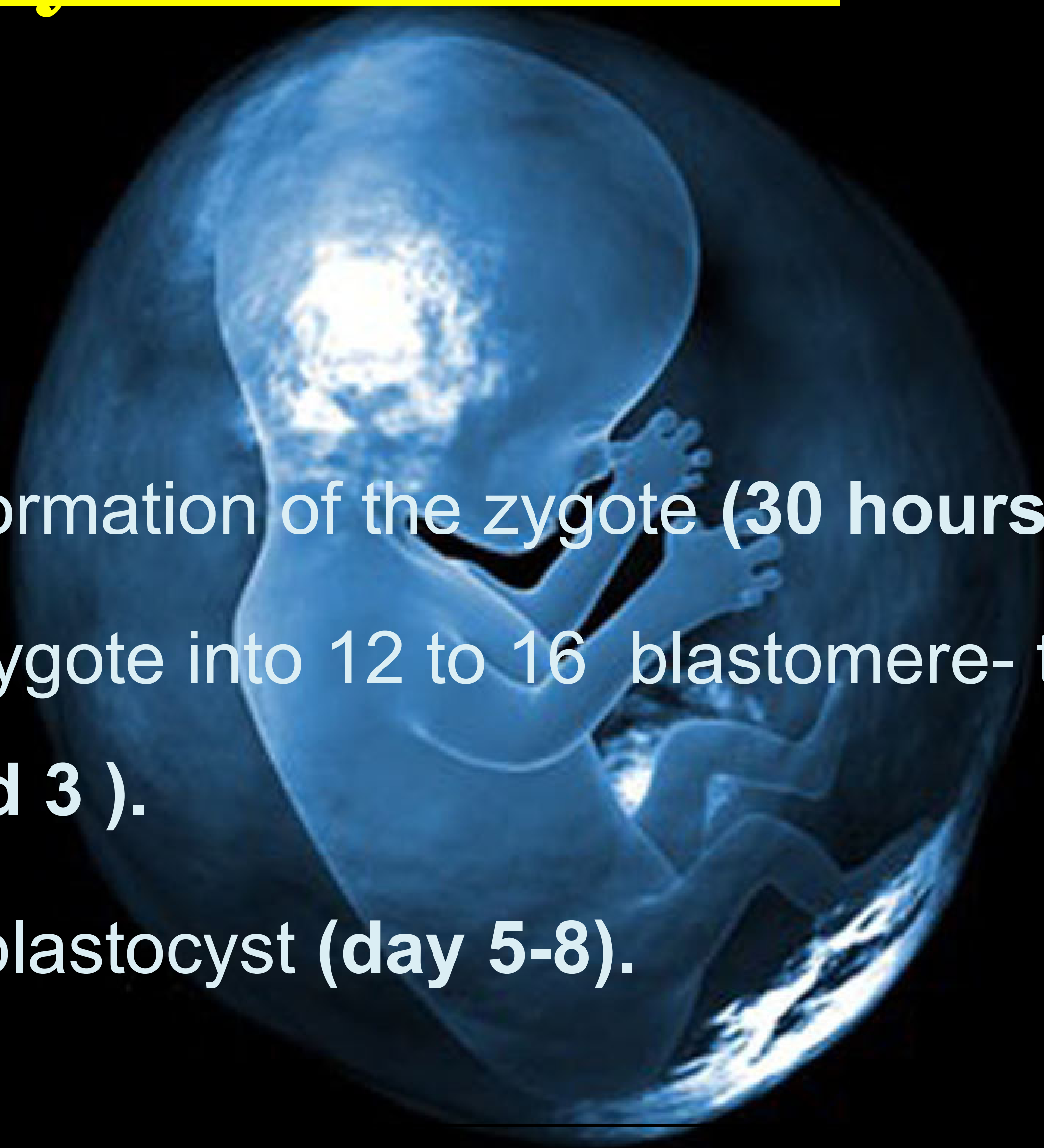
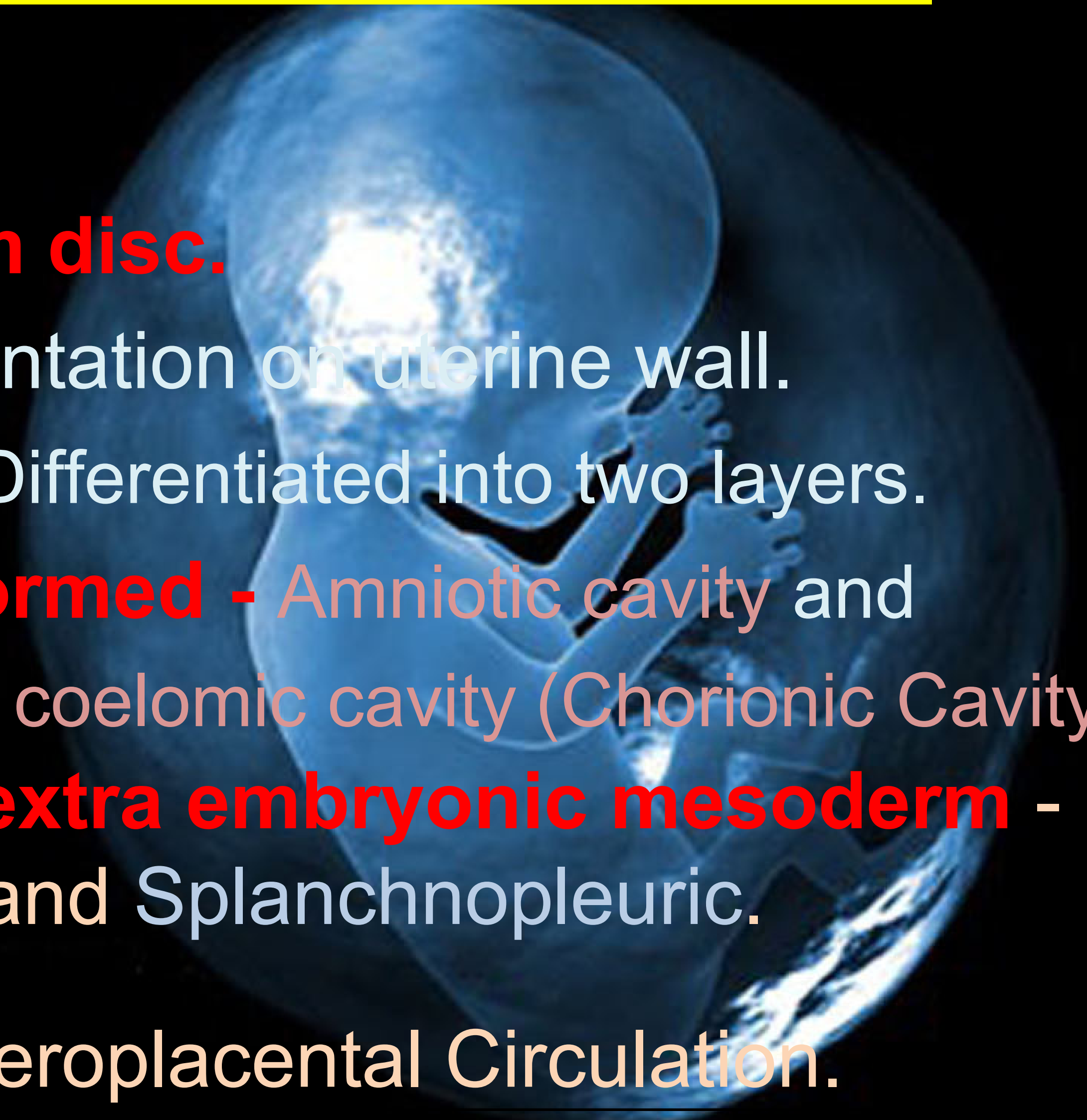
Summary of first week.



- Fertilization and formation of the zygote **(30 hours).**
- Cleavage of the zygote into 12 to 16 blastomere- the Morula **(day 2 and 3).**
- Formation of the blastocyst **(day 5-8).**

Summary of second week.

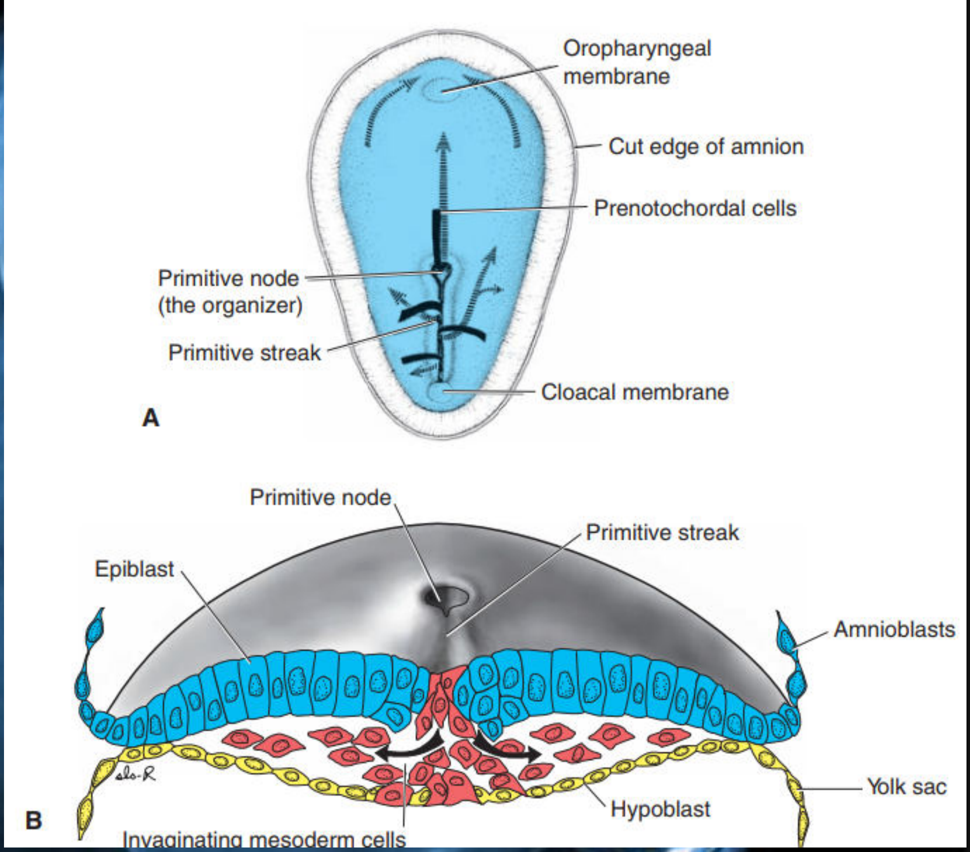


- **Bilaminar germ disc.**
- Complete implantation on uterine wall.
- **Trophoplast -** Differentiated into two layers.
- **Two cavities formed -** Amniotic cavity and Extra embryonic coelomic cavity (Chorionic Cavity)
- **Two layers of extra embryonic mesoderm** - Somatopleuric and Splanchnopleuric.
- Beginning of Uteroplacental Circulation.

3rd week of development

The most characteristic event occurring during the third week is **gastrulation**, which begins with the appearance of the **primitive streak**, which has at its cephalic end the **primitive node**. In the region of the node and streak, **epiblast** cells move inward **(invaginate)** to form new cell layers, **endoderm** and **mesoderm**.

Cells that do not migrate through the streak but remain in the epiblast form **ectoderm.** Hence, epiblast gives rise to all three **germ layers** in the embryo, **ectoderm**, **mesoderm**, and **endoderm**, and these layers form all of the tissues and organs .



The 3rd week of embryonic development is characterized by :

1. **Appearance of primitive streak**
2. **Development of notochord**
3. **Differentiation of three germ layers**

➢ **Gastrulation:**

▪This is the formation of 3 germ layers in embryos.

▪ During gastrulation, the **bilaminar embryonic disc** is converted into a **trilaminar embryonic disc.**

▪Extensive cell shape changes, rearrangement, movement, and changes in adhesive properties contribute to the process of gastrulation

▪Gastrulation is the beginning of **morphogenesis (development of body form)** and is the significant event occurring during the 3rd week

The 1st morphologic sign of gastrulation begins with formation of the ***primitive streak*** on the surface of the epiblast of the embryonic disc

- During this period, the embryo may be referred to as a **gastrula**
- the 3 germ layers are
  - ✓Ectoderm
  - ✓Mesoderm
  - ✓ and endoderm
- Each of these layers gives rise to specific tissues and organs
- **Embryonic ectoderm:** gives rise to the epidermis, central and peripheral nervous systems(CNS & PNS), the eye, and inner ear, neural crest cells
- **Embryonic mesoderm** gives rise to all skeletal muscles, blood cells and the lining of blood vessels, all visceral smooth muscular coats, the serosal linings of all body cavities, the ducts and organs of the reproductive and excretory systems, and most of the cardiovascular system

▪In the trunk, it is the source of all connective tissues, including cartilage, bones, tendons, ligaments, dermis, and stroma of internal organs.

▪**Embryonic endoderm** gives rise to the epithelial linings of the respiratory and alimentary (digestive) tracts, including the glands opening into the gastrointestinal tract and the glandular cells of associated organs such as the liver and pancreas.

➢Primitive streak

▪The first sign of gastrulation is the *appearance of the primitive streak*

▪The primitive streak results from the proliferation and movement of cells of the epiblast to the median plane of the embryonic disc

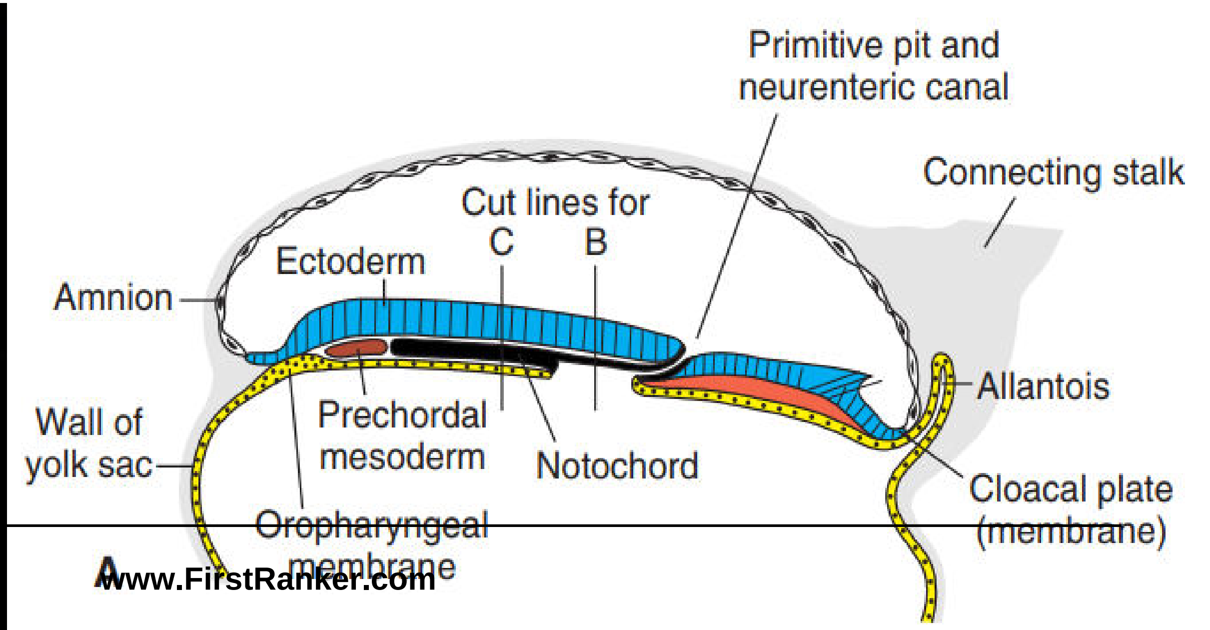
▪At the beginning of the 3rd week, the **primitive streak** appears caudally (tail end) in the median plane of the dorsal (posterior) aspect of the embryonic disc .

With formation of the primitive streak, several axes of an embryo get defined.

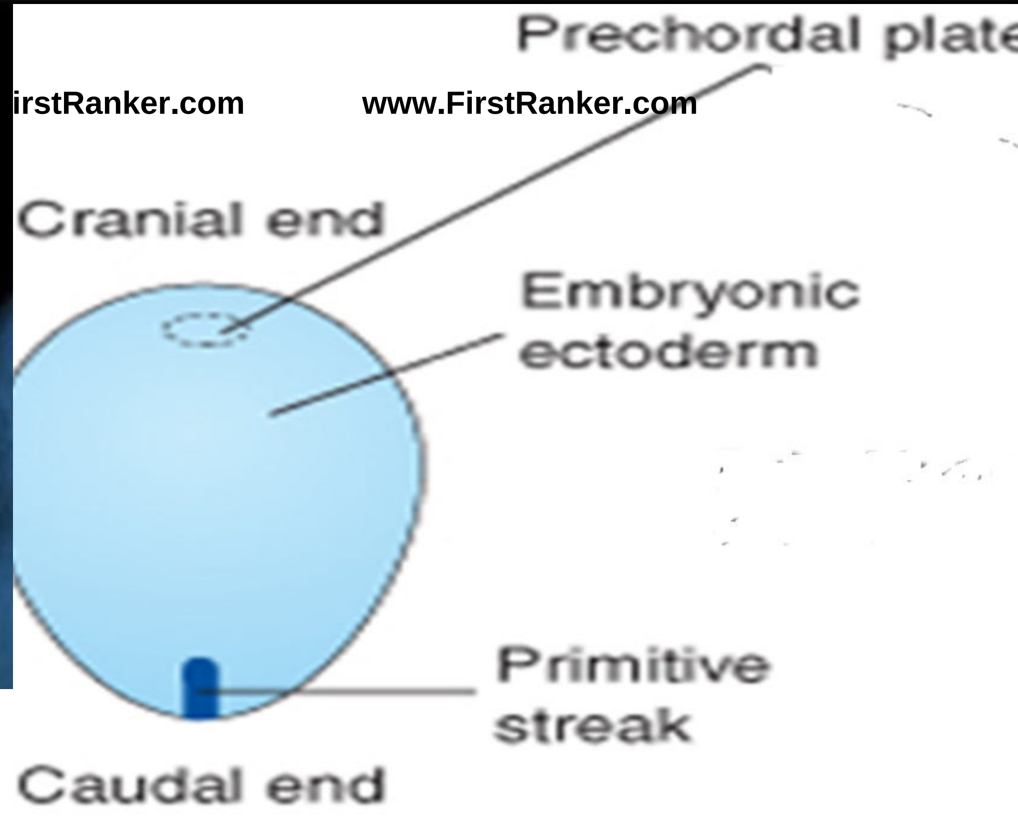
- **Craniocaudal (anteroposterior) axis:** As the primitive streak is present in the posterior half of the embryo, the craniocaudal axis of the embryo gets defined
- **Medial and lateral axes:** Since the primitive streak is present in the median plane of the embryonic disk, anything away from the median plane becomes lateral to the median plane.
- **Right and left axes:** As the primitive streak lies in the median plane, while visualizing the germ disk from the amniotic cavity, the right half of the germ disk represents the right side and the left half of the germ disk represents the left half.
- **Dorsal-ventral axis:** At this stage, the dorsal-ventral axis gets vaguely defined. The ectoderm is dorsal and endoderm is ventral . This axis gets well defined after folding of the embryo

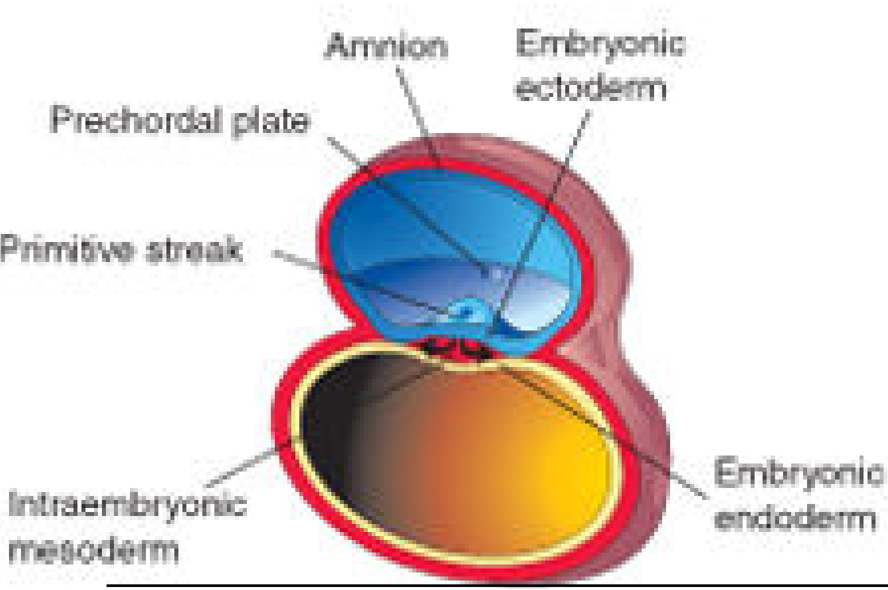
There are five subdivisions of Embryonic mesoderm:

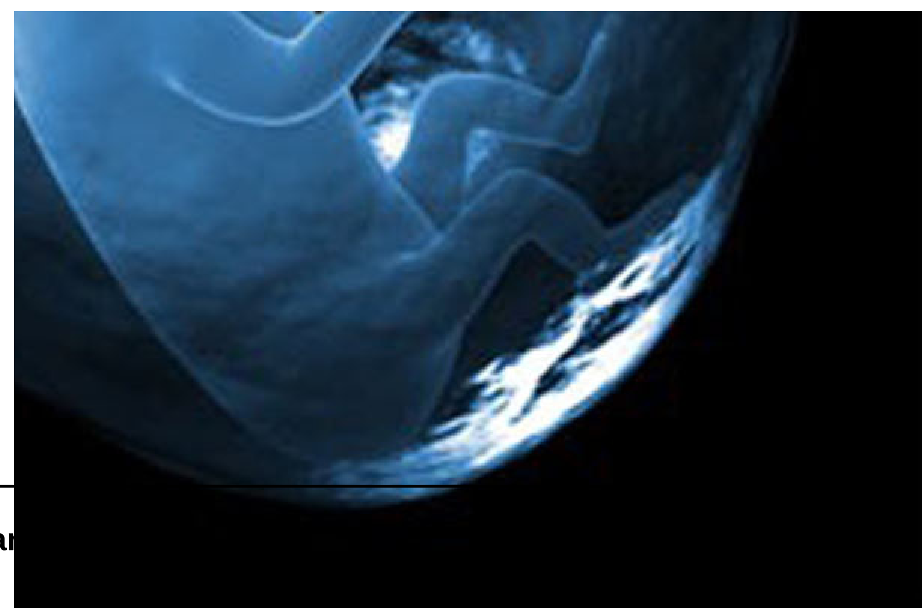
- Paraxial mesoderm
- Intermediate mesoderm
- Lat plate mesoderm
- Cardiogenic mesoderm
- In median plate
  Prechordal plate and
  Notochord.

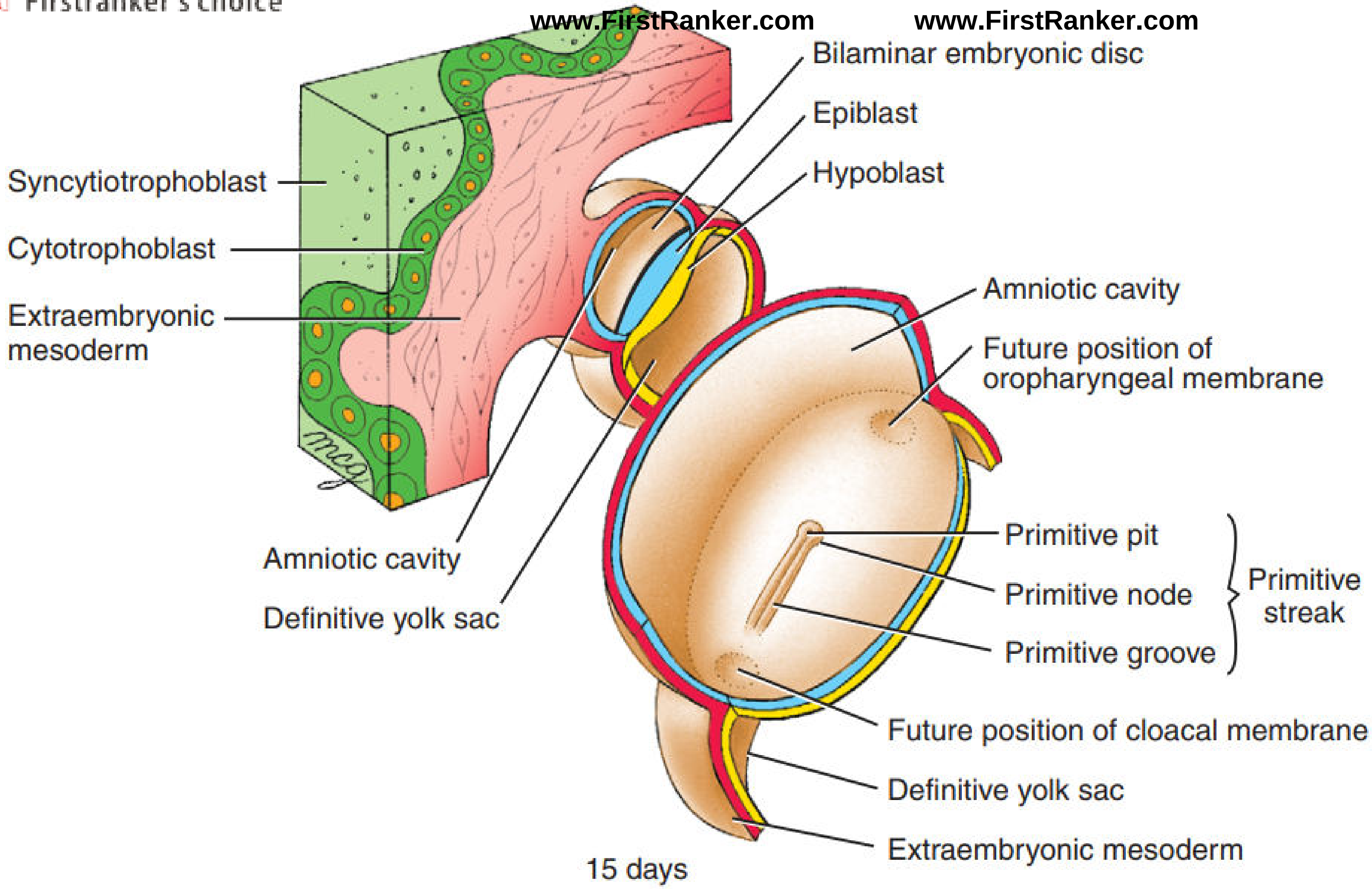


In development of vertebrate animals, the **prechordal plate** is a "uniquely thickened portion" of the endoderm that is in contact with ectoderm immediately rostral to the cephalic tip of the notochord. It is the most likely origin of the rostral cranial mesoderm









View of dorsal surface of bilaminar embryonic disc through sectioned amnion and yolk sac. Inset at upper left shows relation of the embryo to the wall of the chorionic cavity. The primitive streak, now 1 day old, occupies 50% of the length of the embryonic disc. The future positions of oropharyngeal and cloacal membranes are indicated.

Formation of the **primitive streak** also defines all major body axes. The primitive streak forms in the caudal midline of the embryonic disc, thus defining the cranial-caudal axis and medial-lateral axis (with the primitive streak forming in the midline, that is, most medially).

- **The Primitive streak**

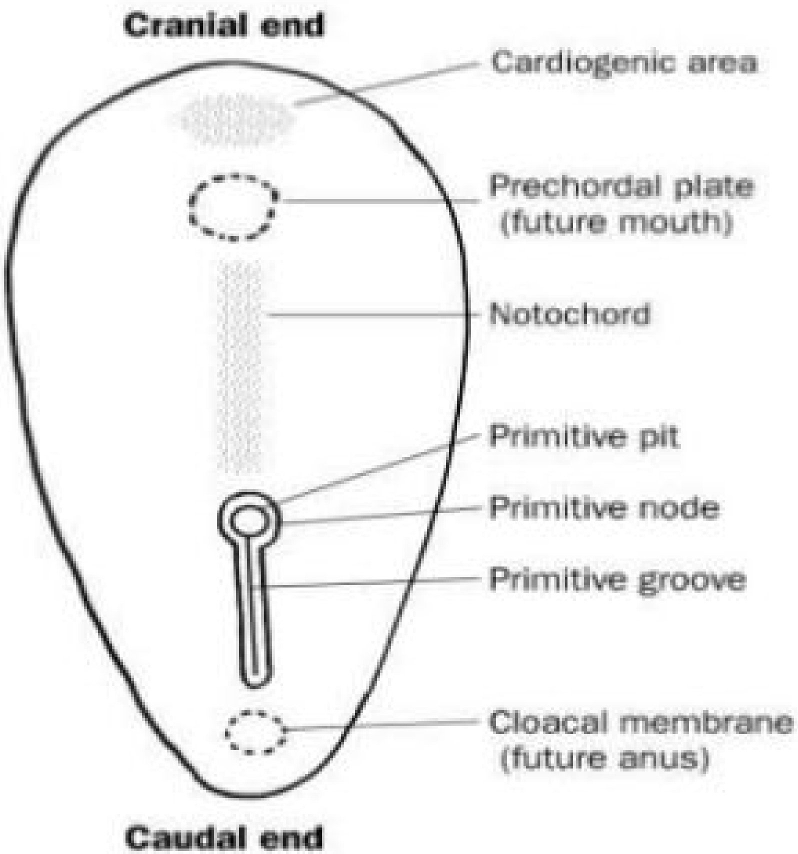
consists of:

1. primitive groove.
2. Primitive node.
3. Primitive pit.

After primitive streak formation, the embryo has:

1. Craniocuadal axis.
2. Dorsal &ventral surfaces.
3. Right & left sides.

By the end of 4th week the primitive streak shows regressive changes, rapidly shrinks and soon DISAPPEARS.



As the *primitive streak elongates* by addition of cells to its caudal end, its cranial end proliferates to form a **primitive node.**

Concurrently, a narrow groove called the **primitive groove** develops in the primitive streak .This 'primitive groove' is continuous with a small depression in the primitive node called the **primitive pit.**

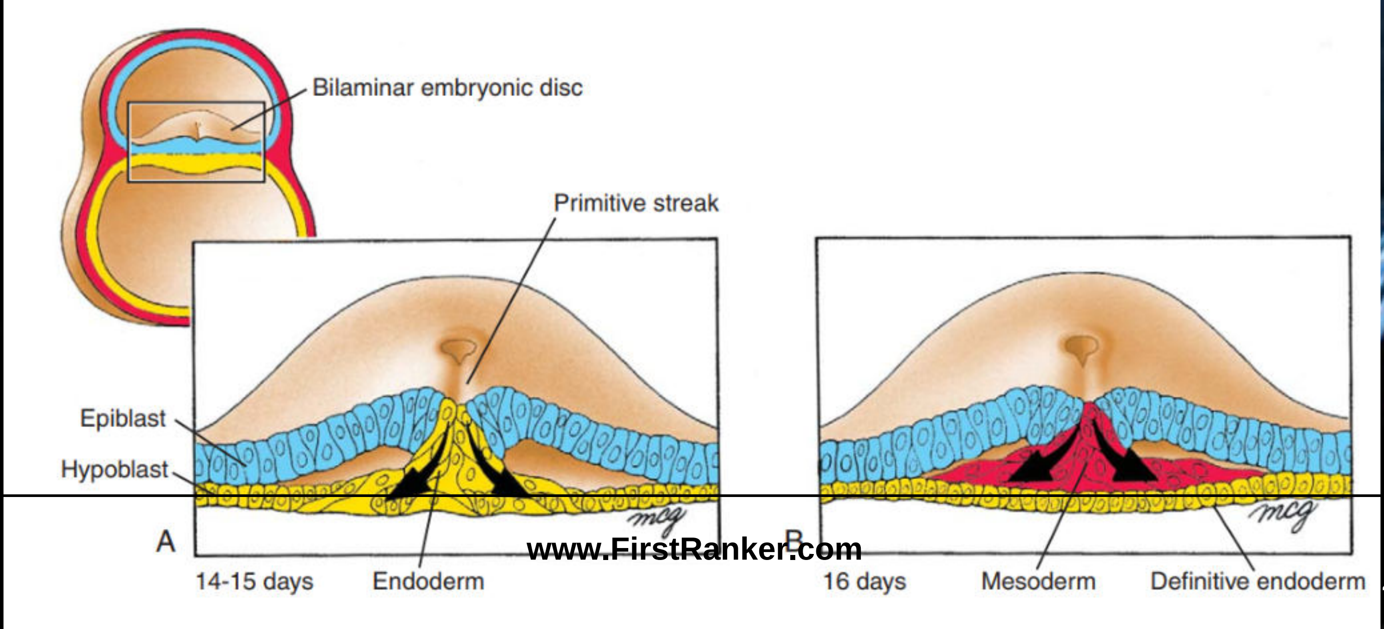
Shortly after the primitive streak appears, cells leave its deep surface and form **mesenchyme** (a tissue consisting of loosely arranged cells suspended in a gelatinous matrix).

