

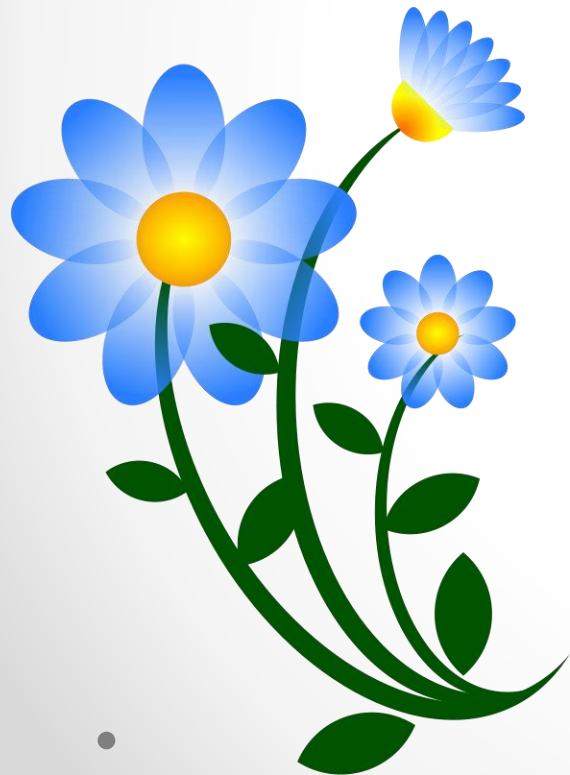
CEREBRUM **and** **cerebellum**



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CEREBRUM



**Areas of
Specialization**

Definition



Cortex Cells

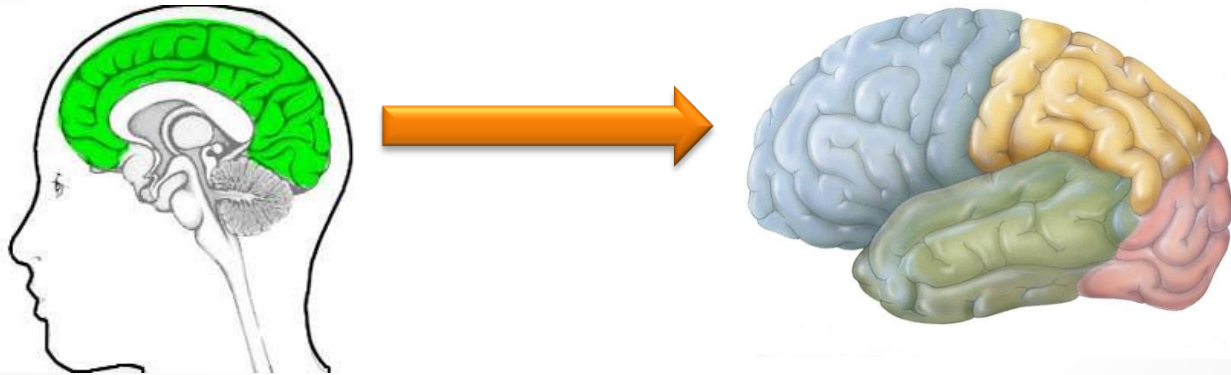
Cortex Layers



CEREBRUM

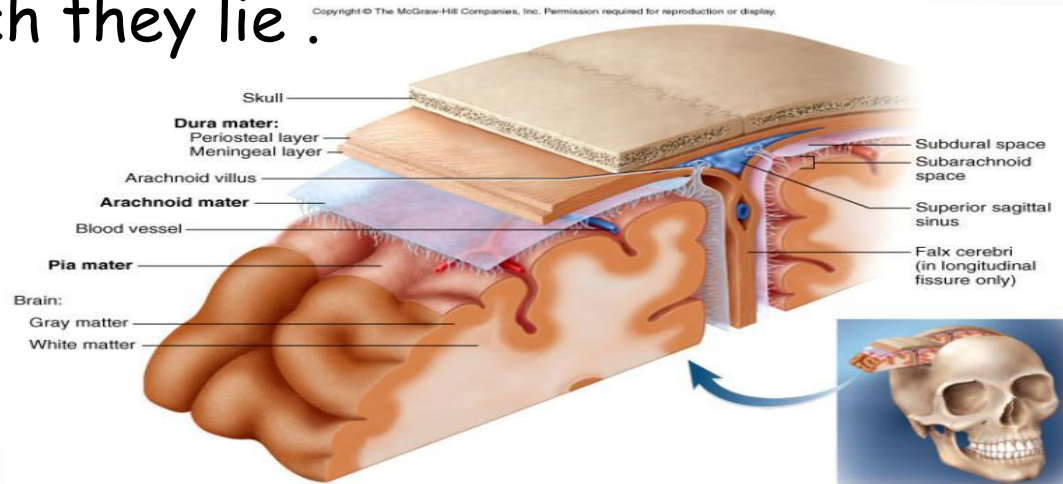
The **cerebrum** is the largest part of the brain and consists of two cerebral **hemispheres** connected by a mass of white matter called the **corpus callosum**.

Each **hemisphere** extends from the frontal to the occipital bones; above the anterior and middle cranial fossae; and, posteriorly, above the tentorium cerebelli.



CEREBRUM

The surface layer of each hemisphere is called the **cortex** and is composed of **gray matter**. The cerebral cortex is thrown into folds, or **gyri**, separated by fissures, or **sulci**. By this means the surface area of the cortex is greatly increased. Several of the large sulci conveniently subdivide the surface of each hemisphere into lobes. The lobes are named for the bones of the cranium under which they lie .



Cortex Cells



According to the morphology 5 cells present in the cortex:

1. Pyramidal cells
2. Stellate cells
3. Cells of Martinotti
4. Fusiform cells
5. Horizontal cells of "Cajal"

In addition the cerebral cortex contains supporting cells (Astrocyte, Oligodendrocyte, Microglia & Ependymal cells).

Cortex Cells

- **Pyramidal cells**

are pyramidal shape cells having an apex directed towards the surface + cylindrical axons arises from the bases of the cells & passes down into the underlying white matter.

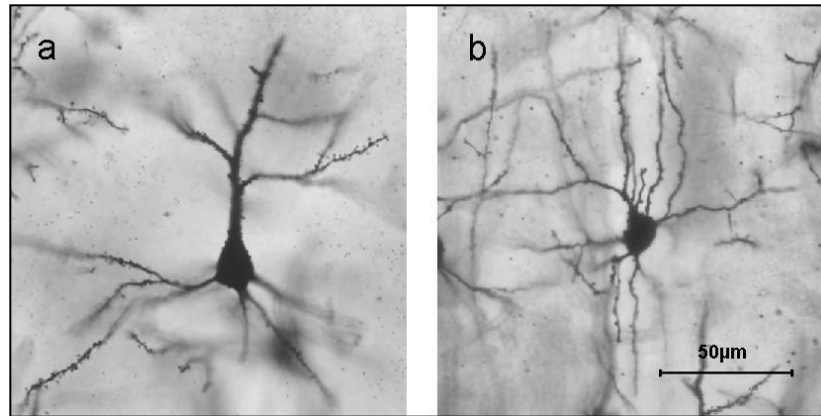


Cortex Cells

- *Stellaite cells*

small neurons with short vertical axons & small short branching dendrites giving it a shape of a "star".

the axon terminate on the nearby neurons.

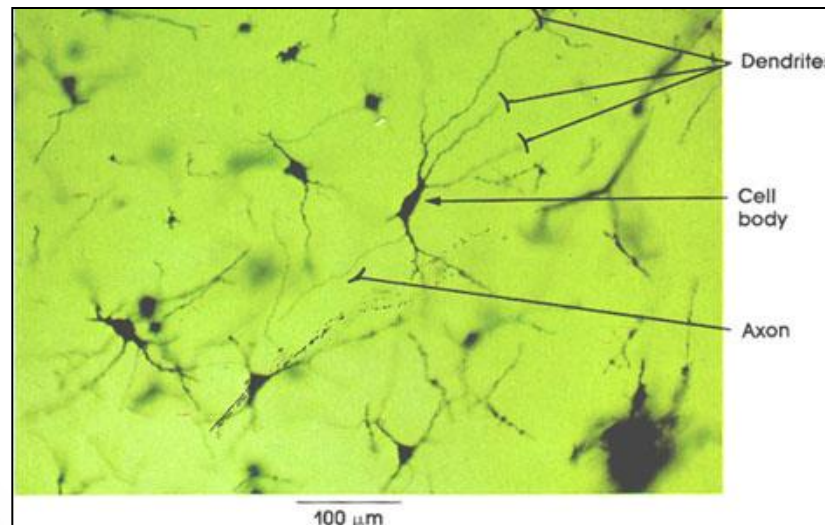


Cortex Cells

- *Cells of Martinotti*

small polygonal cells with few short dendrites, their axons extend towards the surface & bifurcate to run horizontally in the superficial layer.

they are present through out the levels of the cortex.

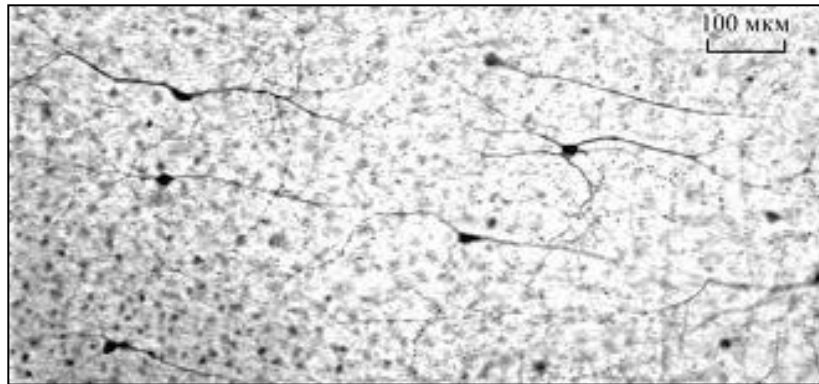


Cortex Cells

- Fusiform cells

spindle-shaped cells oriented at right angle to the cerebral cortex, their axons arise from the side of the cell body & pass superficially.

their dendrites extend from each end of the cell body branching in to the deeper & more superficial layers.



Cortex Cells



- Horizontal cells of "Cajal"

small spindle-shaped oriented parallel to the surface, they are least common found in the most superficial layer where their axons pass laterally to synaps with the dendrites of the pyramidal cells.

