



Cerebellum

Objectives:

- ❖ Describe the divisions of the cerebellum
- ❖ Describe the functional divisions of the cerebellum (vestibulocerebellum, spinocerebellum and cerebrocerebellum).
- ❖ Understand cell types / nuclei of the cerebellum
- ❖ Understand the functions of cerebellum in regulation of movement, tone and balance.
- ❖ Understand the abnormalities associated with cerebellar disease.

Done by:

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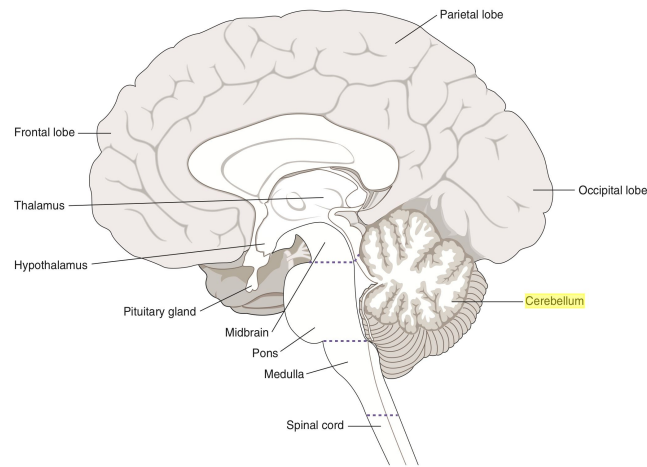
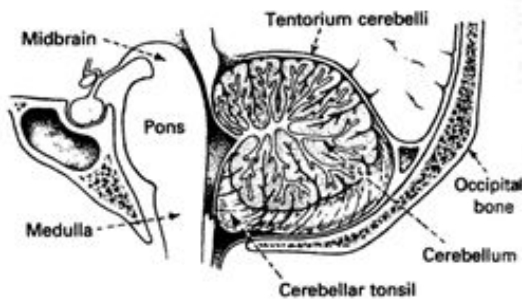
Colour index:

- important
- Numbers
- Extra

CEREBELLUM:

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

- **Shape:** Oval shaped, with an approximate weight is 150 gm
- **Location:** Situated in the posterior cranial fossa
- **Anteriorly:** 4th ventricle, pons, and medulla oblongata
- **Superiorly:** Covered by tentorium cerebelli
- **Posterior-inferiorly:** Squamous occipital



The role of three

3 lobes

- Flocculonodular Lobe
- Anterior lobe
- Posterior lobe

3 Cortical Layers

- Molecular layer
- Purkinje cell layer
- Granular layer

3 purkinje's cells afferent paths

- Mossy fibers from all afferent fibers & help in voluntary movements
- Climbing fibers from the *ION & responsible for learning new movements
- 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

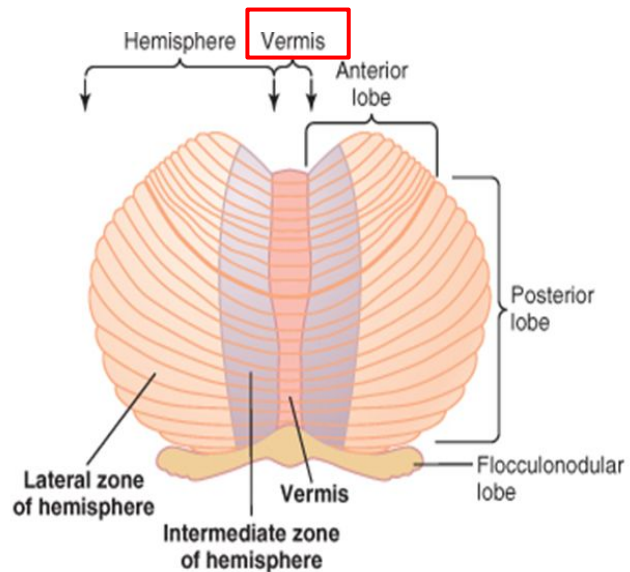
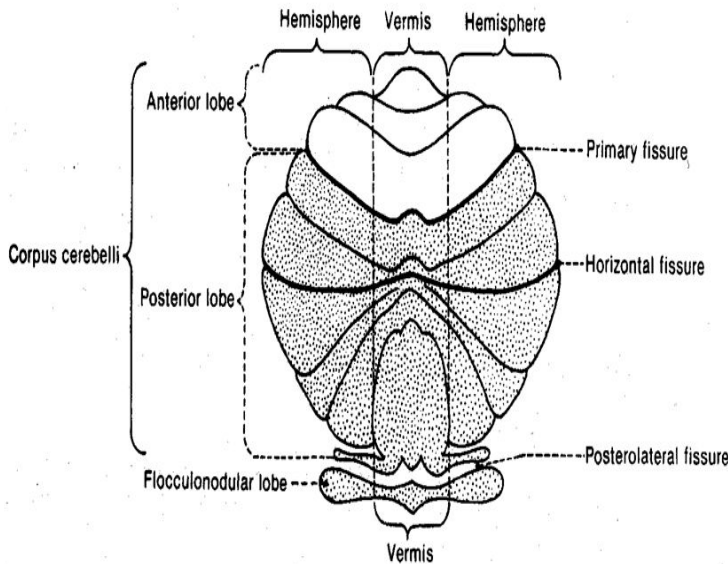
Describe the functional divisions of the cerebellum (vestibulocerebellum, spinocerebellum and cerebrocerebellum).