Mesenchymal cells are ameboid and actively phagocytic.
Mesenchyme forms the supporting tissues of the embryo, such as most of the connective tissues of the body and the connective tissue framework of glands

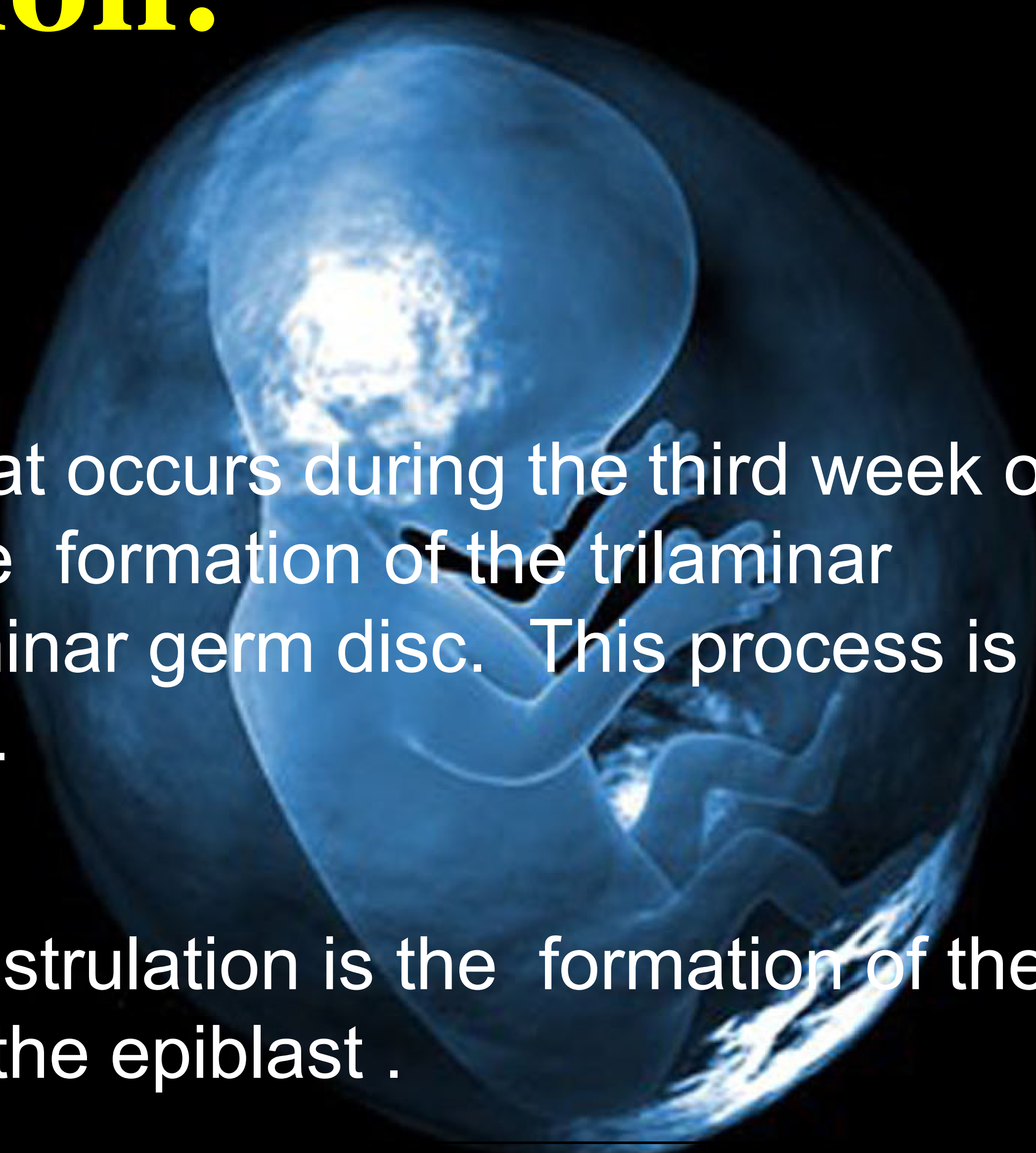
Events in Gastrulation:

Cell proliferation:

Formation of the primitive streak heralds the beginning of gastrulation. During gastrulation, epiblast cells move toward the primitive streak, enter the primitive streak, and then migrate away from the primitive streak as individual cells. The movement of cells through the primitive streak and into the interior of the embryo is called ingression



Gastrulation:

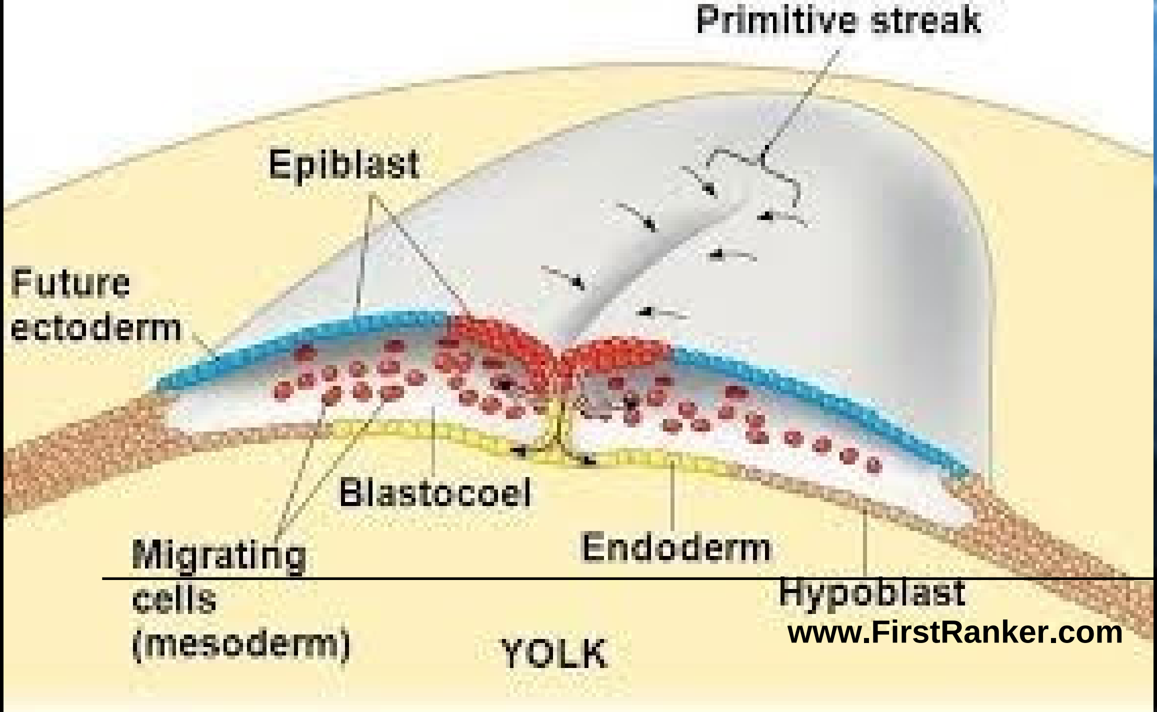


- The main event that occurs during the third week of development is the formation of the trilaminar embryo from bilaminar germ disc. This process is called gastrulation.
- The first sign of gastrulation is the formation of the primitive streak in the epiblast .

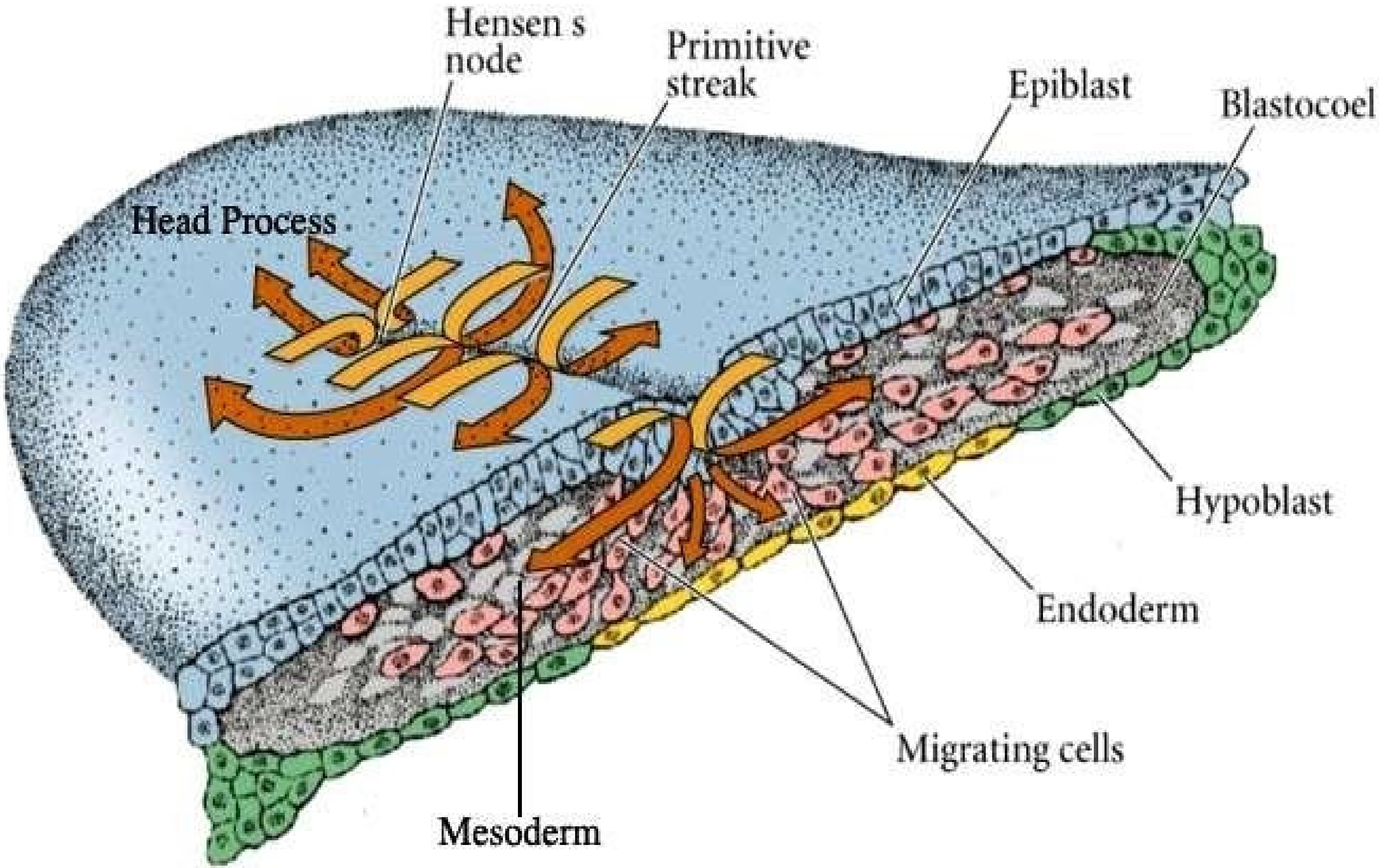
Because formation of the primitive streak occurs in the midline, when the epiblast is viewed looking down at it from inside the amniotic cavity, what lies to the right of the primitive streak represents the right side of the embryo and what lies to the left represents its left side .

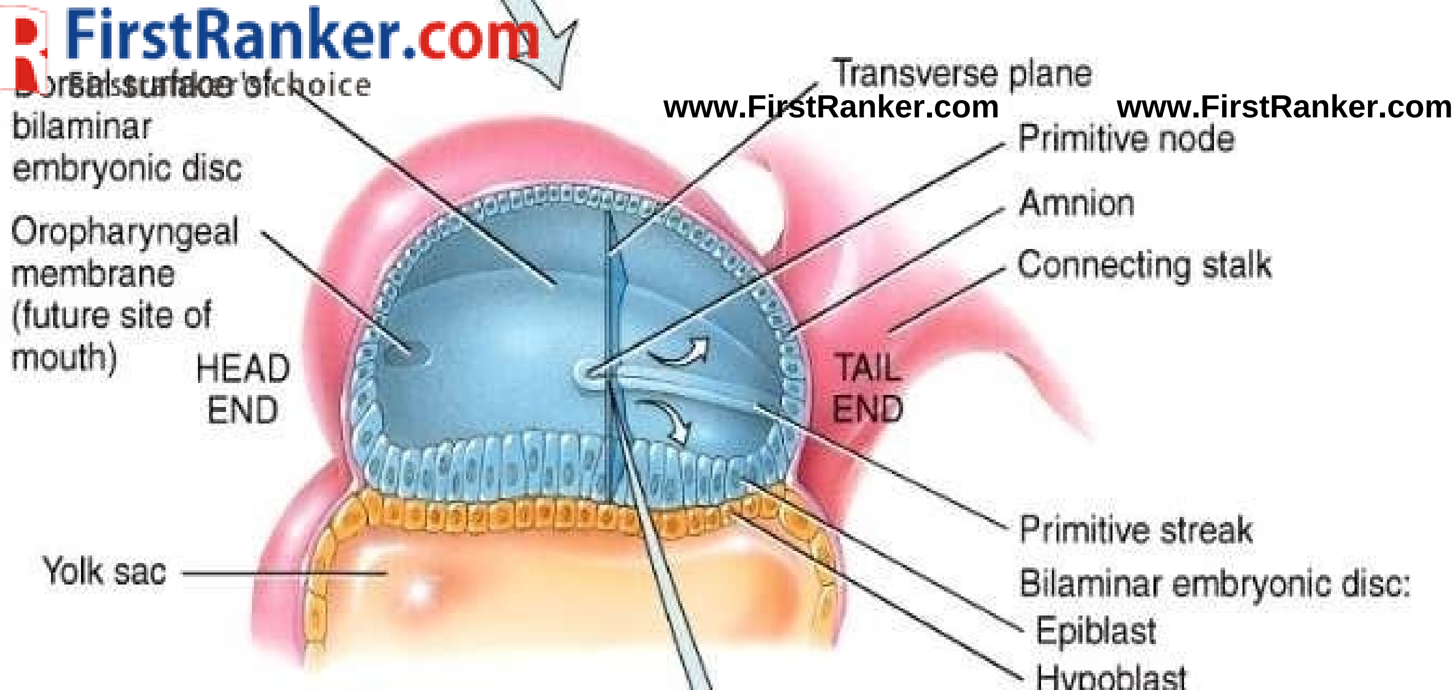
Formation of Definitive Endoderm

On day 16, epiblast cells lateral to the primitive streak begin to move into the primitive streak where they undergo an epithelial-to-mesen chymal transformation (EMT).

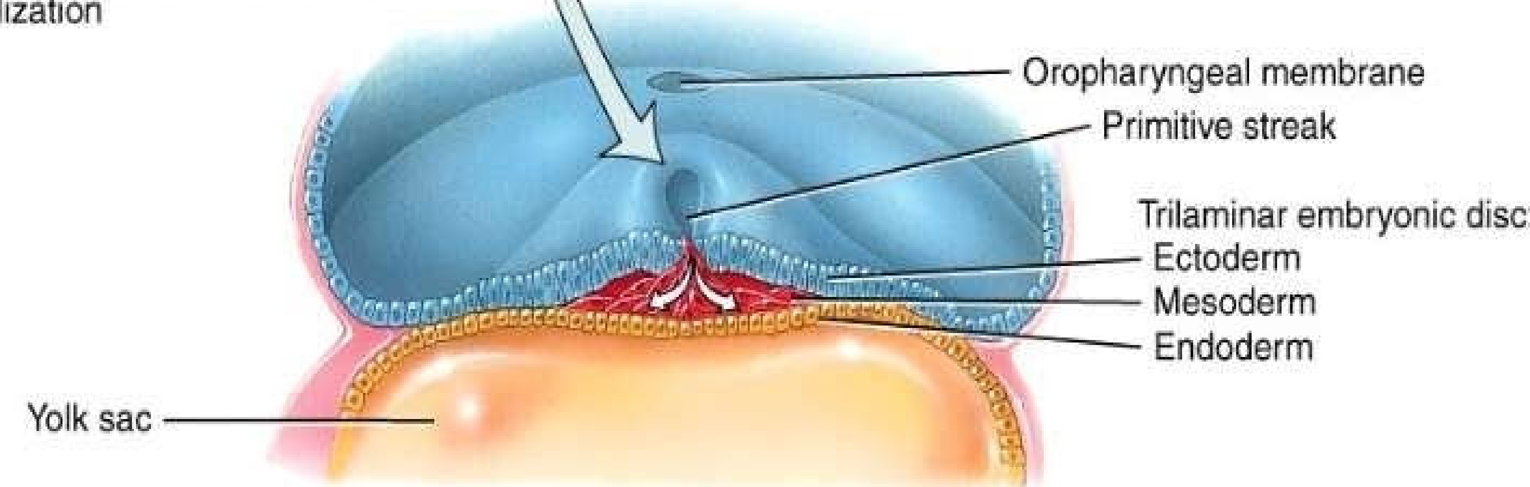


This collective movement of cells through the primitive streak and into the interior of the embryo to form the three primary germ layers constitutes gastrulation .

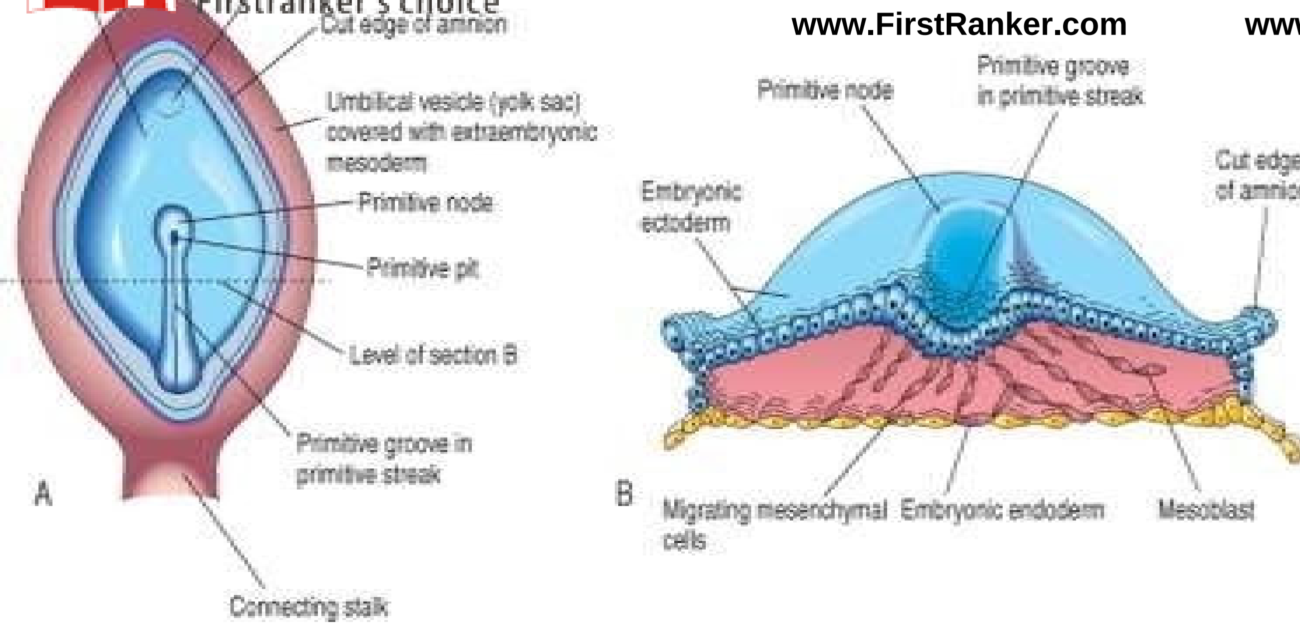

Hensen s node
Primitive streak
Epiblast
Blastocoel
Head Process
Hypoblast
Endoderm
Migrating cells
Mesoderm

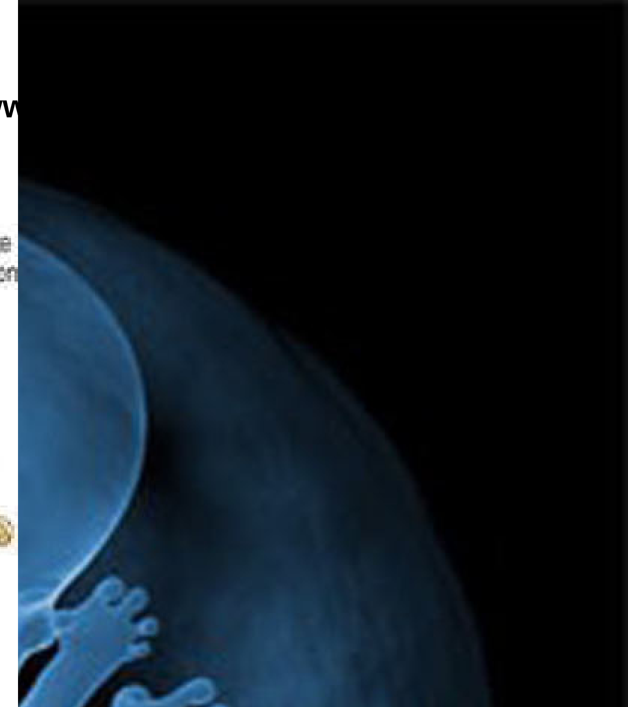


(a) Dorsal and partial sectional views of embryonic disc, about 15 days after fertilization

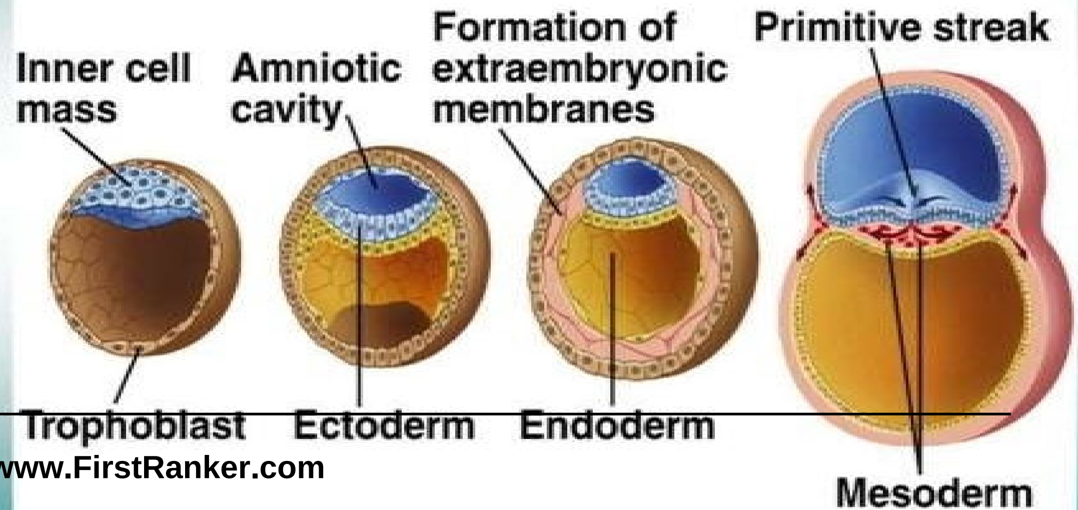


(b) Transverse section of trilaminar embryonic disc, about 16 days after fertilization





Gastrulation — Mammal



Some mesenchyme forms **mesoblast** (undifferentiated mesoderm), which forms the ***intraembryonic or embryonic mesoderm .***

Cells from the epiblast, as well as from the primitive node and other parts of the primitive streak migrate in order to displace the hypoblast This inward movement is known as **invagination.**

Cell migration and specification are controlled by fibroblast growth factor 8 (FGF8), which is synthesized by streak cells themselves

Once the cells have invaginated, some displace the hypoblast, creating the embryonic **endoderm,** and others come to lie between the epiblast and newly created endoderm to form **mesoderm.**
Cells remaining in the epiblast then form **ectoderm**

In summary, cells of the epiblast, through the process of gastrulation, give rise to all 3 germ layers in the embryo, the primordia of all its tissues and organs.

Fate of the Primitive Streak

The primitive streak actively forms mesoderm by the ingression of cells until the early part of the fourth week; thereafter, production of mesoderm slows down.

The primitive streak diminishes in relative size and becomes an insignificant structure in the sacrococcygeal region of the embryo

Normally the primitive streak undergoes degenerative changes and disappears by the end of the 4th week

Clinical correlate: **Sacrococcygeal Teratoma**

Remnants of the primitive streak may persist and give rise to a **sacrococcygeal teratoma**. Because they are derived from pluripotent primitive streak cells, these tumors contain tissues derived from all three germ layers in incomplete stages of differentiation

Sacrococcygeal teratomas are the most common tumor in newborns and have an incidence of approximately one in 35,000. most affected infants (80%) are female. These are usually diagnosed on routine antenatal ultrasonography, and most tumors are benign.

These tumors are usually surgically excised promptly, and the prognosis is good.

- **Cell migration**

  by amoeboid movement – the cells insinuate themselves between the epiblast and hypoblast

- **Cell determination:**

  - the cells arising from the primitive streak are determined to give rise to different tissues

Dorsal view of the germ disc showing the primitive streak and a fate map for epiblast cells Specific regions of the epiblast migrate through different parts of the node and streak to form mesoderm. Thus, cells migrating at the cranial most part of the node will form the notochord; those migrating more posteriorly through the node and cranial most aspect of the streak will form paraxial mesoderm (*pm;* somitomeres and somites); those migrating through the next portion of the streak will form intermediate mesoderm (*im;* urogenital system); those migrating through the more caudal part of the streak will form lateral plate mesoderm (*lpm;* body wall); and those migrating through the most caudal part will contribute to extraembryonic mesoderm (*eem;* chorion).

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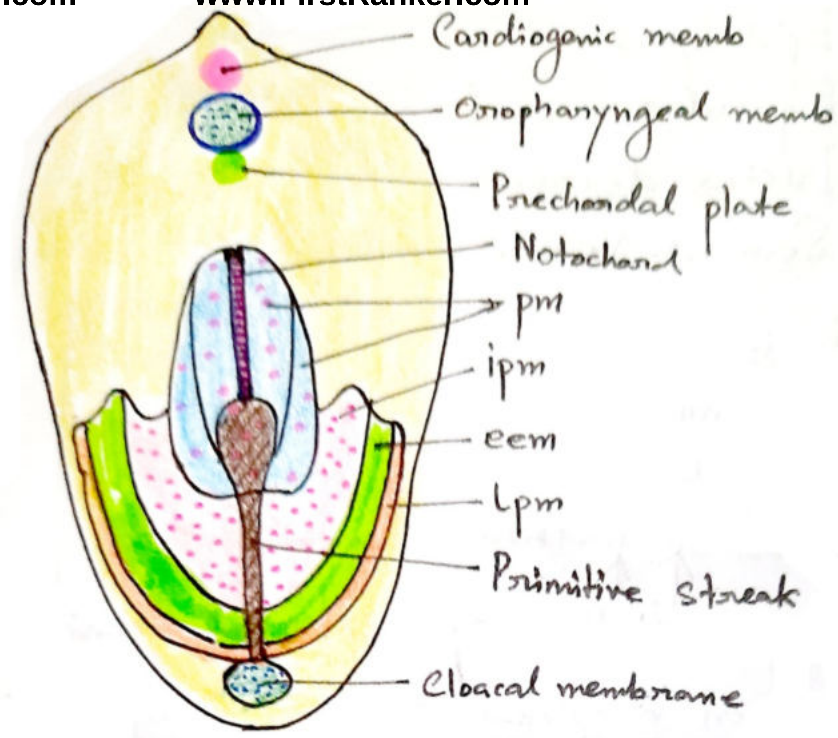
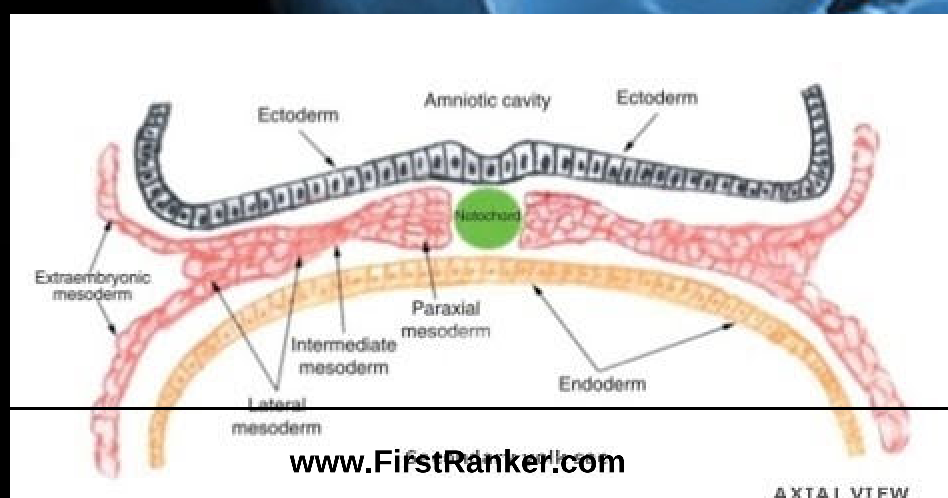


Fate map of Bilaminar Germ Disc

1. ***Ectoderm*** develops into *CNS* (induced by mesoderm and skin)
2. ***Endoderm*** forms the lining of the Alimentary System and Respiratory System.
3. ***Mesoderm*** forms the CVS (induced by endoderm)



Intraembryonic mesoderm gives rise to all skeletal muscles, blood cells, the lining of blood vessels, all visceral smooth muscular coats, serosal linings of all body cavities, ducts and organs of the reproductive and excretory systems, and most of the cardiovascular system.

- ✓ In the body (trunk or torso), excluding the head and limbs, it is the source of all connective tissues, including cartilage, bones, tendons, ligaments, dermis, and stroma (connective tissue) of internal organs.

- ✓ Head - connective tissues is derived from **Neural Crest cells.**

- ✓ In Limb - Intially, **the limb** bud mesenchyme consists exclusively of cells **derived from the lateral plate mesoderm**. These cells give rise to **the** skeleton, **connective tissue**, and some blood vessels. Mesenchymal cells **derived** from **the somites** migrate into **the limb** bud as precursors of **muscle** and endothelial cells.

- **Midline mesoderm** forms **notochord.**
- **Paraxial mesoderm** gives rise to **myotomes** (skeletal muscle); **sclerotomes** (vertebra); and **dermatomes** (dermis).

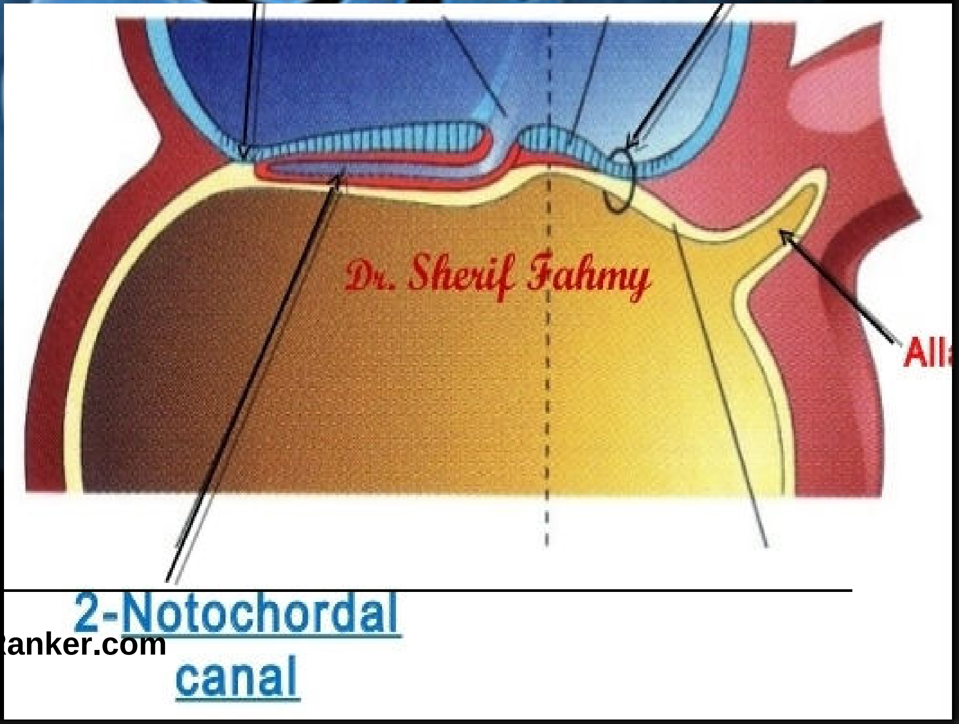
Notochordal process and notochord

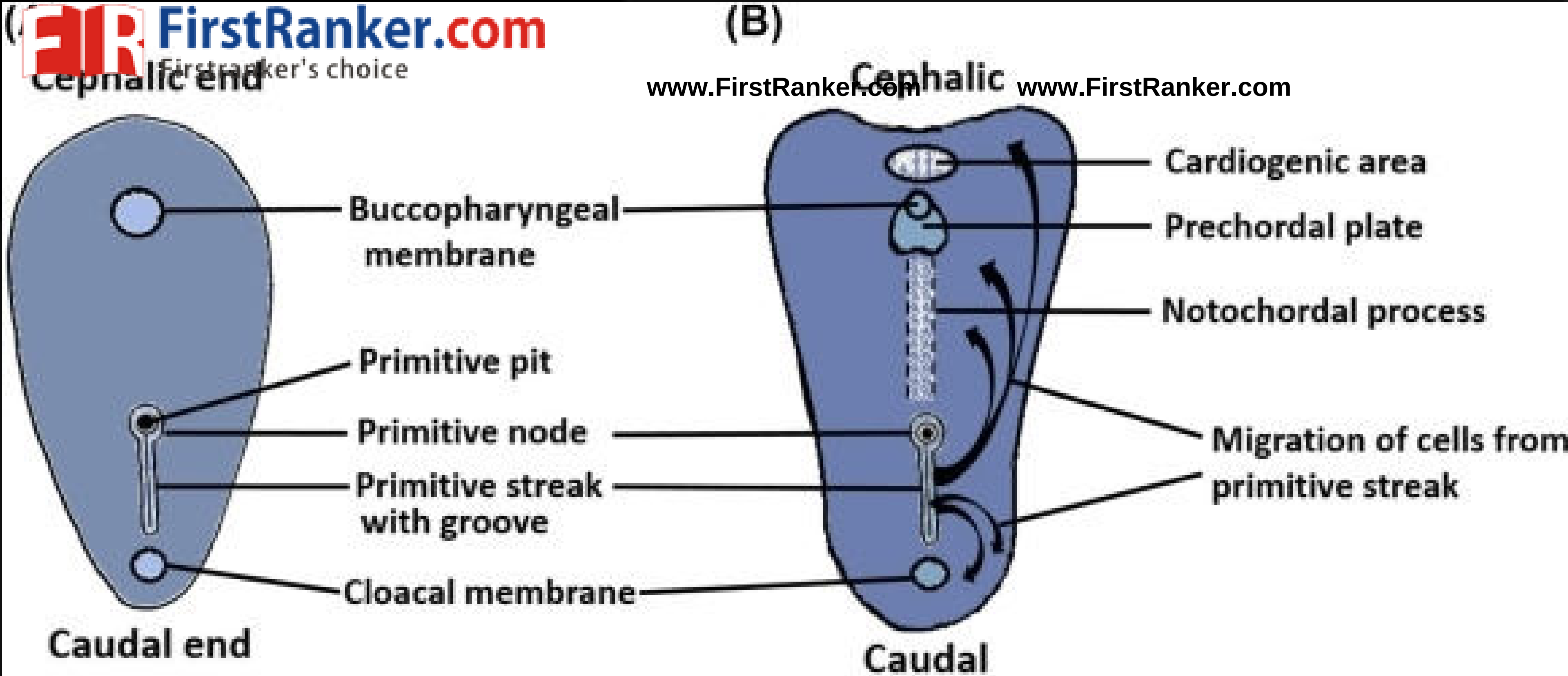
Notochordal process

- Some mesenchymal cells that have ingressed through the streak, acquired mesodermal cell and migrate cranially from the primitive node and pit, forming a median cellular cord, the **notochordal process** .

