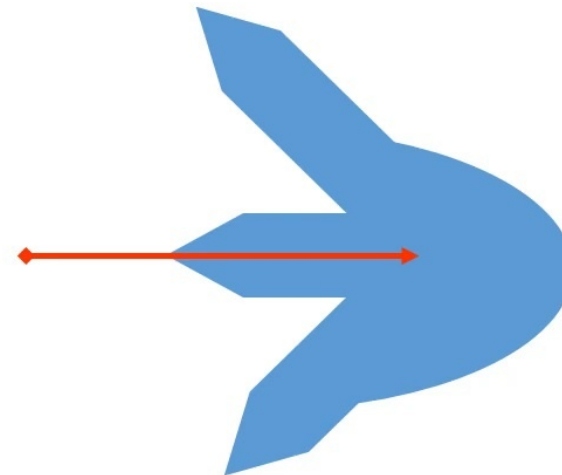


Cerebellar Peduncles

- MCP

- Aff

1. Ponto cerebellar



Cerebellar Peduncles

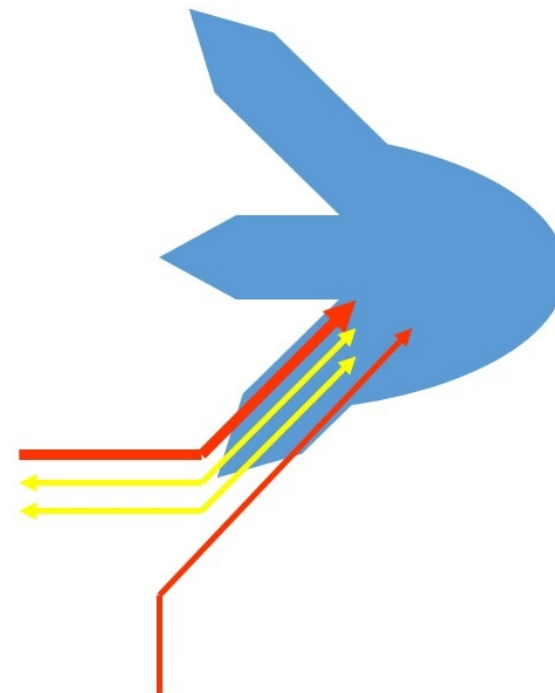
- ICP

- Aff

1. Anterior external arcuate
2. Cuneo cerebellar
3. Stria medullaris
4. Olivo cerebellar
5. Dorsal spino cerebellar
6. D&I vestibulo cerebellar
7. Reticulocerebellar

