Central Nervous System

Lecture 9: Cerebellum, MLB & Reticular Formatiom

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Medial Longitudinal Bundle: MLB

** A bundle of fibers extending longitudinally in the brain stem on each side of the median plane.

** It extends upwards till the interstitial nucleus of Cajal in the posterior commissure & below it continues into the spinal cord as the medial vestibulospinal tract.

** It connects the vestibular and cochlear nuclei with motor nuclei of cranial nerves that move the eye III, IV, VI and with the spinal nucleus of accessory nerve that moves the neck.

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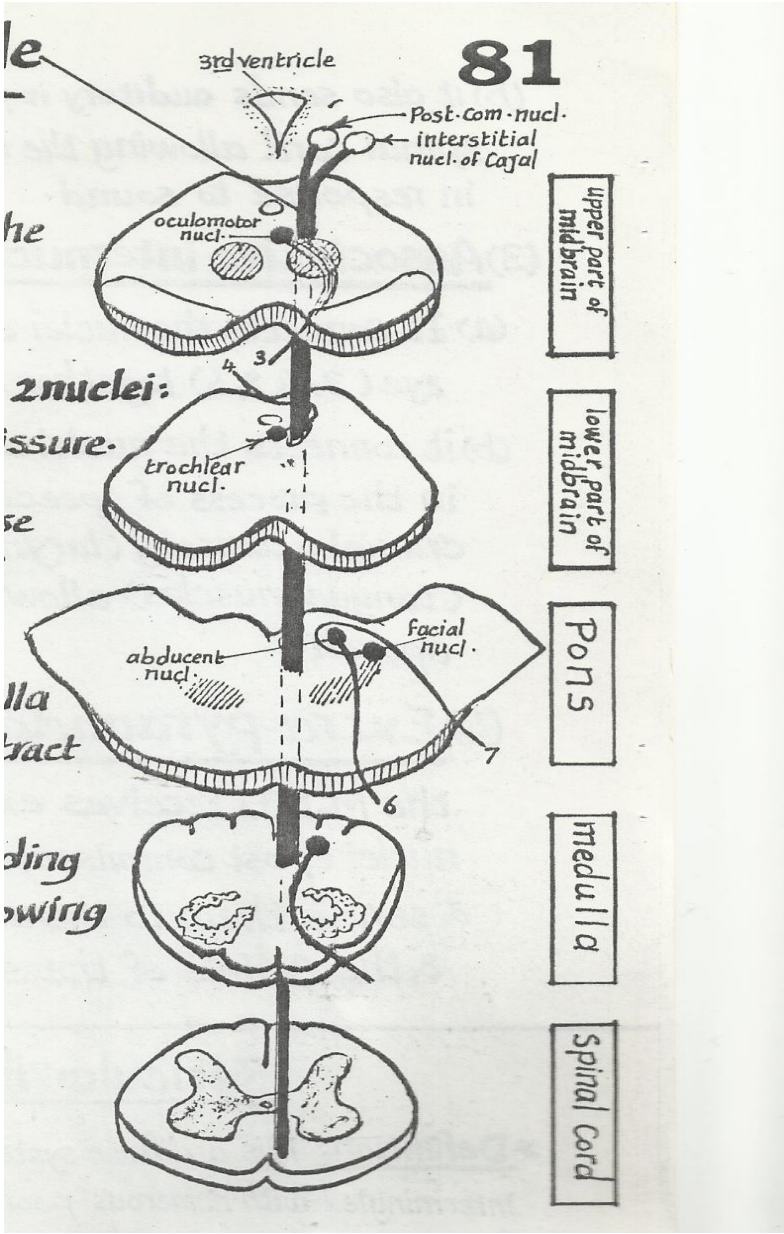
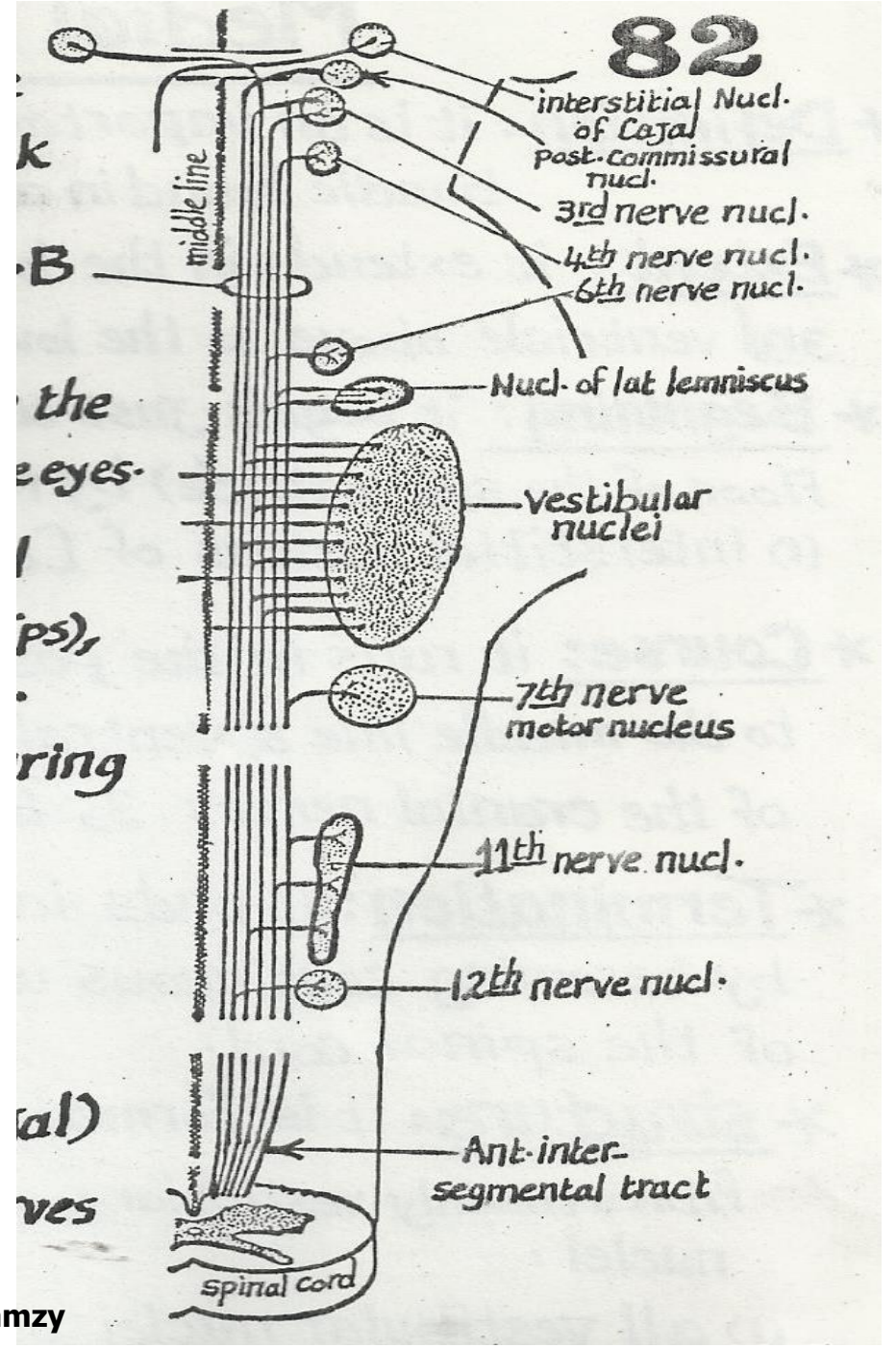


** Function:

* Involved in coordinated movements of eyeball and head in response to vestibulo-cochlear stimuli.
* Involved in pathway for conjugate lateral movements of the eye; i.e., it connects the abducent nucleus of one side with oculomotor nucleus of opposite side.



RETICULAR FORMATION

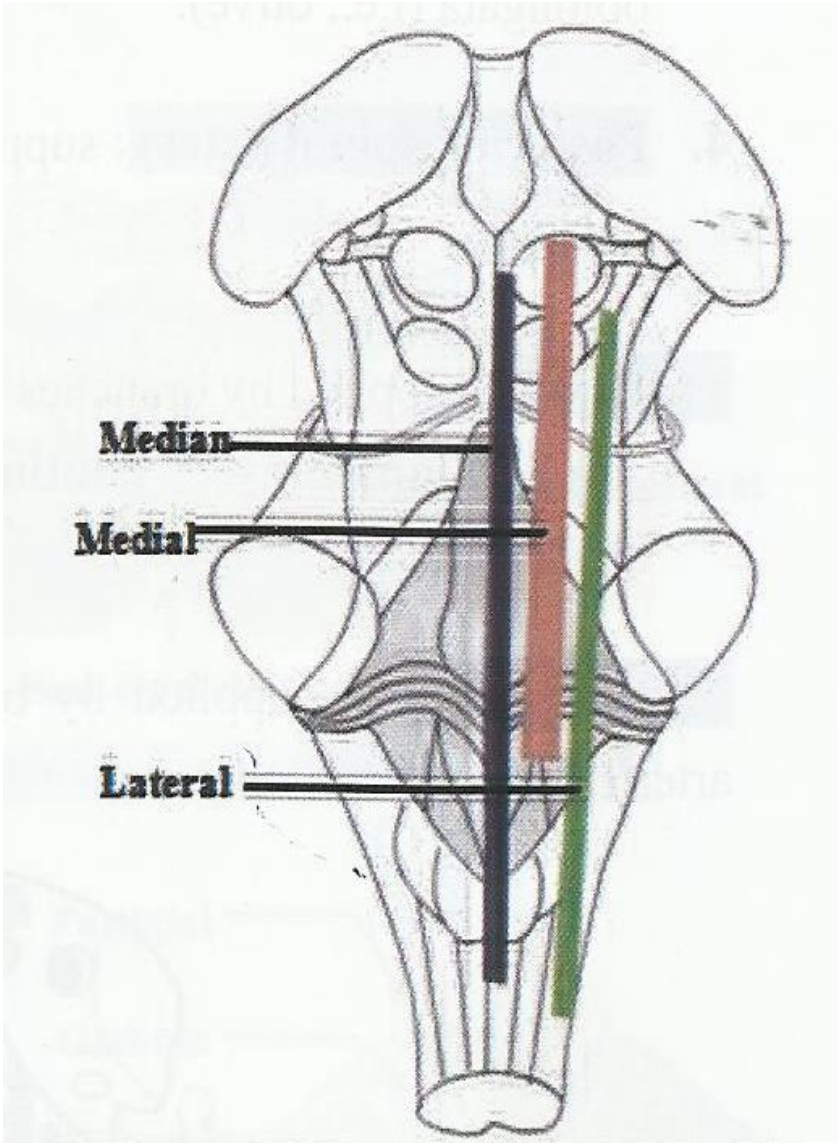
** It consists of nerve cells and nerve fibers scattered within the brain stem extending superiorly to hypothalamus & thalamus and inferiorly to spinal cord. Its neurons are arranged into 3 columns: median, medial & lateral.

