

Embryology team



Development of cerebrum and cerebellum

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Student Guide:

1- The notes, which are written by the team, are in

Blue

2- Everything written in Red is important.

EARLY DEVELOPMENT

1

- By the **beginning of the 3rd week** of development, three germ cell layers become established, **ectoderm, mesoderm** and **endoderm**.

2

- During the **middle of the 3rd week**, the **dorsal midline ectoderm** undergoes thickening to form the **neural plate**.

3

- The margins of the plate become elevated, forming **neural folds**.

4

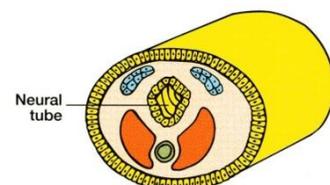
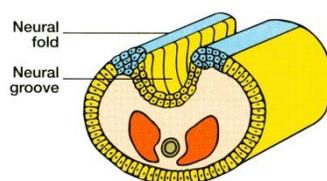
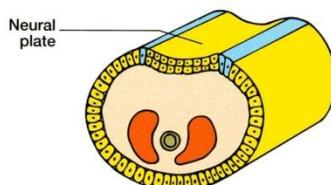
- A longitudinal, midline depression, called the **neural groove** is formed.

5

- The 2 neural folds then fuse together, to form the **neural tube**.

6

- Formation of the neural tube is completed by the **middle of the fourth week** of development.

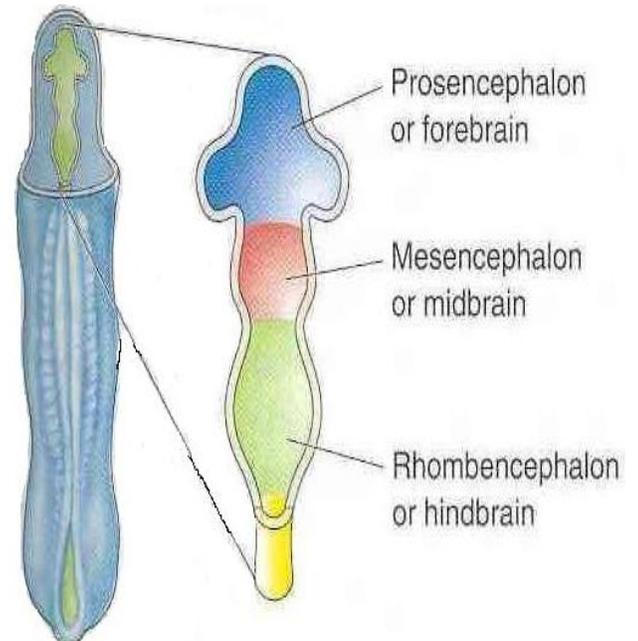


Neural Tube Development Three-vesicles stage (End of 4th Week)

