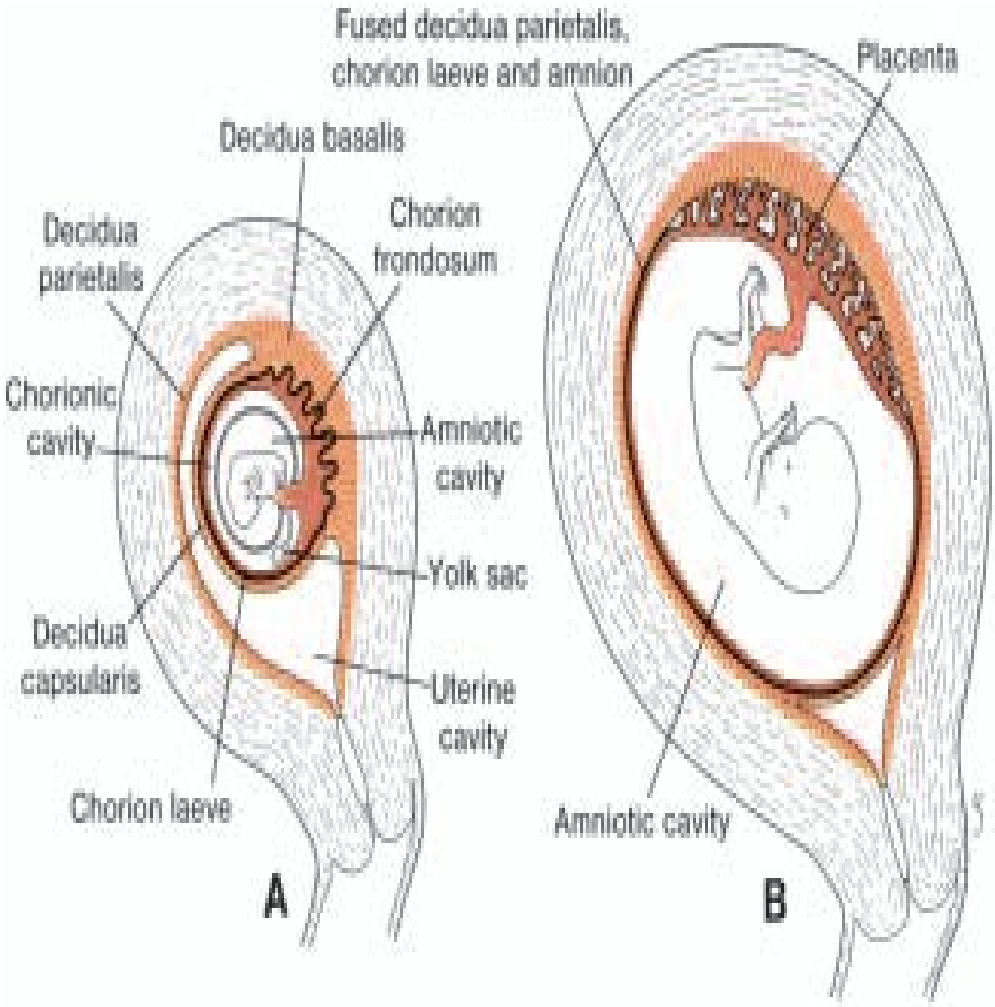
SECOND WEEK OF EMBRYONIC DEVELOPMENT

Second week of Embryonic development

- Implantation completion,& Ectopic pregnancies
- Formation of Bilaminar germ disc,
- Formation of Amniotic cavity,
- Primary yolk sac& Umblical vesicle, connecting stalk

IMPLANTATION

- The pregnant uterine endometrium is called as DECIDUA.
- shed during parturition.
- Three regions of the decidua are named according to their relation to the implantation site



COMPLETION OF IMPLANTATION AND CONTINUATION OF EMBRYONIC DEVELOPMENT

- Implantation of the blastocyst is completed by the end of the second week.
- It occurs during a restricted time period 6 to 10 days after ovulation.
- As the blastocyst implants more trophoblast contacts the endometrium and differentiates into.