** Functions:

A. The median periaqueductal grey (PAG) and "Raphe" nuclei (serotonergic): projects to:

1. Substantia gelatinosa (to induce analgesia).
2. Diencephalon (to induce sleep).

B. The medial column: controls skeletal muscle activity (through reticulospinal tracts).



C. The lateral column: which includes the locus coeruleus (noradrenergic) is concerned with:

1. Reticular activating system (RAS) which receives afferents from sensory inputs:

a. Anterolateral system (spinothalamic & spinoreticular tracts).

b. Trigeminal lemniscus.

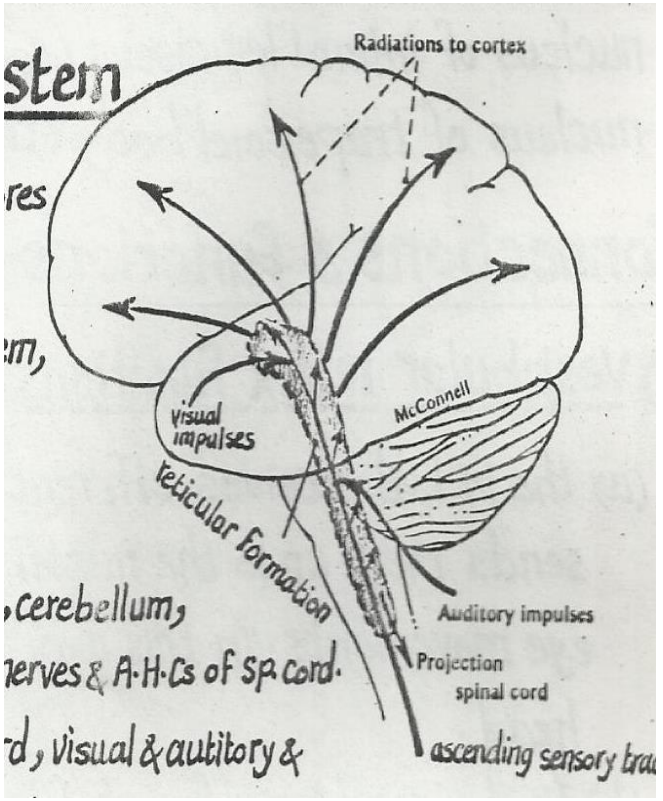
c. Auditory, visual & olfactory pathways.

*** RAS projects to whole cerebral cortex directly or after relay in the intralaminar nuclei of thalamus. It is essential for wakening, attention & level of consciousness.**

2. Contain respiratory center and vasomotor centers.

3. Control the autonomic nervous system (the descending reticulospinal tracts contain autonomic fibers).

4. Influence circadian rhythm & biological clock.



Blood supply of Brain stem

** The medulla: is supplied by the four branches of the vertebral artery:

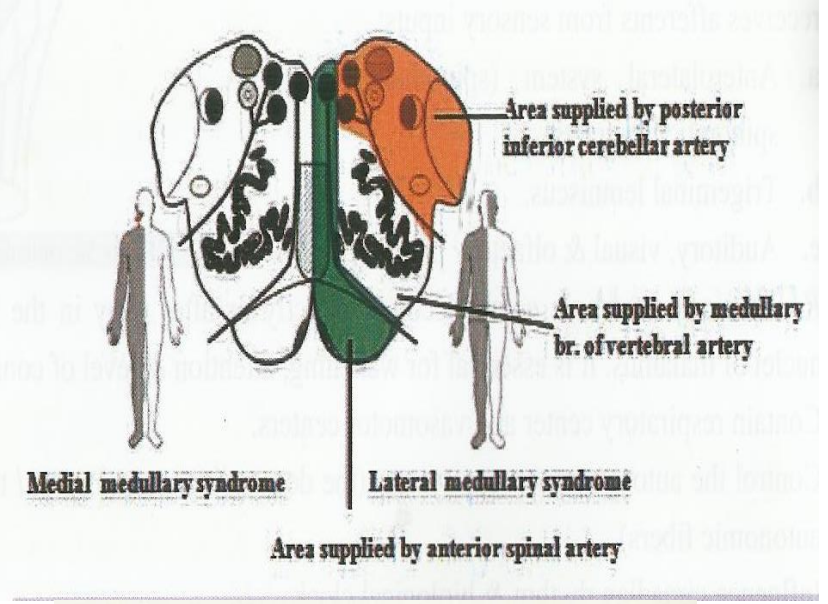
1. Anterior spinal artery: supplies the part of the medulla medial to hypoglossal nerve (containing the XII nucleus, medial lemniscus & pyramid).

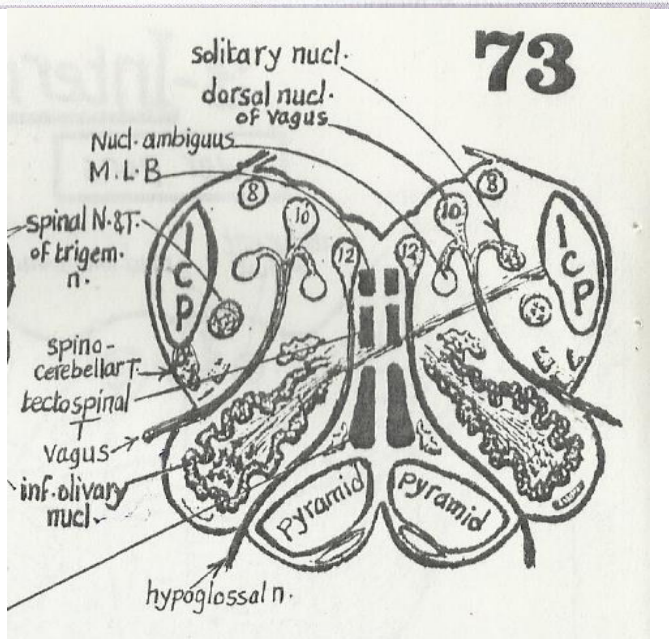
* Its occlusion → Medial medullary syndrome which involves the following:

a. Pyramid → contralateral hemiplegia of the UMNL type but paralysis is flaccid.

b. Medial lemniscus → contralateral loss of proprioception & fine touch

c. XII nucleus → ipsilateral LMNL paralysis of tongue muscles (ask patient to protrude tongue, it deviates towards paralyzed side).





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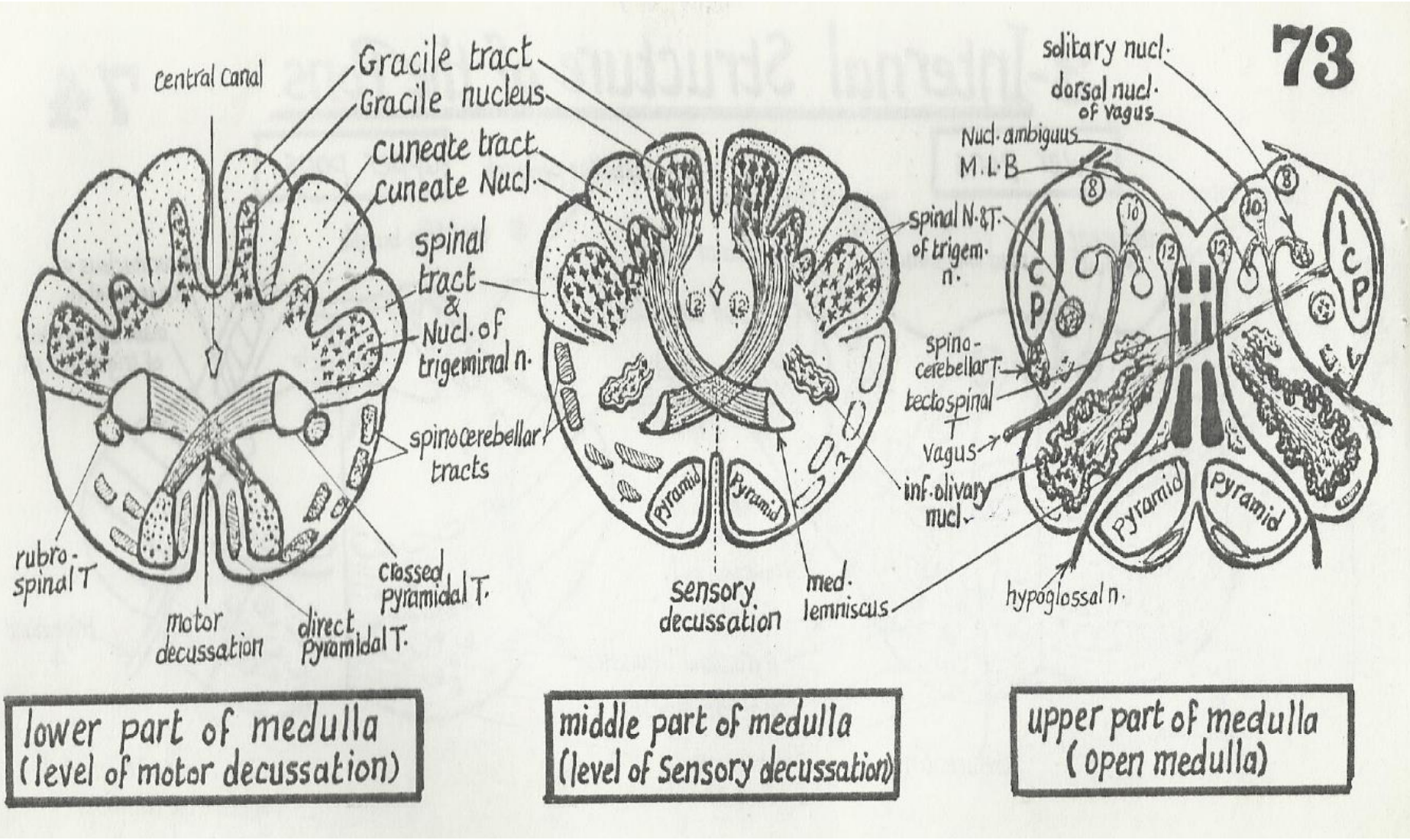

