

Primitive streak & notochord formation

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- DEVELOPMENT OF A EMBRYO FROM FERTILIZATION UPTO BILAMMINAR DISC IS DESCRIBED AS **PRE-ORGANOGENESIS** PERIOD.
- These events take place in first 14 days of pregnancy.
- establishment of primitive streak & formation of intraembryonic mesoderm mark the onset of gastrulation.
- gastrulation begins in 3rd week , also marked as beginning of embryonic period.(3rd-8th week)

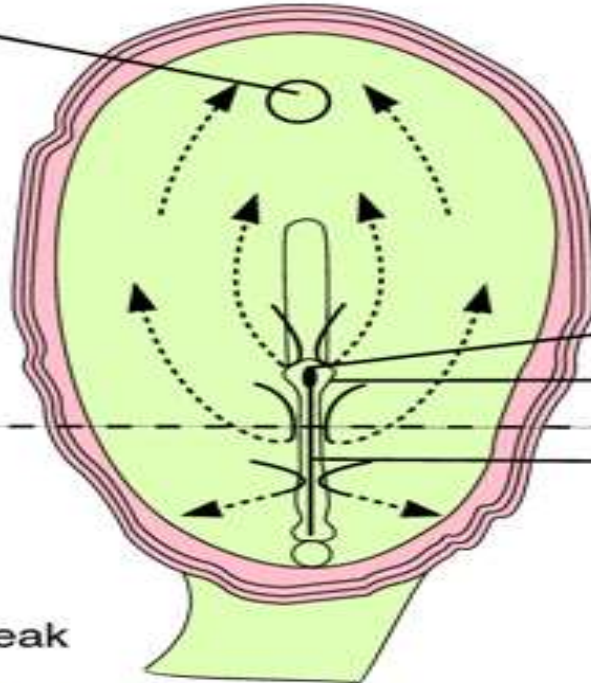
Applied aspect

- as inner cell mass cells have the potential to differentiate into three different germ layers & all the cells, tissues & organs of body are formed from these three layers , so **inner cell mass** are **called embryonic stem cells**.
- if these cells are exposed to certain specific growth factors , in culture, the stem cells can form various type of adult cells , so called as **pleuripotent** cells. **it has been seen that if these cells are introduced to a living tissues of a person, the local environment help these stem cells to differentiate into cells similar to those of tissue into which they are placed.**
- This quality is being of tremendous use in treatment of few diseases....like , parkinson's disease , alzheimers disease,diabeties ,myocardial infarction,blood diseases, severe burns,osteoprosis,spinal cord injury etc.
- but complication of immune rejection is always present as genetic constitution of stem cell is different from that of patient.