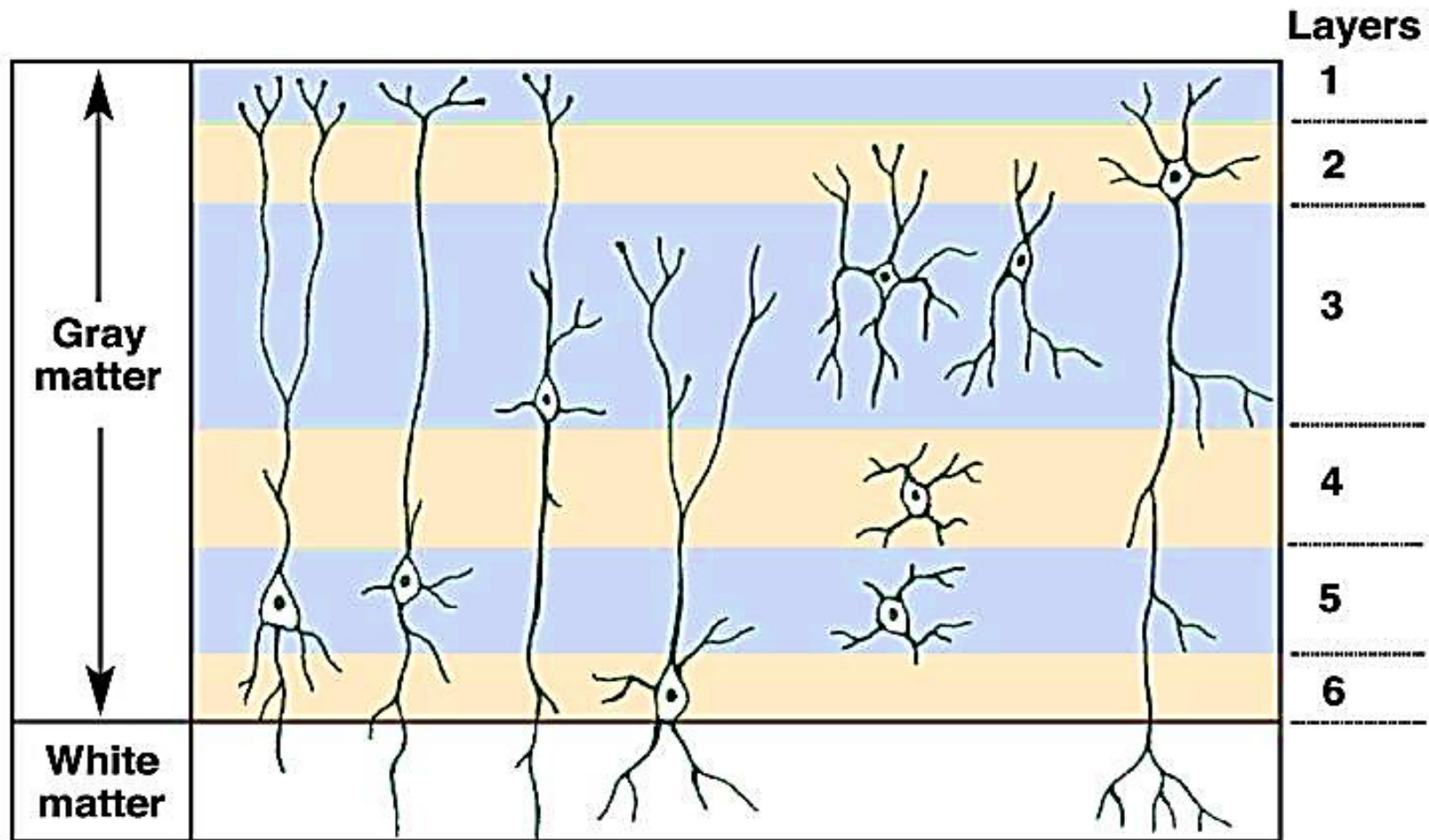
Cortex Layers



- For descriptive purpose, the cerebral cortex can be divided into 6 layers vary in the type ,density & arrangement of their cells. According to the layers we have 6 layers:

1. Molecular (plexiform) layer
2. Outer granular layer
3. Pyramidal cell layer
4. Inner granular layer
5. Ganglionic layer
6. Multiform cell layer

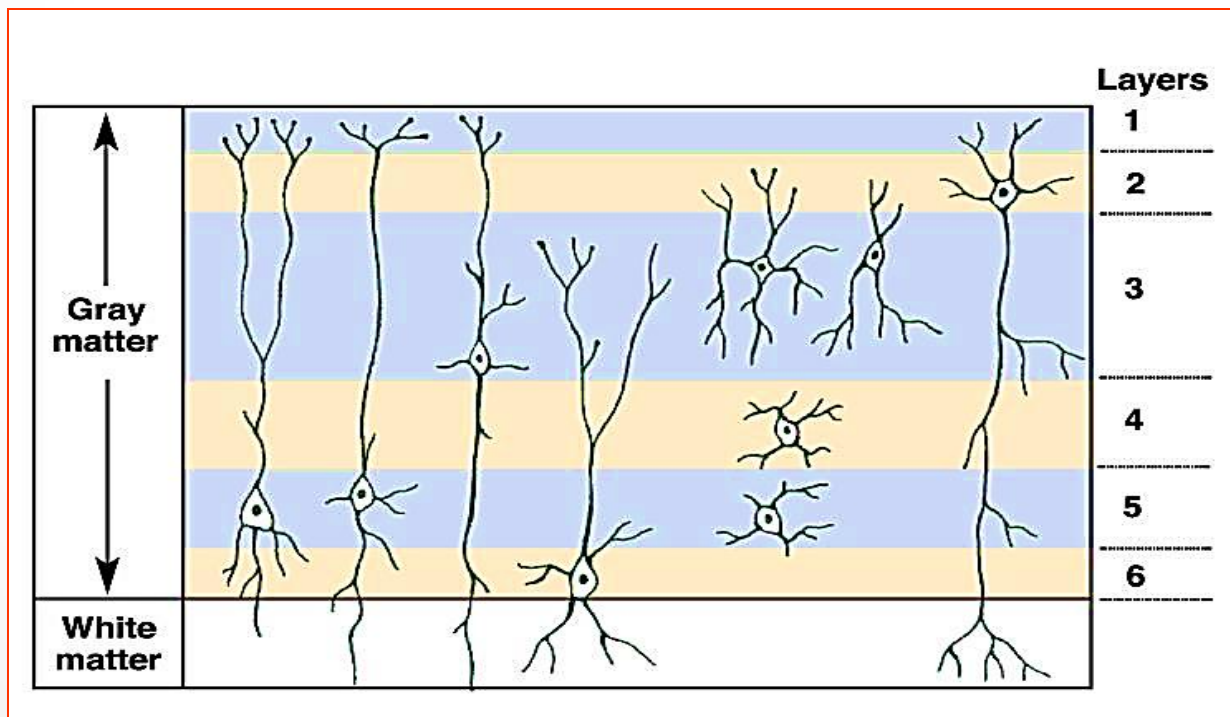
Cortex Layers



Cortex Layers

1. Molecular (plexiform) layer

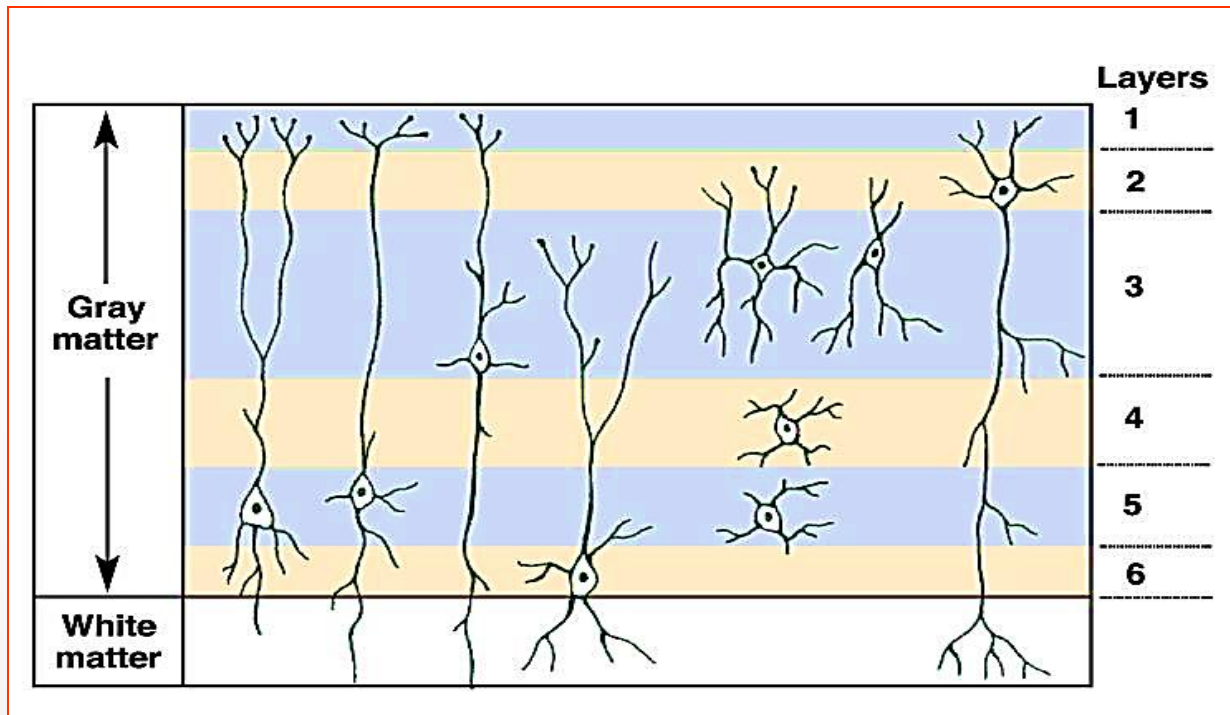
is the most superficial layer contains axons & dendrites of the cortical neurons making synaps with each other.



Cortex Layers

2. Outer granular layer

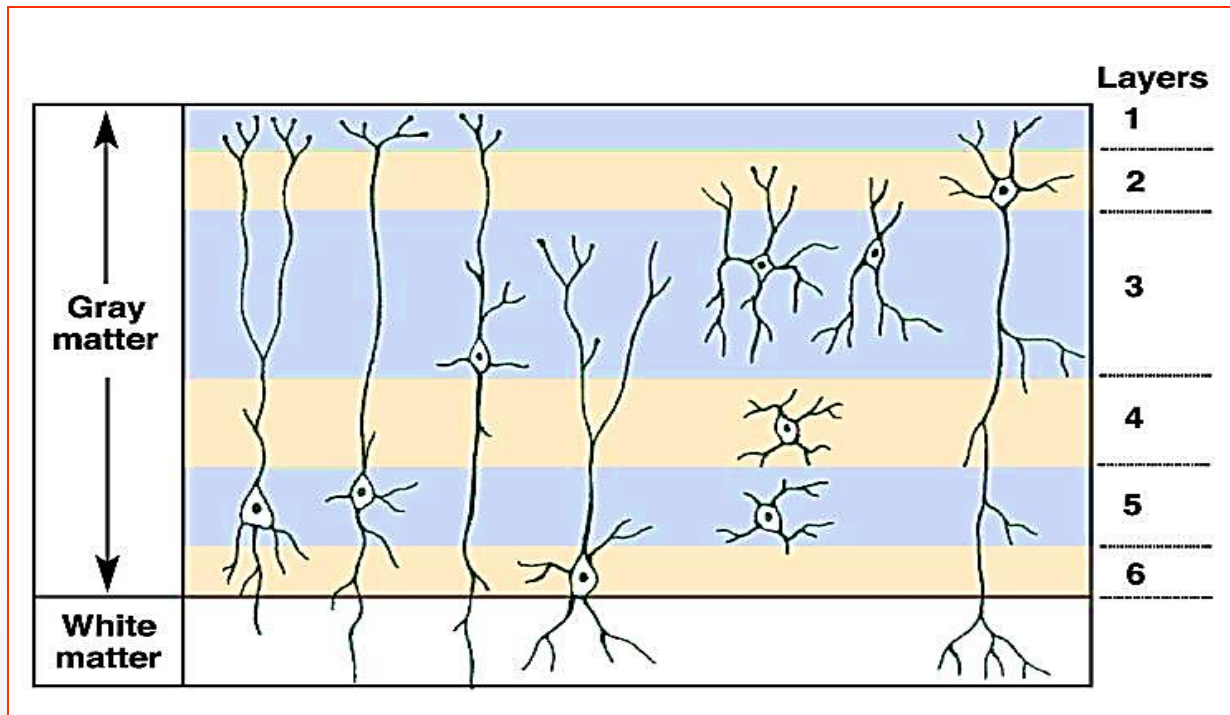
thin layer consists of small pyramidal + few stellate cells.



