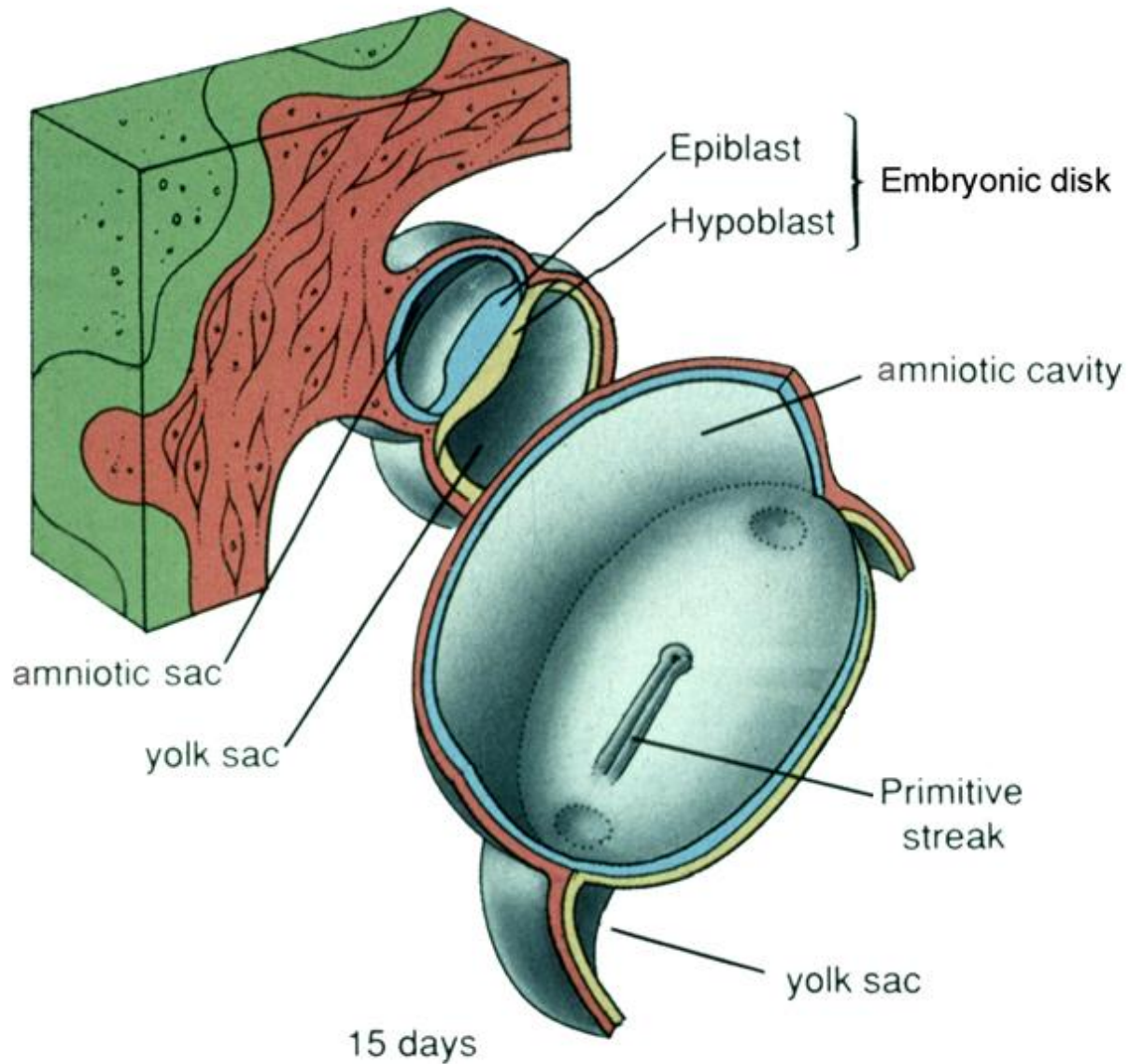


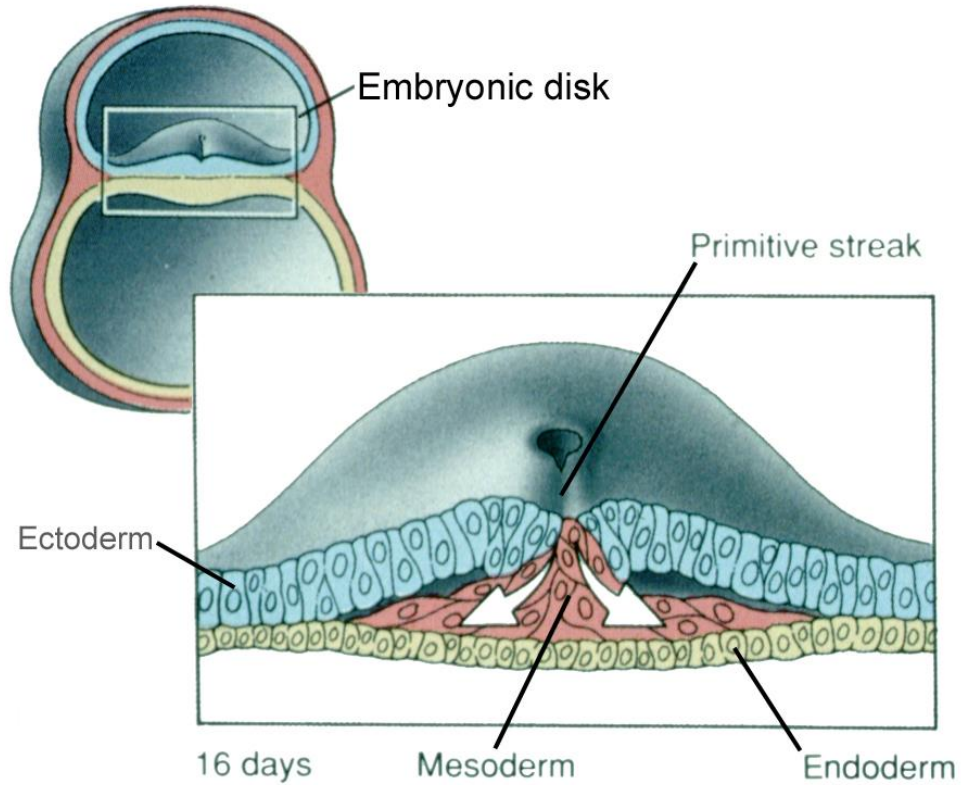
Development of the Nervous System

Steven McLoon
Department of Neuroscience
University of Minnesota

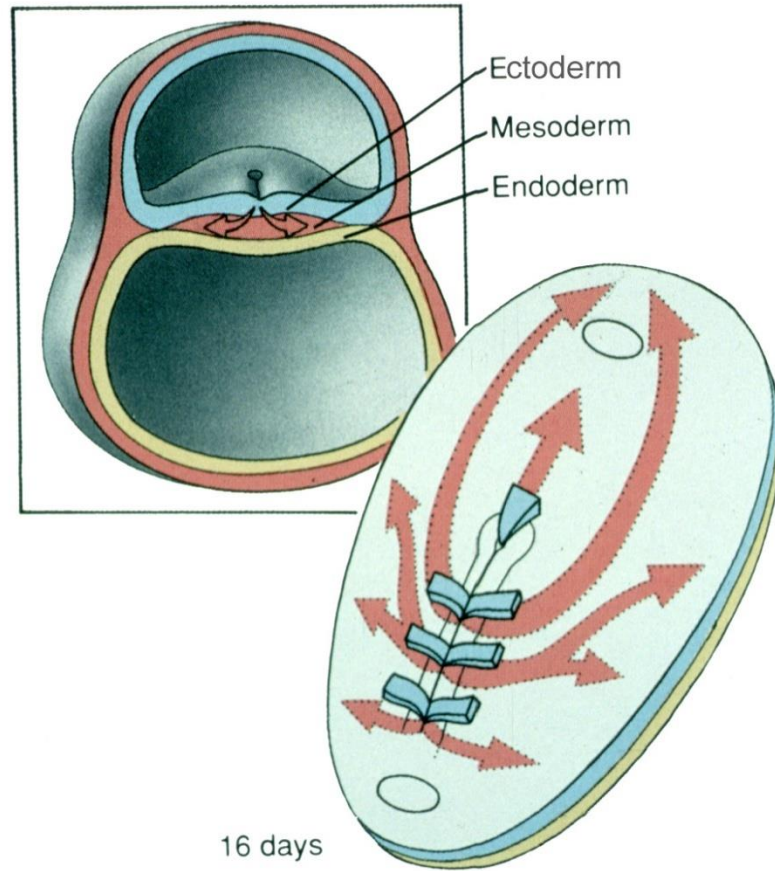
In the blastula stage embryo, the embryonic disk has two layers.



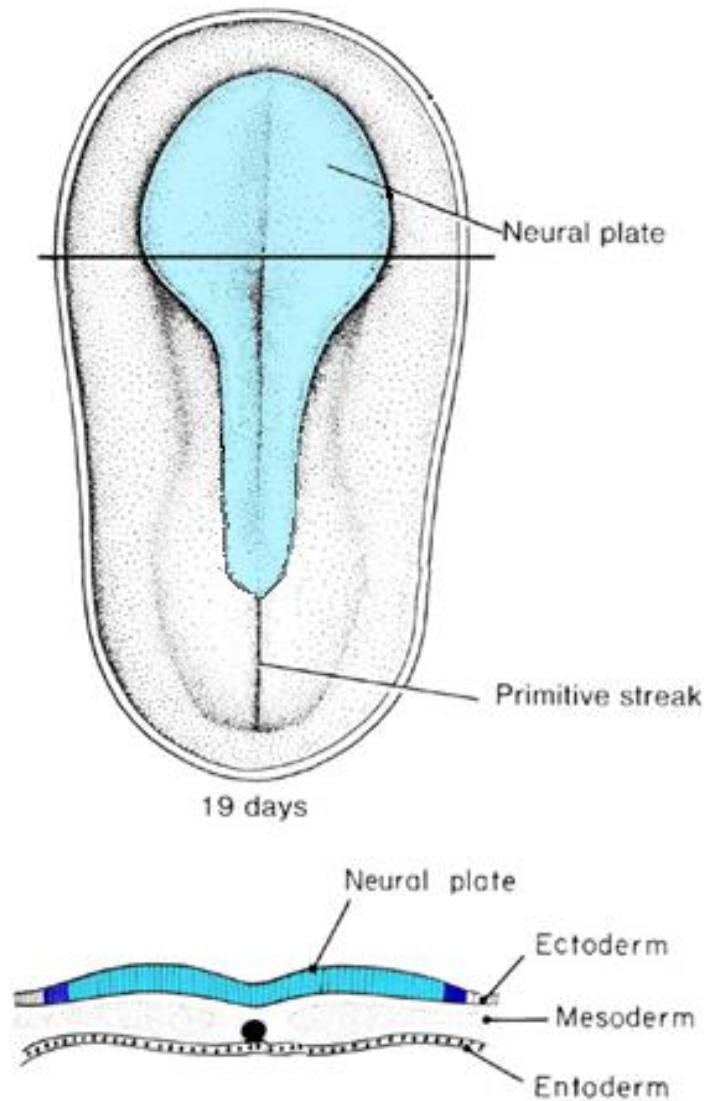
During gastrulation, cells migrate to form a three layered embryo.



