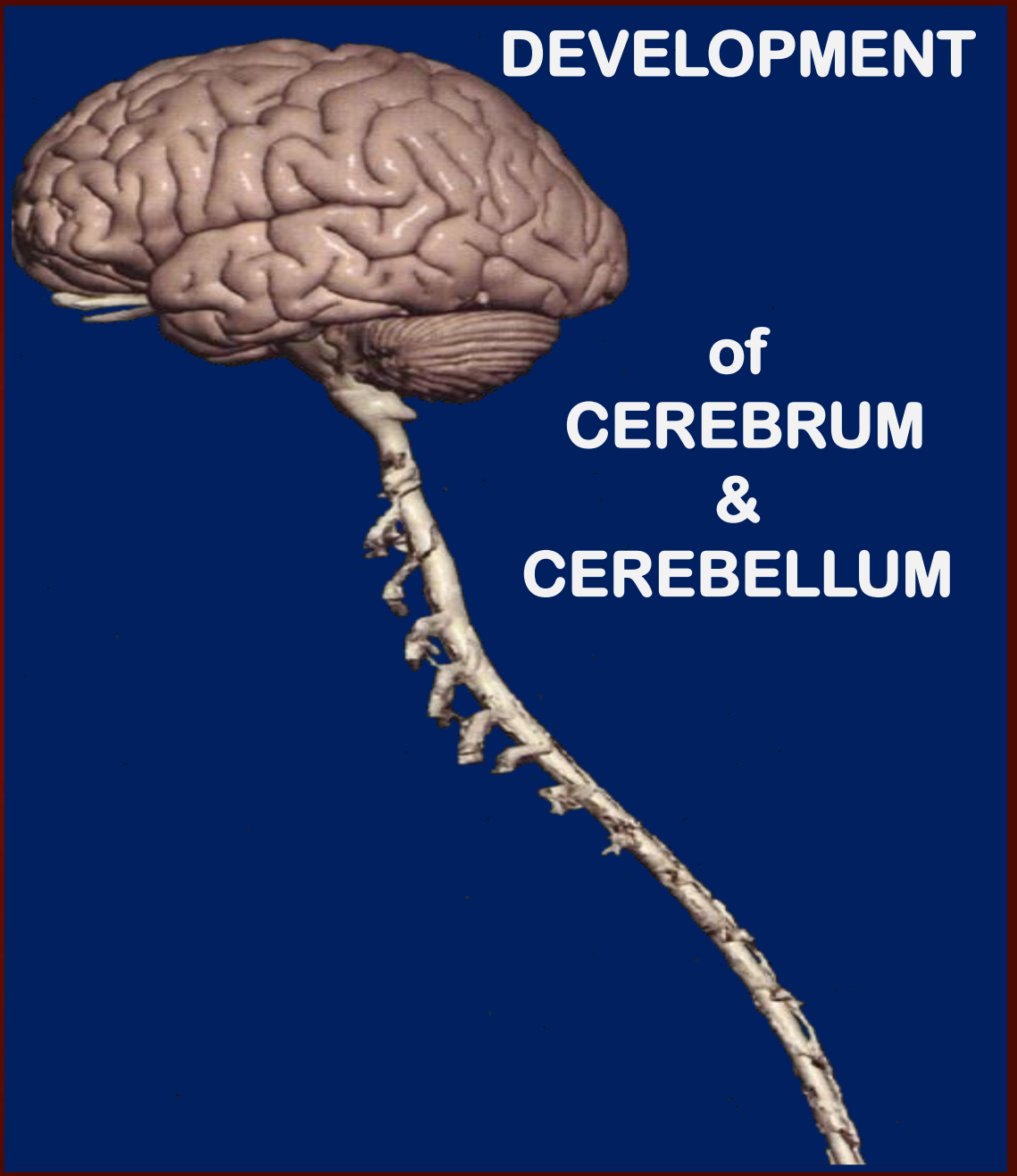
DEVELOPMENT



# of CEREBRUM & CEREBELLUM

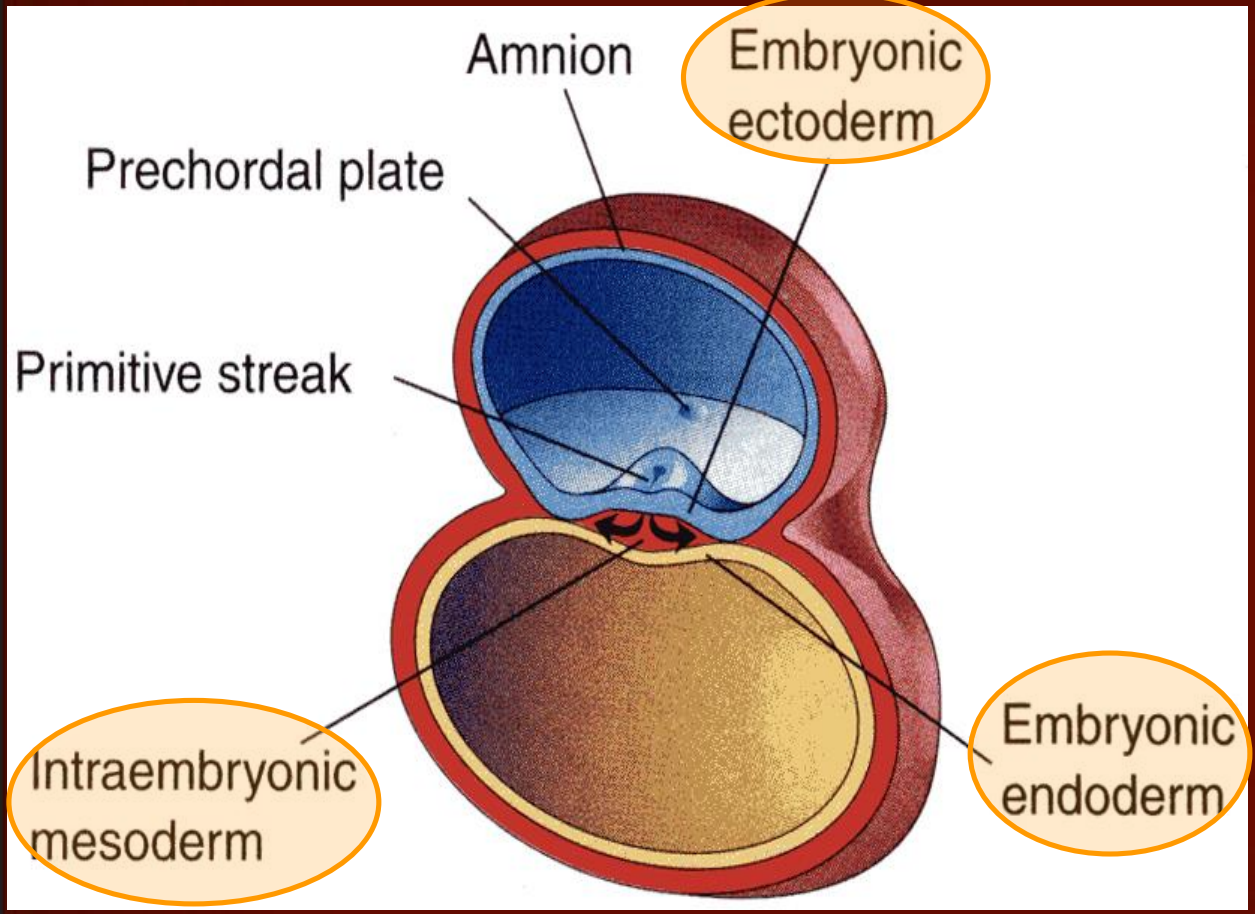
Prof Saeed Abuel Makarem

OBJECTIVES

By the end of the lecture you should be able to:

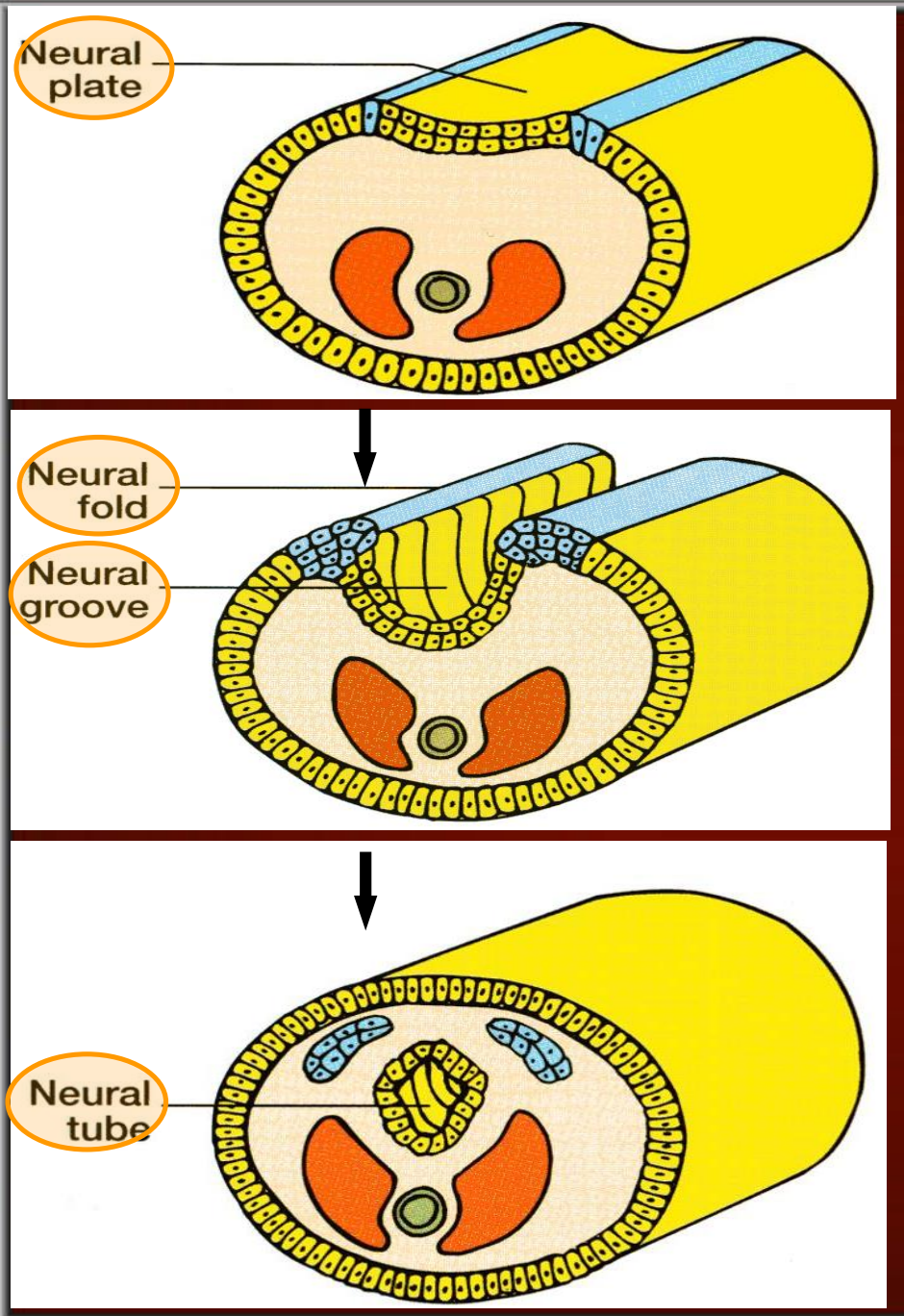
- Describe the formation of the neural tube.
- List the 3 primary brain vesicles and their derivatives.
- Describe the brain flexures.
- Describe briefly the development of the cerebrum.
- Describe briefly the development of the cerebellum.
- Enumerate the most common congenital anomalies in the development of CNS.