- The cytotrophoblast, a layer of cells that is mitotically active and forms new cells that migrate into the increasing mass of syncytiotrophoblast, where they fuse and lose their cell membranes.
- The syncytiotrophoblast, a rapidly expanding, multinucleated mass in which no cell boundaries are discernible.
- The erosive **syncytiotrophoblast** invades the endometrial connective tissue, and the blastocyst slowly embeds itself in the endometrium.

- The endometrial cells undergo **apoptosis** (programmed cell death), which facilitates the invasion.
- The molecular mechanisms of implantation involve synchronization between the invading blastocyst and a receptive endometrium.
- The microvilli of endometrial cells (pinopodes), cell adhesion molecules, cytokines, prostaglandins, homeobox genes, growth factors, and matrix metalloproteins play a role in making the endometrium receptive.

Implantation of the Blastocyst

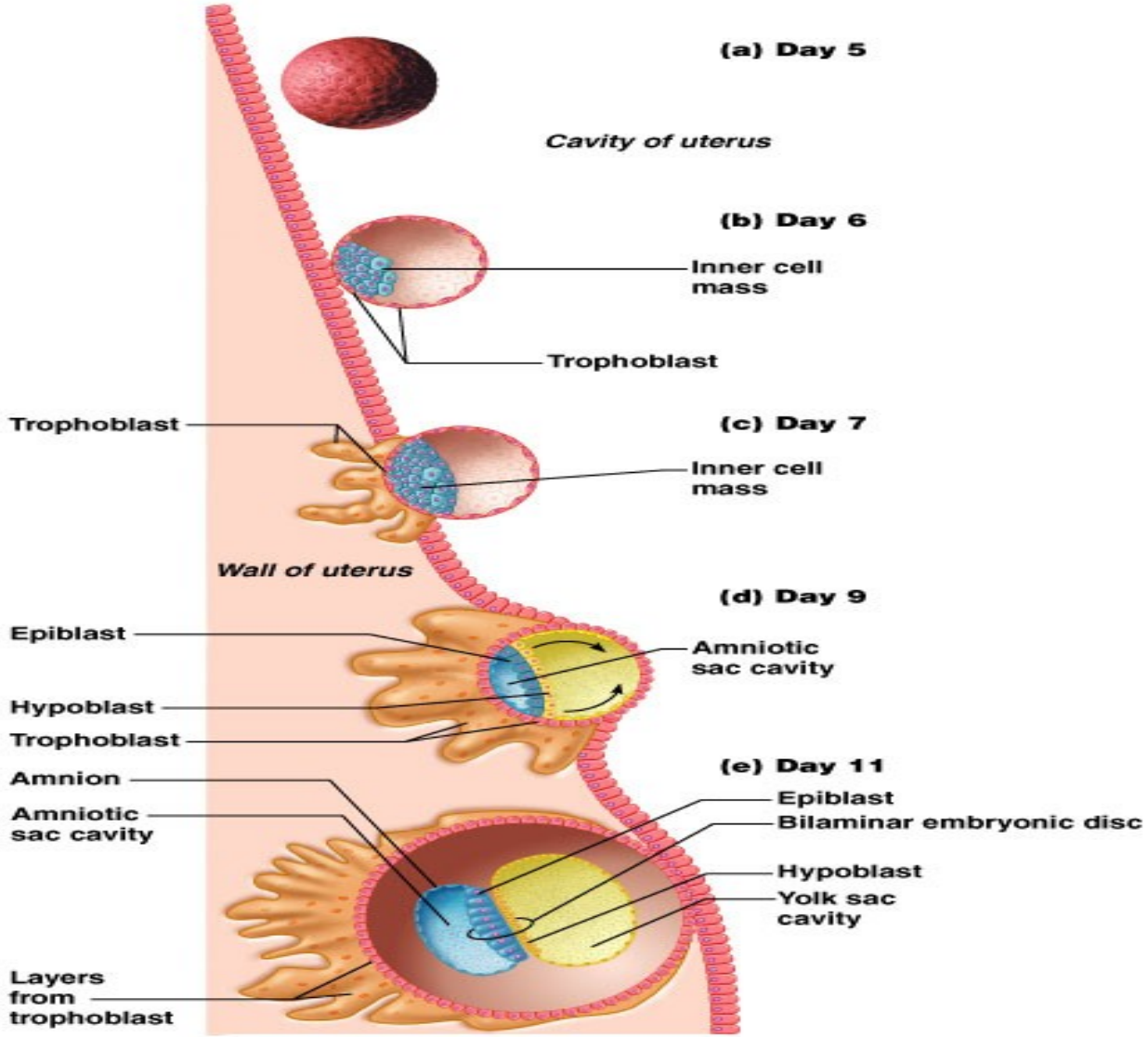
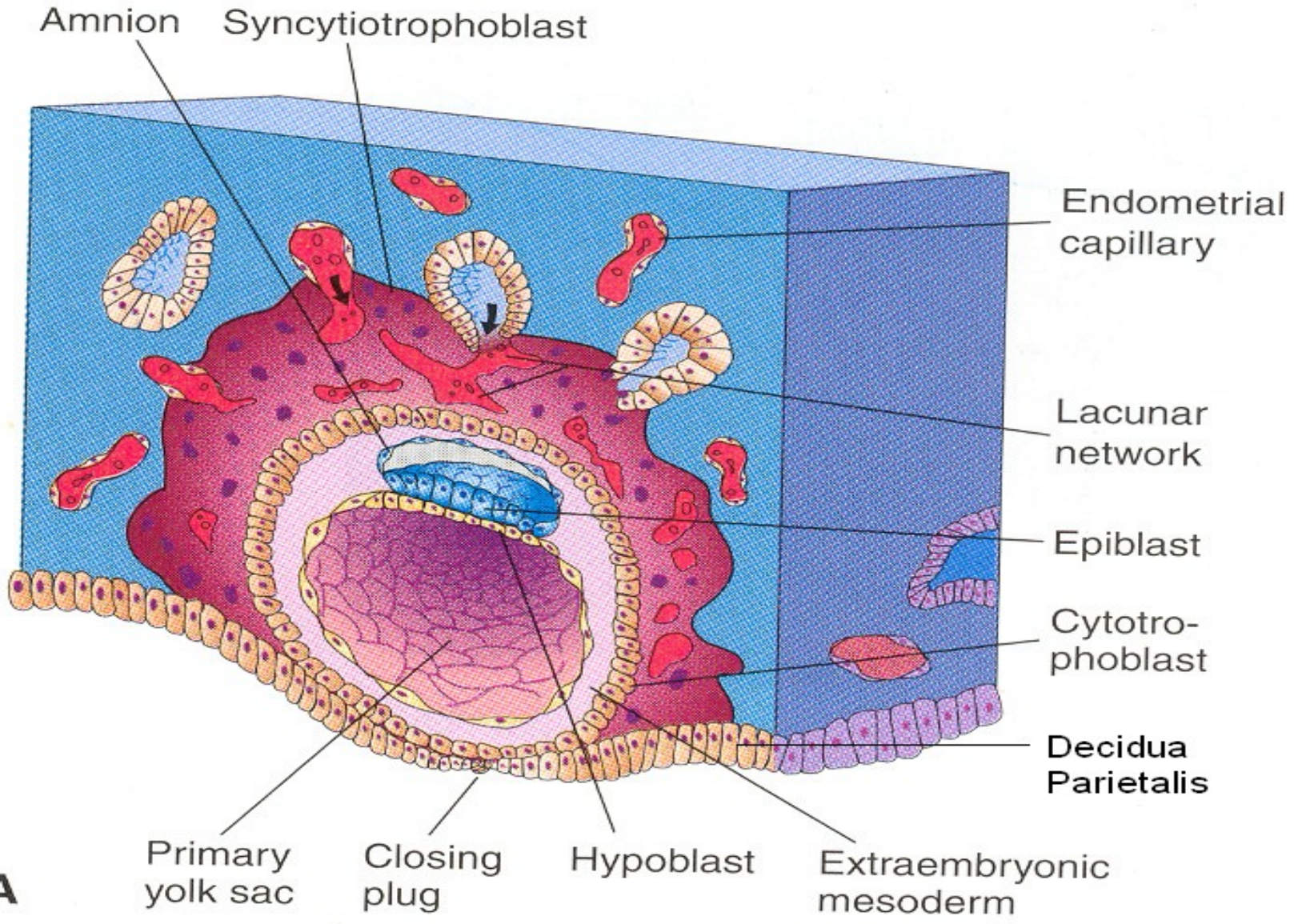


