

CEREBELLUM II

FUNCTIONAL ANATOMY OF THE CEREBELLUM :

- The cerebellum is often regarded as consisting of *three functional subdivisions*, based upon phylogenetic, anatomical and functional considerations.
 - **The archicerebellum**, or oldest portion in phylogenetic terms, is equated with the **flocculonodular lobe** and the associated **fastigial nuclei**.
 - **The paleocerebellum** approximates to the midline **vermis** and surrounding **paravermis**, together with the **globose** and **emboliform nuclei**.
 - **The neocerebellum** comprises the remainder (and vast majority) of the **cerebellar hemisphere** and the **dentate nuclei**.

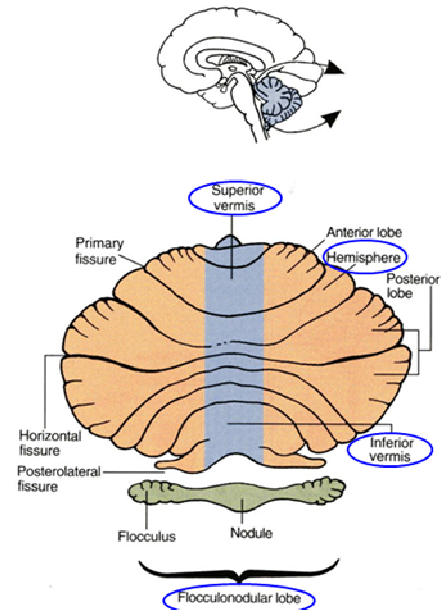
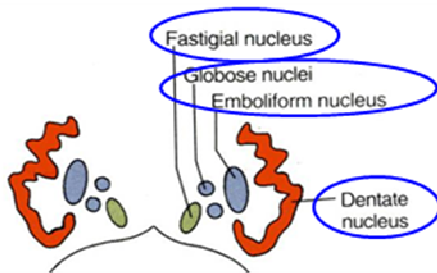


Fig. 11.5 Schematic drawing of the cerebellum in which the peduncles have been cut and the surface flattened out. The relationships between the anatomical and functional divisions of the cerebellum are shown. (Green, archicerebellum; blue, paleocerebellum; pink, neocerebellum.)

ARCHICEREBELLUM :

- The archicerebellum is primarily concerned with the **maintenance of balance (equilibrium)**.
- It has extensive connections with the **vestibular** and **reticular nuclei** of the brain stem, through the inferior cerebellar peduncles.
- **Vestibular information** is carried from the vestibular nuclei to the cortex of the ipsilateral flocculonodular lobe.
- Cortical efferent (Purkinje cell) fibres project to the **fastigial nucleus**, which, in turn, projects back to the vestibular nuclei and to the reticular formation.
- A significant proportion of fastigial efferents cross to the contralateral side of the brain stem.
- The influence of the archicerebellum upon the lower motor system is, therefore, **bilateral** and principally mediated by means of **descending vestibulospinal and reticulospinal projections**.

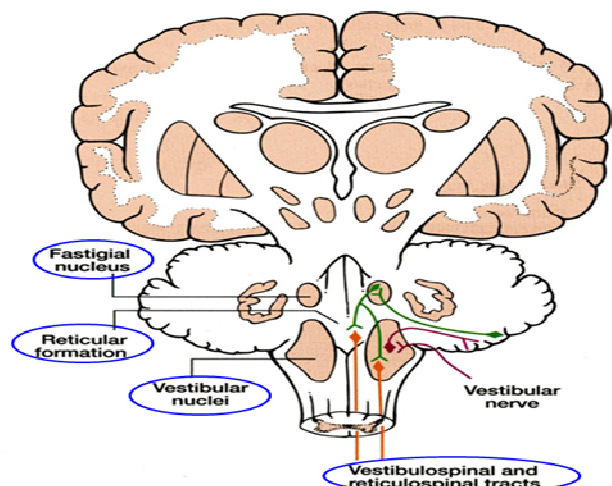


Fig. 11.10 Connections of the archicerebellum. Contralateral projections of the fastigial nucleus are not shown.

PALEOCEREBELLUM :

- The paleocerebellum influences **muscle tone** and **posture**.
- **Afferents** consist principally of **dorsal and ventral spinocerebellar tract** neurones that carry information from muscle, joint and cutaneous receptors and enter the cerebellum through the inferior and superior cerebellar peduncles, respectively.
- Fibres terminate largely in the **cortex of the ipsilateral vermis and paravermis**.
- Cerebellar cortical **efferents** from these areas pass to the **globose** and **emboliform nuclei** and also to the **fastigial nucleus**.
- The globose and emboliform nuclei project via the superior cerebellar peduncle to the **contralateral red nucleus** of the midbrain, where they influence the activity of cells giving rise to the descending **rubrospinal tract**.

