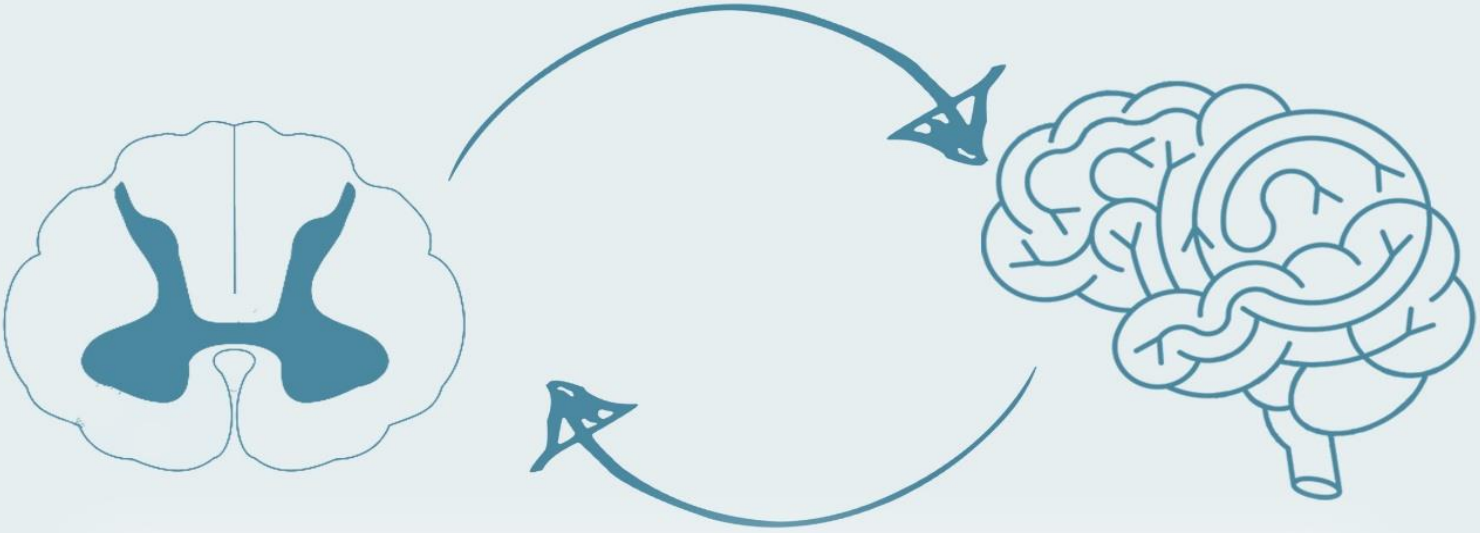


CNS

Anatomy

slides sheets

number	Lec #18
Done by	Mariam Hassouneh
Correction	Dr.Maha El-Beltagy
Doctor	Dr.Maha El-Beltagy

Brief note: This Lecture's record is on the Batch's channel - named "A18"- and it starts at 3.22min; recorded lecture is for Section 3; this lecture is the one we took on Monday preceding CNS mid exam "hope you all did well in it ♥", I hope you'd enjoy this one, most of the info will be repeated again in the next lecture so don't you ever worry :D!

Important: 3.22min to 8.13min period was a revision of Lab slides (Slides 1-10 here) belonging to Lab#1-Dr.Maha; they were all discussed in Lab #1 sheet except floor of the 4th ventricle which was formed by pons and superior part of medulla oblongata; it'll be discussed – along with the cerebellum- in Lab #5.

In this lecture we'll discuss mainly anatomy of the cerebellum, which will be covered again in the Lab.

- *Anatomy Atlas is for need only ^.^*

The Cerebellum; Our little brain

First, where are we now??

We are in the area below the big boss, yet we'll meet his most trusted assistant that has all the country's secrets!

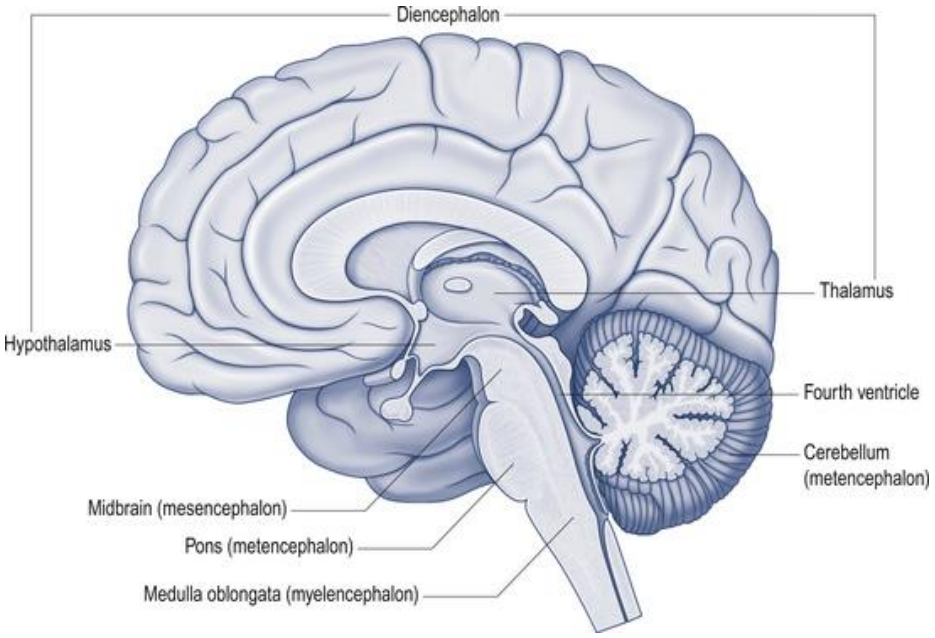
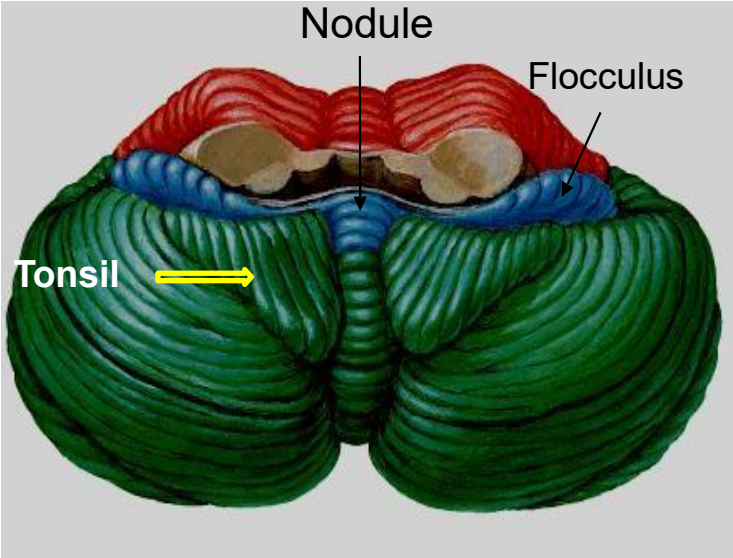


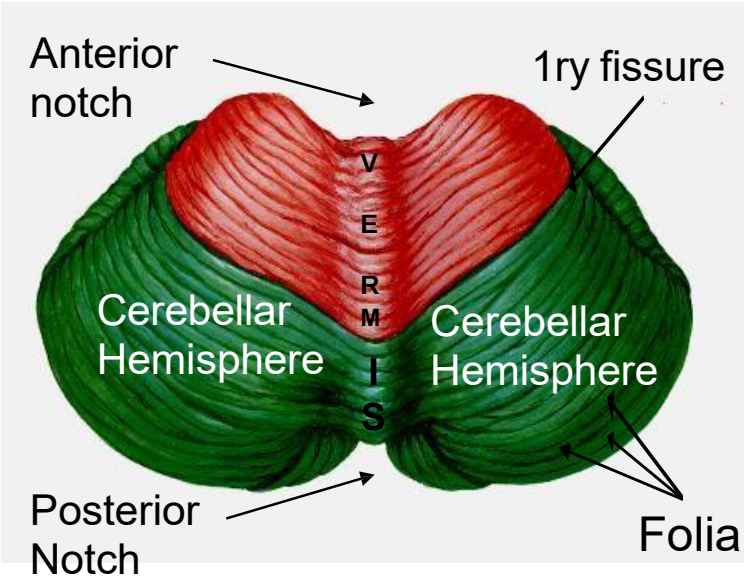
Figure 1: mid-sagittal section of the brain

Our dear cerebellum lies in the posterior cranial fossa below the cerebrum, separated from it by a fold of dura mater called "tentorium cerebelli", why is it called so? Because it's like a tent covering the cerebellum. In front of it we'll find the Brain stem with its famous three parts "Midbrain, pons, medulla oblongata", and between the brain stem and the cerebellum we'll see the last cavity in the brain before we reach spinal cord's central canal, which is the 4th ventricle!

