VINGUS ACADEMIC TEAM

BAU-Medicine

**Sheet no.** 12
**Lecture Date:** 2/3/2021
**Lecture Title:** Development of the CNS II
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# Development of the CNS II

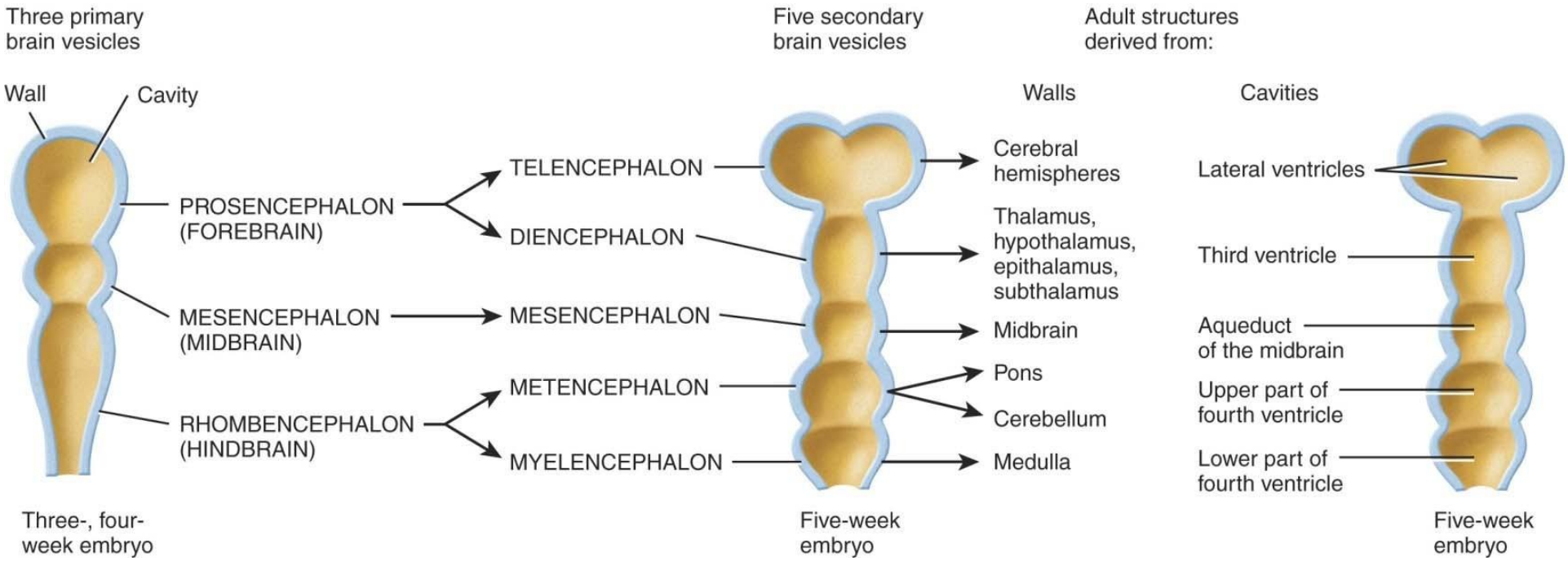
Normal and Abnormal

**In the previous lecture, the focus was on the development of Spinal Cord.**
**This lecture will be on the development of the Brain.**

# Lectures Objectives

- Describe the formation of neural tube and neural crest.
- Describe the development of brain and spinal cord.
- Describe the positional changes of spinal cord.
- Describe the development of the spinal nerves and their spinal ganglia.
- Describe the development of meninges.
- Describe the development of brain vesicles from the neural tube.
- Describe the development of the different parts of brain.
- Describe the development of brain ventricles and choroid plexuses.
- Describe the development of the cranial nerves and their ganglia.
- Describe the congenital anomalies of brain and spinal cord.

# Development of the Brain: Vesicles




▶ ▶ **pay attention for the details within the picture**

# Sheet #1 :

- **Growth of the rostral part of neural tube forms the brain**

- **Proliferation of cells will give "balloon-like" structures or dilatations called Brain Vesicles** " it is the first thing developed"

- **We have 3 primary Vesicles: Prosencephalon, Mesencephalon, and Rhombencephalon.**

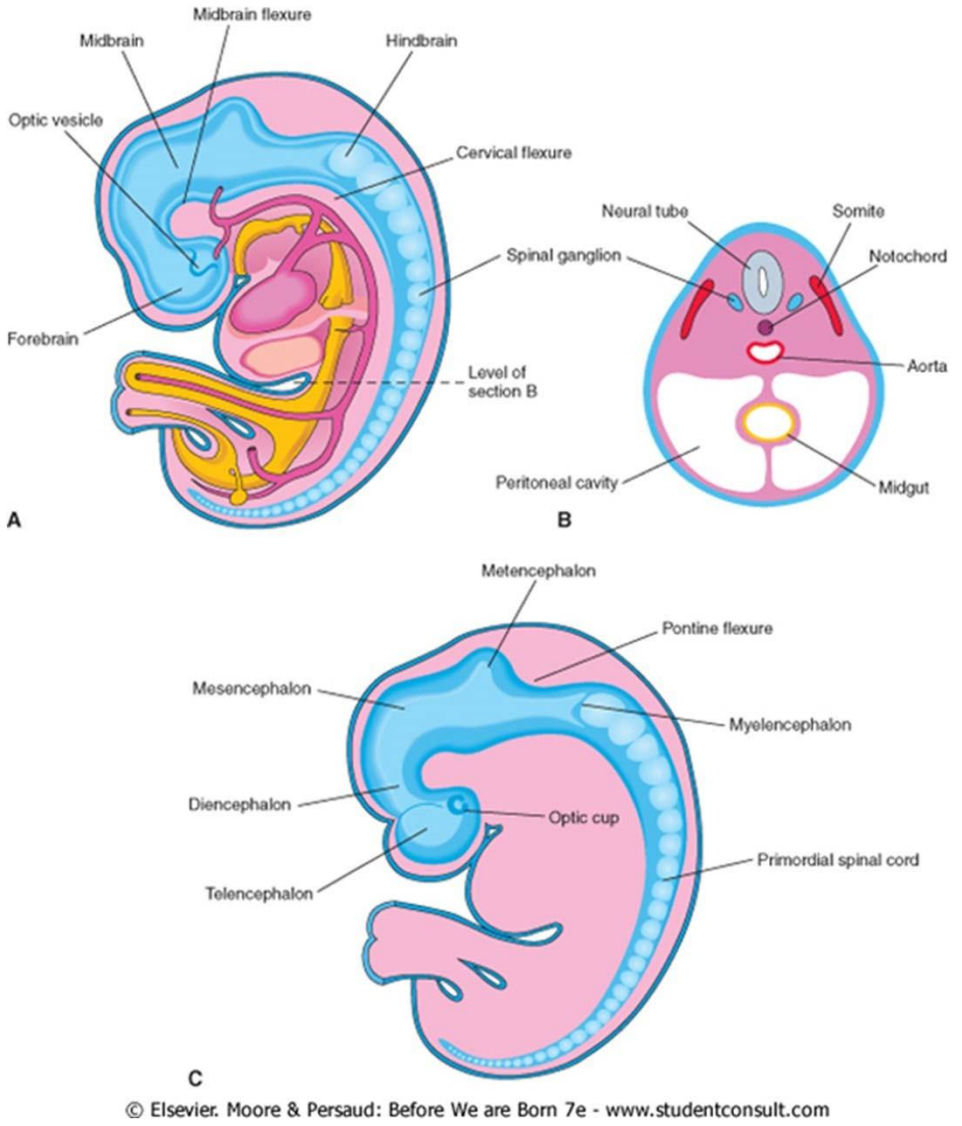
- **Mesencephalon doesn't have subdivisions and gives the midbrain. (Unlike Prosencephalon and Rhombencephalon)**