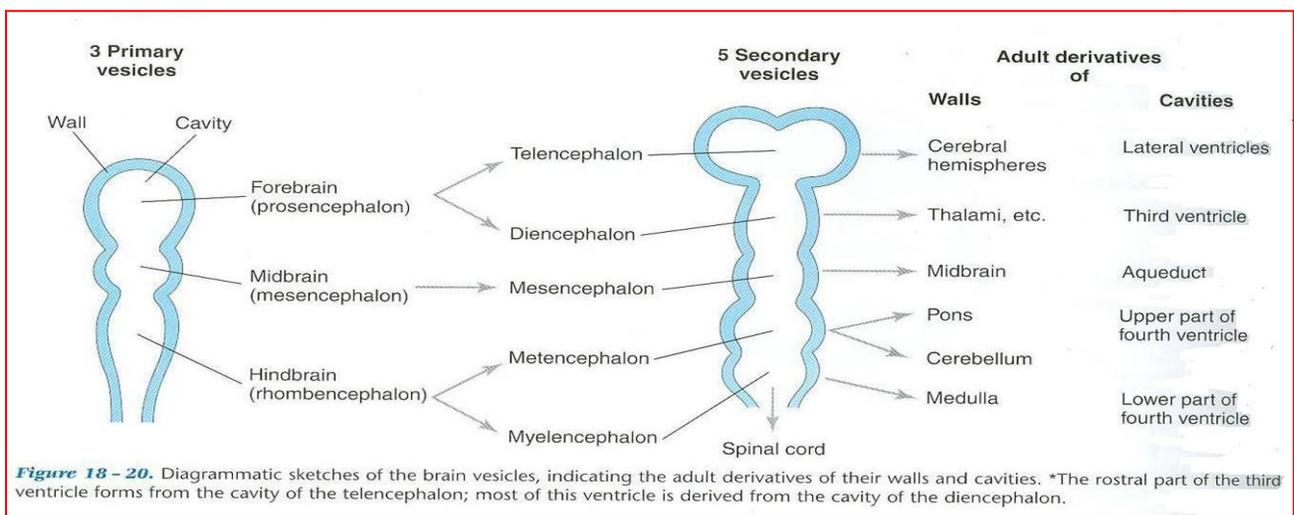
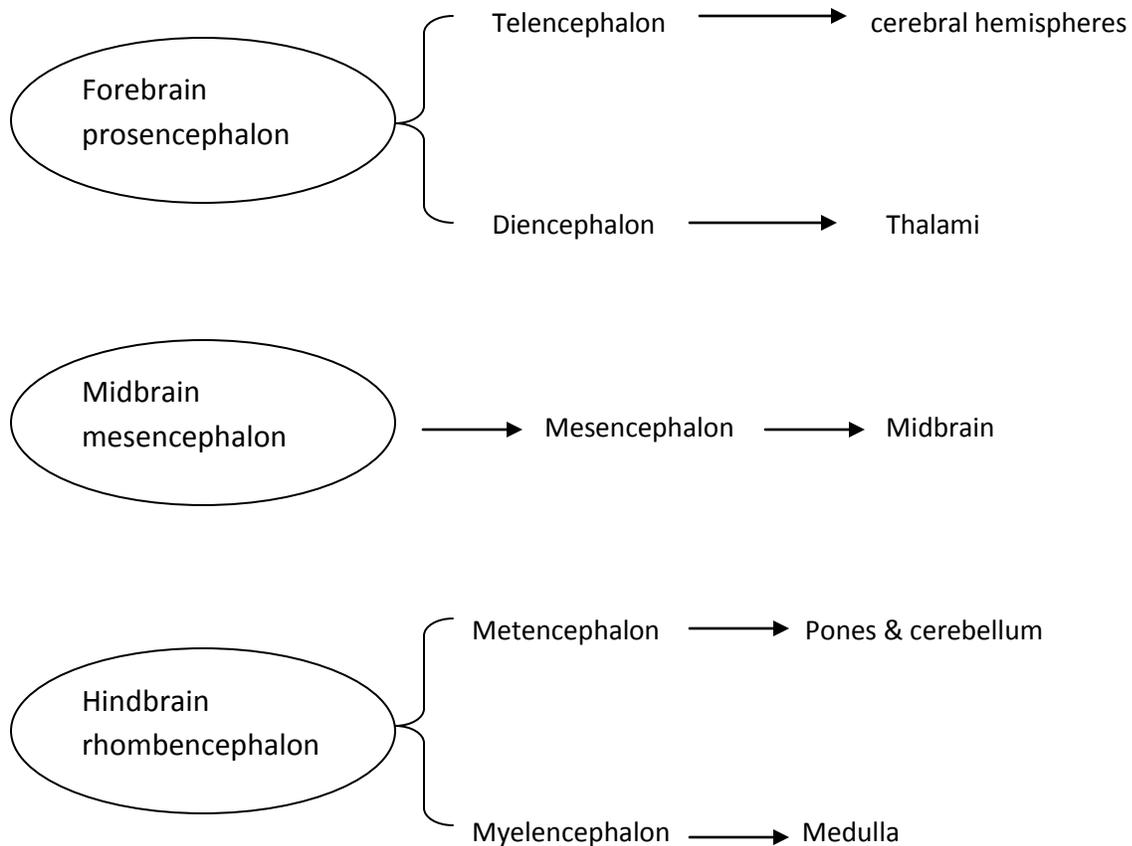
The cranial part of neural tube dilates to form **brain vesicle**. The caudal part remains narrow and cylindrical to give **spinal cord**

The brain vesicle grows and gives 3 dilatations named as:

- **Prosencephalon**
- **Mesencephalon**
- **Rhombencephalon**



Neural Tube Development Five-vesicles stage (5th Week)



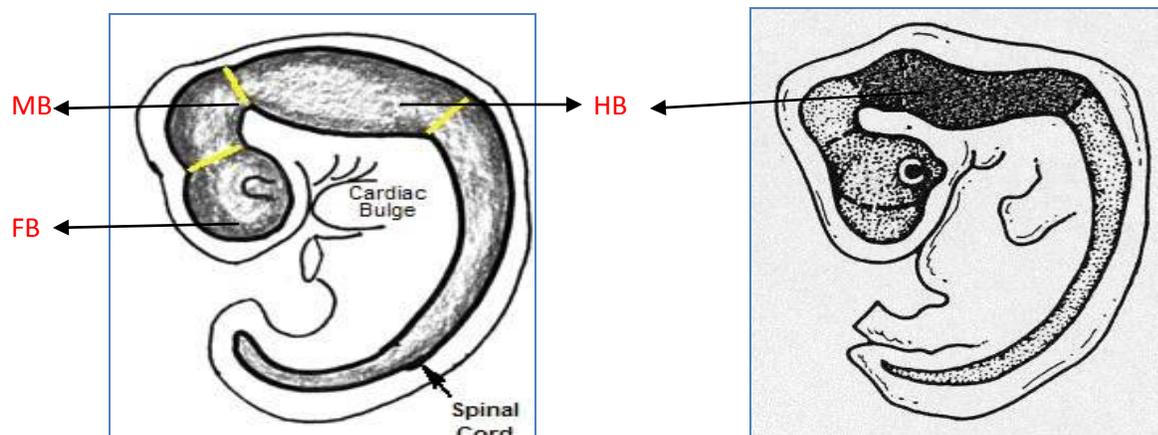
By the end of 4th week → the 3 primary vesicles develop (3 vesicles stage)