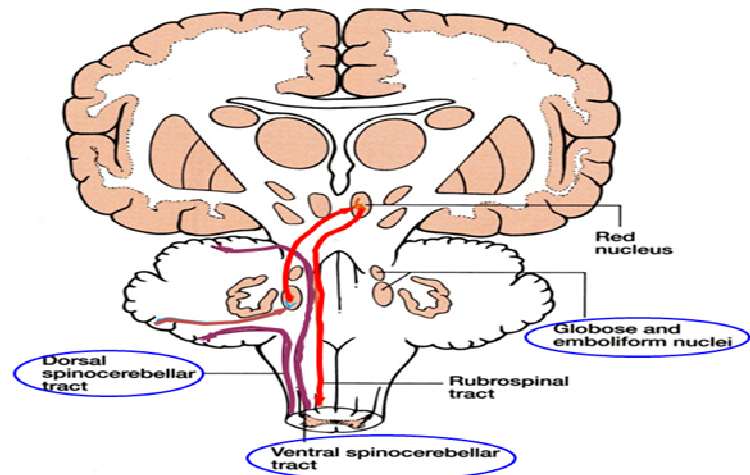


Fig. 11.11 Connections of the paleocerebellum.

NEOCEREBELLUM :

- The neocerebellum is concerned with muscular coordination, including the **trajectory, speed and force of movements**.
- The principal **afferent pathway** consists of **pontocerebellar fibres**.
- These originate in the **pontine nuclei** of the basal portion of the pons and cross to the opposite side, entering the cerebellum through its middle peduncle.
- Pontocerebellar neurones are **influenced by** widespread regions of the **cerebral cortex** involved in the planning and execution of movement.
- Pontocerebellar fibres terminate predominantly in the **lateral parts of the cerebellar hemisphere**.
- **Output** from the neocerebellar cortex is directed to the **dentate nucleus**.
- The dentate nucleus, in turn, projects to the contralateral red nucleus and **ventral lateral nucleus of the thalamus**.
- The dentate is the largest of cerebellar nuclei and its efferents form a major part of **superior cerebellar peduncle**.
- The fibres **decussate** in the caudal midbrain just before reaching the red nucleus.
- Some relay in the red nucleus with rubrothalamic cells but most bypass the red nucleus and pass directly to the **ventral lateral thalamus**.
- The **ventral lateral nucleus of the thalamus** projects to the cerebral cortex, particularly **the motor cortex of the frontal lobe**.
- The neocerebellum thus exerts its **coordinating role in movement** primarily **through an action on cerebral cortical areas**, giving rise to **descending corticospinal and corticobulbar pathways**.

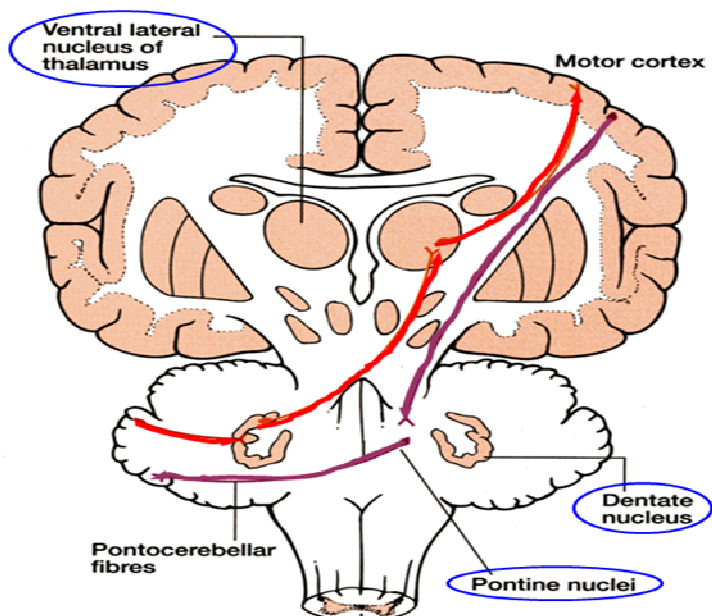


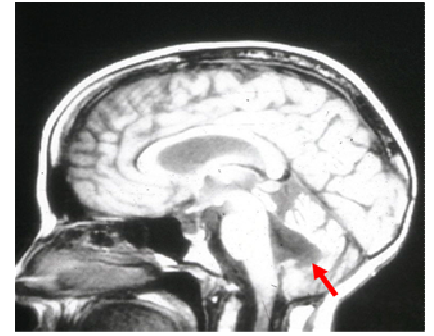
Fig. 11.12 Connections of the neocerebellum.