Figure 3.4

- The connective tissue cells around the implantation site accumulate glycogen and lipids and assume a polyhedral appearance. Some of these cells-**decidual cells-**degenerate adjacent to the penetrating syncytiotrophoblast.
- The syncytiotrophoblast engulfs these degenerating cells, providing a rich source of embryonic nutrition.


Amnion
Syncytiotrophoblast
Endometrial capillary
Lacunar network
Epiblast
Cytotro-phoblast
Decidua Parietalis
Primary yolk sac
Closing plug
Hypoblast
Extraembryonic mesoderm
A
Actual size of implanted blastocyst :

- The syncytiotrophoblast produces a hormone-*human chorionic gonadotrophin* (hCG), which enters the maternal blood via lacunae (Latin, hollow cavities) in the syncytiotrophoblast .
- hCG maintains the hormonal activity of the corpus luteum in the ovary during pregnancy.

- Highly sensitive radioimmunoassays are available for detecting hCG and pregnancy and forms the basis for *pregnancy tests*.
- Enough hCG is produced by the syncytiotrophoblast at the end of the second week to give a positive pregnancy test, even though the woman is probably unaware that she is pregnant..

IMPLANTATION SITES OF BLASTOCYSTS

- Implantation of blastocysts usually occurs in the endometrium of the uterus, superior in the body of the uterus, slightly more often on the posterior than on the anterior wall.
- Implantation of a blastocyst can be detected by ultrasonography and highly sensitive radioimmunoassays of hCG as early as the end of the second week.

Extra uterine Implantation

- Blastocysts may implant outside the uterus.
- These implantations result in **ectopic pregnancies**; 95% to 98% of ectopic implantations occur in the uterine tubes, *most often in the ampulla and isthmus*.
- The incidence of ectopic pregnancy has increased in most countries, ranging from 1 in 80 to 1 in 250 pregnancies, depending on the socioeconomic level of the population.

- In the United States, the frequency of ectopic pregnancy is approximately 2% of all pregnancies, and it is the main cause of maternal deaths during the first trimester.
- A woman with a **tubal pregnancy** has signs and symptoms of pregnancy.
- She may also experience abdominal pain and tenderness because of distention of the uterine tube, abnormal bleeding, and irritation of the pelvic peritoneum (peritonitis).

- The pain may be confused with *appendicitis* if the pregnancy is in the right uterine tube.
- Ectopic pregnancies produce Î²-human chorionic gonadotropin at a slower rate than normal pregnancies; consequently Î²-human chorionic gonadotropin assays may give false-negative results if performed too early.
- *Transvaginal ultrasonography is very helpful in the early detection of ectopic tubal pregnancies*.

- Ectopic tubal pregnancies usually result in rupture of the uterine tube and hemorrhage into the peritoneal cavity during the first 8 weeks, followed by death of the embryo.
- Tubal rupture and hemorrhage constitute a threat to the mother's life. The affected tube and conceptus are usually surgically removed.

- When blastocysts implant in the isthmus of the uterine tube the tube tends to rupture early because this narrow part of the tube is relatively unexpandable, and often with extensive bleeding, probably because of the rich anastomoses between ovarian and uterine vessels in this area.
- When blastocysts implant in the uterine (intramural) part of the tube they may develop beyond 8 weeks before expulsion occurs. When a uterine tubal pregnancy ruptures, it usually bleeds profusely.

