DEVELOPMENT of CEREBRUM & CEREBELLUM

NEUROPSYCHIATRY BLOCK

Embryology team

Color Code:

- Important
- Doctors Notes
- Extra explanation

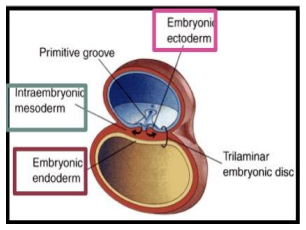
MED437
KING SAUD UNIVERSITY

437 Embryology

OBJECTIVES:

- 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.

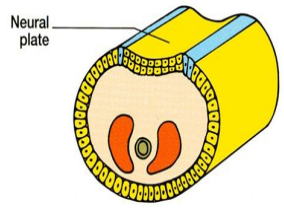
Introduction:



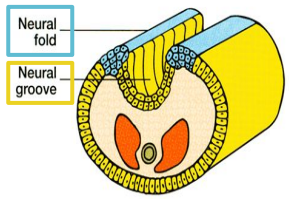
By the beginning of the **3rd** week of development, three germ cell layers become established.

Ectoderm, Mesoderm and Endoderm.

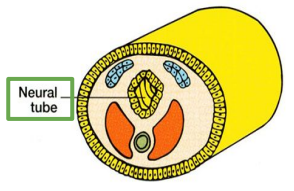
Early Development:



During the middle of the 3rd week(16-17 days)the dorsal midline ectoderm undergoes thickening to form the neural plate (neuroectoderm).



- The 2 margins of the plate elevate, forming **neural folds**
- A longitudinal, midline depression, called the **neural groove** is formed.
- The 2 neural folds approximate then fuse together, thus sealing the neural groove and creating the **neural tube.** (complete close).
- Formation of neural tube is completed by the **middle of 4th week**.

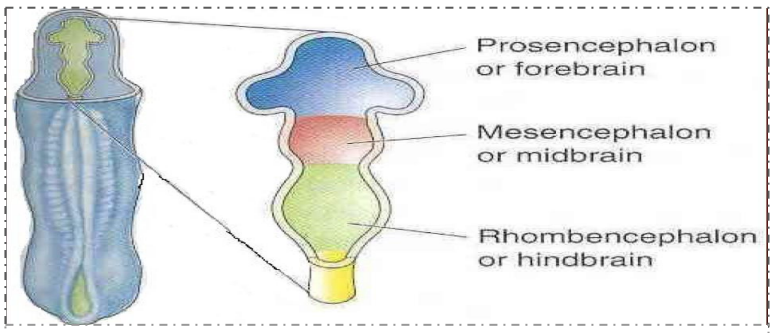


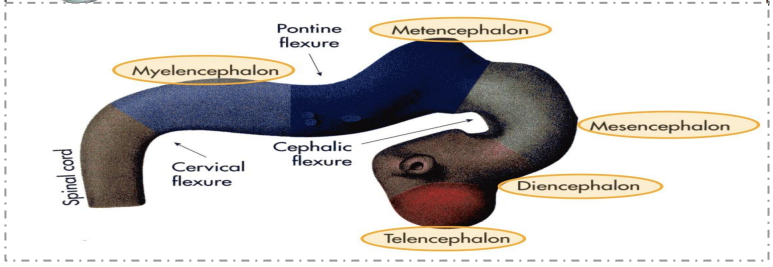
Brain develops from cranial 1\3 of neural tube

Neural Tube Development:

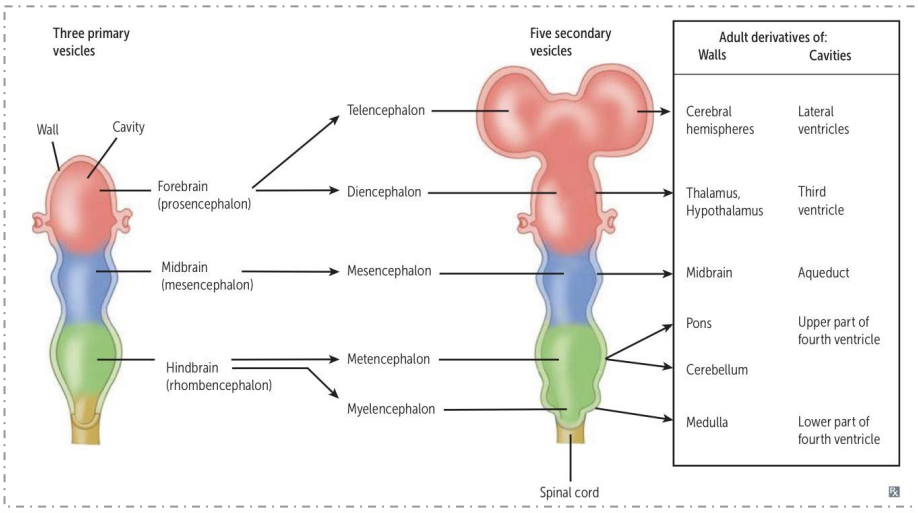
تنقسم مرحلة تكون إلى مرحلتين

Three- primary brain vesicles stage (end of 4th week) (28 days) Neural tube upper end dilates and shows 3 vesicles This 3 vesicles are: (from up to down)
1. Prosencephalon (Forebrain)
2. Mesencephalon (Midbrain)
3. Rhombencephalon (Hindbrain)





five secondary brain vesicles stage **(5th week)**	
Prosencephalon divides into:	1. Telencephalon
	2. Diencephalon
Mesencephalon	Mesencephalon
Rhombencephalon divides into:	1. Metencephalon
	2. Myelencephalon



Derivatives of Brain Vesicles: **important**

Primary Brain Vesicles	Secondary Brain Vesicles	**Derivatives** In Mature Brain
Prosencephalon (forebrain)	1. Two telencephalon	Cerebral hemisphere
	2.. Diencephalon	thalamus
Mesencephalon (midbrain)	mesencephalon	midbrain
Rhombencephalon (hindbrain)	1. metencephalon	Pons Cerebellum
	2. myelencephalon	Medulla oblongata

By the 4th week, The neural tube grows rapidly and faster than cranial cavity.

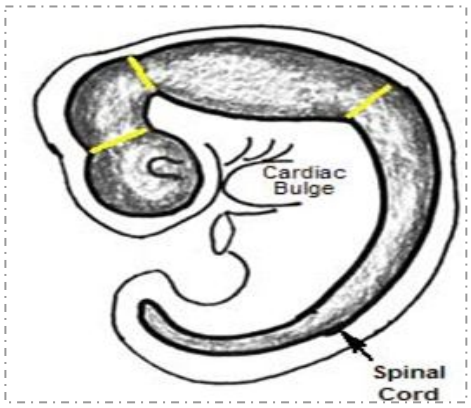
There are 3 brain flexures

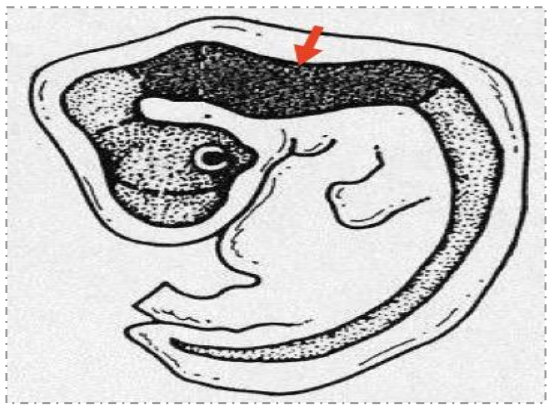
1. **Cervical flexure** (ventral) 2. **Midbrain flexure** (ventral) 3. **Pontine flexure** (dorsal flexure)

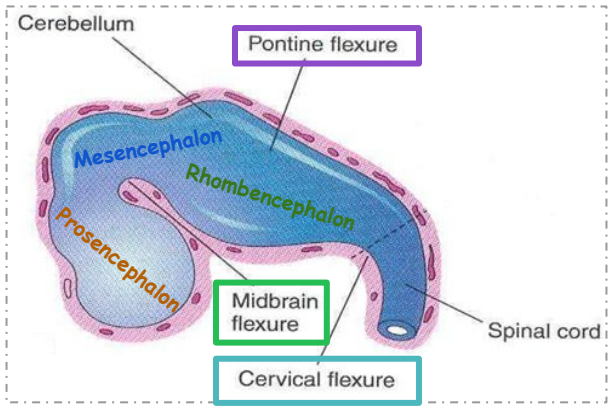
The neural tube grows rapidly and bends ventrally, producing two flexures:

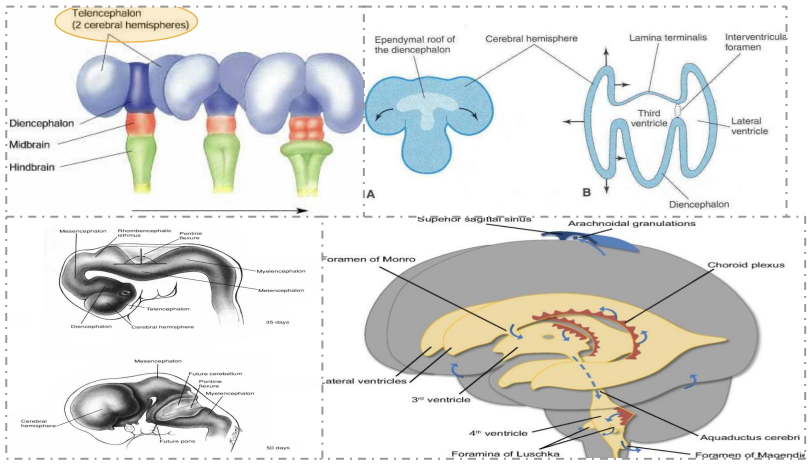
1. Midbrain flexure: (cephalic) between the **prosencephalon** & the **mesencephalon (midbrain)**
2. Cervical flexure: between the **Rhombencephalon (hindbrain)** & the **spinal cord.**

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









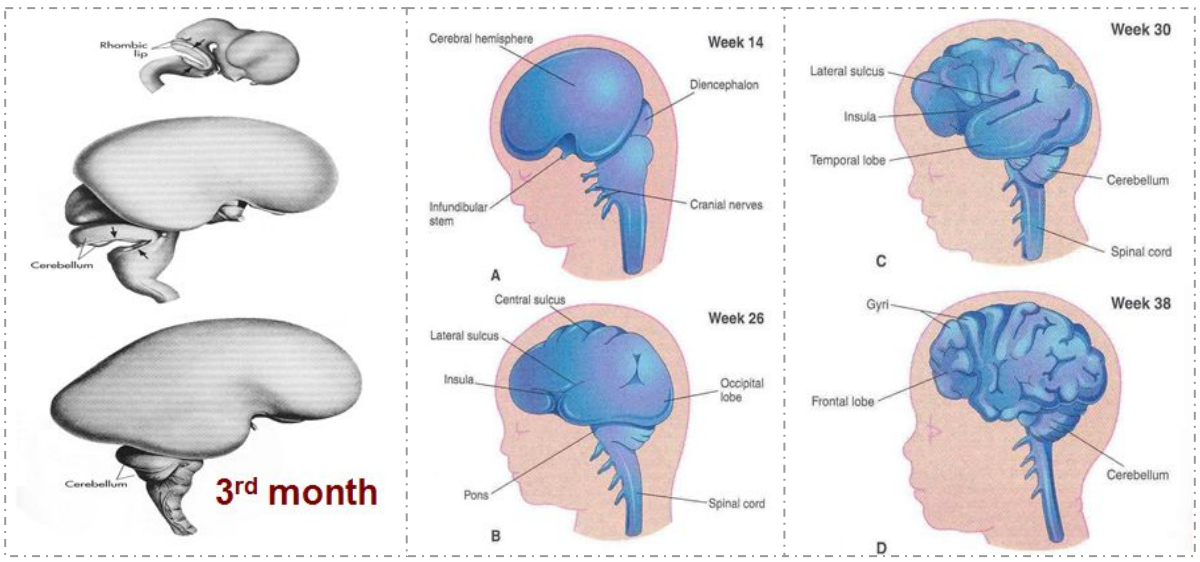
Development of the cerebrum (cerebral hemisphere):

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.)

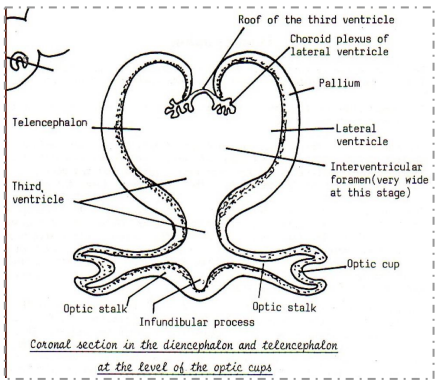
- The lumen gives the 2 lateral ventricles and the 3rd ventricle.
- Both cavities communicating with each other through a wide interventricular foramen.
- The cerebral hemispheres expand in all directions .
- Its medial wall becomes thin, flat and it is the site of choroid plexus of the lateral ventricle.
- The Cerebral hemispheres first appear on the day 32 of pregnancy 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.
- The detailed pattern of gyri & sulci varies somewhat from individual to individual.