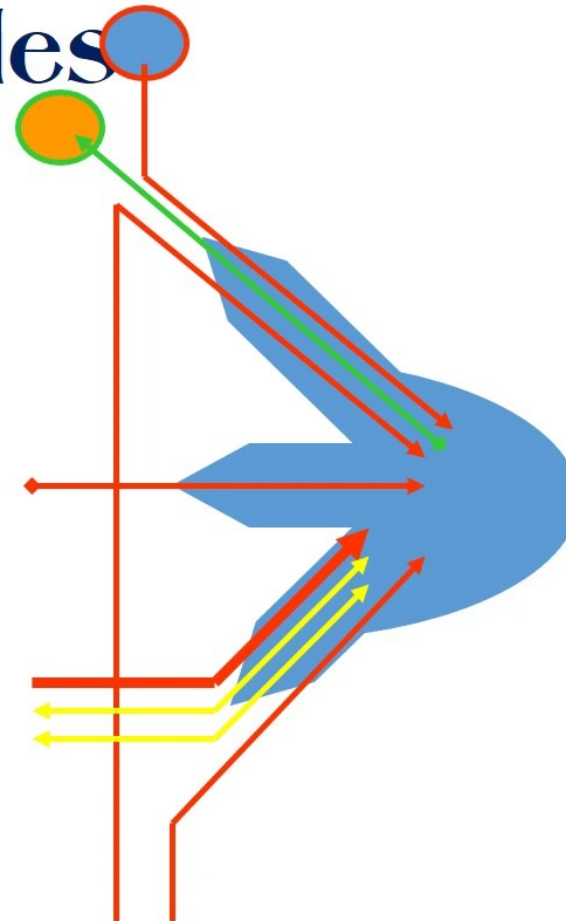
- Eff

1. Cerebello vestibular
2. Cerebello reticular



Cerebellar Peduncles

- SCP
 - Aff
 - Ventral spino cerebellar
 - Tecto cerebellar
 - Eff
 - Dentato rubro thalamic
- MCP
 - Aff
 - Ponto cerebellar
- ICP
 - Aff
 - Anterior external arcuate
 - Cuneo cerebellar
 - Stria medullaris
 - Olivo cerebellar
 - D&I vestibulo cerebellar
 - Reticulocerebellar
 - Dorsal spino cerebellar
 - Eff
 - Cerebello vestibular
 - Cerebello reticular



Functional Anatomy

1. Outer Cerebellar Cortex
 - Grey matter
2. Inner white matter
- Deep nuclei
 1. Dentate
 - Most laterally
 2. Interpositus
 1. Globose &
 2. Emboliform
 - In the middle
 3. Fastigial
 - Most medial



Functional Anatomy

- Afferent fibers
 - → deep nuclei + cerebellar cortex
 - Cerebellar cortex → deep nuclei
- All efferent
 - originate from the
 - deep nuclei



