جامعة الملك سعود
King Saud University

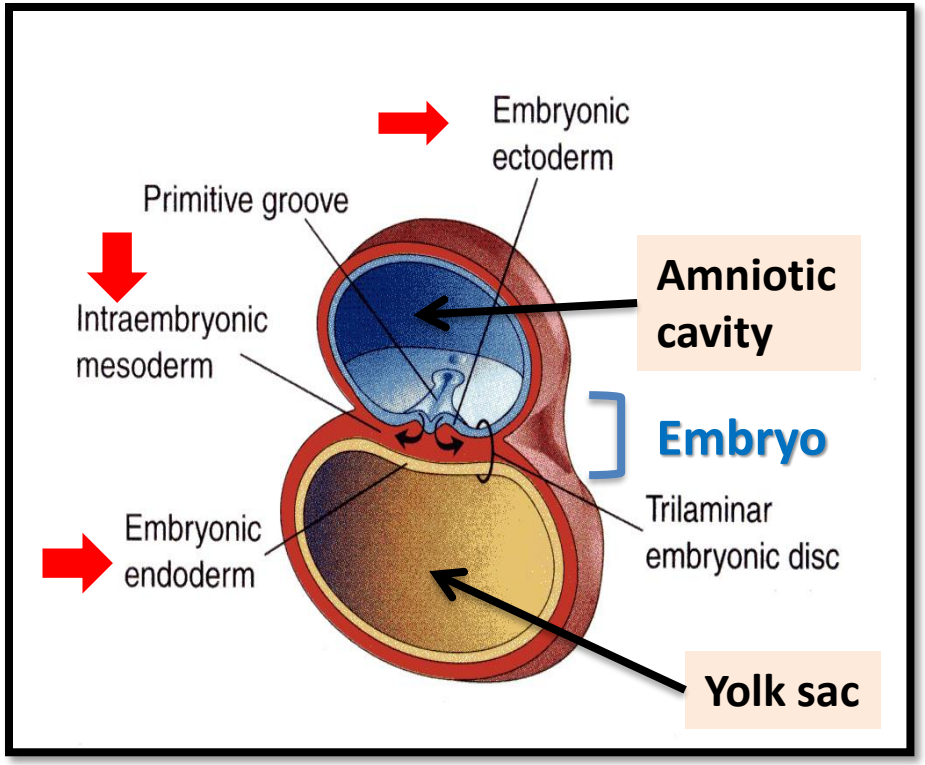
DEVELOPMENT OF CEREBRUM & CEREBELLUM

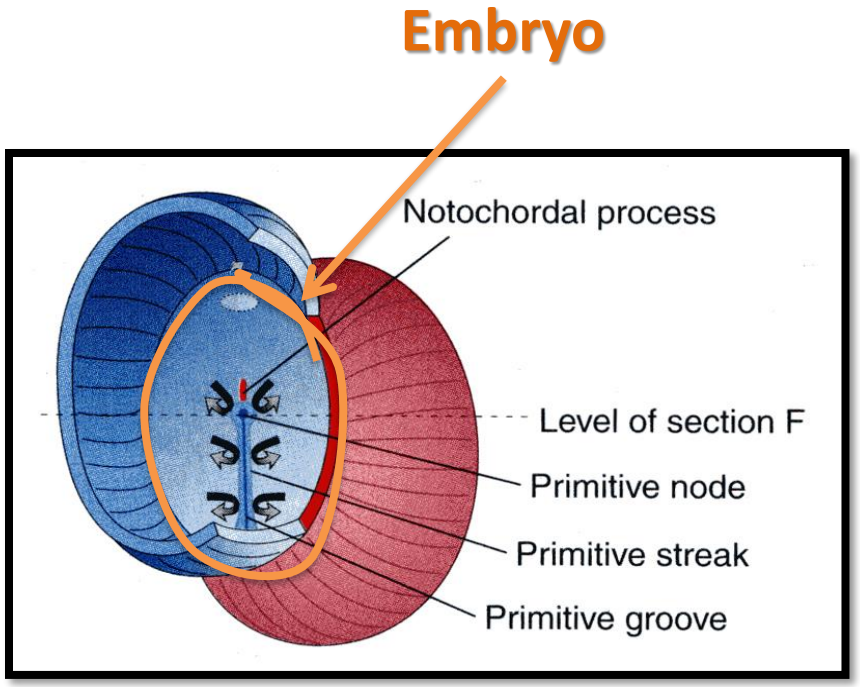
PROF. AHMED FATHALLA IBRAHIM ELFOUHIL

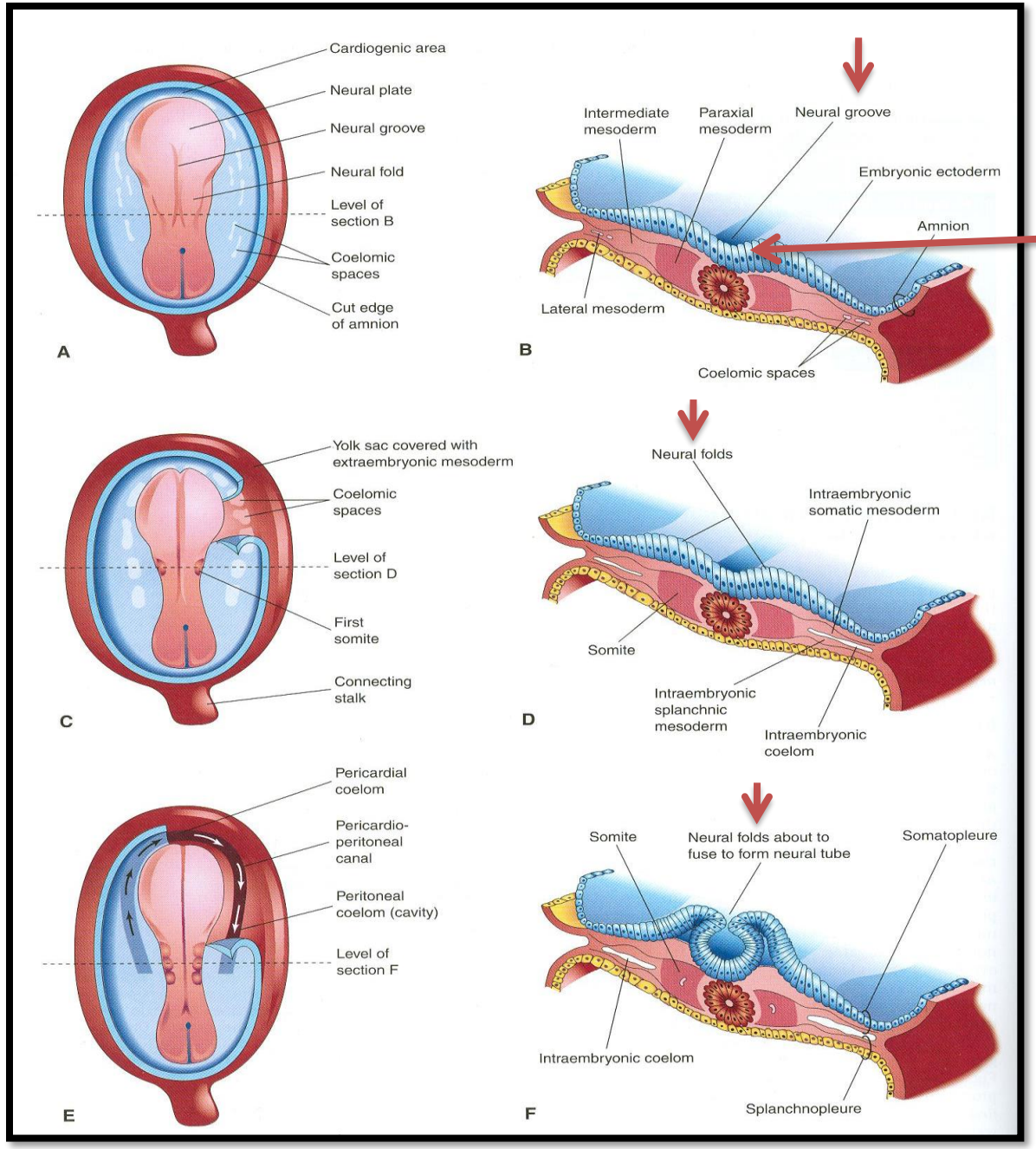
OBJECTIVES

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.
- List important congenital anomalies related to the development of CNS.


Embryonic ectoderm
Primitive groove
Amniotic cavity
Intraembryonic mesoderm
Embryo
Trilaminar embryonic disc
Embryonic endoderm
Yolk sac


Embryo
Notochordal process
Level of section F
Primitive node
Primitive streak
Primitive groove



DEVELOPMENT OF NEURAL TUBE