Cortex Layers

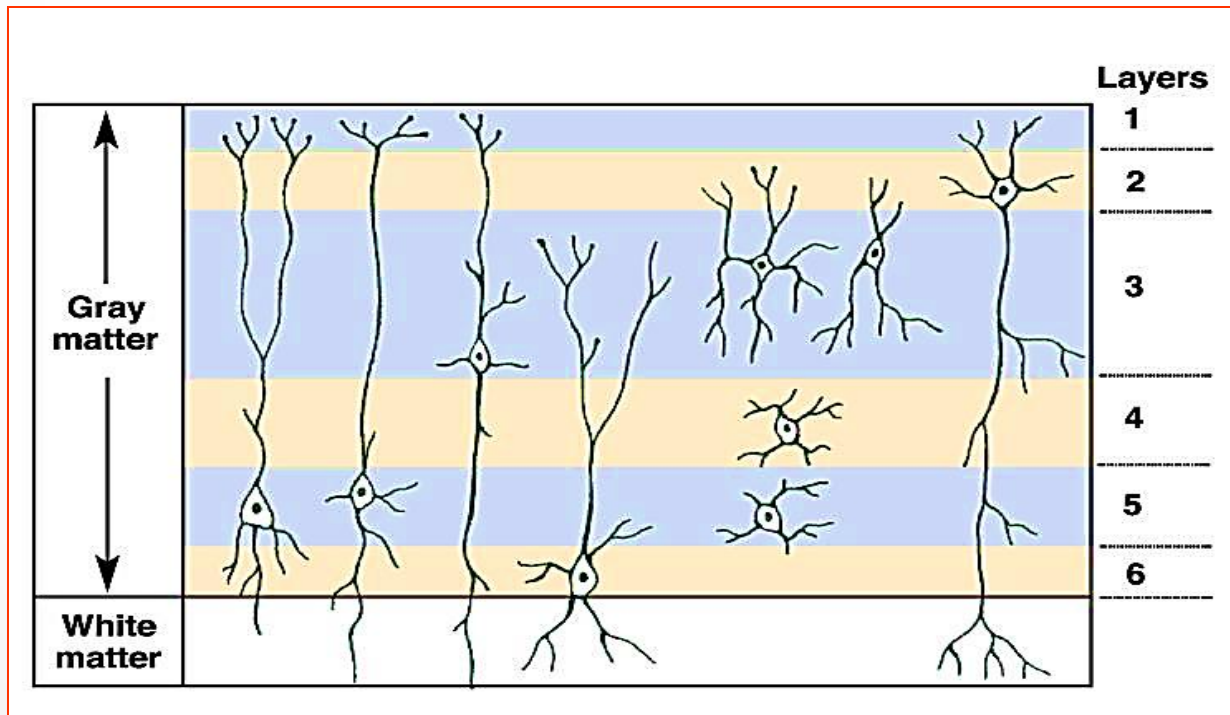
3. Pyramidal cell layer

a broad layer composed mainly of moderate size pyramidal cells, the cells gradually increased in size in the deeper portion of this layer.



Cortex Layers

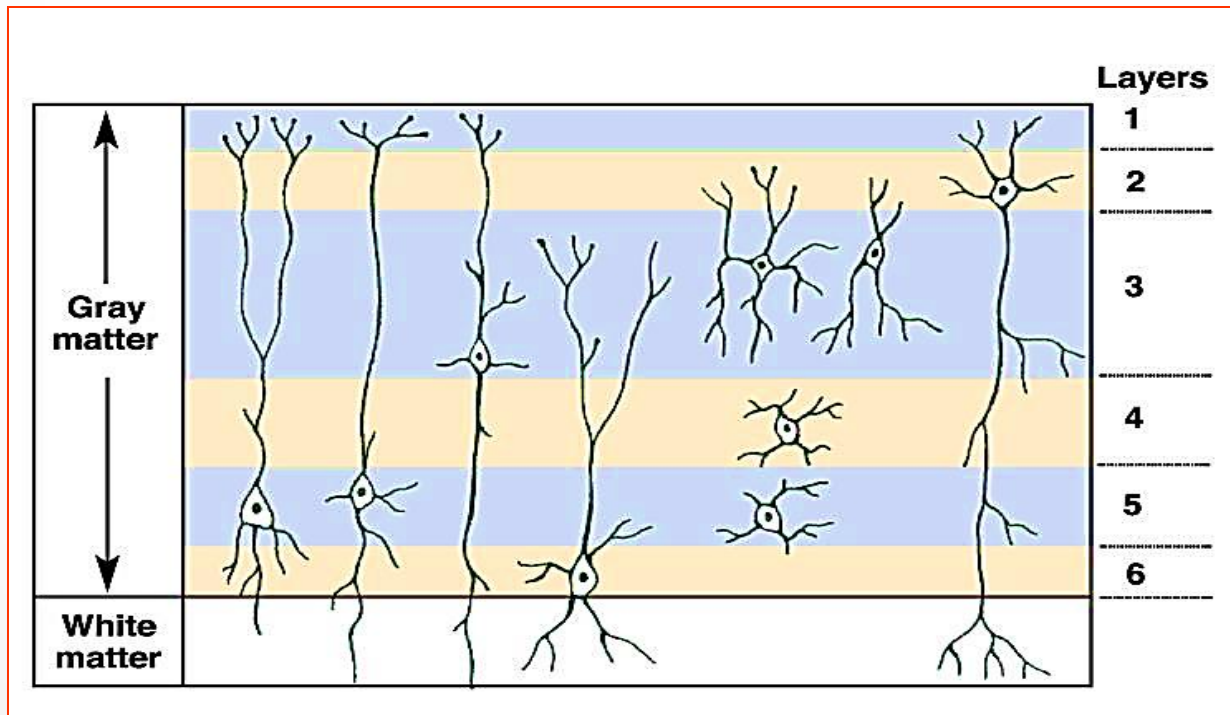
4. Inner granular layer
consists of densely packed stellate cells.



Cortex Layers

5. Ganglionic layer

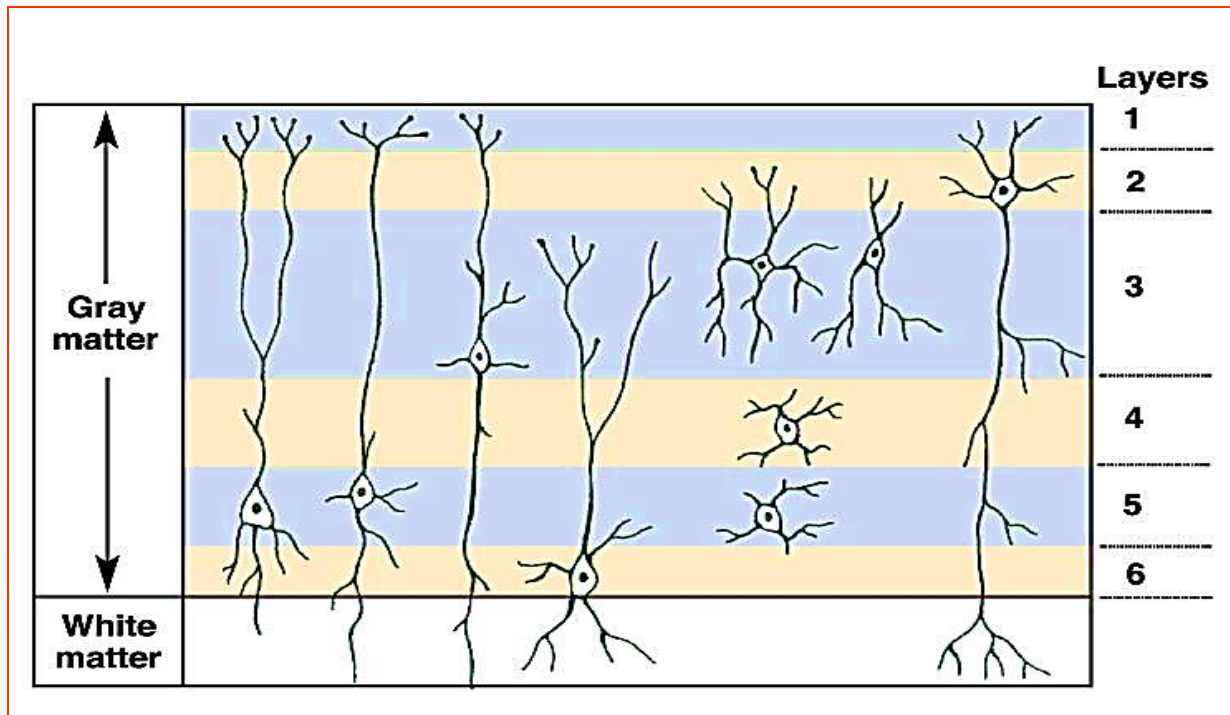
large pyramidal cells + stellate + cells of Martinotti.



Cortex Layers

6. Multiform cell layer

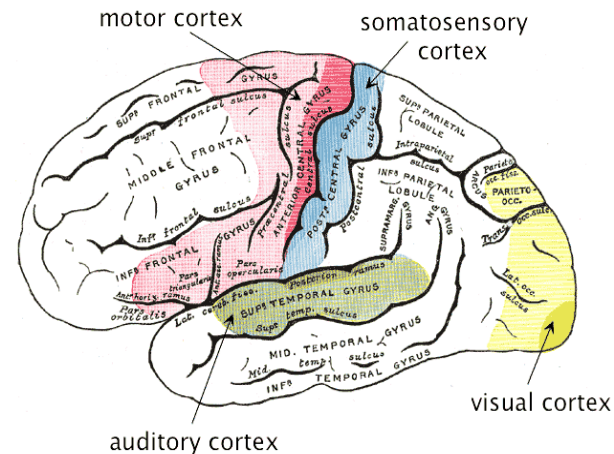
contains wide variety of different morphological forms of cells, it contains numerous small pyramidal cells + cells of Martinotti + stellate cells lie superficially & fusiform cells lie in the deeper part.



Areas of Specialization

In the **motor cortex** (in the precentral gyrus), there is relative absence of stellate cells in the 2nd & 4th layers.

