

★ Development of the CNS

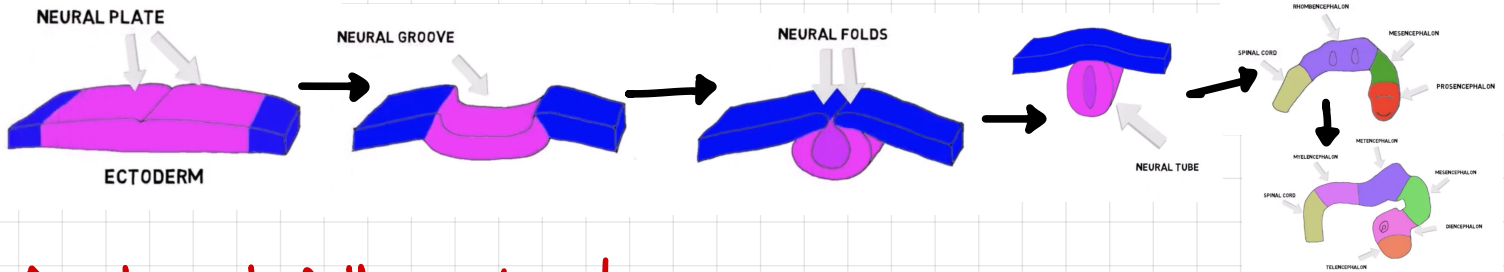
• Development of the neural tube

- ↳ Neural plate:- 3rd week ectoderm thickening in the middle of trilaminar germ disc
- ↳ Neural groove:- invagination of Neural plate
- ↳ Neural tube:- Lips of neural groove approach each other & fuse together

↳ Anterior neuropore:- close at day 25
 ↳ posterior neuropore:- close at day 27 } → Transform neural tube to closed tube

• Lips → intermediate zone of neural crest → spinal ganglion (gray matter).

• Notochord:- Trigger the formation of the tube, posterior to ectoderm, form nucleus pulposus.



• Development of the spinal cord

↳ Matrix:- one cell layer lining the neural tube → Repeated division → ↑ Length & diameter of the neural tube

- ↳ ventricular zone:- epithelium that extends from the cavity of the tube to the exterior.
- ↳ intermediate zone:- cells that migrate peripherally
- ↳ marginal zone (white matter):- neuroblast → nerves peripherally → external layer.
- ↳ astrocyte & oligodendrocytes:- from neuroblast
- ↳ Microglia:- from surrounding mesenchyme.

↳ 3 Layers

- ↳ inner ependymal layer:- forms ependymal lining of central canal & ventricles.
- ↳ middle mantle layer:- forms the gray matter of spinal cord (from the lips).
- ↳ outer marginal layer:- forms the white matter of spinal cord.

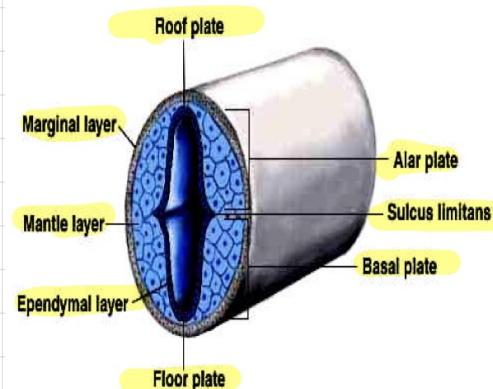
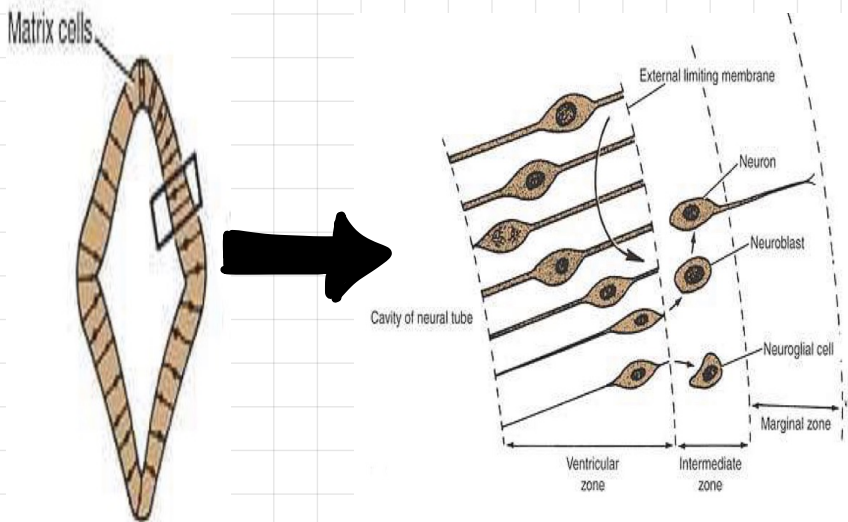
↳ Lateral walls are connected by

- ↳ Roof plate:- Dorsal
- ↳ floor plate:- ventral

↳ A groove sulcus limitans in lateral wall dividing it into

- ↳ Alar plate:- Dorsal, sensory horn.
- ↳ Basal plate:- ventral, Motor horn.

↳ central canal:- cavity of the tube remains narrow.



- **Development of the meninges:-** From mesenchyme (sclerotome) that surrounds the tube.
 - ↳ Subarachnoid space:- cavity in the mesenchyme, filled with CSF.

- Spinal cord & vertebral column relation by aging.