By the 5th week → 5 secondary vesicles develop (5 vesicles stage)

Brain Flexures

By 4th week:

- By the 4th week: The neural tube grows rapidly and bends ventrally with the head fold, producing **two** flexures:
- **Midbrain (cephalic) flexure:** In the region of midbrain.
- **Cervical flexure:** between the hind brain & the spinal cord.
- Later **Pontine flexure** appears in the hindbrain, in the opposite direction of the cephalic & cervical flexures, resulting in stretching and thinning of the roof of the hindbrain.



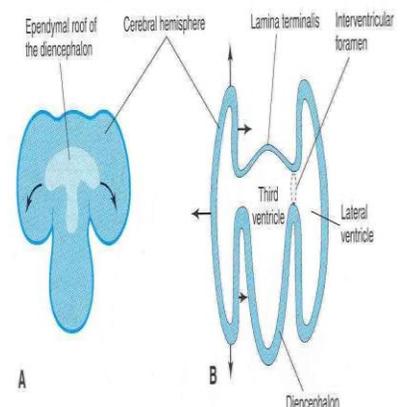
A flexure is an angular or rounded shape made by folding.

Differentiation of Forebrain

*The prosencephalon or the forebrain vesicle differentiates into:

- 1) A **median** part
- 2) The **diencephalon**
- 3) **Two** lateral cerebral vesicles or (**telencephalic** vesicles.)

*The **lumen** gives the **3rd** ventricle and the **2 lateral** ventricles.

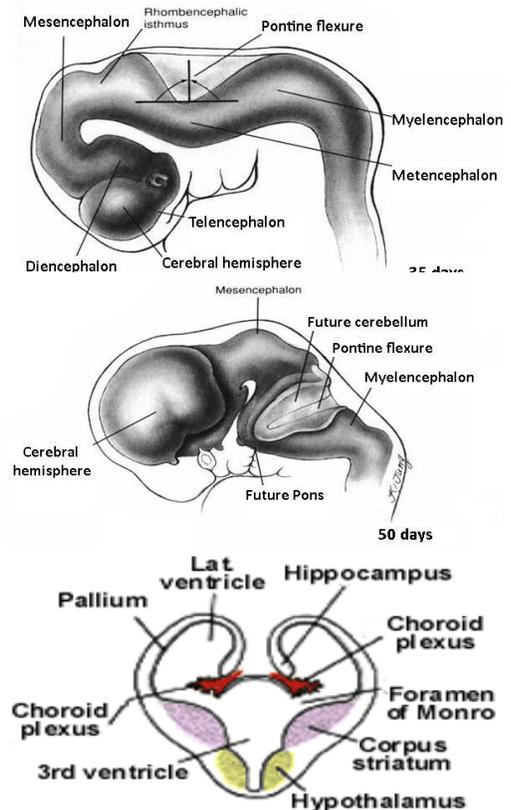


Both cavities communicate with each other through a large interventricular foramen .

Development of the Cerebrum

The cerebrum develops from the **Telencephalon**.

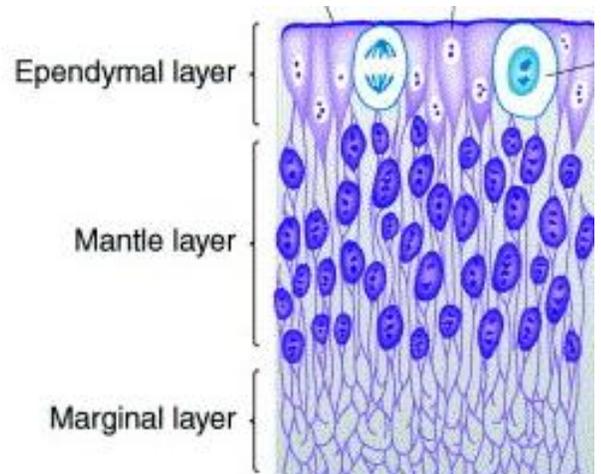
- *The **cerebral hemispheres** first appear on the **day 32** as a pair of **bubble-like** outgrowths of the Telencephalon.
- ***By 16 weeks**, the rapidly growing hemispheres are **oval in shape** and cover the diencephalon.
- *The cerebral hemispheres expand in all directions.
- *Its **medial wall** becomes thin, flat and it is the site of **choroid plexus** of the lateral ventricle.



