Neuroanatomy

the cerebellum

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If you have any corrections or questions, don't hesitate to contact me

1. cerebrospinal fluid communicates with the subarachnoid space via the……

a. 4th ventricle
b. 3rd ventricle
c. subarachnoid granulations
d. choroids plexus
e. tela choroidia

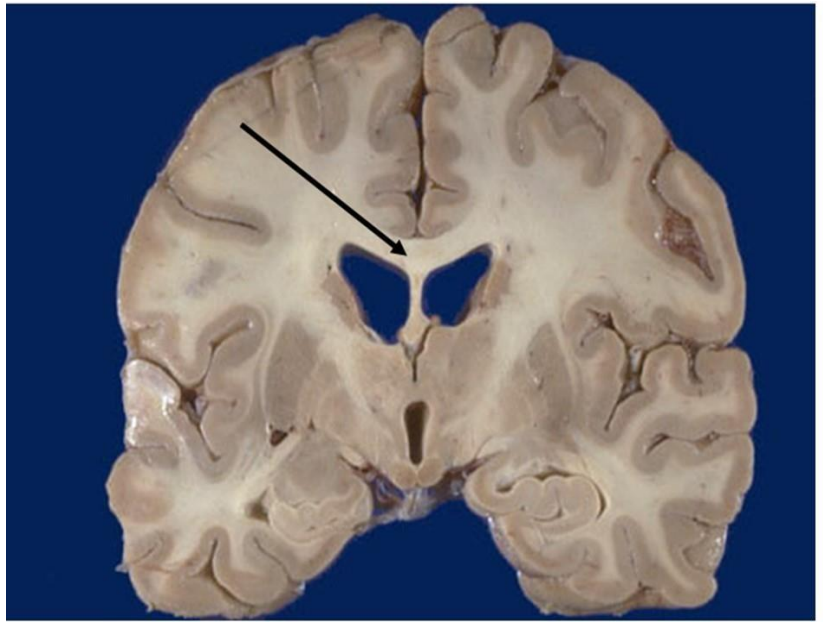
Revision slide: by now we should be able to identify the structures on those 2 pics. Solve these questions to test yourself!

2. Regarding the speech centers, chose the correct answer

a. It is supplied by Anterior cerebral artery
b. Broca's area is posterior
c. Wernicke's area controls motor response
d. Damage to Broca's area produces motor aphasia
e. Damage to Wernicke's area produces expressive aphasia

3- One of the following is not sharing in the anterior wall of the third ventricle:

A- anterior commissure
B- optic chiasma
C- lamina terminalis
D- Anterior column of the fornix
E- None of the above



The Cerebellum

Site: In the posterior cranial fossa in the infratentorial space, separated from the cerebrum above by a dural fold called the tentorium cerebelli

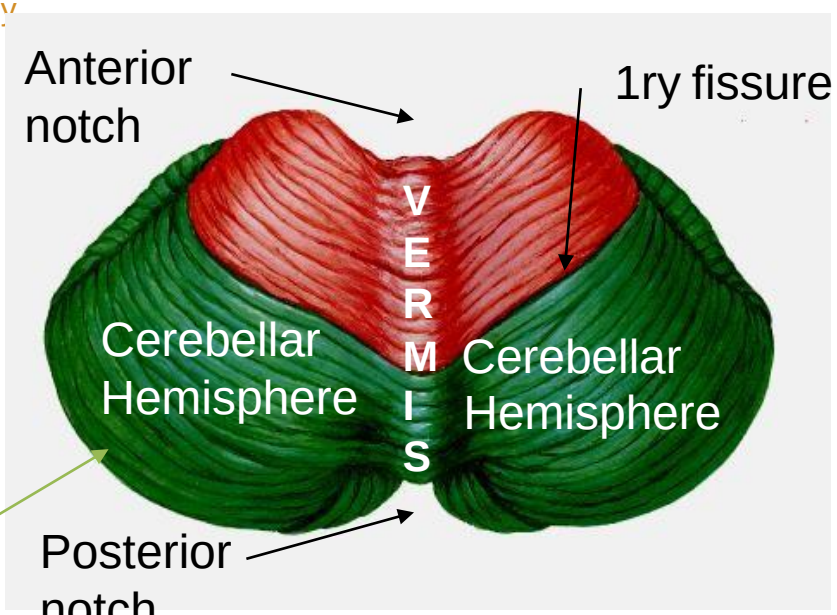
Components: It is formed of 2 cerebellar hemispheres connected through the median vermis.

It has 2 surfaces:

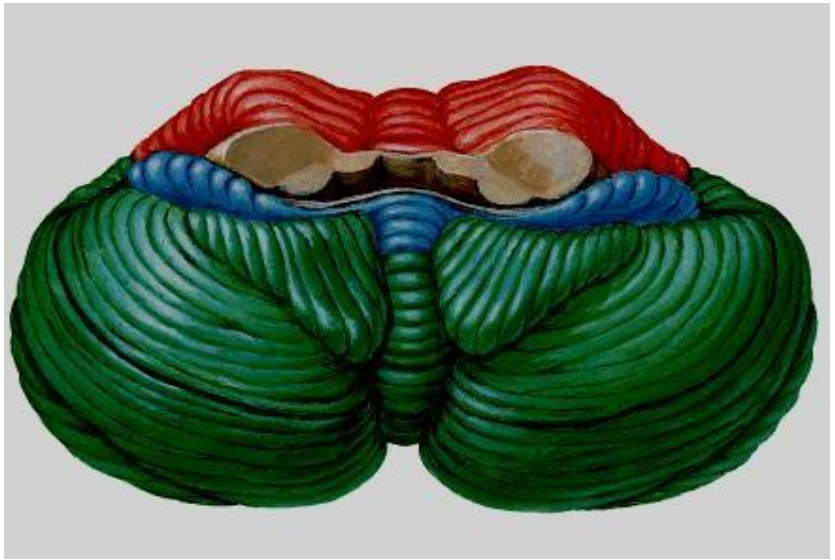
- **Superior surface**: facing the midbrain & tentorium cerebelli .
- **Inferior surface**: divided into **anterior** & **posterior** parts.
- **The surfaces have many parallel folds called folia,** they're the smallest unit of the cerebellum, and separated like lobules inside each lobe of the cerebellum.

It has 2 notches: notice on the superior surface:

- **Anterior notch (AKA the midbrain notch)** because it's occupied by the brain stem (specifically the midbrain) and it's connected to the midbrain through the superior cerebellar peduncle.
- **Posterior notch (called vellecula)** occupied by falx cerebelli (a dural fold separating the two cerebellar hemispheres).



Superior surface



Inferior surface

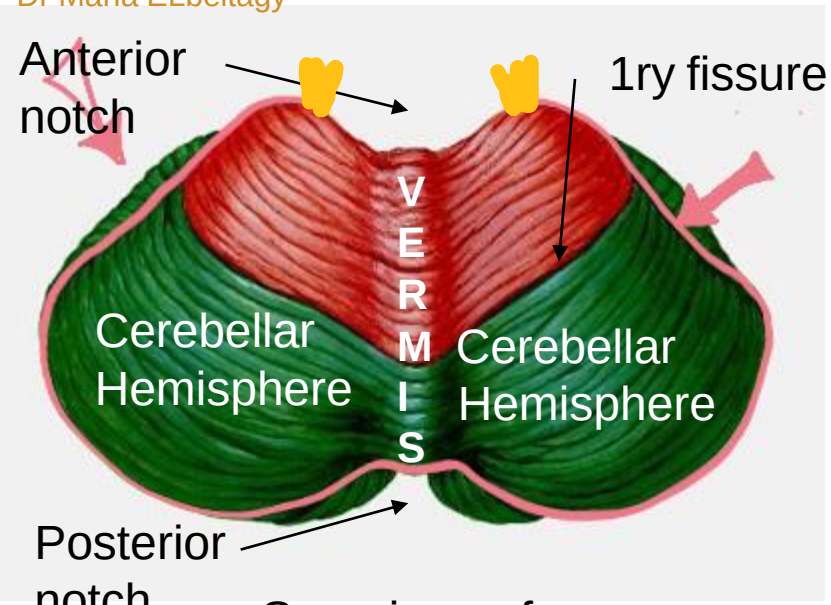
The Cerebellum

Dr Maha ELbeltagy

The main fissures of the cerebellum:

- **Primary fissure**: separates the anterior & posterior lobes (or the anterior third and posterior 2 thirds). Visible on the superior surface
- **Horizontal fissure**: Extends between the middle cerebellar peduncles **(begins peripheral to the site of attachment of the middle cerebellar peduncle with the pons (yellow) and encircles the entire cerebellum dividing it into superior and inferior parts- in pink)**

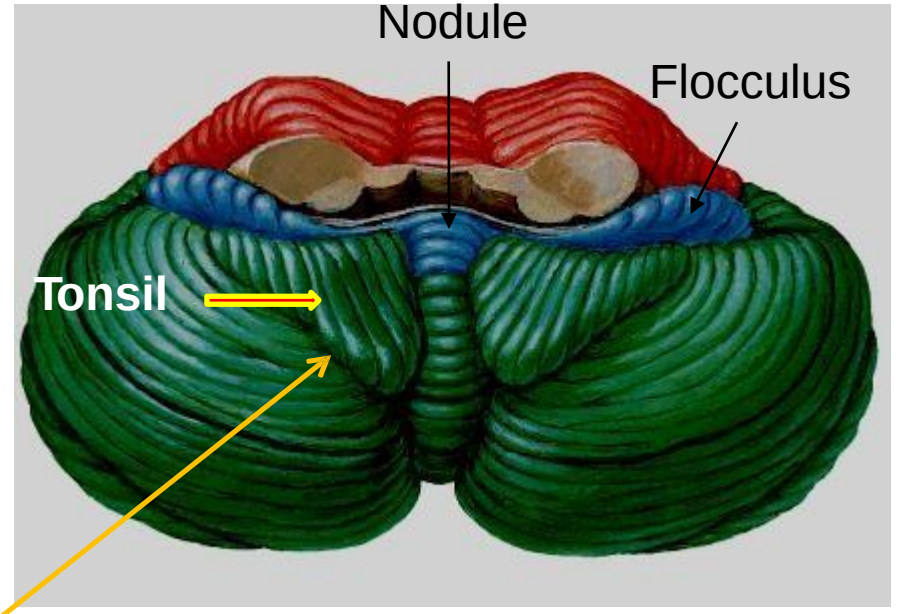
  (Think of the cerebellum as a burger bun, this fissure separates the 2 pieces :D)
- **Posterolateral fissure (on the inferior surface)** : Separates the flocculus & nodule (the flocculo-nodular lobe) from the rest of the cerebellum.



Superior surface

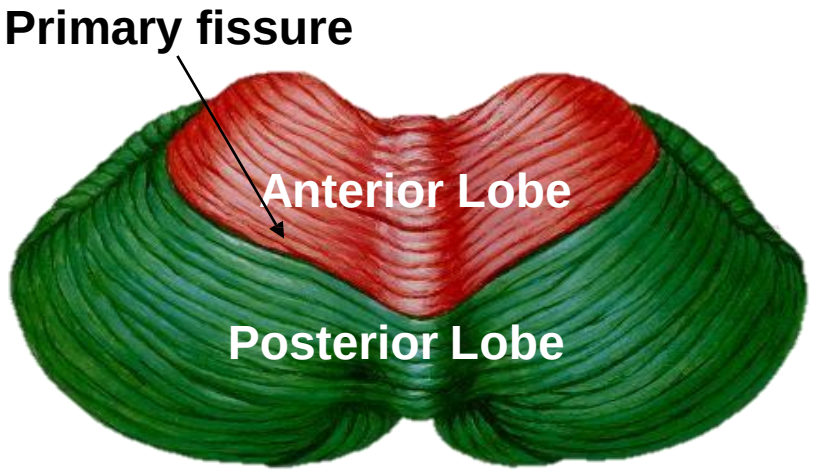
Also on the inferior surface:

- **Cerebellar tonsils** : on either sides of uvula of inferior vermis, normally they're just in contact with the medulla oblongata around the foramen magnum, but they don't descend through the foramen magnum or else the condition is called **tonsillar herniation,** which causes obstruction of the CSF.
- **Retrotonsillar fissure** : separates tonsil from the rest of cerebellum.