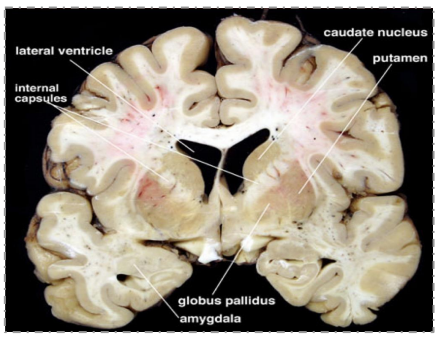


Development of the cerebrum:

The wall of the telencephalon is formed of 3 layers :

Ependymal	Mantel	Marginal
lining the cavity of the lateral ventricle.	nerve cells forming the grey matter.	nerve fibers forming the white matter.





ليه صار هذا الإنتقال في المخ وما صار في الحبل الشوكي ؟
لأن القشرة الخارجية للدماغ تتكون من القراي ماتر وجوّا وايت ماتر بعكس الحبل الشوكي ، ولكن مو جميع الخلايا تنتقل فيه جزء قليل منها يبقى .. ليه؟
لأن هذا الجزء الباقي بيكون البيزال قانقليا اللي هي عبارة عن قراي ماتر جوّا الوايت ماتر .

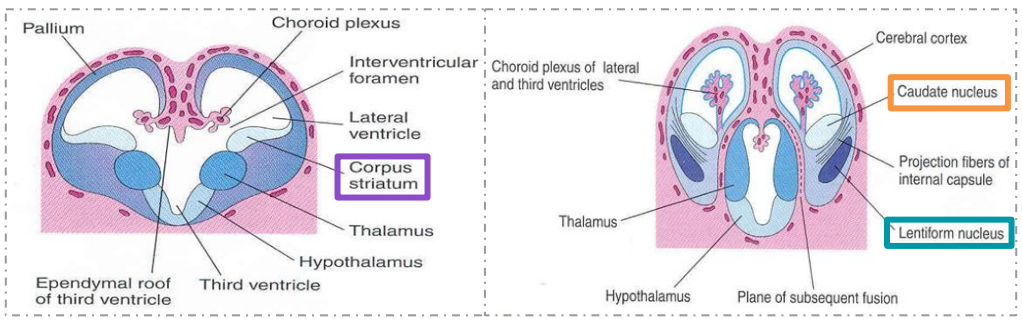
As development proceeds the following changes occur:

- Most of the nerve cells in mantle layer migrate to the marginal layer forming the cerebral cortex.
- Some cells do not migrate and remains to form the basal ganglia.

Corpus striatum: is the basal ganglia nuclei in the cerebral hemisphere.

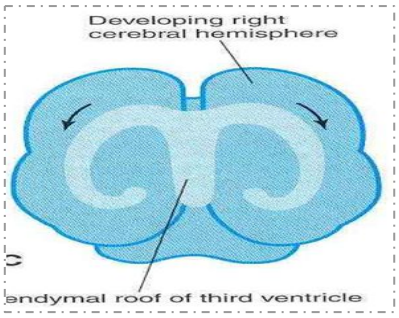
- It appears in 6th week in the floor of each cerebral hemisphere. As the cerebral cortex differentiates and the fibers passing to and from it, pass through the corpus striatum. The corpus striatum now divides into :
  1. caudate nucleus.
  2. lentiform nucleus.
- This fiber pathway forms the internal capsule.

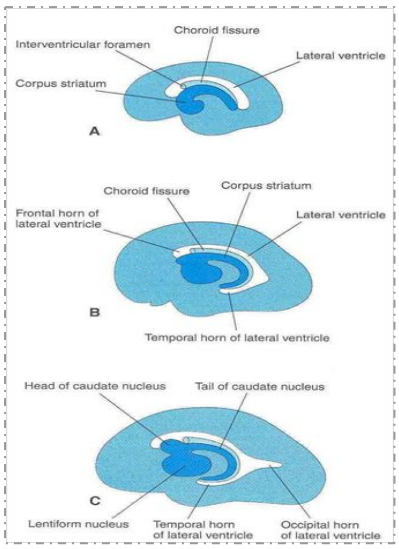
Internal capsule
جت بعد ما حصل لها
Well differentiation of cerebral cortex



- Further expansion of cerebral hemisphere gives 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.

