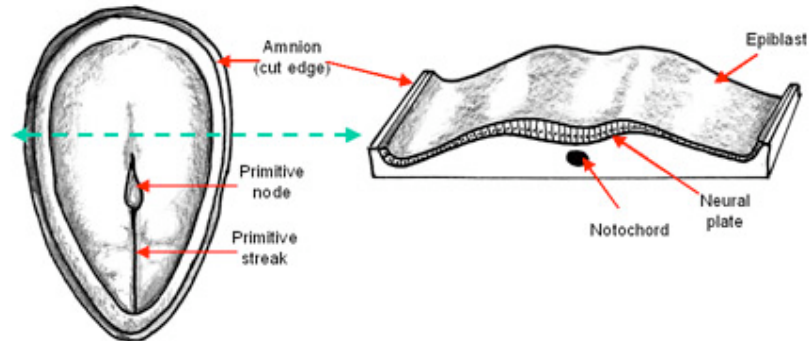


## II. NEURO-EMBRYOLOGY

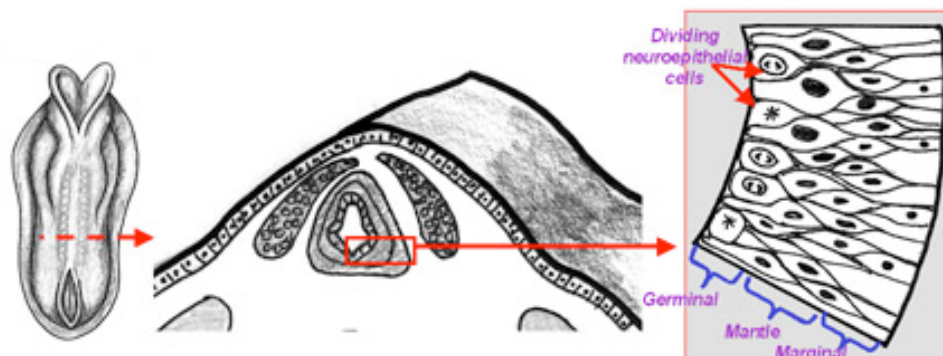
### DEVELOPMENT OF NEURAL TUBE



- **Neural Plate:** thickening of embryonic ectoderm, Day 18.
- **Notochord:** Just ventral to the neural plate. It induces formation of the **Neural Tube**.
- **Neural Folds** are formed on the Neural Plate. Next, they begin to move toward each other, forming a **Neural Groove**.
- **NEURAL TUBE:** Is formed from the primitive Neural Groove. *This occurs first in the midsection of the embryo and then proceeds rostrally and caudally.*
  - **Rostral Neuropore** and **Caudal Neuropore** are the open ends of the Neural Tube.
- **NEURAL TUBE DEFECTS:**
  - **SPINA BIFIDA:** Failed closure of the caudal part of the Neural Tube. But, the nervous system continues to develop normally.
  - **Meningocele** (outpocketings of meninges) and **Meningomyelocele** (outpocketings of meninges + nervous tissue) will result.
  - **ANENCEPHALY:** Failure of rostral closure of neural tube and subsequent differentiation.

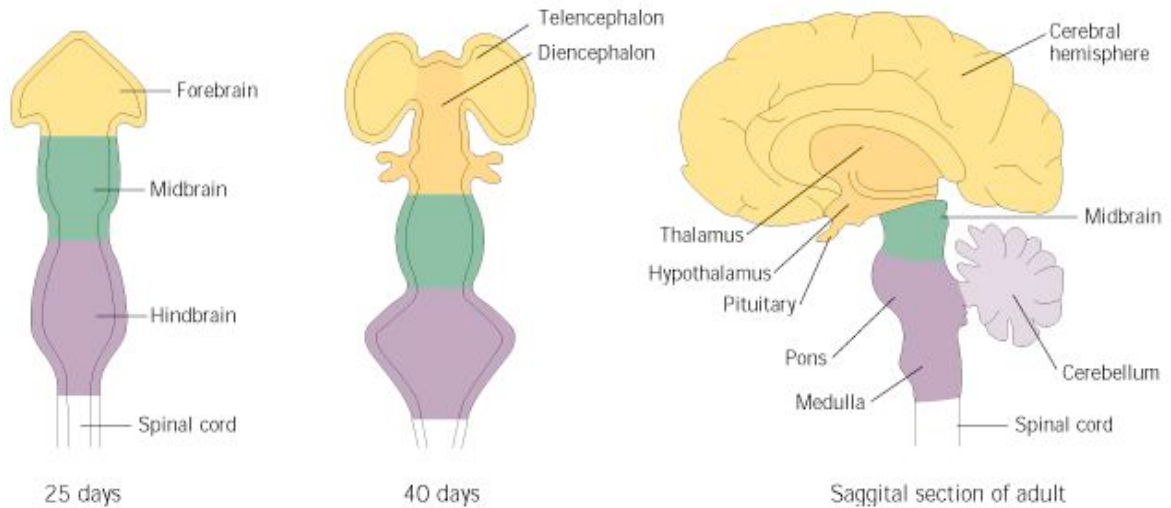
**NEURAL CREST CELLS:** Lie on either side of the Neural Groove and are pinched off by closure of the Neural Tube. They form a number of important structures.