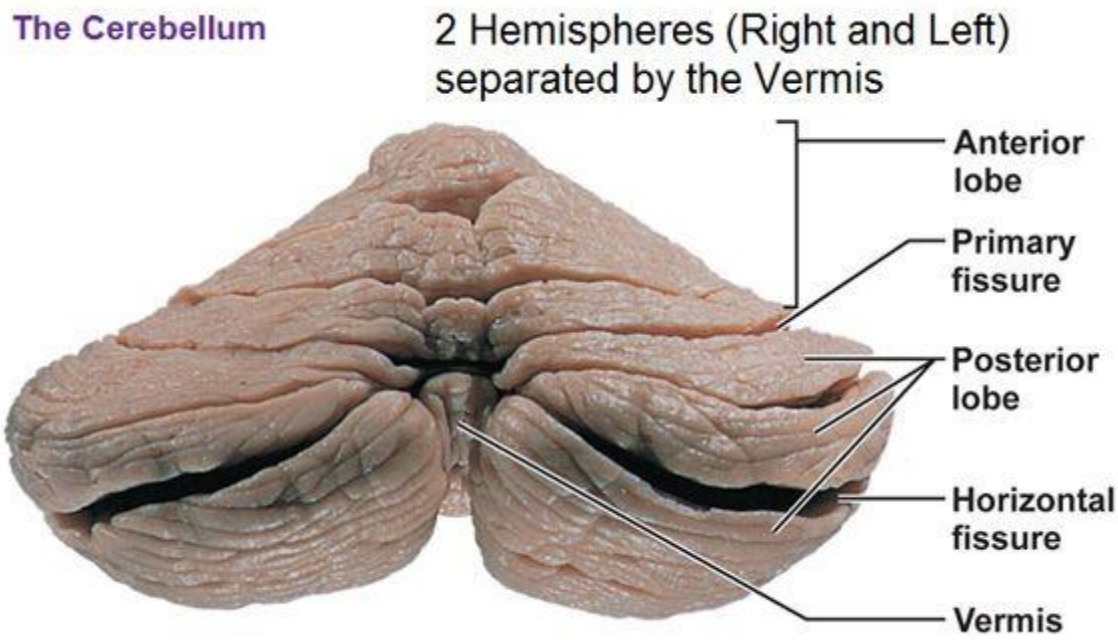
Get to know the cerebellum more … Send warm greetings to 3 views of it!



Inferior surface



Superior surface



Posterior view

Figure 2: Views of the cerebellum. Left; inferior, Right; superior, Bottom; posterior

I guess you have noticed that the cerebellum somehow shares the same feature as the cerebrum in having 2 HEMISPHERES. These 2 cerebellar hemispheres are linked together by a middle structure called the "VERMIS". Vermis; a worm-like structure.

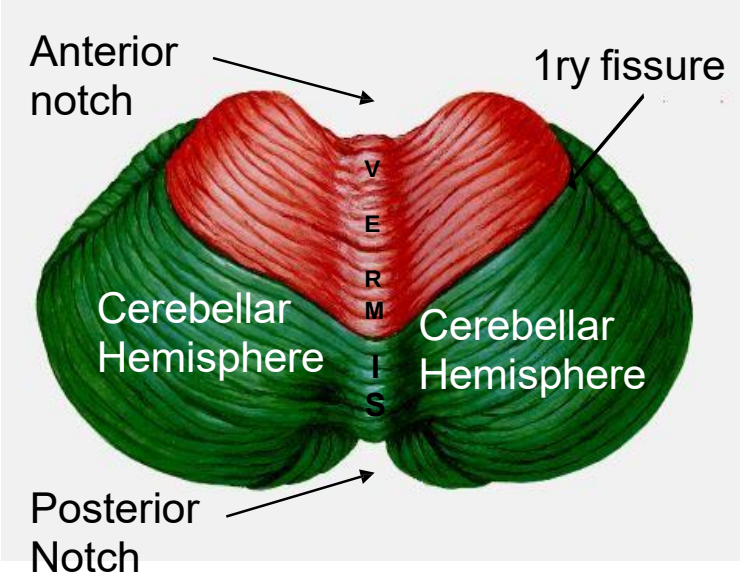


Figure 3: Superior surface

If you referred to figure 2, you can notice that the Vermis can be seen on the superior and inferior surfaces; so **Vermis** is the **midline structure of the cerebellum**. Note carefully which words we used; always keep in your mind that Vermis is **a part of the cerebellum itself** ,with the same consistency تكوين, NOT a group of commissural fibers of white matter that connect the hemispheres together like corpus callosum did to the cerebral hemispheres.

- Notches of the cerebellum. Notch; A depression or indentation أخدود on an organ. (Anatomy Atlas – 1)

1. Anterior Notch: Occupied by the brain stem.

2. Posterior Notch (Vallecula): Occupied by falx cerebelli "Falx; a sickle منجل" which is a fold of dura between the 2 cerebellar hemispheres; Part of it can be seen in figure 3 and it continues then in the inferior surface. Falx cerebelli is attached to the internal occipital protuberance نتوء and crest قمة from inside between the 2 occipital bones. (Anatomy Atlas – 2). Vallecula; Latin for Valley وادي, a depression below the general surface level of a part.

- Surfaces of the cerebellum.

1. Superior surface (Figure 3)

2. Inferior surface "as if you're flipping the cerebellum to see this view"

- Fissures of the cerebellum.

Since we have cerebellar lobes "will be discussed later", we must have got things that separate them from each other, and these are what we call fissures "deep sulci"; as the cerebral sulci separated between the Gyri, these fissures will separate between parts of the cerebellum we call **Folia** "leaf-like ورقة شجر structures". We can see that we have many transverse ridges قمم جبال separated by the fissures, so if you cut the part between 2 fissures, this elevation is what we call a **Folium**; **these folia are which form cerebellum substance.**

If you took a section of a folium to see under the microscope (figure 4), you'll notice that gray matter lies outside while white matter is observed inside "similar to the cerebrum". The gray matter represents nuclei that from it efferent cerebellar axons go to the white matter; the inner core white matter represents the axons getting out of the cerebellum or coming to it "E.g. Spino-cerebellar tracts".

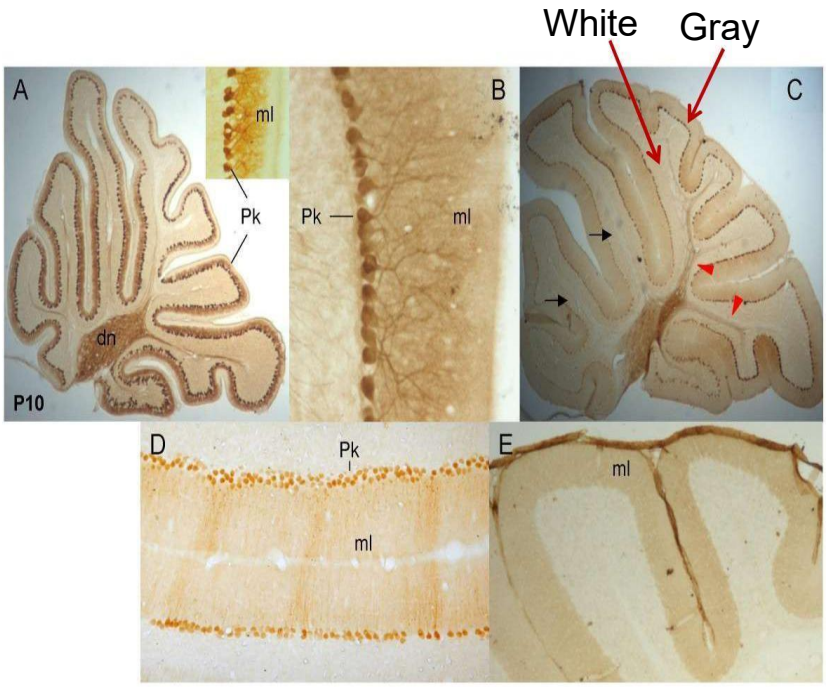


Figure 4: The cerebellum under microscope

We have 4 MAIN fissures which separate the cerebellum into lobes:

1. Primary fissure "Fissure prima".

It's a V-shaped sulcus which separates between the anterior & posterior lobes (figure 5).

So we can see that lobes were assigned as posterior or anterior **based on their relation to the primary fissure**. The anterior lobe represents the anterior third of the cerebellum while the posterior lobe represents the remaining 2 thirds.