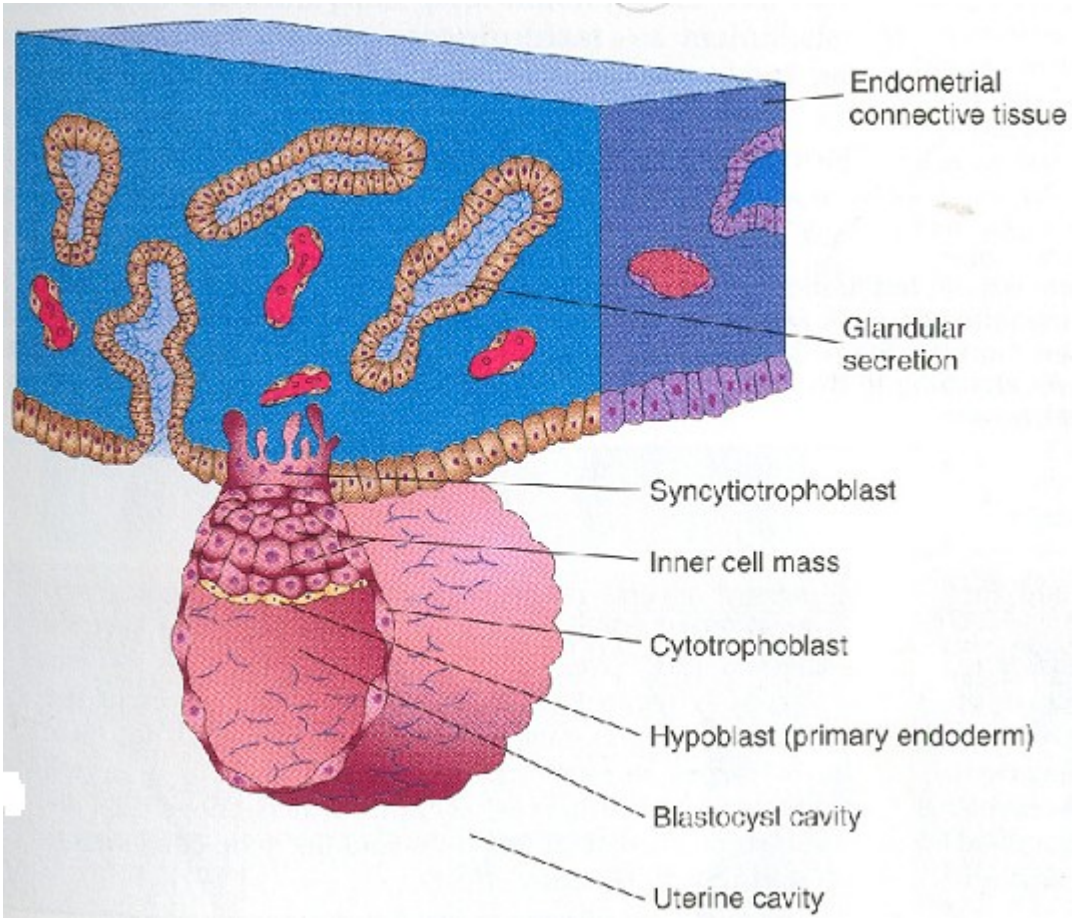
- Blastocysts that implant in the ampulla or on fimbriae of the uterine tube may be expelled into the peritoneal cavity where they commonly implant in the rectouterine pouch.
- In exceptional cases, an **abdominal pregnancy** may continue to full term and the fetus may be delivered alive through an abdominal incision.
- Usually, however, the placenta attaches to abdominal organs and causes considerable intraperitoneal bleeding.