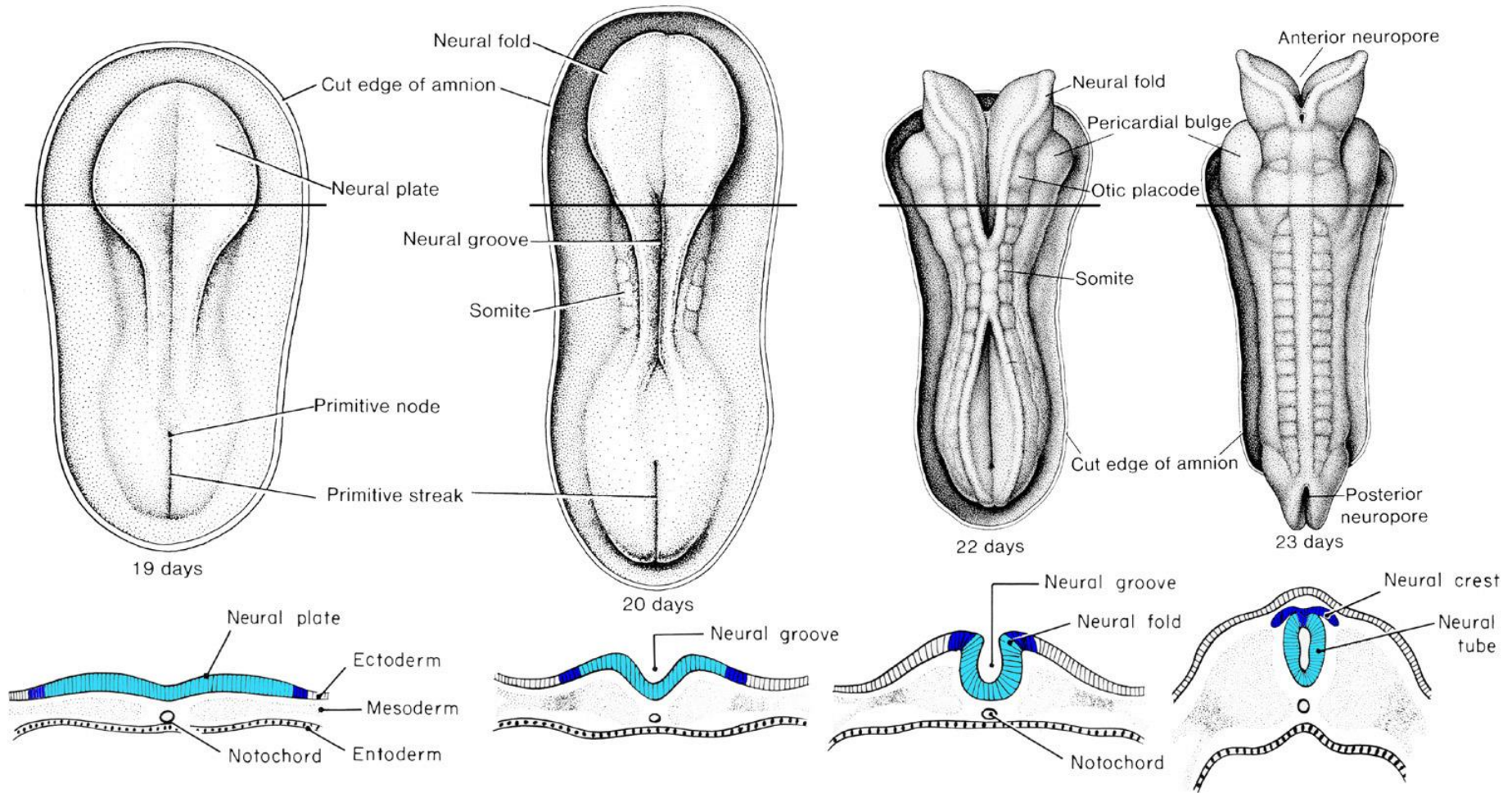
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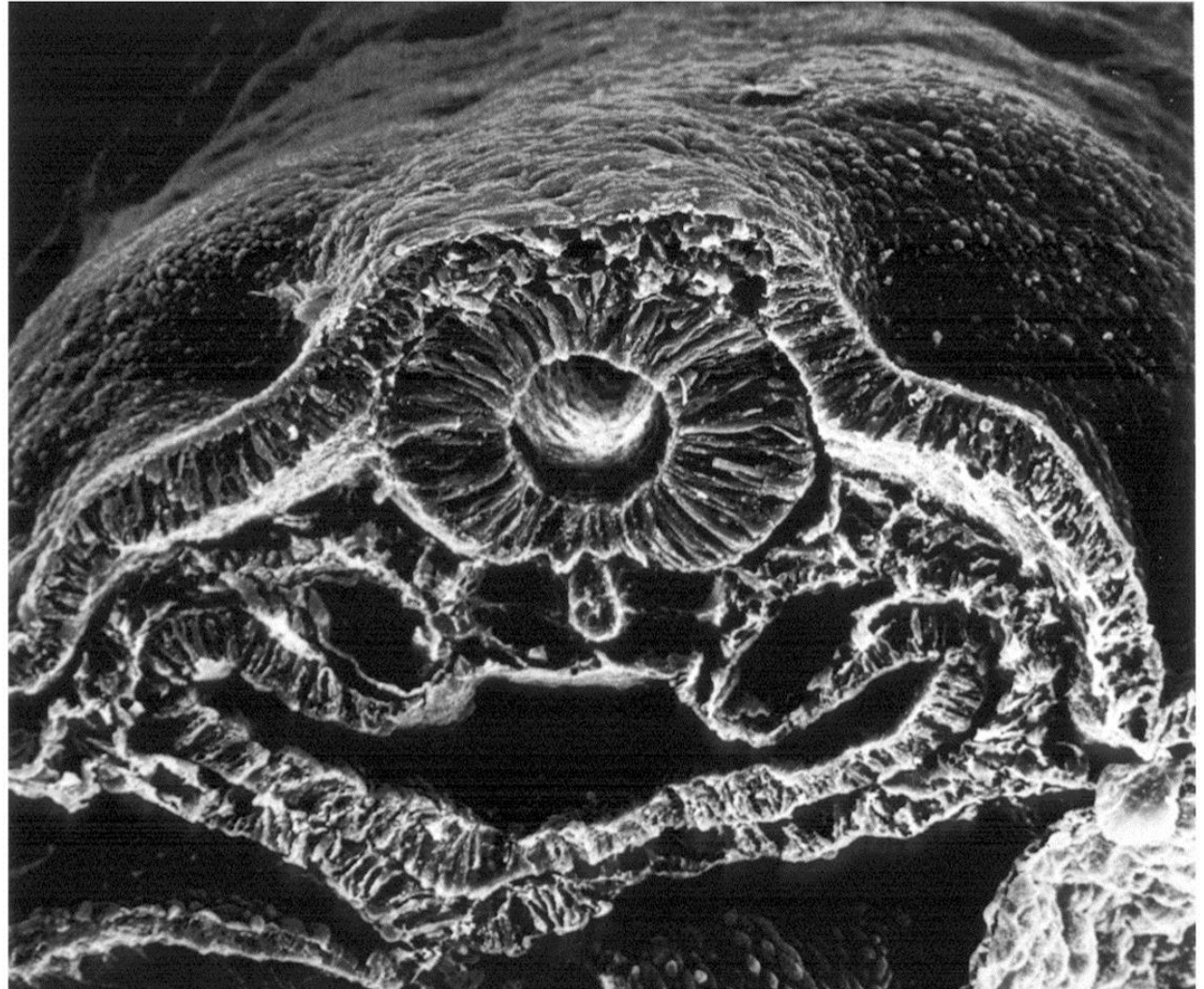
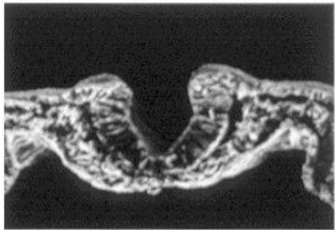
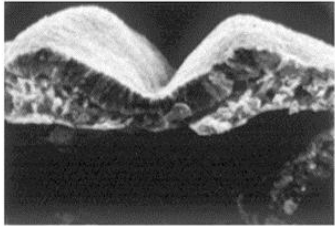
Factors from the midline mesoderm induce nervous system in the overlying ectoderm, and the neural plate forms.



The neural tube develops from the neural plate in a process called neurulation.

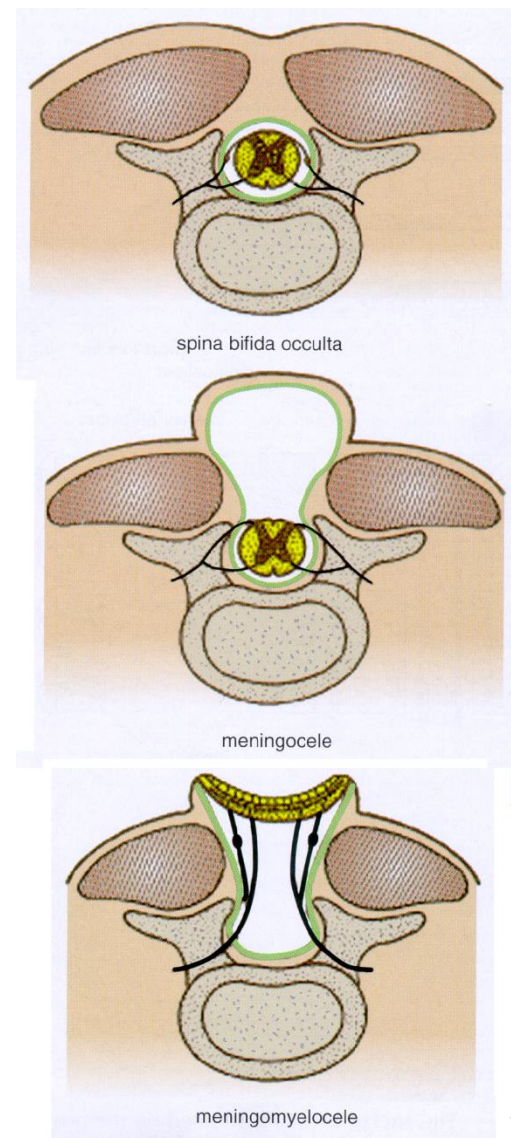


The neural tube develops from the neural plate in a process called neurulation.



Incomplete closure of the neural tube is a common birth defect.

- Spina bifida:
 - Incomplete closure of the spinal neural tube and/or the spine.
 - The severity of the defect is variable and most often is of no consequence.
 - ~1 in 50 live births exhibit spina bifida occulta, making this one of the most common birth defects.



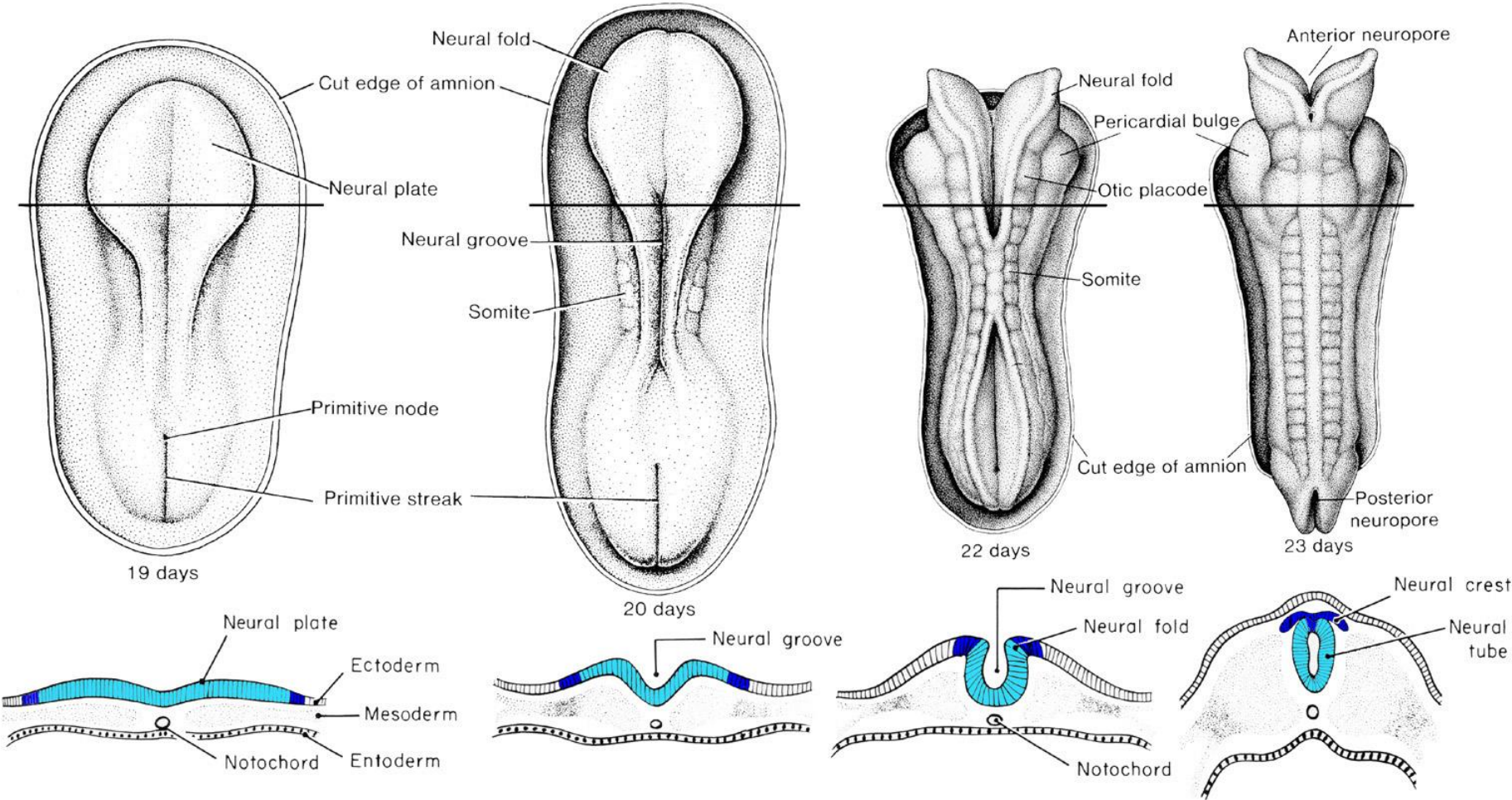
Incomplete closure of the neural tube is a common birth defect.

- Spina bifida (continued):
 - ★★★ A daily supplement of folic acid (vitamin B9) in the diet of pregnant mothers reduces the incidence of spina bifida by over 70%. ★★★
 - Folic acid is converted to a molecule that is essential for DNA replication and repair.