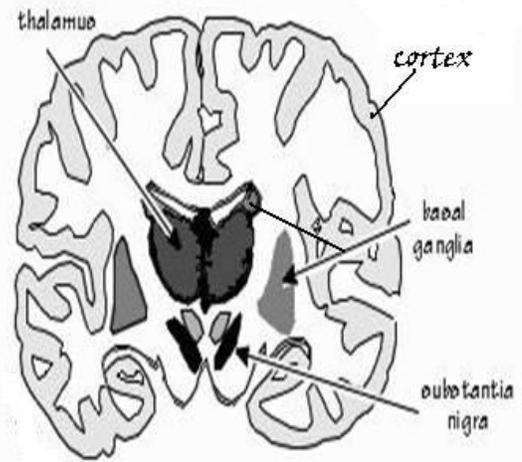
Bubble = cell proliferation

The bubbles grow posteriorly, anteriorly, inferiorly, and superiorly covering the diencephalon.

- The wall of the telencephalon is formed of **3 layers**:
- **Ependyma:** lining the cavity of the **lateral ventricle**.
 - **Mantle layer:** Intermediate layer contains nerve cells (**grey matter**).
 - **Marginal layer:** Outer layer contains nerve fibers (**white matter**).



As development proceeds most of the nerve cells in the mantle layer migrate to the outer aspect of the marginal layer to form the **cerebral cortex**. The remaining cells form the **basal ganglia (corpus striatum)**.



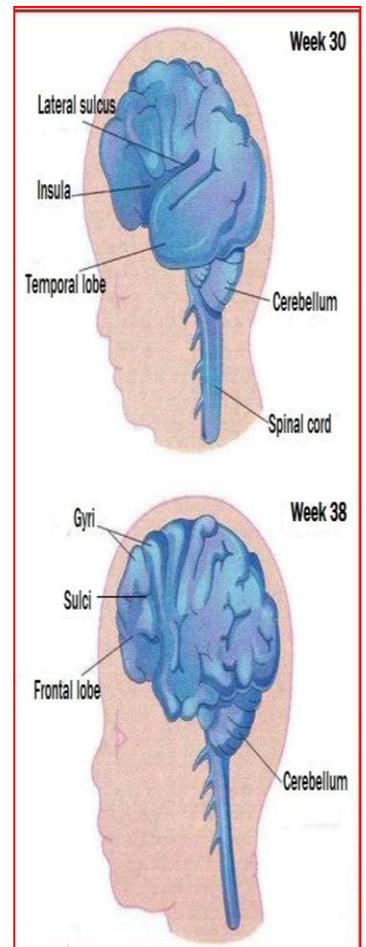
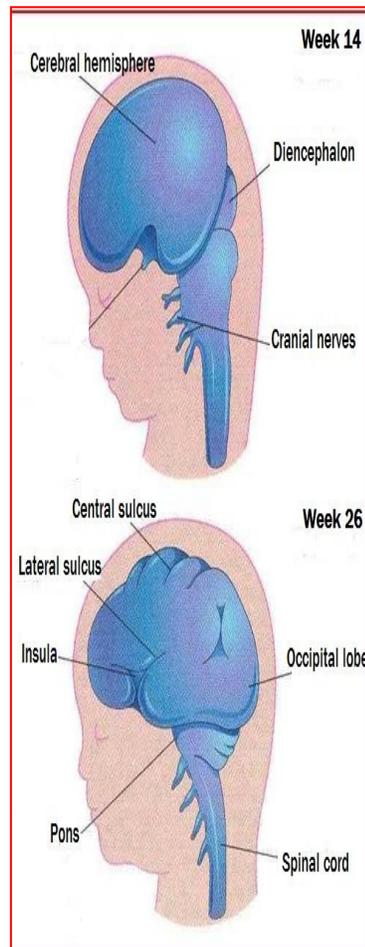
Mental → passes through marginal → covers the outer layer → cortex