- Ectodermal cells dorsal to notochord thickens to form the neural plate.
- A longitudinal groove develops in the neural plate (neural groove).
- The margins of the neural plate (neural folds) approach to each other and fuse to form the neural tube (by the middle of 4th Week).

DEVELOPMENT OF BRAIN

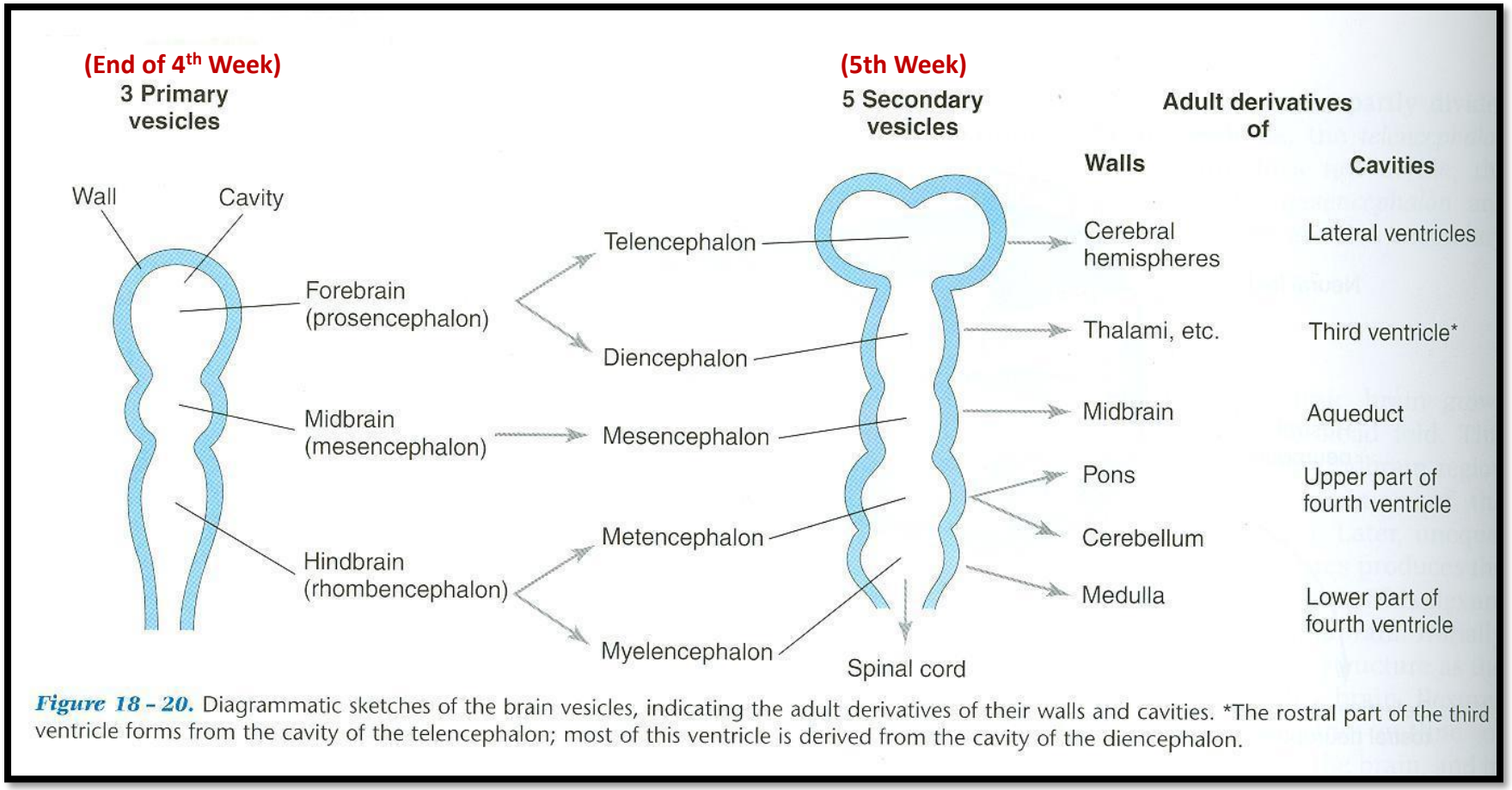


Figure 18 - 20. Diagrammatic sketches of the brain vesicles, indicating the adult derivatives of their walls and cavities. *The rostral part of the third ventricle forms from the cavity of the telencephalon; most of this ventricle is derived from the cavity of the diencephalon.