Primitive streak

Buccopharangeal

Surface view of embryonic disc



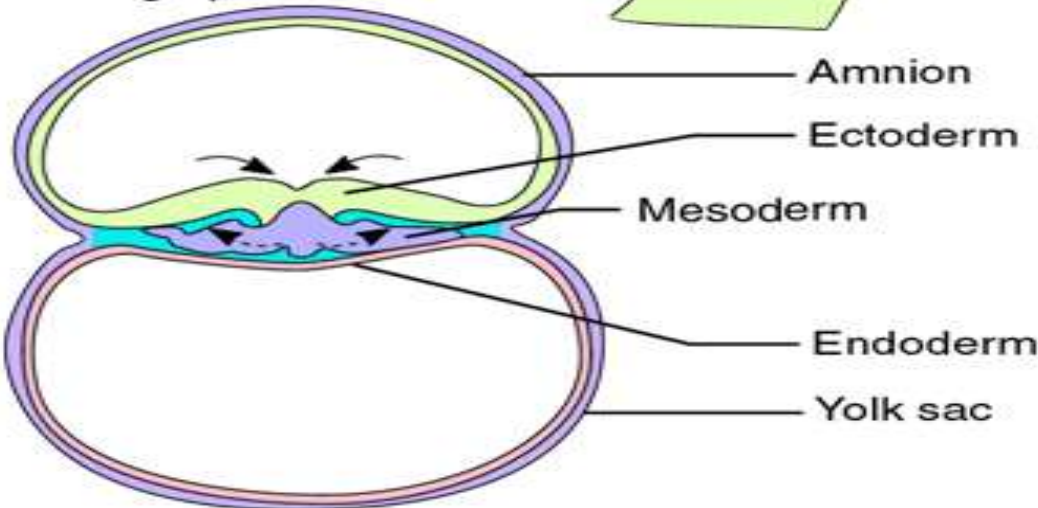
Primitive pit

Primitive node

Primitive groove

Primitive Streak

Cross section through primitive streak



Amnion

Ectoderm

Mesoderm

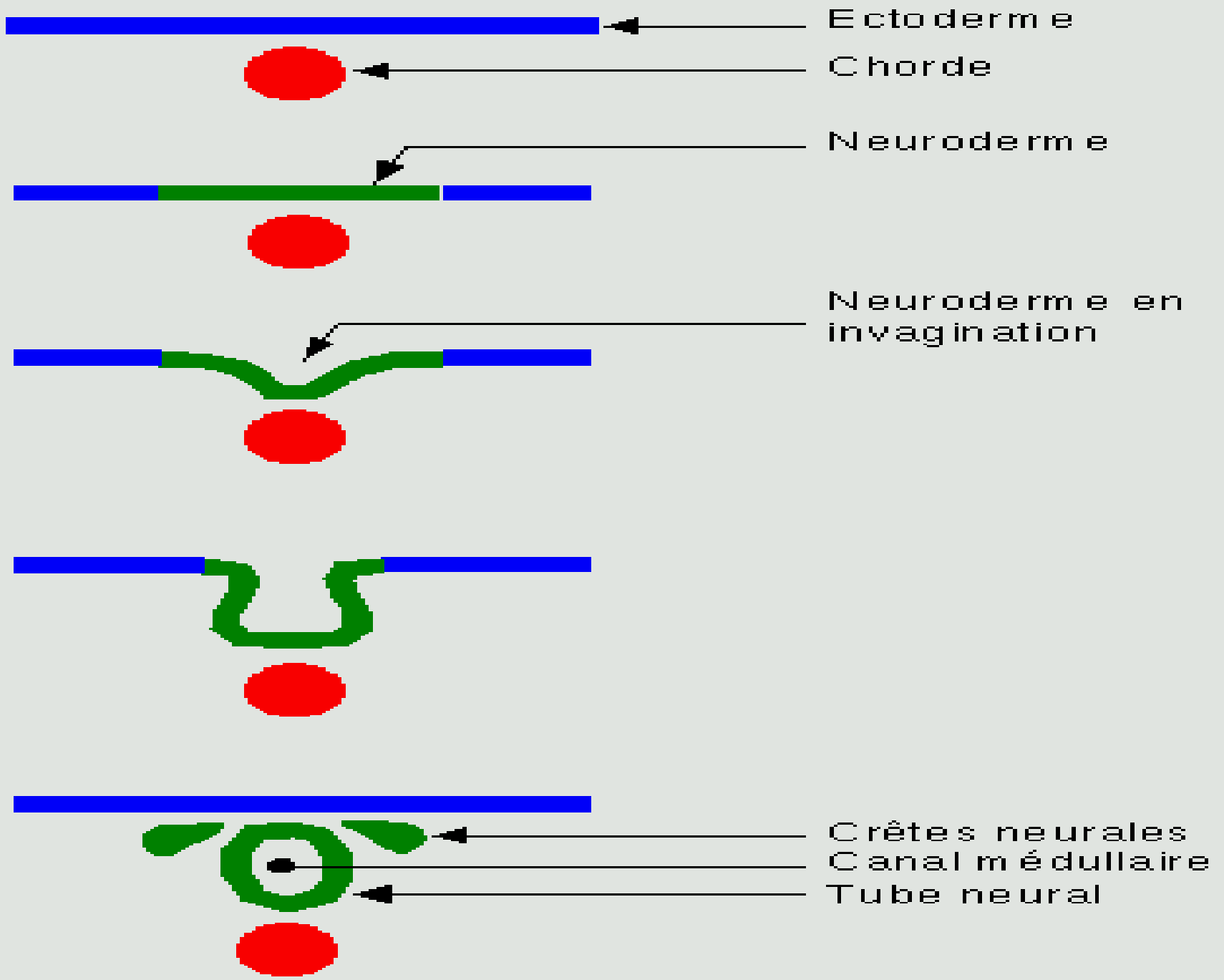
Endoderm

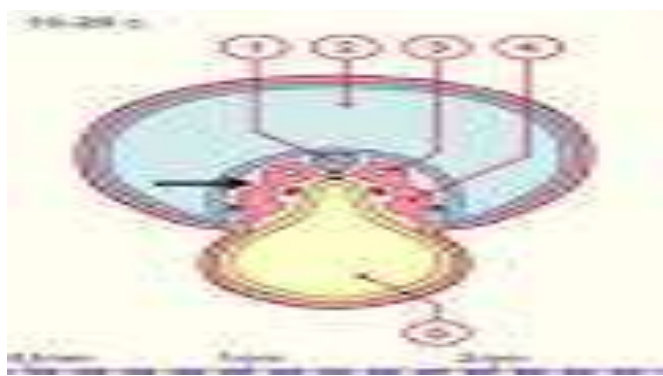
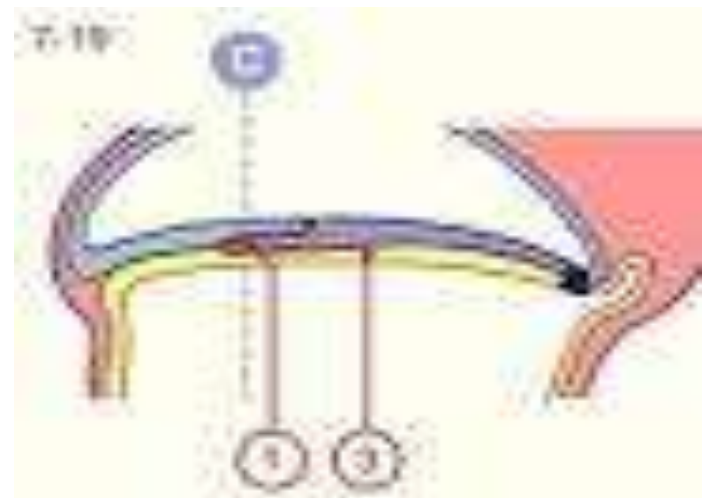
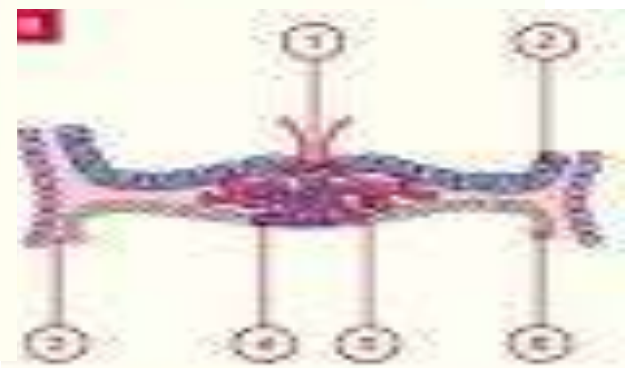
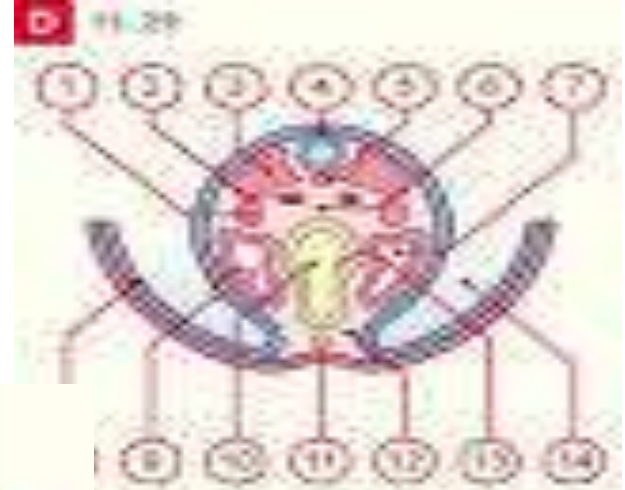
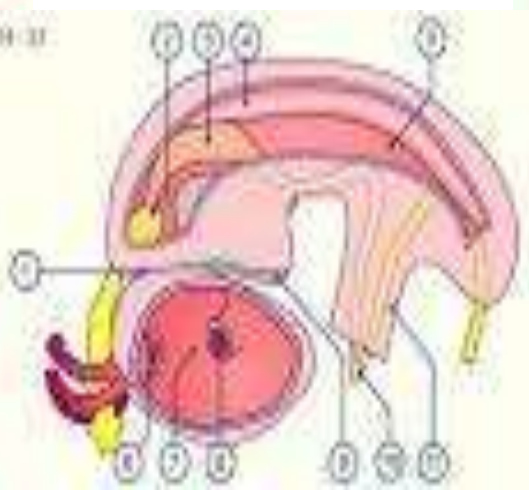
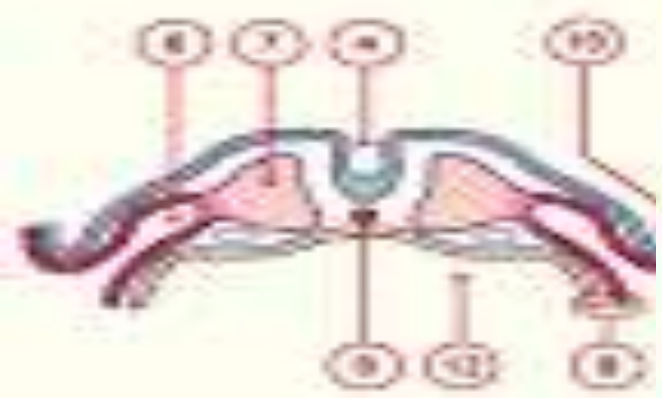
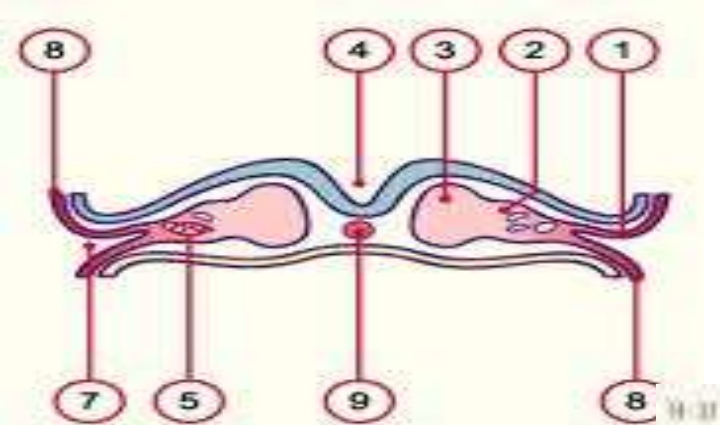
Yolk sac

- the cranial end of primitive streak enlarges to form –**primitive knot**.
- cells of primitive knot multiply & pass cranially to form rod like structure reaching upto prochordal plate---**notochordal process**.
- The notochordal process undergo changes that convert it first into a canal & then into a plate & finally back into a rod like structure – called **notochord**.

NOTOCHORD

- A MIDLINE STRUCTURE that develops in the region lying between the cranial end of primitive streak & caudal end of prochordal plate.
- the cranial end of primitive streak firstly gets thickened called now as **primitive knot, primitive node, henson's node.**
- a depression then appears in centre of primitive knot called **blastopore.**





- cells in primitive knot multiply & pass cranially in the middle line, b/w ectoderm & endoderm, reaching upto caudal margin of prochordal plate...**notochordal process or head process.**
- cells of this then undergo several stages of rearrangement –ending in formation of a solid rod called **notochord.**

- as embryo enlarges notochord elongates , lies in midline & most of it disappears , part of it persists in the region of each intervertebral disc as **nucleus pulposus**.
- i.e in short----notochordal canal----notochordal plate----notochord.
- Thus in humans it appears in embryo but only small remnants of it remain in the adult.

Formation of neural tube

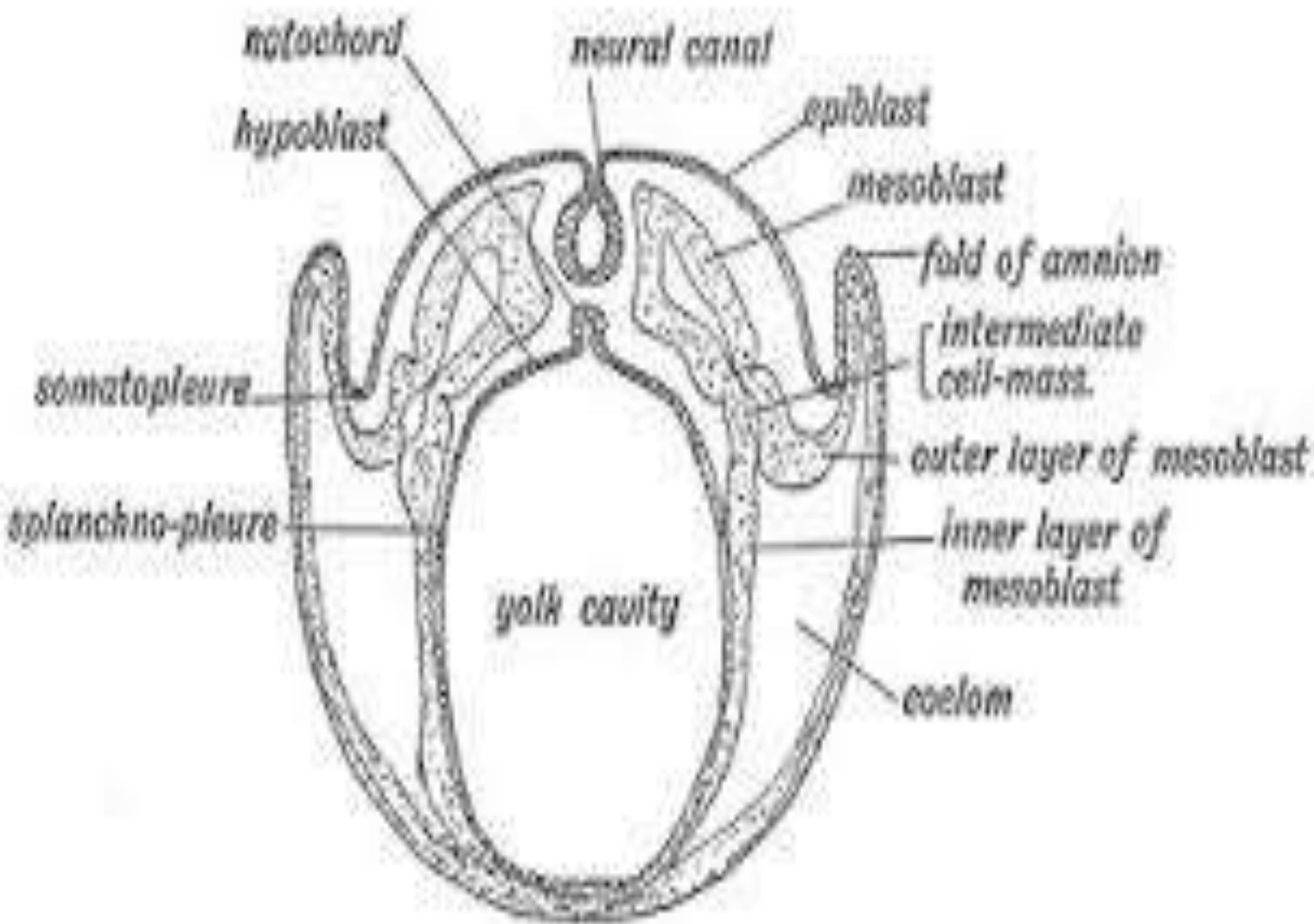
- give rise to brain & spinal cord,
- formed from ectoderm overlying notochord & thus extend from prochordal plate to primitive knot.
- it soon divisible into: --a cranial enlarged part that forms brain& a caudal tubular part that form the spinal cord.
- this process of formation of neural tube is called **neurulation**.