The rest of the mental → basal ganglia

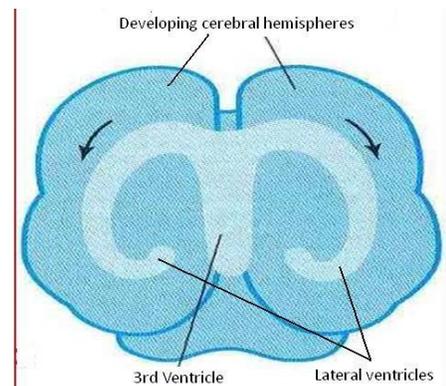
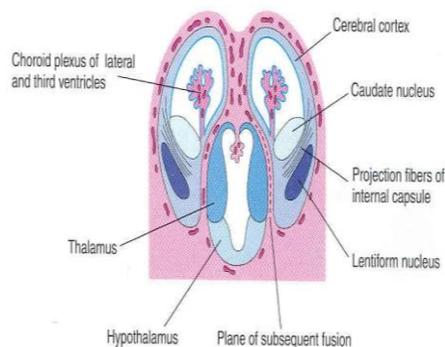
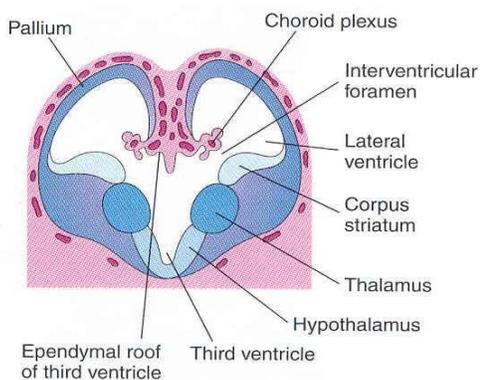
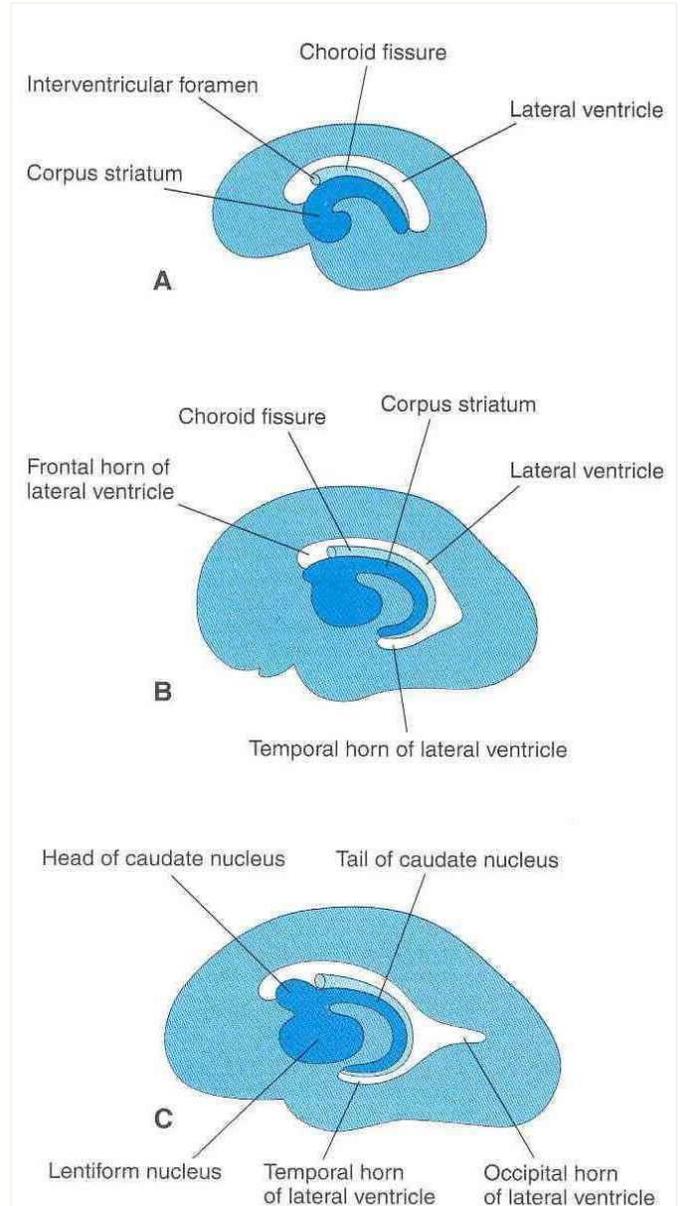
Corpus striatum = nucleus

***By the end of the 3rd month the surfaces of the cerebral hemispheres are smooth. By 4th month the grey matter grows faster than the white matter with the result that the cortex becomes folded into gyri separated by sulci.**

***The gyri and sulci effectively increase the surface area of the brain. The detailed pattern of gyri & sulci varies somewhat from individual to individual .**

