

# DEVELOPMENT



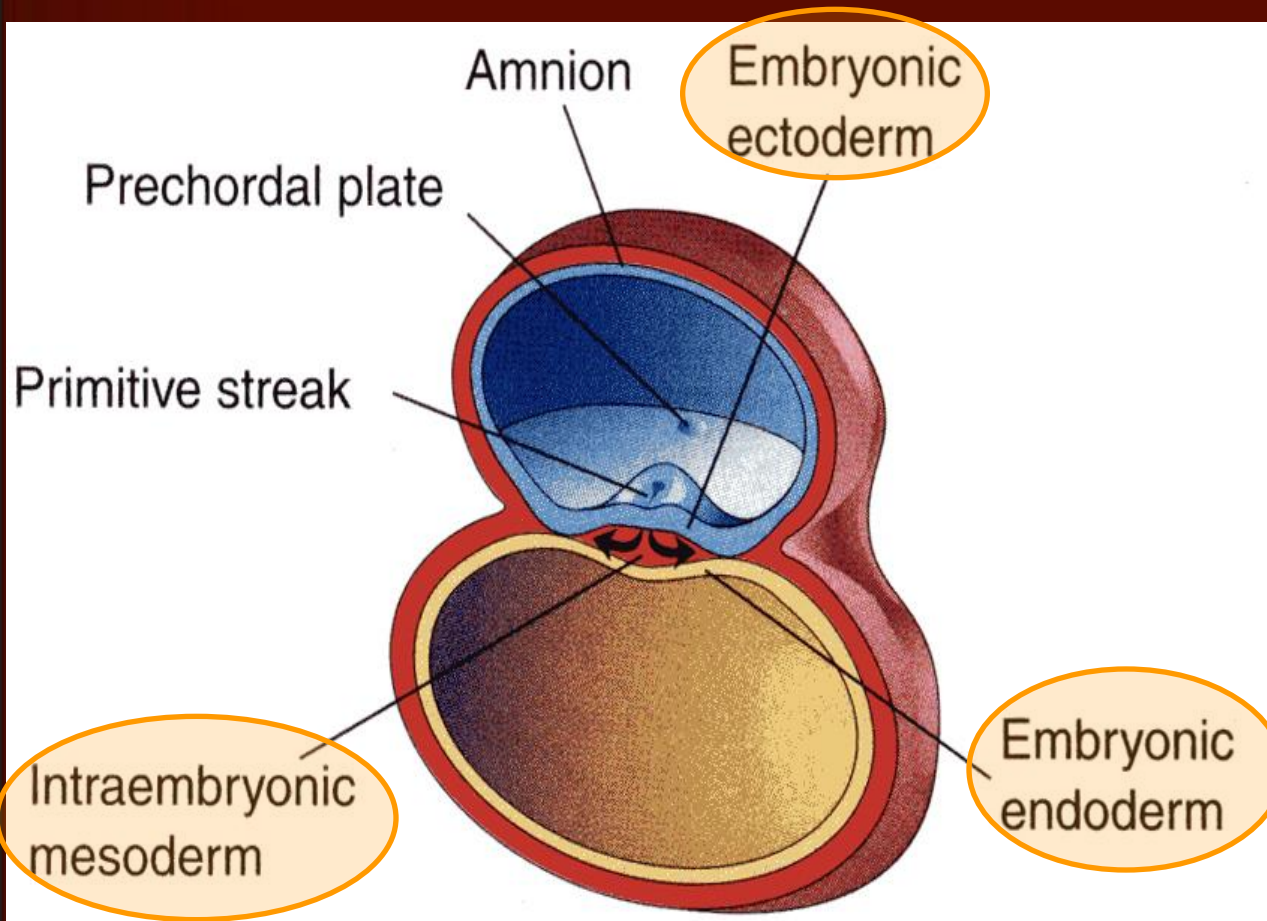
## of CEREBRUM & CEREBELLUM

# OBJECTIVES

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

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

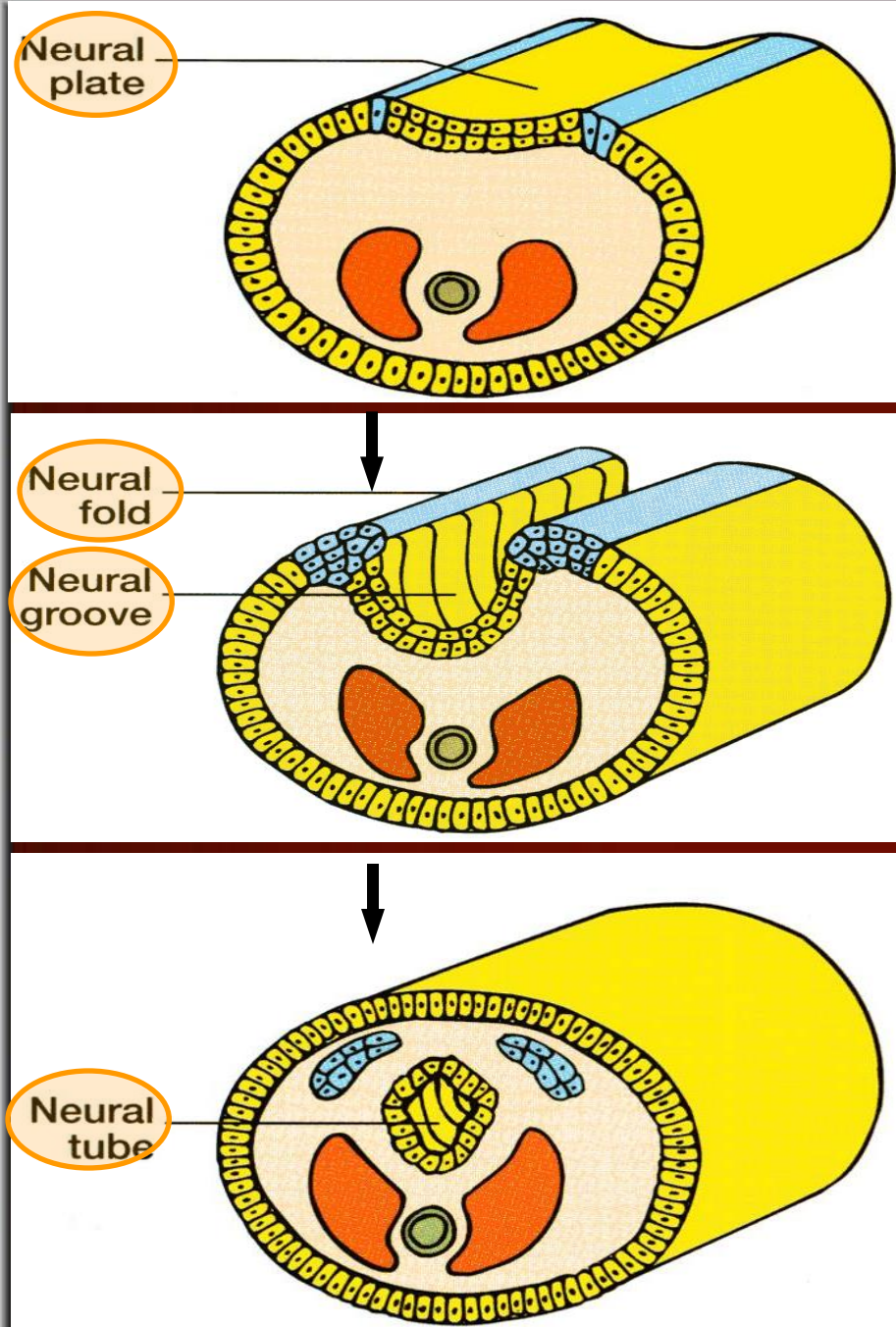
# INTRODUCTION



By the beginning of the 3<sup>rd</sup> week of development, three germ cell layers become established, **Ectoderm, Mesoderm and Endoderm.**

# EARLY DEVELOPMENT

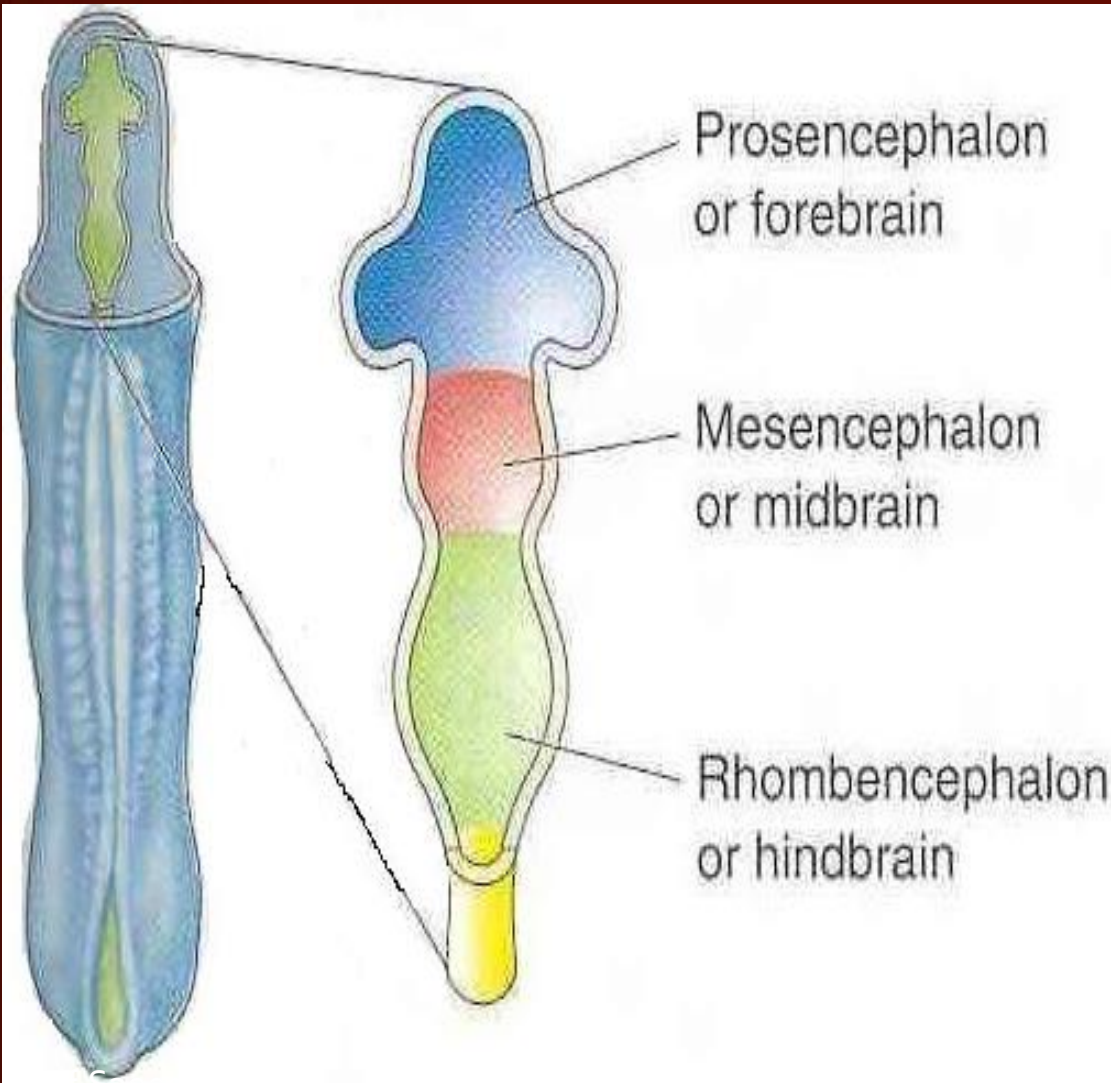
- During the middle of the 3rd week, *the dorsal midline ectoderm* undergoes thickening to form the **neural plate**.
- The margins of the neural plate become elevated, forming **neural folds**.
- So a longitudinal, midline depression, called the **neural groove** is formed.
- The **2** neural folds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