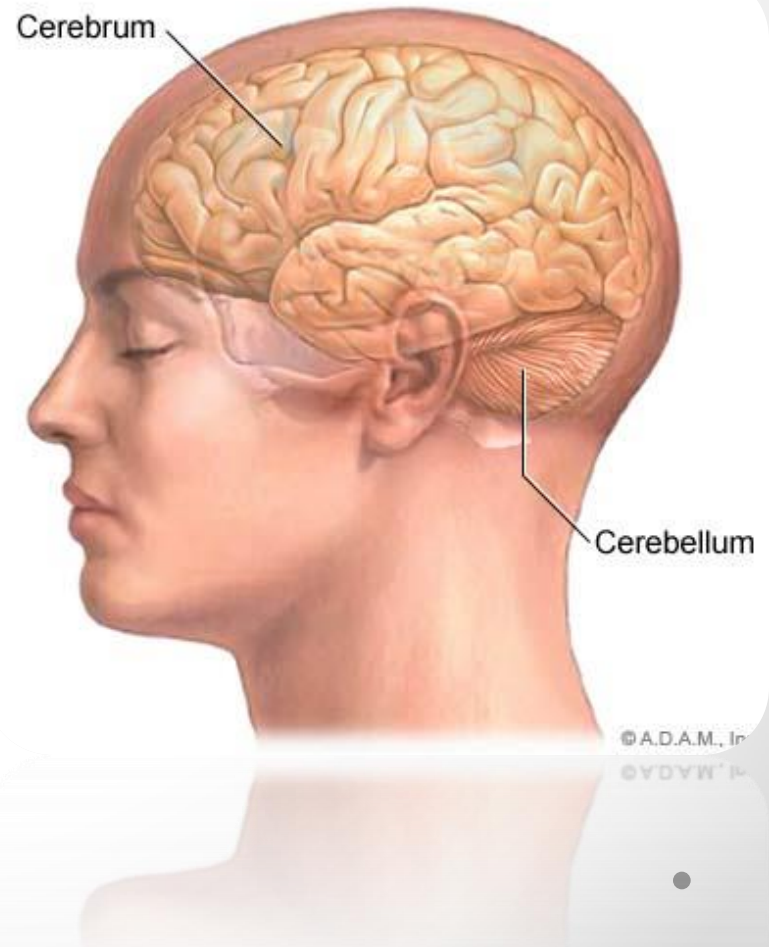
In the **sensory cortex** (in the postcentral gyrus), there is a relative absence of pyramidal cells in the 3rd & 5th layers.

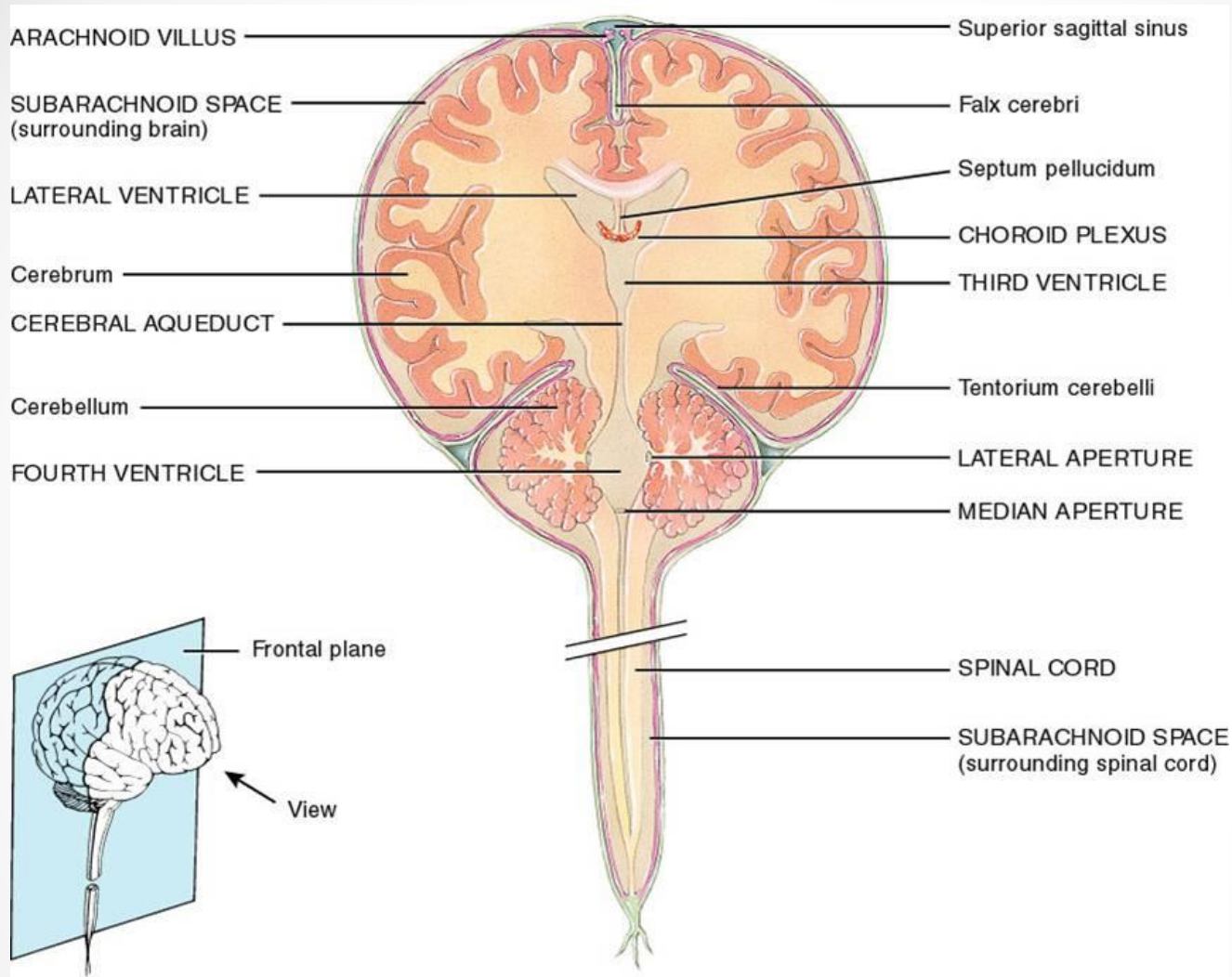


cerebellum

Cerebellum

The largest part of hind brain
Lies above and behind the medulla and pons and occupies posterior cranial fossa and separated from them by the cavity of the 4th ventricle and separated from Occipital part of each cerebral hemispheres by tentorium Cerebelli.





(b) Frontal section of brain and spinal cord

External features

It consists of two hemispheres connected by **vermis** , The part of vermis that is seen from above is the superior vermis while that seen from below is inferior vermis also it consists of two surfaces superior and inferior.

And it has two notches anterior and posterior .The anterior one receives the back of the brain stem and the posterior one receives the falx cerebelli.

It has an outer grey matter and inner white matter. It is like cerebral hemispheres . Its surface is highly convoluted, forming folds or folia, being oriented transversely. **The superior surface** shows the fissure prima that separates the anterior lobe from the middle . **The inferior surface** shows a depression called vallecula at the bottom of the vallecula we have inferior vermis (formed of nodule, uvula and pyramid). Also we have tonsil of the cerebellum in the inferior surface situated at the side of the inferior vermis.

The cerebellum has three fissures:

1- Primary fissure : V-shaped , well defined fissure, lies on superior surface and separates the small anterior lobe from the larger middle lobe (or posterior lobe).

2- Horizontal fissure: lies along the sides of cerebellum, extending from anterior notch to posterior notch, separates the superior from the inferior surfaces.

3- Secondary (posterolateral) fissure: lies on inferior surface and separates flocculo-nodular lobe from the remainder of cerebellum.

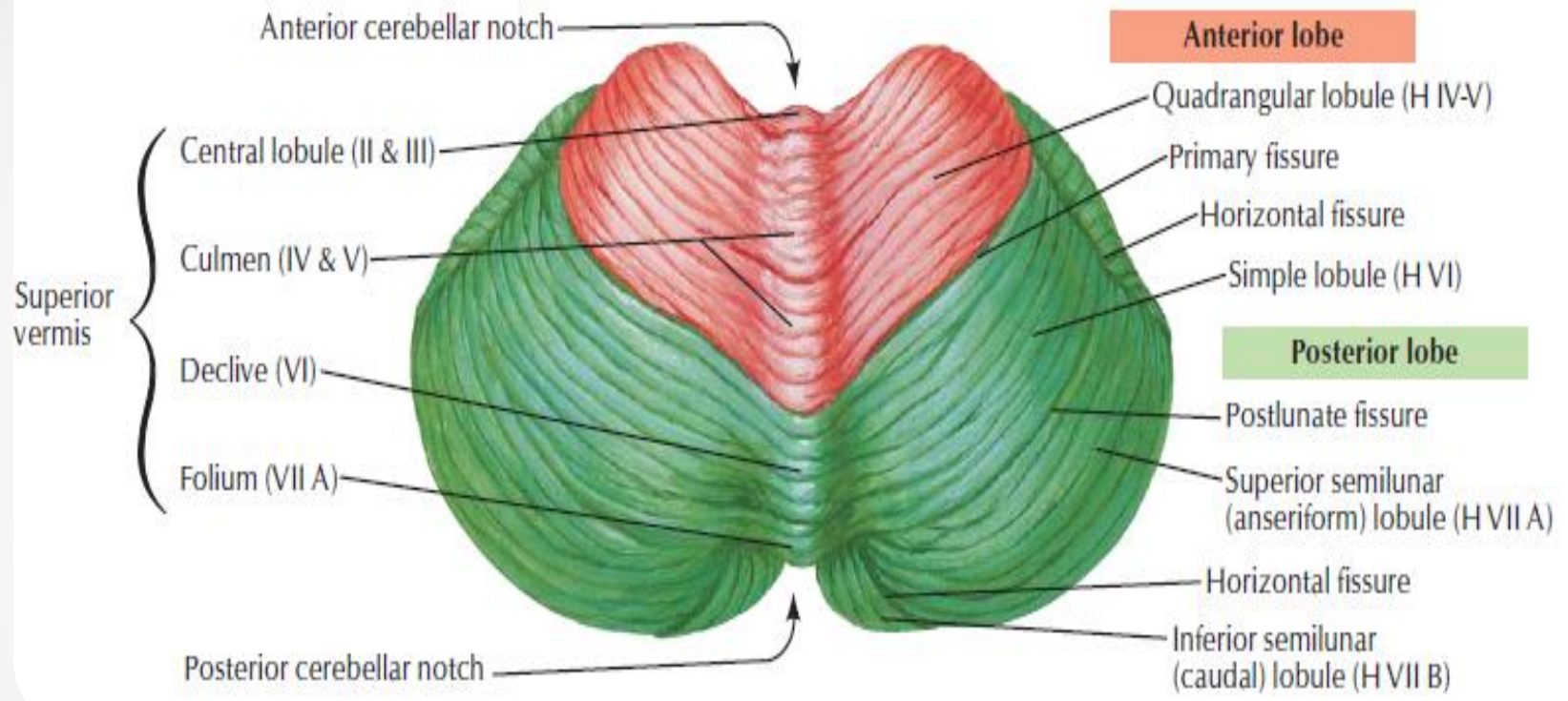
The lobes of the cerebellum :

1-Anterior lobe : It lies in front of the fissure prima connected to the spinal cord and control the muscle tone .

2-Middle lobe : Extends from fissure prima to postero-lateral fissure , and the tonsils part of it . Connected with cerebrum and regulate the fine movement .

3-Flocculo- nodular lobe : Consist of the nodule of the vermis and two flocculi one each side. Connected to vestibular part concerned with the equilibrium.