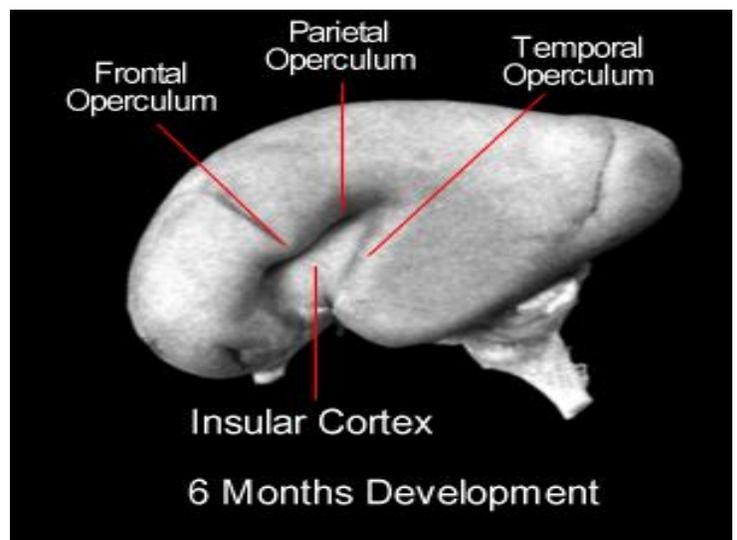
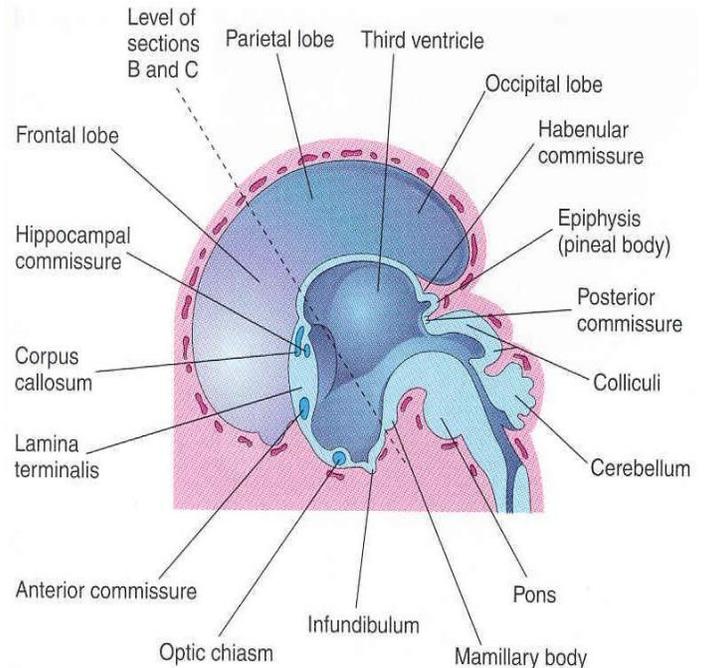


- **Corpus striatum** appears in **6th week** in the floor of each cerebral hemisphere.
- The cerebral cortex differentiates and the fibers passing to and from it, pass through the corpus striatum, dividing it into **caudate nucleus & lentiform nucleus**.
- This fiber pathway forms the **internal capsule**.
- Further expansion of cerebral hemisphere give **C-shape** to the hemisphere itself as well as the lateral ventricle.
- Also the **caudate nucleus** elongates and assumes the shape of the lateral ventricle and remains related to it.



Development of the Cerebral Commissures

- As the cerebral cortex develops, group of fibers, the **commissures**, connect the corresponding regions of the cortex in the two hemispheres.
- These are:
 1. Lamina terminalis.
 2. Optic chiasma.
 3. Anterior commissure.
 4. Posterior commissure.
 5. Hippocampal commissure.
 6. Habenular commissure.
 7. Corpus callosum.
- The cortex covering the surface of the corpus striatum grows relatively slowly, so it is overgrown by the rest of the hemisphere and lies in the depth of the lateral sulcus. This is **the insula**.

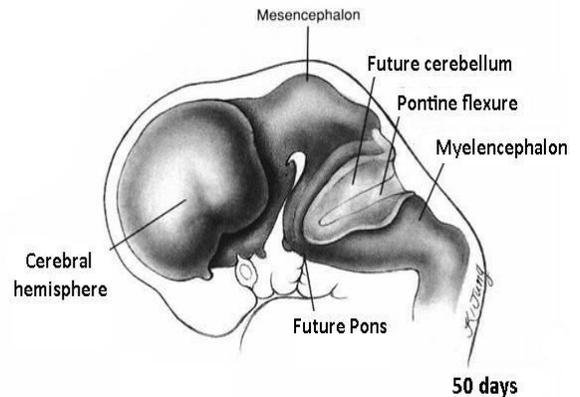


Development of the Cerebellum

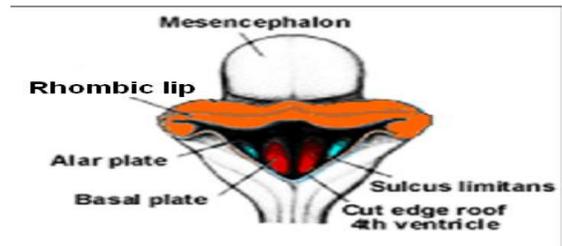
The cerebellum develops from the **dorsal part of the alar plates of the Metencephalon**