# Neural Tube Development

## Three-vesicles stage (End of 4<sup>th</sup> Week)



Formation of the neural tube is completed by the middle of the fourth week. By the end of the 4<sup>th</sup> week,

Its upper end dilates and shows 3 brain vesicles:

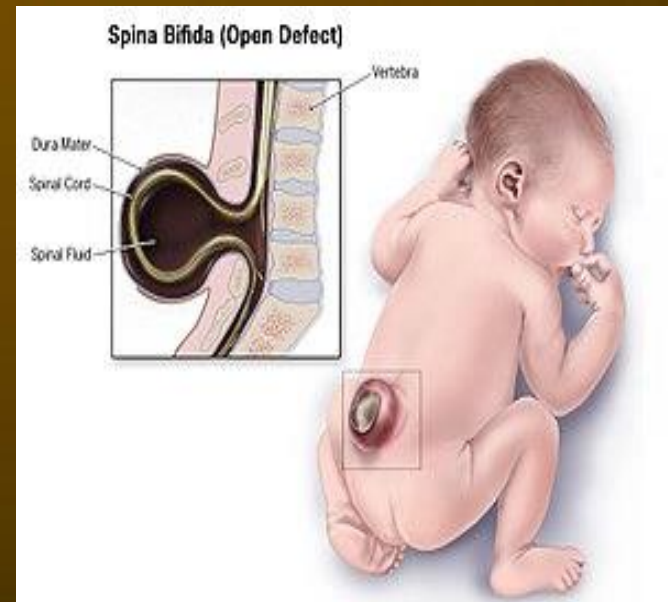
**Prosencephalon, or forebrain.**

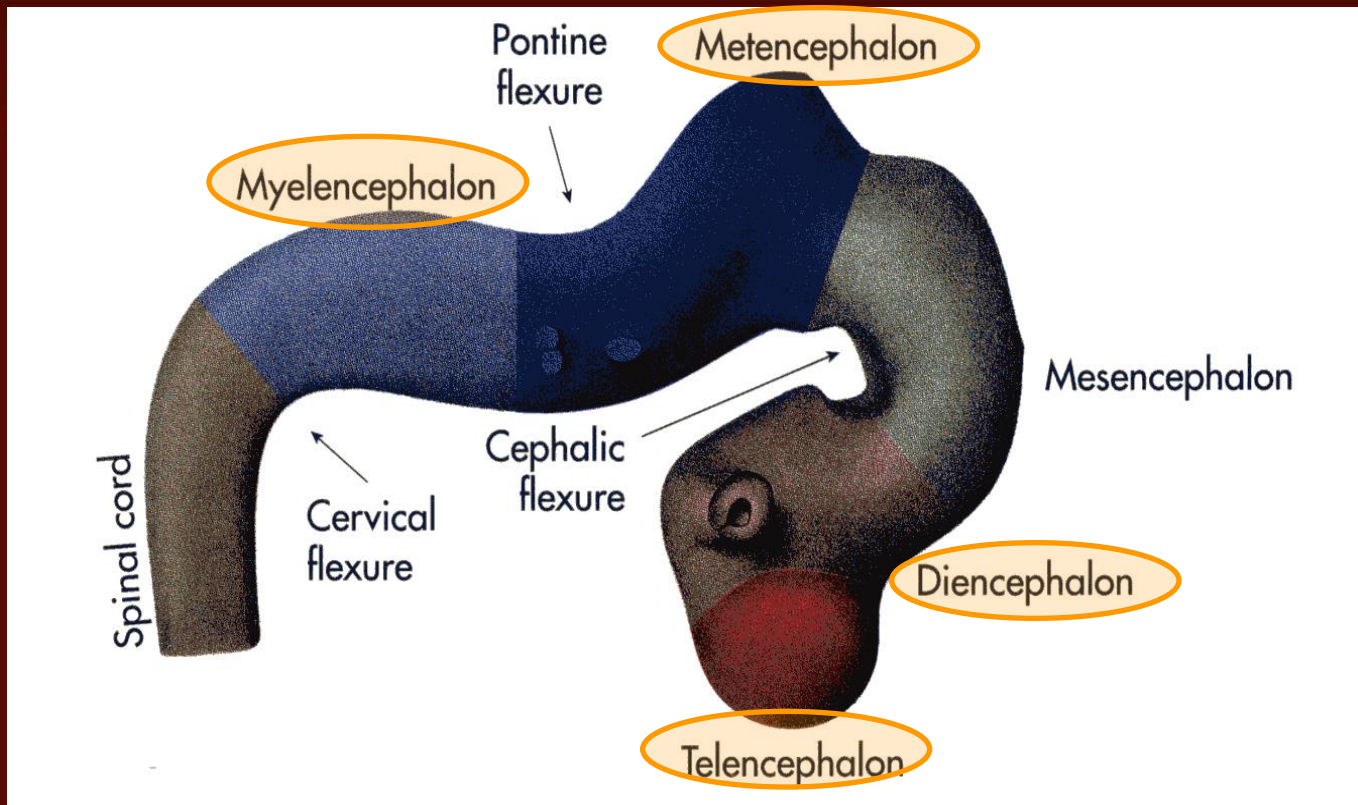
**Mesencephalon, or midbrain &**

**Rhombencephalon or hindbrain.**

# The two Ends of the neural tube

- The 2 ends of the neural tube are opened.
- The upper end is closed on the 23<sup>rd</sup> to 26<sup>th</sup> day of development.
- While the lower end is closed by the 27<sup>th</sup> day of development.
- If the upper end fail to close it will lead to anencephaly.
- If the lower opening fail to close it will lead to spina bifida.



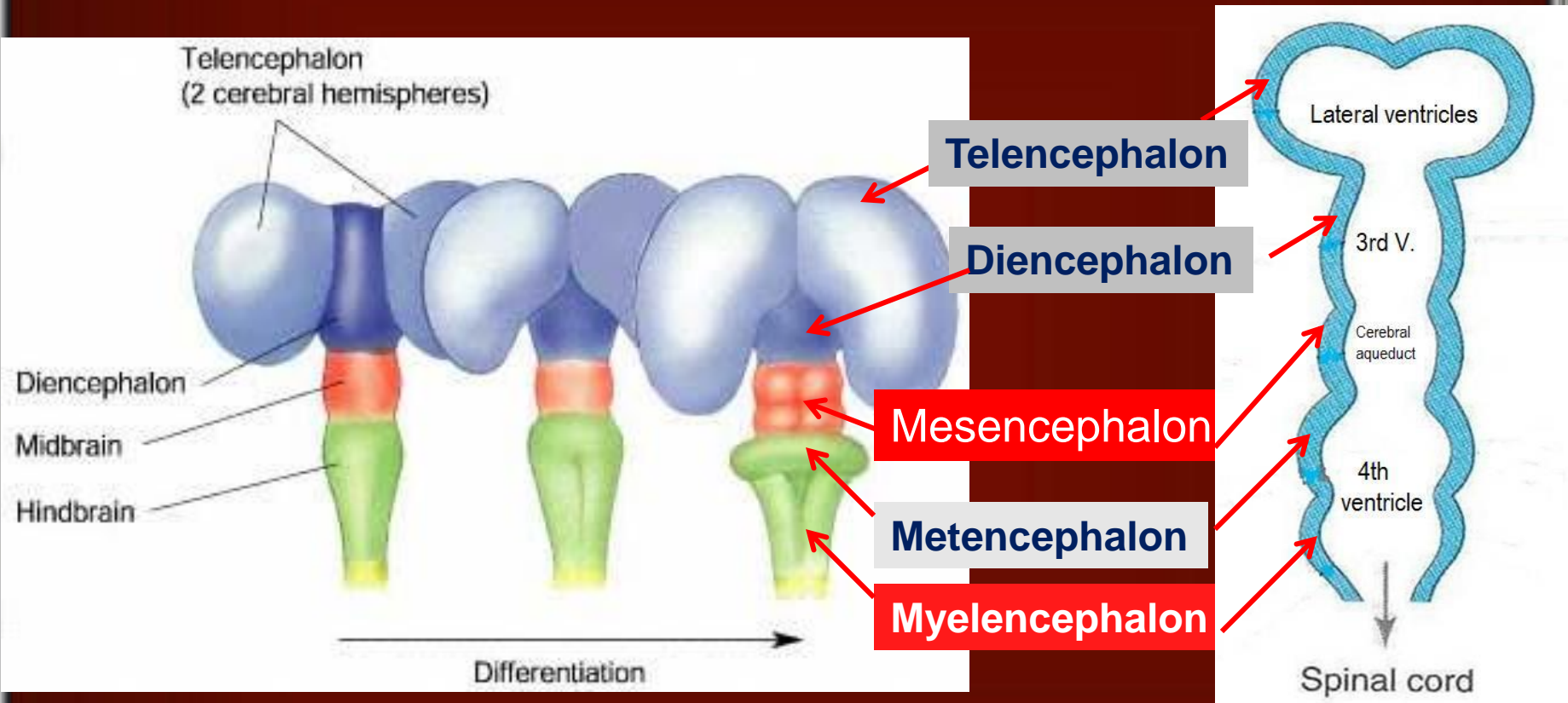


By the **5<sup>th</sup> week** further differentiation distinguishes **five 2ry brain vesicles**:

- *The prosencephalon* divides into the two **telencephalon** and one **diencephalon** and
- *The Rhombencephalon* divides into **metencephalon** and **myelencephalon**.