Superior surface



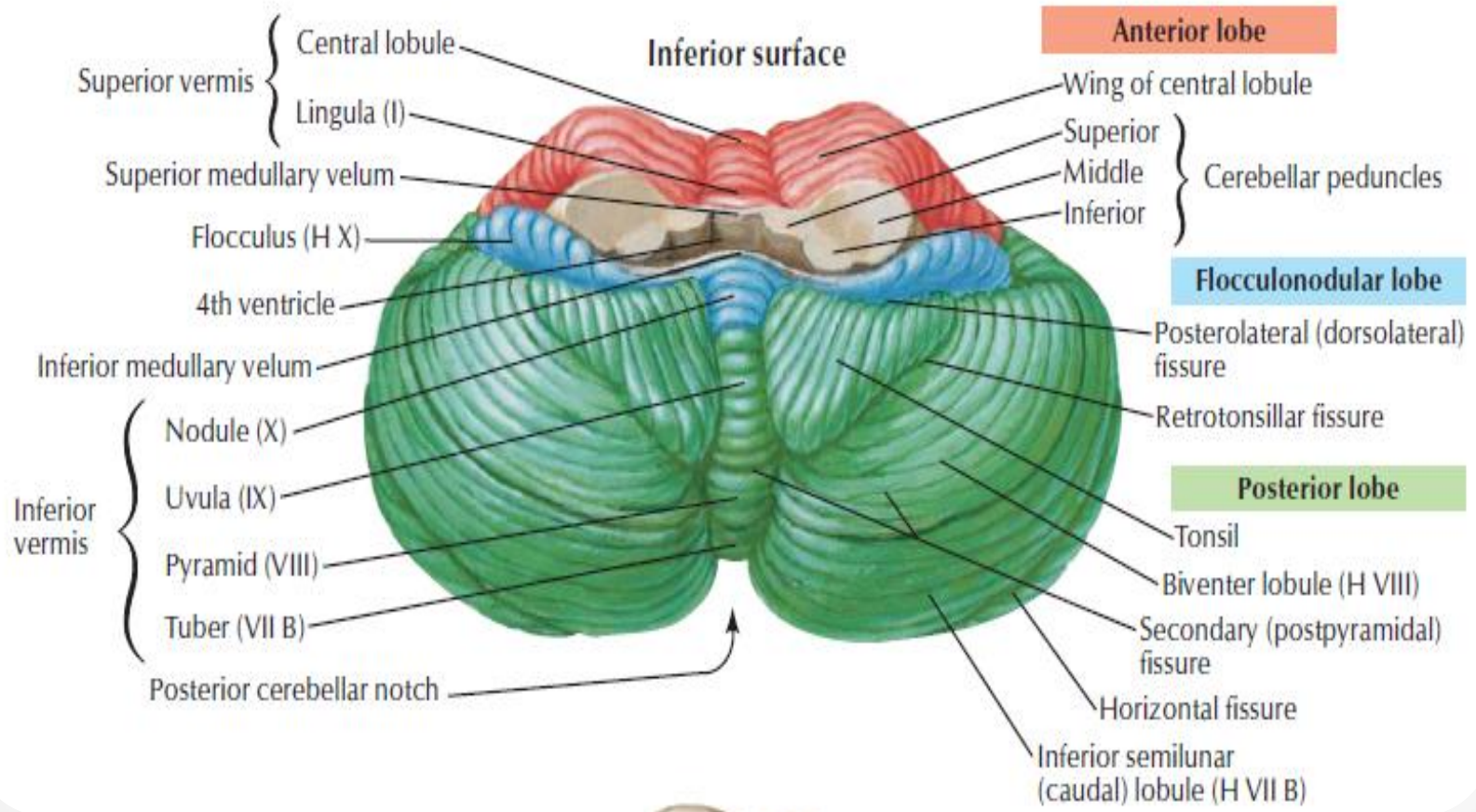
Posterior cerebellar notch

(caudal) lobule (H VII B)

inferior semilunar

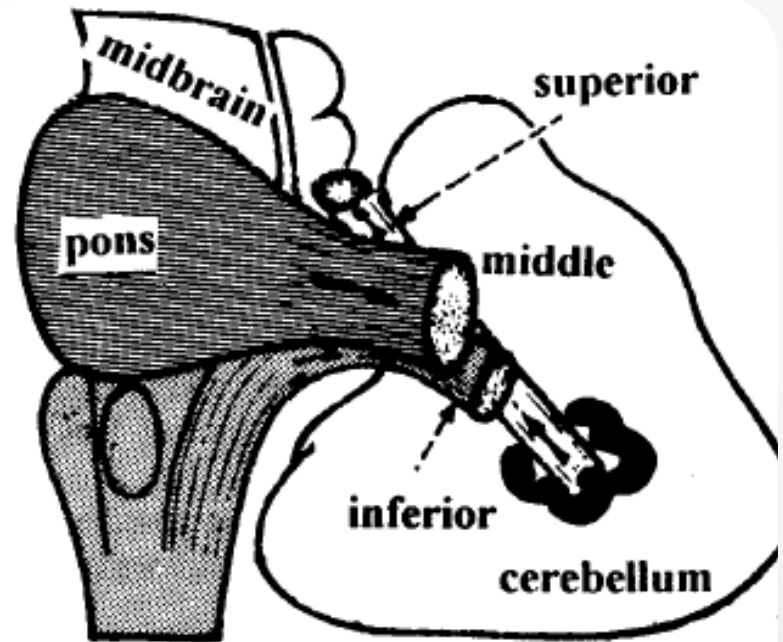
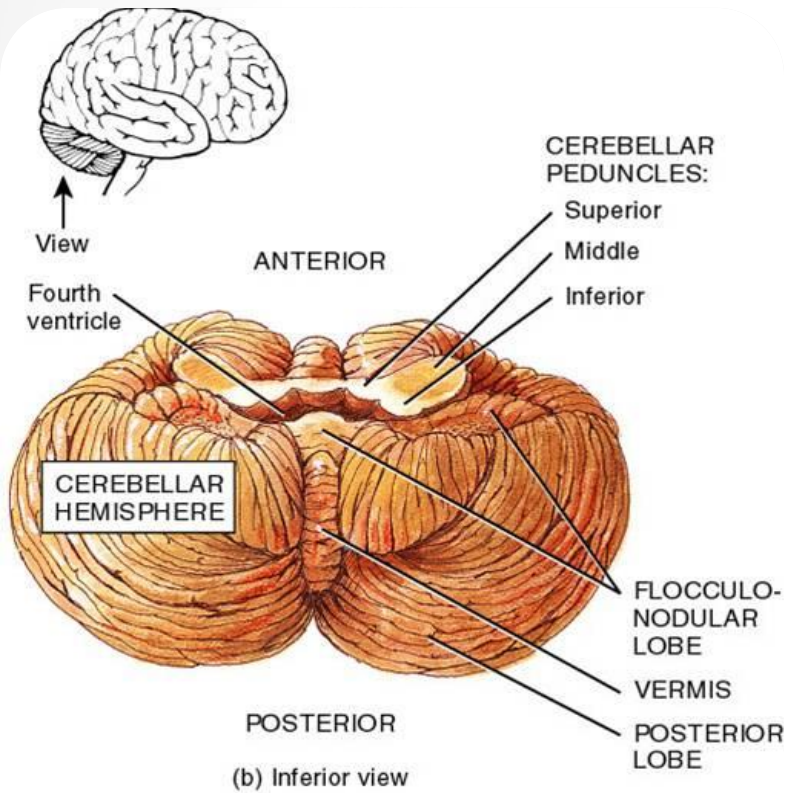
horizontal fissure

(anterior) lobule (H VII A)



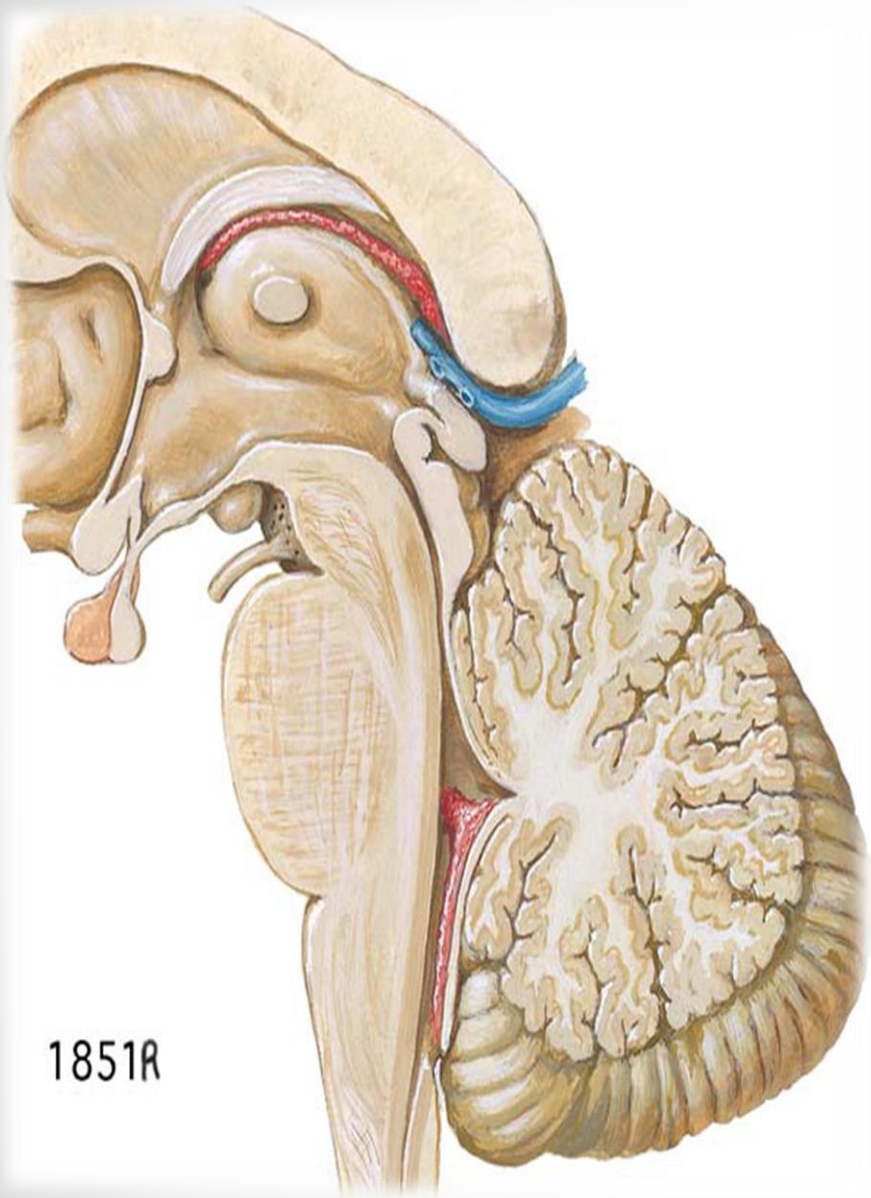
External features

The cerebellum is connected to the midbrain, pons and medulla oblongata by **three pairs of peduncles**