INTRODUCTION



By the beginning of the 3rd week of development, three germ cell layers become established:

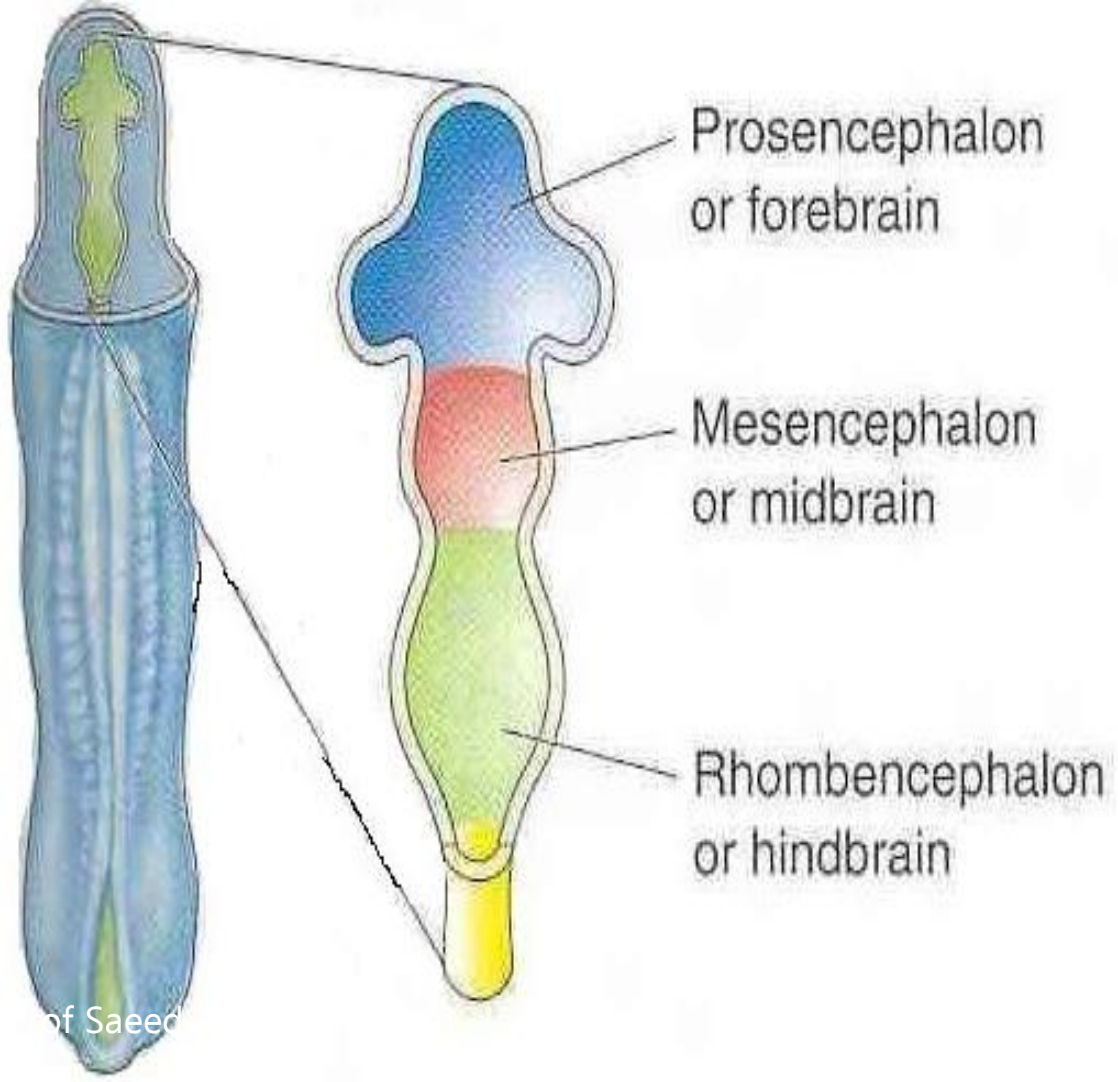
1. **Ectoderm,**
2. **Mesoderm &**
3. **Endoderm.**



EARLY DEVELOPMENT

- During the middle of the 3rd week, ***the dorsal midline ectoderm*** undergoes proliferation and thickening to form the **neural plate.**
- The margins of the neural plate become elevated, forming **neural folds.**
- So a longitudinal, midline depression, called the **neural groove** **is formed.**
- Then the **2** neural folds approximate to each other and fuse together, thus sealing the neural groove and forming the **neural tube.**

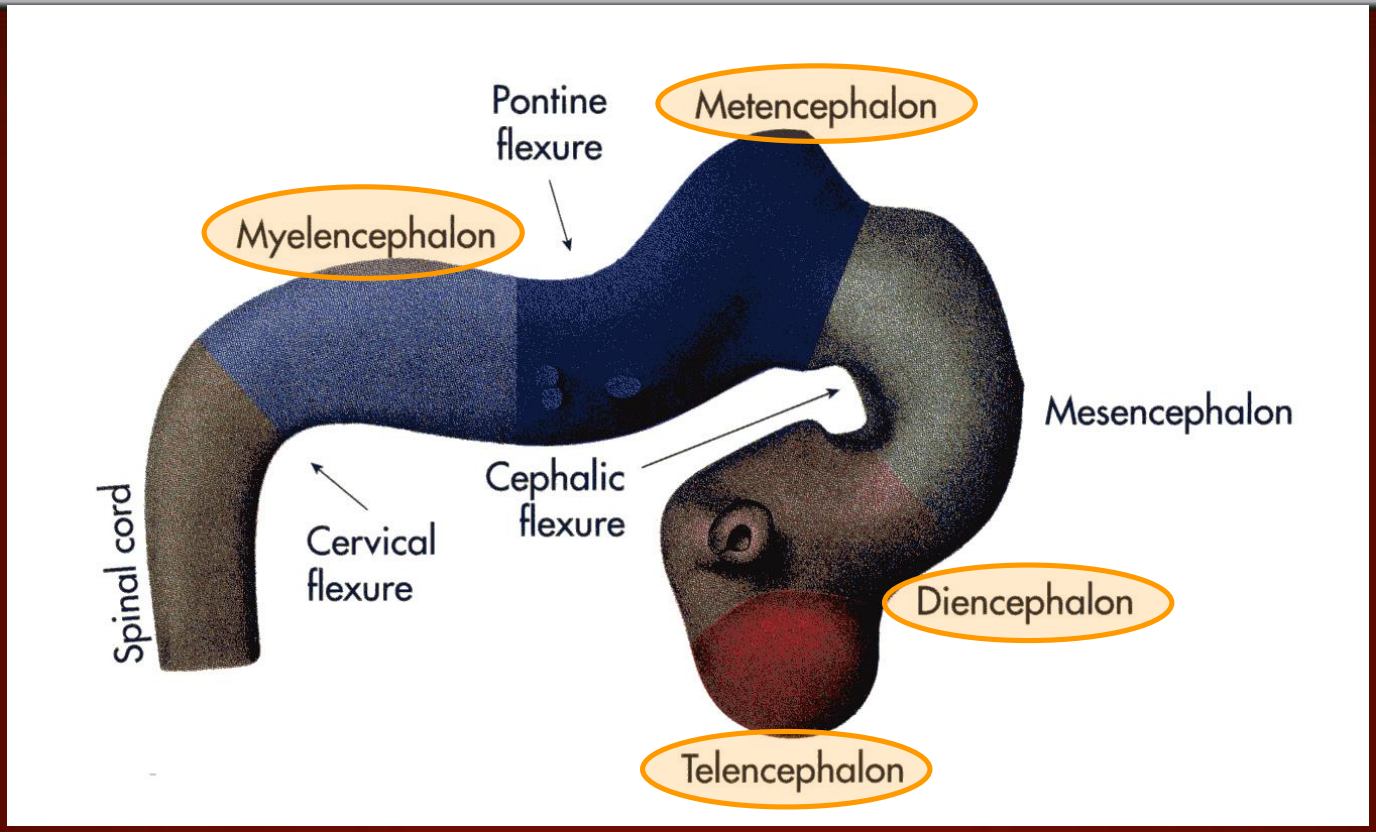
Neural Tube Development
Three-vesicles stage (End of 4th Week)



Formation of the neural tube is completed by the middle of the fourth week. **By the end of the 4th week**, the upper part of the neural tube dilates and shows 3 brain vesicles:

Prosencephalon, or forebrain.

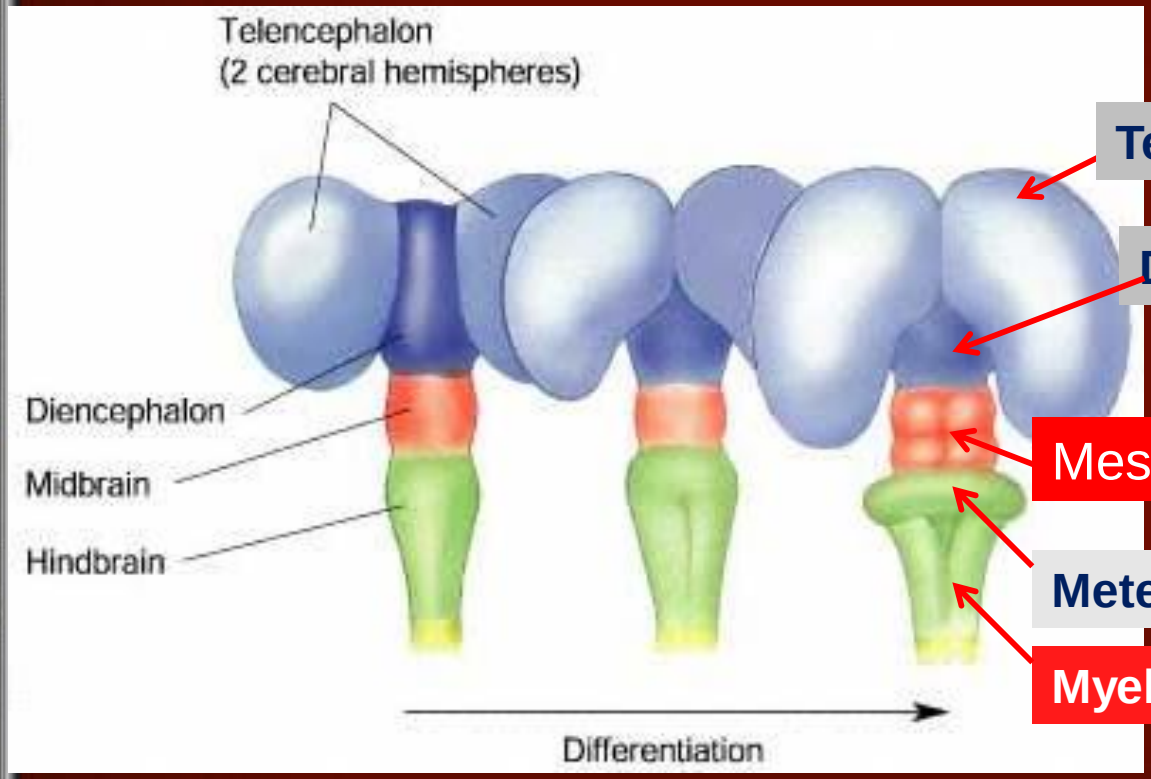
Mesencephalon, or midbrain & **Rhombencephalon or hindbrain.**



By the **5th** ***week*** further differentiation distinguishes **five** secondary **brain vesicles:**

- ***The prosencephalon*** divides into 2 lateral **telencephalon** and one **median diencephalon.**
- ***The Rhombencephalon*** divides into **metencephalon** and **myelencephalon.**