- **Notice how Pons and cerebellum come from the same subdivision which is Metencephalon.**

- **Finally, Within the neural canal each subdivision will give a part of the ventricular system respectively as seen on the picture on the right.**

# Brain Flexures

- Happens due to the rapid growth of the brain
- Midbrain flexure
  - Ventrally
- Cervical flexure
  - Between hindbrain & SC
  - Ventrally
- Pontine flexure
  - Between metencephalon & myelencephalon
  - Dorsally



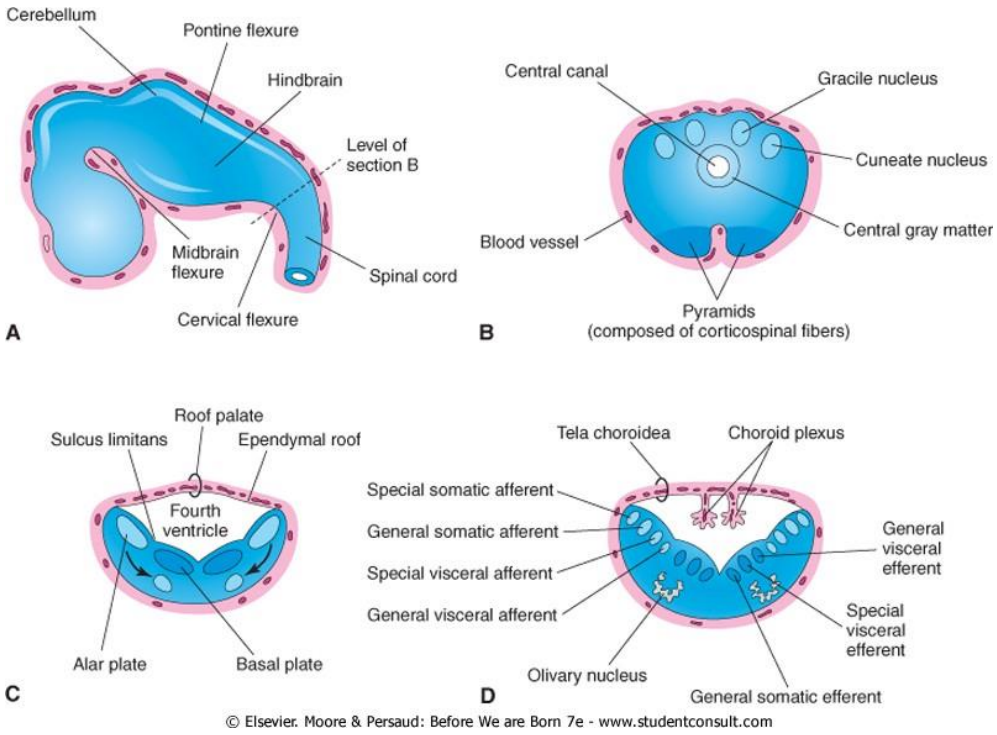


Remember: Development of neural tube is faster than the development of body itself.

**1.** Rostral to Pontine flexure is pons and cerebellum.
**2.** Caudal to Pontine flexure is medulla oblongata.

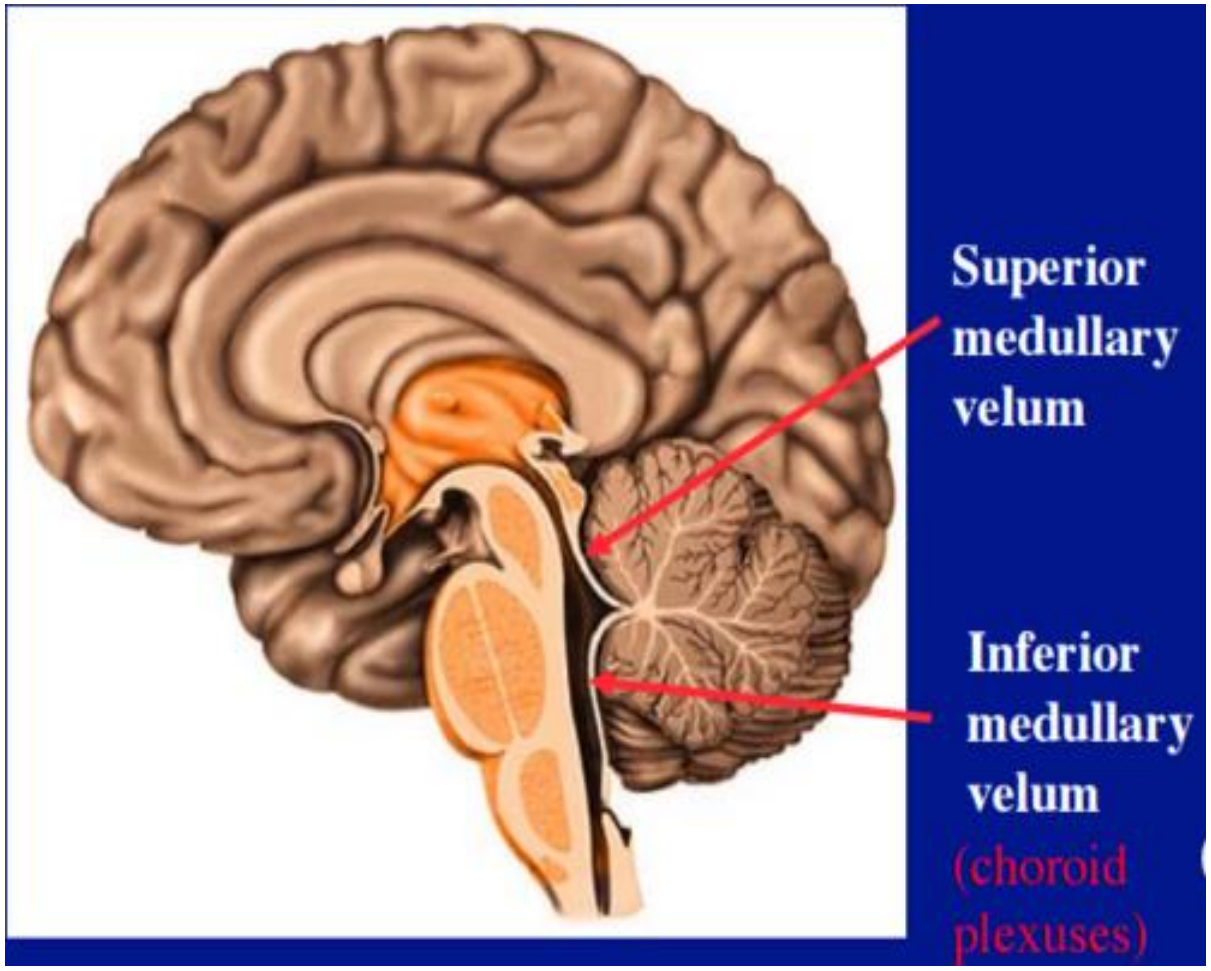
# Myelencephalon

- Caudal part
  - Closed part (spinal canal)
  - Neuroblasts from alar plates migrate into the marginal zone
    - Gracile & cuneate nuclei
  - Pyramids – ventrally
- Rostral part
  - Open part
    - Lateral plates diverts away & roof plate widens
      - Alar plates lateral
        - » Afferent neurons
        - » Olivary nuclei
      - Basal plates medial
        - » Efferent nuclei



