EMBRYOLOGY

DEVELOPMENT OF THE CEREBRUM AND CEREBELLUM

Lecture Objectives :

1.Describe the formation of the neural tube.

2.List the 3 brain vesicles and their derivatives.

3.Describe the brain flexures.

4.Describe briefly the development of the cerebrum.

5.Describe briefly the development of the cerebellum.

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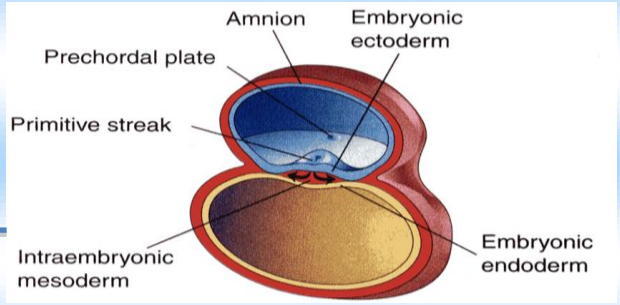
By the beginning of the 3rd week of development, three germ cell layers become established, **Ectoderm, Mesoderm** and **Endoderm**.

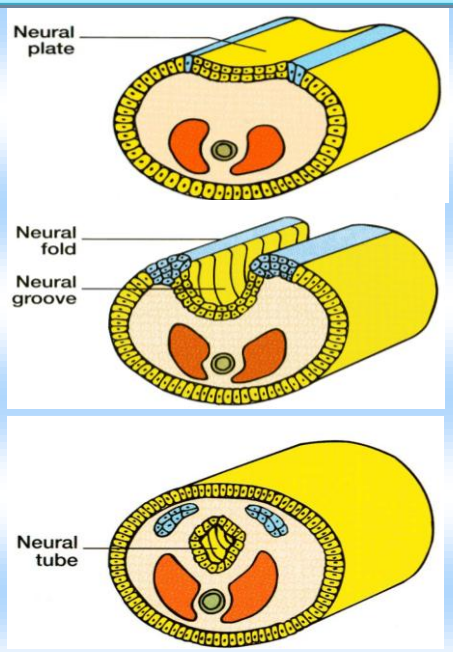


1-During the middle of the 3rd week, ***the dorsal midline ectoderm*** undergoes thickening to form the **neural plate.**

2-margins of the plate form **neural folds**

3-So a longitudinal, midline depression, called the **neural groove**

4-The 2 neural folds then fuse together, thus sealing the neural groove and creating the **neural tube**



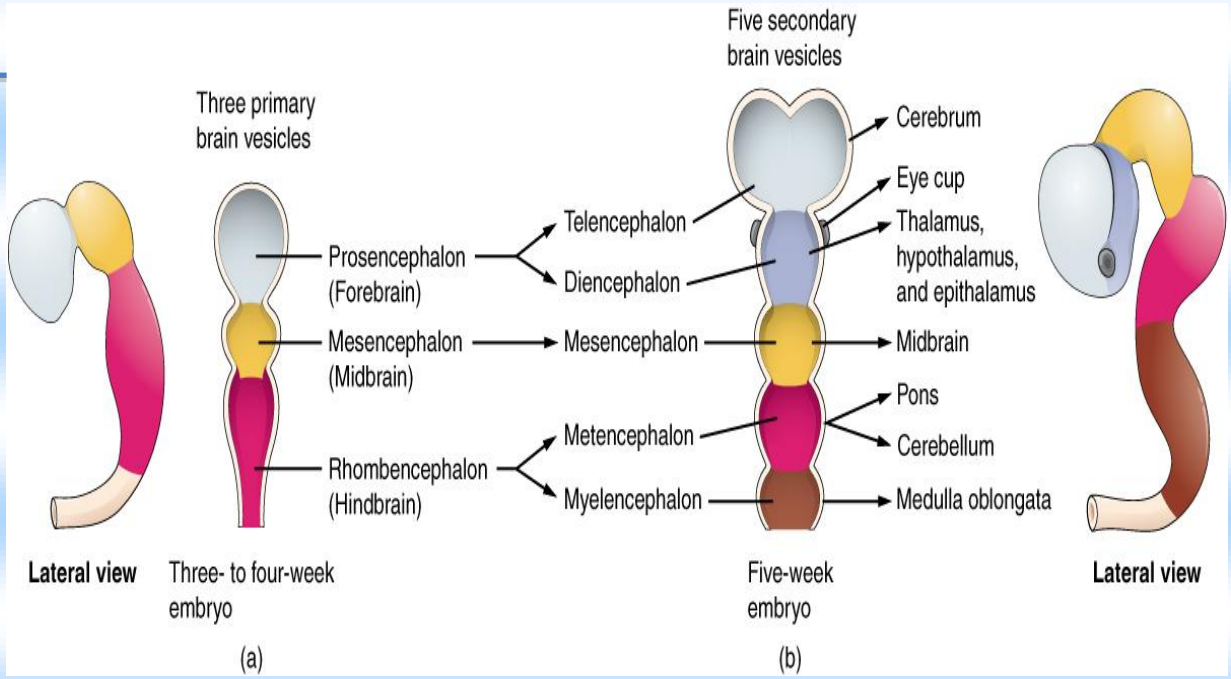
Formation of the neural tube is completed by the **middle of the fourth week.**