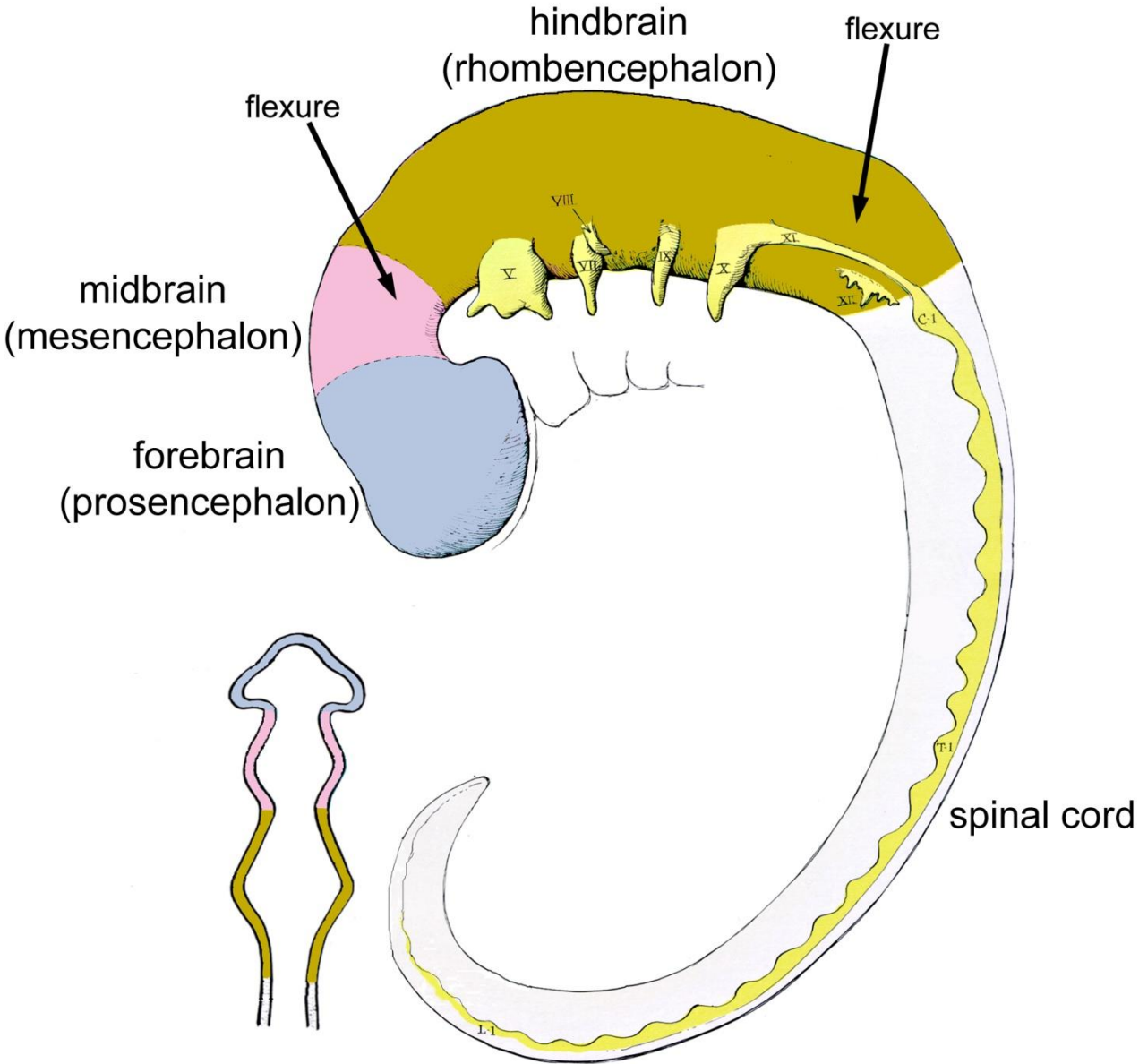
Incomplete closure of the neural tube is a common birth defect.

- Anencephaly = incomplete closure of the brain end of the neural tube
- Rare and lethal.

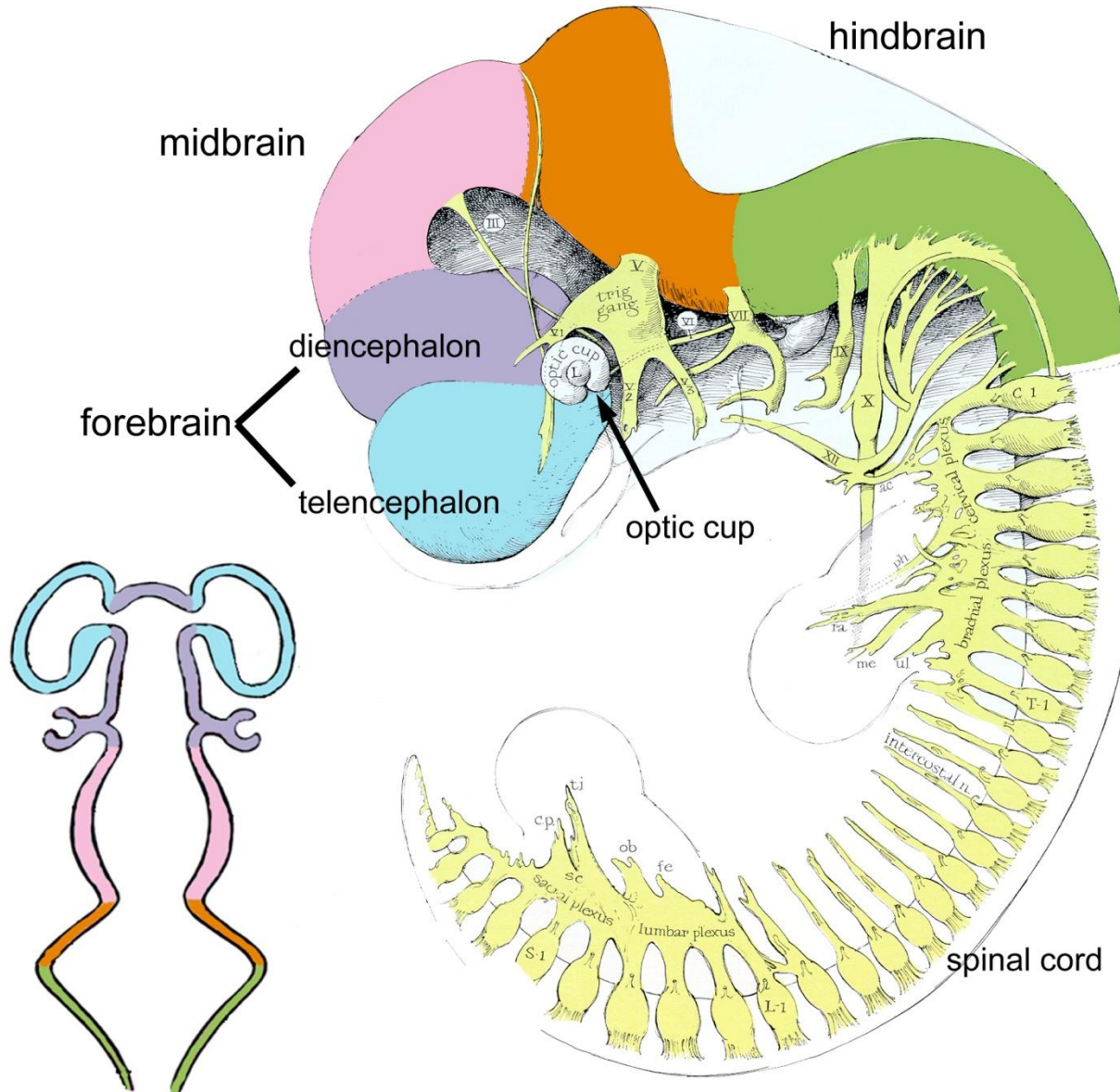
Neural tube forms three primary brain vesicles and spinal cord.



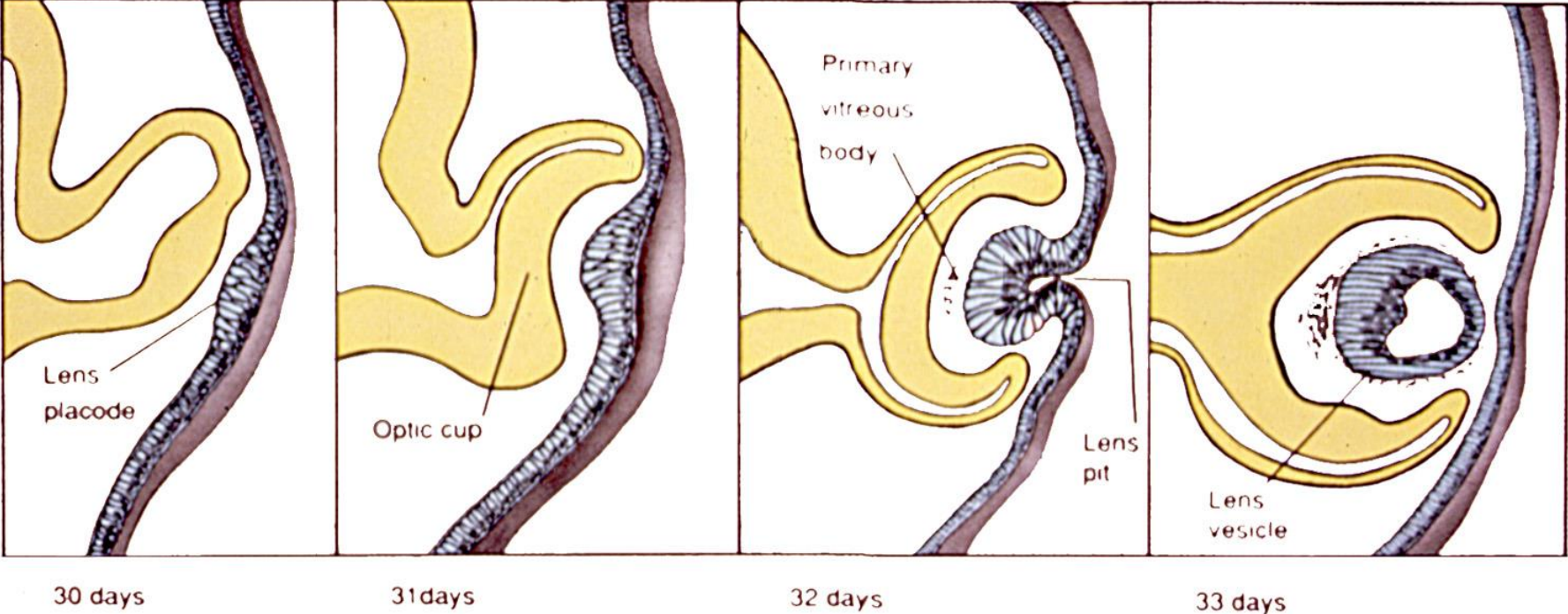
Neural tube forms three primary brain vesicles and spinal cord.



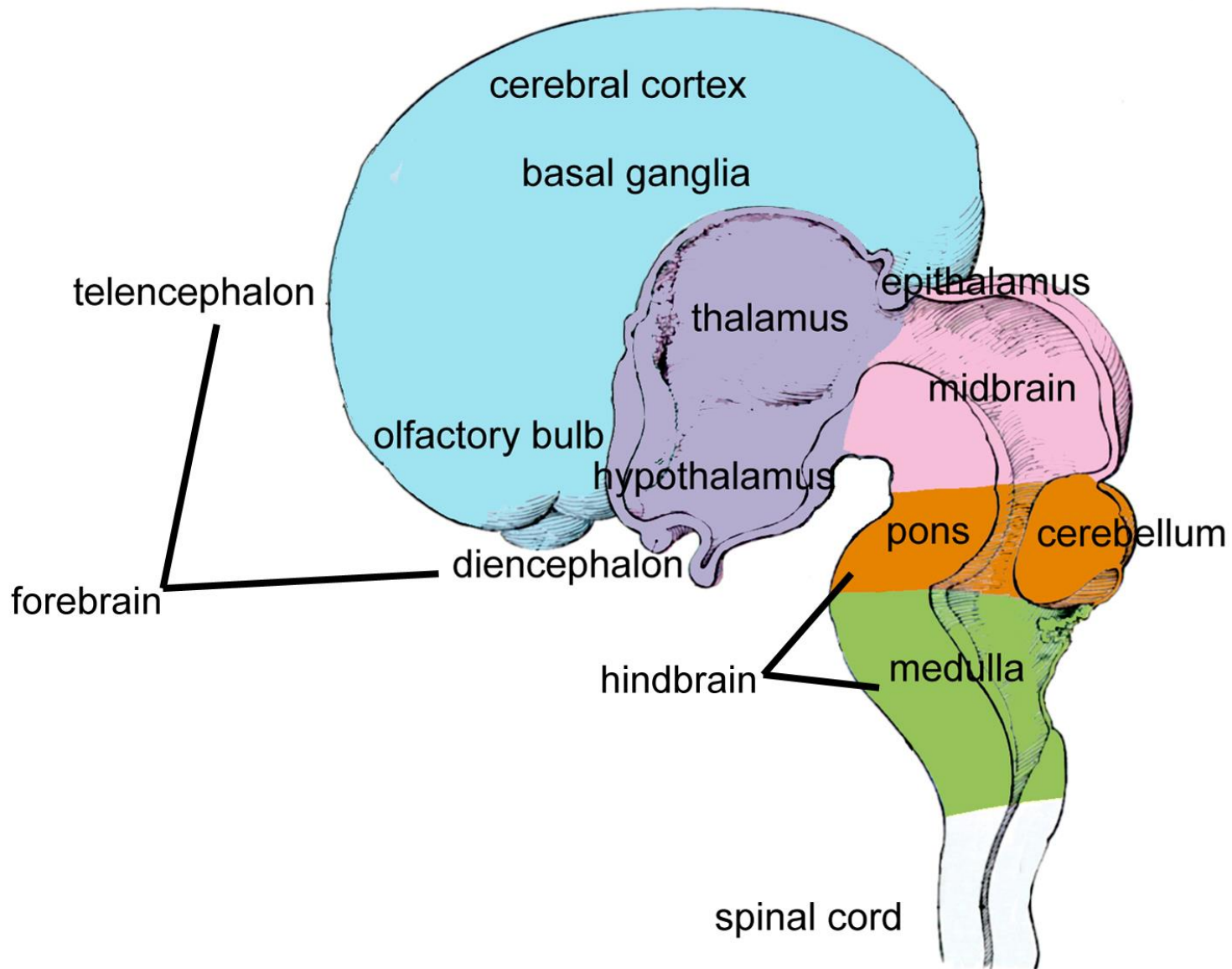
Additional changes form the five secondary brain vesicles.

