Lecture (48 and 49)
The embryonic period

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Learning objectives

-Know the sequences that occur from the 3rd to 8th week of development.

-Know derivatives of the ectodermal germ layer.

-Know neurulation.

The embryonic period (period of organogenesis):

1-**Timing**:occurs from the **third to the eighth weeks of development**

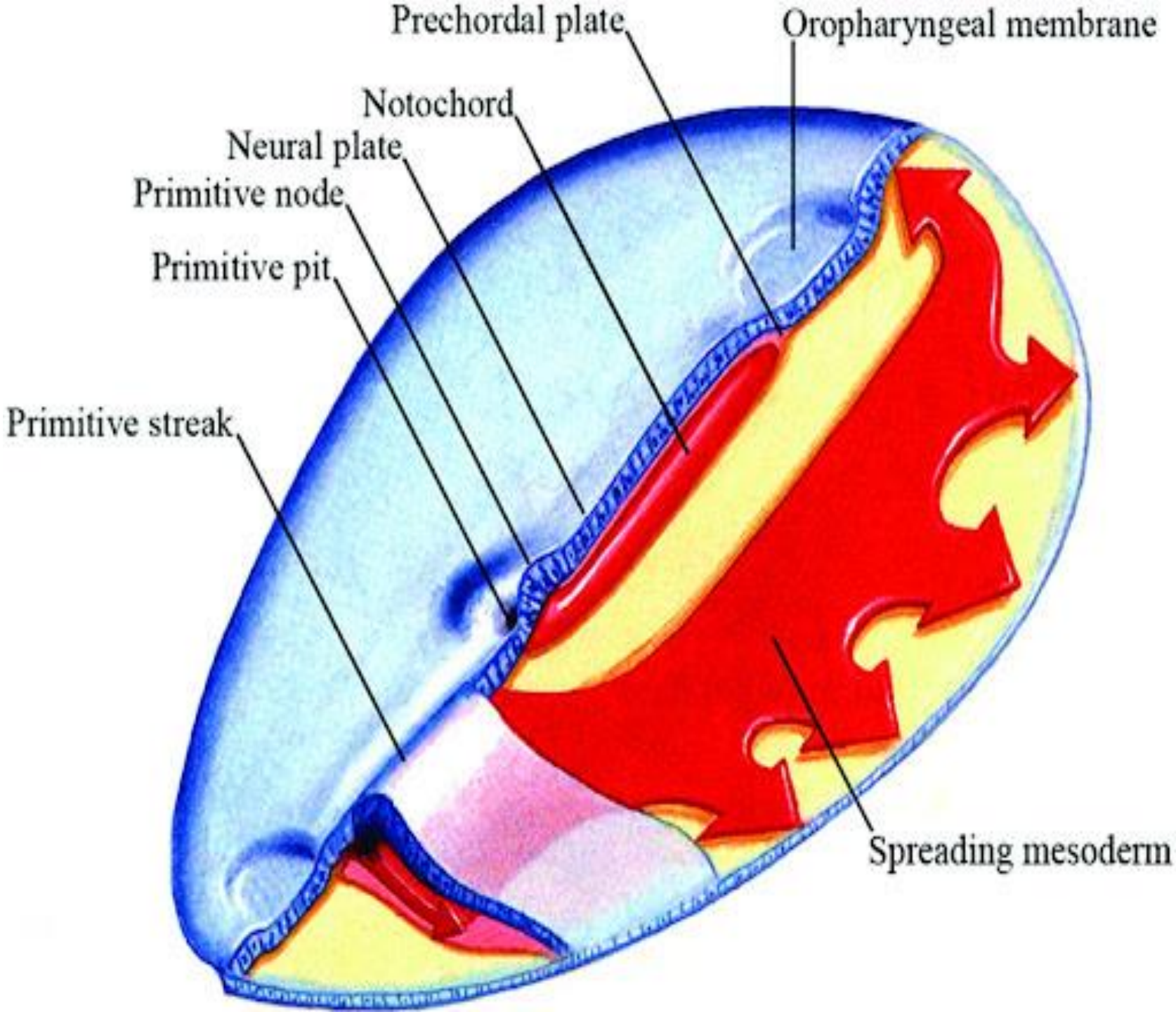
2- **Events at this period**: It is the time when each of the three germ layers, ectoderm, mesoderm, and endoderm, gives rise to several specific tissues and organs. By the end of the embryonic period, the main organ systems have been established, and the major external body features can be recognizable by the **end of the second month**.

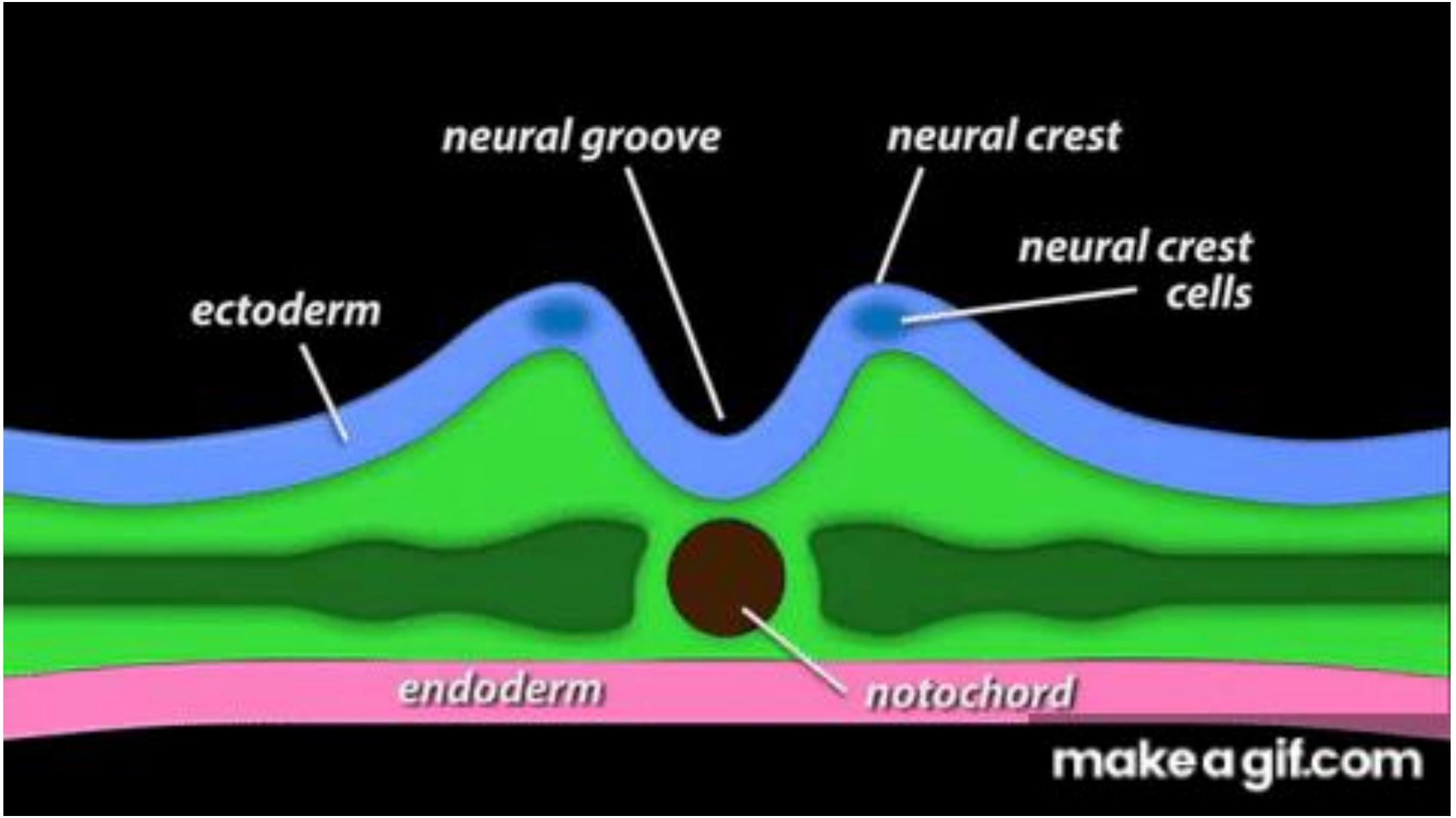
3-Importance of the embryonic period: It is highly sensitive period for the occurrence of congenital malformations (teratogensis).

Derivatives of the ectodermal germ layer:

1-At the beginning of the third week of development, the ectodermal germ layer has the shape of a disc that is broader in the cephalic than in the caudal region.

2-Appearance of the **notochord and prechordal mesoderm** induces the overlying ectoderm to thicken and form the **neural plate** .Cells of the plate make up the neuroectoderm, and their induction represents the initial event in the process of **neurulation**.


Prechordal plate
Oropharyngeal membrane
Notochord
Neural plate
Primitive node
Primitive pit
Primitive streak
Spreading mesoderm

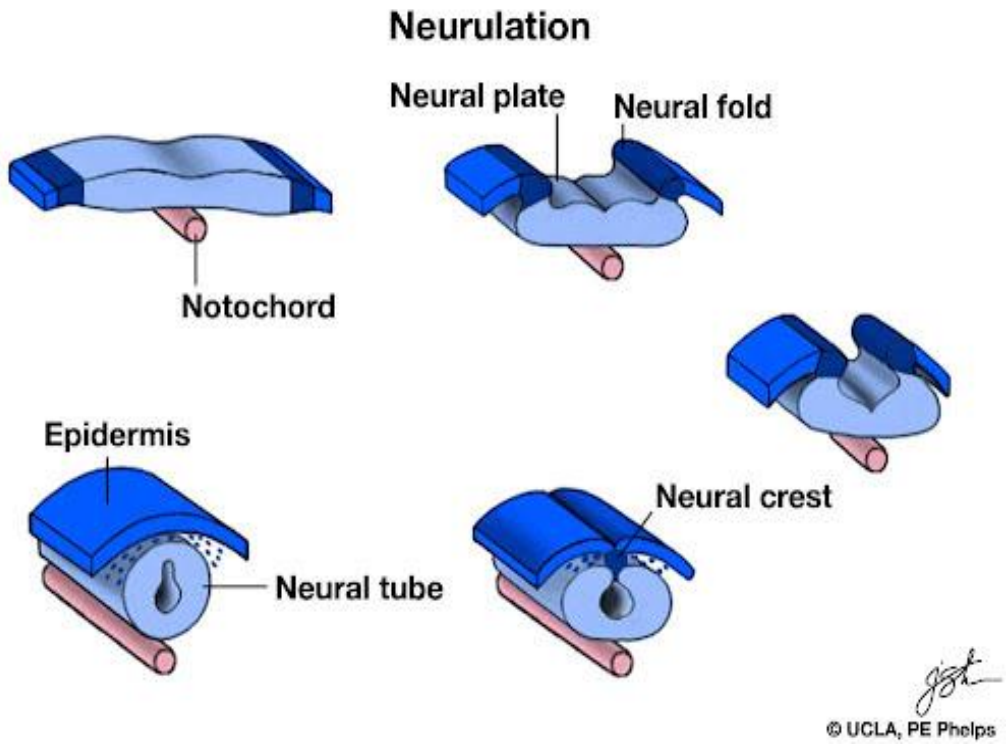

neural groove
neural crest
neural crest cells
ectoderm
endoderm
notochord
makeagif.com