This process soon acquires a lumen, the **notochordal canal.**

The notochordal process grows cranially between the ectoderm and endoderm until it reaches the **prechordal plate**, a small circular area of columnar endodermal cells where the ectoderm and endoderm are in contact .The prechordal plate is the primordium of the **oropharyngeal membrane** located at the future site of the oral cavity. Caudal to the primitive streak there is a circular area-the **cloacal membrane**, which indicates the future site of the anus.



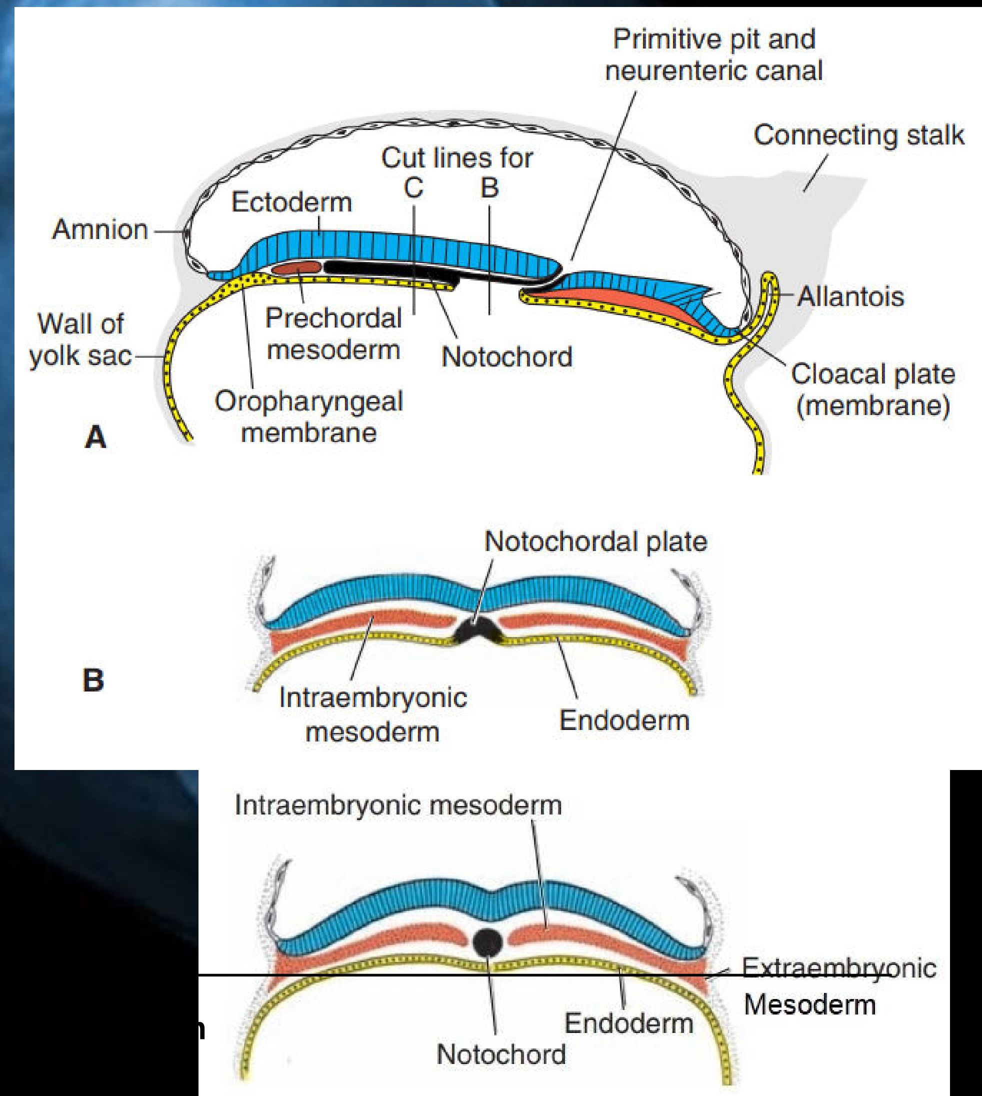


Cranially on each side of the notochordal process is a region of mesoderm called the cardiogenic region(area),This region lies **rostral** *(anterior/cranial)* to the prochordal plate, and it is where the primordium heart begins to develop at the end of the third week .

The embryonic disc remains **bilaminar** at the cloaca and oropharyngeal membrane.

This is because the embryonic ectoderm and endoderm are **fused** at these sites, thereby preventing migration of mesenchymal cells (which form mesoderm) between them. By the middle of the 3rd week, intraembryonic mesoderm separates the ectoderm and endoderm everywhere except :-

I. At the oropharyngeal membrane cranially.
II. In the median plane cranial to the primitive node, where the notochordal process is located.
III. at the cloacal membrane caudally.

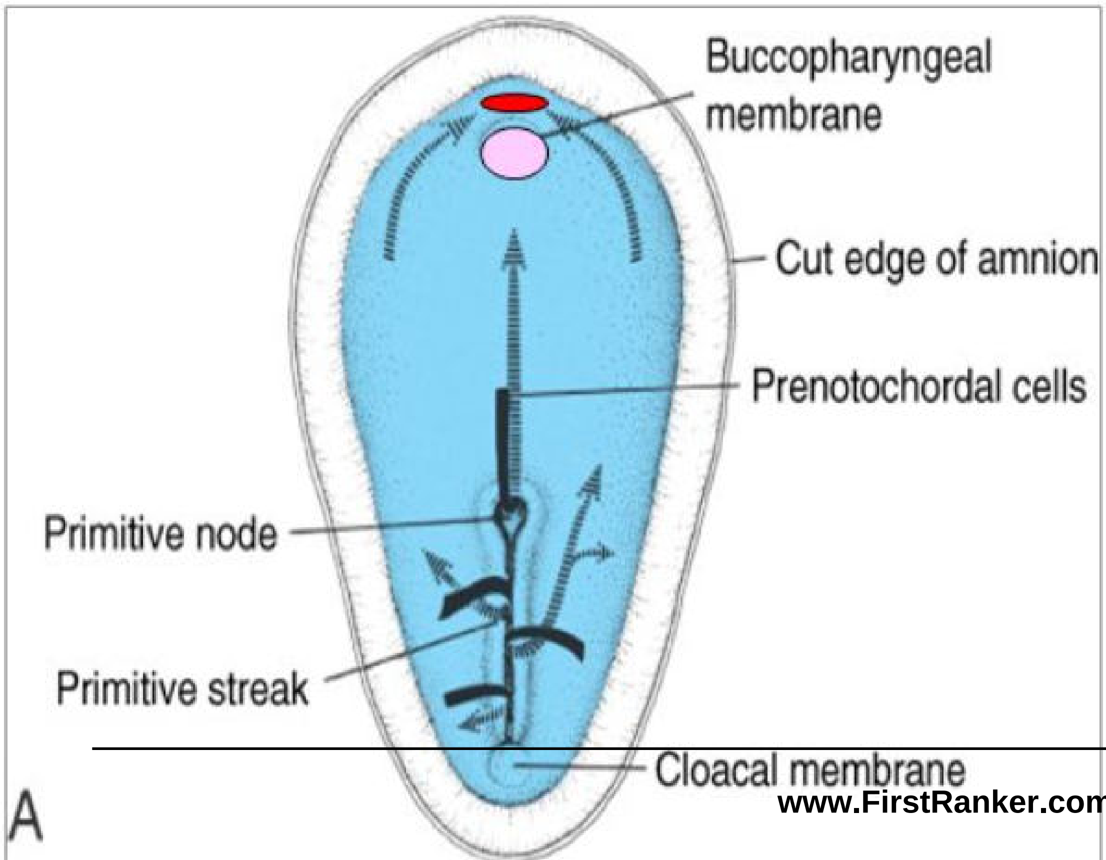


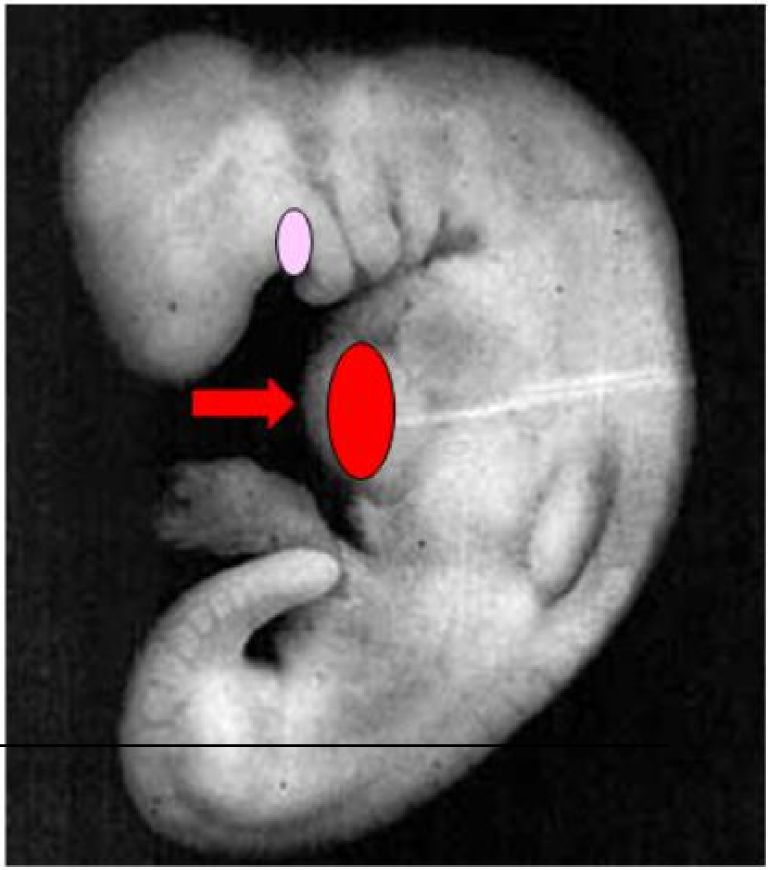
Notochord

- Notochord is a rod of mesenchymal cells

✓located in the midline

✓extending *cranially* from the the **primitive node** to the **buccopharyngeal membrane .**

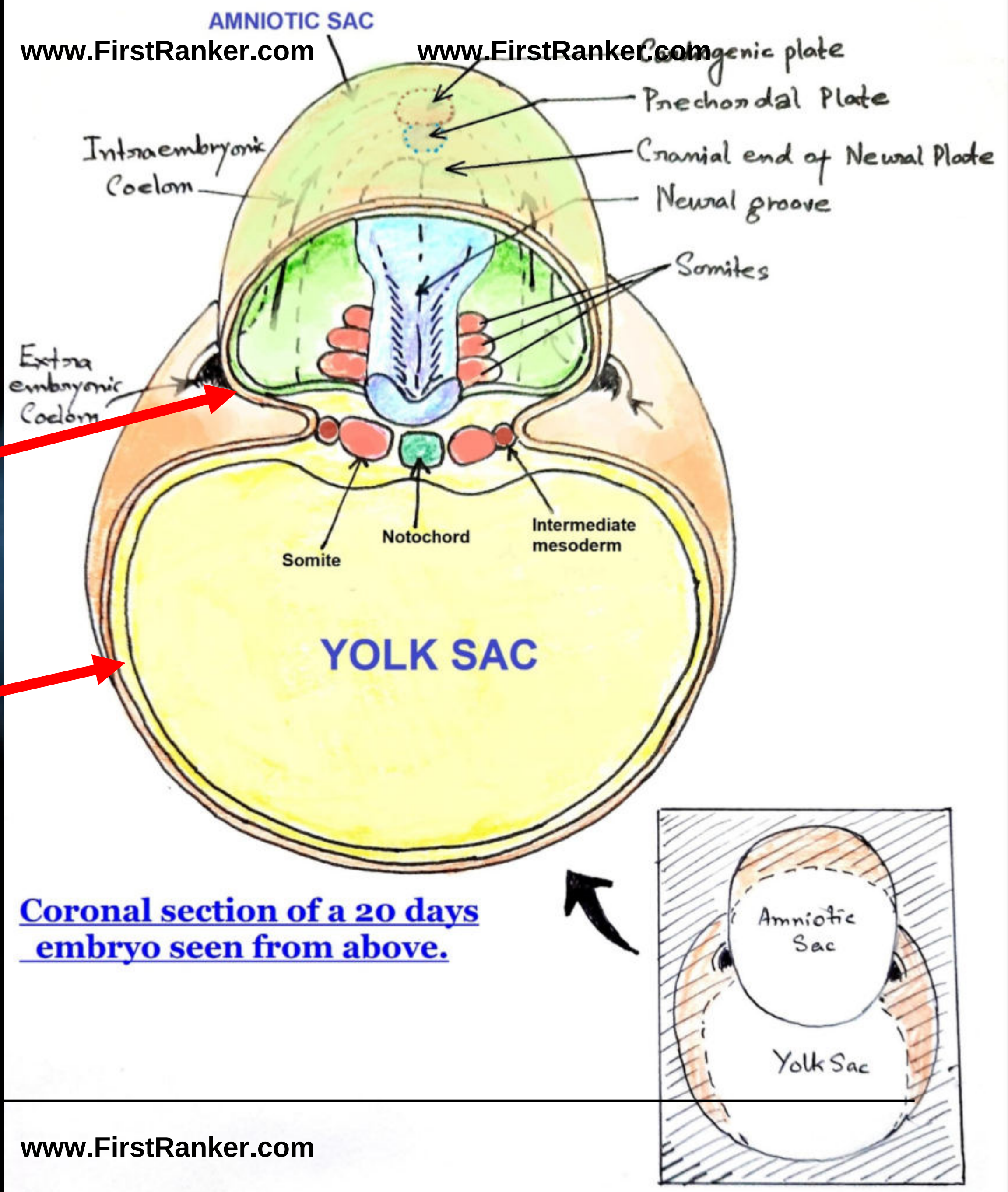




Trilaminar embryo seen from above

Cut end of Amniotic sac

Cut end of Yolk sac



Coronal section of a 20 days embryo seen from above.

Formation of the notochord

1. The **notochordal process** elongates by invagination of cells from the primitive pit (**fig 1a & b**)

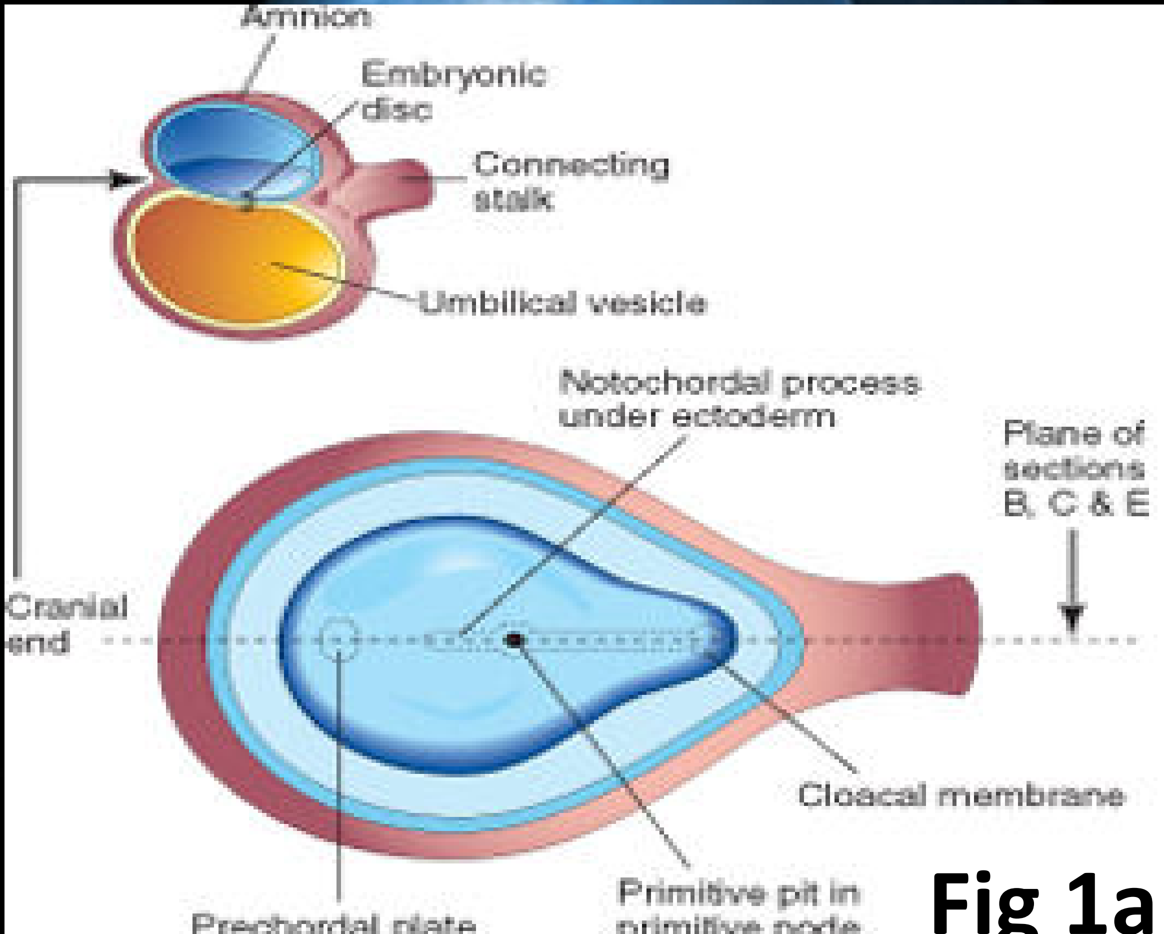


Fig 1a

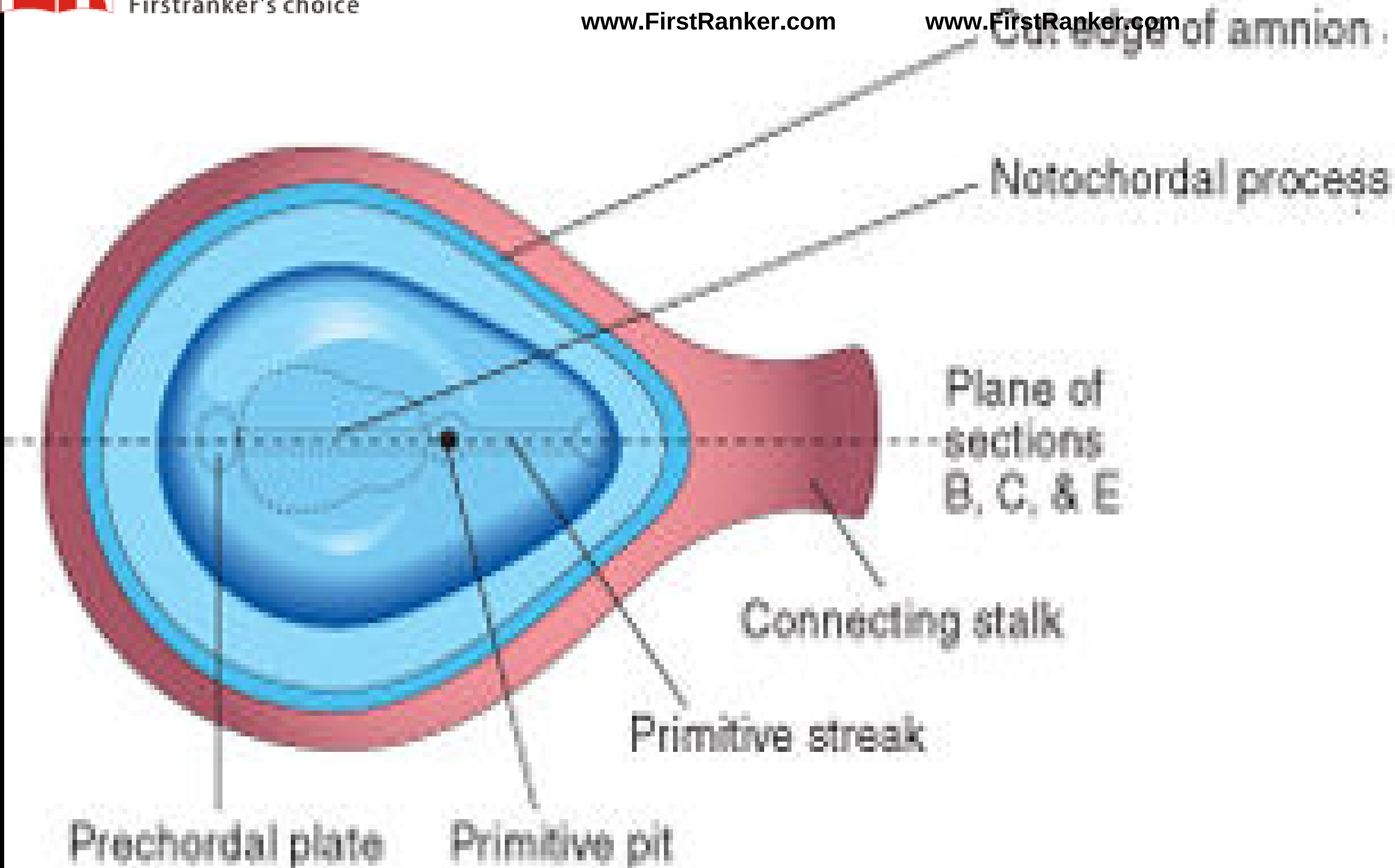

Cut edge of amnion
Notochordal process
Plane of
sections
B, C, & E
Connecting stalk
Primitive streak
Prechordal plate
Primitive pit

Fig 1b

2. The primitive pit extends into the notochordal process, forming a **notochordal canal** (fig 2a & b)

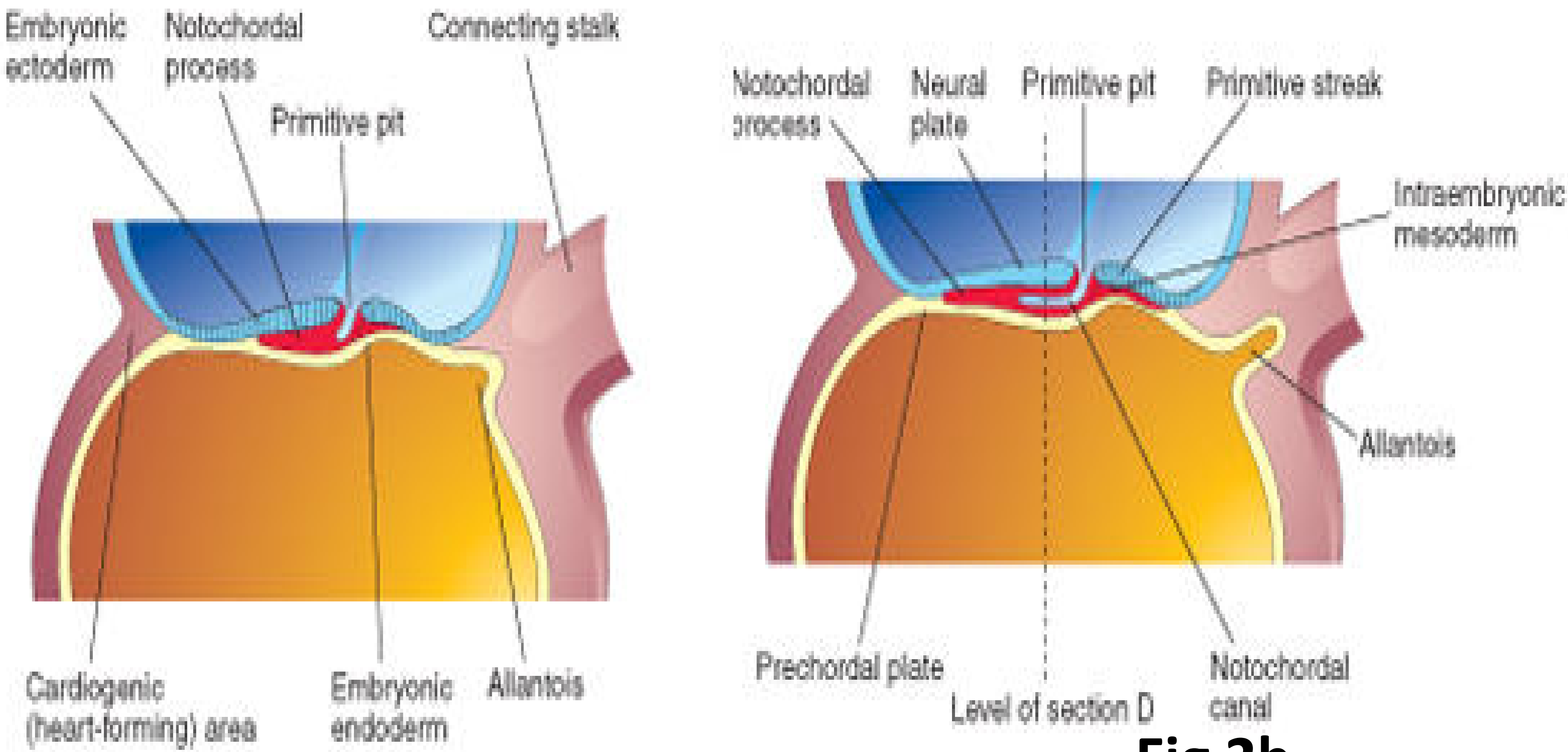


Fig 2a

Fig 2b

3 [illegible] floor of the notochordal process fuses with the underlying embryonic endoderm (**fig 3a**)

The fused layers gradually undergo degeneration, resulting in the formation of openings in the floor of the notochordal process, which brings the notochordal canal into communication with the umbilical vesicle (**fig 3b**)