By the end of the 4th week Its upper end dilates and shows 3 vesicle:

1.Prosencephalo

2.Mesencephalon

3.Rhombencephalon



By the **5th week** further differentiation distinguishes **five 2ry brain vesicles:**

1- prosencephalon divides into the two **telencephalon(future brain)** and one **diencephalon.**

2- Rhombencephalon divides into **metencephalon (future pons,** Cerebellum) and **myelencephalon (future medulla)**

By the 4th week:

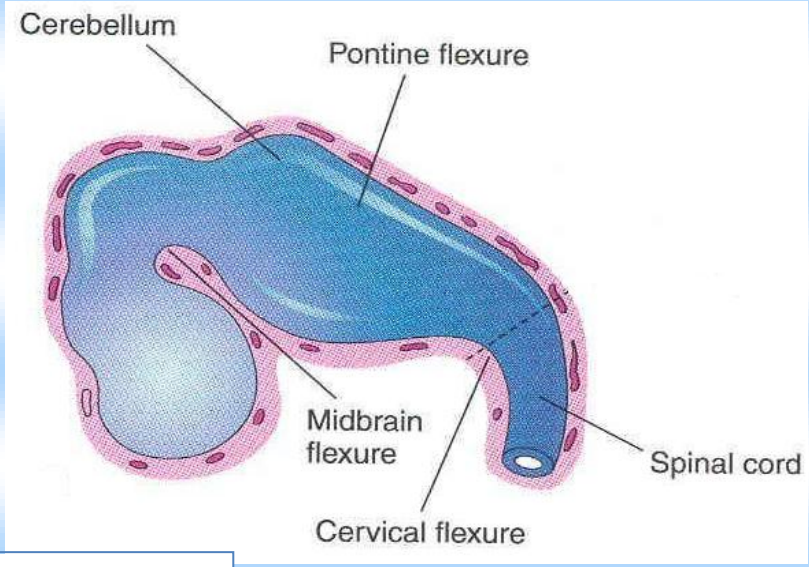
The neural tube grows rapidly and bends ventrally, producing two flexures

Midbrain flexure:

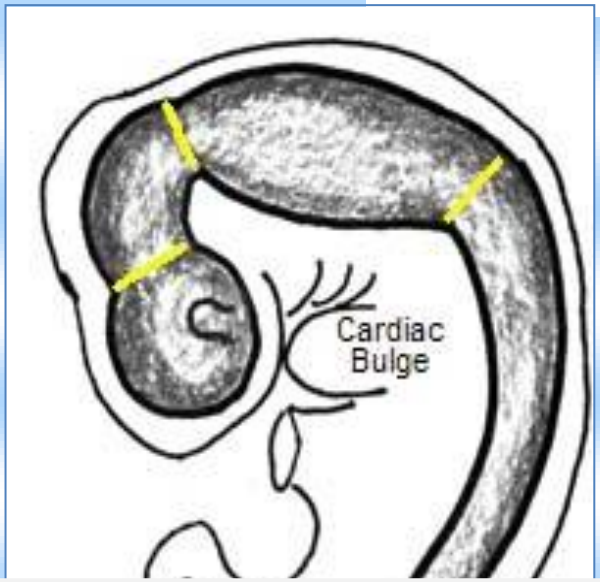
between the prosencephalon & the mesencephalon (midbrain)

Cervical flexure:

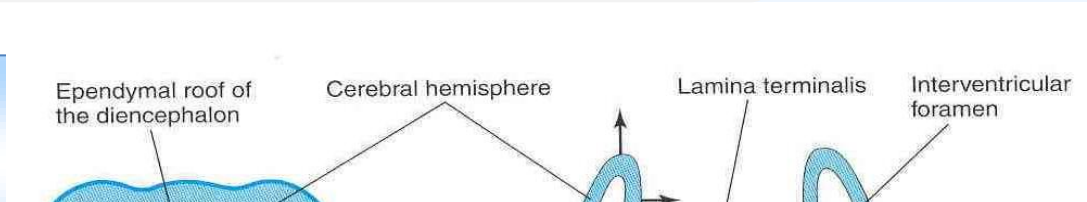
Between the hind brain & the spinal cord



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



#DEVELOPMENT OF THE **CEREBRUM:**



The cerebrum develops from the **Telencephalon**

he (prosencephalon) or the forebrain vesicle differentiates into a:

1- Median part (diencephalon).

2-Two lateral cerebral vesicles (telencephalic vesicles)

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

Both cavities communicating with each other through a wide interventricular foramen.