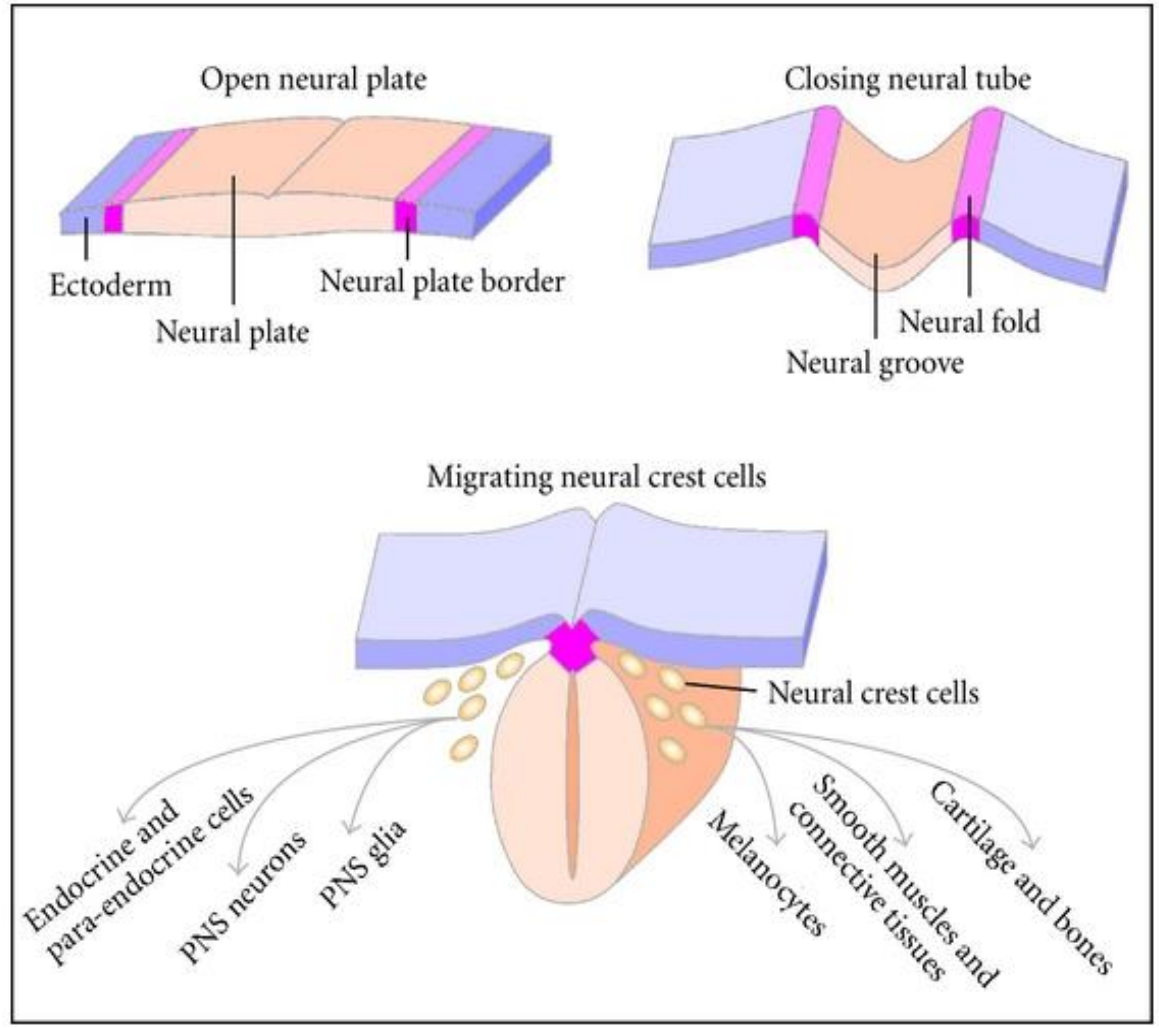
3- Neurulation:

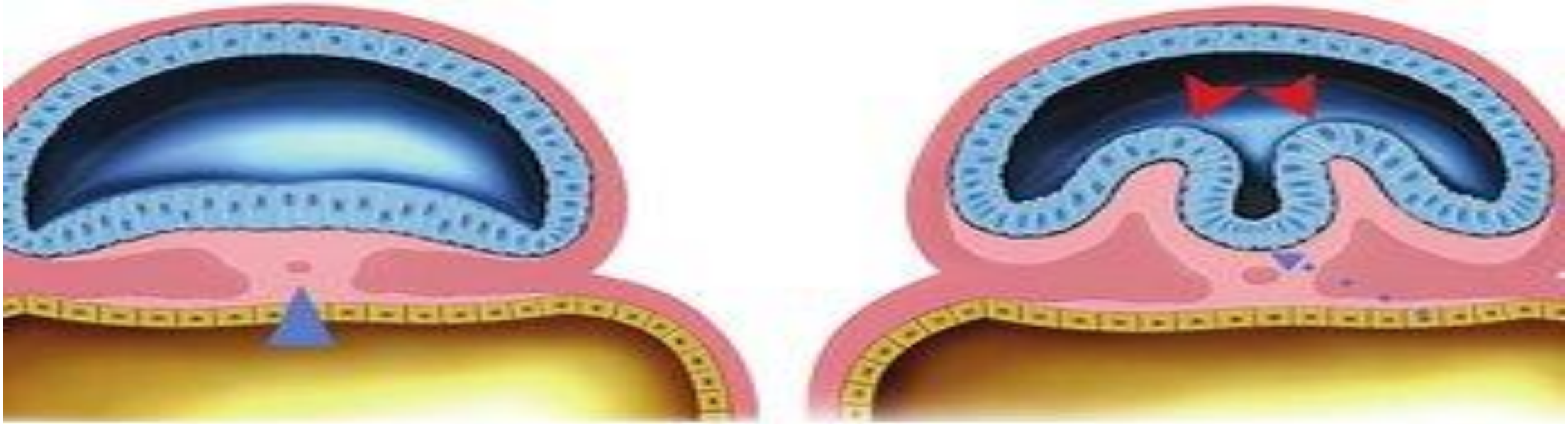
-Definition: It is the process of formation of neural tube.

- **Timing** :At **nineteenth day(19) of development.**
- **Stages:**

A- By the ***end of the third week***, the lateral edges of the neural plate become elevated to form **neural folds**, and the depressed mid region forms the **neural groove**.


Neurulation
Neural plate
Neural fold
Notochord
Epidermis
Neural tube
Neural crest
© UCLA, PE Phelps

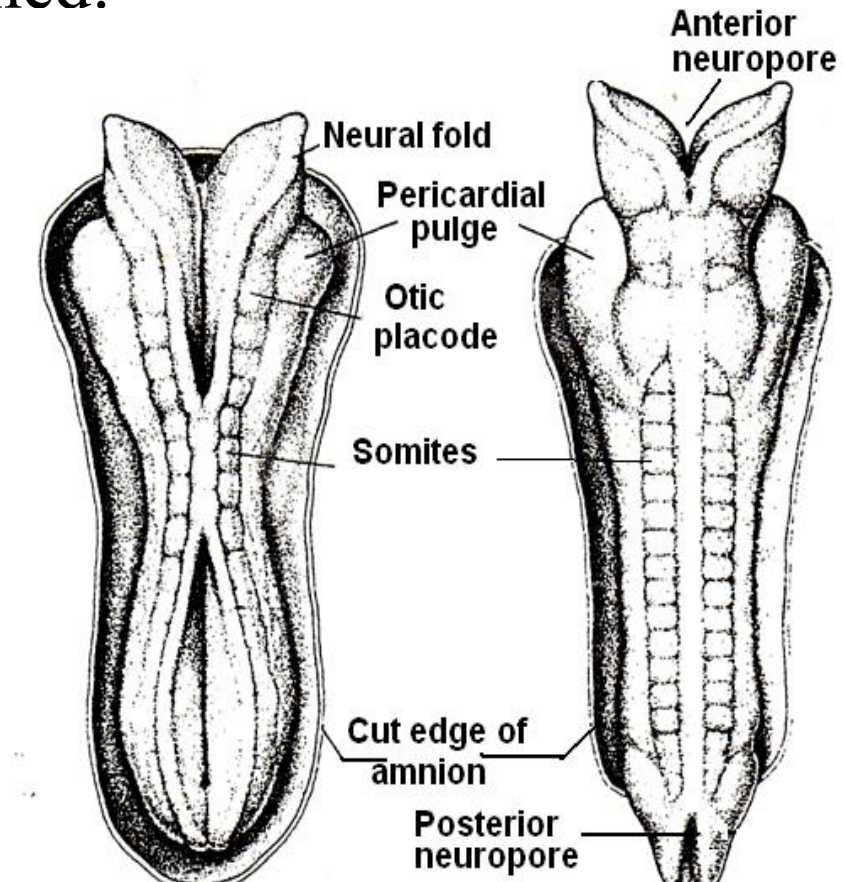

Open neural plate
Ectoderm
Neural plate
Neural plate border
Closing neural tube
Neural fold
Neural groove
Migrating neural crest cells
Neural crest cells
Endocrine and para-endocrine cells
PNS neurons
PNS glia
Melanocytes
Smooth muscles and connective tissues
Cartilage and bones



b.

d.

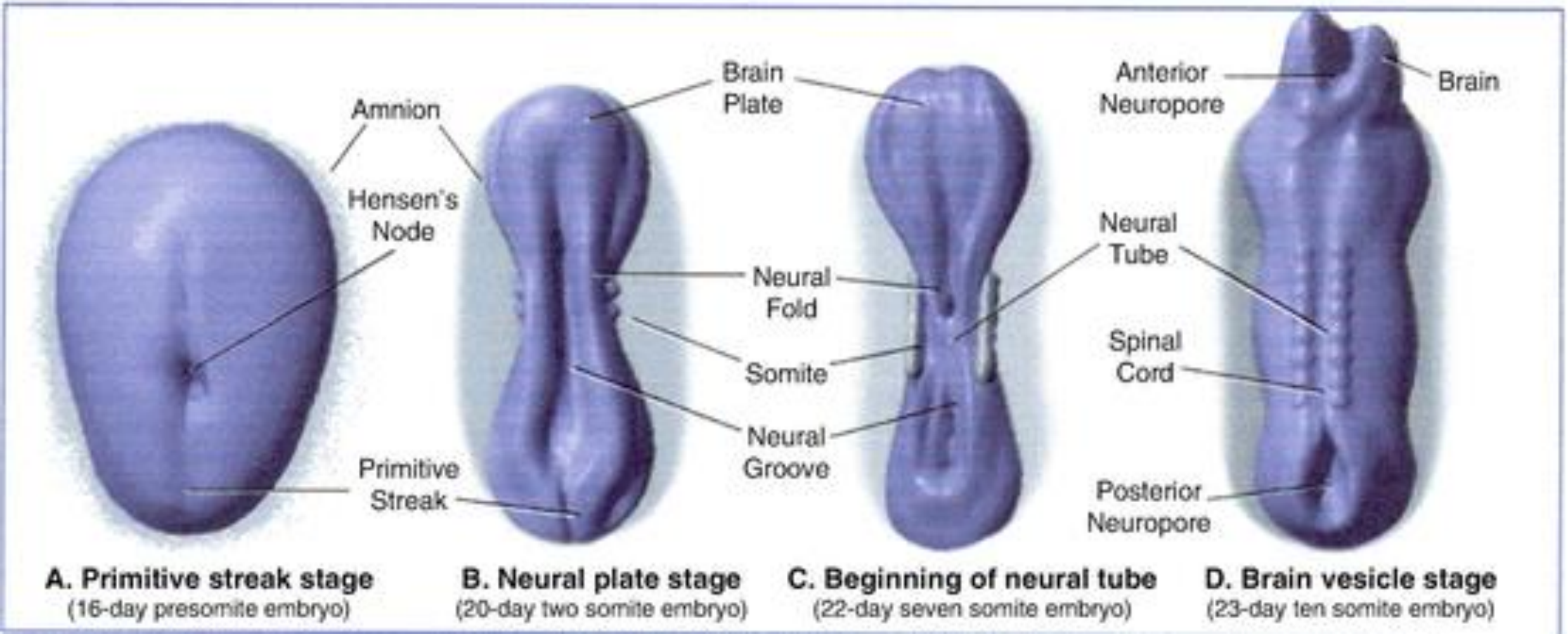
-B-Gradually, the neural folds approach each other in the midline, where they fuse . Fusion begins in the cervical region (fifth somite) and proceeds cranially and caudally .As a result, the **neural tube** is formed.