Inferior surface

Lobes of the cerebellum: (Horizontal division)



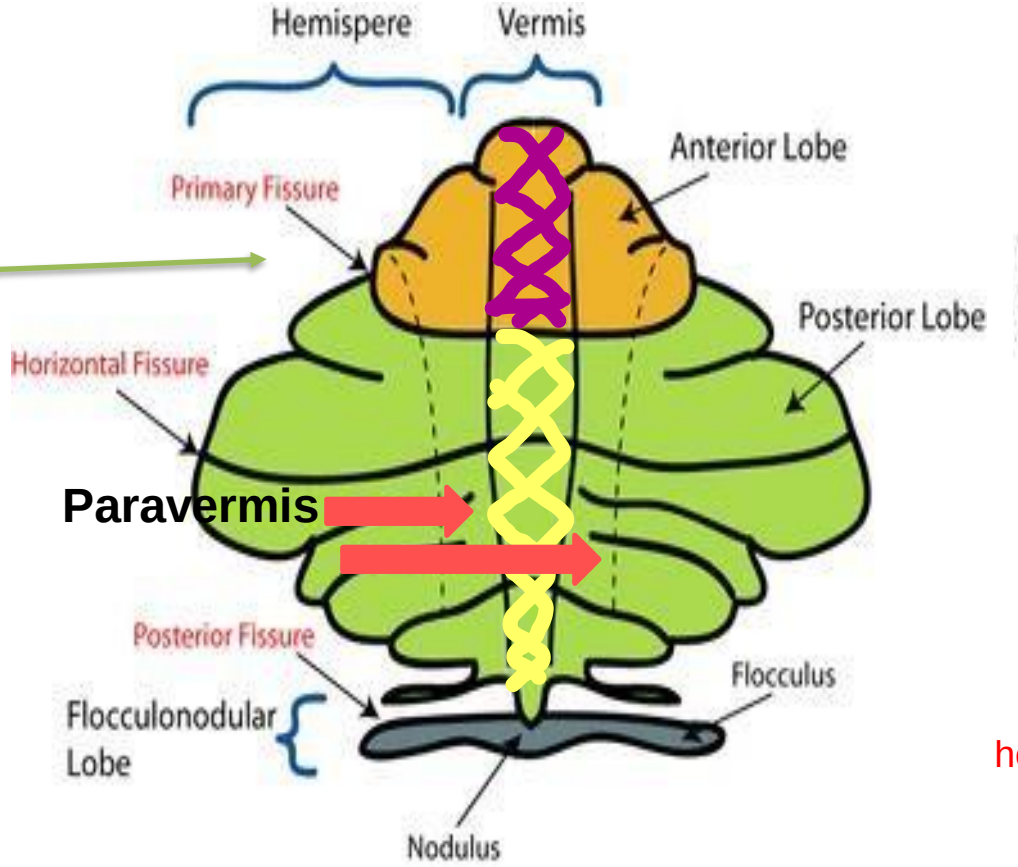
- **Anterior lobe**: in front of the primary fissure.
- **Posterior lobe**: behind the primary fissure.
- **Flocculo-nodular lobe**: Consists of the flocculus & nodule .

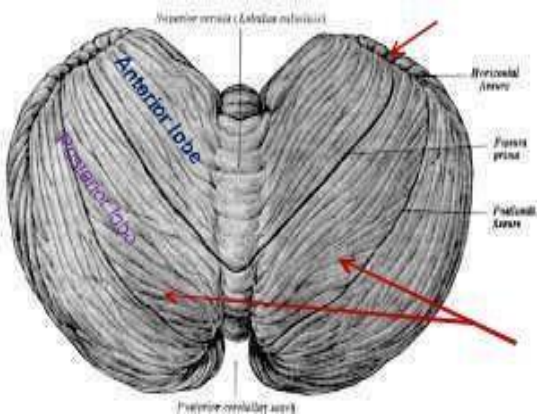
This is an unfolded cerebellum → an opened burger bun

- It shows an external flattened view of the cerebellum
- Notice the details on the picture.

Important: Identification of the vermis (superior vermis is lined with purple and the inferior with yellow)

-The area just surrounding the vermis is called the paravermal region (inside the dashed lines)



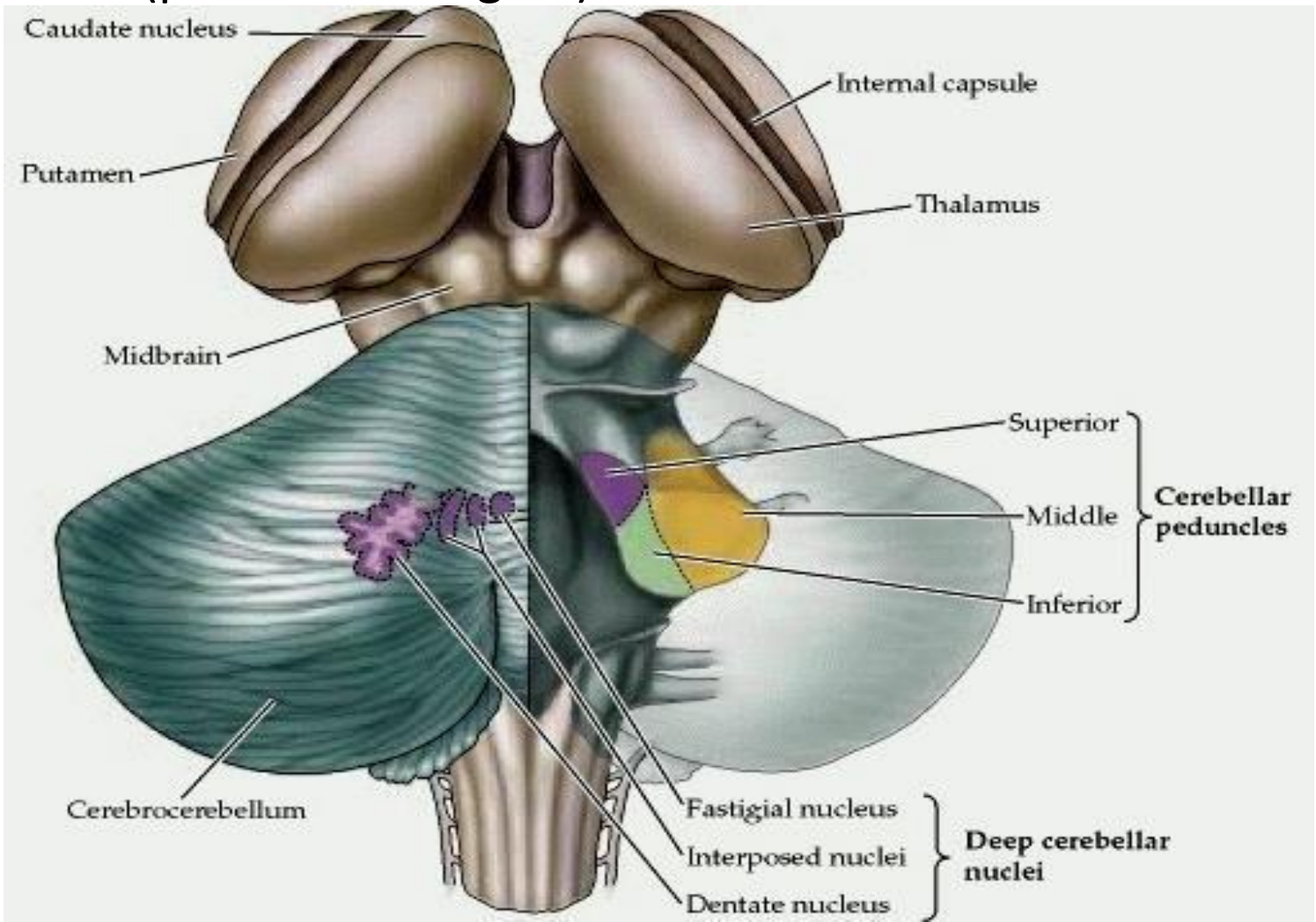


hemispheres

Cerebellar nuclei:

Arranged in this sentence from lateral to medial: *"Don't Eat Greasy Food"*

- **D**entate nucleus (lateral part of the cerebellum)
- Interposed nuclei: **E**mboliform – **G**lobose (paravermal region)
- **F**astigial (vermal region)



Arbor vitae

In latin " **tree of life**".

- It is the white matter of cerebellum (vermis specifically)
- 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

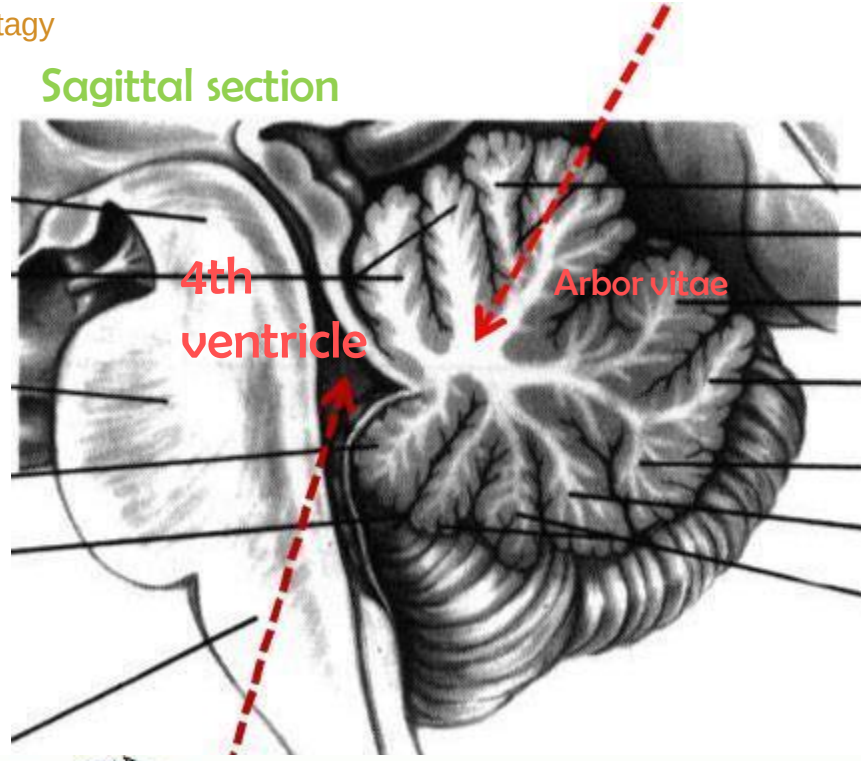
1- Vermis (central part): represents head, neck, trunk, shoulders and hips (axial muscles).
-Projects to **Fastigeal N**

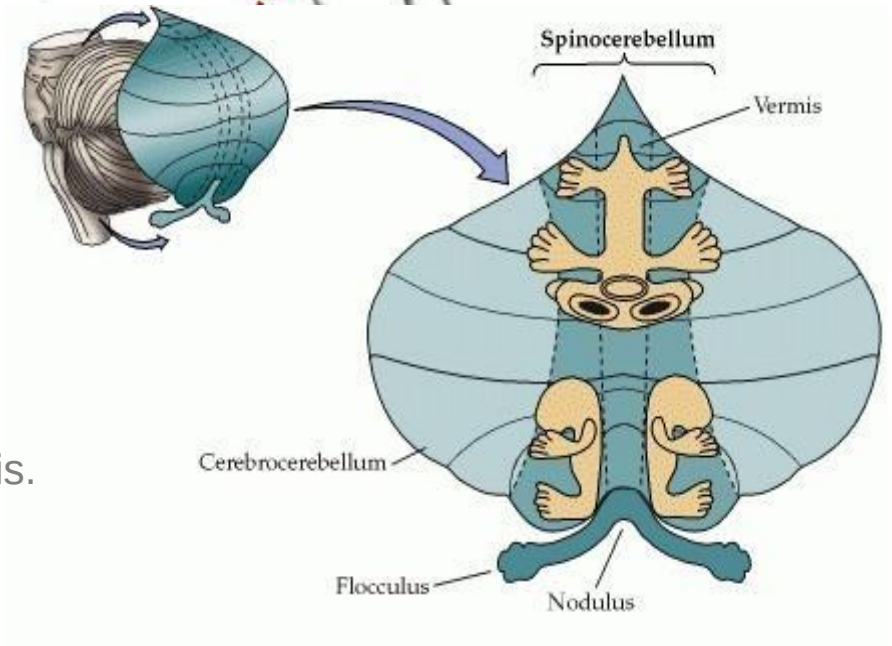
2- Paravermis (lateral to vermis) represent muscles of upper and lower limbs (distal muscles)
-Projects to **Globose and Emboliform N**

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

In the anterior lobe the body is represented in an upside-down axial manner where the trunk is represented on the vermis, and the limbs are on the paravermis.
In the posterior lobe the body is represented in a bilateral way, but the trunk and axis representation is still more medial than the limbs representation