The cerebral hemispheres expand in all directions.

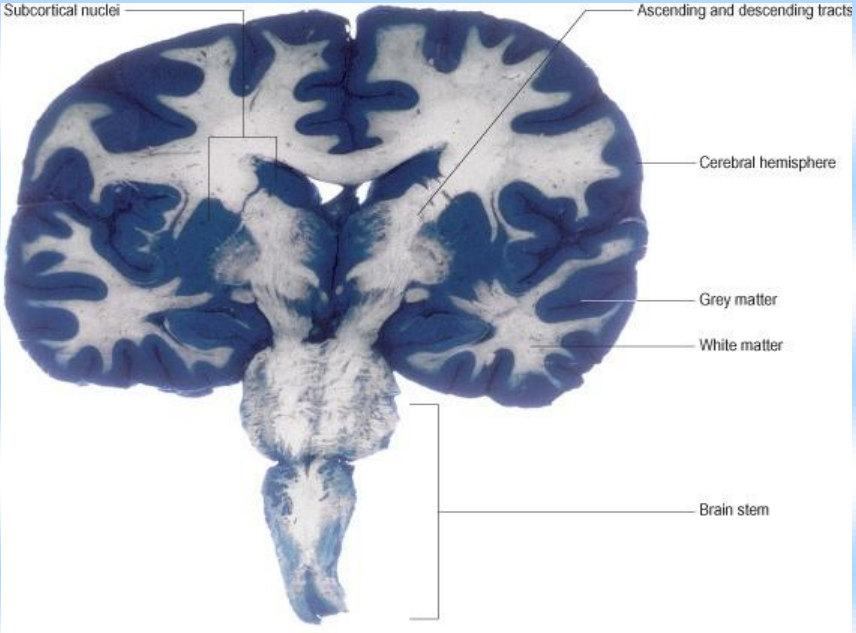
Its medial wall becomes thin, flat and it is the site of **choroid plexus** of the lateral ventricle.

The wall of the telencephalon is formed of 3 layers:

1- Ependymal (lining the cavity of the lateral ventricle.

2- Marginal nerve fibers forming the white matter.

3- Mantel nerve cells forming the grey matter.

