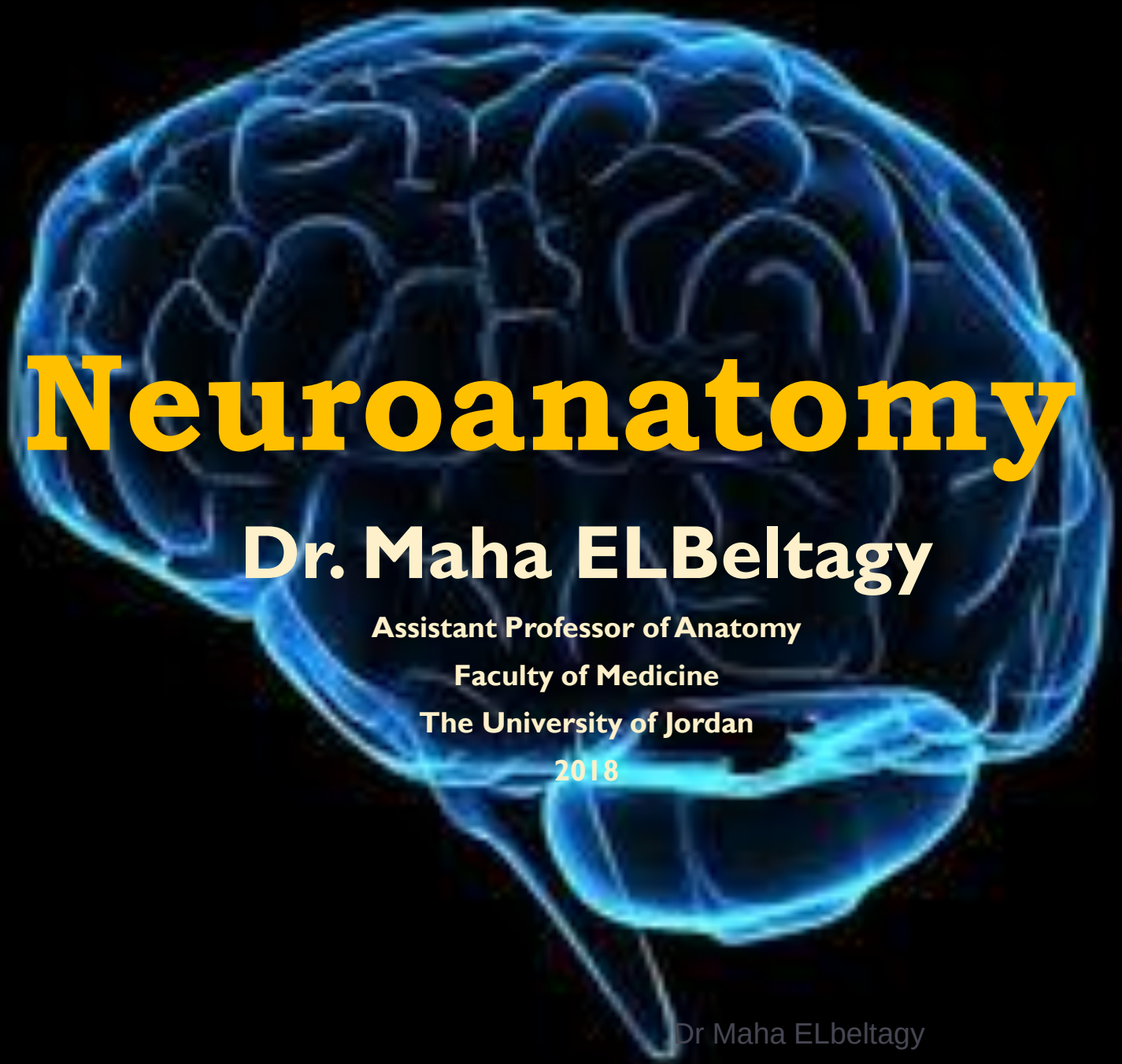

Neuroanatomy

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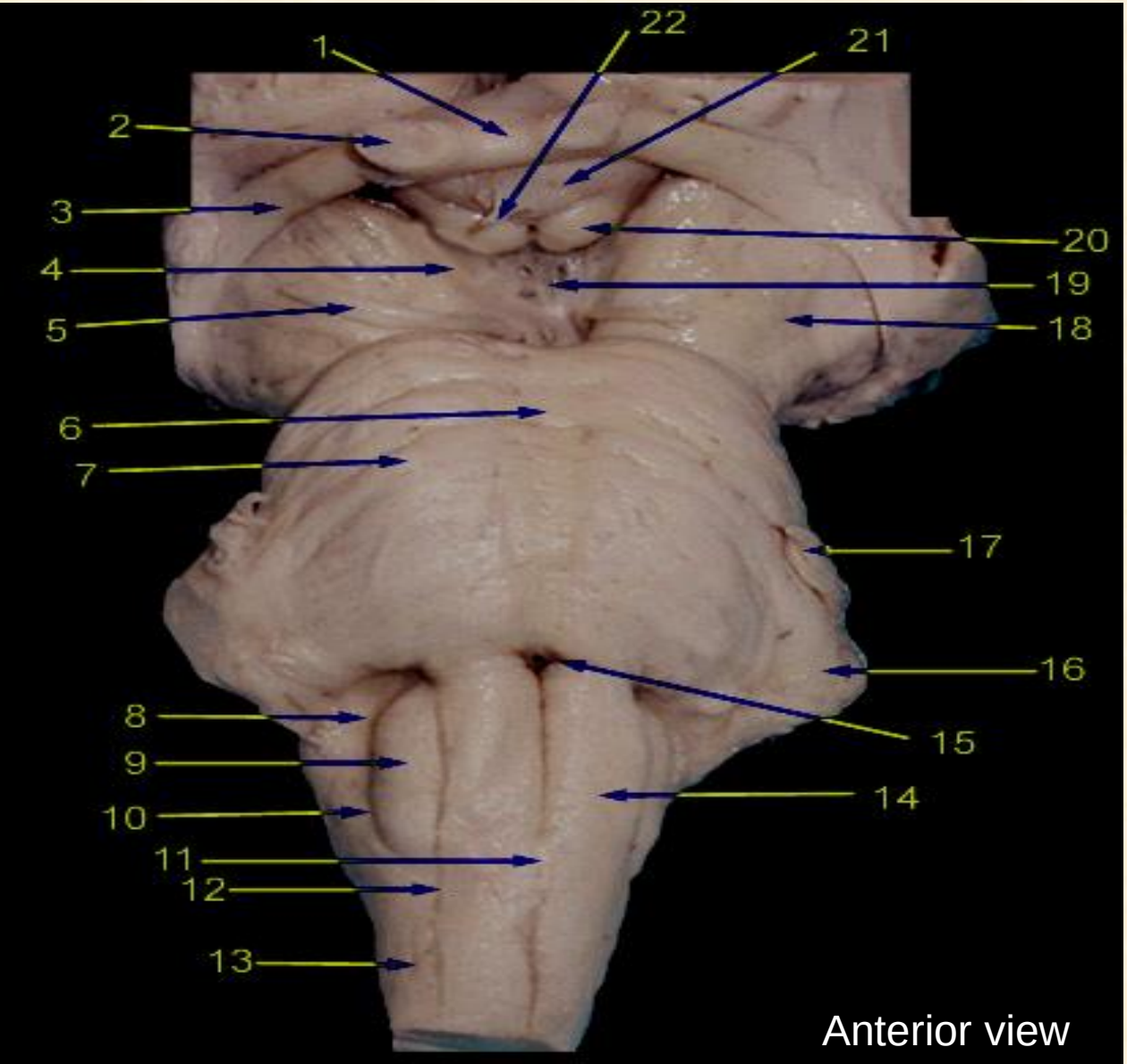
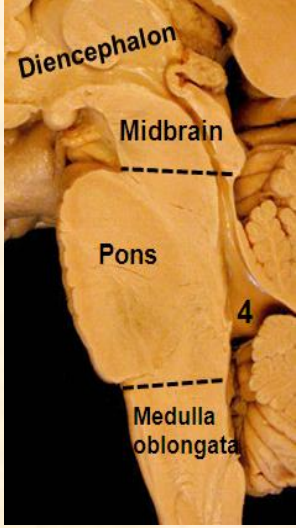
2018

THE BRAIN STEM

It includes: **Midbrain - Pons - Medulla oblongata**





1. Optic chiasma
2. Optic nerve
3. Optic tract
4. Medial sulcus of the crus cerebri
5. Oculomotor nerve
6. Pons
7. Pyramidal eminence of the pons
8. Retroolivary fossa
9. Olive
10. Posterolateral sulcus
11. Decusssation of the pyramids
12. Anterolateral sulcus
13. Lateral funiculus
14. Pyramid
15. Foramen caecum
16. Middle cerebellar pedunculus
17. Trigeminal nerve
18. Crus cerebri
19. Posterior perforated substance
20. Mammillary body
21. Tuber cinereum
22. Infundibulum

The midbrain

The cerebral aqueduct divides the midbrain into :

- **Tectum** (behind the duct).
- **2 cerebral peduncles**: each one consist of Crus cerebri (2), Substantia nigra & Tegmentum.

Anterior surface of midbrain:

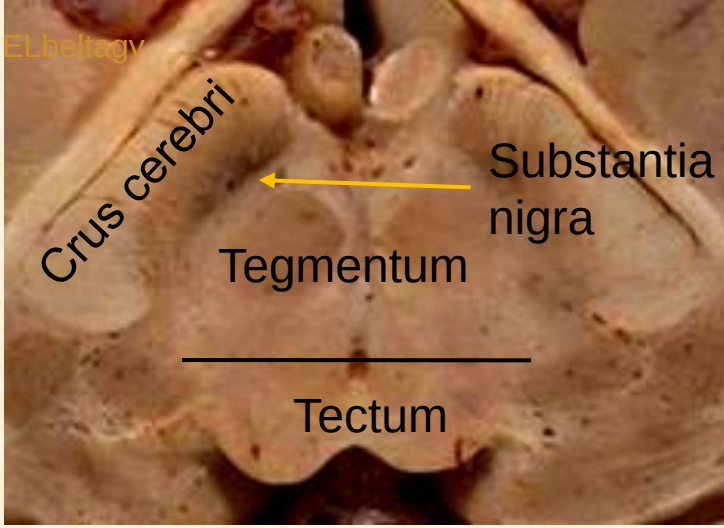
Is formed of the 2 crura enclosing interpeduncular fossa in between them. The oculomotor nerve (1) emerges from the medial aspect of the crus cerebri.

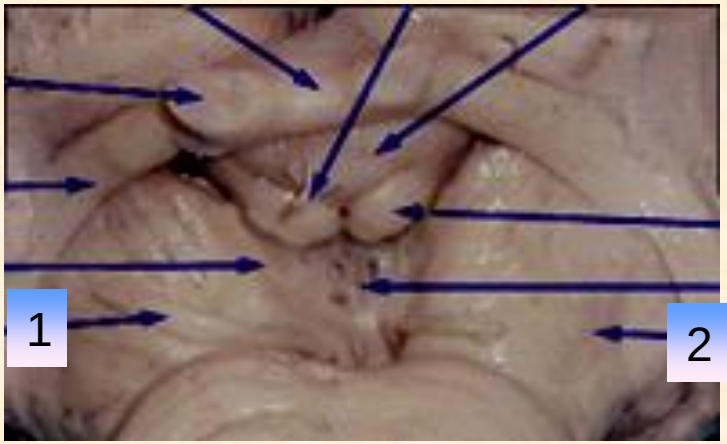
Posterior surface: Is formed of :

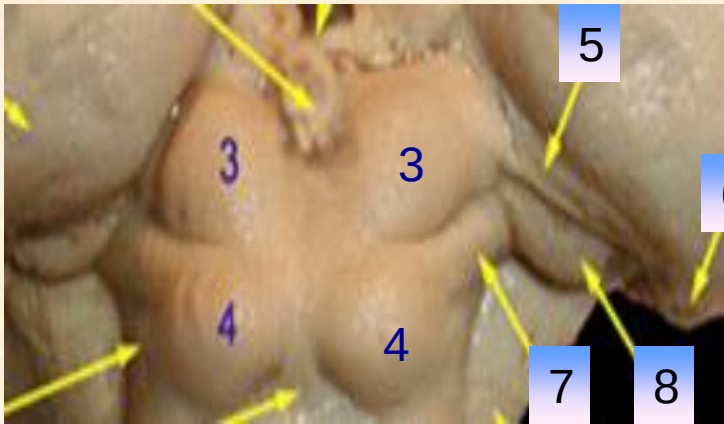
2 superior colliculi (3): connected to the lateral geniculate body (6) by superior brachium (5).

2 inferior colliculi (4) : connected to the medial geniculate body (8) by inferior brachium (7).

The trochlear nerve emerges from the back of midbrain.







The interpeduncular Fossa

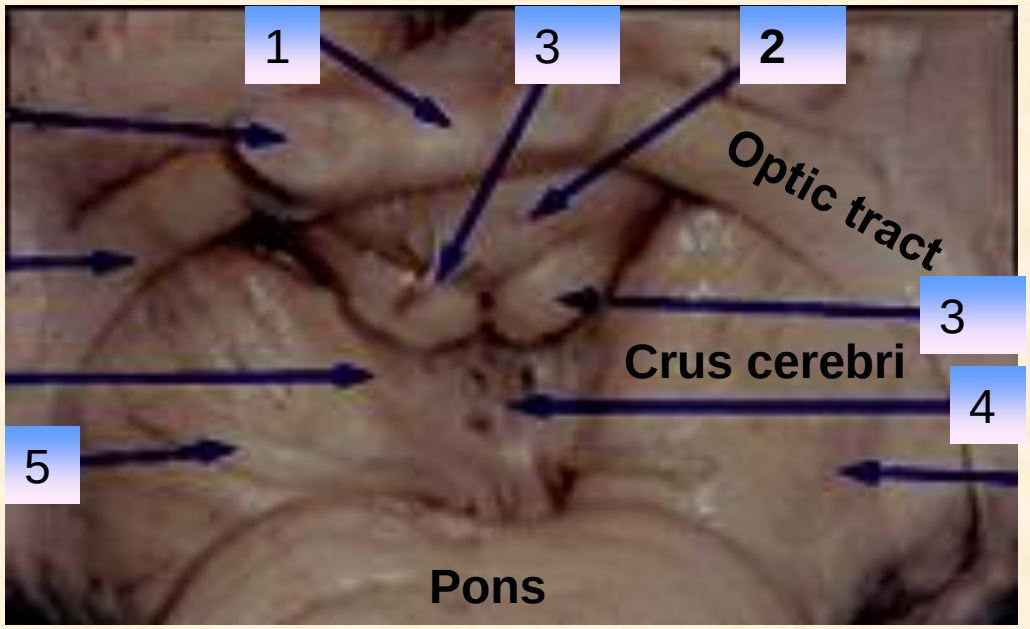
Boundaries:

Anterior: Optic chiasma (1).

Posterior: Pons

Anterolateral:

- Optic tract & crura cerebri



Contents:

- Tuber cinereum (2).
- Mammillary bodies (3)
- Posterior perforated substance (4)
- Oculomotor nerve (5) emerges from the medial aspect of crus cerebri .

The Pons

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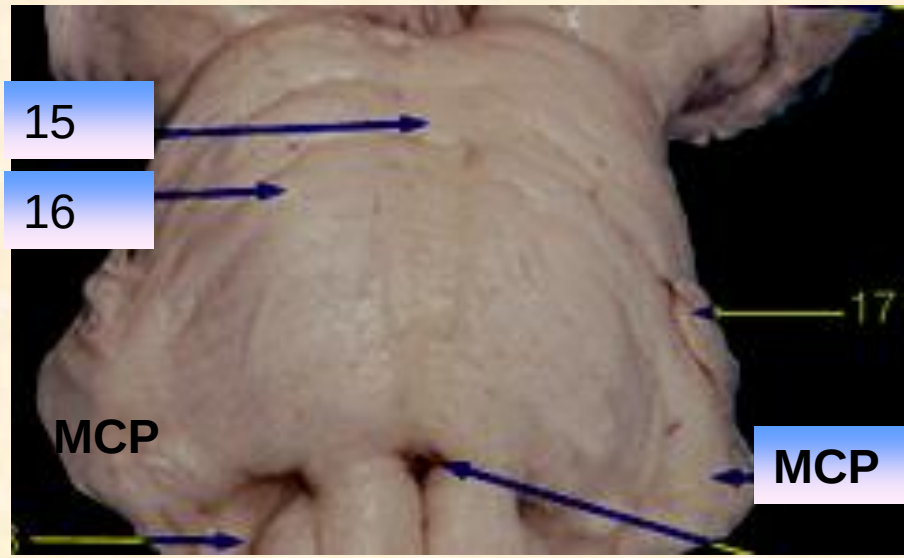
Anterior surface:

- Has a median basilar groove for basilar artery (15).
- Pyramidal eminence (16) on either side of basilar groove with transverse pontine fibers.
- Middle cerebellar peduncle (MCP).
- Trigeminal nerve (17) between the pons & MCP.