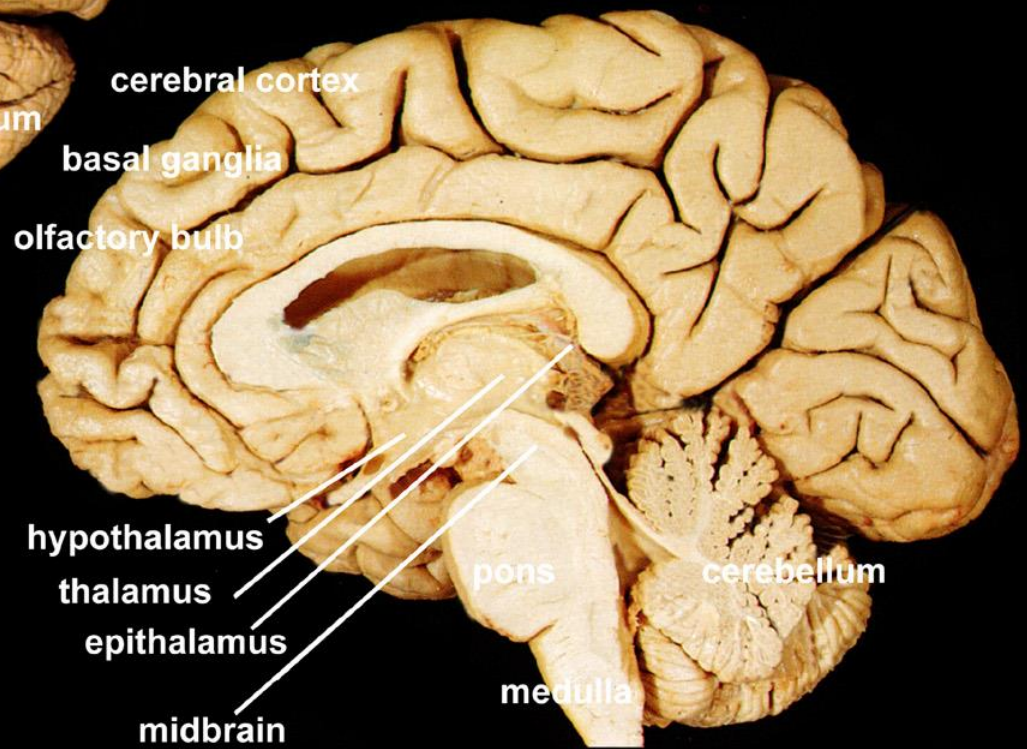
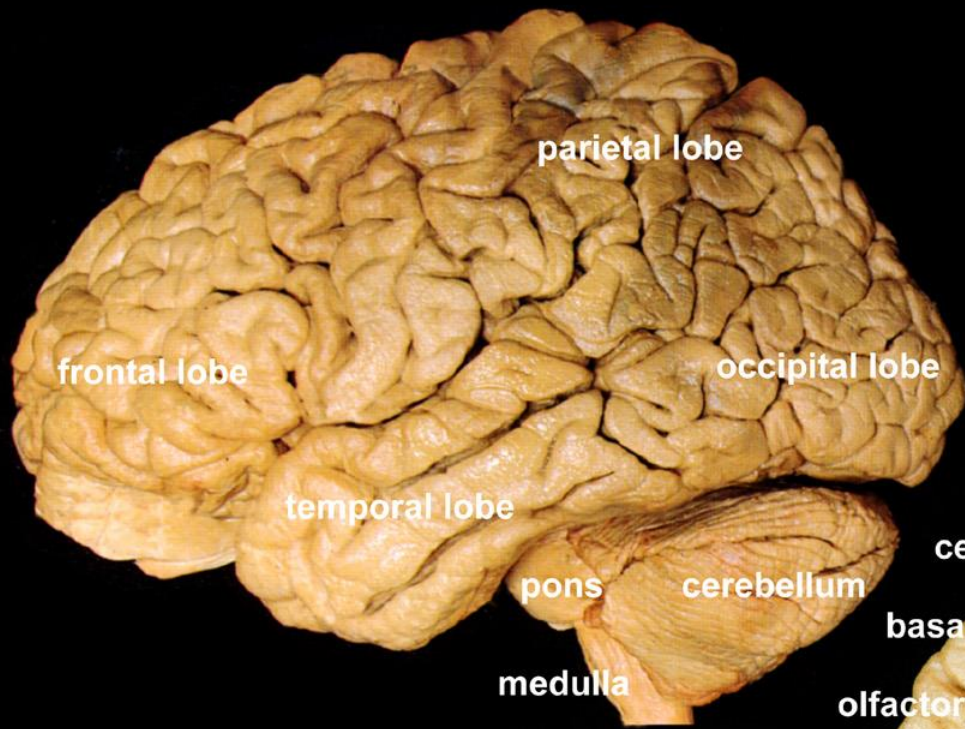


Optic vesicles give rise to retina.

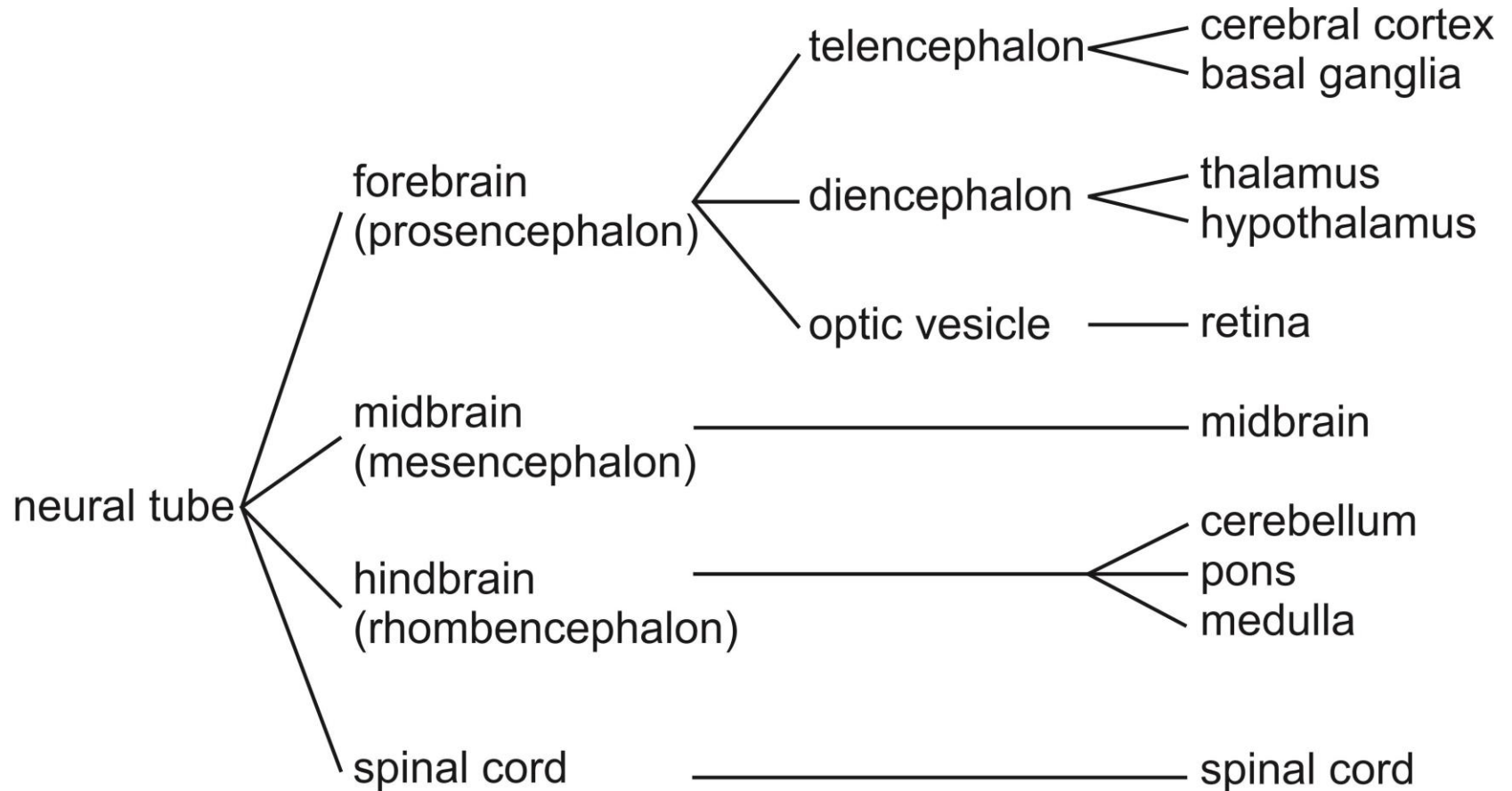


Each major adult brain region develops from a brain vesicle.

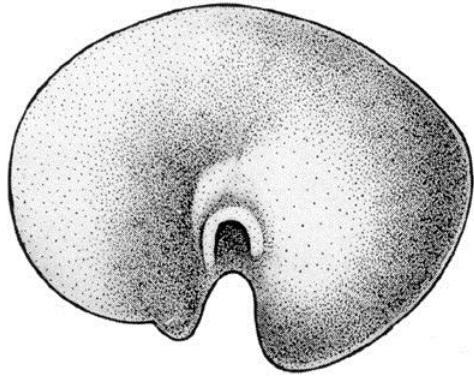




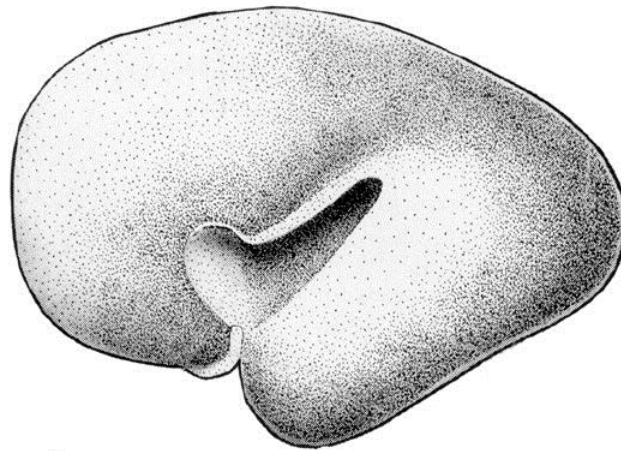
Each major adult brain region develops from a brain vesicle.



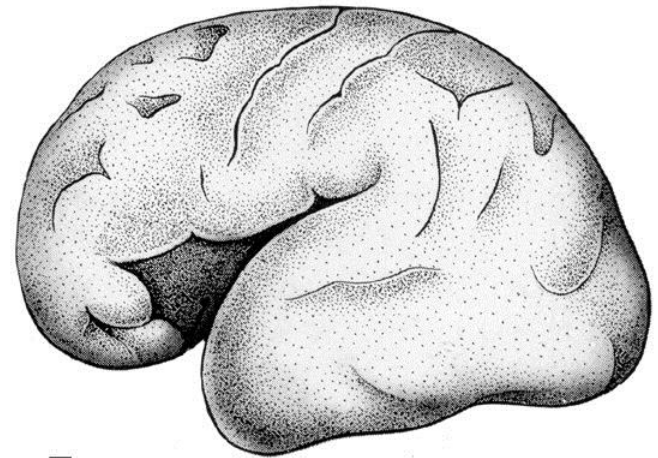
**The 'ram's horn' pattern of growth of the cortex
forms the temporal lobe.**



3 mos.



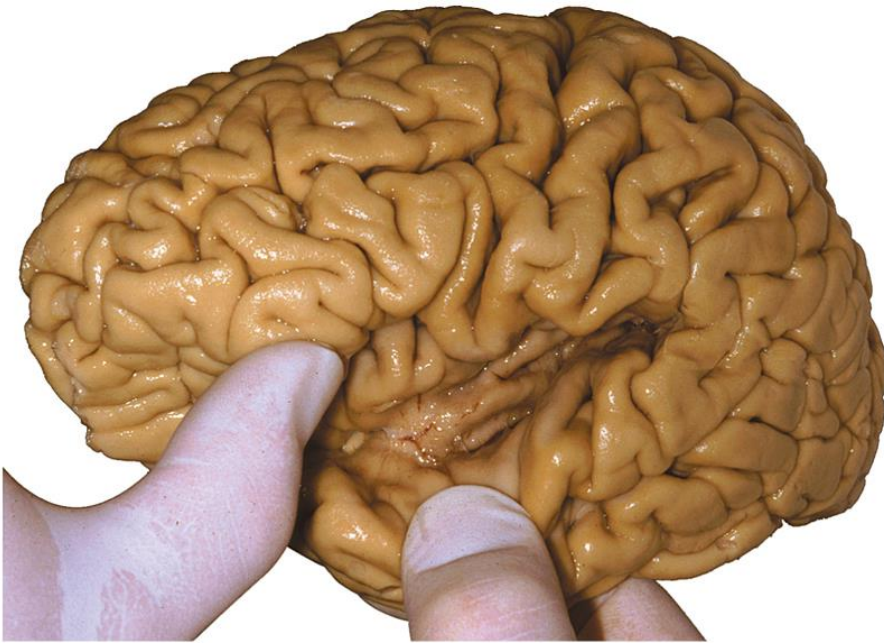
5 mos.