Cerebellum: Deep Nuclei

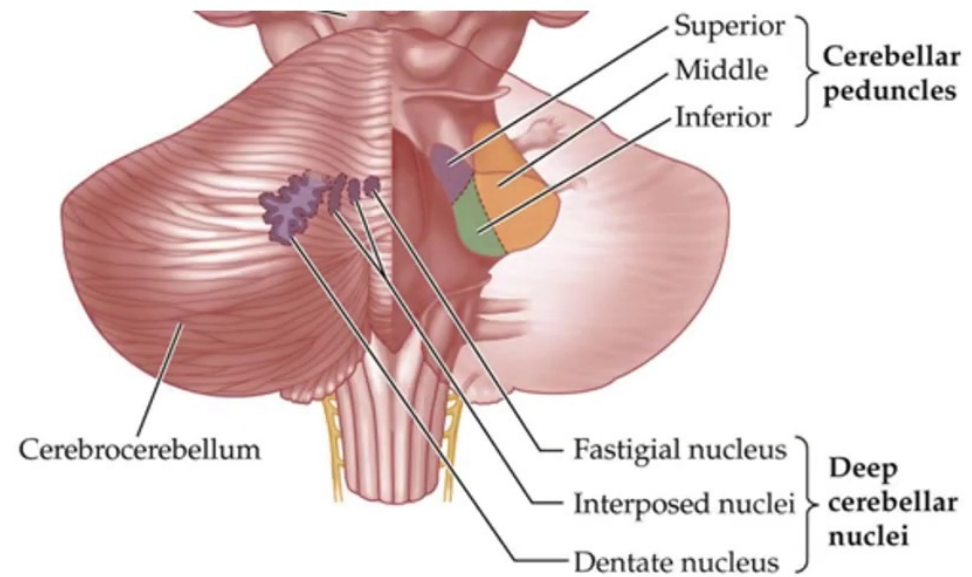
- 3 pairs of Cerebellar Nuclei

1. Fastigial Nc

2. Interposed Nc

1. Embiliform Nc
2. Globose Nc

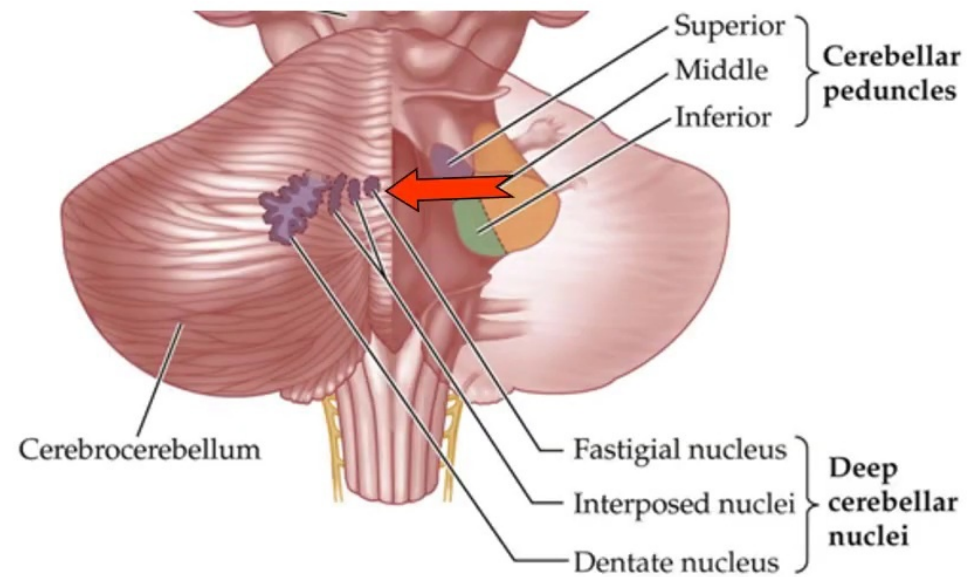
3. Dentate Nc



Cerebellum: Deep Nuclei

1) Fastigial Nc

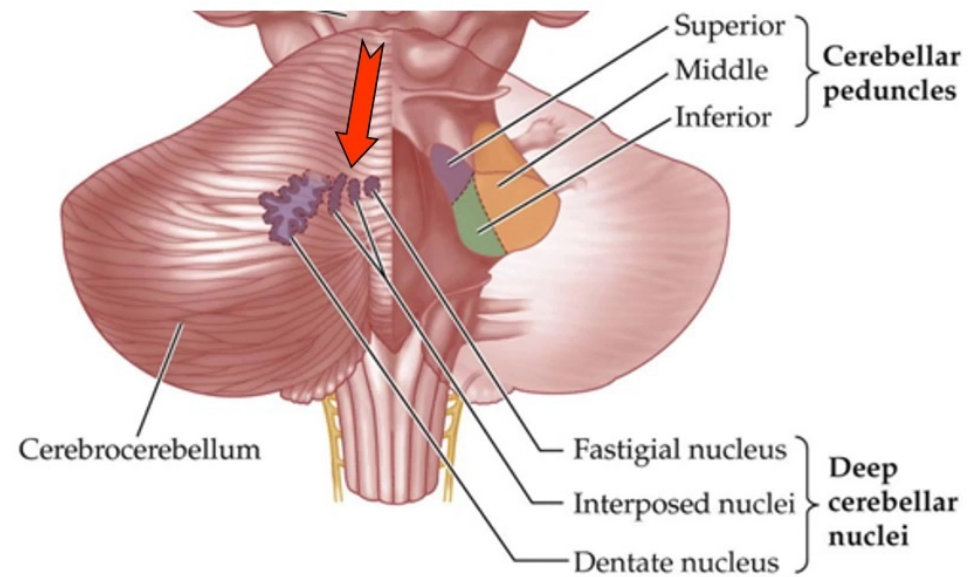
- Medial
- ~
- Vermal zone &
- Spinocerebellum