Central canal
Gracile tract
Gracile nucleus
cuneate tract
cuneate Nucl.
spinal tract & Nucl. of trigeminal n.
spinocerebellar tracts
rubro-spinal T
motor decussation
direct pyramidal T.
crossed pyramidal T.
Pyramid
Pyramid
sensory decussation
med. lemniscus
solitary nucl.
dorsal nucl. of Vagus
Nucl. ambiguus
M.L.B
Spinal N.&T. of trigem. n.
Spino-cerebellar T.
tectospinal T
Vagus
inf. olivary nucl.
hypoglossal n.
ICP
ICP
Pyramid
Pyramid
lower part of medulla (level of motor decussation)
middle part of medulla (level of Sensory decussation)
upper part of medulla (open medulla)

2. Posterior inferior cerebellar artery (PICA): supplies lateral part of MO.

** **PICA occlusion → Lateral medullary syndrome which involves the following:**

a. **Spino-cerebellar tract & ICP → cerebellar ataxia.**

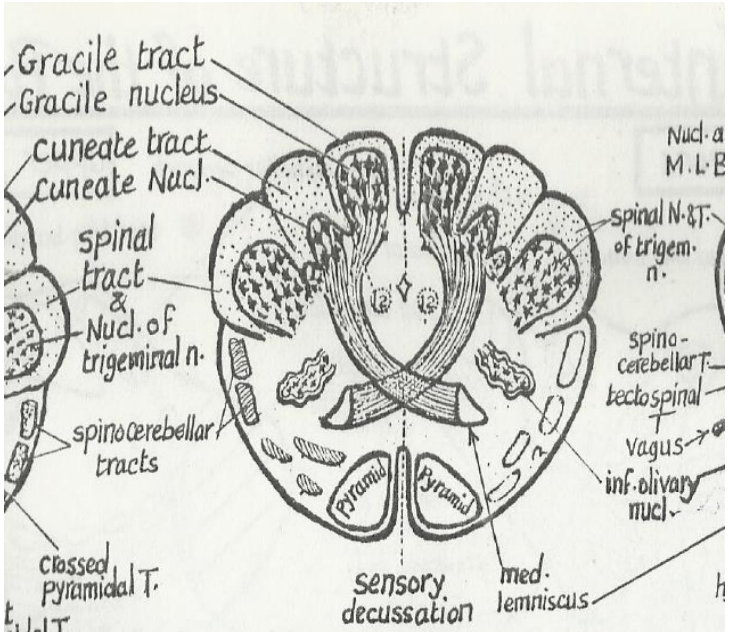
b. **Spinal N. & tract of V → loss of pain & temp. from ipsilateral face.**

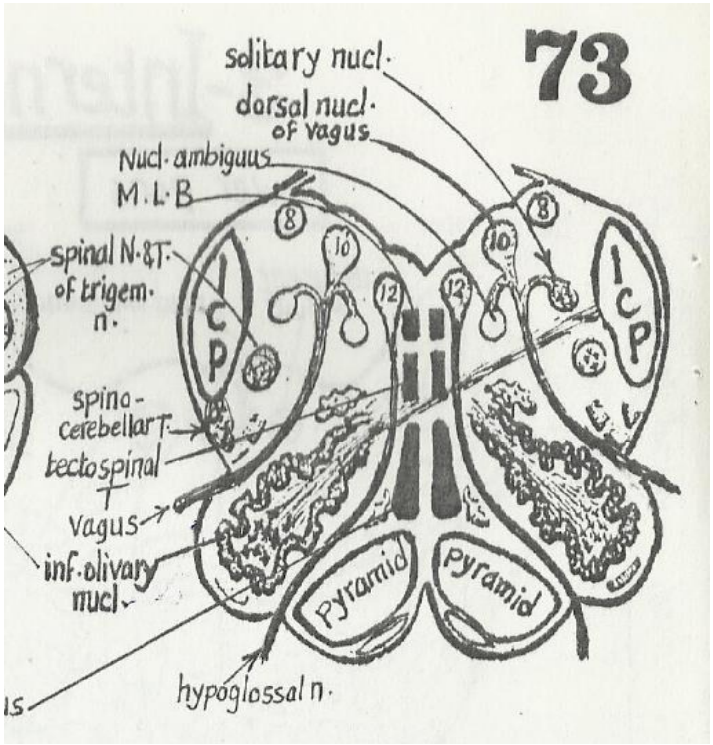
c. **Spinal lemniscus → loss of pain & temp. from opposite half of body.**

d. **Nucleus ambiguus → ipsilateral paralysis of palate, pharynx & larynx.**

e. **Nucleus solitarius → loss of taste sensation.**

f. **Descending sympathetic fibers → ipsilateral Horner's syndrome (ptosis, miosis, anhydrosis, enophthalmos).**





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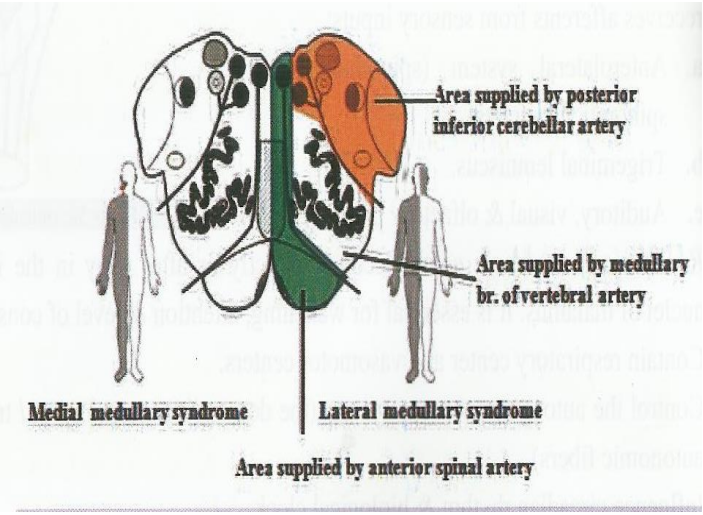
3. **Medullary branches of vertebral artery:** supply intermediate area of medulla oblongata (i.e., olive).

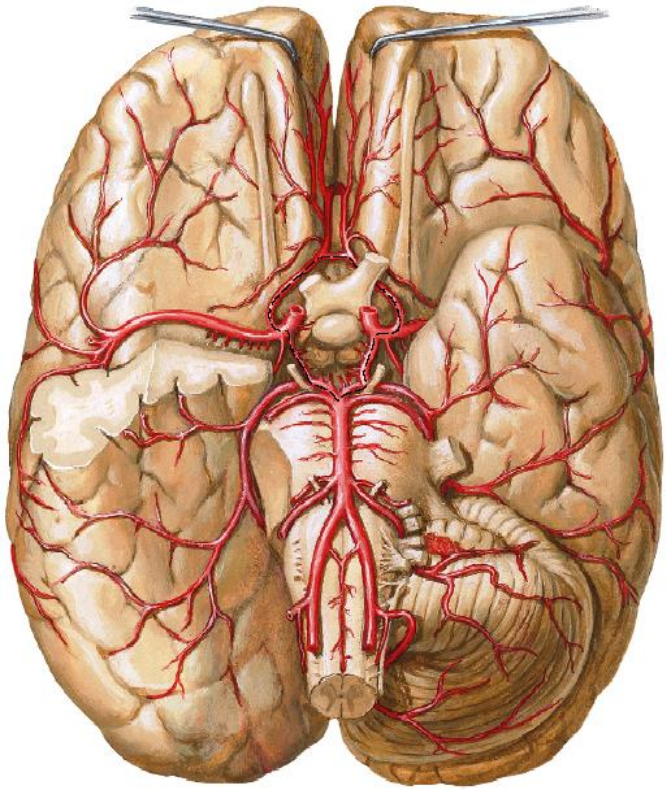
4. **Posterior spinal artery:** supplies posterior part of closed medulla (i.e. gracile & cuneate nuclei).