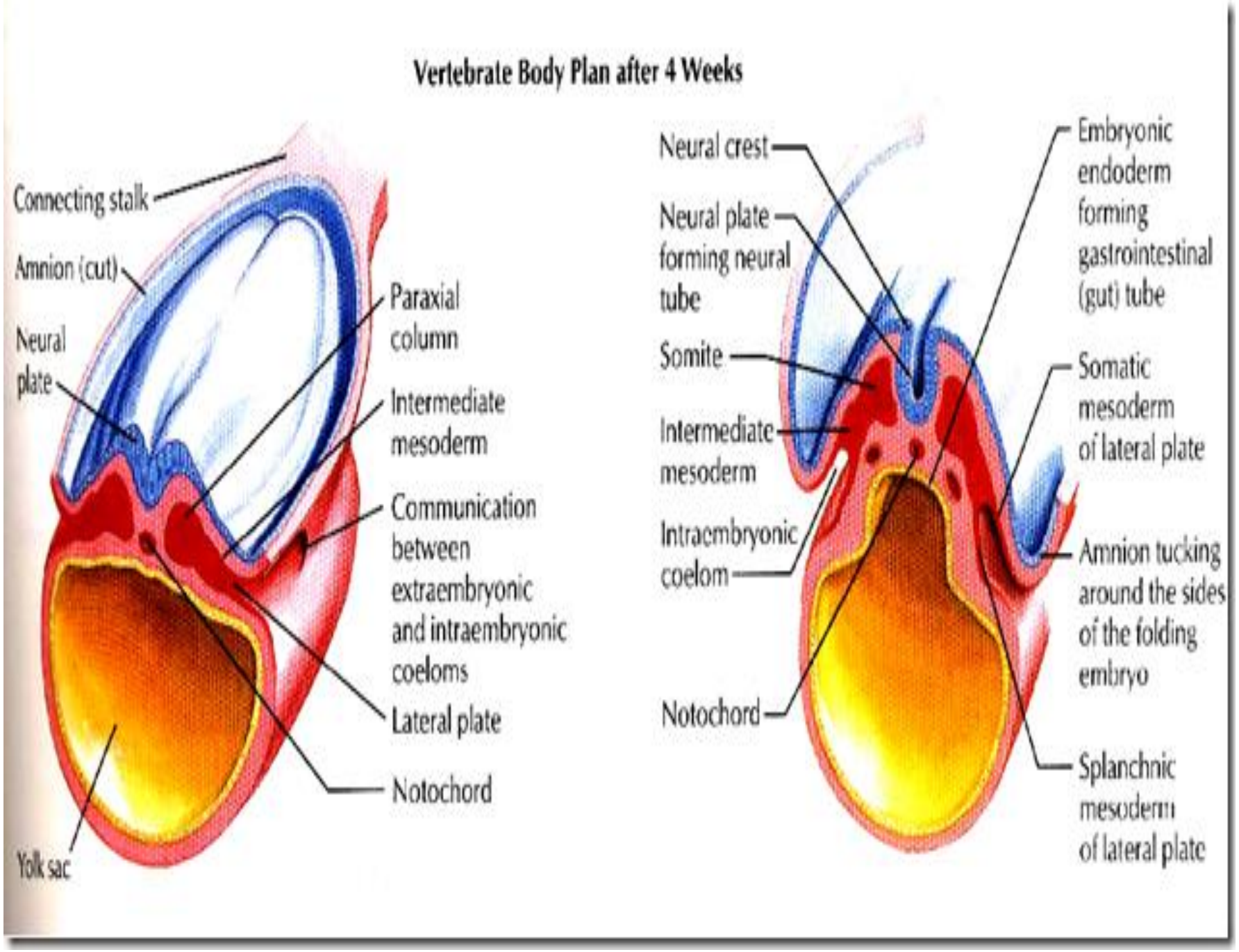


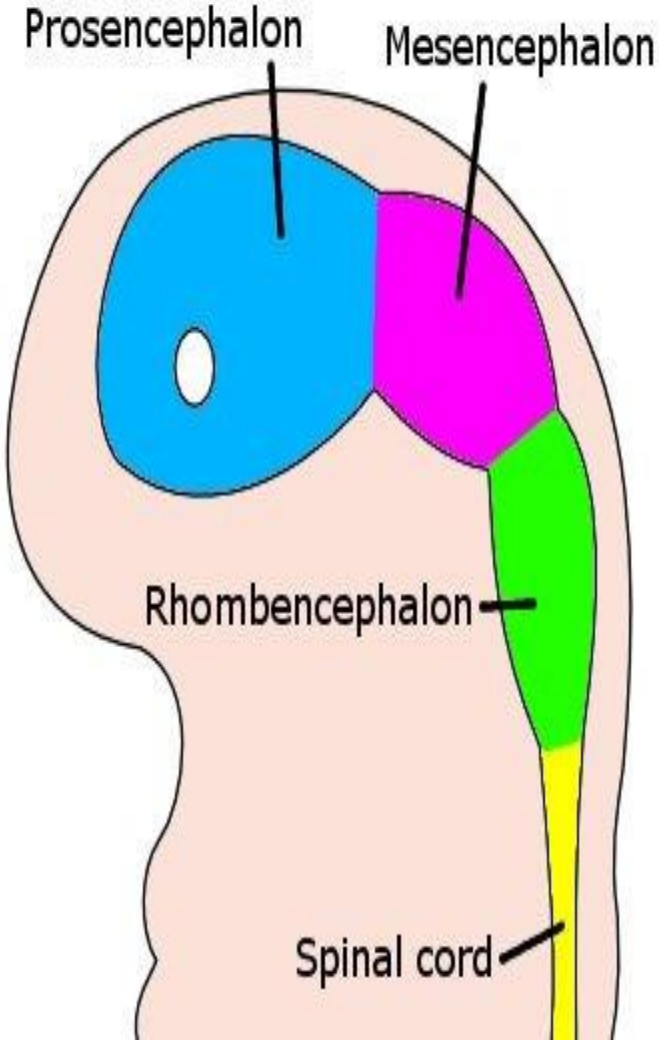
-C-Until fusion is complete, the cephalic and caudal ends of the neural tube communicate with the amniotic cavity by way of the anterior (cranial) and posterior (caudal) neuropores.

-D-Closure of the **cranial neuropore** occurs at approximately **day 25** (18- to 20-somite stage), whereas the **posterior neuropore** closes at day 28 (25-somite stage)

-E- Neurulation is then complete, and the central nervous system is represented by a closed tubular structure with a **narrow caudal portion, the spinal cord**, and a much broader cephalic portion characterized by several dilations **(3)**, **the brain vesicles (forebrain, midbrain and hindbrain)**.


Amnion
Hensen's Node
Primitive Streak
Brain Plate
Neural Fold
Somite
Neural Groove
Anterior Neuropore
Brain
Neural Tube
Spinal Cord
Posterior Neuropore
A. Primitive streak stage
(16-day presomite embryo)
B. Neural plate stage
(20-day two somite embryo)
C. Beginning of neural tube
(22-day seven somite embryo)
D. Brain vesicle stage
(23-day ten somite embryo)


Vertebrate Body Plan after 4 Weeks
Connecting stalk
Amnion (cut)
Neural plate
Paraxial column
Intermediate mesoderm
Communication between extraembryonic and intraembryonic coeloms
Lateral plate
Notochord
Yolk sac
Neural crest
Neural plate forming neural tube
Somite
Intermediate mesoderm
Intraembryonic coelom
Notochord
Embryonic endoderm forming gastrointestinal (gut) tube
Somatic mesoderm of lateral plate
Amnion tucking around the sides of the folding embryo
Splanchnic mesoderm of lateral plate


Prosencephalon
Mesencephalon
Rhombencephalon
Spinal cord

- **Anomalies (neural tube defects) (NTDs)**

1- ***Spina bifida :*** it consists of splitting of vertebral arches with or without involvement of underlying neural tissue.

(A) Spina bifida occulta: it is a defect in the vertebral arches that covered by skin and usually **does not** involve the neural tissue. It occurs in the lumbosacral region and usually marked by a patch of hair **without neurological deficit**.

(B) Spina bifida cystica (Manifesta):

-It is a severe type of NTDs in which the neural tissue and meninges protrude through defect in the vertebral arches and skin. Mostly, it occur in the **lumbosacral region with neurological deficit.**

- **Types:**

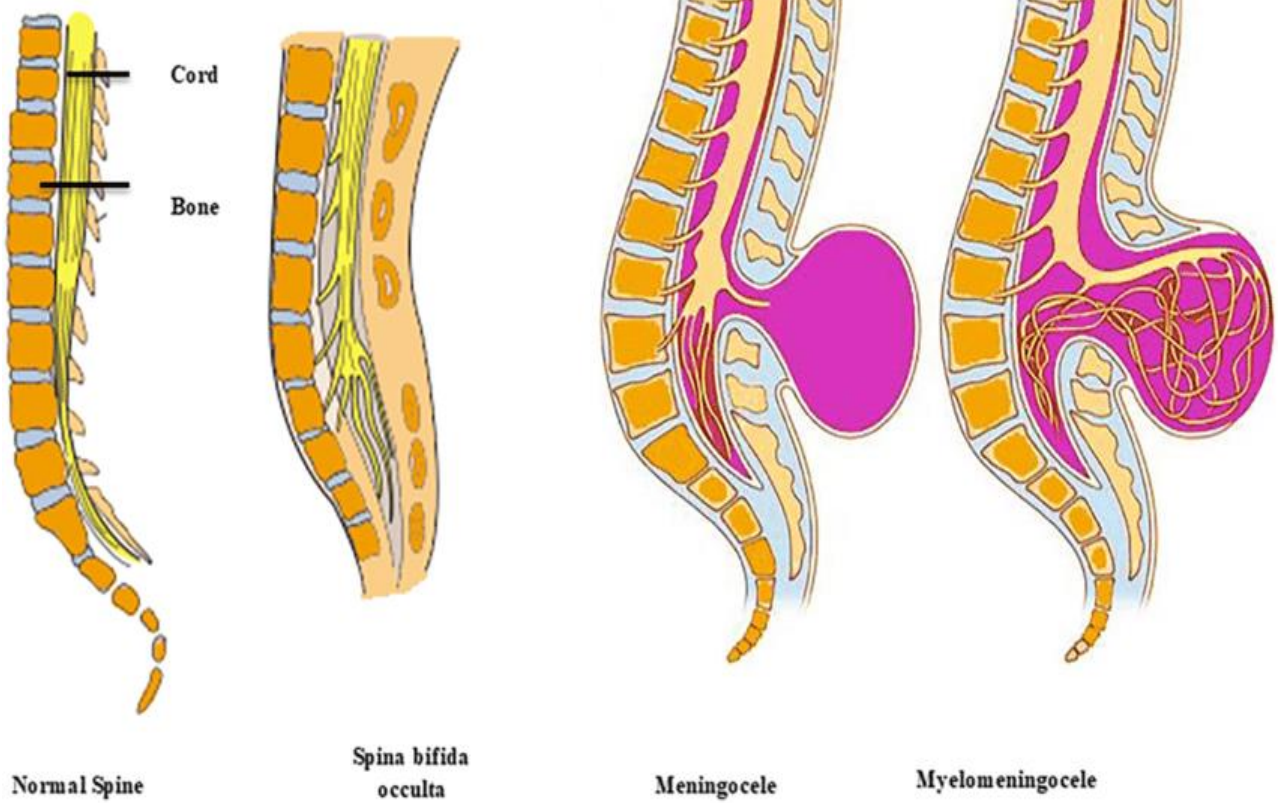
1- **Meningocele**: only fluid filled meninges protrude through the defect.

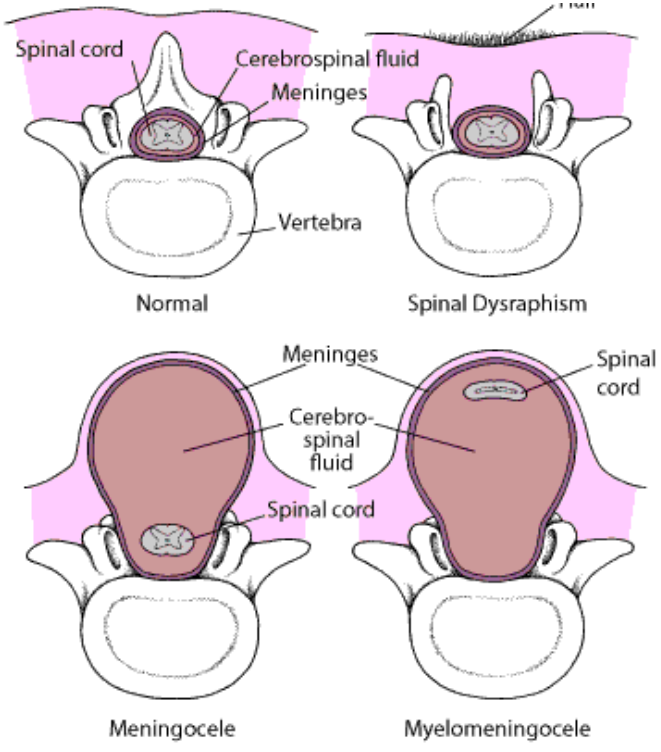
2- **Meningeomylocele**: meninges and neural tissue protrude through the defect.

