Fetal Membranes

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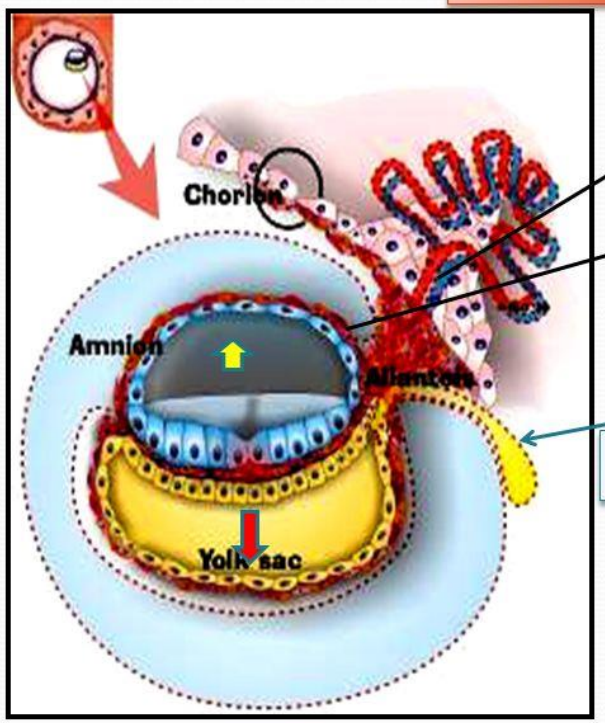
Fetal Membranes

- The fetal part of the placenta and fetal membranes separate the fetus from the endometrium of the uterus
- An interchange of substances such as nutrients and oxygen occurs between the maternal and fetal blood streams through the placenta

What constitute a Fetal Membrane

- Decidua
- Chorion
- Amnion
- Yolk sac
- Allantois

Components

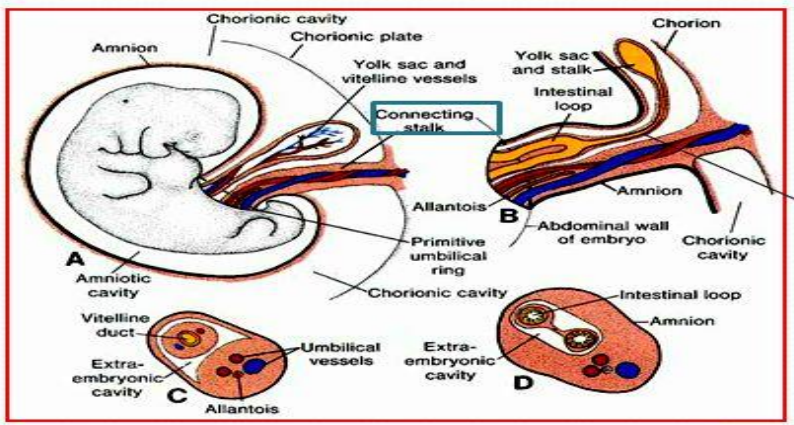


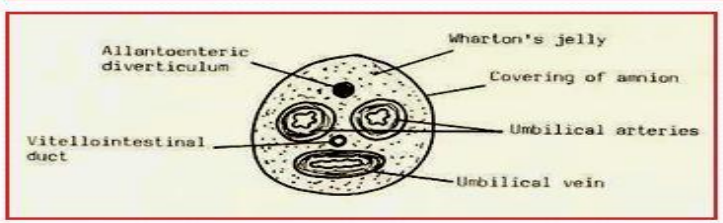
- Umbilical cord (Connecting Stalk)
- Amnion
- Amniotic Fluid
- Yolk Sac
- Allantois

Functions

1. Protection
2. Nutrition
3. Respiration
4. Excretion
5. Synthesis of Hormones

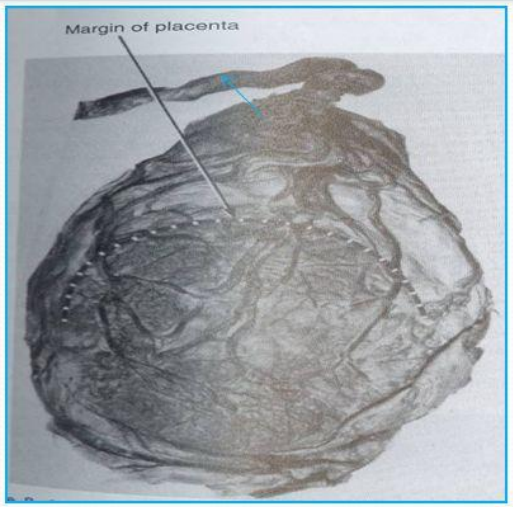
Structure of Umbilical Cord

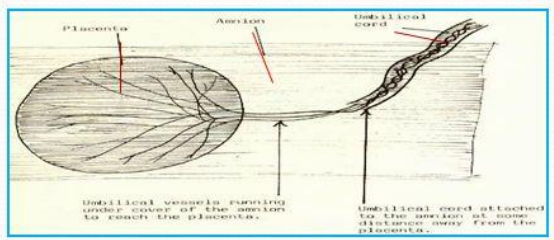




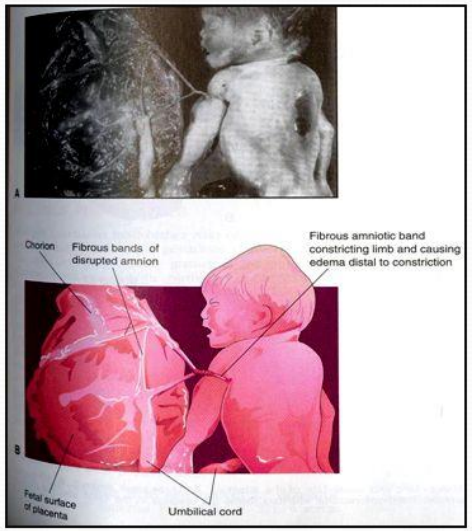
- **1-Connecting stalk:**
  - **Alantois + two Umbilical arteries + two Umbilical veins)**
  - **The extra embryonic mesoderm** forms **Wharton's jelly**
- **2-Yolk stalk (Vitello-intestinal duct):**
  - A narrow, elongated duct which connects gut to yolk sac
  - It contains **Vitelline Vessels**
  - Later on , it is obliterated and the vitelline vessels disappear.