Sagittal section



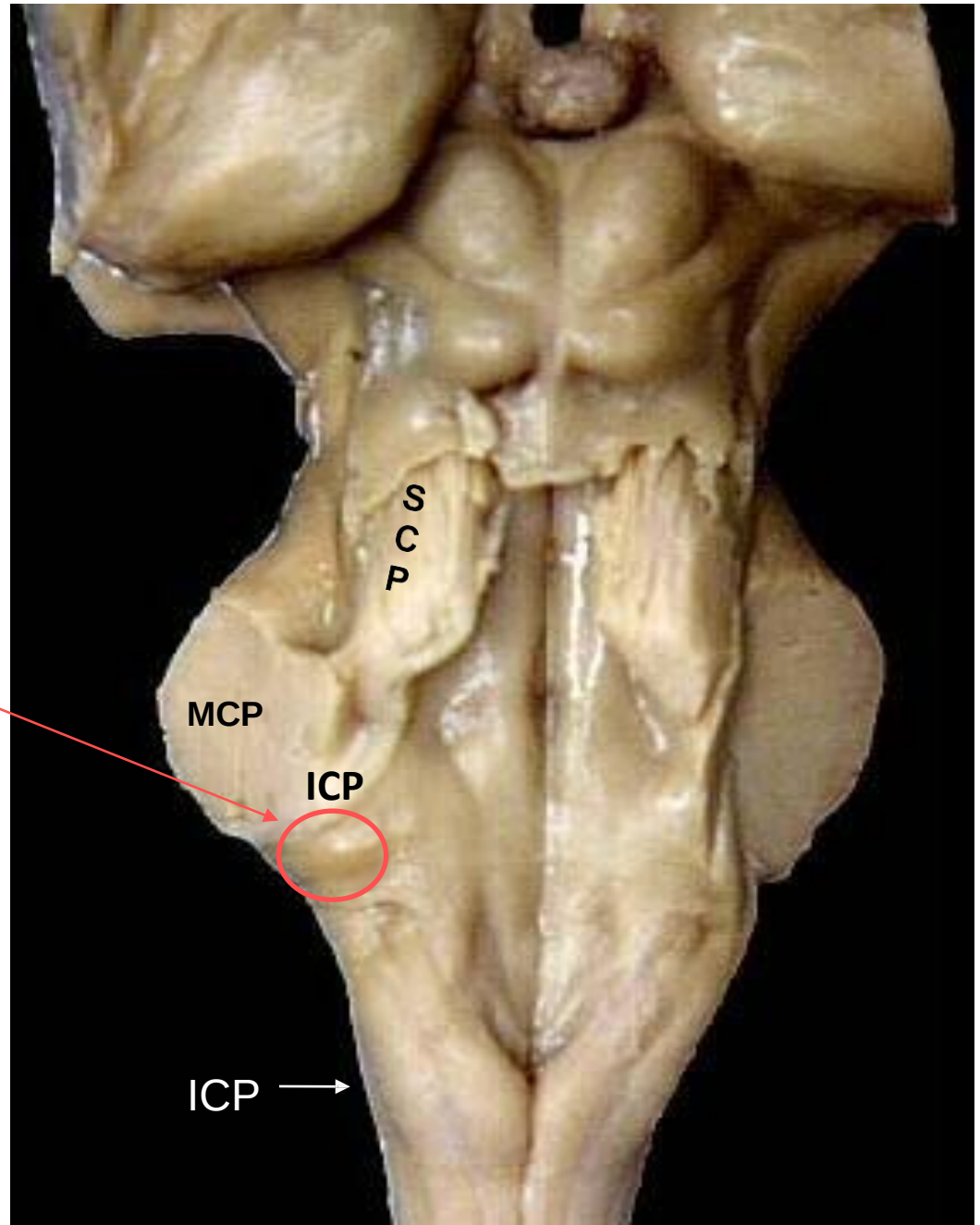


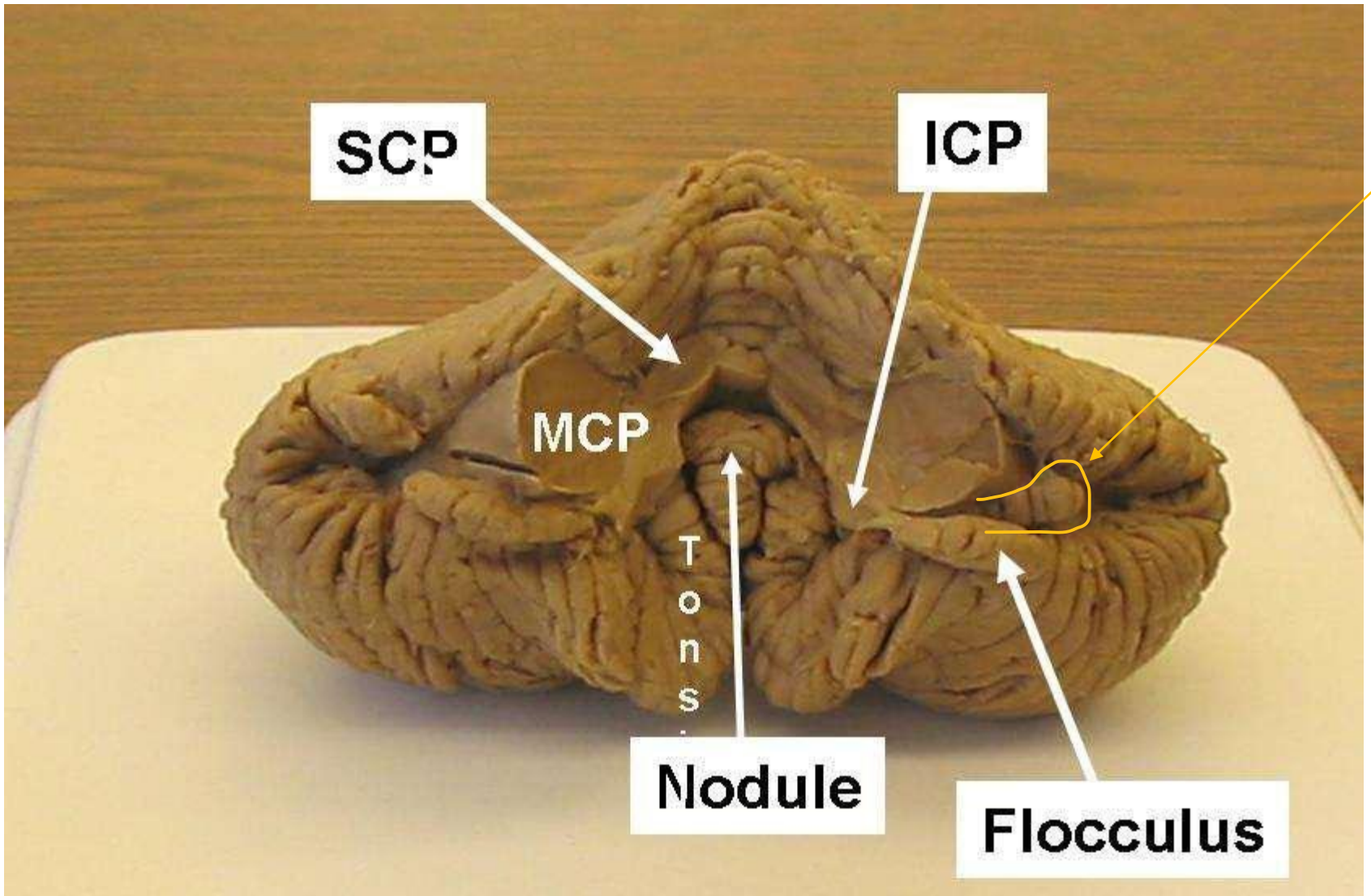
Cerebellar peduncles:

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

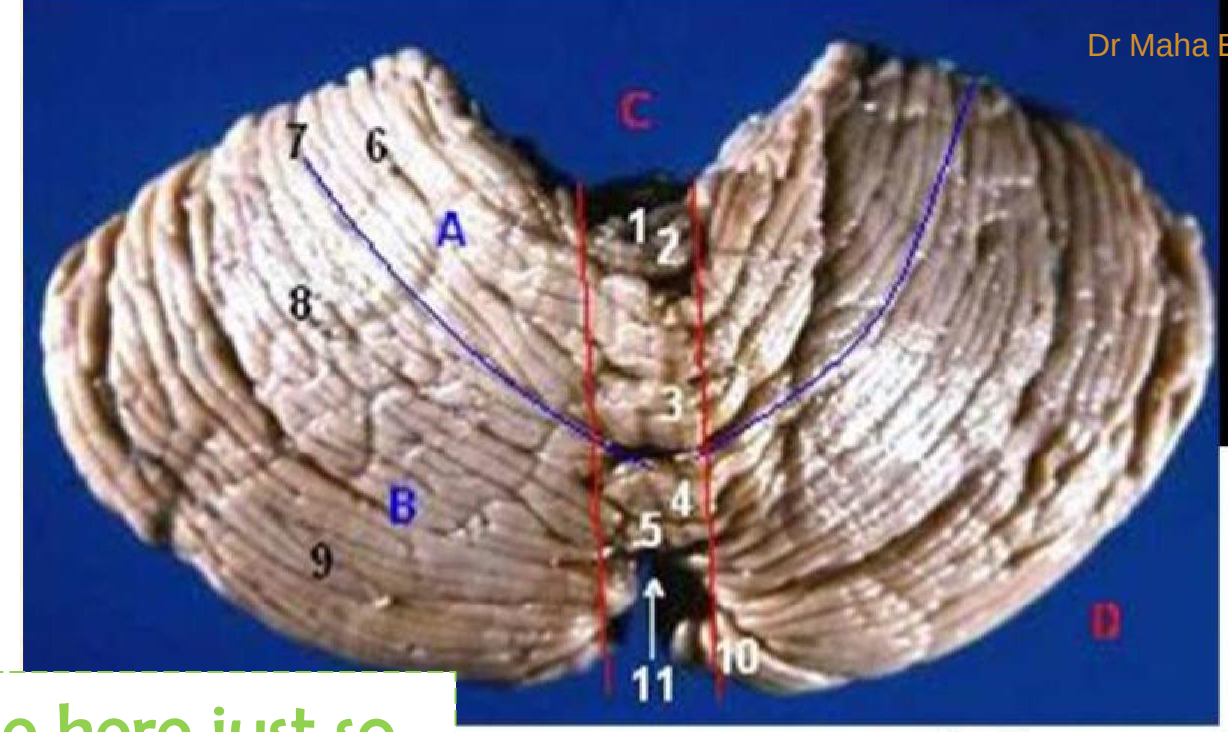
Middle cerebellar peduncle (MCP):
Connects the cerebellum with the pons.

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





Para flocculus



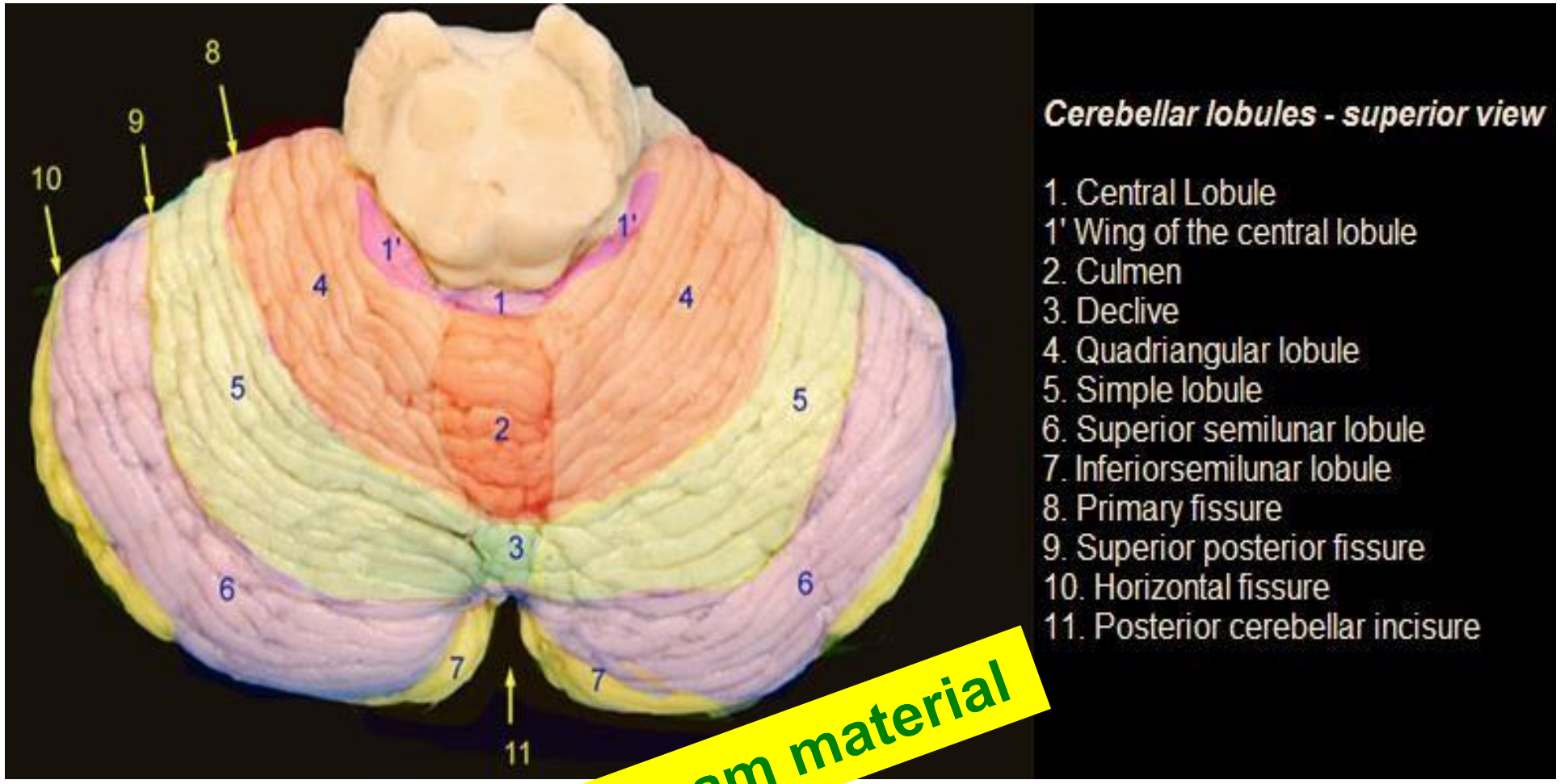
I left these here just so you can skip them and feel the triumph
(If you want)