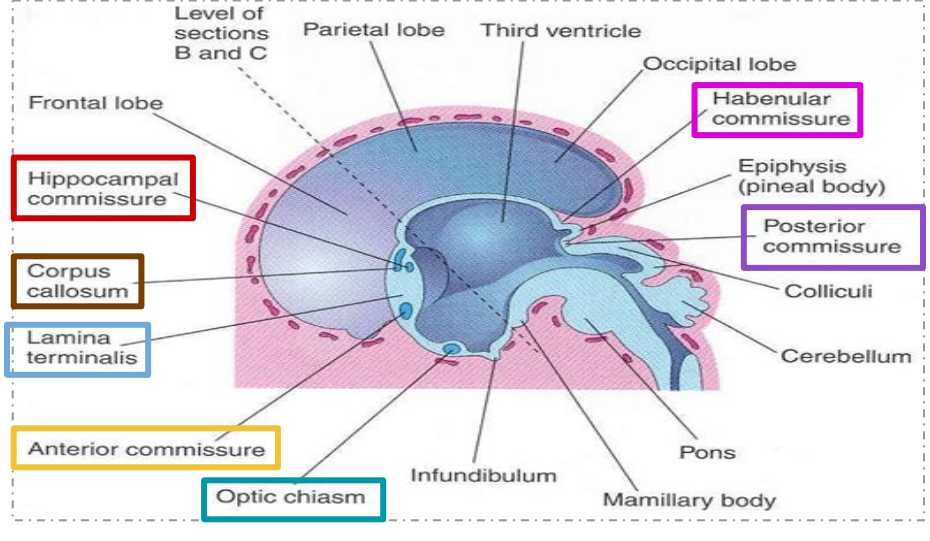
grow faster الي برا
grow slower الي جوا





Development of the Cerebral Commissures: اهم شي corpus callosum

- 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**.(is a major commissural fibres that connect the two cerebral hemispheres). **(Important)** Transverse axons between 2 cerebral hemisphere

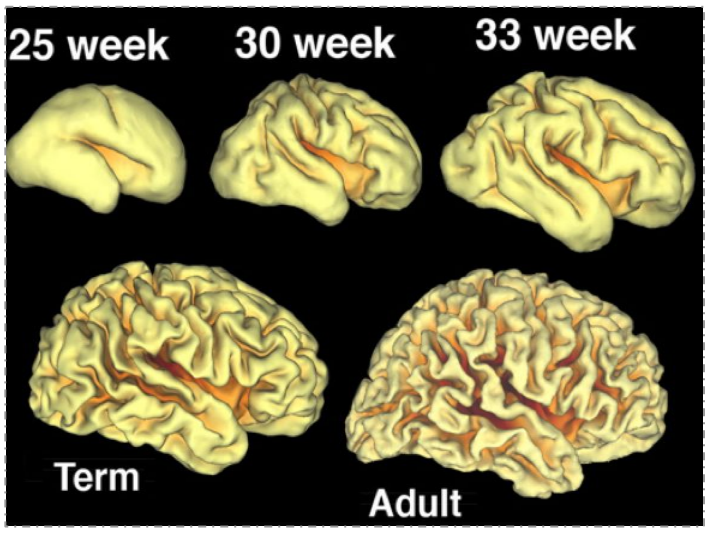


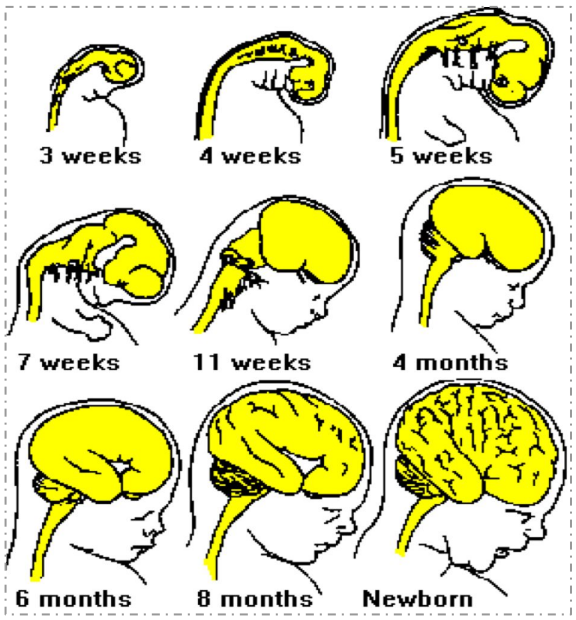
Development of Insula:

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 invaginated to lie deep within the lateral sulcus.