The cerebellum is anatomically and physiologically divided into three parts:

“Physiologically” “Anatomically” “Functionally”

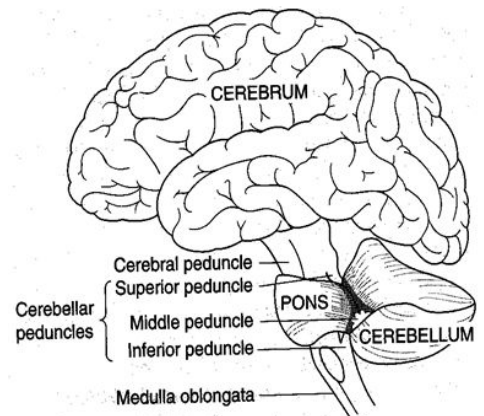
- A. **Paleocerebellum:** Anterior lobe [Spinocerebellum]
- B. **Neocerebellum:** Posterior lobe [Cerebrocerebellum]
- C. **Archicerebellum:** Flocculonodular Lobe [Vestibulocerebellum]

Vermis is a narrow band that separate the two cerebral hemispheres



CEREBELLAR PEDUNCLES: CARRY AFFERENTS FROM WHERE?

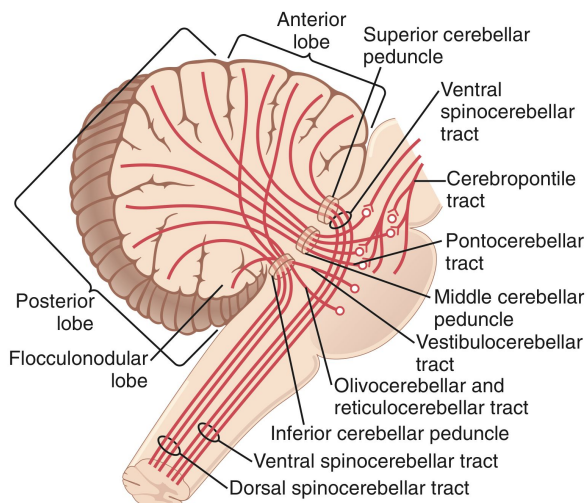
Superior Cerebellar Peduncle	Inputs to the Cerebellum from the cerebrum
Middle Cerebellar Peduncle	Inputs to the Cerebellum from from the Pons
Inferior Cerebellar Peduncle	Inputs to the Cerebellum from the Medulla Oblongata