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



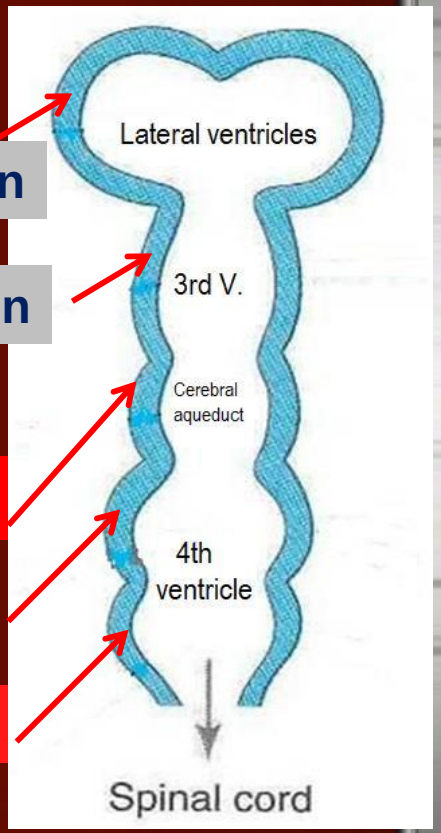
Telencephalon

Diencephalon

Mesencephalon

Metencephalon

Myelencephalon



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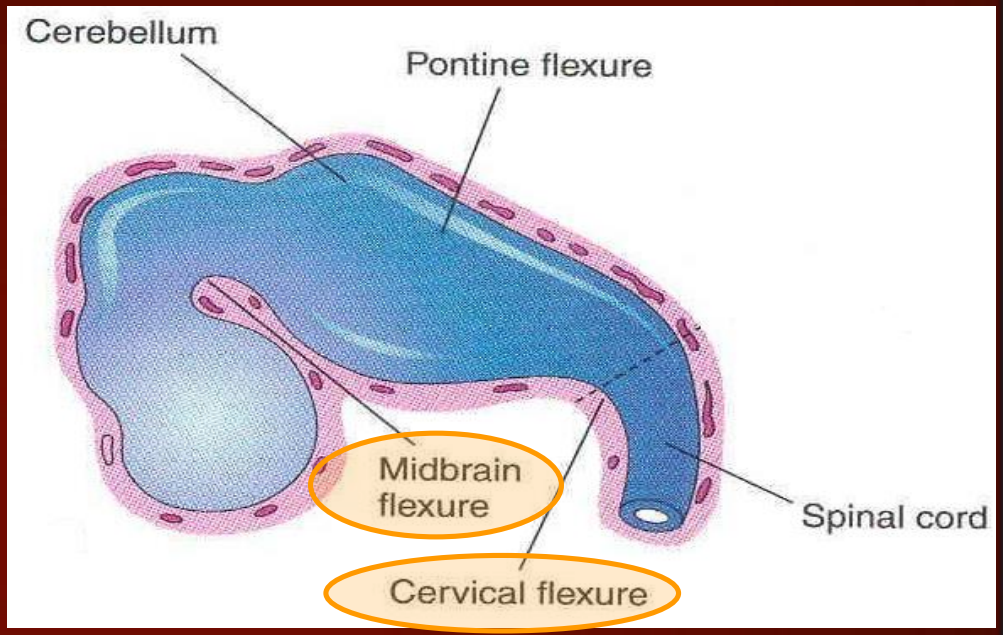
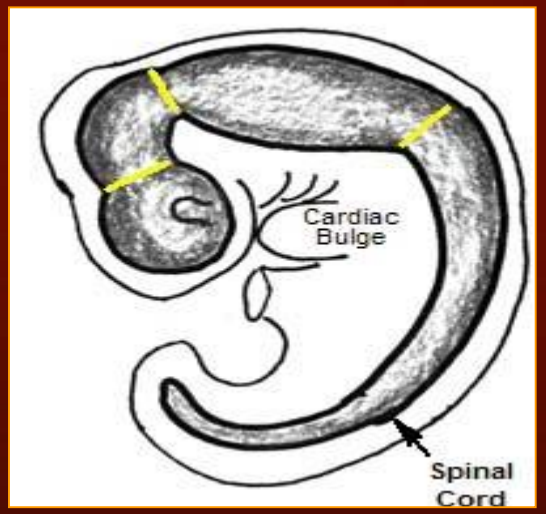
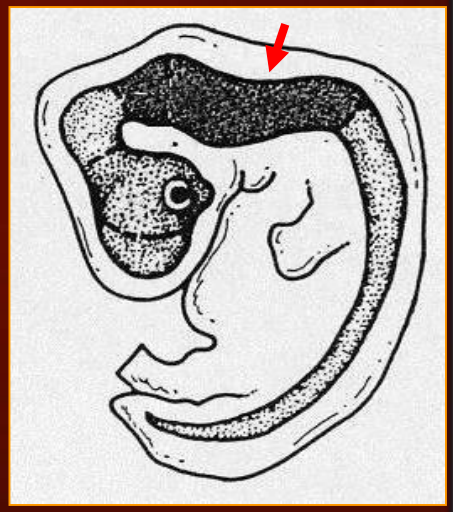
3 Brain Flexures

- By the **4th week**:
- The neural tube grows rapidly and faster than the cranial cavity.
- So it bends twice ventrally, producing **two flexures:**
- **Midbrain** flexure: between prosencephalon and mesencephalon (midbrain).
- **Cervical** flexure:
- Between the hind brain & the spinal cord.



- Later on a 3rd flexure (Pontine flexure), appears dorsally (in **opposite direction)**, resulting in thinning of the roof of hindbrain.





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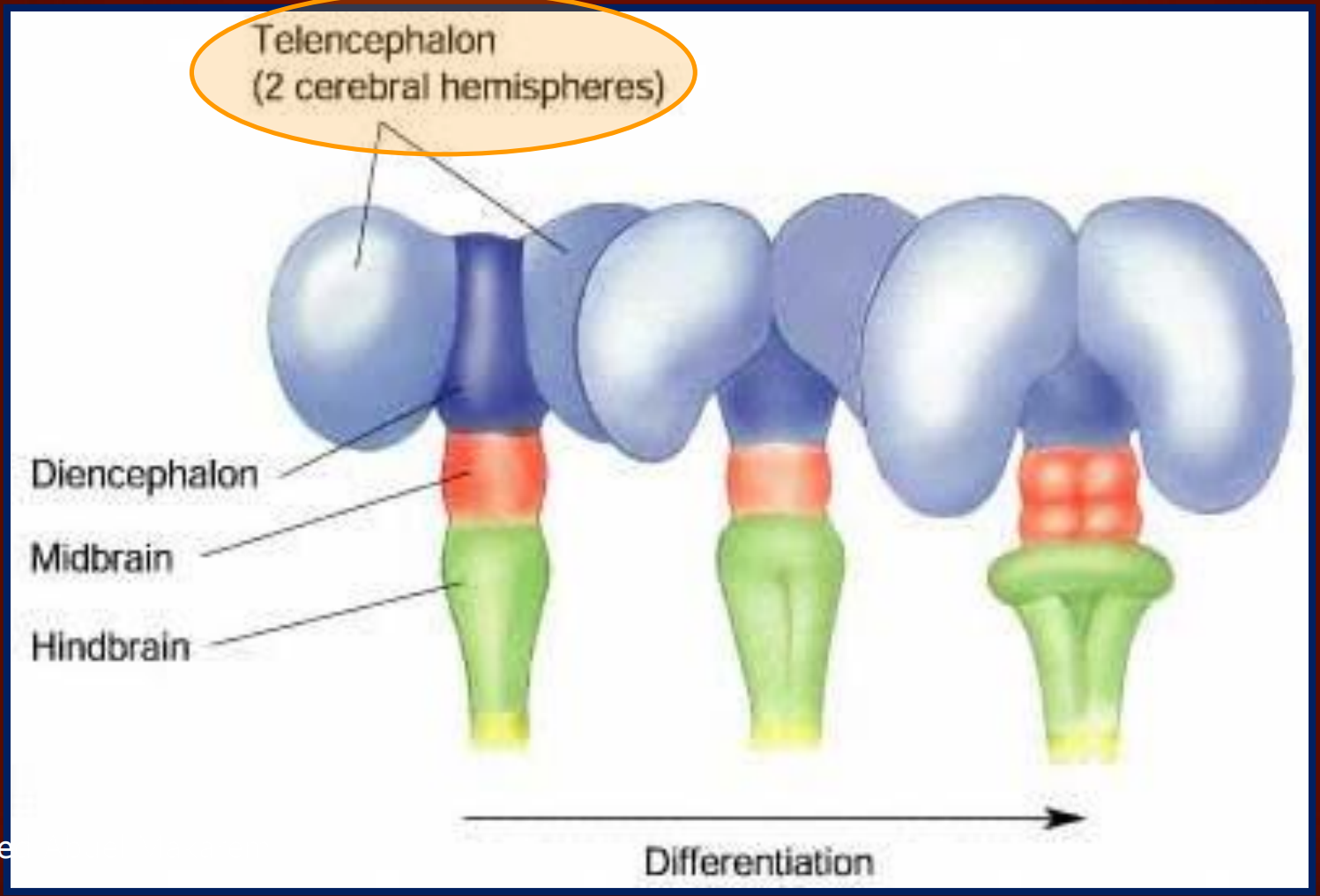
Primary brain vesicles	Secondary brain vesicles	Derivatives in mature brain
Prosencephalon (forebrain)	Telencephalon	Cerebral hemisphere
	Diencephalon	Thalamus
Mesencephalon (midbrain)	Mesencephalon	Midbrain
Rhombencephalon	Metencephalon	Pons, cerebellum
(hindbrain)	Myelencephalon	Medulla oblongata

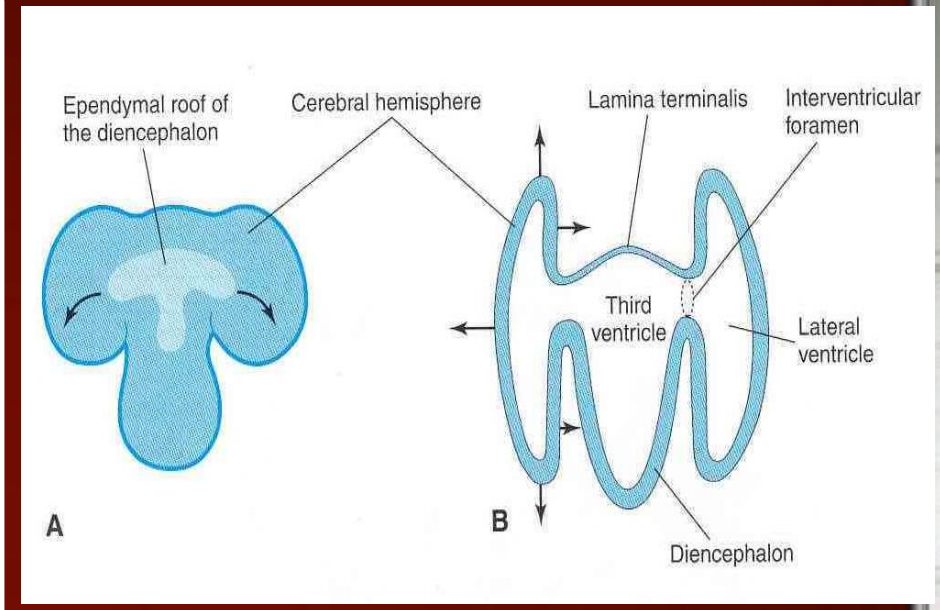
Development of the Cerebrum

The cerebrum develops from the **Telencephalon**

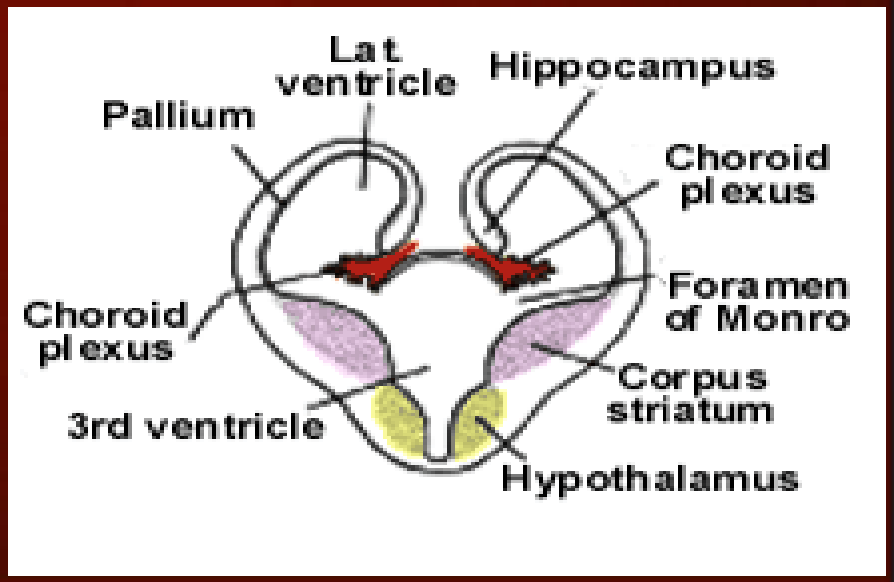


Differentiation of Forebrain Vesicle

- The (prosencephalon) or the forebrain vesicle differentiates into a:
1. **Two** lateral cerebral vesicles or (telencephalic vesicles.)
2. Median part, (diencephalon),
- Their lumen gives the 2 lateral ventricles and the 3rd ventricle.
- Both cavities communicating with each other through a very wide interventricular foramen.