Intraembryonic mesoderm

- It is formed from proliferation of cells in primitive streak, it separates ectoderm & endoderm except in region of ---**prochordal plate, cloacal membrane, & in midline** which is occupied by notochord.
- cranial to prochordal plate, mesoderm of two sides meets in midline.
- intraembryonic mesoderm is subdivided into three **parts—paraxial mesoderm**, i.e. on either side of notochord.
- Laterally---**lateral plate mesoderm**,
- **intermediate mesoderm** b/w these two mesoderm.

Paraxial mesoderm

- Cells are homogenously arranged.,later mesoderm gets segmented.
- Segments are of two **catagories—somites & somitomeres.**
- **Somites**---cubical, distinctly segmented,most cranial segments are formed in occipital region,followed caudally.
- Total **44 pairs of somites**---4 occipital, 8 cervical ,12 thoracic , 5 lumber ,5 sacral ,8-10 coccygeal.



Pericardial coelom

Ectoderm

Cardiogenic area

A

Notochord

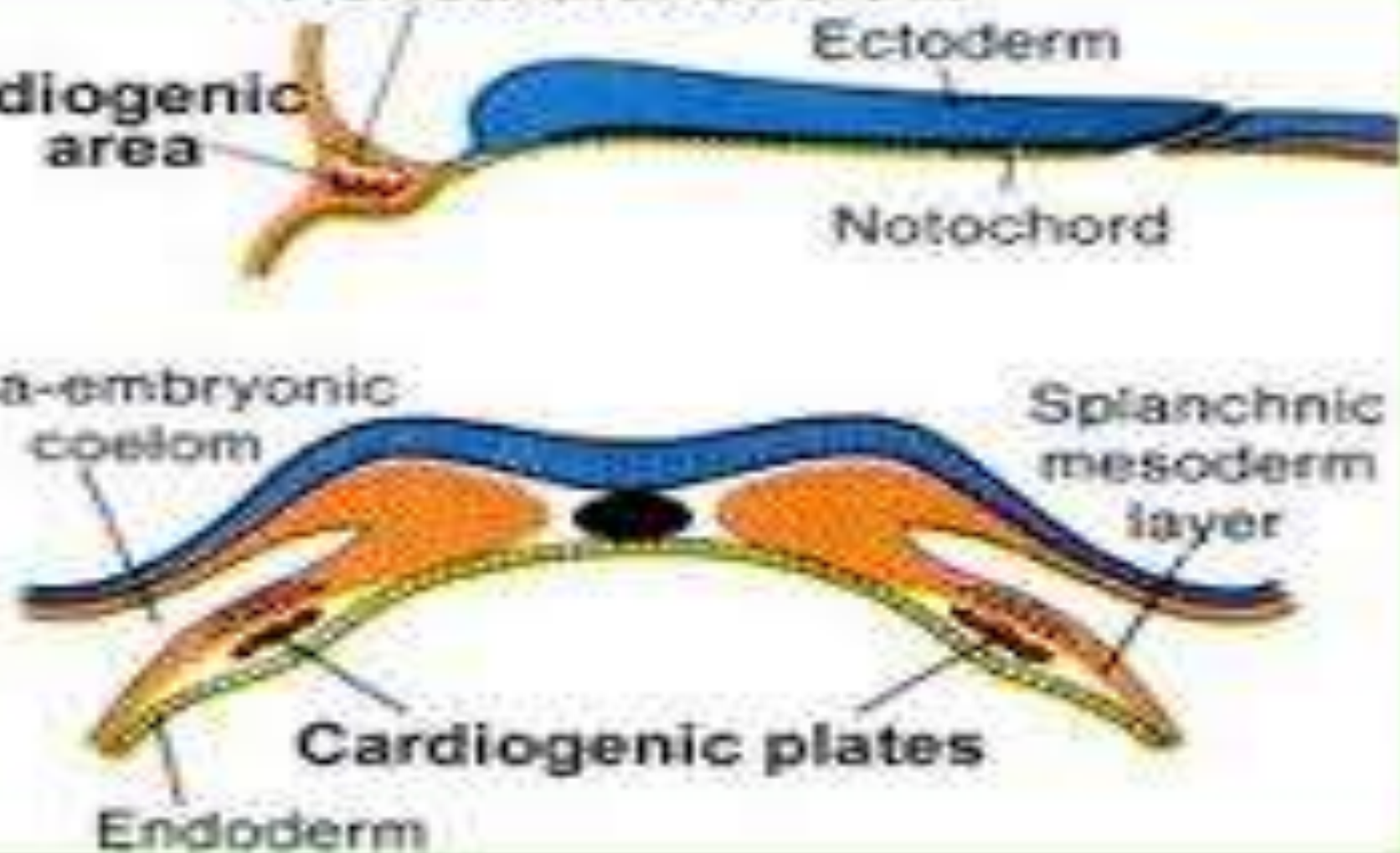
Intra-embryonic coelom

Splanchnic mesoderm layer

B

Cardiogenic plates

Endoderm



- occipital somites form muscles of tongue
- somites form axial skeleton , skeletal muscle & part of skin.

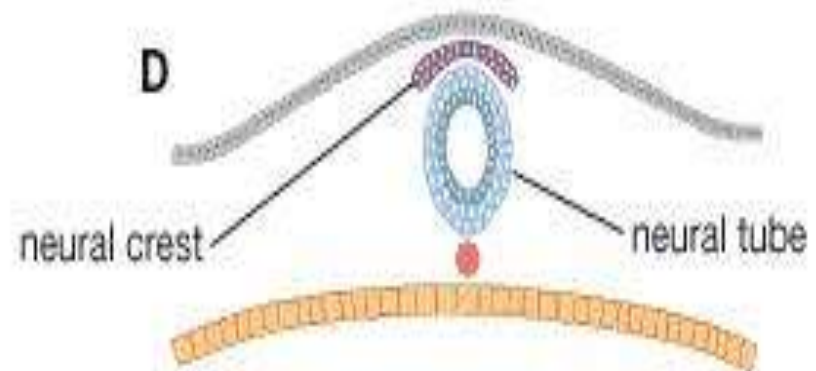
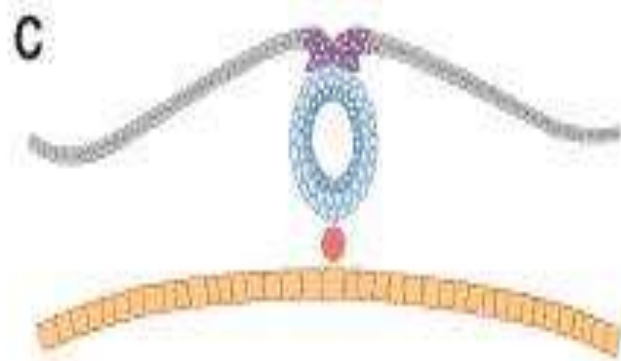
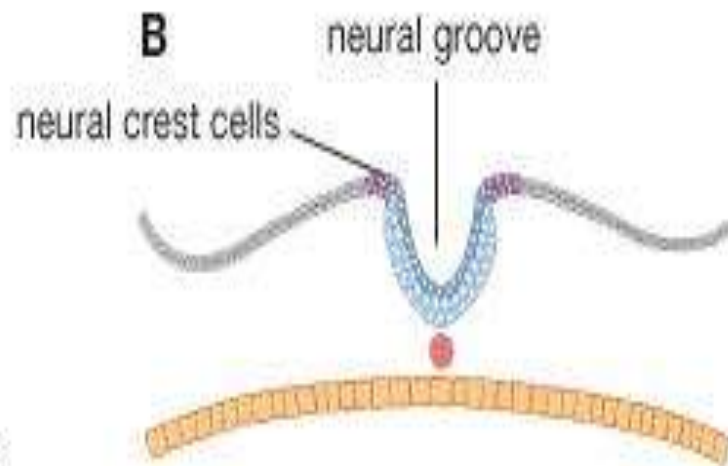
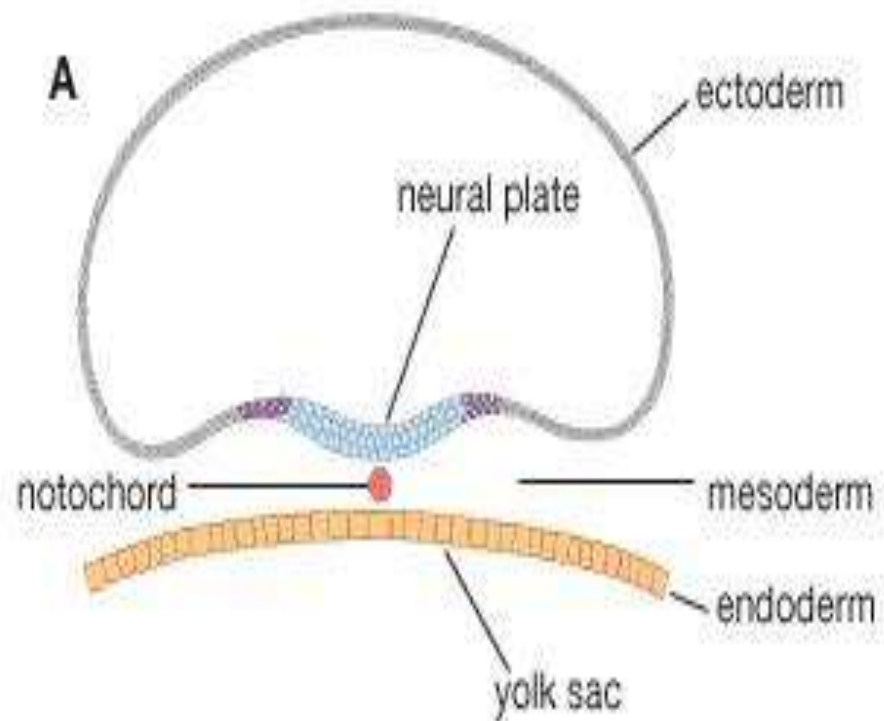
Intraembryonic coelom