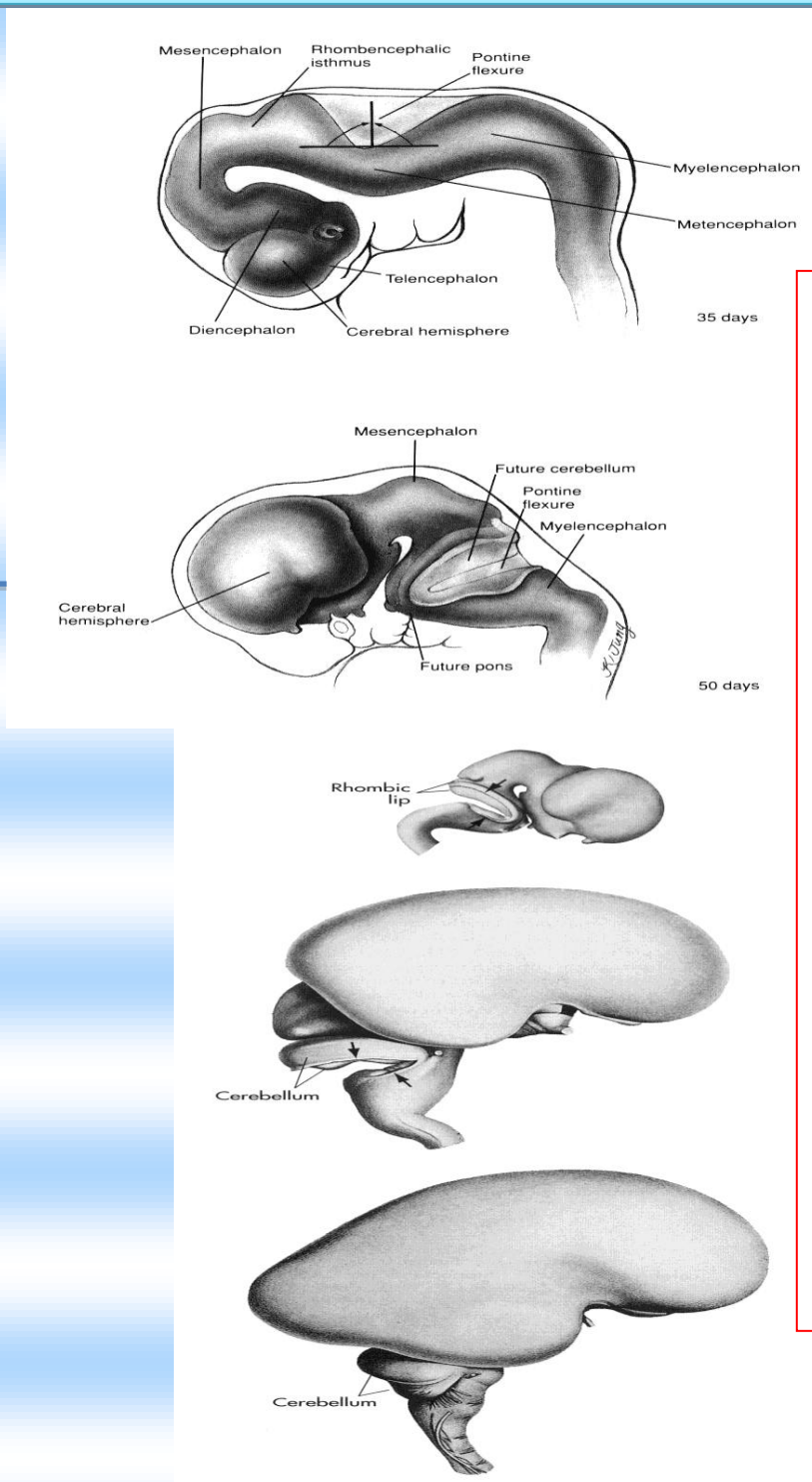


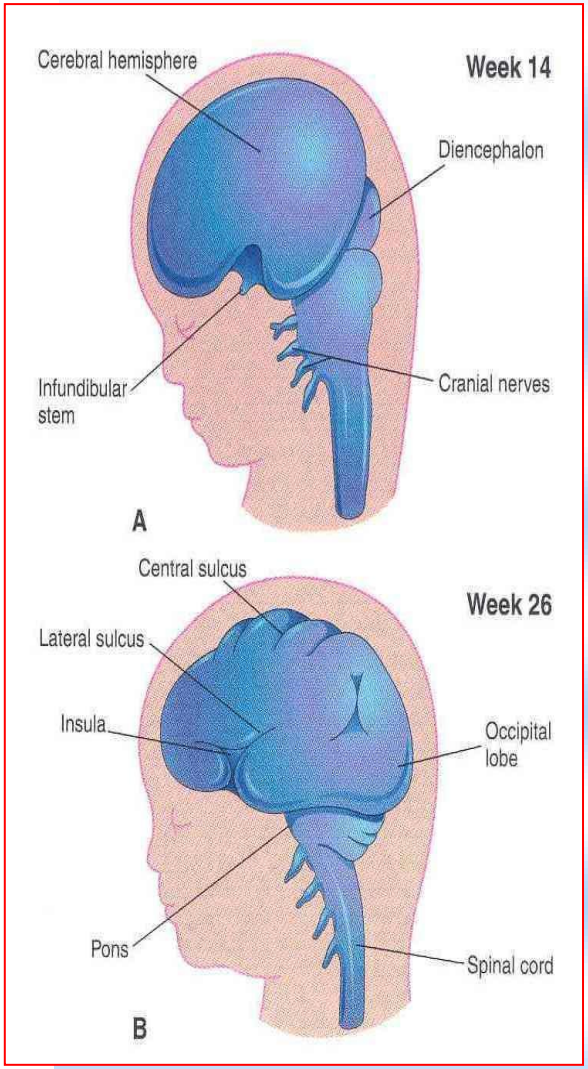
As development proceeds the Most of the nerve cells migrate to the marginal layer forming the cerebral cortex.

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

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

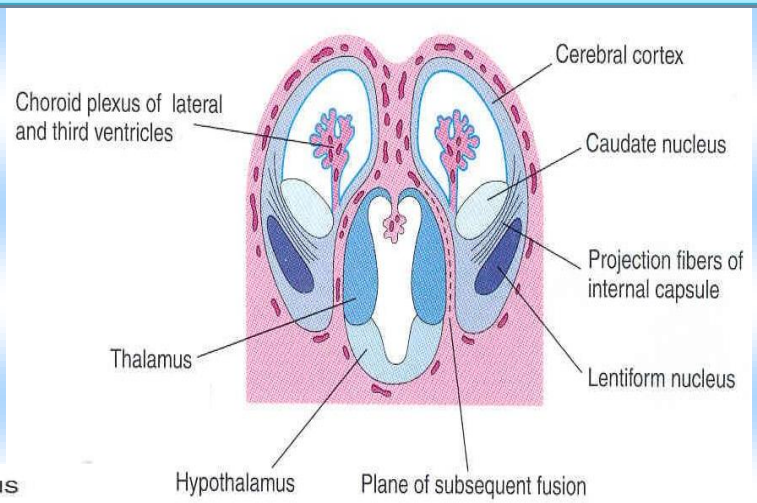
By the end of the 3rd month the surfaces of the cerebral hemispheres are smooth. By the 4th month the grey matter grows faster than the white matter, so, the cortex becomes folded into gyri separated by sulci. The gyri and sulci effectively increase the surface area of the brain.