- 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.



Development of the Cerebrum

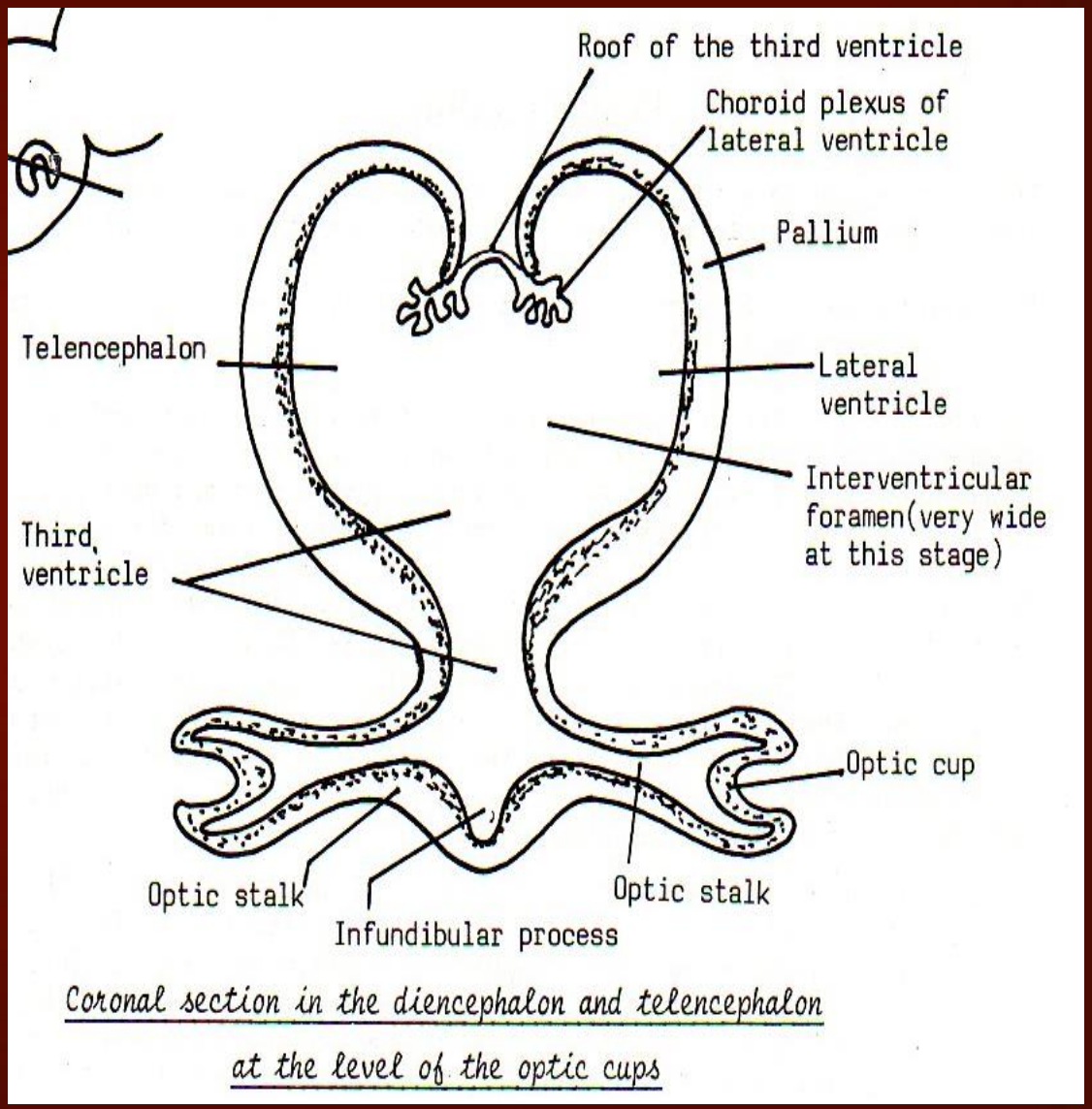
- The wall of the telencephalon is formed of 3 layers; from inwards to outwards they are:

1. Ependymal layer:
(lining the cavity of the lateral ventricle.

2. Mantel layer:

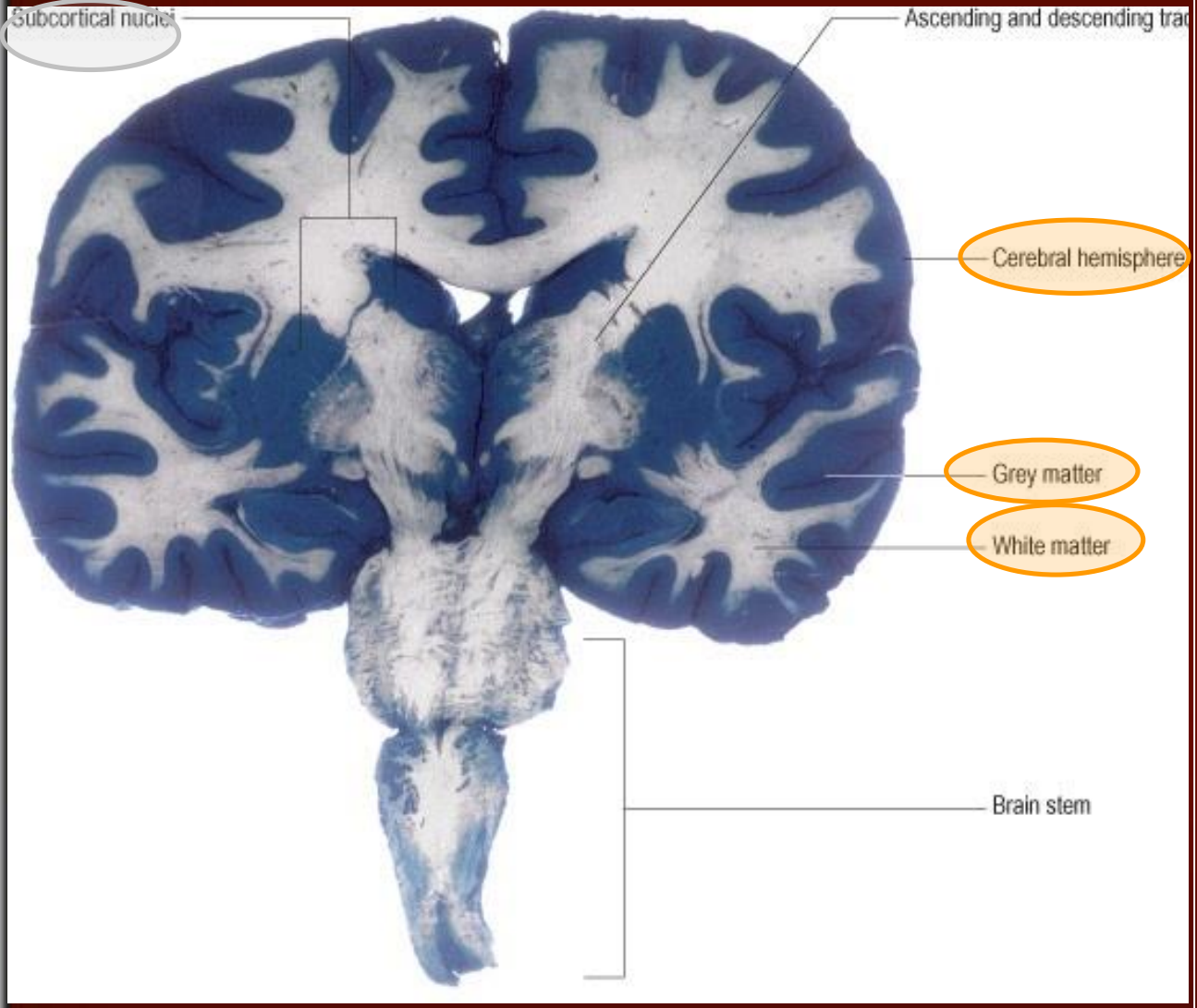
nerve cells forming the grey matter.

3. Marginal layer:
nerve fibers forming the white matter.



Coronal section in the diencephalon and telencephalon at the level of the optic cups

As development proceeds the following changes occur:

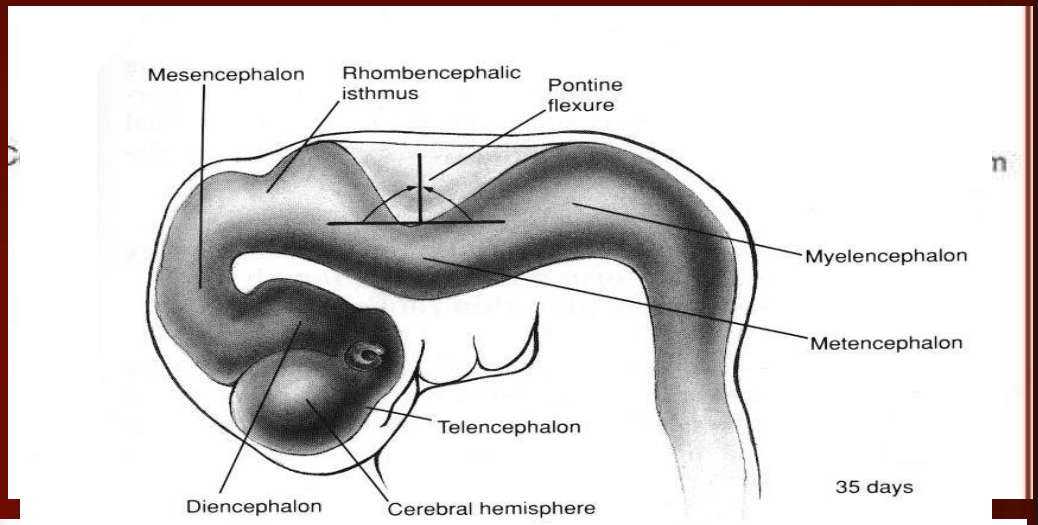


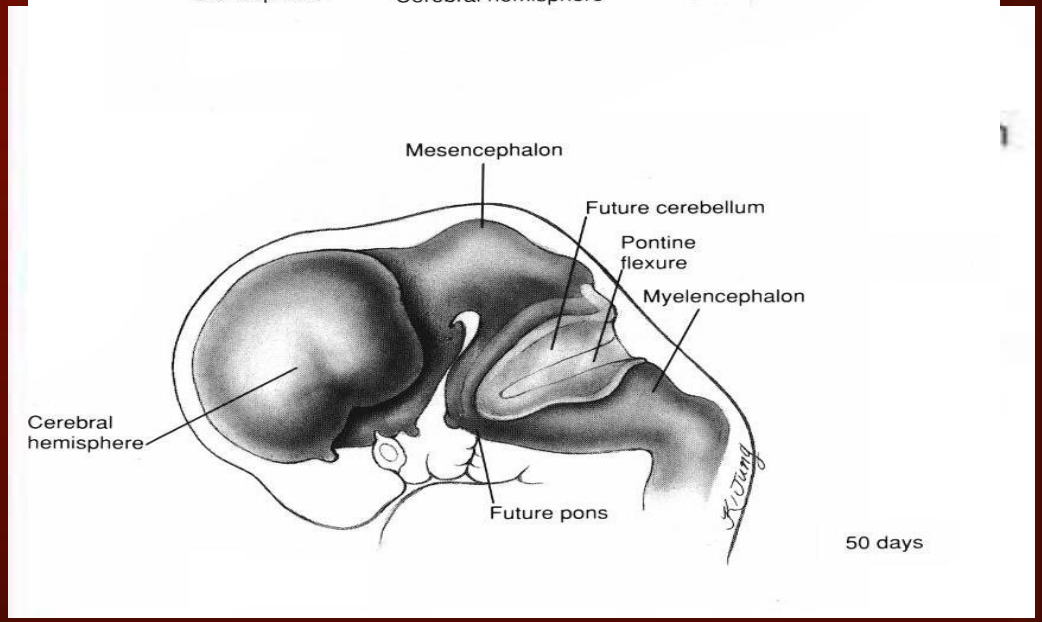
Most of the nerve cells migrate from the mantel layer to the marginal layer forming the cerebral cortex.