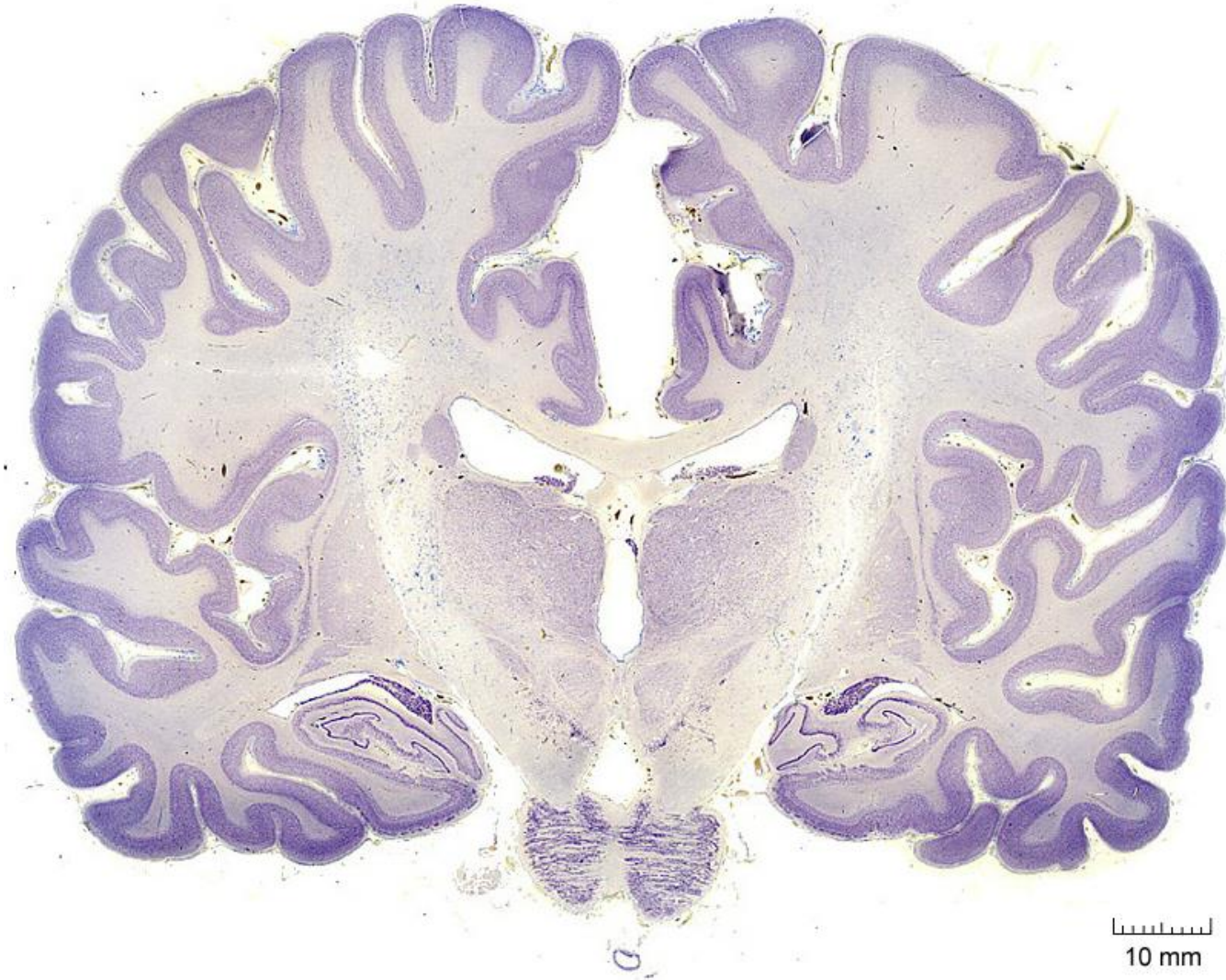
7 mos.

The 'ram's horn' pattern of growth of the cortex forms the temporal lobe.

- The temporal lobe covers the insula.

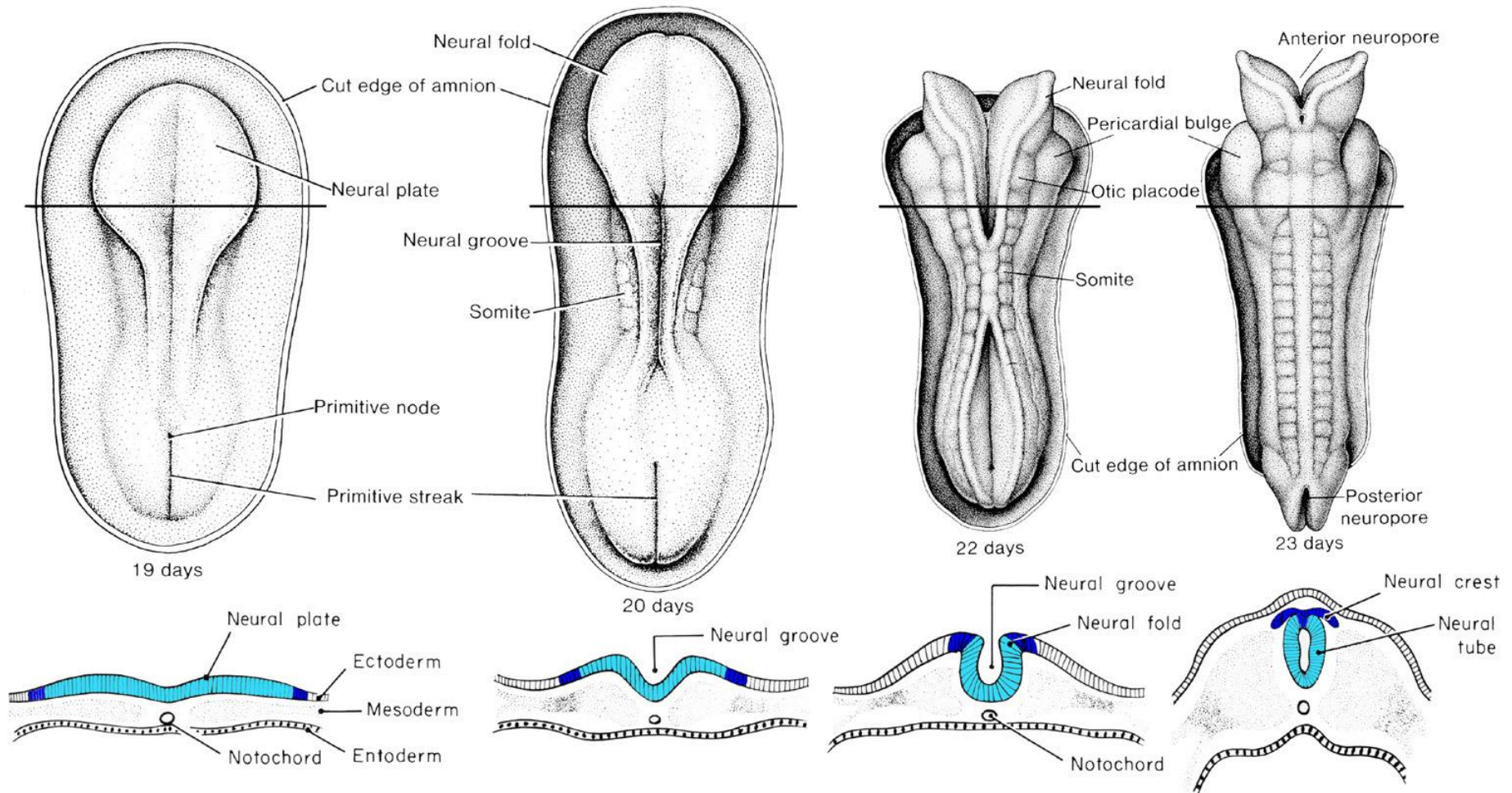


**The lumen of the neural tube persists
as the ventricular system of the adult brain.**



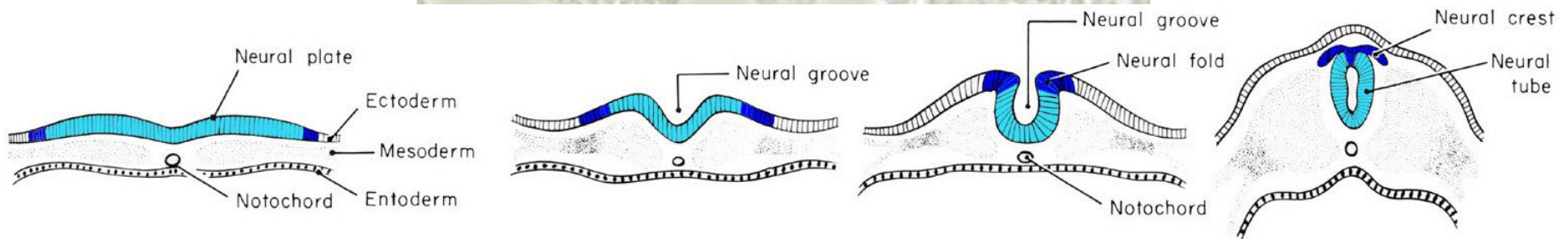
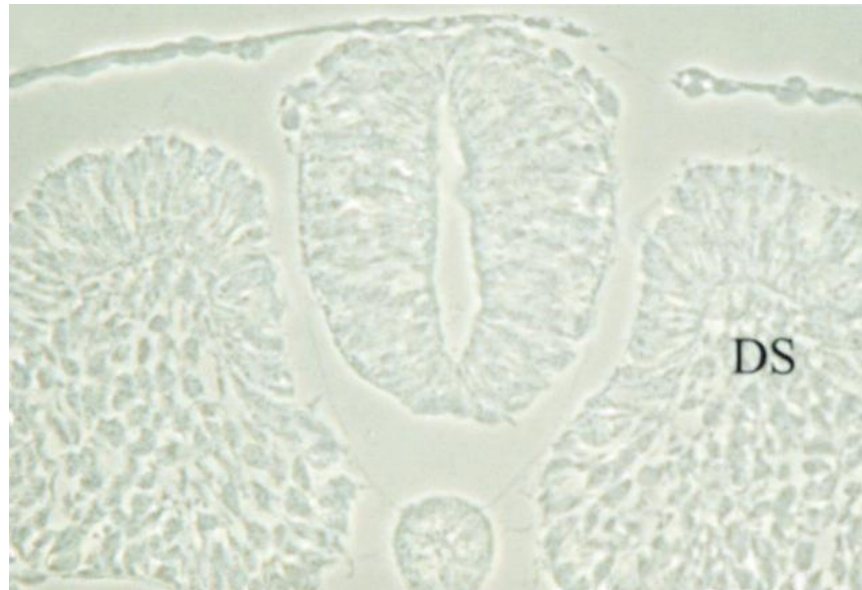
Neural crest gives rise to the peripheral nervous system.

- Neural crest develops from cells at the margin of the neural plate.



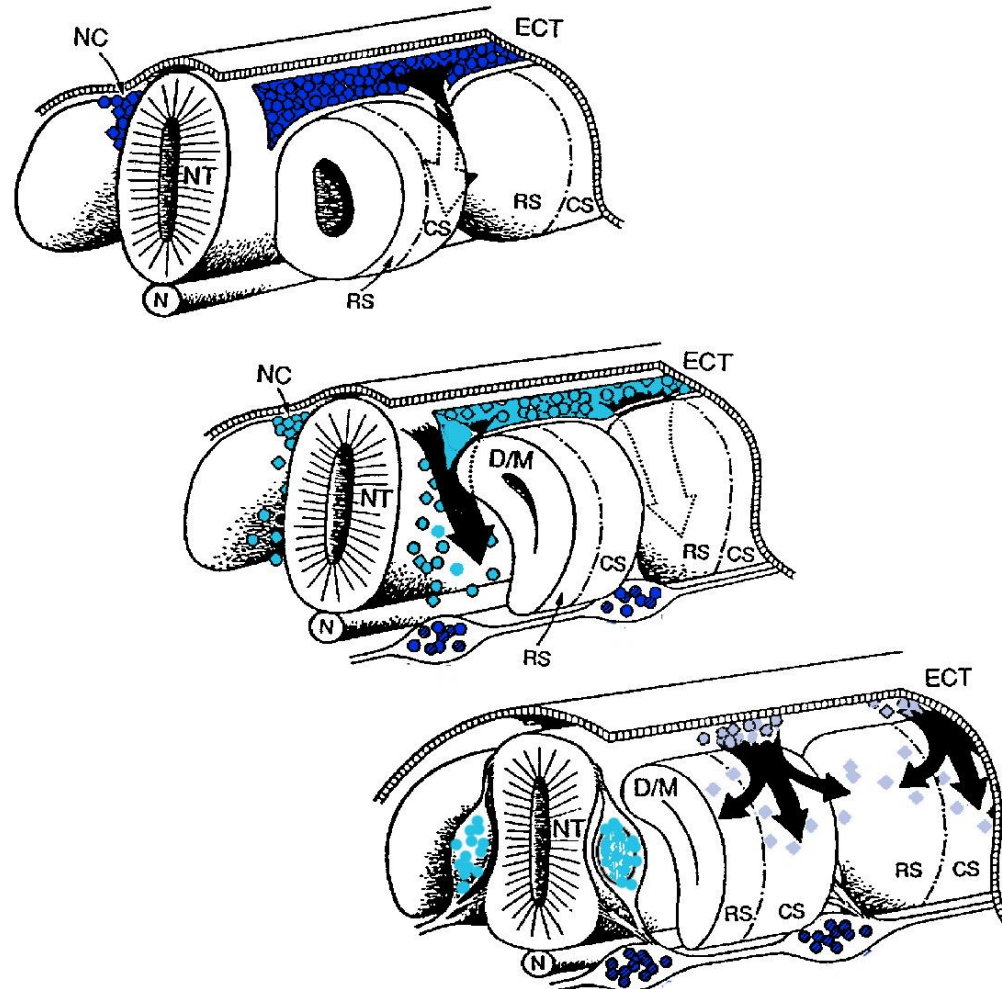
Neural crest gives rise to the peripheral nervous system.