** **The pons** is supplied by: branches of **basilar artery.**

** **Applied anatomy: pontine hemorrhage** → pin-point pupil + hyperpyrexia + quadriplegia.

** **The midbrain** is supplied by: branches of the **posterior cerebral & superior cerebellar arteries.**



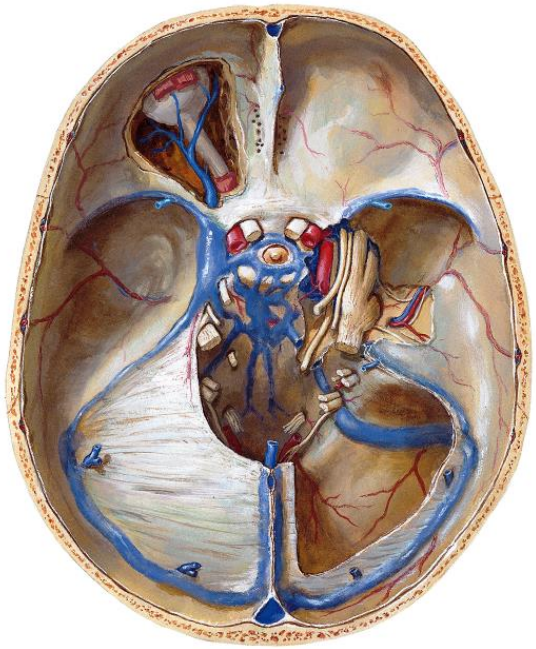


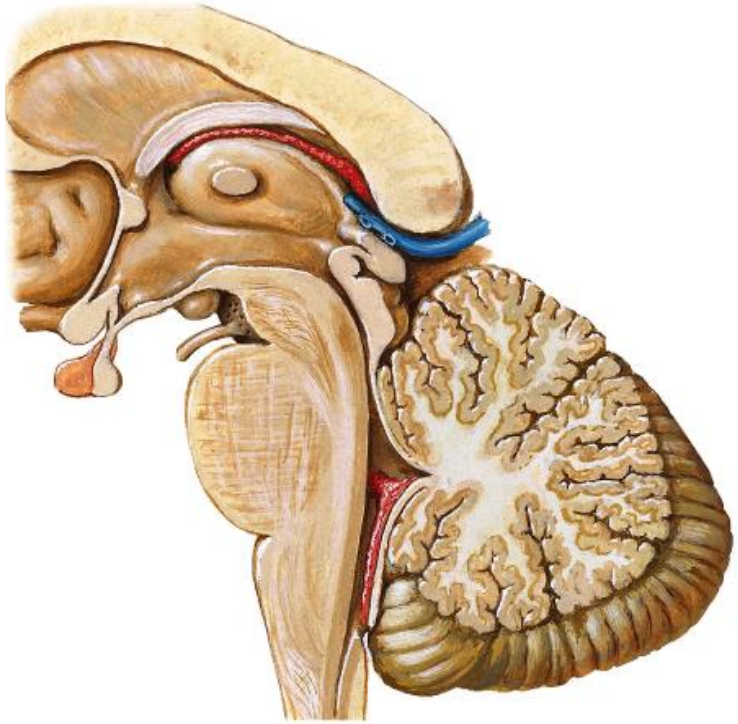
CEREBELLUM

** It is the largest part of the hindbrain.

** It lies in the posterior cranial fossa with the tentorium cerebelli roofing over and separating it from the cerebrum.

** It lies posterior to the pons and medulla with the cavity of the fourth ventricle intervening.

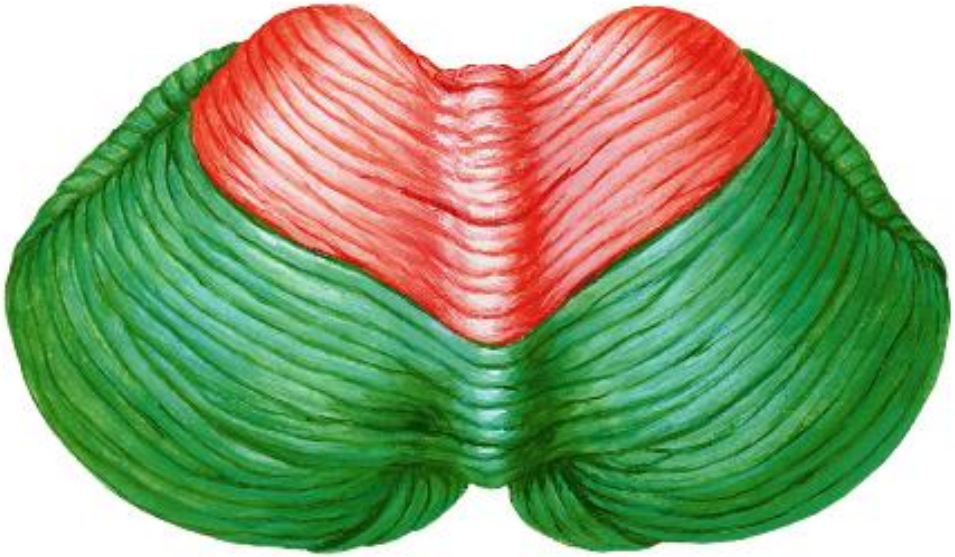




** It has two notches: an anterior notch which lodges the pons and medulla, and a posterior notch that lodges the falx cerebelli.

** It is formed of two cerebellar hemispheres joined by a median narrow part; the vermis.

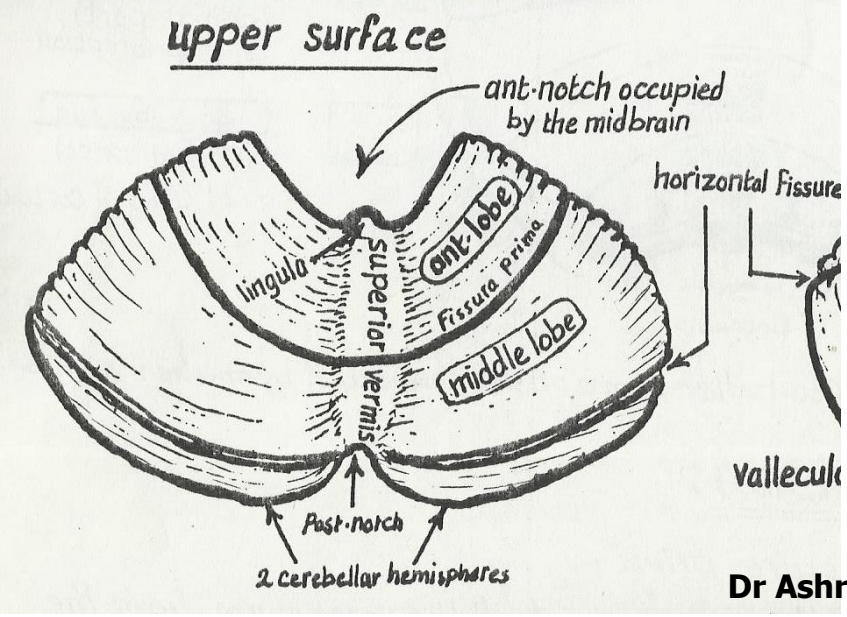
** The surface of the cerebellum shows many fissures. A deep fissure; the horizontal fissure, lies along the margin of the cerebellum and separates the superior from the inferior surface.

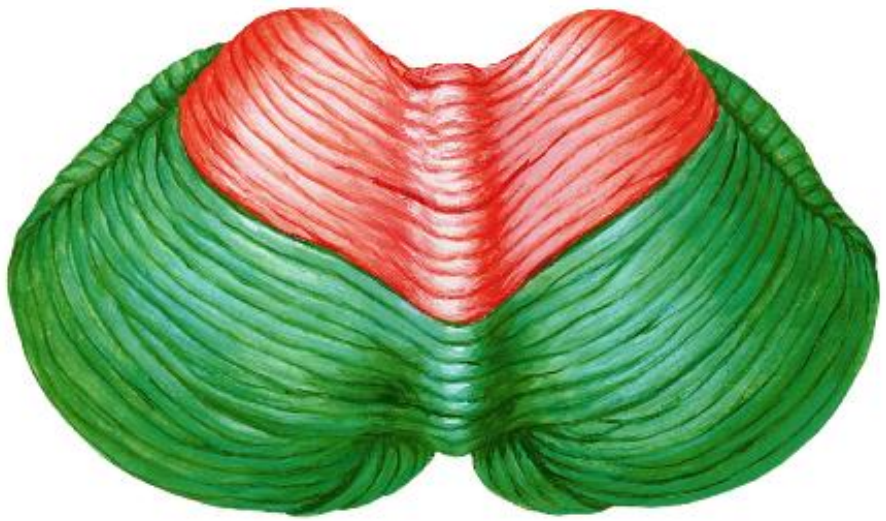


Surfaces of Cerebellum

I. Superior Surface:

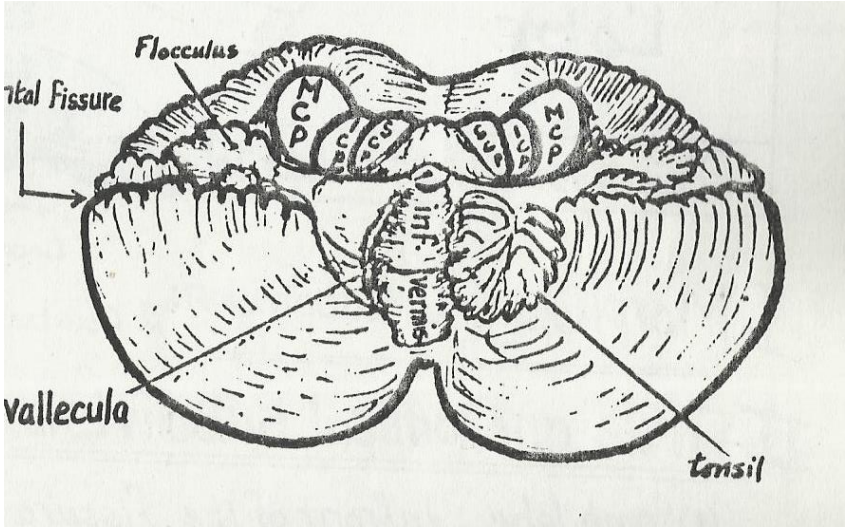
It shows the superior vermis raised more than the cerebellar hemispheres. It also shows a deep fissure, Fissura prima, that separates anterior lobe of cerebellum from posterior lobe of cerebellum.