Some cells do not migrate and remains in the mantel layer to form the basal ganglia.

Development of the Cerebrum

- By the day **32** the cerebral hemispheres first appear as a pair of bubble-like outgrowths of the **Telencephalon.**
- By 16 weeks, the rapidly growing hemispheres are oval and have expanded back to cover the diencephalon.



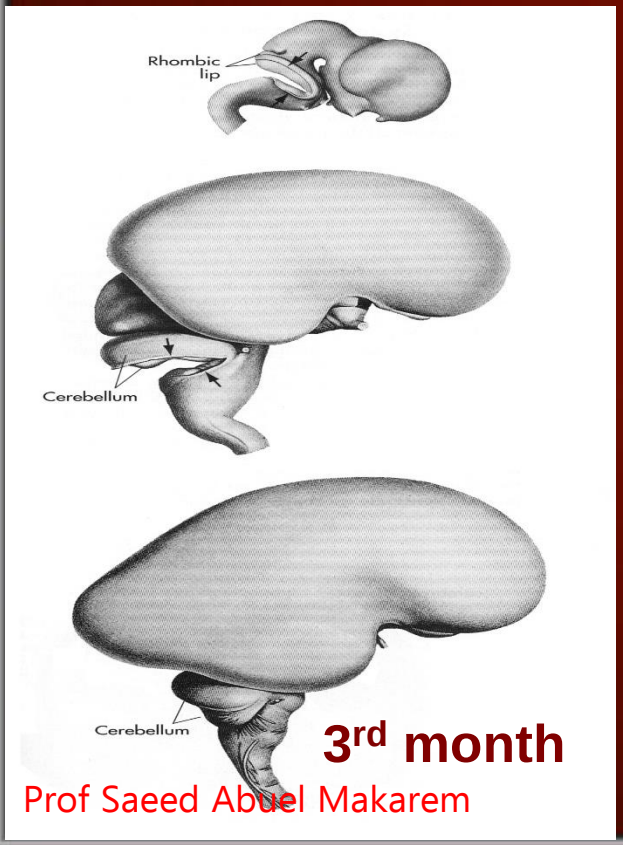


By the end of **3rd month** all surfaces of the cerebral hemispheres are smooth.

By **the 4th month** the grey matter grows faster than the white matter so, 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 to some extend f**rom individual to individual.



3rd month

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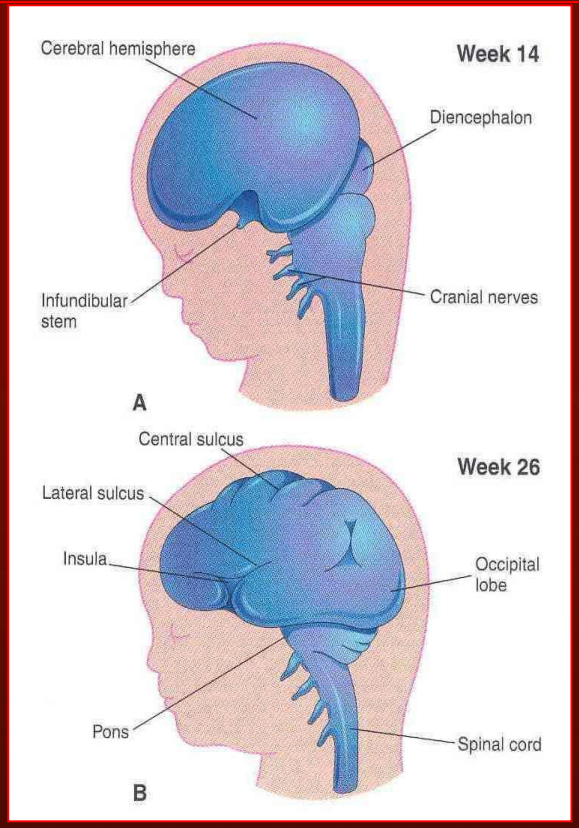
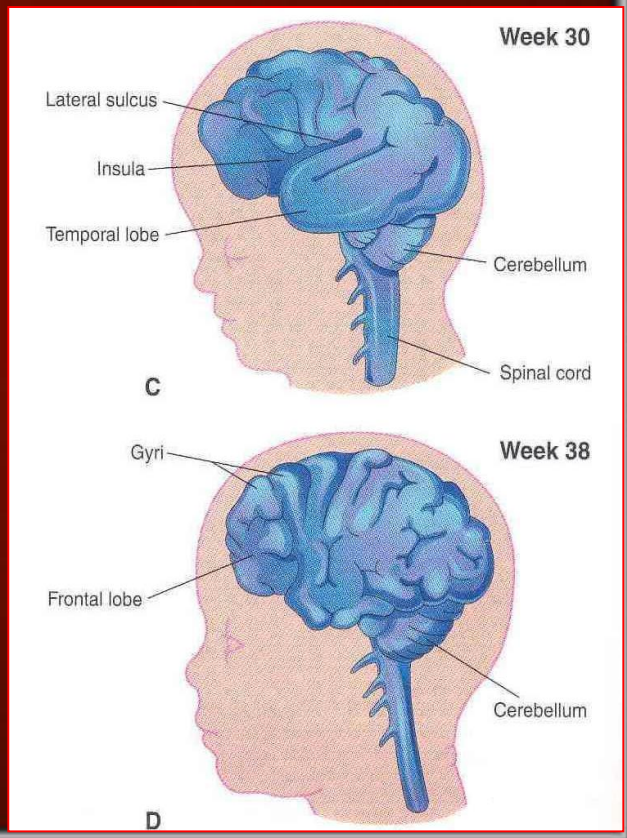
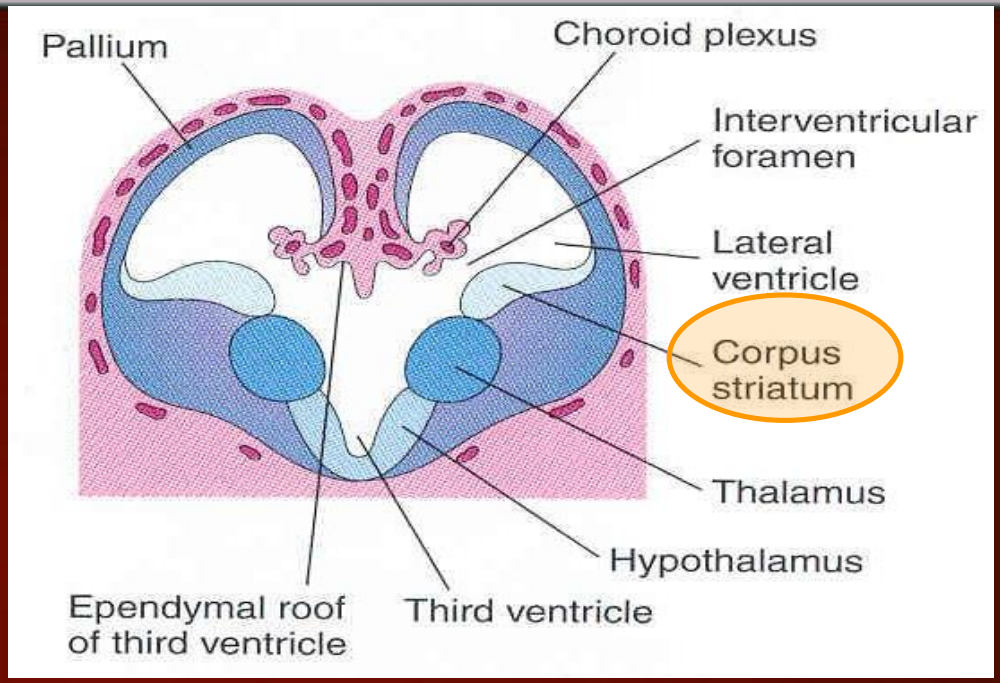
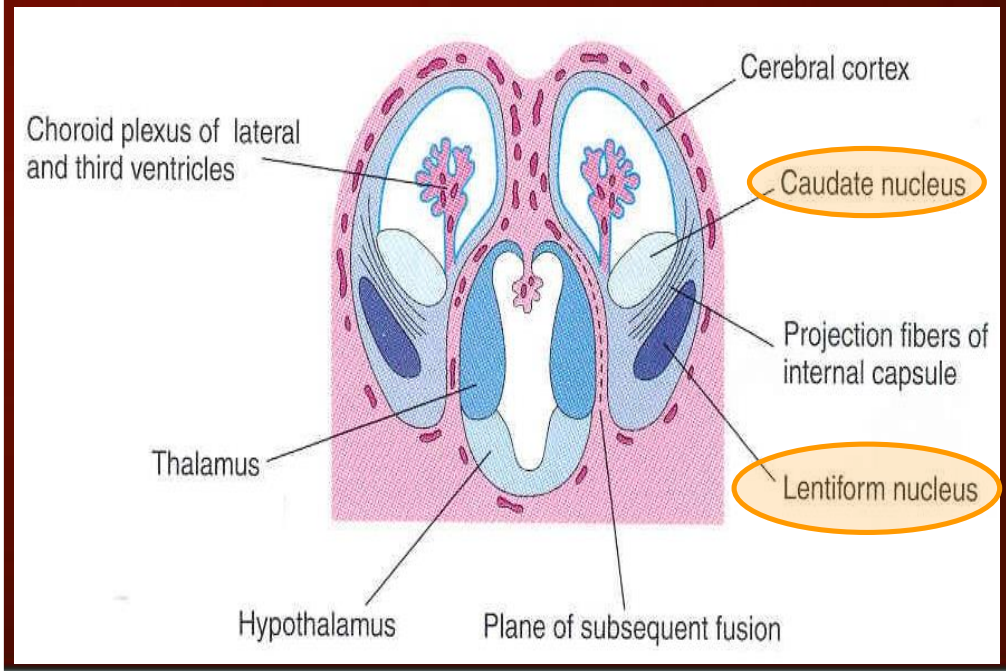


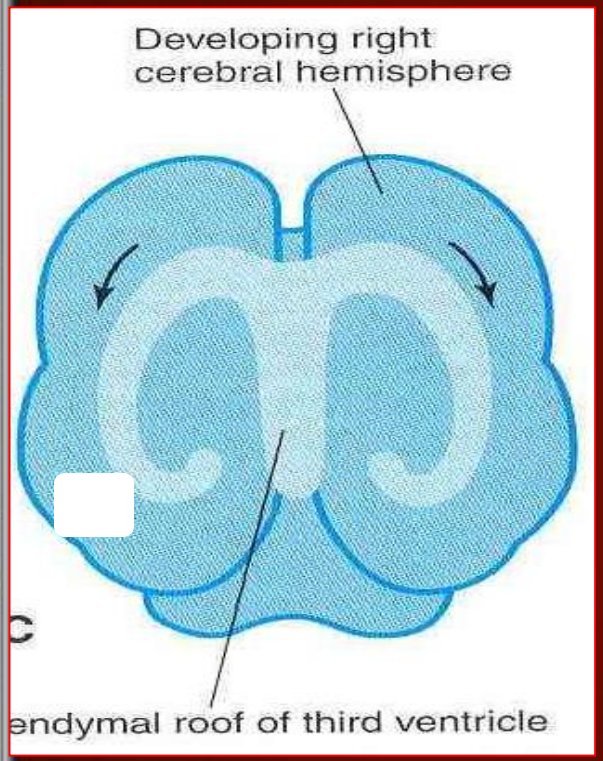


- **Corpus striatum:**
- It appears in **6th** week in the floor of each cerebral hemisphere.
- As the cerebral cortex differentiates and its fibers passing to and from it.
- These fibers pass through the corpus striatum.
- So the corpus striatum now is divided into caudate nucleus & lentiform nucleus.
- This fiber pathway forms the internal capsule.