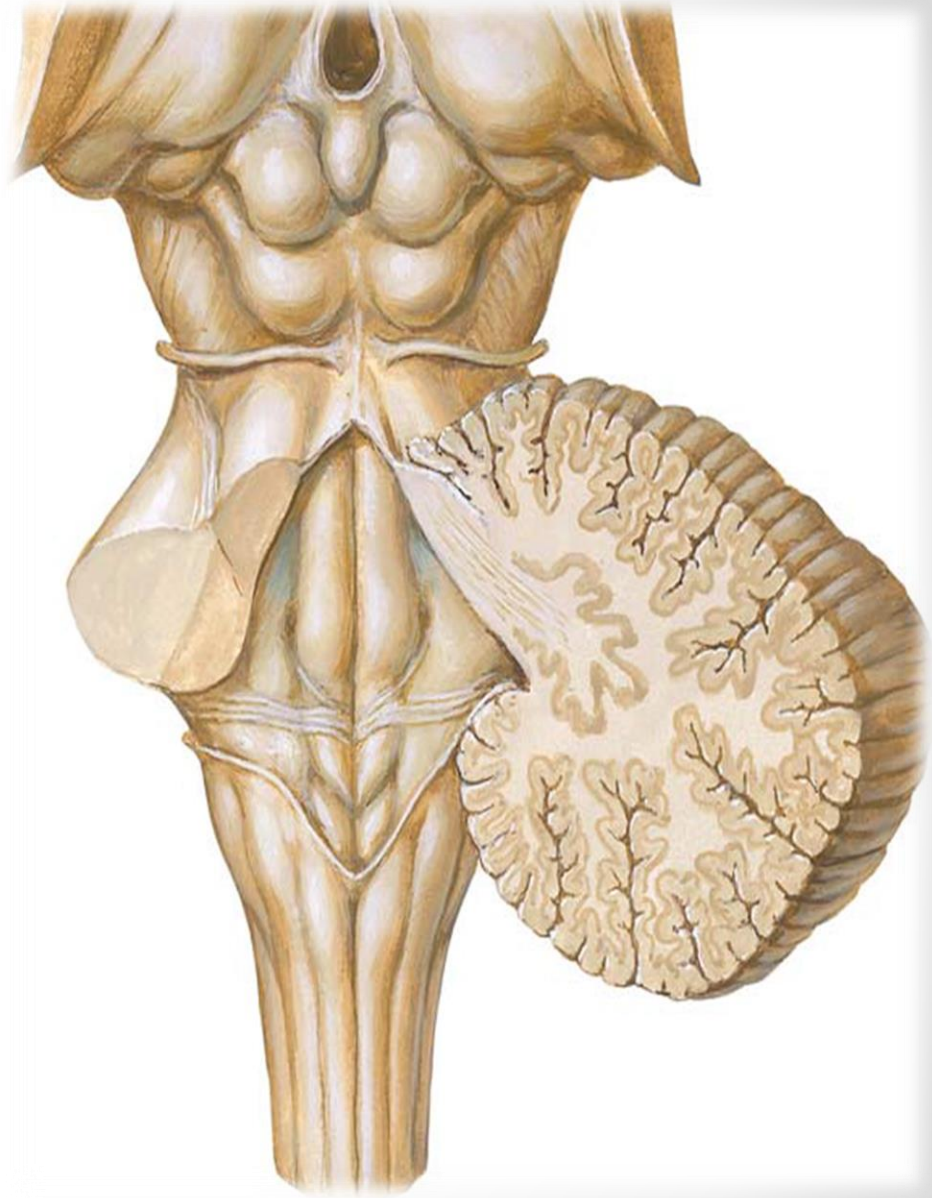


(Fig. 88)

(Fig. 88)



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1. Inferior cerebellar peduncle : It connects the cerebellum with the medulla

Afferent fibers :

- 1- Posterior spinocerebellar tract .
- 2- Olivocerebellar fibers .
- 3- Vestibulocerebellar fibers .
- 4- Dorsal external arcuate fibers .
- 5- Ventral external arcuate fibers .

Efferent fibers :

- A- Cerebello-olivary .
- B- Cerebellovestibular .
- C- Cerebelloreticular .

2. Middle Cerebellar peduncle:- It connects the cerebellum with the pons.

Afferent fibers:

6- Pontocerebellar fibers .

7- Trigemino-cerebellar fibers .

Efferent fibers:

D-Cerebellopontine fibers .

3. Superior cerebellar peduncle:- It connects the cerebellum with the midbrain.

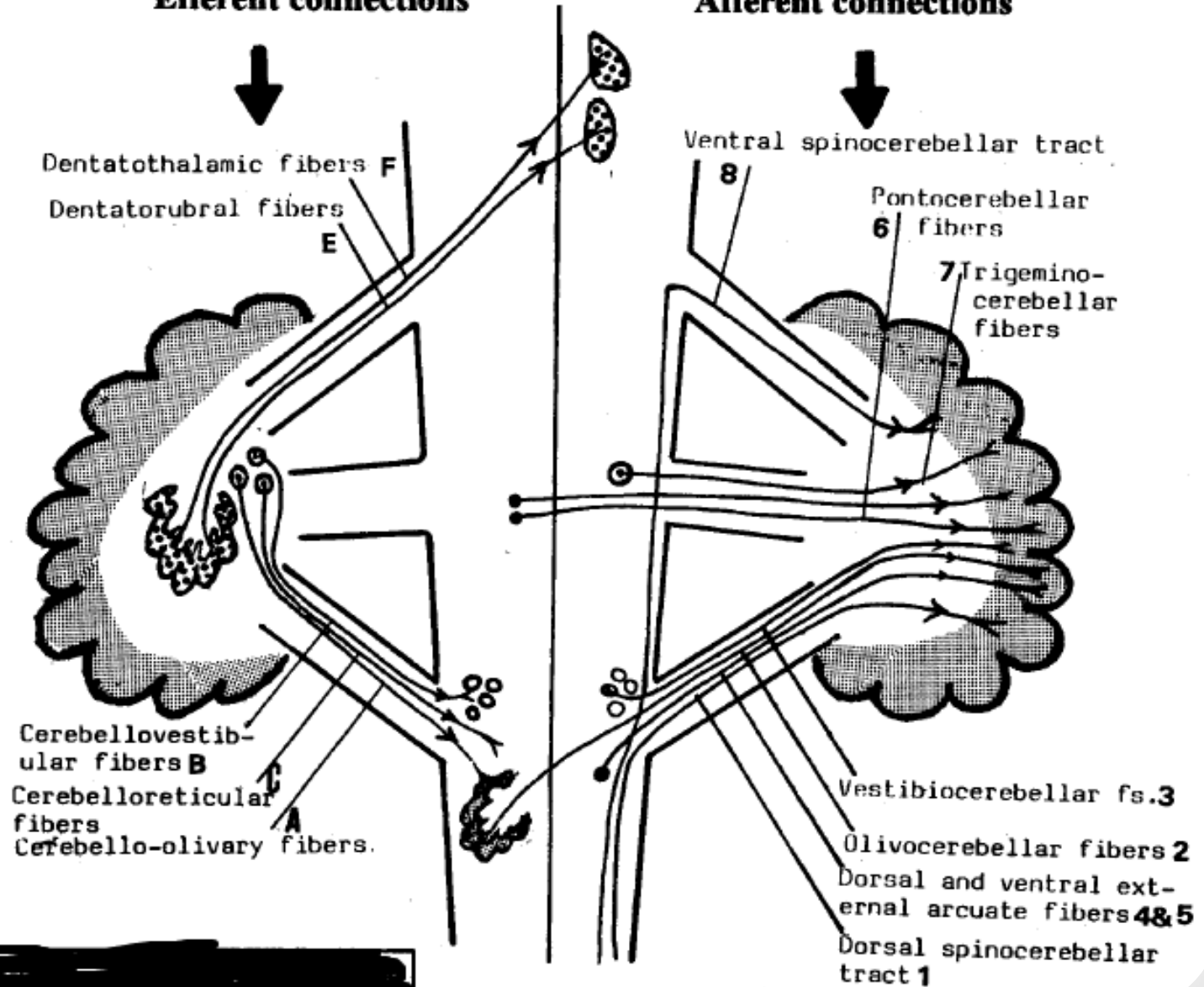
Afferent fibers: 8- Anterior spinocerebellar tract.

Efferent fibers: E-Dentato-rubral, F- Dentato-thalamic.

Connections of the cerebellum or the cerebellar peduncles

Efferent connections

Afferent connections



trac f
dorsal spinocerebellar

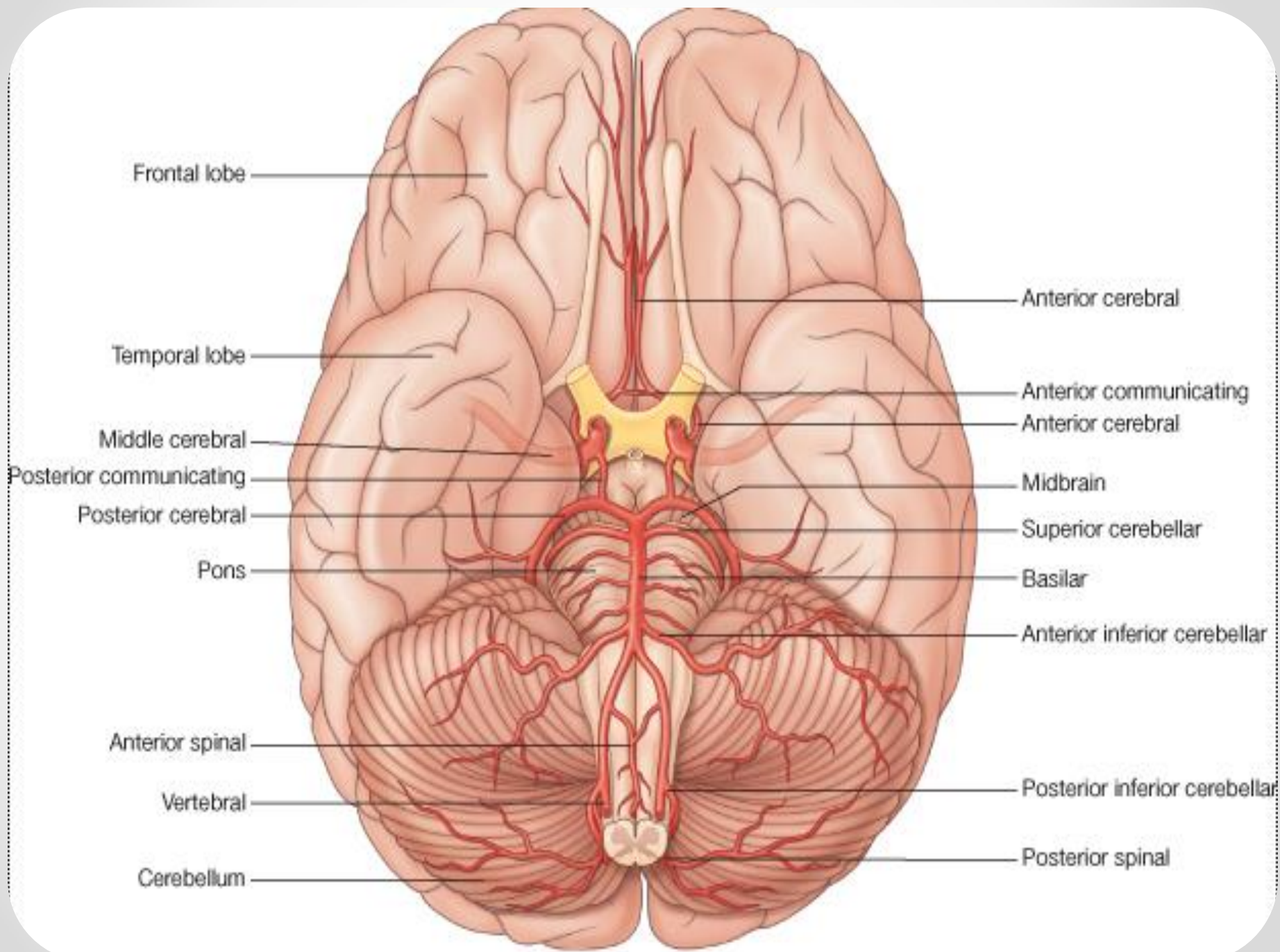
Blood Supply

Superior cerebellar artery (SCA): branch from basilar artery supplies most of cerebellar cortex, nuclei, superior vermis, middle/superior cerebellar peduncles

Anterior inferior cerebellar artery (AICA): branch from basilar artery supplies to anterior portion of the inferior cerebellum, FN, as well as CN 7,8

posterior inferior cerebellar artery (PICA): branch from vertebral artery branch supplies posterior inferior cerebellum, inferior vermis, inferior cerebellar peduncle





Function of Cerebellum:

The strongest clues to the function of the cerebellum have come from examining the consequences of damage to it. Animals and humans with cerebellar dysfunction show, above all, problems with motor control. They continue to be able to generate motor activity, but it loses precision, producing erratic, uncoordinated, or incorrectly timed movements.



