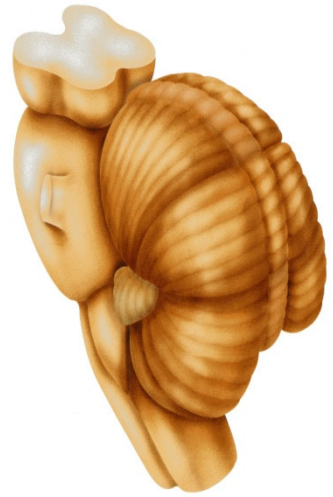
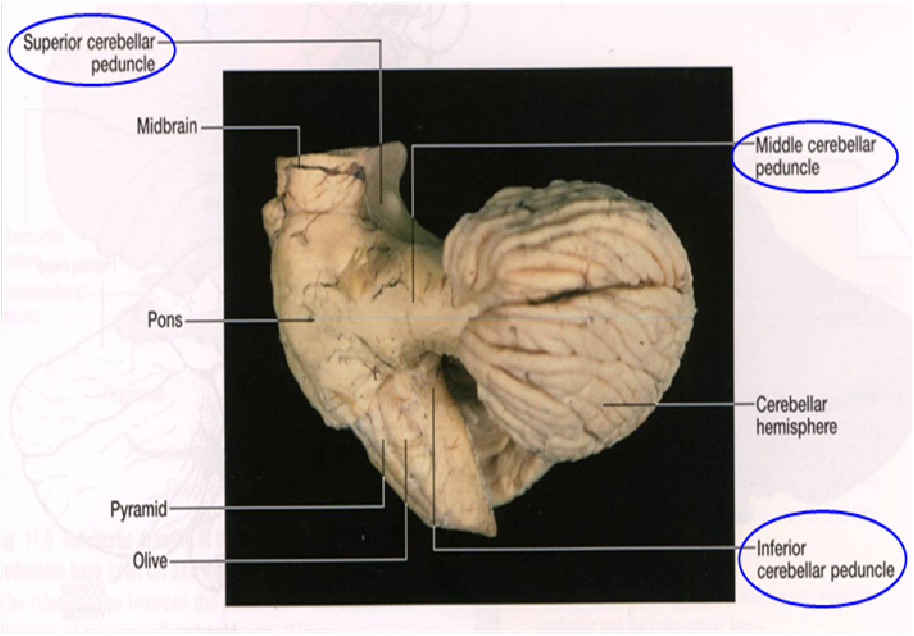
CEREBELLUM I

INTRODUCTION :

- The cerebellum is the largest part of the hindbrain.
- It originates from the dorsal aspect of the brain stem and overlies the fourth ventricle.
- The cerebellum is connected to the brain stem by three stout pairs of fibre bundles, called the **inferior, middle and superior cerebellar peduncles**, which join the cerebellum to the medulla, pons and midbrain, respectively.