Anomalies of Umbilical Cord

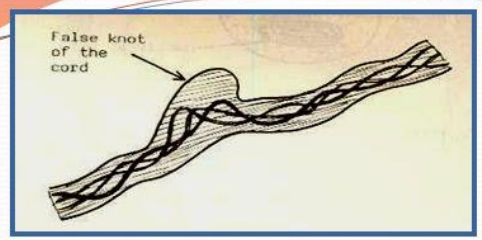


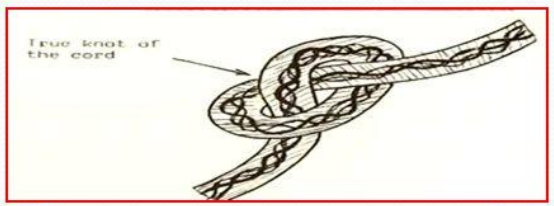


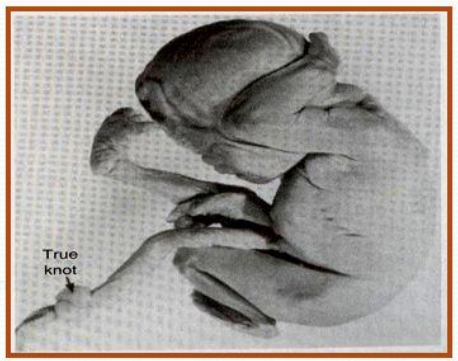
- **(1) Abnormal Attachment:**
  - **a-Battledore placenta :**
    - The UC is attached to the margin of the placenta (it **is not dangerous).**
  - **b-Velamentous insertion of the cord :**
    - UC is attached to the amnion **away from placenta**, (It is **dangerous** to the fetus due to **rupture of blood vessels during labor)**



- **(2) Abnormalities in Length:**
- **a-Very Long Cord**:
  - **It is dangerous** , it may surround the neck of the fetus and causes its death.
- **b-Very Short Cord:**
  - **It is dangerous** because it may cause premature separation of placenta, or the cord itself may rupture







- **(3) False and True knots of umbilical cord:**

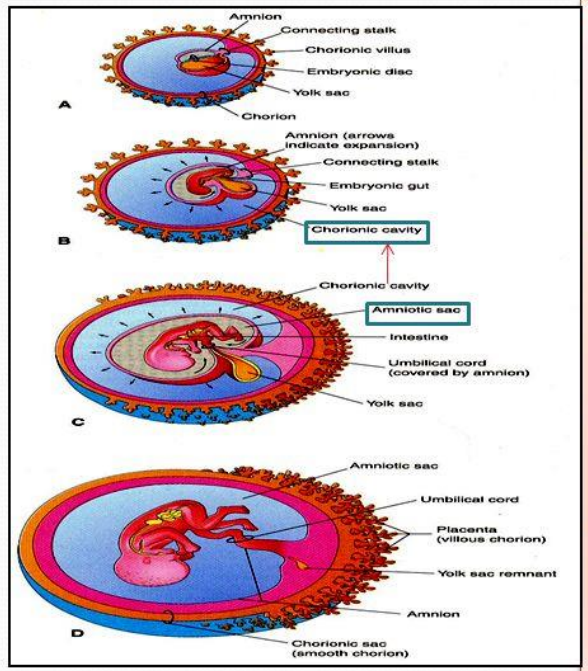
  a-False knots:
  - **UC looks tortuous due to twisting of umbilical vessels (umbilical vessels are longer than the cord), these knots are normal and do not cause any harm to the fetus**

- **b-True knots:**
  - **Are rare (1%) of pregnancy, but very dangerous because they may cause obstruction to blood flow in umbilical vessels, leading to fetal anoxia & fetal death**

Amnion

- Thin but tough
- Forms a fluid filled membranous amniotic sac that surrounds the embryo and fetus
- Is attached to the margins of the embryonic disc
- Its junction with embryo located on the ventral surface after the folding

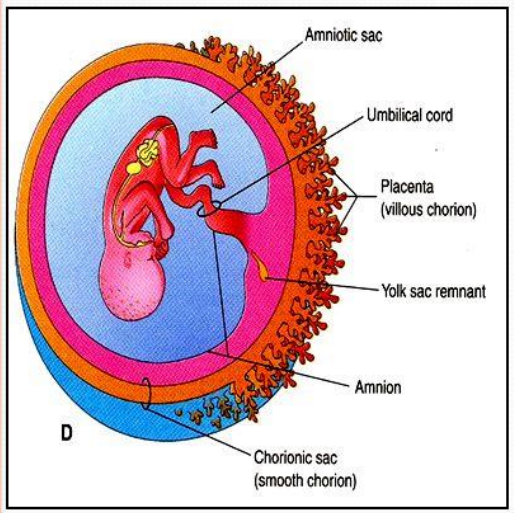
Amnion



- It is a thin, transparent & tough fluid-filled, membranous sac surrounding the embryo.
- **At First :** It is seen as a small cavity lying **dorsal** to the embryonic plate.
- **At Stage of Chorionic Vesicle:** The amnion becomes separated from the chorion by **chorionic cavity** or **extra embryonic coelom**.
- **After Folding:** the amnion expands greatly and is becomes on the **ventral surface** of the embryo.
- As a result of expansion of the amnion, the extra embryonic coelom is gradually obliterated and amnion forms the epithelial covering of umbilical cord.