Not an exam material

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



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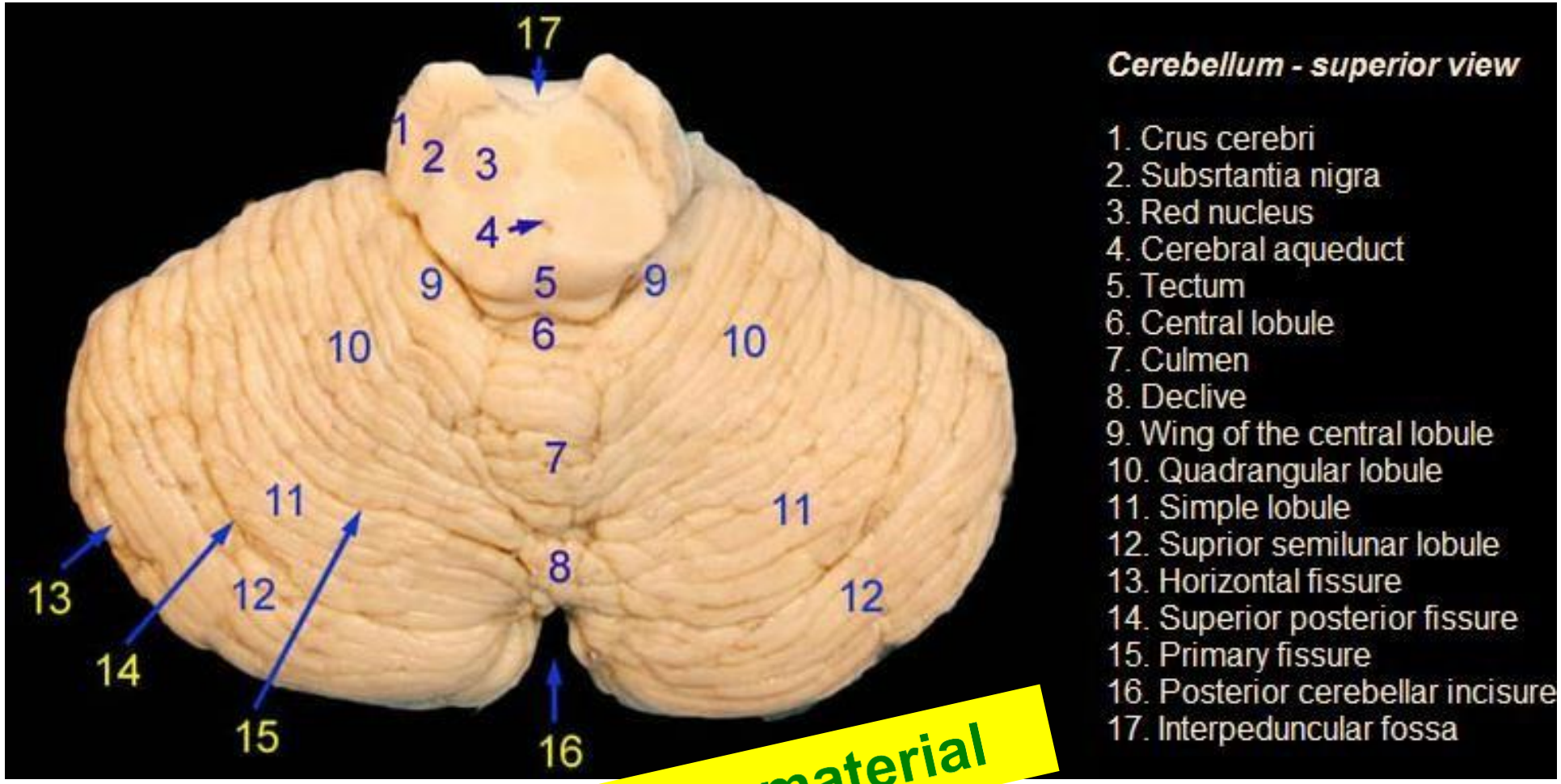
Cerebellar lobules - Superior view



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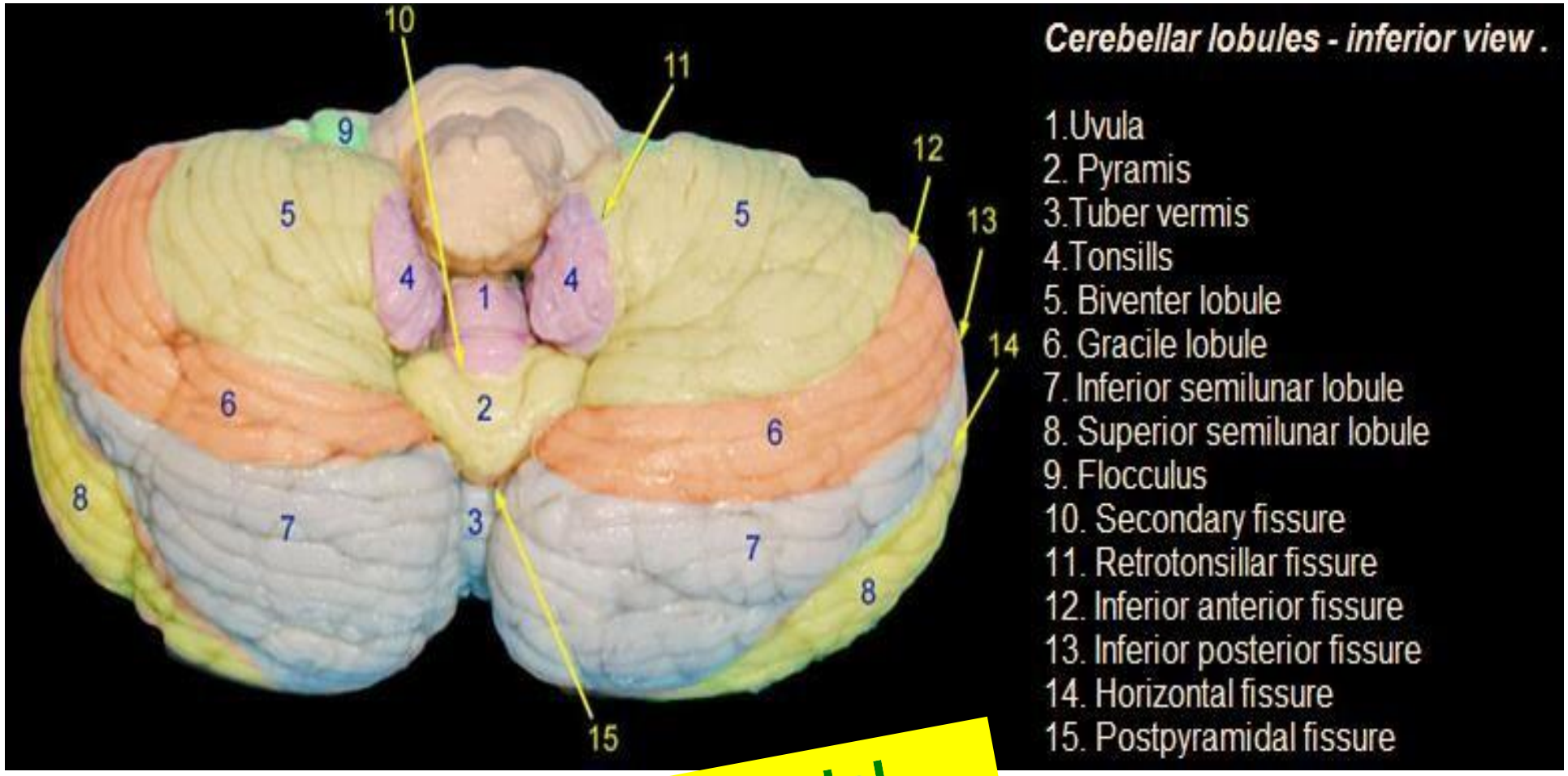
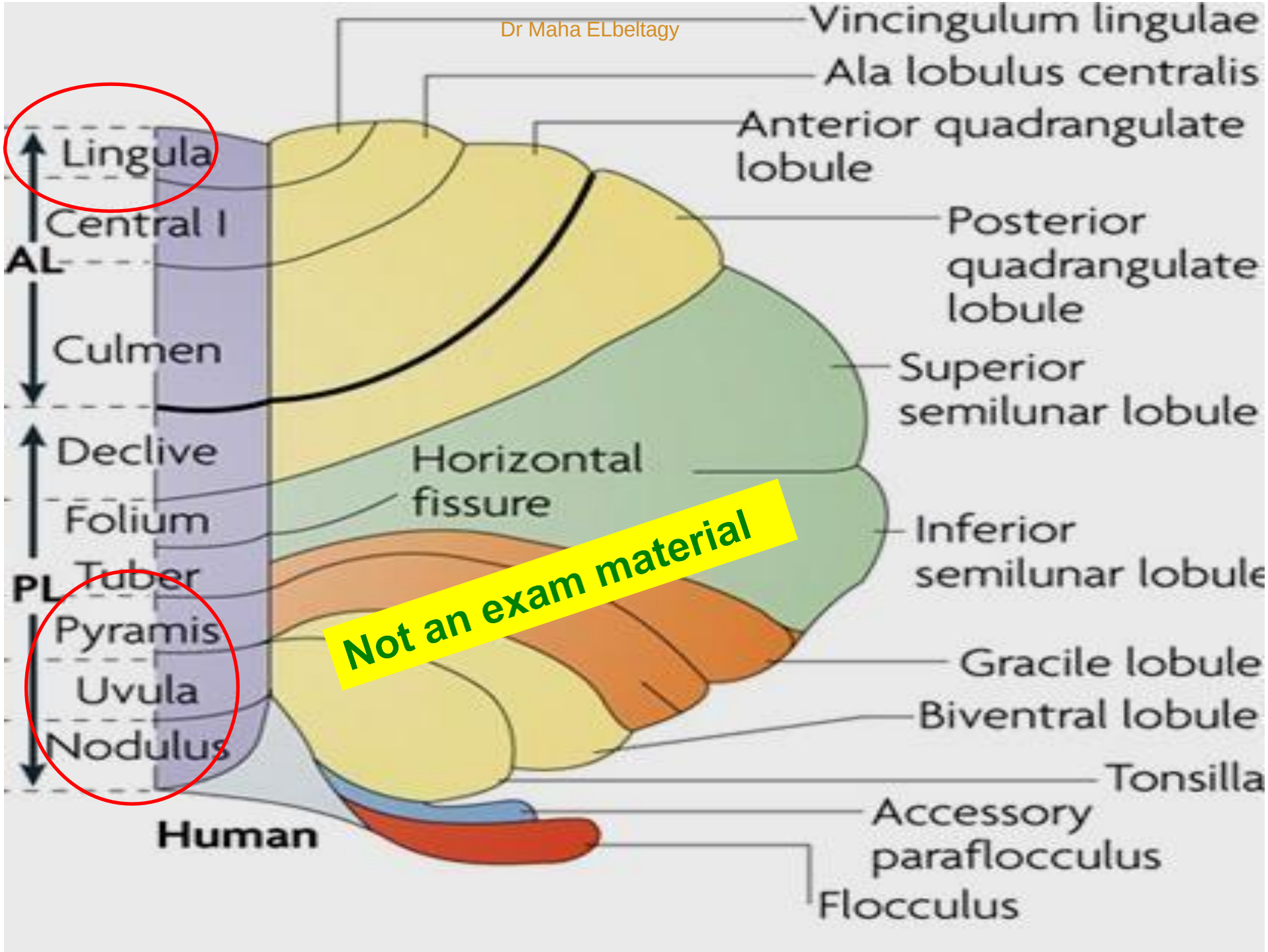
Cerebellar Lobules (inferior view)