- while paraxial mesoderm is undergoing segmentation changes are also occurring in lateral plate mesoderm..small cavities appear in it ,which coalesce to form one large cavity— intraembryonic coelom
- cavity is horse shoe shaped cavity,
- the lateral plate mesoderm now splits into – somatopleuric/ parietal
- splanchnopleuric/visceral.
- i/e coelom give rise to pericardial,pleural,peritoneal cavities

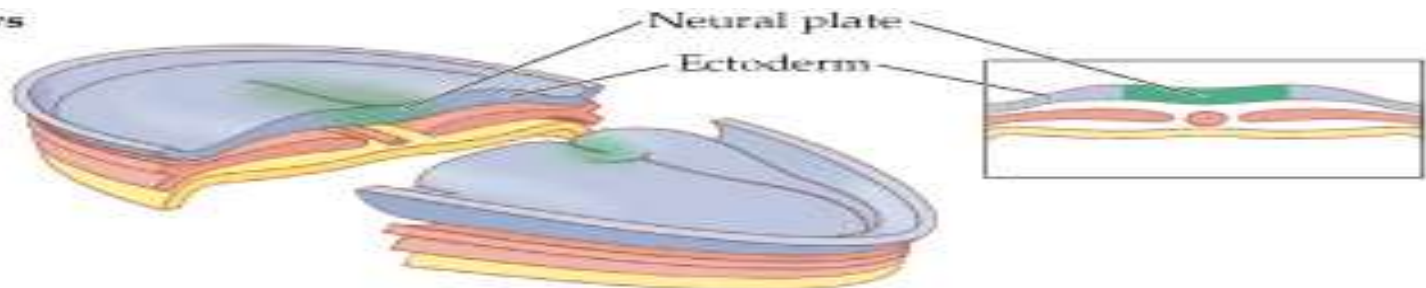
- heart—splanchnopleuric mesoderm from floor of this part of coelom.
- cranial to this area is unsplit mesoderm(where somatopleuric & splanchnopleuric mesoderm are continuous) ---septum transversum.

Formation of neural tube

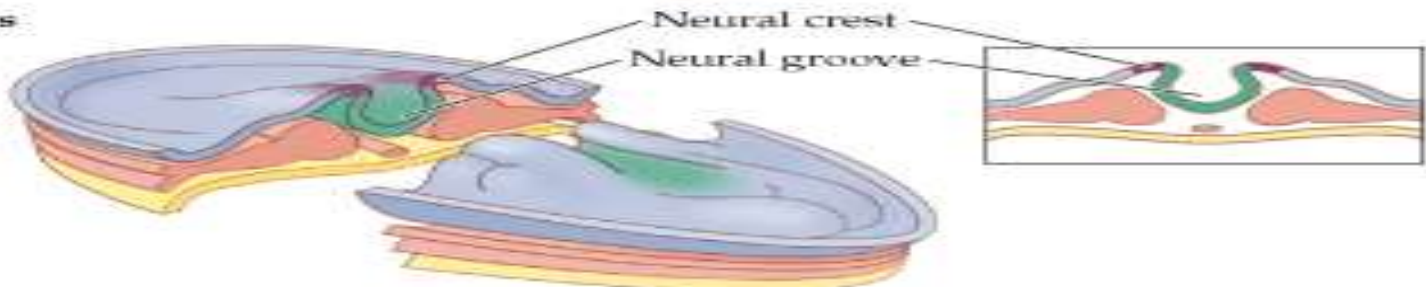
- neural tube give rise to brain & spinal cord
- neural tube is formed from **ectoderm overlying notocord** and therefore extends from prochordal plate to primitive knot
- neural tube is soon divisible into –cranial enlarged part that forms the brain ,caudal tubular part that forms spinal cord.
- The developing brain forms a large conspicuous mass on dorsal aspect .this process of formation of neural tube is referred to as **neurulation**.



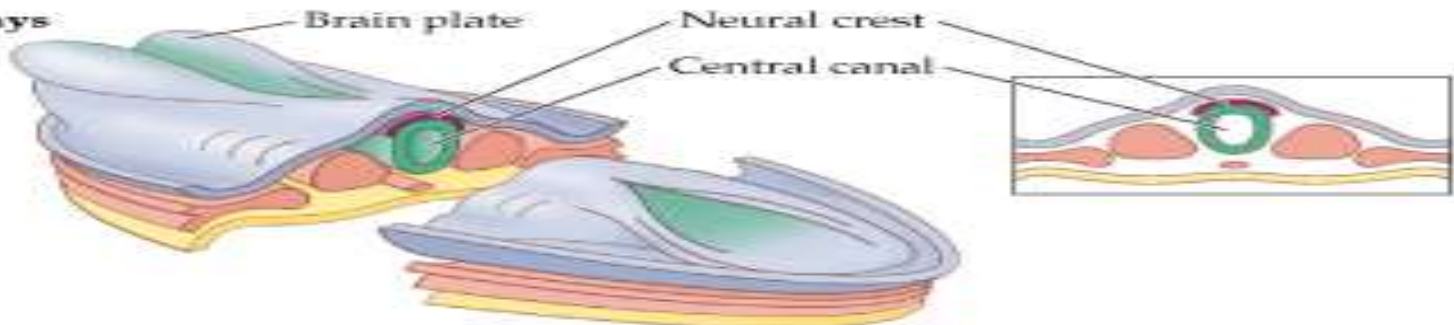
(A) 18 days



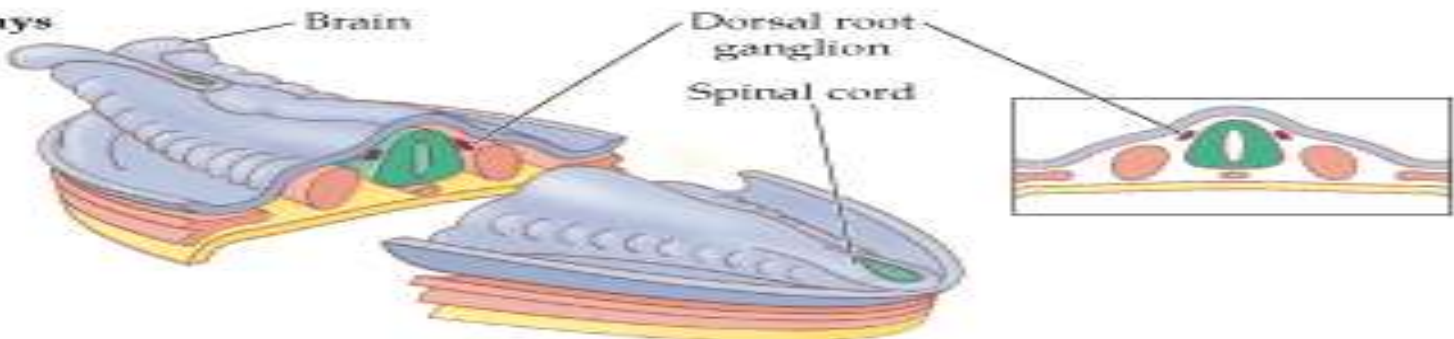
(B) 20 days

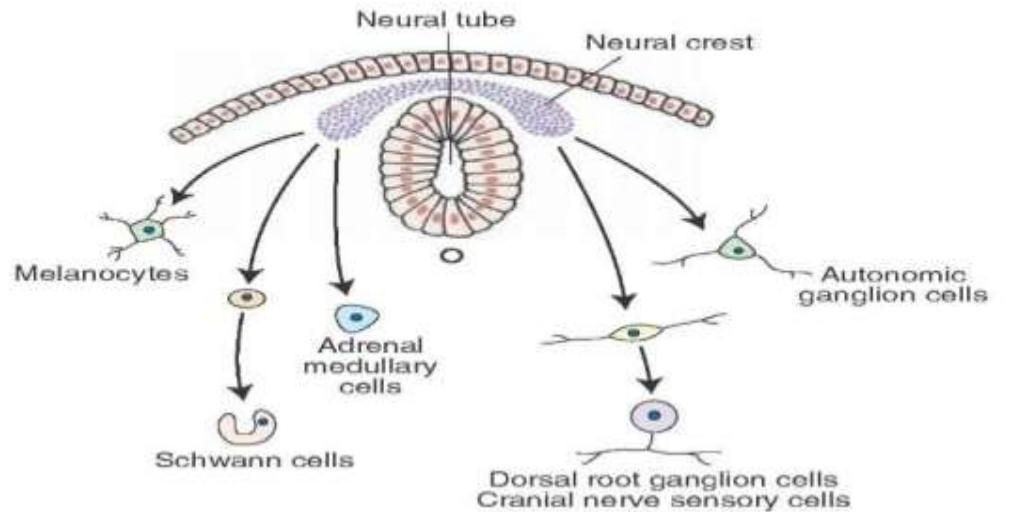
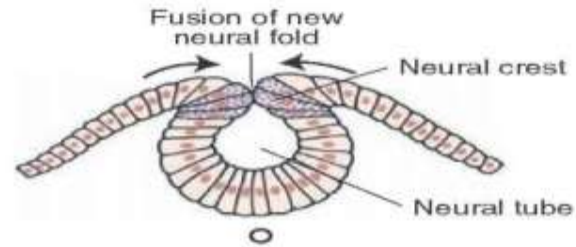
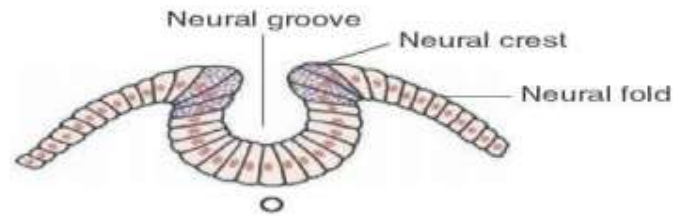
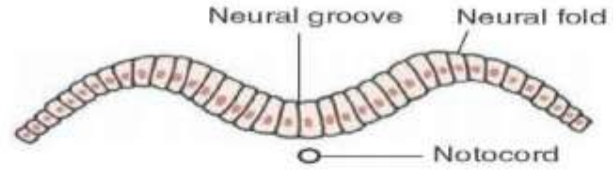
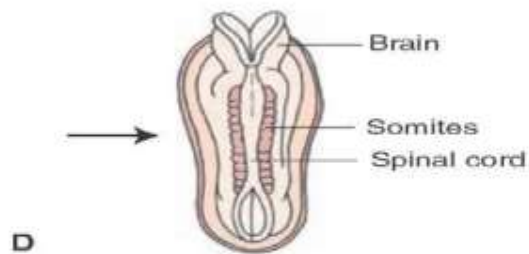
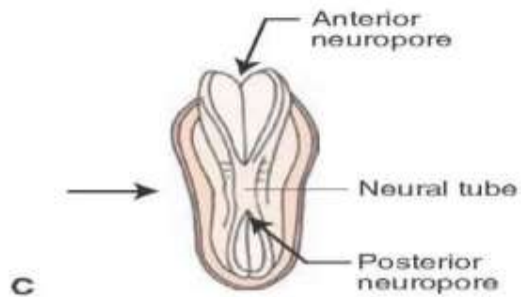
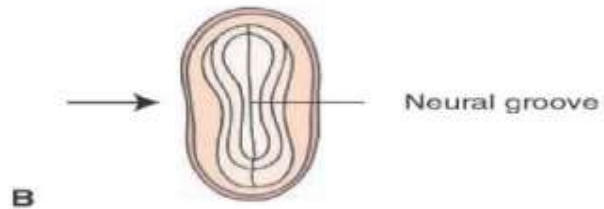
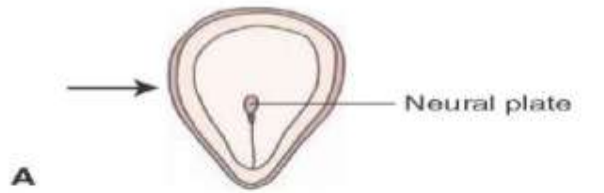