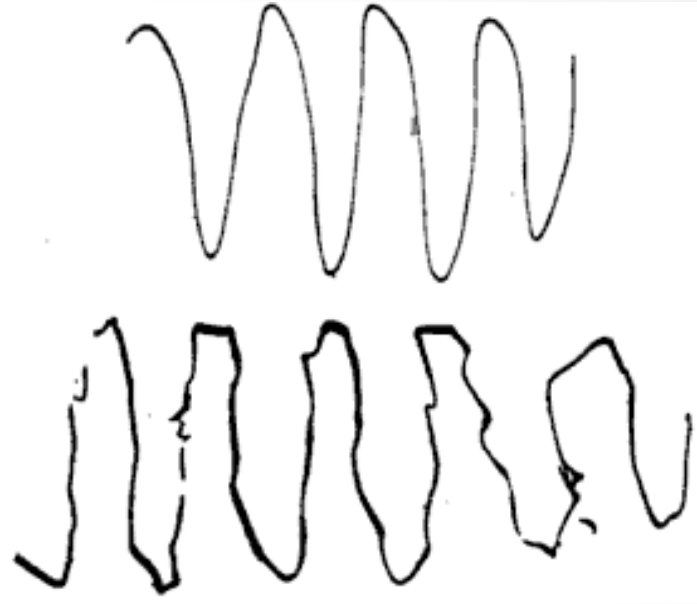
Functional imaging studies have shown cerebellar activation in relation to language, attention, and mental imagery; correlation studies have shown interactions between the cerebellum and non-motoric areas of the cerebral cortex; and a variety of non-motor symptoms have been recognized in people with damage that appears to be confined to the cerebellum.



Thus, the general conclusion reached decades ago is that the basic function of the cerebellum is not to initiate movements, or to decide which movements to execute, but rather to calibrate the detailed form of a movement.



This is a typical test used by neurologists to assess the function of Cerebellum.



The lower trace shows an attempt by a patient with cerebellar disease to reproduce the upper trace



Altered walking gait of a woman with cerebellar disease.

Functional divisions of Cerebellum

The smallest region, the Flocculonodular lobe, is often called the vestibulocerebellum . participates mainly in balance and spatial orientation; its primary connections are with the vestibular nuclei, although it also receives visual and other sensory input. Damage to it causes disturbances of balance and gait.

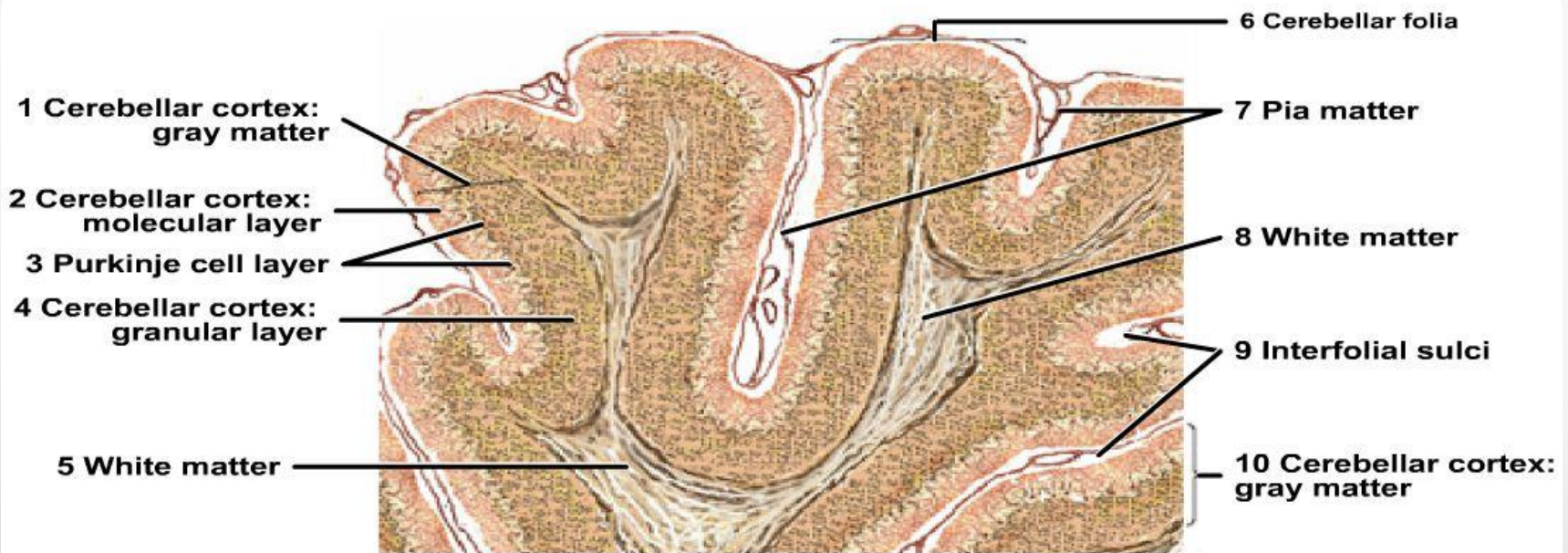


The medial zone of the anterior and posterior lobes constitutes the spinocerebellum, This sector of the cerebellum functions mainly to fine-tune body and limb movements. It receives proprioception input from the dorsal columns of the spinal cord (including the spinocerebellar tract) and from the trigeminal nerve, as well as from visual and auditory systems

Histological Picture Of Cerebellum

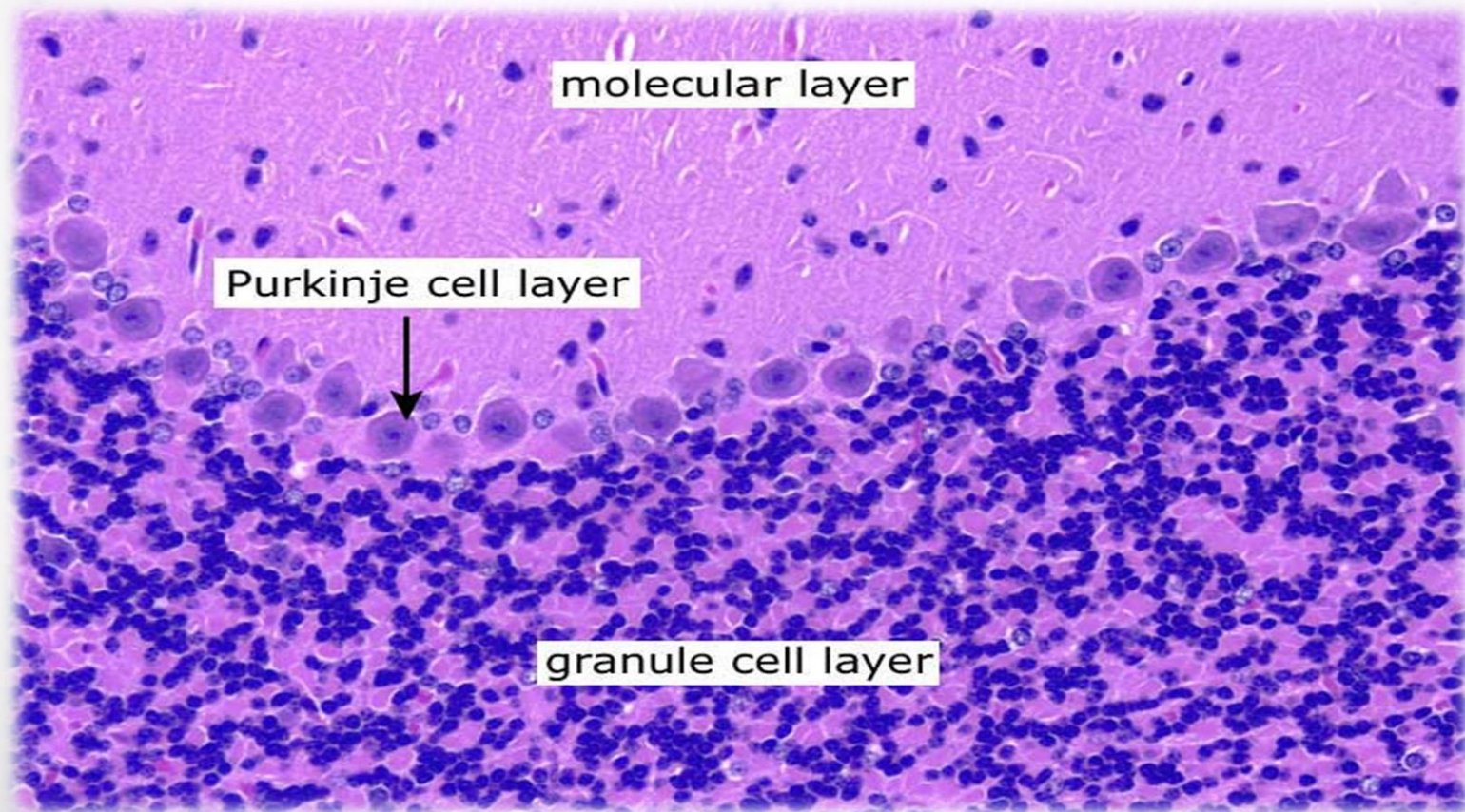
The Cerebellum consists of:

- 1.Outer cortex of grey matter
- 2.Inner core of white matter containing 4 pairs of nuclei (Dentate, Globase, Festigial, Rostiform)