Afferent comes from	Goes to the cerebellar cortex	Efferent passes through	Goes from the cerebrum	To	Notes
Vestibular nucleus	Ipsilateral	Fastigial N.	Ipsilateral + Contralateral	Vestibular nucleus (then vestibulospinal tract)	1- It's a two-way pathway 2- Concerned with BALANCE 3- Thru inf. cerebellar ped. 4- The effect is Bilateral 5- From "Archicerebellum"
Reticular nucleus	Ipsilateral	Fastigial N.	Ipsilateral + Contralateral	Reticular nucleus (then reticulospinal tract)	1- It's a two-way pathway 2- Concerned with BALANCE 3- Thru inf. cerebellar ped. 4- The effect is Bilateral 5- From "Archicerebellum"
Spinocerebellar tract " vent. + dors. "	Ipsilateral	Globose + Emboliform nuclei	Contralateral	Red nucleus (then rubrospinal tract)	1- Responsible for muscle tone and posture 2- Thru sup. + inf. afferent 3- Thru sup. cerebellar P. efferent 4- From paleocerebellum
Pontocerebellar tract	Contralateral	Dentate N.	Contralateral	Vent. Lat. N. of the thalamus (some relay in red nucleus) then to the cortex	1- Coordination 2- Afferent "mid cerebellar P." 3- Efferent "sup. cerebellar P." 4- From neocerebellum

LESIONS OF THE CEREBELLUM

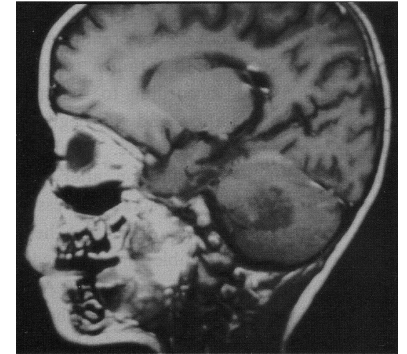
MIDLINE LESIONS :

- A **midline lesion of the cerebellum** (such as a tumour) **leads to loss of postural control**; as a result it is impossible to stand or sit without toppling over, despite preserved coordination of the limbs.
- Sagittal view of patient who had a **medulloblastoma** surgically removed.
- The large hole in the middle of the cerebellum is where the tumor used to be.
- This patient was very unsteady and had strong positional nystagmus due to removal of her cerebellar nodulus.



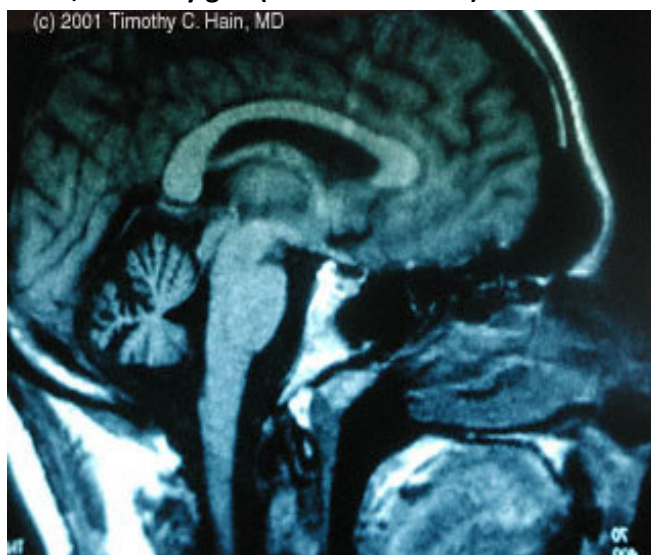
UNILATERAL LESIONS OF THE HEMISPHERE :

- Because of the pattern of ipsilateral and decussated pathways that enter and leave the cerebellum, **unilateral lesions of the cerebellar hemisphere cause symptoms on the same side of the body.**
- This is in contrast to cerebral lesions (e.g. in the cerebral cortex, internal capsule or basal ganglia), which give rise to contralateral symptoms.
- Cerebellar hemisphere glioma (MRI).