Pontine flexure results in:

1. Moving the alar plates **laterally**
2. **Stretching and thinning** of the roof plate
3. **Widening** of the cavity to form the **4th ventricle**



The dorsal parts of the alar plates thicken to form **Rhombic lip**, that gives rise to the **cerebellum**.

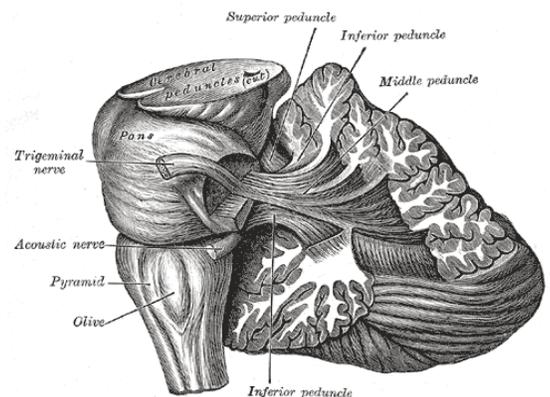
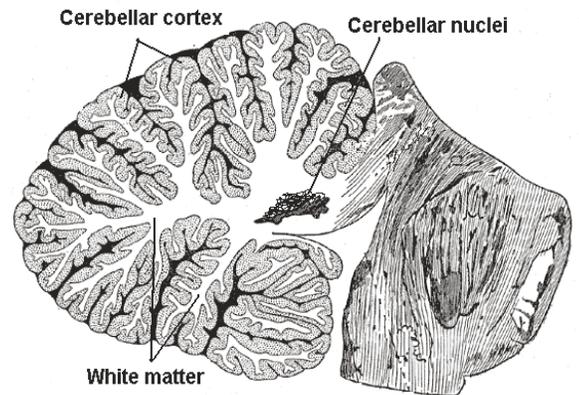


The wall of the Metencephalon is formed of **3 layers: Ependyma, Mantle layer and Marginal layer**

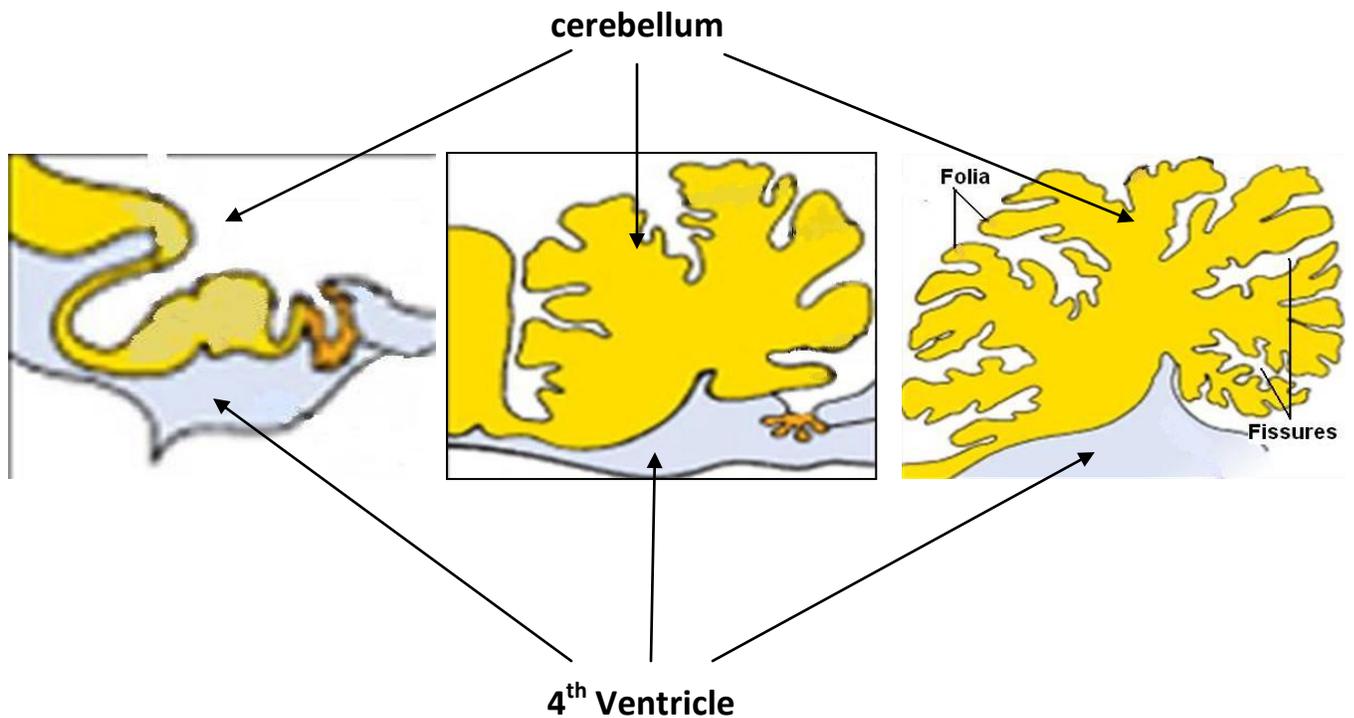
Some neuroblasts migrate from the **mantle layer**, through the marginal layer and form the **cerebellar cortex**.