# Sheet #2:

- Myelencephalon will form the medulla oblongata.
- In caudal part, neural canal will stay as central canal and won't form any part of ventricular system.
- Alar plate and Basal plates undergo division and migration towards tegmentum.
- The alar and basal plates do not overtake the place of roof plate but keep it's integrity and reorient themselves away from it. This roof plate form Superior and inferior velum.
- Medial eminence, facial colliculus, and trigons all keep their position close to midline in relation to rhomboid fossa during development.
- Sulcus limitans is a remnant of development and separates alar and basal plates.
- Alar plate moves ventrally away from roof plate and divides in marginal zone.
- Efferent nuclei (Basal plate): -Hypoglossal nucleus
  -Dorsal nucleus of vagus nerve
  -Ambiguous nucleus
- Afferent nuclei (Alar plate): Spinal nuclei of trigeminal nerve, Nucleus Solitarius " sensory nuclei", Vestibulocochlear nuclei

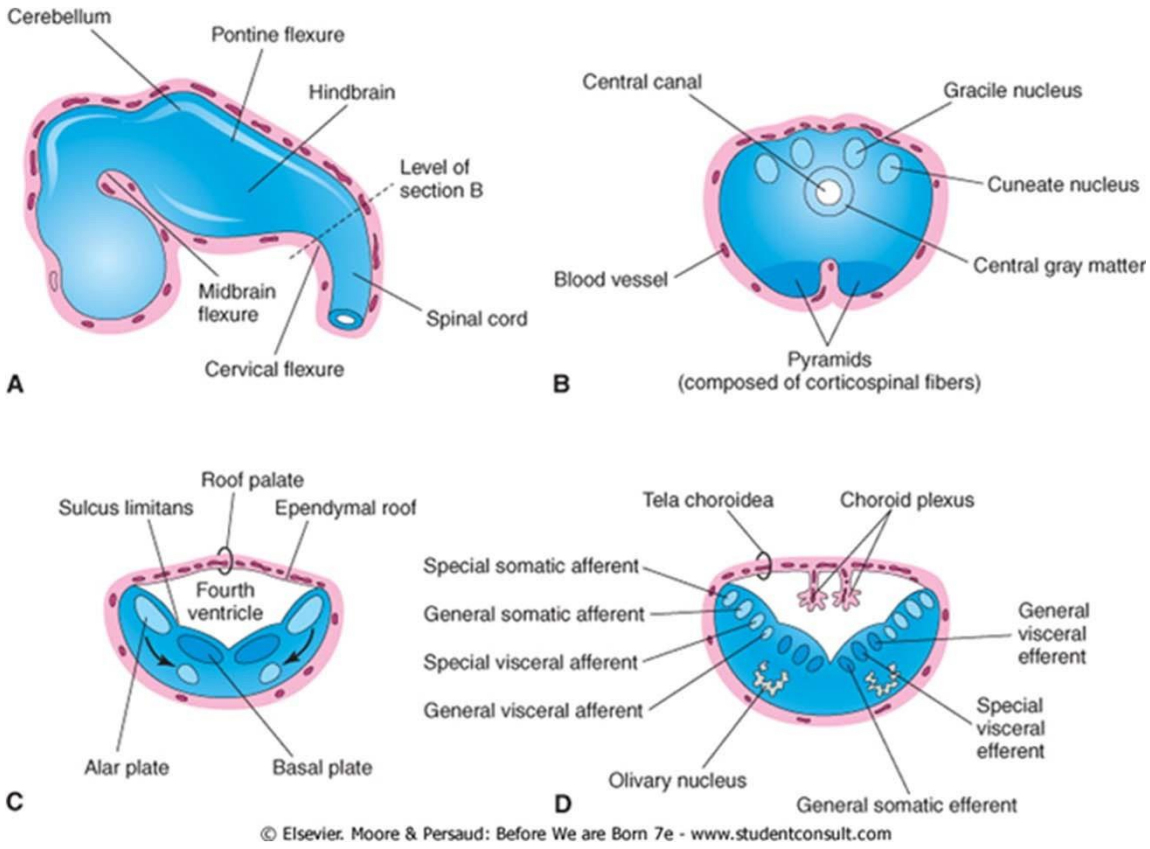



They form from the roof plate.

# Myelencephalon

## Functional components of cranial nerves

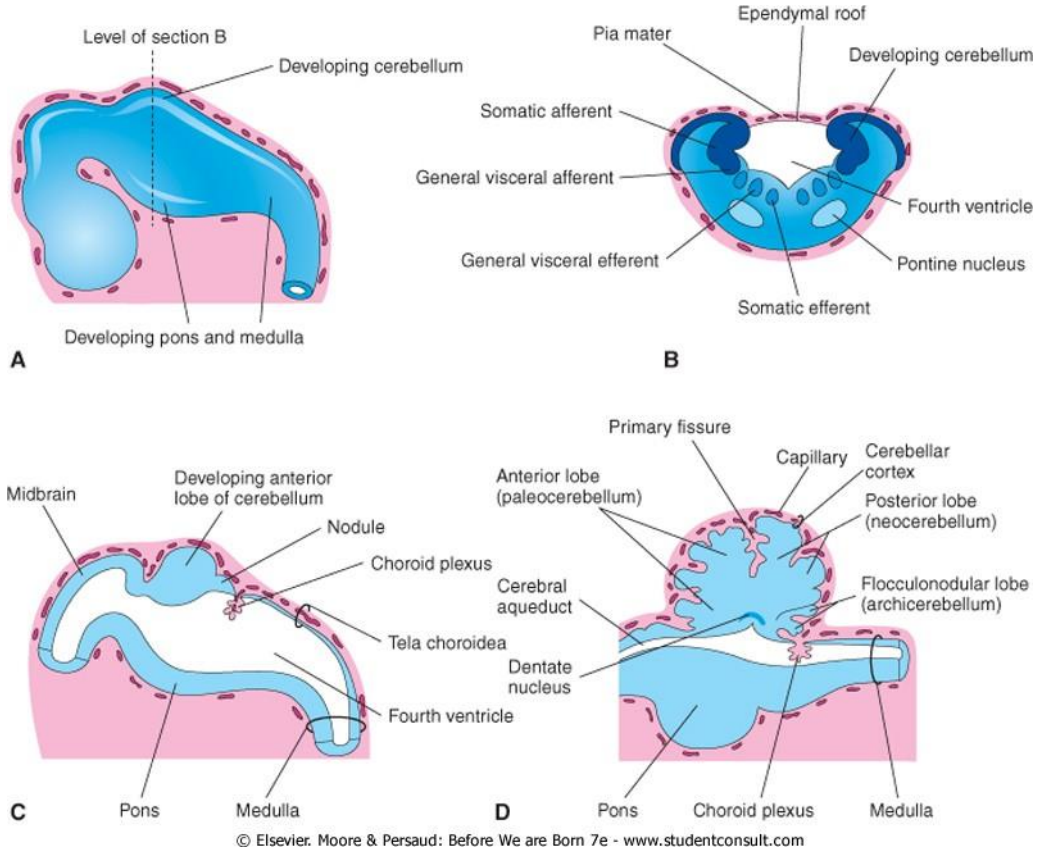
- Basal plates
  - GSE – IIX nerve
  - SVE – IX nerve
  - GVE – X, XI nerves
- ➢ Sulcus limitans
- Alar plates
  - GVA
  - SVA
  - GSA
  - SSA
- ❖ This order is valid for entire brainstem