Amniotic Fluid

- It is **a watery fluid** inside the amniotic cavity (sac).
- It has a major role in fetal growth & development
- It increases slowly, to become **(700-1000) ml** by full term (37) weeks.
- **Composition:**
- **99% of amniotic fluid is water**
- It contains un-dissolved material of desquamated fetal epithelial cells + organic + inorganic salts
- **As pregnancy advances,** composition of amniotic fluid changes as **fetal excreta (meconium = fetal feces & urine) are added**



Amniotic Fluid

- Plays a major role in fetal growth and development
- Most of it is derived from maternal tissue and by diffusion across the amniochorionic membrane from the decidua parietalis
- Later there is a diffusion of fluid through the chorionic plate from blood in the intervillous space of the placenta

Amniotic Fluid

- Amniotic fluid is similar to fetal tissue fluid
- Before keratinization of the skin the pathway for passage of water and solutes in tissue fluid from the fetus to the amniotic cavity is through the skin
- Fluid is also secreted by the fetal respiratory tract and enters the amniotic cavity

Amniotic Fluid

- Daily contribution of fluid from respiratory tract is 300-400 ml
- Fetus contributes to the amniotic fluid by excreting urine into the amniotic cavity
- Half a liter of urine is added daily during the late pregnancy
- Amniotic fluid volume is 30 ml at 10 weeks, 350 ml at 20 weeks, 700-1000 ml at 37 weeks

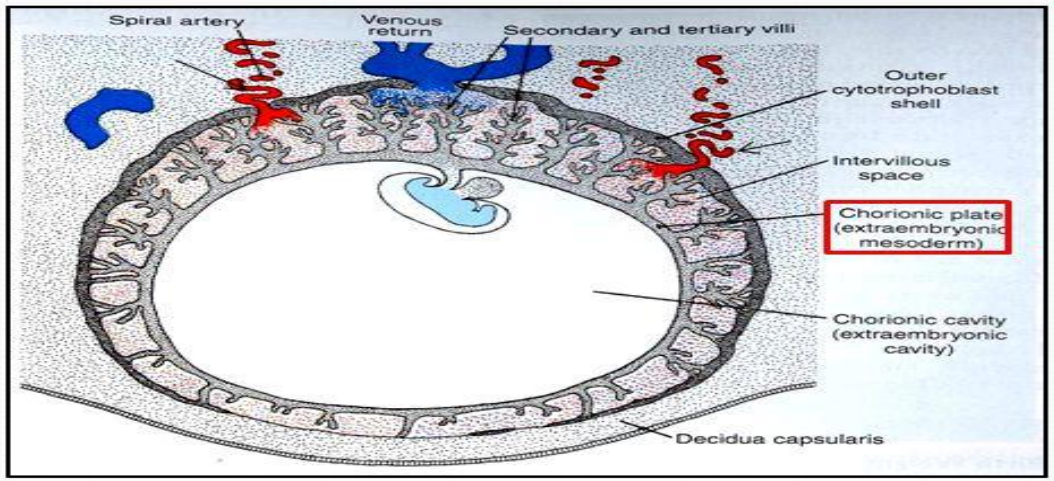
Composition of Amniotic Fluid

- 99 % is water
- Desquamated fetal epithelial cells
- Organic & inorganic salts
- Protein, carbohydrates, fats, enzymes, hormones
- Meconium & urine in the late stage
- Amniocentesis can be performed to check the concentration of different compounds for diagnostic purpose

Composition of Amniotic Fluid

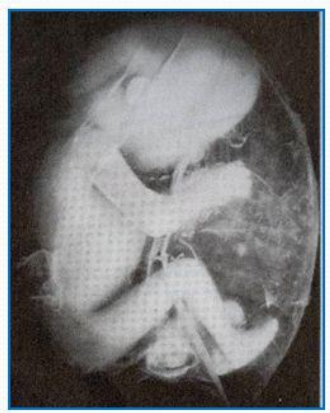
- High levels of alpha-phetoprotein (AFP) in amniotic fluid usually indicate the presence of a severe neural tube defect (meroanencephaly)
- Low levels of AFP may indicate chromosomal aberrations such as trisomy 21

Sources of amniotic fluid



- **Fetal & Maternal Sources:**
  - **Initially,** some amniotic fluid is secreted by **amniotic cells.**
  - **Most of fluid** is derived from **Maternal tissue** by:
    - 1-Diffusion **across** amnio-chorionic membrane **from placenta.**
    - 2-Diffusion **across** chorionic plate (chorionic wall related to placenta) **from the maternal blood in the intervillous spaces.**
  - **Later, it is derived from Fetus** through:
    - **Skin, Fetal Respiratory Tract & mostly by Excreting Urine (at beginning of 11th week)**

Functions of amniotic fluid



- Provides **symmetrical external growth** of the embryo
- Acts as a **barrier to infection** (it is an aseptic medium)
- Permits **normal fetal lung development**
- **Prevents adherence of embryo to amnion**
- It **protects embryo against external injuries**
- Keeps the **fetal body temperature constant**
- Allows the embryo to move freely, **aiding muscular development in the limbs**
- It is involved in **maintaining homeostasis of fluids & electrolytes**
- It permits studies on fetal enzymes, hormones and diagnosis of fetal sex and chromosomal abnormalities

Circulation & Fate of amniotic fluid

- Amniotic fluid remains constant & in balance
- --Most of fluid **is swallowed** and **few** passes into lungs by fetus, and absorbed **into fetal blood,** where it is metabolised
- -- Part of fluid passes through placental membrane **into maternal blood** in intervillus space,
- Other part of fluid is excreted by **fetal kidneys into amniotic sac**

Circulation of Amniotic Fluid

- Water content of amniotic fluid changes every 3 hours
- It is been swallowed by the fetus and absorbed by respiratory & digestive tracts
- Fetus swallows up to 400 ml of fluid per day during the end days of pregnancy

Circulation of Amniotic Fluid

- Fluid passes into the fetal blood stream and the waste products in it cross the placental membrane and enter the maternal blood in the intervillous space
- Excess water in the fetal blood is excreted by the fetal kidneys and returned to the amniotic sac as a urine