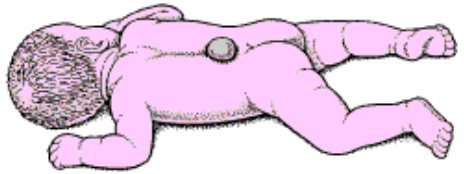
3- **Myeloschisis (Rachischisis)**: The neural fold do not elevate and remain as flattened mass of neural tissue.

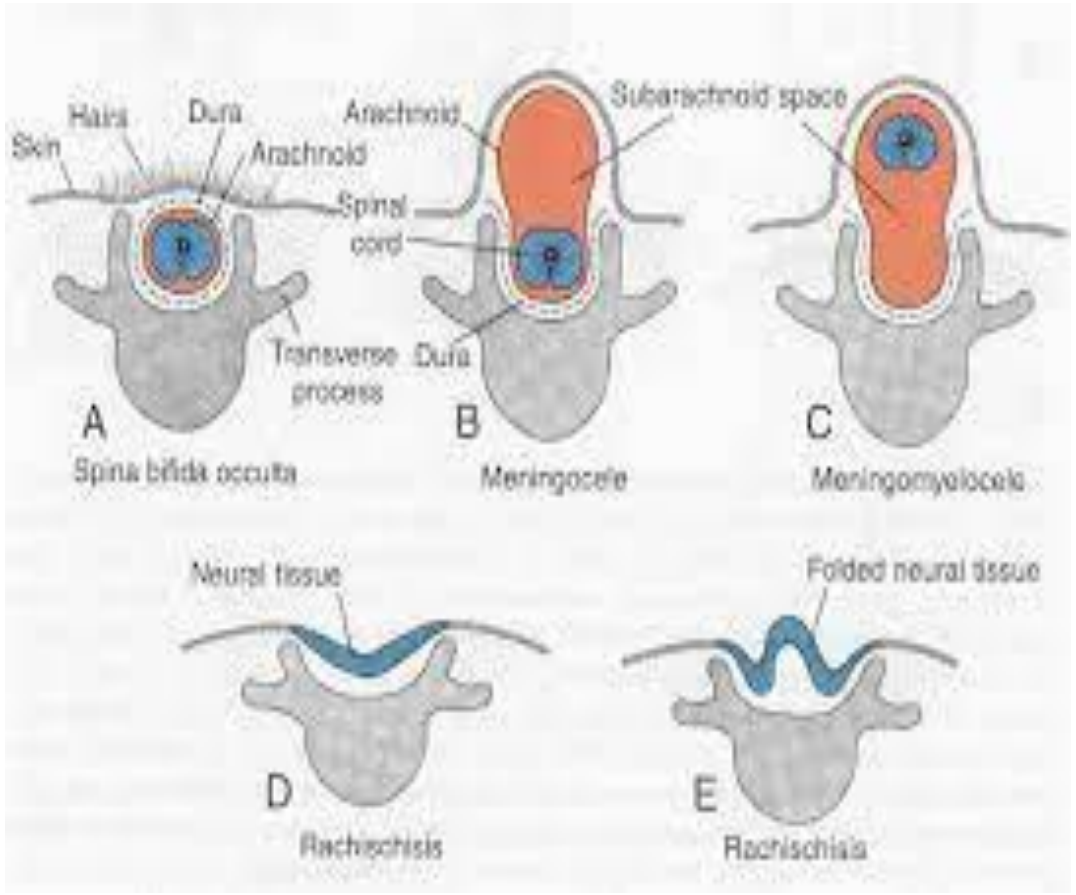
- Diagnosis

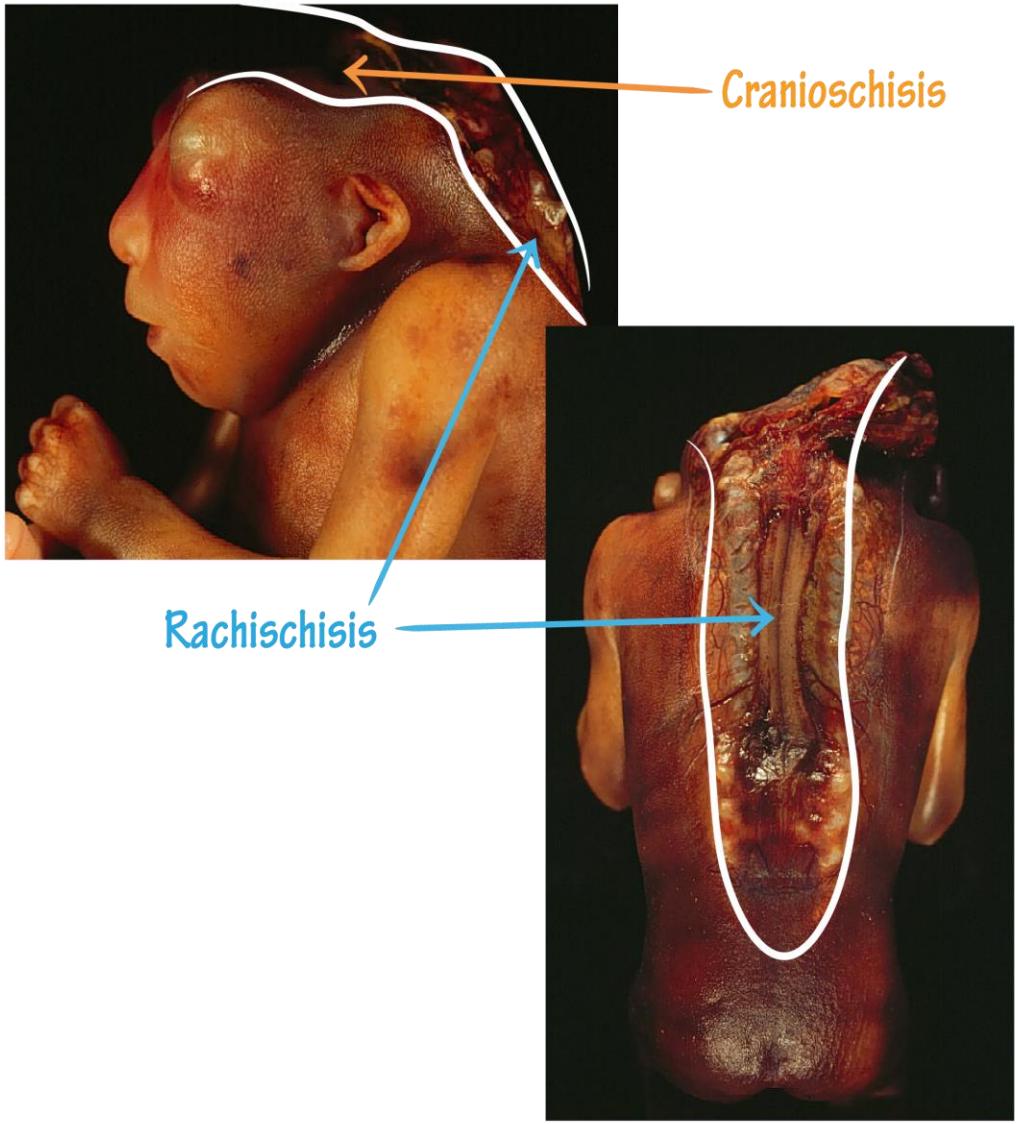
It can be diagnosed with ultrasound and determination of α fetoprotein level.

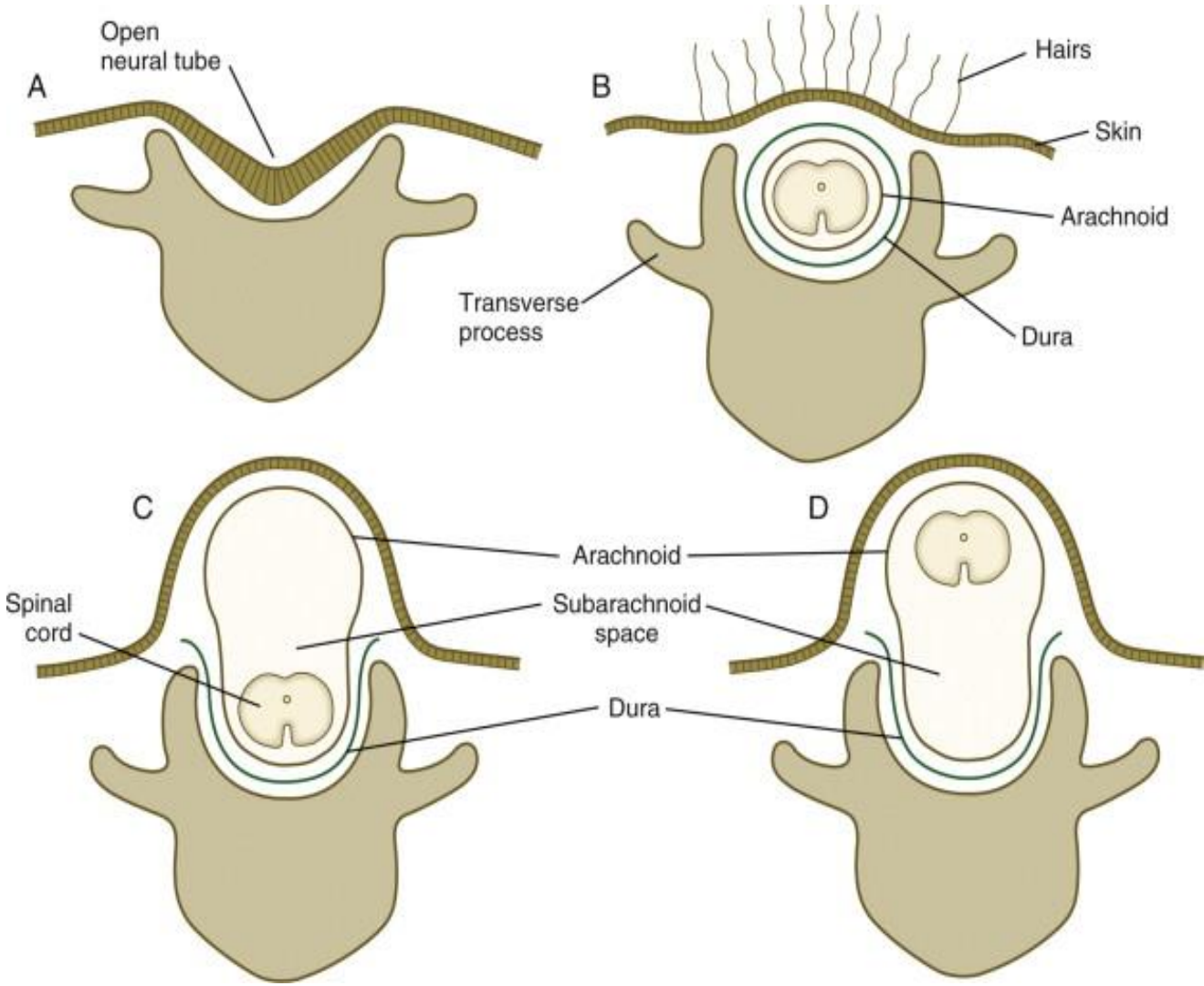







Skin
Hairs
Dura
Arachnoid
Arachnoid
Subarachnoid space
Spinal cord
Transverse process
Dura
A
Spina bifida occulta
B
Meningocele
C
Meningomyelocele
Neural tissue
Folded neural tissue
D
Rachischisis
E
Rachischisis


Cranioschisis
Rachischisis


A
Open
neural tube
B
Hairs
Skin
Arachnoid
Transverse
process
Dura
C
D
Arachnoid
Spinal
cord
Subarachnoid
space
Dura