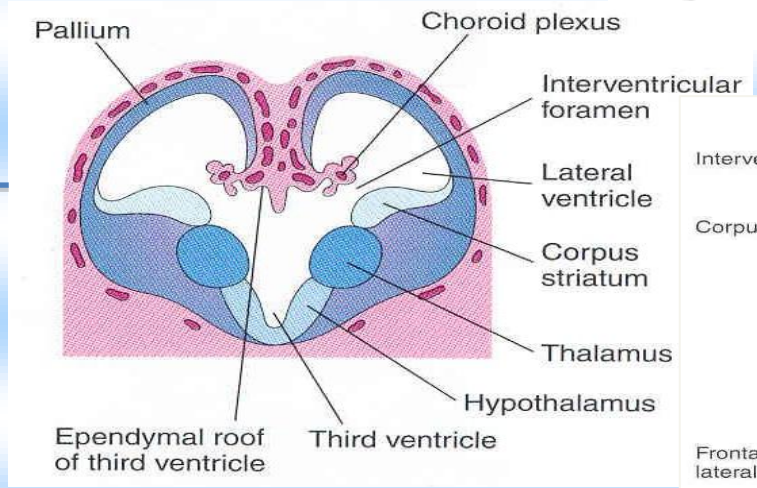


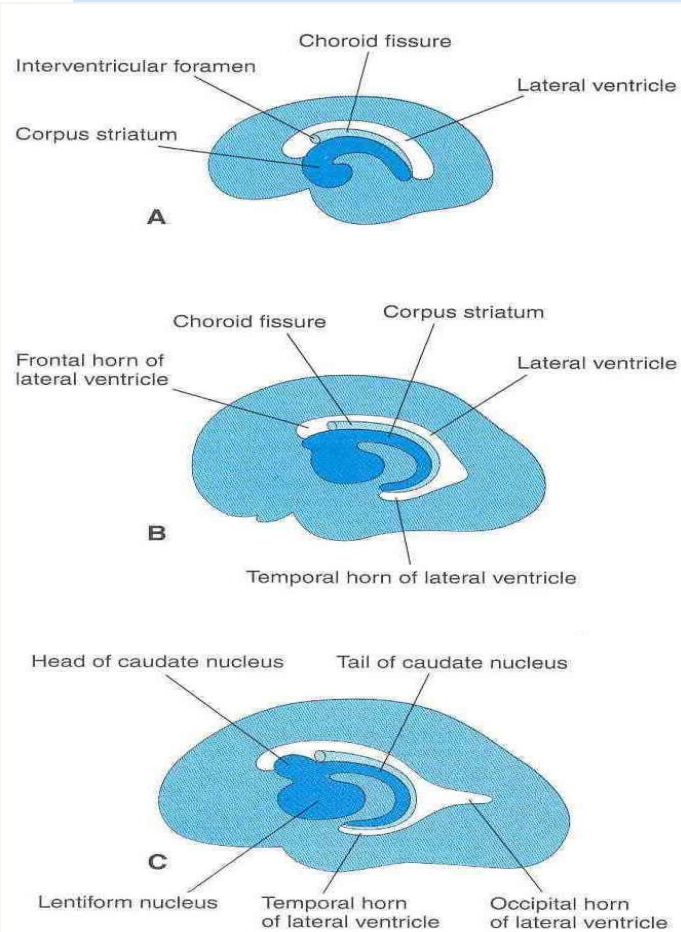
Corpus striatum:

It appears in 6th 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 divides 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).