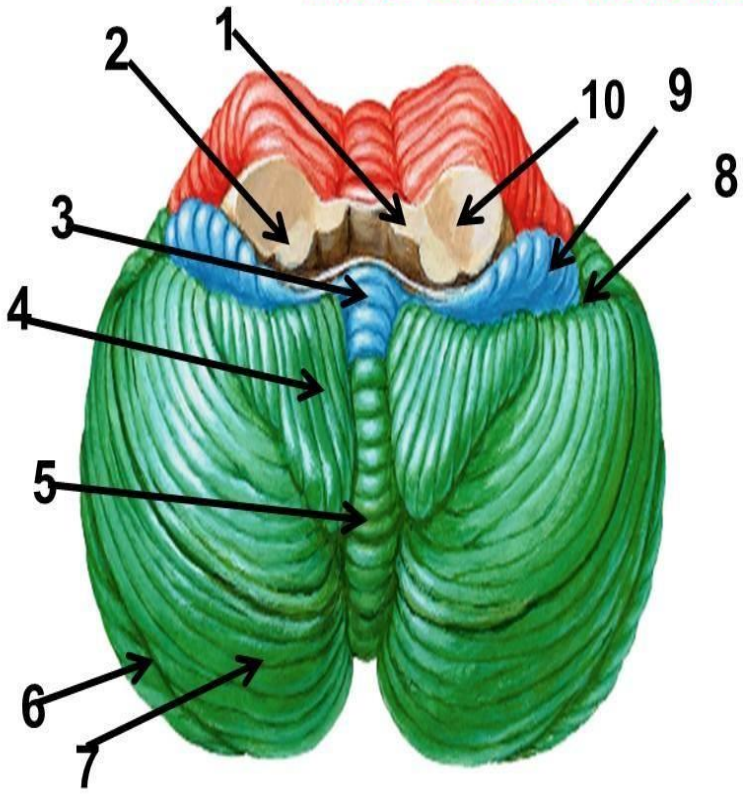
Not an exam material

Just remember
here that the lingula is the most anterior part of the superior vermis
And the nodule is the most anterior part of the vermis on the inferior surface
Everything else is not required



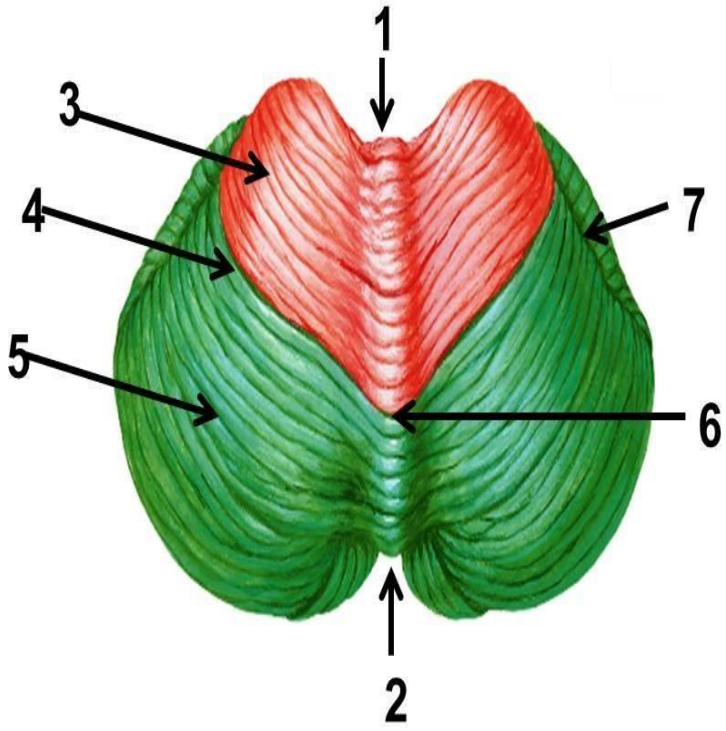
These should be easy now:

Inferior surface of the cerebellum



1- superior cerebellar peduncle
2- inferior cerebellar peduncle
3- Nodule
4- cerebellar tonsil
5- inferior vermis
6- horizontal fissure
7- posterior lobe
8- posterolateral fissure
9- floculonodular lobe
10- middle cerebellar peduncle

superior surface of the cerebellum



1- Antrior notch
2- posterior notch
3- anterior lobe
4- primary fissure
5- posterior lobe
6- superior vemis
7- horizontal fissure

Structure of the cerebellum (histology)

1 Cerebellar Cortex: consists of three layeres

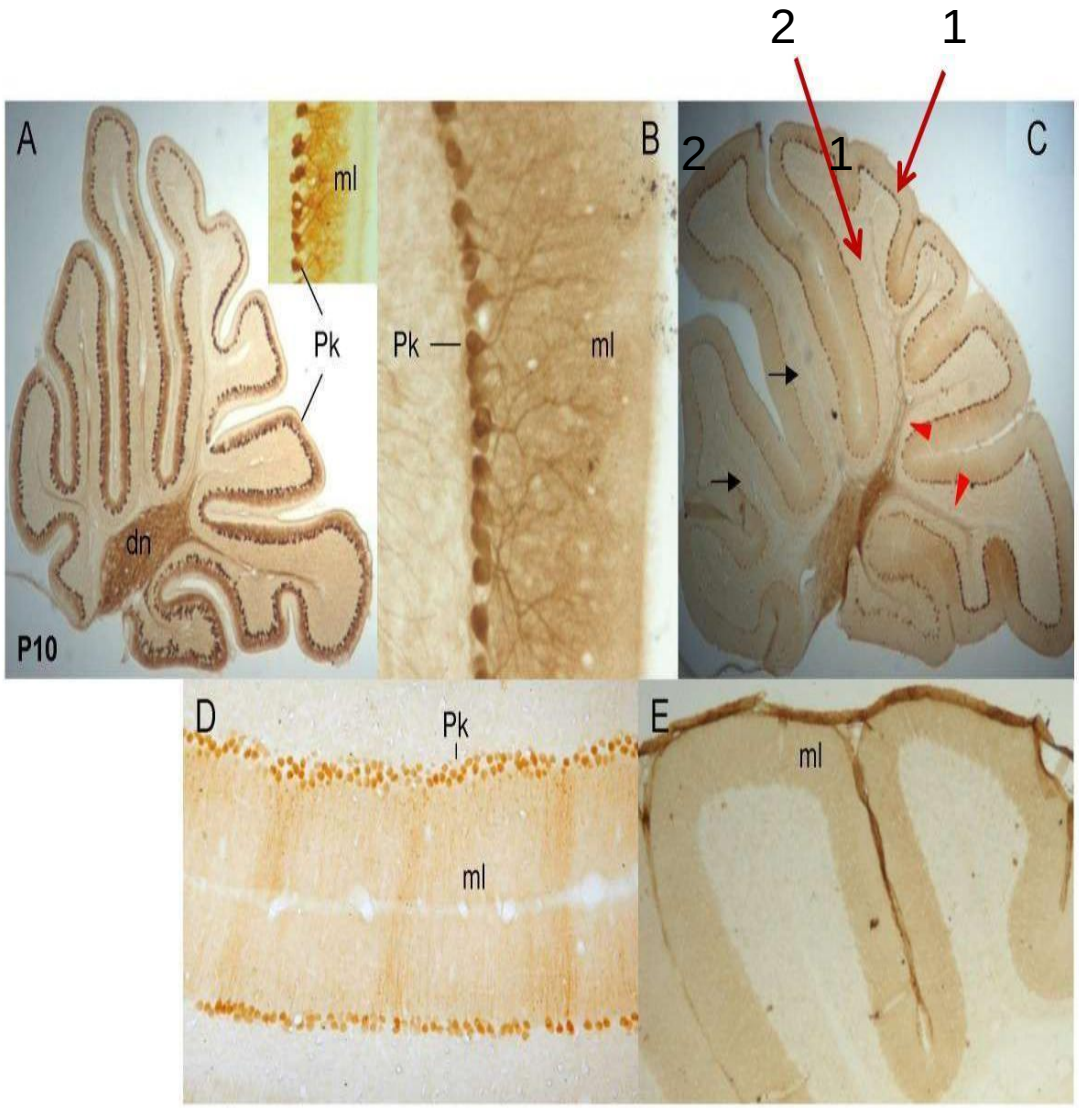
Outer Molecular Layer
(2 types of cells: stellate and basket cells)

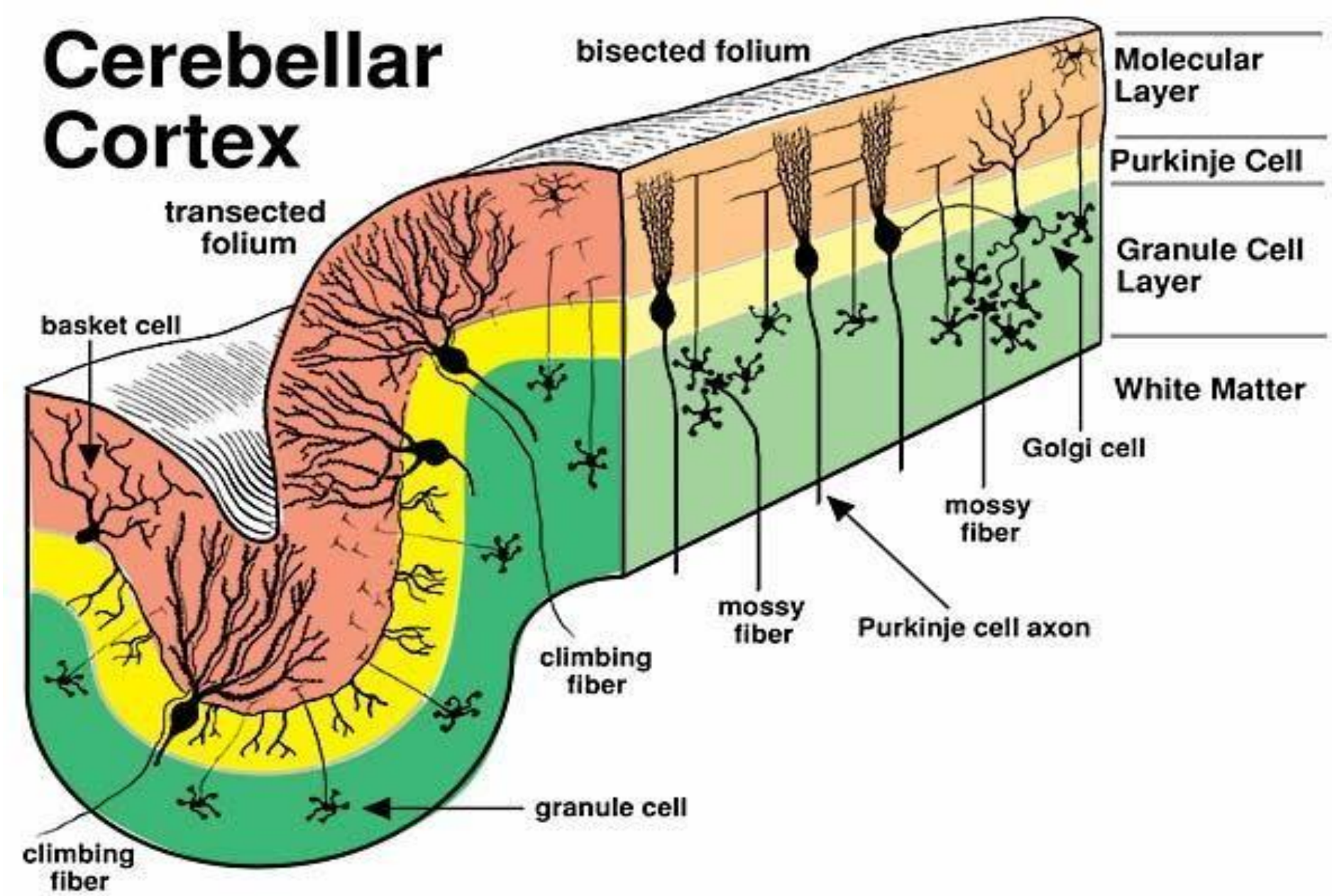
Middle Purkinje Cell Layer (most important cell layer)
(purkinje cells that are **inhibitory to all other cells)**