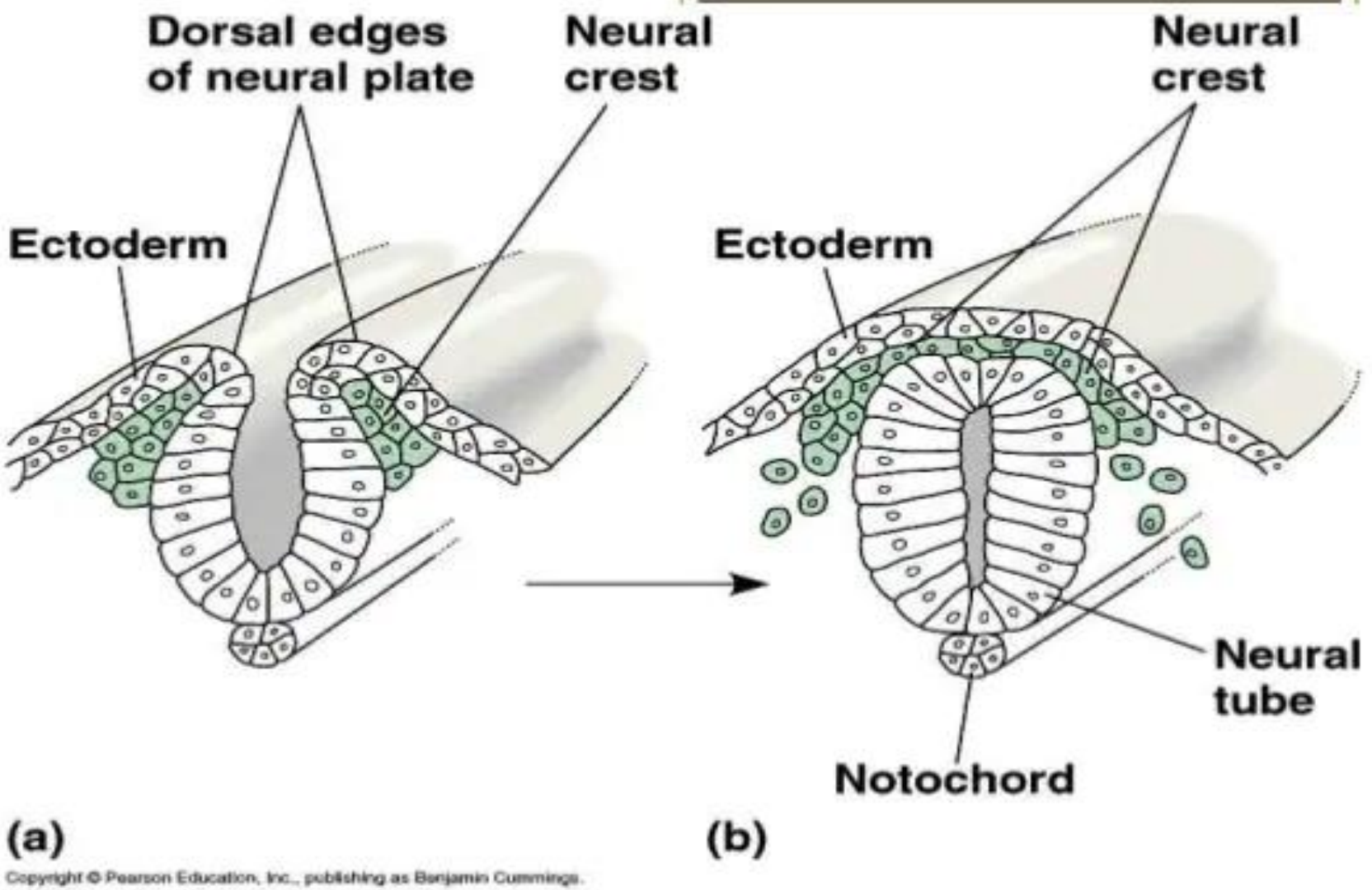
2- Anencephaly:

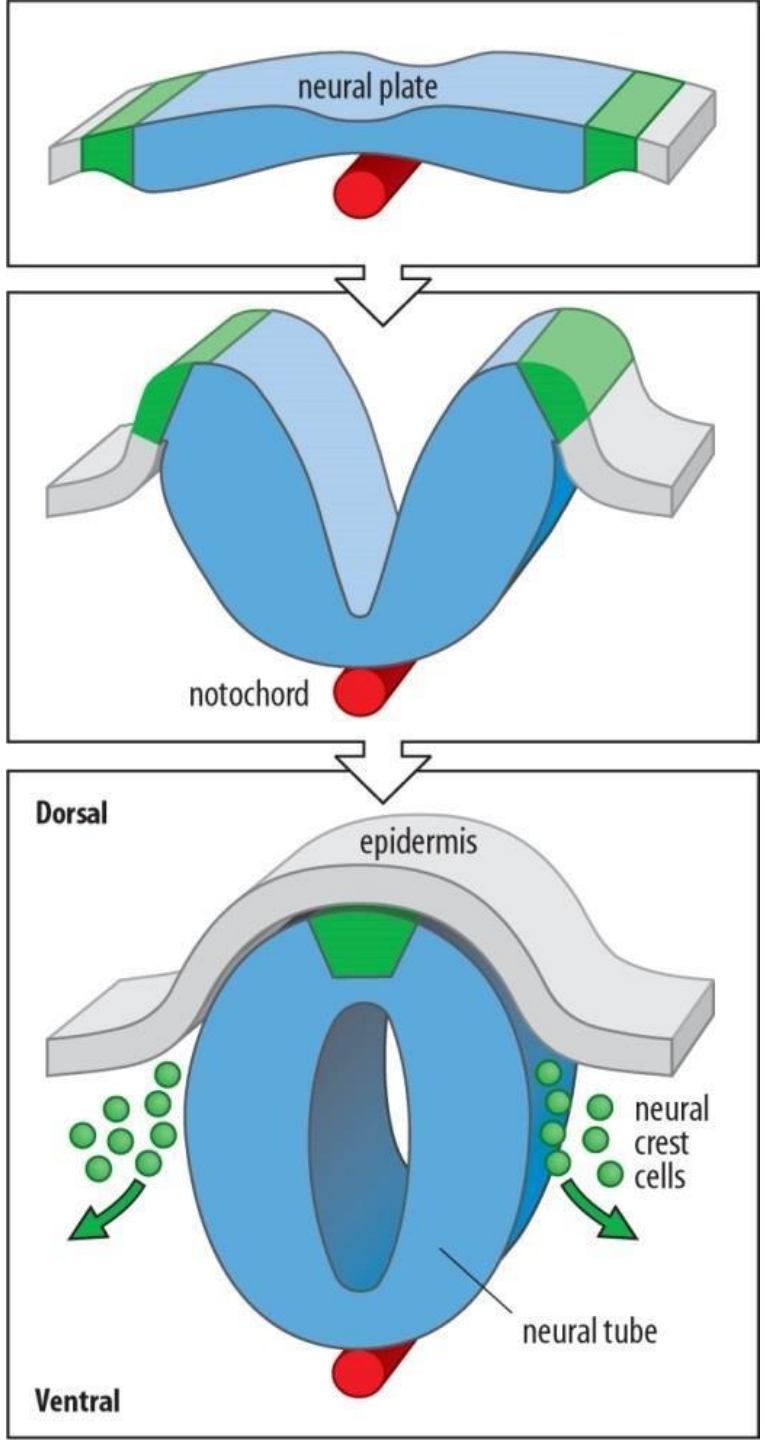
-It is characterized by failure of closure of the cephalic part of neural tube. As a result, the vault of skull does not form leaving malformed brain tissue exposed.

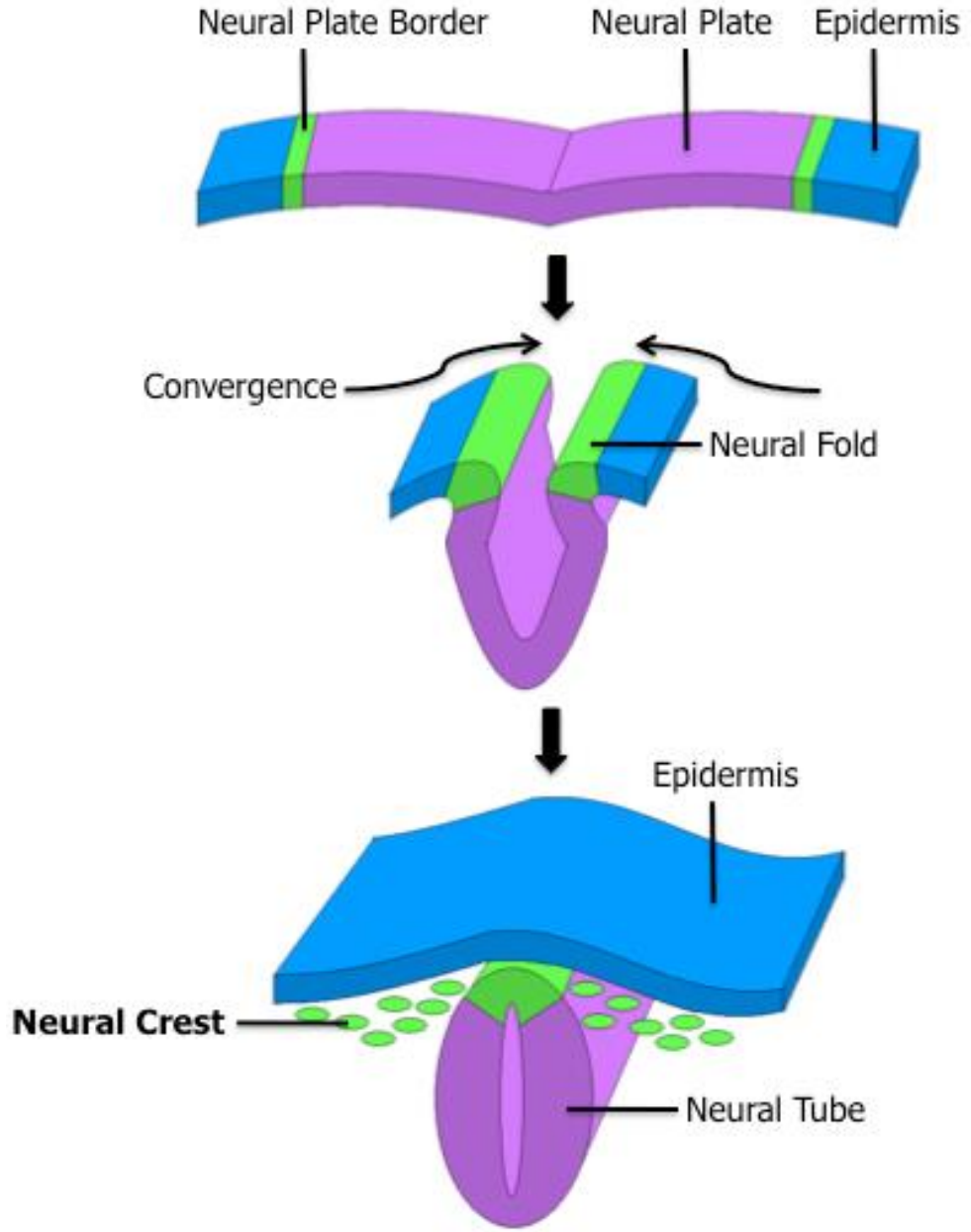
Neural crest cells :

A- **Formation:**

- As the neural folds elevate and fuse, cells at the lateral border or crest of the neuroectoderm begin to dissociate from their neighbors. This cell population, **the neural crest cells.**
- They will undergo an **epithelial-to-mesenchymal transition** as it leaves the neuroectoderm and displacement to enter the underlying **mesoderm (intraembryonic)**. The **Mesenchyme** refers to loosely organized embryonic connective tissue regardless of origin. It is **considered as the fourth germ layer.**




neural plate
notochord
Dorsal
epidermis
neural
crest
cells
neural tube
Ventral


Neural Plate Border
Neural Plate
Epidermis
Convergence
Neural Fold
Epidermis
Neural Crest
Neural Tube

B-Derivatives:

1. Pseudo unipolar ganglion cells of the spinal and cranial nerve ganglia.
2. Schwann cells (neurolemmal sheath cells that form myelin in the PNS).
3. Multipolar ganglion cells of the autonomic ganglia.
4. Leptomeninges (pia-arachnoid).
5. Chromaffin cells of the suprarenal medulla.

6. Pigment cells (melanocytes)& iris pigment cells.

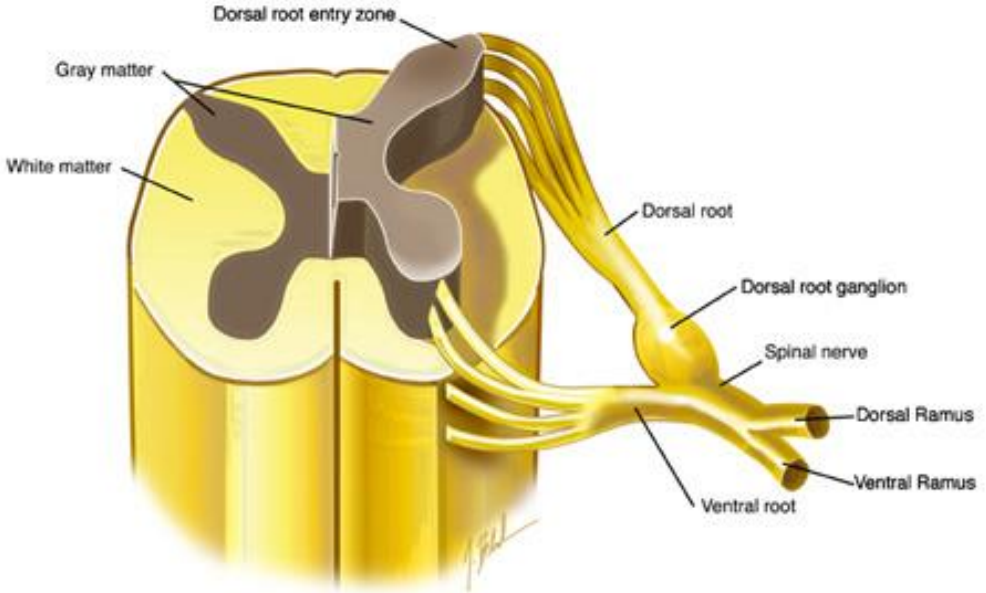
7. Odontoblasts (dentine-forming cells).