DEVELOPMENT OF BRAIN

- The brain develops from the cranial part of neural tube.
- By the end of 4th week, the cranial part of neural tube dilates and divides into 3 parts (Three Vesicles Stage):
  - *PROSENCEPHALON (FOREBRAIN)
  - *MESENCEPHALON (MIDBRAIN)
  - *RHOMBENCEPHALON (HINDBRAIN)
- By the 5th week, further differentiation distinguishes five secondary brain vesicles (Five Vesicles Stage):
  - *PROSENCEPHALON which subdivides into:
    - 1-Two lateral telencephalons
    - 2-One median diencephalon
  - *MESENCEPHALON
  - *RHOMBENCEPHALON which subdivides into:
    - 1-Metencephalon
    - 2-Myelencephalon

PRIMARY BRAIN VESICLES	SECONDARY BRAIN VESICLES	DERIVATIVES IN MATURE BRAIN	CAVITY
PROSENCEPHALON (FOREBRAIN)	TELENCENPHALON	CEREBRAL HEMISPHERE	LATREAL VENTRICLE
	DIENCEPHALON	THALAMUS, HYPOTHALAMUS, EPITHALAMUS, SUBTHALAMUS	THIRD VENTRICLE
MESENCEPHALON (MIDBRAIN)	MESENCEPHALON	MIDBRAIN	CEREBRAL ACQUEDUCT
RHOMBENCEPHALON (HINDBRAIN)	METENCEPHALON	PONS, CEREBELLUM	FOURTH VENTRICLE
	MYELENCEPHALON	MEDULLA OBLONGATA	

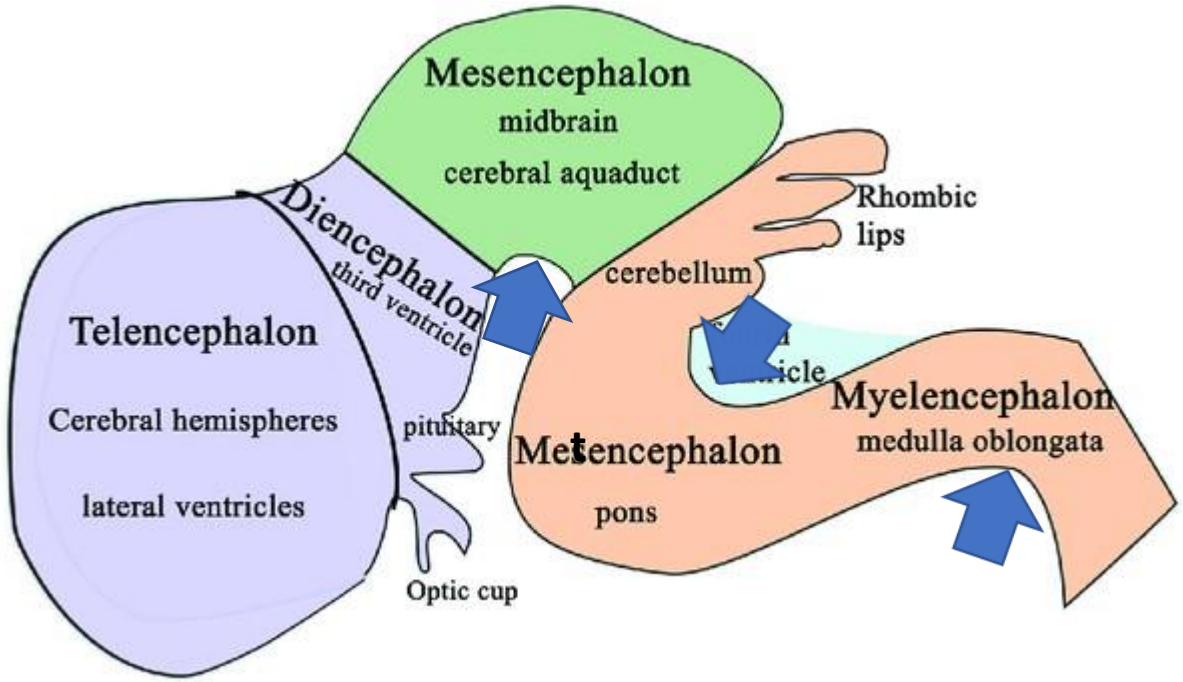
BRAIN FLEXURES

- **In 4th week**, brain grows rapidly and bends ventrally producing:

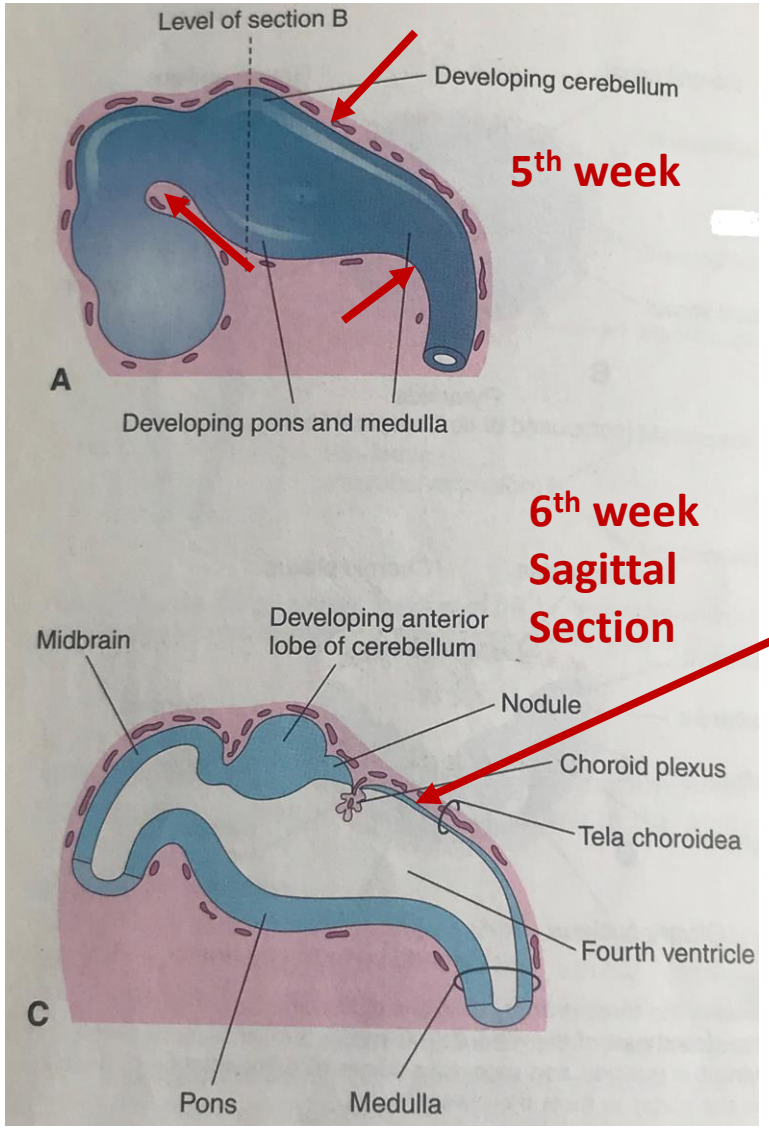
  a) **Midbrain flexure:** in the midbrain region.

  b) **Cervical flexure:** between hindbrain & spinal cord.