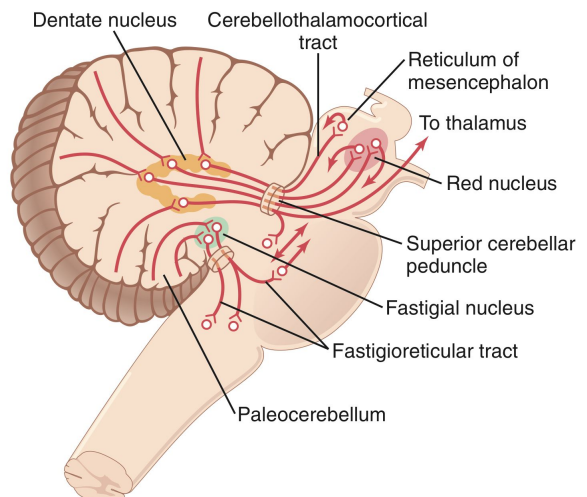
PRINCIPAL AFFERENT TRACTS TO THE CEREBELLUM

AFFERENT TRACTS	TRANSMITS
Vestibulocerebellar	Vestibular impulses from labyrinths , direct & via vestibular nuclei.
Dorsal Spinocerebellar	Proprioceptive & exteroceptive impulses from the body .
Ventral Spinocerebellar	Proprioceptive & exteroceptive impulses from the body .
Cuneocerebellar	Proprioceptive 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 AFFERENT TRACTS TO THE CEREBELLUM :



PRINCIPAL EFFERENT TRACTS TO THE CEREBELLUM :



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

Purkinje cells (output cells)

Basket cells

Golgi cells

Stellate cells

GABA ... Inhibition

Cerebellar nuclei:

Dentate Nucleus

Globose Nucleus

Emboliform Nucleus

Fastigial Nuclei

Granular cells

Stellate cells

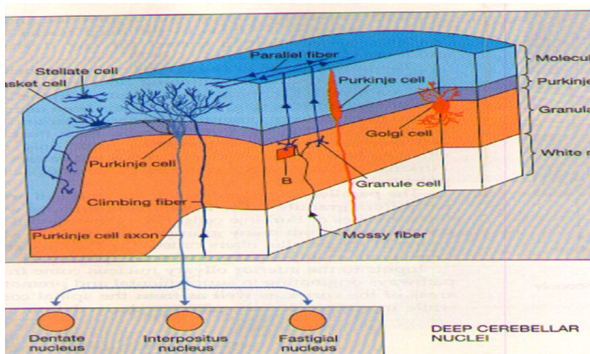
Glutamate ... Excitation

Taurine Inhibition

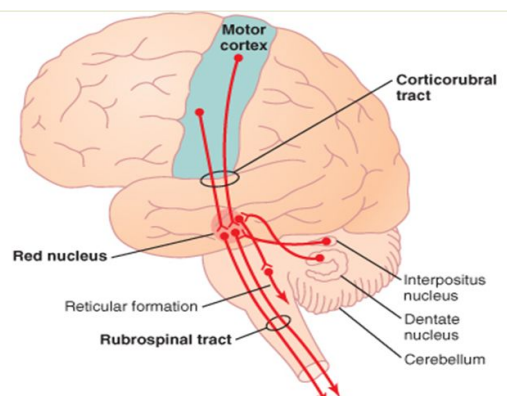
Granular cells are the only excitatory cerebral cortex cells.

Note: Globose and Emboliform also known as **interpositus nucleus**

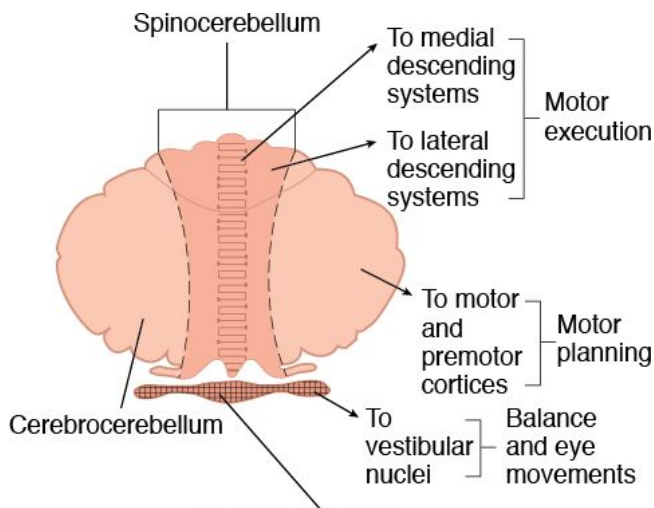
TYPES OF THE CELLS IN THE CEREBELLUM



TYPES OF THE CELLS IN THE CEREBELLUM



Functional division of the cerebellum



*this picture is important

Functional divisions of cerebellum:

1. Vestibulocerebellum:

- its main connection is with the vestibular apparatus
- its responsible for equilibrium, balance, and eye movement