Anterior surface

Posterior surface:

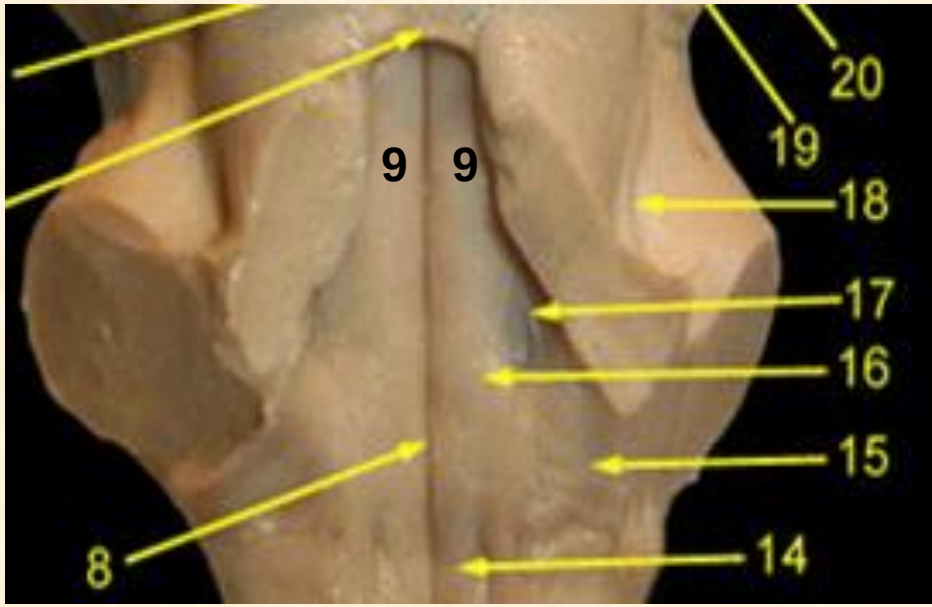
Forms the upper part of the floor of the 4th ventricle.

It is separated from the medulla by medullary stria (15).

It has a posterior median sulcus (8) with medial eminence (9) on either side.

Facial colliculus (16) is a small swelling in the lower part of the medial eminence

Superior fovea (17) is a depression lateral to facial colliculus



Posterior surface

The Medulla Oblongata

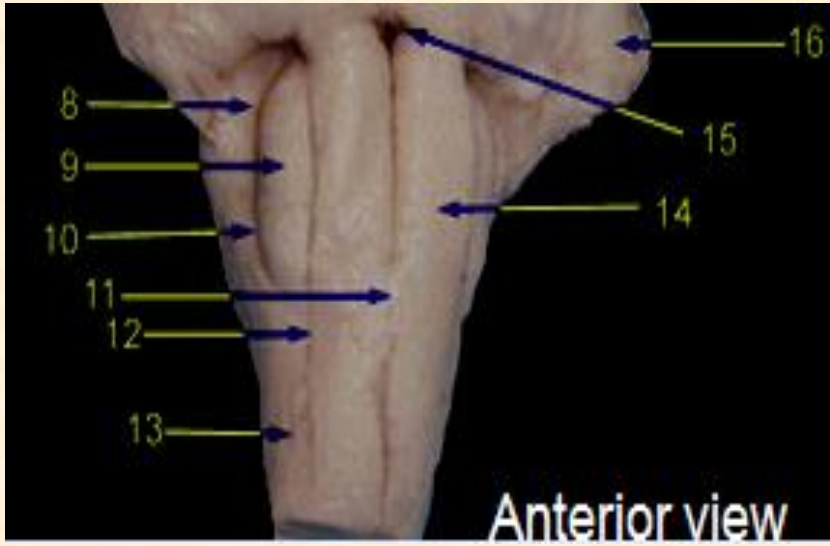
- Its upper ½ has no central canal & is known as open medulla.
- Its lower ½ has central canal & is known as open medulla.

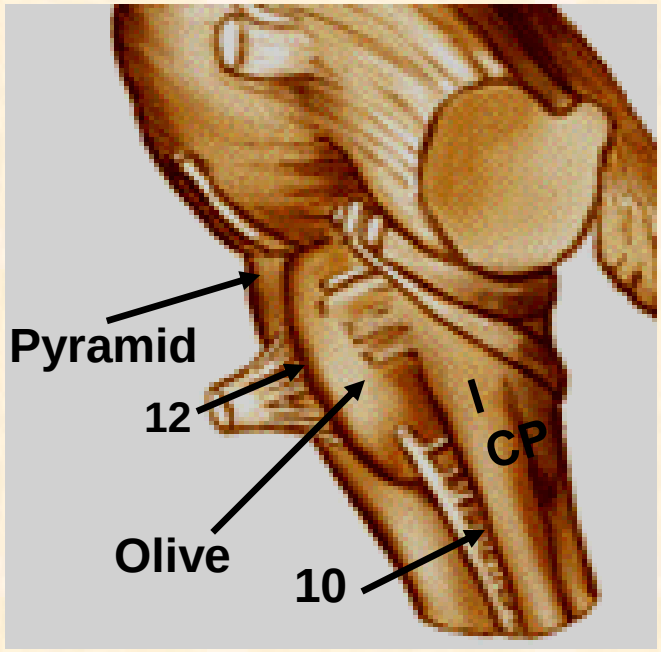
Anterior surface: Has:

- Anterior median fissure which is obliterated below by pyramidal decussation (11).
- Pyramid (14) on either side of the median fissure

Lateral surface: Has

- Olive (9) separated from the pyramid by anterolateral sulcus (12) to which rootlets of hypoglossal nerve are attached.
- Inferior cerebellar peduncle (ICP) separated from the olive by posterolateral sulcus (10) to which rootlets of glossopharyngeal, vagus & accessory nerves are attached.





Lateral surface

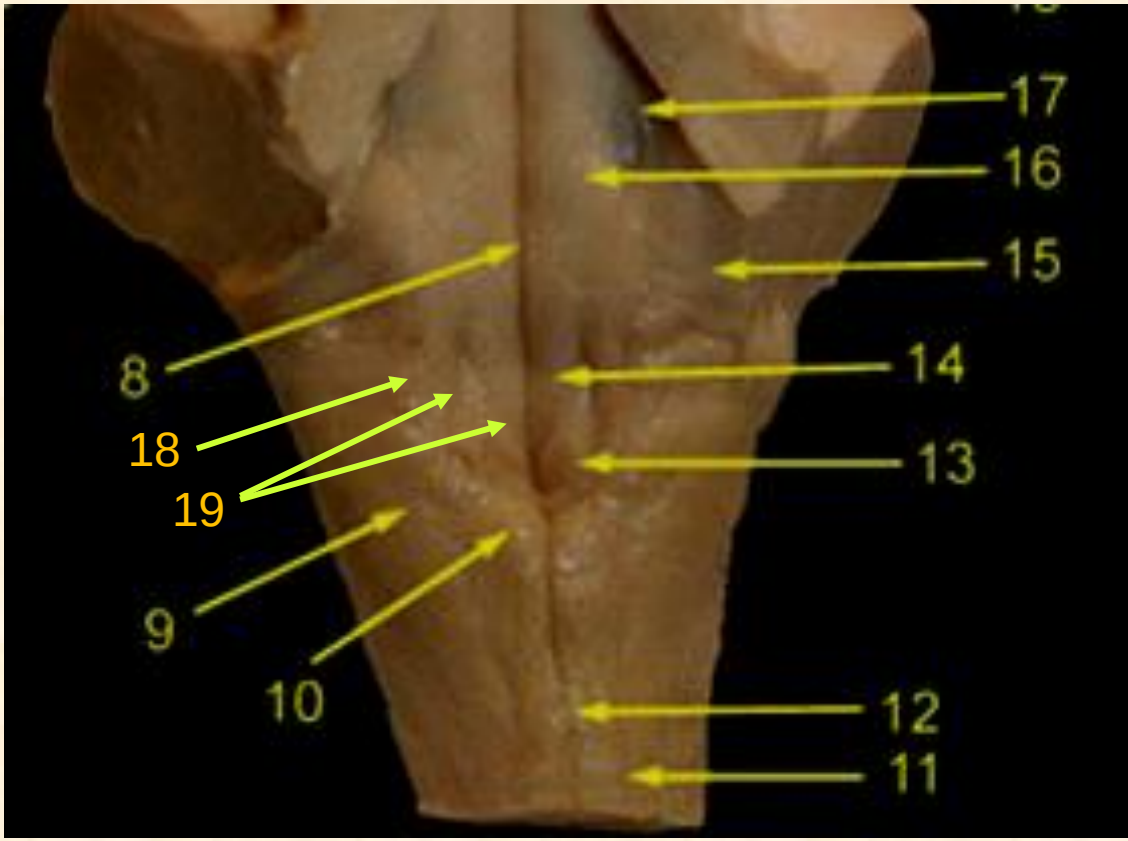
Posterior surface:

Upper part: forms lower part of the floor of the 4th ventricle & has the following features:

- Posterior median sulcus.
- Inferior fovea ((19) which is an inverted V-shaped sulcus dividing the back of medulla into; Hypoglossal triangle (14), vagal triangle (13) & vestibular area (18).

Lower part: back of closed medulla which has the following features:

- Posterior median sulcus.
- On either side of the sulcus Gracile & Cuneate tracts ascend & expand above to form Gracile (10) & Cuneate tubercle (9).



The fourth ventricle

It is a diamond shaped cavity of the hindbrain.

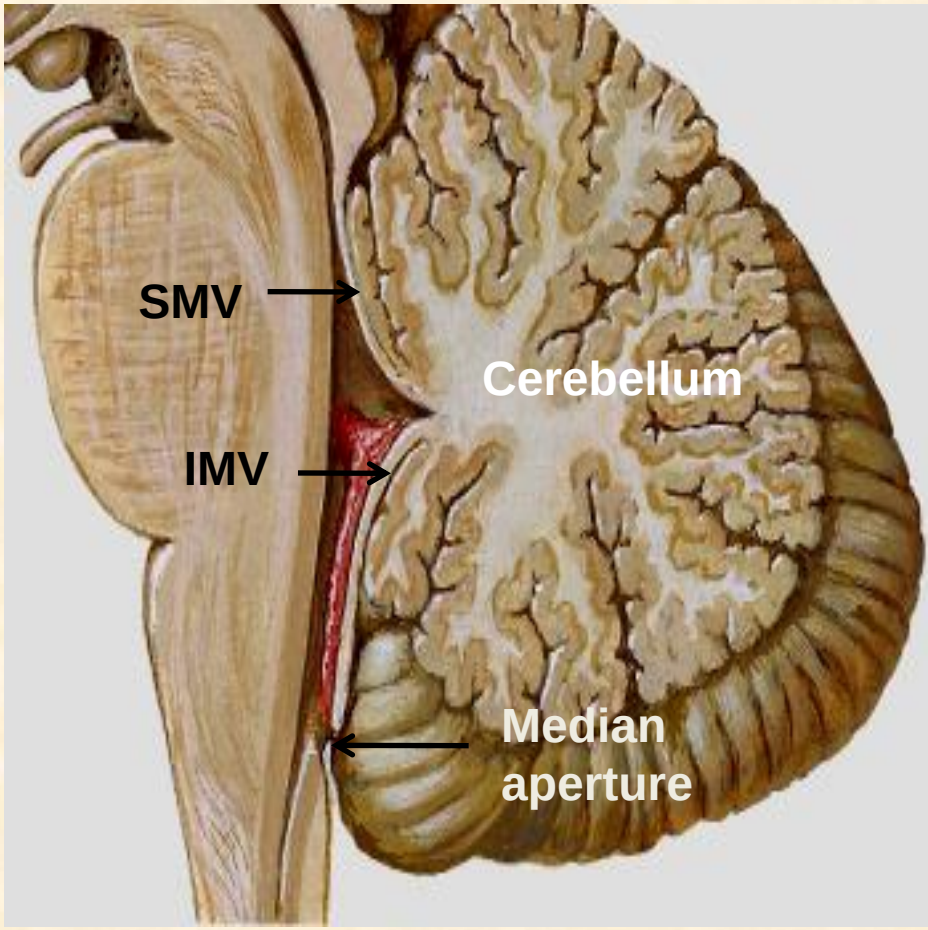
It lies behind the pons & open medulla & in front of the cerebellum.

Its **superior angle** is continuous with the cerebral aqueduct of midbrain & its **inferior angle** is continuous with the central canal of closed medulla (at the obex).

It has **2 lateral recesses** which curve around the inferior cerebellar peduncle & open by lateral apertures in the subarachnoid space at the flocculus .

The roof: Is tent shaped & is formed of

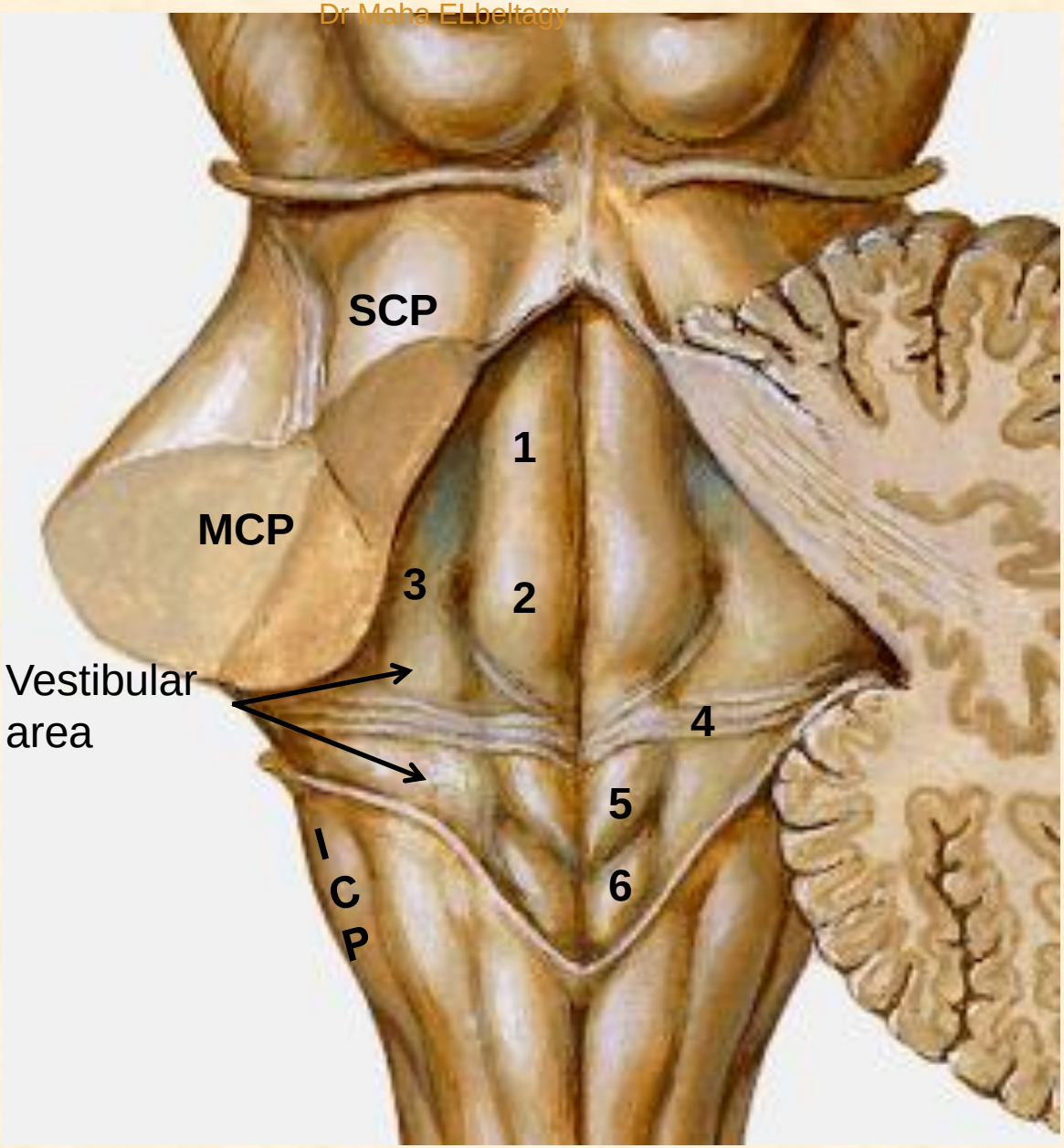
- The superior cerebellar peduncles (SCPs).
- the superior medullary velum (SMV) stretching between the 2 SCPs.
- The inferior medullary velum (IMV) which has a median aperture (of Magendie) connecting the 4th ventricle to the subarachnoid space.