Cerebellum: Deep Nuclei

2) Interposed Nc

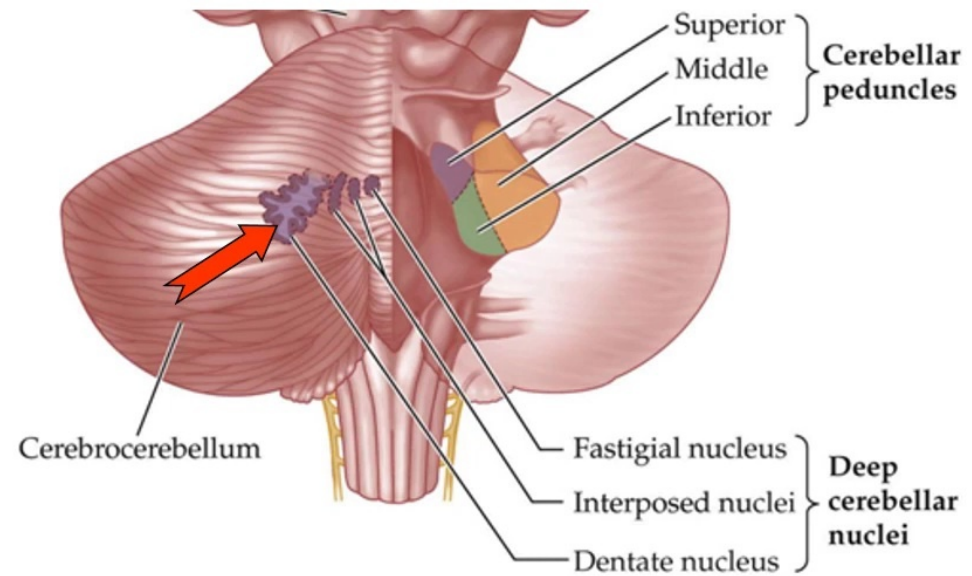
- Intermediate
- **Embiliform Nc**
 - Anterior interposed Nc
- **Globose Nc**
 - Posterior interposed Nc
- ~
- Paravermal Zone &
- Neocerebellum



Cerebellum: Deep Nuclei

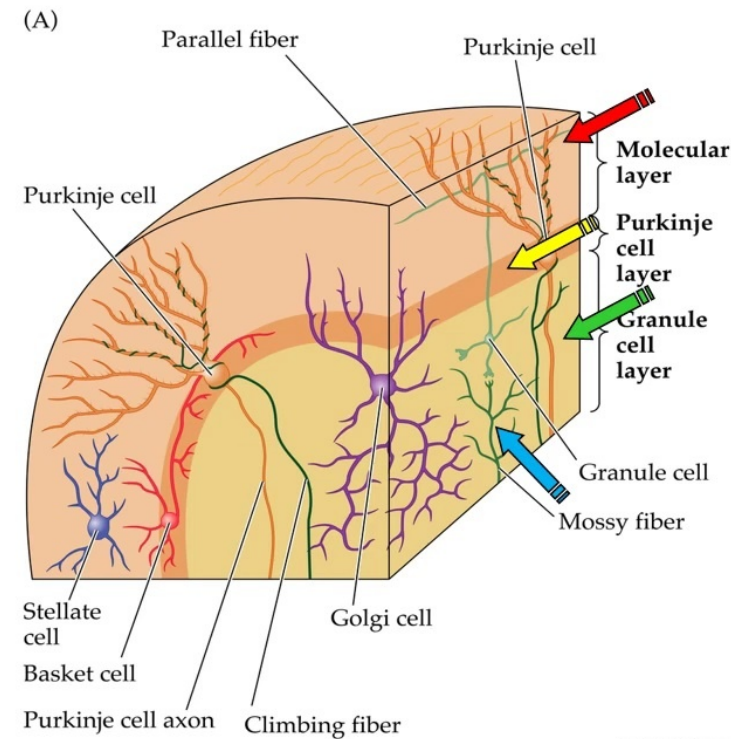
3) Dentate Nc

- Lateral
- ~ Neocerebellum
- Input
 - Inhibitory F from Purkinji cells
- Output
 - Excitatory F
 - The major source of Cerebellar Efferents



Cerebellum: Afferent Nerve Fibres

- 3 layers of cortex
 1. Molecular
 2. Purkinji
 3. Granule
- 3 Functional Afferent NF Types
 1. Mossy F
 2. Climbing F
 3. Monaminergic F