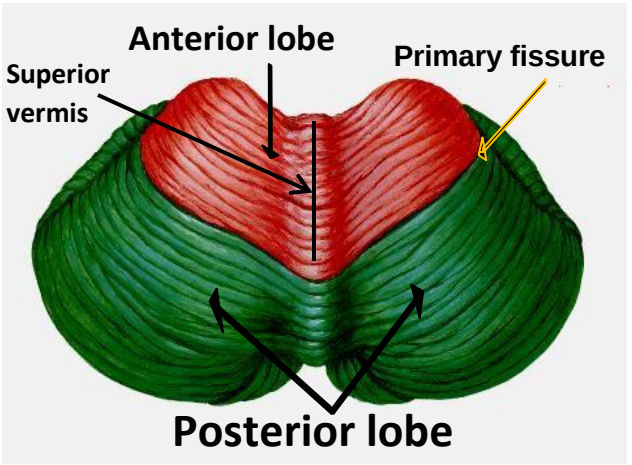


Figure 5: Superior surface

We can notice from figure 2 that the anterior lobe lies superiorly, so if we flipped the cerebellum to see the inferior surface, we won't be able to see the Anterior lobe clearly; instead, we'll be able to see the large posterior lobe "whole green part" which extended from the superior surface all the way to the inferior surface. We can also see that **Vermis also got separated** in a way that its anterior third is within the Anterior lobe superiorly, and its posterior 2 thirds are within the posterior lobe superiorly and inferiorly.

TO SUM UP: The 1ry fissure separated the cerebellar substance into (1) anterior lobe + anterior vermis in the superior surface, and (2) posterior Lobe + Posterior vermis which are mainly in the inferior surface but are also seen in the superior.

Another important lobe is the lobe in blue seen in the inferior surface; we call this lobe the “flocculo-nodular lobe”, why is it called so? Because it’s formed by 2 strucutes; the 2 flocculi laterally “butterfly wings”, and the nodule medially “which is part of the vermis and it’s the most anterior part of the inferior vermis”. This tiny Butterfly shaped lobe is the one responsible for your balance!

Can we see it from the superior view? 100% absolutely not!!!!! This lobe can only be seen in the inferior surface.

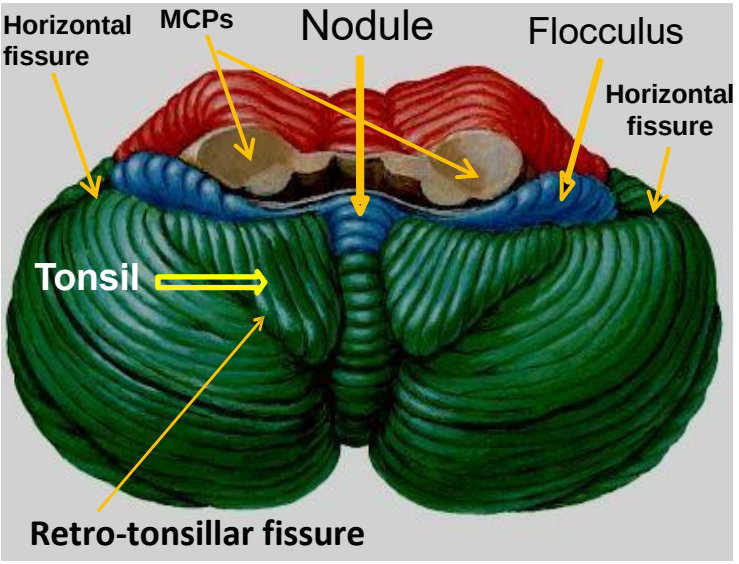


Figure 6: Inferior surface

Floccus; flock of wool صوف كتلة, Nodulus; a small knot عقدة

2. Postero-lateral fissure: Separates the flocculus & nodule totally from the rest of the cerebellum.

This fissure can ONLY be seen on the inferior surface; it separates the FN Lobe totally from the rest of the cerebellum in a way that you can grab it from both sides and separate it easily from the cerebellum; it’s called so because it lies posteriorly “hence Postero-“ and laterally “-lateral” to the FN Lobe.

3. Retro-tonsillar fissure: separates tonsil from the rest of cerebellum.

It’s less important; as the name implies, it lies behind “Retro” the cerebellar tonsils. Remember Arnold-Chiari Malformation “Remember Lab #3”, which in it herniation of the tonsils happened through foramen magnum and pressed on the medulla (Anatomy Atlas-4)??? Well, you’ve finally met the movie star!!

Tonsils are structures of the cerebellum itself “same consistency; same folia exist”, and they are situated just lateral to the inferior vermis so they are located in the inferior surface “and sure cannot be seen from superior” (figure 6).

Normally, tonsils along with the rest of cerebellum exist above foramen magnum but never normally pass through it; yet, in cases of increased intracranial pressure, whether sporadic or congenital, **herniation** of tonsils might be the next to expect! And since a really important structure pass through this foramen – of course we’re talking about medulla oblongata, the chance of pressing on a respiratory center to cause respiratory failure, or pressing on cardiovascular center to cause cardiac arrest does exist! And this is what we actually see.

4. Horizontal "transverse" fissure (figure 7): Extends between the middle cerebellar peduncles.

If you observed the posterior view of the cerebellum, you'll notice clearly a deep fissure extending **horizontally on the lateral surface of the cerebellum** from a side of the anterior notch, circling around the whole lateral surface, passing through the posterior notch A.K.A the vellecula, getting back to circling until reaching the anterior notch again from the other side (see also figure 6).

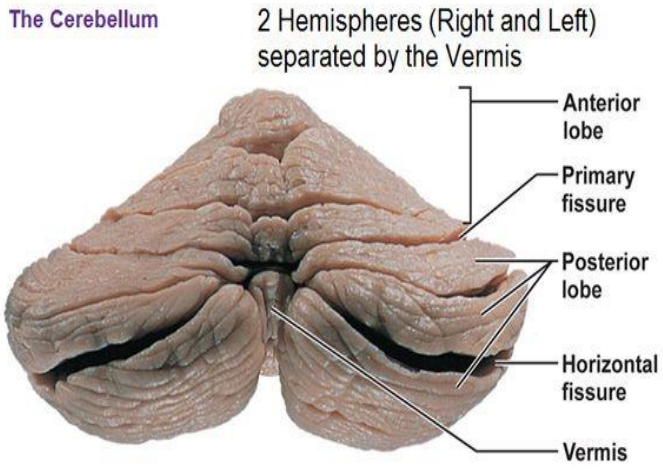


Figure 7: Posterior surface

It's of no functional significance, but what it does is that it simply separates the cerebellum into superior part "above" and inferior part "below". Of course we must conclude that Vermis also got separated by it into superior part and inferior part.

Since it reaches the anterior notch from 2 sides, it's predictable that it has a relation somehow with what's occupying it, which is the brain stem for sure! So it can be seen "as in figure 6" extending between Middle cerebellar peduncles posteriorly. (Anatomy atlas -3)

8.13min-21.00min/ slides covered: 11

We have separated the cerebellum into posterior, anterior, flocculo-nodular lobes based on the fissures; what if we unfolded the cerebellum, what extra things would we see & add??