► ► **Most of the development of the brain stem is "ventrally "**

# Metencephalon

- Walls → pons & cerebellum
- Cavity → rostral part of 4th ventricle
- Alar plates gives rise to cerebellar swellings
- Cerebellar swelling fuse in the midline
- Neuroblasts from alar plates forms
  - Cerebellar cortex
  - Central nuclei of cerebellum
  - Pontine nuclei (cochlear & vestibular nuclei)
  - Sensory nuclei of trigeminal nerve

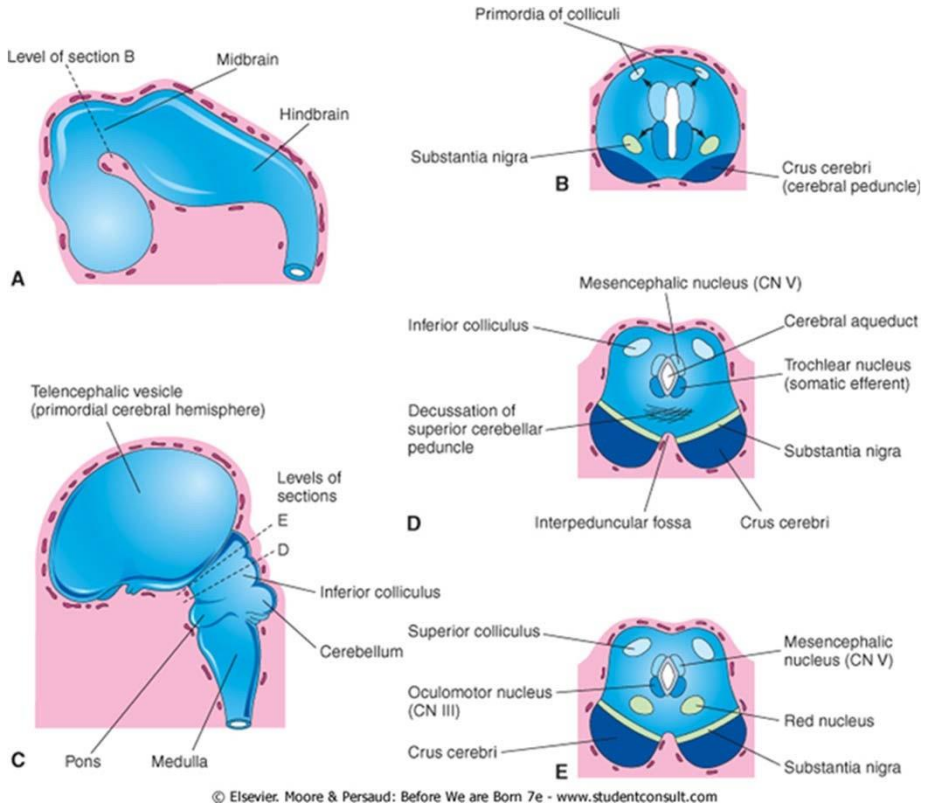


## Sheet #3:

- **Alar plate moves laterally and dorsal roof thickens enclosing on 4th ventricle**
- **Cerebellar swellings unite dorsally and form the cerebellum.**
- **Basal plate develops to give efferent nuclei (Abducens, facial, etc…)**

# Midbrain

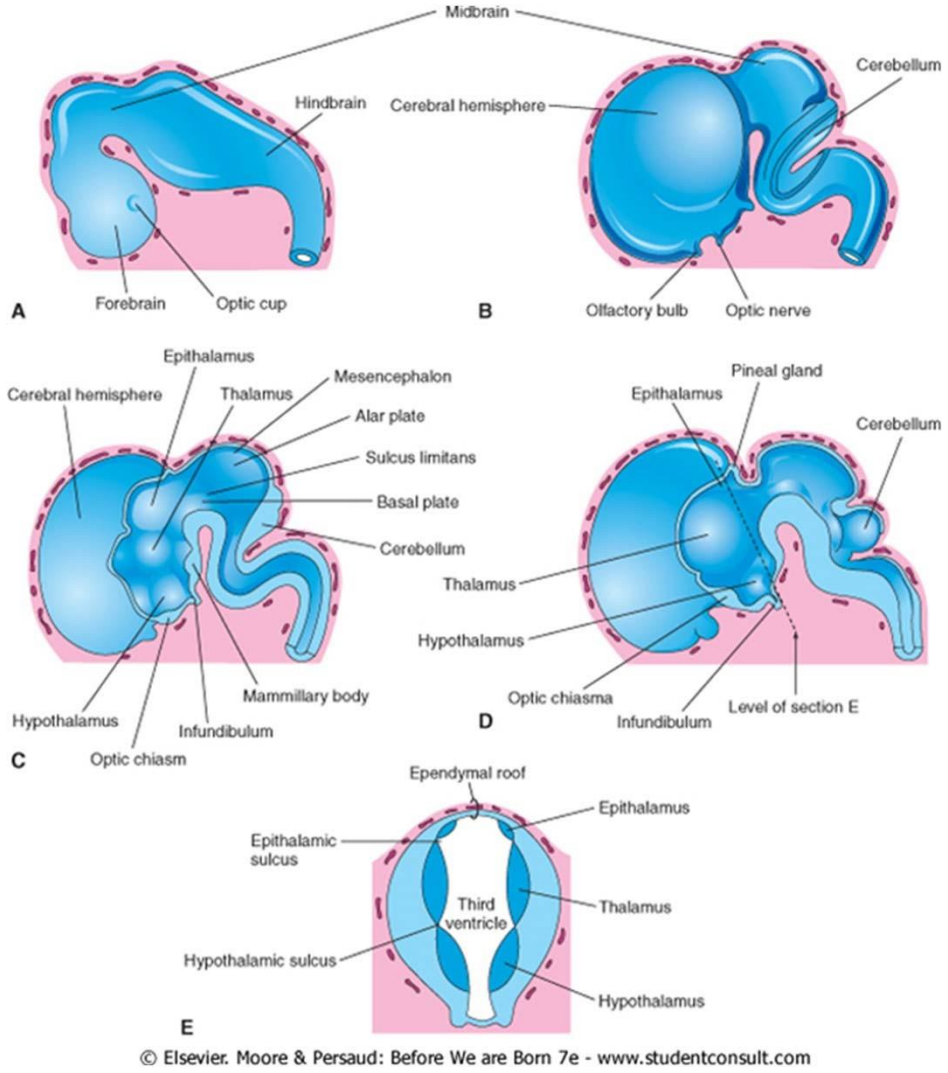
- Neural canal → cerebral aqueduct
- Alar plates
  - Tectum nuclei
    - Superior & inferior colliculi
- Basal plates
  - Tegmentum nuclei
    - III, IV nerves
    - Red nucleus
    - Substantia nigra




Alar plates develop into posterior structures, while basal plates give anterior structures.