(C) 22 days



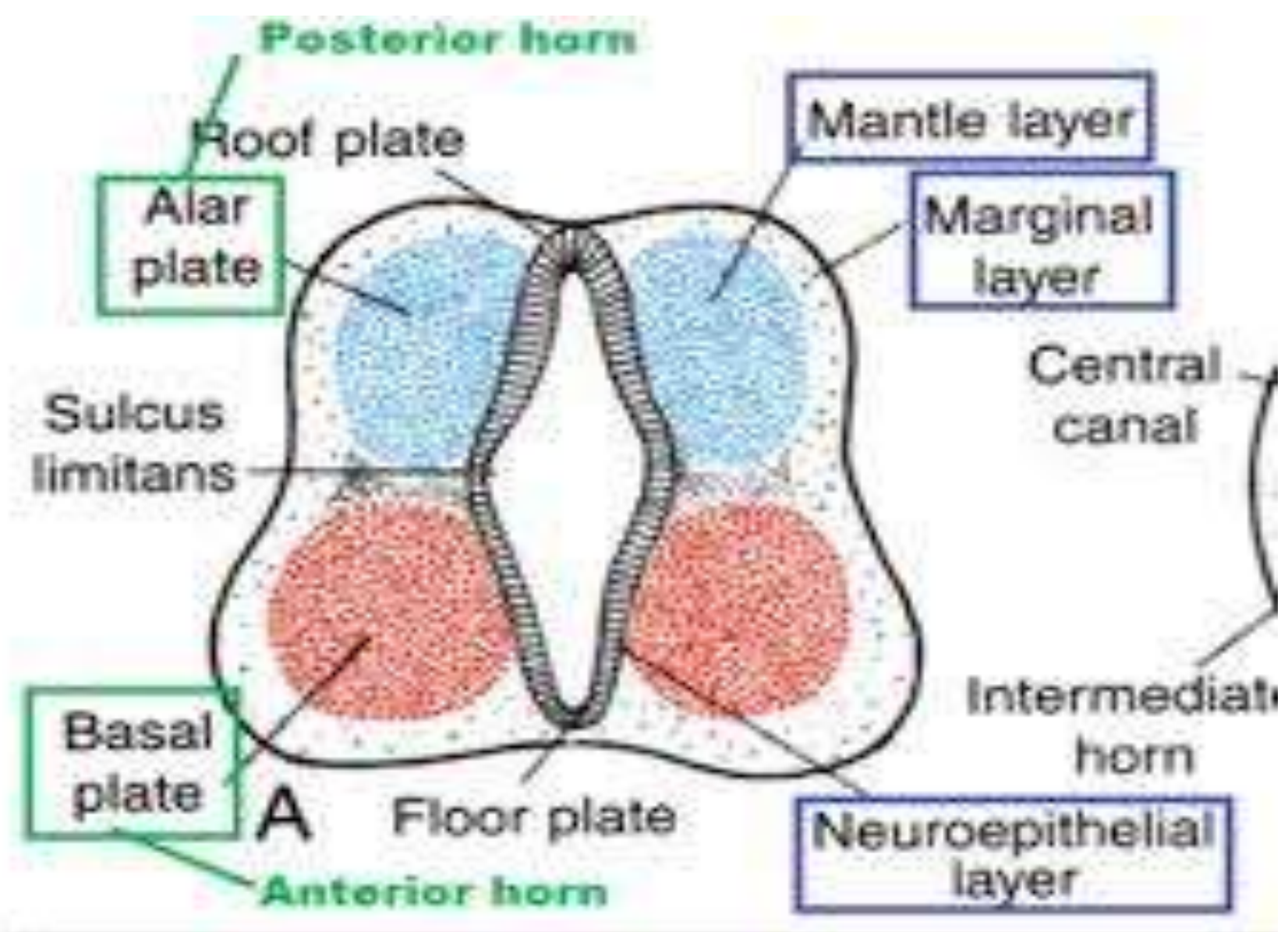
(D) 24 days

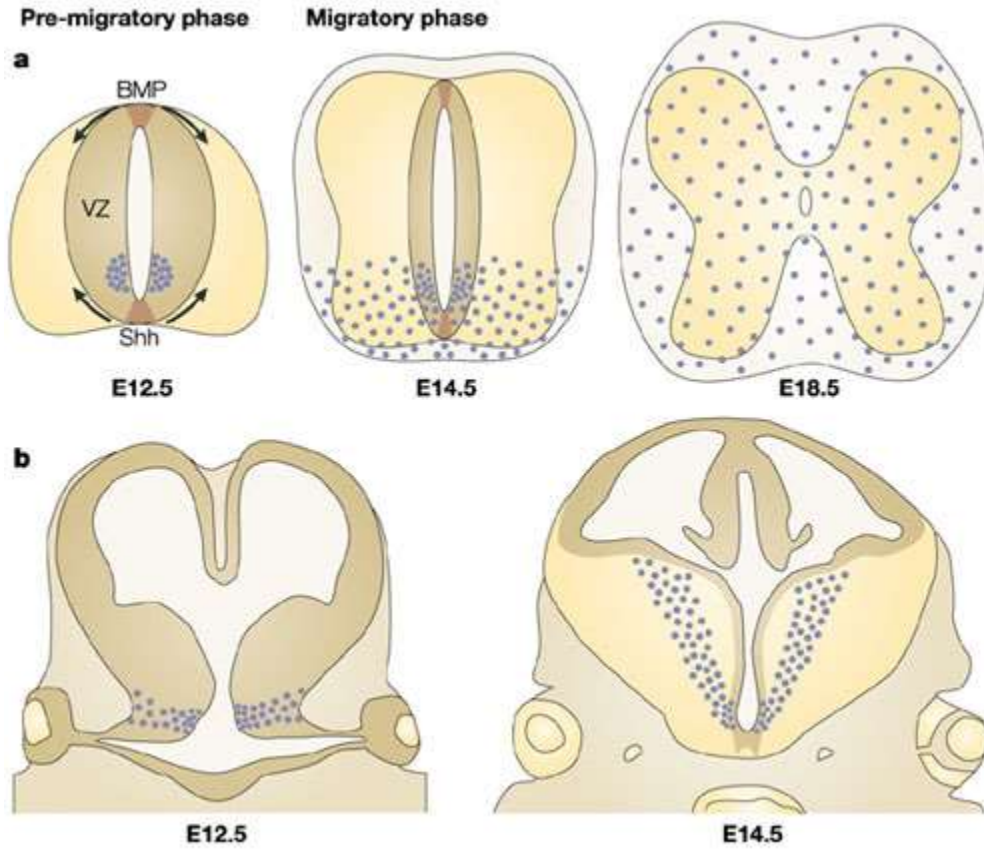


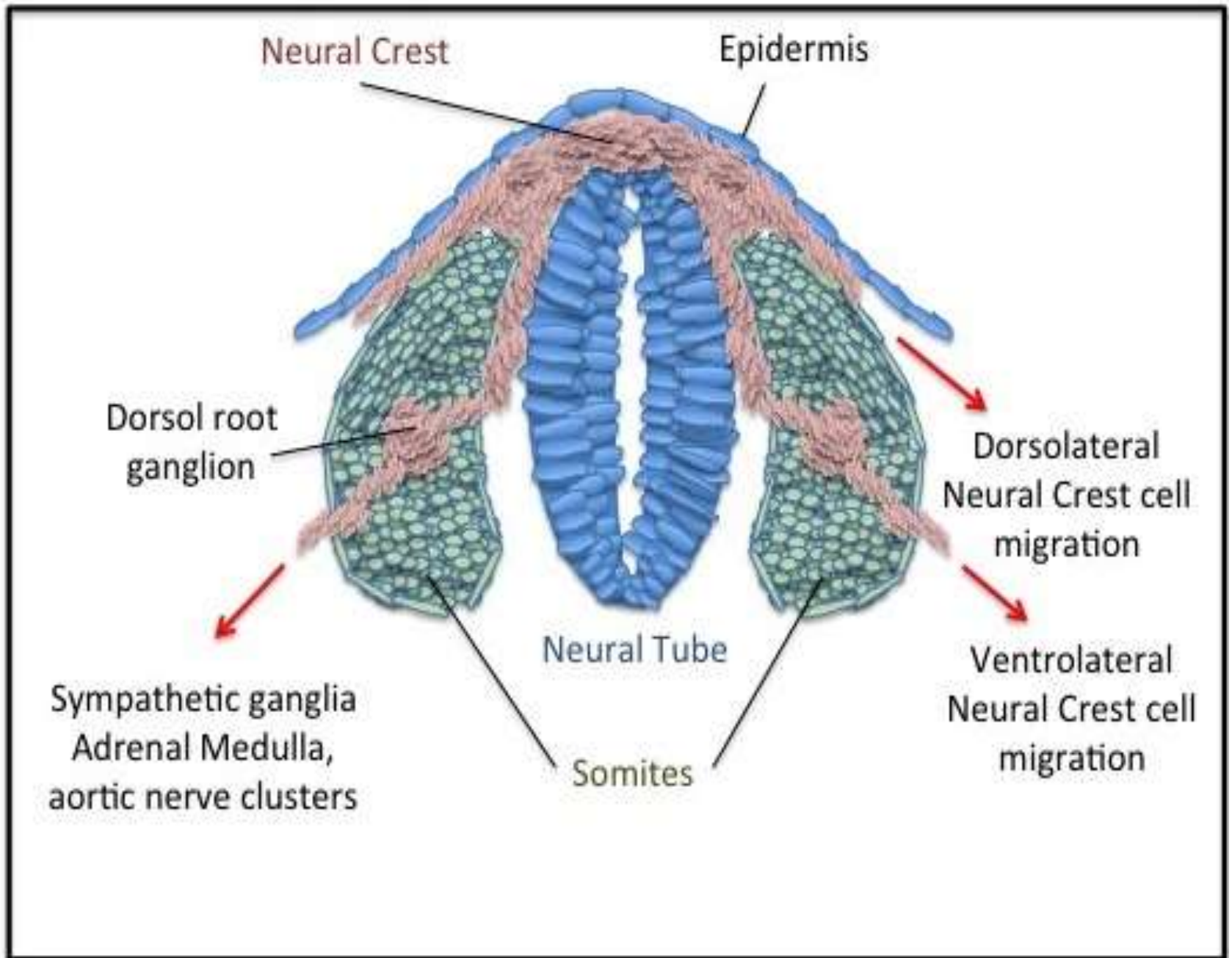


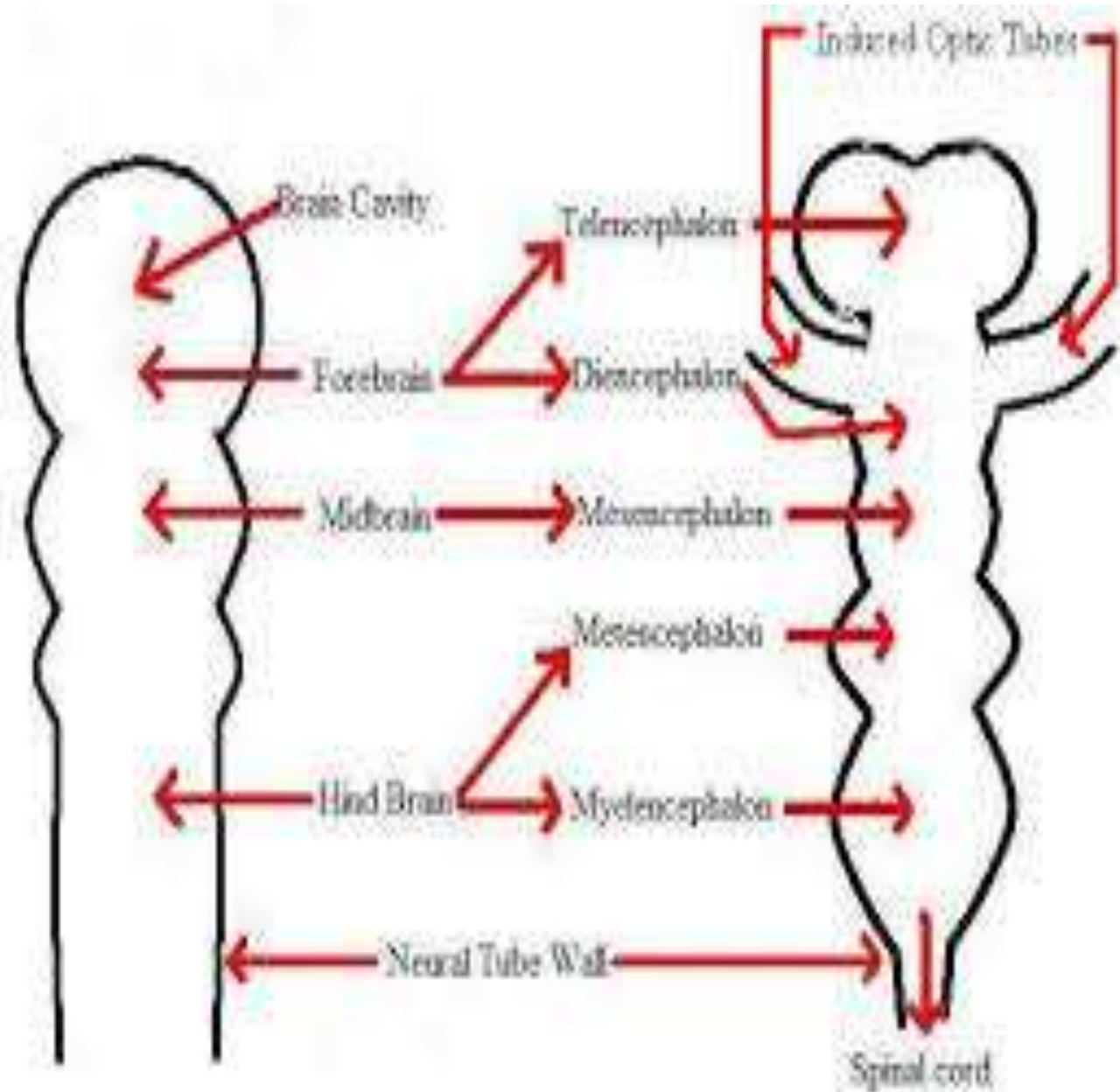
- Neurons and many neuroglial cells are formed in neural tube.
- at first it is lined by a single layer of cells .
- These proliferate to form several layers.
- Nearest the lumen of tube is matrix cell layer (primitive **ependymal or germinal** layer)---this give rise to nerve cells, neuroglial cells, germinal cells.

