THIRD WEEK OF DEVELOPMENT

It is not birth, marriage or death,
but
gastrulation,
which is truly the most important time in your life

Lewis Wolpert (1986)

The most characteristic event occurring during the **third week** of gestation is

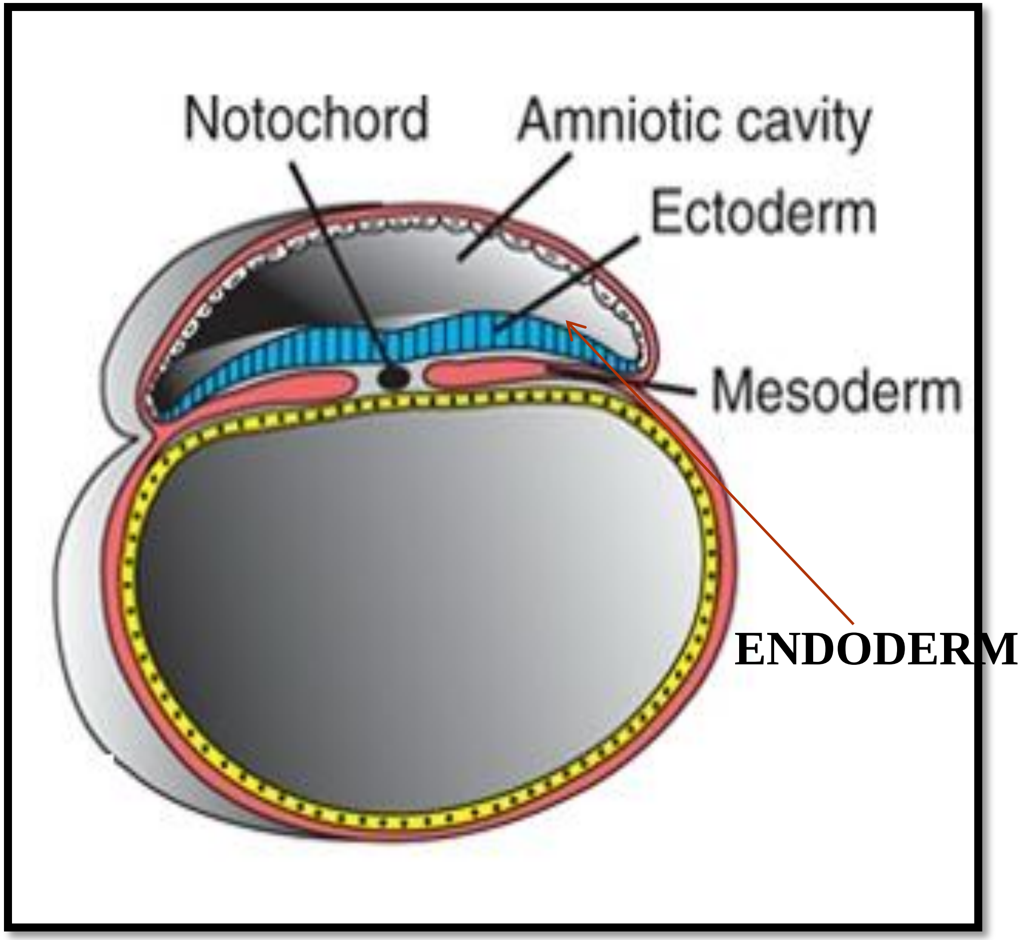
GASTRULATION,

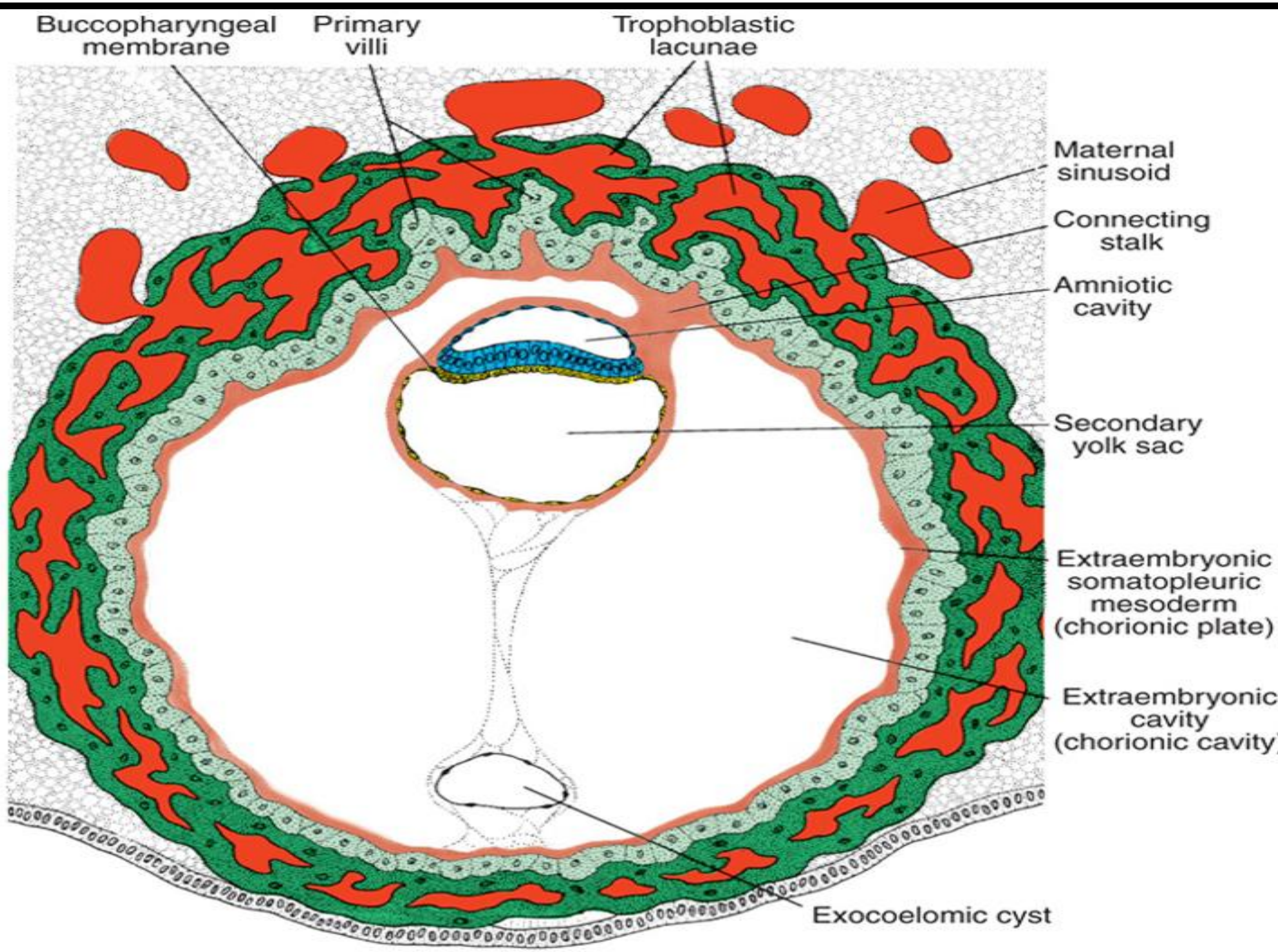
the process that establishes all three germ layers in the embryo

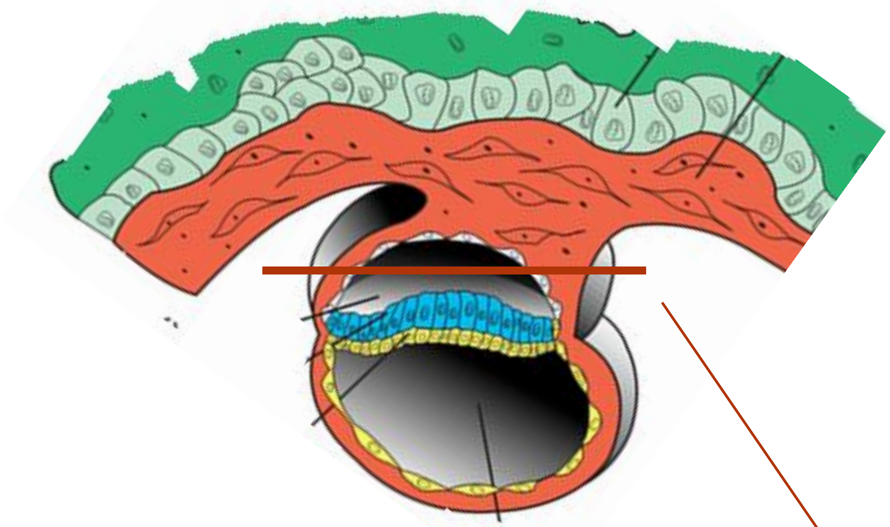
1-ECTODERM

2-MESODERM

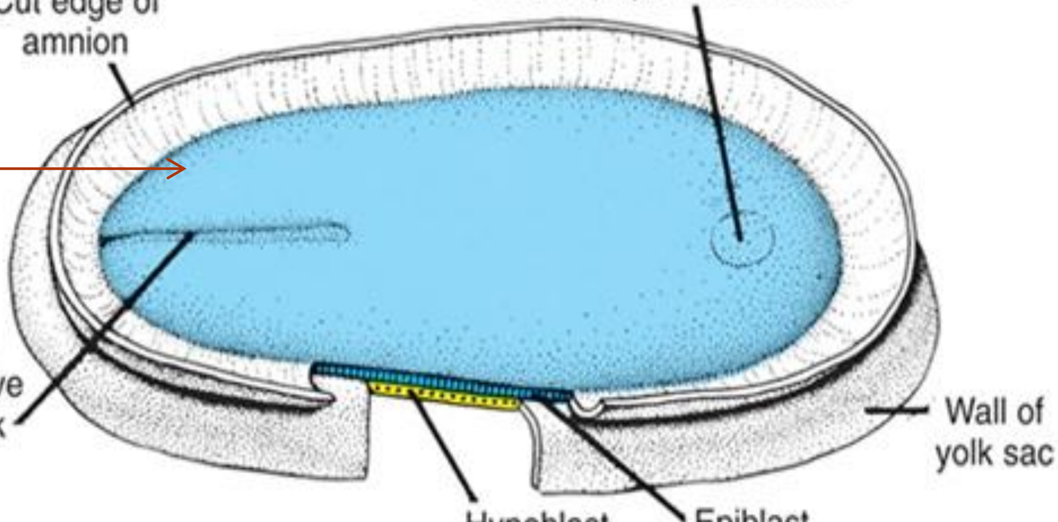
3-ENDODERM




Buccopharyngeal membrane
Primary villi
Trophoblastic lacunae
Maternal sinusoid
Connecting stalk
Amniotic cavity
Secondary yolk sac
Extraembryonic somatopleuric mesoderm (chorionic plate)
Extraembryonic cavity (chorionic cavity)
Exocoelomic cyst



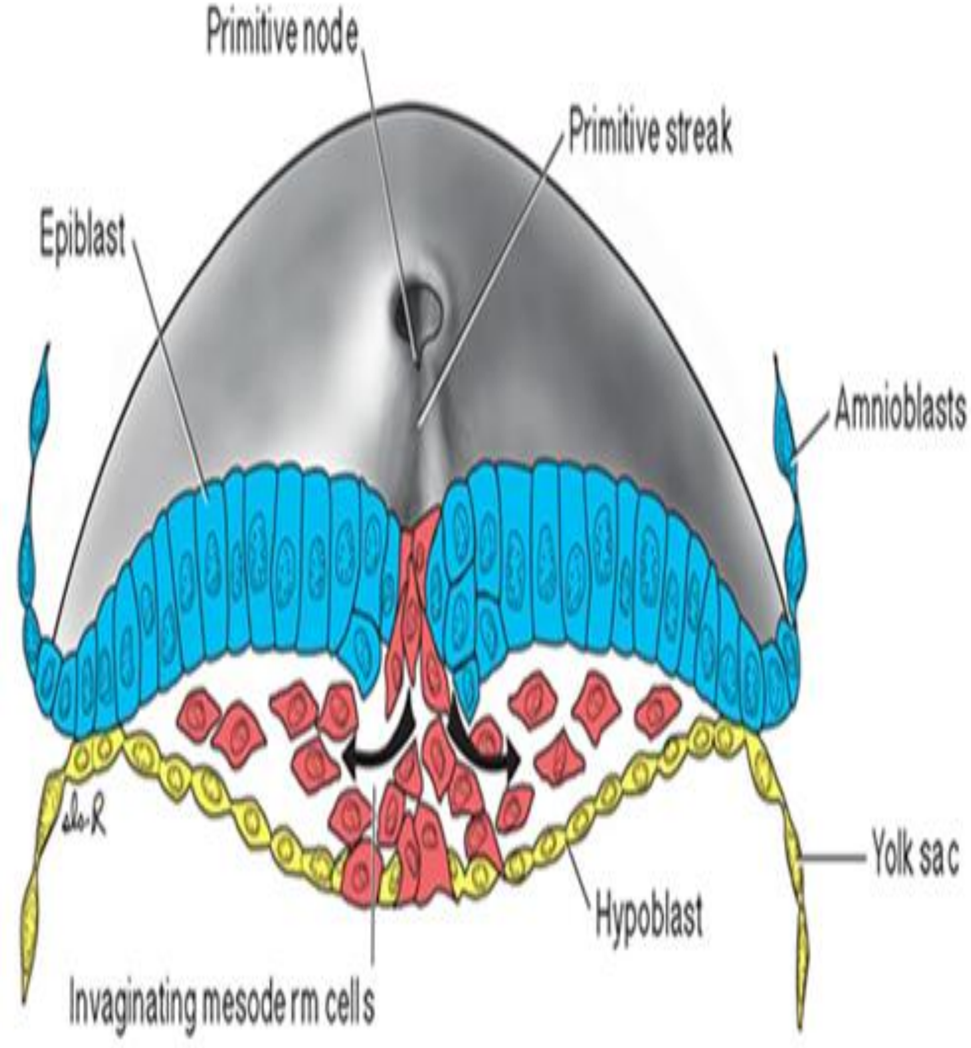
When viewed from above, through the amniotic cavity, the epiblast appears as an oval disc