# Neural Tube Development

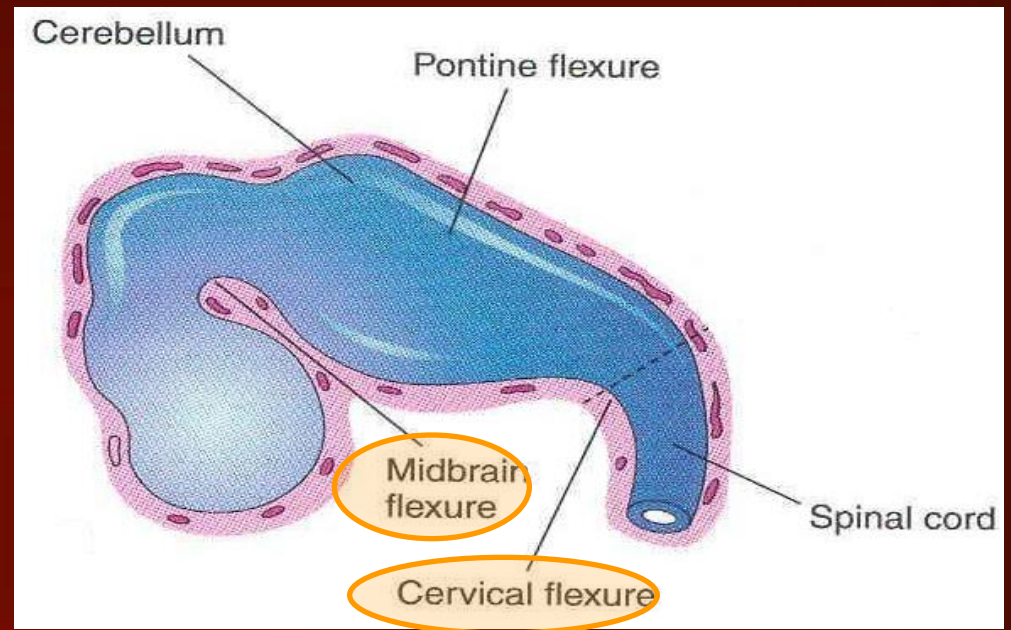
## Five-vesicles stage (5<sup>th</sup> week)



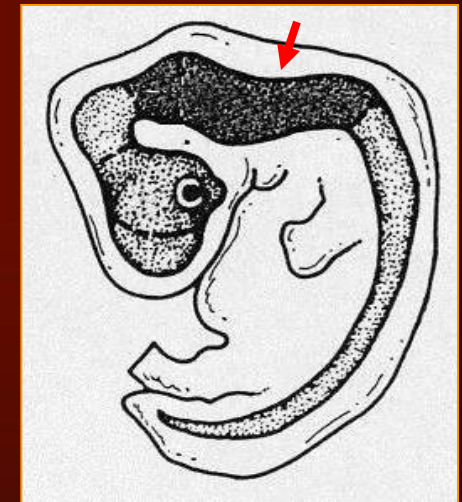
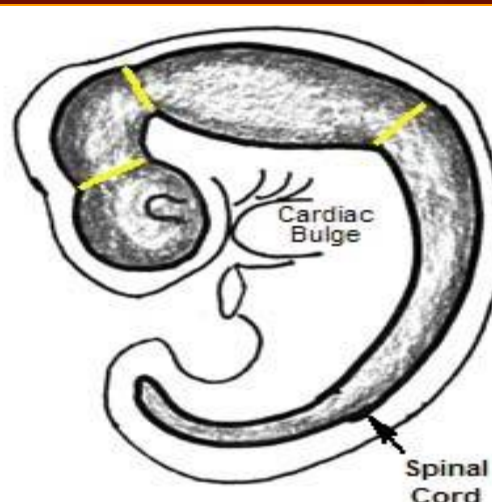


## 3 Brain Flexures

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



- Later on a **Pontine flexure** appears in the hindbrain, in the **opposite direction**, resulting in thinning of the roof of the hindbrain.





## Primary brain vesicles

## Secondary brain vesicles

## Derivatives in mature brain

Prosencephalon (forebrain)

Telencephalon

Cerebral hemisphere

Diencephalon

Thalamus

Mesencephalon (midbrain)

Mesencephalon

Midbrain

Rhombencephalon  
(hindbrain)

Metencephalon

Pons, cerebellum

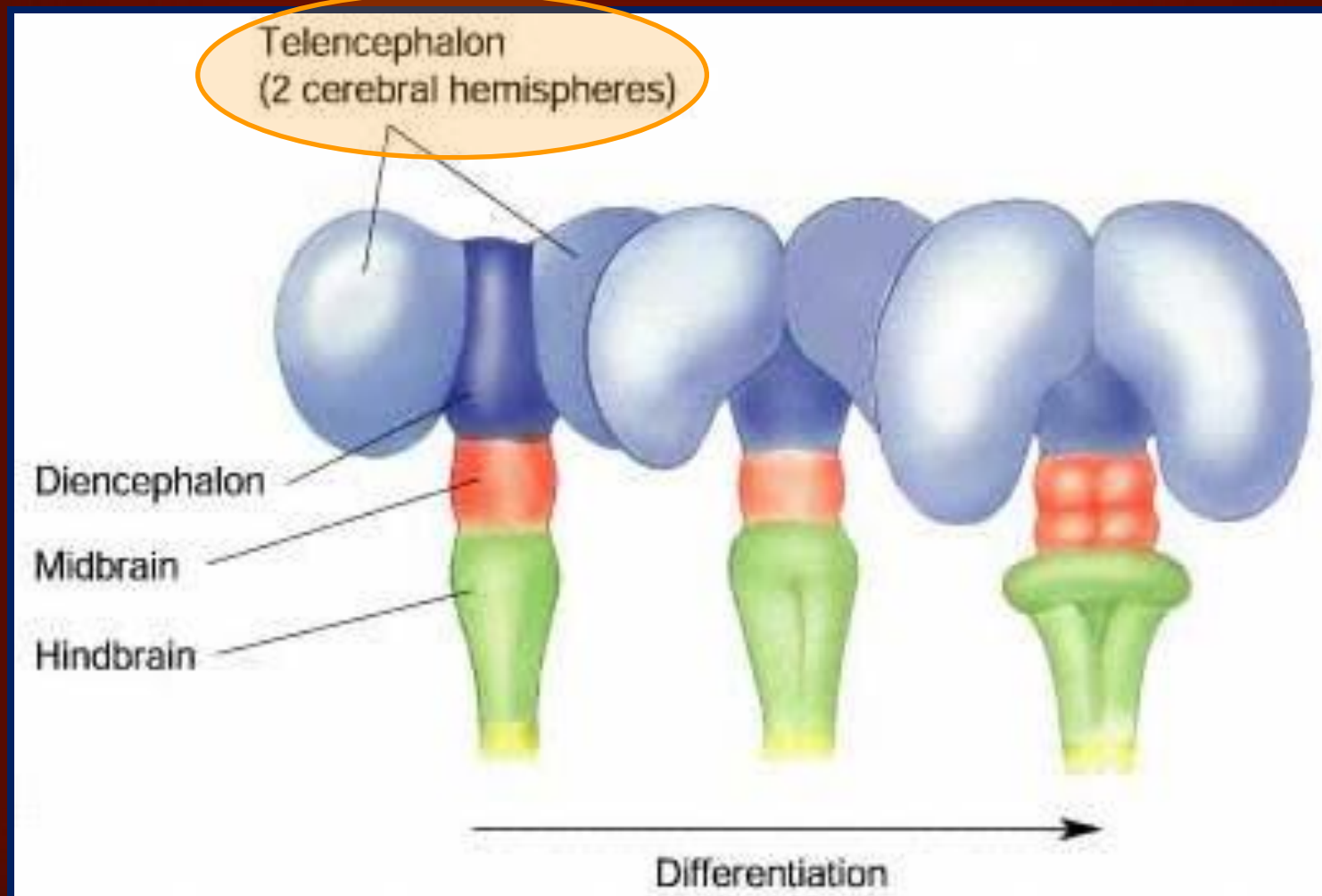
Myelencephalon

Medulla oblongata



# Development of the Cerebrum

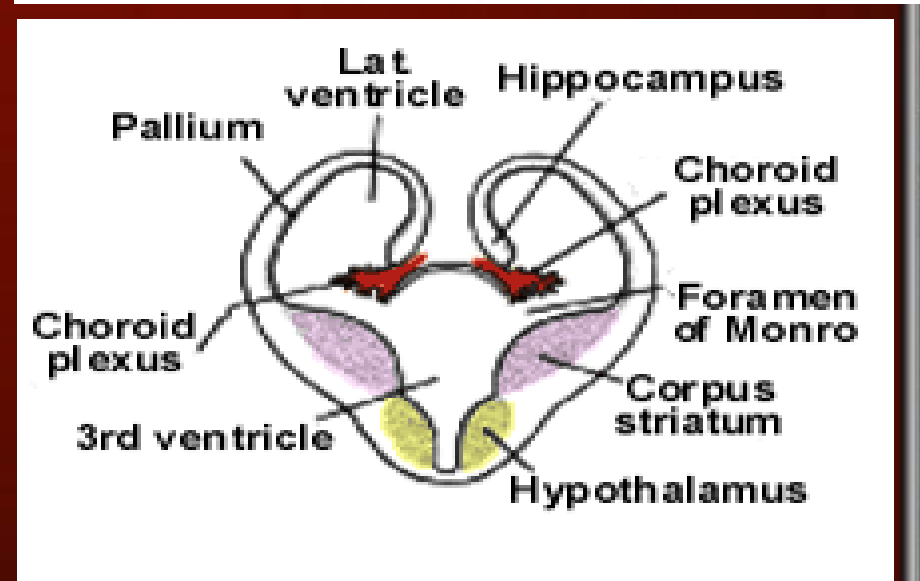
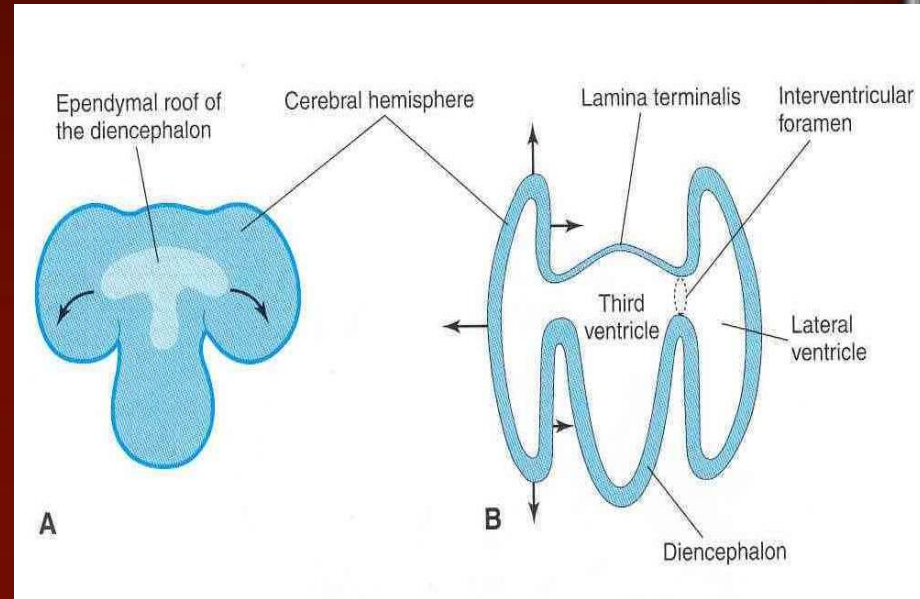
The cerebrum develops from the **Telencephalon**