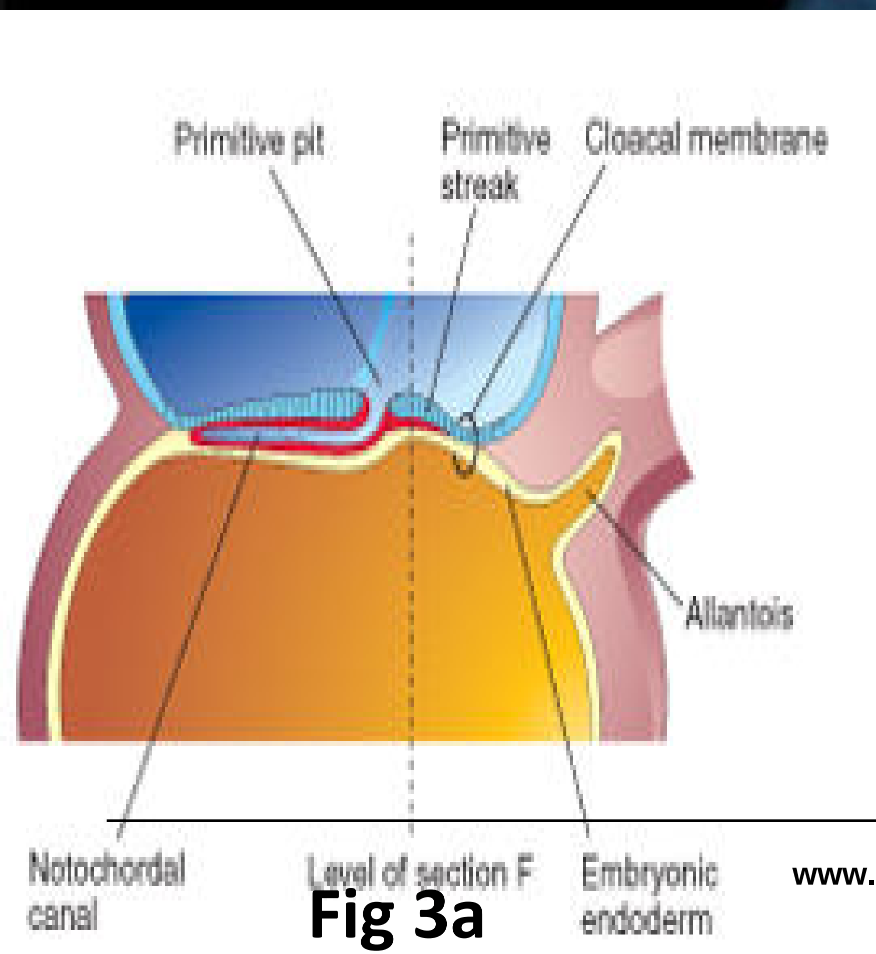


Fig 3a

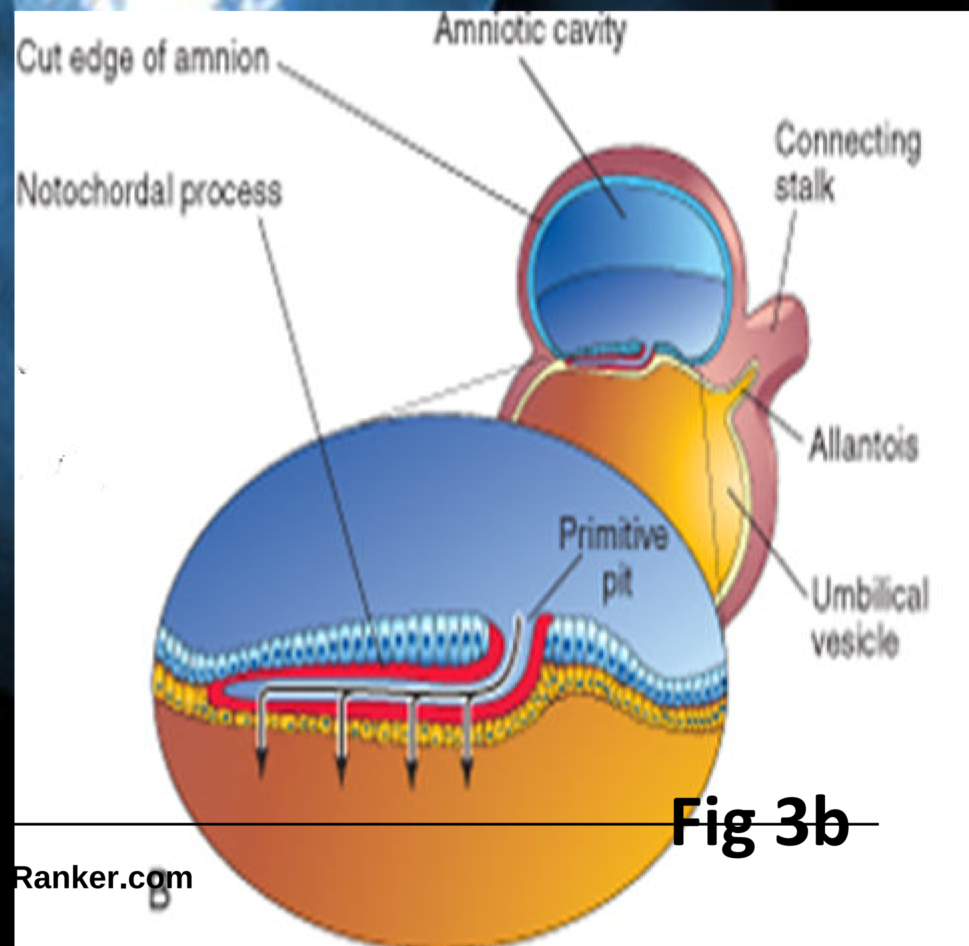


Fig 3b

4 The openings rapidly become confluent and the floor of the notochordal canal disappears (fig 4)

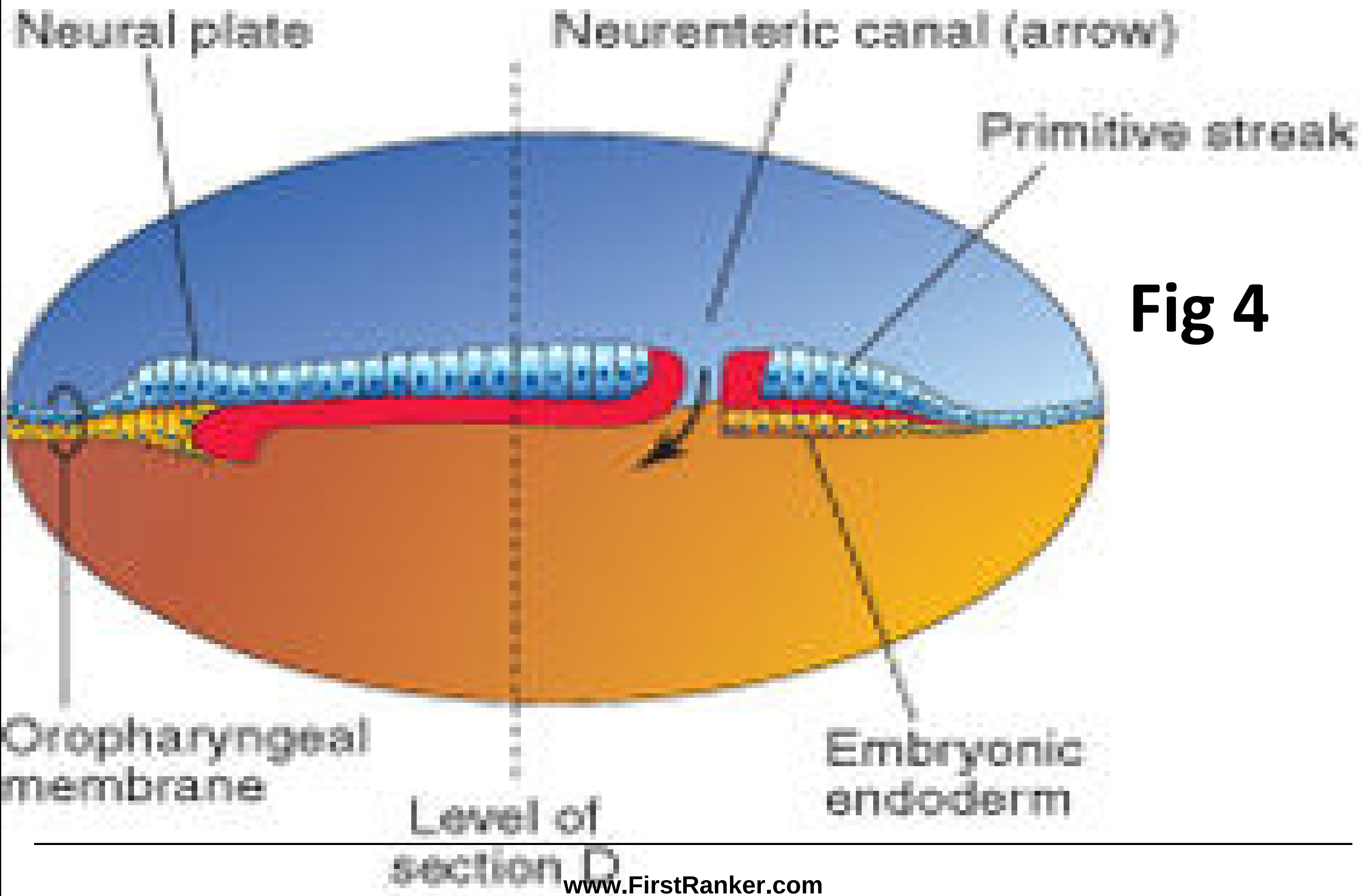
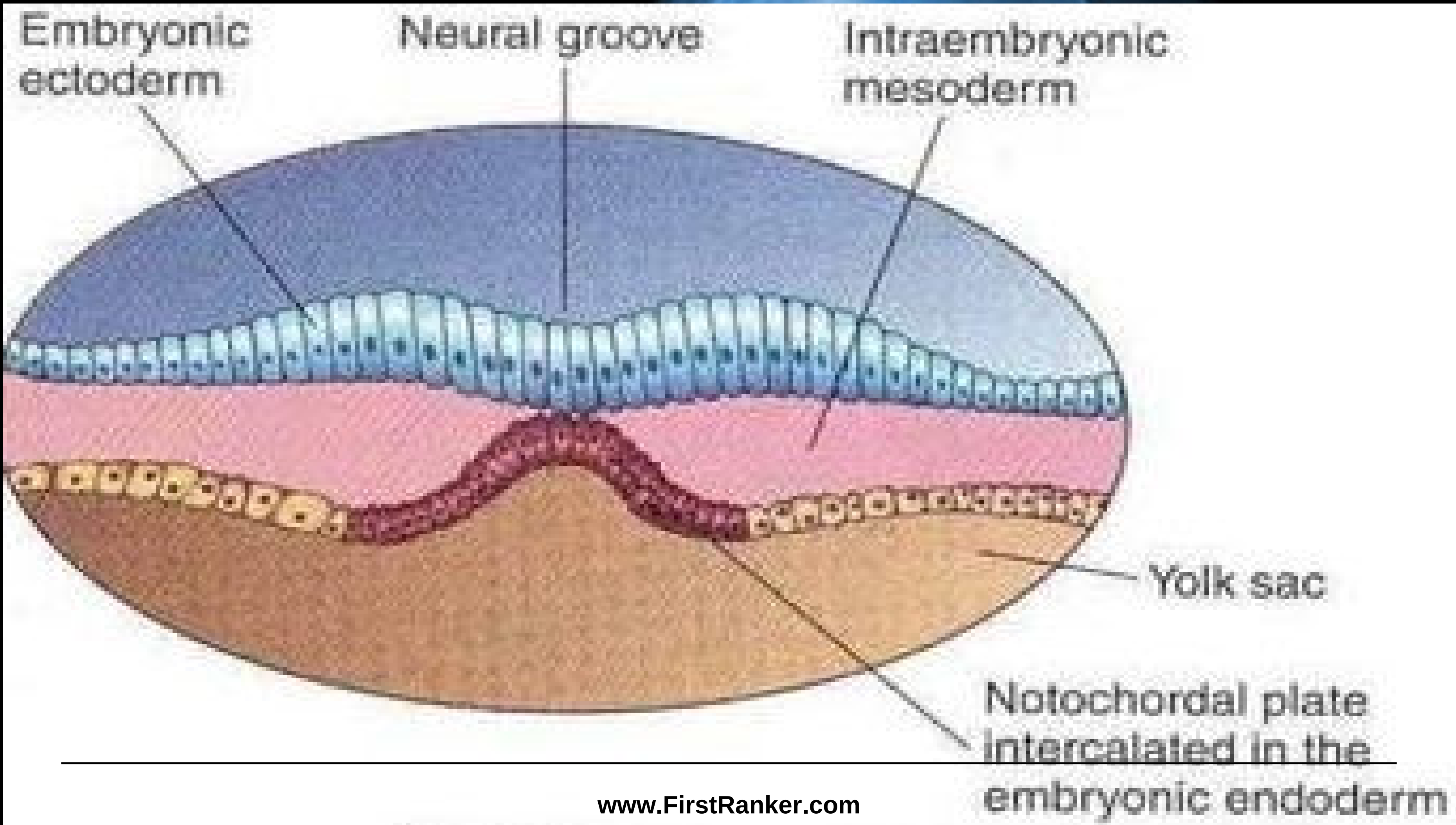


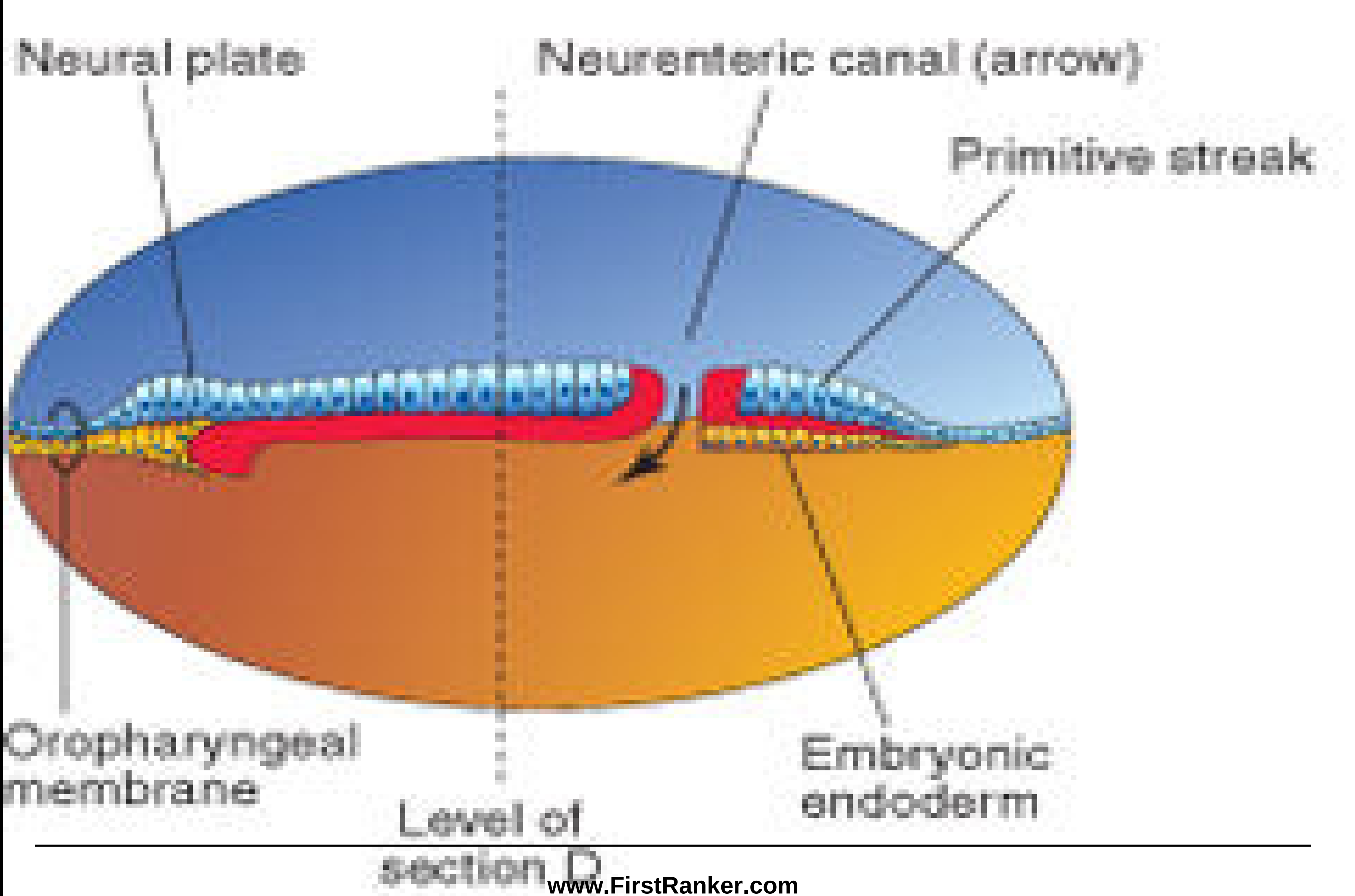
Fig 4

6 floor of the tube and the underlying endoderm fuse and then break down, forming a **notochordal plate**

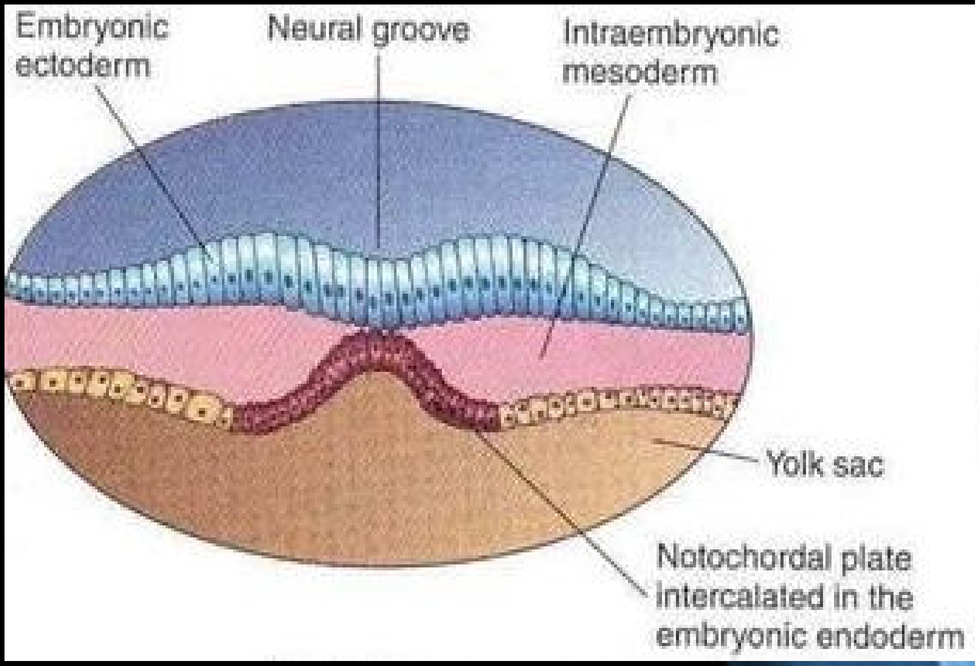
The notochordal plate becomes continuous with the endodermal layer

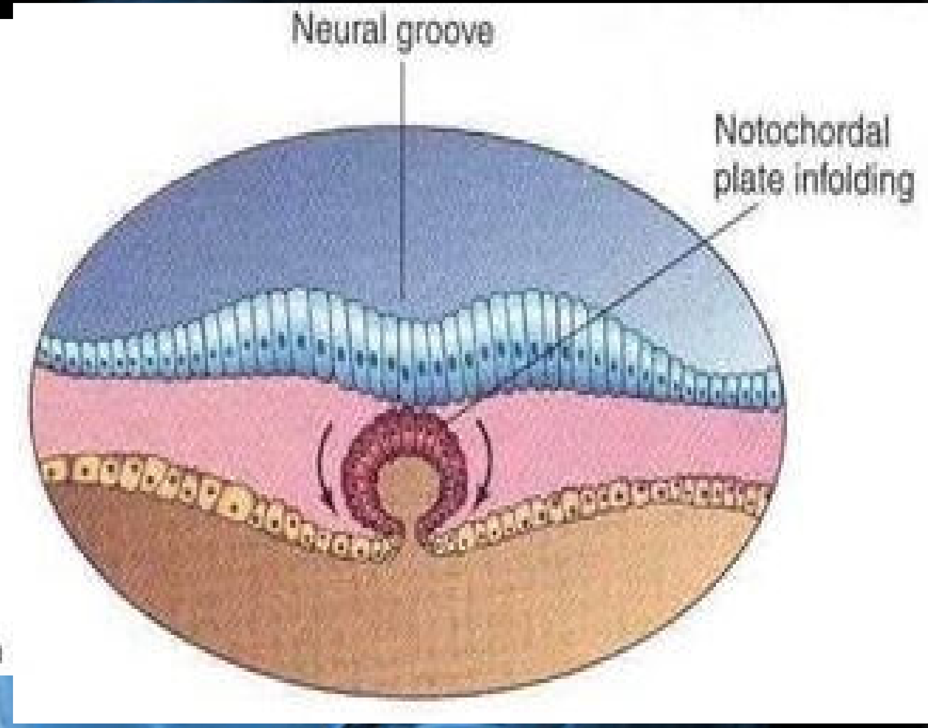


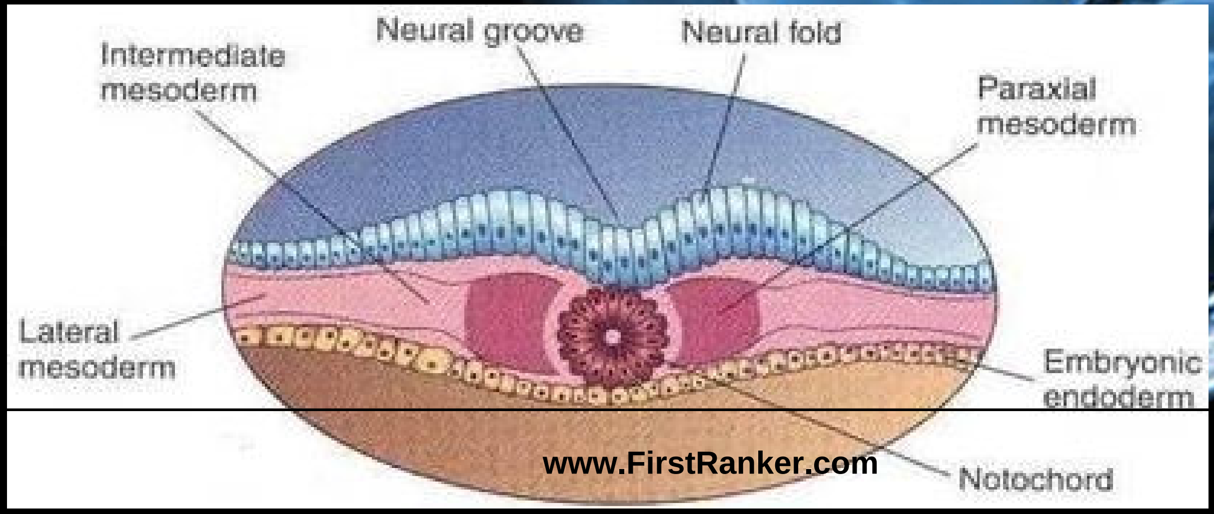
A temporary communication is established between the amniotic cavity and the yolk sac, termed the **neurenteric canal**



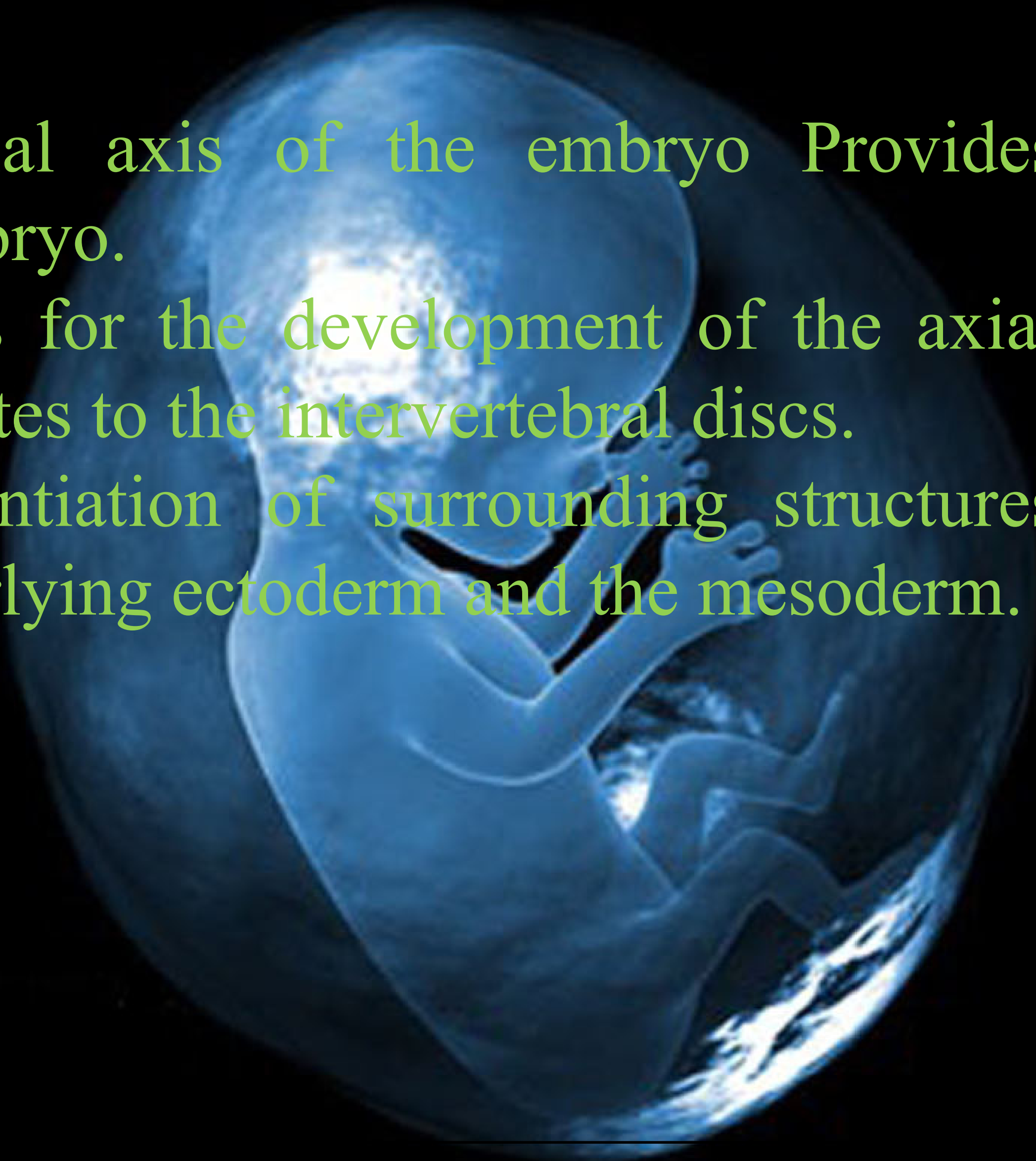
Notochordal plate folds to form the **notochord**,which gets separated from the underlying endoderm







Functions of Notochord



- ❖ Defines primordial axis of the embryo Provides rigidity to the embryo.
- ❖ Serves as a basis for the development of the axial skeleton Contributes to the intervertebral discs.
- ❖ Regulates differentiation of surrounding structures including the overlying ectoderm and the mesoderm.

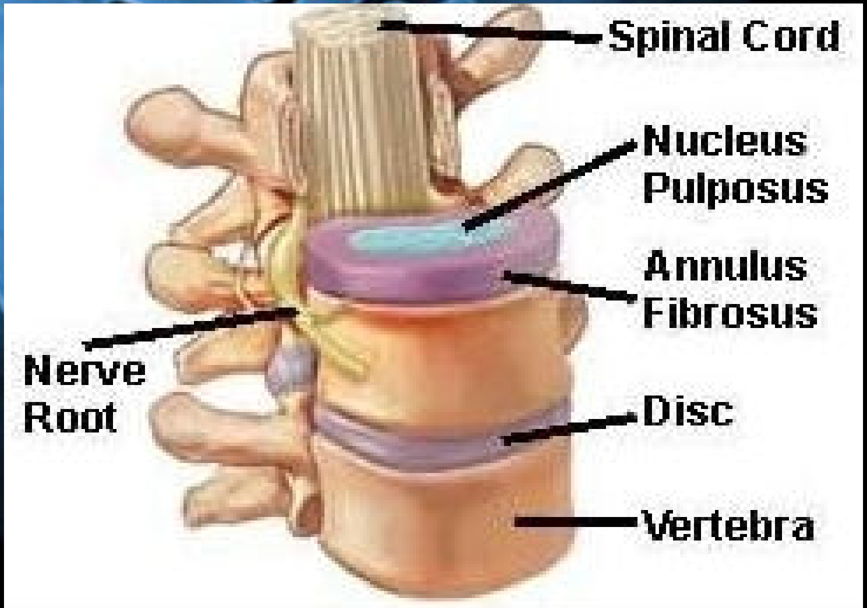
Fate of notochord

•Degenerates and disappears as the bodies of the vertebrae develop

•The part that lies between the vertebral bodies persists as the nucleus pulposus of each intervertebral disc

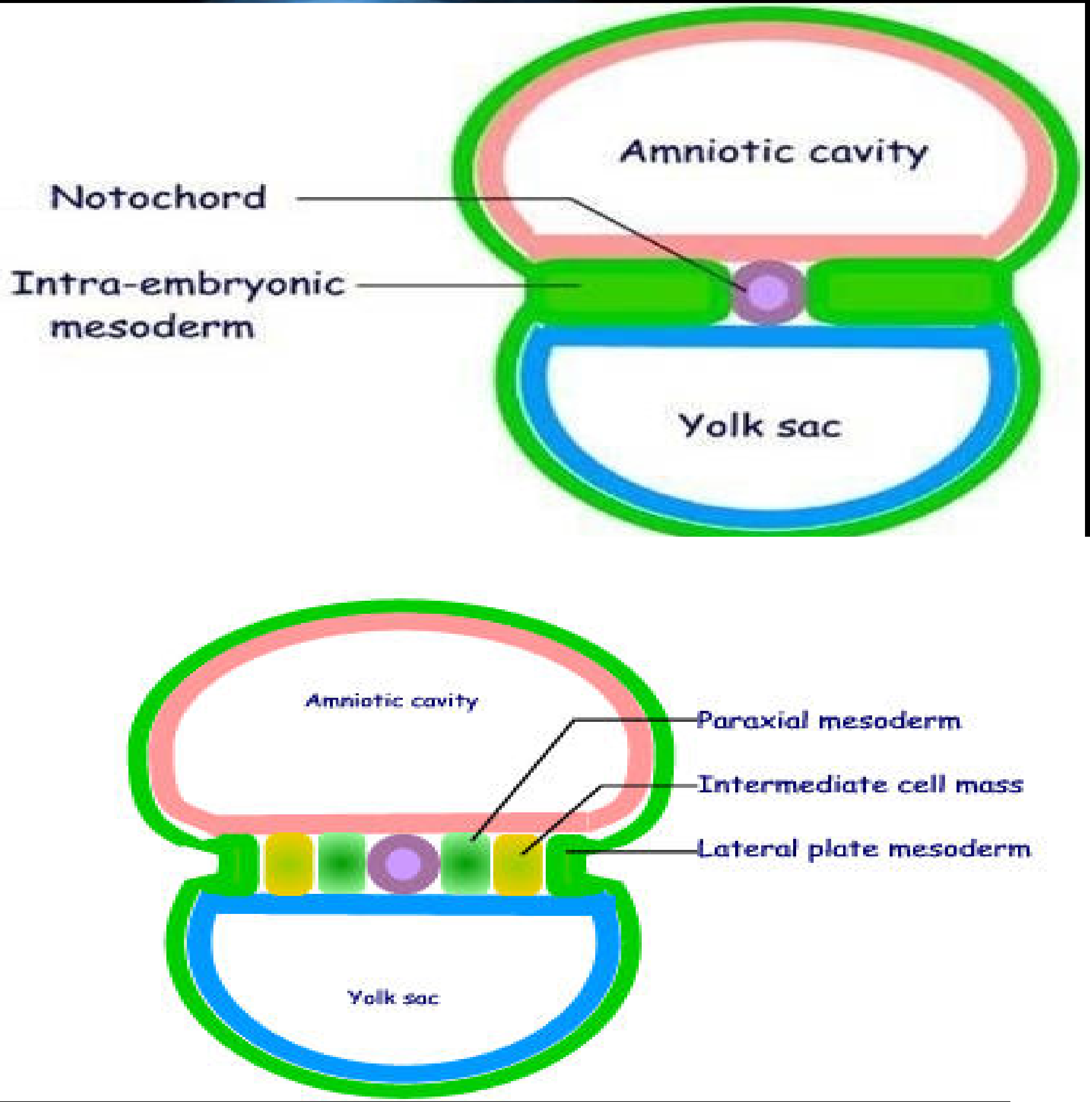
•Remnants of notochordal tissue give rise to tumors called Chordomas

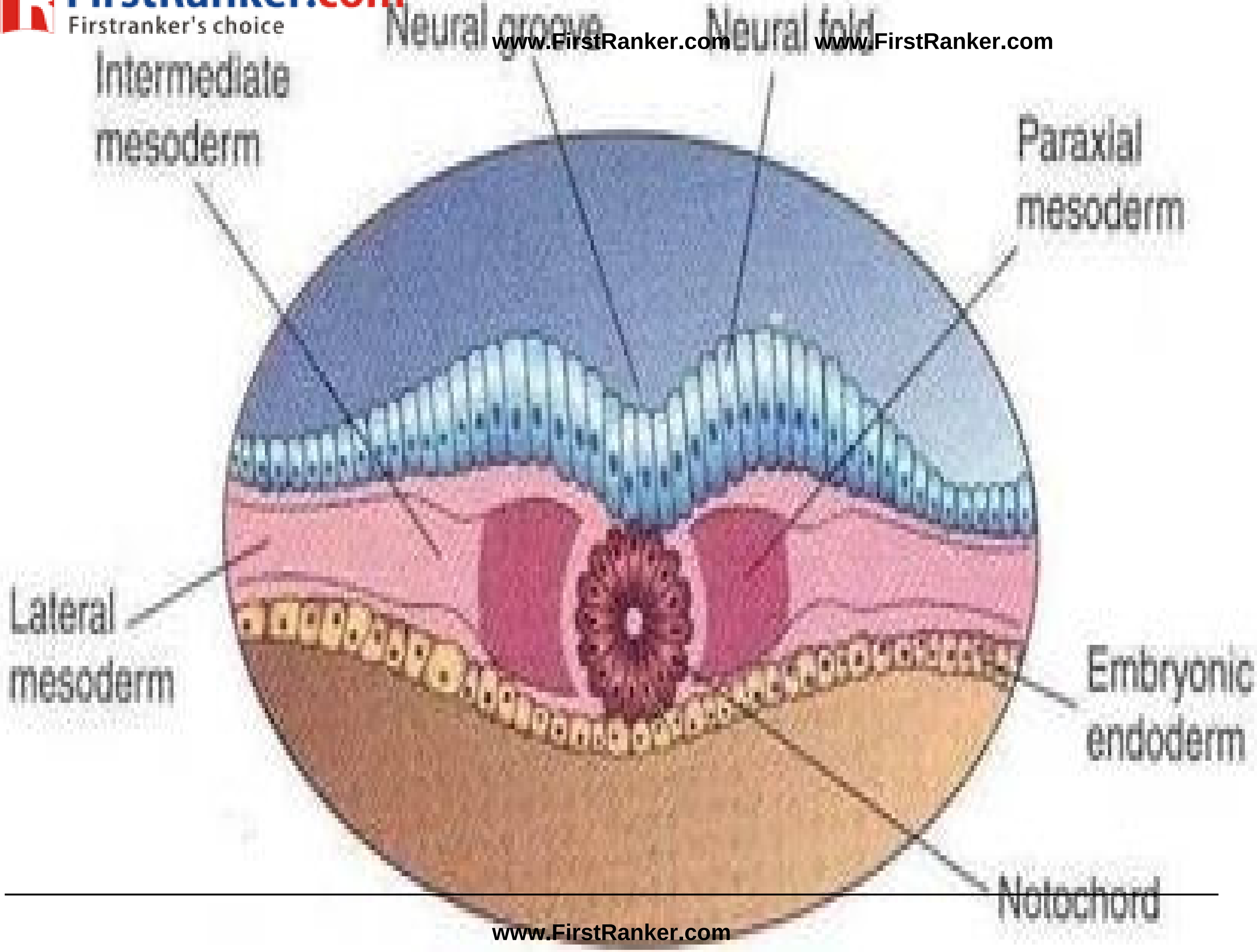
•Approximately one third of chordomas occur at the base of the cranium and extend to the nasopharynx.