The cells of the **EPIBLAST** are capable of **proliferation and migration**

These two features of the epiblast will lead to:

- The cells of the epiblast start to proliferate forming **a swilling called PRIMITIVE NODE**



➢As the primitive node elongates

➢**THE PRIMITIVE STREAK**

appears

As soon as the primitive streak appears, it is possible to

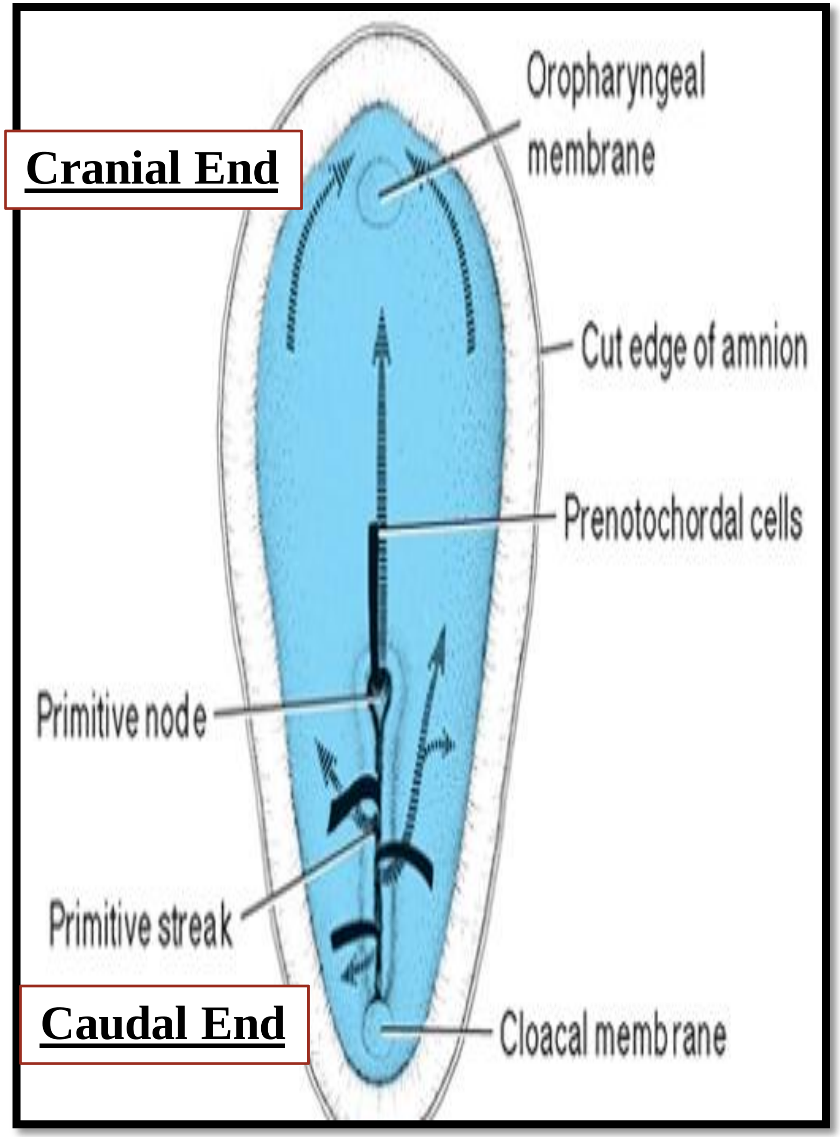
identify the embryo's

1-Craniocaudal axis

(<u>Cranial & Caudal Ends)</u>

2- <u>Dorsal & Ventral Surfaces</u>

3- <u>Right & Left Sides</u>



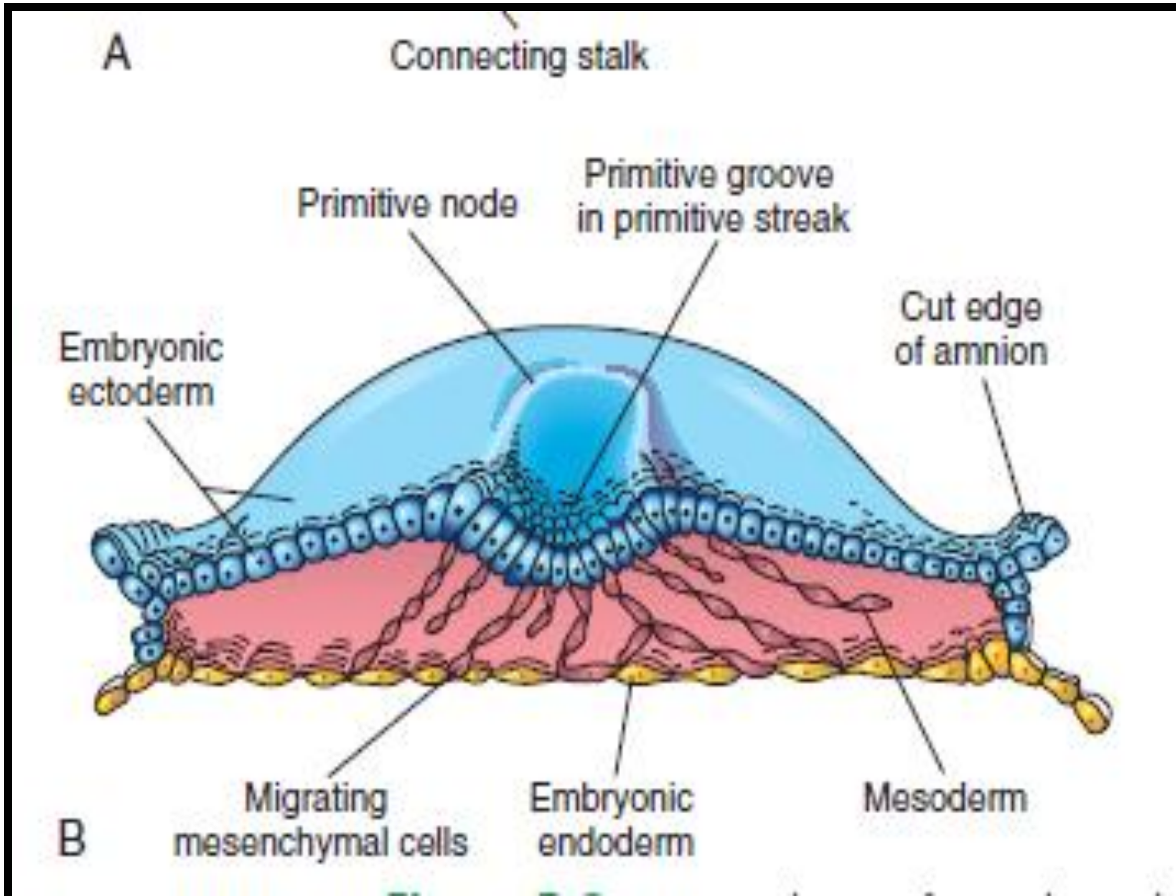
➢Cells of the epiblast

migrate toward the primitive streak .

➢The cells of the primitive streak **ingress** in the epiblast making **a pore** in the middle

➢Upon arrival in the region of the streak, they **detach** from the epiblast, and **slip beneath it**.

➢This **inward movement** is known as invagination.



➢**Once the cells have invaginated, some *<u>displace</u>* the hypoblast, creating the embryonic**

ENDODERM

➢Other cells come to lie between the epiblast and newly created endoderm to form

MESODERM

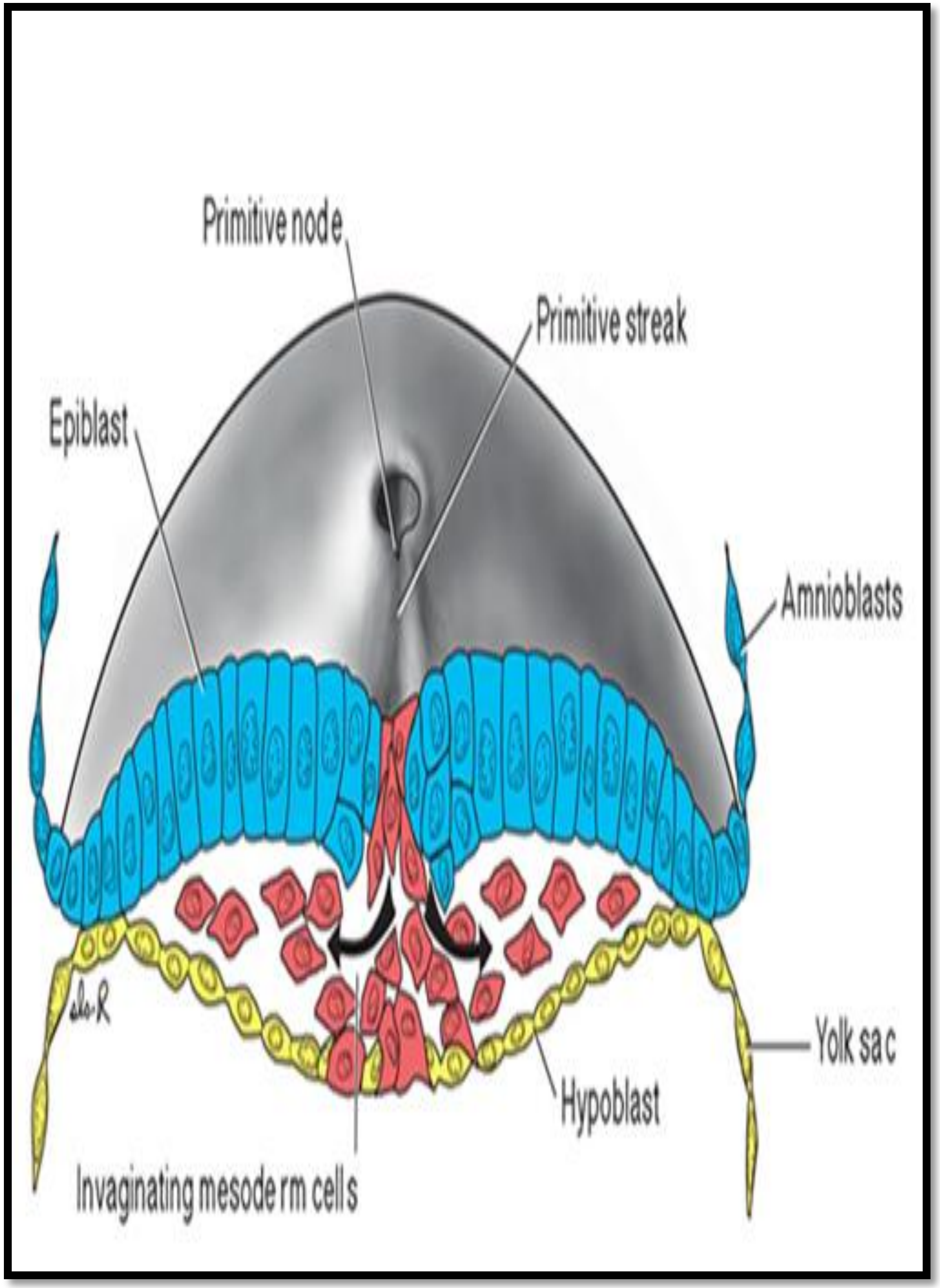
➢Cells remaining in the epiblast then form

ECTODERM.