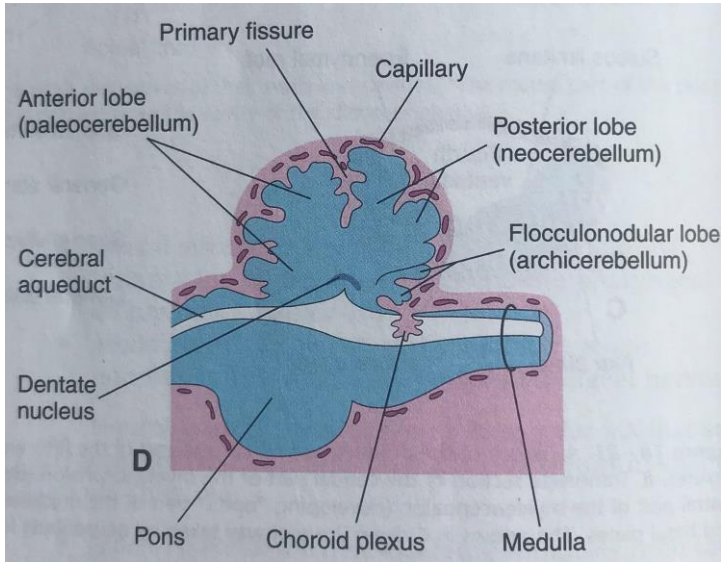
- Later, unequal growth of the brain between the 2 flexures produces the **pontine flexure**, in the opposite direction.



BRAIN FLEXURES

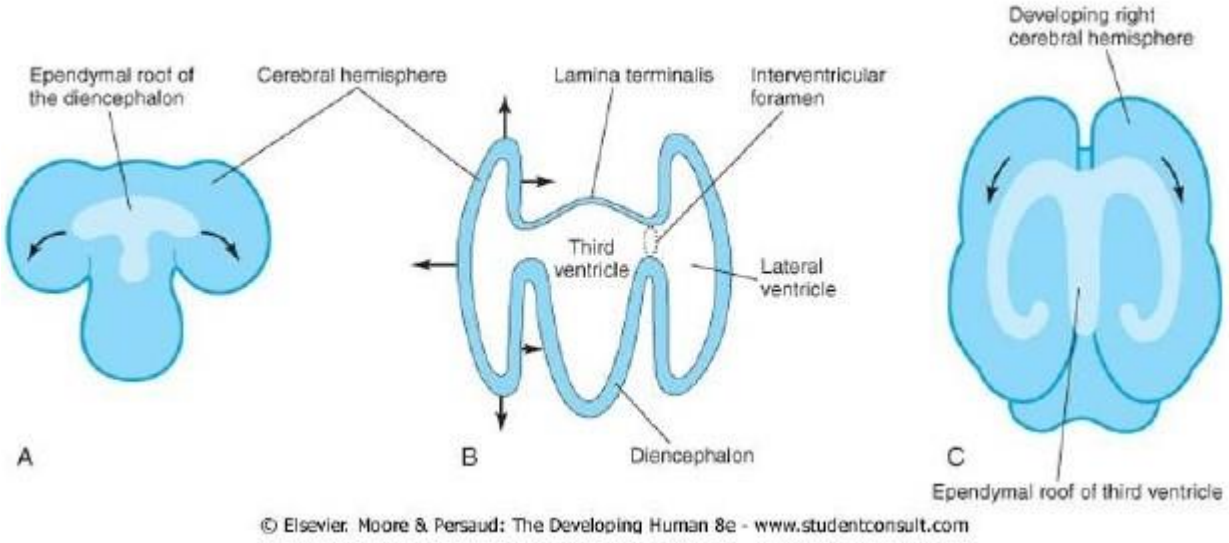


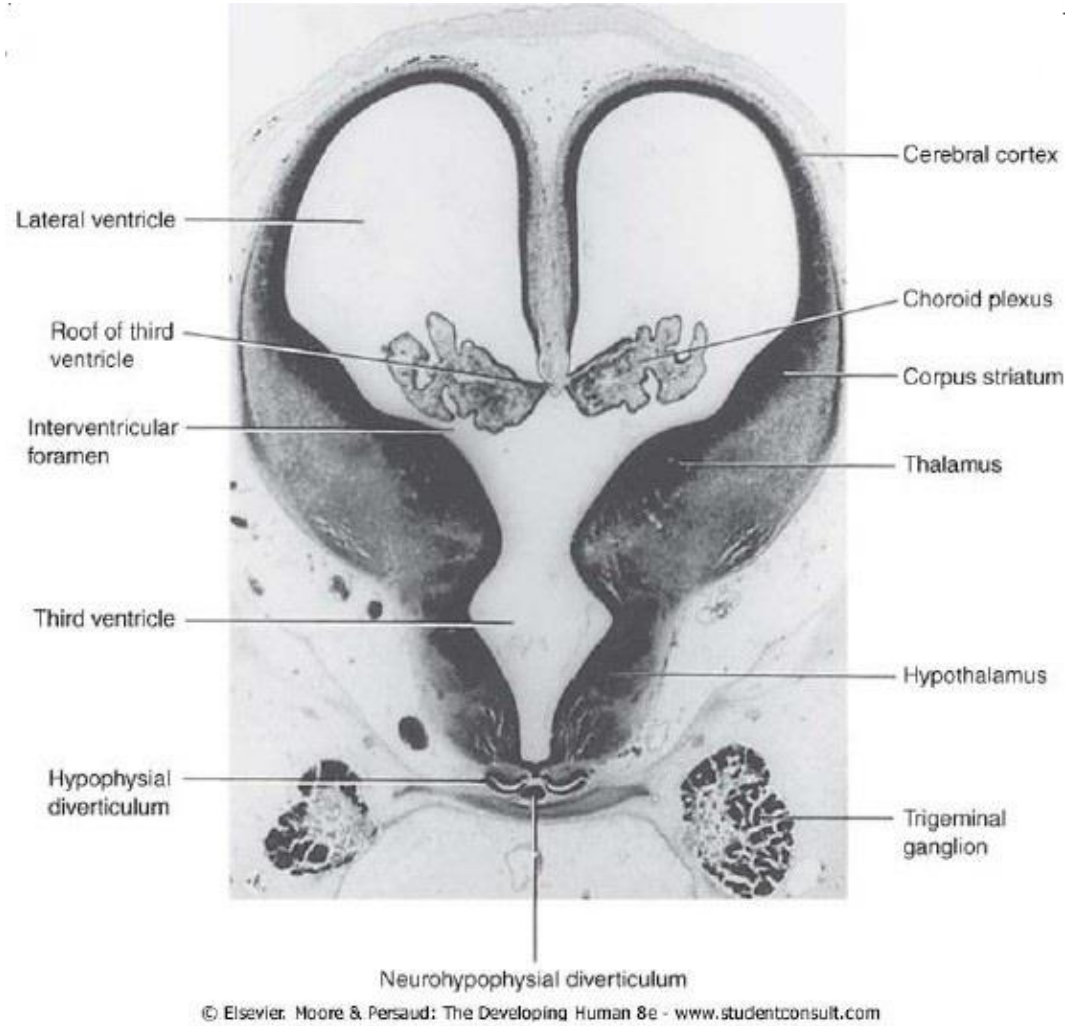
The pontine flexure results in thinning of the roof of hindbrain