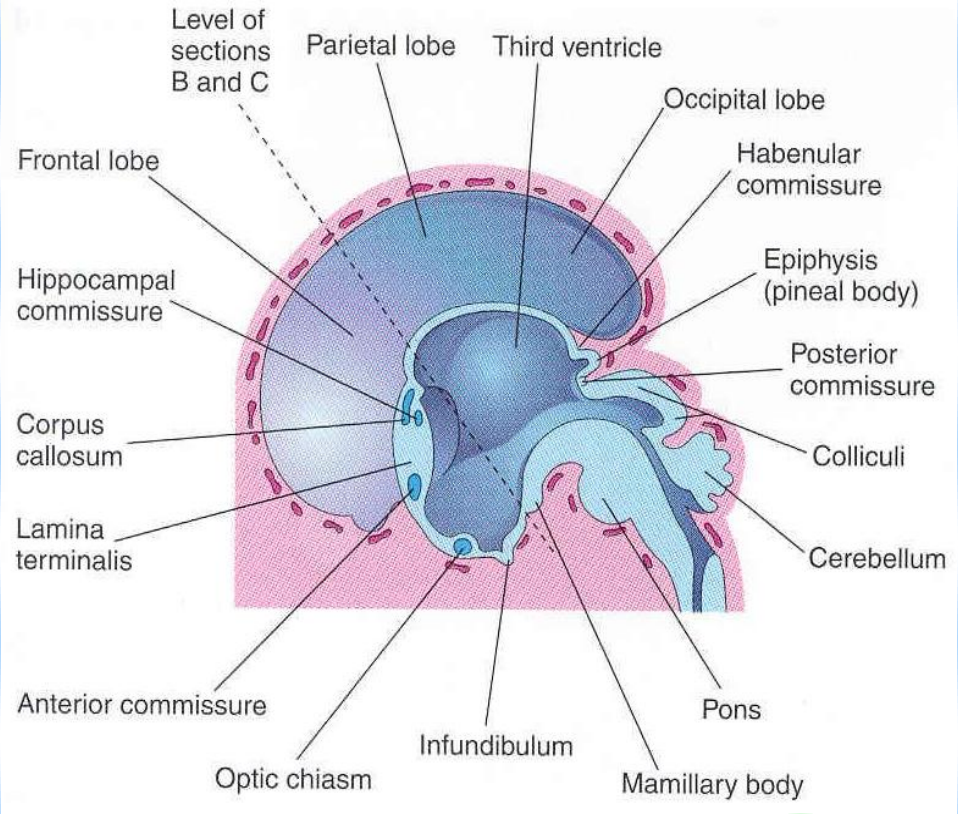




Also the caudate nucleus elongates and assumes the shape of the lateral ventricle and remains related to it.

#DEVELOPMENT OF THE CEREBRAL COMMISSURES:

As the cerebral cortex develops, group of fibers, (commissures), connect the corresponding regions of the cortex.



7 commissures

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

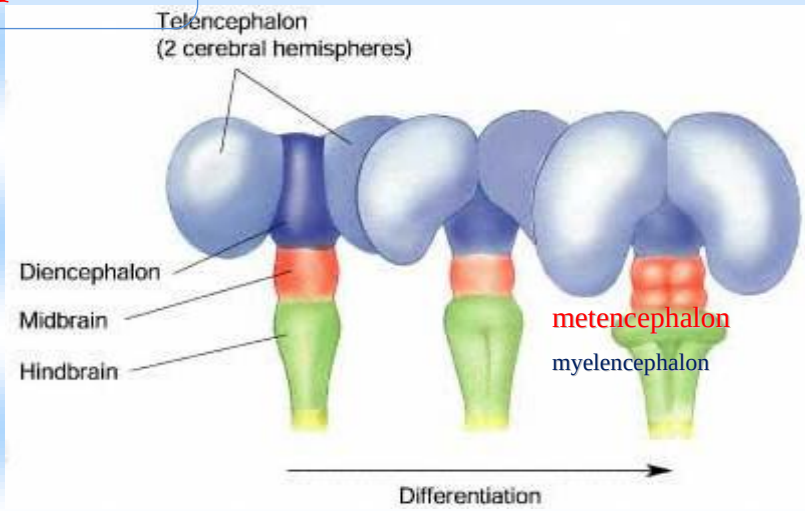
INSULA:

Because of 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 and called insula.

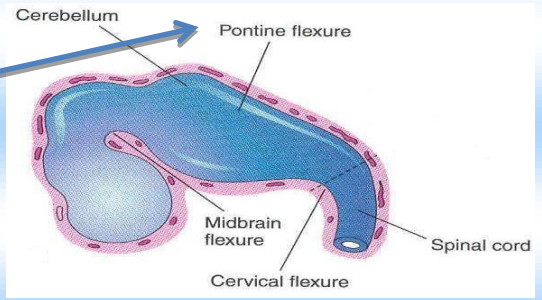
#DEVELOPMENT OF THE CEREBELLUM:

It develops from the dorsal part of the Metencephalon

Remember : metencephalon give cerebrum and Pons .



#DEVELOPMENT OF THE CEREBELLUM:

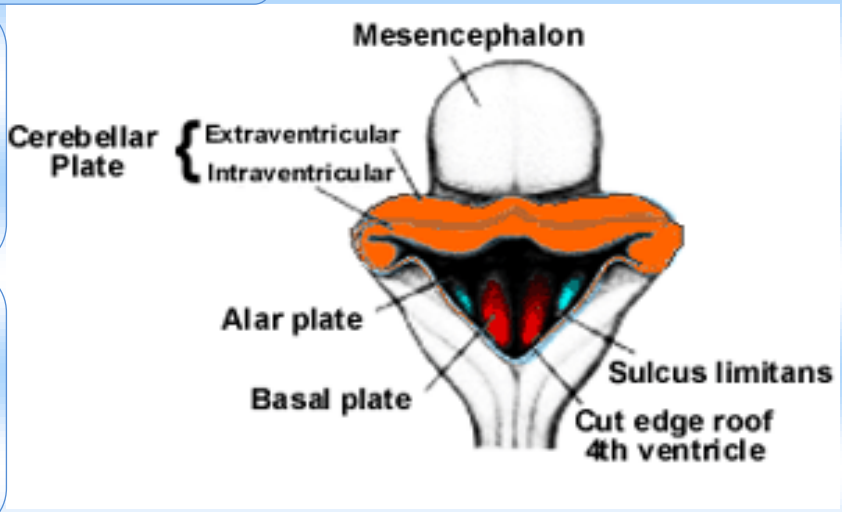


Do you remember Later Pontine flexure which appears in the hindbrain? .