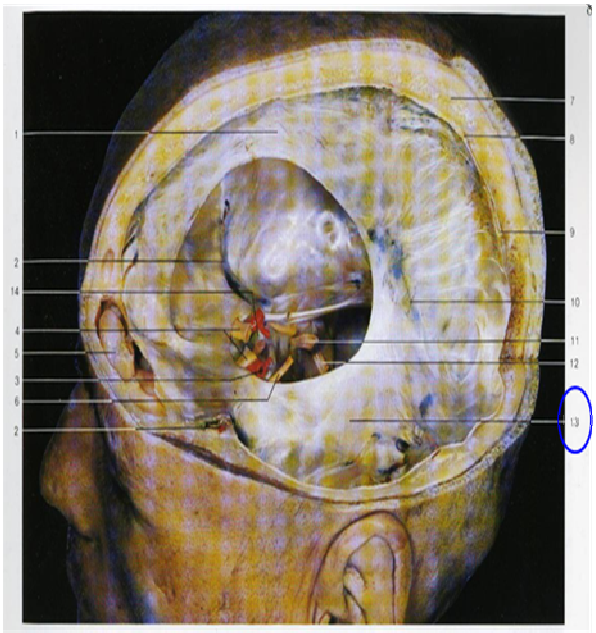


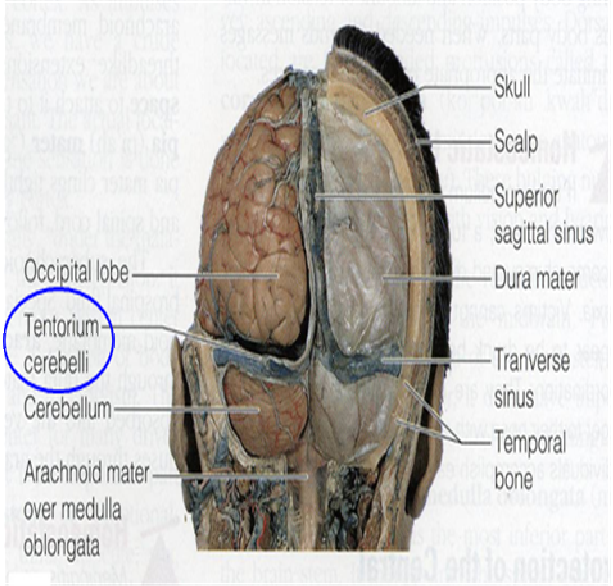


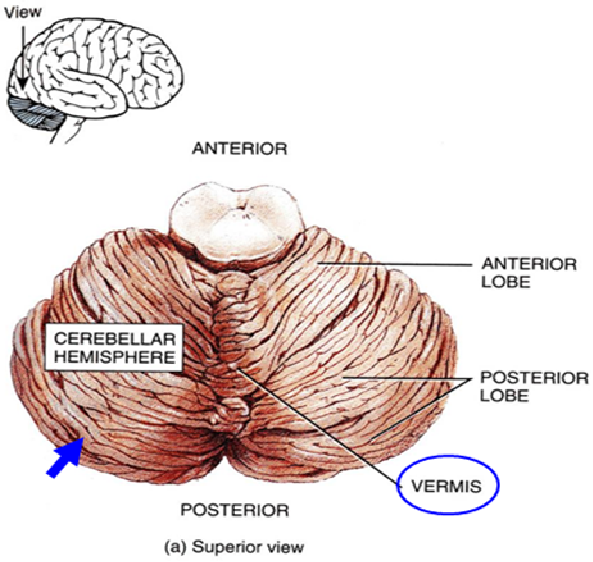
- The functions of the cerebellum are **entirely motor** and it operates at an unconscious level.
- It controls :
  - the maintenance of equilibrium (balance),
  - influences posture and muscle tone, and
  - it coordinates movement.

EXTERNAL FEATURES OF THE CEREBELLUM :

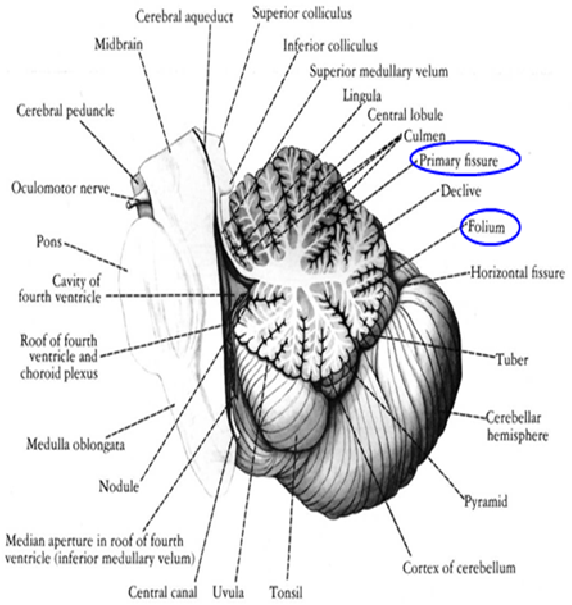
- The cerebellum consists of :
  - two laterally located **hemispheres**, joined in the midline by
  - the **vermis**.
- The superior surface of the cerebellum lies beneath the *tentorium cerebelli*.
- The **superior vermis** is raised, forming a midline ridge.
- Conversely, the **inferior vermis** lies in a deep groove between the hemispheres.
- The surface of the cerebellum is highly convoluted, the folds, or **folia,** being oriented approximately transversely.
- Between the folia lie **fissures** of varying depths.



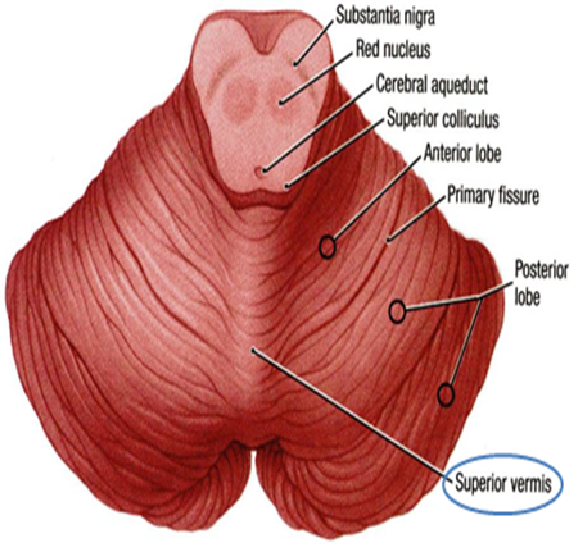




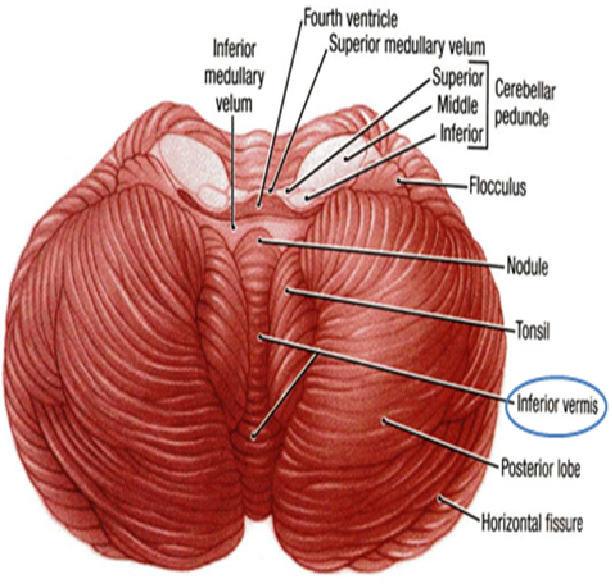
(a) Superior view



Sagittal section through the brainstem and the vermis of the cerebellum.