The floor:

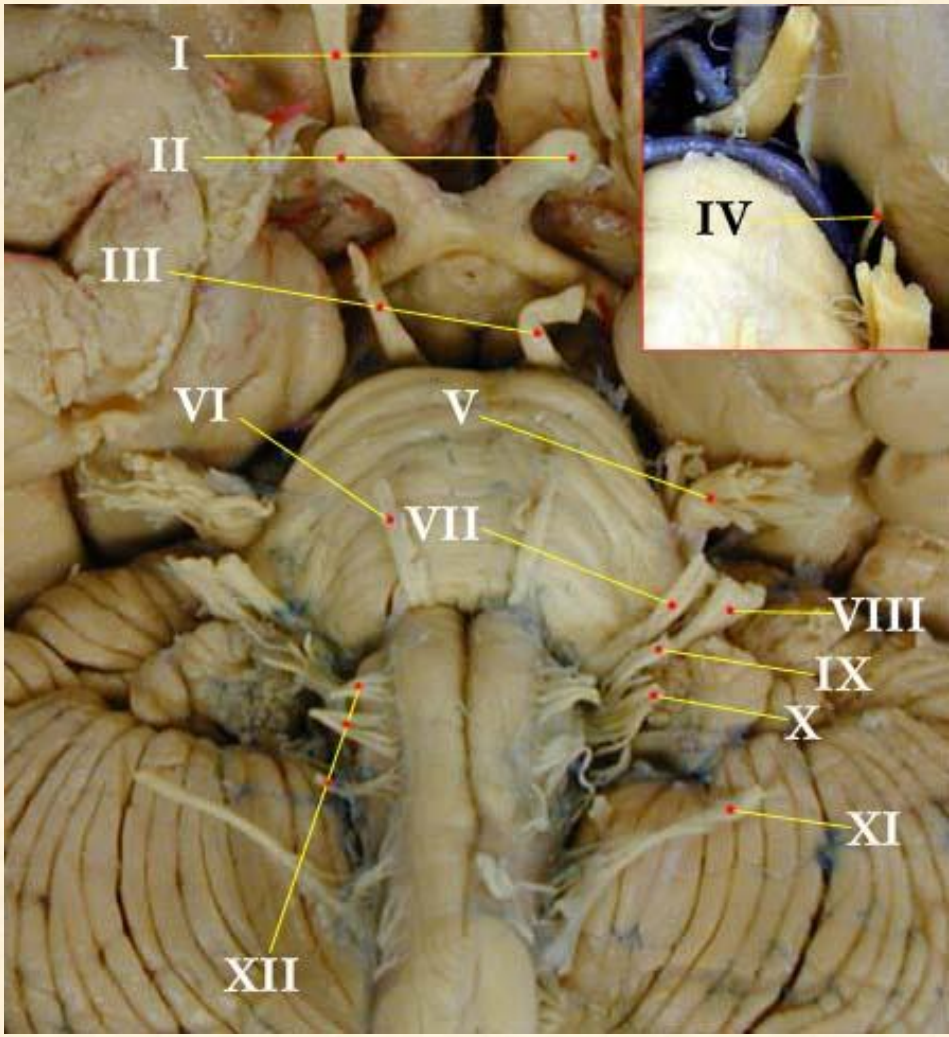
Is formed of :

- **The posterior surface of the pons: with posterior median sulcus, medial eminence (1), facial colliculus (2) & superior fovea (3).**
- **Medullary stria (4)**
- **The posterior surface of the open medulla: with inferior fovea, hypoglossal triangle (5), vagal triangle (6) & vestibular area,**



Superficial Attachment of cranial nerves

1) **Olfactory (I) Nerve** is formed of about 20 rootlets which pass through the cribriform plate of ethmoid to end in the olfactory bulb.
2) **Optic (II) Nerve** is attached to the optic chiasma.
3) **Oculomotor (III) Nerve** is attached to the medial side of crus cerebri of the midbrain.
4) **Trochlear (IV) Nerve** emerges from the back of midbrain below the inferior colliculus then it winds around the midbrain to appear on its anterior aspect.
5) **Trigeminal (V) Nerve** is attached to the pons at its junction with the middle cerebellar peduncle.
6) **Abducent (VI) Nerve** arises from the pons at the pontomedullary junction between pons & the pyramid of the medulla.
7) **Facial (VII) Nerve** arises from the pons at the ponto cerebellar angle.
8) **Auditory or Stato-Acoust or Vestibulocochlear (VIII) Nerve** arises from the pons at the pontocerebellar angle above the olive of the medulla.
9) **Glossopharyngeal (IX), Vagus (X) & Accessory (XI) Nerves** are attached to the posterolateral sulcus of the medulla.
10) **Hypoglossal (XII) Nerve** is attached to the anterolateral sulcus of the medulla between the pyramid & olive.



The Cerebellum

Dr Maha ELbeltagy

It is formed of median vermis & 2 cerebellar hemispheres.

It has 2 surfaces:

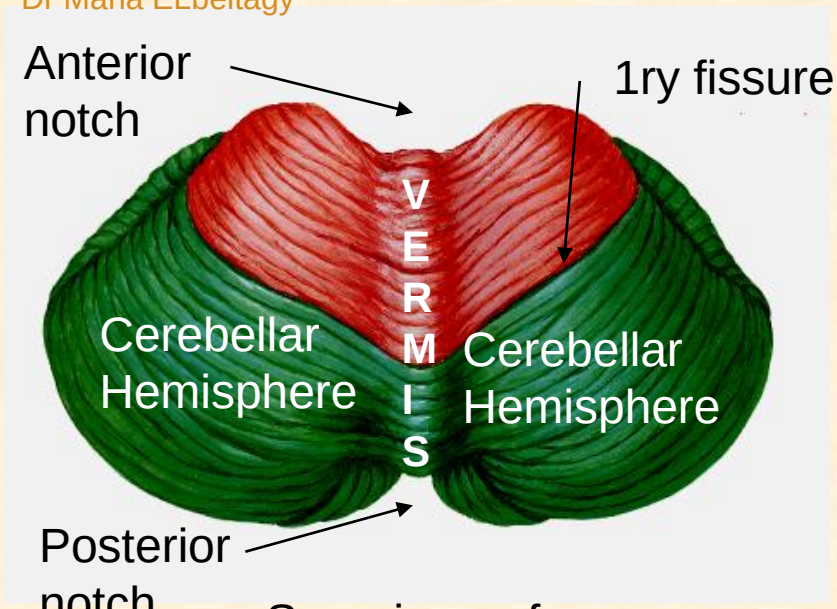
- **Superior surface**: facing the midbrain & tentorium cerebelli .
- **Inferior surface**: divided into **anterior** & **posterior** parts.
- The surfaces have many parallel folds called folia

It has 2 notches:

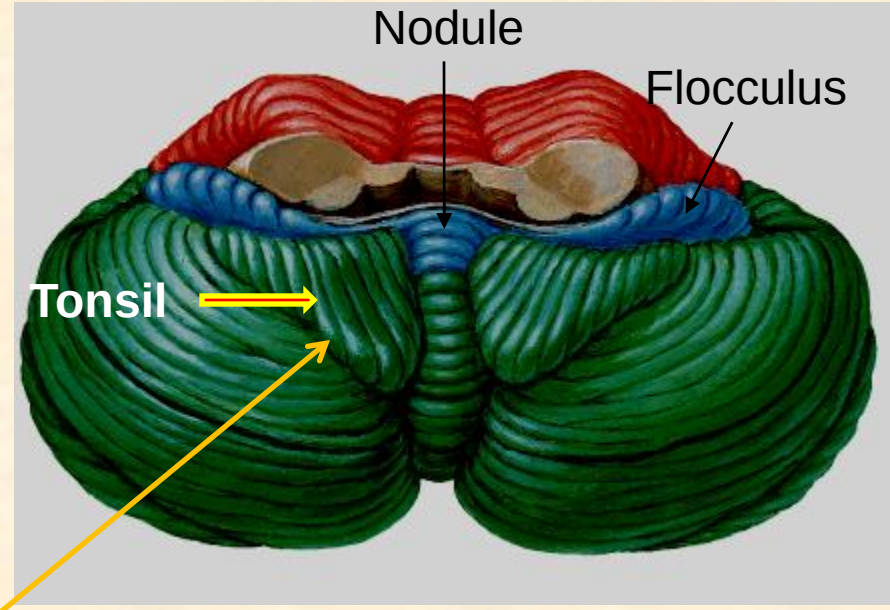
- **Anterior notch** occupied by the brain stem.
- **Posterior notch** (vellecula) occupied by falx cerebelli.

The main fissures of the cerebellum:

- **Primary fissure**: separates the anterior & posterior lobes.
- **Horizontal fissure**: Extends between the middle cerebellar peduncles .
- **Posterolateral fissure**: Separates the flocculus & nodule from the rest of the cerebellum.
- **Cerebellar tonsil** : on either sides of uvula of inferior vermis
- **Retrotonsillar fissure** : separates tonsil from the rest of cerebellum.



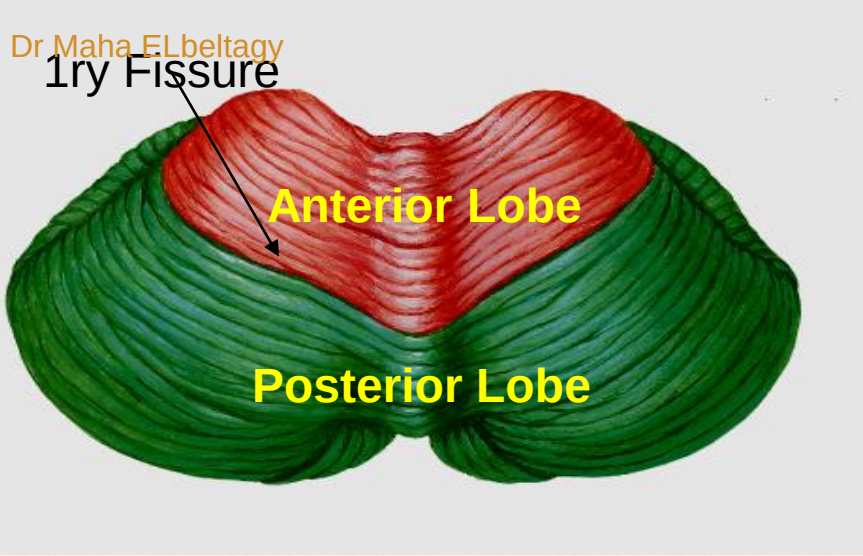
Superior surface

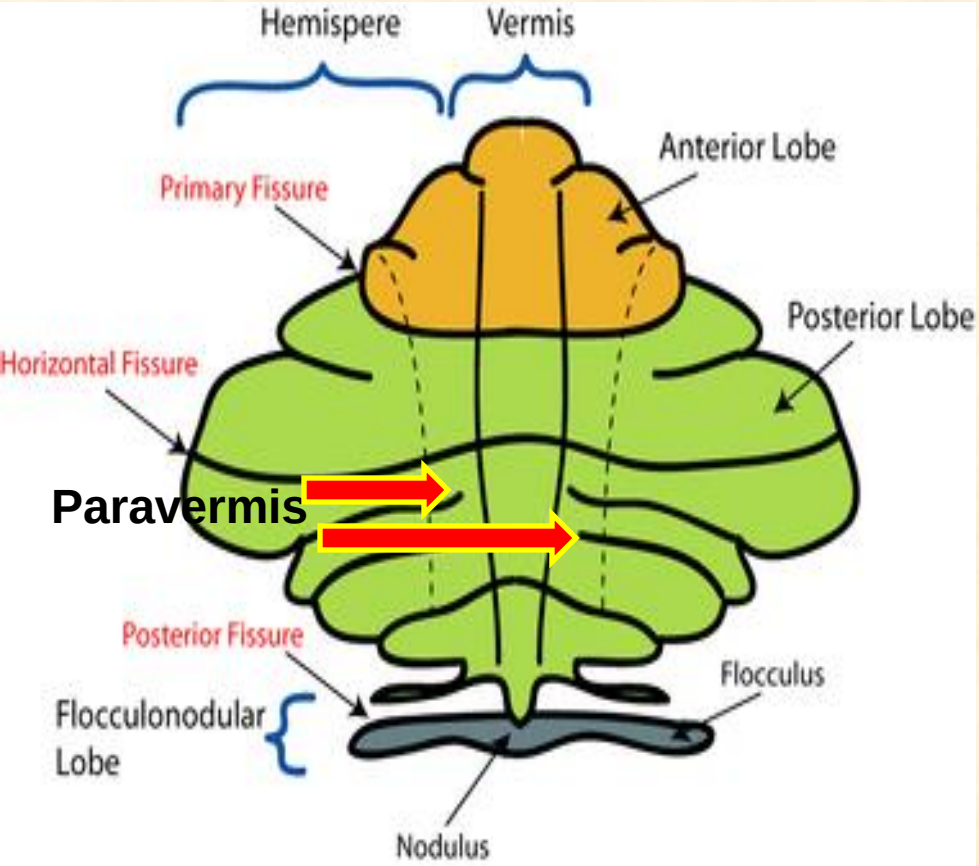


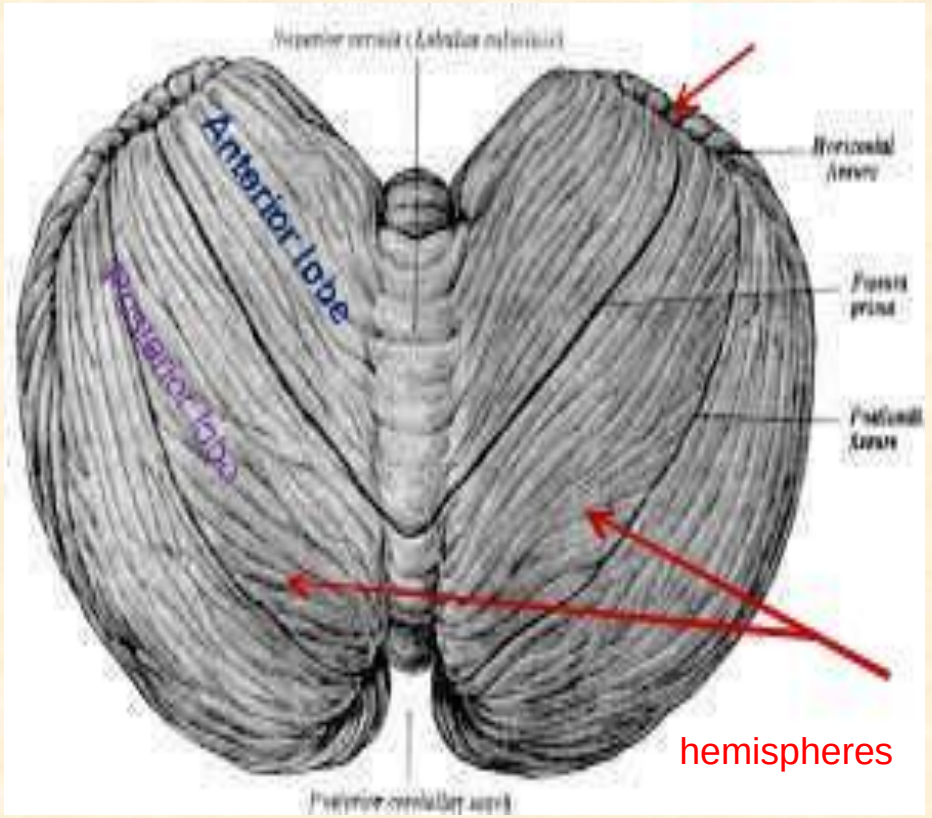
Inferior surface

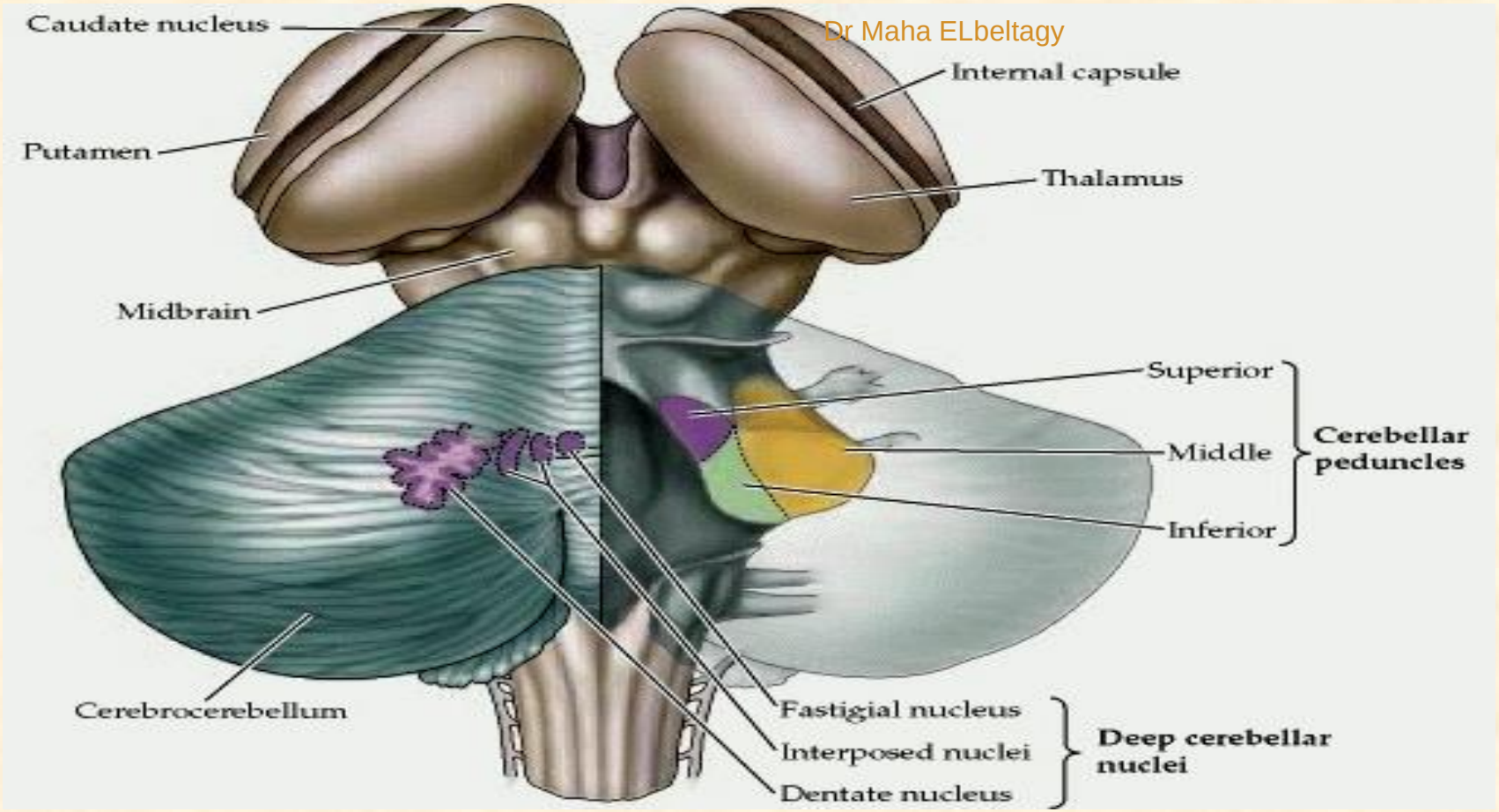
Lobes of the cerebellum: (Horizontal division)

- **Anterior lobe**: in front of the primary fissure.
- **Posterior lobe**: behind the primary fissure.
- **Flocculo-nodular lobe**: Consists of the flocculus & nodule .