- Neural crest cells leave the neural tube just after the tube closes.

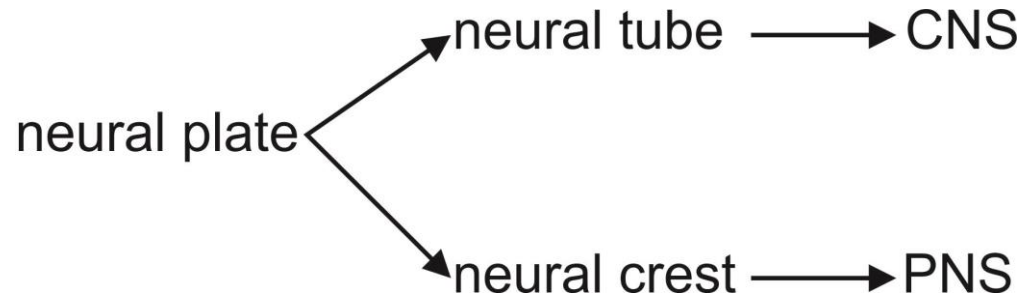


Neural crest gives rise to the peripheral nervous system.

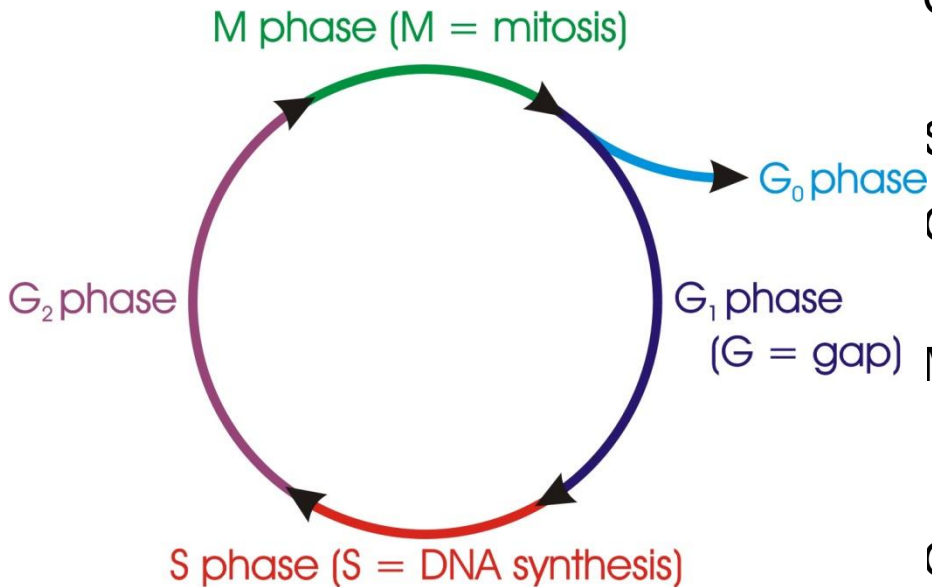
- Neural crest cells migrate throughout the body and develop into the neurons and glia of the peripheral nervous system.



Origin of the Nervous System

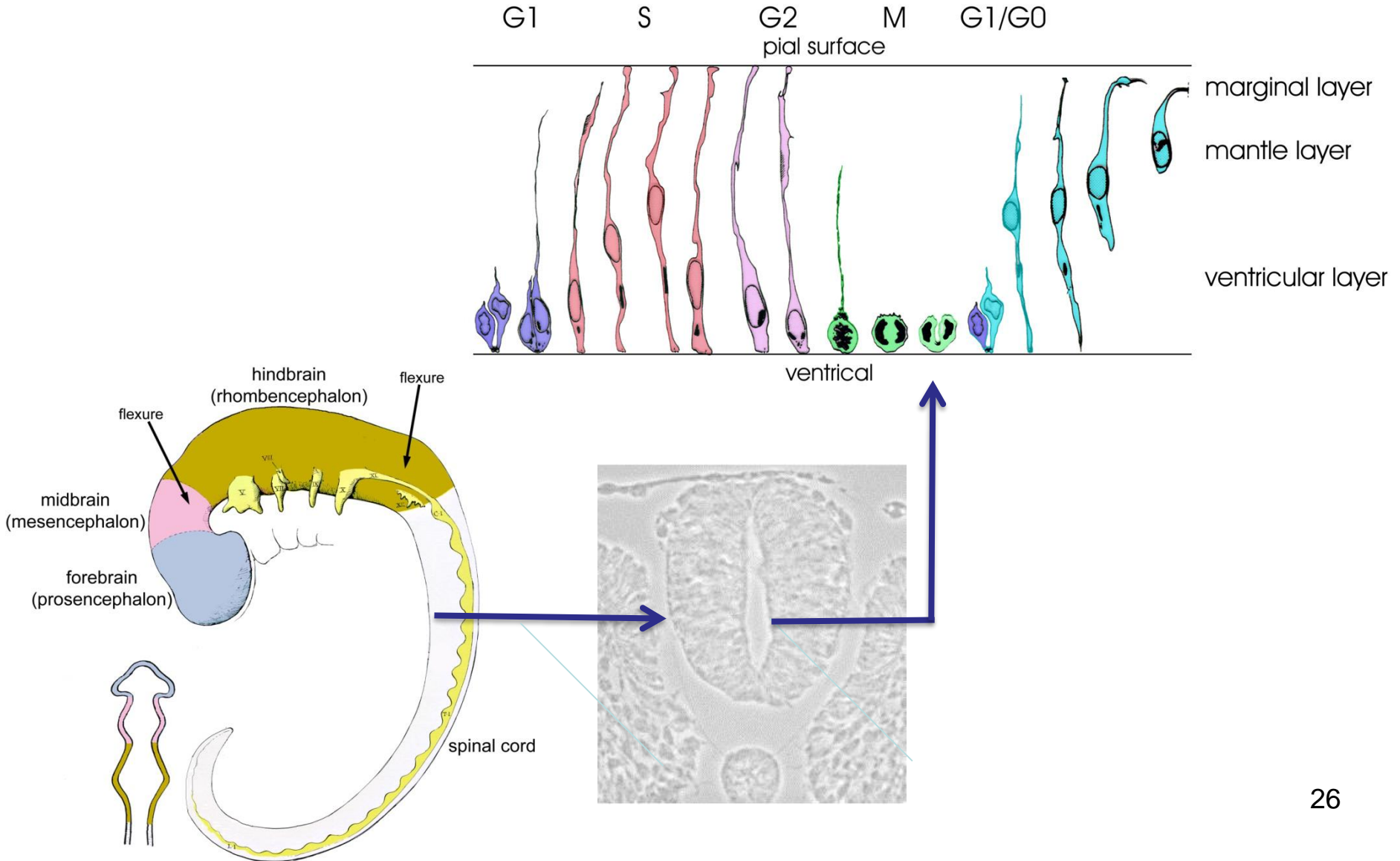


Cell Cycle (steps involved in cell division)

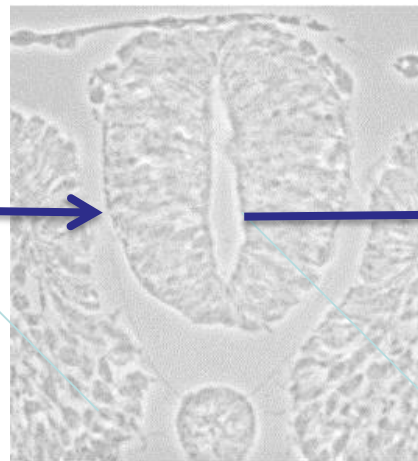
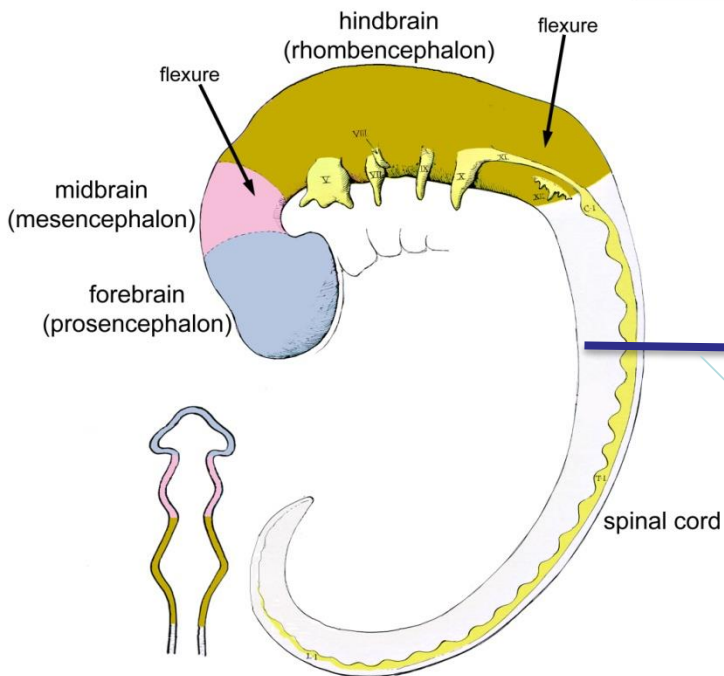
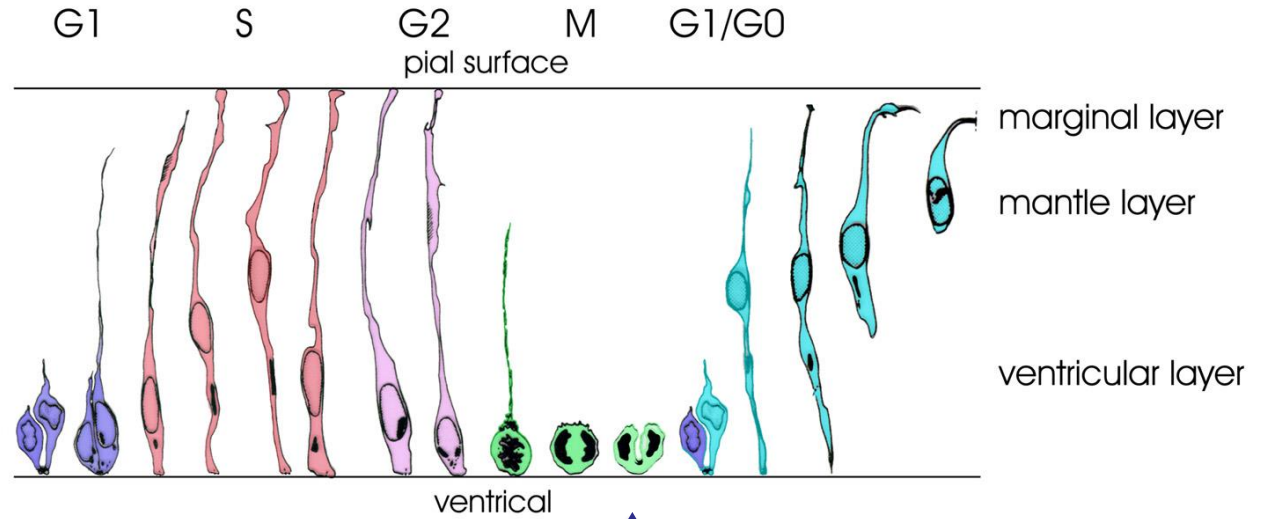


- G₁ period during which proteins that initiate or block division are expressed
- S period during which DNA is replicated
- G₂ period during which proteins needed for mitosis are expressed
- M period during which cell divides into two; steps are: prophase, metaphase, anaphase, telophase and cytokinesis
- G₀ permanent arrest in G₁; period during which neurons differentiate and function

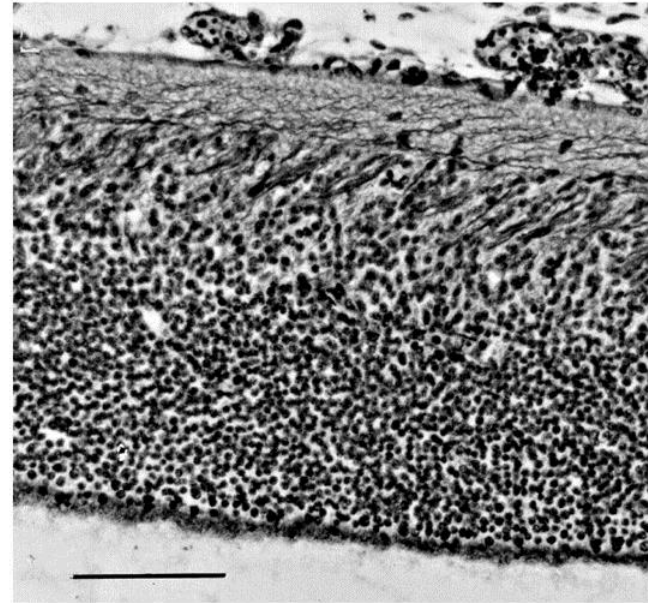
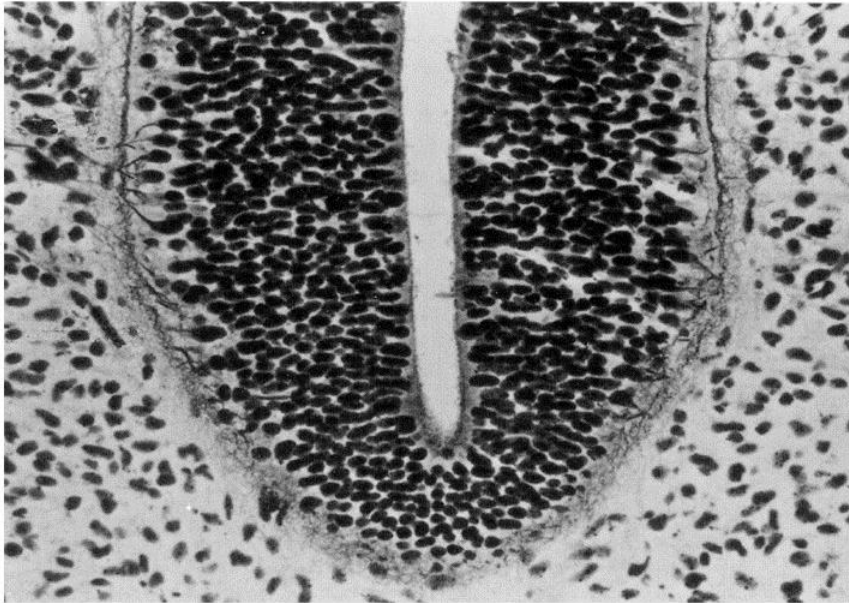
Initially, all cells in the neural tube are dividing.