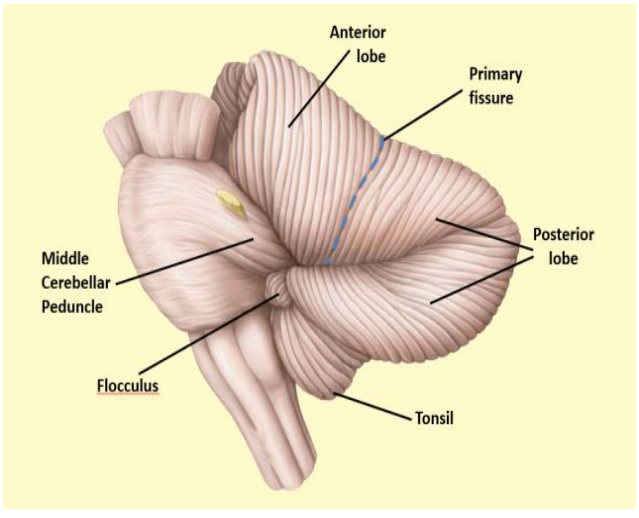


Figure 8: folded Cerebellum

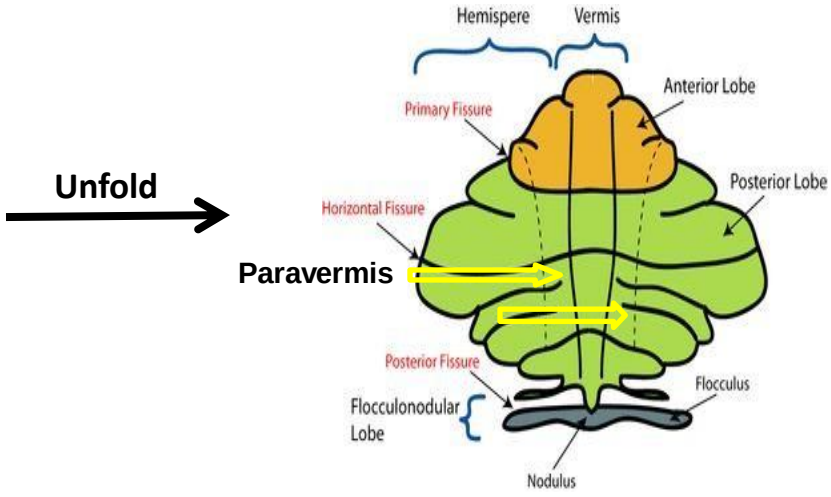
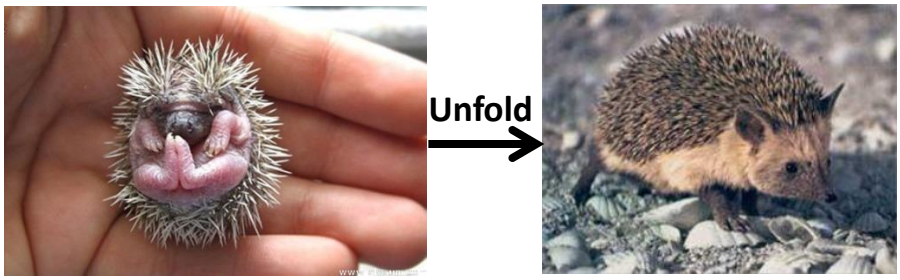


Figure 9: Unfolded Cerebellum

- Unfolding of the cerebellum



The cerebellum is folded like a hedgehog قنفذ, if you tried to unfold it like a sheet, first you'll have to grab its tips أطرافه, and in this case its tips are the most anterior parts of superior and inferior surfaces which are the closest to the brain stem. They are the most anterior part of the anterior lobe superiorly, which corresponds to the **most anterior part of the superior vermis** (figure 5), and the flocculonodular lobe inferiorly- specifically the **nodule** which represents the most anterior part of the inferior vermis (figure 6, 8).

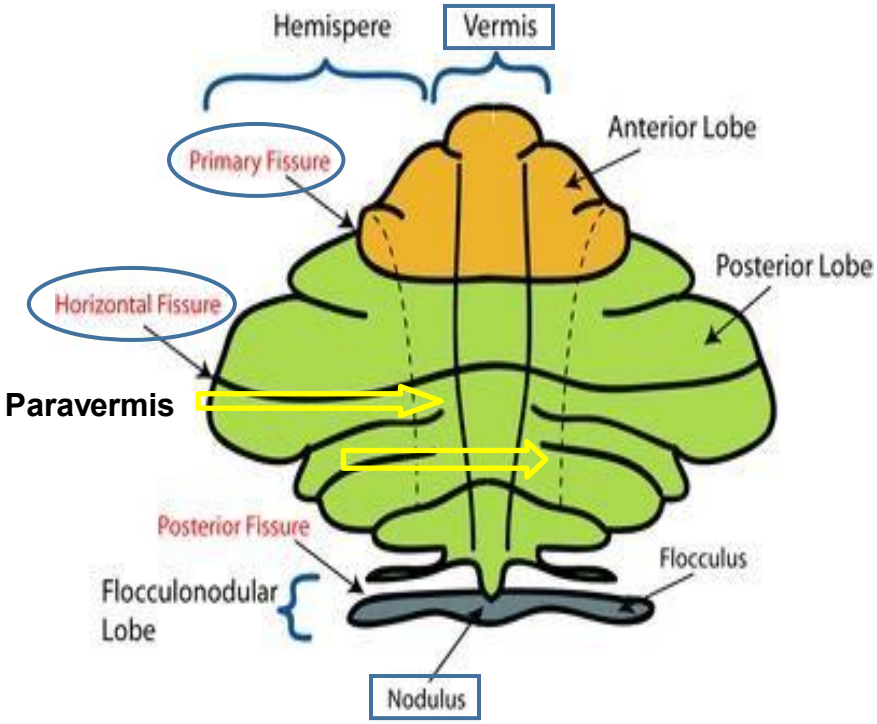


Figure 10: Unfolded Cerebellum; Vertical classification of the cerebellum

What are your observations?

1. You can see that in the Midline, we'll always see the Vermis "whether it was superior or inferior vermis in folded shape".

2. The fissures are seen clearly "horizontal, primary"

3. The nodule is seen in tip of the inferior vermis "so it'll be the most Anterior upon folding"

4. Beside the Vermis, 1cm to the right and 1 cm to the left you can see an area which we'll call Para Vermis "para, beside".

5. The rest of the posterior lobe is called "The rest of the cerebellar hemisphere".

السؤال القوي: Why to bother ourselves in unfolding and vertically classifying the cerebellum, wouldn't it be enough to just classify it horizontally to lobes as we did?? For sure each vertical part has a separate function "which will be discussed in details next lecture!"

In the cerebellum, we said that we have outer gray matter, and inner white matter, but like father like son, as the cerebrum has deep basal nuclei "Lentiform, caudate, substantia nigra, subthalamic nucleus, Amygdalla", the cerebellum will also have ones, which we put together in the famous sentence "Don't eat greasy food".

- Deep cerebellar Nuclei

Note: Don't worry; all the connections with these nuclei will be taken next lecture.

1. **D**entate (having tooth like projections) nucleus: Most lateral; connected to the Red nucleus in Midbrain.

2. Interposed متوسطة nuclei: **E**mboliform "oval; to lateral" and **G**lobose "rounded; to medial".

3. **F**astigial (Fastigatus; narrowing at the top) nucleus: Most medial.

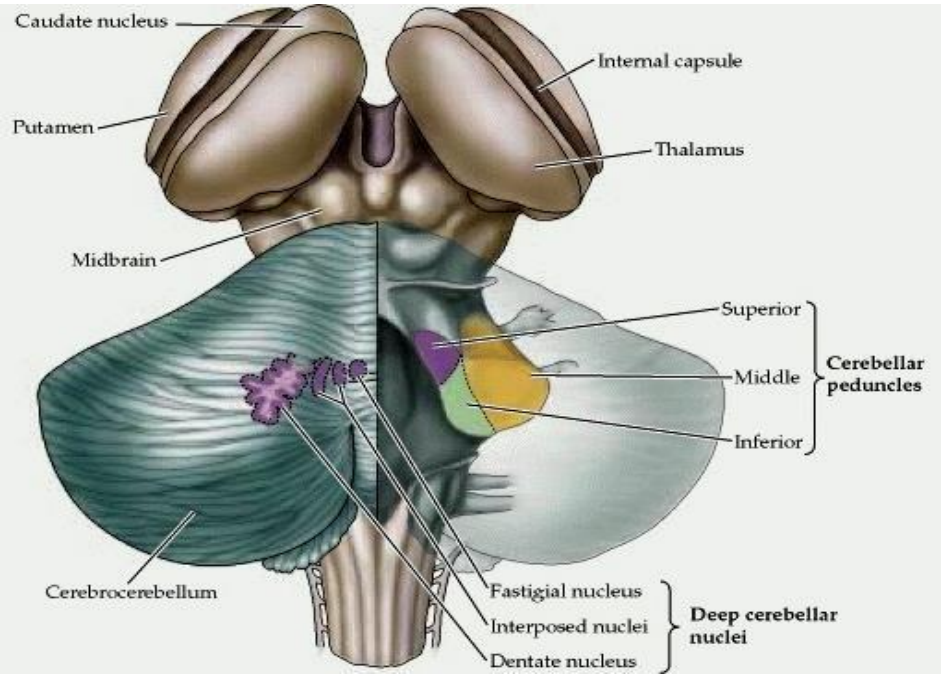


Figure 11: Deep cerebellar Nuclei

All in a sentence: "*Don't Eat Greasy Food*"

What is the importance of this order??
It's very very important in their connections with the cerebellar hemisphere "Remember first that they're deep nuclei inside, so we're relating to their sites anatomically in the outer parts of the cerebellum we see". How?? The Dentate nucleus is in the rest of cerebellar hemisphere, interposed nuclei are in the paravermis, and the fastigial nucleus is in the vermis. So sure these nuclei are connected to cerebellar parts they exist in, how? They're connected in a way that they share functions of the cerebellum.