# Differentiation of Forebrain Vesicle

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

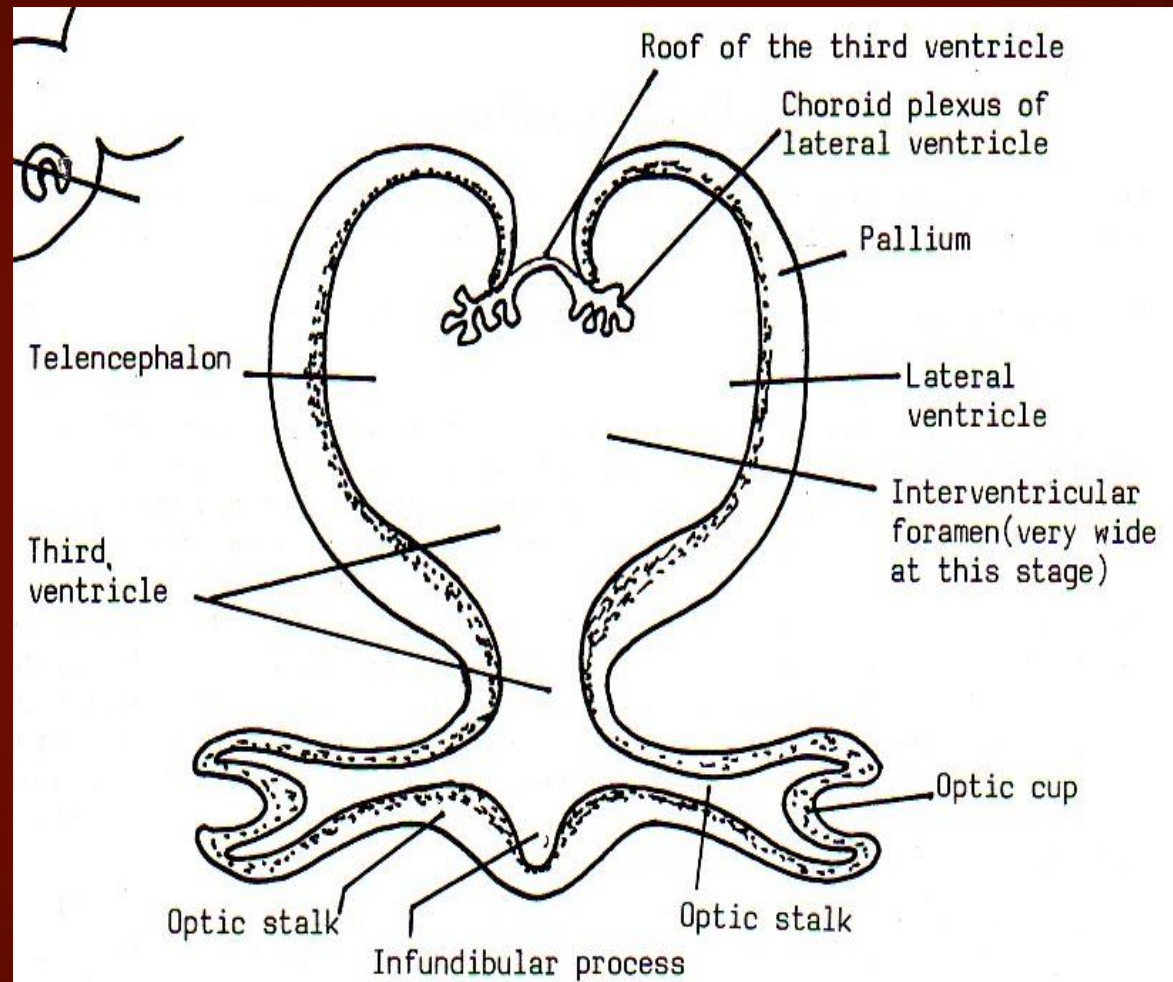
- The cerebral hemispheres expand in all directions.
- Its medial wall becomes thin, flat and it is the site of choroid plexus of the lateral ventricle.





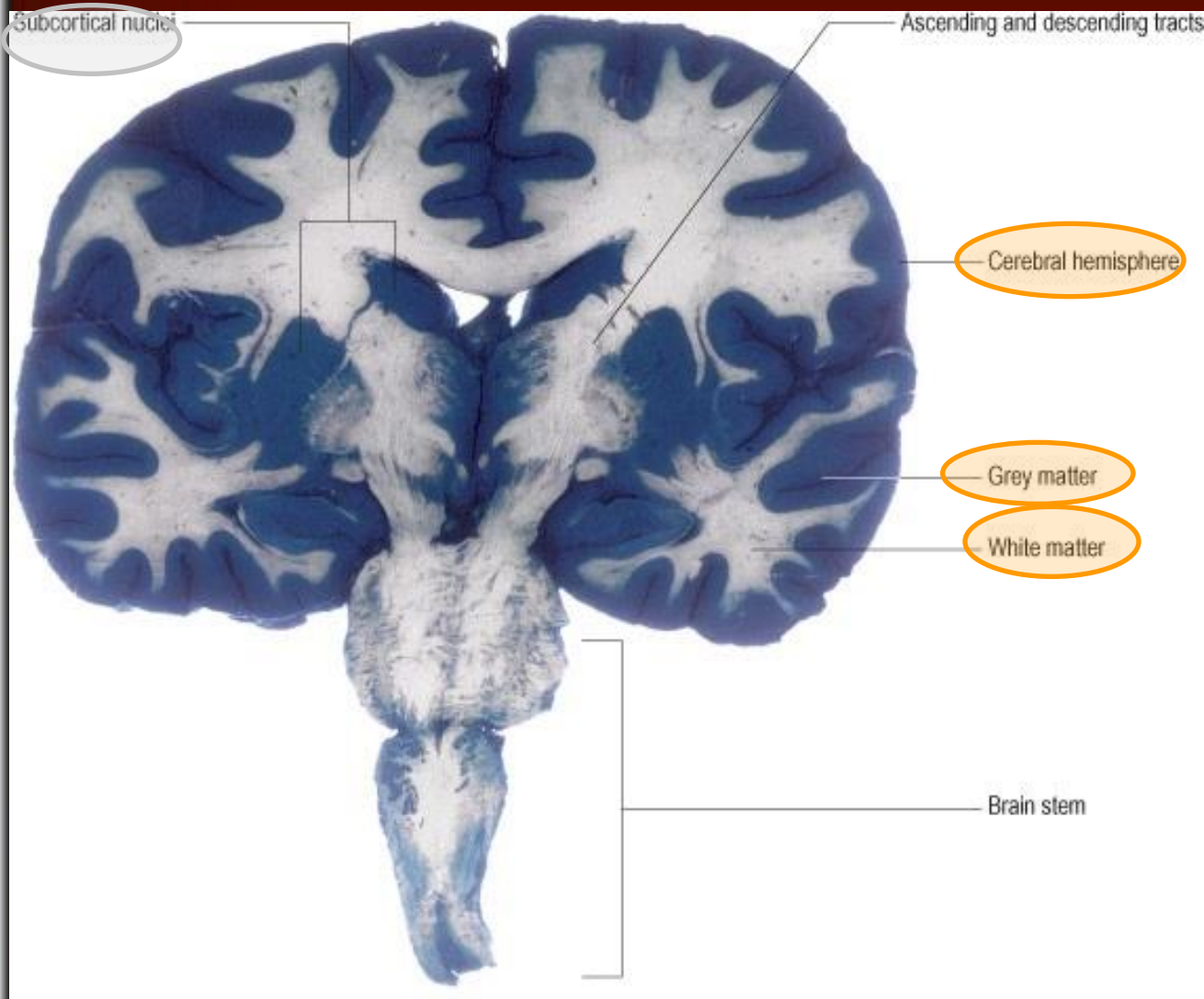
# Development of the Cerebrum

- The wall of the telencephalon is formed of 3 layers;
- Ependymal (lining the cavity of the lateral ventricle).
- Marginal; nerve fibers forming the white matter.
- Mantel; nerve cells forming the grey matter.



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

As development proceeds the following changes occur:

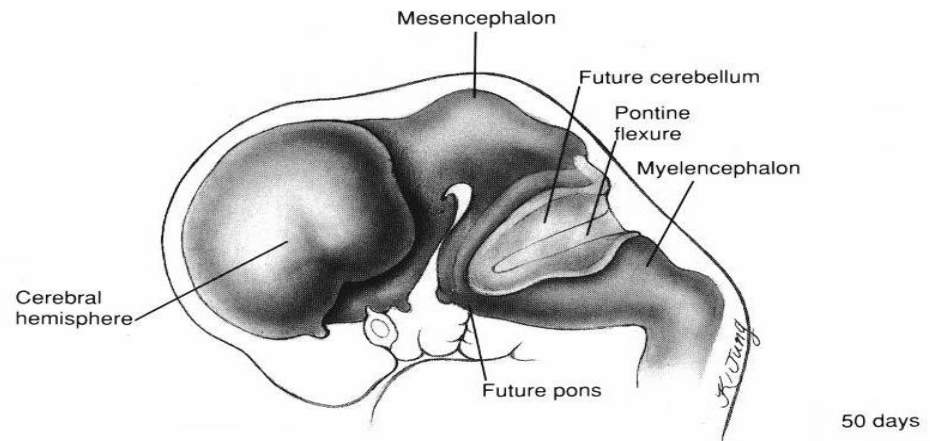
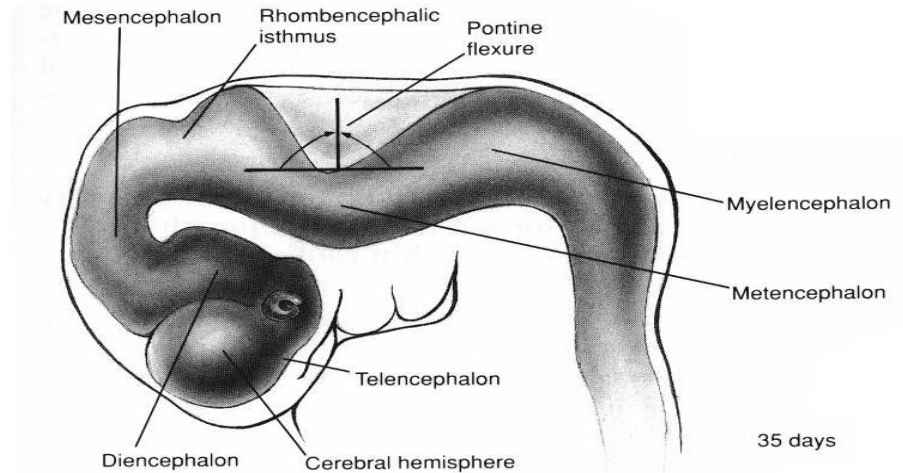


Most of the **nerve cells** migrate from the mantle layer to the marginal layer forming the cerebral cortex.