Pontine flexure results in three things :

1- Moving the alar plates laterally then pending medially

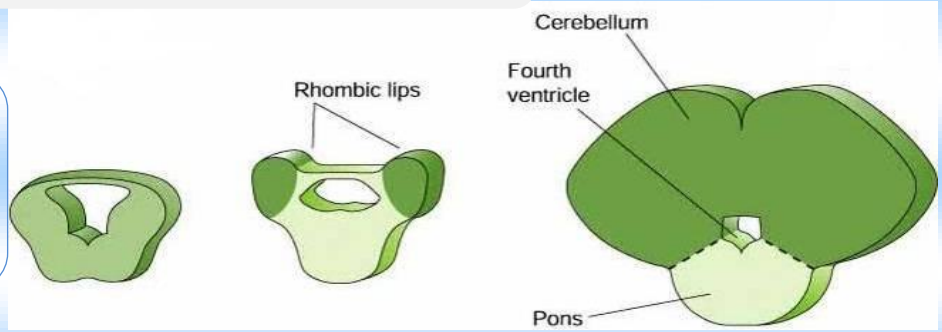
2-streching and thinning of the roof of the plate



3- widening of the cavity of the 4th 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 mantel layer to the marginal layer and form the – cerebellar cortex.

Others remains in the mantel layer and give rise to the cerebellar nuclei. –

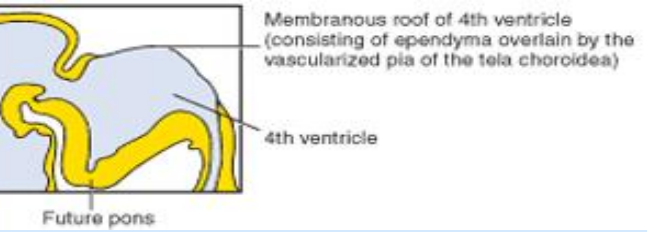
The cerebellar peduncles develop later as the axons of the neurones of the cerebellar nuclei – grows out to reach the brain stem.

CONTINUE ...

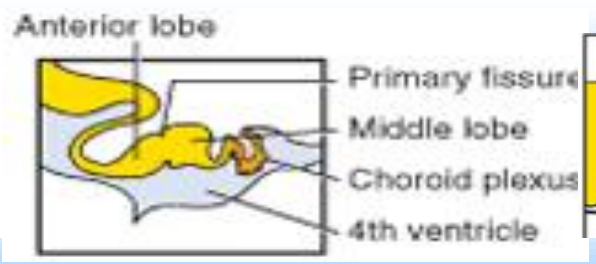
- As the cerebellar hemispheres develops they undergo a complicated process of transverse folding and form closely packed, leaf-like transverse gyri called folia.

These processes of fissure formation and foliation continue throughout embryonic, fetal, and postnatal life, and they increase the surface area of the cerebellar cortex.

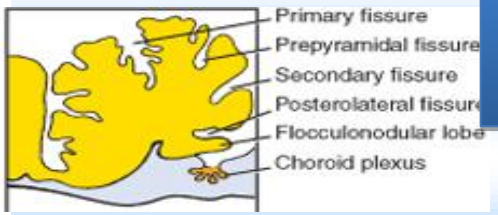
35 d



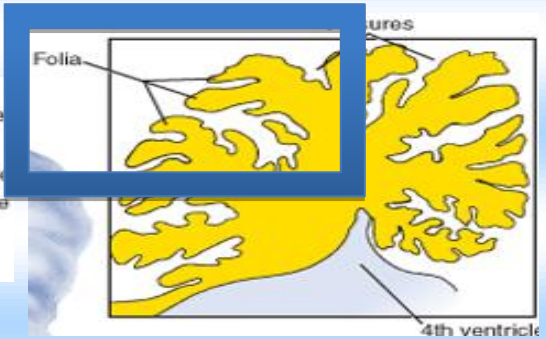
50 d



90 d



150 d



CONGENITAL ANOMALIES OF THE BRAIN

MAYBE ...

Mental retardation. –

Seizures. –

Cerebral palsy. –

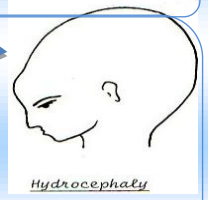
Cranium bifidum with or without – meningocele* & meningoencephalocele**.