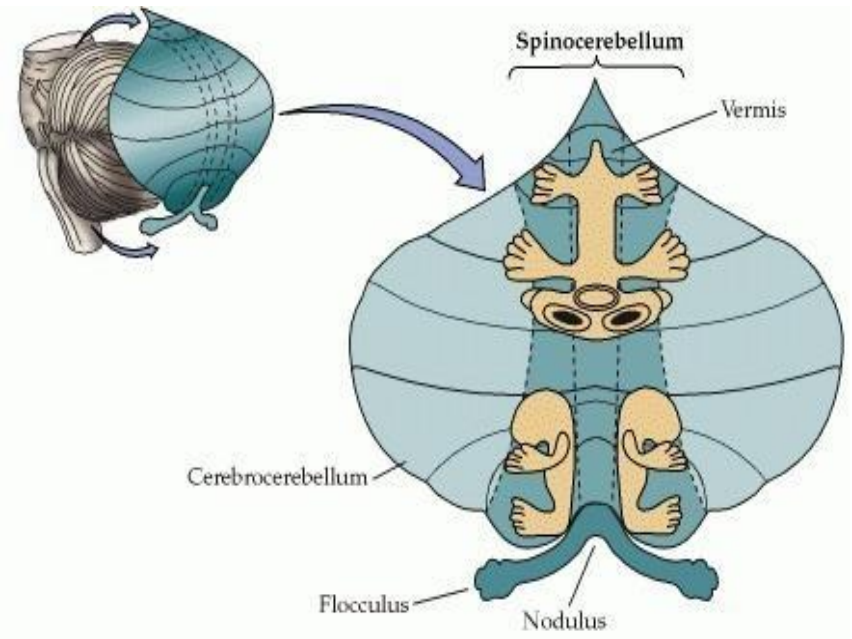


Figure 12: Cerebellum vertical parts and corresponding functions

1. Vermis (central part on superior and inferior surfaces) represents head, neck, trunk, shoulders and hips so by default the proximal muscles of the body; it controls these body parts to control the Posture "it'll prevent you from swaying to right or left while standing"; so its fibers will sure project to Fastigial Nucleus.

2. Paravemis (lateral to vermis) represents muscles lateral to the midline; we mean by that distal parts of the upper and lower limbs. Its fibers will sure project to Globose and Emboliform Nuclei.

- Vermis and Para vermis "and a part of the anterior lobe" are called the SPINO-cerebellar part of the cerebellum; since they control body's proximal and distal muscles, this will make sense right??!

It receives proprioception "remember that it's the unconscious proprioception" from the spinal cord through anterior and posterior SPINO-cerebellar tracts "and a tract called cuneo-cerebellar tract coming from accessory cuneate nucleus; Anatomy Atlas - 5". *Remember*: Conscious proprioception was through PCML tract.

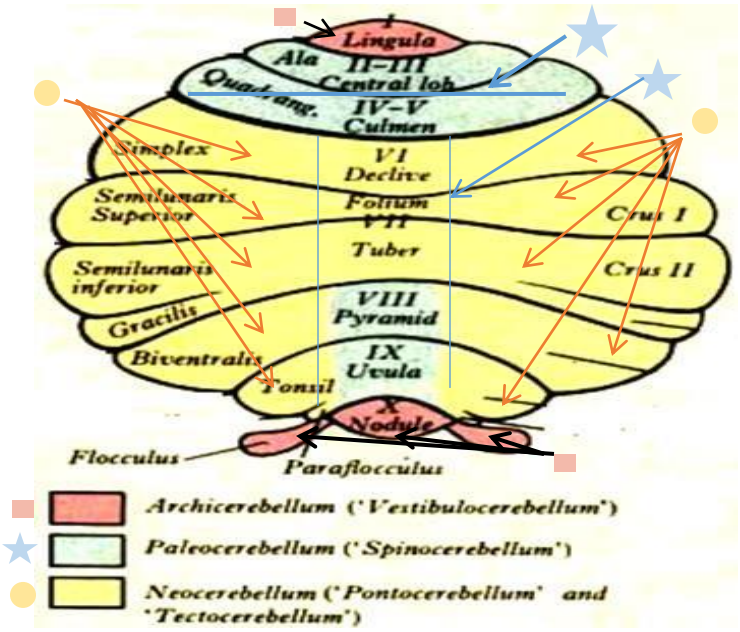
Emboliform and globose nuclei receive these afferent fibers and then send efferent fibers to go the spinal cord and control muscle tone.

3. Rest of cerebellar hemispheres has fibers projecting to Dentate Nucleus. What's their function? Planning and Coordination of the motor movement.

E.g. In a tennis game, the player will always try to plan how to stand and place his legs and bend his trunk in the ball direction, he'll plan how to place his hand and rotate his wrist in a way that he'll succeed in hitting the ball. All these coordination plans are the function of dentate and rest of cerebellar hemispheres; they represent sites of the cerebellum that the cerebrum consulted for planning of movement; of course they were consulted along with the basal ganglia which are also important in these situations.

Besides (1) controlling proximal and distal muscles' tone, (2) planning and coordination, the last function of the cerebellum is (3) balance, which was the function of the flocculo-nodular lobe "we'll get to know in the next lecture its association with the vestibular nuclei which also play the most important role in balance".

- In this figure, you can see the pink colored **nodule** "which we said it's a part of the inferior vermis" attached to the pink colored **flocculi "A.K.A: flocculo-nodular lobe"**. In embryology, this lobe is called **Archi**cerebellum, which means the most old العتيق and primitive part of the cerebellum. As we called the vermis and paravermis <u>functionally</u> the spinocerebellum, we also call this lobe functionally the Vestibulocerebellum. Makes sense right??



- We can see that the lingula as well, which is the most anterior part of the superior vermis, is included embryonically in Archicerebellum.

- This picture seems to be a bit old, so in fact we should see the **whole vermis** "including the yellow midline structures", the **paravermis**, and the **anterior lobe** "anterior to primary fissure" all coming from the same embryonic origin -here in green- which is paleocerebellum "paleo; old". These parts formed the spinocerebellum which controlled "along with interposed and fastigial nuclei" the body muscles' tone.

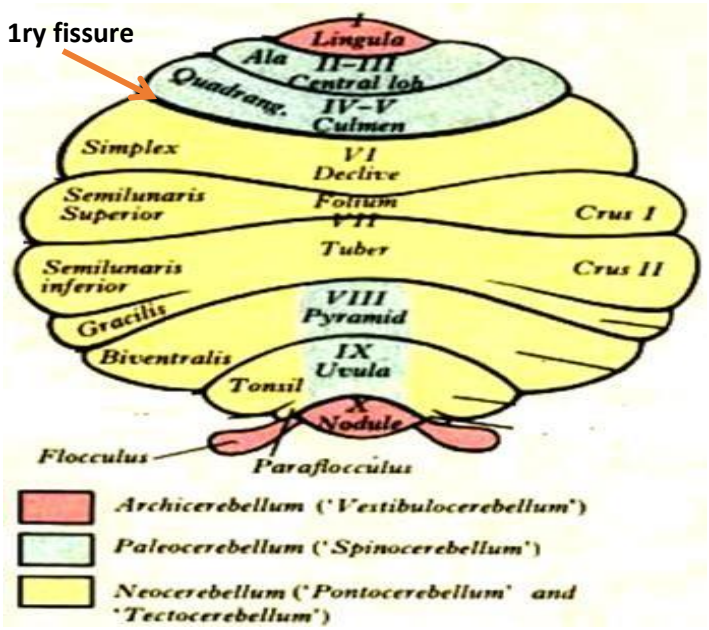


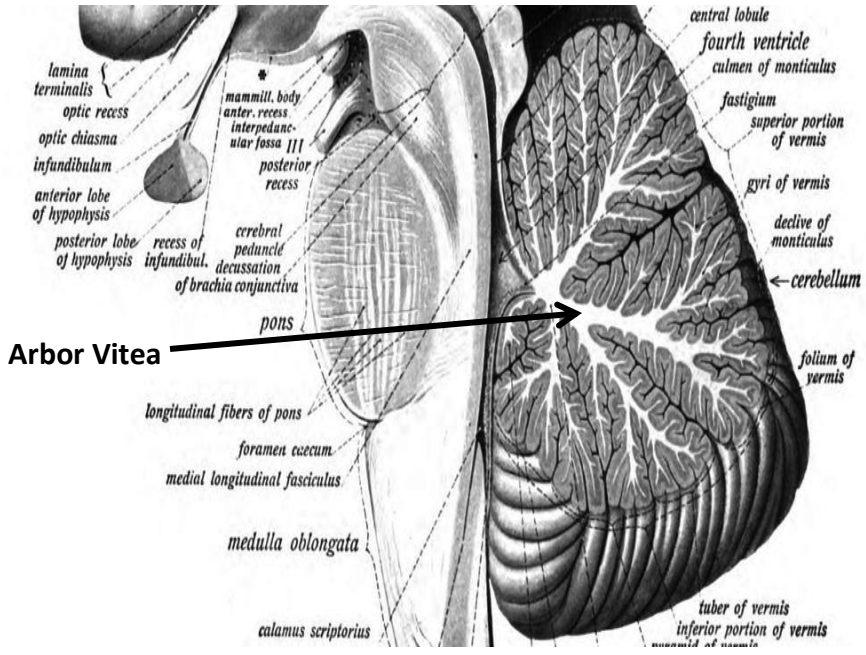
Figure 13: the embryological divisions of the cerebellum

- The rest of the cerebellum- seen here colored in yellow- comes from the neocerebellum "neo; new". This part is called functionally the cerebrocerebellum, thus along with dentate nucleus it's responsible for movement coordination and planning.