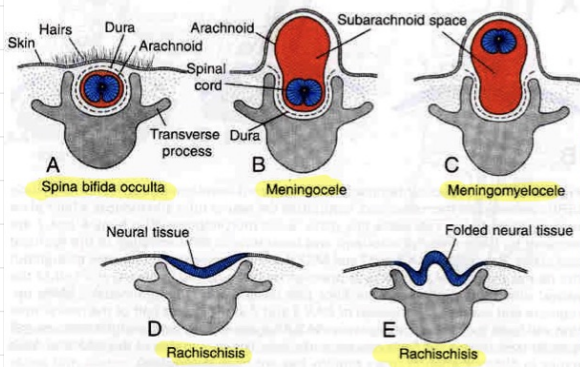
- ↳ first 2 months of intrauterine life:- same length.
- ↳ at birth:- coccygeal end at Lvl of L3.
- ↳ In adult:- lower end of spinal cord at the lower end of L1 (L1-L2)
 - ↳ conus medullaris.
 - ↳ cauda equina.

Regions	Spinal segments	Vertebral level	General rule
Upper cervical	C2	C2	Same level
Lower cervical	C6	C5	One vertebra above
Upper thoracic	T5	T3	Two vertebrae above
Lower thoracic	T10	T7	Three vertebrae above
Lumbar	L1-L5	T10-T11	Three to five vertebrae above
Sacral and coccygeal	S1-S5 and Cx1	T12-L1	Six to ten vertebrae above

- **Congenital malformation of spinal cord development.**

- ↳ 1) Spina bifida occulta:- Absent vertebral arch (posteriorly) with normal spinal cord, Most common in lumbosacral area & its usually covered with hairy skin.
- ↳ 2) Spina bifida cystica:- Absent vertebral arch + affected spinal cord.
 - ↳ **meningocele**:- meninges herniation through the spina bifida → subcutaneous sac (CSF).
 - ↳ **meningomyelocele**:- the spinal cord herniates + meningocele.
 - ↳ **myelocele (Rachischisis)**:- failure of obliteration of the neural tube.

Severity ↓



- **Development of the Brain:-** the cranial part of the neural tube forms 3 Brain vesicles.

- ↳ 1) Fore Brain (prosencephalon)
 - ↳ Telencephalon:- 2 Lateral evaginations (proximal part).
 - ↳ Diencephalon:- median part.
- ↳ 2) Mid Brain (Mesencephalon).
- ↳ 3) Hind Brain (Rhombencephalon)
 - ↳ metencephalon.
 - ↳ myelencephalon.

Primary vesicle	Secondary vesicle	Derivatives
Prosencephalon	telencephalon • Lateral ventricle	Cerebral cortex Cerebral white matter Basal ganglia
	diencephalon • Third ventricle	Thalamus Hypothalamus Subthalamus Epithalamus
Mesencephalon	mesencephalon • Cerebral aqueduct	Midbrain
Rhombencephalon • Floor of fourth ventricle	metencephalon	Cerebellum Pons
	myelencephalon	Medulla oblongata

Development of medulla oblongata (myelencephalon)

- As spinal cord
 - Alar plate: sensory nuclei of medulla.
 - Basal plate: motor nuclei of medulla.
 - Sulcus limitans
 - Roof plate: lateral walls move away → stretch it → 4th ventricle (floor).
 - Floor plate → 4-5m: local resorption of Roof plate → Luschka (2) Majendie

(metencephalon)

- Development of pons & cerebellum: same as medulla but the alar plates bend medially to form 2 rhombic lips → cerebellar plate → Medially → vermis → Laterally → cerebellar hemisphere
 - Basal plate → pons
 - Cavity → part of 4th ventricle.

Development of midbrain (mesencephalon) :- Same as others.

- Alar plate: tectum (divided by ventral & transverse grooves into 4 colliculi).
- Basal plate: motor nuclei in the tegmentum
 - Marginal layer → crus cerebri.
- cerebral aqueduct between them (narrow).

Development of the diencephalon :- median part of forebrain (prosencephalon).

- 2 lateral walls: connected by roof plate & floor plate.
- Roof plate
 - Anterior part: chroid plexus of 3rd ventricle.
 - posterior part: pineal body.
- Hypothalamic sulcus: separate thalamus/hypothalamus in the lateral wall.
- Floor plate: posterior lobe of the pituitary gland.

Development of the cerebral hemisphere :- lateral evaginations in forebrain (prosencephalon).

- Lateral ventricle: expansion of the cavities.
- 3 layers of the hemisphere walls
 - ependymal
 - mantle → Basal ganglia.
 - marginal
- The hemisphere enlarge & overlaps the brainstem & cerebellum.

Congenital malformation of Brain development.

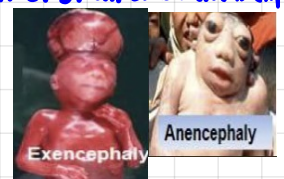
1 Hydrocephalus: ↑CSF

- internal: ↑CSF in ventricles.
- external: ↑CSF between the brain & arachnoid mater.



2 Exencephaly: failure of closure of anterior neuropore (day 25), absent vault of skull & brain is exposed.

- Anencephaly: Exencephaly + brain degeneration.



3 meningocele: meninges herniated through a deficient part of the skull.

4 Meningoencephalocele: part of brain herniated + meningocele.



5 Menigo-hydro-encephalocele: part of ventricle found within the brain tissue herniated through the meningocele.

6 Holoprosencephaly: degeneration of midline structures → fusion of lateral ventricles, orbital & nasal cavities.