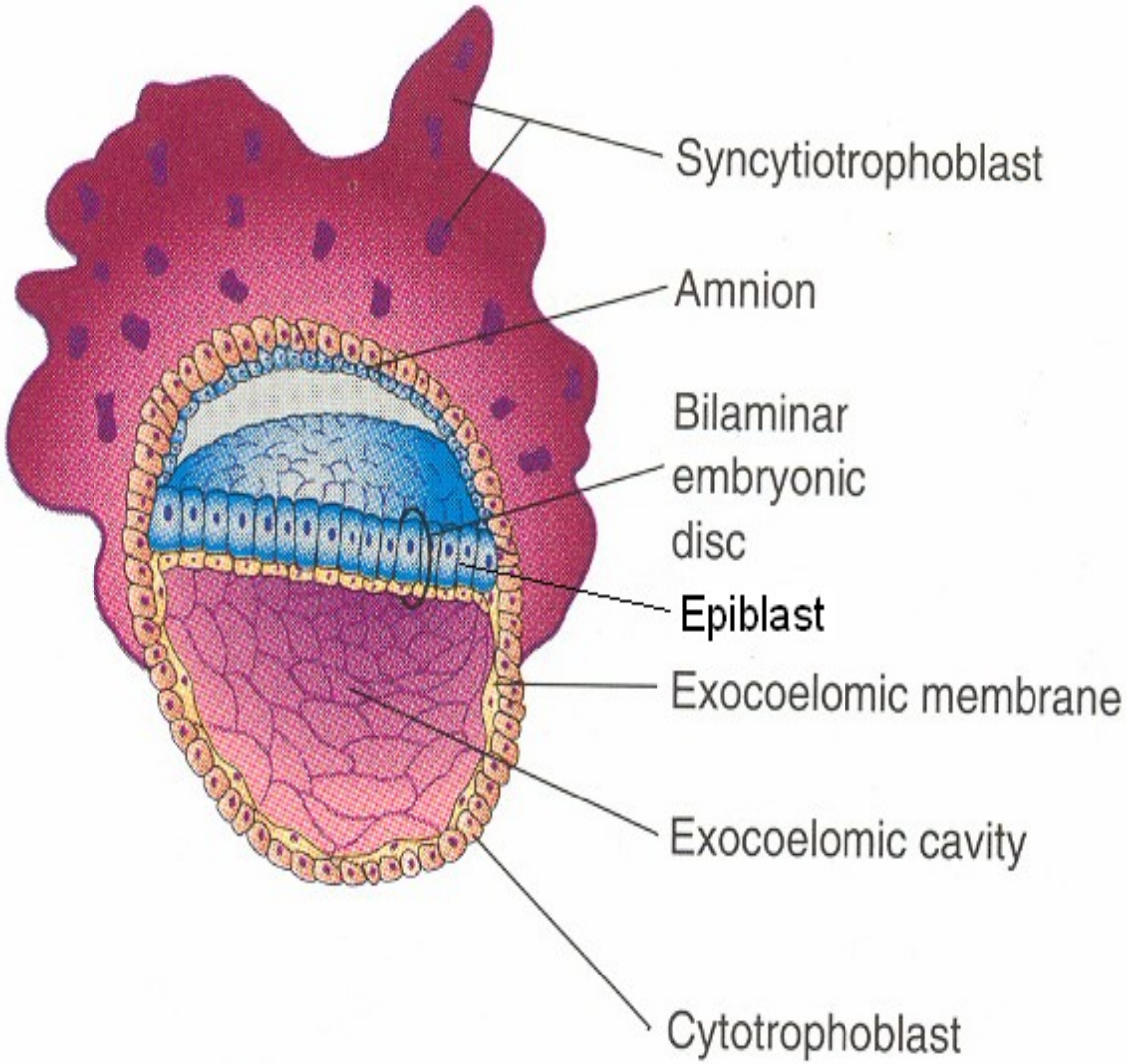
- In very unusual cases, an abdominal conceptus dies and is not detected; the fetus becomes calcified, forming a "stone fetus"-*lithopedion* (Greek, *lithos*, stone, + *paidion*, child).
- Simultaneous intrauterine and extrauterine pregnancies are unusual, occurring approximately 1 in 7000
- *Cervical implantations are unusual* in some cases, the placenta becomes firmly attached to fibrous and muscular tissues of the cervix, often resulting in bleeding and requiring subsequent surgical intervention, such as *hysterectomy* (excision of uterus).