As development progresses, some cells cease to divide and begin to differentiate.



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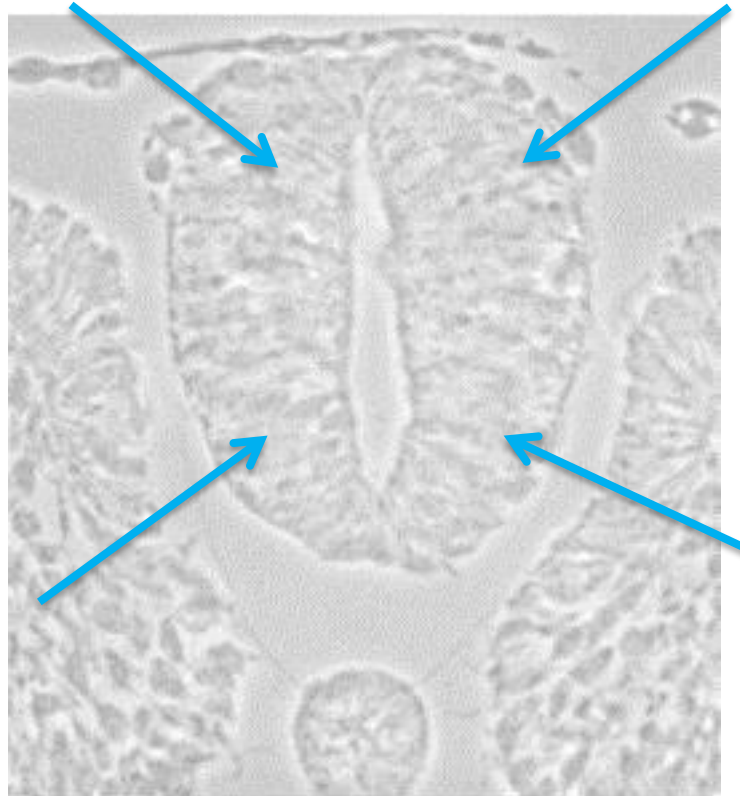


marginal layer

mantle layer

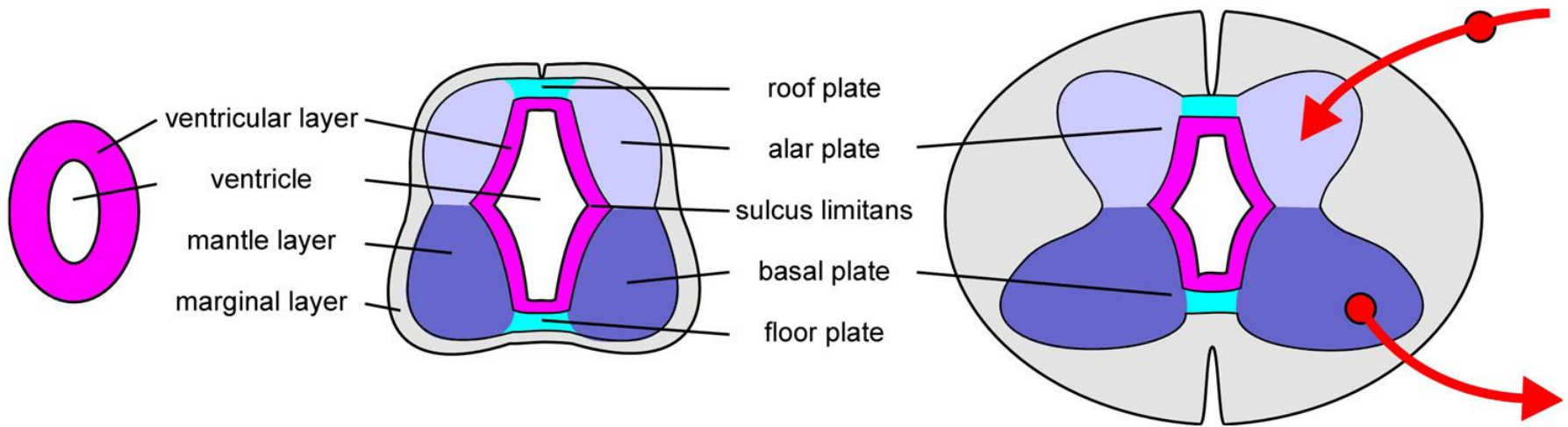
ventricular
layer

Cell division is not uniform around the neural tube.

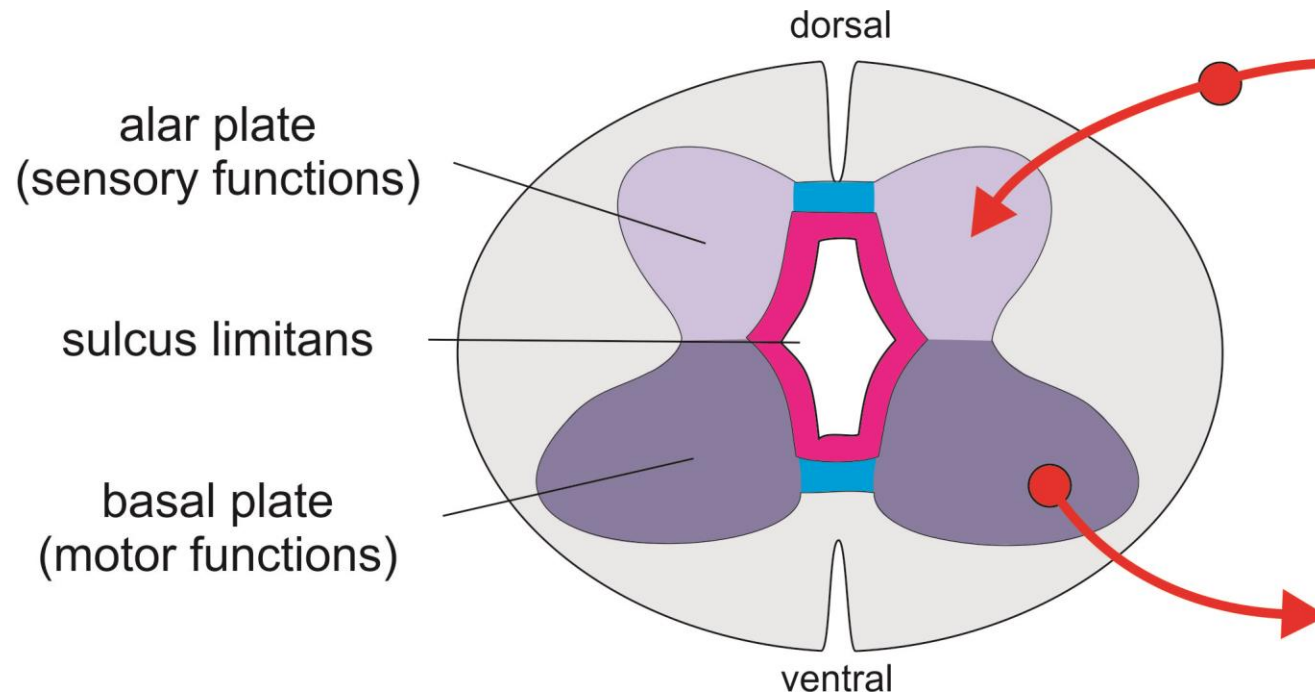


Arrows indicate areas of more cell division.

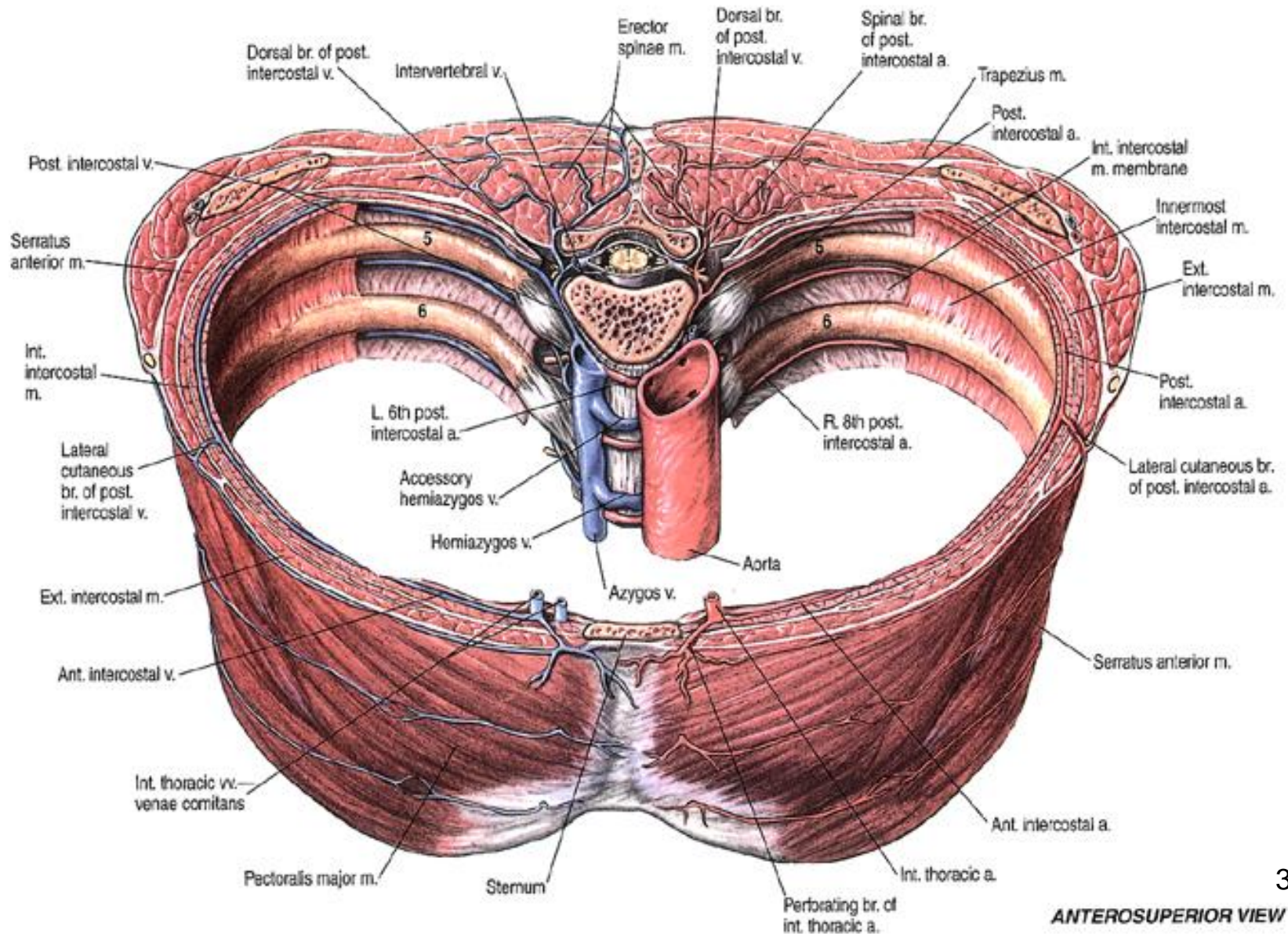
Uneven cell division results in greater accumulation of cells in certain areas around the tube.