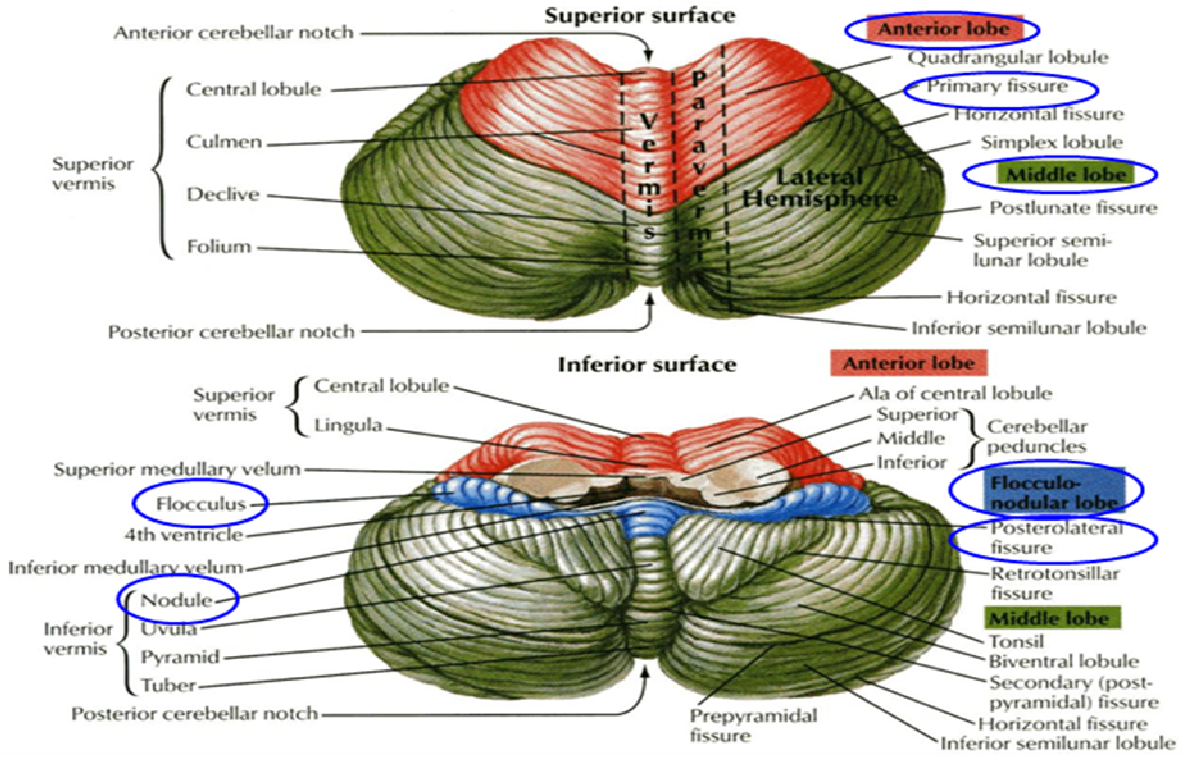


Superior View



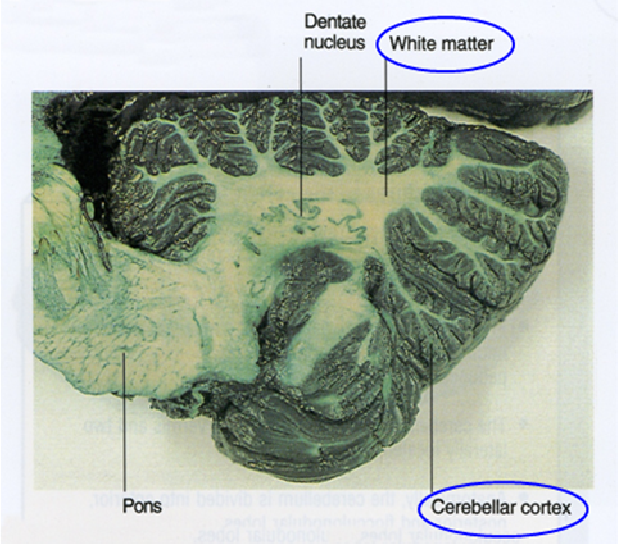
Inferior View

- Some of the fissures are landmarks that are used to divide the cerebellum anatomically into three lobes.
- On the superior surface, the deep **primary fissure**
    - separates the relatively small **anterior lobe** from
    - the much larger **posterior lobe.**
- On the underside, the conspicuous **posterolateral fissure** demarcates the location of small regions of hemisphere
    - **the flocculus** and **the nodule (of vermis)** which together form the **flocculonodular lobe.**



INTERNAL STRUCTURE OF THE CEREBELLUM :

- The cerebellum basically consists of :
    - an outer layer of grey matter, the **cerebellar cortex,** and
    - an inner core of **white matter.**
- The white matter is made up largely of afferent and efferent fibres that run to and from the cortex and towards which it extends irregular, branch-like projections.
- Buried deep within the white matter are four pairs of **cerebellar nuclei,** which have important connections with the cerebellar cortex and with certain nuclei of the brain stem and thalamus.



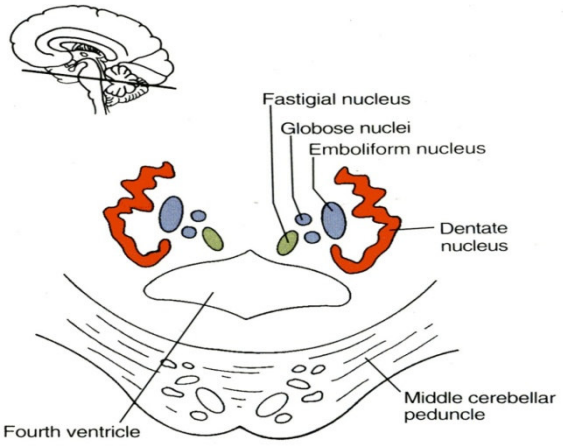
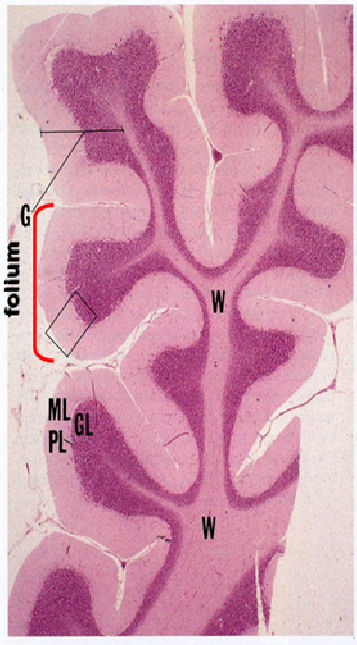
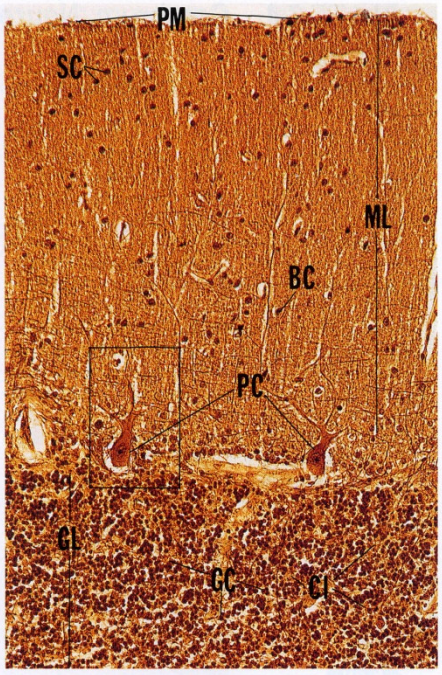