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 fibres

A. Mossy fibres (afferent)

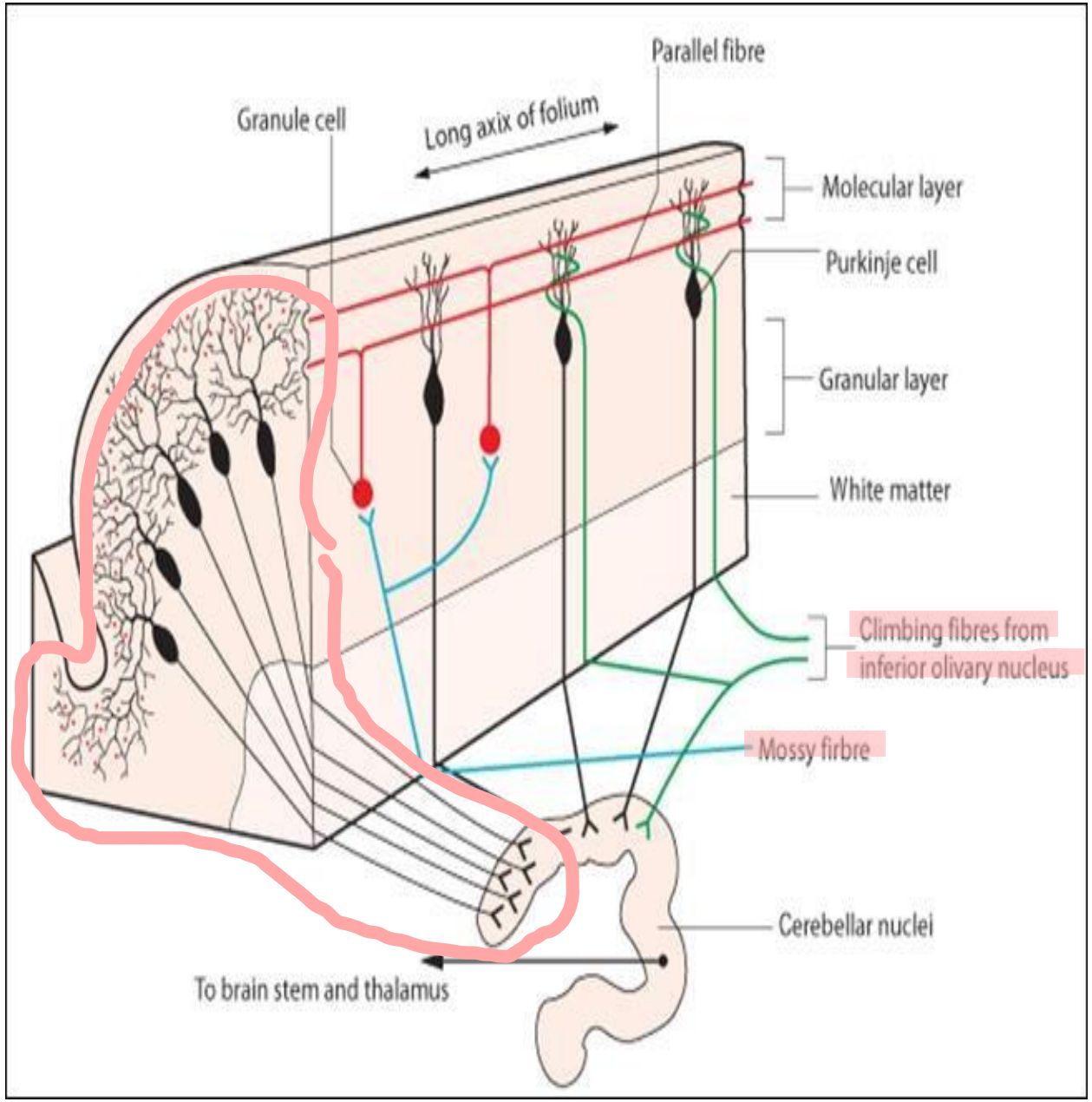
They end in the granular layer activating it first, then they activate the purkinje layer (Indirect activation of purkinje).

B. Climbing fibres (afferent)

Fibers of the olivocerebellar tracts mainly, they come from the inferior olivary nucleus of the medulla then they end directly in purkinje (direct activation) or molecular layer

C. Axons of purkinje cells (efferent) (encircled with pink)

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

The cerebellum is divided into 3 divisions: archicerebellum (vestibulocerebellum), paleocerebellum (spinocerebellum), & neocerebellum (cerebrocerebellum)

Names give you hints of the functions :D

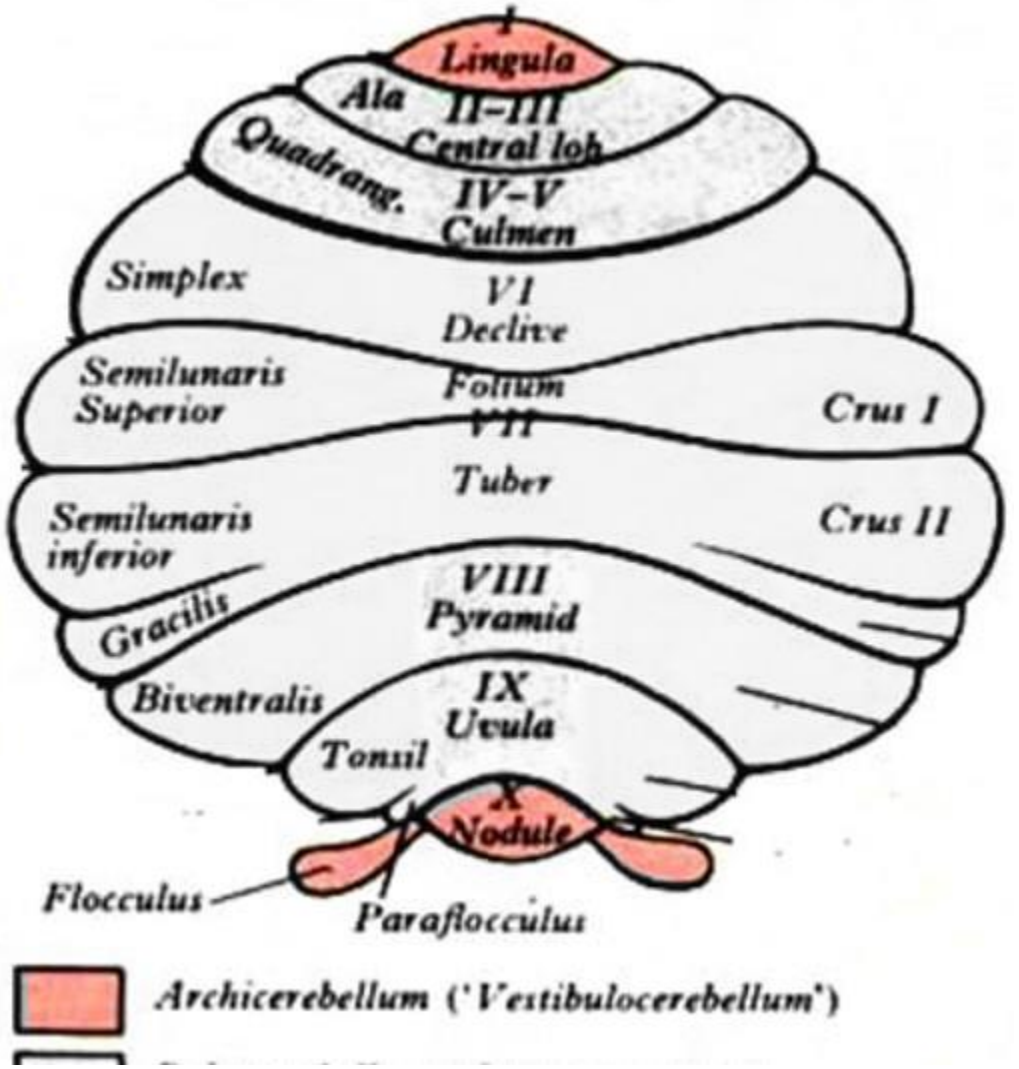
Archicerebellum (Vestibulo-cerebellum):

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

Efferent: vestibular nuclei give rise to:

- **Vestibulospinal tracts** to antigravity extensor muscles.
- **Vestibulo-ocular** fibers (vestibulo-ocular reflex: in a nutshell, it's the involuntary movement of your eyes to the direction of head movement)
- Vestibulo-cerebellar tracts
- Vestibulo-cortical fibers

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



Paleocerebellum (Spino-cerebelllum):

Consists of 1- Anterior lobe+ midline vermis (connected to the fastigeal N)
2- surrounding paravermis + globose & emboliform nuclei.

1- Vermal zone of the spino- cerebellum (axial muscles control)

Purkinje neurons of each hemivermis project inhibitory axons to ipsilateral fastigeal nuclei.

Function: Regulate muscle tone of axial and proximal limb muscles

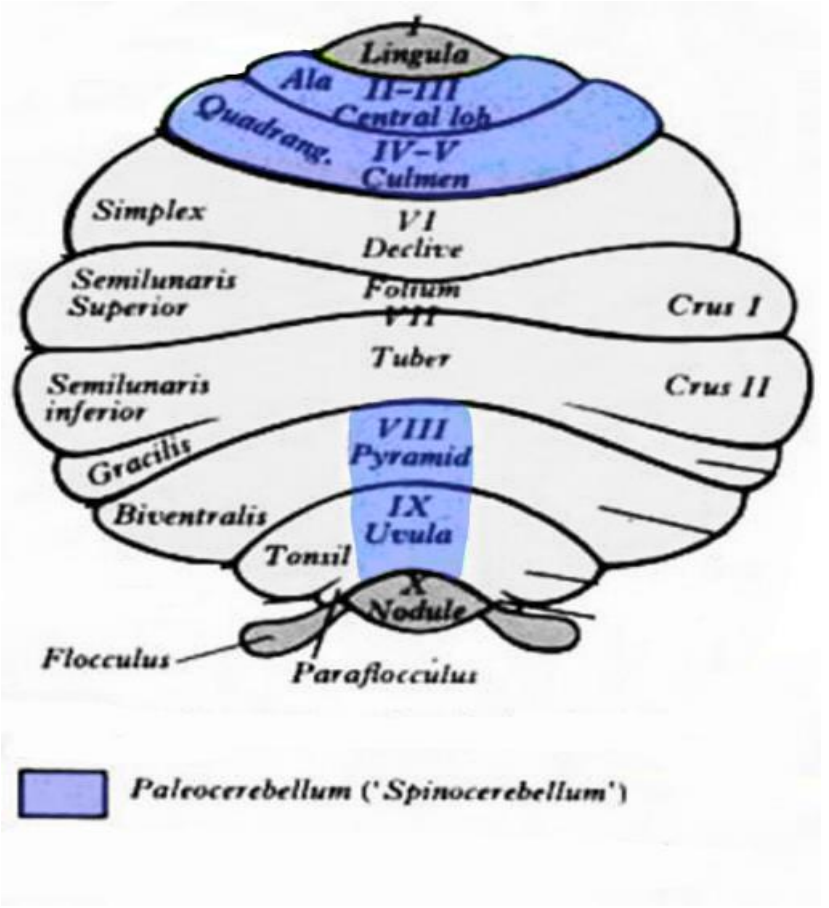
How?

Afferents from venteral and dorsal spinocerebellar, olivo-cerebellar and cuneocerebellar tracts (which control unconscious muscle tone) end in the **fastigeal N.**

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

Efferent fibers:

- **Mainly: Anterior cortico-spinal tract (cerebello-fastigeo-thalamo-cortico- spinal)** deduct the path from the name:
  After fibers reach the cerebellum, they leave the fastigial nucleus to ipsilateral and contralateral **VL nuclei** of thalamus then project to the trunk part of area 4 then descend to the spinal cord
- **Fastigeo-Vestibulo-spinal tract**
  Fibers come from the fastigial N to the ipsilateral and contralateral **vestibular nuclei**, then descend the spinal cord in the same fashion
- **Fastigeo- Reticulo-spinal**
  Fastigial fibers go to Ipsilateral and contralateral RF to the spinal cord



I made up some mnemonics with this fast summary hopping it helps if you're suffering.

Paleocerebullum is an old man with spinal pains **(paleo-spinocerebellum)**

The vermal zone is his favorite fishing area: control of Axial muscle tone

Afferents

venteral and dorsal **spino**cerebellar. **olivo**-cerebellar and **cuneo**cerebellar tracts

→

Fastigeal nucleus

→

Sends Bilateral **bilateral** excitatory fibers to the **medial motor system through:**

Anterior cortico-spinal tract
(cerebello-fastigeo-thalamo-cortico-spinal)
Crazy Fish Travel Cold Seas

Fastigeo-Vestibulo-spinal tract
Fish Value Seas

Fastigeo- Reticulo-spinal
Fish Respect Seas

2- para-vermal zone of spino- cerebellum

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

It receives **afferent** proprio-ceptive impulses from Muscles & tendons **Via spino-cerebellar tracts** (dorsal & ventral), olivo-cerebellar and cuneorebellar which transmit the unconscious proprioceptive impulse to paravermal nuclei:

Globose and Emboliform N

Efferents from those nuclei leave to:

- **lateral motor pathway**:

Projections of the interposed nuclei go to **Contralateral VL nuclei of thalamus** which project to precenteral gyrus (distal limbs area/4) from which **lateral corticospinal fibers** arise

Pathway name: Cerebello-Globose- Embliform- thalamo- cortical-spinal pathway

- **Contralateral red nucleus of midbrain (the red nucleus is also concerned with control of distal flexor muscles)**

Pathway name: Cerebello-Globose-Emboliform-Rubral-spinal pathway

Paleocerebullum is an old man with spinal pains **(paleo-spinocerebellum)**

The paravermal zone is his favorite restaurant: muscle tone (mainly flexors) and regulation of voluntary movements of the **distal muscles**.