Significance of Amniotic Fluid

- Permits symmetrical external growth of the embryo and fetus
- Acts as a barrier to infection
- Permits normal fetal lung development
- Prevents adherence of amnion to fetus
- Cushions & protects the embryo and fetus
- Helps maintain the body temperature
- Enables the fetus to move freely

Exchange of Amniotic Fluid

- Large amount of amniotic fluid move in both directions between the fetal and maternal circulations mainly through the placental membrane
- Most fluid passes into GIT but some passes into lungs
- Fluid is absorbed in either case and enters the fetal circulation
- It then passes into the maternal circulation through the placental membrane

Anomalies of Volume of Amniotic Fluid

- **(1) Oligohydramnios:**
- The volume is less than ½ liters
  - **Causes :**
    - **Placental insufficiency** with low placental blood flow
    - Preterm rupture of amnio-chorionic membrane occurs in 10% of pregnancies
    - **Renal Agenesis** (failure of kidney development)
    - **Obstructive Uropathy** (urinary tract obstruction) lead to absence of fetal urine (the main source)
  - **Complications :**
    - **Fetal abnormalities** (pulmonary, facial & limb defects)

Disorders of Amniotic Fluid Volume

- Oligohydromnios
- Renal agenesis
- Obstructive uropathy
- Polyhydromnios
- Esophageal atresia

Yolk Sac

- It is large at 32 days
- Shrinks to 5mm pear shaped remnant by 10^{th} week & connected to the midgut by a narrow yolk stalk
- Becomes very small at 20 weeks
- Usually not visible thereafter

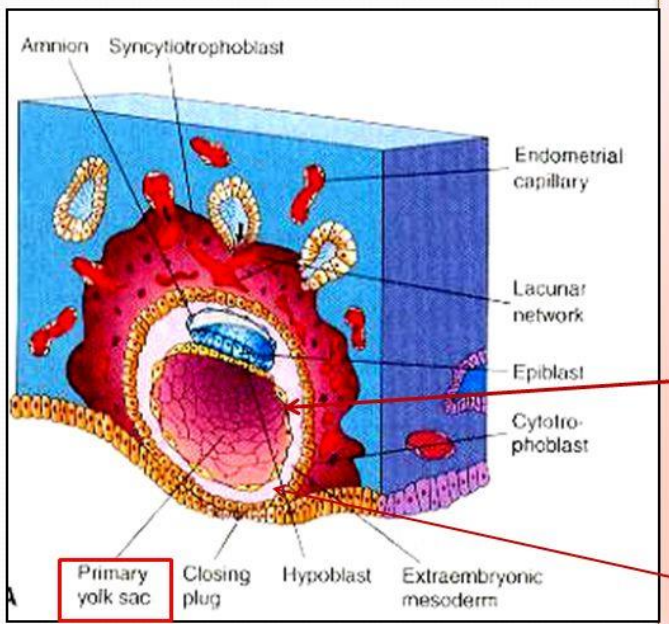
Significance of Yolk Sac

- Has a role in transfer of nutrients during the 2nd and 3rd weeks
- Blood development first occurs here
- Incorporate into the endoderm of embryo as a primordial gut
- Primordial germ cells appear in the endodermal lining of the wall of the yolk sac in the 3rd week

Fate of Yolk Sac

- At 10 weeks lies in the chorionic cavity between chorionic and amniotic sac
- Atrophies as pregnancy advances
- Sometimes it persists throughout the pregnancy but of no significance
- In about 2% of adults the proximal intra-abdominal part of yolk stalk persists as an ileal diverticulum or Meckel diverticulum

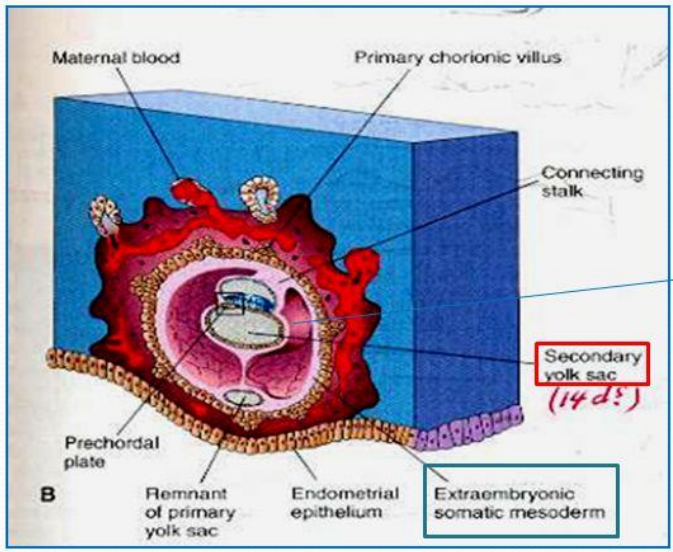
Primary Yolk Sac



Appears in the **Blastocyst** stage at 10-days, it lies ventral to the embryonic plate.

- Its roof is formed by **hypoblast (primary endoderm),**
- Its wall is formed by **exocoelomic membrane**, it lines the inner surface of the cytotrophoblast, and separated from it by the **extraembryonic mesoderm**