17th week
Sagittal Section

DIFFERENTIATION OF FOREBRAIN





The Forebrain (prosencephalon) differentiates into:

1. **A median part: diencephalon**
2. **Two lateral vesicles: telencephalic or cerebral vesicles**

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

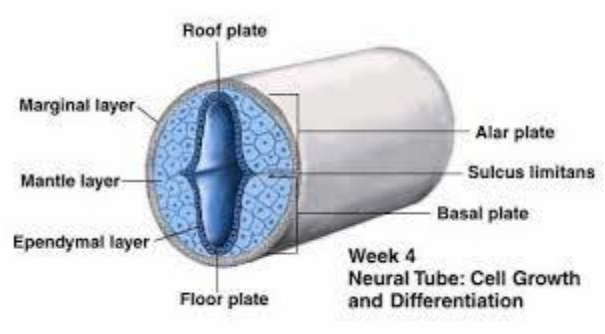
Both cavities **communicate** with each other through **a wide interventricular foramen**.

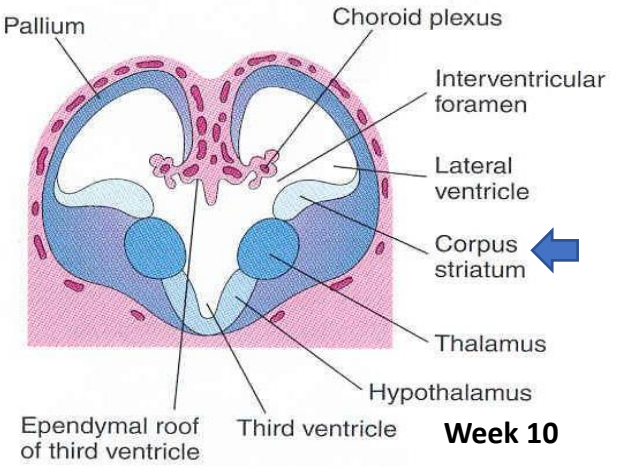
The cerebral hemispheres **expand in all directions.**

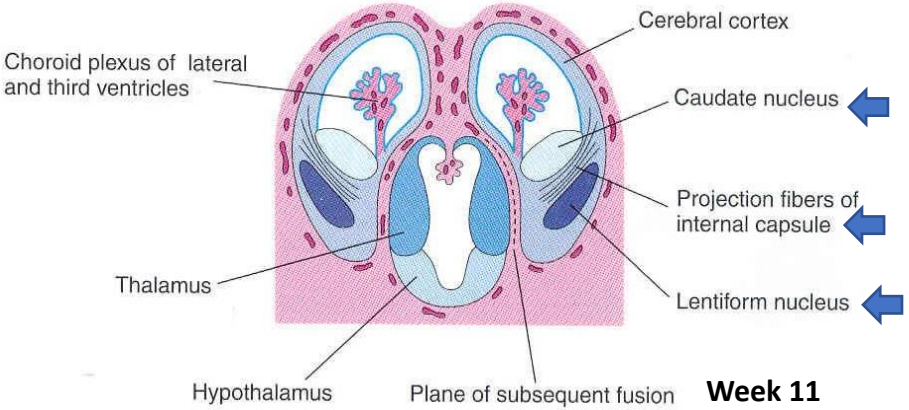
A part of their medial wall becomes thin (site of formation of choroid plexus of the lateral ventricle).

DEVELOPMENT OF CEREBRUM

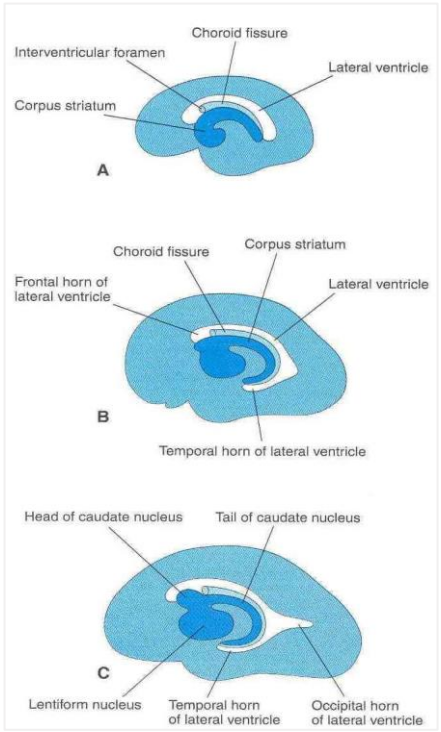
- The wall of the telencephalon is formed of 3 layers :
  - **Ependymal :** lining the cavity of the lateral ventricle.
  - **Mantle**: nerve cells forming the **grey matter**.
  - **Marginal:** nerve fibers forming the **white matter**.
- Most of the nerve cells in mantle layer migrate outside forming the **cerebral cortex**.
- Some cells **do not migrate** and remains to form the **basal ganglia (nuclei)**.
- **In 6th week**, **the corpus striatum** (a part of the basal ganglia) appears as a swelling in **the floor** of each cerebral hemisphere.
- Fibers, passing to and from the cerebral cortex, divide the corpus striatum into **caudate nucleus** & **lentiform nucleus**. This pathway of fibers forms **the internal capsule**.