- ALL IN ALL: You'll have to know the function "balance, tone ..."; anatomical "post, Ant, Flocculo-nodular", functional "vestibule, cerebro, spino…", and embryonic "paleo, archi, neo" classification of each lobe.

21.00min-31.35min/ slides covered: 12, 13, 14, and 25

Now coming to a beautiful view of the cerebellum. The view of "tree of life"♥!!



If we took a sagittal section like in figure 14, we'll notice that the cerebellum looks like a tree with branches going everywhere; this appearance is called Arbor Vitea or "The Tree Of Life".

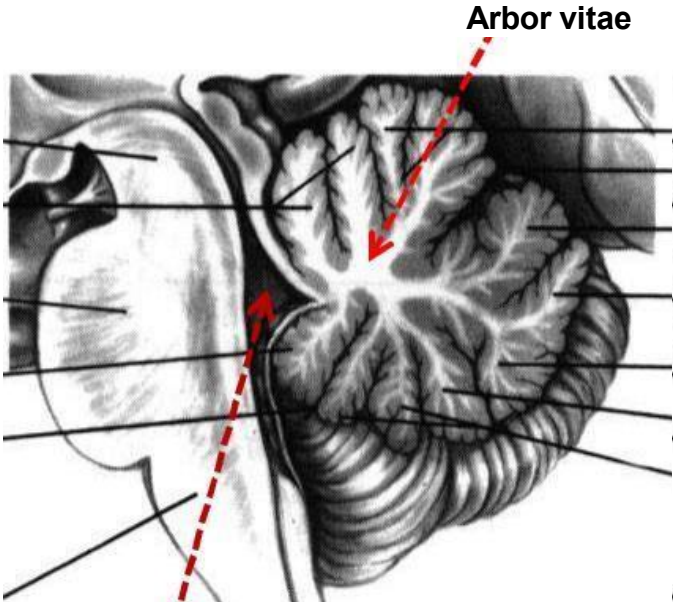


Figure 14: Mid-sagittal section in the brain

This tree is of white matter after all, so all the **afferent** fibers coming to the cerebellum and all the **efferent** fibers going from the cerebellum to their destinations "cerebrum, spine, vestibular nuclei" will be found there.

Can you see how in this view the cerebellum is divided further into small branches? Think with me brilliant; we did a cut in the midline of the cerebellum didn't we, and which structure was representing the Medline? Yes you're absolutely true! And why was it a worm like structure, what made it look like that? Because it was separated into what we call "**lobules**". When cutting in the midline, we would by that cut the vermis of course, and the vermis isn't continuous like the anterior or posterior lobe. It is rather further divided into small lobules.

Explain please: In the anterior and posterior lobes we had only transverse folia but here between each certain group of folia we have a thing that separates them from the other groups, that's why this gave us cerebellar lobules; each lobule, however, preserved the characteristic of having gray matter outside and white matter inside. This made the scientists figure out that each has different function, so they named them, and connected each vermis' part with a part of the cerebellar hemisphere beside it as a lobule. (Figure 15)

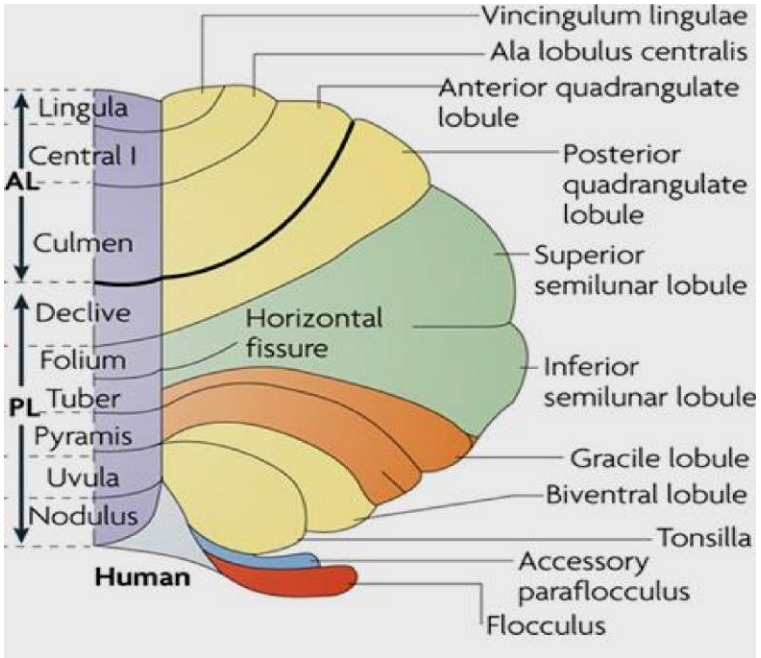


Figure 15: Cerebellar lobules; unfolded cerebellum

IMPORTANT: all the details related to function of each lobule are not required, nor the names of all lobules; what is required is only to know that we have a superior vermis on the superior surface, and an inferior vermis on the inferior surface, and some names of important parts of vermis which we'll mention just in a second.

Important Vermis parts “refer to figure 15 please”:

1. In Superior vermis:
    A. **Lingula**. The most anterior part of the superior vermis; it forms a part of the spinocrebellum.
    B. Central
    C. Culmen. “culmen; ridge جبل قمة”

By that we covered the whole superior vermis which is anterior to the 1ry fissure.

2. In inferior vermis:
    a) Nodule. The most anterior part of the inferior vermis; it forms a part of the vestibulocrebellum which is important for balance.
    b) Uvula “Diminutive تصغير of Uva; grape عنب”
    c) Pyramis “also called Pyramid”.

- Functional classification of the cerebellar lobes.

Today we’ll only discuss the function of the flocculo-nodular lobe; the rest will all be discussed in the upcoming lecture.

We’ve already known that it maintains the balance, but also it participates in what we call “vestibulo-ocular reflex”. What’s that??

The movement of your eyes in the opposite direction of your head rotation is what this reflex is all about. This happens because there’s a connection between the vestibular part of the 8th C.N. and this lobe.

Note: in each connection we’ll discuss the afferent fibers coming to the cerebellum and the efferent fibers getting out from it.

So, if we got back to remember, which spinal tract was mainly responsible for controlling balance? Vestibulo-spinal tract; which enhanced axial extensors “anti-gravity muscles”.

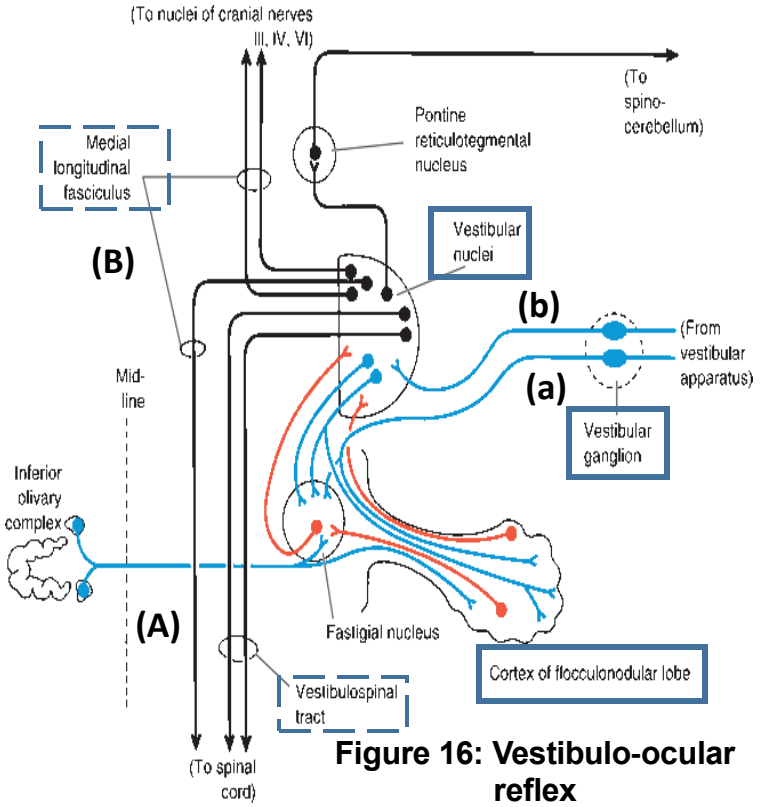


Figure 16: Vestibulo-ocular reflex

1. Afferent fibers: they come by two ways; either (a) directly from the vestibule to the FN lobe, or (b) from the vestibule “the vestibular apparatus in the internal ear ”, fibers synapse in vestibular nuclei then go as vestibulo-cerebellar tract to FN lobe.