Differentiation of the Intraembryonic Mesoderm

- Induced by the notochord
- Differentiates into the:




Neural groove
Neural fold
Intermediate mesoderm
Paraxial mesoderm
Lateral mesoderm
Embryonic endoderm
Notochord

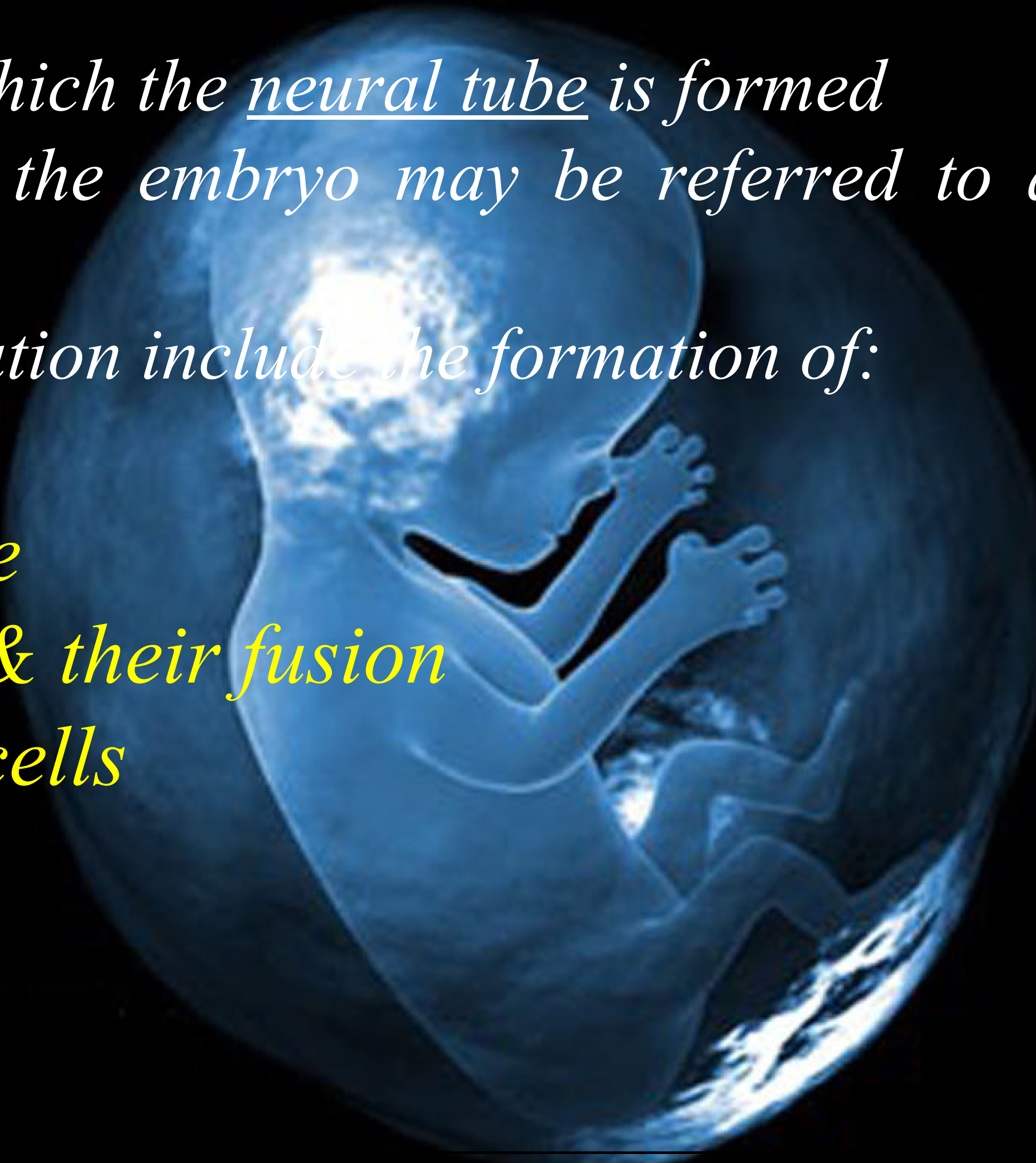
Note:

- *The **embryonic period**, or **period of organogenesis**, occurs from the third to the eighth weeks of development and is the time when each of the three germ layers, ectoderm, mesoderm, and endoderm, gives rise to a number of specific tissues and organs*

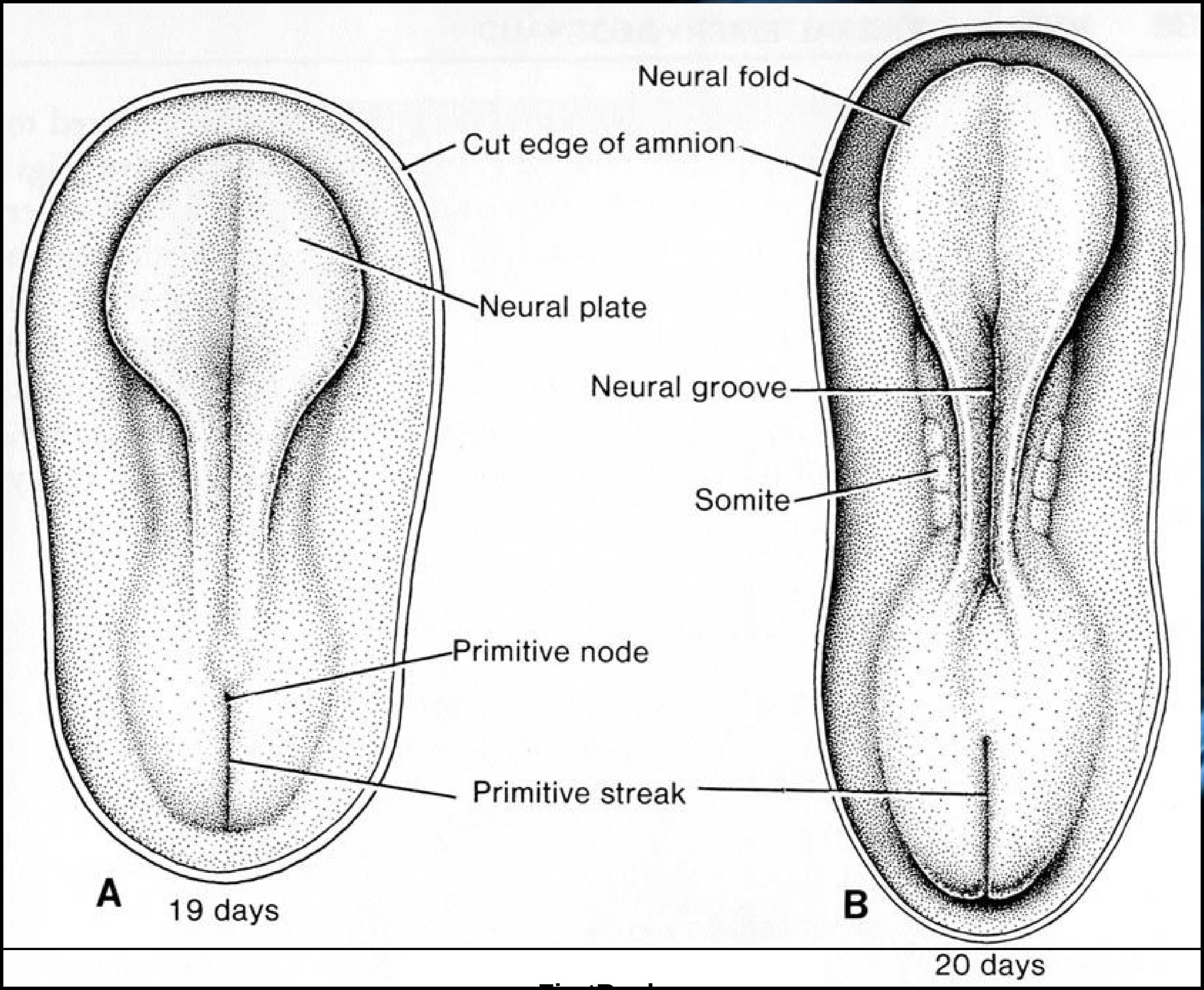
- *By the end of the embryonic period, the main organ systems have been established, rendering the major features of the external body form recognizable by the end of the second month.*

Neurulation

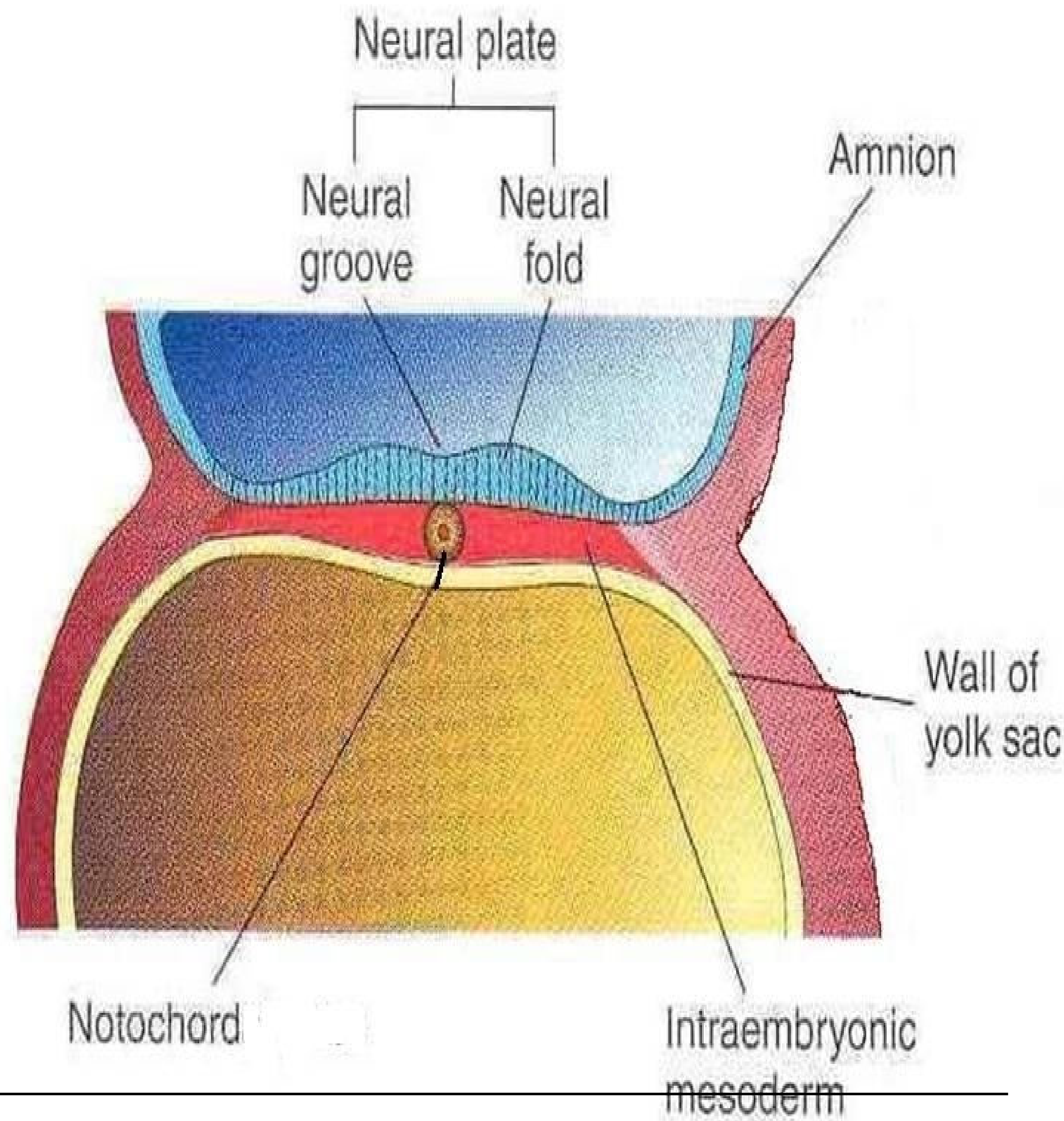
- *It is the process by which the neural tube is formed*
- *During neurulation, the embryo may be referred to as a* ***neurula***
- *The stages of neurulation include the formation of:*
    - ✓ *Neural plate*
    - ✓ *Neural groove*
    - ✓ *Neural folds & their fusion*
    - ✓ *Neural crest cells*
    - ✓ *Neural tube*



Onset of Neurulation

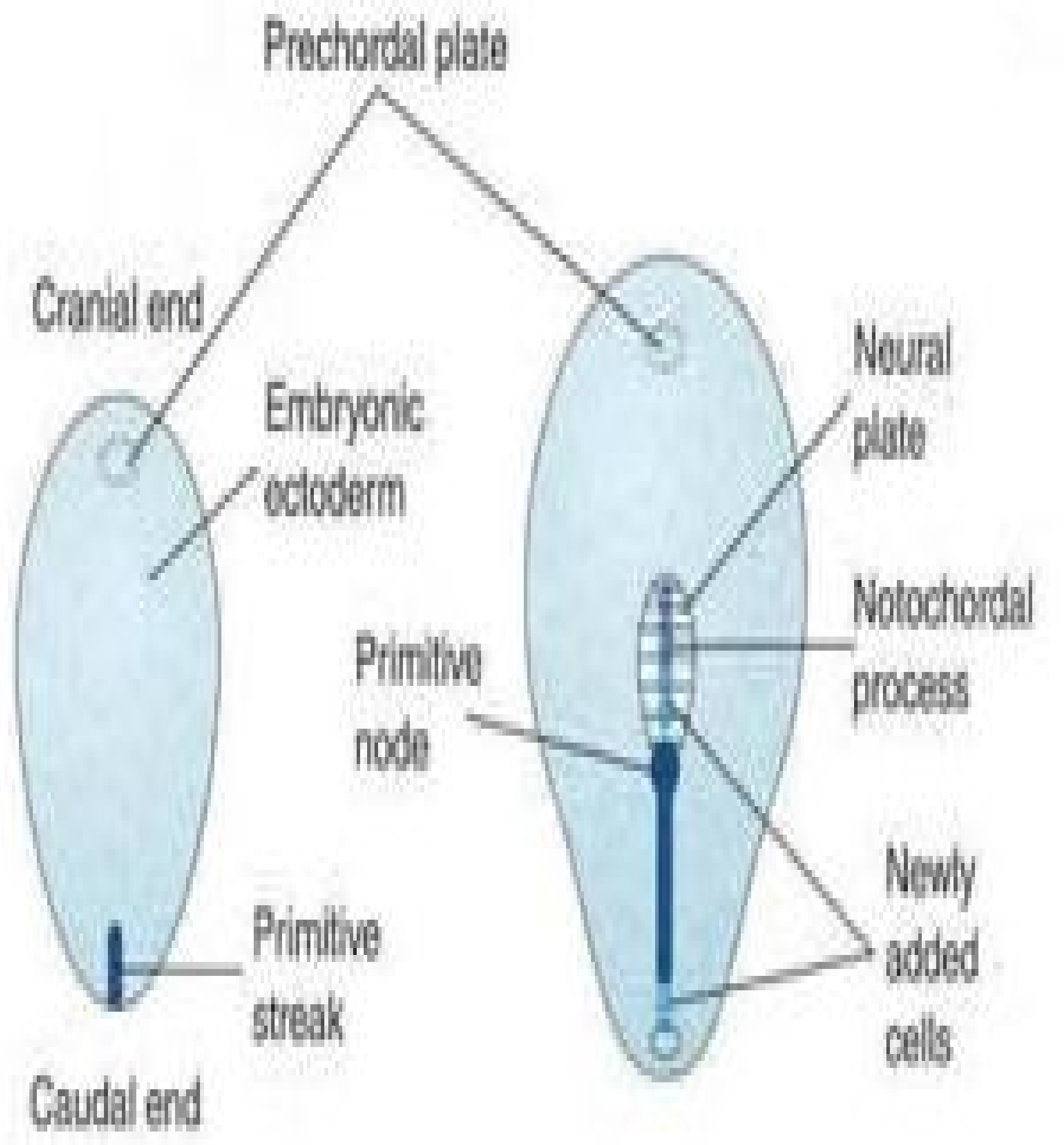


Under the inducing effect of the developing notochord, the overlying ***ectodermal cells thickens to form the*** ***neural plate*.**



At first the neural plate:

- ✓ *cranial to the primitive node*
- ✓ *dorsal(posterior) to the developing notochord & the mesoderm adjacent to it*
- ✓ *corresponds in length to the underlying notochord*

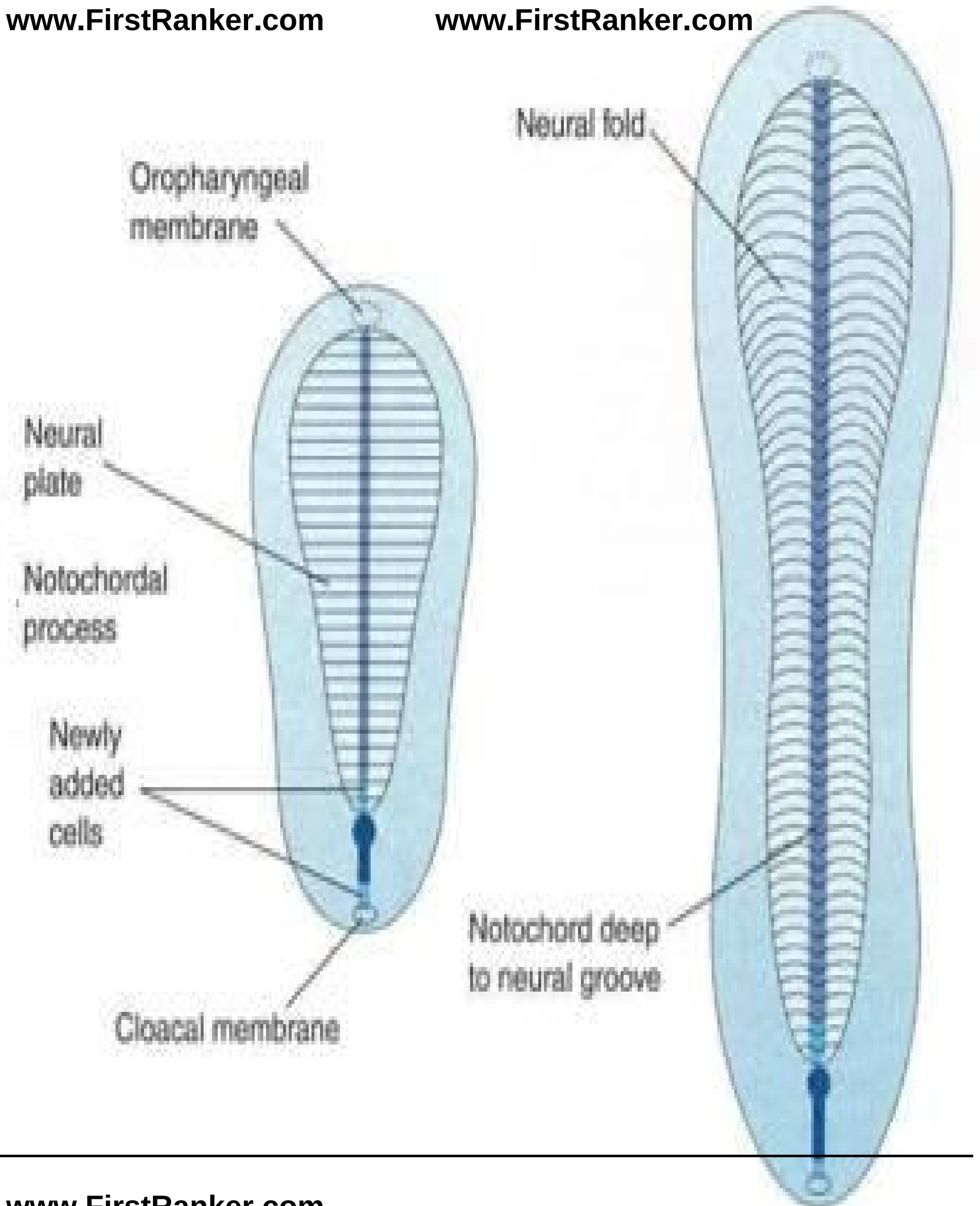


As the notochord forms & elongates:

✓ *The embryonic disc elongates and becomes club-shaped*

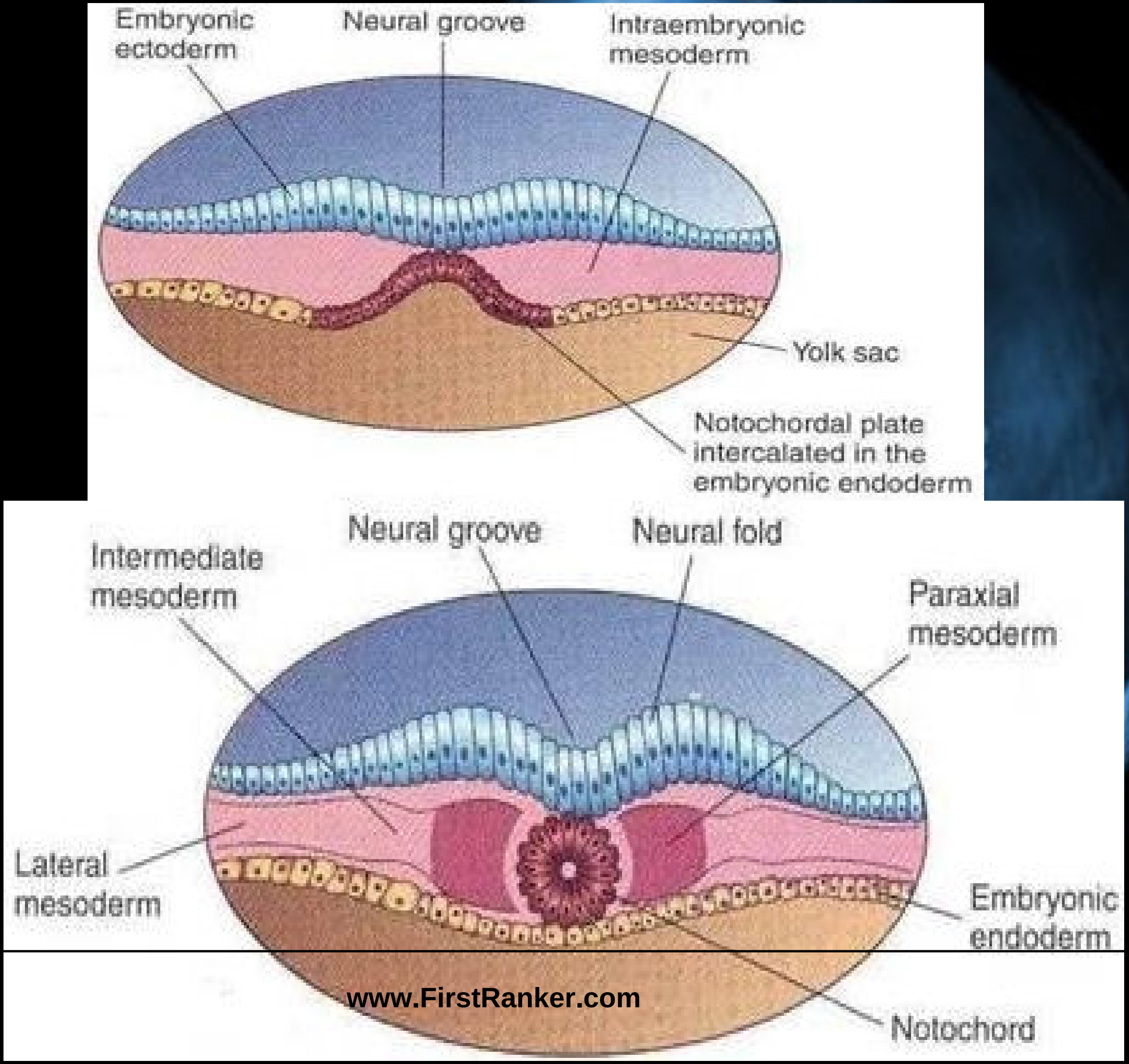
✓ *The neural plate broadens and extends cranially as far as the buccopharyngeal membrane,*

✓ *later on grows beyond the notochord*



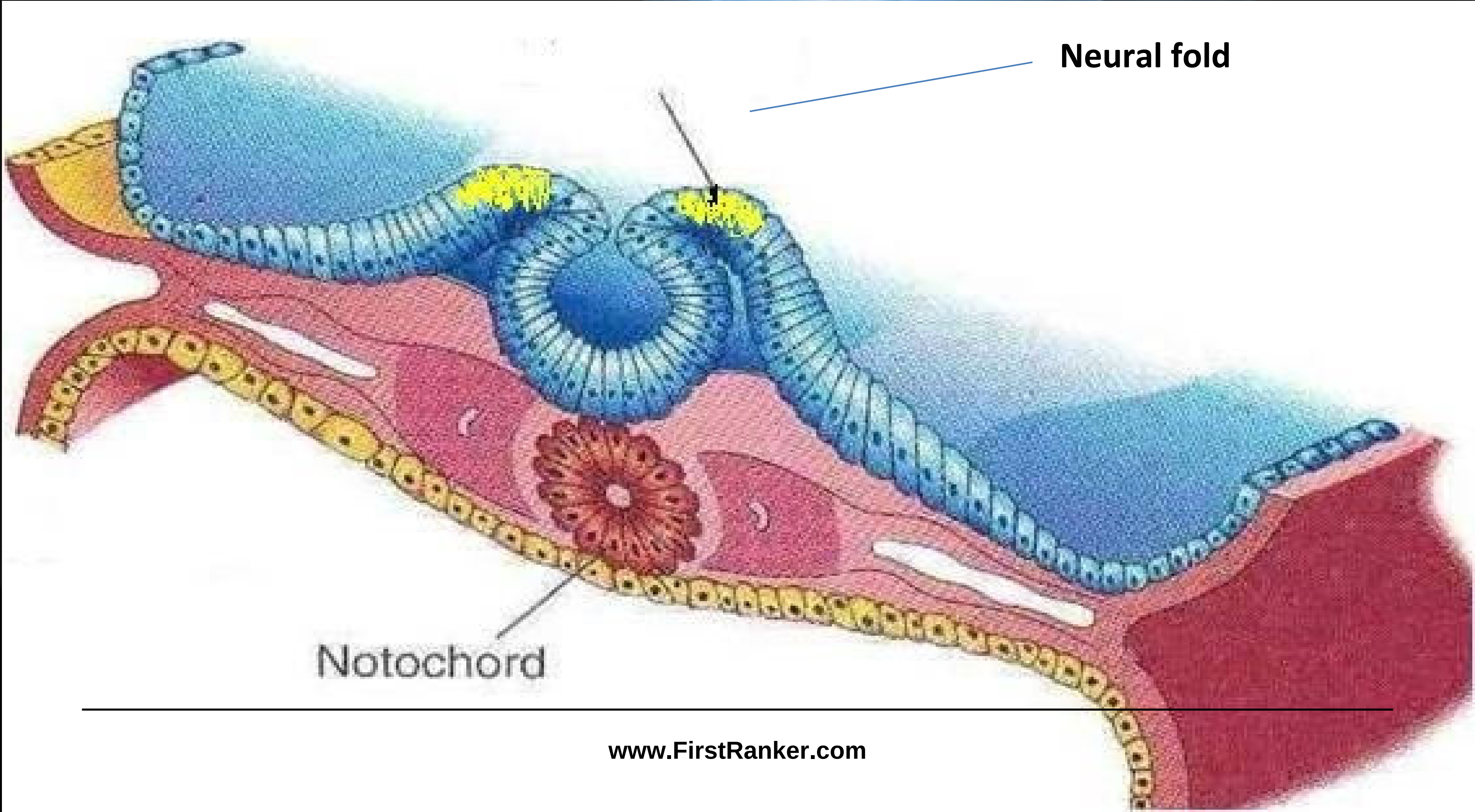
On 18th day: the neural plate invaginates to form neural groove & neural folds

-

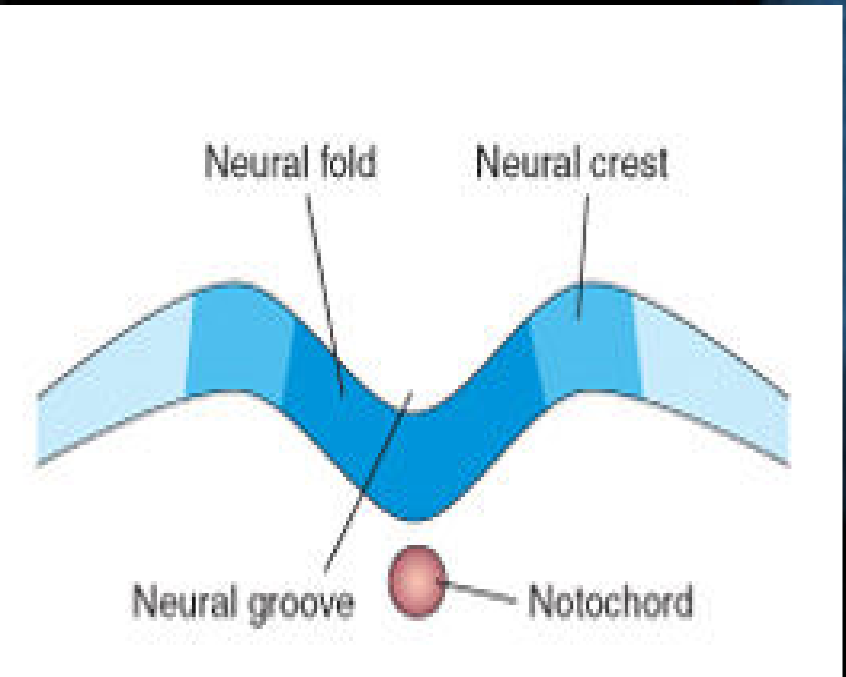


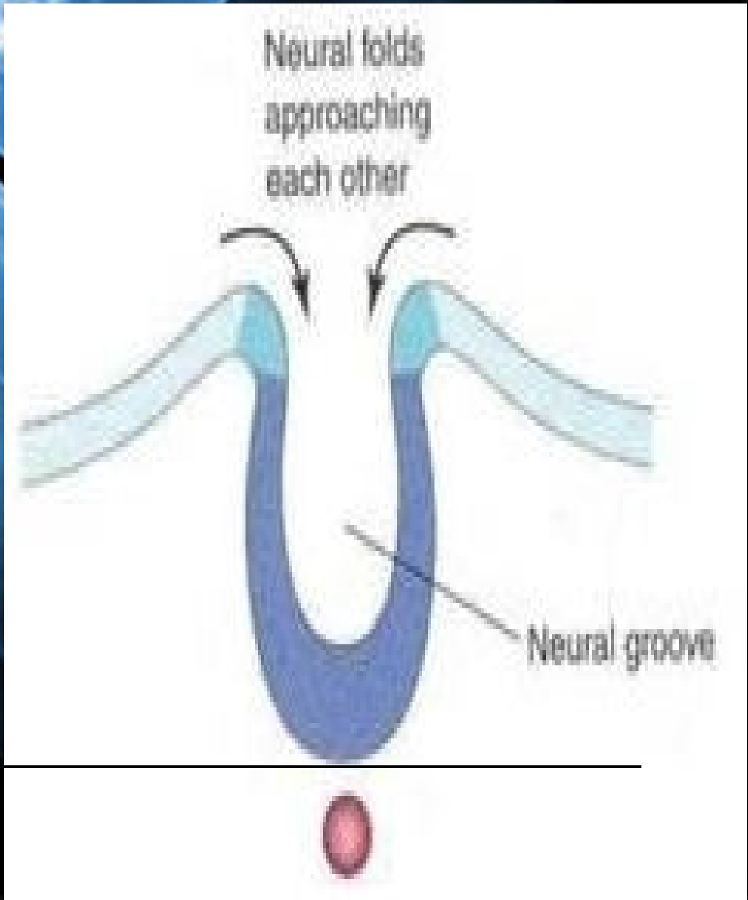
neuroectodermal cells along the crest of the neural fold differentiate as the **neural crest cells.**

❖ ***Note**: (neuroectoderm: the ectoderm of the neural plate)*

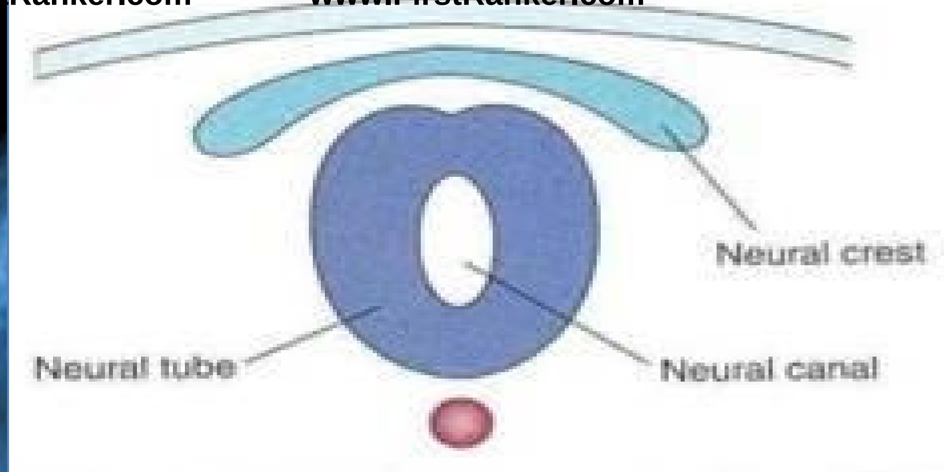


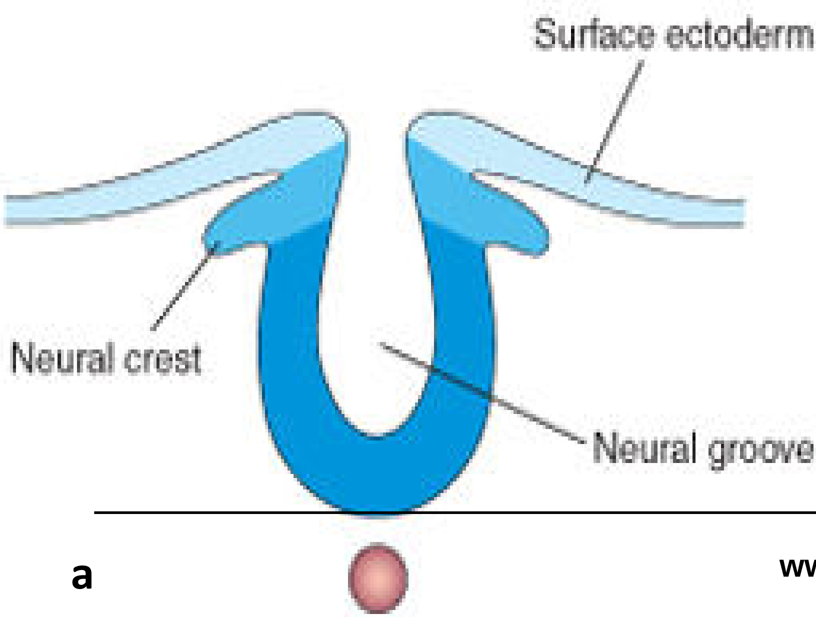
By the end of 3^{rd} week, the neural folds move to the midline and fuse to form the ***neural tube.***