Cerebellar nuclei:

- **D**entate nucleus
- Interposed nuclei: **E**mboliform - **G**lobose
- **F**astigial

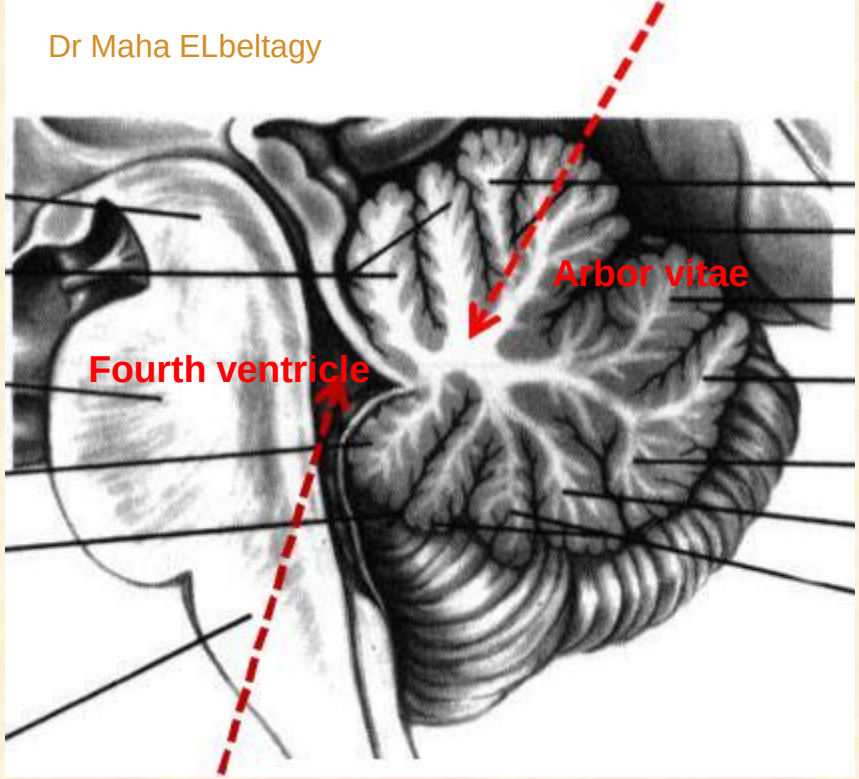
"***Don't Eat Greasy Food***"

Arbor vitae

In latin " ***tree of life***" it is the white matter of the white matter of cerebellum.

•It is so called because of the tree like appearance.

•It brings sensory and motor sensation to and from cerebellum

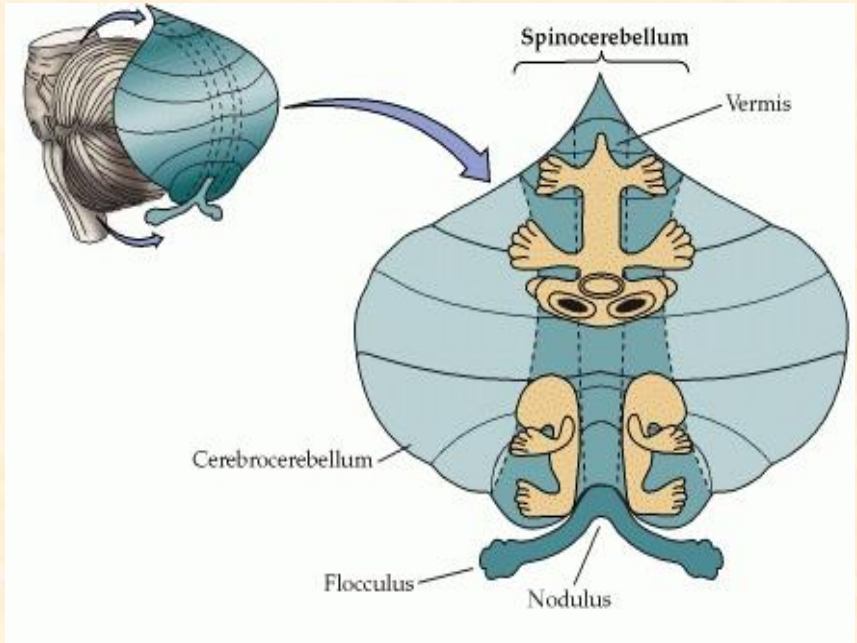


Vertical subdivisions of the cerebellum

1- vermis (central part on superior and inferior surfaces) represents head, neck, trunk, shoulders and hips). Projects to **Fastigeal N**

2- Paravemis (lateral to vermis) represents muscles of upper and lower limbs Projects to **Globose and Emboliform N**

3- Rest of cerebellar hemispheres Project to **Dentate N**

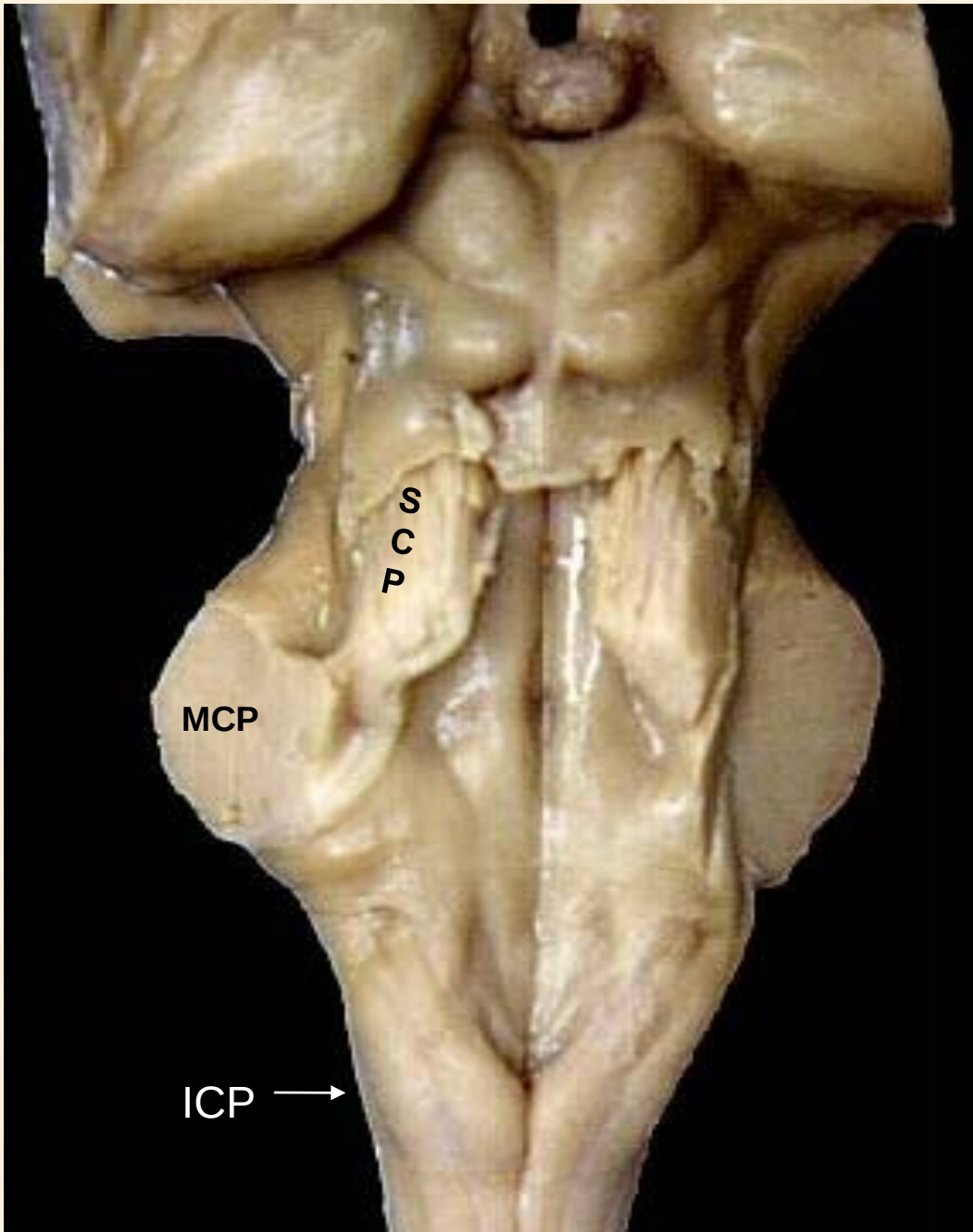


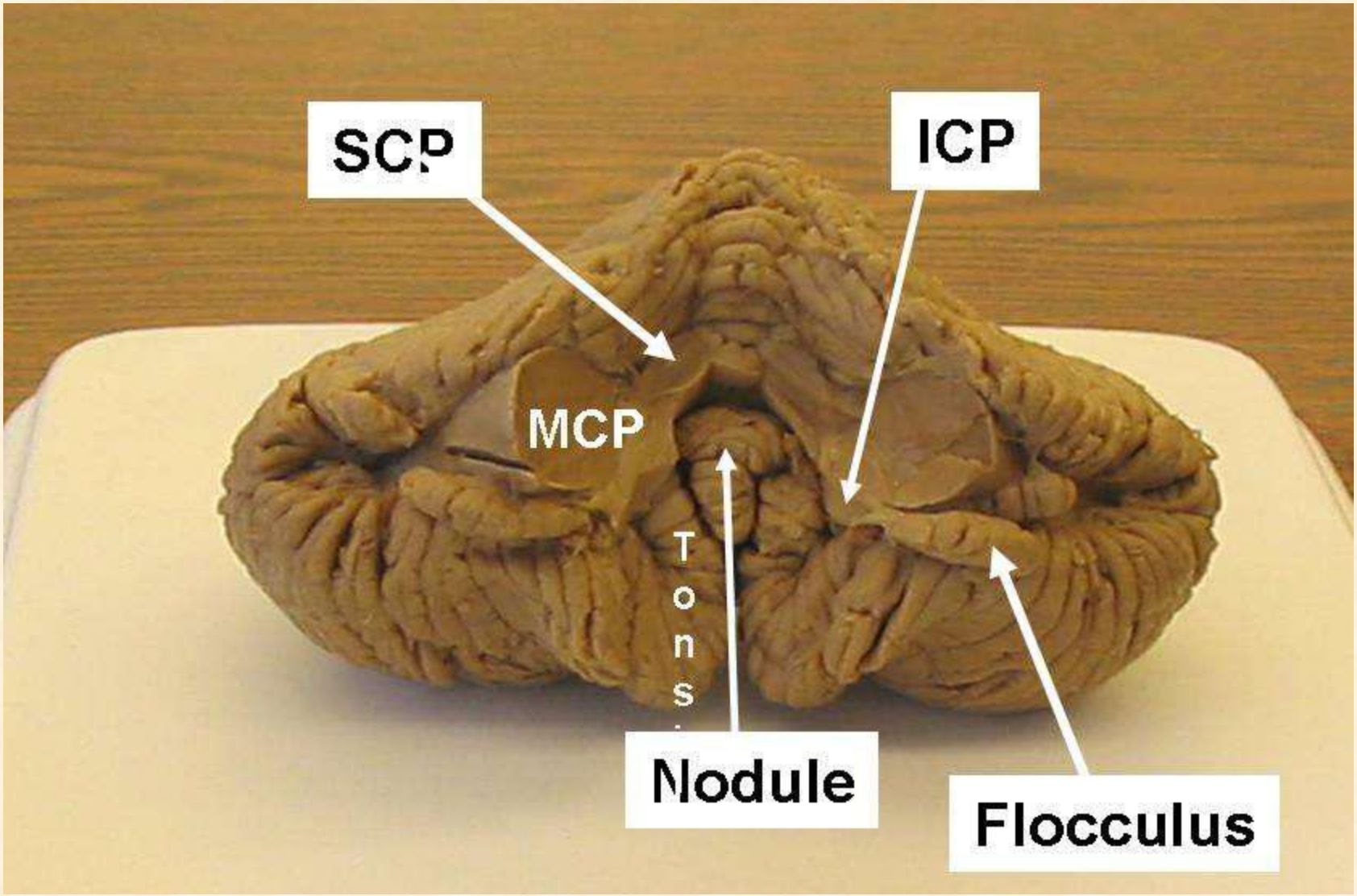
Cerebellar peduncles:

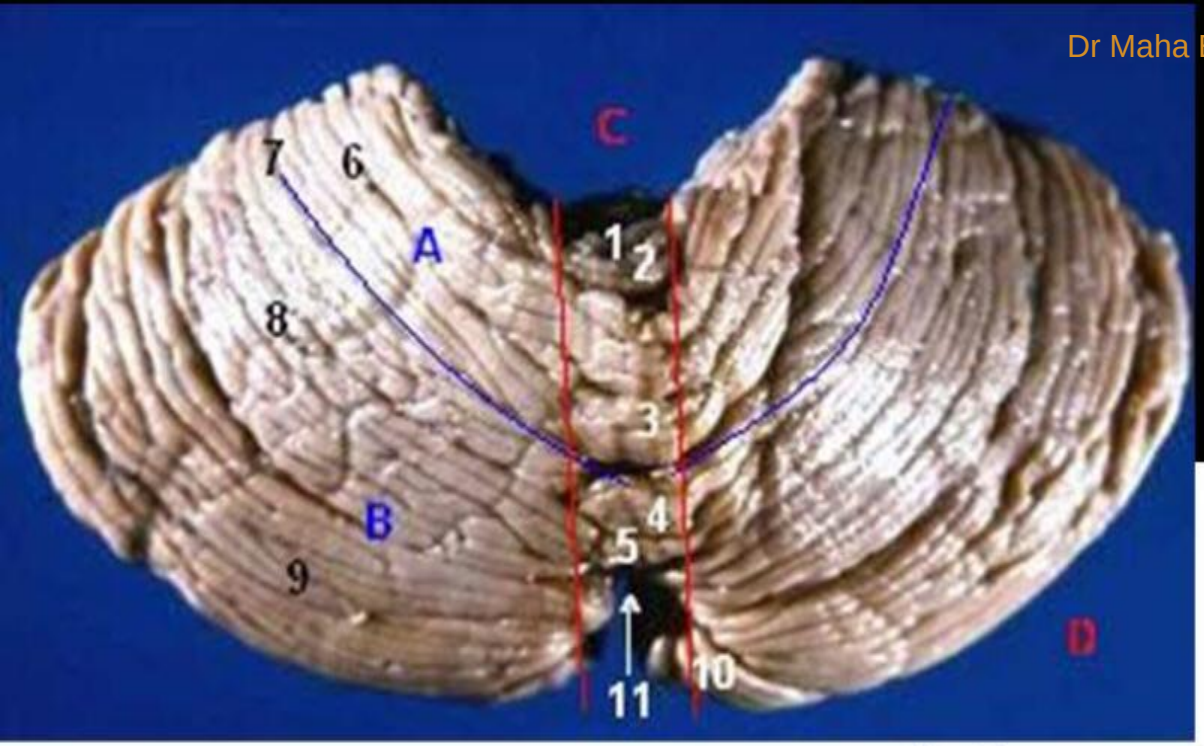
Superior cerebellar peduncle (SCP):
Connects the cerebellum with the midbrain.

Middle cerebellar peduncle (MCP):
Connects the cerebellum with the pons.

Inferior cerebellar peduncle (ICP):
Connects the cerebellum with the medulla oblongata.