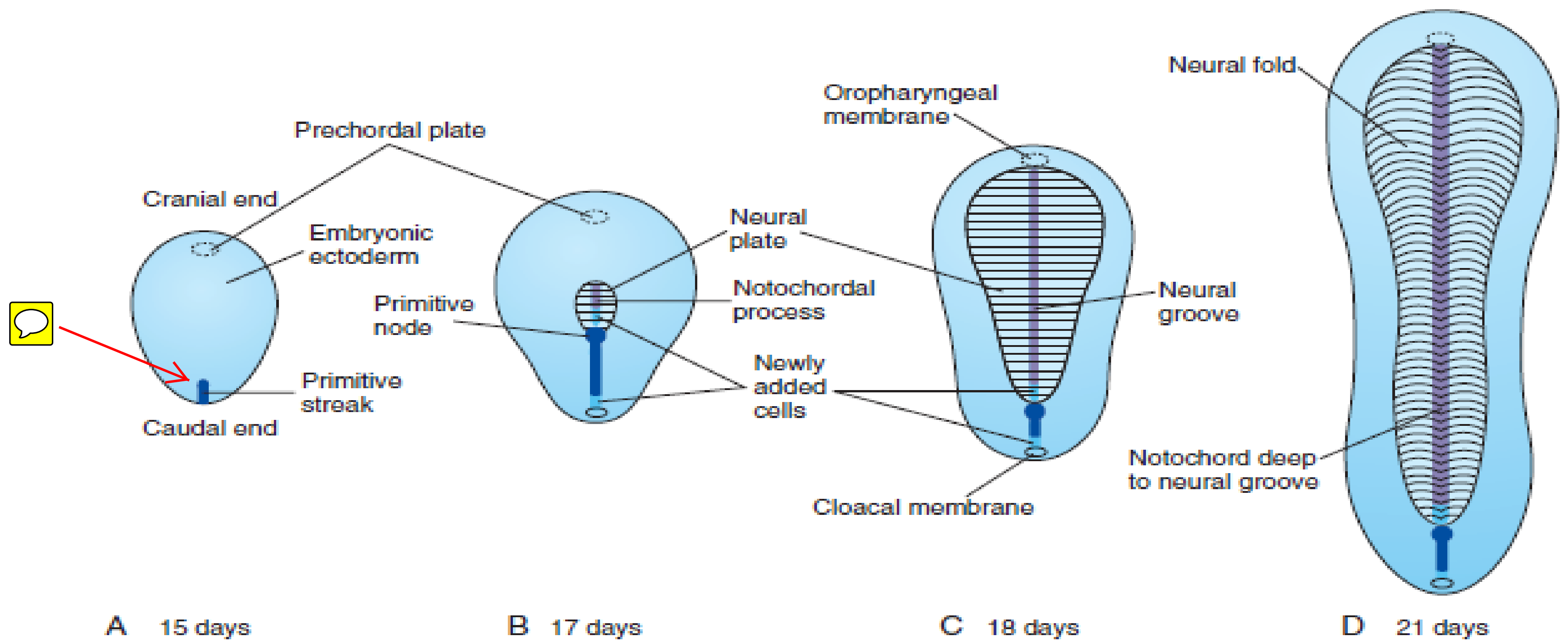
Thus, <u>THE EPIBLAST,</u> through the process of gastrulation,

is the source of all of the germ layers.

cells in these layers will give rise to all of the *<u>tissues and organs in the embryo</u>*.



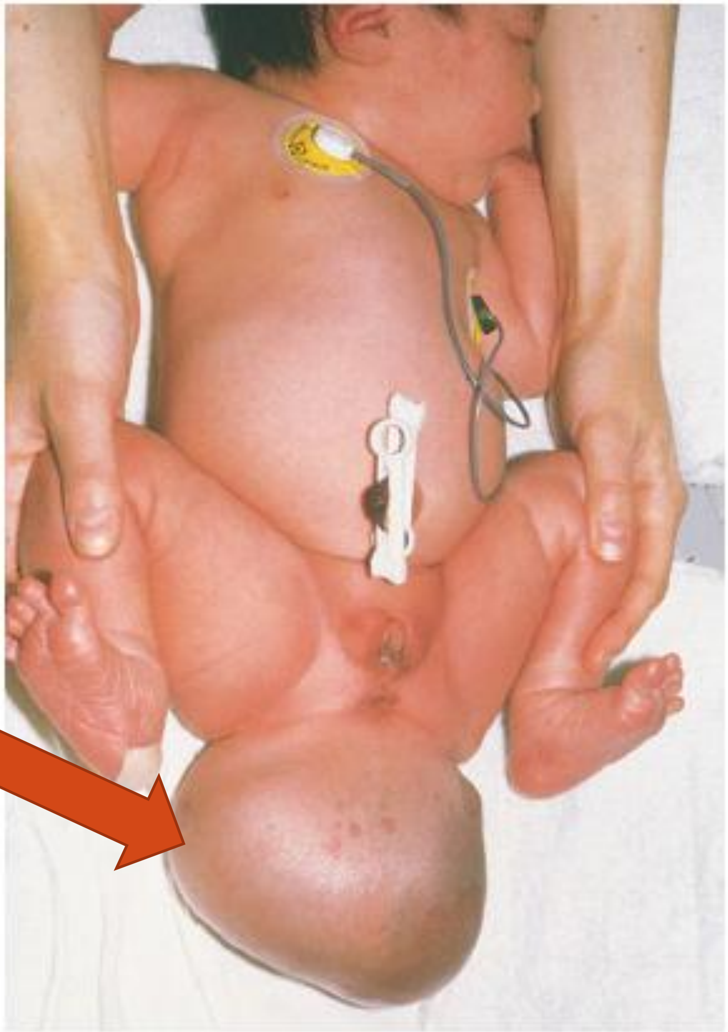
The ***primitive streak actively forms mesoderm until*** the early part of the fourth week; thereafter, its production slows down. The streak diminishes in relative size and becomes an insignificant structure in the sacrococcygeal region of the embryo



A to D, Dorsal views of the embryonic disc, showing how it lengthens and changes shape during the third week. The primitive streak lengthens by the addition of cells at its caudal end; the notochordal process lengthens by the migration of cells from the primitive node. At the end of the third week, the notochordal process is transformed into the notochord.

SACROCOCCYGEAL TERATOMA

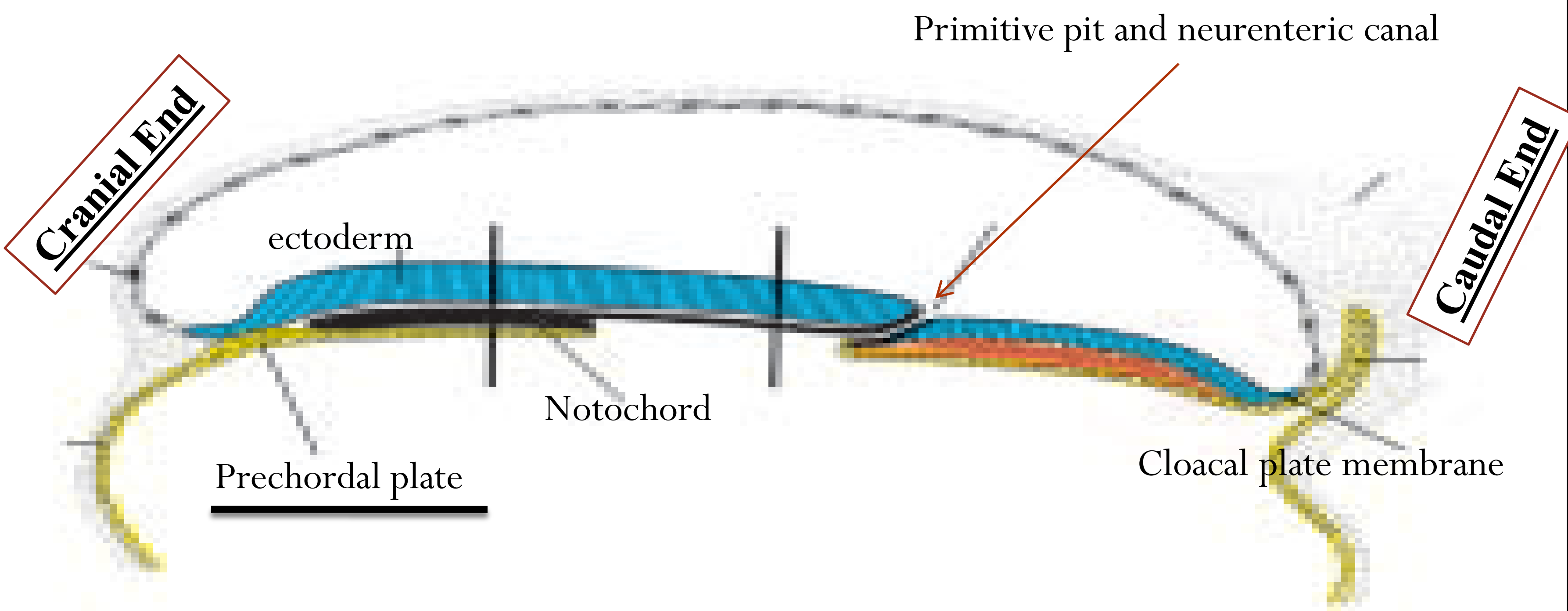
Remnants of the primitive streak may persist and give rise to a large tumor known as a sacrococcygeal teratoma (Fig. 5-12). Because it is derived from pluripotent primitive streak cells, the tumor contains tissues derived from all three germ layers in incomplete stages of differentiation. Sacrococcygeal teratomas are the most common tumors in newborn infants and have an incidence of approximately 1 in 27,000 neonates. These tumors are usually surgically excised promptly, and the prognosis is good.



A female infant with a large sacrococcygeal teratoma that developed from remnants of the primitive streak.

Prechordal plate.

The prechordal plate
forms between the tip of the **<u>notochord</u>**
and the **buccopharyngeal membrane**
and is derived from some of the first cells that migrate through the
node in a cephalic direction. Later, the prechordal plate will be important for induction of the
forebrain

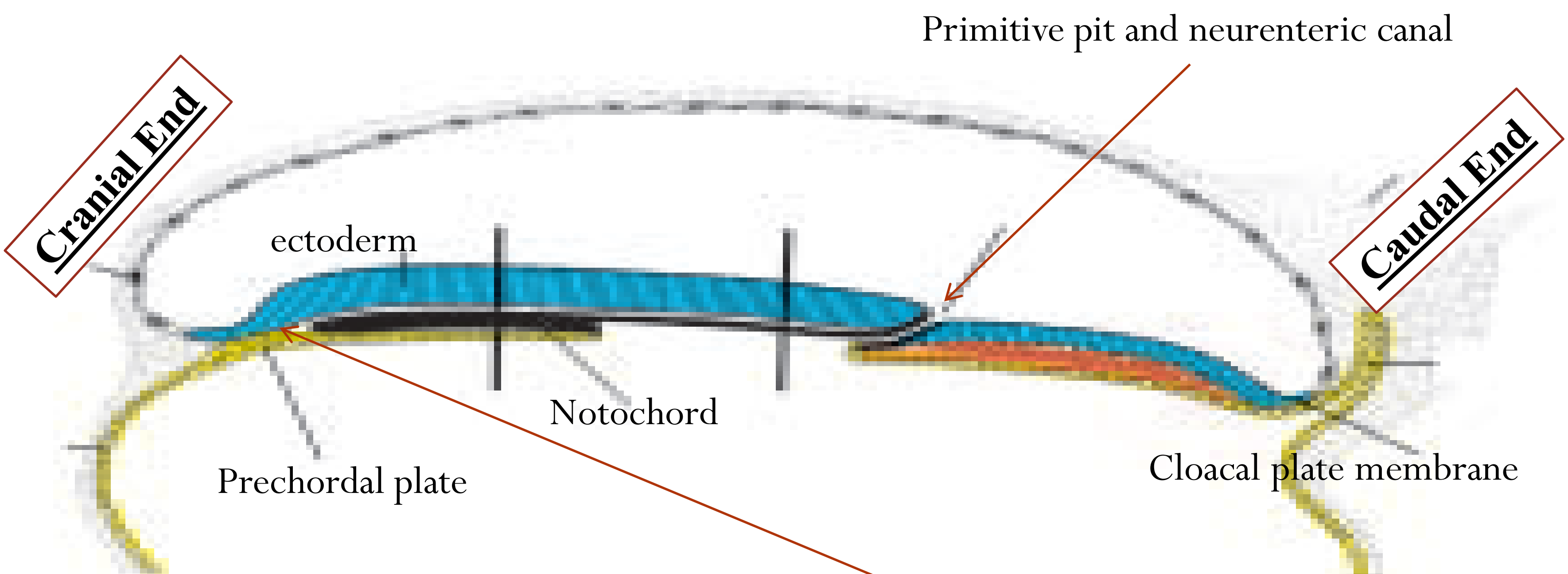


The notochord

grows cranially between

<u>the ectoderm and endoderm</u>

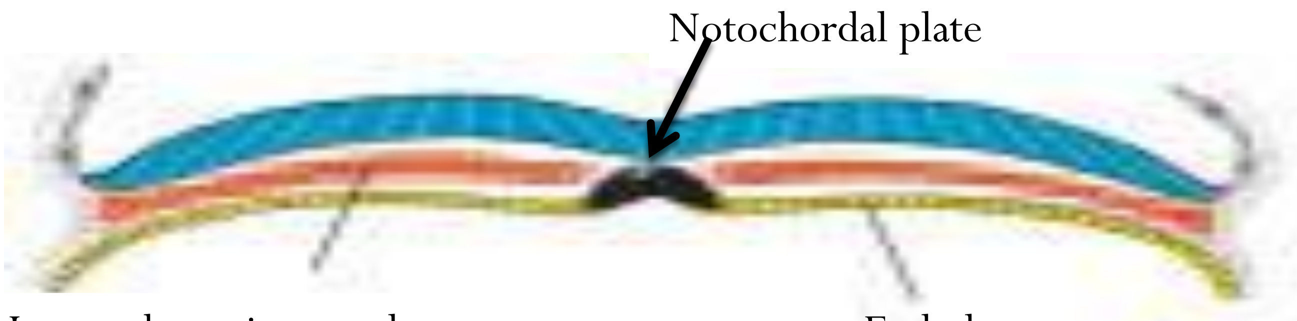
until it reaches the **prechordal plate**