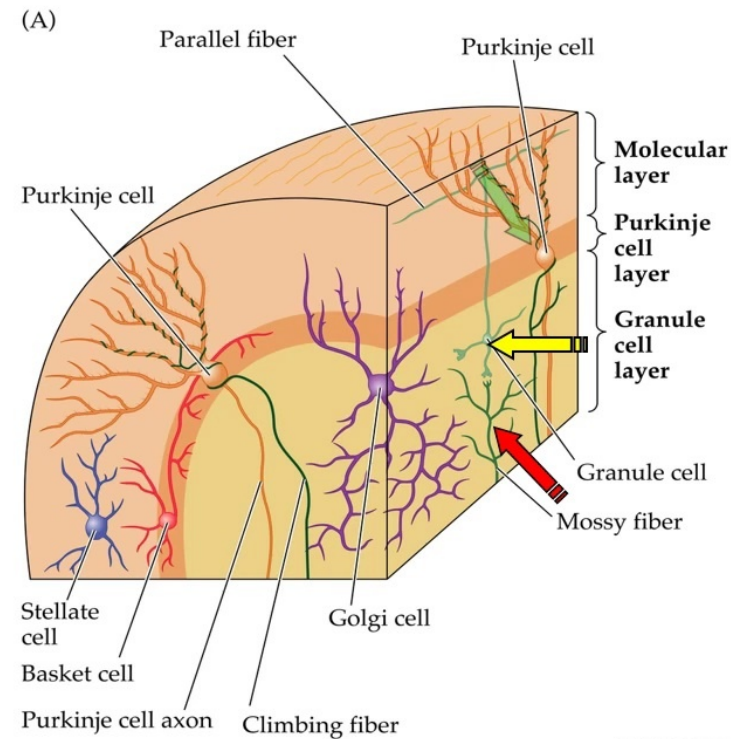
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Cerebellum: Afferent Nerve Fibres

1) Mossy F

- All afferents
- Except
- Olivocerebellar F
- End at
- Granule Cells
- Excite
- Purkinji Cells



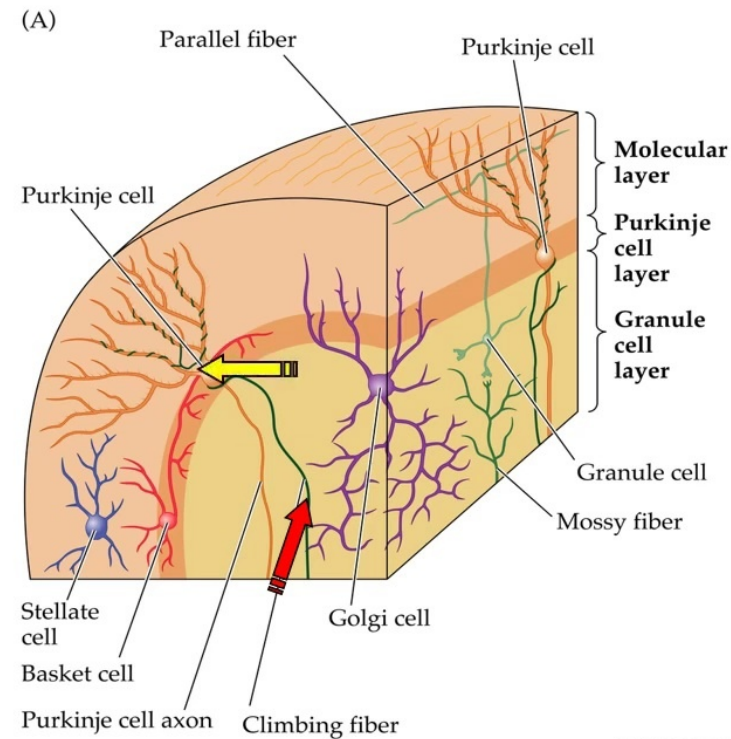
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Cerebellum: Afferent Nerve Fibres