Microcephaly. –

Agenesis of corpus callosum. –

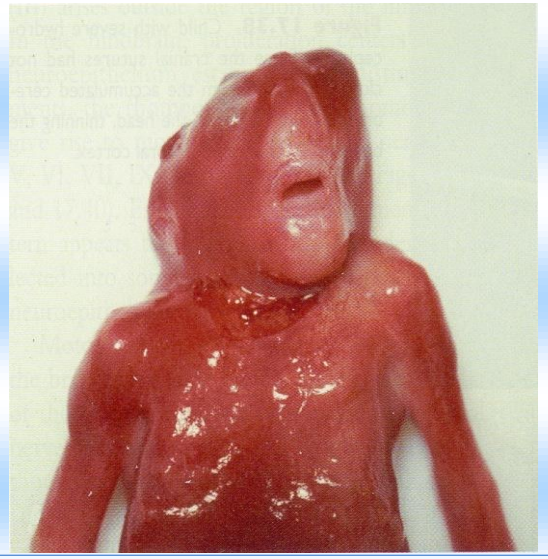
Hydrocephalus.* obstruction og CSF circulation

Arnold-Chiari malformation. Is a – condition in which part of cerebellum or brain protruded through foramen magnum. *Accompanied with Hydrocephalus.



Anencephaly. –

ANENCEPHALY



In **anencephaly**, the brain and – skull are minute (very small) and the infant does not usually survive.

*Meningocele: herniation of meninges. –

**Meningoencephalocele: herniation of meninges and brain . –

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SUMMARY

- Cerebral hemisphere is derived from the cranial 1/3 of the neural tube.
- At the end of 4th week, Neural tube gives rise to 3 vesicles: Prosencephalone, Mesencephalon and Rhomboencephalon.
- Later on, some of them divides to form 5 vesicles: Telencephalon (Cerebrum), Diencephalon (Thalamus), Mesencephalon (Midbrain), Metencephalon (Cerebellum & Pons), Myelencephalon (Medulla Oblongata).
- It shows two ventral flexures: Midbrain flexure & cervical flexure.
- The two Lateral ventricles & the 3rd ventricle communicate through Foramen of Monro.
- Hemispheres surrounding the ventricles made of three layers: Inner Ependymal / Middle Mantle / Outer Marginal.
- Most of the cells in the mantle layer migrate superficially (Cerebral cortex) and some do not (Basal ganglia).
- At the 3rd month the hemispheres are smooth, they become convoluted by the 4th month (due to faster grey matter growth).
- Corpus striatum: appears at the 6th week and divided by the internal capsule into Caudate and Lentiform nuclei.
- The two hemispheres are connected by commissural fibers, most important is Corpus Callosum.
- Cerebellum develops from the dorsal part of Metencephalon, exactly from the rhombic lips.
- Most of the cells in the mantle layer migrate superficially (Cerebellar cortex) and some do not (Deep nuclei).
- Later, axons from cerebellar nuclei continue as Cerebellar peduncles.
- Fetus may develop one of many cerebral and cerebellar anomalies during pregnancy (e.g. Anencephaly).

HELPFUL YOUTUBE VIDEOS :	http://www.youtube.com/watch?v=3H_73ArqinM	http://www.youtube.com/watch?v=px8zX3n7-dY

TIMELINE FOR THE DEVELOPMENT CHANES

TIME	CHANGES
Week 3	Early : # 1- germ cell layers Middle: # 2- neuronal plate
Week 4	# 1- Appearance of flexures Middle :# 2- complete neuronal tube End : # 3- the 3 vesicles appearance
Week 5	# 1- day 32 appearance of cerebral bubble # 2- the 5 secondary brain vesicles appearance
Week 6	# 1- appearance of Corpus striatum
Week 16	# 1- cerebral growing is oval
Month 3	# 1- cerebral hemisphere smooth
Month 4	# 1- gray matter of cerebral grow faster than white

QUIZ YOURSELF

1-The formation of the neural tube is completed at:

A-End of 3rd week.
B-Beginning of 4th week.
C-middle of 4th week.
D-End of 4th week.

2-One of these is not a brain flexure:

A-Midbrain flexure.
B-Medullary flexure.
C-Cervical flexure.
D-Pontine flexure.

3-The precursor of cerebral hemisphere is:

A-Mylencephalon.
B-Diencephalon.
C-Telencephalon.
D-Mesencephalon.

4-The middle layer of the cerebral wall is:

A-Ependymal.
B-Ventricular.
C-Mantle.
D-Marginal.

5-The appearance of convoluted surface of the cerebrum occurs at:

A-1st month.
B-2nd month.
C-3rd month.
D-4th month.

6-One of these is (not) a part of commissural fibers:

A-Uncinate fibers.
B-Lamina terminalis.
C-Hebinular commissure.
D-Corpus callosum.

7-One of these malformations is characterized by large head size:

A-Cranium bifidum.
B-Microcephaly.
C-Anencephaly.
D-Hydrocephalus.

Answers: C-B-C-C-D-A-D

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BEST WISHES

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