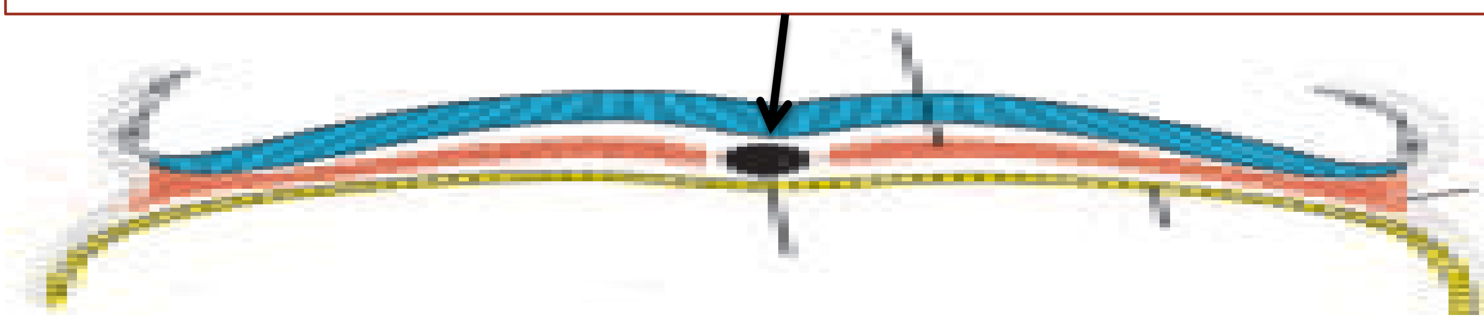
The notochord
can extend no farther because the prechordal plate is firmly attached to the overlying ectoderm.

Formation of the Notochord

1-Prenotochordal cells invaginating in the primitive pit
And
become intercalated in the hypoblast to form the
notochordal plate

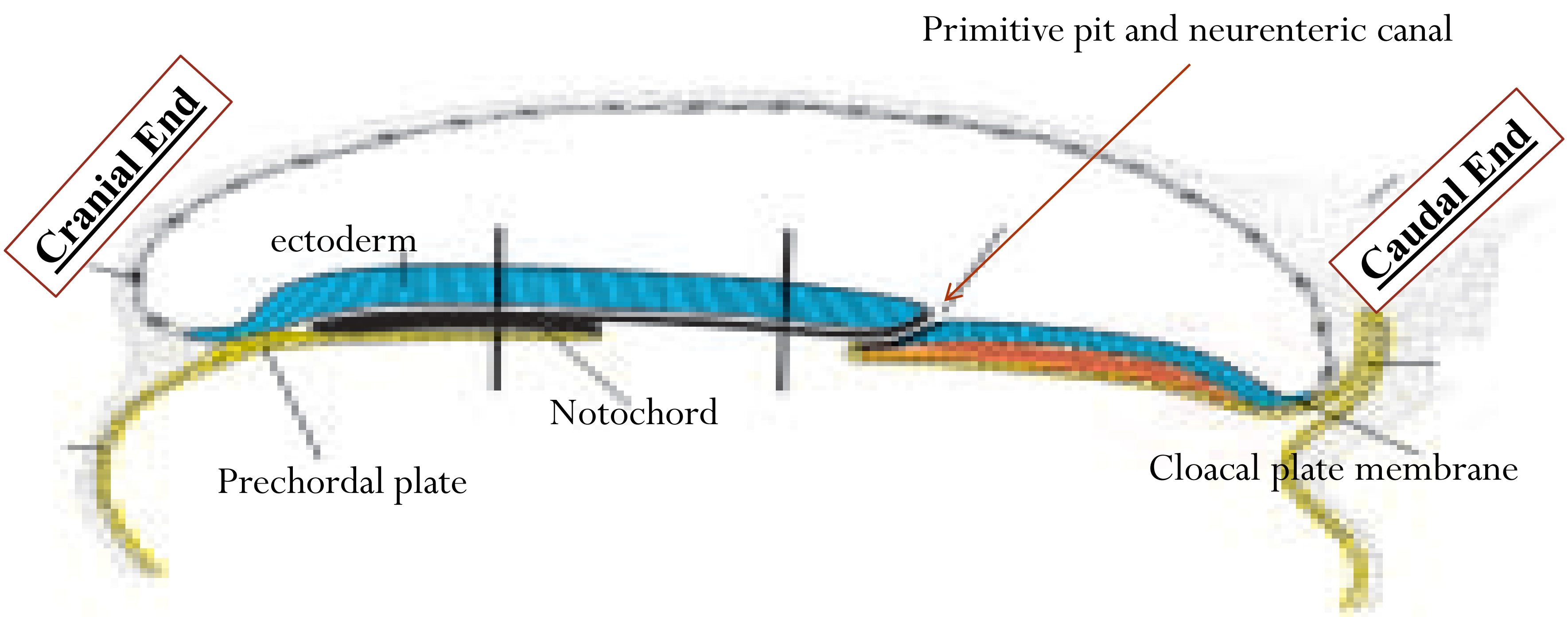


2-cells of the notochordal **plate proliferate** and **detach** from the endoderm. They then form a solid cord of cells,
the **definitive notochord**

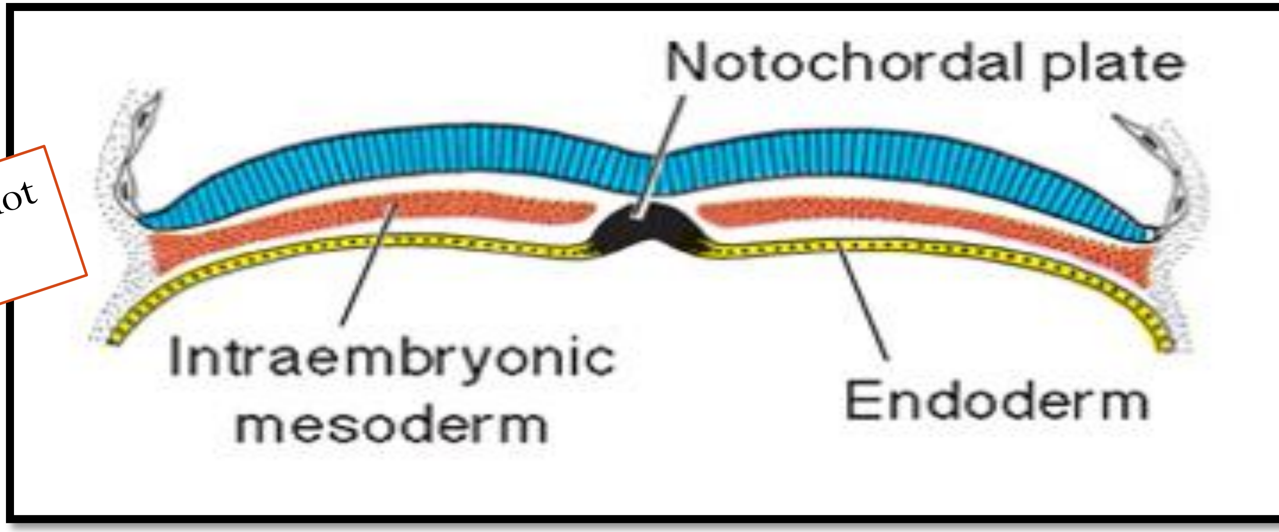


- The cranial end of the notochord forms first and caudal regions are added later.
- The notochord extend cranially to the prechordal plate and caudally to the primitive pit.

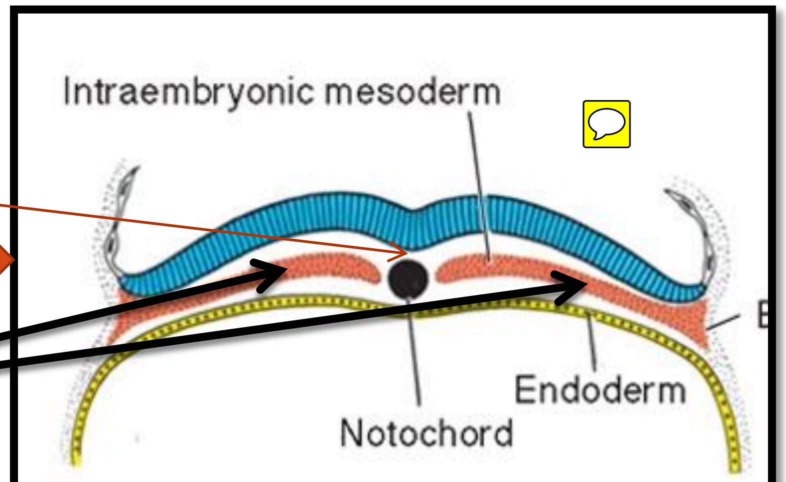
At the point where the pit forms an indentation in the epiblast, the **neurenteric canal temporarily connects the amniotic and yolk sac cavities**



The Mesodermal layer is not continuous



Because
of the presence of the notochord in the middle of the trilaminar disc , the migrating cells from the epiblast will fill only the paraxial region (the area around the axis)



Functions of the notochord

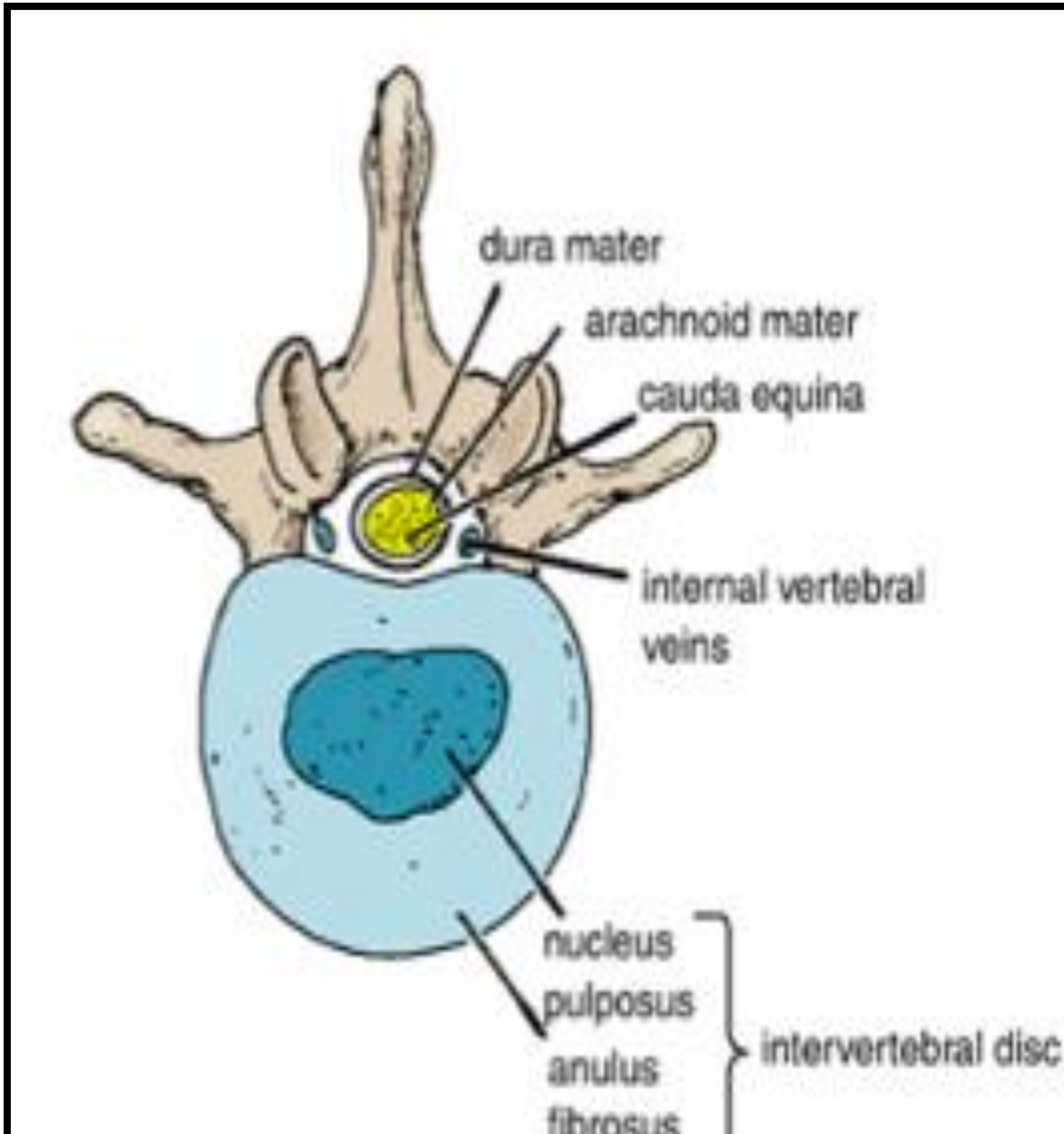
- Defines the axis of the embryo and gives it some rigidity
- Serves as the basis for the development of the axial skeleton (such as the bones of the head and vertebral column)
- Indicates the future site of the vertebral bodies