Afferents

Proprioception from venteral and dorsal **spino**cerebellar. **olivo**-cerebellar and **cuneo**cerebellar tracts

Globose and Emboliform N

Efferents from those nuclei leave through:

Lateral motor pathway

Cerebello-Globose- Embliform- Thalamo- Cortical-Spinal pathway

Chef Gem Eats Turkey Cold Sandwich

Contralateral red nucleus of midbrain

Cerebello-Globose-Emboliform-Rubral-Spinal pathway

College Guys Eat Ribs & Sauce

Neocerebellum (cerebrocerebellum)

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

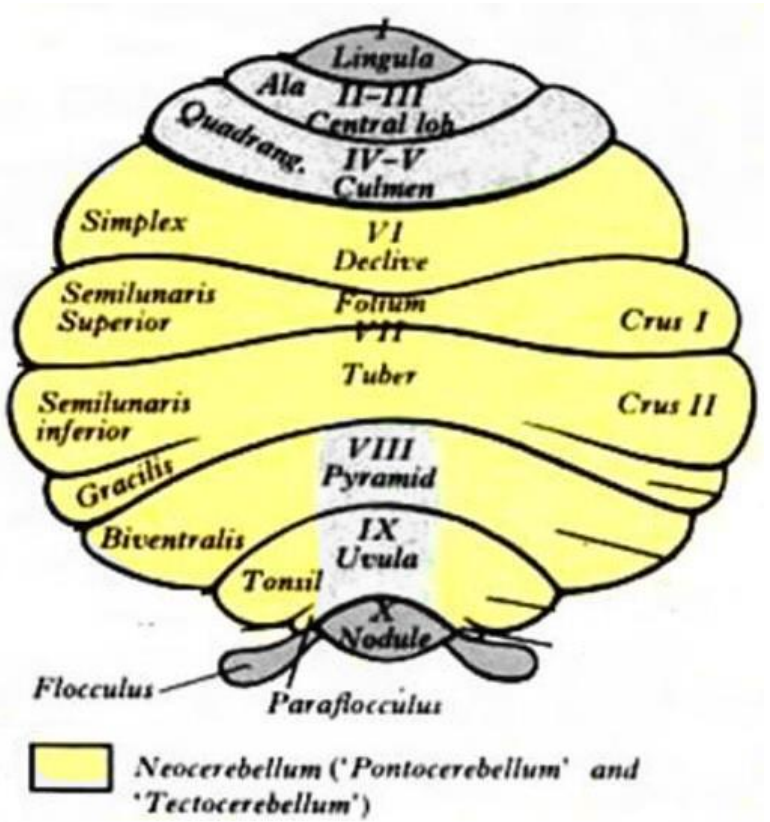
Function:

- controls voluntary movements, planning of sequence of intended movements

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

Remember: the cerebellum and the basal nuclei do this function

- Regulation of force and timing of Movement.
- Learning new complex movements



It receives **afferent** impulses from the **cerebral cortex (4/6) +pons** Via **cerebro-ponto- cerebellar** pathway which project to the (contralateral) **dentate N.** through the middle cerebellar peduncle

It then sends **efferents** **to contralateral red nucleus** that projects to **Ventro lateral nucleus of thalamus (VL)** to the cortex

The pathway: Cortico-ponto-cerebellar- Dentato-rubro-thalamo-cortical

Neocerebellum is a smart college student (neo-cerebrocerebellum)

- **He ecxcels in:** anticipation, Regulation of force and timing of Movement, Learning new complex movements

Afferents

cerebral cortex (4/6) +pons which project through the middle cerebellar peduncle to the:

→

Dentate nucleus

→

sends **efferents to contralateral red nucleus** that projects to the **VL nucleus of thalamus**

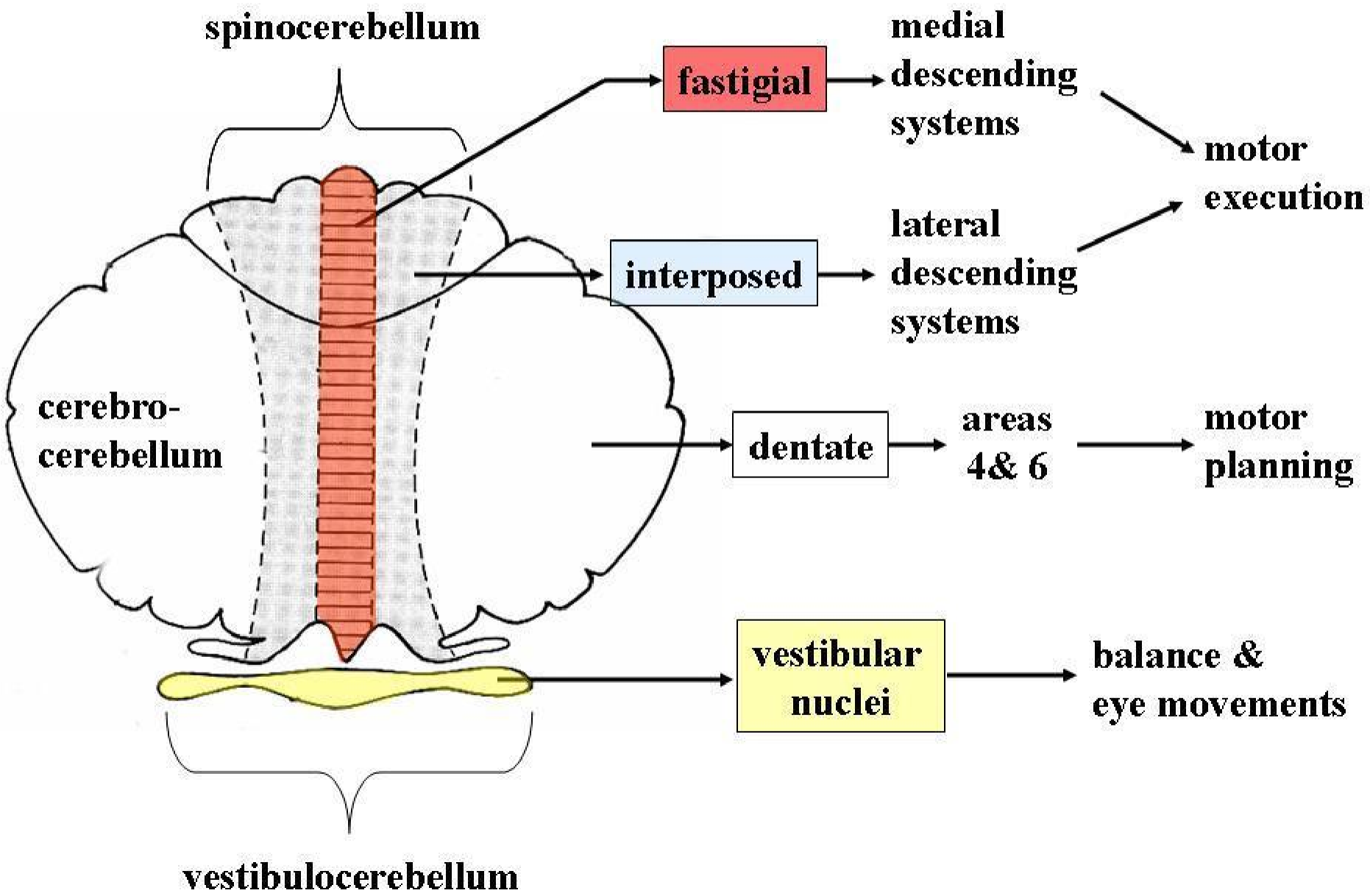
↓

Pathway:

Cortico-Ponto-Cerebellar- Dentato-Rubro-Thalamo-Cortical

CNS Pupils Can Do Remarkable Things Continuously

Cerebellar Output



This slide summarises what we went over previously, please connect the division of the cerebellum, with its corresponding nuclei with the function. Then revise the names of pathways discussed before.

Fibres entering and leaving through cerebellar peduncles

Superior cerebellar peduncle (major efferent)

Fibres entering the cerebellum

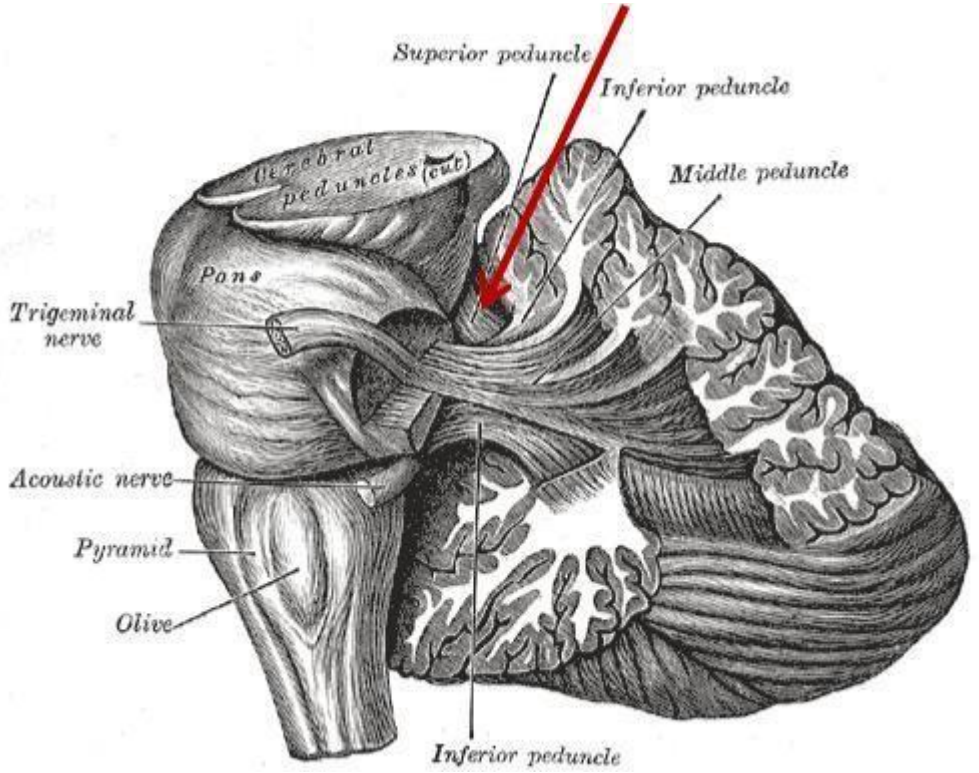
- Ventral spino-cerebellar tract
- Trigimino-cerebellar from Mesencephalic nucleus
- Tecto-cerebellar fibres

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

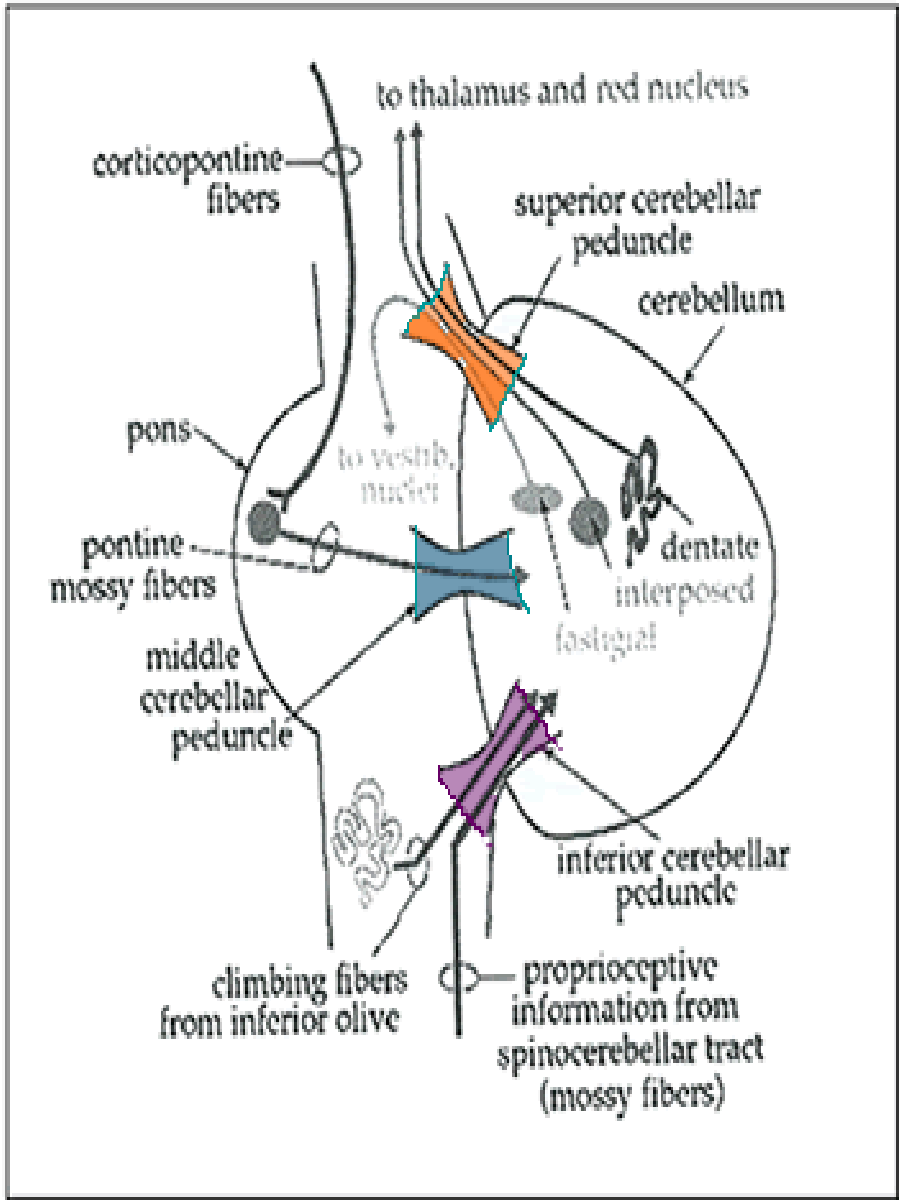
Inferior cerebellar peduncle

Fibres entering cerebellum (restiform body)