**Some cells** do not migrate and remains to form the basal ganglia.

# Development of the Cerebrum

- 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 and have expanded back to cover the diencephalon.

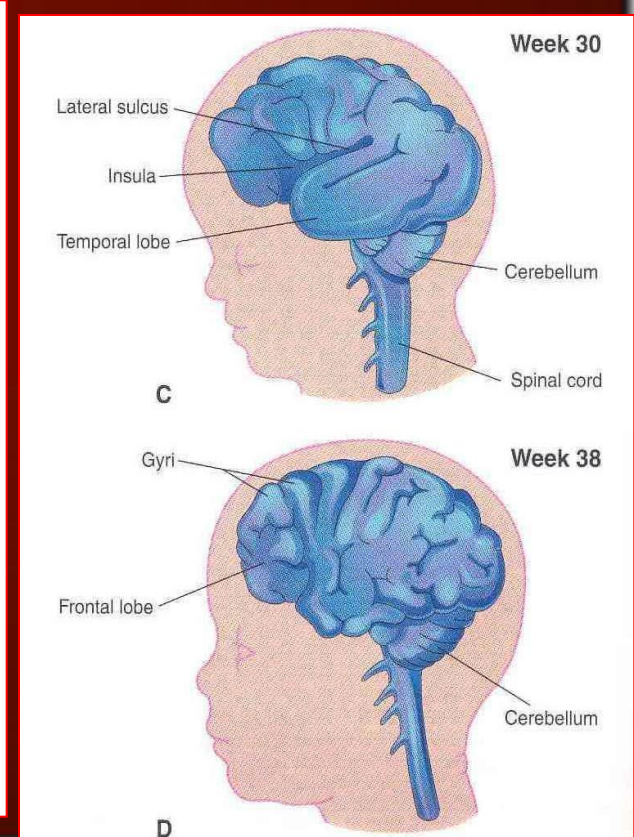
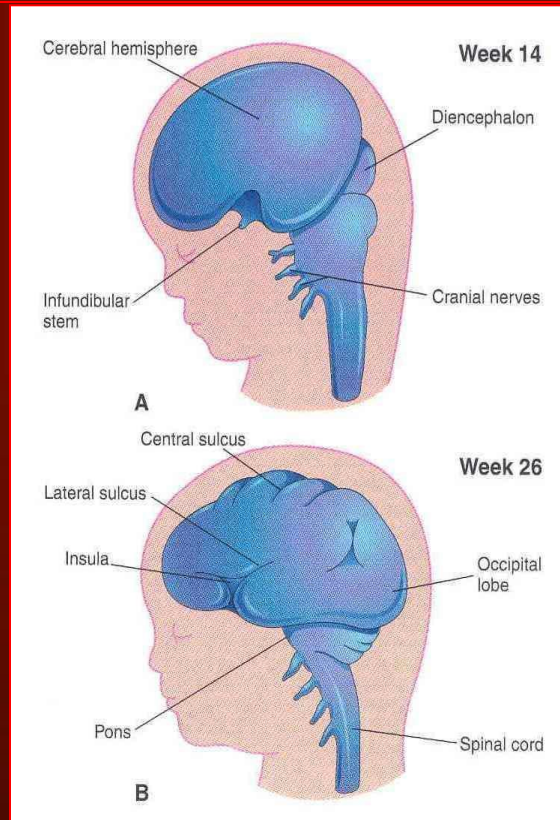
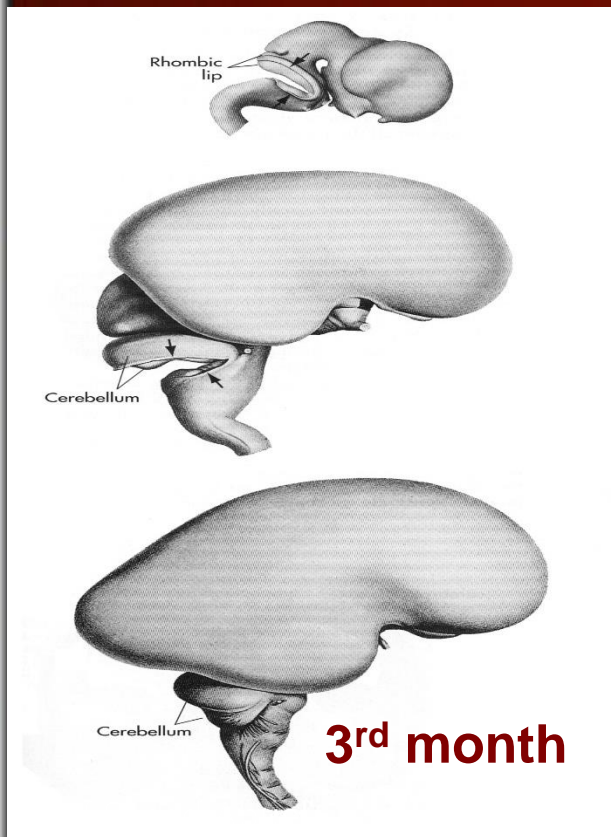




By the end of the 3<sup>rd</sup> month all the surfaces of the cerebral hemispheres are smooth.

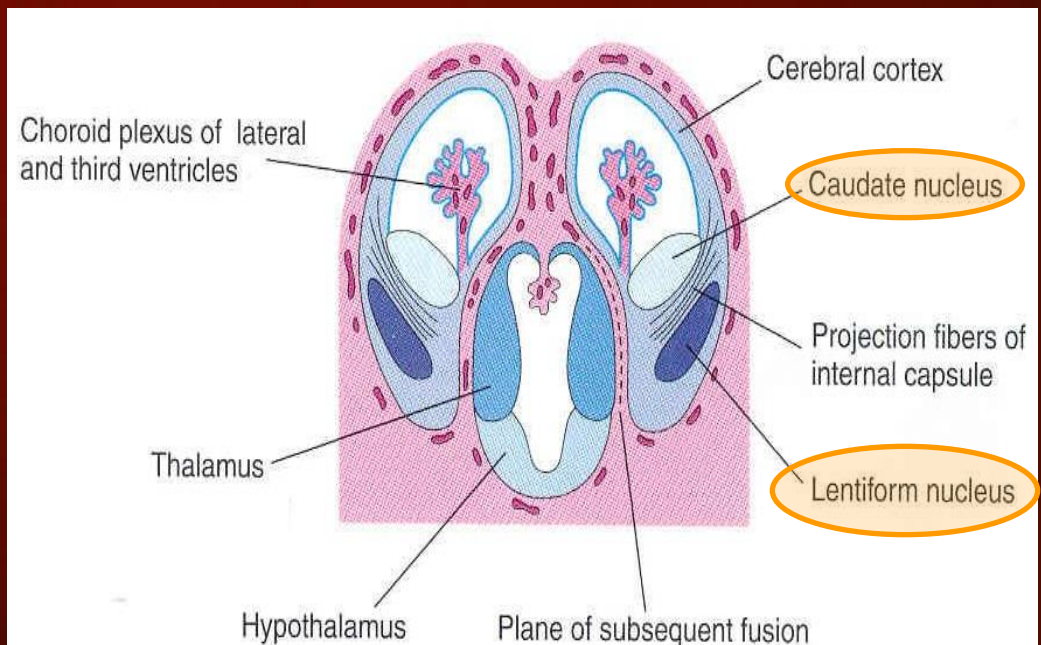
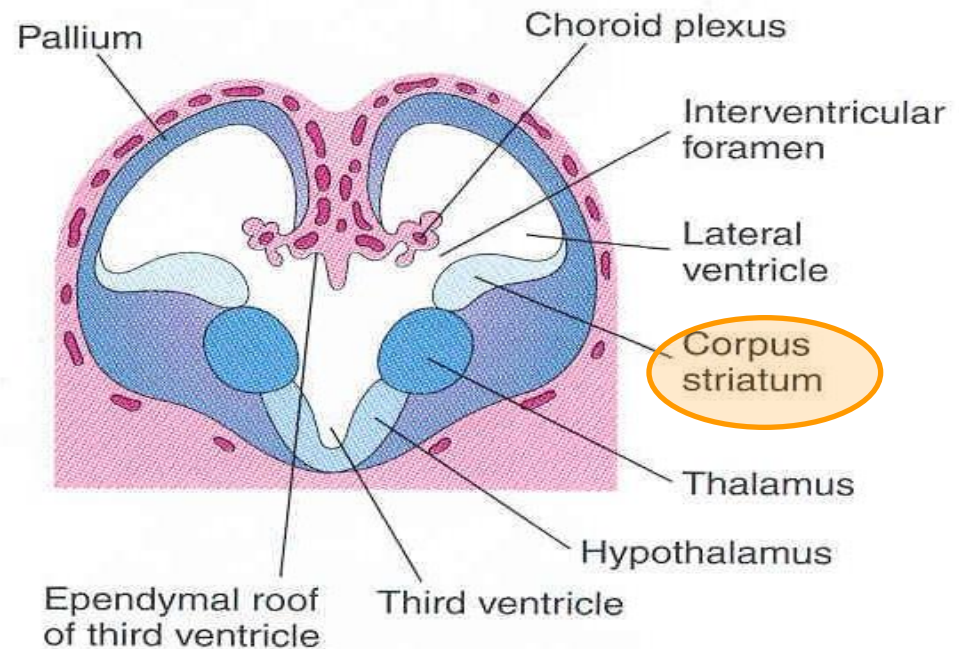
By the 4<sup>th</sup> month the grey matter grows faster than the white matter, so, the cortex becomes folded into gyri separated by sulci.