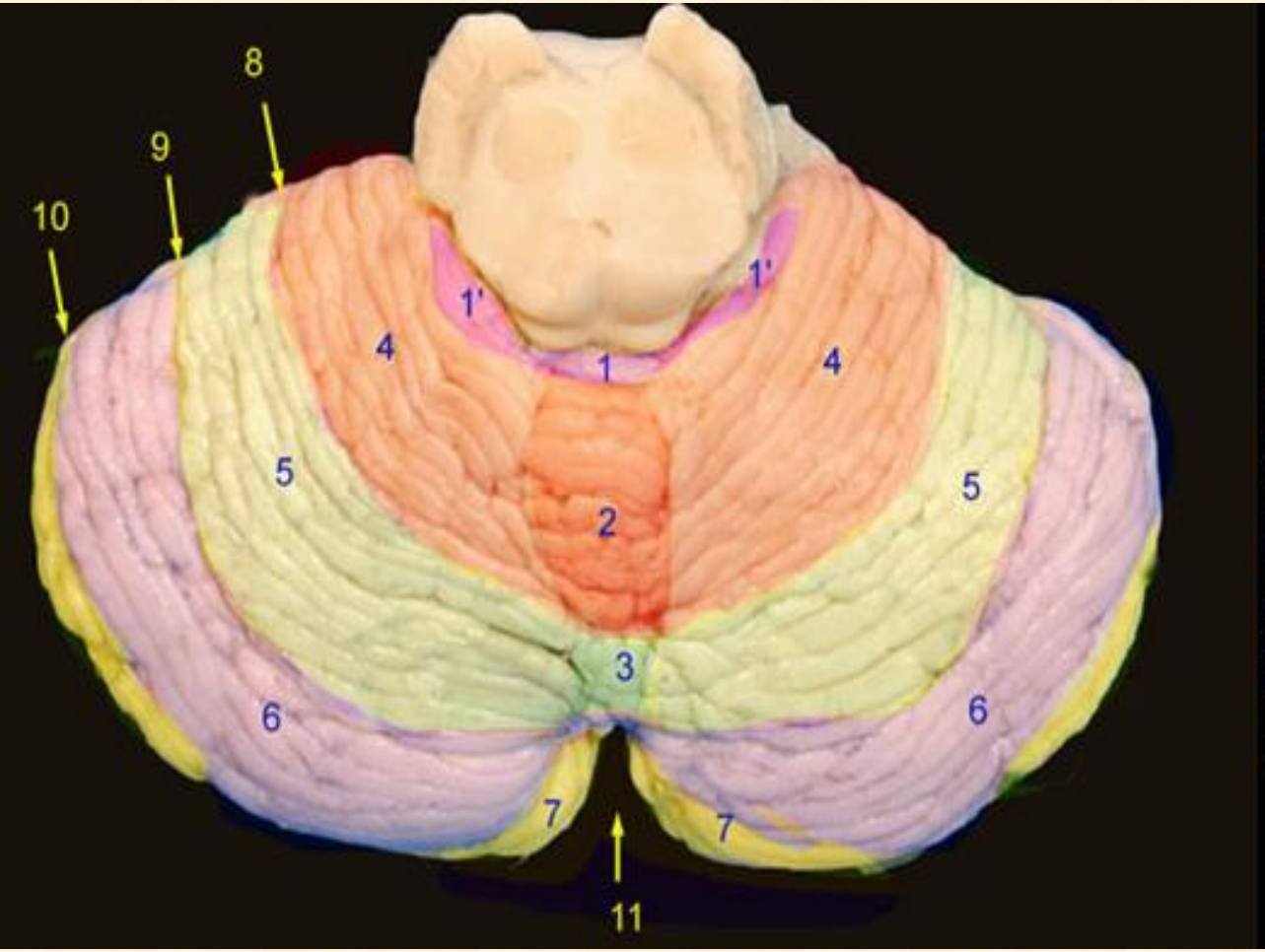

SCP
ICP
MCP
Tons.
Nodule
Flocculus



an cerebellum - posterior view

1-Lingula cerebelli
2-Lobulus centralis
3-Culmen
4-Declive
5-Folium vermis
6-Lobulus quadrangularis anterior, Pars anterior
7-Fissura prima
8-Lobulus simplex, Lobulus quadrangularis posterior
9-Lobulus semilunaris superior
10-Lobulus semilunaris inferior
11-Tuber vermis

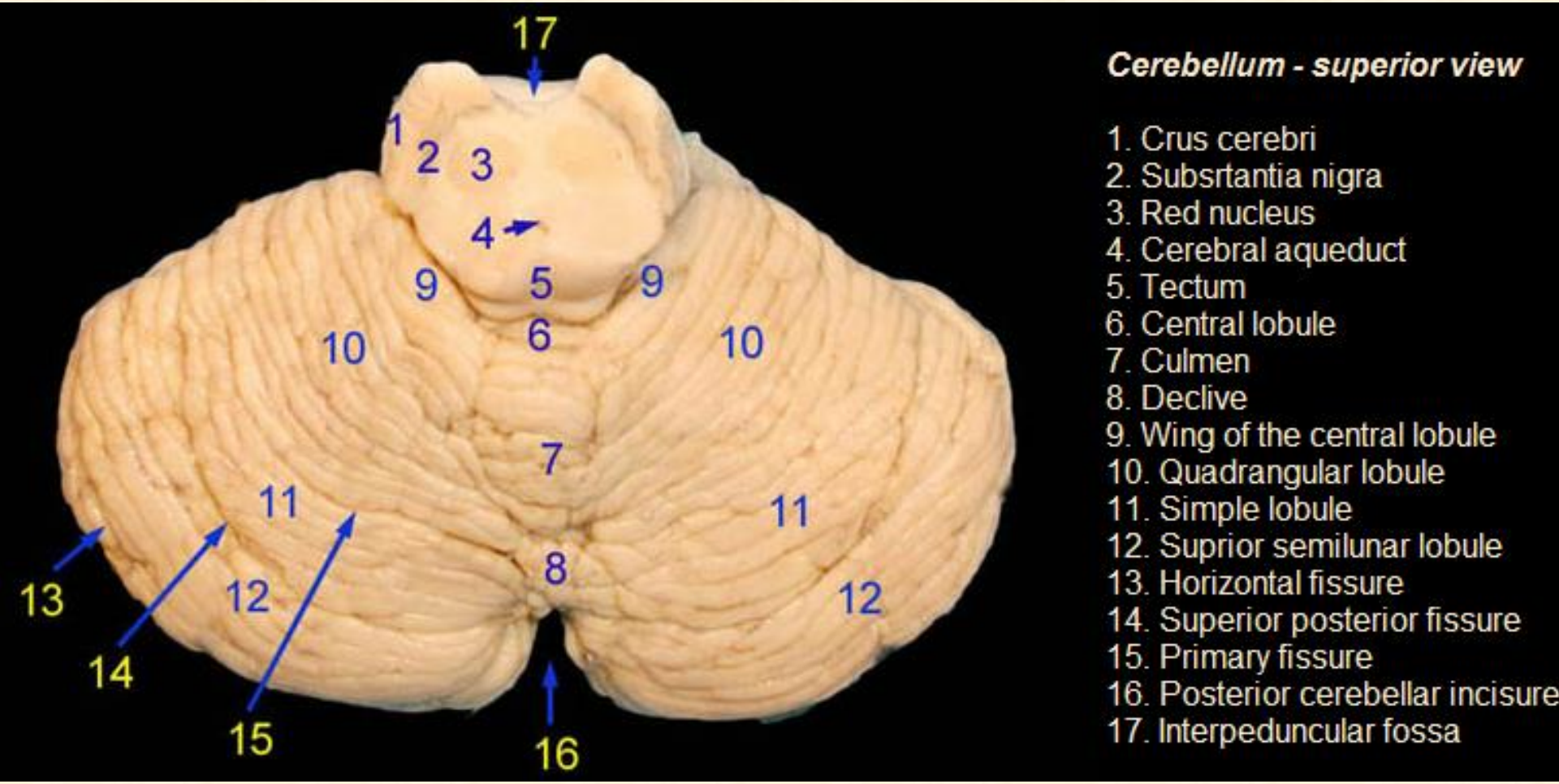
Cerebellar lobules - Superior view



Cerebellar lobules - superior view

1. Central Lobule
1' Wing of the central lobule
2. Culmen
3. Declive
4. Quadriangular lobule
5. Simple lobule
6. Superior semilunar lobule
7. Inferiorsemilunar lobule
8. Primary fissure
9. Superior posterior fissure
10. Horizontal fissure
11. Posterior cerebellar incisure

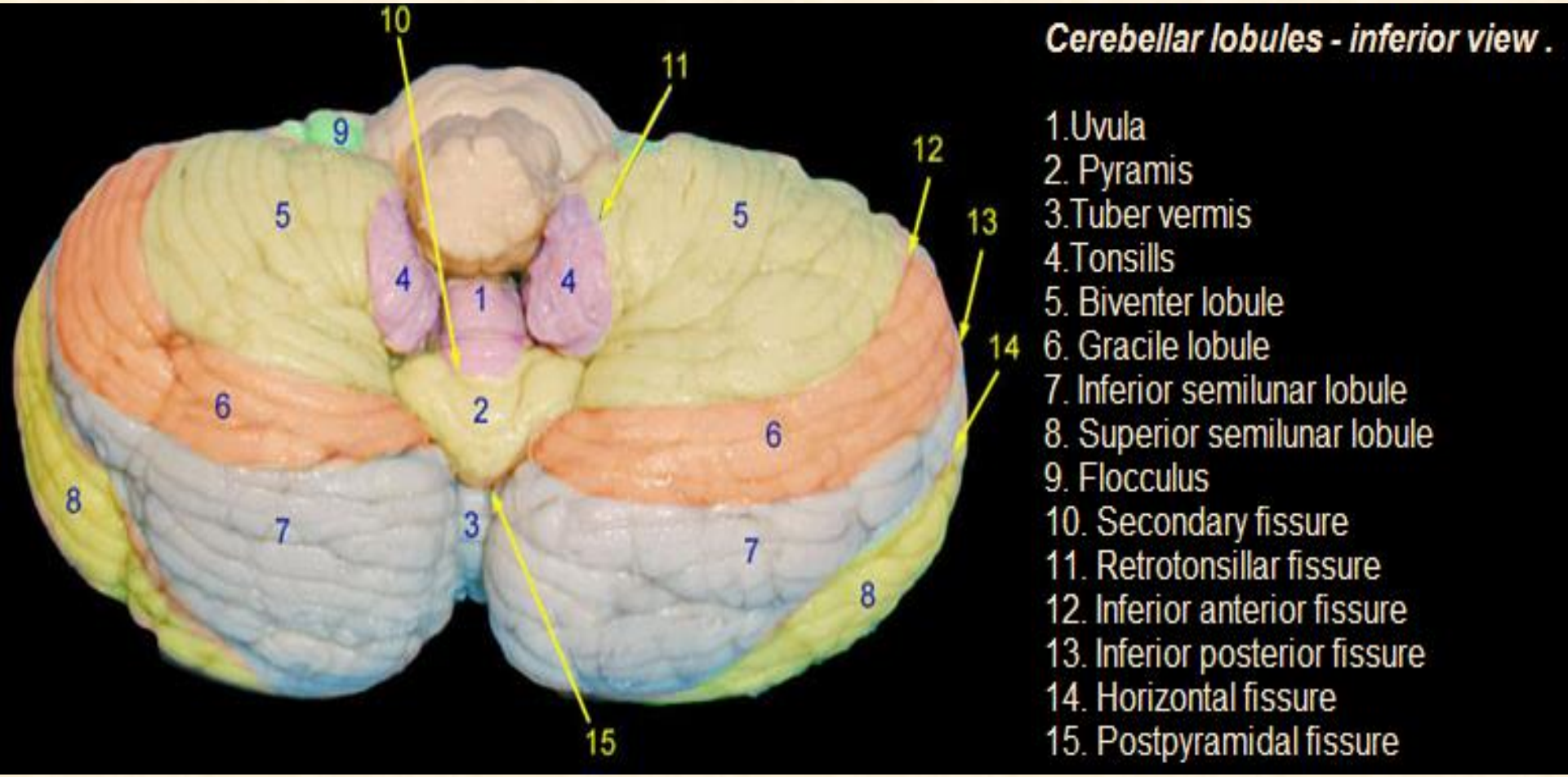
Cerebellar lobules - Superior view



Cerebellum - superior view

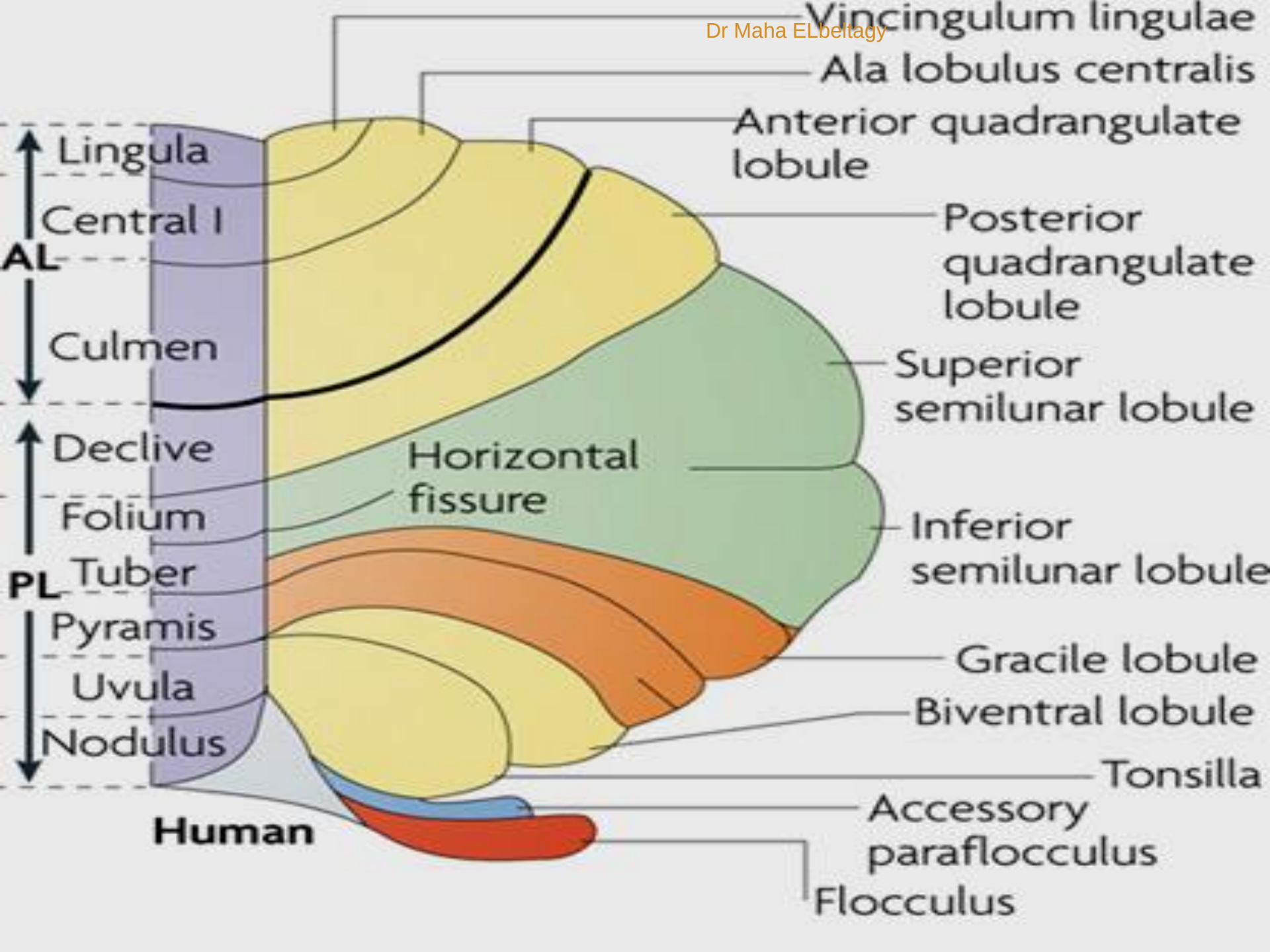
1. Crus cerebri
2. Subsrtantia nigra
3. Red nucleus
4. Cerebral aqueduct
5. Tectum
6. Central lobule
7. Culmen
8. Declive
9. Wing of the central lobule
10. Quadrangular lobule
11. Simple lobule
12. Suprior semilunar lobule
13. Horizontal fissure
14. Superior posterior fissure
15. Primary fissure
16. Posterior cerebellar incisure
17. Interpeduncular fossa

Cerebellar Lobules (inferior view)



Cerebellar lobules - inferior view .

1. Uvula
2. Pyramis
3. Tuber vermis
4. Tonsills
5. Biventer lobule
6. Gracile lobule
7. Inferior semilunar lobule
8. Superior semilunar lobule
9. Flocculus
10. Secondary fissure
11. Retrotonsillar fissure
12. Inferior anterior fissure
13. Inferior posterior fissure
14. Horizontal fissure
15. Postpyramidal fissure



Structure of the cerebellum

1- Cerebellar Cortex

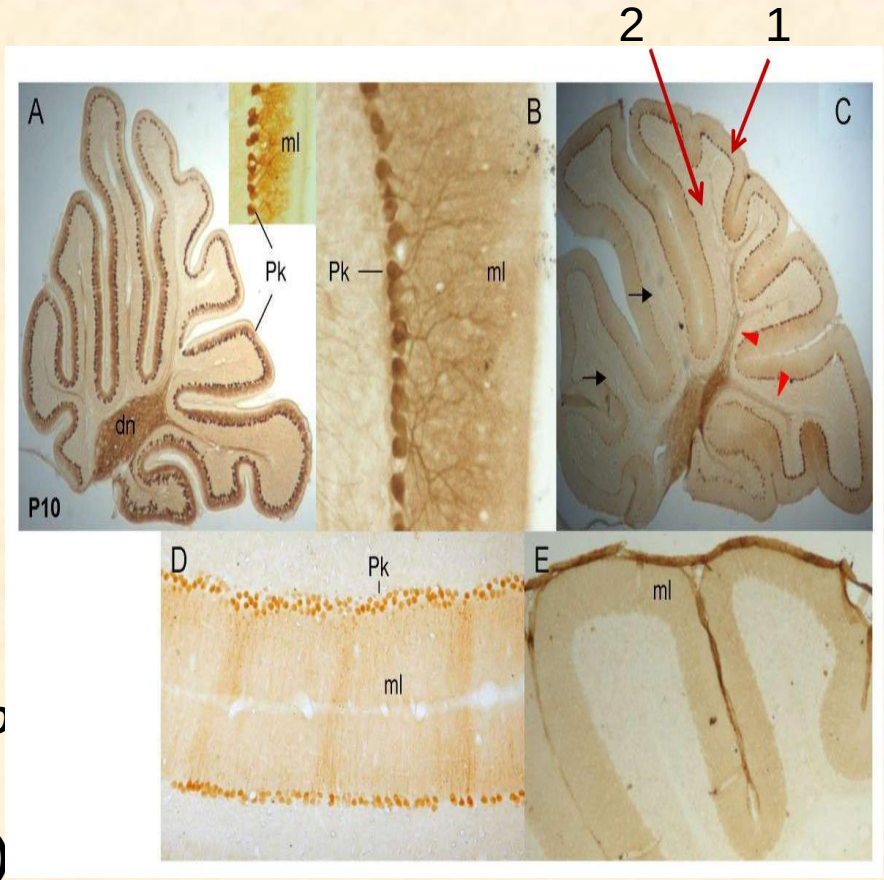
Outer Molecular Layer ***(stellate and basket cells)***