CEREBELLAR ATAXIA :

- **Bilateral dysfunction of the cerebellum**, caused by :
 - alcoholic intoxication,
 - hypothyroidism,
 - inherited cerebellar degeneration/ataxia,
 - multiple sclerosis, or
 - non-metastatic disease.
- **Causes :**
 - **slowness and slurring of speech (dysarthria),**
 - **incoordination of both arms, and**
 - **a staggering, wide-based, unsteady gait (cerebellar ataxia).**



Inherited cerebellar degeneration of unknown origin

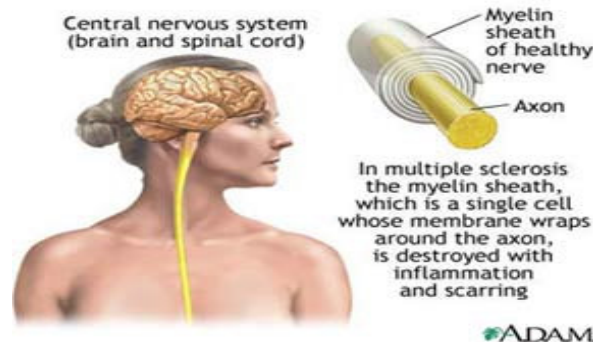
NYSTAGMUS :

- Cerebellar lesions also **impair coordination of eye movements** and the eyes exhibit a to-and-fro motion (**nystagmus**), greatest in amplitude when gaze is directed to the same side as the lesion.
- Nystagmus is a very common feature of **multiple sclerosis**.
- **The combination of nystagmus with dysarthria and intention tremor** constitutes '**Charcot's triad**', which is highly diagnostic of the disease.



Jean-Martin Charcot
1825-1893

MULTIPLE SCLEROSIS :



ADAM

Multiple sclerosis

Despite extensive research, the underlying cause of multiple sclerosis is not known. Some experts believe its cause could be a combination of a viral infection, destruction of the body's immune system and heredity. Here's a look at the crippling disease:

SYMPTOMS

Vary according to which nerves are infected

Urinating

Urinary tract infections, lack of control in urinating

Visibility

Temporary blurring of vision, pain behind eyes

Feeling

Tingling and numbness

Movement

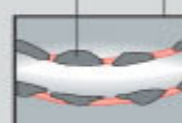
Unsteady movement, weak muscles, muscle spasms

THE DISEASE

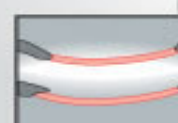
- Multiple sclerosis occurs in any part of the brain and spinal cord's nerves
- Nerve tracts, or pathways, are sheathed in a covering called myelin. Myelin sheath acts as an insulating material, enabling speedy passage of electrical impulses along the nerves
- Multiple sclerosis makes the myelin sheath become inflamed, swollen and eventually die, reducing the nerves' passage of impulses

NERVES

Myelin



Healthy



Damaged

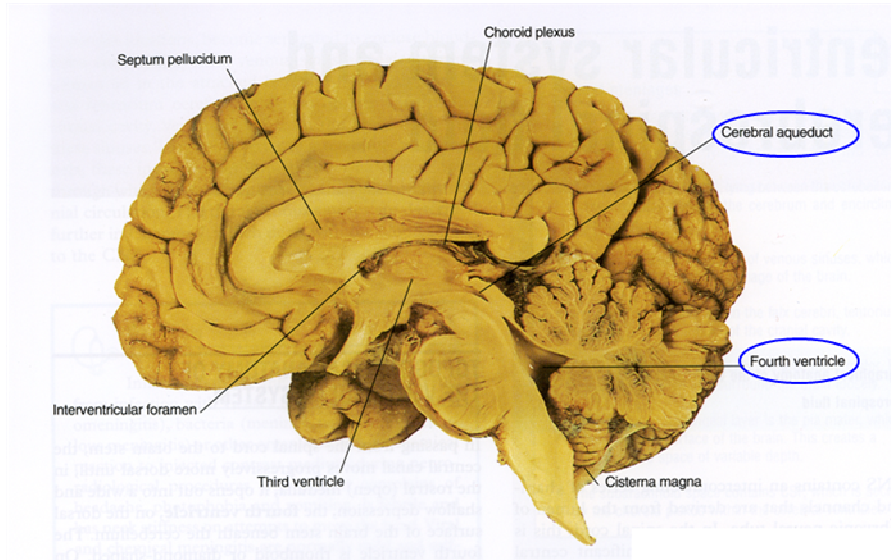
SOURCES: THE AMERICAN MEDICAL ASSOCIATION, FAMILY MEDICAL GUIDE, THE COMPLETE FAMILY HEALTH ENCYCLOPEDIA, NEWS IN MOTION