القشرة الخارجية تنمو أسرع من القشرة اللي تغطي الكوربس ستريتم ، علشان كذا الكروبس ستريتم والقشرة اللي بتغطيها بتكون بالعمق لأن القشرة الخارجية نمت أسرع .. علشان كذا لما نوخر القشرة الخارجية بنقدر نشوف القشرة " البطيئة " جوا اللي هي الإنسيولا .





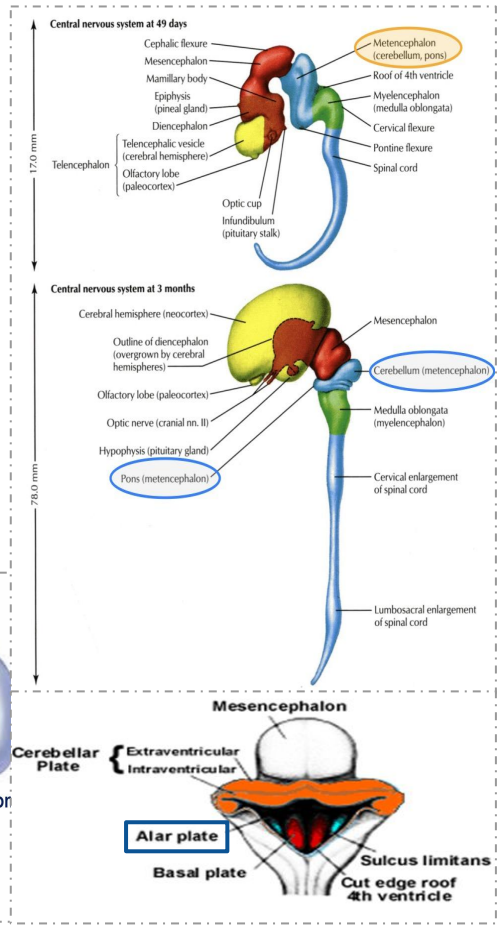
Development of the cerebellum:

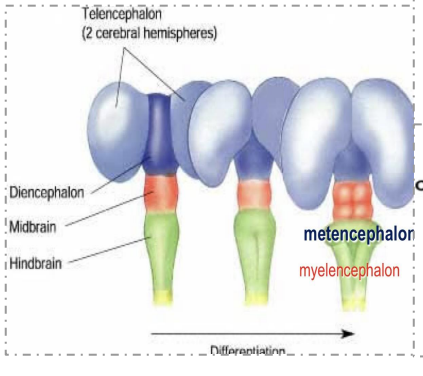
It develops from the dorsal part of the Metencephalon.

The metencephalon develops into the pons (anteriorly) and overlying Cerebellum (posteriorly)

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.**





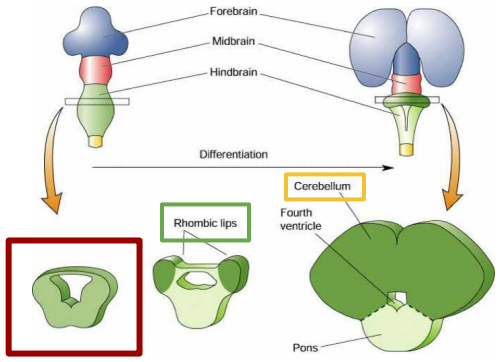
Metencephalon Changes in Alar plates :