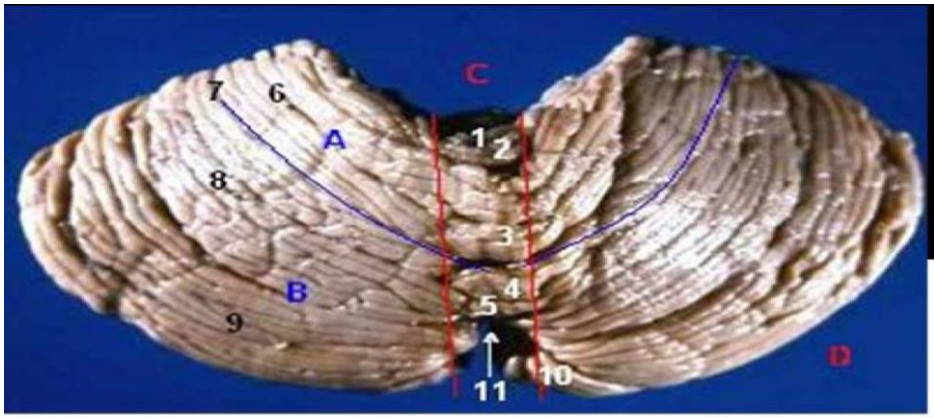
We have many vestibular nuclei "lateral, medial, superior and inferior vestibular nuclei"; all exist in the floor of the 4th ventricle "back of pons and upper part of medulla" on the lateral side (Anatomy atlas 6). They say that the most related nucleus to this reflex is the **lateral vestibular nucleus**; they even say that the lateral vestibular nucleus was originally a part of the cerebellum but during development it was partially laterally displaced to finally be situated in the floor of the 4th ventricle.

2. Efferent fibers get out of the FN lobe to (A) affect extrapyramidal **vestibulo-spinal tract**. It also (B) sends impulses to the vestibular tract related to 3rd, 4th, and 6th cranial nerves "**vestibule-occular tract**", which forms the **medial longitudinal fasciculus** responsible for coordinating the head movement with eyes movement.

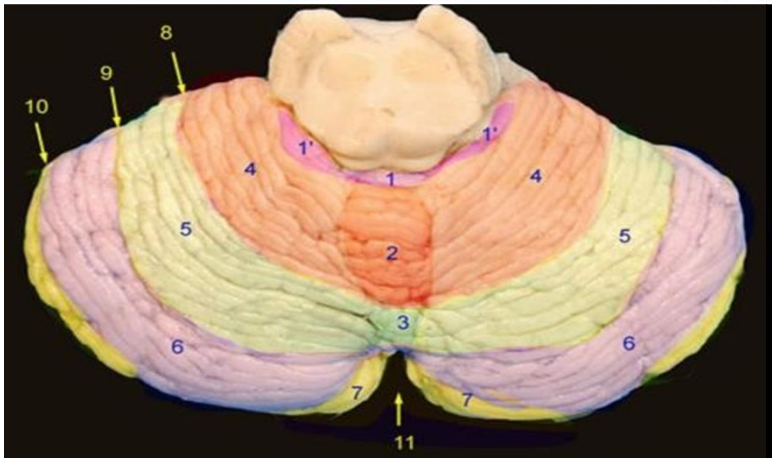
So over all, we can affirm the FN lobe role in **balance and preserving the posture** by knowing that it affects the vestibulo-spinal tract, and we can affirm its role in the **vestibulo-ocular reflex** by affecting the vestibulo-ocular tract.

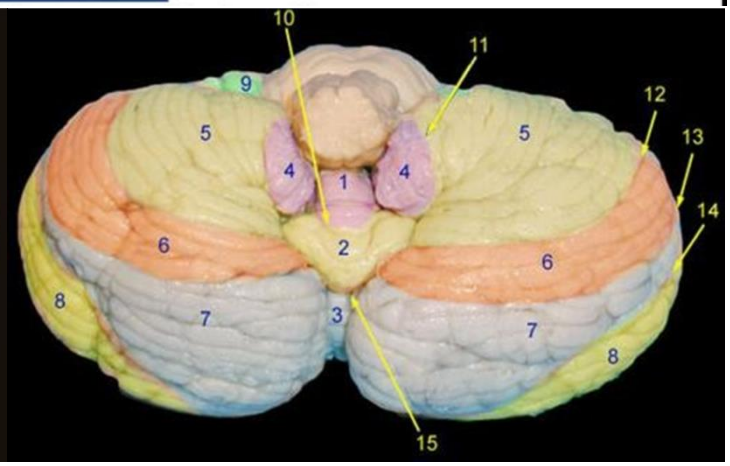
Note: the rest of tracts will be discussed in the next lecture :D

Finally, Test yourself with these 3 pictures discussed in the lecture, answers are in next page!



On the right below: Notice here how the flocculo-nodular lobe is removed!





Cerebellar lobules: Up; posterior, left; superior, right; inferior

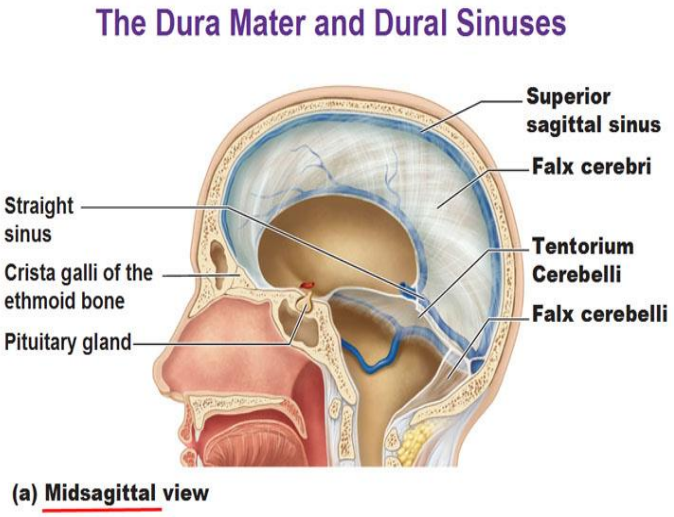
****Not all numbers are supposed to be known, what you've learnt today would be more than enough :D**

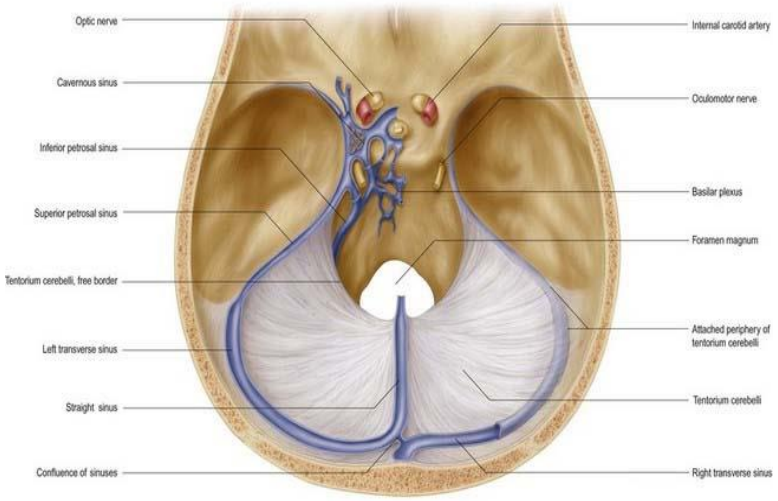
31.35min-42.20min/ slides covered: 14, 17, 18, 20, 21, and 26

Thank you for your time :D

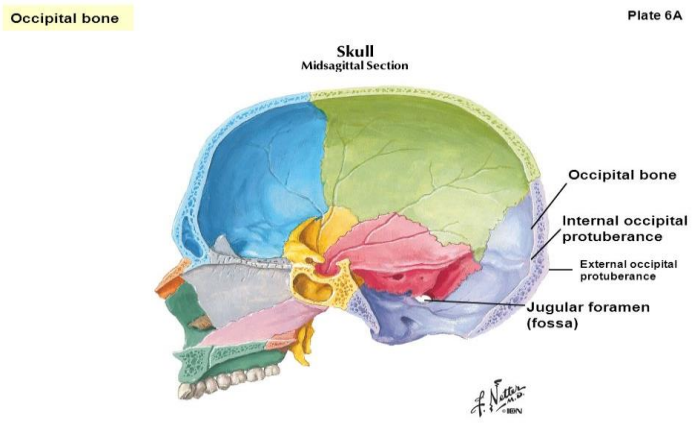
Anatomy Atlas

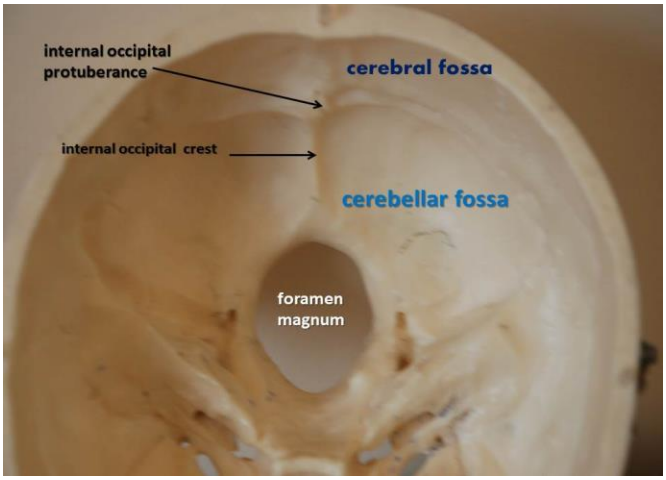
1. Dura mater folds; Falx cerebelli and tentorium cerebelli