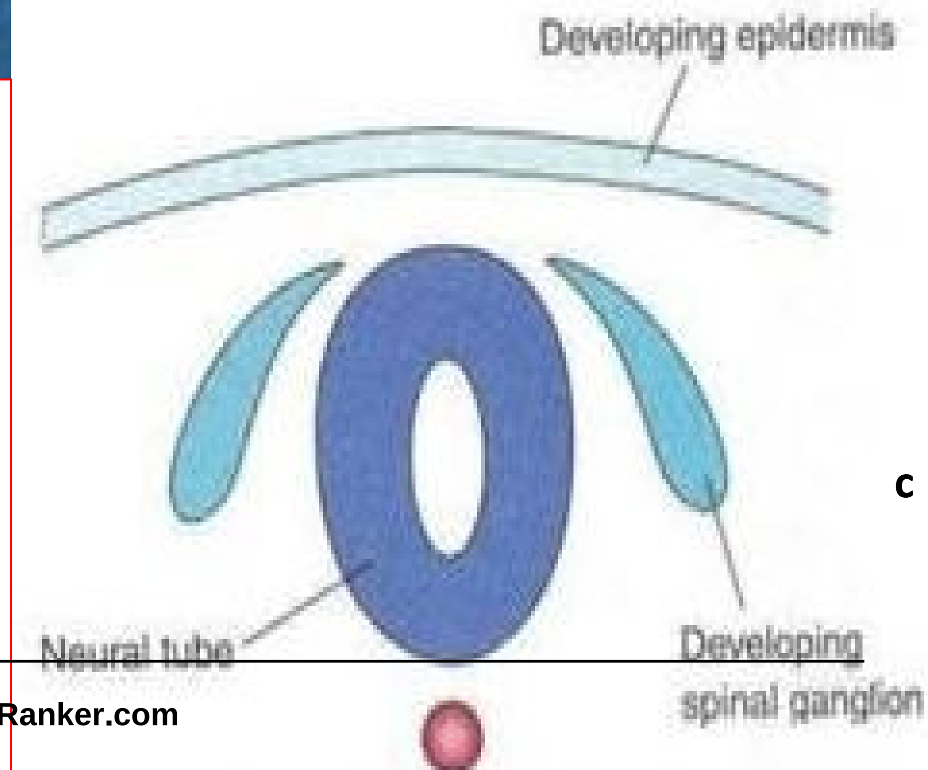


Following fusion of the neural folds, the neural crest cells become separated and move laterally to form the <u>sensory neurons of the spinal (dorsal root) ganglia.</u>



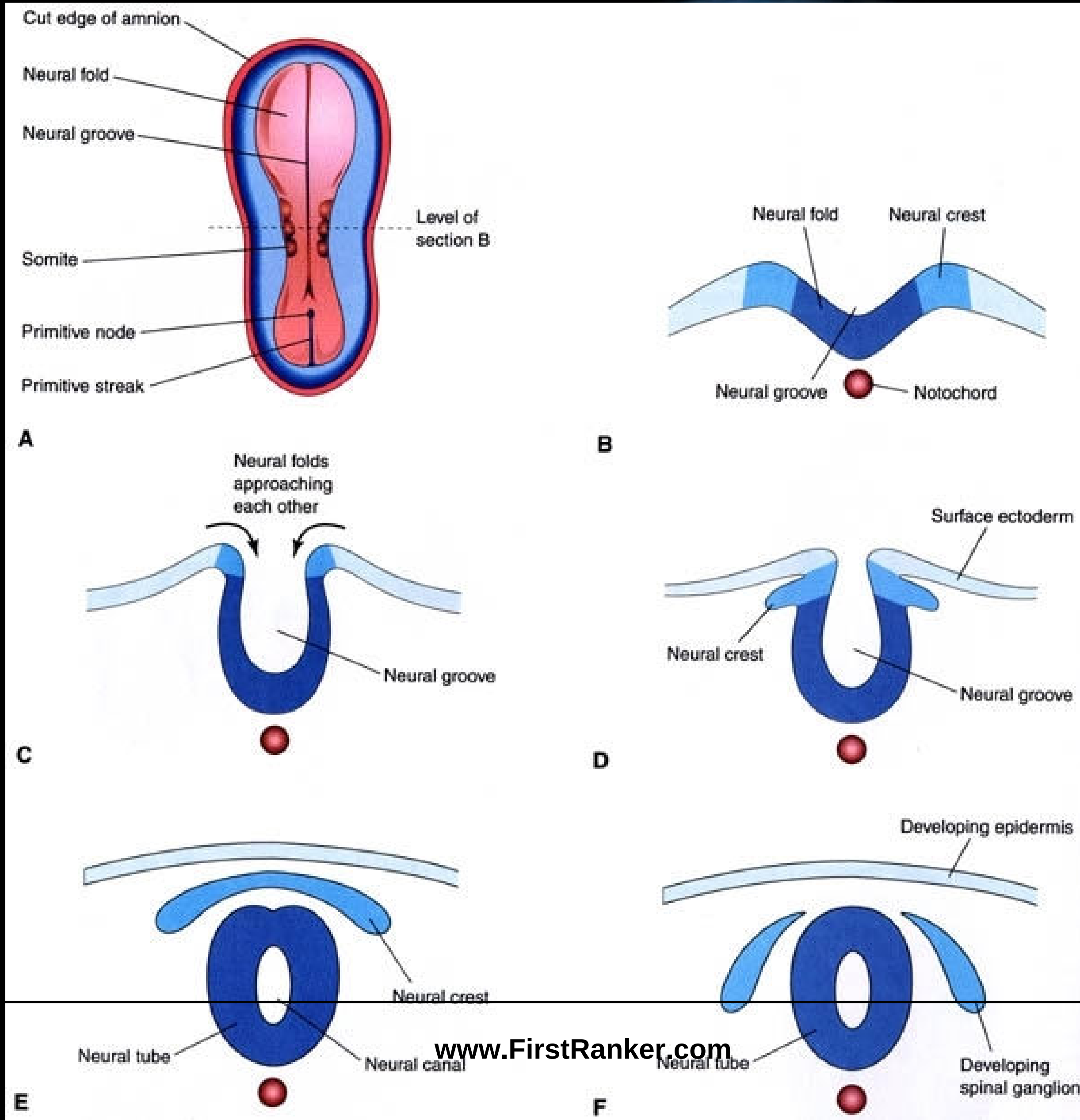


a



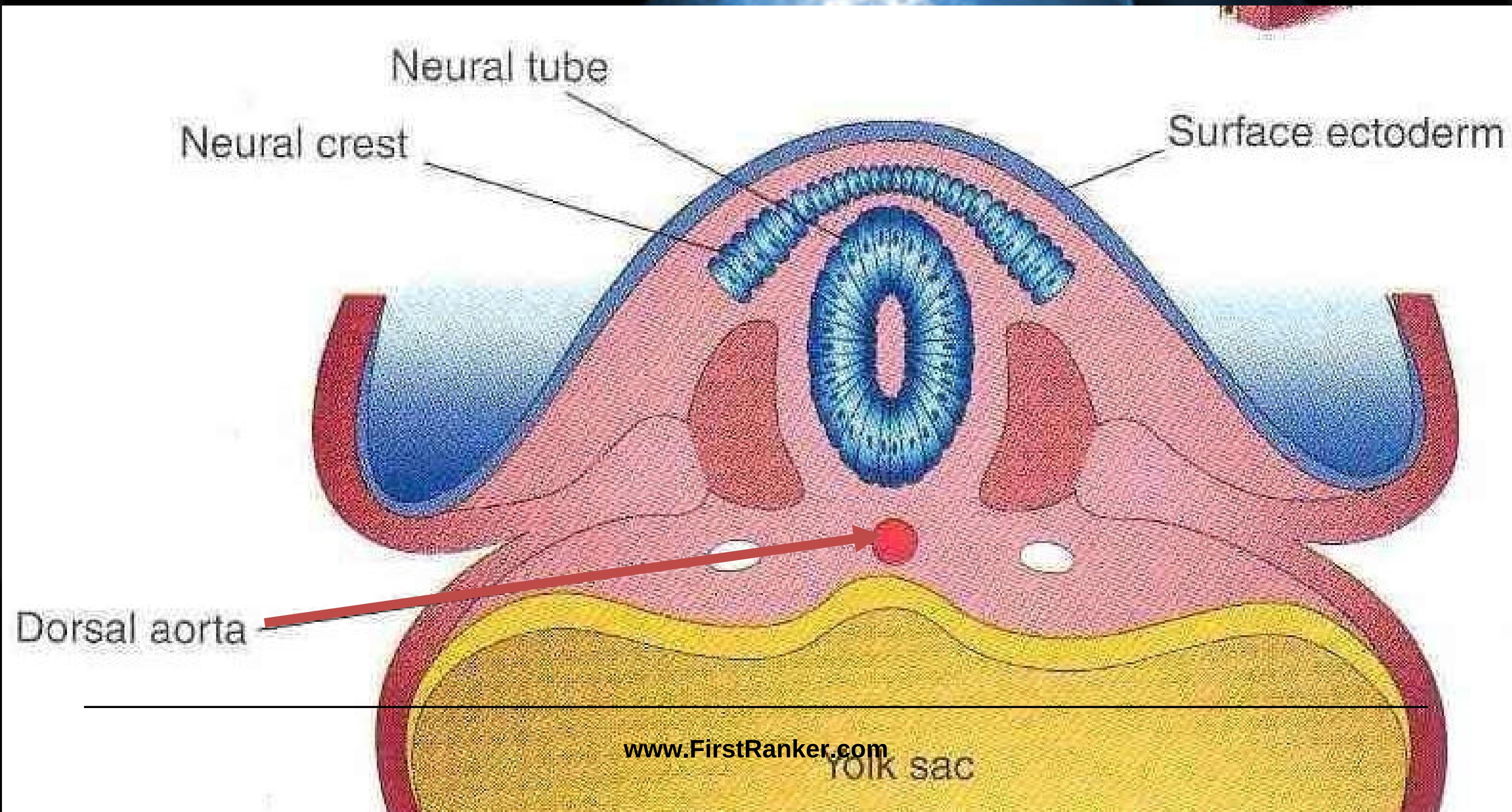
c

Neurulation: Formation of the Neural Tube



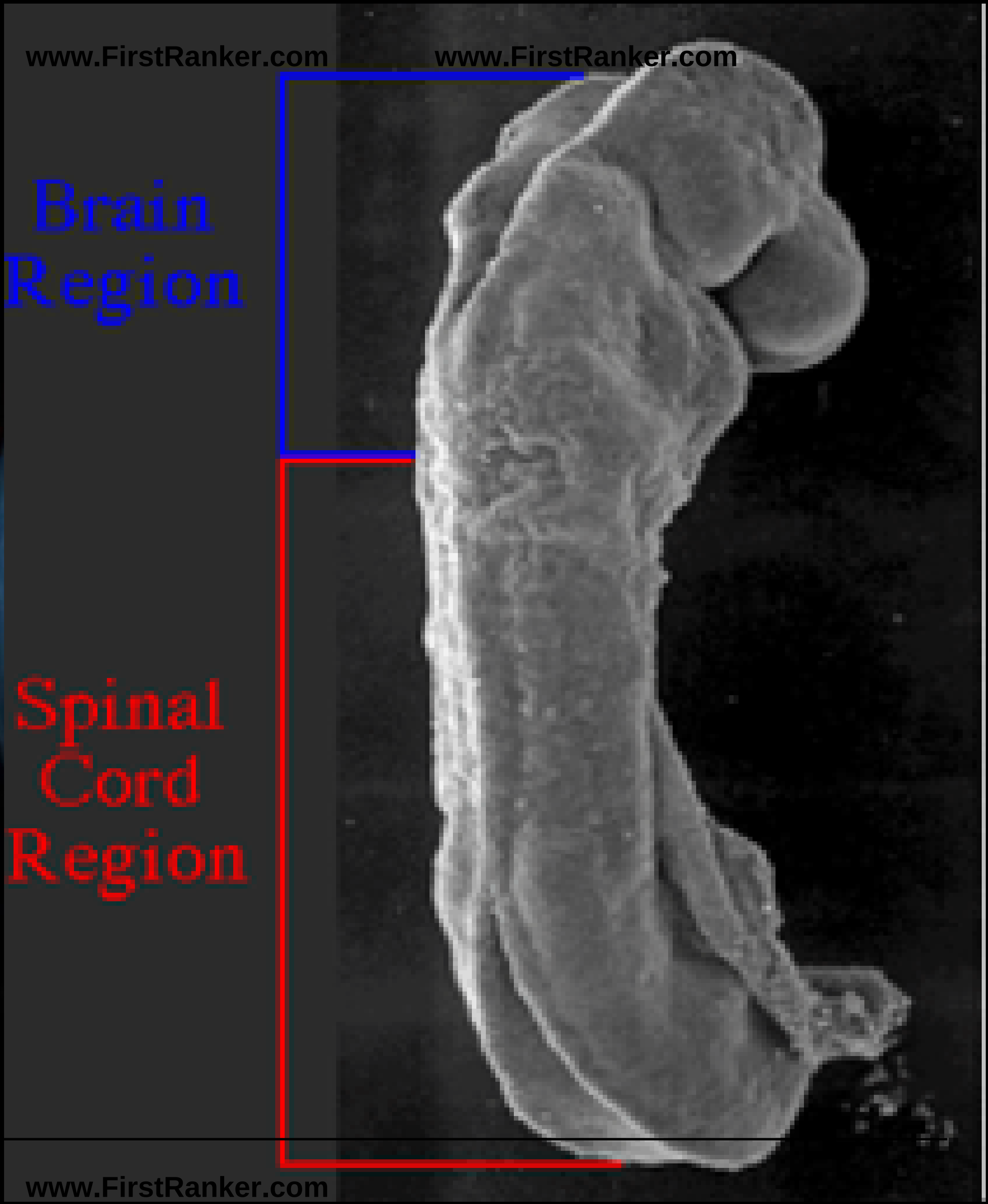
By the end of 3rd week, the neural folds move to the midline and fuse to form the **neural tube**

The *neural tube separates from the surface ectoderm*, lies in the midline, dorsal to the notochord.



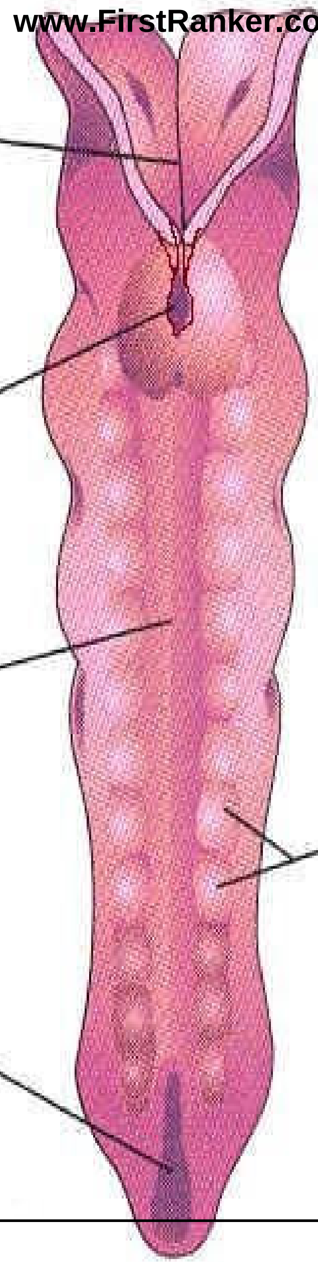
✓ *The cranial ⅓ of the neural tube represent the future brain*

✓ *The caudal ⅔ represents the future spinal cord*

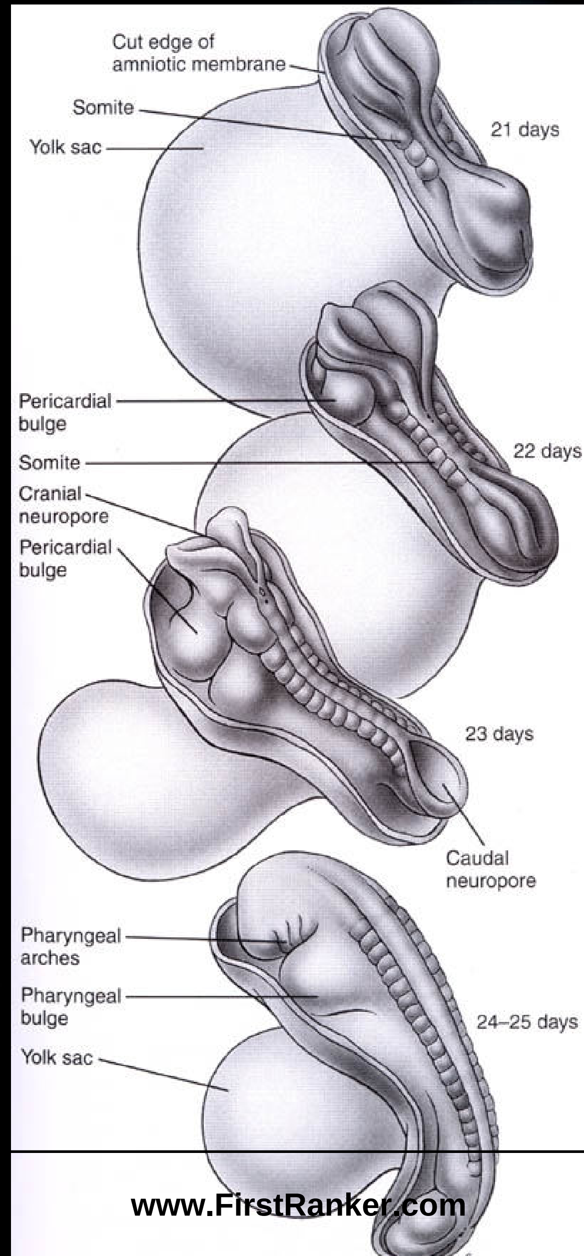


✓ *Neural tube is open at both ends, communicating freely with the amniotic cavity*

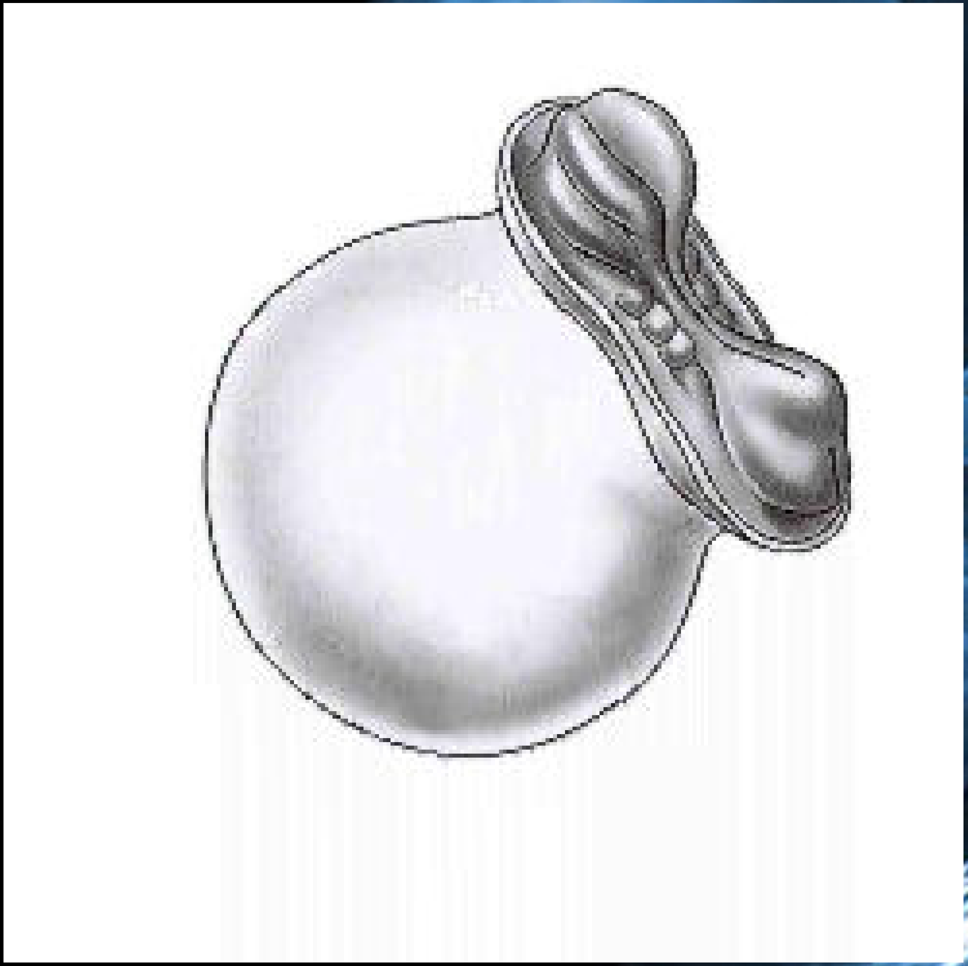
✓ *The cranial opening, the <u>rostral neuropore closes</u> at about 25th day while the caudal neuropore closes at about the 27th day(2 days after)*



Closure of the Neural Tube (Day 22)



Closure of the Neural Tube proceeds Bilaterally



Congenital anomalies

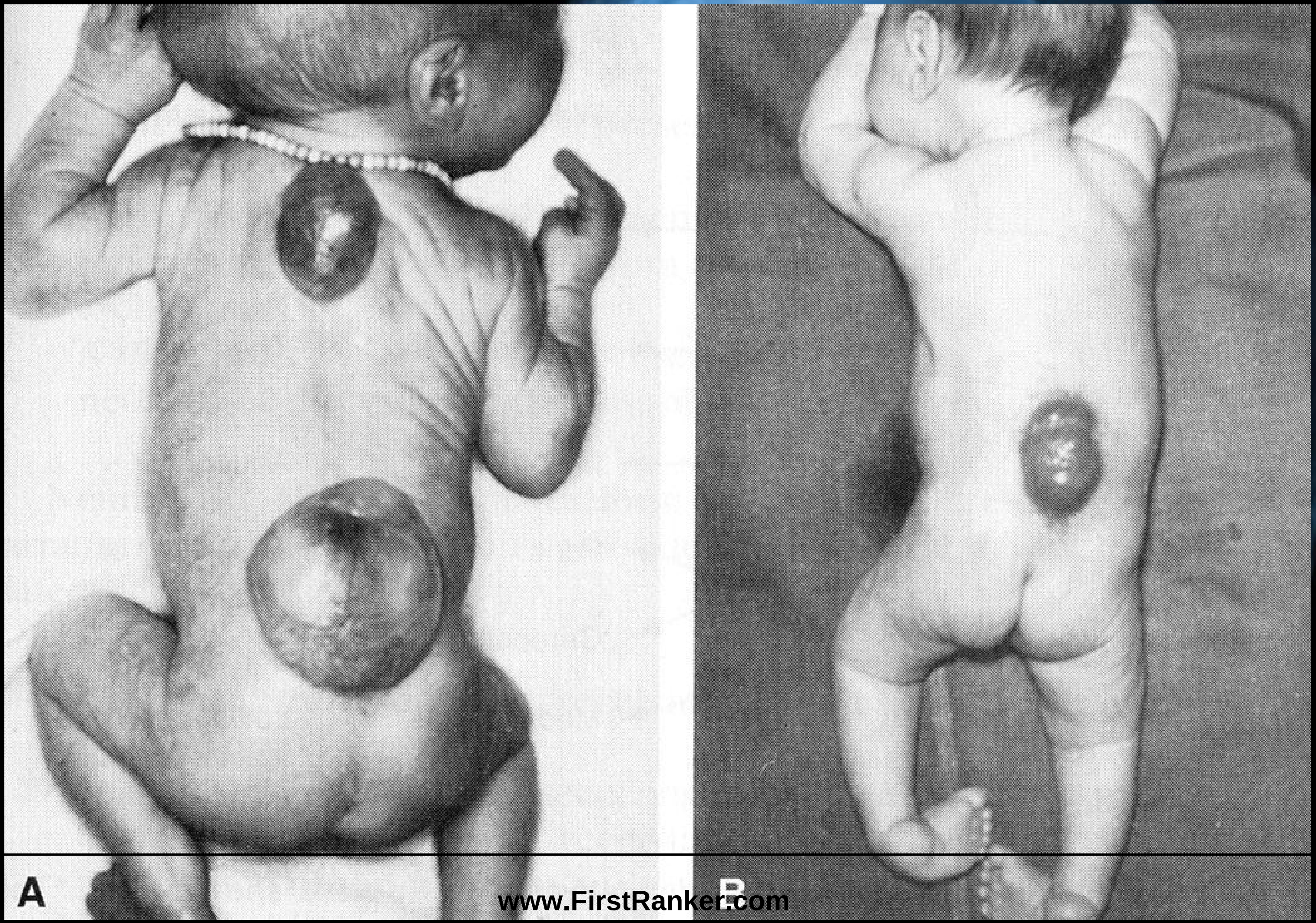
Disturbance of neurulation may result in severe abnormalities of the brain and the spinal cord. Most defects are the result of non-closure or defective closure of the neural tube:

1. In the brain region (e.g. anencephaly: total absence of the brain.

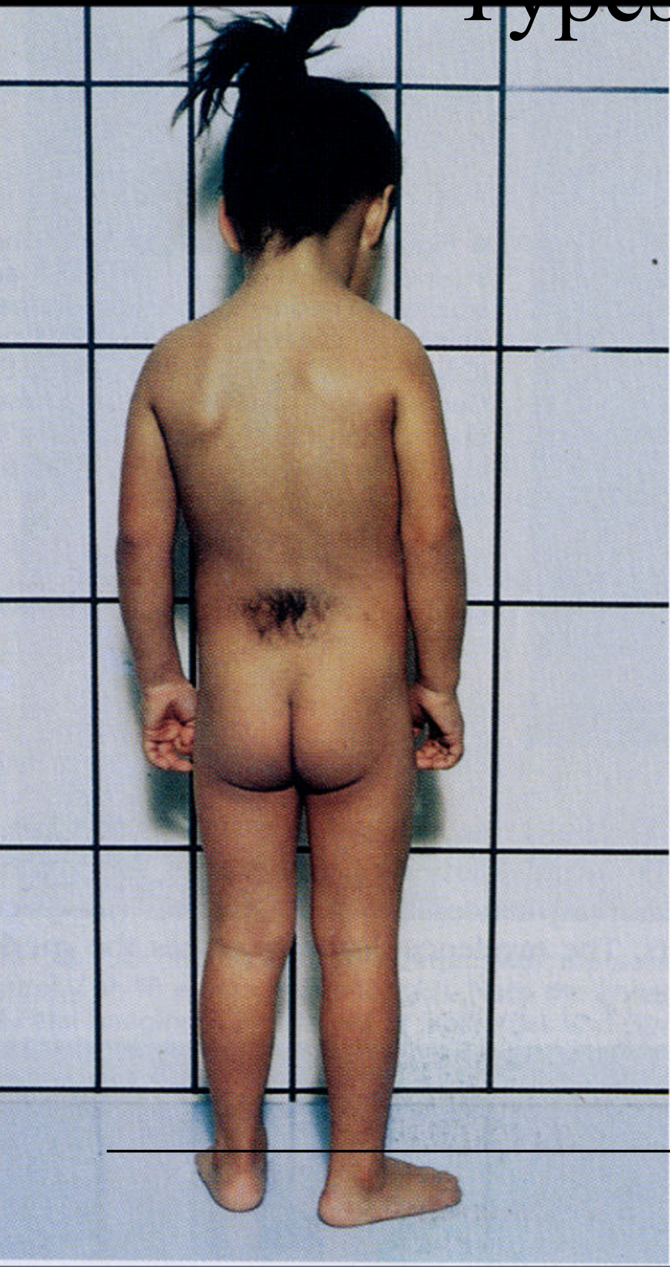
2. Meroencephaly (partial absence of the brain) is the most severe neural tube defect and is also the most common anomaly affecting the CNS.

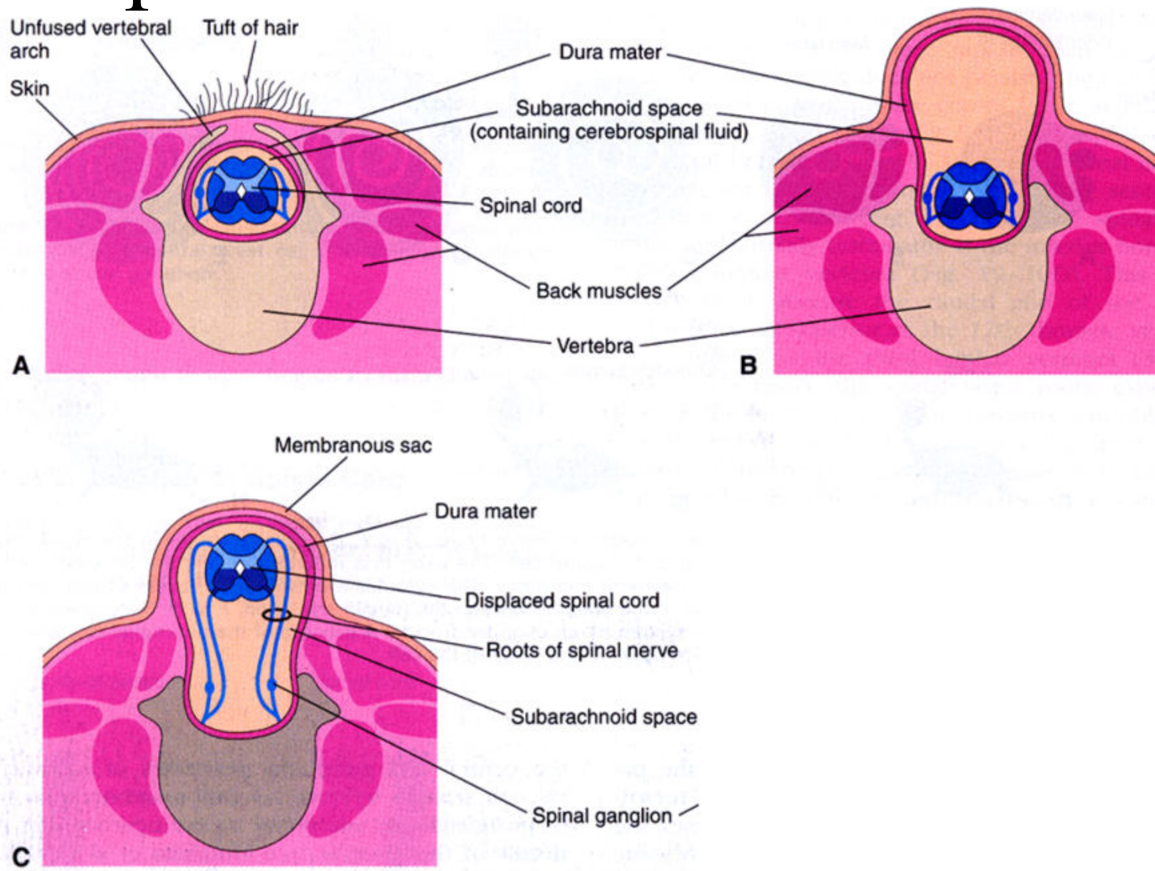
3. In the spinal cord regions (e.g. spina bifida)

Malformations of Neural Tube Closure (1 in 600 births)

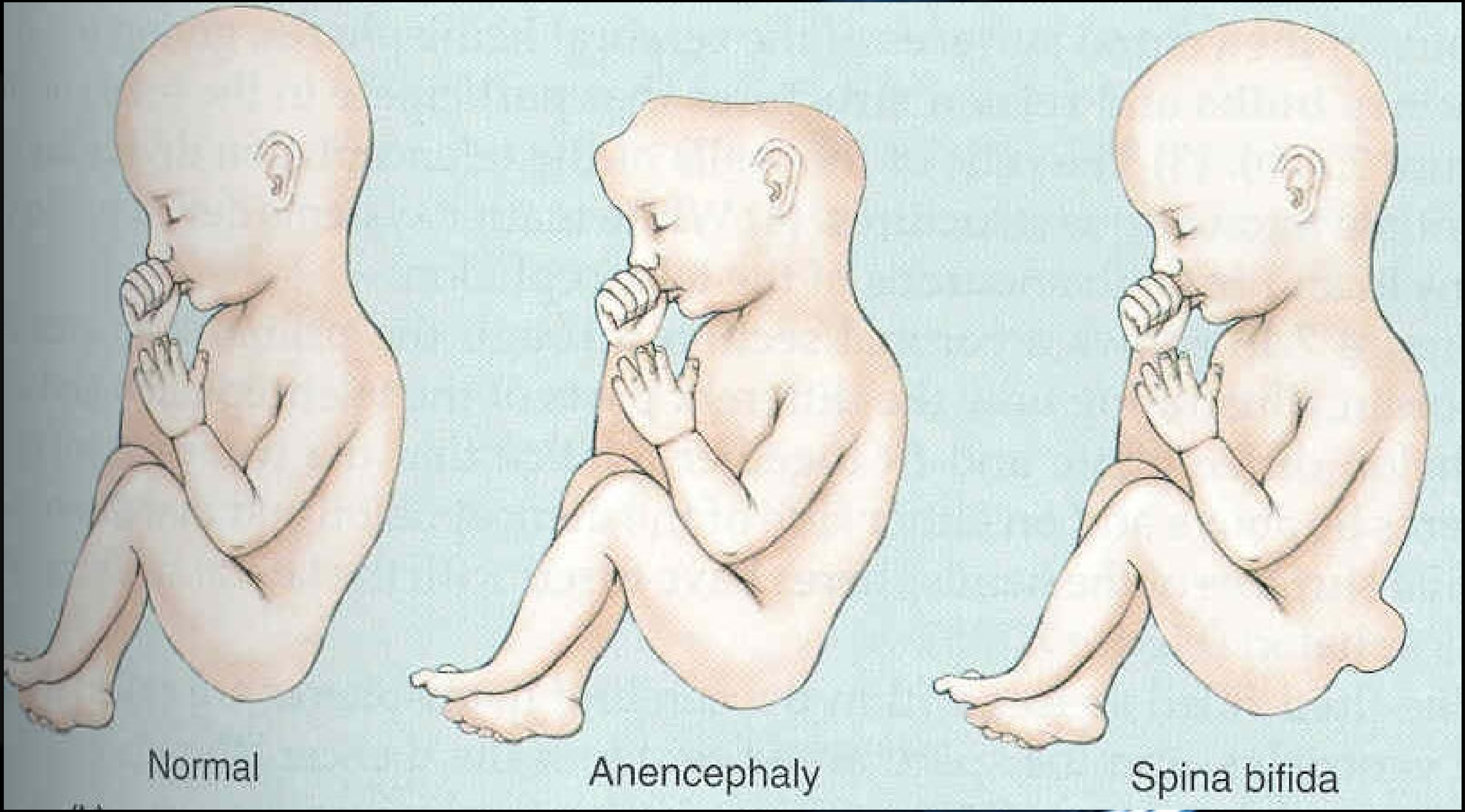


Types of Spina Bifida





A: Spinal bifida occulta
B: Spina bifida with meningocele
C: Spina bifida with meningomyelocele