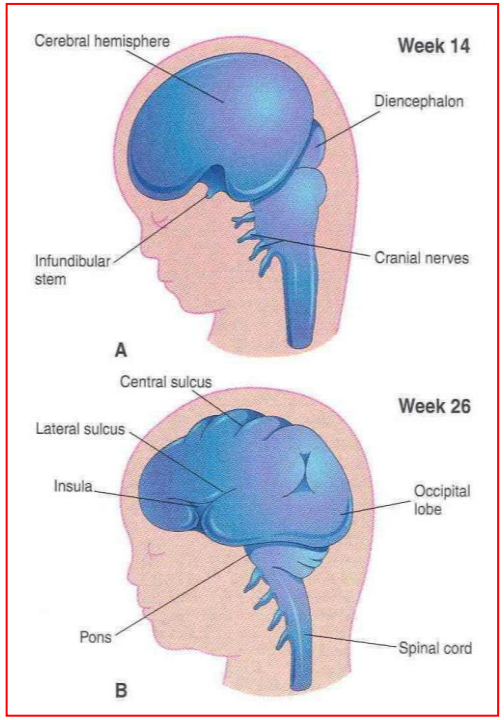


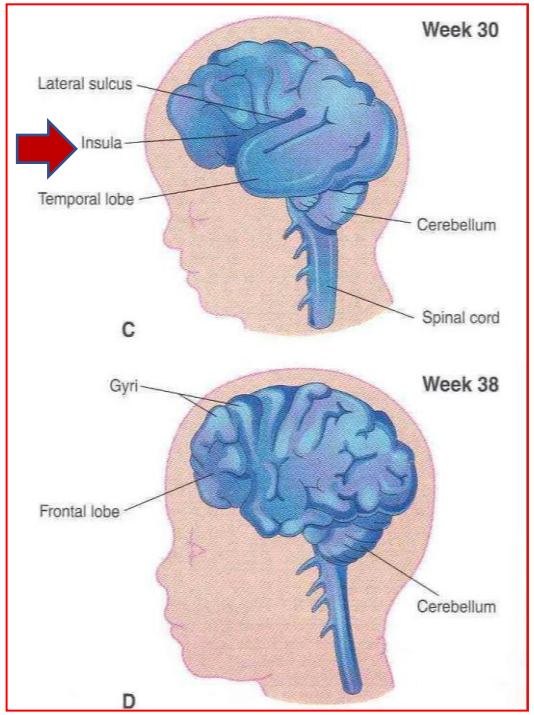




DEVELOPMENT OF CEREBRUM







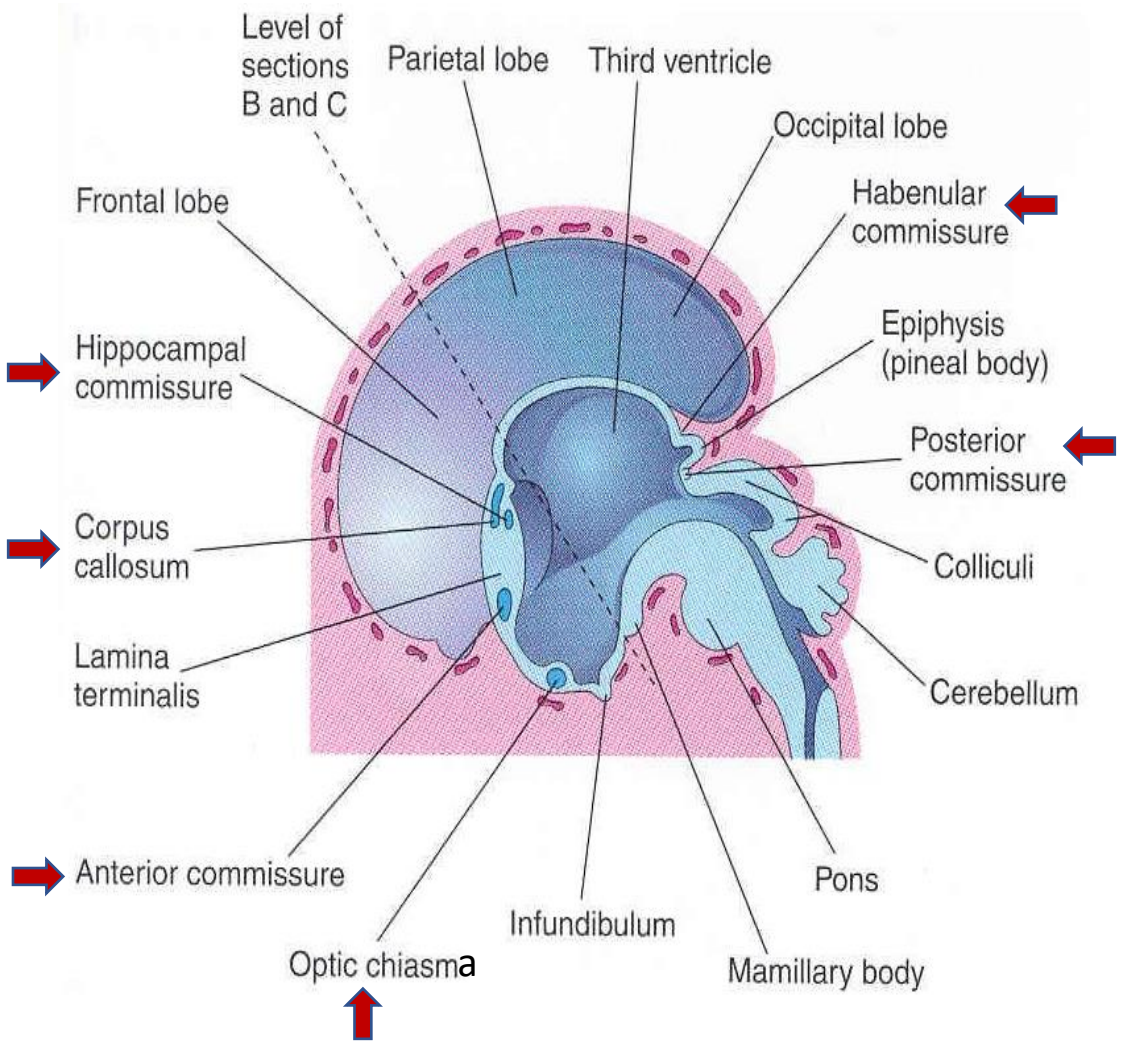
The floor of each cerebral hemisphere, containing the large corpus striatum, **expands more slowly** than its thin cortical walls. As a result, **the cerebral hemisphere become C-shaped**, as well as, **the lateral ventricle**.
Initially, the surface of the hemispheres is **smooth**. As **grey matter grows faster** than white matter, **the cortex becomes folded into sulci and gyri** that increase the surface area of the cortex without requiring an extensive increase in cranial size. **The cortex covering the external surface of corpus striatum grows slowly** and is soon overgrown. **This buried cortex**, hidden from view in the depths of the lateral sulcus is **the insula**.

DEVELOPMENT OF THE CEREBRAL COMMISSURE

As the cerebral cortex develops, group of fibers **– commissures -** connect corresponding areas of the cerebral hemispheres.