Secondary Yolk Sac



- **Appears in the chorionic vesicle stage**
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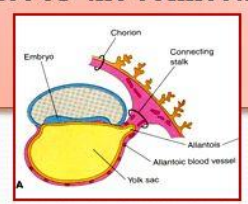
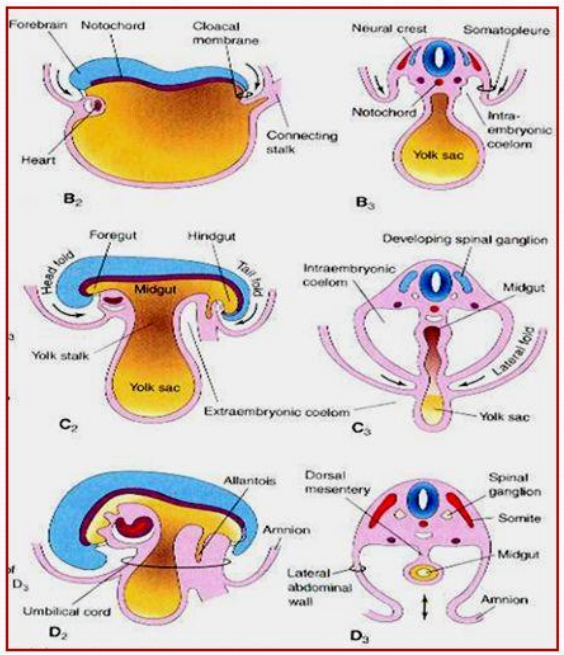
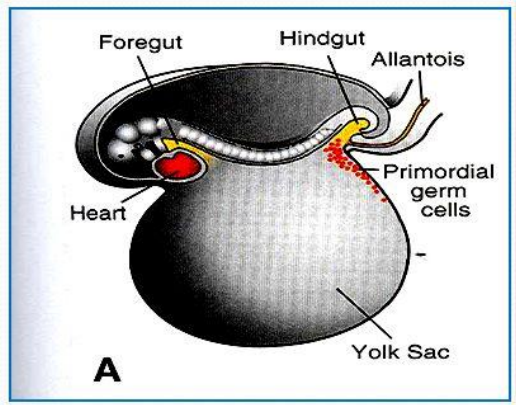


Definitive Yolk Sac



- After folding, part of Yolk Sac is enclosed within the embryo to form the Gut **(Foregut, Midgut & Hindgut).**
- The remainder of Yolk Sac that remains outside the embryo becomes the ***Definitive Yolk Sac***
- The midgut is temporarily connected to Definitive Yolk Sac by a narrow duct **Vitello-intestinal duct** **(Yolk stalk),** which is incorporated inside the umbilical cord.
- This is fibrosed and degenerated by the end of **(6th week)**

Functions of Yolk Sac



➢3rd week:

➢(a) Blood formationt

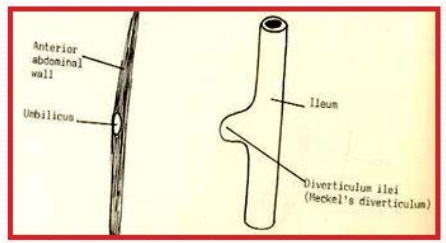
First formed in the extra-embryonic mesoderm covering the wall of the yolk sac, until hemopoietic activity begins in the liver during 6th week

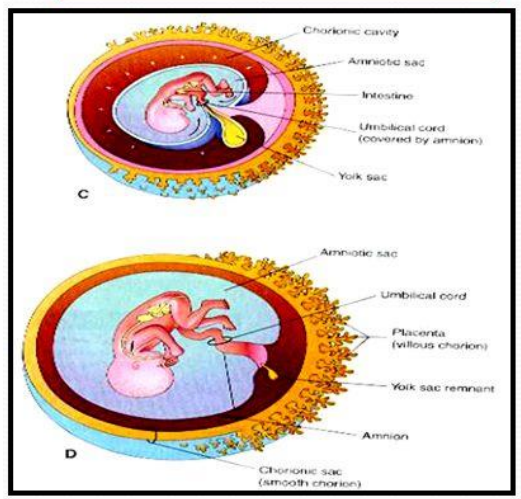
➢4th week: endoderm of yolk sac is incorporated into the embryo to form primordial gut

➢Epithelium of Respiratory system &G.I.T.

(b)Primordial germ cells in the endodermal lining of the wall of caudal end of the yolk sac migrate into the developing sex glands to differentiate into germ cells (spermatogonia or oogonia)

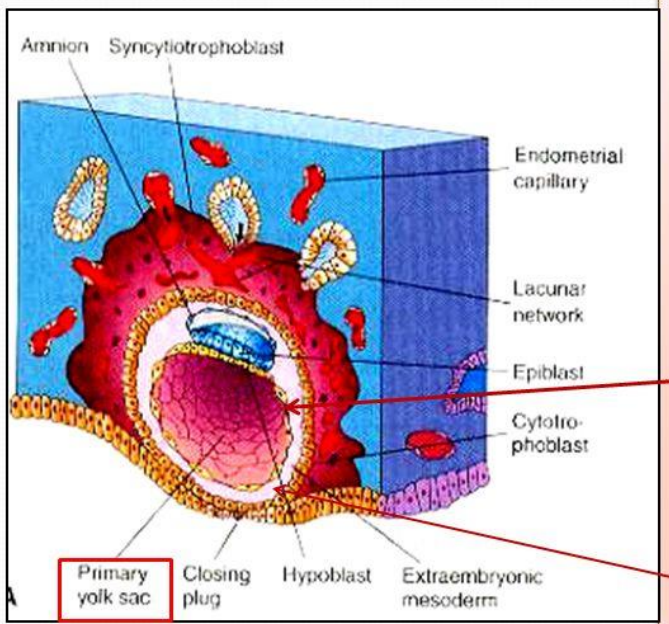
Fate of Yolk Sac





- Yolk stalk detached from midgut by the end of 6th week. In (2%) of adults, its proximal intra-abdominal part persists as ileal diverticulum (Meckel diverticulum).
- At 10 week, small definitive yolk sac lies in the chorionic cavity between amniotic & chorionic sacs
- At 20 weeks, as pregnancy advances, definitive yolk sac atrophies and becomes a very small cyst.
- In unusual cases, it persists under the amnion near the attachment of Umbilical cord, on the fetal surface of the placenta. Its persistence is of no significance