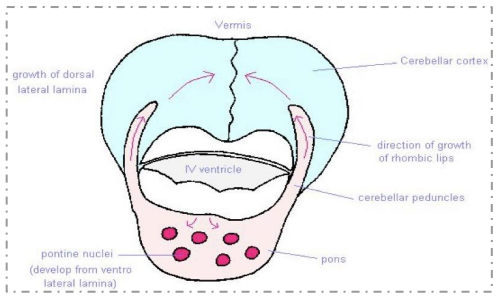
a. The dorsal parts thicken to form **Rhombic lips**, that will give rise to the **cerebellum.**

b. 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**

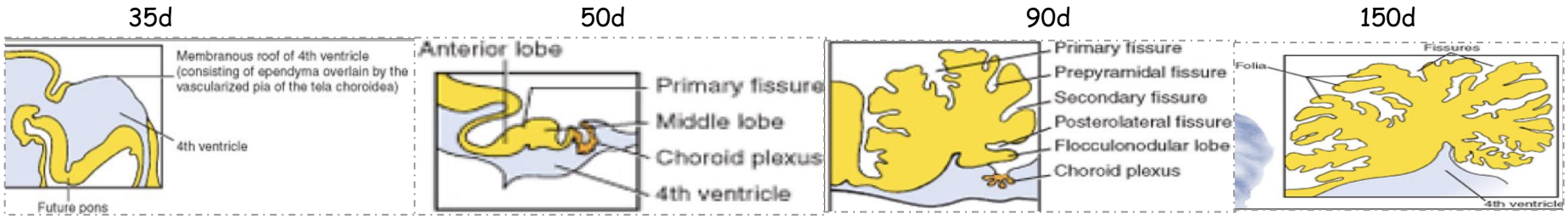
c. The cerebellar peduncles develop later as the axons of the neurons of the cerebellar nuclei grow out to reach the brain stem.





The surface of the cerebellum

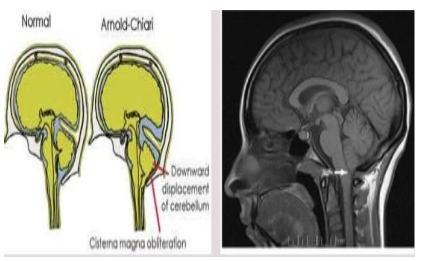
- As the **cerebellar hemispheres** develops they **undergo a complicated process of transverse folding** to form closely packed, leaf-like **transverse gyri** called **folia**.
- These processes of fissure formation and foliation continue throughout embryonic, fetal, and postnatal life, and they vastly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



Transverse folding “folia”Separated by fissures

The 2 ends of the neural tube are opened.
The upper end is closed on the 23rd to 26th day of development.
While the lower end is closed by the 27th 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.

Congenital Anomalies of The Brain

1. Mental retardation.		
2. Seizures	changes in electrical activity.	
3. Cerebral palsy. الشلل الدماغي .. يوجد إعاقة بالحركة		
4. Agenesis of corpus callosum.		
5. Cranium bifidum with or without meningocele & meningoencephalocele.		
6. **Microcephaly**	abnormal smallness of the head, a congenital condition associated with incomplete brain development).	
7. **Hydrocephalus**	Increase secretion of (CSF) and decrease absorption of it . Which leads to Enlargement of lateral ventricles	
8. **Arnold-Chiari Malformation**	herniated part of cerebellum through the foramen magnum leading to CSF obstruction ,so hydrocephalus results), also in **aqueductal stenosis** between the 4th and 3rd ventricles and in **brain tumours**.	
9. **Anencephaly**	It is due to failure of closure of the cranial neuropore of the neural tube. the brain and skull are minute and the infant does not usually survive. The frequency of this case 1:1000.	

Summary

Time	Changes
Beginning of the 3rd week	Formation of 3 germ cell layers (ectoderm,mesoderm,endoderm)
Middle of 3rd week	Forming Neural plate (Beginning of neural tube formation)
4th week	Forming brain flexures
Middle of the 4th week	End of neural tube formation
End of 4th week	Three vesicles stage (3 primary vesicles)
5th week	Five vesicles stage (2ry brain vesicles)
Development of cerebrum	
Day 32 (between 4th and 5th week)	The Cerebral hemispheres appear as a pair of bubble-like outgrowths of the Telencephalon.
6th week	Formation of corpus striatum
16 week	Cerebral hemispheres are oval and have expanded back to cover the diencephalon
The end of 3rd month	Smooth Surfaces of the cerebral hemispheres
4th month	The cortex become folded into gyri separated by sulci