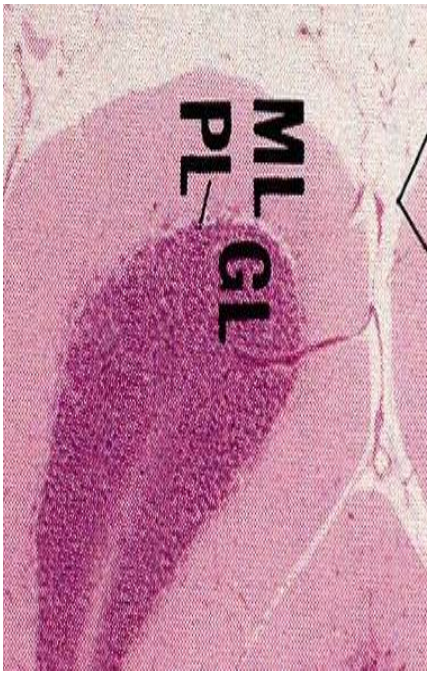
Fig. 11.7 **Transverse section through the cerebellum and brain stem at the level of the fourth ventricle, showing the cerebellar nuclei.**

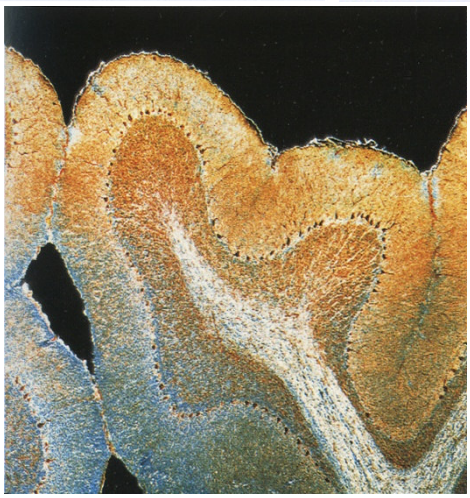
CEREBELLAR CORTEX :

- The cerebellar cortex is **highly convoluted,** forming numerous transversely oriented **folia.**
- Within the cortex lie the cell bodies, dendrites and synaptic connections of the vast majority of cerebellar neurones.
- *The cellular organisation of the cortex is the same in all regions*.
- It is divided histologically into **three layers :**
  1. The outer, fibre-rich, **molecular layer (ML)**.
  2. The intermediate, **Purkinje cell layer (PL)**.
  3. The inner **granular layer (GL),** which is dominated by the **granule cell.**