The notochord

gives rise to the

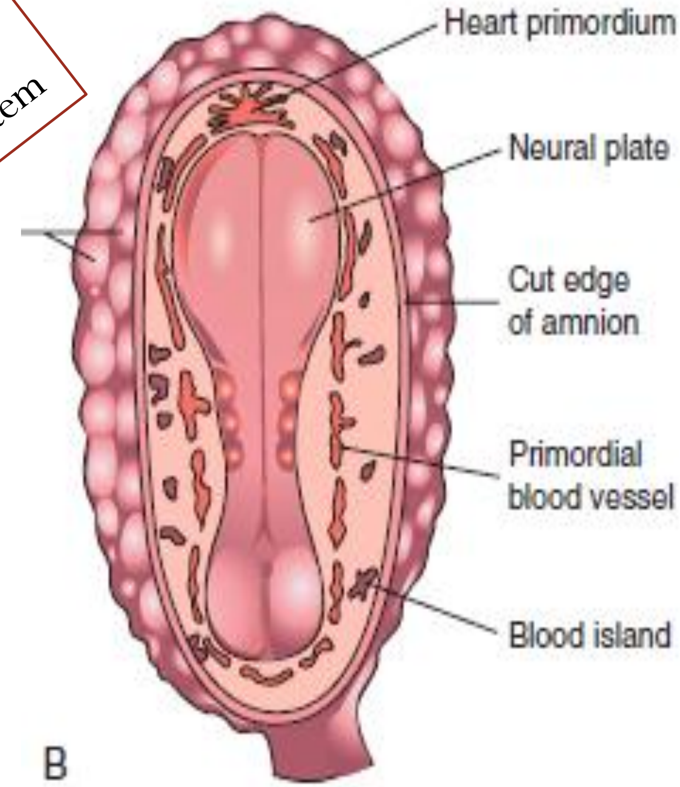
Nucleus pulpous

Of the intervertebral disk



Some cells from the primitive streak migrate cranially on each side of the notochordal process and around the prechordal plate. They meet cranially to form the cardiogenic mesoderm in the cardiogenic area, where the heart primordium begins to develop at the end of the third week

From this slide the story of the heart development starts
Which will be part of your third year course of the cardiovascular system



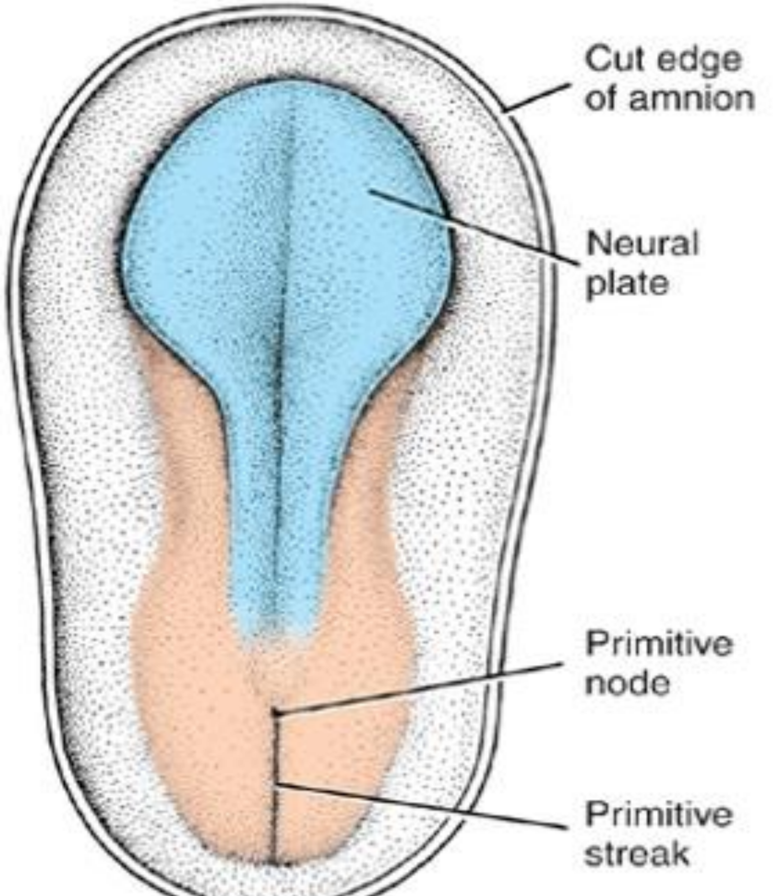
DERIVATIVES OF THE ECTODERMAL GERM LAYER

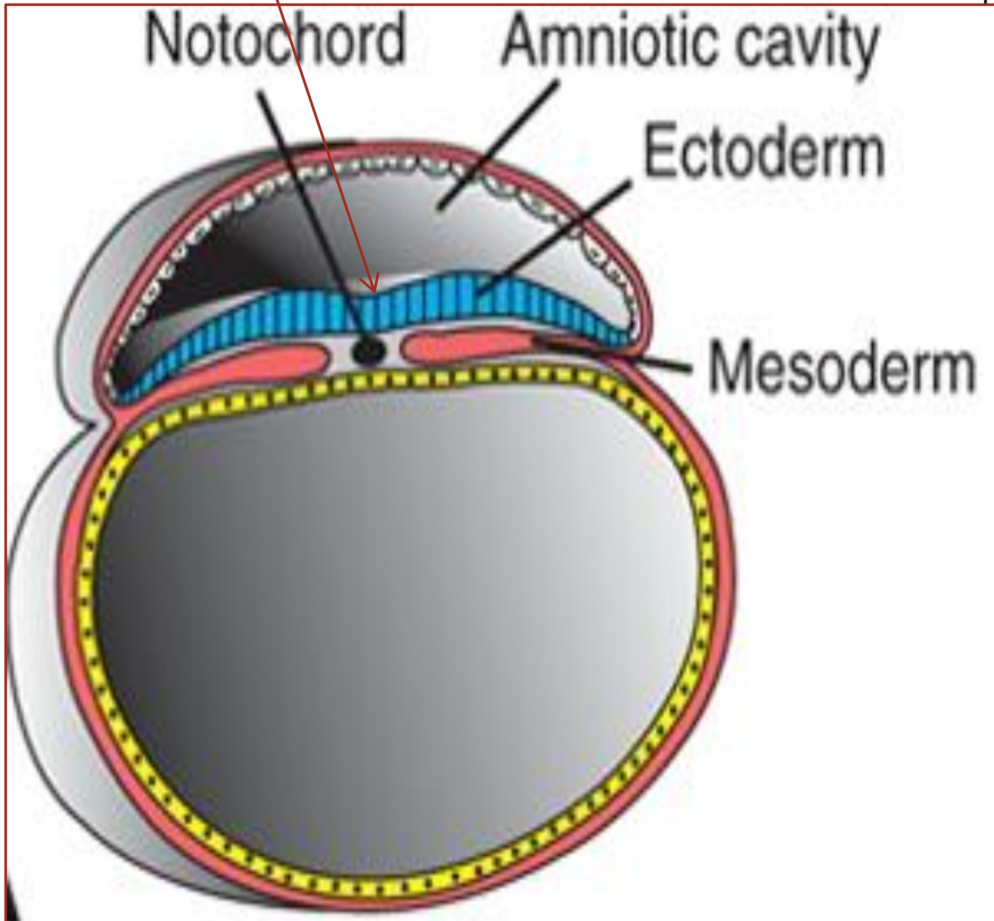
Development of the neural tube

At the middle of the epiblast another swelling called

1- <u>neural plate appears</u>

The neural plate replaces the receding primitive streak and closes the pore formed before