Primary Yolk Sac



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- Its roof is formed by **hypoblast (primary endoderm),**
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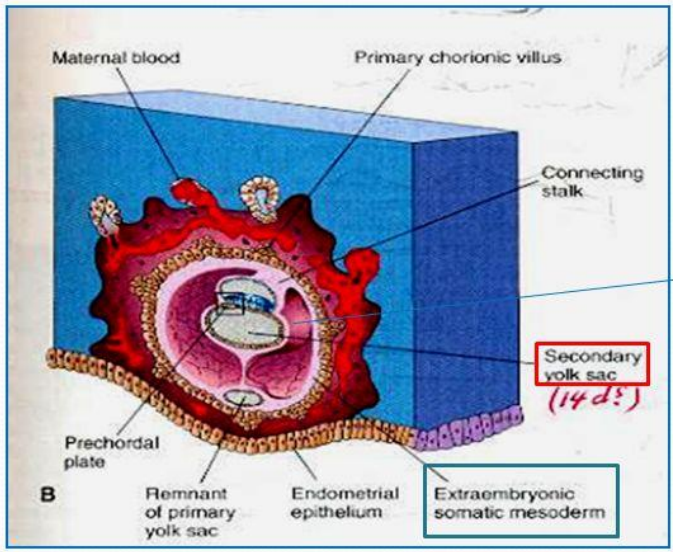

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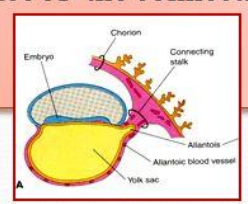
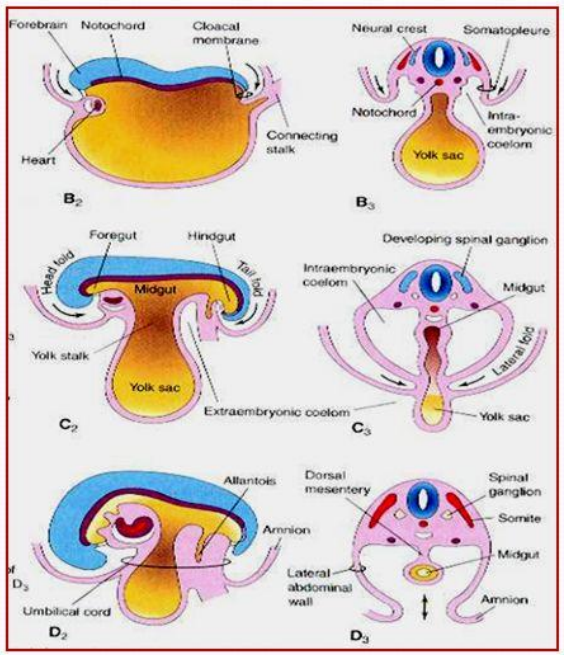


Definitive Yolk Sac



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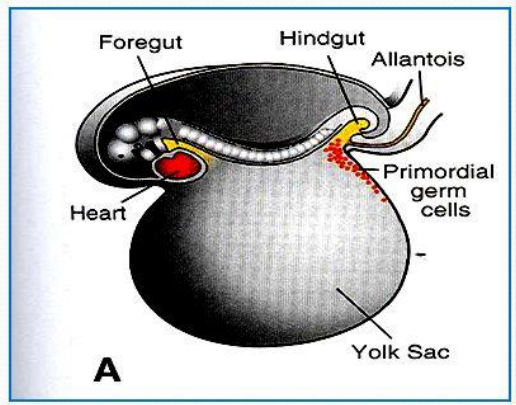
Functions of Yolk Sac



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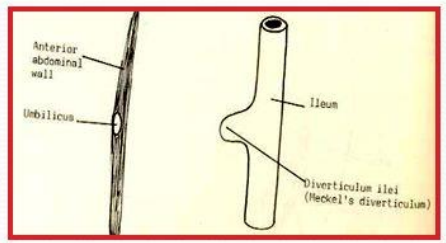

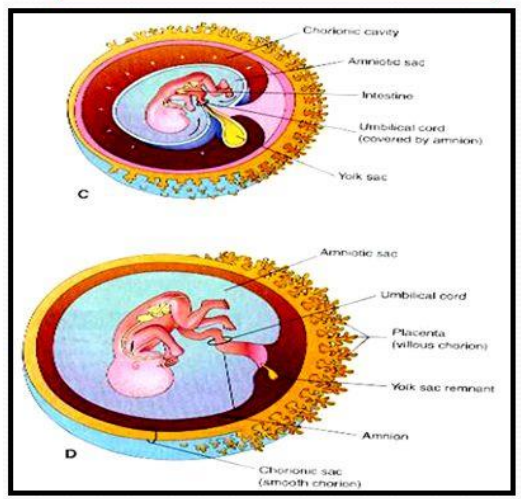

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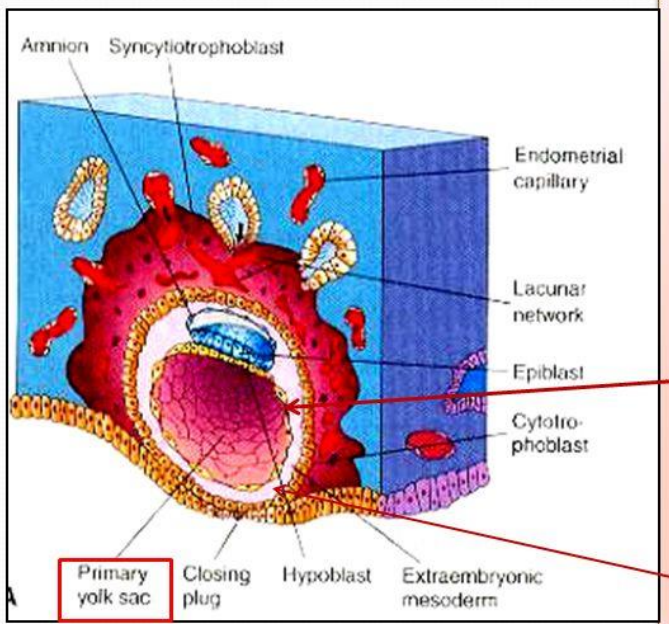