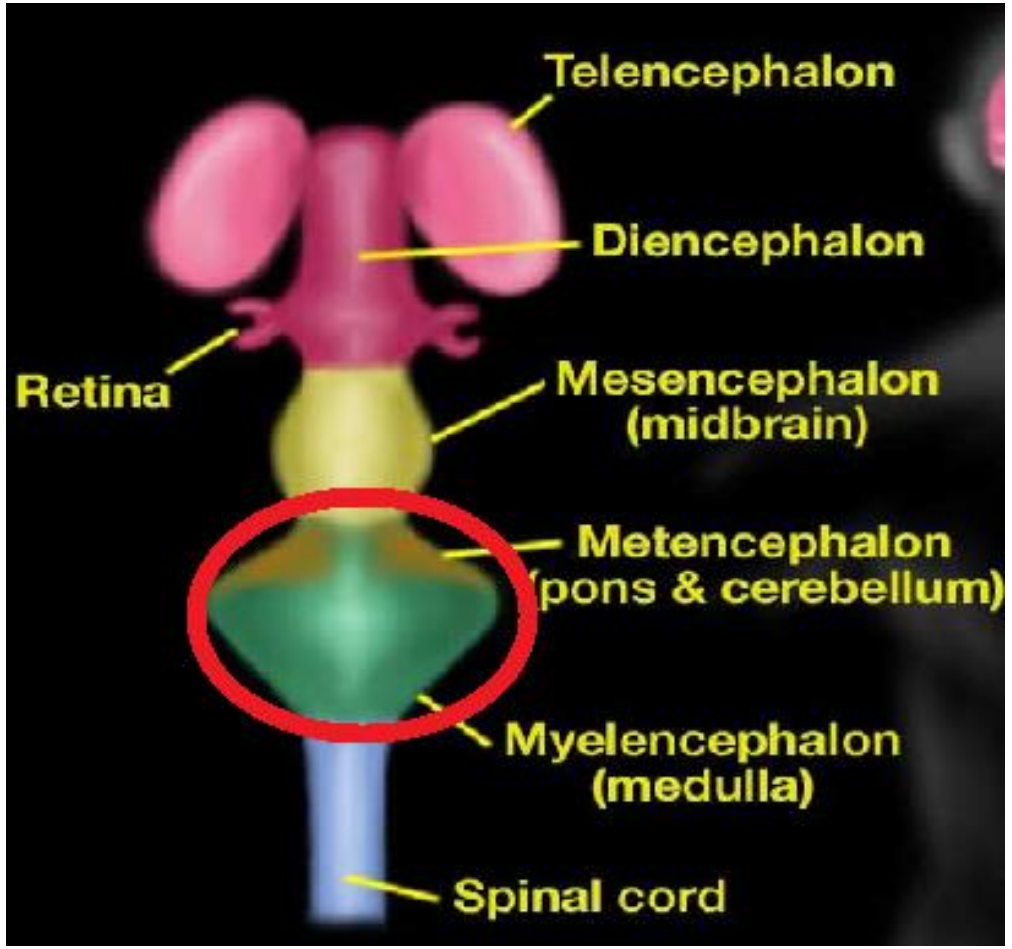
These are:

- **Optic chiasma.**
- **Anterior commissure.**
- **Posterior commissure.**
- **Hippocampal commissure.**
- **Habenular commissure.**
- **Corpus callosum (the largest).**

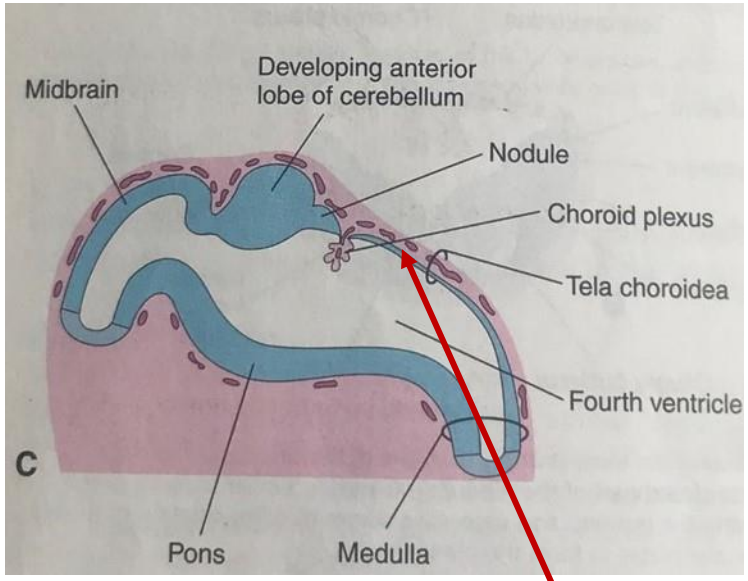


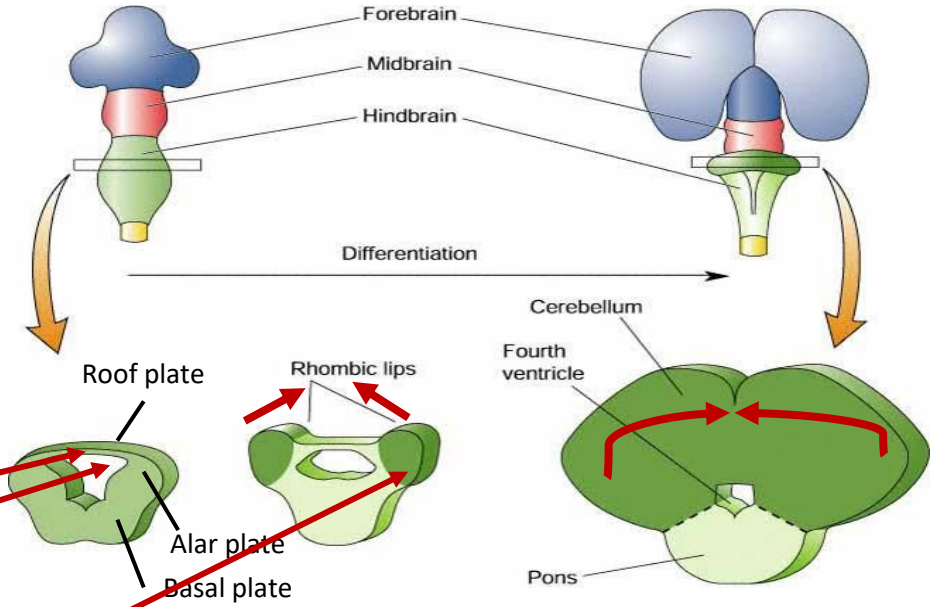
DEVELOPMENT OF THE CEREBELLUM

The cerebellum develops from the dorsal part of the metencepalon.