2. Spinocerebellum:

- its main connection is with the spinal cord which control the movement of axial and peripheral muscles.
- its function is regulating muscle tone and coordination of skilled voluntary movement

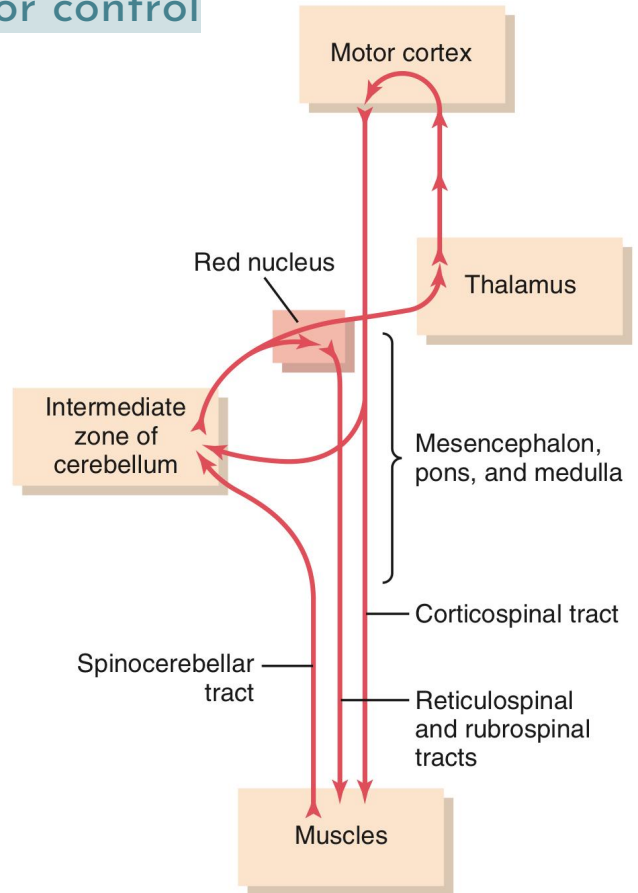
3. Cerebrocerebellum:

- its main connection is with the cerebral cortex and basal ganglia to initiate voluntary movement
- its function is timing and planning which means how many muscles will cooperate in each movement, what is the type of function of each muscle and when will each muscle start working, etc.

Understand the functions of cerebellum in regulation of movement, tone and balance.

Cerebellum and voluntary motor control

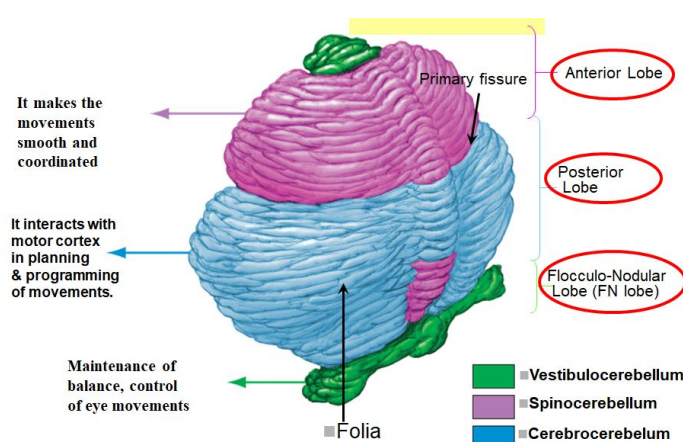
Cerebral and cerebellar control of voluntary movements, involving especially the intermediate zone of the cerebellum.



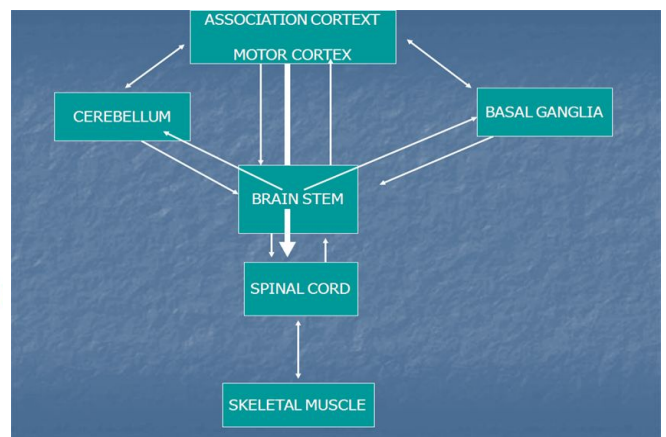
- 1) As the motor cortex sends the descending discharge to the muscle to contract it will also send another copy of impulses to the spinocerebellum so now the spinocerebellum knows the plan of each movement.
- 2) Then the muscle will perform its own plan of the movement and after that it will send another copy of the plan to the spinocerebellum where it will compare between each plan.
- 3) If the plan was the same then the spinocerebellum will keep sending the same impulses to the motor cortex and if it was different then it will send different impulses to correct the action.