Normal
Anencephaly
Spina bifida


Spinal bifida

Ectoderm

1. **Surface ectoderm**
2. **Neuroectoderm**

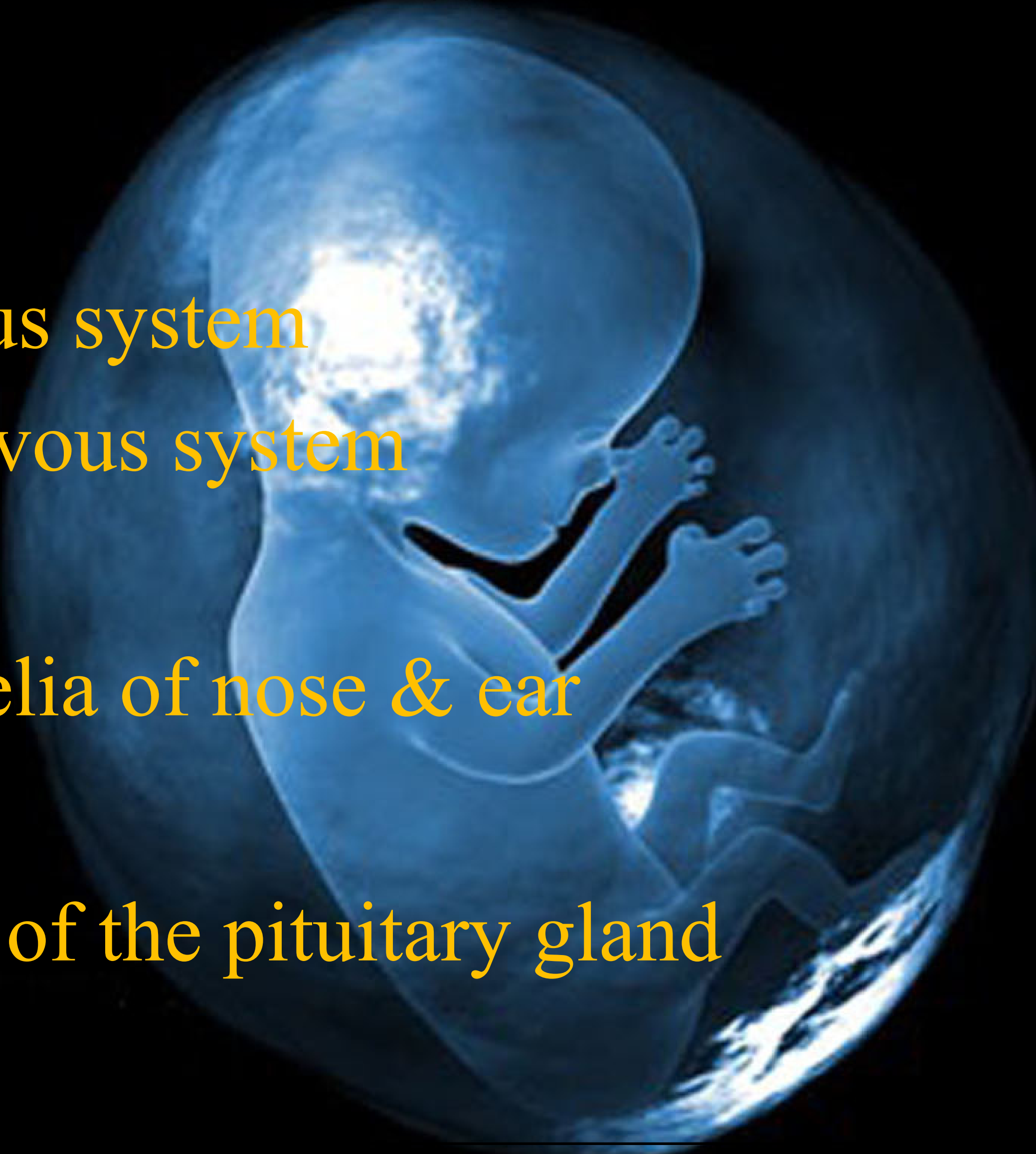
Surface Ectoderm Derivatives

- Epidermis of the skin
- Hair
- Nail
- Sweat & Sebaceous glands
- Mammary glands
- Enamel of the teeth
- Lens of eye
- Internal ear
- Anterior lobe of the pituitary gland

Neuroectoderm

- Neural Tube
- Neural Crest Cells

Neural Tube Derivatives



- Central nervous system
- Peripheral nervous system
- Retina
- Sensory epithelia of nose & ear
- Pineal gland
- Posterior lobe of the pituitary gland

Neural Crest Cells Derivatives

- Sensory ganglia (cranial & spinal)
- Autonomic ganglia
- Meninges (Pia mater & Arachnoid mater) of the brain & spinal cord
- Schwann cells
- Satellite cells
- Melanoblasts
- Suprarenal medulla (chromaffin cells)
- Several skeletal & muscular components in the head (derived from pharyngeal arches)

Derivatives of mesodermal germ layer

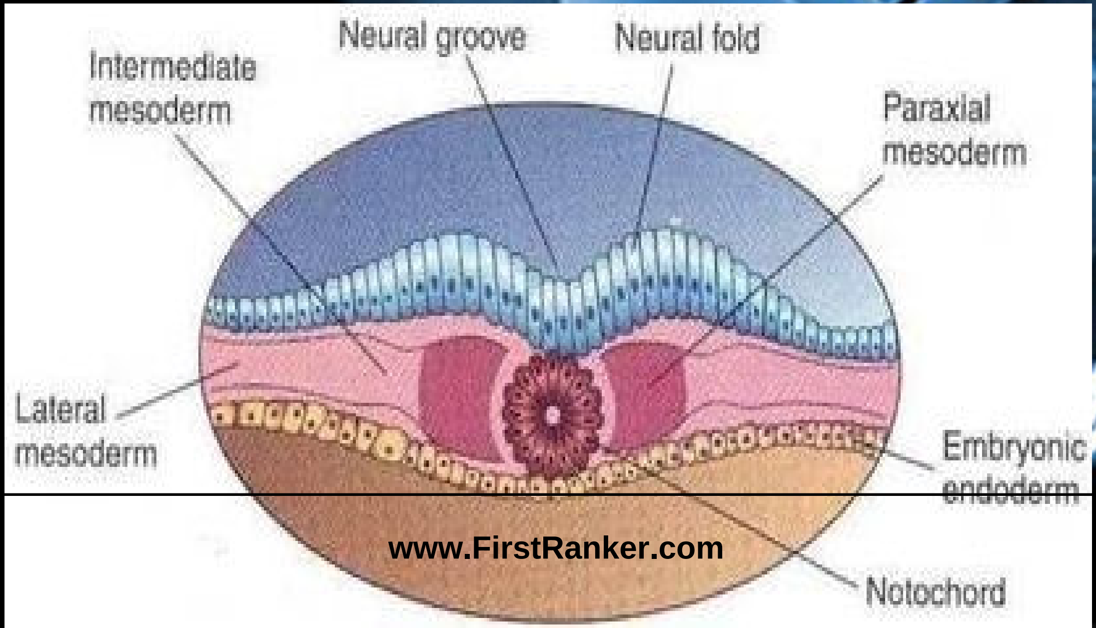
As the notochord & neural tube form, the ***intraembryonic mesoderm*** on each side of them proliferates to form:

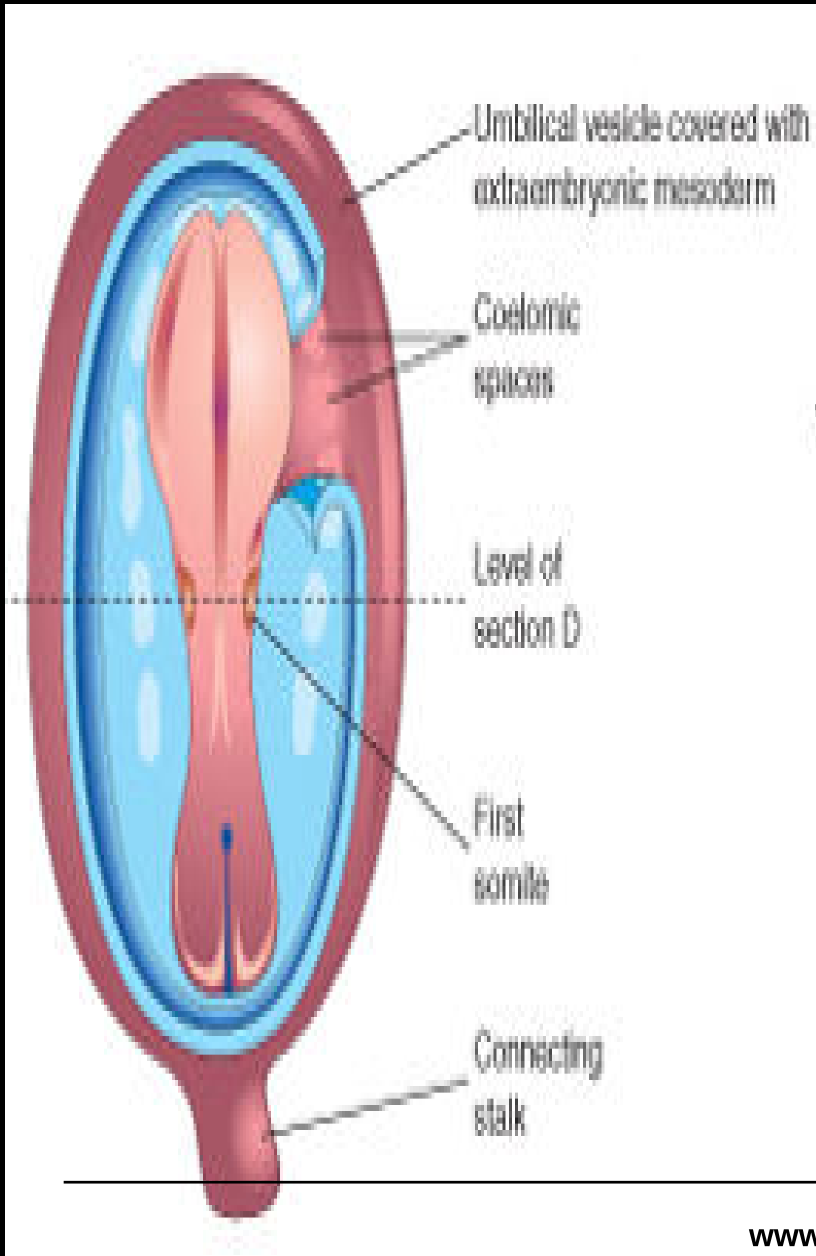
I. a thick, longitudinal column of ***paraxial mesoderm***

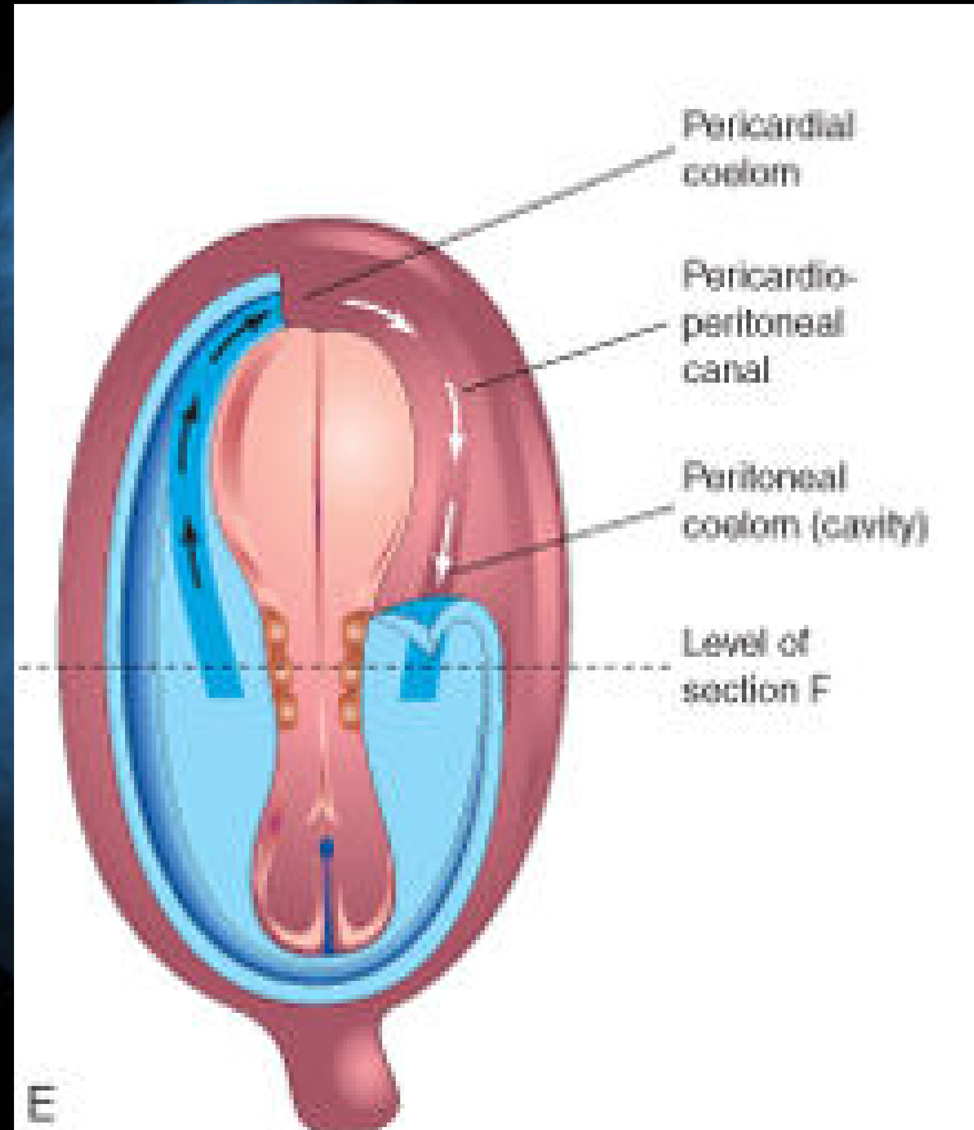
II. which is continuous with ***intermediate mesoderm*** which gradually thins into

III. ***lateral mesoderm***

❖ The lateral mesoderm is continuous with the *extraembryonic mesoderm* covering the yolk sac & amnion.




Umbilical vesicle covered with extraembryonic mesoderm
Coelomic spaces
Level of section D
First somite
Connecting stalk


Pericardial coelom
Pericardio-peritoneal canal
Peritoneal coelom (cavity)
Level of section F
E

Paraxial mesoderm:

By the beginning of the 3^{rd} week, paraxial mesoderm is organized into segments called ***somitomeres***

Somitomeres appear first in the cephalic region of the embryo, and their formation proceeds cephalocaudally (extends cranially and caudally /from head to tail or crown to rump)

From the occipital region caudally, *somitomeres* further organize into *somites*

Toward the end of the 3^{rd} week (at approximately the 20th day of development), the 1st pair of somites arises in the occipital region

From here, new somites appear in craniocaudal sequence at a rate of approximately 3 pairs per day

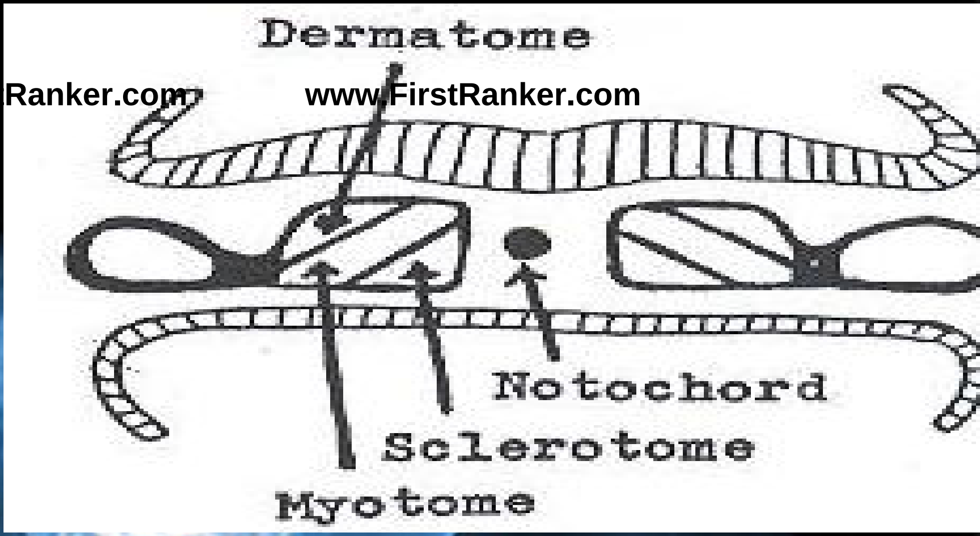
The somite period of human embryo development is from days 20 – 30

About *38 pairs of somites* are present on *day 30*

By the end of the 5^{th} week, *42 to 44 pairs of **somites** are present*

There are

- ✓ 4 occipital,
- ✓ 8 cervical,
- ✓ 12 thoracic,
- ✓ 5 lumbar,
- ✓ 5 sacral,
- ✓ and 8 to 10 coccygeal pairs



➢ The <u>1st occipital</u> and the <u>last 5-7 coccygeal somites later disappear</u>

The remaining somites divide into:

a. ventromedial part called ***sclerotome***
   sclerotome gives rise to the bones, cartilages and ligaments of the vertebral column & ribs
   So, the somites give rise to most of the axial skeleton
b. Middle part called ***myotome***
   myotome gives rise to skeletal muscles of the chest and abdomen

c orsolateral part called ***dermatome.***

It gives rise to dermis and subcutaneous tissue of the skin

➢Because the somites are so prominent during the 4th and 5th weeks, they are used as one of several criteria for *determining an embryo's age*

Intermediate mesoderm

connects paraxial mesoderm with the lateral plate *differentiates into urogenital* structures . Excretory units of the urinary system (kidney) and the gonads (testis and ovary) develop from the intermediate mesoderm.

Lateral mesoderm

•is a thin plate of mesoderm located along the lateral sides of the embryo

•Large spaces develop in the lateral mesoderm and coalesce to from the *intraembryonic coelom*

The intraembryonic coelom divides the lateral mesoderm into 2 layers:

✓somatic/ parietal layer of lateral mesoderm

✓ splanchnic or *visceral layer* of lateral mesoderm

➢somatic/*parietal layer* : is located beneath the ectodermal epithelium and continuous with the extraembryonic mesoderm covering the amnion

➢ splanchnic or *visceral layer*: is located adjacent to the endoderm and continuous with the extraembryonic mesoderm covering the umbilical vesicle (yolk sac).

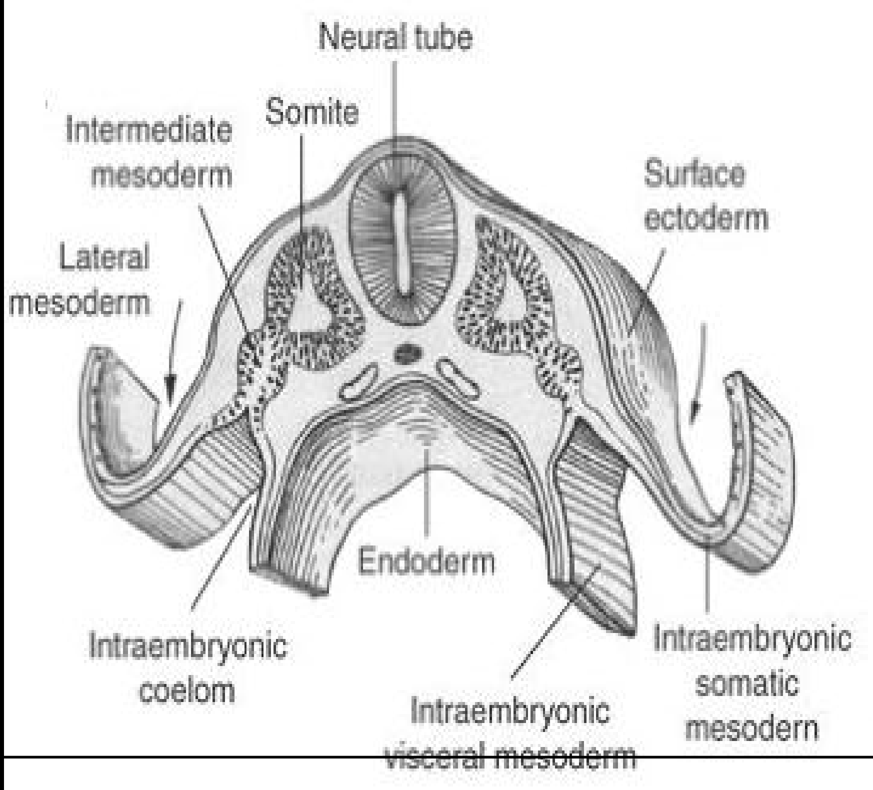
- The somatic mesoderm and overlying embryonic ectoderm form the embryonic body wall or **somatopleure**
- whereas the splanchnic mesoderm and underlying embryonic endoderm form the embryonic gut or **splanchnopleure**

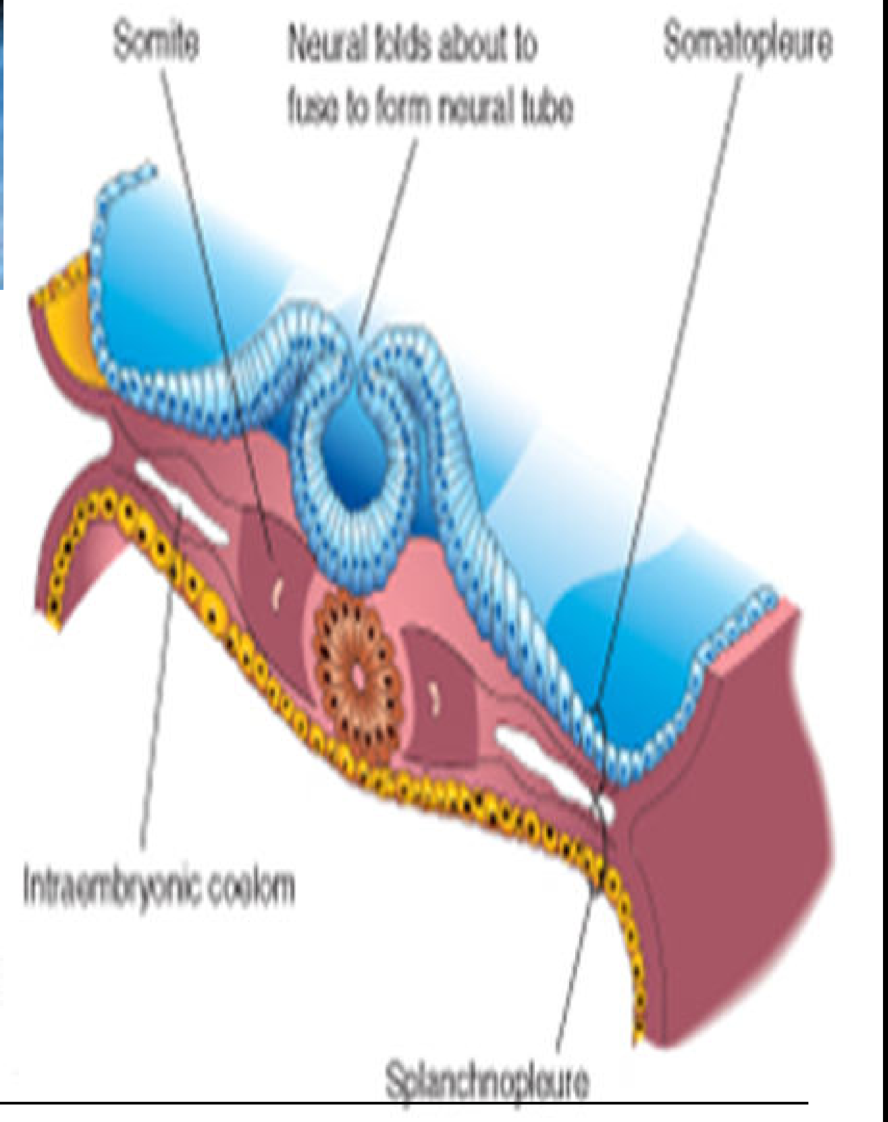
During the second month, the intraembryonic coelom is divided into three body cavities:

Pericardial cavity

Pleural cavities

Peritoneal cavity





and Blood Vessels

Blood cells and blood vessels also arise from mesoderm

- ➢ Blood vessels form in two ways:
- ✓ vasculogenesis: whereby vessels arise from blood islands and
- ✓angiogenesis, which entails sprouting from existing vessels

A) Mesenchymal Vasculogenesis (blood vessels)

cells differentiate into endothelial precursors called angioblasts (vessel-forming cells)

Angioblasts aggregate to form blood islands. Small cavities appear within the blood islands. Angioblasts flatten and arrange themselves around the cavities to form endothelial cells of blood vessels.

These endothelium – lined cavities soon fuse to form networks of endothelial channels.

B : Angiogenesis: entails sprouting from existing vessels .

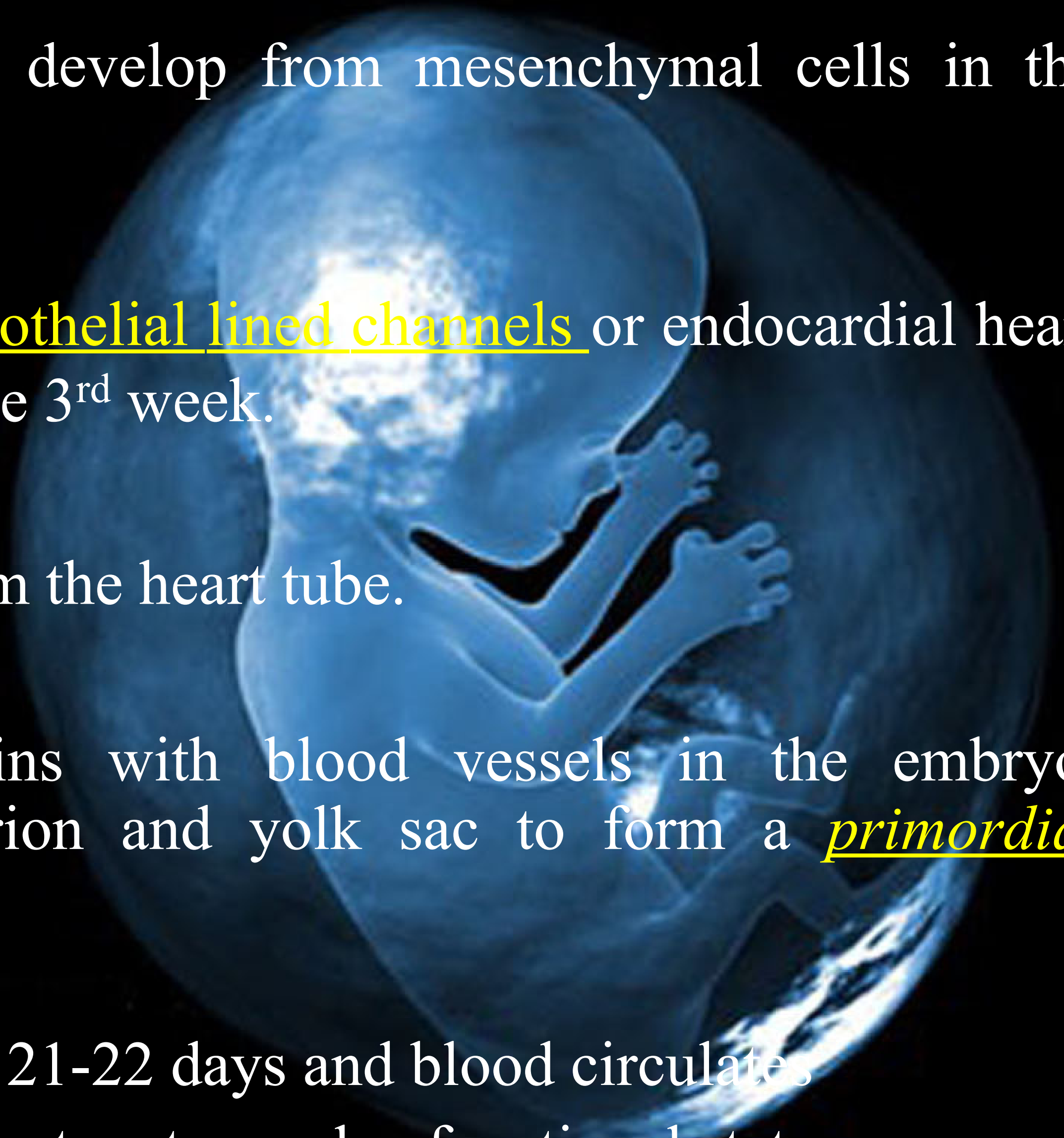
cells formation

blood cells(hamatoblasts) develop from the endothelial cells of vessels develop on the umbilical vesicle(yolk sac) and allantois at the end of the 3rd week

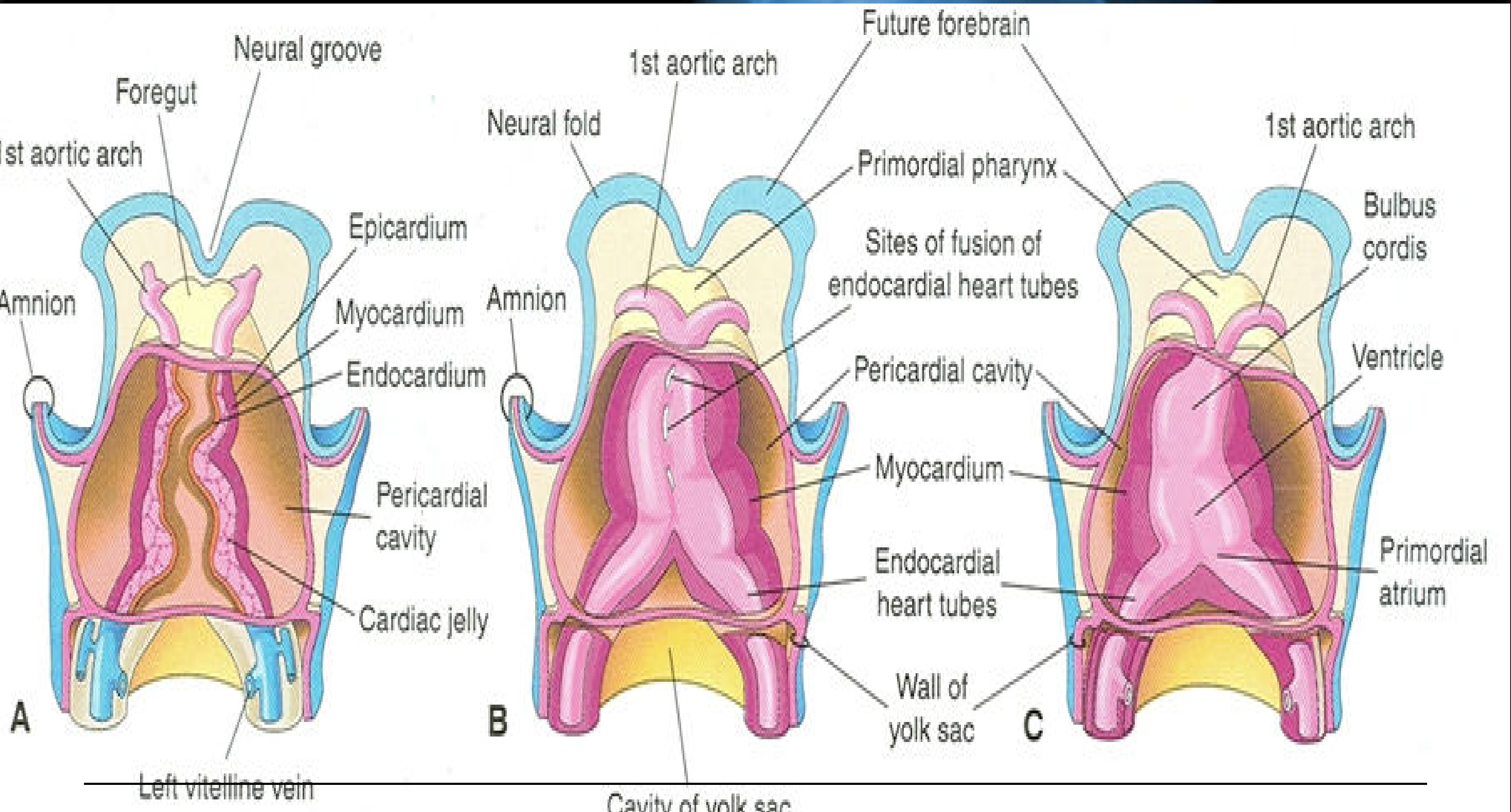
Blood formation (**hematogenesis**) does not begin in the embryo until the fifth week.