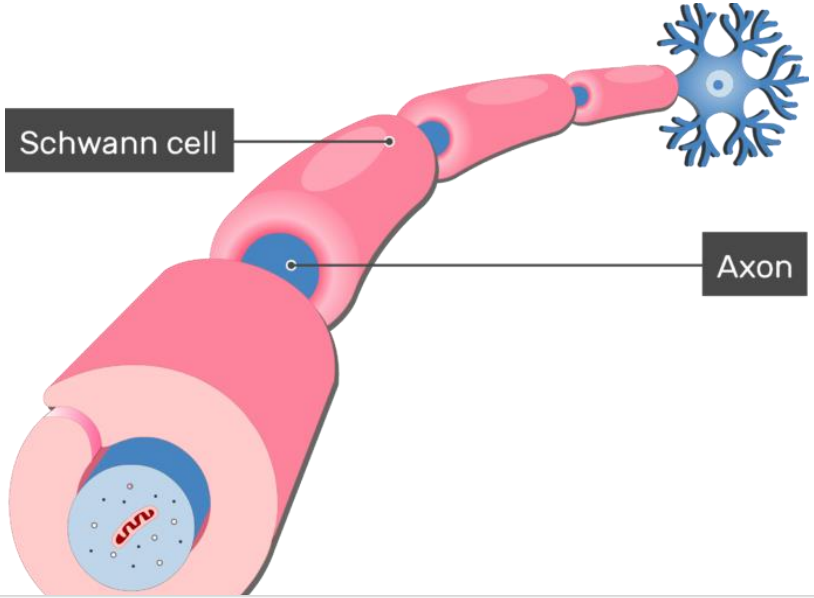
8. Skeletal and connective components of the pharyngeal arches.

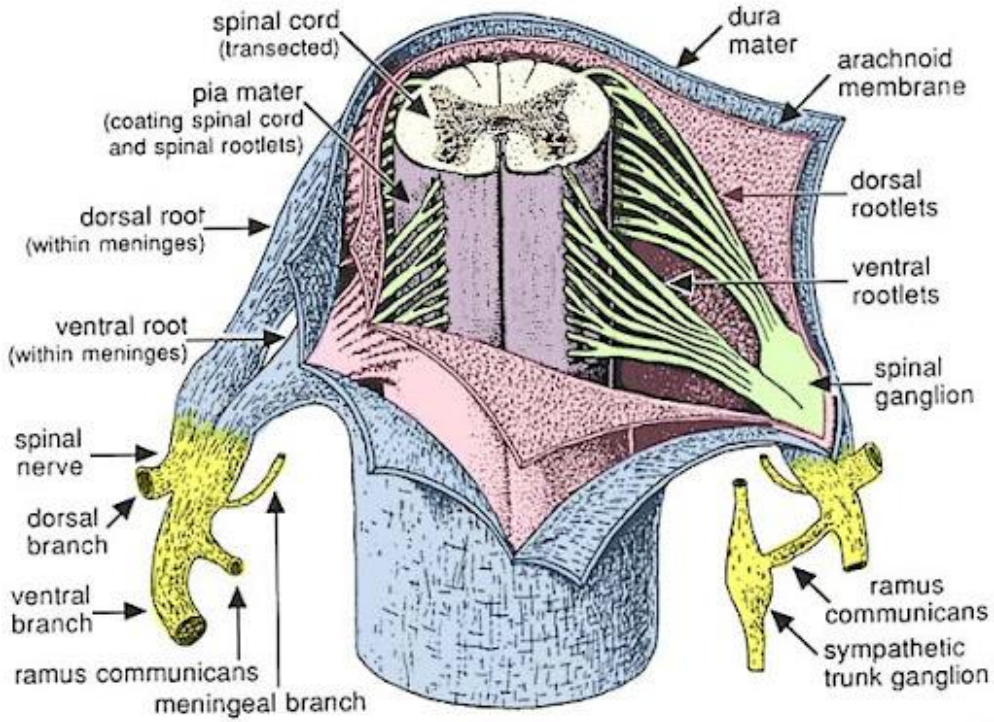
N.B. The original mesoderm of the pharyngeal arches gives rise to the pharyngeal muscles.

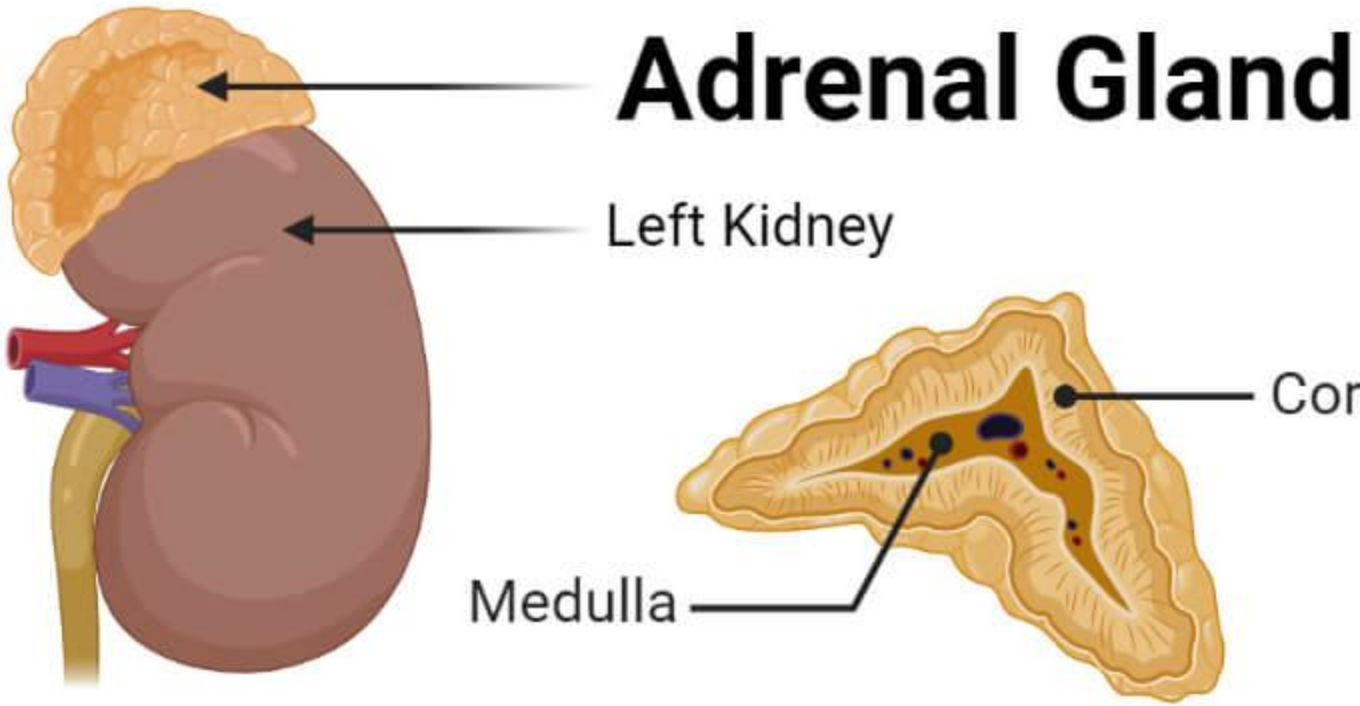
9. Aorticopulmonary septum of the heart.

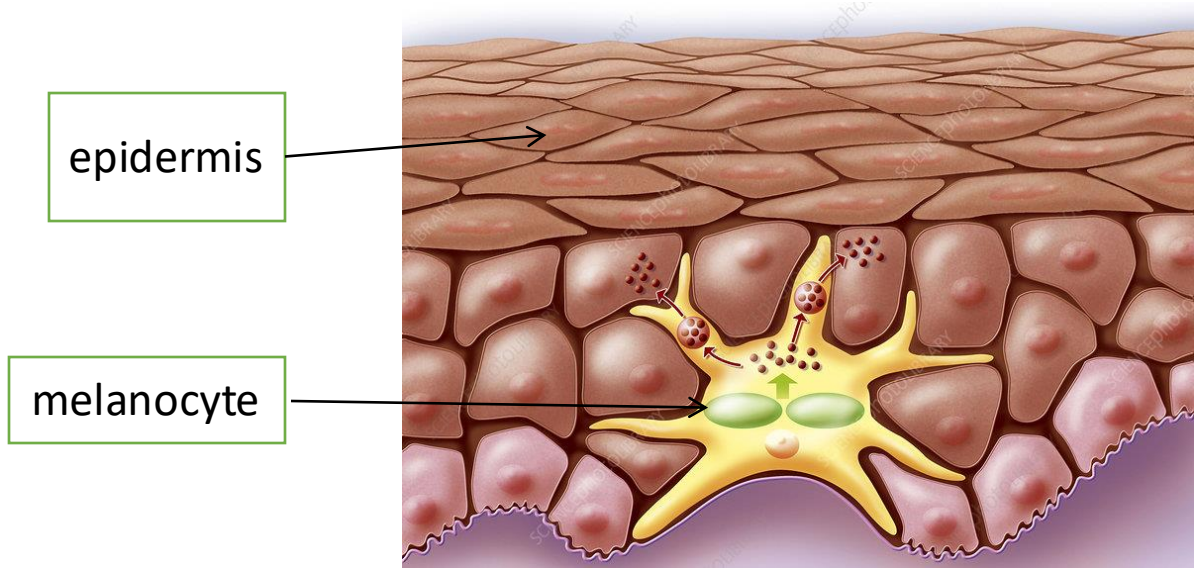
10. Parafollicular cells (calcitonin-producing C cells).

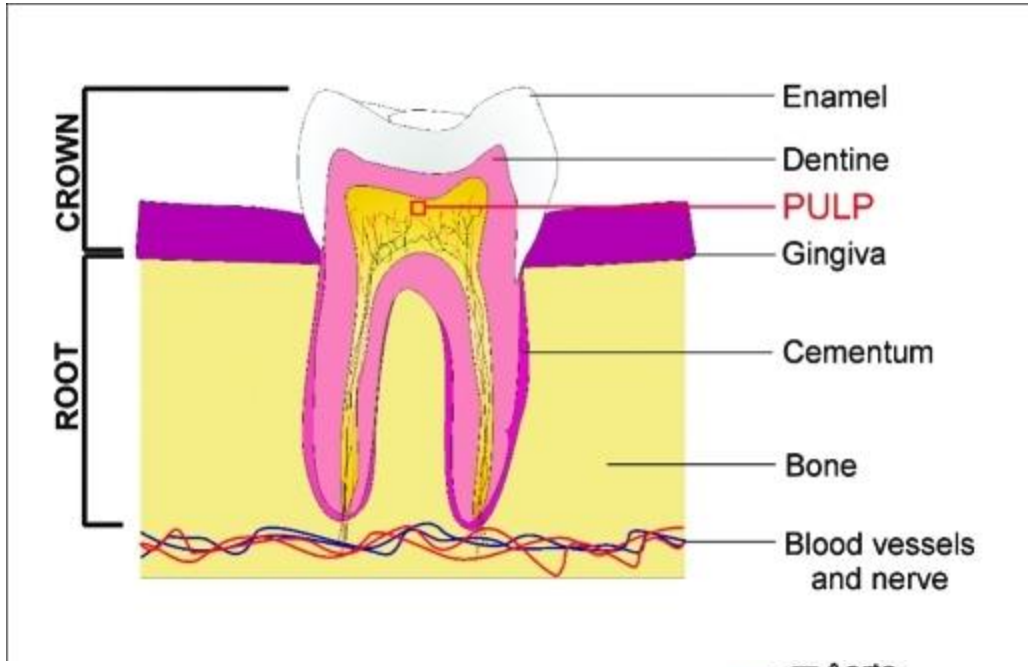

Dorsal root entry zone
Gray matter
White matter
Dorsal root
Dorsal root ganglion
Spinal nerve
Dorsal Ramus
Ventral Ramus
Ventral root