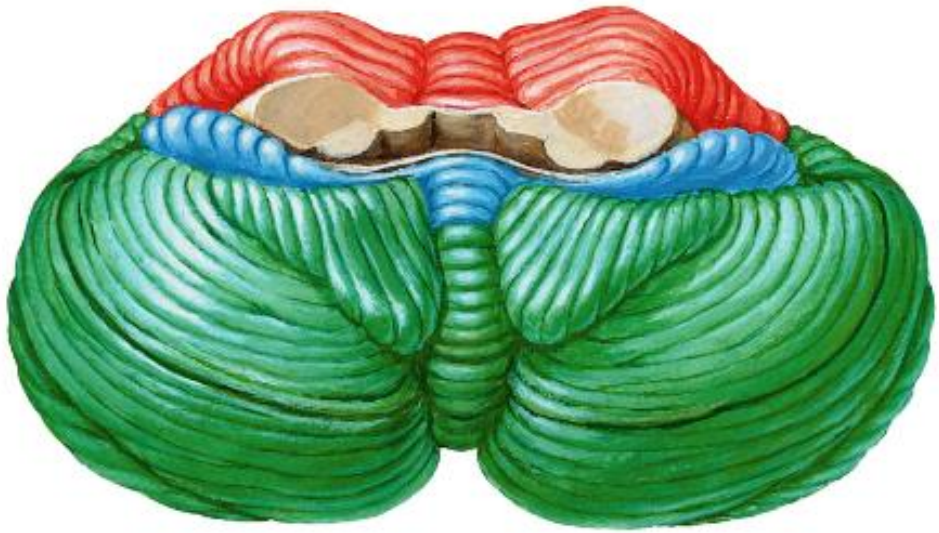




II. Inferior Surface:

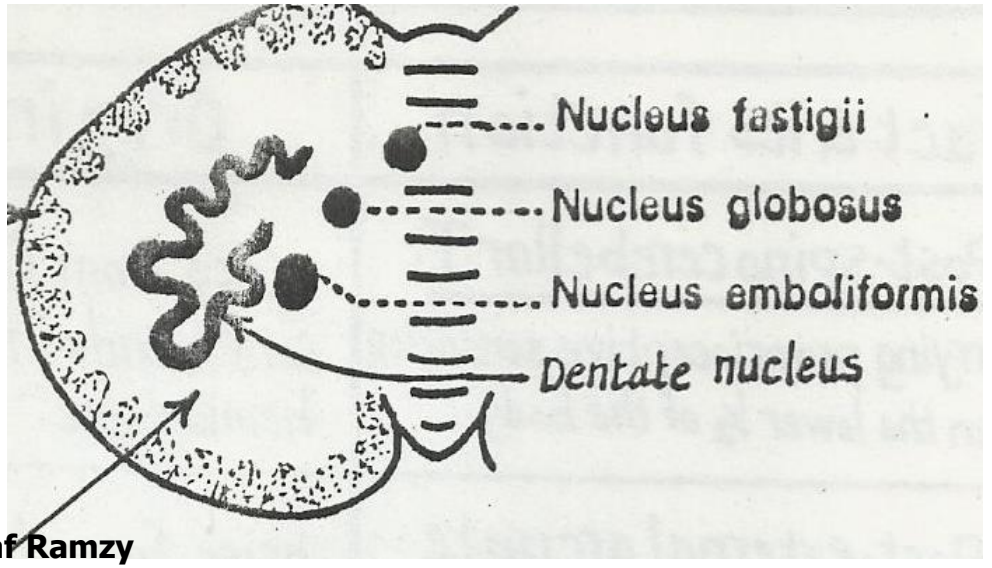
The inferior vermis is present in a deep groove, vallecula that lies between the two cerebellar hemispheres. A posterolateral fissure separates the posterior lobe from the flocculo-nodular lobe.





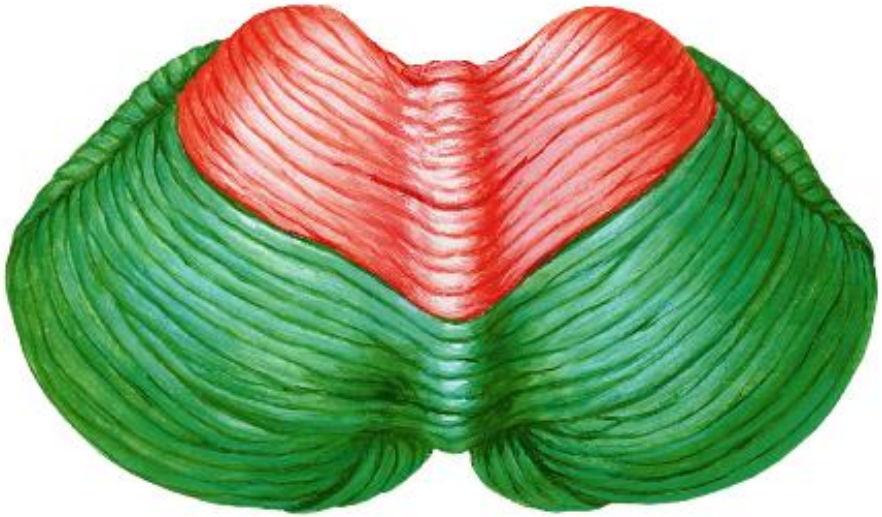
Grey matter of cerebellum

1. **Cerebellar cortex: (on the surface). The cortex is folded by parallel and transverse fissures into folia. The whole cerebellar cortex has a similar histological structure**
2. **Cerebellar nuclei: (scattered in the white matter core). They include the Dentate, Emboliform, Globose and Fastigial nuclei from lateral to medial.**



Lobes of Cerebellum

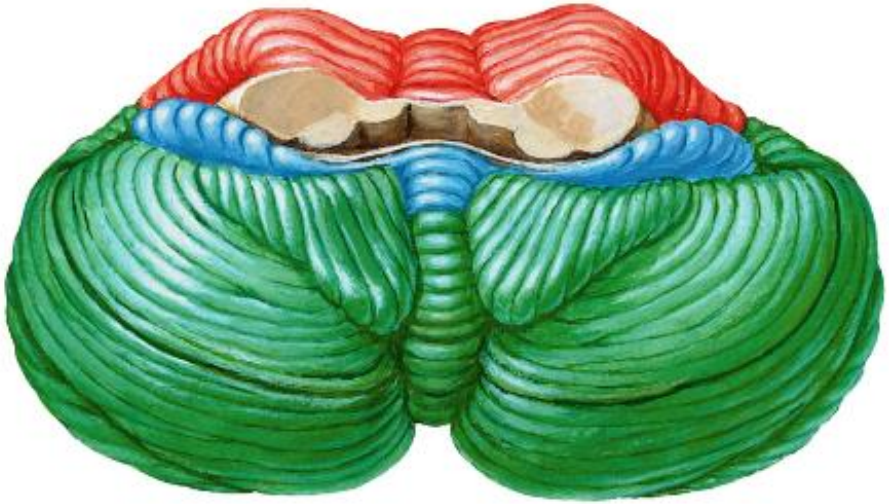
** **Anatomically:** the cerebellum is divided into 3 lobes: Anterior lobe infront of the fissura prima, posterior lobe behind fissura prima, and Flocculonodular lobe separated from posterior lobe by the posterolateral fissure.



** **Functionally:** the Cerebellum is also divided into 3 lobes:

1. **Archicerebellum:**

* Its connections are vestibular.
* It is concerned with equilibrium.
* It is formed of 2 Flocculi + Nodule (part of inf. Vermis)

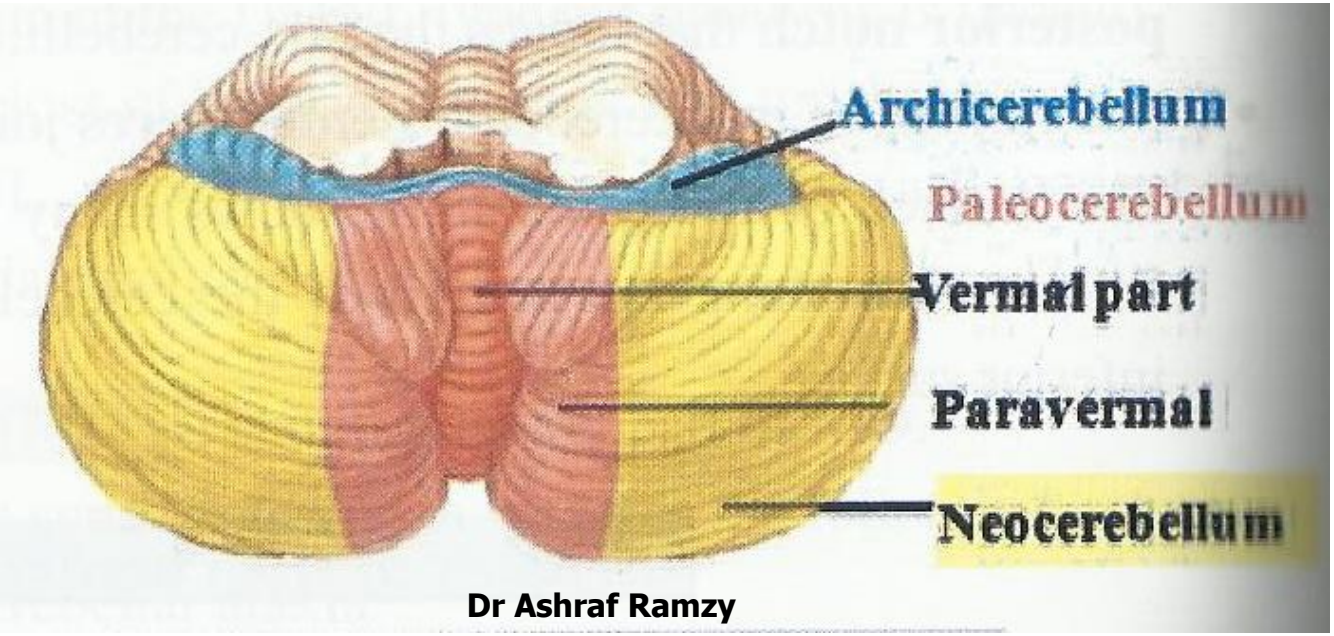


2. Paleocerebellum:

* Its connections are spinal (spino-cerebellar).
* It controls muscle tone, posture & coordinates movements.
* It is formed of 3 parts:

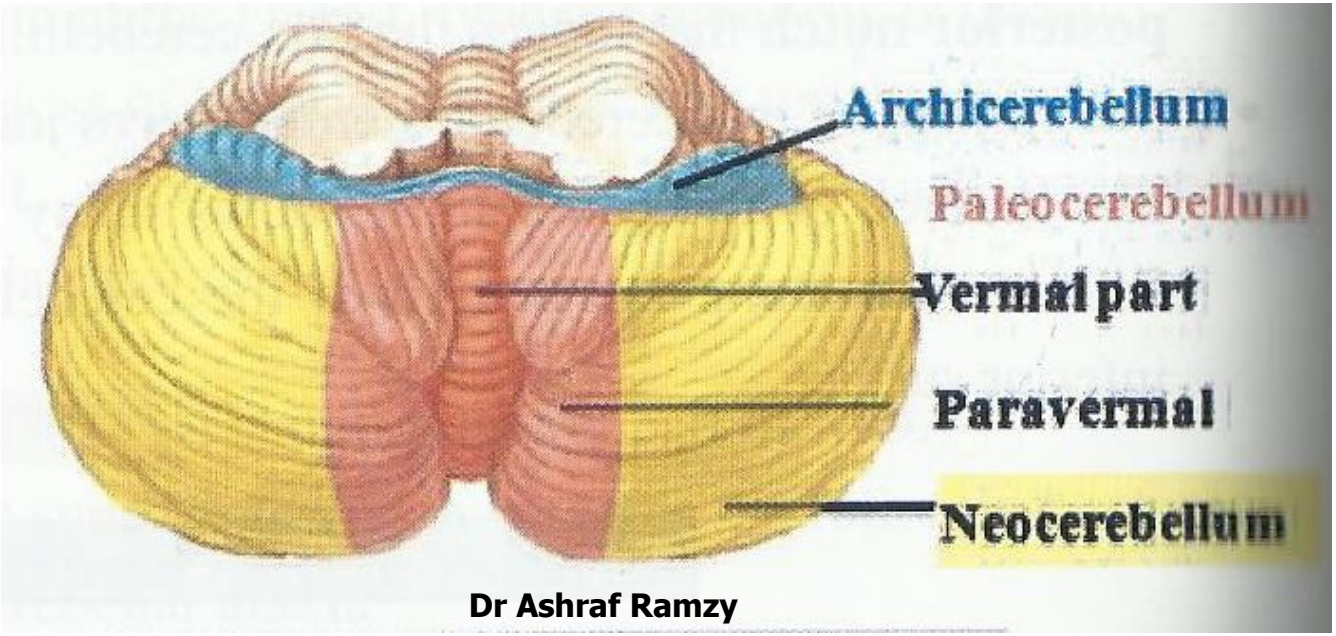
a. Vermal part: includes the whole vermis. It has connections to the trunk muscles of both sides via the fastigial nucleus.

b. 2 paravermal parts: of the cerebellar hemispheres: are connected to the distal limb muscles of the same side via the globose and emboliform nuclei.



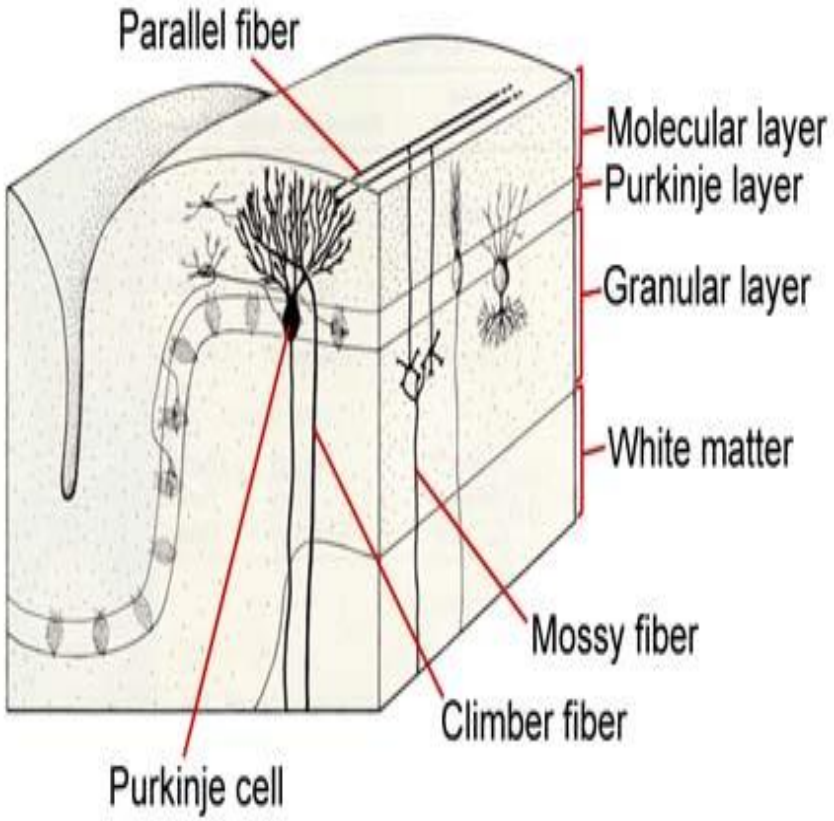
3. Neocerebellum:

* Its connections are cortico-ponto-cerebellar & projects to the contralateral cerebral cortex via the dentate nucleus.
* It interacts with motor cortex in planning & programming movement.
* It is formed of the most lateral parts of cerebellar hemispheres.



** **Notes:**

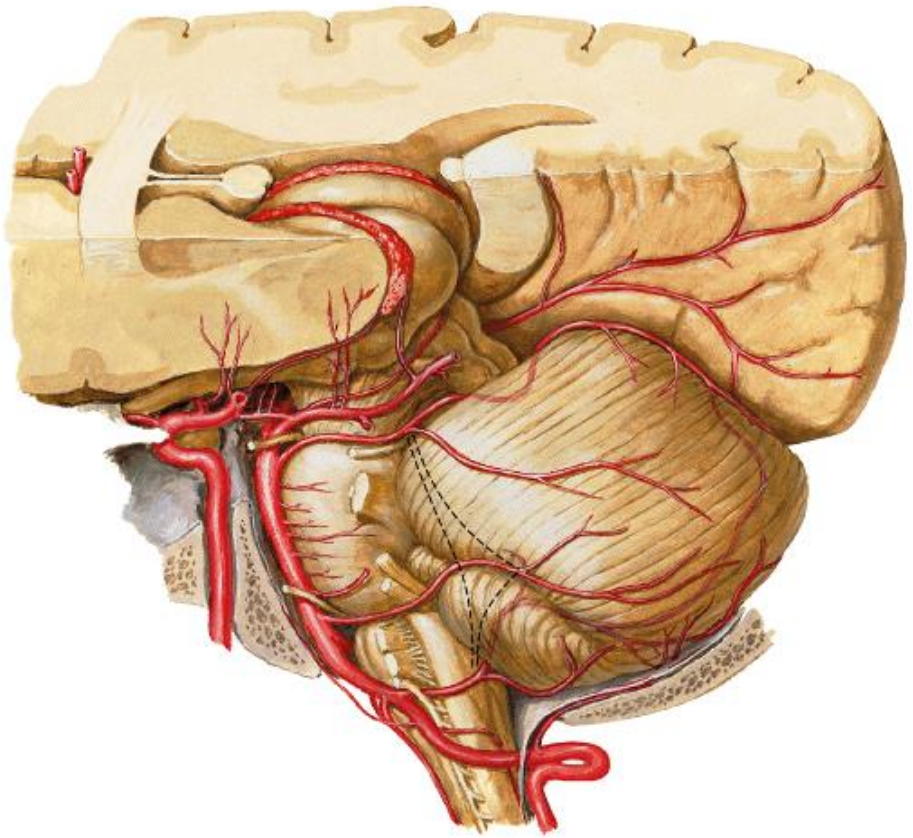
1. **The purkinje cells are the key cells in the cerebellar cortex. They receive 2 types of afferent fibers: Climbing fibers directly from the olivary nuclei & Mossy fibers which include all other cerebellar afferents which relay first on granule cells.**
2. **The purkinje cell axons are inhibitory to cerebellar nuclei which send all cerebellar efferents. All purkinje cells discharge to cerebellar nuclei except in the flocculonodular lobe where they discharge directly to vestibular nuclei.**
3. **Each cerebellar hemisphere is connected with the ipsilateral side of the body or the contralateral cerebral hemisphere.**



Blood Supply of Cerebellum

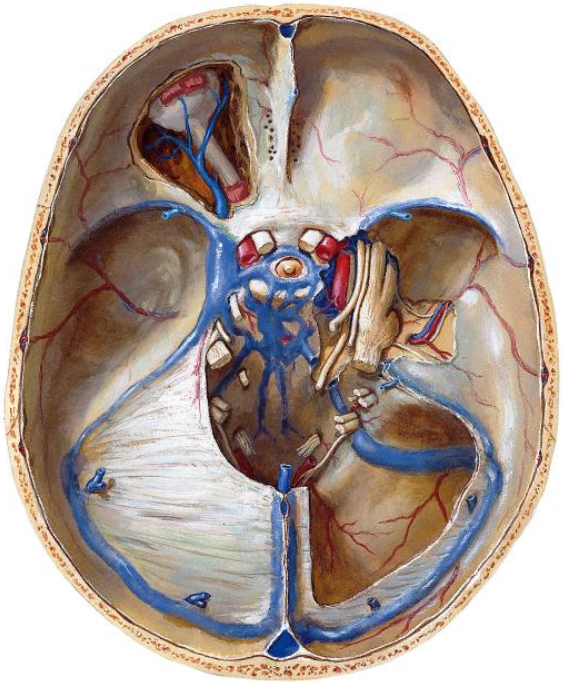
A. Arteries: one artery to the upper surface & 2 arteries to the lower surface:

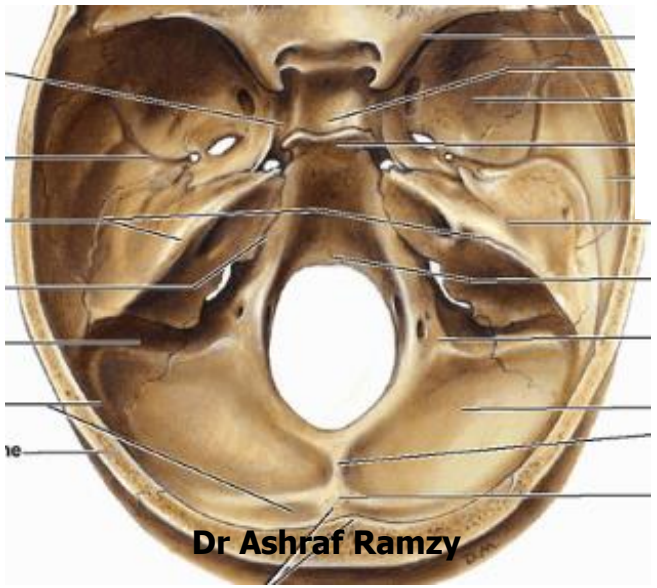
1. **Superior Cerebellar a. (br. of basilar A.).**
2. **Anterior-inferior Cerebellar a. (br. of basilar A.).**
3. **Posterior-inferior Cerebellar a. (br. of vertebral A.).**

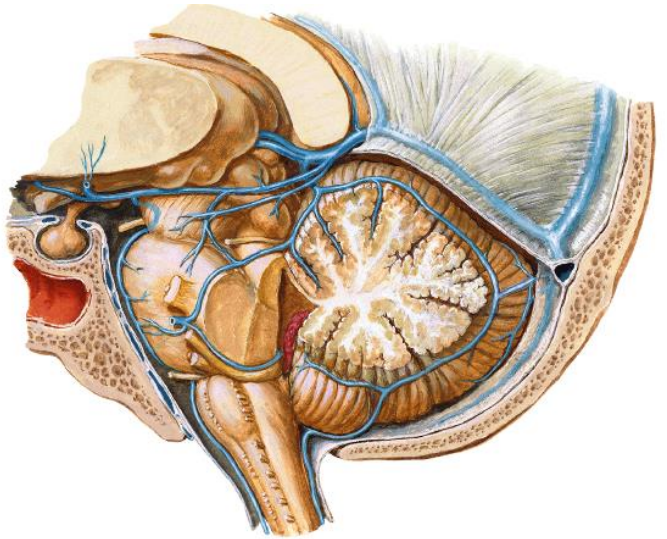


B. Veins:

1. **Superior Cerebellar veins** → drain into venous sinuses (Straight & transverse) & into great cerebral vein
2. **Inferior Cerebellar Veins** → drain into venous sinuses (Straight, sigmoid, occipital & inf. petrosal).







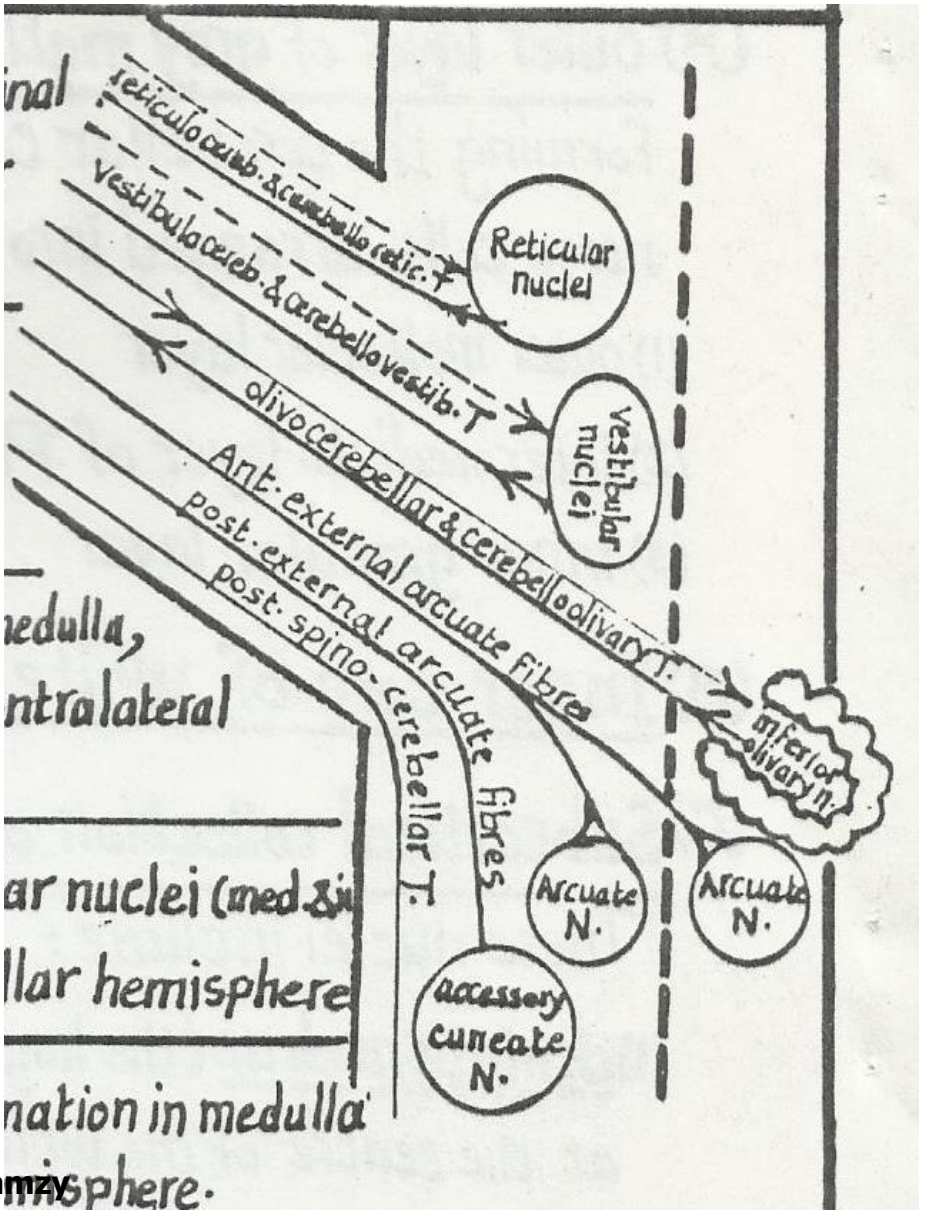
Cerebellar peduncles

A. Inferior cerebellar Peduncle:

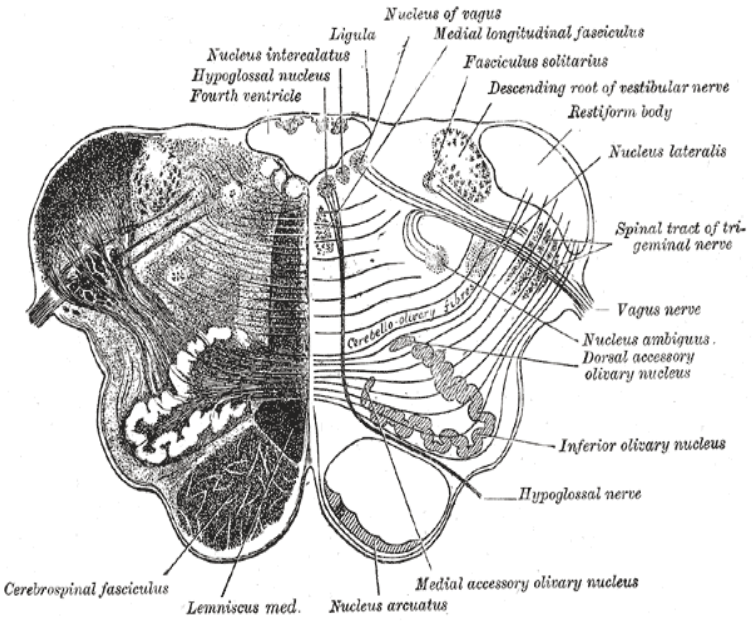
* It connects cerebellum to medulla. It is formed mostly of afferent fibers.

* Afferent Fibers:

1. Posterior Spinocerebellar tract (from ipsilateral Clarke's nucleus).
2. Dorsal external arcuate fibers = Cuneo-cerebellar (from accessory cuneate nucleus).
3. Ventral external arcuate fibers (from arcuate nucleus).