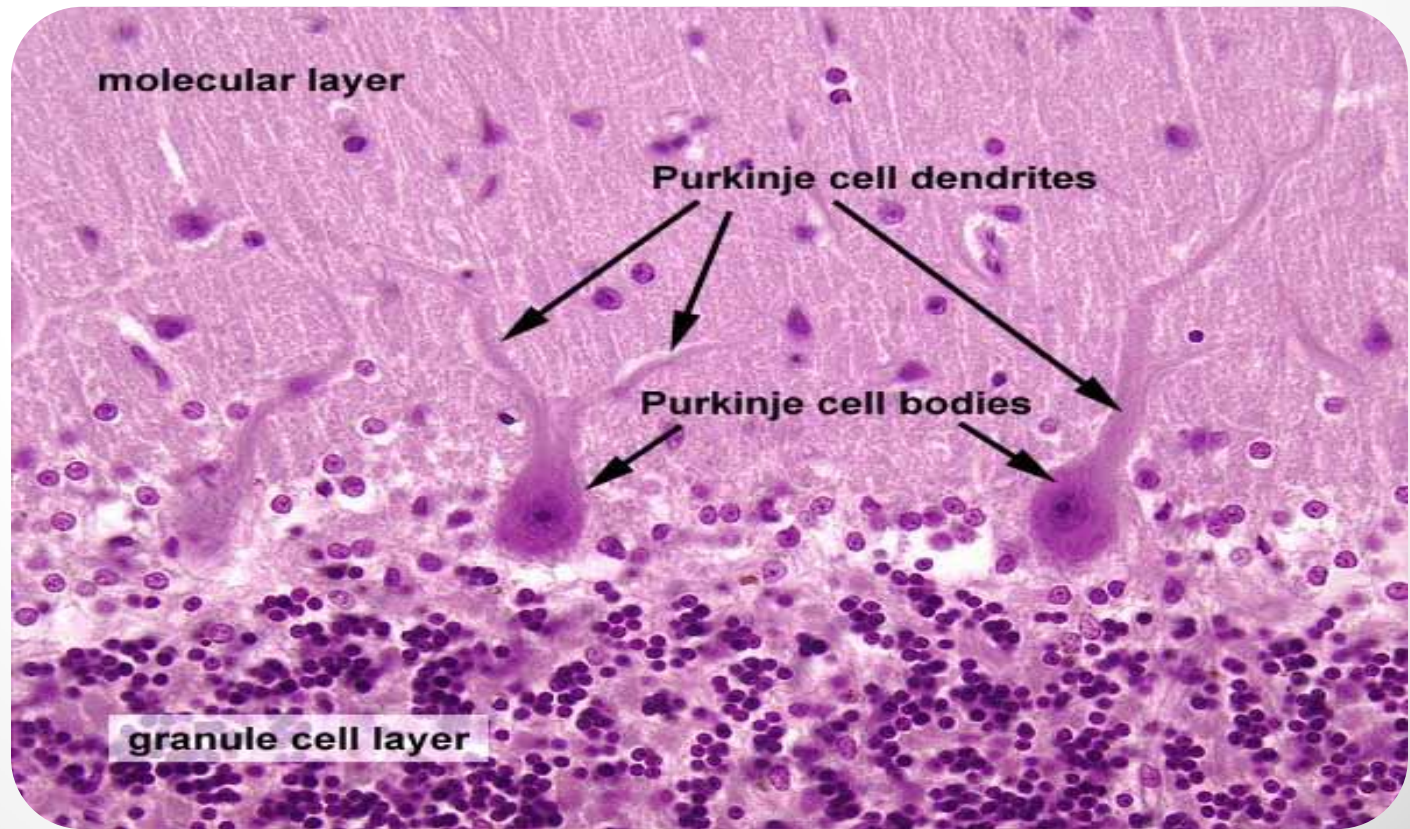


The Cerebellar cortex is thrown into a series of convolutions or Folia & it is composed of 3 layers:

1. Outer molecular layer : consisting almost entirely of granule cell axons together with Purkinje cell dendrites

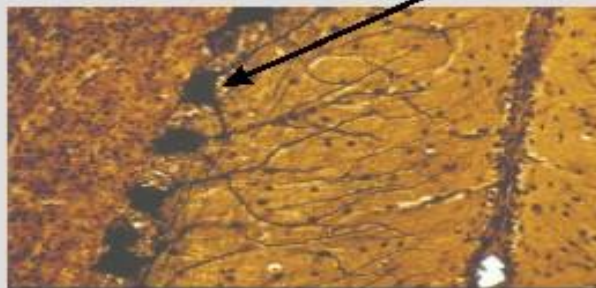
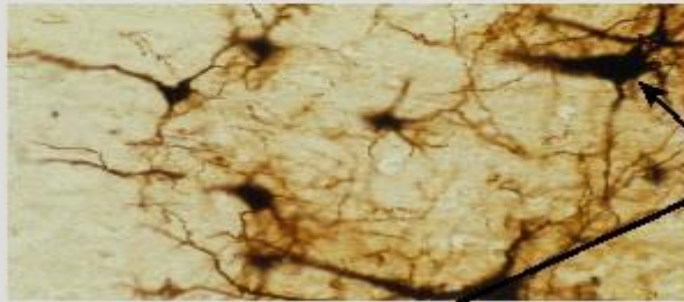


2.Inner granular layer : is highly cellular layer , packed with small cells which have densely staining nuclei and scanty cytoplasm called “granule cells” they have non-myelinated axons which pass outward to the molecular layer where they bifurcate to run parallel to the surface to synapse with dendrite of the Purkinje cells.



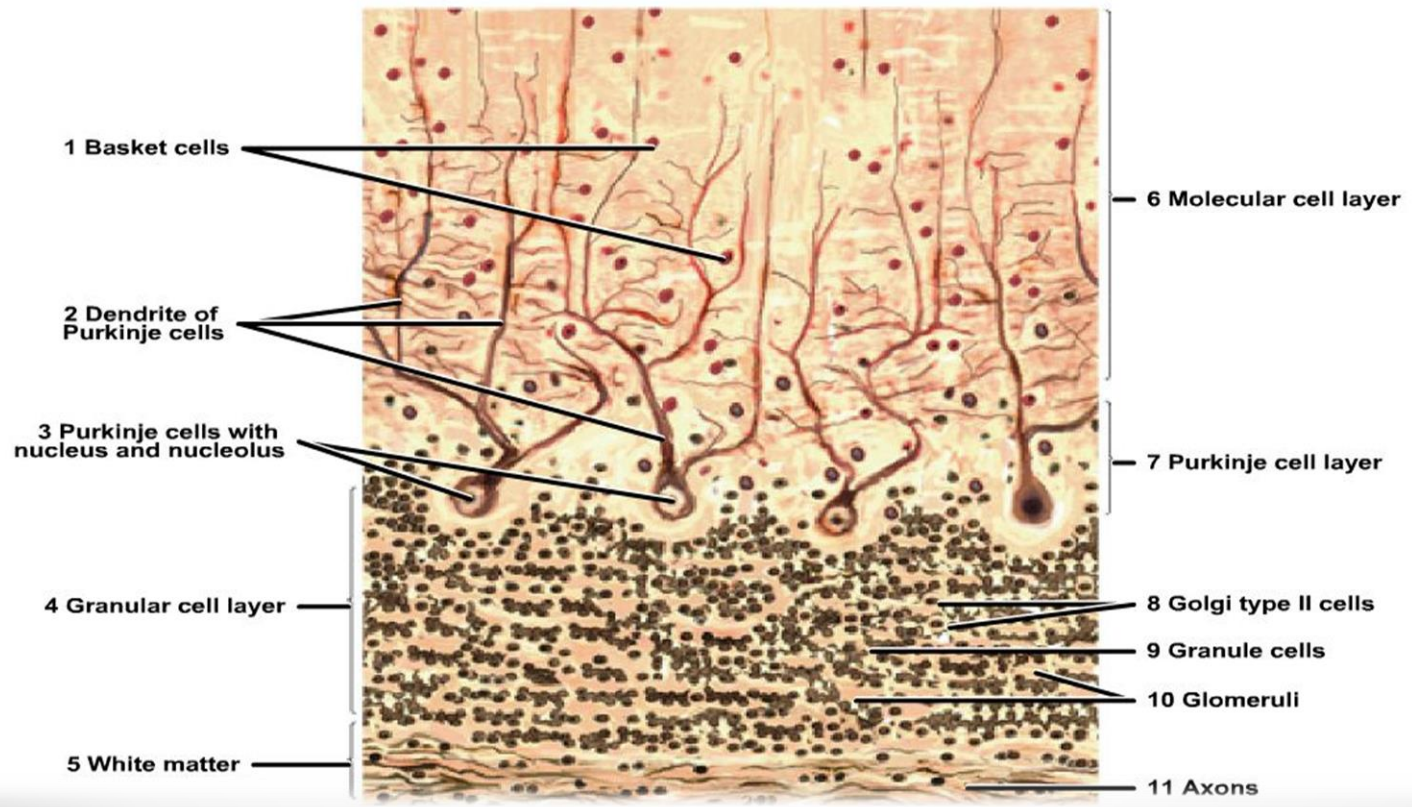
3. Purkinje cell layer : lies between the outer and inner layer consist of a huge neurons called “Purkinje cells” each cell have very large cell bodies , flask-shape with rounded nucleus , they are arranged in a single raw and each cell have fine axon arise from the base of the cell extending down through the granular layer to enter the white matter + extensively branched dendrite which branch to the outer layer where they undergo profuse branching.

Cerebellar Purkinje Cells



Purkinje cells are the largest and most distinguishing cells of the cerebellum. They have numerous dendrites and an axon which is the beginning of cerebellar outflow.

There are three other types of small neurons in the cerebellar cortex which are supportive cells called "stellate" & "Basket" cells are scattered in the molecular Layer & "Golgi cells" which are scattered in the granular layer



Cerebellum lesions

Ataxia

Altered walking gait of a person with cerebellar disease

The most salient symptoms of cerebellar dysfunction are motor related, the specific symptoms depend on which part of the cerebellum is involved and how it is disrupted

Damage to the flocculonodular lobe (the **vestibular** part) may show up as a loss of equilibrium and, in particular, an altered walking gait, with a wide stance that indicates difficulty in balancing

- ◎ Damage to the lateral zone, or the cerebrocerebellum, results in problems with skilled voluntary and planned movements. This can cause errors in the force, direction, speed and amplitude of movements. Some manifestations include **hypotonia** (decreased muscle tone), **dysarthria** (problems with speech articulation), **dysmetria** (problems judging distances or ranges of movement), **dysdiadokinesia** (inability to perform rapid alternating movements), impaired check reflex or rebound phenomenon, and tremors (involuntary movement caused by alternating contractions of opposing muscle groups).

- ① Damage to the midline portion may disrupt whole-body movements, whereas damage localized more laterally is more likely to disrupt fine movements of the hands or limbs.
- ① Damage to the upper part of the cerebellum tends to cause gait impairments and other problems with leg coordination; damage to the lower part is more likely to cause uncoordinated or poorly aimed movements of the arms and hands, as well as difficulties in speed. This complex of motor symptoms is called "ataxia".
- ① To identify cerebellar problems, the **neurological examination** includes assessment of gait (a broad-based gait being indicative of ataxia), finger-pointing tests and assessment of posture. If cerebellar dysfunction is indicated, a **magnetic resonance imaging** scan can be used to obtain a detailed picture of any structural alterations that may exist.

⊙ Aging

The human cerebellum changes with age. These changes may differ from those of other parts of the brain, for example the **gene expression** pattern in the human cerebellum shows less age-related alteration than in the **cerebral cortex**. Some studies have reported reductions in numbers of cells or volume of tissue, but the amount of data relating to this question is not very large.

⊙ Tumors

The cerebellum is occasionally afflicted by tumors. In adults, metastatic tumors are very common.

Tumors that commonly arise in the cerebellum include **pilocytic astrocytomas**, **medulloblastomas** (especially in children), and **ependymomas**, (often in the context of **von Hippel-Lindau syndrome**).