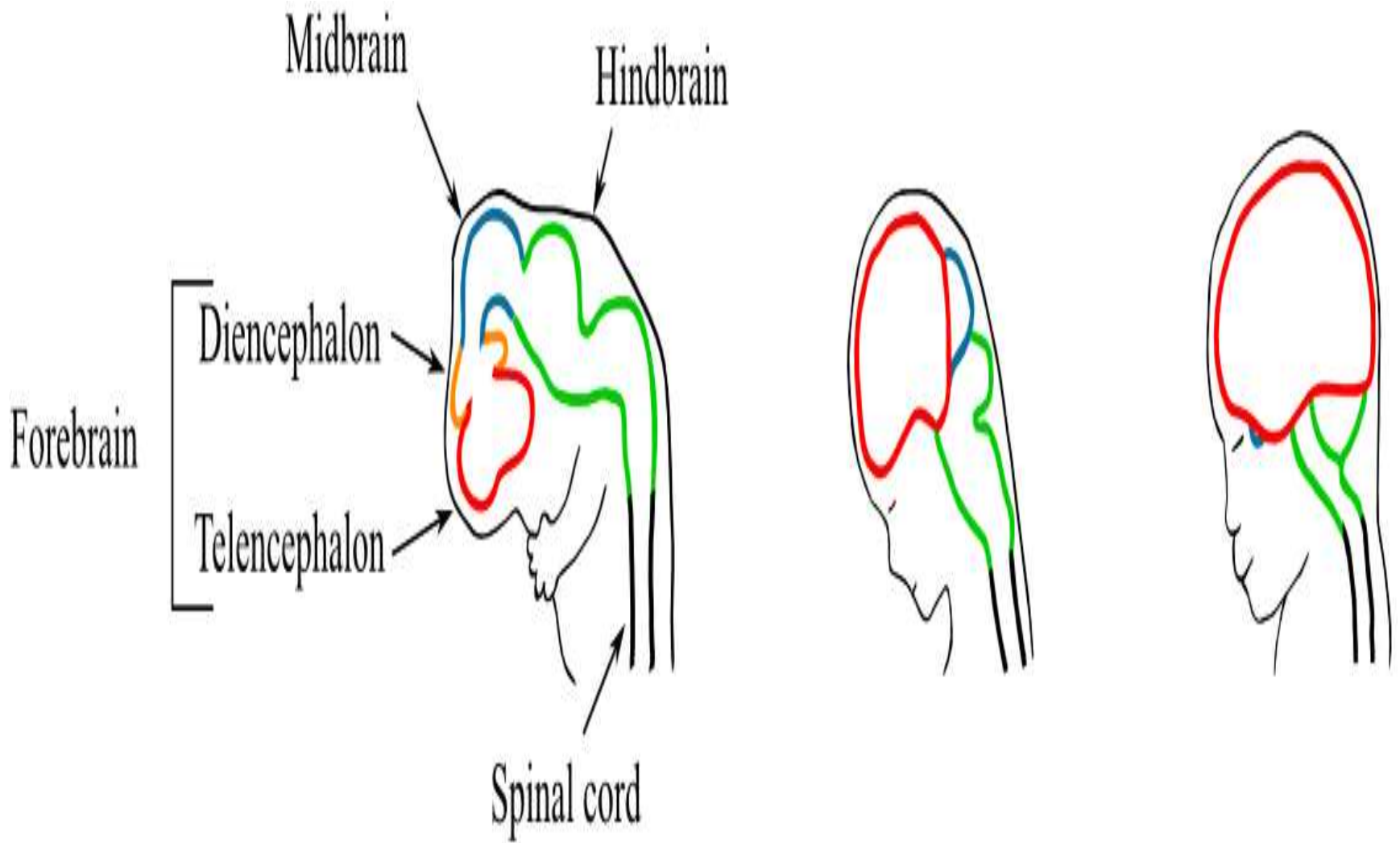
- Next is **mantle layer**---in which developing nerve cells & neuroglial cells are seen.
- outermost layer ---**marginal zone** ---contain no nerve cells, consist of reticulum formed by protoplasmic processes of developing neuroglial cells (**spongioblasts**).this layer provides a framework into which the processes of nerve cells developing in the mantle layer can grow.