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

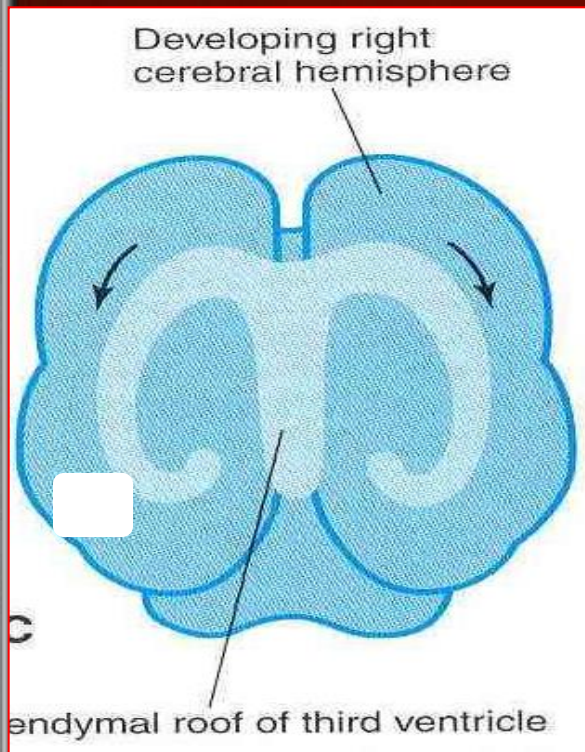




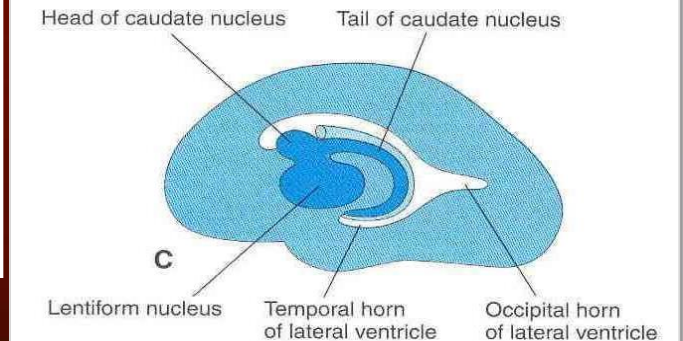
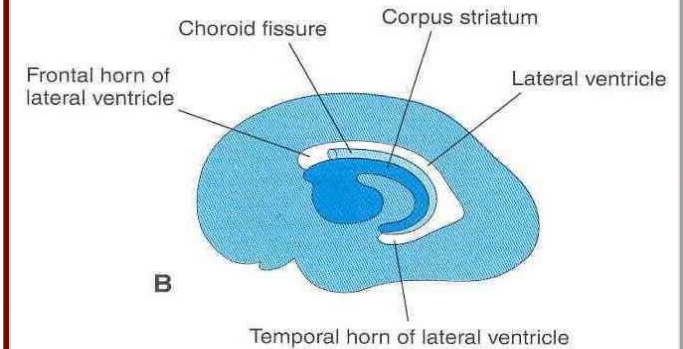
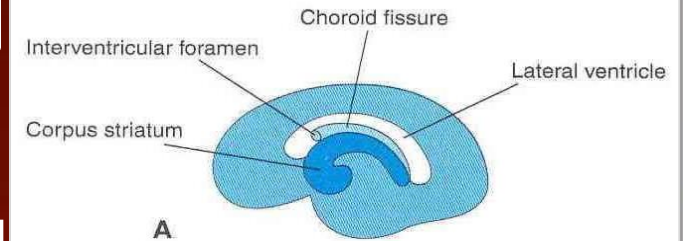
- **Corpus striatum:**
- It appears in **6<sup>th</sup> week** in the **floor** of each **cerebral hemisphere**.
- As the cerebral cortex differentiates and the fibers passing **to and from it**, pass through the **corpus striatum**,
- The **corpus striatum** now is divided into **caudate nucleus & lentiform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



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



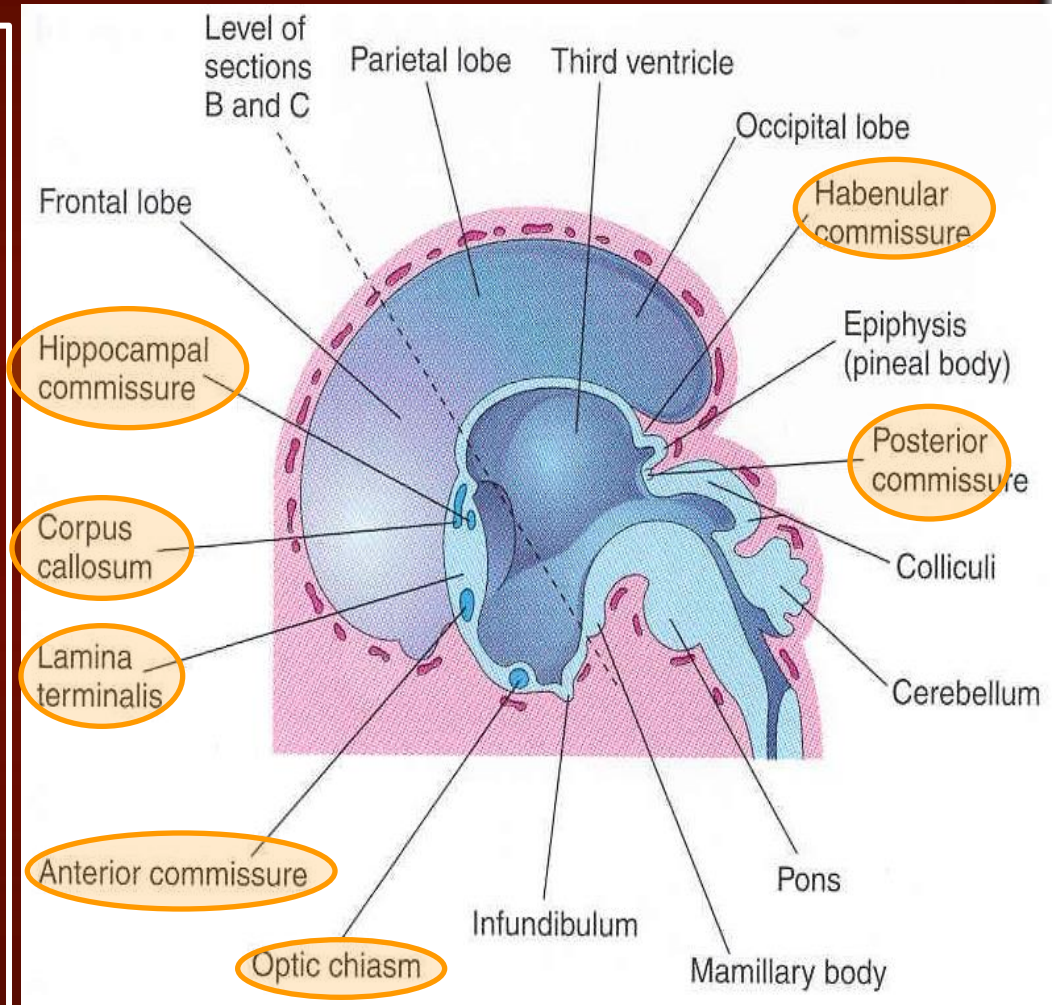
- Also the **caudate nucleus** elongates and assumes the shape of the lateral ventricle and remains related to it.



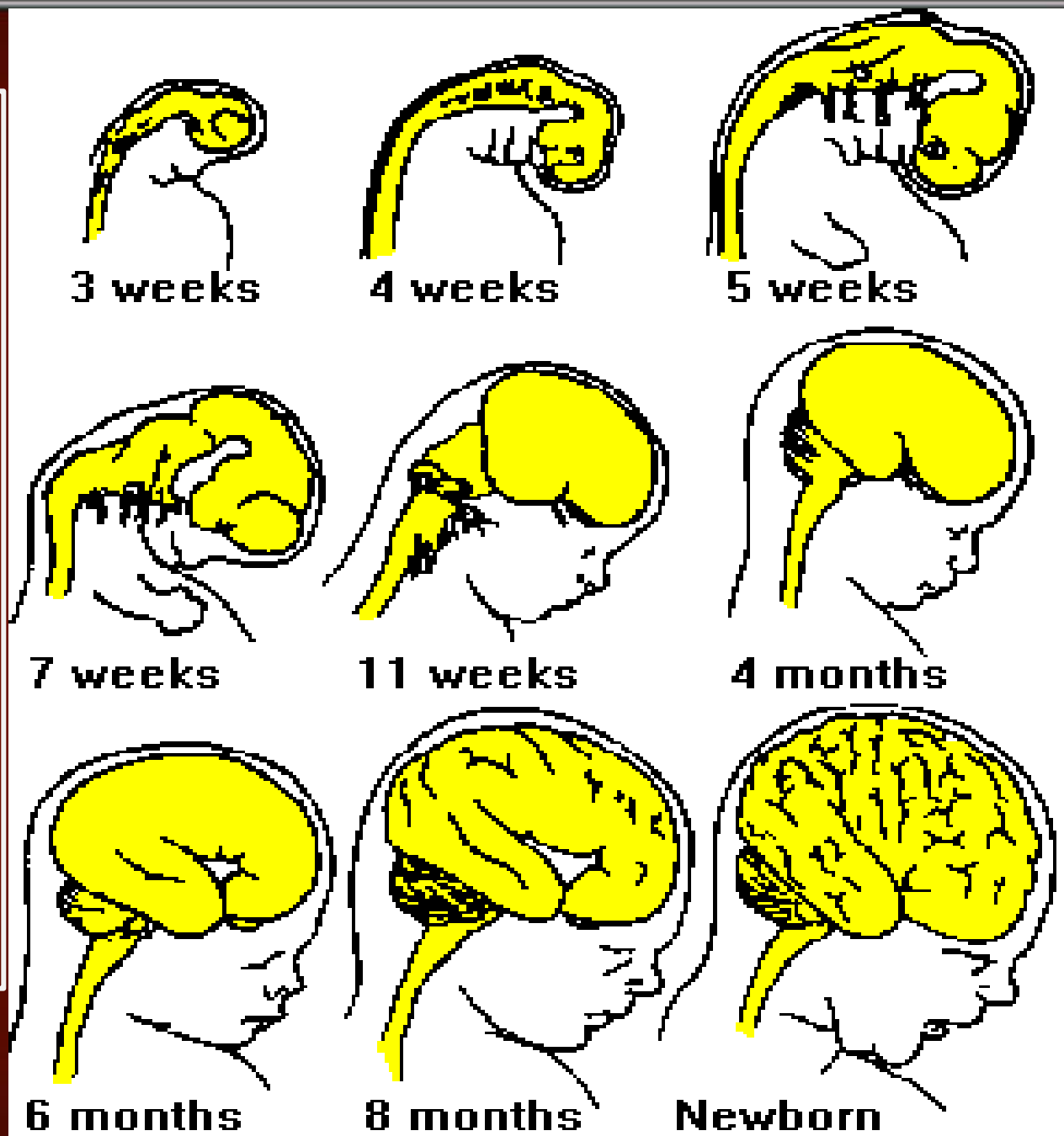


# Development of the Cerebral Commissures

- As the cerebral cortex develops, group of fibers, (commissures), connect the corresponding regions of the cortex.
- These are:
- Lamina terminalis.
- Optic chiasma.
- Anterior commissure.
- Posterior commissure.
- Hippocampal commissure.
- Habenular commissure.
- Corpus callosum.