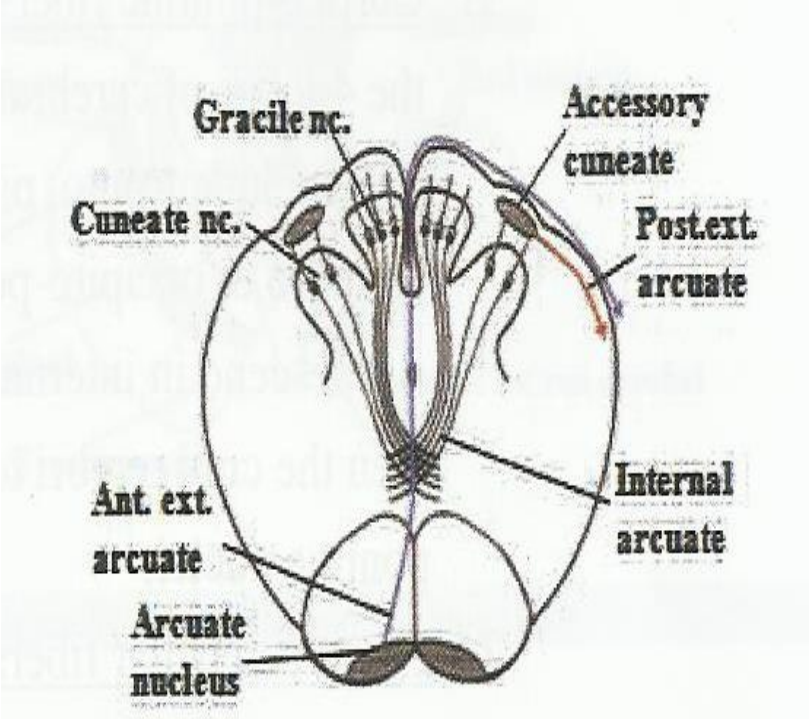


4. Olivo-cerebellar fibers (from the inferior olivary nucleus).
5. Para-olivo-cerebellar fibers (from dorsal & medial accessory olivary nuclei).
6. Vestibulo-cerebellar fibers (from the vestibular nuclei & vestibular ganglion).
7. Reticulo-cerebellar fibers (from the reticular formation).



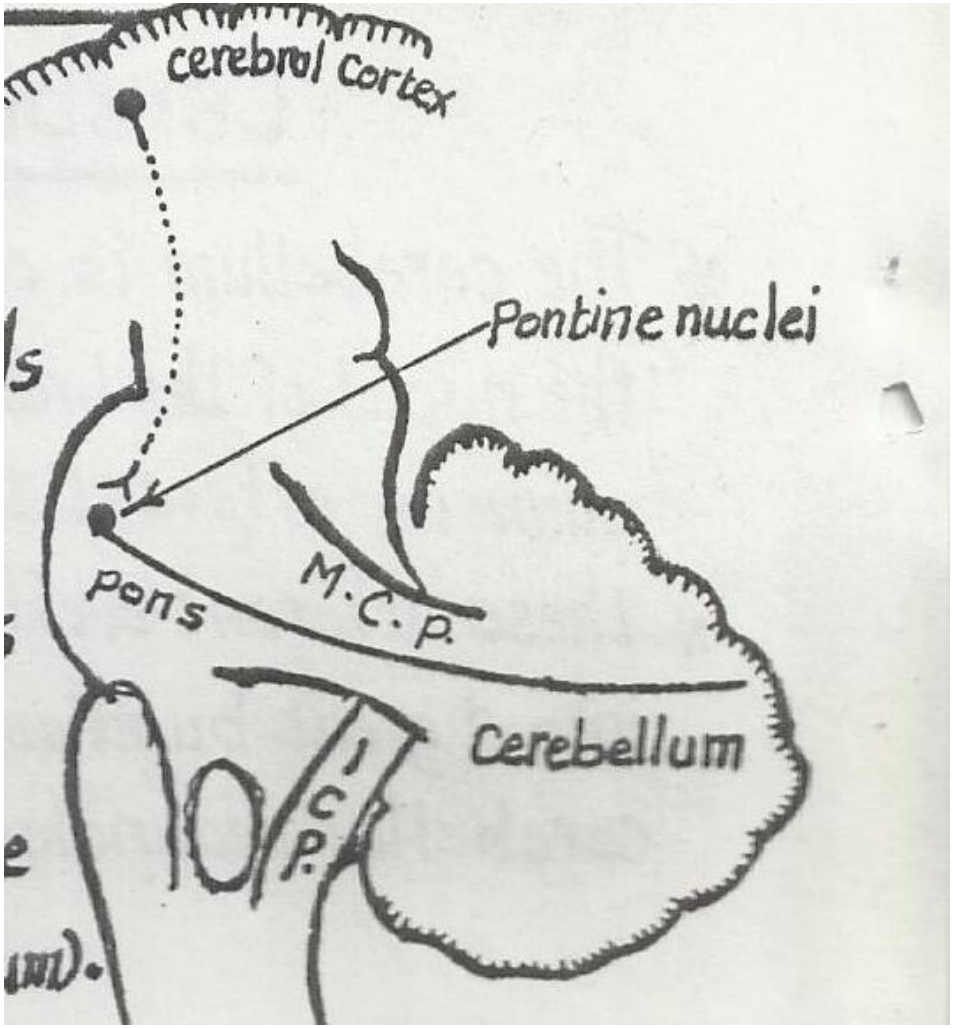
* Efferent Fibers:

1. Cerebello-vestibular Fibers (from flocculonodular lobe to vestibular nuclei).
2. Cerebello-reticular Fibers (to the reticular formation).
3. Cerebello-olivary Fibers (to the inferior olive).



B. Middle Cerebellar peduncle:

* The largest peduncle.
* Connects the cerebellum to the pons.
* Contains cortico-ponto-cerebellar fibers.



C. Superior Cerebellar Peduncle:

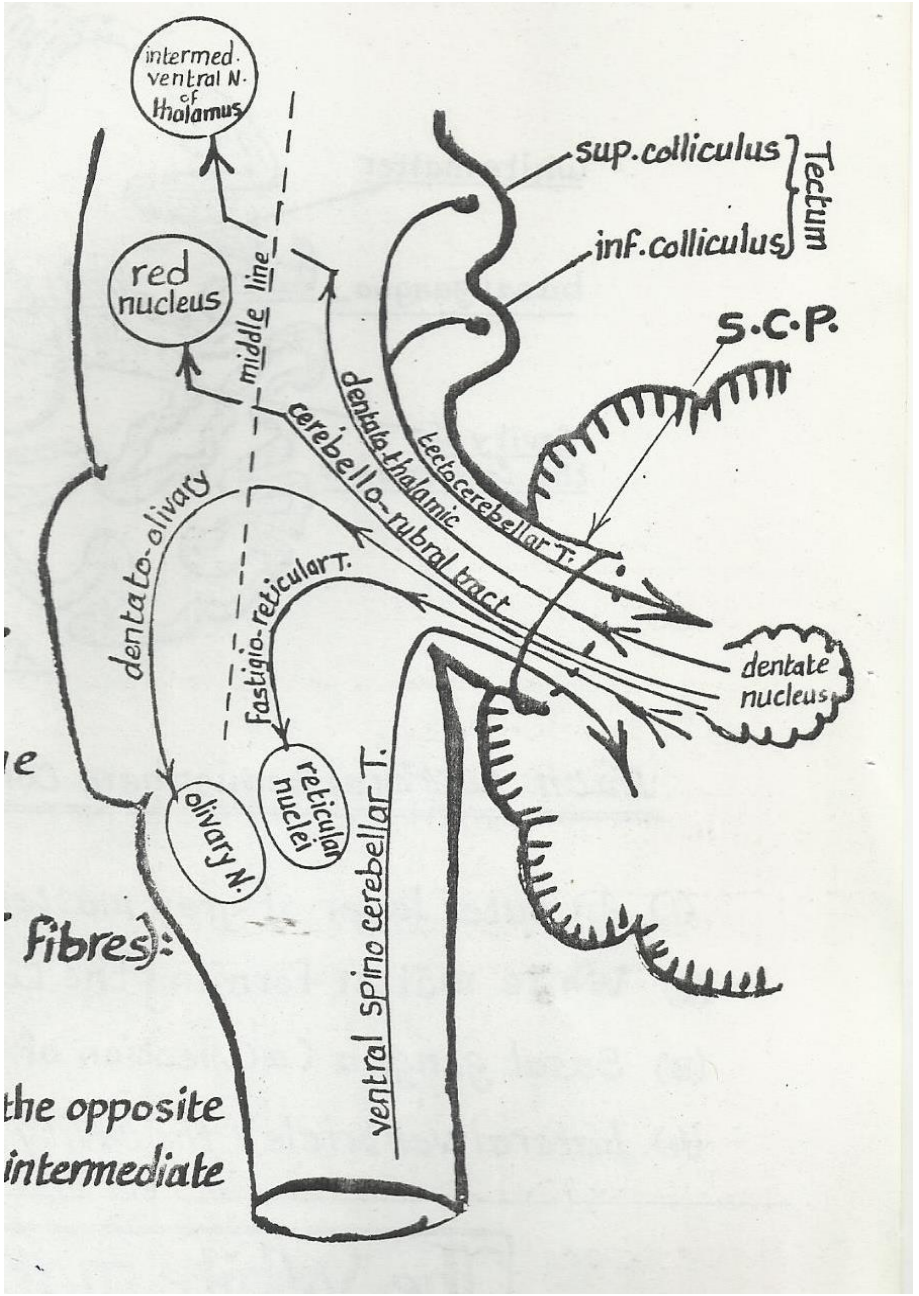
* Connects cerebellum to mid-brain. It is formed mostly of efferent fibers.

* Afferent Fibers:

1. Anterior Spinocerebellar tract.
2. Tecto-cerebellar tract (from the superior colliculus).

* Efferent Fibers:

1. Fastigio-reticular fibers (from fastigial nucleus) to the reticular formation.
2. Cerebello-rubral fibers (from globose & emboliform nuclei) to red nucleus.
3. Dentato-thalamic fibers (to VLN of thalamus) & dentate-rubro-thalamic fibers (to the same nucleus of the thalamus via the red nucleus).



** Applied: lesion in the cerebellum can present as:

* Hypotonia.
* Disturbance in gait & equilibrium.
* Cerebellar ataxia (incoordination of the voluntary movement in absence of motor weakness). The range, rate, force and direction of movement are affected in cerebellar lesions.

1. Nystagmus: horizontal oscillation in both eyes.
2. Staccato speech: interrupted explosive speech.
3. Intention tremors (Shaking of fingers when attempting to do a movement).
4. Dysmetria (Ask patient to point to tip of nose by finger, he either past points it or misses it).
5. Dysdiadokokinesia (Patient is unable to do rapid alternating movements as Pronation & supination).

THANK YOU