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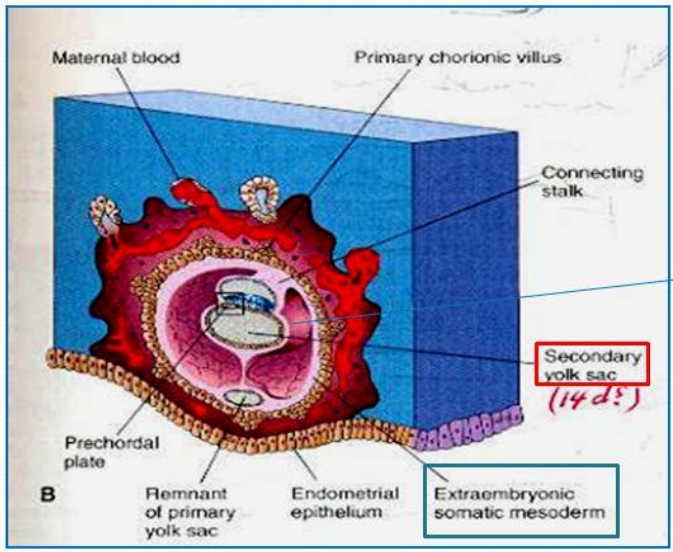

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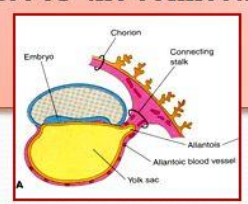

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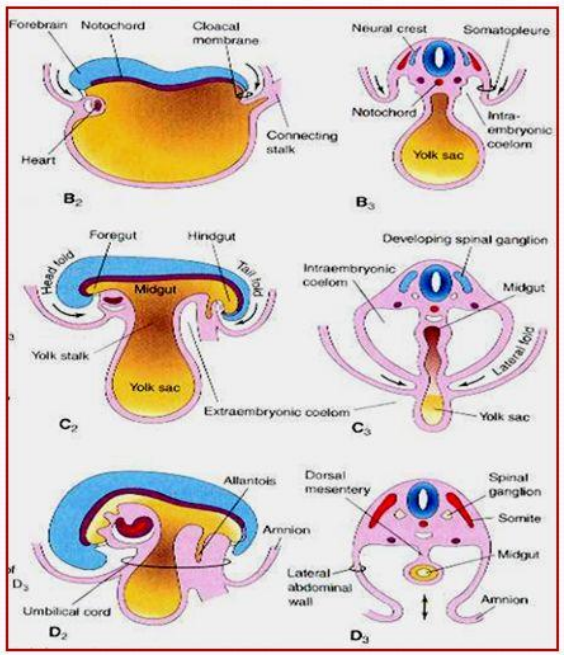

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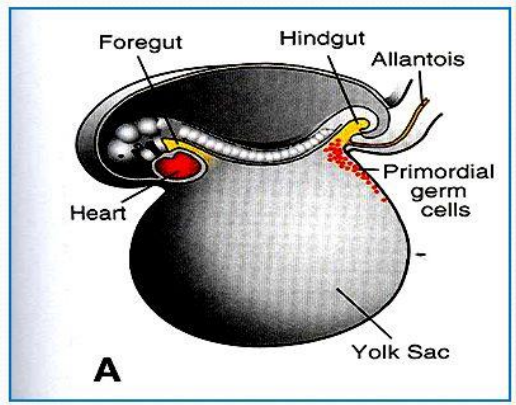
Functions of Yolk Sac



➢3rd week:

➢(a) Blood formationt

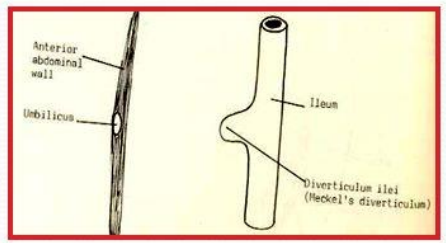
First formed in the extra-embryonic mesoderm covering the wall of the yolk sac, until hemopoietic activity begins in the liver during 6th week

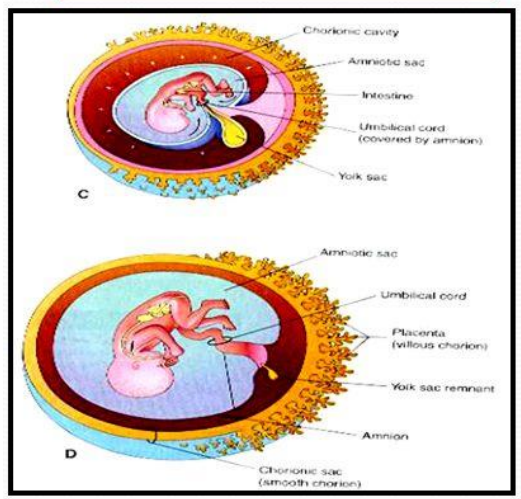
➢4th week: endoderm of yolk sac is incorporated into the embryo to form primordial gut

➢Epithelium of Respiratory system &G.I.T.

(b)Primordial germ cells in the endodermal lining of the wall of caudal end of the yolk sac migrate into the developing sex glands to differentiate into germ cells (spermatogonia or oogonia)

Fate of Yolk Sac



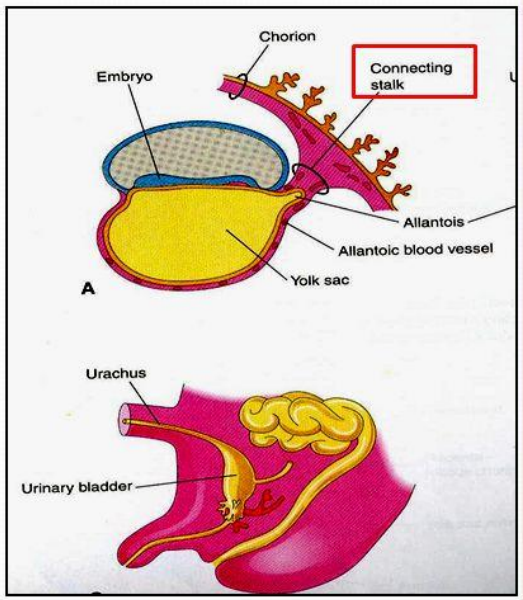


- Yolk stalk detached from midgut by the end of 6th week. In (2%) of adults, its proximal intra-abdominal part persists as ileal diverticulum (Meckel diverticulum).
- At 10 week, small definitive yolk sac lies in the chorionic cavity between amniotic & chorionic sacs
- At 20 weeks, as pregnancy advances, definitive yolk sac atrophies and becomes a very small cyst.
- In unusual cases, it persists under the amnion near the attachment of Umbilical cord, on the fetal surface of the placenta. Its persistence is of no significance