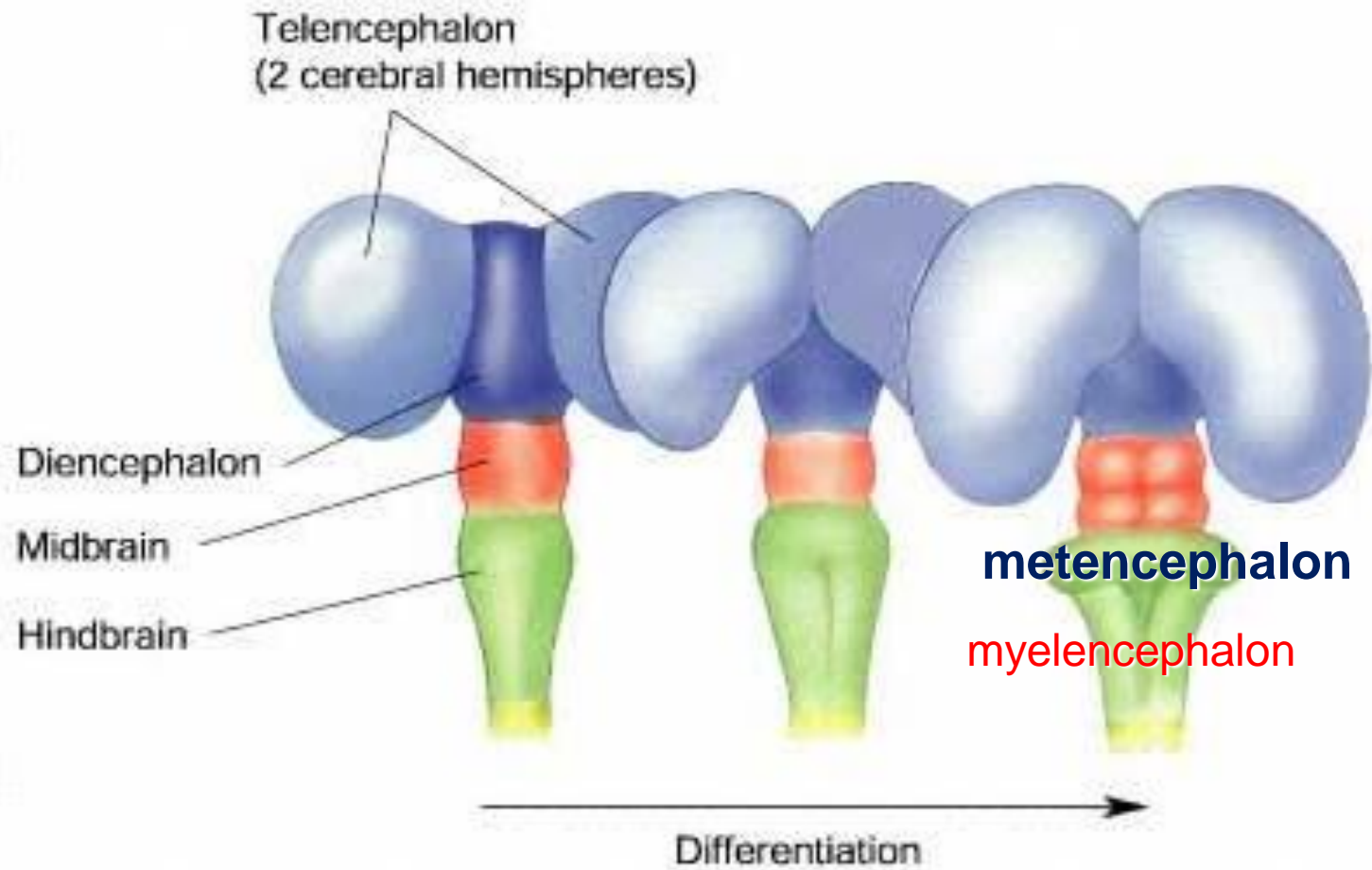
The cortex covering the surface of the corpus striatum: **grows relatively slower than the other cortices**, so it is overgrown by the rest of the hemisphere and **lies in the depth of the lateral sulcus**. This is called the **insula**.