- Posterior spino cerebellar tract
- Cuneo-cerebellar tract
- **Olivo-cerebellar fibres** (from inferior olive of medulla)
- **Reticulo-cerebellar** (from the reticular formation)
- **Vestibulo-cerebellar fibres** (from the vestibular nuclei)
- 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**



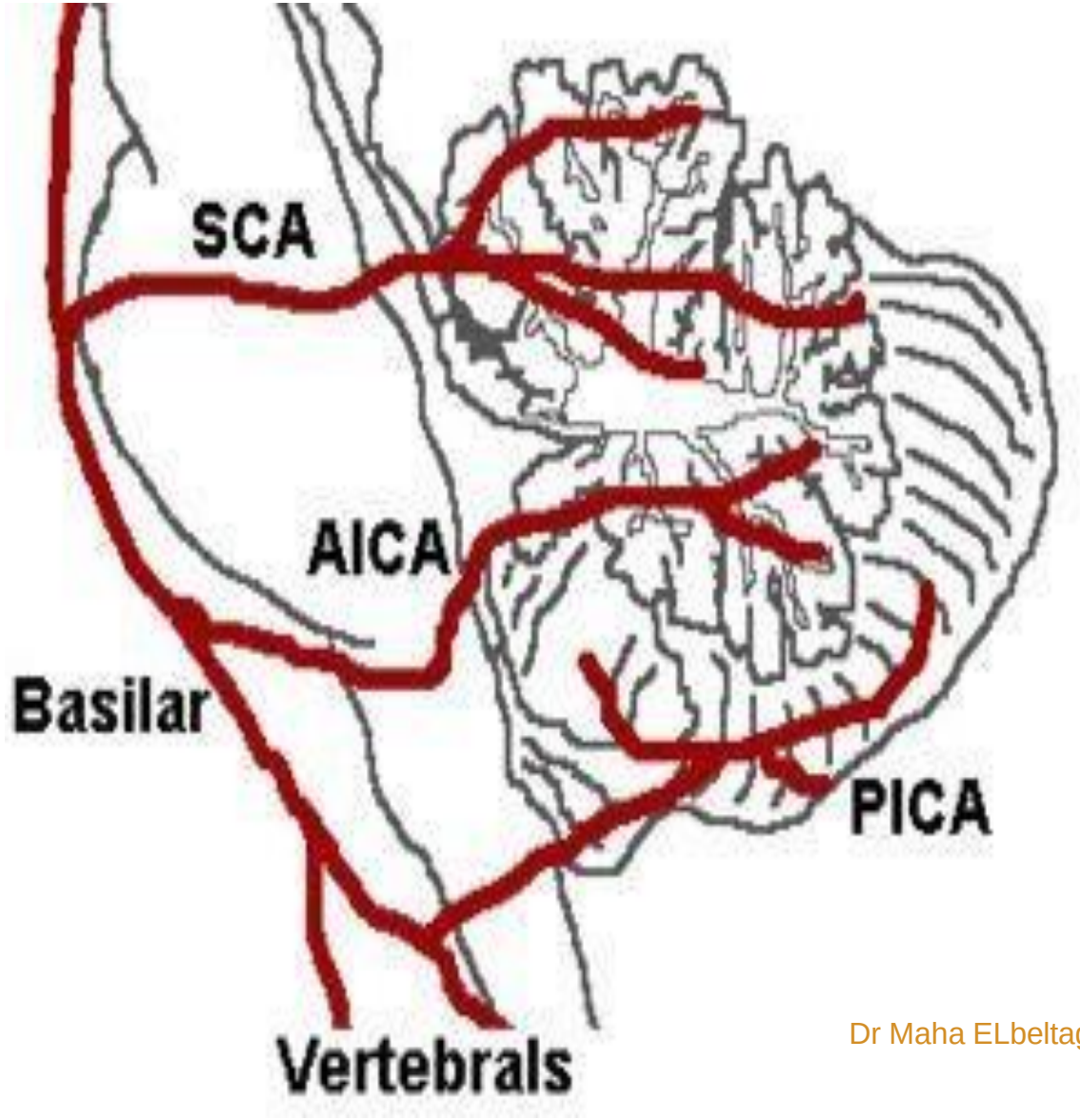
Blood Supply of the Cerebellum

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

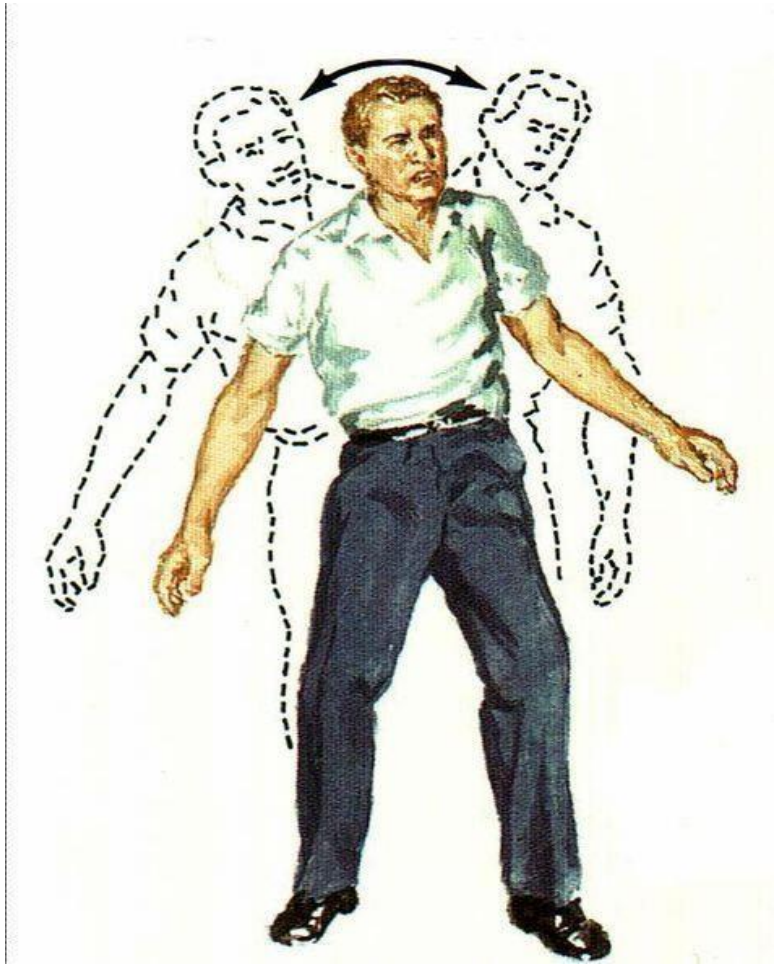
Cerebellm	Basal ganglia
Receive cortico-ponto-cerebellar from **contralateral** cerebral cortex	Receives cortico-striate fibres from **ipsilateral** cerebral cortex
Projects to VL nucleus of the **contralateral thalamus** projects directly to areas 4,6	Projects to VA nucleus of **the ipsilateral thalamus**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

Dr Maha ELbeltagy

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



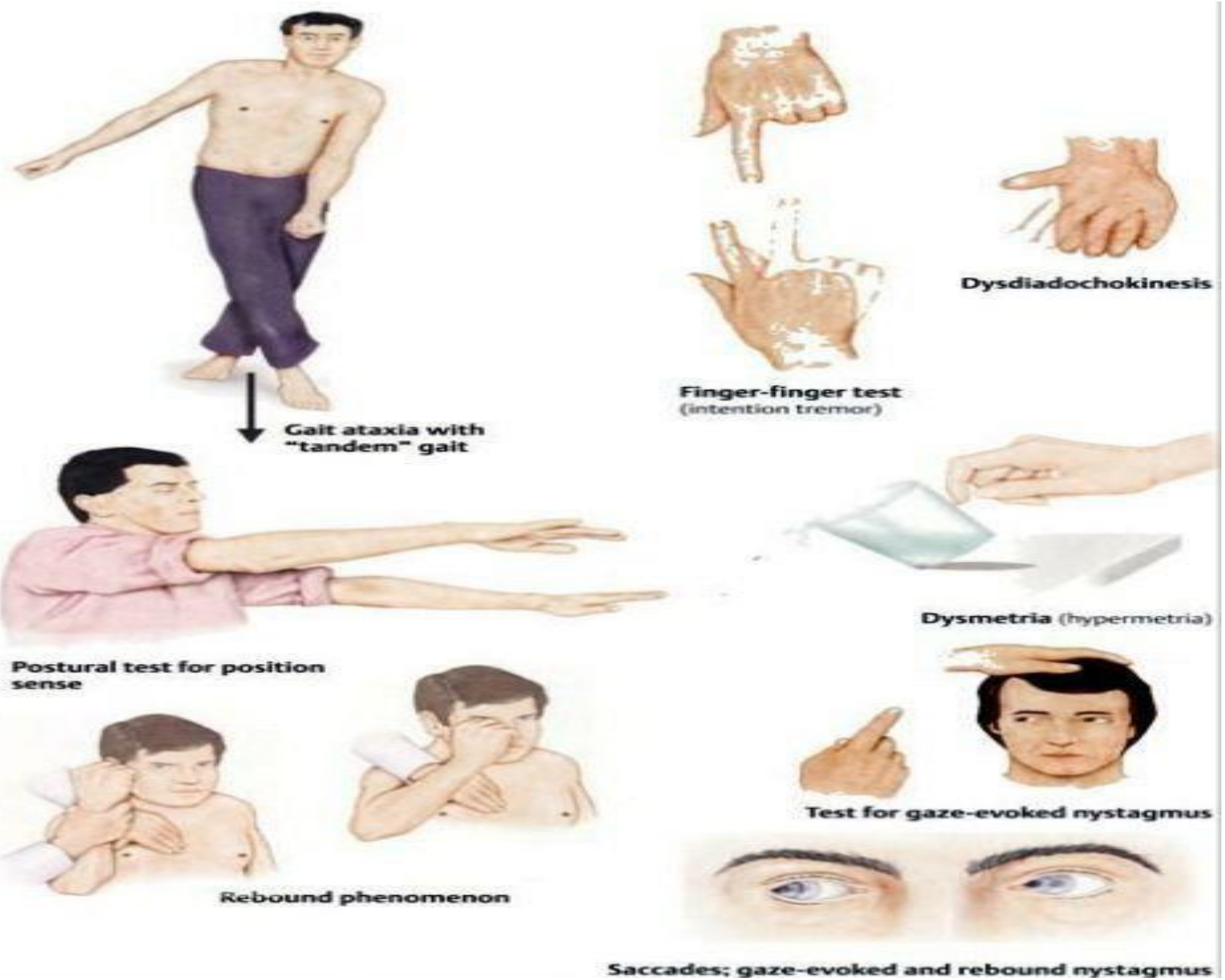
Paleocerebellar Lesion (spinal): gait Disturbance.
Tested by heel shin test

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

Archicerebellar Lesion:

Medulloblastoma (see later)

Here we can see the manifestations and tests performed by doctors for diagnosis



Cerebellar Medulloblastoma

Cerebellar tumor on vermis

Affects trunk and axial muscles that control posture, resulting in:

- **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.

THANK YOU

And I wish you the best of luck