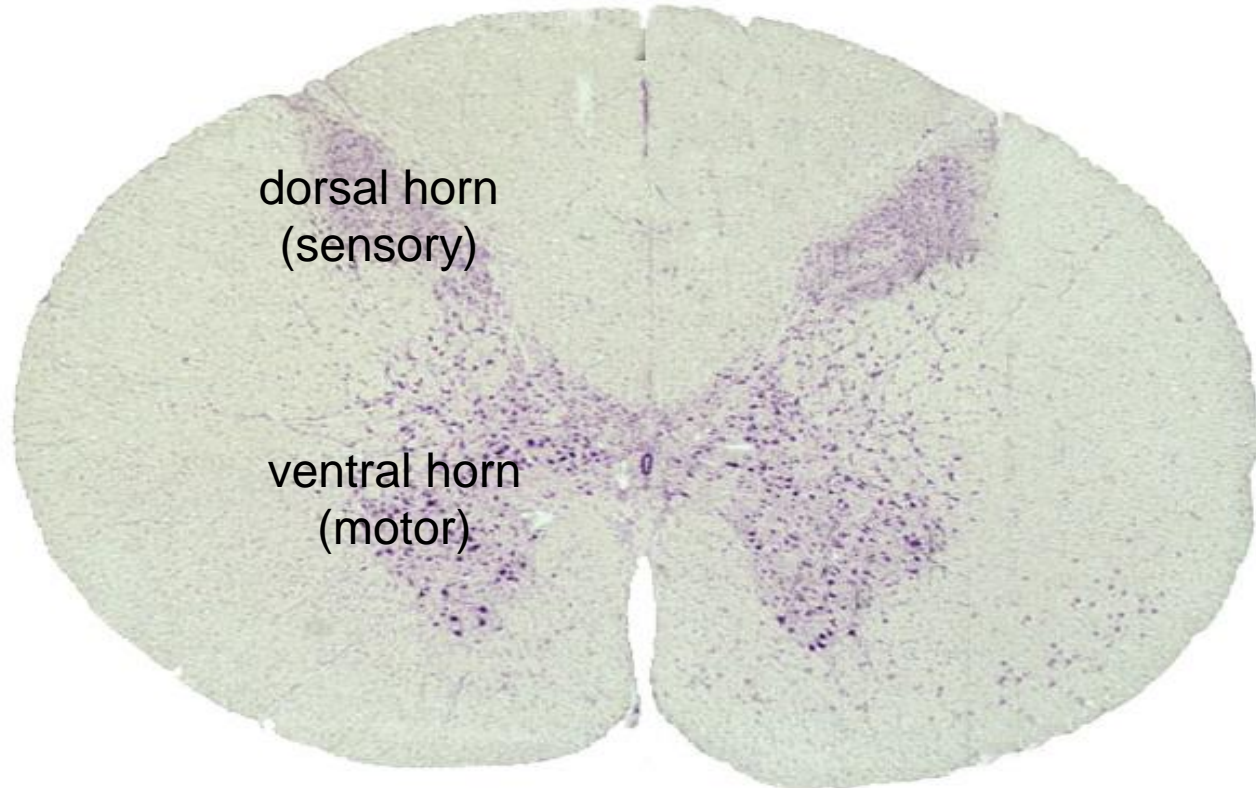
Alar and basal plates represent functional domains.



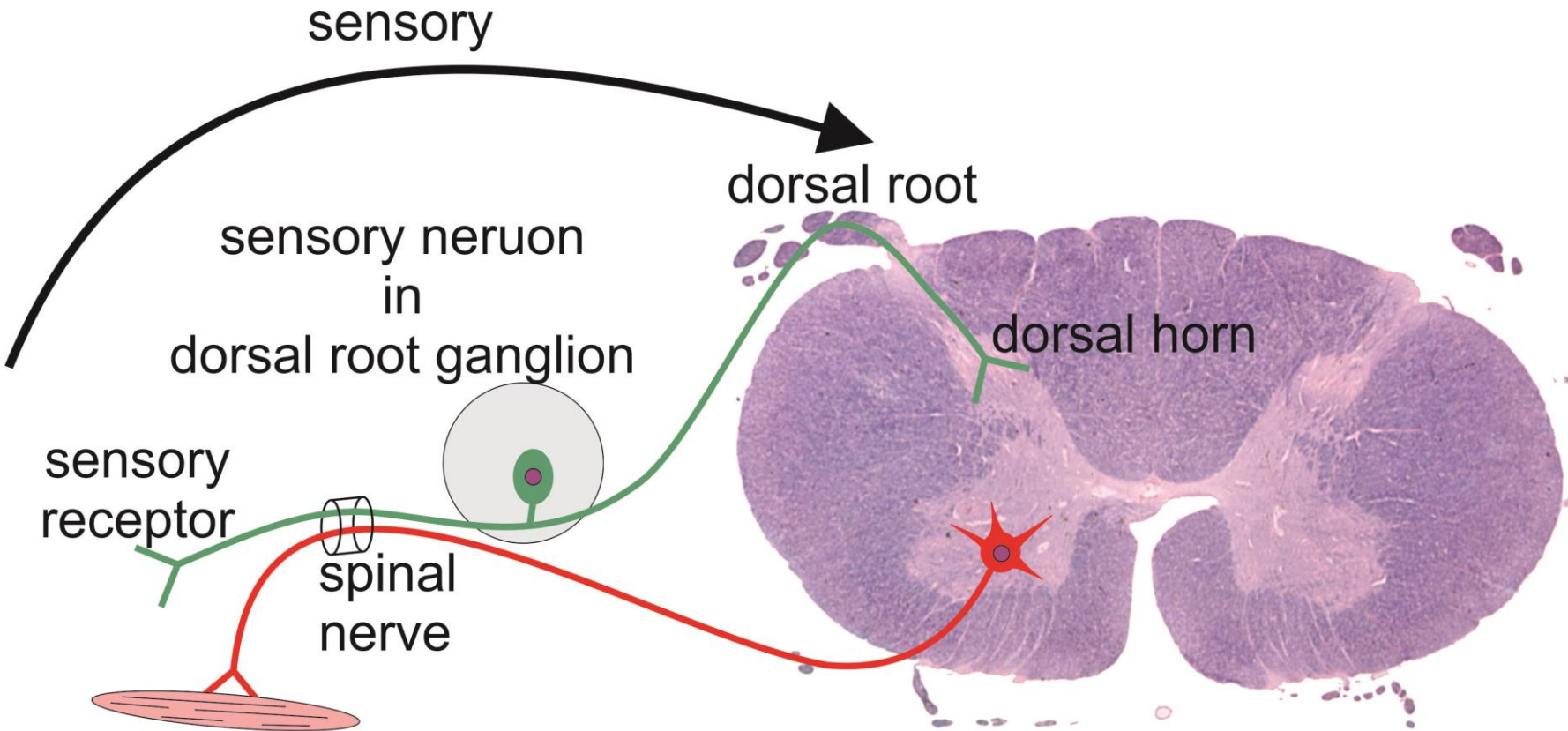
Adult Spinal Cord



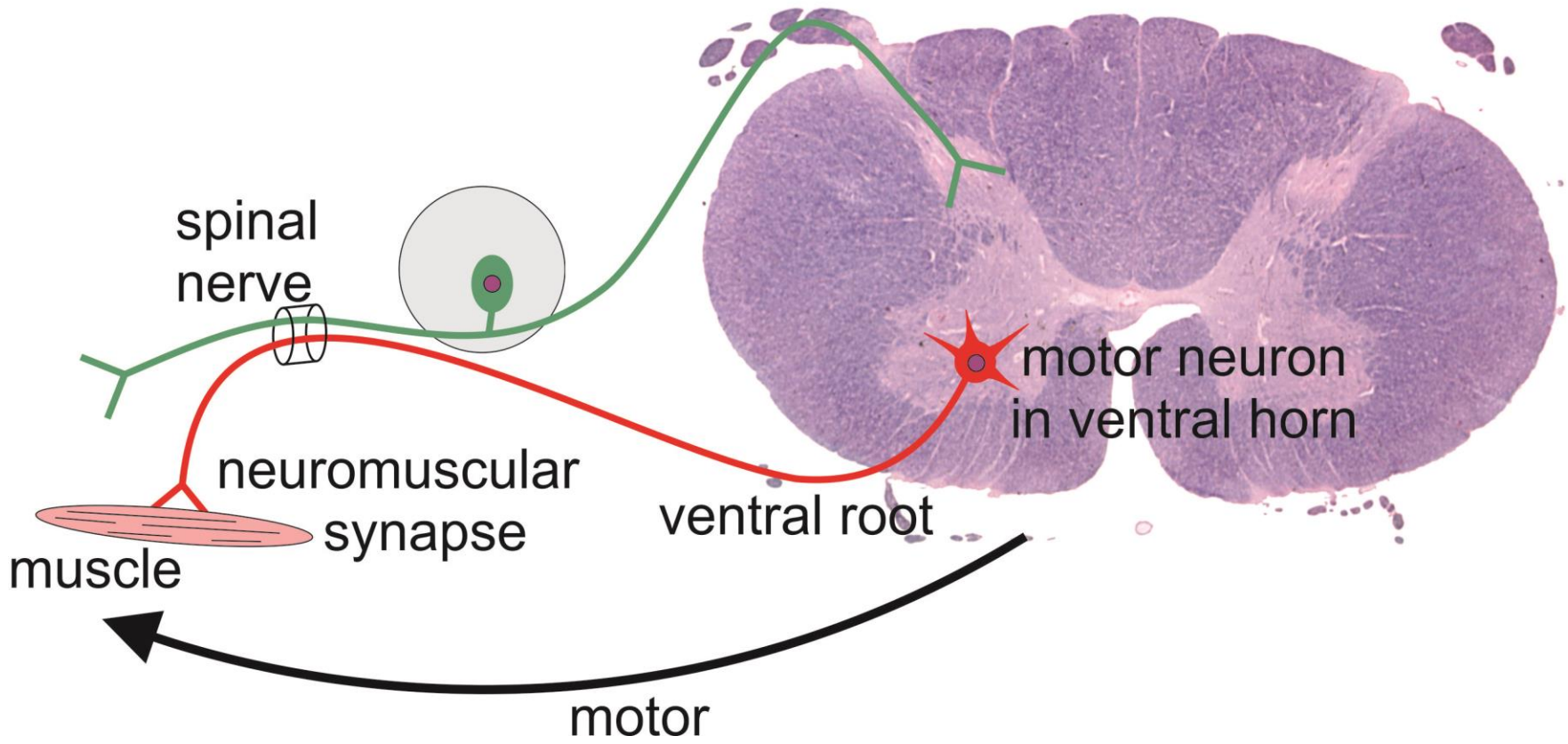
Adult Spinal Cord



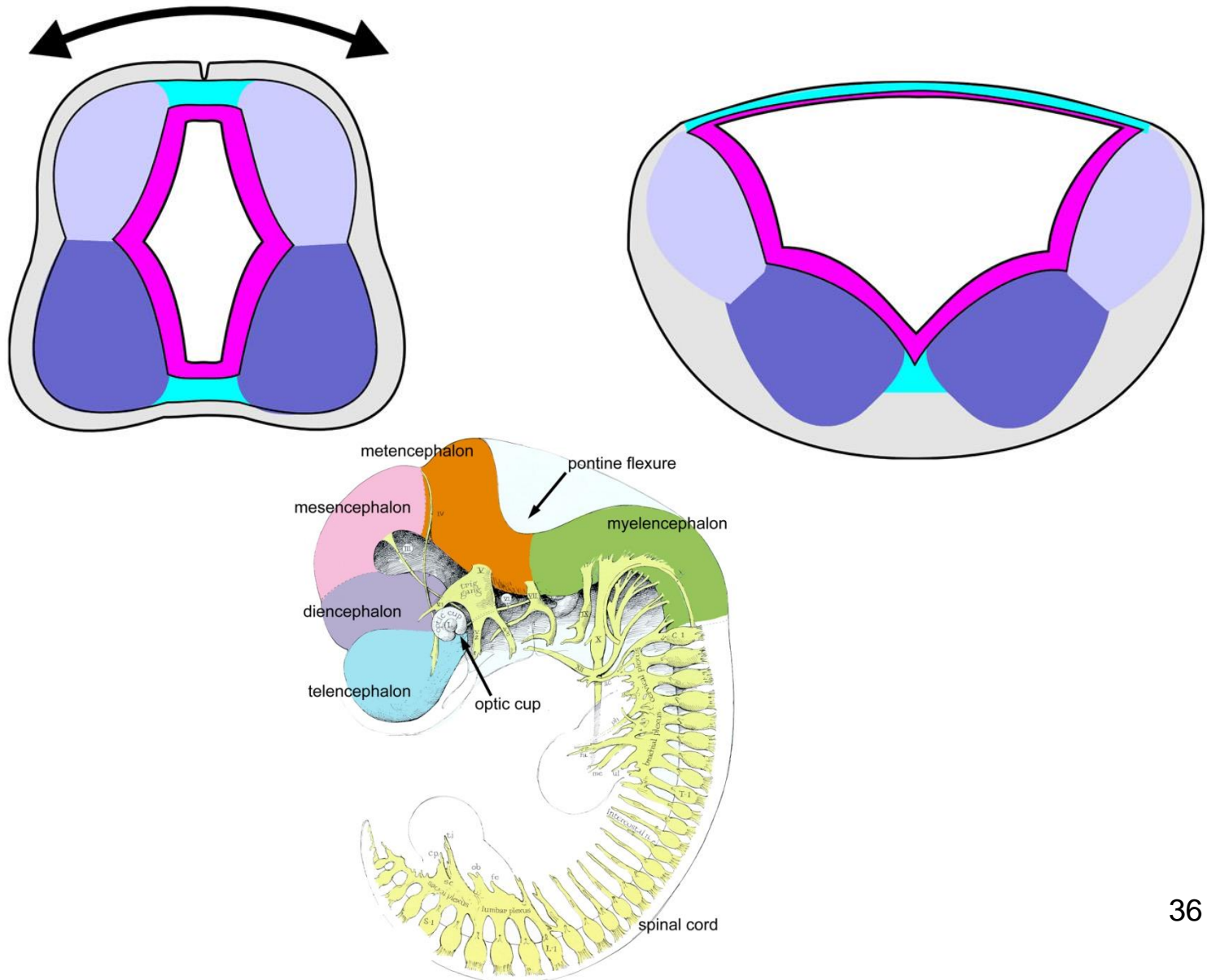
Sensory Input to the Spinal Cord



Motor Output from the Spinal Cord



Brain development is more complicated... because flexures change the positions of alar & basal plates.



Brain development is more complicated... because some alar and basal plates further divide into subgroups with different functions.