Allantois

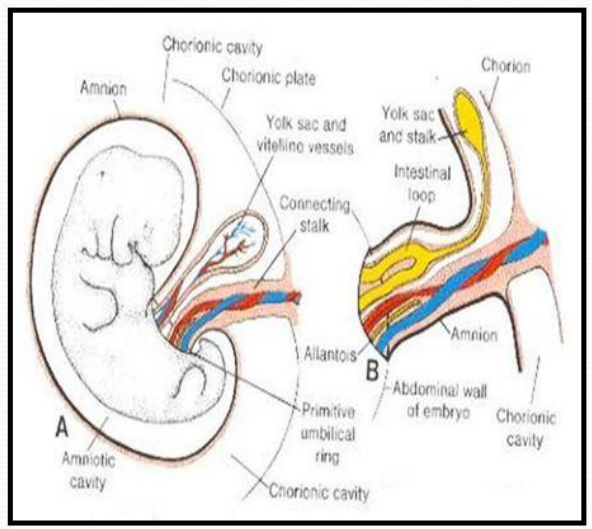
- In the 3rd week it appears as a sausagelike diverticulum from the caudal wall of yolk sac that extends into the connecting stalk
- During the 2nd month, the extraembryonic part of the allantois degenerates

Allantois



- **3rd week:** Appears as a diverticulum from caudal wall of Y.S. that extends into connecting stalk.
- **2nd month:** Its extra- embryonic part degenerates.
- **3rd month:** Its intra-embryonic part extends from UB to UC as thick tube , '(urachus) '
- **After birth:** the urachus is obliterated and fibrosed to form median umbilical ligament, that extends from apex of UB to umbilicus.

Functions of Allantois



- **Blood formation** in its wall during 3rd to 5th week.
- **Its blood vessels** persist as the umbilical vein & arteries.

Functions of Allantois

- Blood formation occurs in the wall during the 3rd to 5th week
- Its blood vessels persist as the umbilical vein and arteries
- Fluid from the amniotic cavity diffuses into the umbilical vein and enters the fetal circulation for transfer to maternal blood through placental membrane
- Becomes Urachus and after birth is transformed into median umbilical ligament extends from the apex of the bladder to the umbilicus

Umbilical Cord

- Is attached to the placenta usually near the center of the fetal surface of this organ
- May attach to any other point
- Is usually 1-2 cm in diameter and 30-90 cm in length
- Long cord may cause prolapse or compression of the cord which may lead to fetal hypoxia
- Short cord may cause premature separation of the placenta from the wall of the uterus during delivery

Umbilical Cord

- Has two arteries and one vein surrounded by Wharton jelly
- Umbilical vessels are longer than the cord, so twisting and bending of the vessels are common
- They frequently form loops, producing false knots, that are of no significance
- In about 1% of pregnancies, true knots form in the cord and cause fetal death

Chorion

- Primary chorionic villi appear by the end of the 2nd week
- Growth of these extensions are caused by underlying extraembryonic somatic mesoderm
- The cellular projections form primary chorionic villi

Chorion

- The extraembryonic somatic mesoderm and the two layers of trophoblast form the chorion
- Chorion forms the wall of chorionic sac
- Embryo and its amniotic and yolk sacs are suspended into it by connecting stalk
- The extraembryonic coelom is now called the chorionic cavity

Chorion

- The amniotic sac with embryonic epiblast form its floor
- The yolk sac with embryonic hypoblast form its roof
- Are analogous to two balloons pressed together, suspended by a connecting stalk from the inside of a larger balloon (chorionic sac)

Chorion

- Transvaginal ultrasound is used to measure the chorionic sac diameter
- This measurement is valuable for evaluating the early embryonic development and pregnancy outcome

Chorion

- Chorionic villi cover the entire chorionic sac until the beginning of 8th week
- As this sac grows, the villi associated with decidua capsularis are compressed, reducing the blood supply to them
- These villi soon degenerates producing an avascular bare area smooth chorion (chorion laeve)

Chorion

- As the villi disappear, those associated with the decidua basalis rapidly increase in number
- Branch profusely and enlarge
- This bushy part of the chorionic sac is villous chorion

Decidua

- The gravid endometrium is known as decidua
- It is the functional layer of endometrium in a pregnant woman
- This part of the endometrium separates from the rest of the uterus after parturition

Regions of Decidua

3 regions of decidua are:

- Decidua basalis: lies deep to the conceptus that forms maternal part of the placenta
- Decidua capsularis: superficial part that overlies the conceptus
- Decidua parietalis: is all the remaining parts of the decidua

Decidua

- In response to increasing progesterone levels in the maternal blood the connective tissue cells of the decidua enlarge to form decidual cells
- These cells enlarge as glycogen and lipid accumulate in their cytoplasm

Decidua

- The cellular and vascular changes occurring in the endometrium as the blastocyst implants constitute the decidual reaction
- Many decidual cells degenerate near the chorionic sac in the region of the syncytiotrophoblast
- Together with maternal blood the uterine secretions provide a rich source of nutrition for the embryo

Decidua

- The full significance of decidual cells is not understood
- They may protect the maternal tissue against uncontrolled invasion by the syncytiotrophoblast
- They may be involved in hormonal production
- Clearly recognizable during ultrasonography to diagnose early pregnancy