Others remain in the mantle layer and give rise to the **cerebellar nuclei**.

The cerebellar peduncles develop later as the axons of the neurones of the cerebellar nuclei grows out to reach the brain stem.



- As the cerebellar hemispheres develops they undergo a complicated process of transverse folding and form closely packed, **leaf-like transverse gyri called folia**.
- These process of fissure formation and foliation continues throughout **embryonic, fetal,** and **postnatal** life, and they vastly **increase the surface area of the cerebellar cortex**.



Congenital Anomalies of Brain

- **Anencephaly.** = No development of the brain and skull.
- **Microcephaly.** =the circumference of the head is more than two standard deviations smaller than average for the person's age and sex
- **Cranium bifidum with or without meningocele** (defect in the bone, and the meninges are coming out from it) & **meningoencephalocele** (meninges + brain tissue are coming out)
- **Hydrocephalus.** = accumulation of CSF in the skull .
- **Mental retardation.**
- **Seizures.**
- **Cerebral palsy.**
- **Meroanencephaly.**
- **Agenesis of corpus callosum.**
- **Arnold-Chiari malformation.**

Primary brain vesicels	Secondary brain vesicels	Dervative in mature brain	Ventricle
Prosencephalon (forebrain)	telencephalon	Cerebral hemisphere	Lateral ventricle
	diencephalon	thalamus	3rd ventricle
Mesencephalon (midbrain)	Mesencephalon	midbrain	Aqueduct (connect 3rd +4th)
Rhombencephalon (hindbrain)	Metencephalon	Pons & cerebullem	Upper part of 4th ventricle
	myelencephalon	Medulla oblongata	Lower part of 4th ventricle

Timetable of cerebrum development		
3 rd week	Beginning	ectoderm, mesoderm and endoderm become established.
	middle	Formation of the neural plate.
4 th week	By the 4 th	Midbrain (cephalic) flexure & Cervical flexure are produced.
	middle	The neural tube is completely formed.
	end	Three-vesicles stage
5 th week	At the 5 th	Five-vesicles stage
	On the day 32	The cerebral hemispheres are pair of bubble-like outgrowths of the Telencephalon.
6 th week	In the 6 th	Corpus striatum appears.
16 weeks	By 16 weeks	The hemispheres are oval in shape and cover the diencephalon.
3 rd month	end	surfaces of the cerebral hemispheres are smooth.
4 th month	By the 4 th	grey matter grows faster than white matter ,and the cortex becomes folded into gyri separated by sulci.

Questions

1-The embryonic forebrain gives rise to the:

- A) Pons & cerebellum.
- B) Cerebral hemisphere & thalamus.
- C) Cerebral hemisphere & pons

2-flexure between the hind brain & the spinal cord:

- A) Midbrain (cephalic) flexure.
- B) Cervical flexure.
- C) Pontine flexure.

3-the mental layer one of the layers which forms the wall of:

- A) diencephalon.
- B) Mesencephalon.
- C) Telencephalon.

4- the brain and skull are minute is a developmental anomaly called :

- A) Microcephaly.
- B) Anencephaly.
- C) Hydrocephalus.

5-The nucleus that has the same shape of the lateral ventricle and the cerebral hemisphere is:

- A) Basal nuclei
- B) Caudate nucleus
- C) Lentiform nucleus

6- The cerebellum develops from:

- A) Ventral part of the basal plate
- B) Dorsal part of the basal plate
- C) Dorsal part of the alar plate

7-which one of the following develops from prosencephalon :

- A) Diencephalon
- B) Mesencephalon
- C) Metencephalon

8- Cerebrum develops from:

- A) Myelencephalon
- B) Metencephalon
- C) Telencephalon

Answers:

B, B, C, B, B,C,A,C