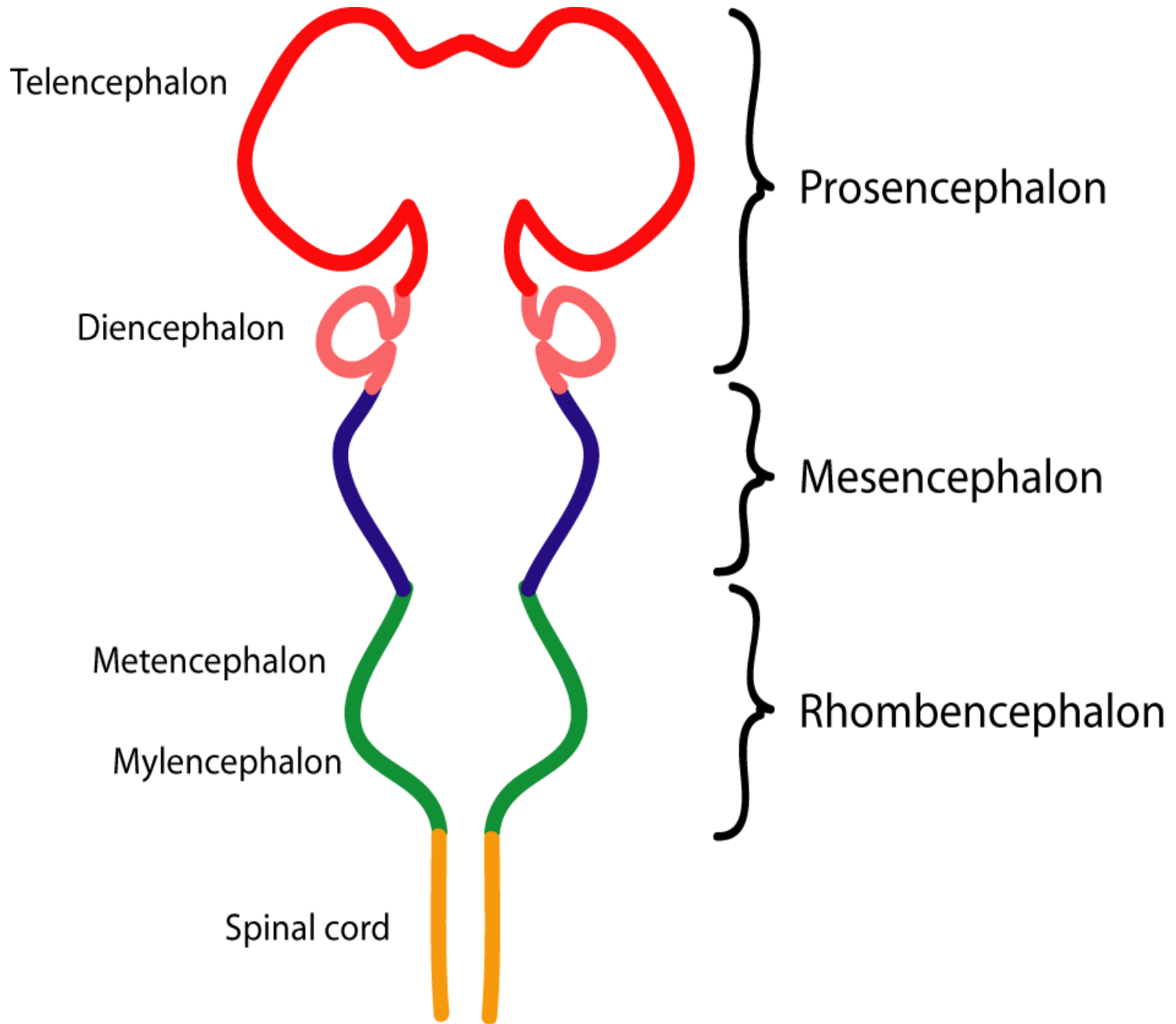






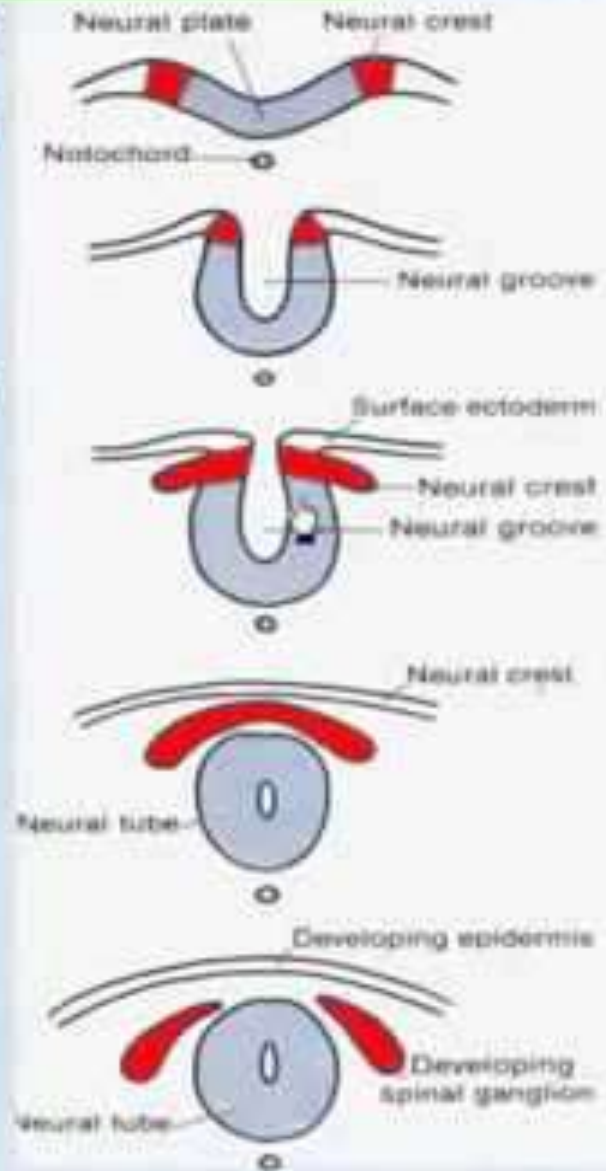
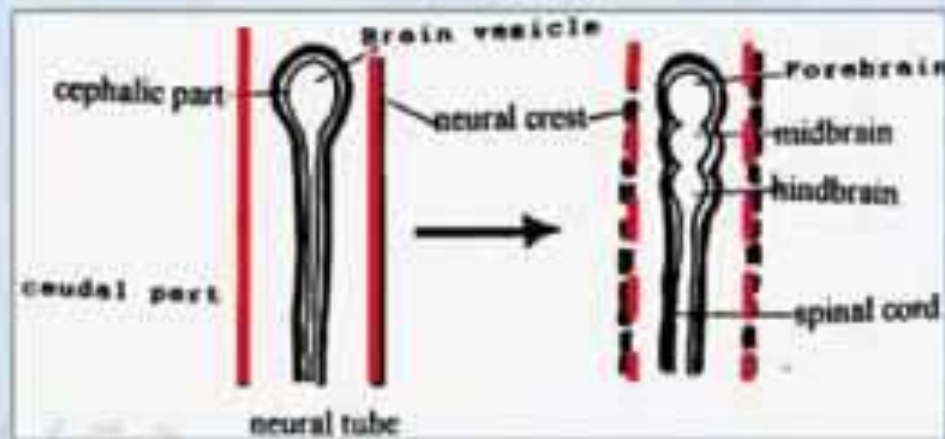






DEVELOPMENT OF NEURAL TUBE

- The neural folds approach each other until the groove becomes converted into a **"neural tube"** which separates from the surface ectoderm.
- The neural tube is at first a simple tube. Later, its cranial end shows 2 constrictions and becomes divided into 3 vesicles: forebrain, midbrain and hindbrain vesicles.



- The stages in formation of nerve cells are as follows.
- one of germinal cells passes from germinal to mantle layer & become **apolar neuroblast**.
- One of processes of neuroblast disappears & it can now be called as **unipolar neuroblast**.
- the process of cell which does not disappear now elongates ,and on opposite side to it numerous small processes form---**multipolar neuroblast**.

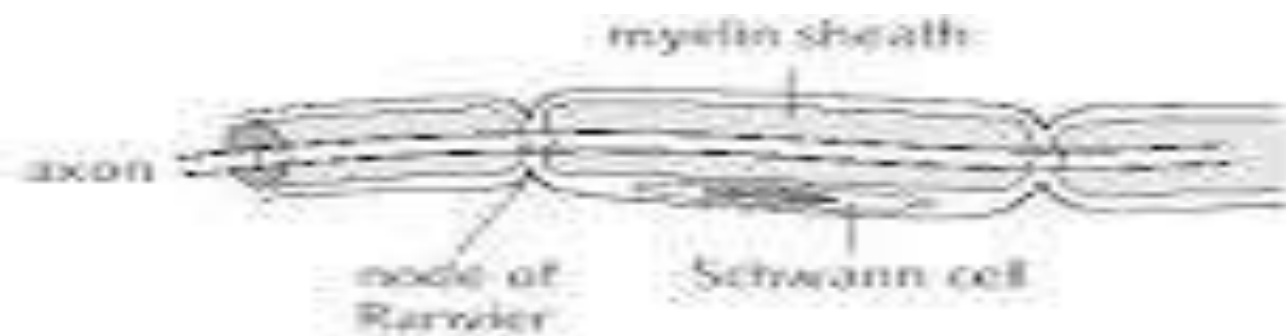
- main process of multipolar neuroblast now grows into marginal layer & becomes axon of nerve cell .
- Axon can grow to considerable length .
- It may either remain within central nervous system or may grow out of it as an efferent nerve fiber of a peripheral nerve. at its destination it establishes connections with cell bodies and dendrites of other neurons or with effecting organ .(muscle)

- The smaller processes of neuroblast are dendrites ,they ramify and establish connections with other nerve cells .
- At first cytoplasm of nerve cell is homogenous ,later nissl's granules make their appearance .after their formation neurons lose ability to divide.