# Diencephalon

- Three swelling from the lateral wall of the 3rd ventricle
  - Epithalamus
    - Epithalamic sulcus
  - Thalamus
    - Hypothalamic sulcus
  - Hypothalamus



# Sheet #4:

- **Within the Diencephalon, the singular cell layer around the 3rd ventricle proliferates and gives the swellings aka the layers of thalamus.(First layer attached to wall is still the ependymal layer)**

- **Epithalamus is most dorsally located and gives rise to pineal and habenular nuclei.**

- **There are sulci that separate between each swelling.**

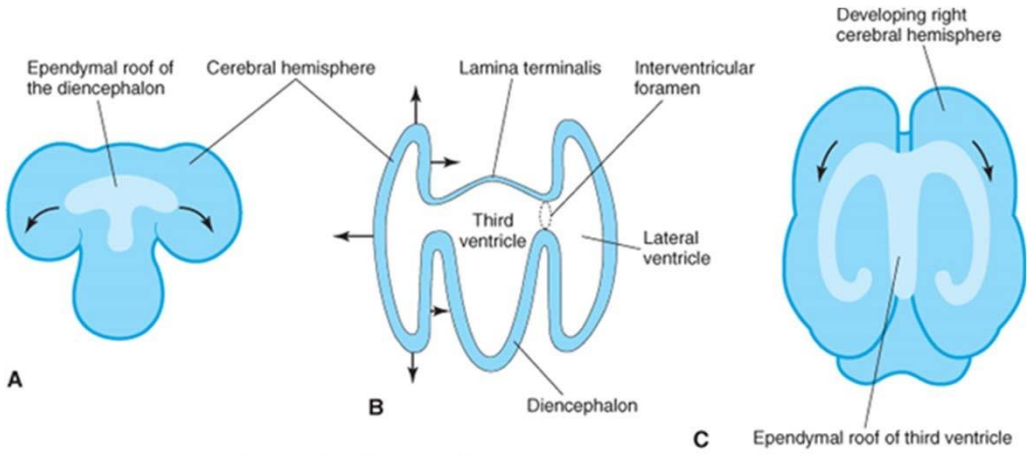
- **Each layer forms it's sub nuclei. Ex: Hypothalamus forms supraoptic nucleus.**

- **Epithalamus : posterior to the thalamus.**

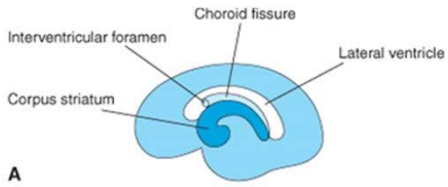
- **Hypothalamus: anterior- inferior to the the thalamus.**

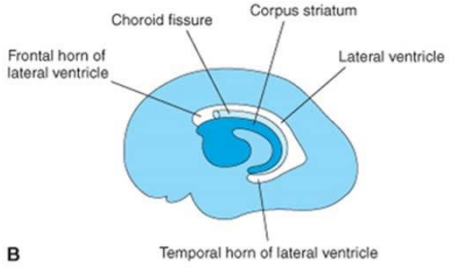
# Telencephalon

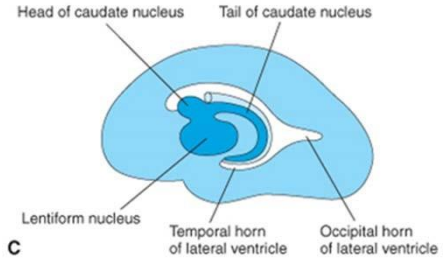
- Cerebral vesicles → cerebral hemispheres
  - Enlarge and becomes C-shape
  - Caudal end enlarge and fold – temporal lobe
- Cavity → anterior part of 3rd ventricle & lateral ventricles (c-shape)
  - Temporal horn follow temporal lobe





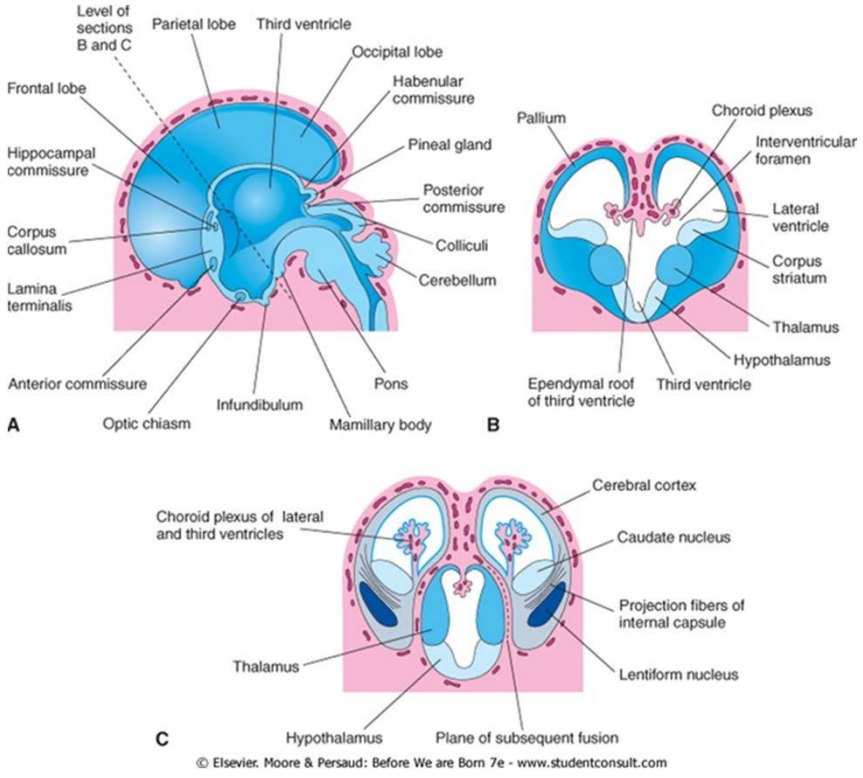


# Telencephalon

- Corpus striatum develops from swelling in the floor of each cerebral hemisphere
  - Fibers (C-shape internal capsule) divide it into C-shape caudate nucleus & lentiform nucleus
- Neuroblast cells migrate to marginal zone to form cerebral cortex