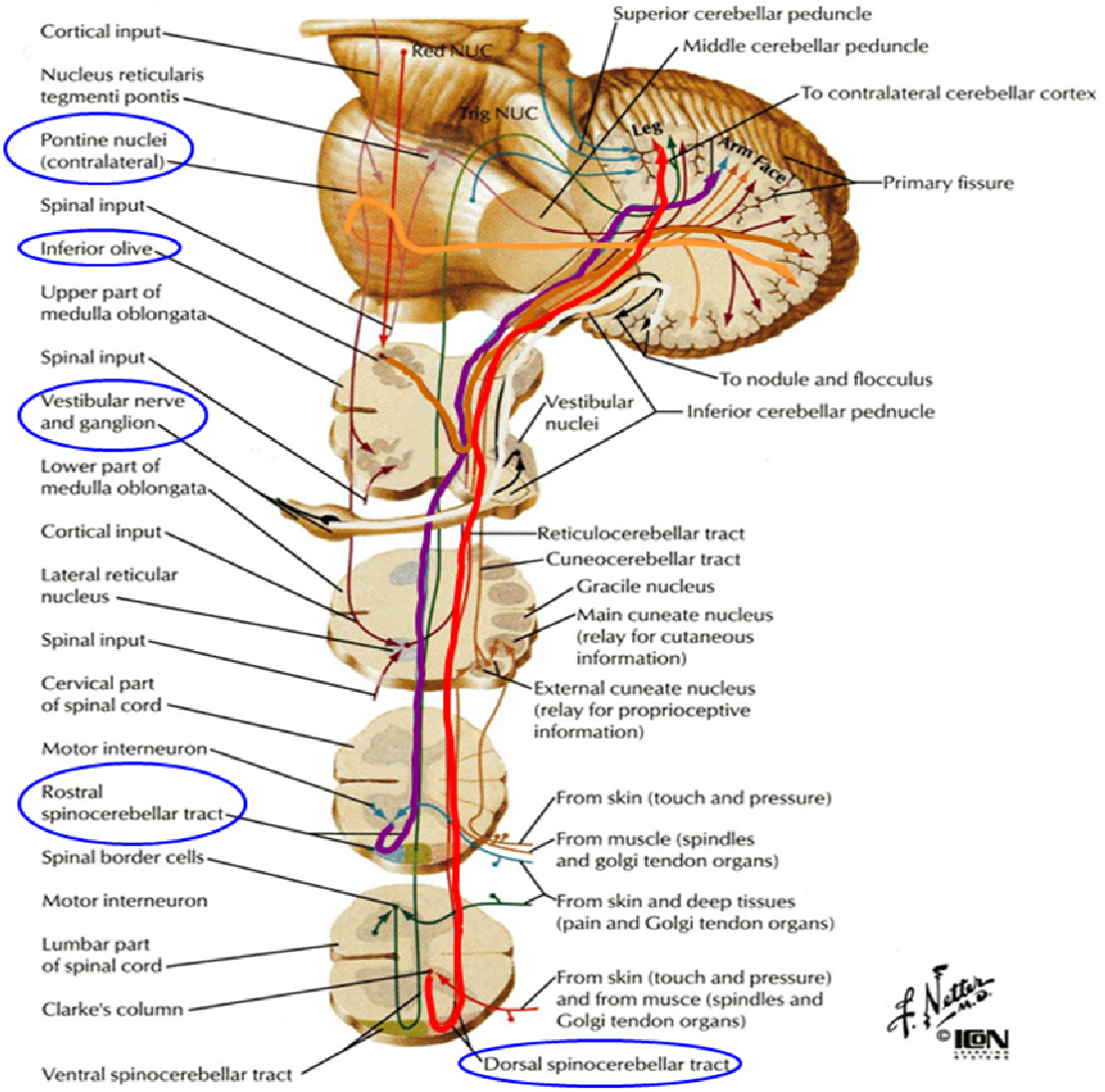




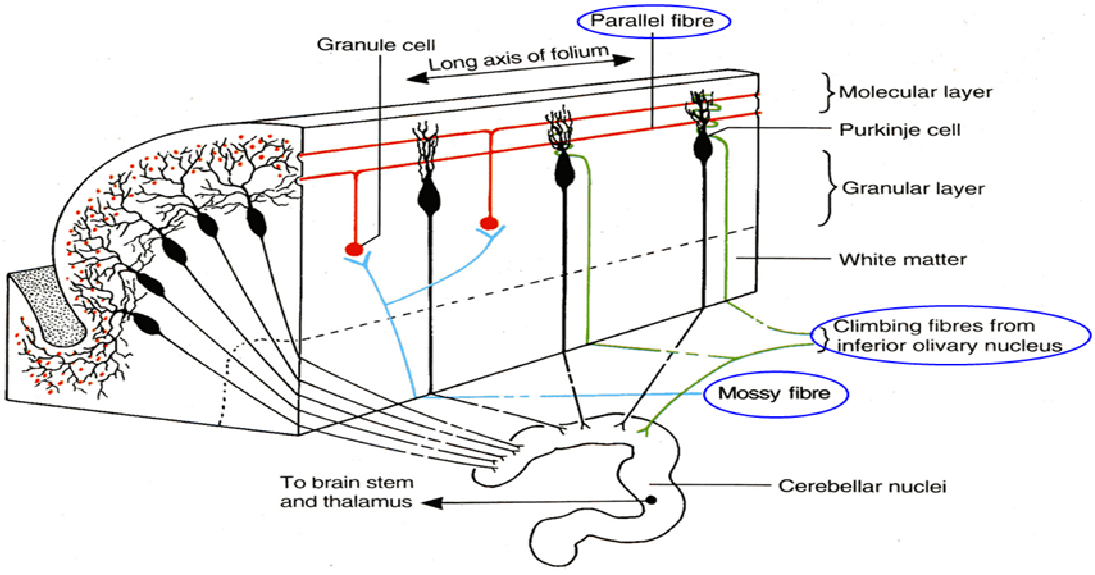
Camillo Golgi
1843-1926

AFFERENT PROJECTIONS :

- Afferent projections to the cerebellum arise principally from the
  - **spinal cord (spinocerebellar fibres),**
  - **inferior olivary nucleus (olivocerebellar fibres),**
  - **vestibular nuclei (vestibulocerebellar fibres)**, and
  - **pons (pontocerebellar fibres).**
- Afferent axons mostly terminate in the **cerebellar cortex,** where they are *excitatory* to cortical neurones.

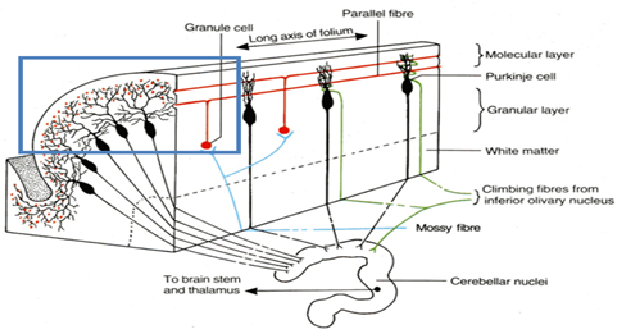


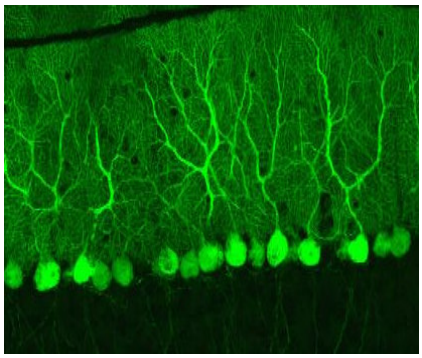
- Fibres enter the cerebellum through one of the cerebellar peduncles and proceed to the cortex as either **mossy fibres** or **climbing fibres,** *depending upon their origin*.
- All afferents originating *elsewhere than the inferior olivary nucleus* end as **mossy fibres.**
- **Mossy fibres** branch to supply several folia and end in the granular layer, in synaptic contact with granule cells.
- The axons of granule cells pass towards the surface of the cortex and enter the *molecular layer*.
- Here they bifurcate to produce two **parallel fibres** that are oriented along the long axis of the folium.