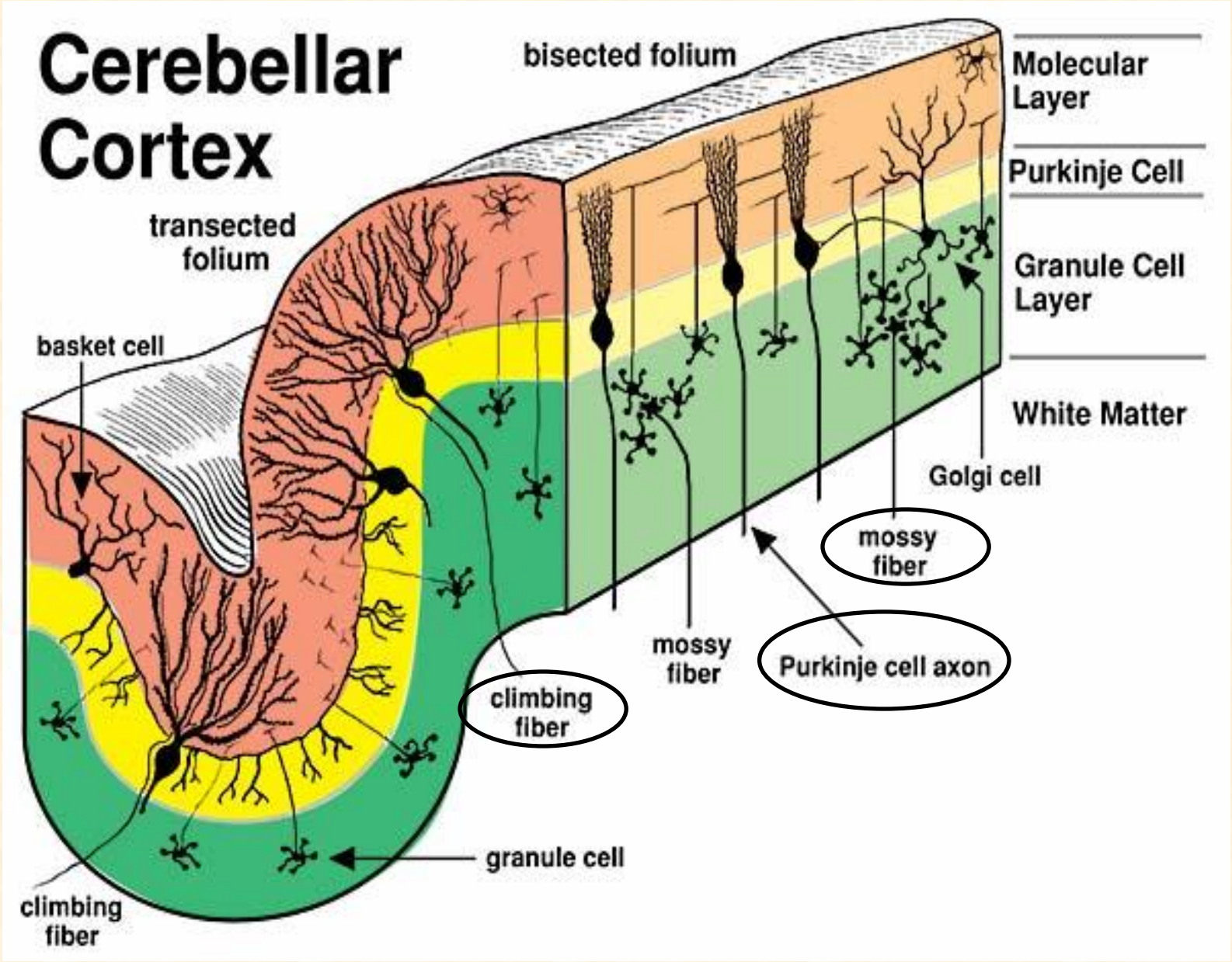
Middle Pyrkinje Cell Layer
(inhibitory to all other cells)

Inner Granular Layer
Include 2G cells (granule and golgi)
Granule cells are the only (excitatory to all other cells).

2- Corpus Medullare (Medullary Center)

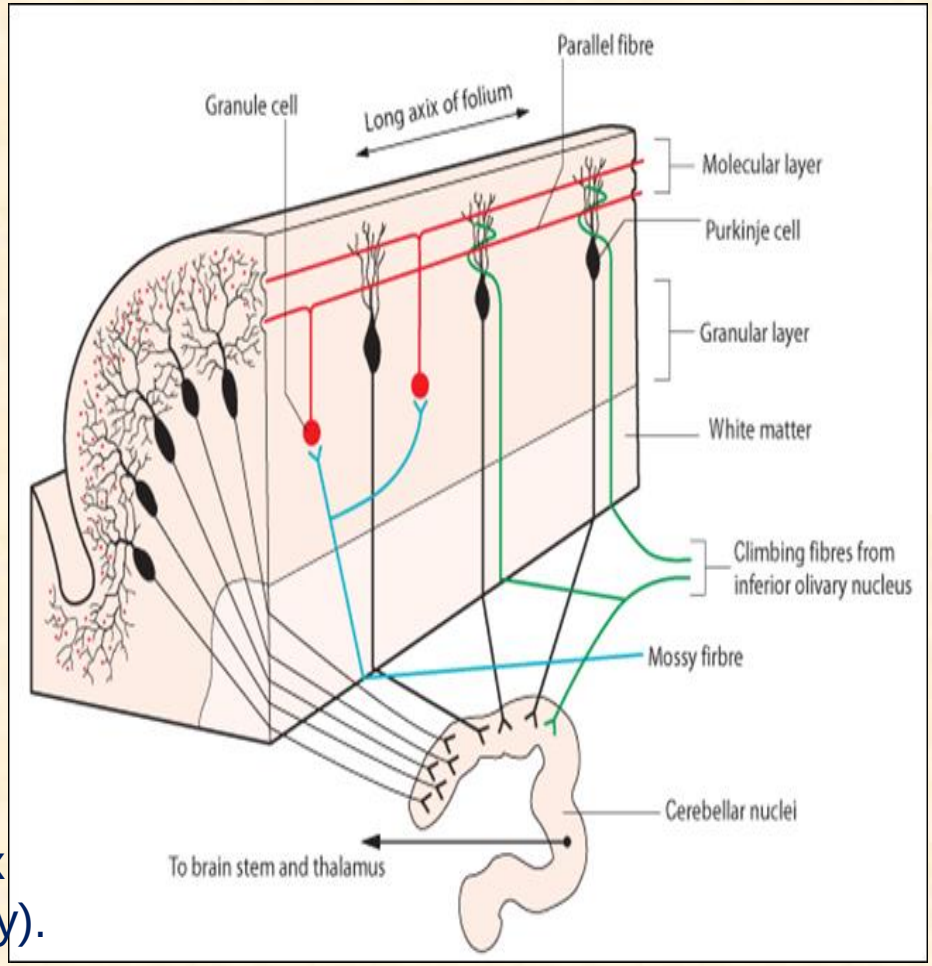
3- Deep Cerebellar Nuclei




Cerebellar Cortex
bisected folium
transected folium
basket cell
Molecular Layer
Purkinje Cell
Granule Cell Layer
White Matter
Golgi cell
mossy fiber
mossy fiber
Purkinje cell axon
climbing fiber
granule cell
climbing fiber

White matter of the cerebellum

•Consists of three types of nerve fibers in the white matter



A. Mossy fibres (afferent)

They end in the granular layer first then pyrkinje layer (indirect activation of pyrkinje).

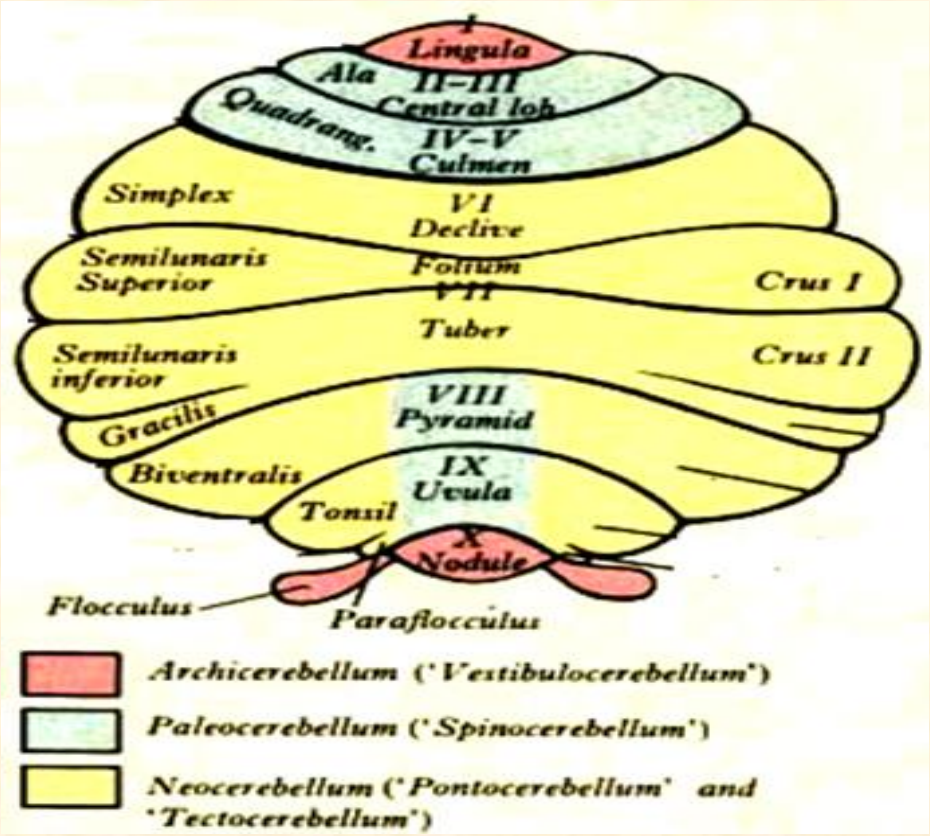
B. Climbing fibers (afferent)

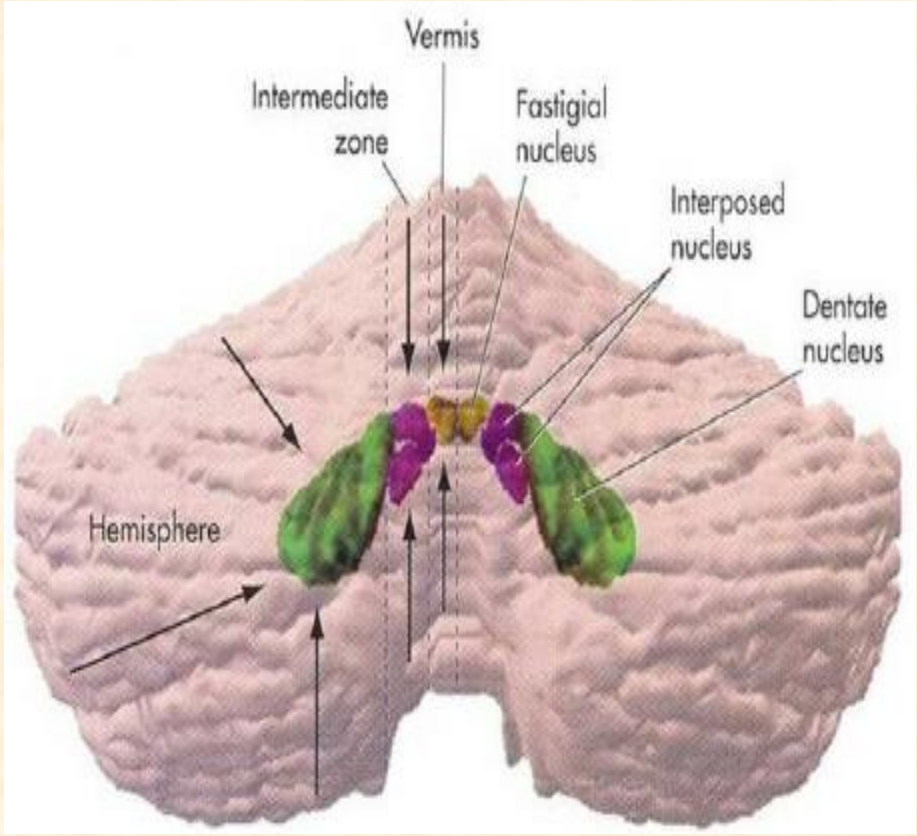
They end directly in pyrkinje (direct activation) or molecular layer (olivocerebellar tracts mainly)

C- Axons of purkinje cells (efferent)

The only axons to leave cerebellar cortex to end in deep cerebellar nuclei (inhibitory). These fibers then projects to brain stem nuclei, thalamus and cerebral cortex.

Functional Subdivisions of The Human Cerebellum





Functional Subdivisions of vestibulo-cerebellum

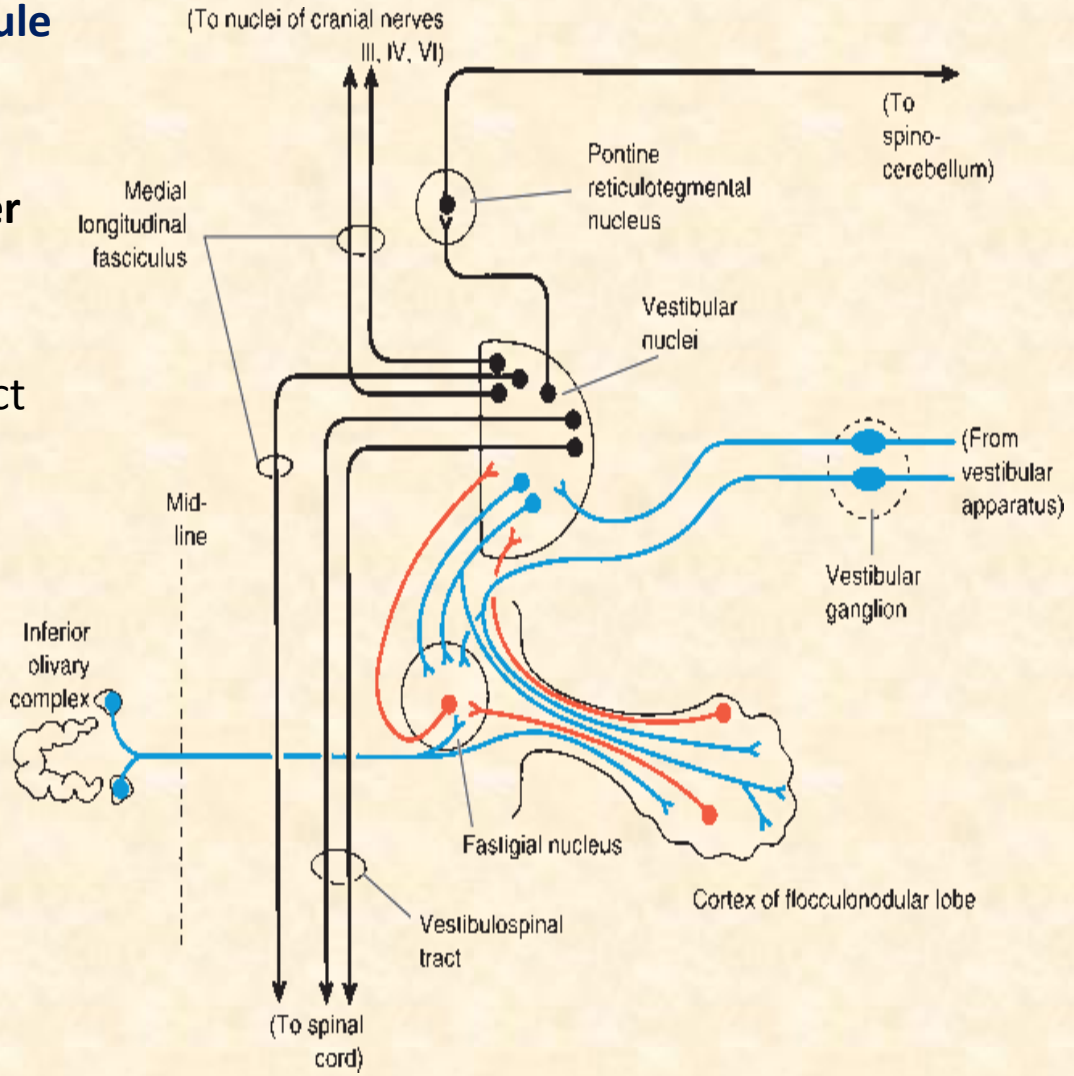
Archicerebellum (Vestibulo-cerebellum):

- **Flocculo-Nodular Lobe, Lingual Lobule**
- It receives **afferent** Fibers From vestibular apparatus of internal ear **Via vestibulo-cerebellar tracts either directly from vestibular ganglia or from vestibular nuclei.**
- Pyrkinje neurons of each lobe project its inhibitory axons directly to ipsilateral vestibular nuclei

Efferent: vestibular nuclei give rise to:

- **Vestibulospinal tracts** to antigravity extensor muscles.
- **Vestibulo-ocular** fibers
- Vestibulo-cerebellar
- Vestivulo-cortical

Function: Equilibrium, Vestibulo-Ocular Reflex (VOR).



Paleocerebellum (Spino-cerebelllum):

1- Anterior lobe+ midline vermis (fastigeal N)

2- surrounding paravermis + globose & emboliform nuclei.