TIM GOHEEN KNIGHT - RIDDER/TRIBUNE

THE FOURTH VENTRICLE

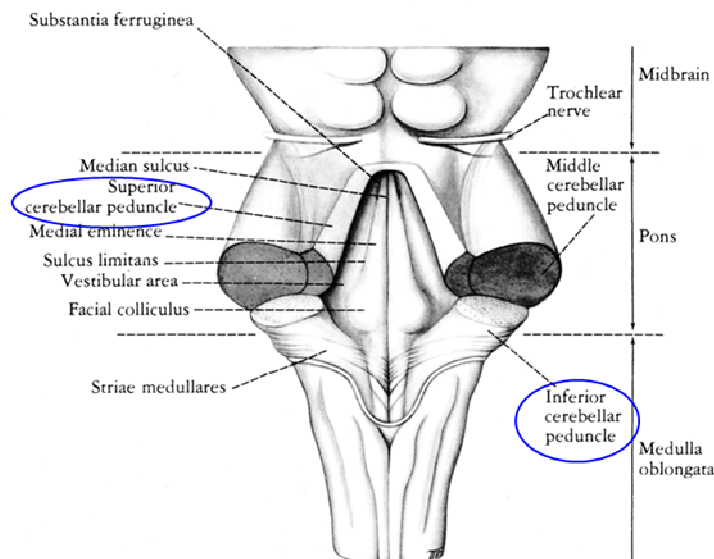
INTRODUCTION :

- The fourth ventricle is a *tent-shaped cavity* filled with cerebrospinal fluid.
- It is situated anterior to the cerebellum and posterior to the pons and the superior half of the medulla oblongata.
- It is *lined with ependyma* and is continuous above with the cerebral aqueduct of the midbrain and below with the central canal of the medulla oblongata and the spinal cord.
- The fourth ventricle possesses lateral boundaries, a roof, and a rhomboid-shaped floor.



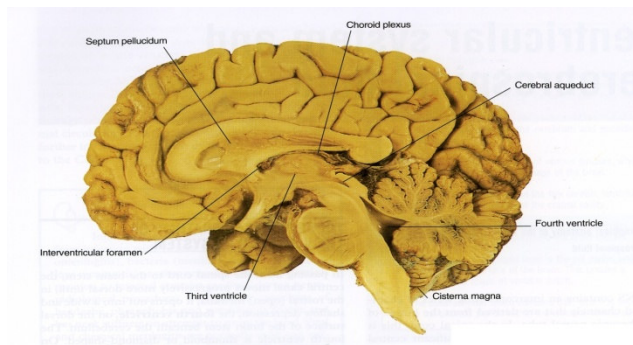
LATERAL BOUNDARIES :

- The *caudal part* of each lateral boundary is formed by the **inferior cerebellar peduncle**.
- The *cranial part* of each lateral boundary is formed by the **superior cerebellar peduncle**.

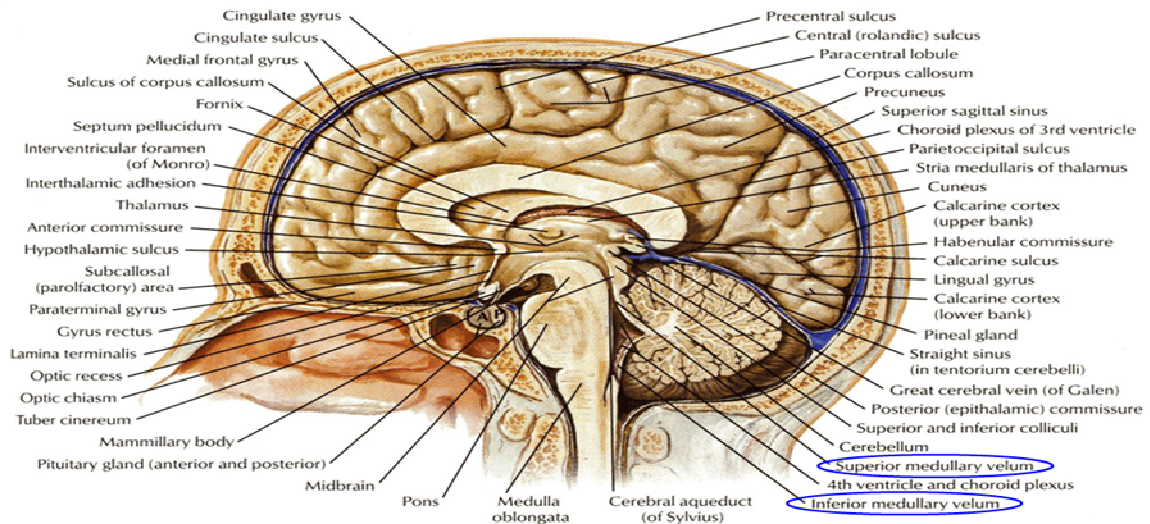


ROOF OR POSTERIOR WALL :