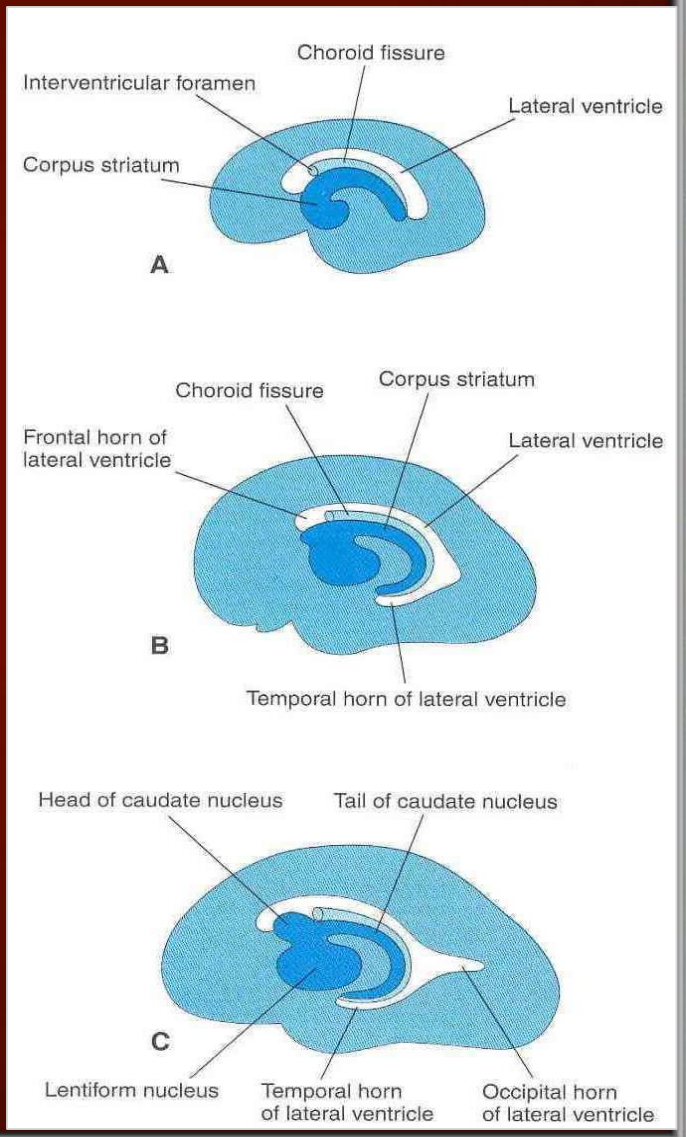




Further expansion give C-shape appearance to the hemisphere itself as well as its cavity (lateral ventricle).



- Also the caudate nucleus elongates and assumes the shape of the lateral ventricle and remains related to it.



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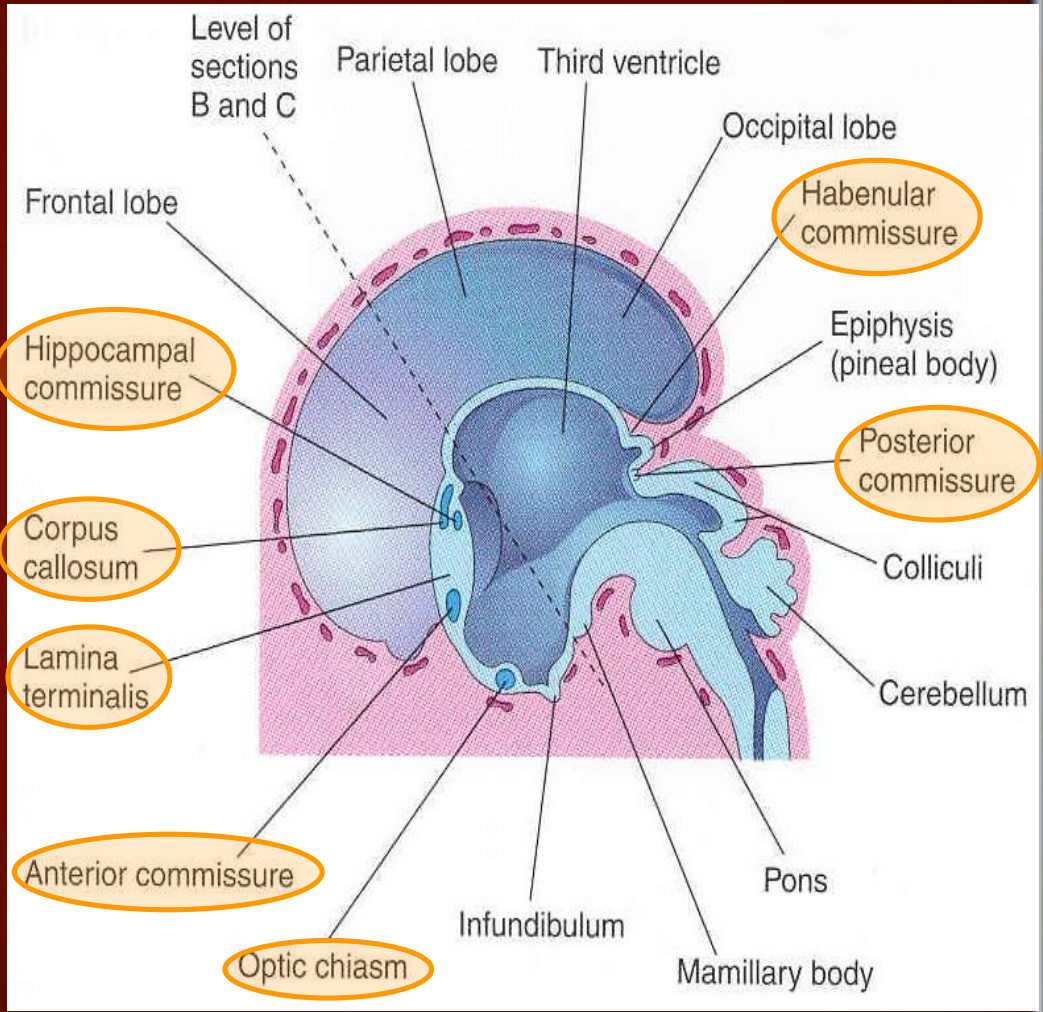
Development of the Cerebral Commissures

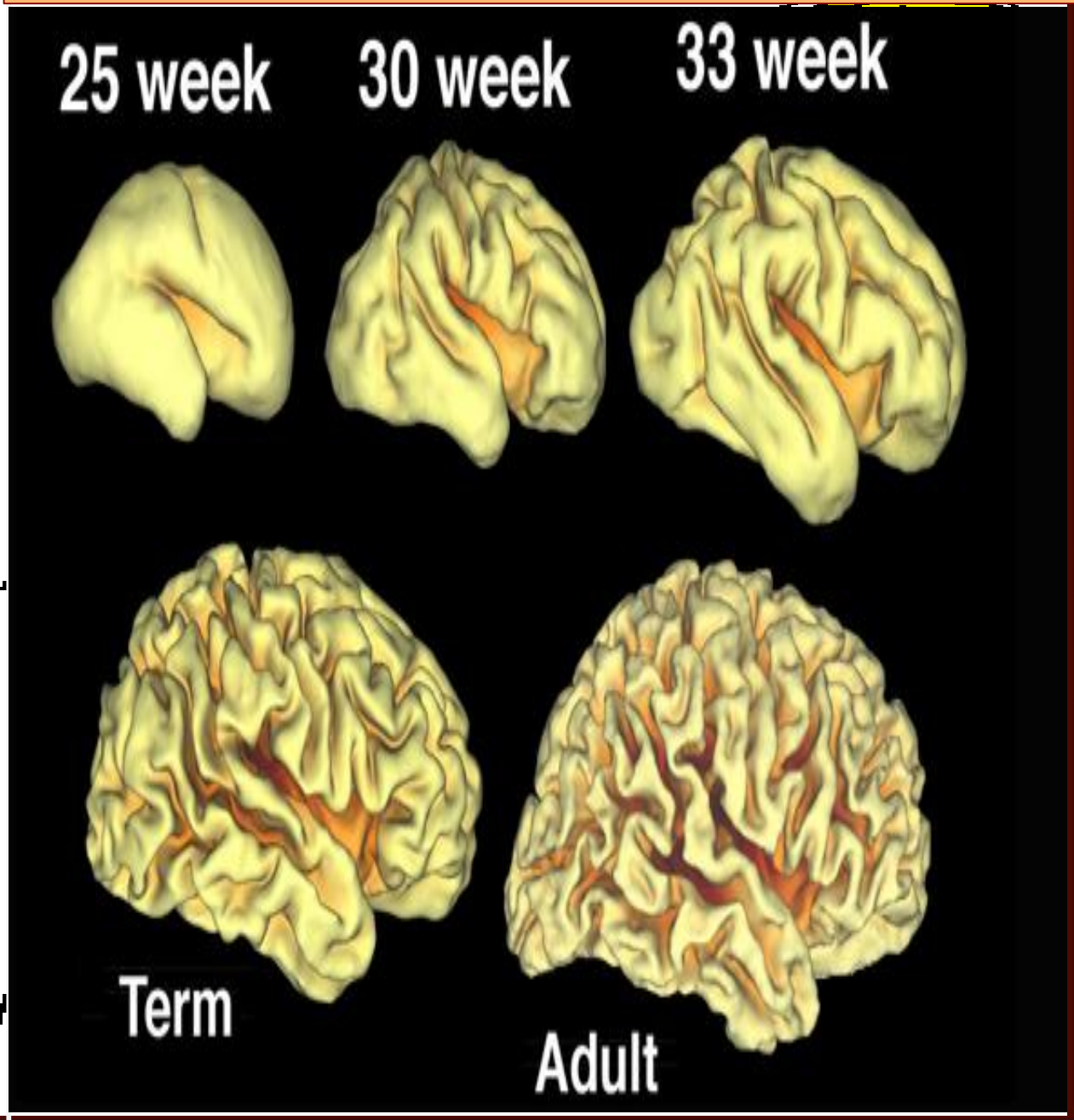
- As the cerebral cortex develops, group of fibers, (commissures), connect the 2 corresponding regions of the cerebral cortex.
- <u>These are:</u>

1. Lamina terminalis.
2. Optic chiasma.
3. Anterior commissure.
4. Posterior commissure.
5. Hippocampal commissure.
6. Habenular commissure.
7. Corpus callosum.