DEVELOPMENT OF THE CEREBELLUM

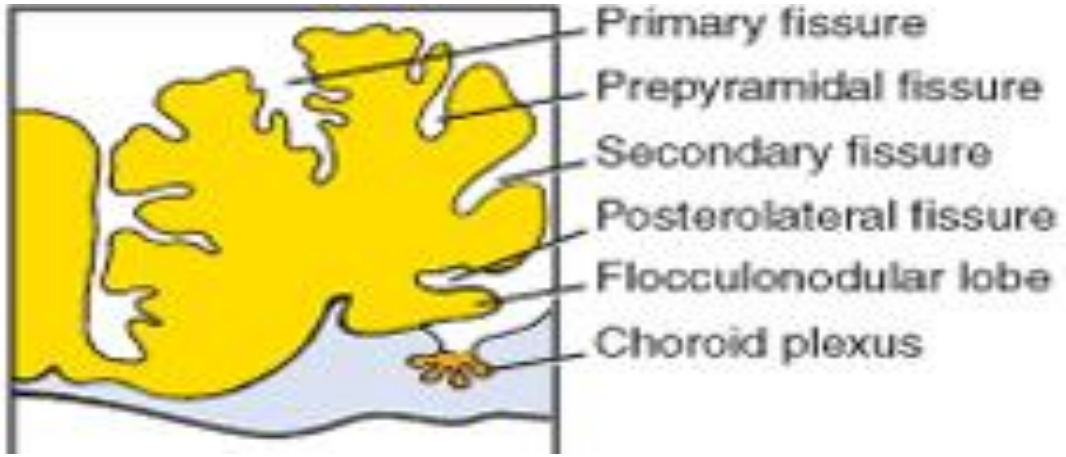


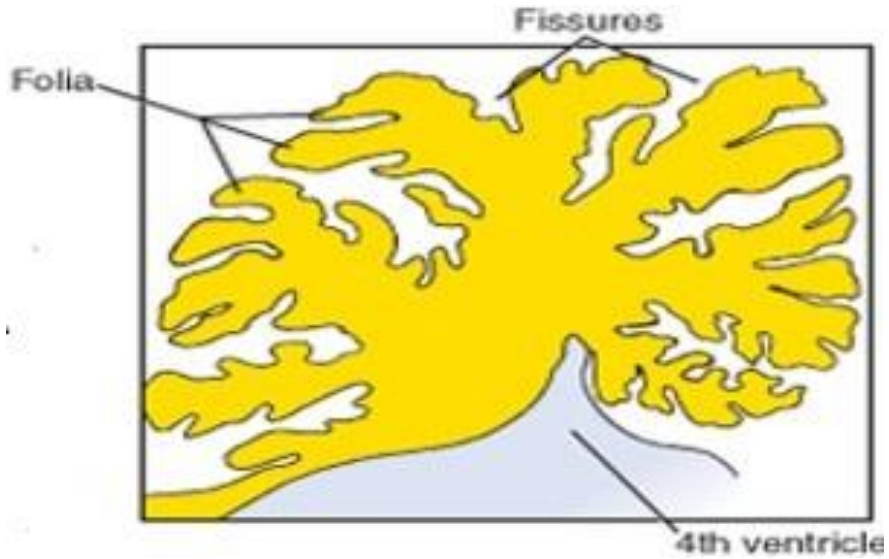


- **The pontine flexure** results in:
  -Stretching and thinning of the roof plate of the fourth ventricle.
  - Widening of the fourth ventricle.
  - Moving the alar plate (dorsal side of neural tube) laterally.
- **The 2 lateral sides of dorsal parts of alar plate** thicken to form **the Rhombic lips**. The Rhombic lips **projects caudally** over the roof plate of fourth ventricle and **unite with each other in the midline** to form **the cerebellum**.
- **Neuroblasts migrate from the mantle layer to the marginal layer** to form **the cerebellar cortex**.
- Some neuroblasts remain in the mantle layer and give rise to **the deep cerebellar nuclei**.
- **The cerebellar peduncles** develop later as **the axons of the deep cerebellar nuclei** and grow out to reach the brain stem.

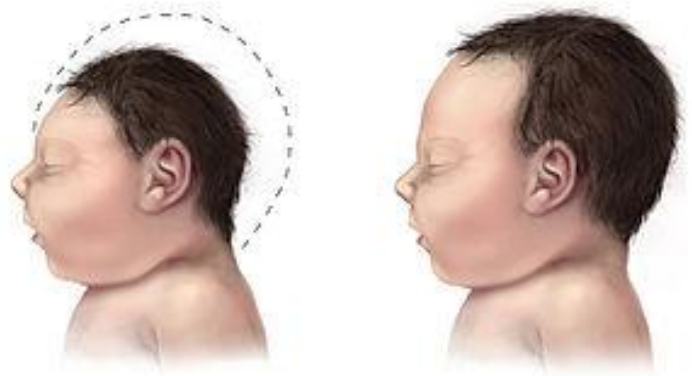
DEVELOPMENT OF THE CEREBELLUM

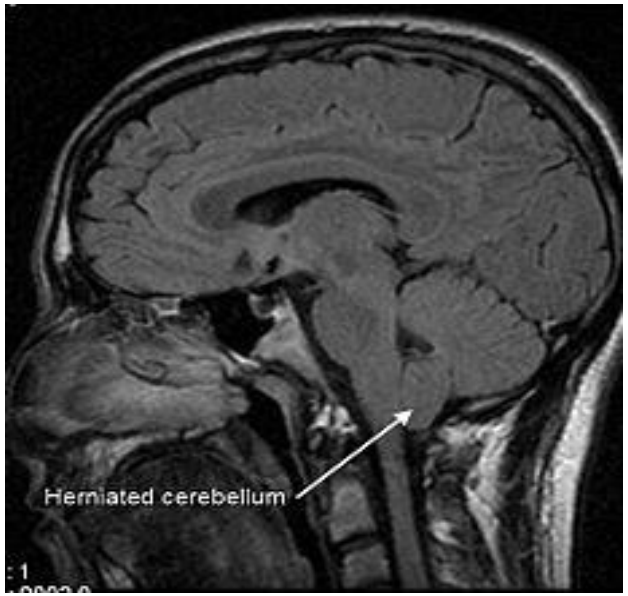
As the cerebellar hemispheres develop, they undergo a **complicated process of transverse folding** and form closely packed, leaf-like transverse gyri called **folia** separated by **fissure**s.
These processes of fissure formation and foliation continues **postnatally** to **increase the surface area of the cerebellar cortex**.





CONGENITAL ANOMALIES OF THE BRAIN





- **Hydrocephalus:** A condition caused by a flow obstruction, hindering the free passage of CSF through the ventricular system and subarachnoid space.
- **Microcephaly:** A condition where the head (circumference) is smaller than normal associated with incomplete brain development.
- **Arnold-Chiari malformation:** A condition in which brain tissue extends into the spinal canal. It occurs when a part of the skull is abnormally small, pressing on the brain and forcing it downward.

CONGENITAL ANOMALIES OF THE BRAIN

Anencephaly: is the absence of a major portion of the brain, skull, and scalp that occurs during embryonic development. It is a cephalic disorder that results from a neural tube defect that occurs when the rostral (head) end of the neural tube fails to close.

THANK YOU