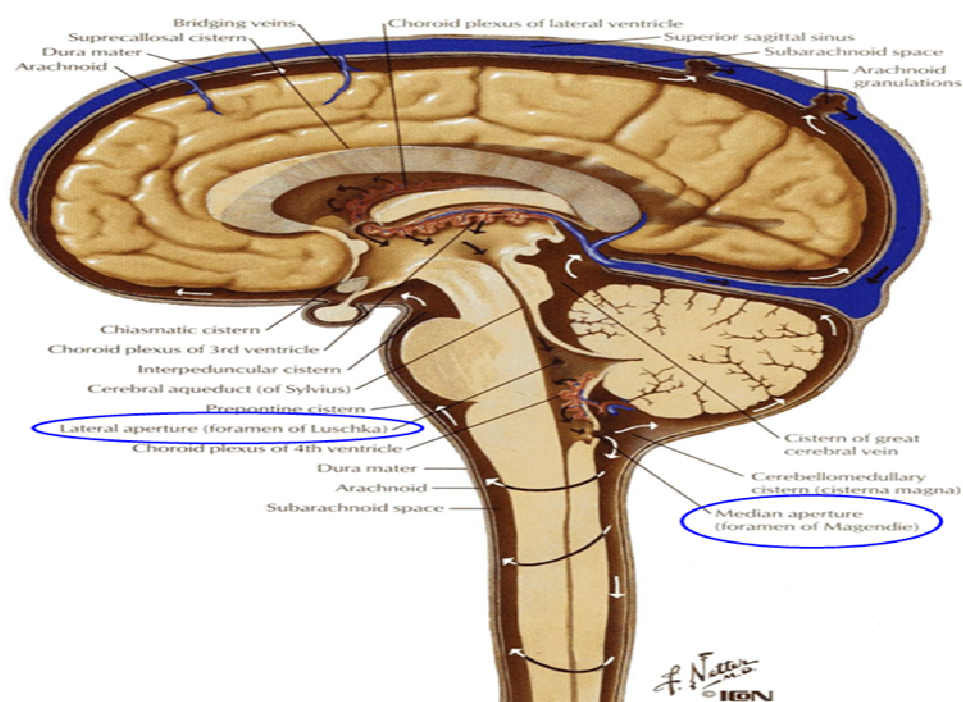
- The superior part is formed by the medial borders of the two superior cerebellar peduncles and a connecting sheet of white matter called the **superior medullary velum**.
- The inferior part of the roof is formed by the **inferior medullary velum**, which consists of a thin sheet devoid of nervous tissue and formed by the ventricular ependyma and its posterior covering of pia mater.



The tent-shaped roof projects into the cerebellum.

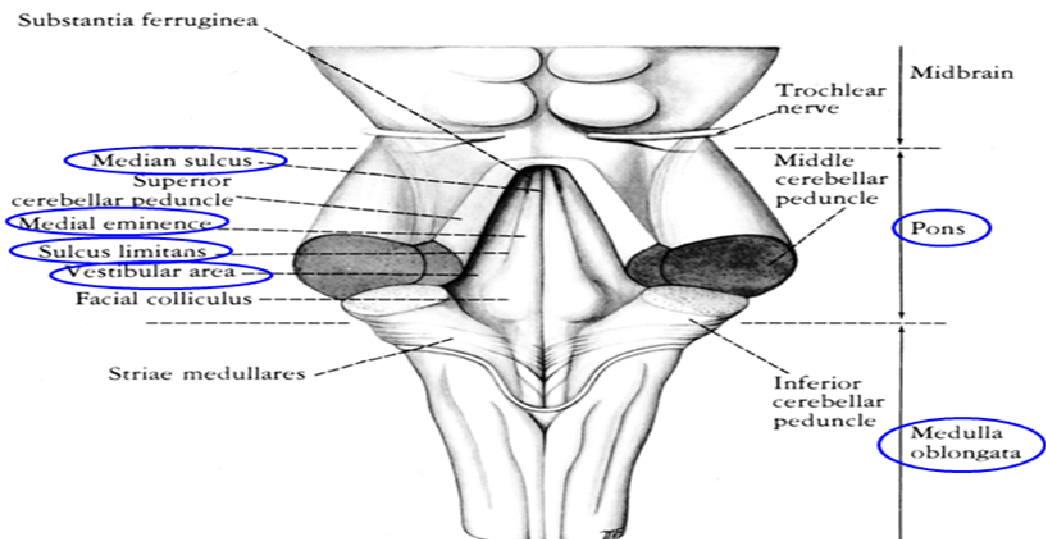


- The inferior part of the roof is pierced in the midline by a large aperture, the **median aperture or foramen of Magendie**.
- Lateral recesses extend laterally around the sides of the medulla and open anteriorly as the **lateral openings of the fourth ventricle**, or the **foramina of Luschka**.
- Thus, the cavity of the fourth ventricle communicates with the subarachnoid space through a single median opening and two lateral apertures.
- These important openings permit the cerebrospinal fluid to flow from the ventricular system into the subarachnoid space.