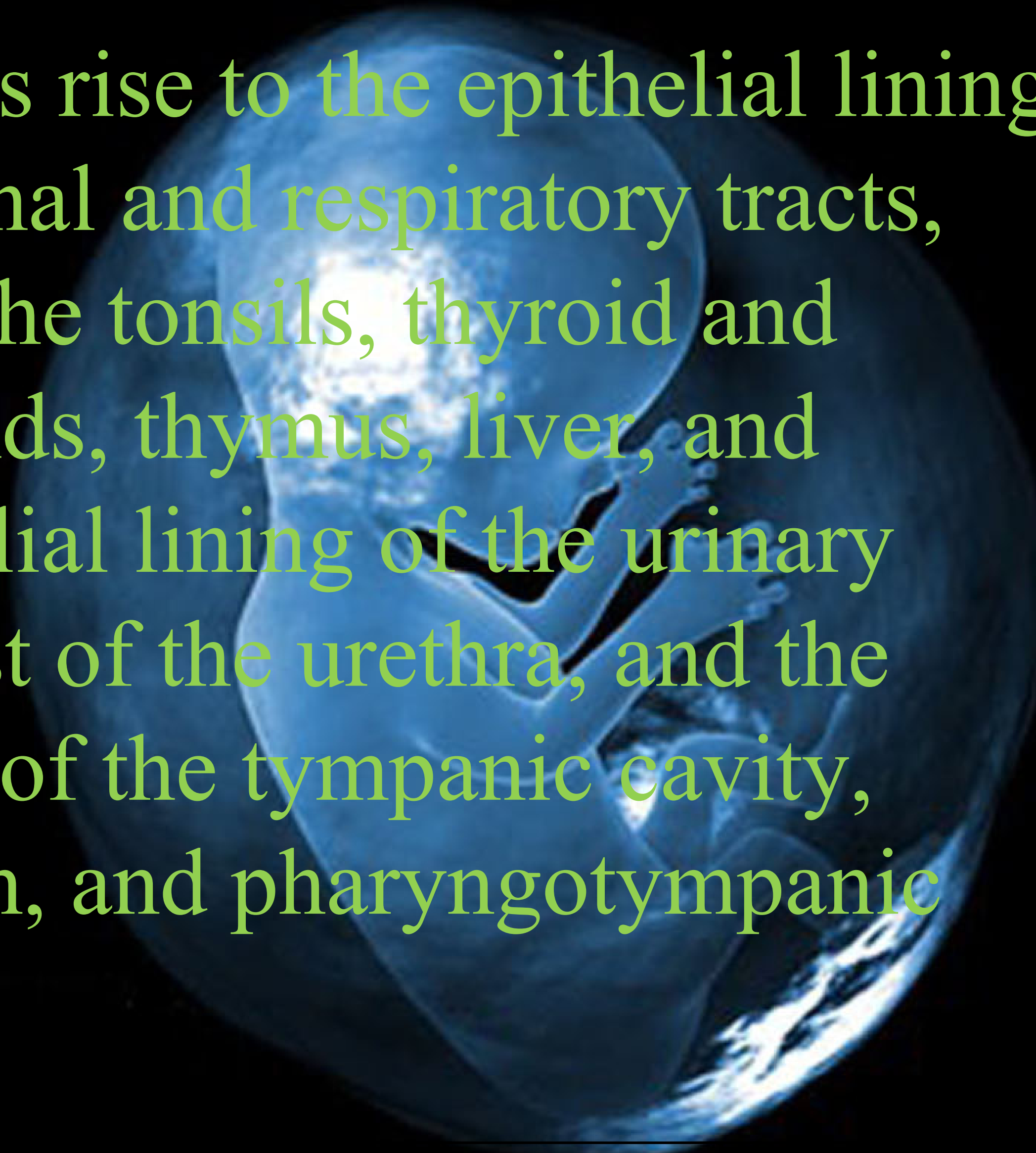
It occurs first along the aorta and then in various parts of the embryonic mesenchyme, mainly, the liver, and later in the spleen, bone marrow, and lymph nodes.

Primodial cardiovascular system



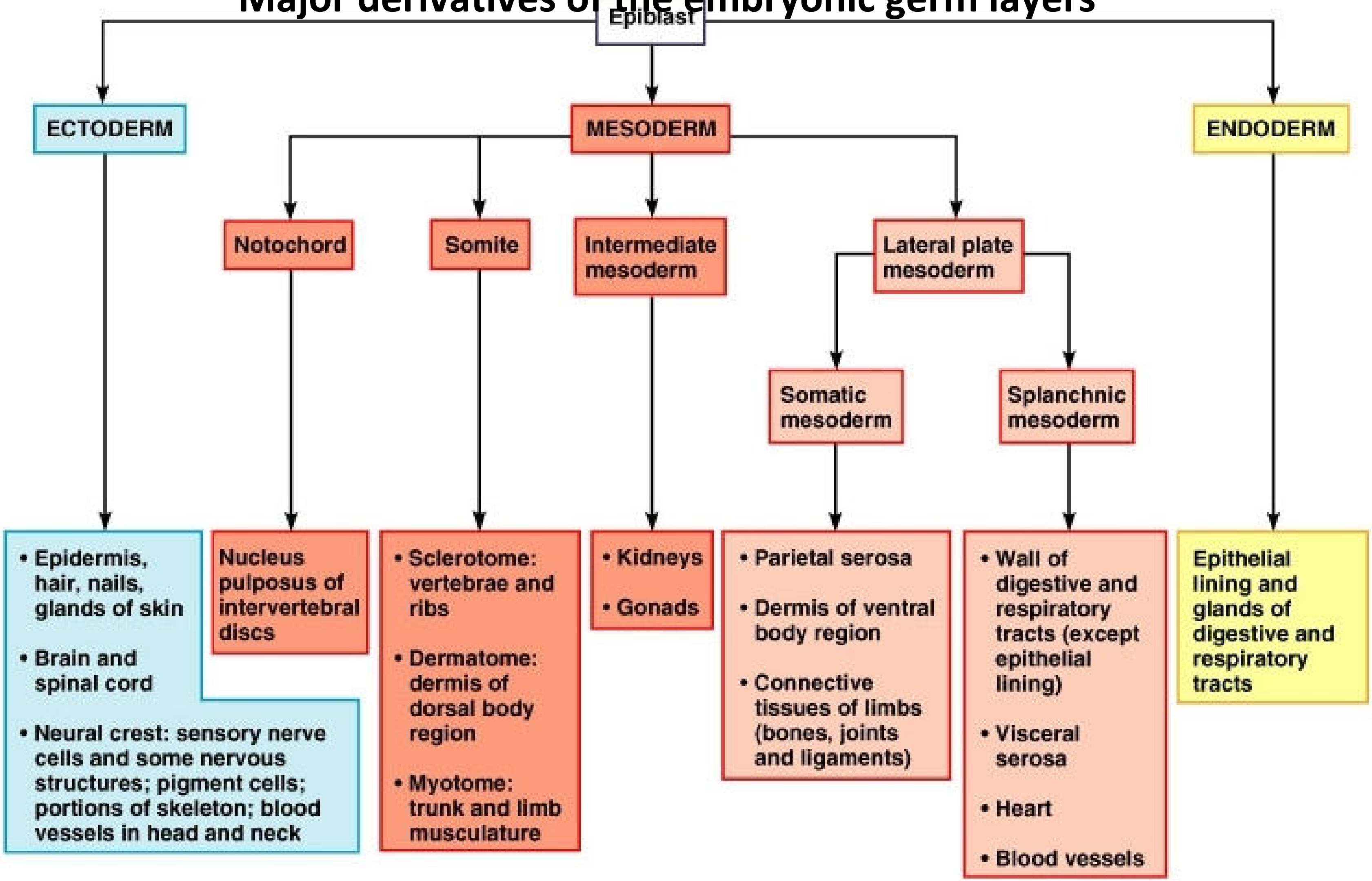
- Heart & great vessels develop from mesenchymal cells in the cardiogenic area.
- Paired longitudinal endothelial lined channels or endocardial heart tubes develop during the 3rd week.
- These tubes fuse to form the heart tube.
- The tubular heart joins with blood vessels in the embryo, connecting stalk, chorion and yolk sac to form a *primordial cardiovascular system*
- Heart begins to beat on 21-22 days and blood circulates
- CVS is the first organ system to reach a functional state

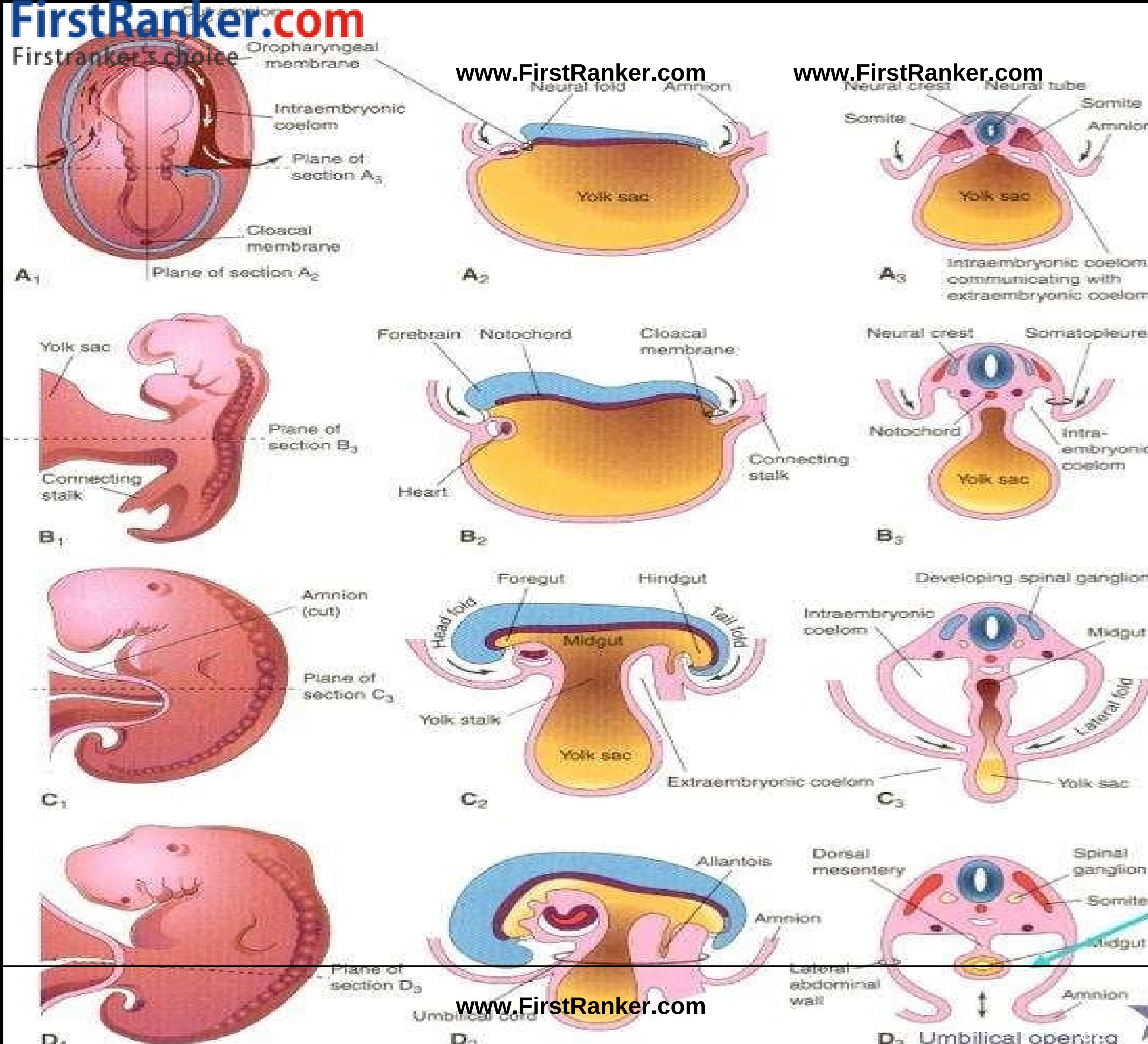

Neural groove
Foregut
1st aortic arch
Epicardium
Amnion
Myocardium
Endocardium
Pericardial
cavity
Cardiac jelly
A
Left vitelline vein
1st aortic arch
Neural fold
Future forebrain
Primordial pharynx
Sites of fusion of
endocardial heart tubes
Amnion
Pericardial cavity
Myocardium
Endocardial
heart tubes
Wall of
yolk sac
B
Cavity of yolk sac
1st aortic arch
Bulbus
cordis
Ventricle
Primordial
atrium
C



Endoderm gives rise to the epithelial lining of the gastrointestinal and respiratory tracts, parenchyma of the tonsils, thyroid and parathyroid glands, thymus, liver, and pancreas, epithelial lining of the urinary bladder and most of the urethra, and the epithelial lining of the tympanic cavity, tympanic antrum, and pharyngotympanic (auditory) tube

Major derivatives of the embryonic germ layers




Oropharyngeal membrane
Intraembryonic coelom
Plane of section A_3
Cloacal membrane
Plane of section A_2
A_1
Neural fold
Amnion
Yolk sac
A_2
Neural crest
Neural tube
Somite
Somite
Amnion
Yolk sac
Intraembryonic coelom communicating with extraembryonic coelom
A_3
Yolk sac
Plane of section B_3
Connecting stalk
B_1
Forebrain
Notochord
Cloacal membrane
Heart
Connecting stalk
B_2
Neural crest
Somatopleure
Notochord
Intra-embryonic coelom
Yolk sac
B_3
Amnion (cut)
Plane of section C_3
C_1
Foregut
Hindgut
Head fold
Tail fold
Midgut
Yolk stalk
Yolk sac
Extraembryonic coelom
C_2
Developing spinal ganglion
Intraembryonic coelom
Midgut
Lateral fold
Yolk sac
C_3
Plane of section D_3
D_1
Allantois
Amnion
Umbilical cord
D_2
Dorsal mesentery
Spinal ganglion
Somite
Midgut
Lateral abdominal wall
Amnion
D_3
Umbilical opening

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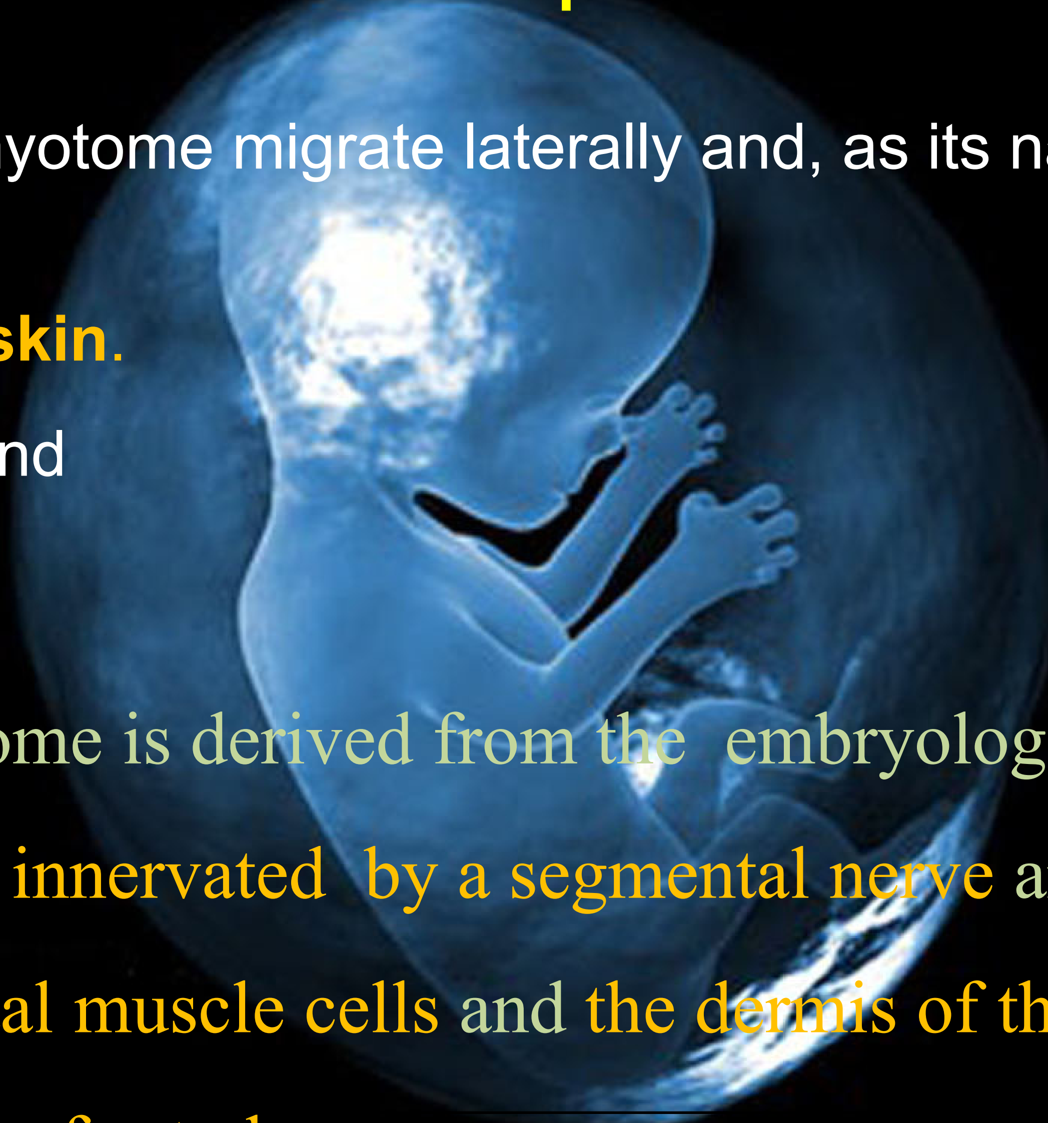
Development of Somites:

- The **dermomyotome** is the **dorso-lateral part of the somite**.

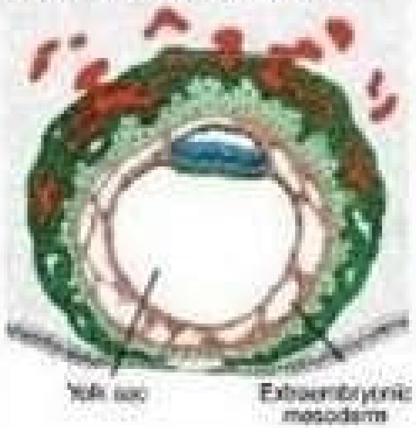
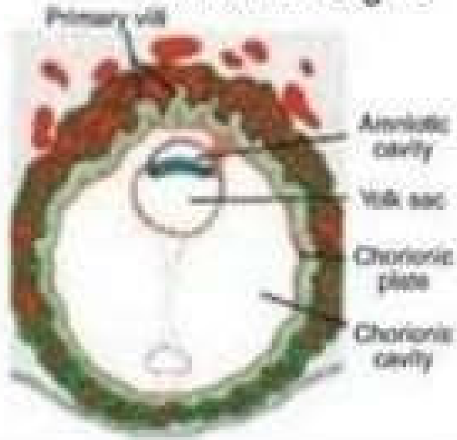
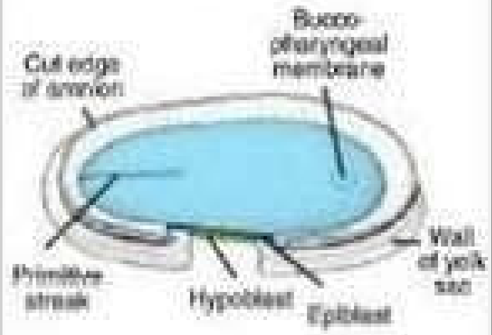
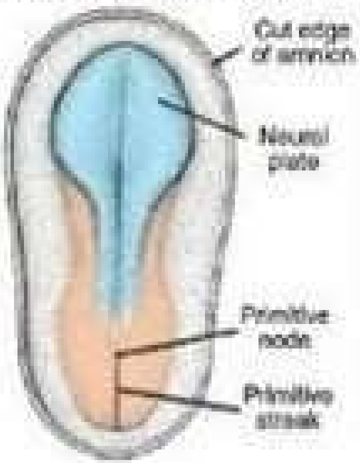
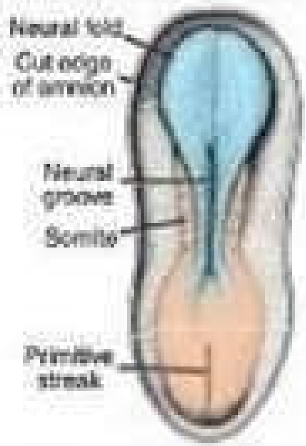
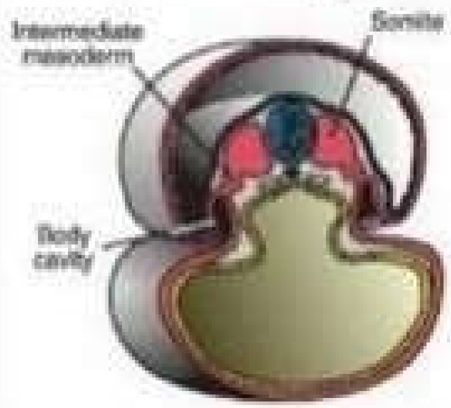
- Cells from the dermomyotome migrate laterally and, as its name implies, gives rise to

  (i) the **dermis of the skin**.

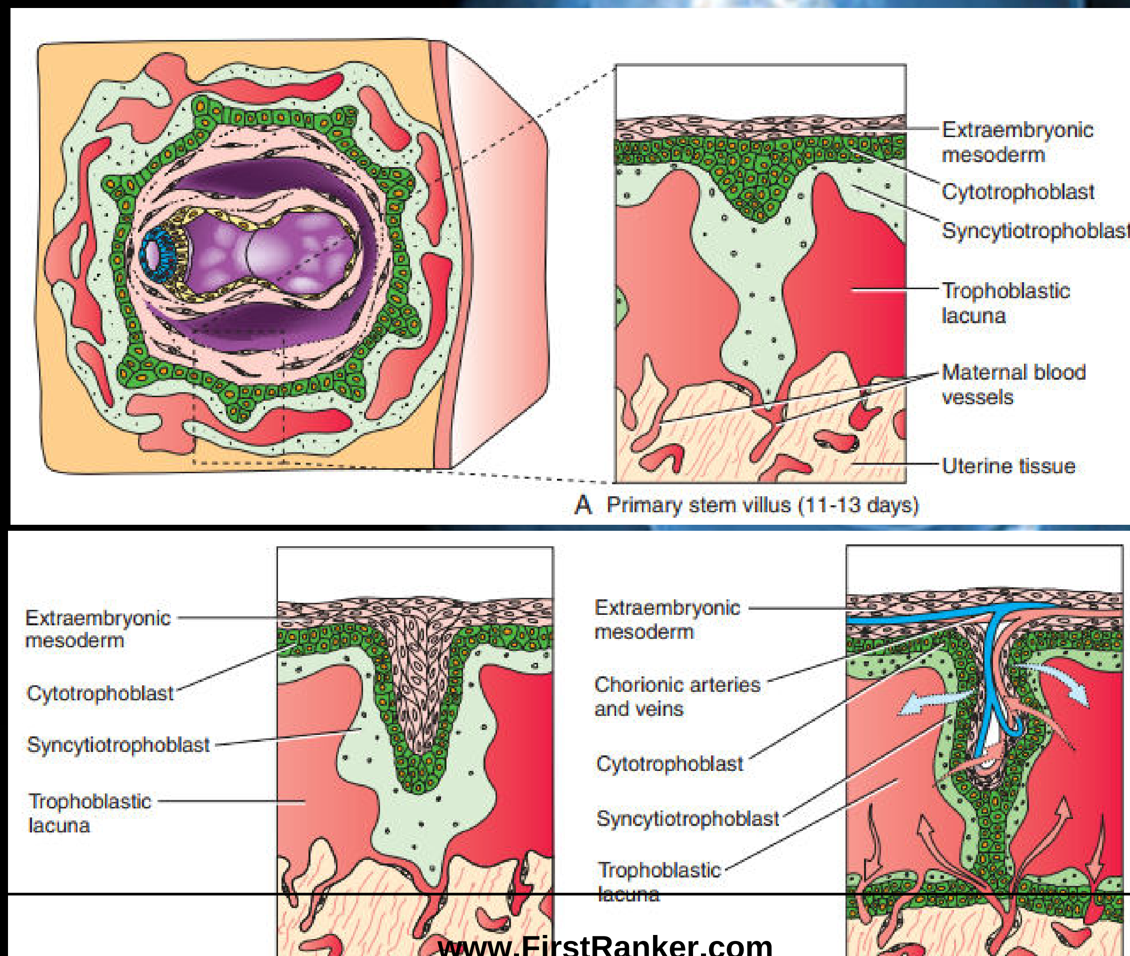
  (ii) skeletal muscle and



Each anatomical myotome is derived from the embryological dermomyotome that is innervated by a segmental nerve and forms a group of skeletal muscle cells and the dermis of the corresponding segment of ectoderm.

Day 12 Extraembryonic mesoderm develops	Day 13 Uteroplacental circulation begins	Day 14 Embryonic disc: dorsal view	Development Week 2
			
Day 19 CNS induction	**Day 20** Neurulation: Neural folds elevate	**Day 21** Transverse section through somite region	Development Week 3
			
Day 26 Pharyngeal arches	**Day 27**	**Day 28** Neurulation	

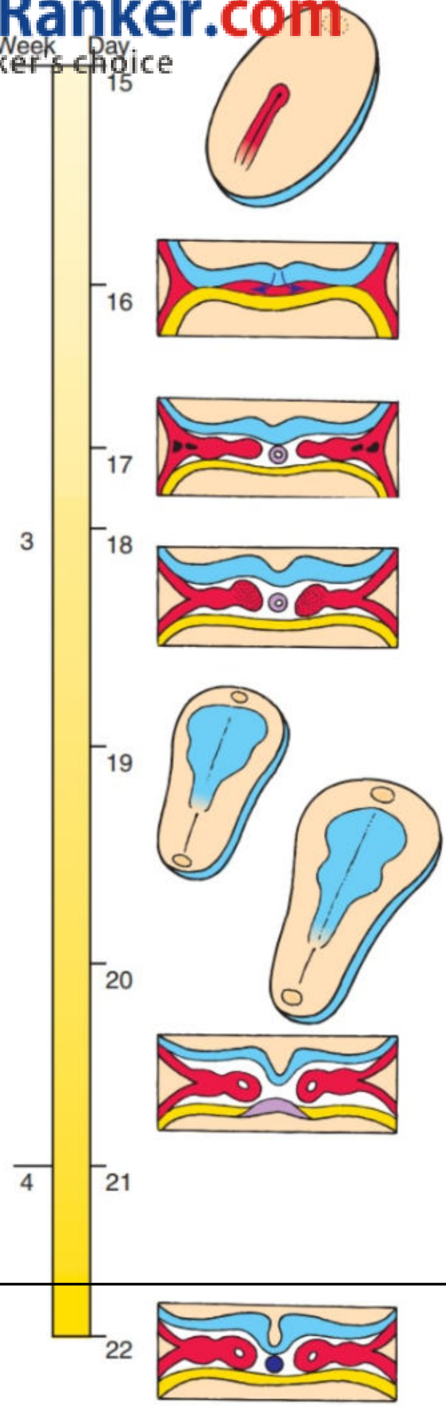
In the meantime, the trophoblast progresses rapidly. **Primary villi** obtain a mesenchymal core in which small capillaries arise. When these villous capillaries make contact with capillaries in the chorionic plate and connecting stalk, the villous system is ready to supply the embryo with its nutrients and oxygen .



A Primary stem villus (11-13 days)

B Secondary stem villus (16 days)

C Tertiary stem villus (21 days)



Primitive streak forms along caudal midline of bilaminar embryonic disc; its cranial end is expanded as the primitive node; the position of the future oropharyngeal membrane is indicated at the cranial end of the embryonic disc

During gastrulation, epiblast cells ingress along primitive streak; first cells to ingress displace hypoblast and form definitive endoderm; subsequent ingressing cells migrate between epiblast and endoderm to form mesoderm

Mesoderm extends cranially from primitive node to form notochordal process, while mesoderm lateral to midline becomes paraxial, intermediate and lateral plate mesoderm; lateral plate mesoderm begins to split into two layers

In the future head, paraxial mesoderm forms head mesoderm, while in the future trunk, paraxial mesoderm forms somites; two layers of lateral plate mesoderm have now formed, somatic mesoderm and splanchnic mesoderm, and the two layers are separated by the intraembryonic coelom

Oropharyngeal and cloacal membranes are present and neural plate forms; expanded cranial part represents future brain, whereas narrow caudal part represents future spinal cord

Notochordal process fuses transiently with endoderm to form notochordal plate

Paraxial mesoderm begins coalescing to eventually form in craniocaudal succession a total of 42-44 somites

Notochordal plate separates from endoderm to form solid notochord

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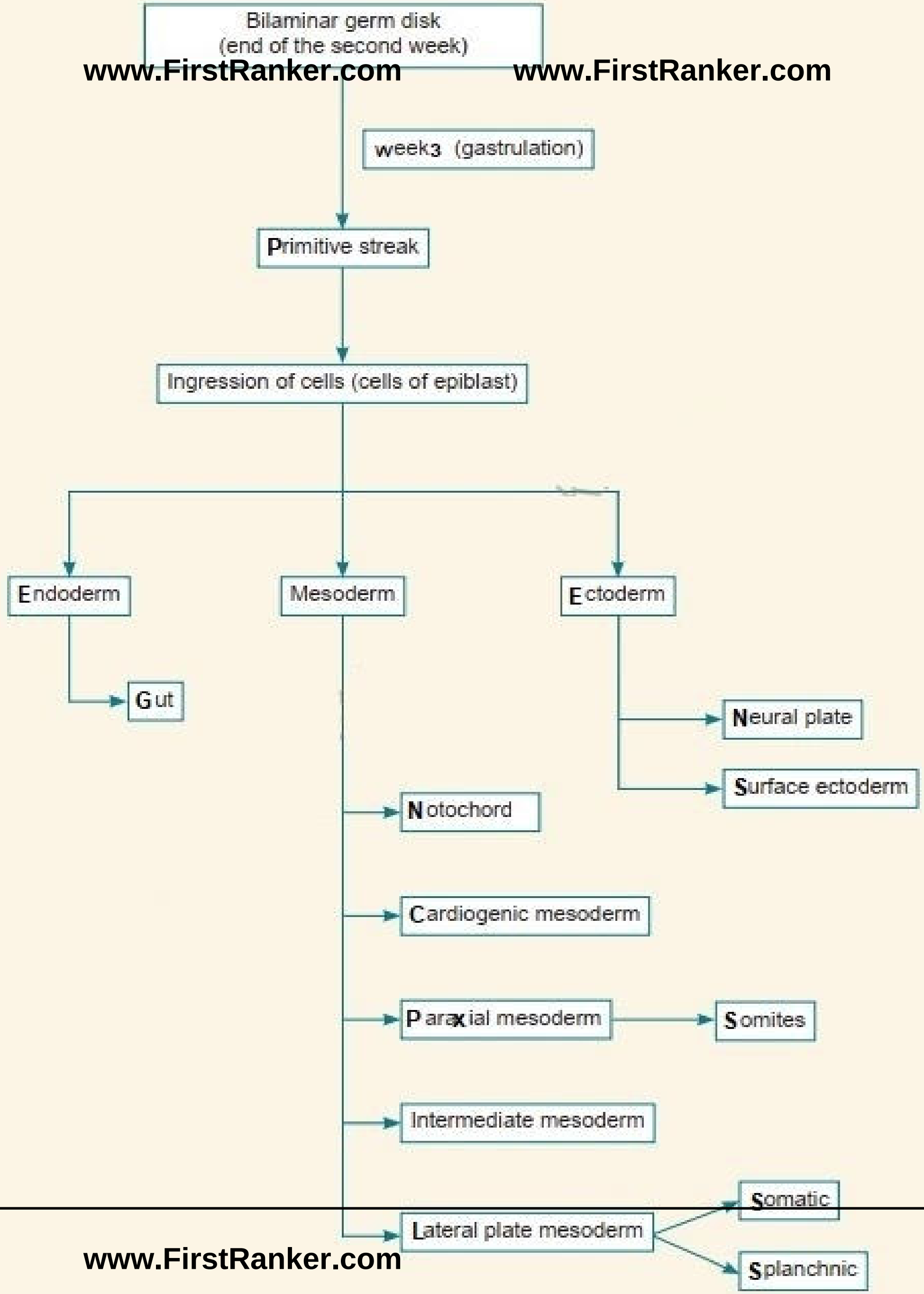

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Thanks to you all