1- Vermal zone of the spino-cerebellum

Function: Regulate muscle tone of axial and proximal limb muscles

Pyrkinje neurons of each hemivermis projects inhibitory axons to ipsilateral fastigeal nuclei.

Afferent : venteral and dorsal spinocerebellar, olivo-cerebellar and cuneocerellar tracts.

Projects to fastigeal N

Fastigeal N gives **bilateral** excitatory fibers to the **medial mtotor system** that controls axial and porximal limb muscles through:

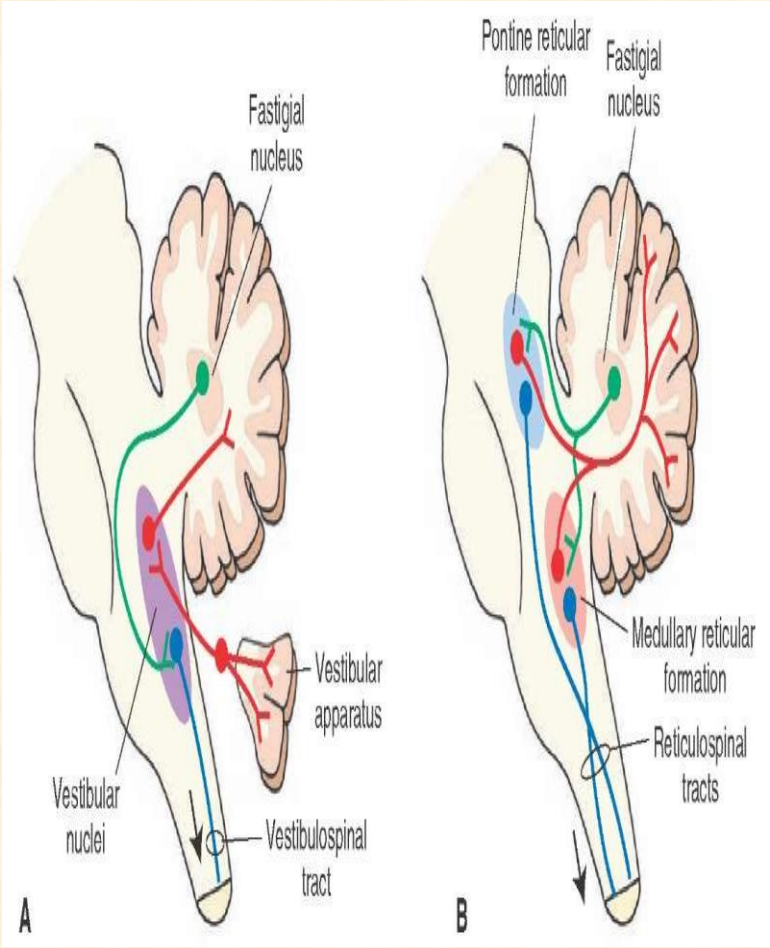
Efferent:

Fasigeo-Vestibulo-spinal (ipsilateral and contralateral vestibular nuclei)

Fastigeo- Reticulo-spinal (Ipsilateral and contralateral RF)

Anterior cortico-spinal (ipsilateral and contralateral VL nucleus of thalamus which project to trunk part of area 4.

(cerebello-fastigeo-thalamo-cortico-spinal)



2- para-vermal zone of spino-cerebellum

It receives **afferent** proprio-ceptive impulses from Ms.& tendons **Via spino-cerebellar tracts** (dorsal & ventral), olivo-cerebellar and cuneorebellar

Project to Globose-Emboliform N

- it sends **efferent** to **lateral motor pathway** :

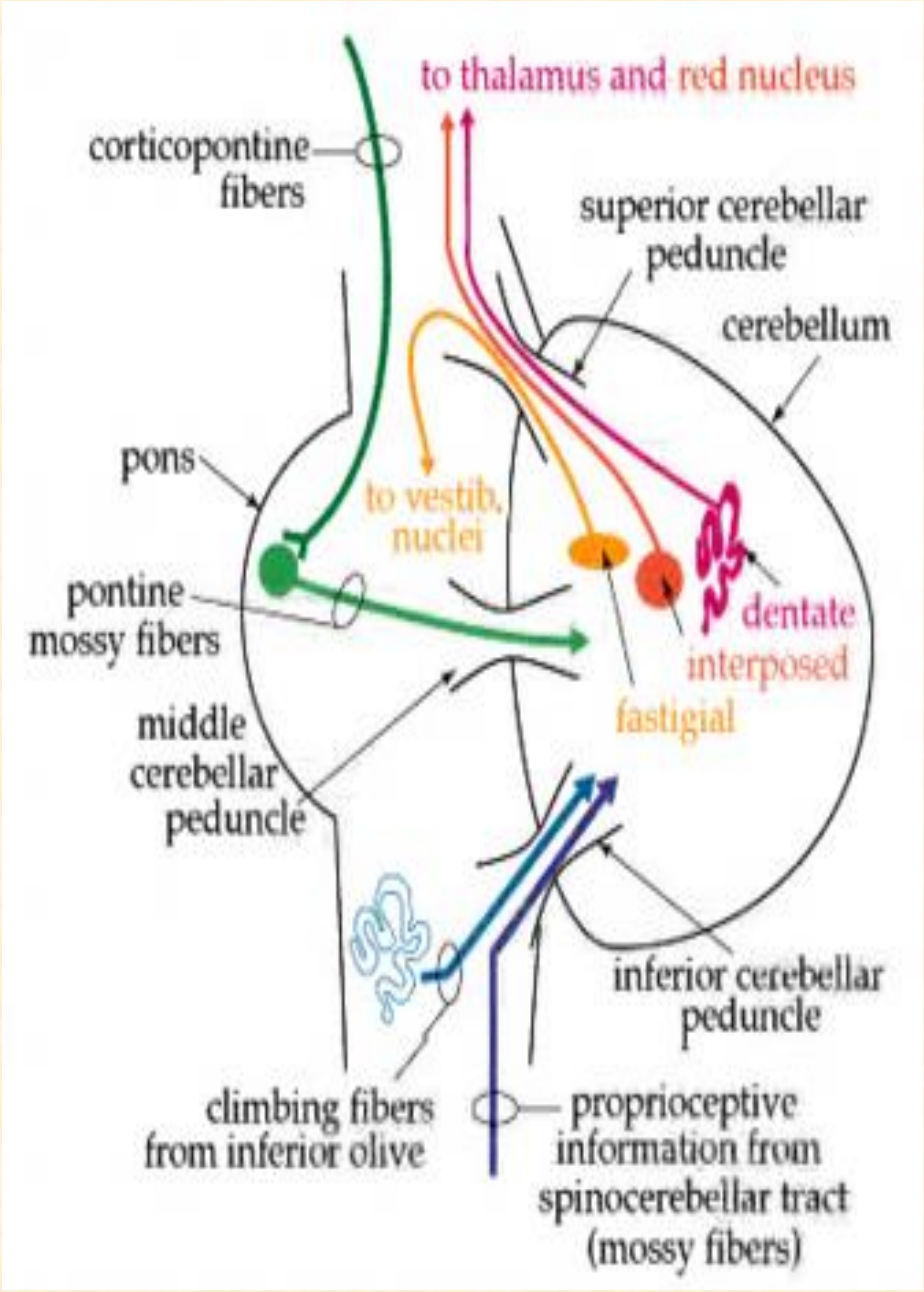
Contralateral VL nuclei of thalamus which project to precenteral gyrus (distal limbs area) from which **lateral corticospinal fibers** arise (control distal limb muscles)

Cerebello-Globose- Embliform- thalamo-cortical-spinal pathway

Contralateral red nucleus of midbrain (controlling distal limb muscles)

Cerebello-Globose-Emboliform-Rubral-spinal pathway

Function: it is concerned with muscle tone (mainly flexors) and regulation of voluntary movements of the distal muscles.



Neocerebellum (cerebro cerebellum)

It includes the most 2-cerebellar hemispheres + dendate nuclei.

It receives **afferent** impulses from the **cerebral cortex+pons** Via **cerebro-ponto- cerebellar** pathway which project to dentate N.

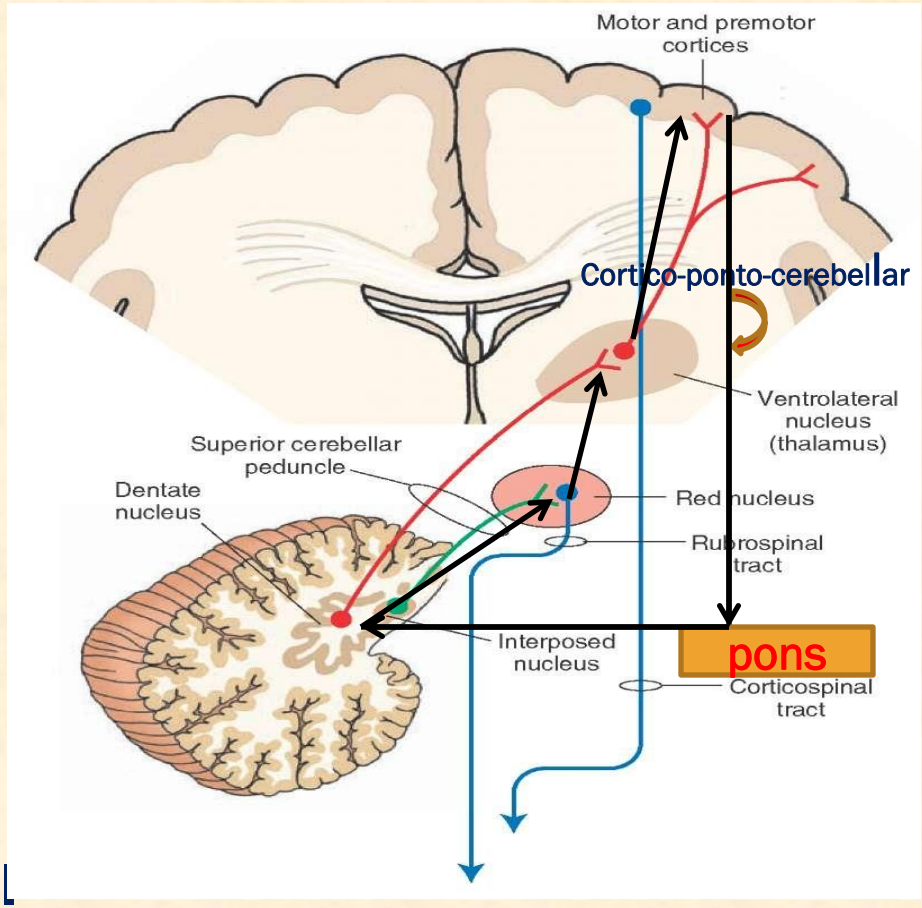
it sends **efferents** to contralateral red nucleus that projects to Ventro lateral nucleus of thalamus (VL).

Function: 1- controls voluntary movements, planning of sequence of intended movements

(even before execution of motor activity) i.e anticipation

2- Regulation of force and timing Of Movement.

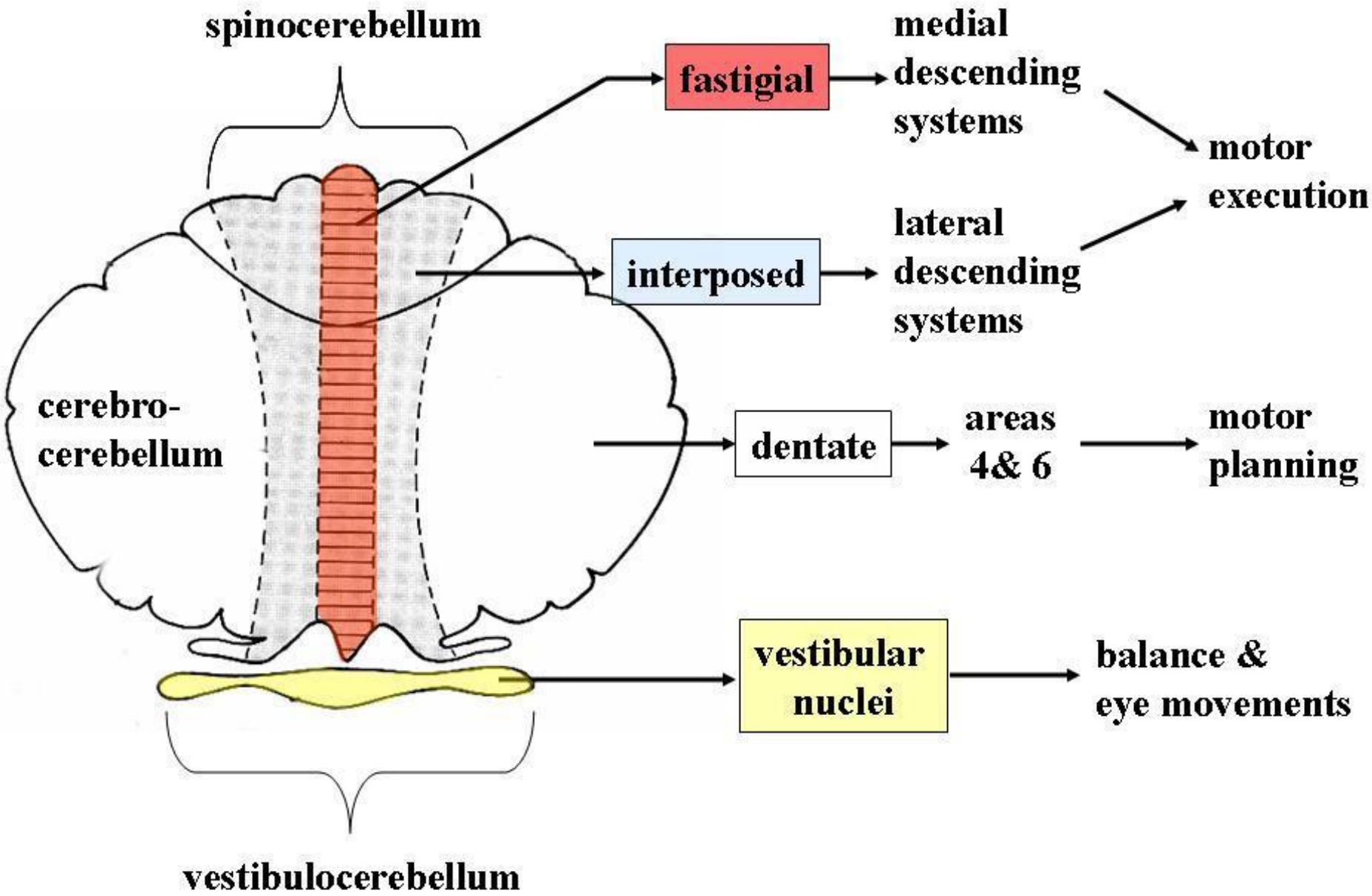
3- Learning new complex movements



The whole pathway

Cortico-ponto-cerebellar-Dentato-rubro-thalamo-cortical

Cerebellar Output



Fibers entering and leaving through cerebellar peduncles

Superior cerebellar peduncle (major efferent)

Fibres entering the cerebellum

Ventral spino-cerebellar tract
Trigimino-cerebellar from Mesencephalic nucleus

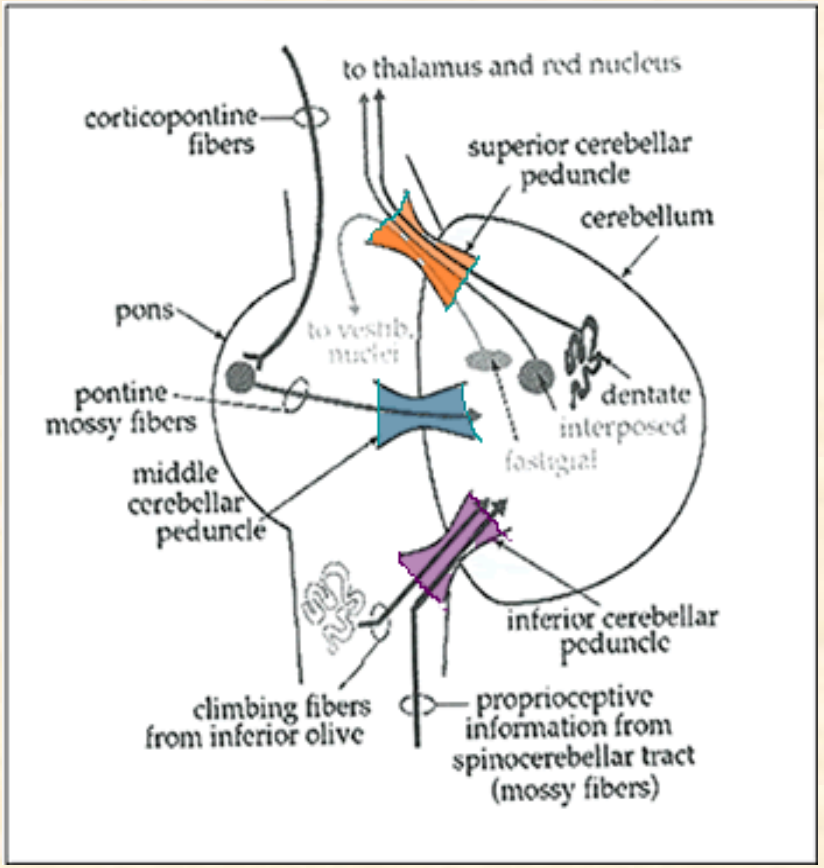
Tecto-cerebellar fibres

Fibres leaving the cerebellum

Cerebello-rubral fibres
(Globose-Emboliform-rubral)

Cerebello-thalamic fibres
(Dentato-thalamo-cortical)

Cerebello-reticular fibres
(**Fastigeal nucleus**)