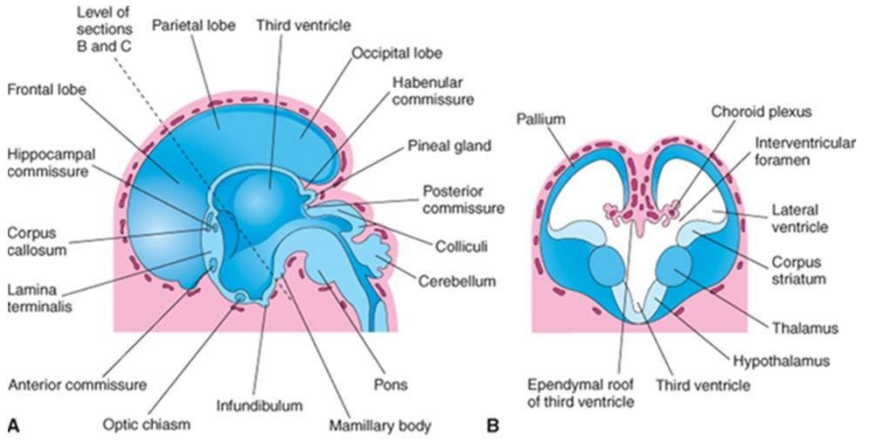


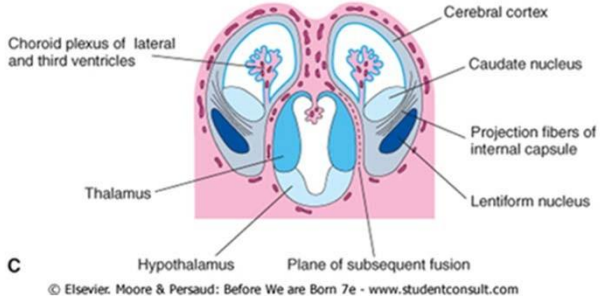

NOTE:
Internal capsule contains PROJECTION FIBERS.

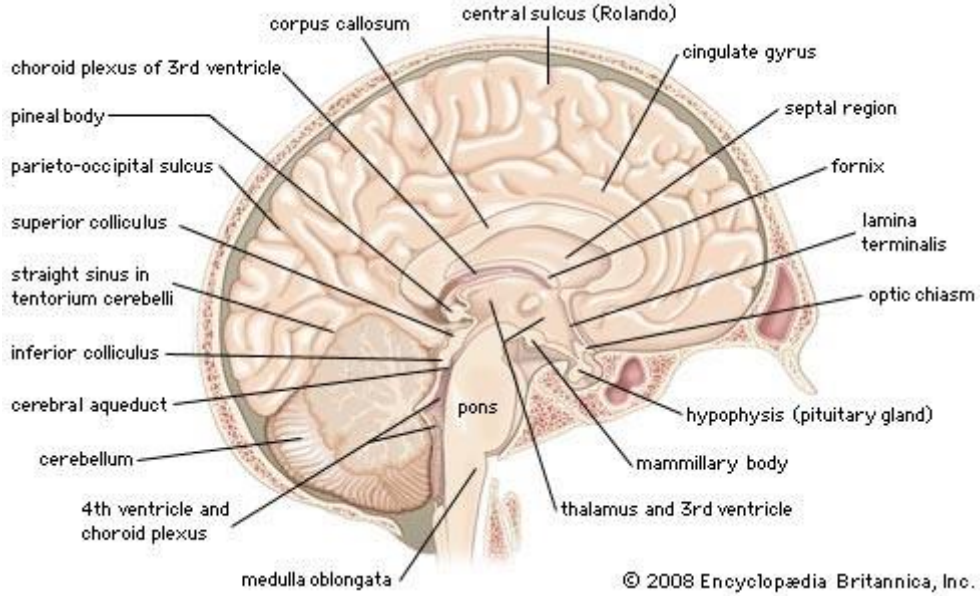
# Telencephalon

- Cerebral commissures
  - Lamina terminalis
    - Anterior commissure
    - Hippocampal commissure (fornix)
    - Corpus callosum
      - Begins at lamina terminalis and grows beyond it
    - Septum pellucidum
      - Between fornix & corpus callosum
    - Optic chiasm

Lamina terminalis stays as a remnant structure of development.

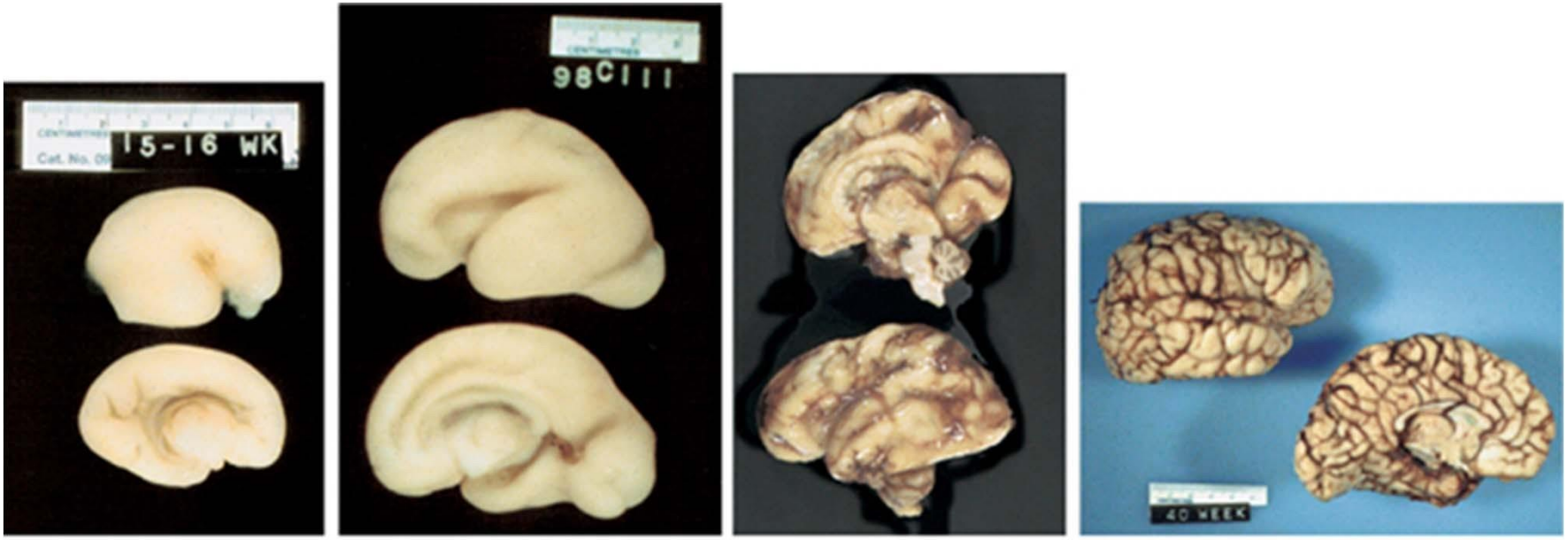


# Telencephalon

- Growth of the cerebral hemispheres results in
  - The development of sulci and gyri
  - The hidden insula