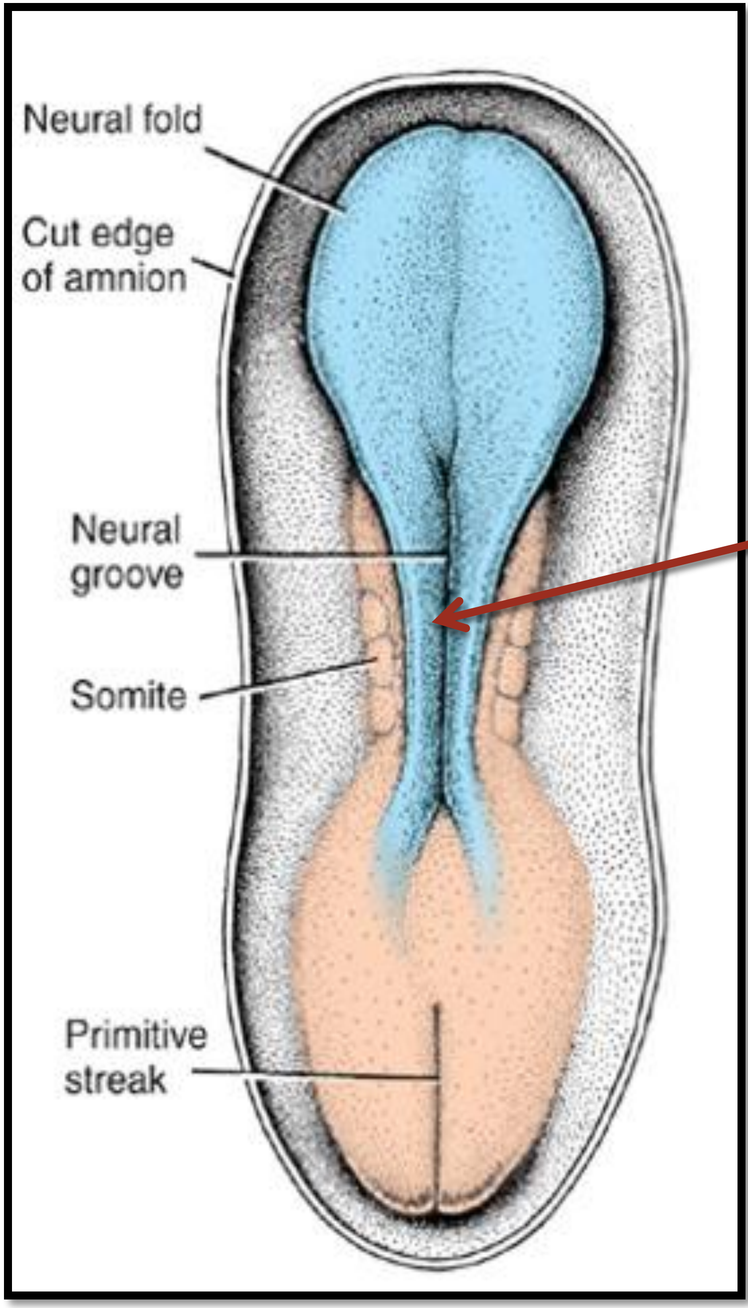


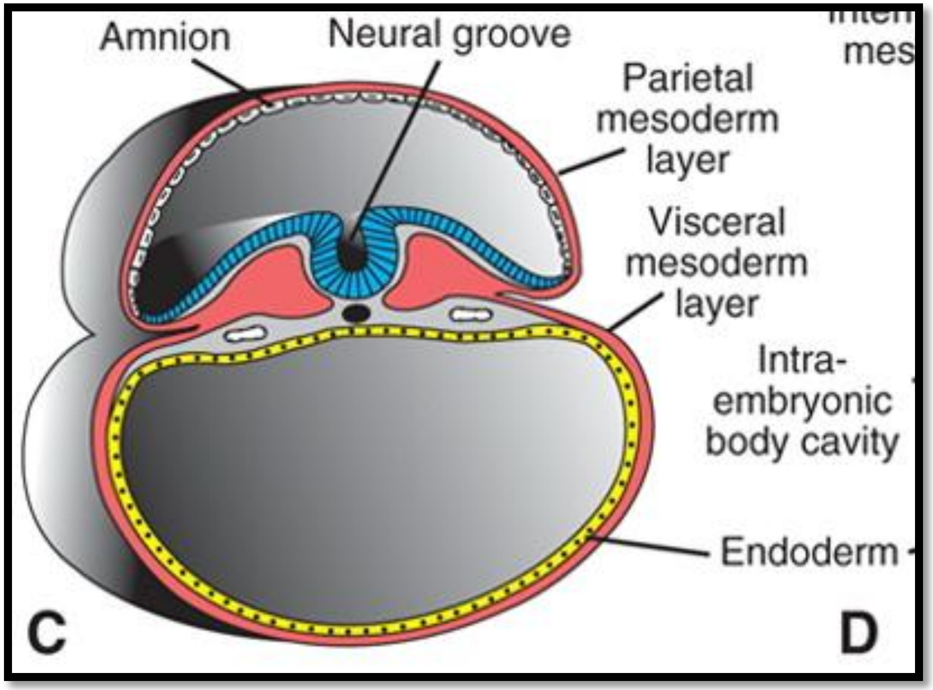
By the end of the third week,
the lateral edges of the neural plate become more elevated to form

<u>neural folds</u>

the depressed midregion forms the

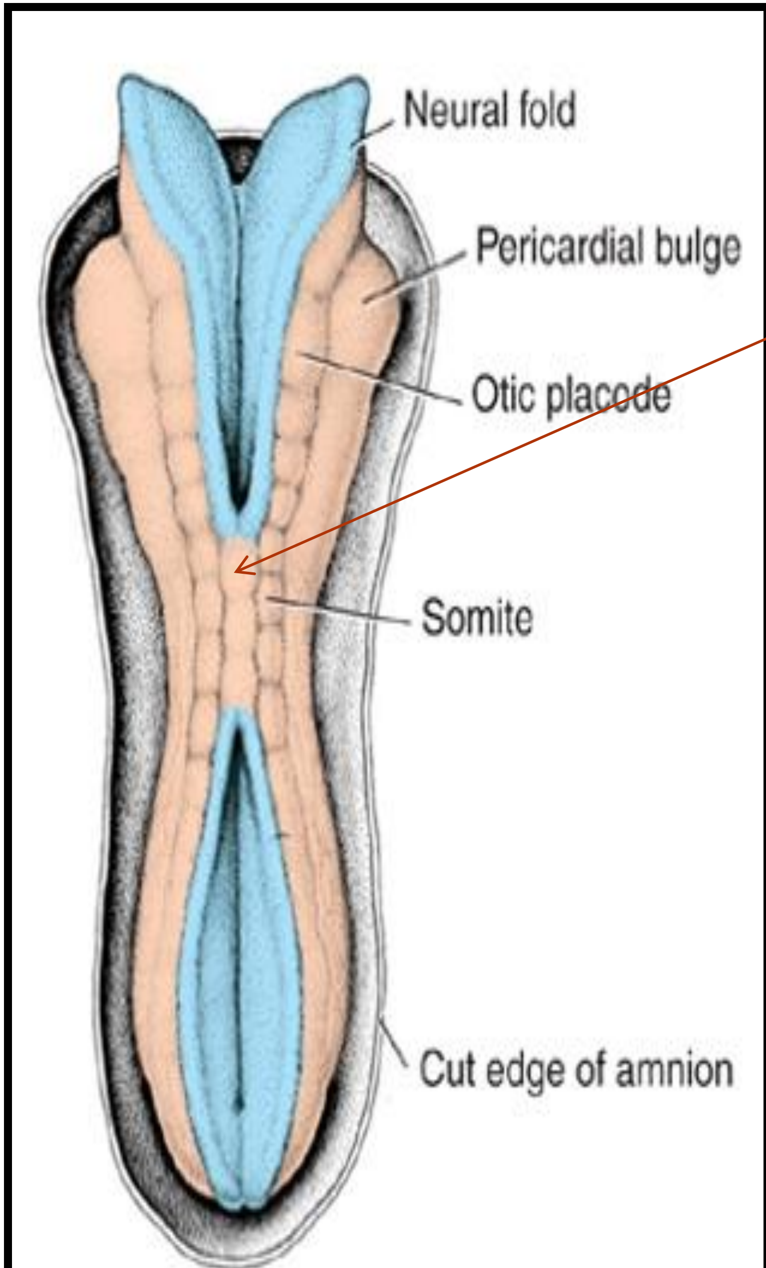
2-Neural groove

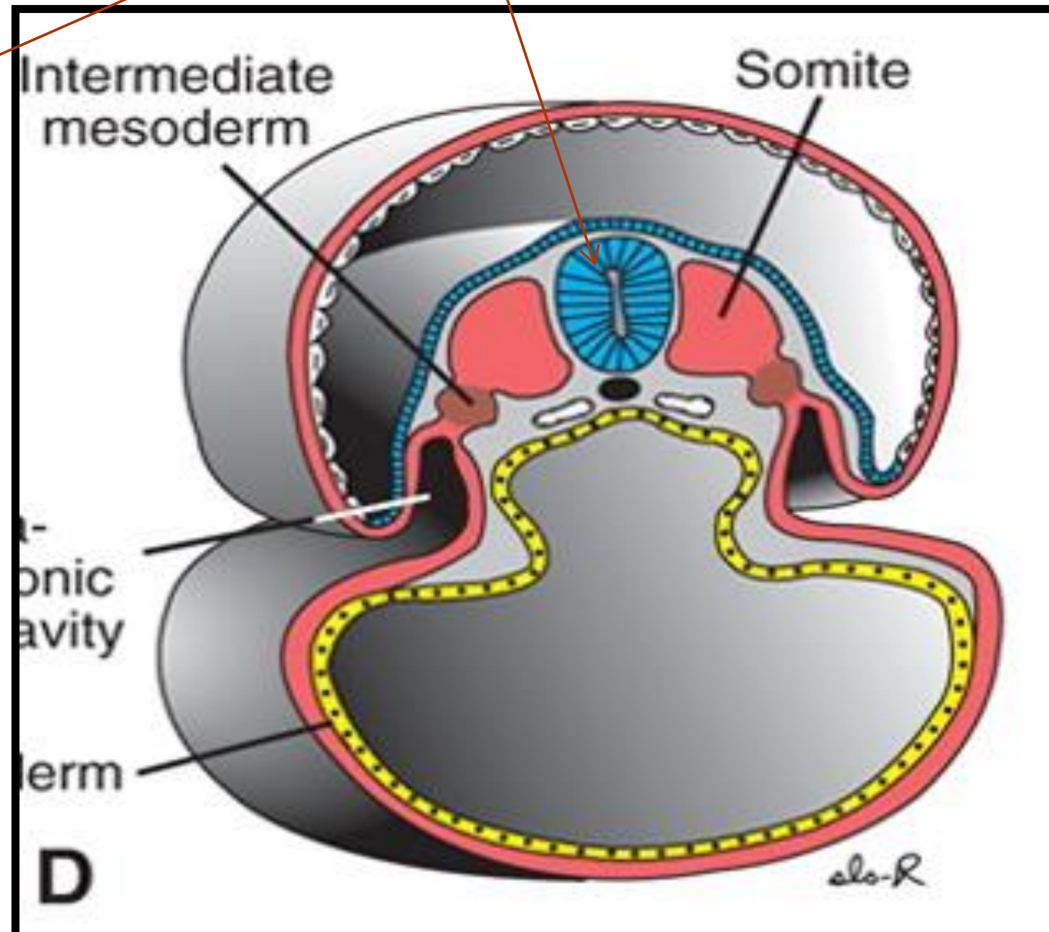




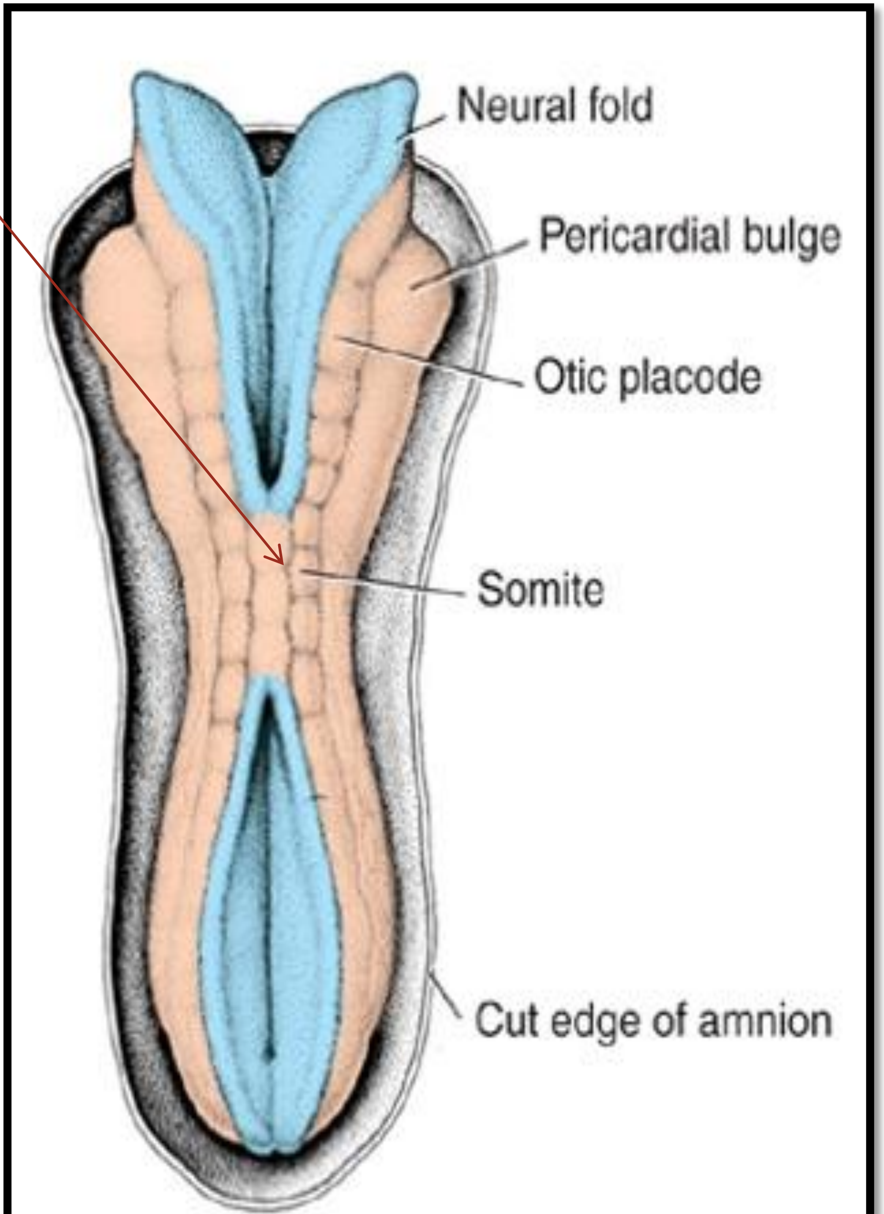
Gradually, the neural folds approach each other in the midline, where they fuse and form:

3-Neural tube



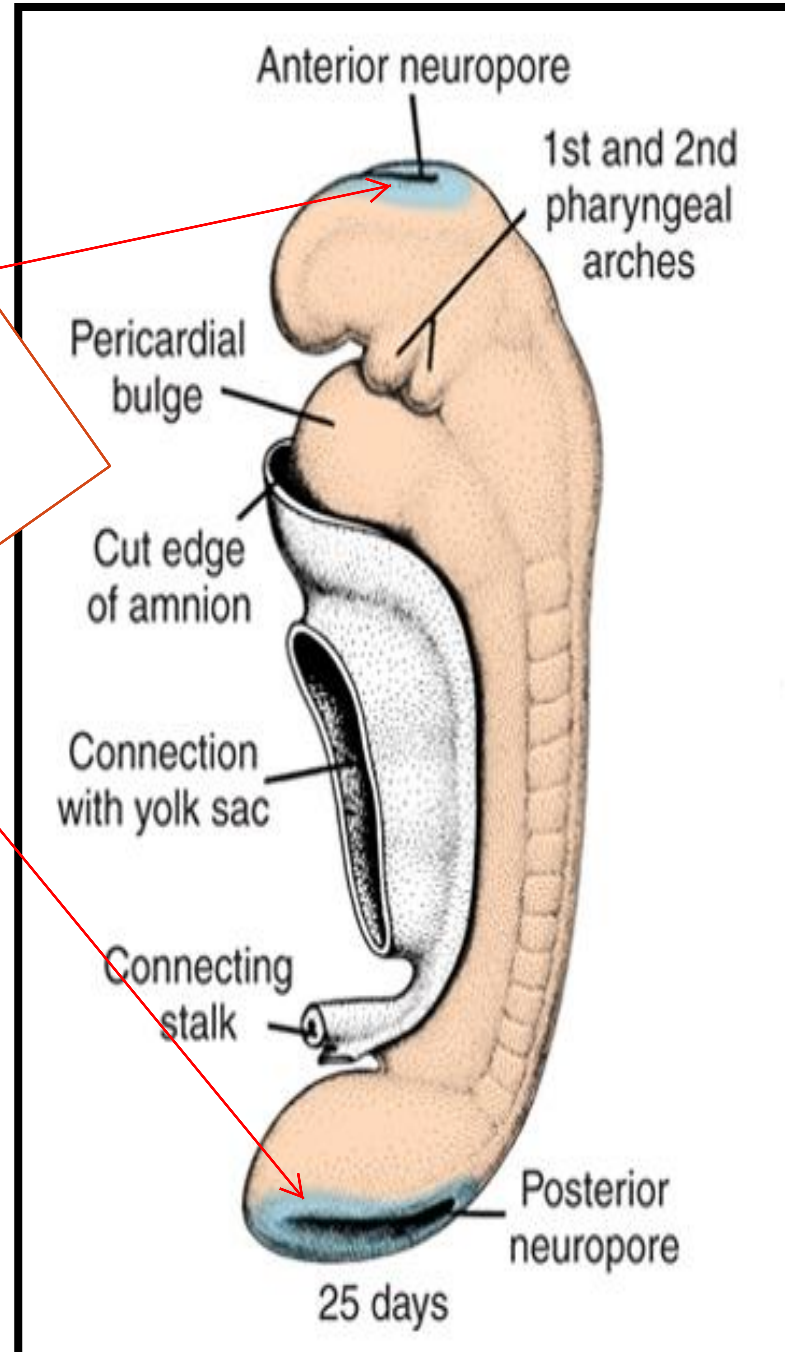


Fusion begins in the cervical region (fifth somite)
and proceeds cranially and caudally As a result the **neural tube is formed.**



Until fusion is complete
the cephalic and caudal ends of the neural tube communicate with the amniotic cavity by way of the **cranial and caudal neuropores**

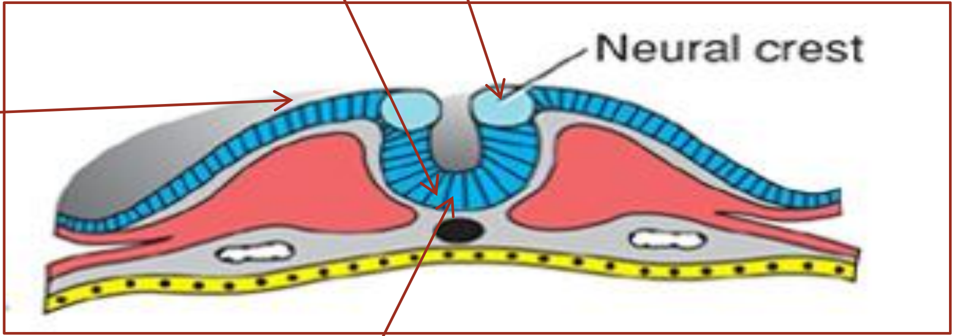
Closure of the **cranial neuropore** occurs at approximately day **25** whereas the **posterior neuropore** closes at day **27**



Parts of the neural tube

1-neural crest
2-alar plate
3-basal plate

alar plate



basal plate

THE NERVOUS SYSTEM IS FORMED FROM THE ECTODERM (THE NEURAL TUBE)

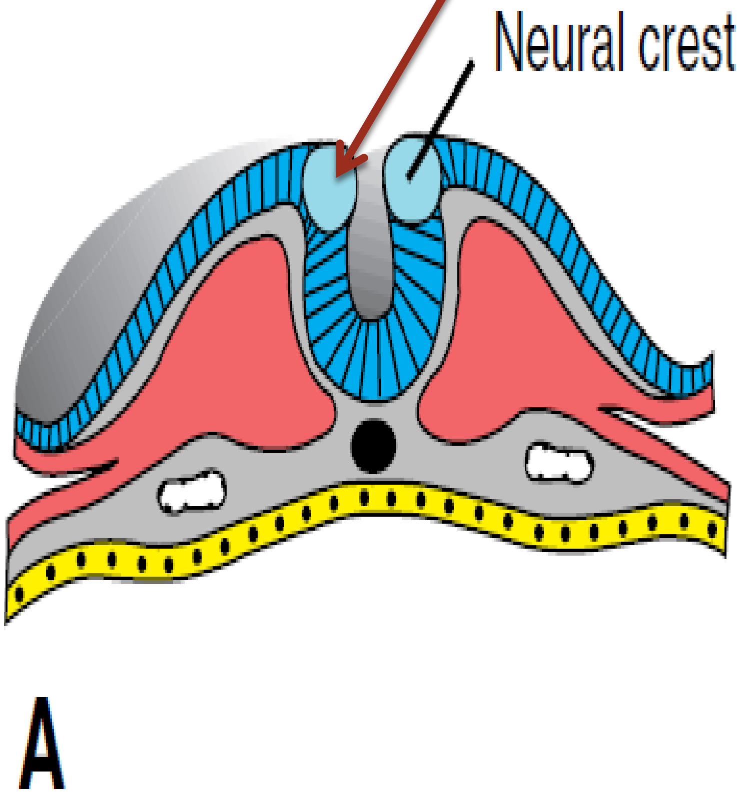
The **neural crest** gives rise to **the ganglia**

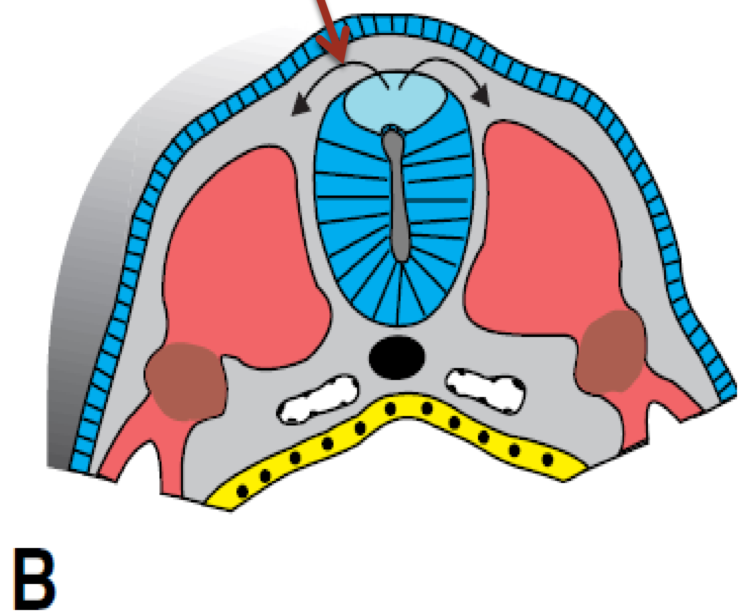
The **alar plate** gives rise to **the sensory** part of the nervous system

The **basal plate** gives rise to **the motor** part of the nervous system

NEURAL CREST

<u>Cells at the lateral border</u> or crest of the neuroectoderm begin to dissociate from their neighbors AND **undergo an epithelial-to-mesenchymal transition as it leaves the neuroectoderm by active migration and displacement to enter the underlying mesoderm**





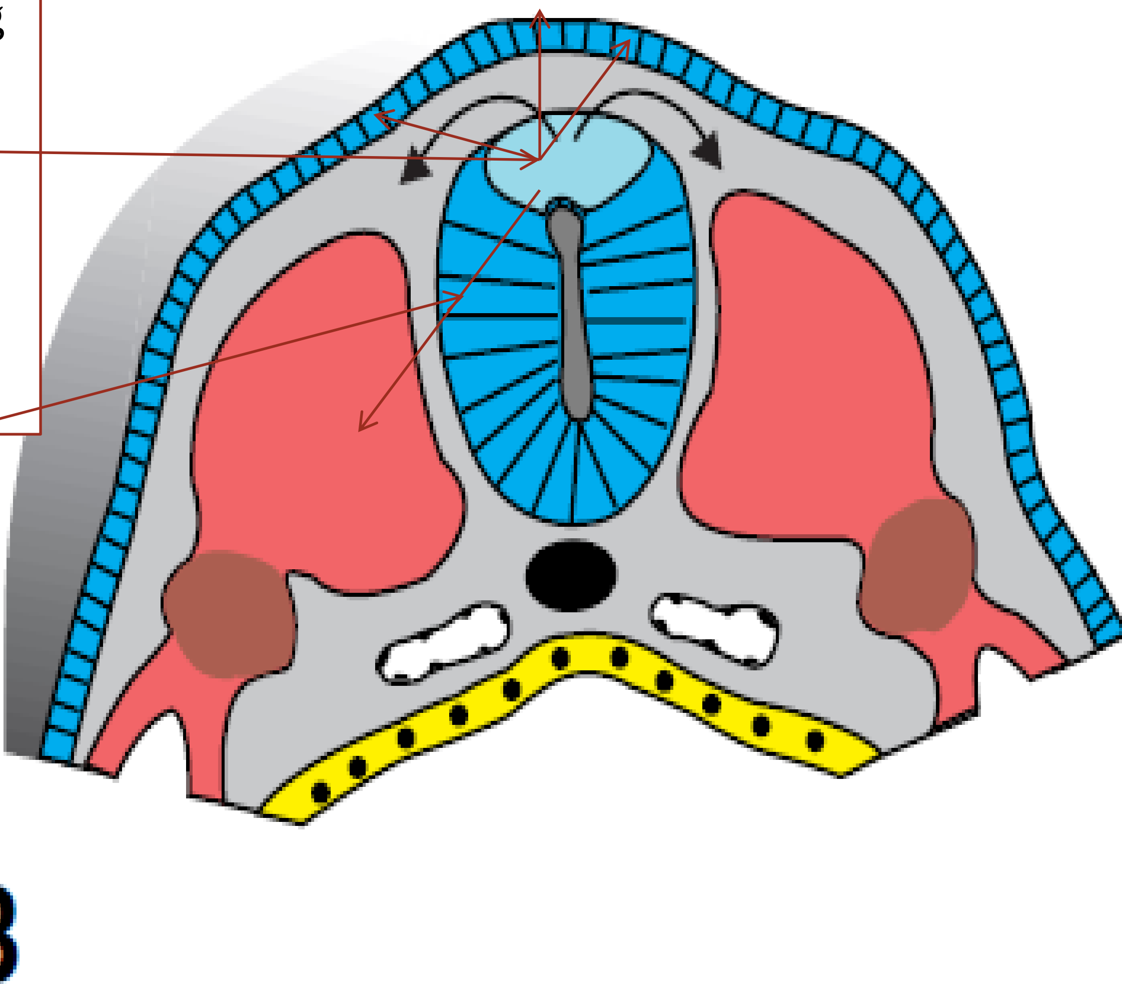
NEURAL CREST cells migrate along one of two pathways:

1) a dorsal pathway through the dermis, where they will enter the ectoderm to form

melanocytes

In the skin and hair follicles

2) a ventral pathway through the anterior half of each somite to become **sensory ganglia, sympathetic and enteric neurons , Schwann cells, and cells of the adrenal medulla**