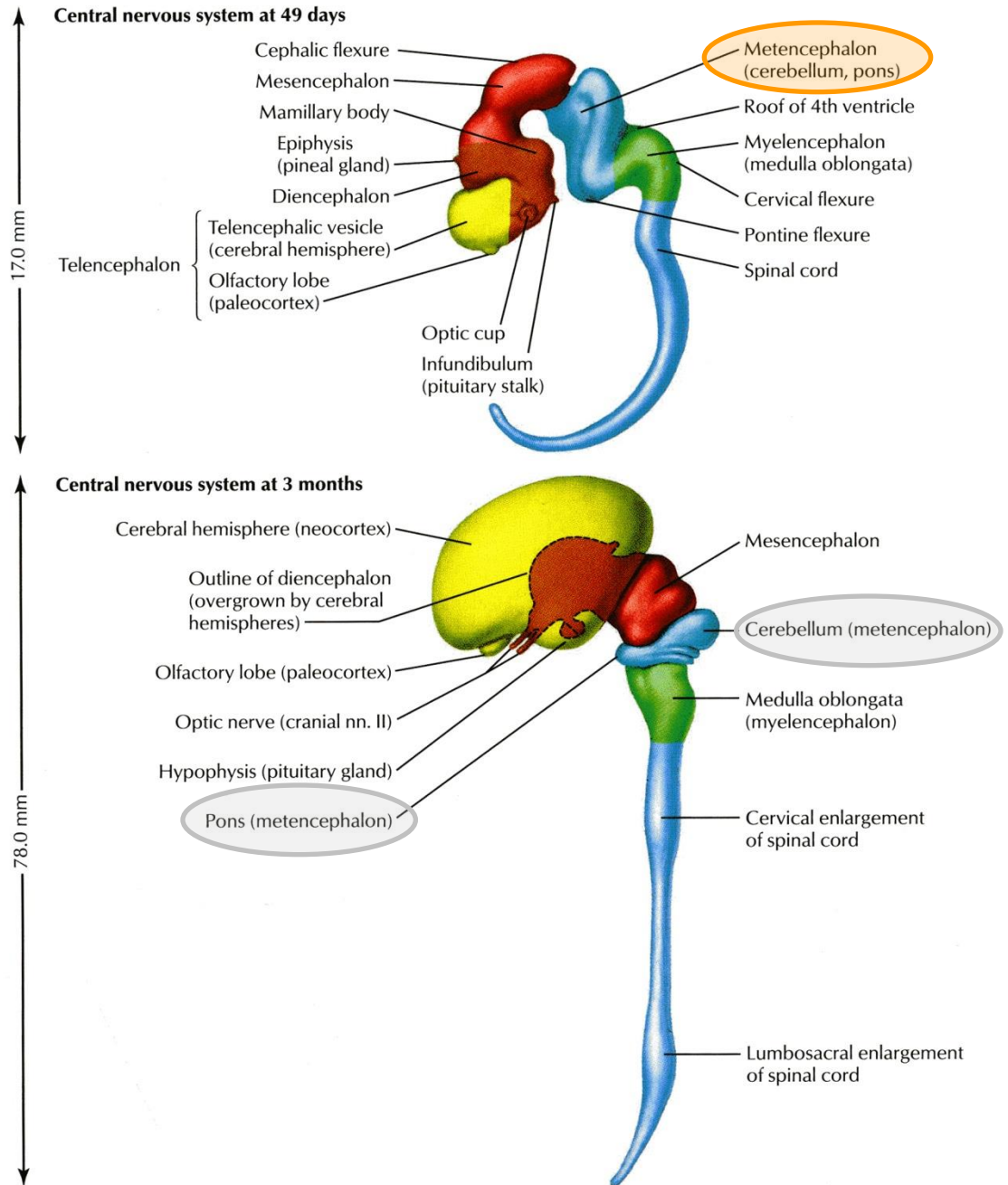


# Development of the Cerebellum

It develops from the dorsal part of the  
**Metencephalon**

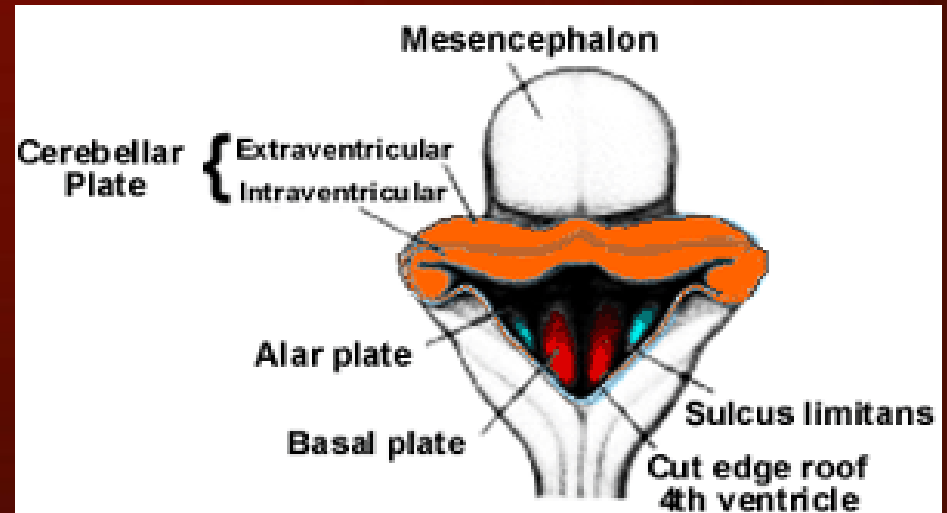
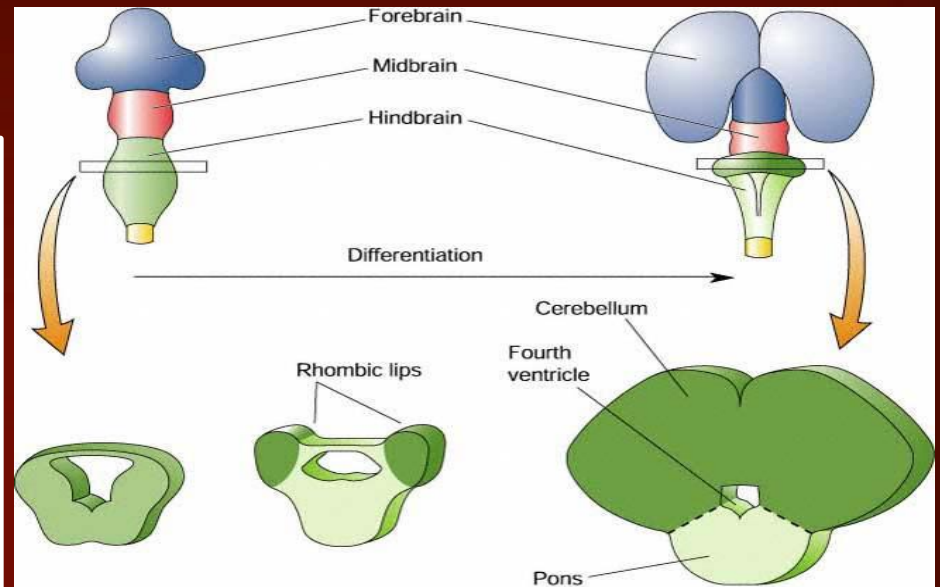


**The metencephalon**  
develops into the  
*pons* and  
*cerebellum*.



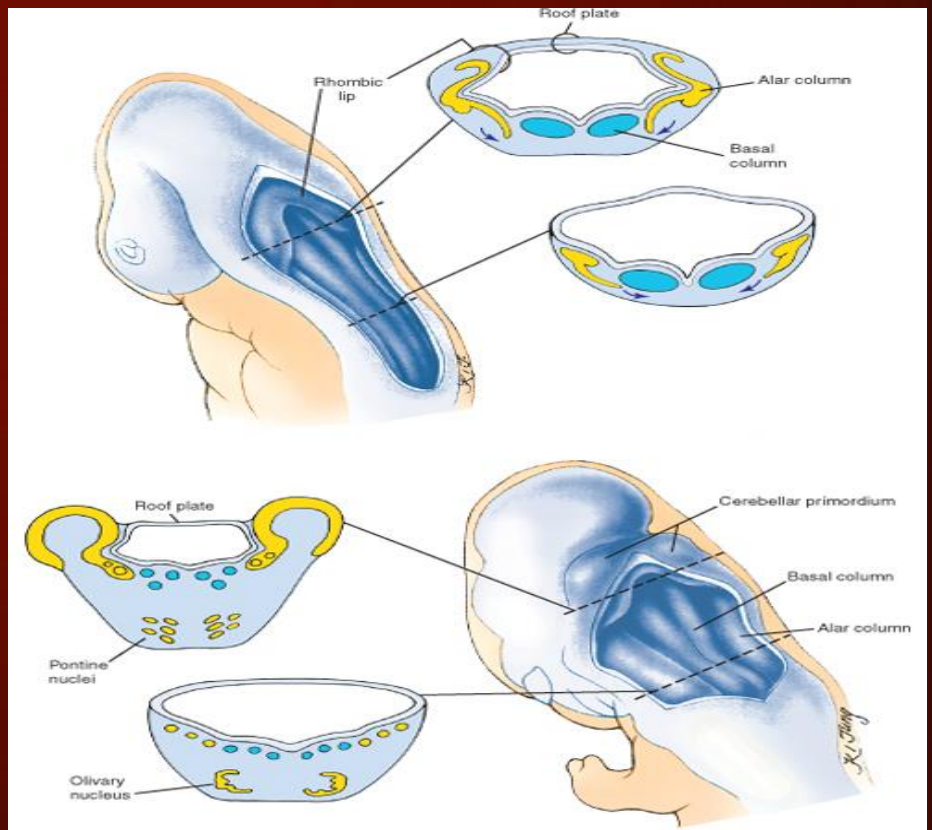
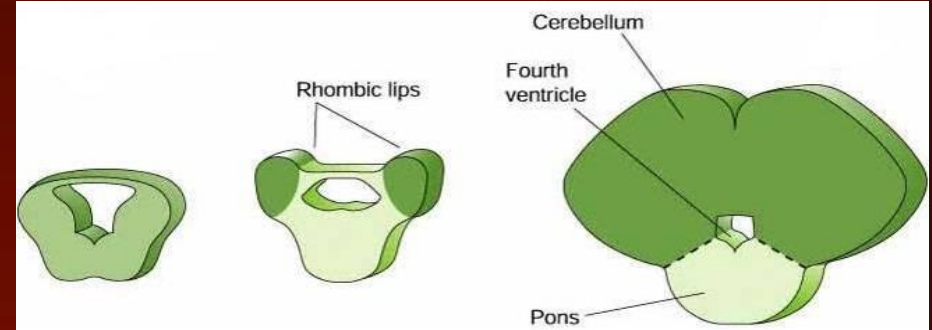
# Development of the Cerebellum

- 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 **4<sup>th</sup> ventricle.**



# Metencephalon: Changes in Alar plates

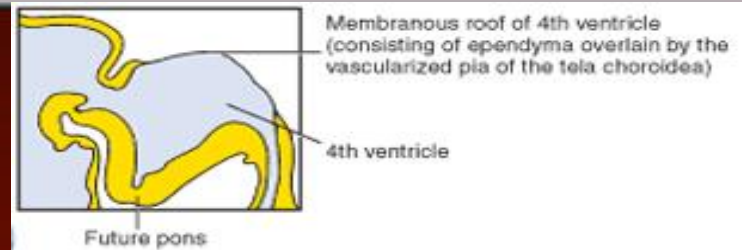
- The dorsal parts thicken to form **Rhombic lips**, that will give rise to the **cerebellum**.
- Some neuroblasts migrate from the mantle layer to the marginal layer and form the **cerebellar cortex**.
- Others remains in the mantle layer and give rise to the **cerebellar nuclei**.
- The cerebellar peduncles develop later as the axons of the neurones of the cerebellar nuclei grows out to reach the brain stem.



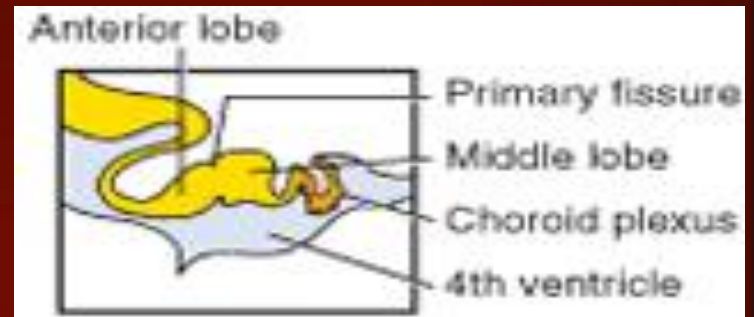


- As the cerebellar hemispheres develop they undergo a complicated process of transverse folding and form closely packed, leaf-like transverse gyri called **folia**.
- These processes of fissure formation and foliation continue **throughout**;
- **Embryonic**,
- **Fetal**, and
- **Postnatal life**, and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

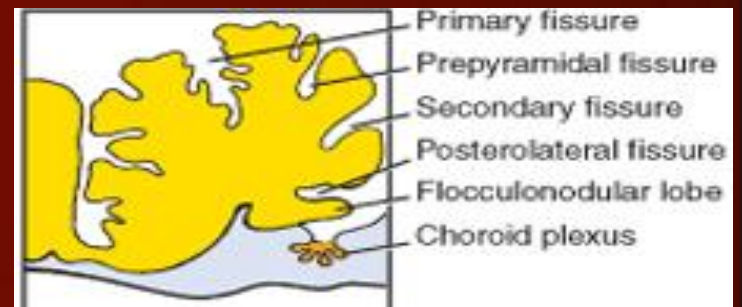
35 d



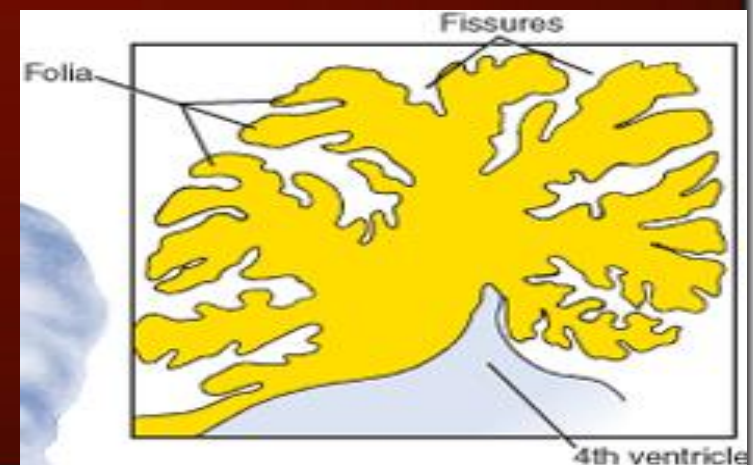
50 d



90 d

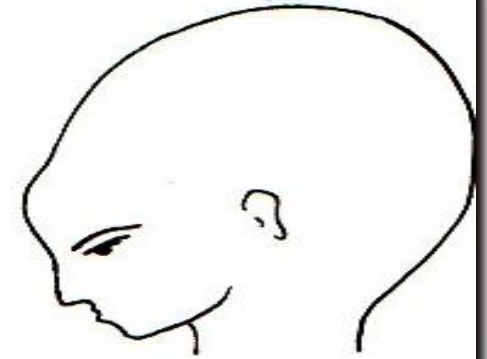


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# Congenital Anomalies of The Brain

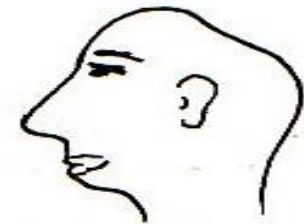
- Hydrocephalus.
- Anencephaly.
- Microcephaly.
- Mental retardation.
- Seizures.
- Cerebral palsy.
- Cranium bifidum with or without meningocele & meningoencephalocele.
- Agenesis of corpus callosum.
- Arnold-Chiari malformation.



Hydrocephaly



Anencephaly



Microcephaly



# ANENCEPHALY

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

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

The frequency of this case 1:1000.