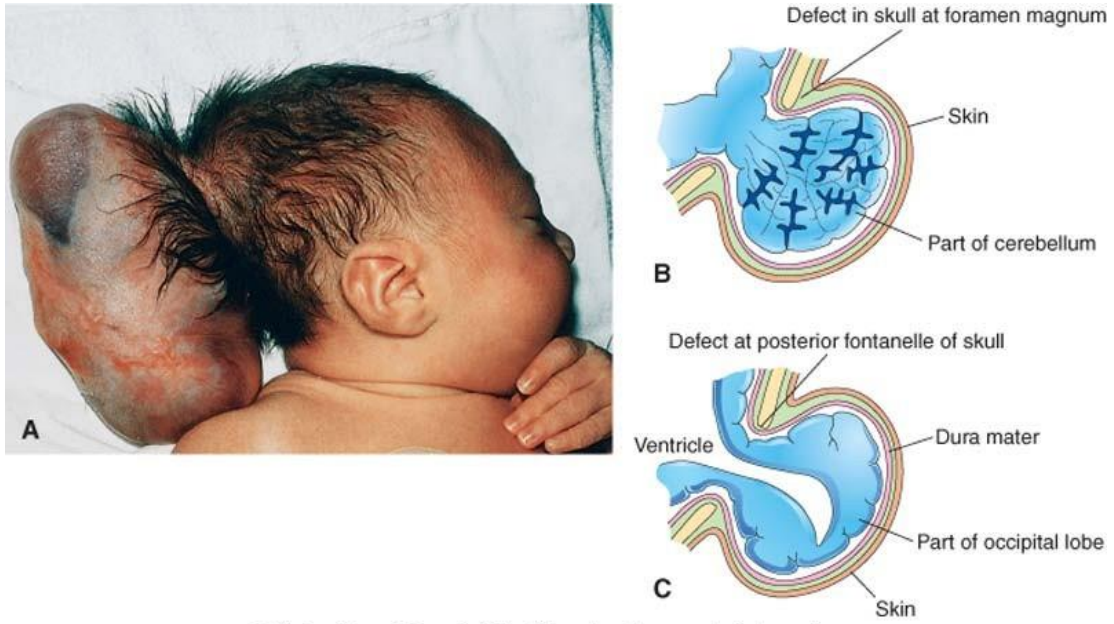



16 weeks 22 weeks 27 weeks 40 weeks

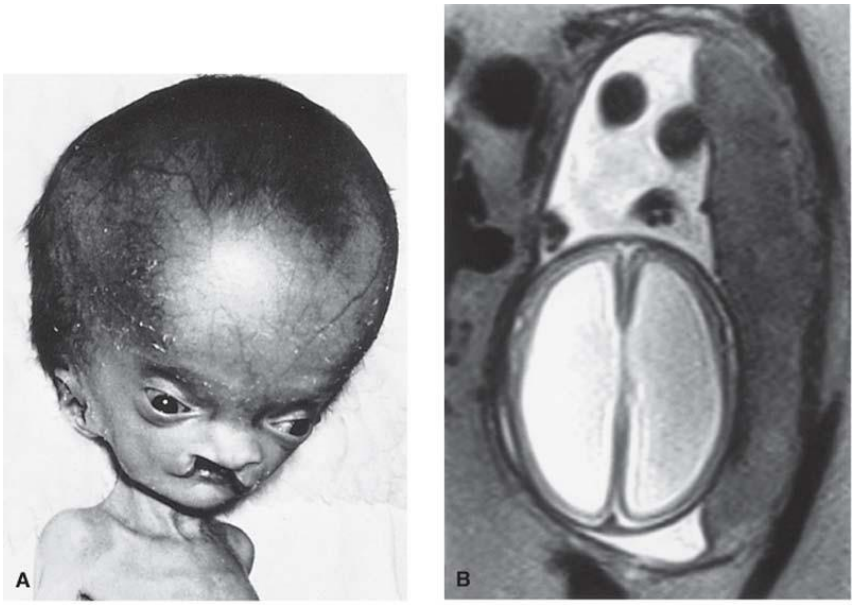
# Congenital Anomalies of the Brain

# Defective Closure of Rostral Neuropore

- Anencephaly
- Meroanencephaly
  - 1/1000
- Cranium bifidum
  - ➢ 1/2000
  - ➢ Mostly in mid-occipital
  - – Cranial meningocele
  - – Meningoencephalocele
  - – meningohydroencephalocele



# Hydrocephalus

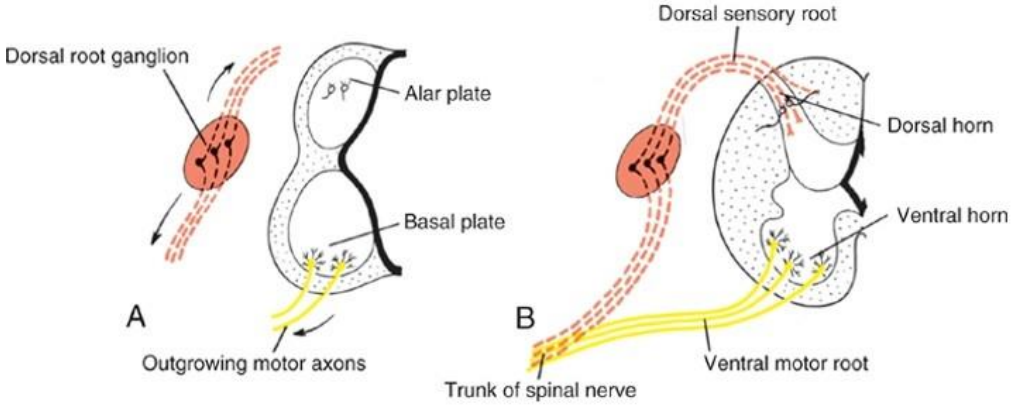


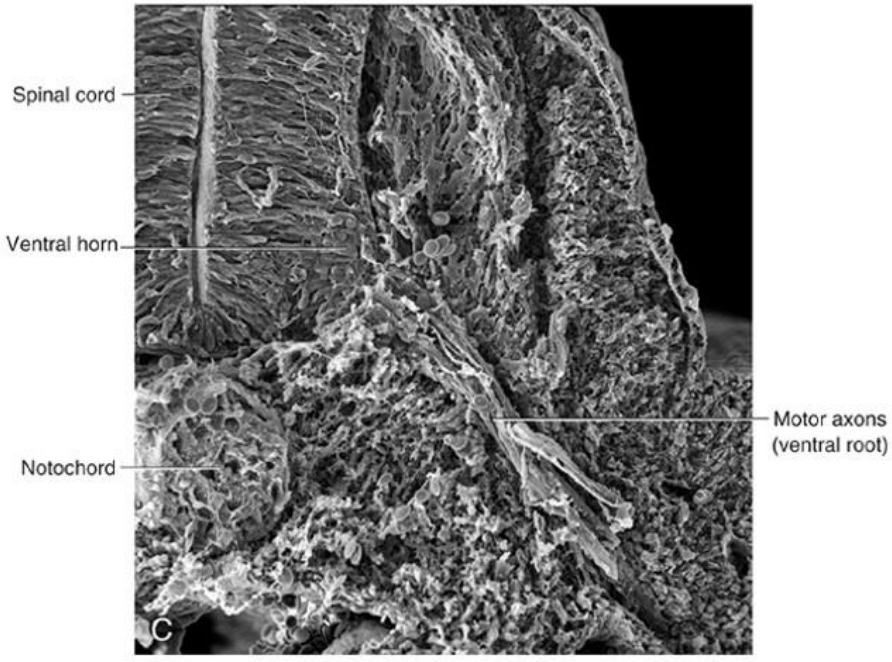


- Blockage of drainage of CSF (tumor, inflammation, developmental malformation, meningitis, hemorrhage or injury)
- Continued production cause an increase in pressure --- hydrocephalus
- In newborn or fetus, the fontanels allow this internal pressure to cause expansion of the skull and damage to the brain tissue
- Neurosurgeon implants a drain shunting the CSF to the veins of the neck or the abdomen