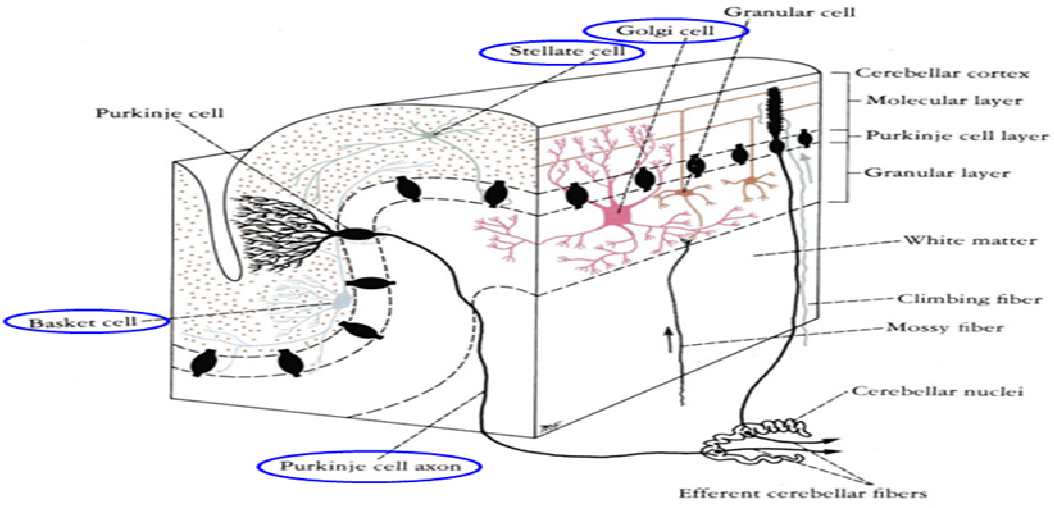


PURKINJE CELL LAYER :

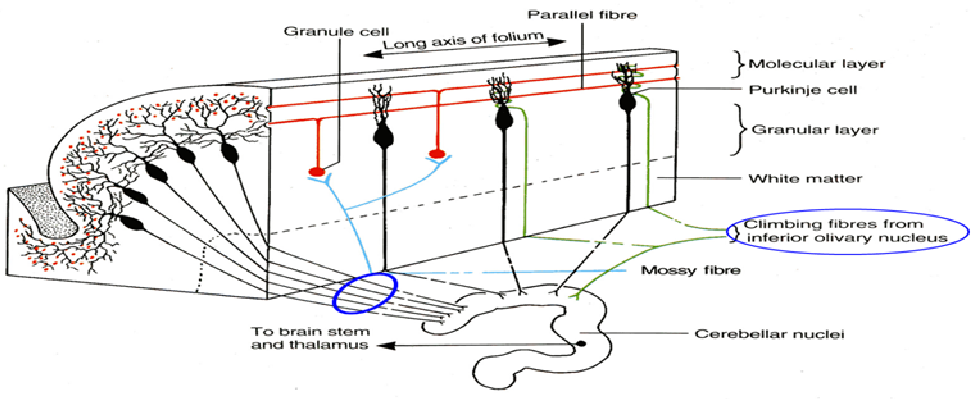
- The Purkinje cell layer consists of a *unicellular layer* of the somata of Purkinje neurones.
- The *profuse dendritic arborisations* of these cells extend towards the surface of the cortex, into the molecular layer.
- *The arborisations are flattened and oriented at right angles to the long axis of the folium*.
- They are, therefore, traversed by numerous parallel fibres, from which they receive excitatory synaptic input.
- **Inhibitory modulation of intracortical circuitry** is provided by numerous other neurones known as ***Golgi, basket*** and ***stellate cells.***
- The axons of Purkinje cells are the only axons to leave the cerebellar cortex.





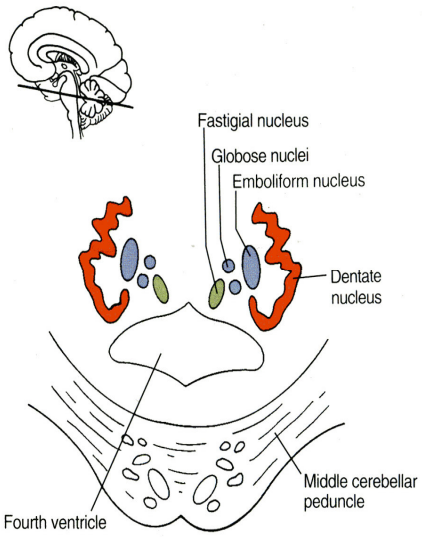


- The great majority of the Purkinje cell axons do not leave the cerebellum entirely but end in the deep cerebellar nuclei.
- The other type of afferent fibre entering the cerebellar cortex, the **climbing fibre,** originates from the inferior olivary nucleus of the medulla.
- These fibres provide relatively discrete excitatory input to Purkinje cells.
- At the same time, axon collaterals of climbing fibres excite the neurones of the deep cerebellar nuclei.
- Purkinje cells utilise GABA as their neurotransmitter, which means that the output of almost the whole of the cerebellar cortex is mediated through the inhibition of cells in the cerebellar nuclei.