Questions

1. aqueductal stenosis is an acquired condition that cause:		2. nerve cells forming the grey matter called:	
A.	Microcephaly	A.	Marginal
B.	Hydrocephalus	B.	Mantle
C.	Seizures	C.	Ependymal
D.	Cerebral palsy	D.	Both A & B
3. Processes of fissure formation and foliation:		4. The distinguish of five secondary brain vesicles from the primary vesicles is in:	
A.	Stop at 4th month	A.	3rd month
B.	Stop at 3rd month	B.	4th month
C.	Continue through postnatal life	C.	5th week
D.	Stop at 5th week	D.	3rd week
5. Surfaces of the cerebral hemispheres are smooth in the:		6. is a major commissural fibers that connect the two cerebral hemisphere:	
A.	End of 3rd month	A.	Hippocampal commissure
B.	6th week	B.	Anterior commissure
C.	Beginning of 3rd month	C.	Corpus callosum
D.	4th month	D.	Posterior commissure
7. Metencephalon develops into:		8. Corpus striatum appears in the floor of each cerebral hemisphere in the:	
A.	Pons and cerebellum	A.	3rd month
B.	Cerebral hemisphere	B.	4th month
C.	Pons	C.	3rd week
D.	Medulla oblongata	D.	6th week

Q	1	2	3	4	5	6	7	8
Answers	B	B	C	C	A	C	A	D

(يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِير)

Team leaders

ميعاد النفيعي - فهد النهابي

Team members

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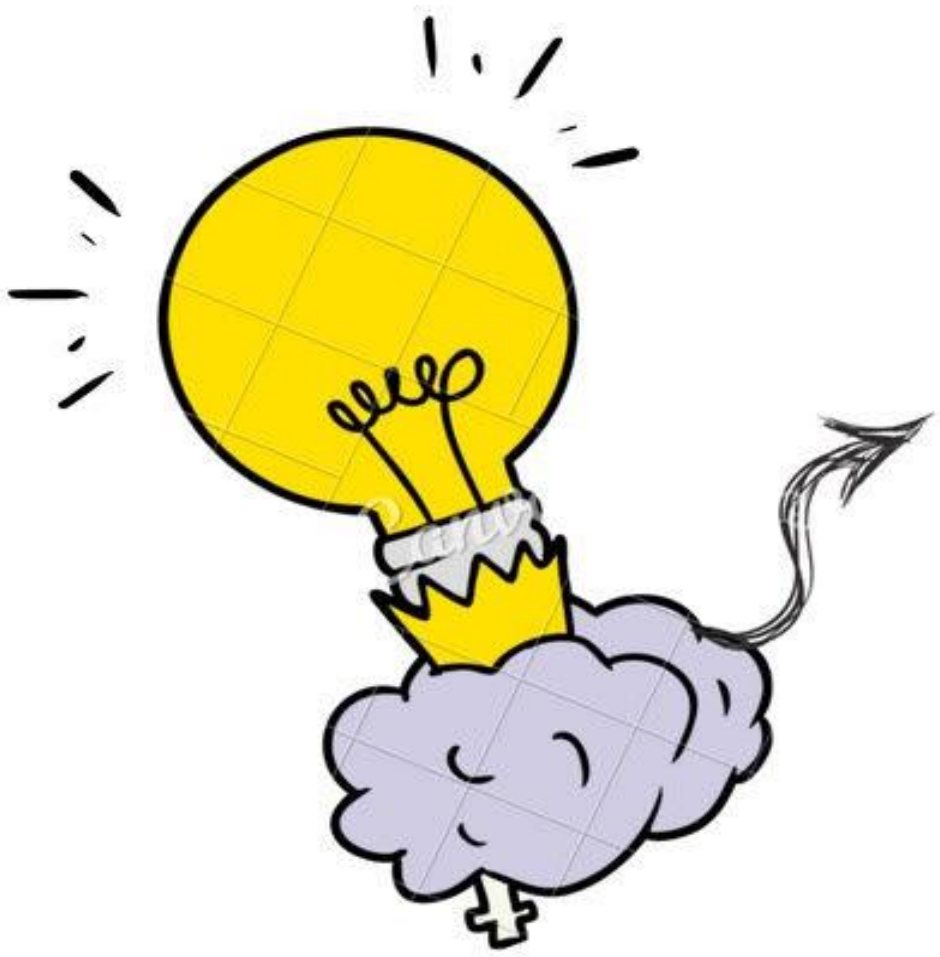

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