BILAMINAR GERM DISC

- The embryoblast cells differentiate into two layers.
- Hypoblast :

The cells towards the blastocyst cavity become Cuboidal.(Endoderm).



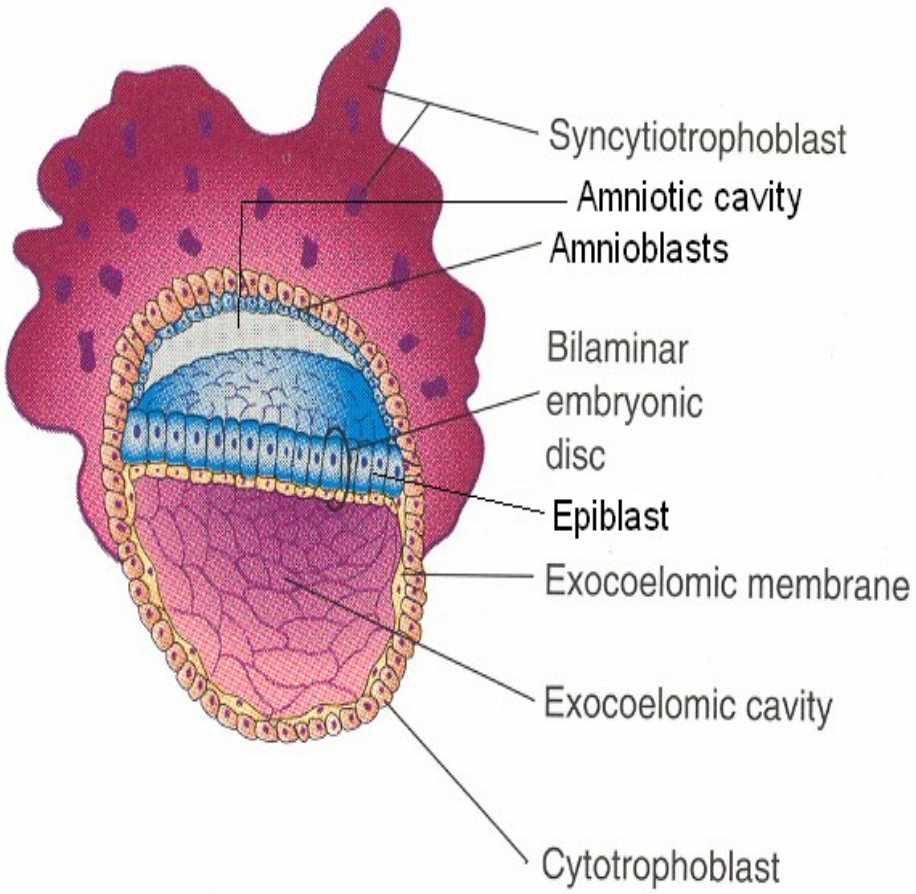


- Epiblast:
  The cells towards the embryonic pole becomes columnar. (Ectoderm)

o Together these form a flat disc BILAMINAR GERM DISC.