# Development of the Spinal Nerves

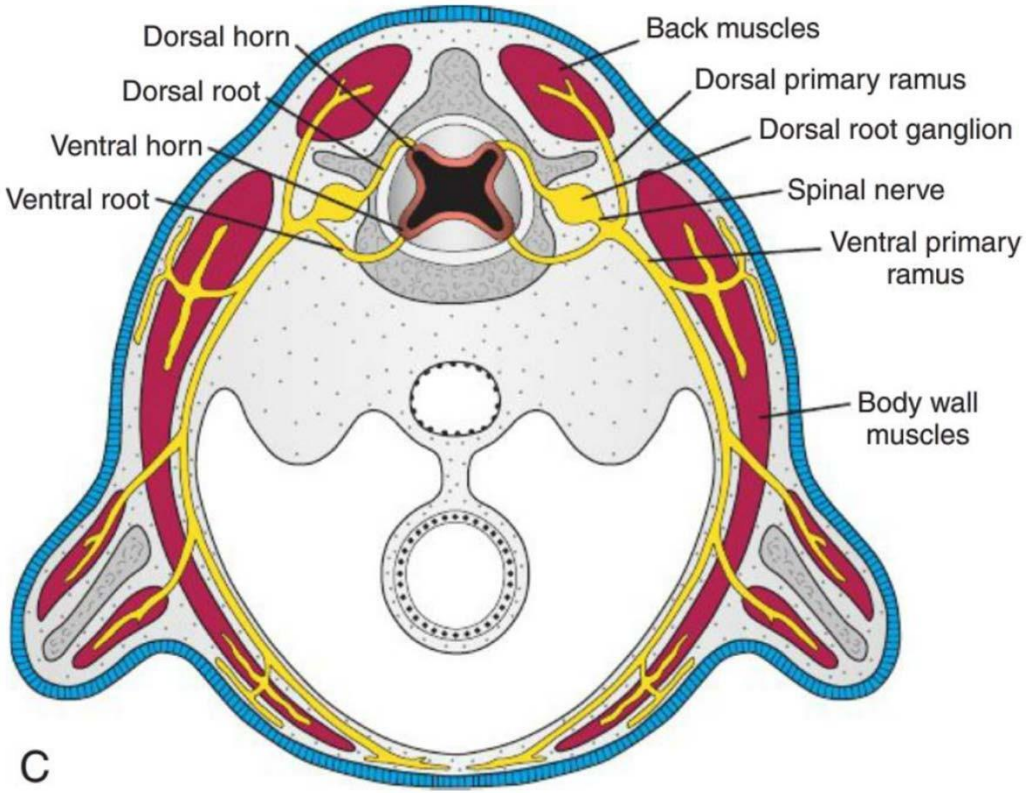
- Motor nerve fibers
  - Begin to appear in the fourth week,
  - **Arising from nerve cell in basal plates**
  - **Form ventral nerve roots**
- **Sensory** fibers form dorsal root
  - Originate from nerve cells in **spinal ganglia**
  - **Derived from neural crest cells**
  - **Proximal** grow into the dorsal horns
  - Distal processes join the ventral nerve roots to form a **spinal nerve**



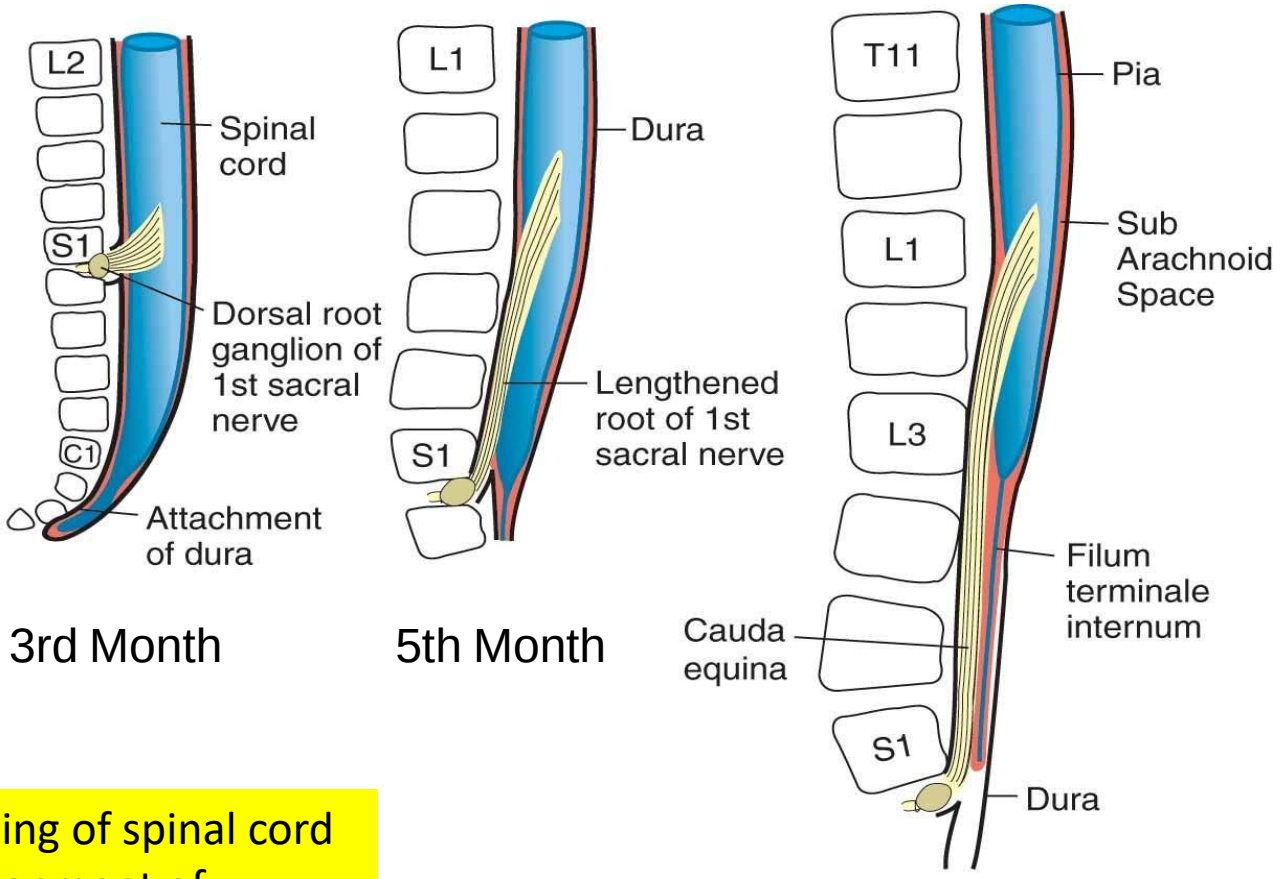



# Development of the Spinal Nerves

- **S**pinal nerves divide into **dorsal** and **ventral primary rami**
  - **Contain both motor and sensory fibers**
- Dorsal rami innervate the back (muscles, vertebral joints, and skin)
- Ventral rami innervate the limbs and ventral body wall
  - Form **nerve plexuses**



# Differential Growth Changes the Position of the Spinal Cord with Respect to the Vertebral Column




Notice the shortening of spinal cord due to faster development of vertebral column than SC.