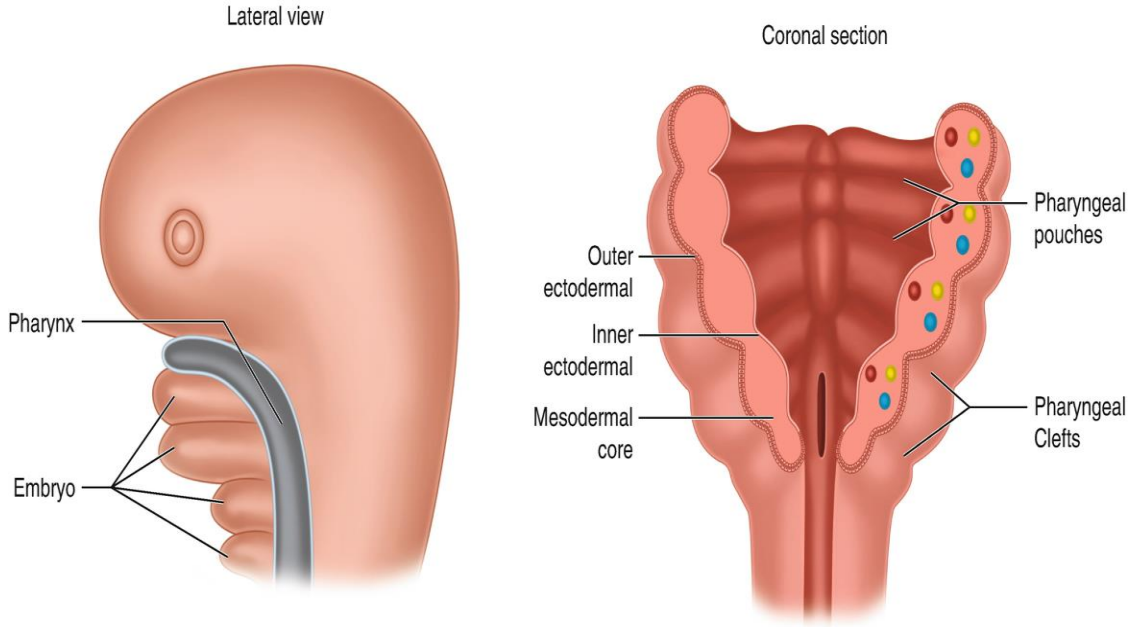

Schwann cell
Axon

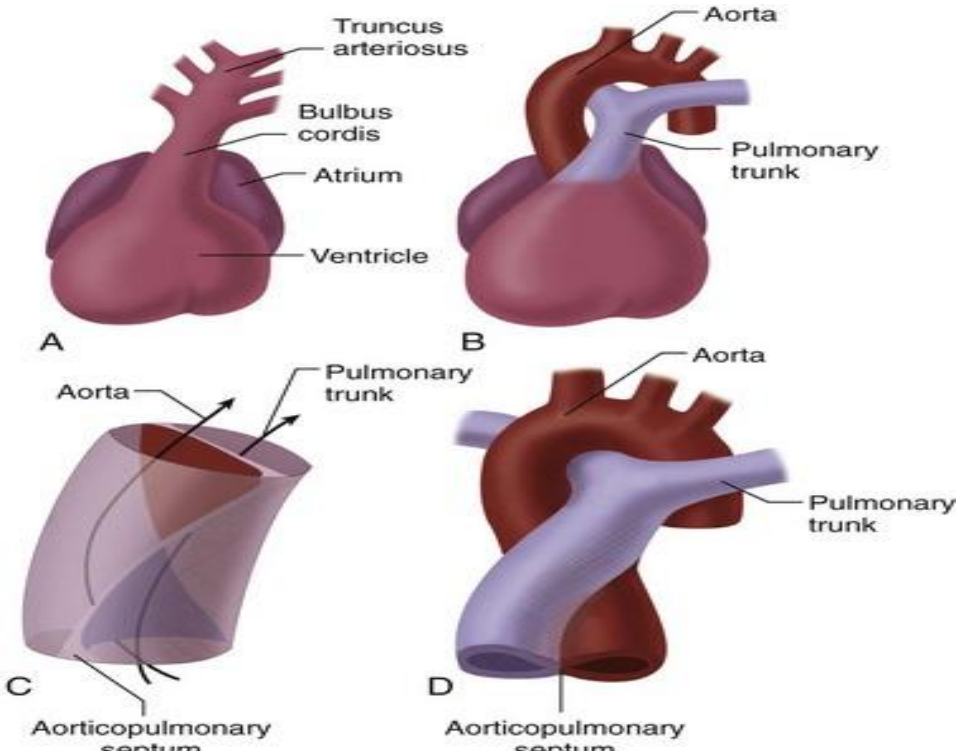

spinal cord
(transected)
dura
mater
arachnoid
membrane
pia mater
(coating spinal cord
and spinal rootlets)
dorsal
rootlets
dorsal root
(within meninges)
ventral
rootlets
ventral root
(within meninges)
spinal
ganglion
spinal
nerve
dorsal
branch
ventral
branch
ramus communicans
meningeal branch
ramus
communicans
sympathetic
trunk ganglion


Adrenal Gland
Left Kidney
Cor
Medulla


epidermis
melanocyte

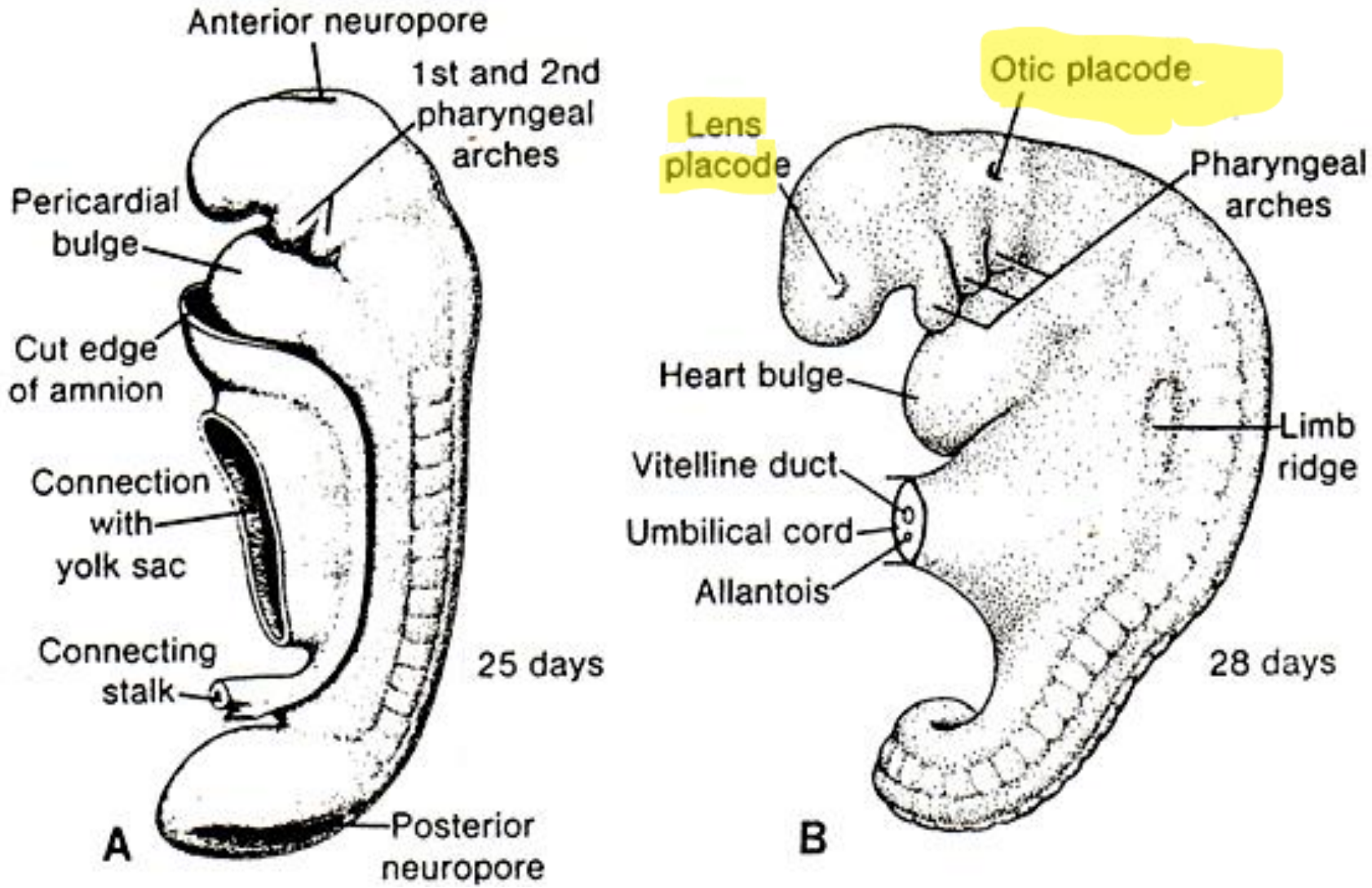

CROWN
ROOT
Enamel
Dentine
PULP
Gingiva
Cementum
Bone
Blood vessels
and nerve

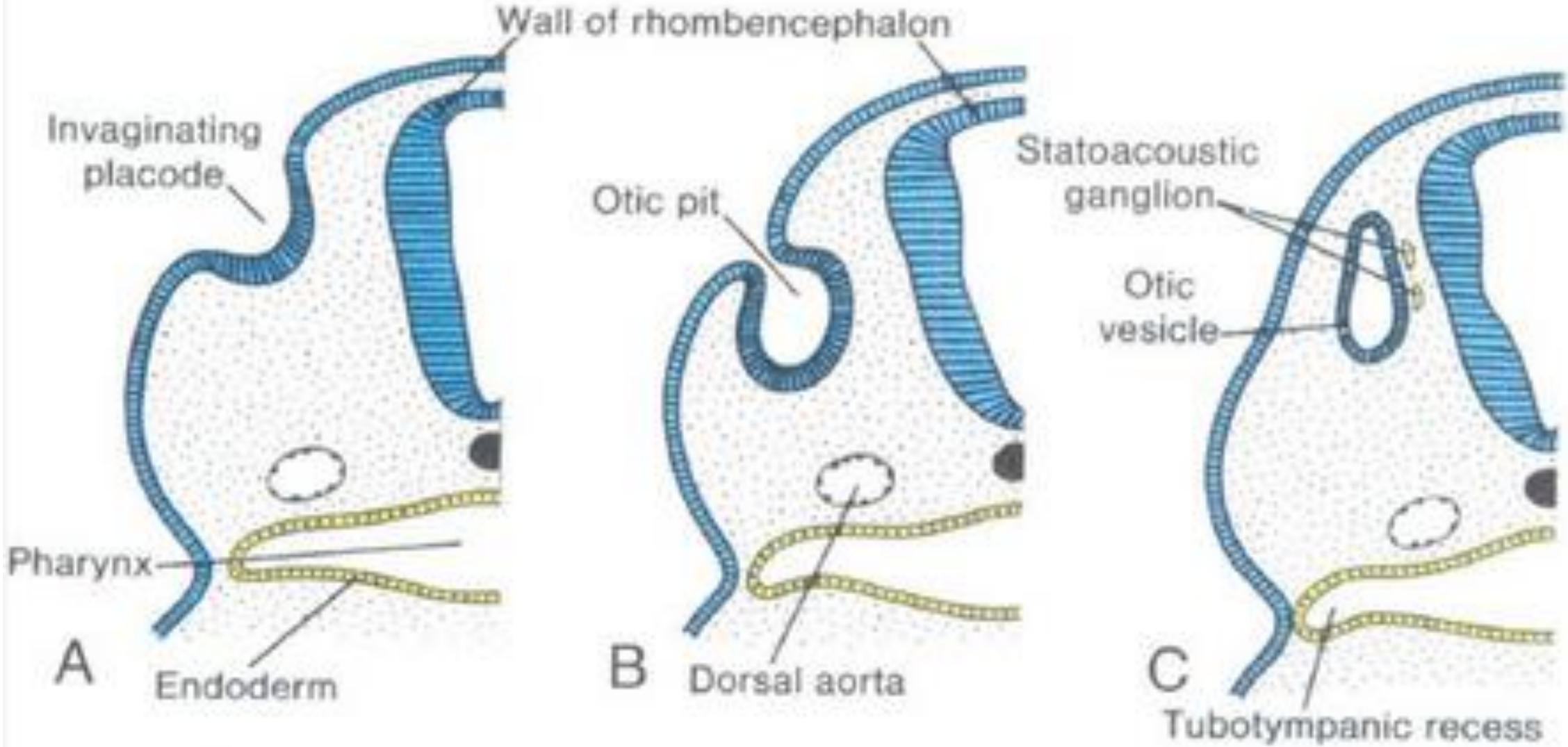

Lateral view
Pharynx
Embryo
Coronal section
Outer
ectodermal
Inner
ectodermal
Mesodermal
core
Pharyngeal
pouches
Pharyngeal
Clefts


Truncus
arteriosus
Bulbus
cordis
Atrium
Ventricle
A
Aorta
Pulmonary
trunk
B
Aorta
Pulmonary
trunk
C
Aorticopulmonary
septum
Aorta
Pulmonary
trunk
D
Aorticopulmonary
septum

4-By the time the neural tube is closed, two bilateral ectodermal thickenings, the ***otic placodes and the lens placodes***, become visible in the cephalic region of the embryo .