Middle cerebellar peduncle (afferent

Pontocerebellar fibres

(cortico-ponto-cerebellum) to dentate nucleus)

Inferior cerebellar peduncle (afferent)

Fibres entering cerebellum

(restiform body)

Posterior spino cerebellar tract

Cuneo-cerebellar tract

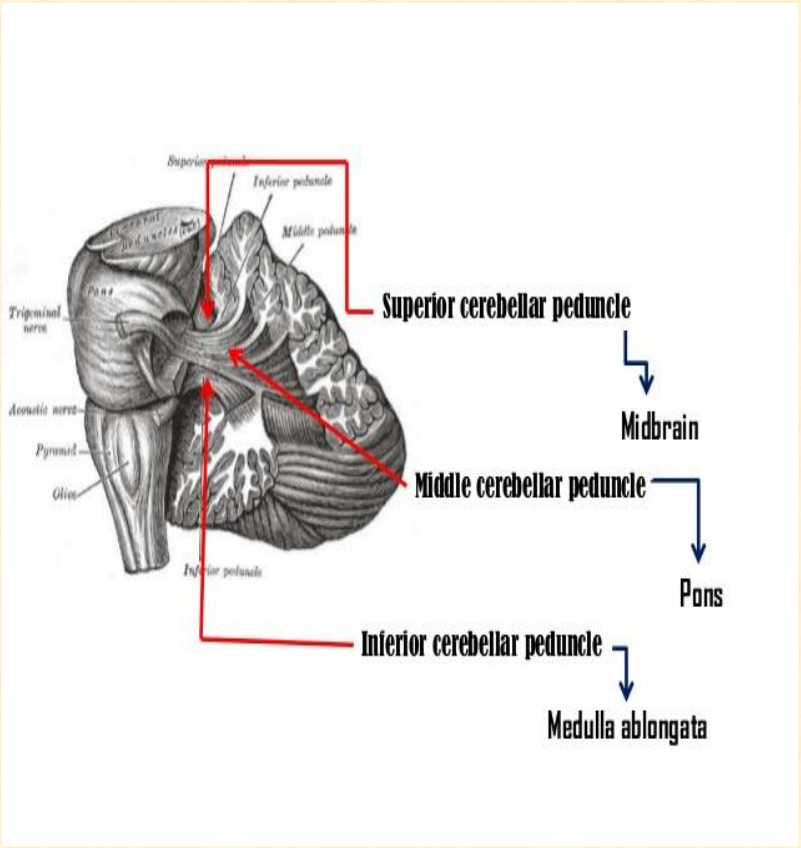
Olivo-cerebellar fibres

Reticulo-cerebellar

Vestibulo-cerebellar fibres

Trigemino-cerebellar fibres

Anterior external arcuate fibers



Fibres Leaving the cerebellum (juxta-restiform body)

Cerebello-olivary fibres

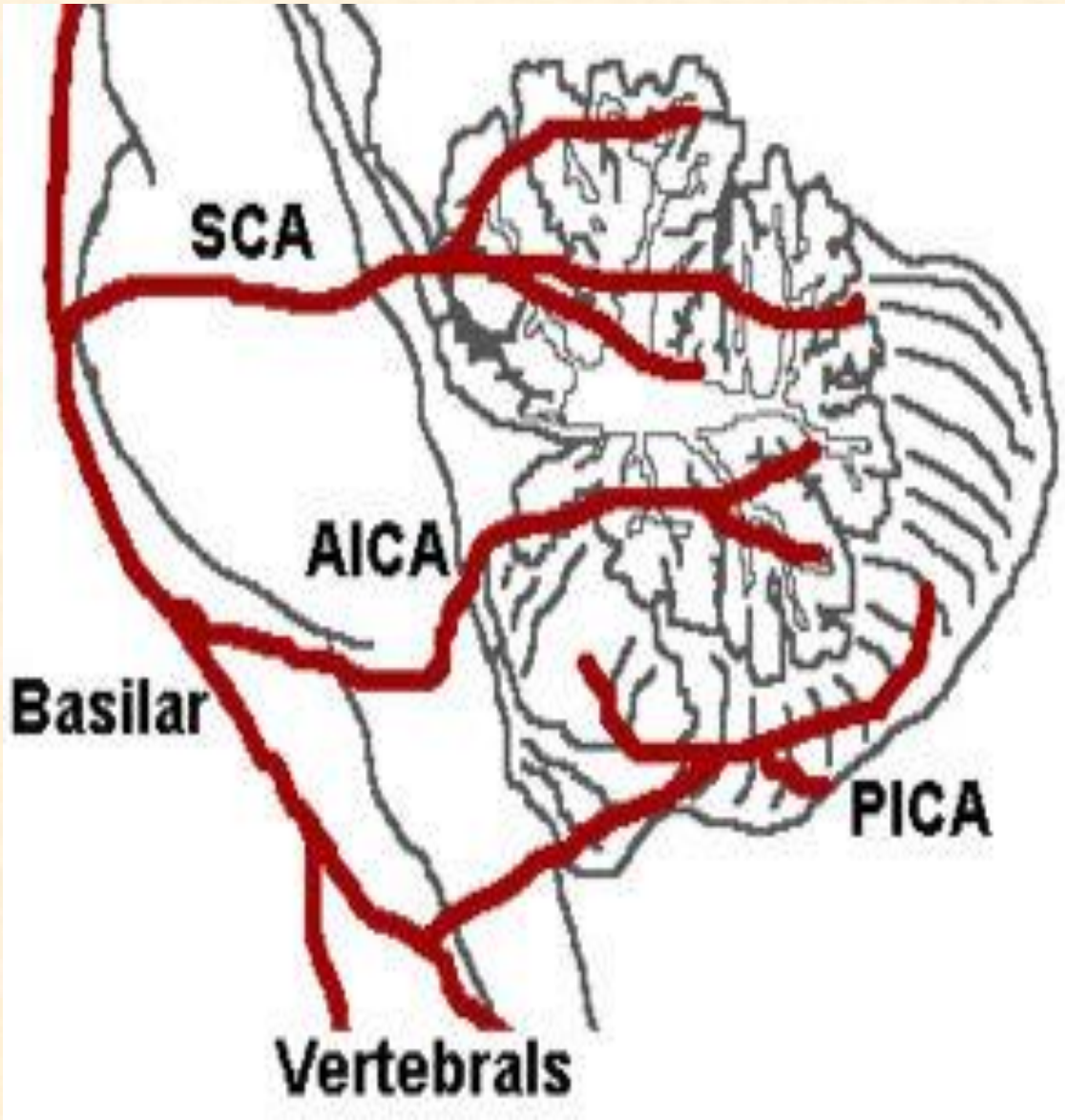
Cerebello (Fastigio)-vestibular fibres

Cerebello (Fastigio)- reticular fibres

Blood Supply of the Cerebellum

It is supplied by 3 cerebellar arteries

- **Superior cerebellar artery**: from the basilar artery
- **Anterior inferior cerebellar artery**: from the basilar artery
- **Posterior inferior cerebellar artery**: from the vertebral artery



Basal ganglia and cerebellum

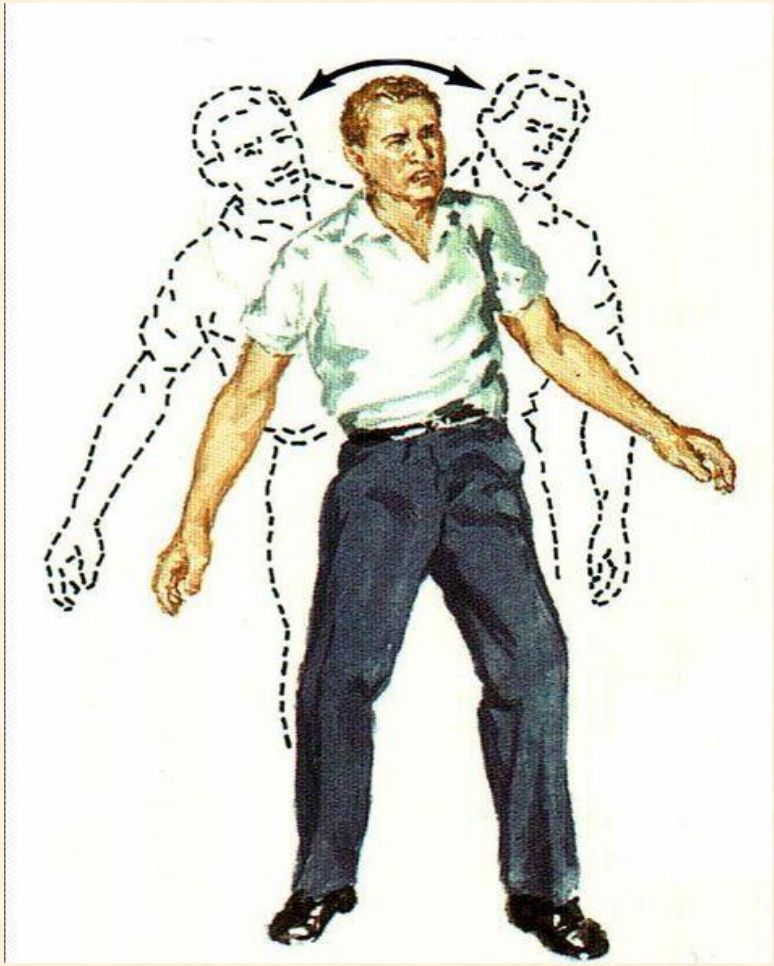
Cerebellum and basal nuclei are the 2 major subcortical centers which affect cortical activity
Both receive input from cortex
Both projet output to the cortex via the thalamus

Cerebellm	Basal ganglia
Receive cortico-ponto-cerebellar from contralateral cerebral cortex	Receives cortico-striate fibres from ipsilateral cerebral cortex
Projects to VL nucleus of the contralateral thalamus projects directly to areas 4,6	Projects to VA nucleus of the ipsilateral thalamus which projects first to SMA then to areas 4,6
Controls movement of the ipsilateral half of the body	Controls movement of the contralateral half of the body

Cerebellar lesion Syndromes

Ataxia:* *incoordination of movement

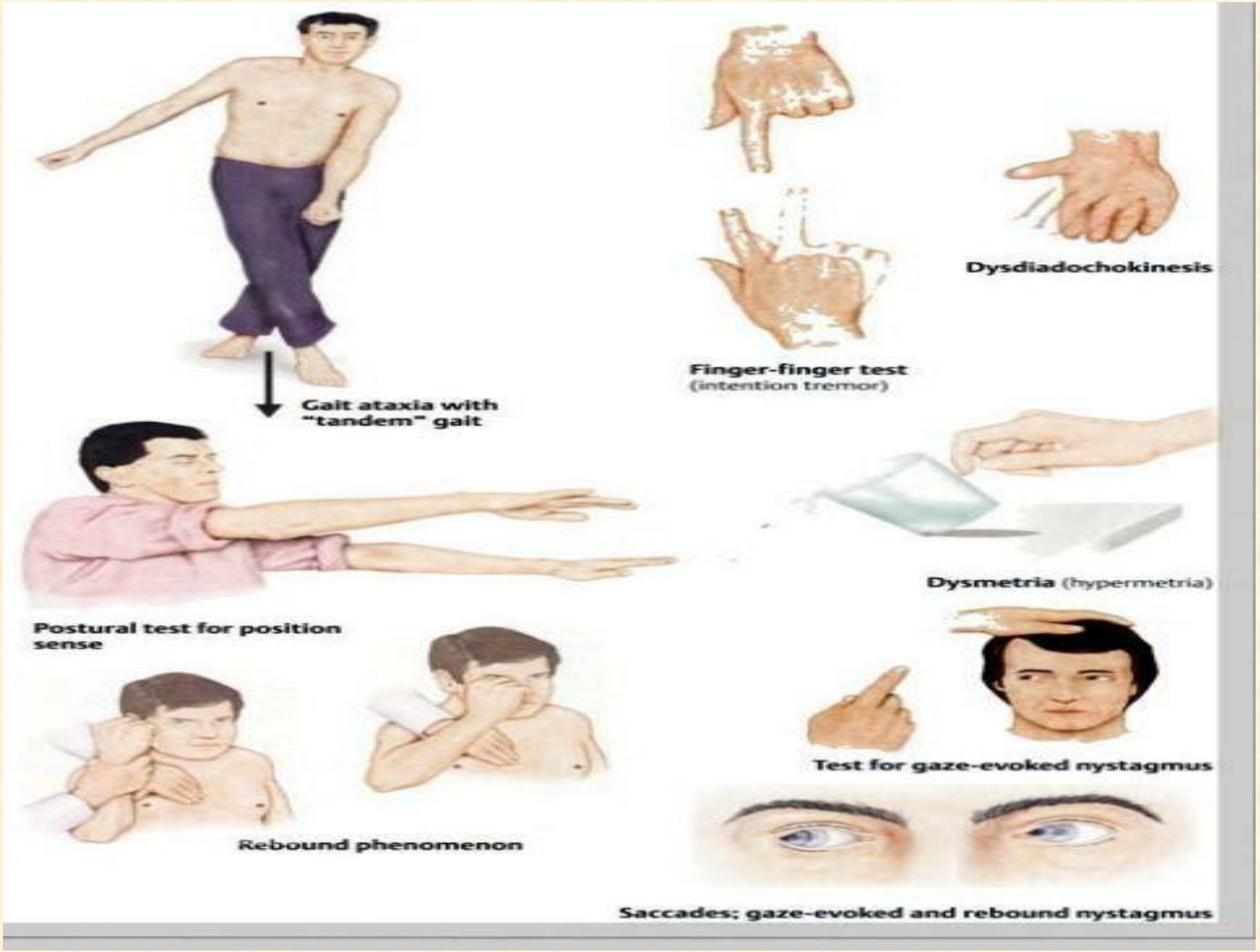
- *decomposition of movement*
- *dysmetria, past-pointing*
- *dysartheria*
- *dysdiadochokinesia*
- *rebound phenomenon of Holmes*
- *gait ataxia, truncal ataxia*
- *Intention Tremor Hypotonia, Nystagmus*



Archicerebellar Lesion:
Medulloblastoma (see later)

Paleocerebellar Lesion*: *gait
Disturbance, tested by heel shin test

Neocerebellar Lesion*: *hypotonia, upper
Limb ataxia , tremor, dysmetria.
Tested by finger to nose test.


Gait ataxia with "tandem" gait
Finger-finger test (intention tremor)
Dysdiadochokinesis
Dysmetria (hypermetria)
Postural test for position sense
Test for gaze-evoked nystagmus
Rebound phenomenon
Saccades; gaze-evoked and rebound nystagmus

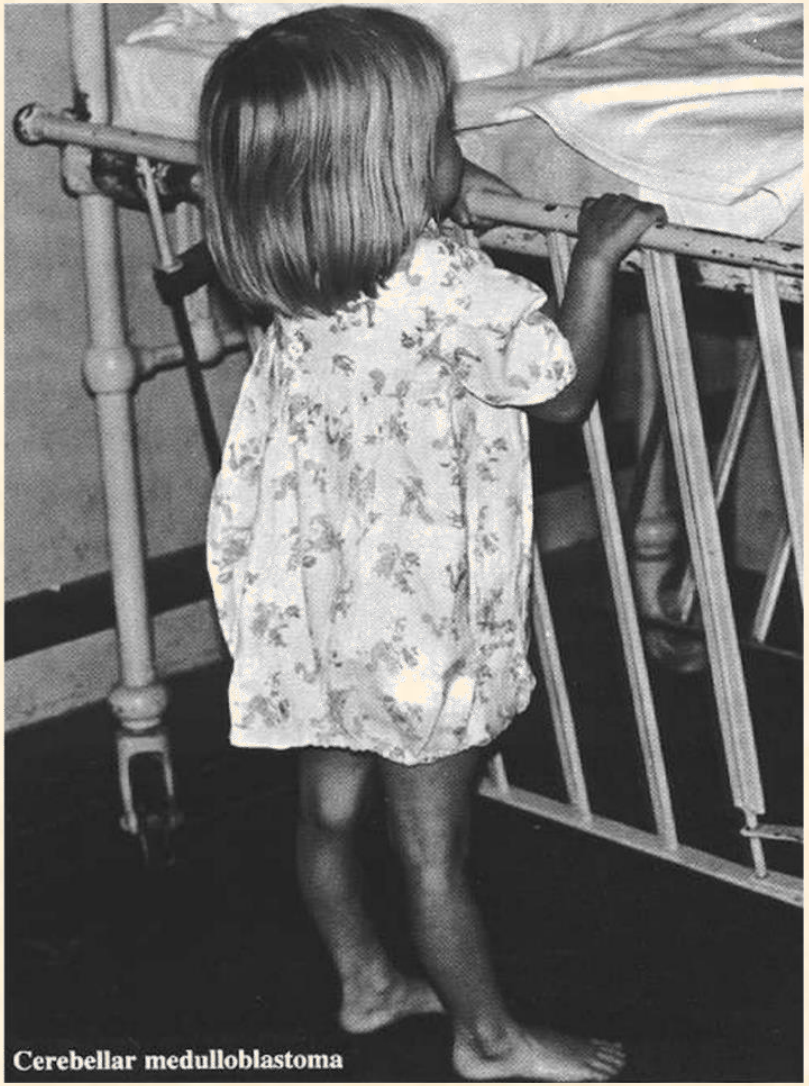
Cerebellar Medulloblastoma

Cerebellar Medulloblastoma

Cerebellar tumors on vermis

- Truncal Ataxia
- Frequent Falling

The child in this picture:
- would not try to stand unsupported
•would not let go of the bed rail if she was stood on the floor.


Cerebellar medulloblastoma

THANK YOU