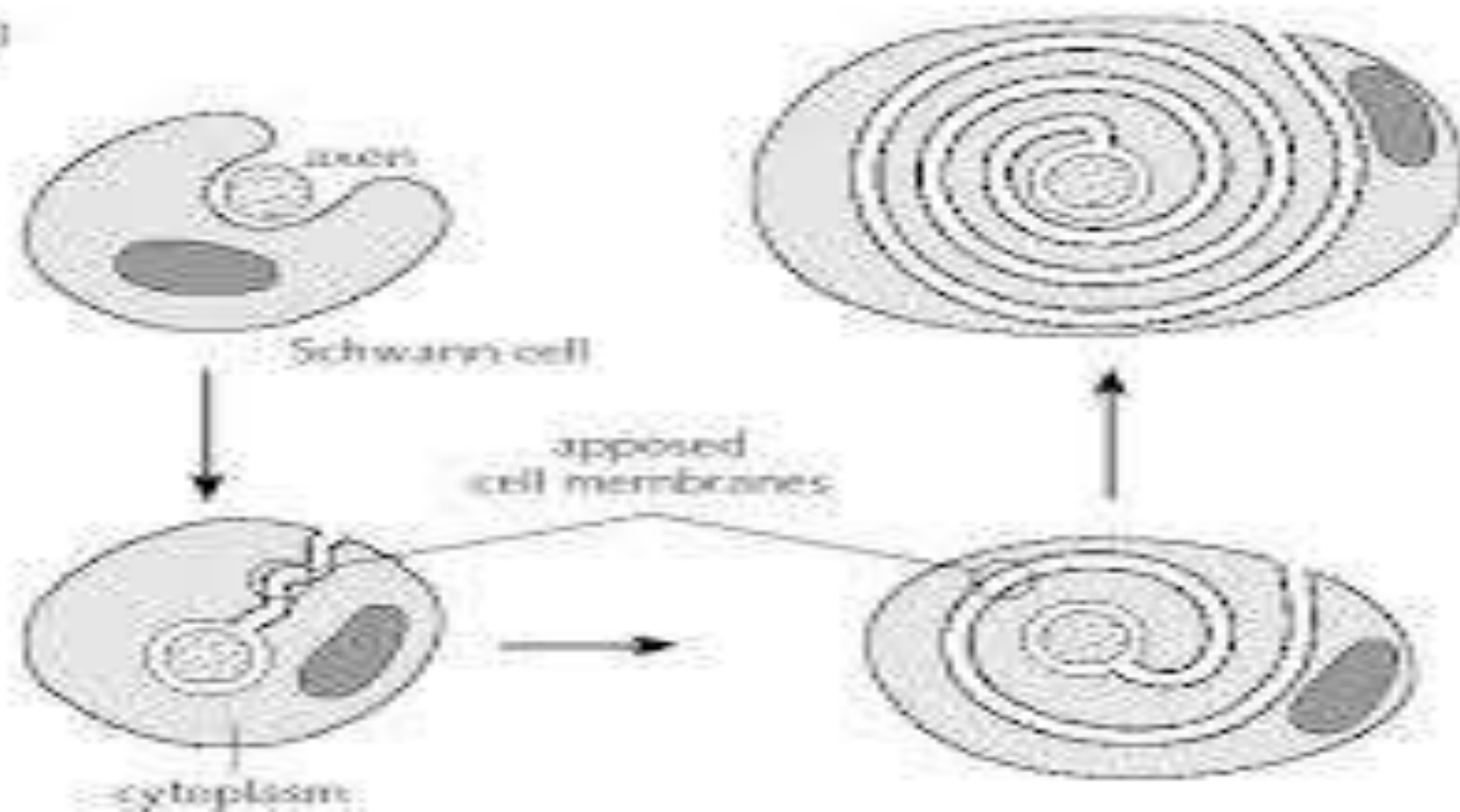
- neuroglial cells are also formed from germinal cells of ependymal layer .
- these cells migrate to mantle & marginal layer /zones as **medulloblasts(or spongioblasts)** which differentiate either into **astroblasts** & subsequently into astrocytes or or **oligodendroblasts** and oligodendrocytes.
- **microglia** type **does not develop from cells of neural tube** ,but migrates into it along with blood vessels .these cells are believed to be of **mesodermal origin**.
- thus **ependymal** / neuroepithelial cells give rise both to neuroblasts and to neuroglia .neuroblasts are formed first , neuroglial cells are formed after differentiation of neuroblasts.

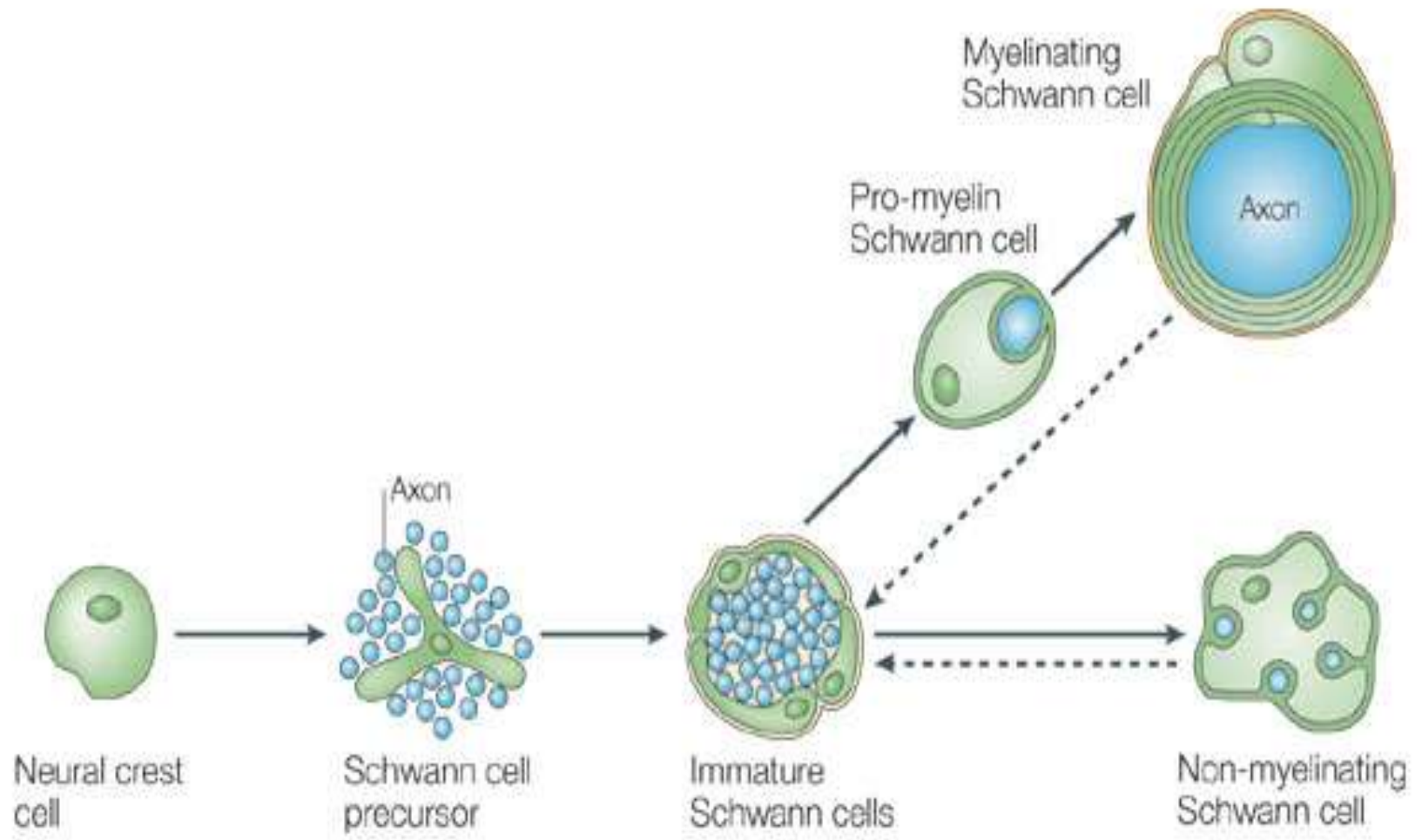
- Myelin sheath ----nerve fibers which remain with in brain and spinal cord , receive support from and are ensheathed by neuroglial cells .
- However nerve fibers ,which leave central nervous system to become constituents of pripheral nerves , aquire a special sheath **called neurilemma** .
- this sheath is derived from some cells of neural crest --**schwann cells**.

(a)



(b)





- At later stage of development , a large no of nerve fibers both inside & outside central nervous system ,develop another sheath between neurolemma and axon ---myelin sheath.
- myelin sheath of peripheral nerves are derived from **schwann cells** (from **neurolemma**)
- In **central nervous system** myelin sheath is formed by neuroglial cells called **oligodendrocytes**

- nerve fibers in different parts of brain and spinal cord become myelinated at different stages of development .
- Process begins at **4th month of intra-uterine** life ,but not completed until child is **2-3yrs old**. Nerve fibers become fully functional only after they have acquired their myelin sheaths.
- Blood vessels of brain & their surrounding connective tissue are not derived from neural tube.these are mesodermal in origin & invade developing brain & spinal cord from surrounding mesoderm.

- pia & arachnoid mater are derived from neural crest cells (leptomeninges) by a school of thought.
- while dura is developing from mesoderm surrounding neural tube.