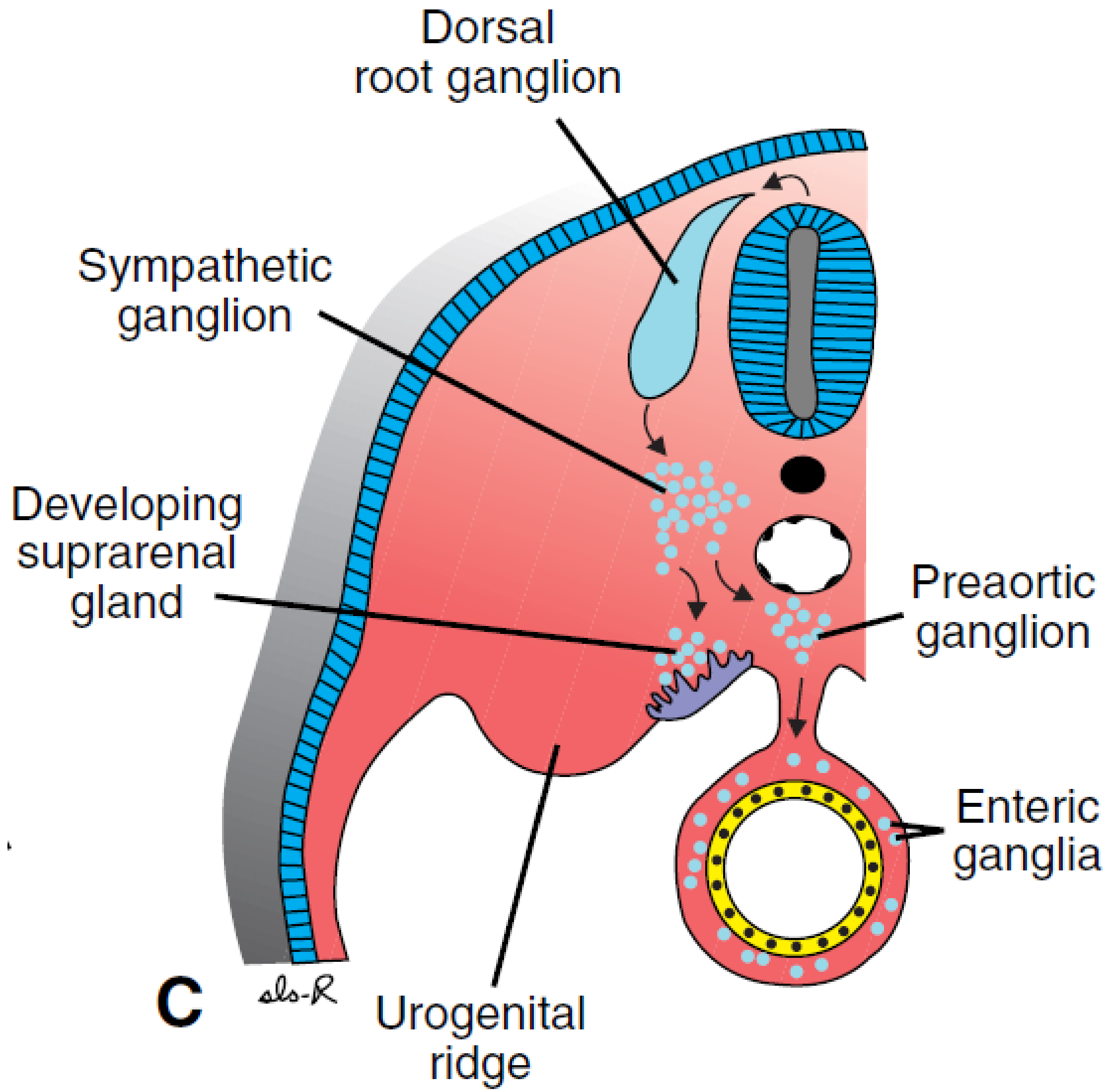
Neural crest cells

also

form and migrate from

cranial neural folds,

leaving the neural tube before closure in this region These cells contribute to the **craniofacial skeleton as well as neurons for cranial ganglia**



Neural Crest Derivatives

1-Connective tissue and ***<u>bones of the face and skull</u>***

2-Cranial nerve ganglia

3-C cells of the thyroid gland

4-Conotruncal septum in the heart

5-Odontoblasts

<u>6-Dermis in face and neck</u>

7-Spinal (dorsal root) ganglia

8-Sympathetic chain and preaortic ganglia

9-Parasympathetic ganglia of the gastrointestinal tract

10-Adrenal medulla

11-Schwann cells

12-Glial cells

13-Arachnoid and pia mater (leptomeninges)

14-**Melanocytes**

Peripheral nervous system

In general terms, the ectodermal germ layer
gives rise to organs and structures
that maintain contact with the outside world:

(*a) the central nervous*

(*b) the peripheral nervous system*

c) the sensory epithelium of the ear, nose, and eye

(*d) the epidermis, including the hair and nails*

In addition,
it gives rise to subcutaneous glands,
the mammary glands,
the pituitary
gland,
and enamel of the teeth.

MAJOR EVENTS OF THE SECOND WEEK OF DEVELOPMENT

A-Completion of implantation of the blastocyst

B-Production of a bilaminar embryonic disc

C-FORMATION OF EXTRAEMBRYONIC STRUCTURES:

1- ***AMNIOTIC CAVITY*** ☆

2- ***AMNION***

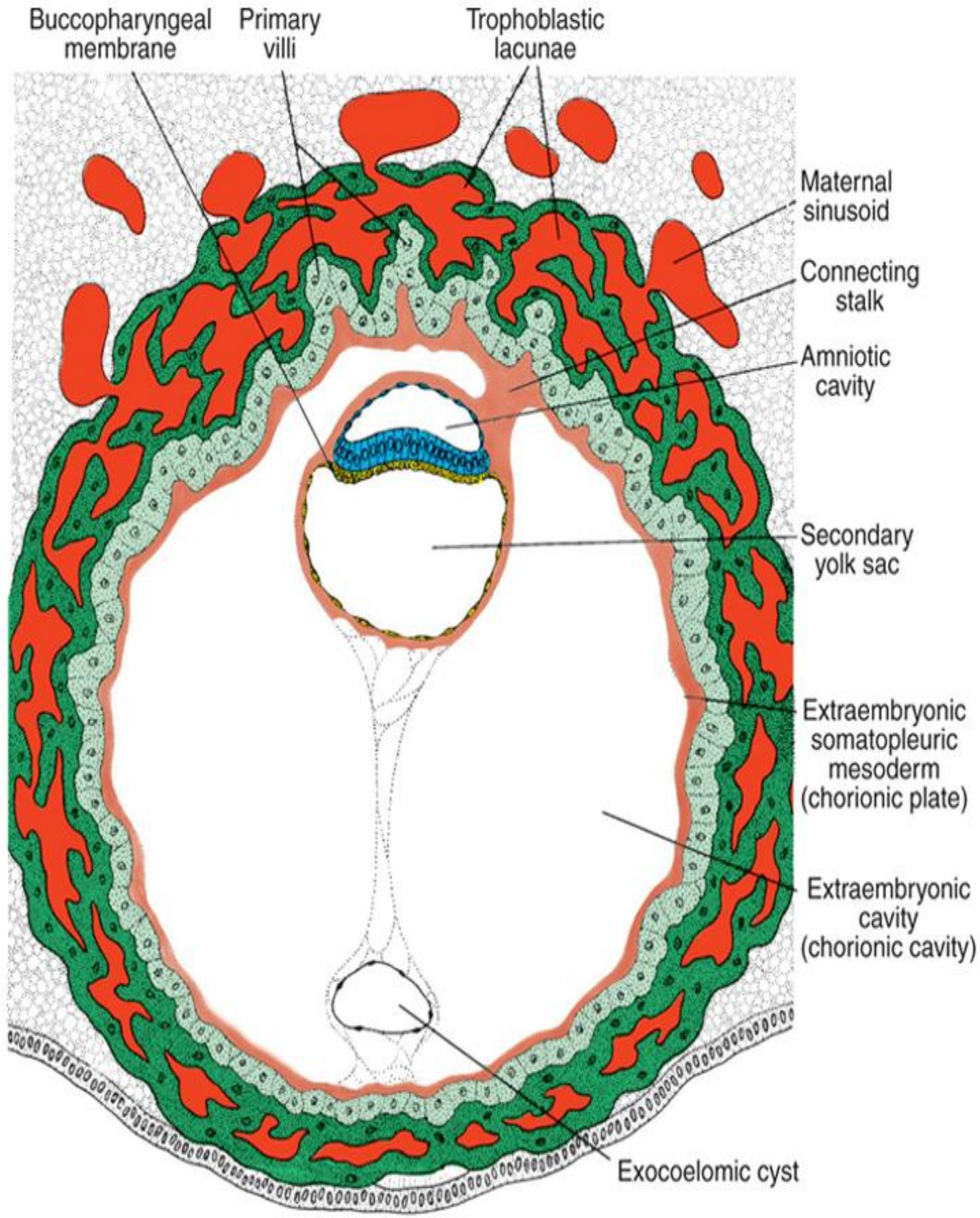
3- ***YOLK SAC***

4- ***CHORIONIC SAC***

5- ***CONNECTING STALK***

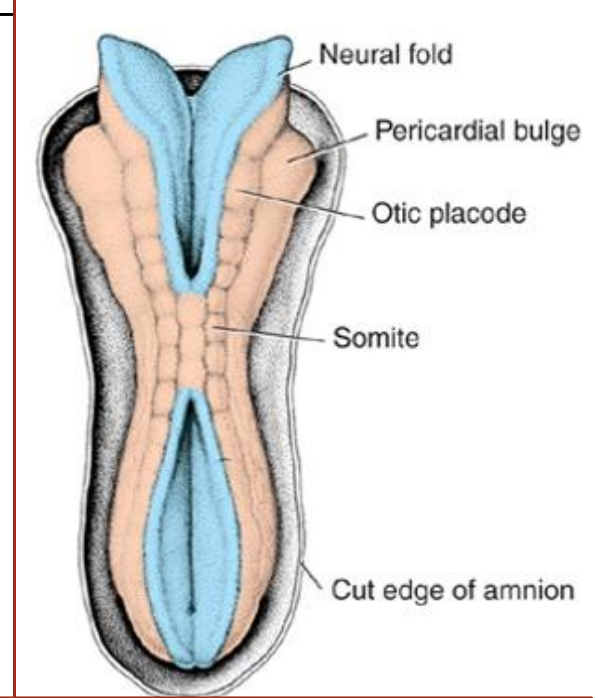
D-APPEARANCE OF PRIMARY CHORIONIC VILLI

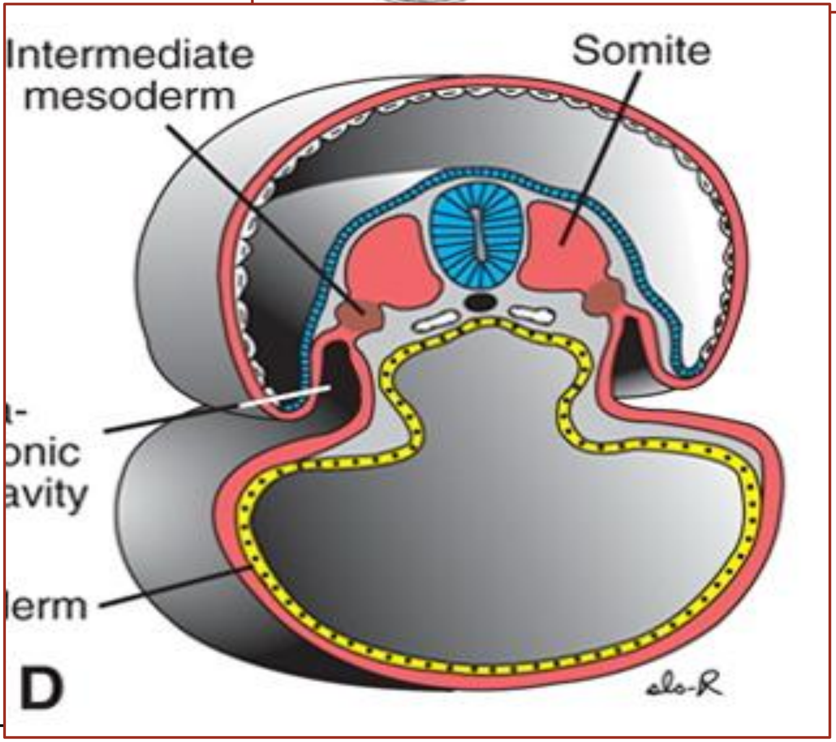
E-APPEARANCE OF THE PRECHORDAL PLATE



MAJOR EVENTS OF THE THIRD WEEK

- **Development of**
  THE PRIMITIVE STREAK
- **Development of**
  THE NOTOCHORD
- **Formation of**
  THE TRILAMINAR GERM DISC
- **Beginning of formation**
  OF NEURAL TUBE





Teratogenesis Associated With Gastrulation

Because this stage is reached 2 weeks after fertilization, it is **approximately 4 weeks** from the last menses. Therefore, the woman may not recognize she is pregnant, having assumed that menstruation is late and will begin shortly. Consequently, she may not take precautions she would normally consider if she knew she was pregnant

High doses of alcohol at this stage kill cells in the anterior midline of the germ disc, producing a deficiency of the midline in craniofacial structures and resulting in **holoprosencephaly.**

In such a child, the forebrain is small