2. Sites of Falx cerebelli attachment in the posterior cranial fossa.



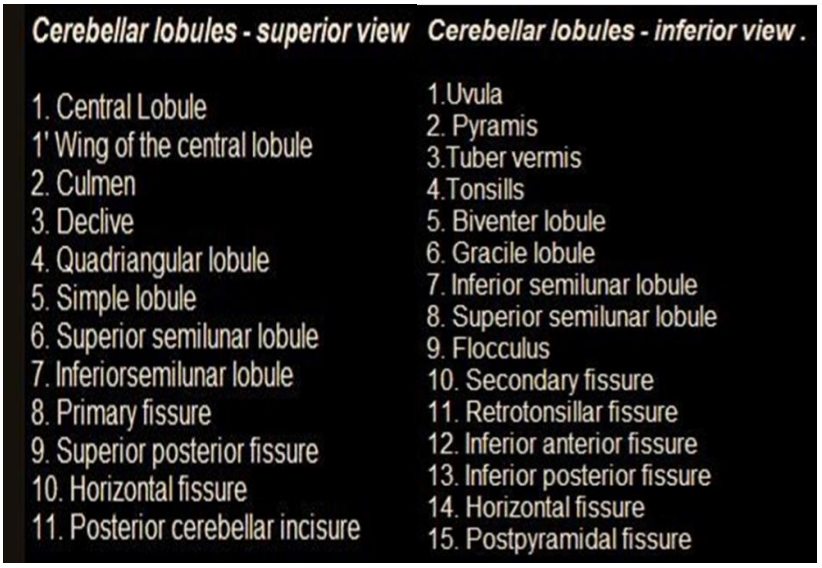


- Answers for Test-your-self pictures

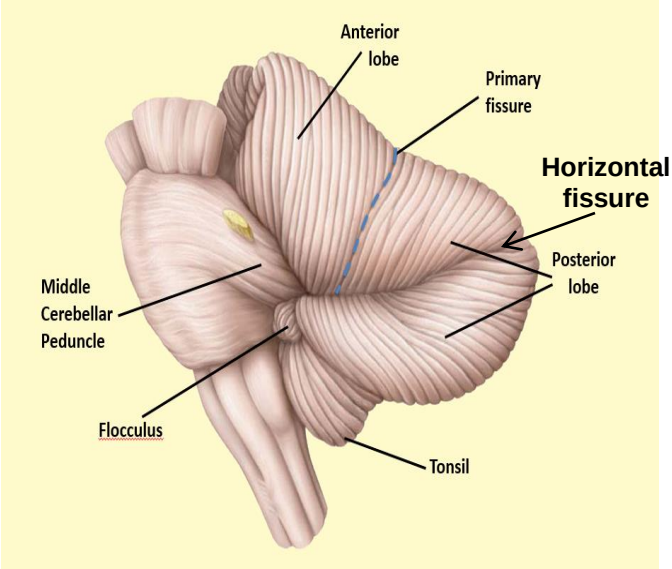
a cerebellum - posterior view
1-Lingula cerebelli
2-Lobulus centralis
3-Culmen
4-Declive
5-Folium vermis
6-Lobulus quadrangularis anterior, Pars anterior
7-Fissura prima
8-Lobulus simplex, Lobulus quadrangularis posterior
9-Lobulus semilunaris superior
10-Lobulus semilunaris inferior
11-Tuber vermis

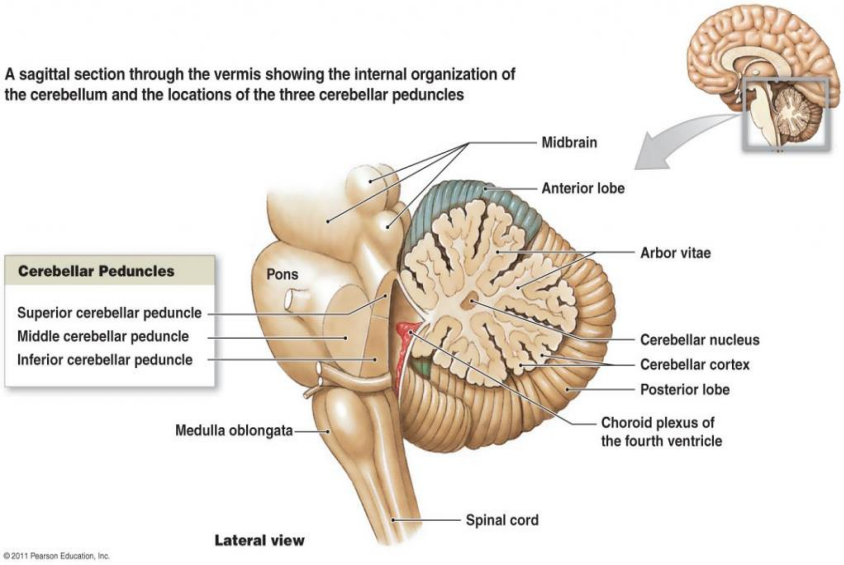
Guessed the most right??

We knew you'll be amazing :D!



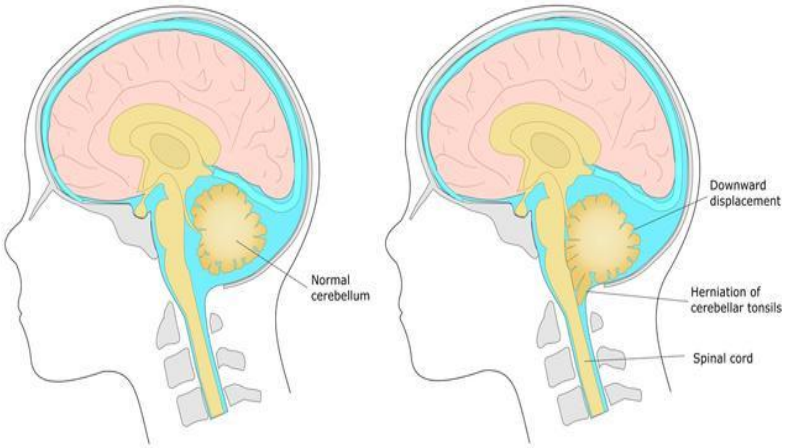
3. Horizontal fissure and middle cerebellar peduncles.



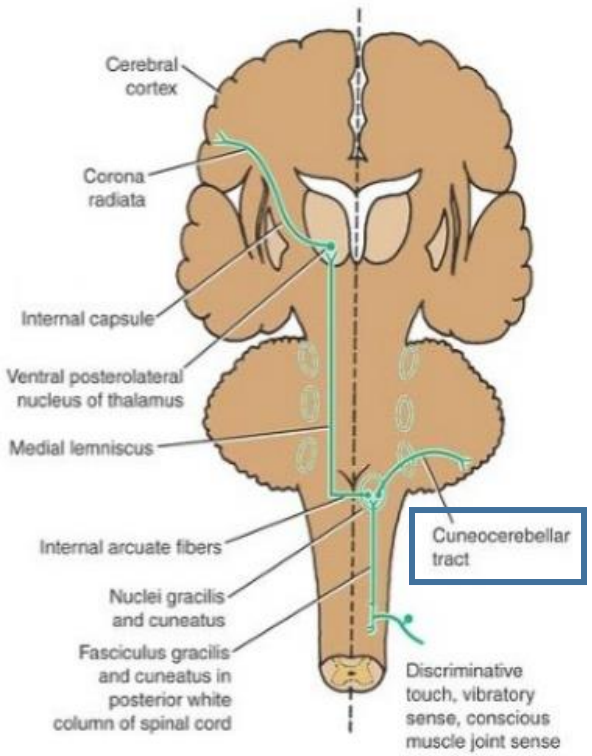


**Sure you can notice how they are in the same horizontal plane, and between the MCPs extending from Pons to cerebellum, you'll find in between posteriorly the horizontal fissure.

4. Arnold- Chiari Malformation



5- Cuneo-cerebellar tract



6. Vestibular nucleus complex