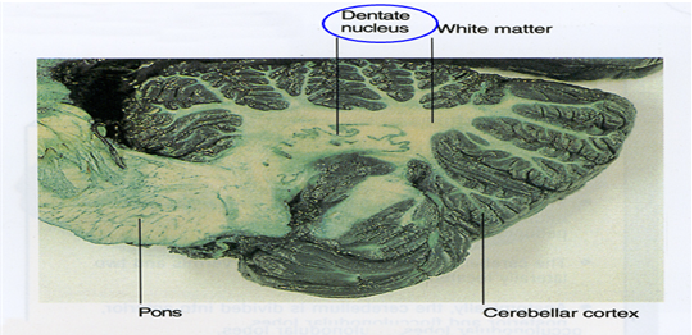


CEREBELLAR NUCLEI :

- Deep within the cerebellar white matter, above the roof of the fourth ventricle, lie four pairs of nuclei.
- From medial to lateral, they are known as :
    - **Fastigial nucleus**.
    - **Globose nucleus**.
    - **Emboliform nucleus.**
    - **Dentate nucleus**.



- The dentate nucleus is by far the largest of the cerebellar nuclei and is the only one that can be discerned clearly with the naked eye.
- It consists of a thin layer of nerve cells folded into a crinkled bag; as a result, it appears somewhat similar to the inferior olivary nucleus of the medulla, from which it receives afferent fibres.
- The cerebellar nuclei also receive extra-cerebellar afferents from the :
    - reticular nuclei,
    - pontine nuclei,
    - vestibular nuclei, and
    - spinocerebellar tracts,
    - predominantly by means of collaterals of mossy fibres destined for the cerebellar cortex.



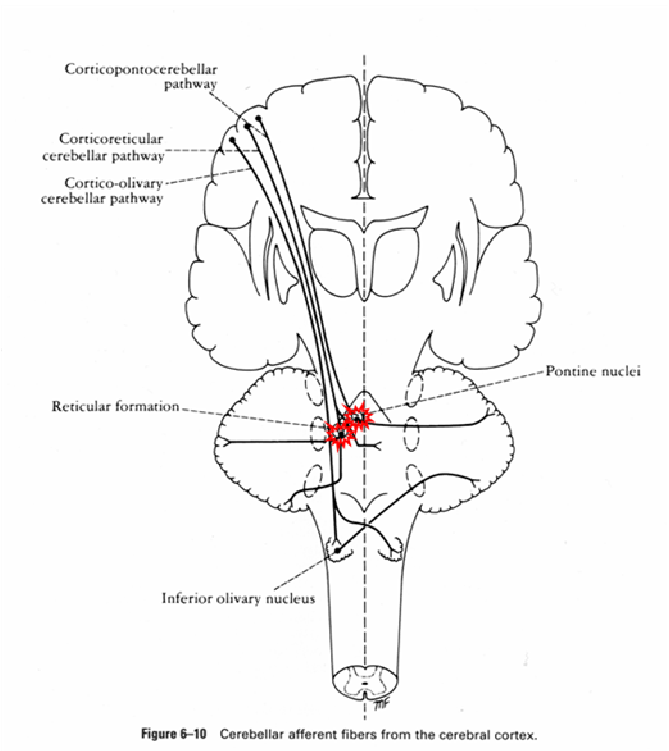


Figure 6–10 Cerebellar afferent fibers from the cerebral cortex.

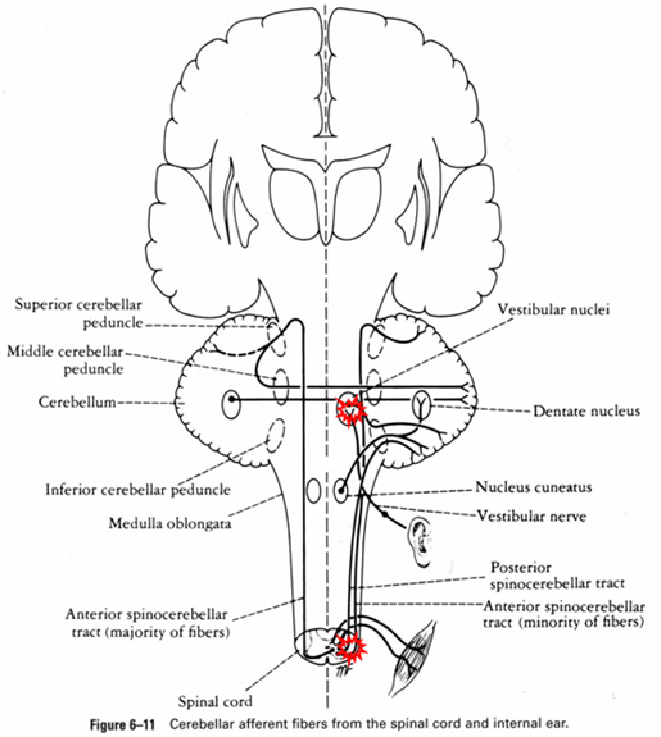


Figure 6–11 Cerebellar afferent fibers from the spinal cord and internal ear.

- From within the cerebellum, the nuclei receive dense innervation from the Purkinje cells of the cerebellar cortex itself.
- The cerebellar nuclei constitute the primary source of efferent fibres from the cerebellum to other parts of brain.
- The principal destinations of **efferent fibres** are :
    - The **reticular** and
    - **vestibular nuclei** of the medulla & pons,
    - The **red nucleus** of the midbrain and
    - the **ventral lateral nucleus** of the thalamus.