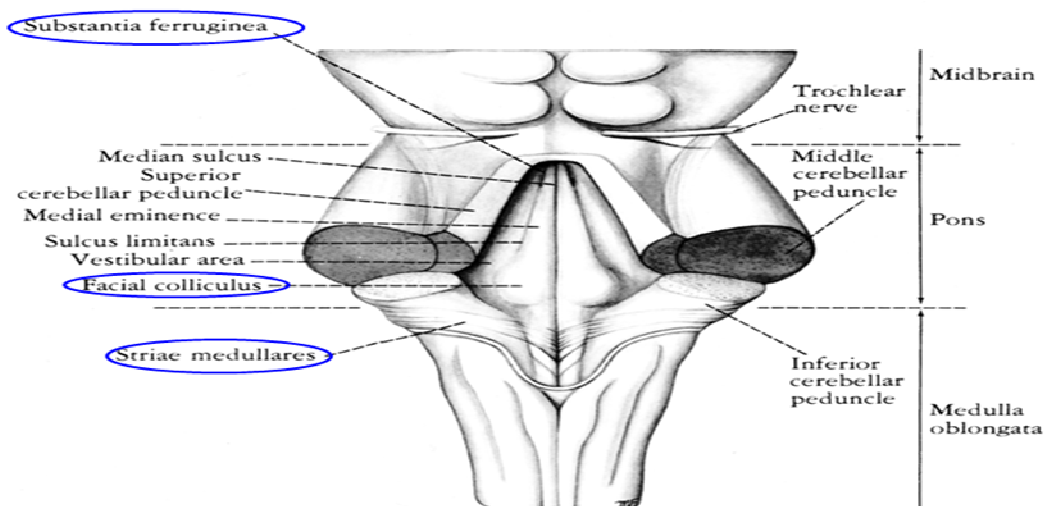


FLOOR OR RHOMBOID FOSSA :

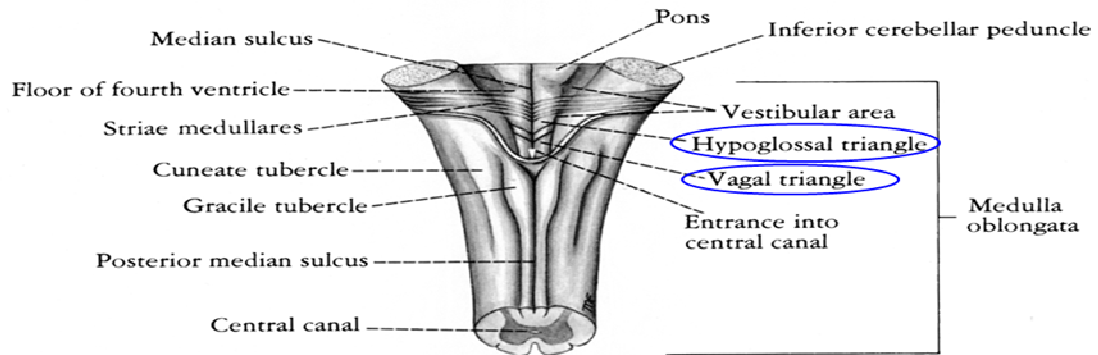
- The diamond-shaped floor is formed by the posterior surface of the pons and the cranial half of medulla oblongata.
- The floor is divided into symmetrical halves by the **median sulcus**.
- On each side of this sulcus there is :
 - an elevation, the **medial eminence**, which is bounded laterally by another sulcus, the **sulcus limitans**.
- Lateral to the sulcus limitans there is an area known as the **vestibular area**.
- The vestibular nuclei lie beneath the vestibular area.



- **The facial colliculus** is a slight swelling at the inferior end of the medial eminence that is produced by the fibers from the motor nucleus of the facial nerve looping over the abducens nucleus.
- At the superior end of the sulcus limitans there is a bluish-gray area produced by a cluster of nerve cells containing *melanin pigment*; the cluster of cells is called the **substantia ferruginea**.
- Strands of nerve fibers, the **striae medullaris**, derived from the arcuate nuclei, emerge from the median sulcus and pass laterally over the medial eminence and the vestibular area and enter the inferior cerebellar peduncle to reach the cerebellum.