2) Climbing F

- OlivoCerebellar F
- Pass straight
- Excite
- Purkinji Cells
- Directly



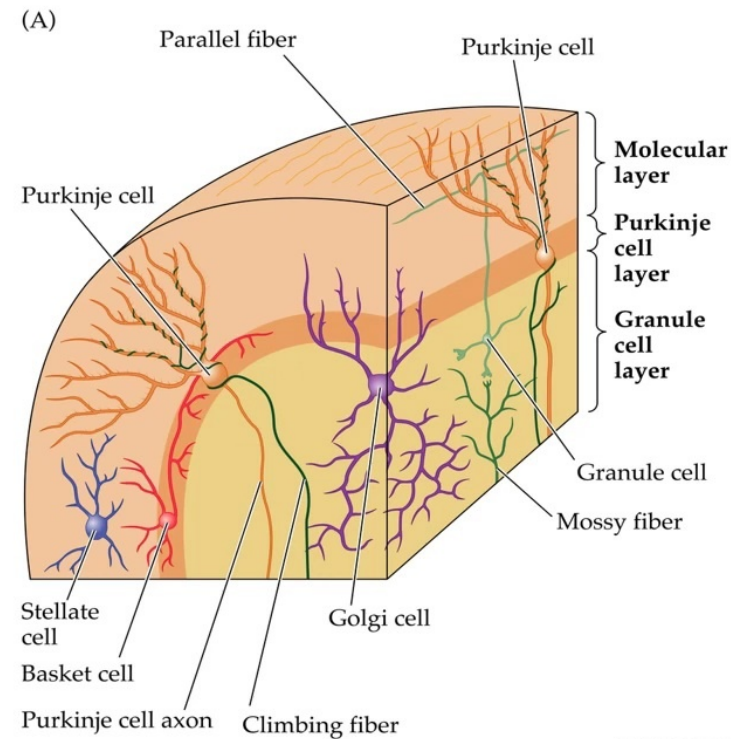
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Cerebellum: Afferent Nerve Fibres

3) Monaminergic F

- Pass to
- All layers of
- Cerebellum
- Serotonergic
- Noradrenergic



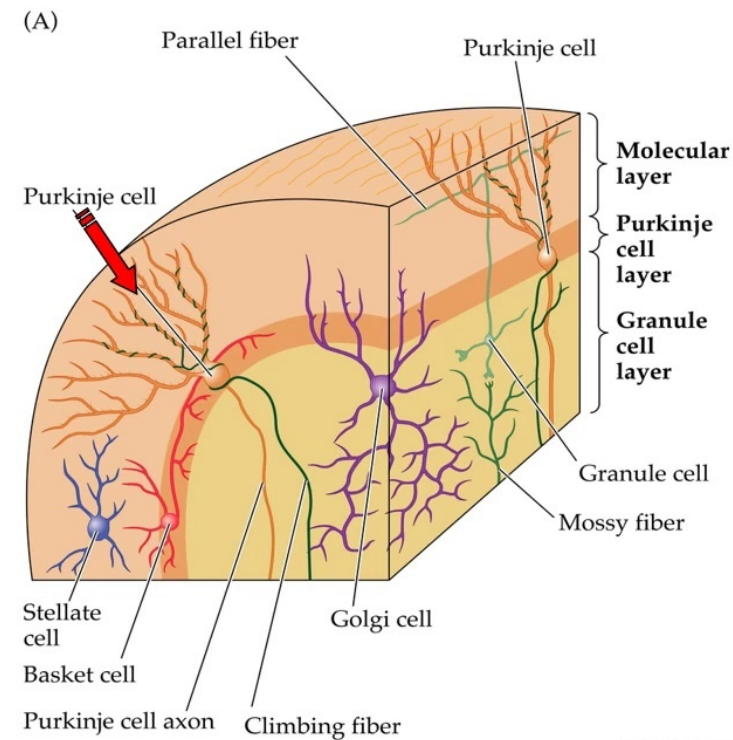
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Cerebellum: Afferent Nerve Fibres

Purkinji cells are

- Excited
 - Directly by
 - Climbing F
 - Indirectly by
 - Mossy F



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Thank you