- Dorsal Root Ganglia and portions of sensory ganglia that are like the Dorsal Root (V, VII, VIII, IX, X)
- Sympathetic Ganglia
- Parasympathetic (Enteric) Ganglia
- Pia and Arachnoid Mater
- Schwann Cells
- Melanocytes Proliferation in Neural Tube:
- Cells start connected both to the internal and external limiting membranes of the neural tube, but ultimately remain connected only to the internal limiting membrane.
- **NEURAL BIRTHDAY:** Occurs when a cell-line has had its last division and remains in the same structure terminally thereafter. Neurons from the same structure tend to have the same Neural Birthdays.
- **THREE LAYERS** of Proliferating Tube:



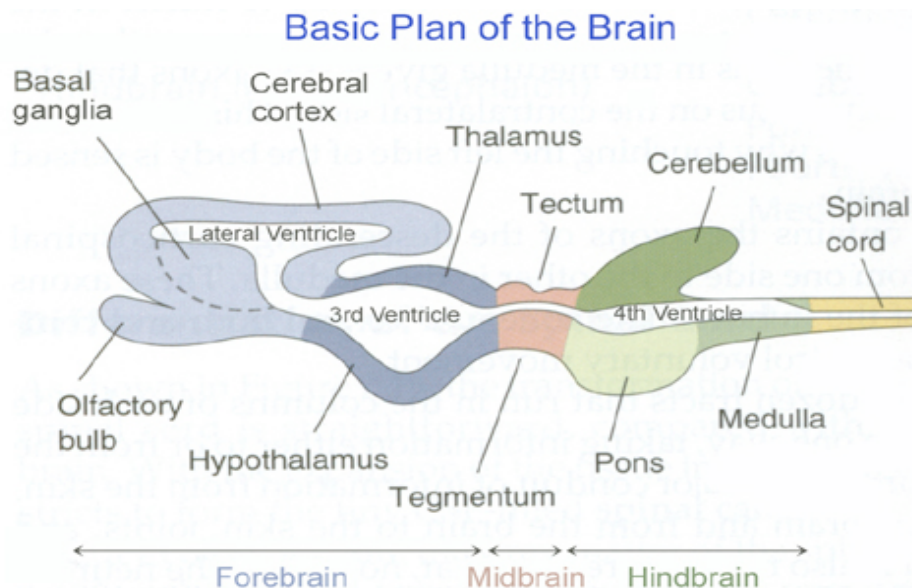
- **Ventricular Layer:** Contains dividing cells.
- **Mantle Layer:** Postmitotic neuronal cells bodies (after their birthday)
- **Marginal Layer:** Axoplasmic extensions of the mantle layer.