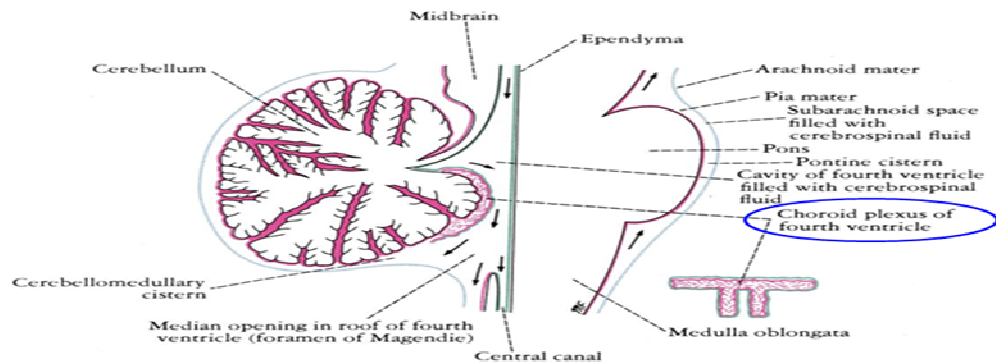


- Inferior to the striae medullaris lie :
 - The most medial is the **hypoglossal triangle**, which indicates the position of the underlying **hypoglossal nucleus**.
 - Lateral to this is the **vagal triangle**, beneath which lies the **dorsal motor nucleus of the vagus**.
 - The **area postrema** is a narrow area between the vagal triangle and the lateral margin of the ventricle, just rostral to the opening into the central canal.
 - The inferior part of the vestibular area also lies lateral to the vagal triangle.



CHOROID PLEXUS OF THE FOURTH VENTRICLE :

- The choroid plexus has a T shape; the vertical part of the T is double.
- It is suspended from the inferior half of the roof of ventricle and is formed from the highly vascular **tela choroidea**.
- The **tela choroidea** is a two-layered fold of pia mater that projects through the roof of the ventricle and is covered by ependyma.
- The blood supply to the plexus is from the **posterior inferior cerebellar arteries**.
- The **function** of the choroid plexus is to produce cerebrospinal fluid.



N.B. Functional Anatomy of the Cerebellum :

1. The archicerebellum corresponds to the flocculonodular lobe and fastigial nucleus. Its principal connections are with the vestibular and reticular nuclei of the brain stem and it is concerned with the maintenance of equilibrium.
2. The paleocerebellum corresponds to the vermis and paravermal area, together with the globose and emboliform nuclei. It receives fibres from the spinocerebellar tracts and projects to the red nucleus of the midbrain.
3. The neocerebellum corresponds to most of the cerebellar hemisphere and the dentate nucleus. It receives afferents from the pons and projects to the ventral lateral nucleus of the thalamus.
4. Cerebellar lesions cause incoordination of the upper limbs (intention tremor), lower limbs (cerebellar ataxia), speech (dysarthria) and eyes (nystagmus).

THE END

LoveTomy Team 426

Team leader : Dr. hams

Dr. S Dr. noop Omar H

ابنسم !! همي بروحي

M.A.M Abo Slo7 Cute Killer



SELF QUIZ

1. Regarding the cerebellum, all are true EXCEPT :

- a. The cerebellum is the largest part of the hindbrain.
- b. It operates at an unconscious level.
- c. The superior vermis lies in a deep groove between the hemispheres.
- d. The functions of the cerebellum are entirely motor.
- e. The cerebellum basically consists of : cerebellar cortex and an inner core of white matter.

2. Regarding the cerebellar cortex, all are true EXCEPT :

- a. It is highly convoluted, forming numerous transversely oriented folia.
- b. The cellular organization of the cortex is different in regions.
- c. It is divided histologically into three layers.
- d. Afferent axons mostly terminate in the cerebellar cortex.
- e. Afferent axons excitatory to cortical neurones.

3. Regarding the Purkinje cell layer, all are true EXCEPT :

- a. The Purkinje cell layer consists of a unicellular layer of the somata of Purkinje neurones.
- b. The axons of Purkinje cells are the only axons to leave the cerebellar cortex.
- c. Purkinje cells utilize GABA as their neurotransmitter.
- d. The profuse dendritic arborisations of these cells extend towards the surface of the cortex, into the molecular layer.
- e. Inferior olivary nucleus provide relatively discrete inhibitory input to Purkinje cells.

4. Regarding the archicerebellum, all are true EXCEPT :

- a. It is primarily concerned with the maintenance of balance (equilibrium).
- b. It has extensive connections with the vestibular and reticular nuclei.
- c. A significant proportion of fastigial efferents cross to the ipsilateral side of the brain stem.
- d. Vestibular information is carried from the vestibular nuclei to the cortex of the ipsilateral flocculonodular lobe.
- e. None of the above.

5. Regarding the fourth ventricle, all are true EXCEPT :

- a. It is a tent-shaped cavity.
- b. It is situated anterior to the cerebellum and posterior to the pons and the superior half of medulla oblongata.
- c. It is lined with endothelium.
- d. The fourth ventricle possesses lateral boundaries, a roof, and a rhomboid-shaped floor.
- e. None of the above.

1. c	2. b	3. e	4. c	5. c
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