معنى هذا الكلام انه بالبداية يبجي أمر للعضلات إنها تنفذ حركة معينة وكم ان هذا الأمر بيروح لل spinocerebellum عشان تحط خطة للطريقة اللي المفروض هذي العضلة تنفذ الحركة فيها. بعد ما يبجي أمر للعضلات إنها تنفذ حركة معينة بتنفيذها بطريقة خاصة وبعدين العضلة بترسل نسخة ثانيه من الخطة اللي نفذتها لل spinocerebellum عشان بعدين ببصير فيه مقارنة بين الخطين. اذا مثلا كانت الخطة فيها خطأ بترسل لل motor cortex أمر ثاني عشان يصحح الحركة اما اذا كانت نفسها ما راح يتغير شيء.

Cerebellum



Connections of the cerebellum



Summary: functions of cerebellum

Cerebellum Lobe	Nuclei	Cortex	Inputs	Outputs	Function
Paleocerebellum	Interpositus Fastigial	Vermis & Medial portions of Cerebellar hemispheres	Spinal and brainstem paths	SCP to Red Nucleus; Fastigial to RF	Muscle tone, posture & coordination of movements
Neocerebellum	Dentate	Lateral portions of Cerebellar Hemisphere	Corticopontine/ pontocerebellar	SCP	Planning and executive of voluntary & skilled hand movements
Archicerebellum	Fastigial	Flocculonodula r	Vestibular nuclei	Vestibular nuclei; RF	Balance, equilibrium

Abnormalities associated with cerebellar disease

Disorder	Description
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 <div style="border: 1px dashed gray; padding: 2px; display: inline-block; margin-left: 20px;">Speech becomes staccato or scanning</div>
Dysdiadochokinesia	Inability to perform rapid alternating (opposite) movements
Dysmetria	Inability to control range of movement
Hypotonia	Decreased muscle tone due to loss of the facilitatory effect of the CB on the stretch reflex, and it is associated with pendular .knee jerk caused by lesions in cerebrocerebellum & spinocerebellum b/c they increase the muscle tone
Nystagmus <div style="border: 1px dashed gray; padding: 2px; display: inline-block; margin-left: 20px;">Tremor of the eye</div>	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.



Dysdiadochokinesis:

“rapidly alternating movements”

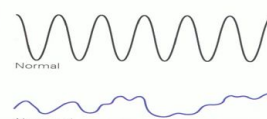
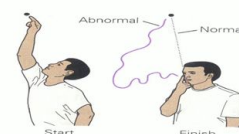
dysdiadochokinesia: Inability to perform rapidly alternating movements. Is called. It is usually caused by multiple sclerosis in adults and cerebellar tumors in children. Patients with other movement disorders (e.g. Parkinson's disease) may have abnormal rapid alternating movement testing secondary to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



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.



Incoordination/ rapid alternating movements (dysdiadochokinesia)

Cerebellar Signs

1-Signals from motor areas of the cortex reach the contralateral cerebellum after first passing through which one of the following structures?

- A) Thalamus
- B) Caudate nucleus
- C) Red nucleus
- D) Basilar pontine nuclei

2-Neurological disease associated with the cerebellum produces which of the following types of symptoms?

- A) Resting tremor
- B) Athetosis
- C) Rigidity
- D) Ataxia

3-Inability to perform rapid alternating movements?

- A) tremor
- B) Dysdiadochokinesia
- C) Dysarthria
- D) Ataxia

4-which of the following cells secrete excitatory neurotransmitter?

- A)stellate
- B)granular
- C)basket
- D)Purkinje cells

answers:

- 1-D
- 2-D
- 3-B
- 4-B