6-During further development, the otic placodes invaginate and form the **otic vesicles**, which will develop into structures needed for hearing and maintenance of equilibrium. At the same time, the **lens placodes** appear and invaginate during the fifth week to form the **lenses of the eyes.**


Anterior neuropore
1st and 2nd pharyngeal arches
Pericardial bulge
Cut edge of amnion
Connection with yolk sac
Connecting stalk
25 days
Posterior neuropore
A
Otic placode
Lens placode
Pharyngeal arches
Heart bulge
Limb ridge
Vitelline duct
Umbilical cord
Allantois
28 days
B


Wall of rhombencephalon
Invaginating placode
Otic pit
Statoacoustic ganglion
Otic vesicle
Pharynx
A
Endoderm
B
Dorsal aorta
C
Tubotympanic recess

In general terms the ectoderm gives rise to organs and structures that maintain contact with the outside world (Very important):

1- The central nervous system (The brain and spinal cord).

2-The peripheral nervous system.

3-The sensory epithelium of the ear, nose, and eye.

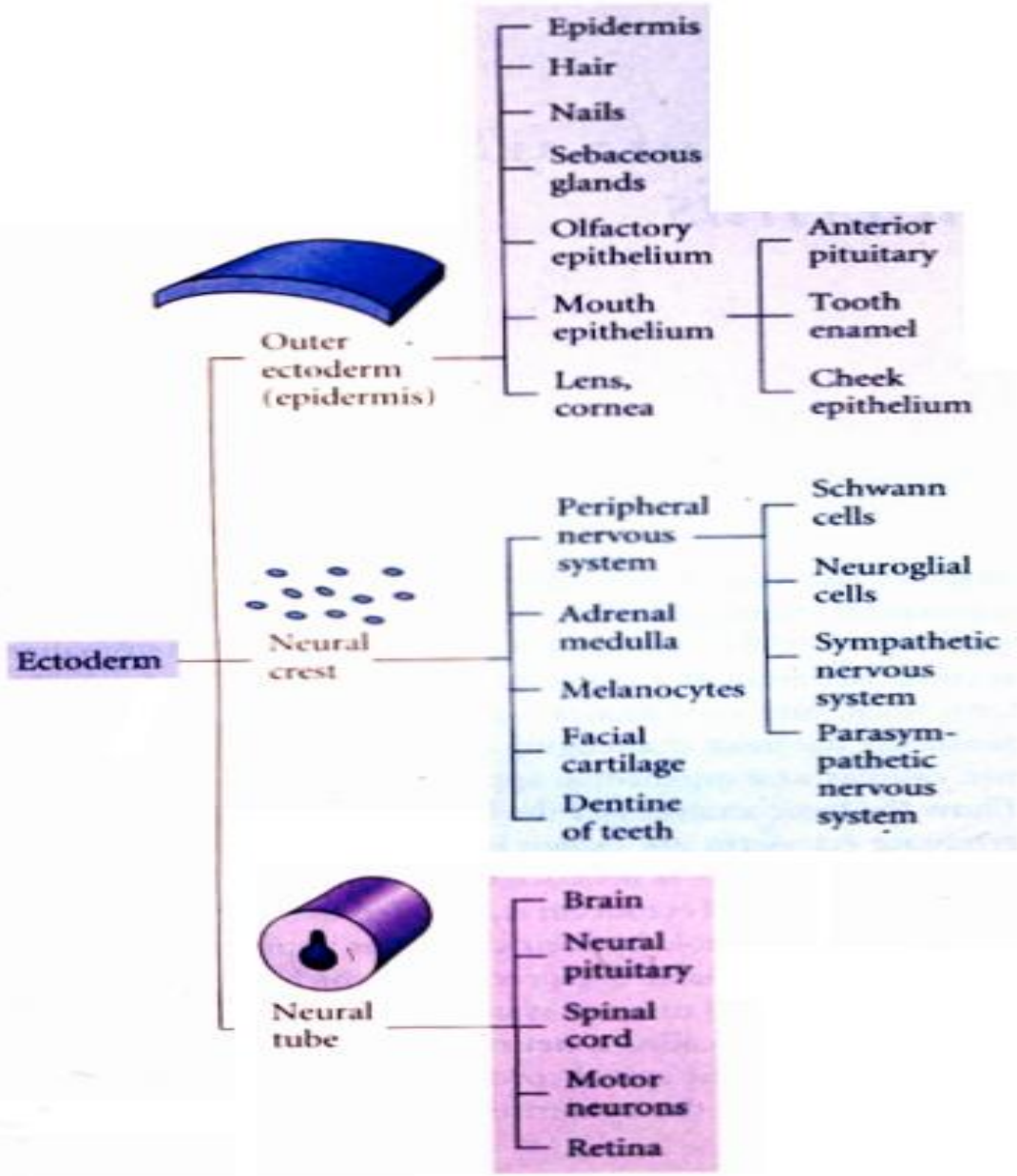
4- The epidermis, including the hair and nails.

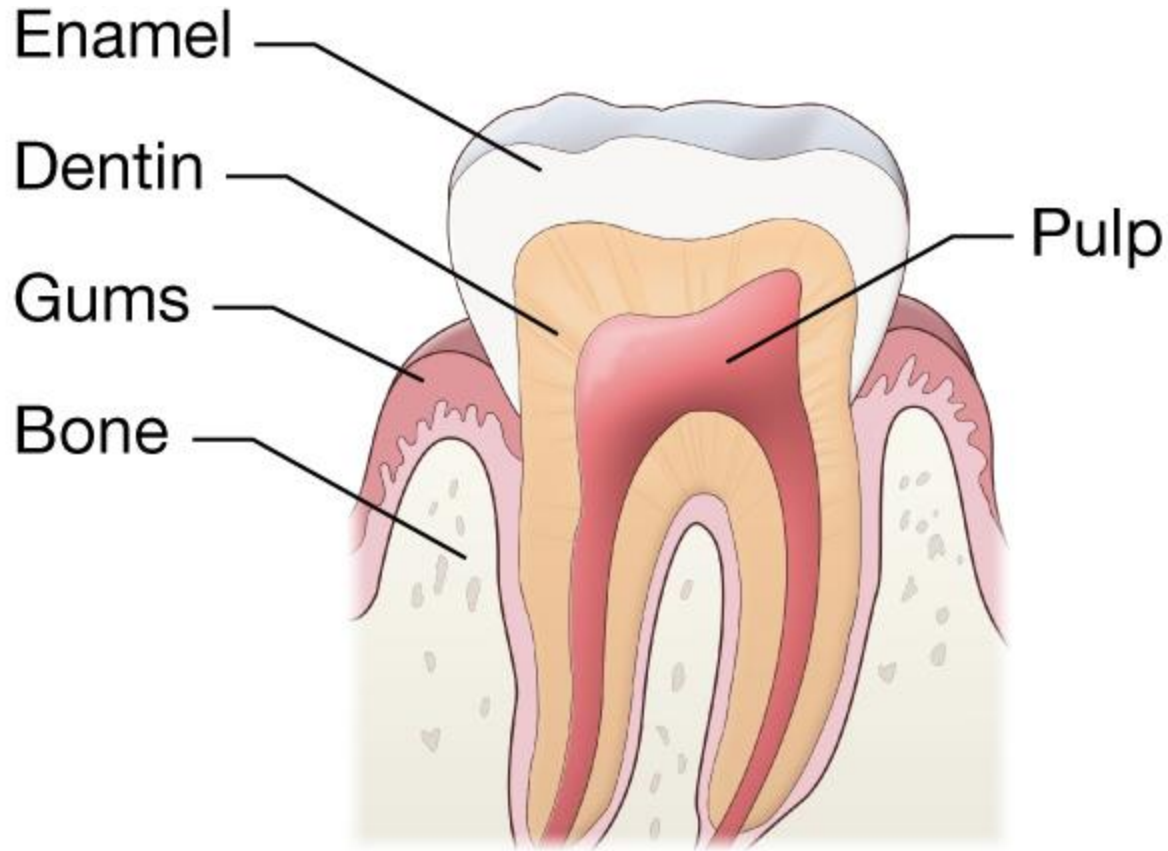
5- Subcutaneous glands (sweet, sebaceous and the mammary glands).

6-The pituitary gland and parotid gland.

7- Enamel of the teeth.

8- Lining of the inlet of the gut (part of oral cavity), and outlet of the gut (lower 1/2 of anal canal).


Ectoderm
Outer ectoderm (epidermis)
Epidermis
Hair
Nails
Sebaceous glands
Olfactory epithelium
Mouth epithelium
Lens, cornea
Anterior pituitary
Tooth enamel
Cheek epithelium
Neural crest
Peripheral nervous system
Adrenal medulla
Melanocytes
Facial cartilage
Dentine of teeth
Schwann cells
Neuroglial cells
Sympathetic nervous system
Parasym-pathetic nervous system
Neural tube
Brain
Neural pituitary
Spinal cord
Motor neurons
Retina


Enamel
Dentin
Gums
Bone
Pulp

Control of embryonic development (reading):

-Development of human body results from genetic plans in the chromosomes.

Most developmental processes depend on a precisely **coordinated interaction of genetic and environmental factors.**

-Several control mechanisms guide differentiation and ensure synchronized development, such as tissue interactions, regulated migration of cells and cell colonies, controlled proliferation, and programmed cell death.

-***Embryonic Development*** is essentially **a process of growth and increasing complexity of structure and function**. **Growth is achieved** by mitosis together with the production of extracellular matrices, whereas **complexity is achieved** through morphogenesis and differentiation.

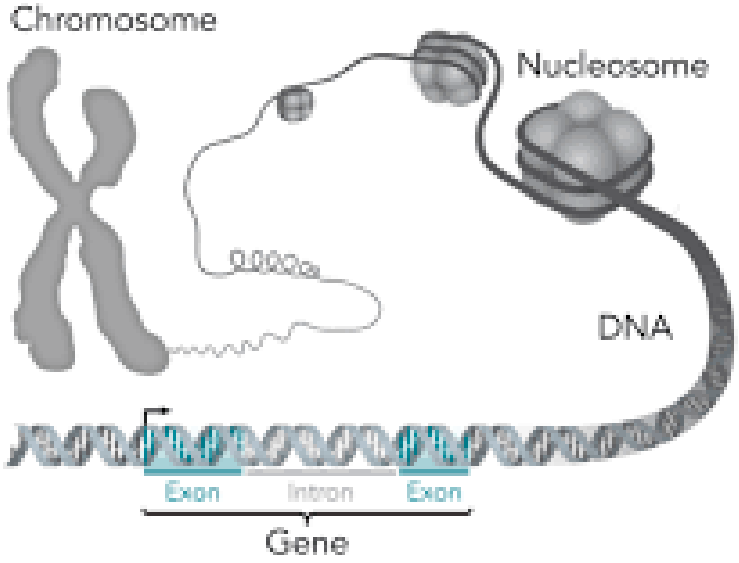


Fig 1. Chromosomes, DNA and Genes.

-The cells that make up the tissues of very early embryos are pluripotential, which under different circumstances are able to follow more than one pathway of development.


THANK
you