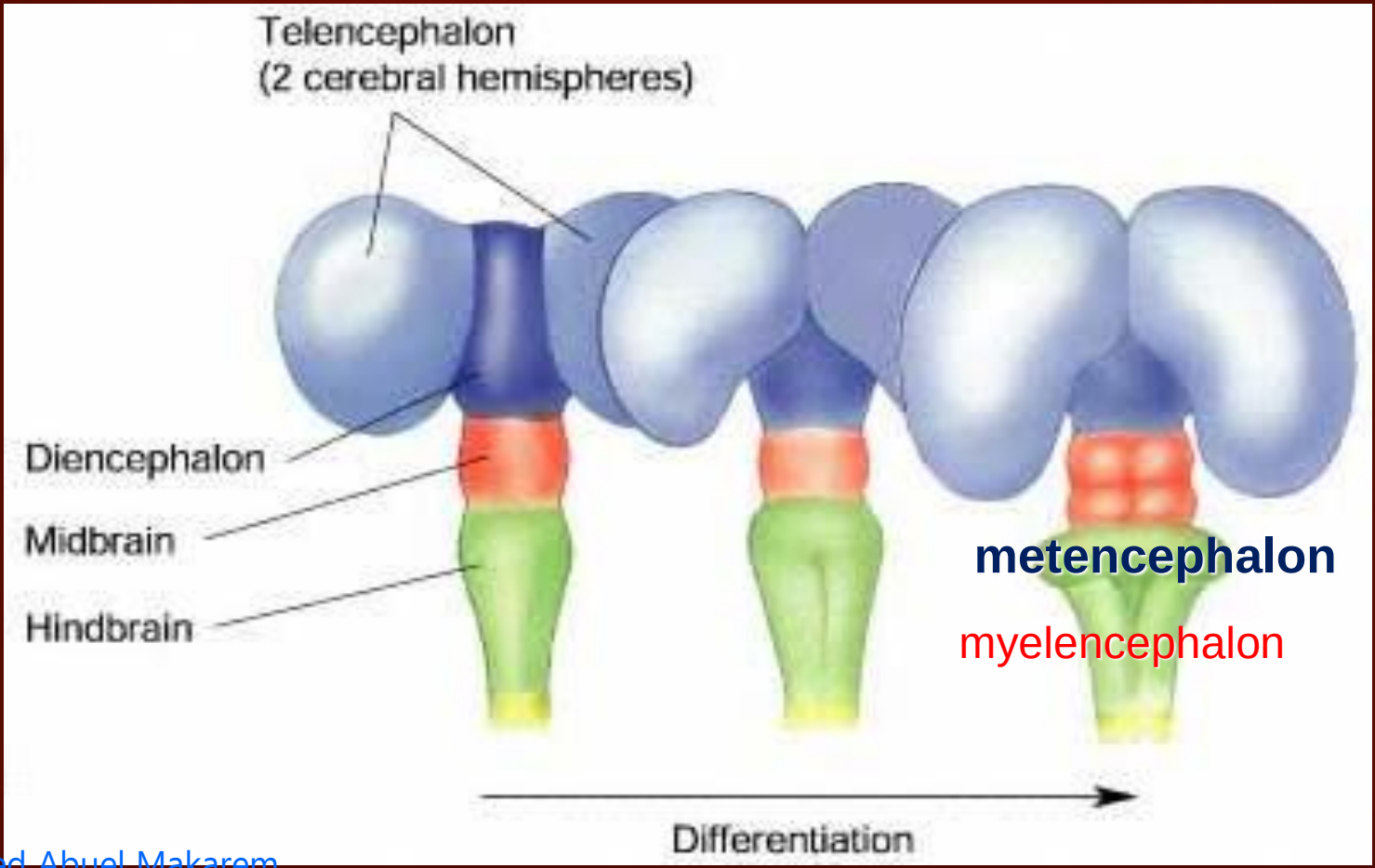
Development of the Insula & lateral fissure

The cortex covering the surface of the corpus striatum, grows relatively slower than the other cortices. So it is overgrown by the rest of the hemisphere and lies in the depth of the lateral sulcus. This is called the insula. So, the insular lobe is a portion of cerebral cortex that has been hidden to lie deep within the lateral sulcus.



Development of the Cerebellum

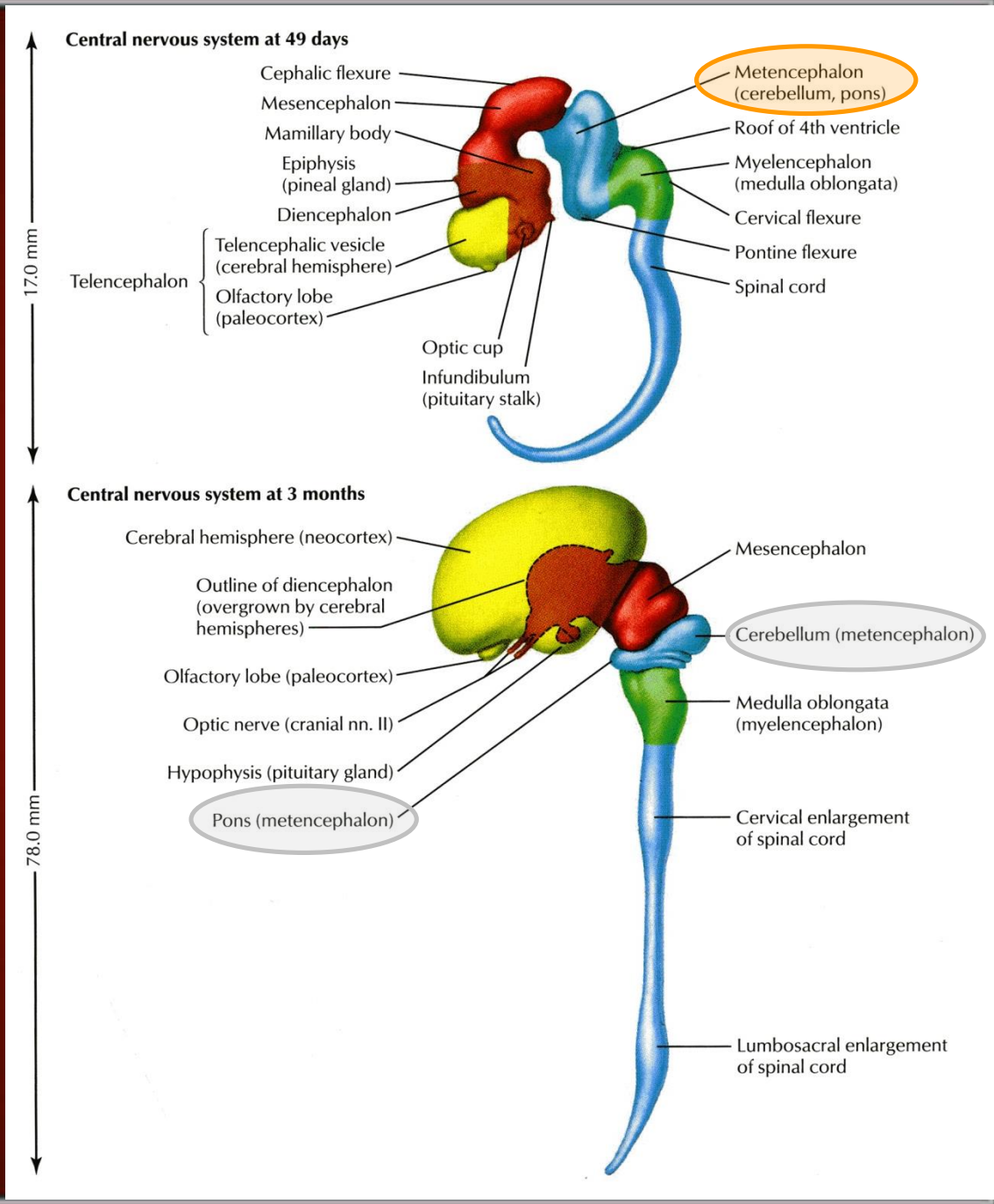
It develops from the dorsal part of the Metencephalon



The metencephalon develops into:

***1. Pons* anteriorly**

***2. Cerebellum* posteriorly.**



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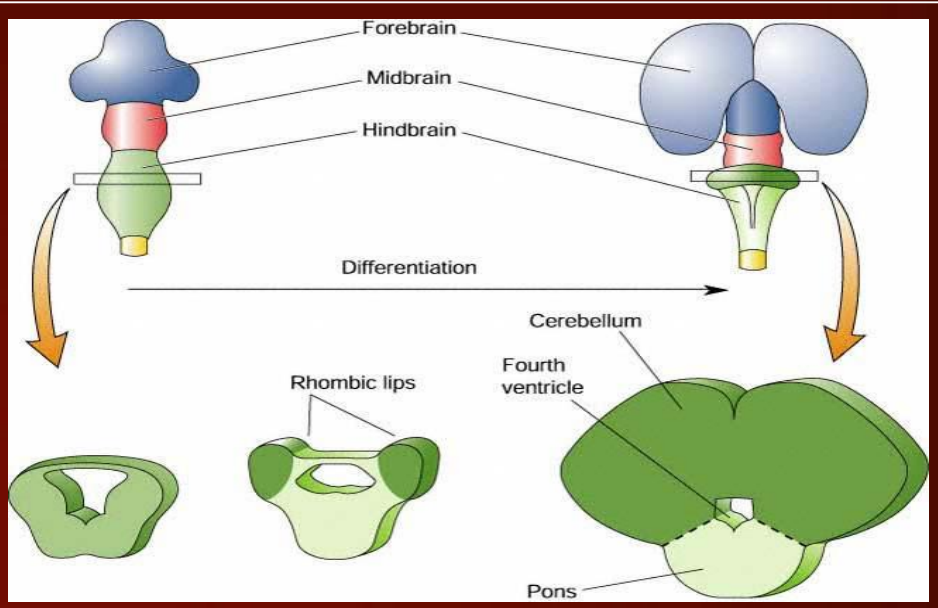
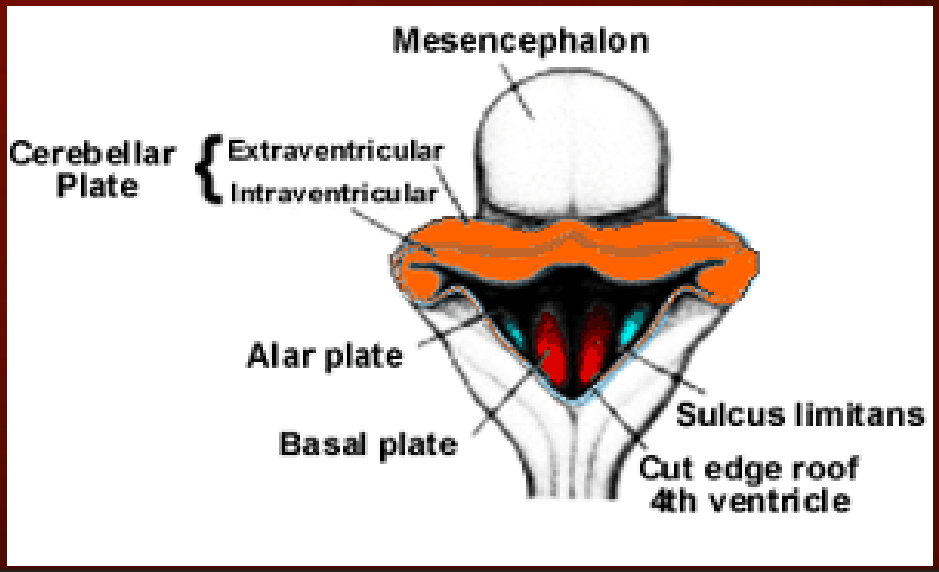
Development of the Cerebellum

- Pontine flexure results in:

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





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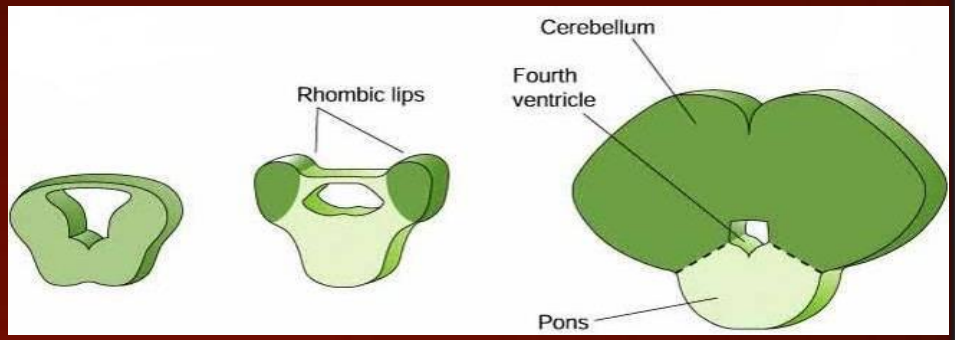
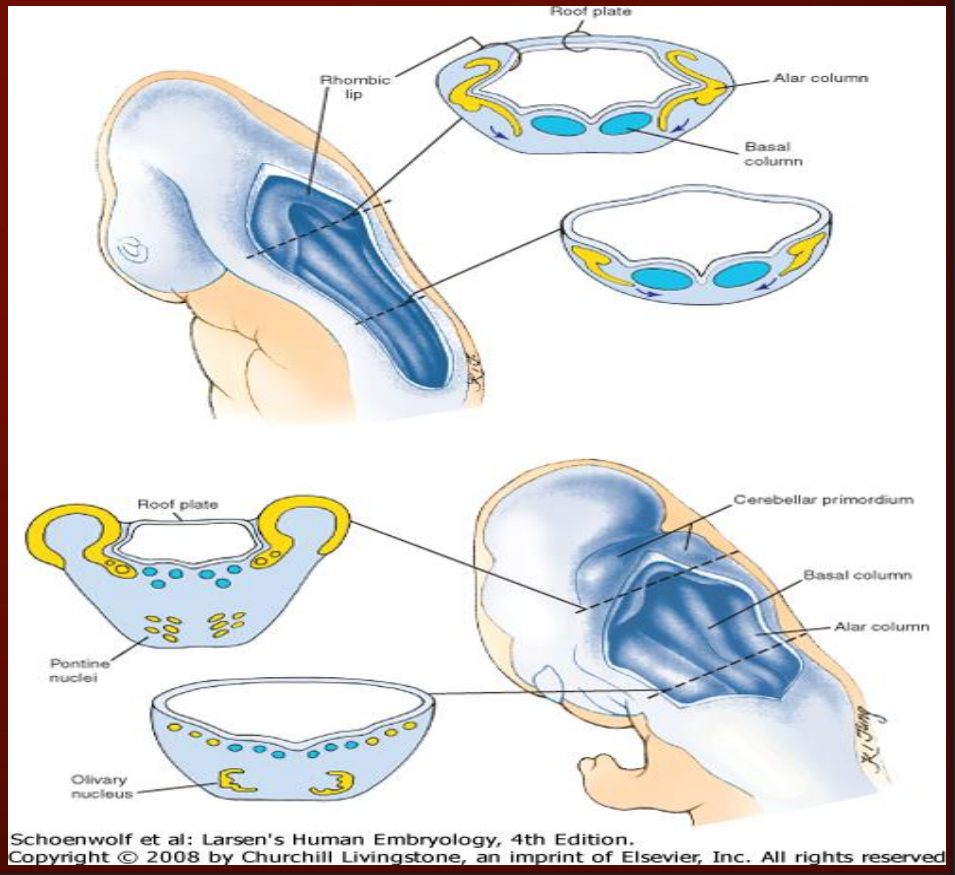
Metencephalon: Changes in Alar plates