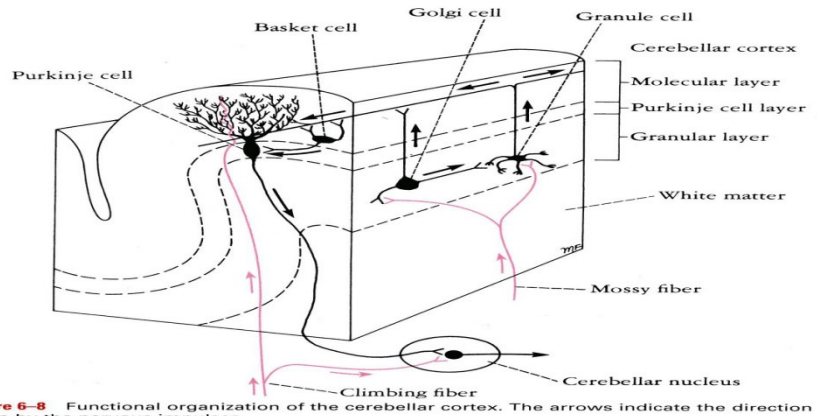


Figure 6–8 Functional organization of the cerebellar cortex. The arrows indicate the direction taken by the nervous impulses.

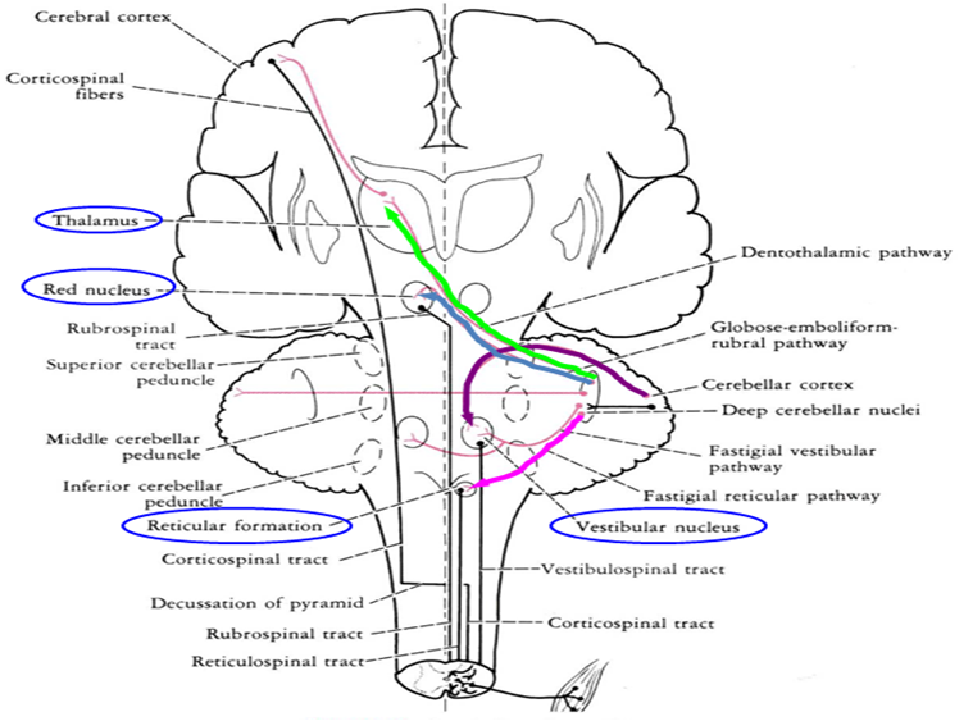


Figure 6–12 Cerebellar efferent fibers.

THE END

LoveTomy Team 426

Team leader : Dr. hams

Dr. S Dr. noop Omar H

ابتسم !! همي بروحي

M.A.M Abo Slo7 Cute Killer

REVIEW

IMPORTANT NOTES :

1. The cerebellum controls the maintenance of *equilibrium*, *posture* and *muscle tone* and it coordinates *movement*. It operates at an *unconscious* level.
2. The cerebellum developed from **metencephalon**.
3. The cerebellum is connected to the *medulla, pons* and *midbrain* by *inferior, middle* and *superior* cerebellar peduncles, respectively.
4. The cerebellum consists of a midline **vermis** and tow laterally located hemispheres.
5. Anatomically, the cerebellum is divided in to anterior, posterior and flocculonodular lobes.
6. Internally, the cerebellum consists of a surface layer of cortex, highly convoluted to form **folia**, beneath which lies white matter.

CEREBELLUM – THE RULE OF THREE

3 Lobes	• Anterior lobe • Posterior lobe • Flocculonodular lobe
3 Cortical Layers	• Molecular layer • Purkinje cell layer • Granular layer
3 Purkinje's cells afferent paths	• Mossy fibers • Climbing fibers • Aminergic fibers
3 Pairs of deep nuclei	• Fastigial • Interposed (globose & emboliform) • Dentate
3 Pairs of peduncles	• Superior (pri. Output) • Middle (pri. Input) • Inferior (pri. Input)
3 Functional division	• Vestibulo-cerebellum • Spino-cerebellum • Cerebro-cerebellum

SELF QUIZ

1- Regarding the cerebellum, all of the following are false EXCEPT :

a. Cerebellum is the largest part of the forebrain.
b. Originate from the dorsal aspect of the diencephalon.
c. Connect to brain stem by cerebellar peduncles.
d. Developed from mesencephalon.
e. None of the above.

2- Regarding the external features of the cerebellum, all of the following are false EXCEPT :

a. Primary fissure separates the large anterior lobe.
b. The cerebellum lies beneath falx cerebelli.
c. Cerebellum is divided in to two laterally flocculonodular.
d. Vermis joined the tow cerebellar hemispheres.
e. None of the above.

3- Regarding the internal features cerebellum, all of the following are true EXCEPT :

a. Consists of an outer layer of gray matter (cerebellar cortex).
b. The cerebellar peduncle proceed to the cortex as mossy fibers only.
c. Intermediate layer of the cortex is Purkinje cell layer.
d. The Purkinje cell layer consists of unicellular layer of somata of Purkinje neurons.
e. Purkinje cells utilize GABA as their neurotransmitter.

1. c	2. d	3. b