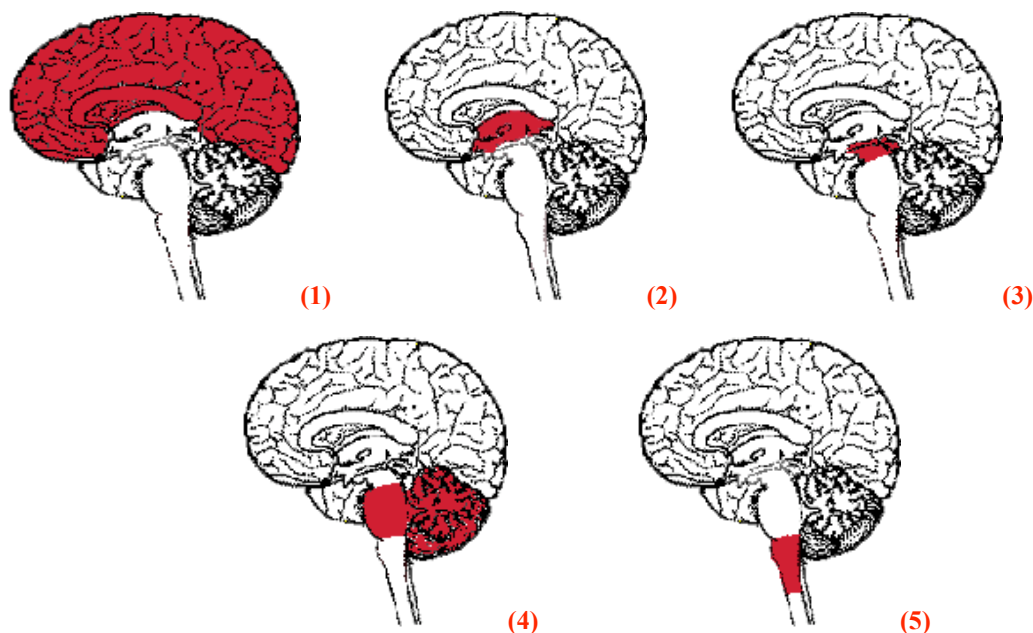
- **NEURAL VESICLES:** At 3 weeks, three distinct outpocketings can be made out. These are the classical three vesicles out of which entire nervous system grows:



- **Rhombencephalon** (Hindbrain)
- **Mesencephalon** (Midbrain) -----> **Midbrain**
- **Prosencephalon** (Forebrain) -----> Diencephalon + Telencephalon
  - Thalamus
  - Epithalamus
  - Hypothalamus
  - Subthalamus
- **VENTRICLES** will arise from the **Central Canal** of the Neural Tube.
- **FLEXURES:** Characteristic flexures create the shape of the CNS
  - 26 Days: Mesencephalic and Cervical Flexures.
  - 35-50 Days: Pontine Flexure brings the Cerebellum to lie dorsal to the Pons.

**GROSS BRAIN DEVELOPMENT**





- **Prosencephalon** (Forebrain) -----> Diencephalon + Telencephalon
  - (1) **Telencephalon** -----> Cerebral Hemispheres
  - (2) **Diencephalon**
- **Mesencephalon** (Midbrain) -----> (3) **Midbrain**
- **Rhombencephalon** (Hindbrain)
  - Metencephalon -----> (4) **Pons, Cerebellum**
  - Myelencephalon -----> (5) **Medulla Oblongata**

#### SPINAL CORD DEVELOPMENT

- **Sulcus Limitans**: It appears along the Neural Tube, and separates dorsal and ventral regions of the spinal cord.
  - **ALAR (DORSAL) PLATE**: Neurons become specialized for sensory.
  - **BASAL (VENTRAL) PLATE**: Neurons become specialized for motor.

#### BRAINSTEM / CEREBELLUM DEVELOPMENT

- **MEDULLA**
  - CN NUCLEI are arranged in *Columns* in the medulla.
  - **CLOSED MEDULLA**:
  - **OPEN MEDULLA**: *The Alar Plate is displaced laterally*. So, sensory stuff is now lateral to motor stuff, which tends to be more medial.
- **PONS**: It maintains the alar / basal plate distinction between sensory / motor.
- **CEREBELLUM**: Formed from the **Rhombic Lips** of the Alar Plate of the Pons.
  - These lips fold medially to cover the Pons, so that Pons is ventral to Cerebellum.
  - There are two proliferative zones present during development:

**TELENCEPHALON**: The neurons develop in an “inside-out” fashion. The earliest neuronal birthdays occur closest to the medullary center, then neurons migrate beyond that.

#### CELLULAR EVENTS IN DEVELOPMENT

- **Making Neuronal Connections**:
  - Sometimes a neuron will **reel out** its axon as it grows.
  - At other times, a neuron will use physical or chemical (**chemotaxis**) cues to grow toward a target.
- **Synaptic Plasticity**: Modifications to neuronal connections made after development is complete.
  - They can be made as an alternative pathway following damage to a connection.
  - They can be made in the process of “learning.”
- **Programmed Cell Death**: More neurons than are needed are made during development.
  - Neurons that are unsuccessful at making their connections are then lost (killed, DEAD) by a pre-programmed neuronal cell death.