- The dorsal parts thicken to form Rhombic lips, that will give rise to the cerebellum.
- Some neuroblasts migrate from the mantel layer to the marginal layer forming the cerebellar cortex.
- Others remains in the mantel 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.





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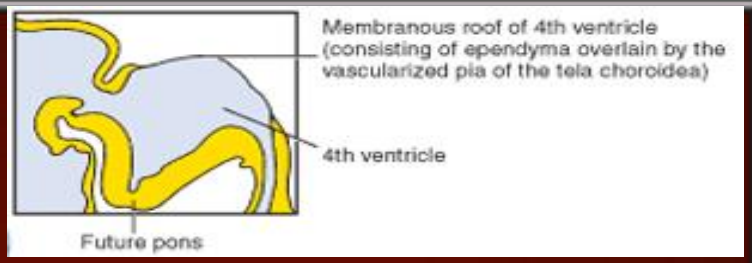
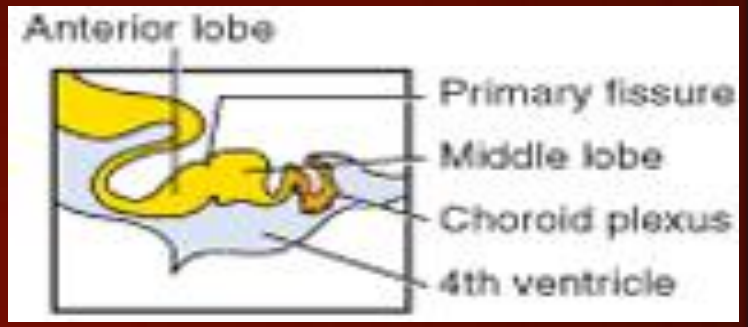
- As the cerebellar hemispheres develops they undergo a complicated process of transverse folding and form closely packed, leaf-like transverse gyri called **folia**.
- These processes of fissure formation and foliation continue throughout;
- Embryonic,
- Fetal, and
- Postnatal life, and they increase the surface area of the cerebellar cortex.

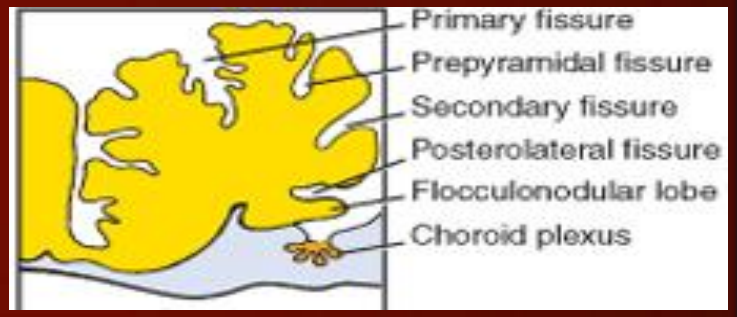
35 d



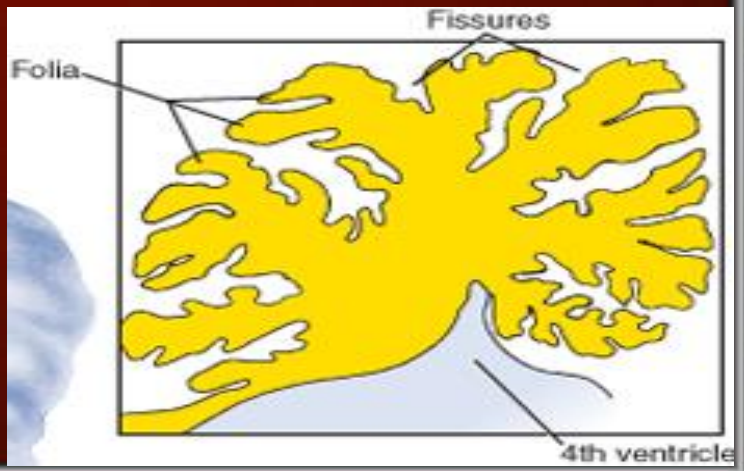
50 d



90 d



150 d



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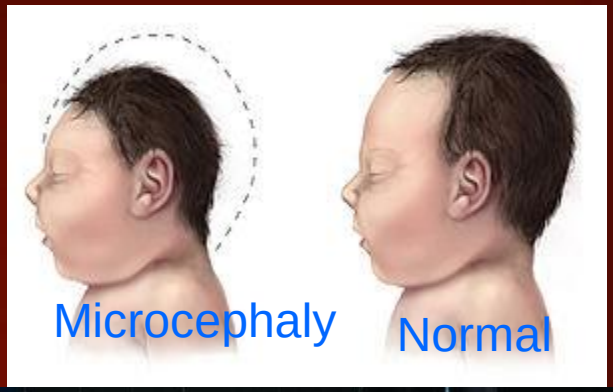
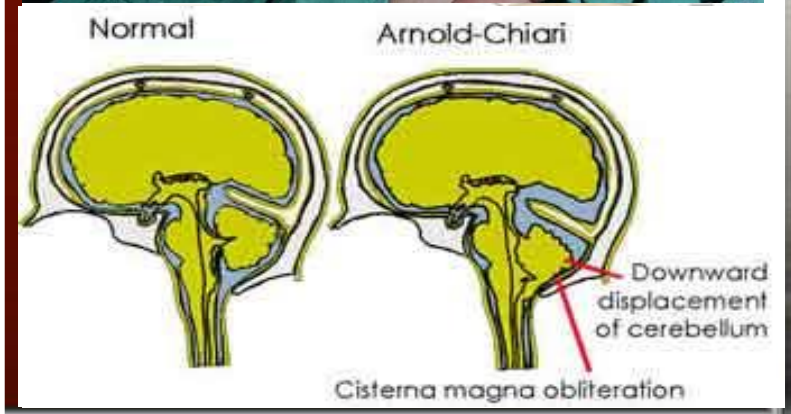
The most Common Congenital Anomalies of The Brain

- Mental retardation.
- Seizures (changes in electrical activity).
- Cerebral palsy.
- Cranium bifidum with or without meningocele & meningoencephalocele.
- Agenesis of corpus callosum.
- Microcephaly (abnormal small head associated with incomplete brain development).
- Hydrocephalus:
- Arnold-Chiari malformation: (herniated part of cerebellum through the foramen magnum leading to CSF obstruction. ,so hydrocephalus results),
- **Aqueductal stenosis.**
- Anencephaly.



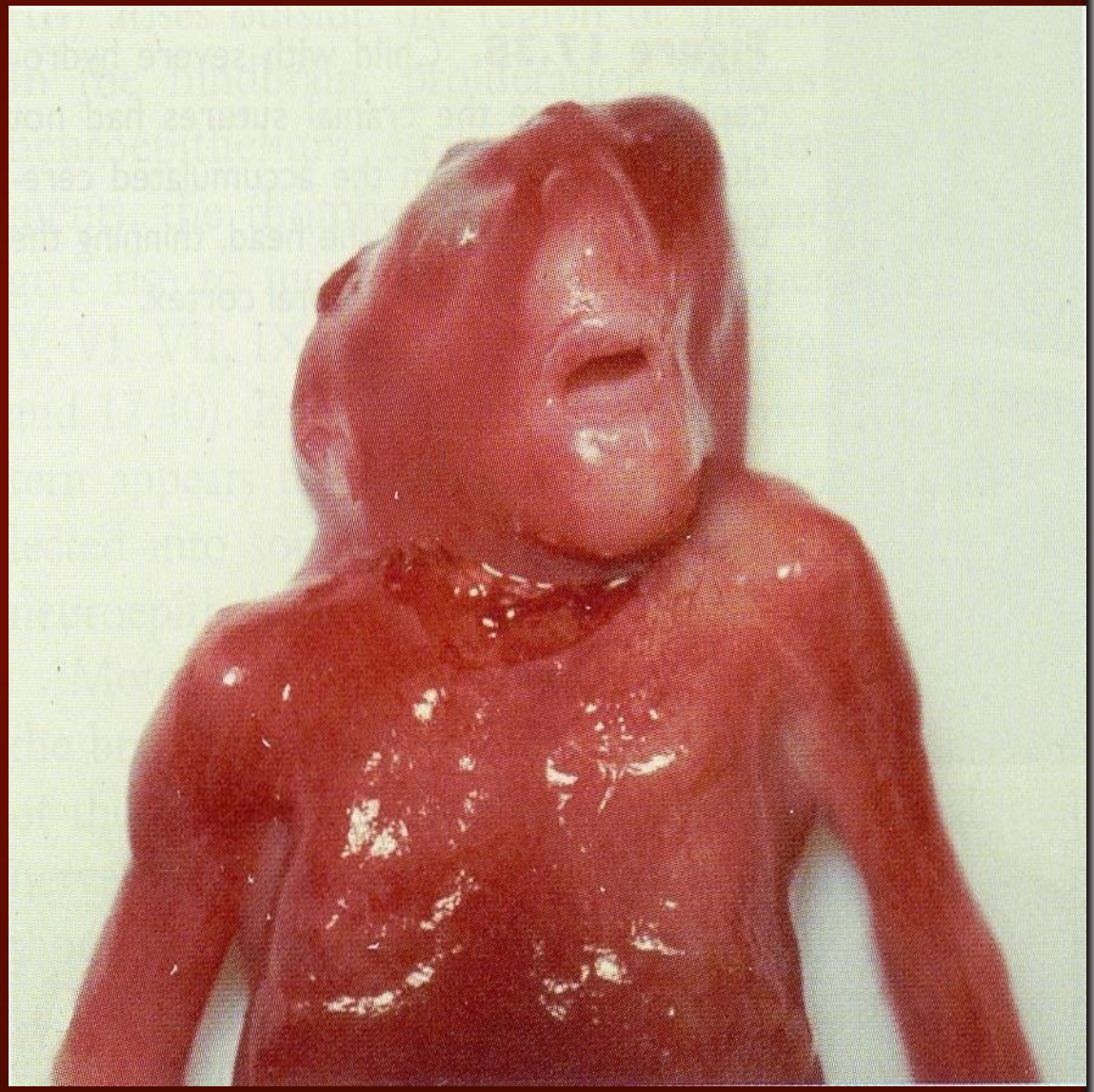


ANENCEPHALY

In anencephaly, the brain and skull are minute and the infant does not survive.

It is due to failure of closure of the cranial neuropore of the neural tube.

The frequency of this case 1:1000.



THANK YOU
AND
GOOD LUCK