FORMATION OF AMNIOTIC CAVITY

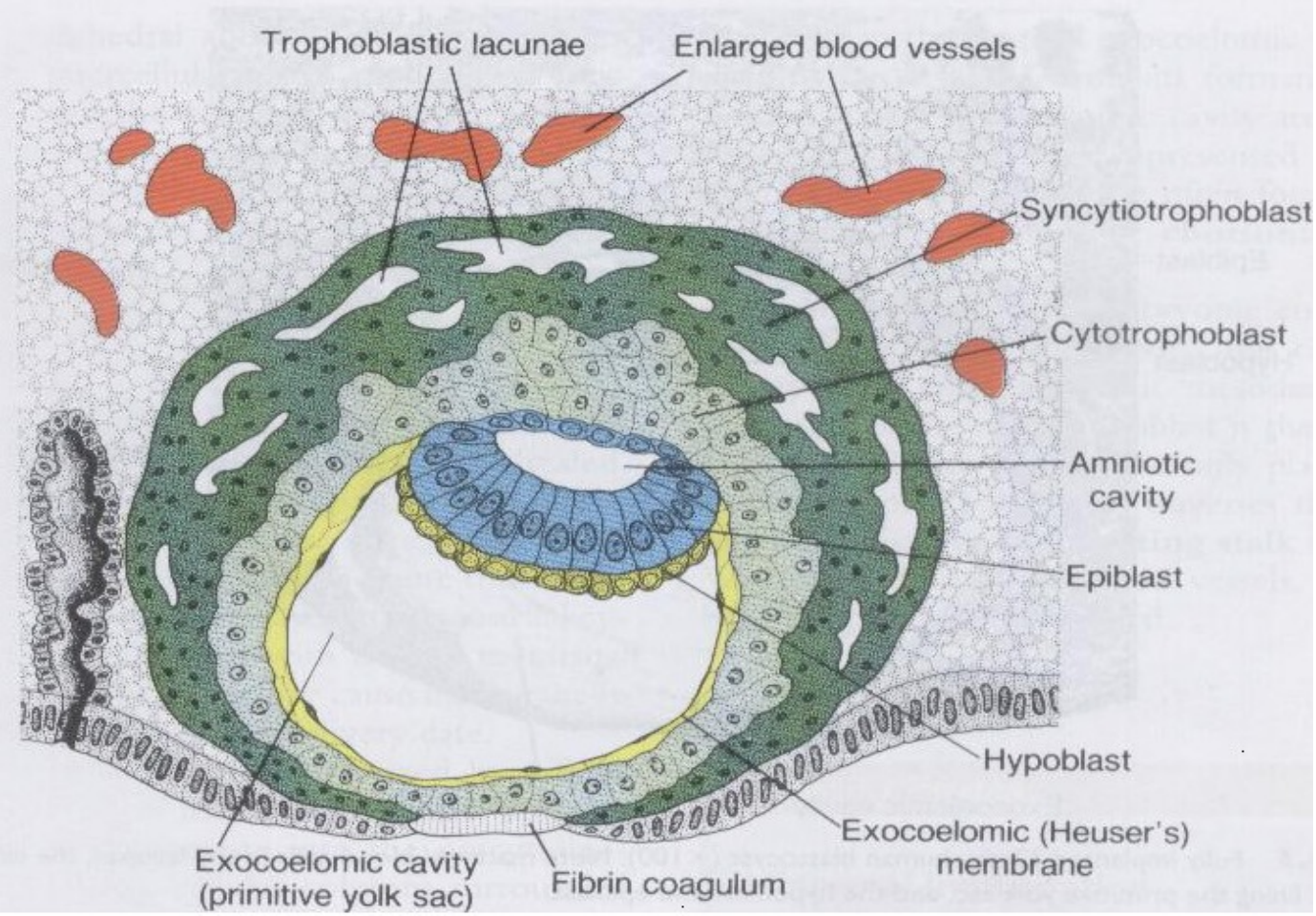
- As implantation of the blastocyst progresses, a small space appears in the embryoblast. This space is the primordium of the **amniotic cavity.**
- Soon amniogenic (amnion-forming) cells-*amnioblasts*-separate from the epiblast and form the **amnion**, which encloses the amniotic cavity.



- Concurrently, morphologic changes occur in the embryoblast that result in the formation of a flat, almost circular bilaminar plate of cells, the **embryonic disc**, consisting of two layers.
- **Epiblast,** the thicker layer, consisting of high columnar cells related to the amniotic cavity
- **Hypoblast,** consisting of small cuboidal cells adjacent to the exocoelomic cavity.

- The epiblast forms the floor of the amniotic cavity and is continuous peripherally with the amnion.
- The hypoblast forms the roof of the **exocoelomic cavity** and is continuous with the thin exocoelomic **membrane**.
- This membrane, together with the hypoblast, lines the **primary umbilical vesicle.**

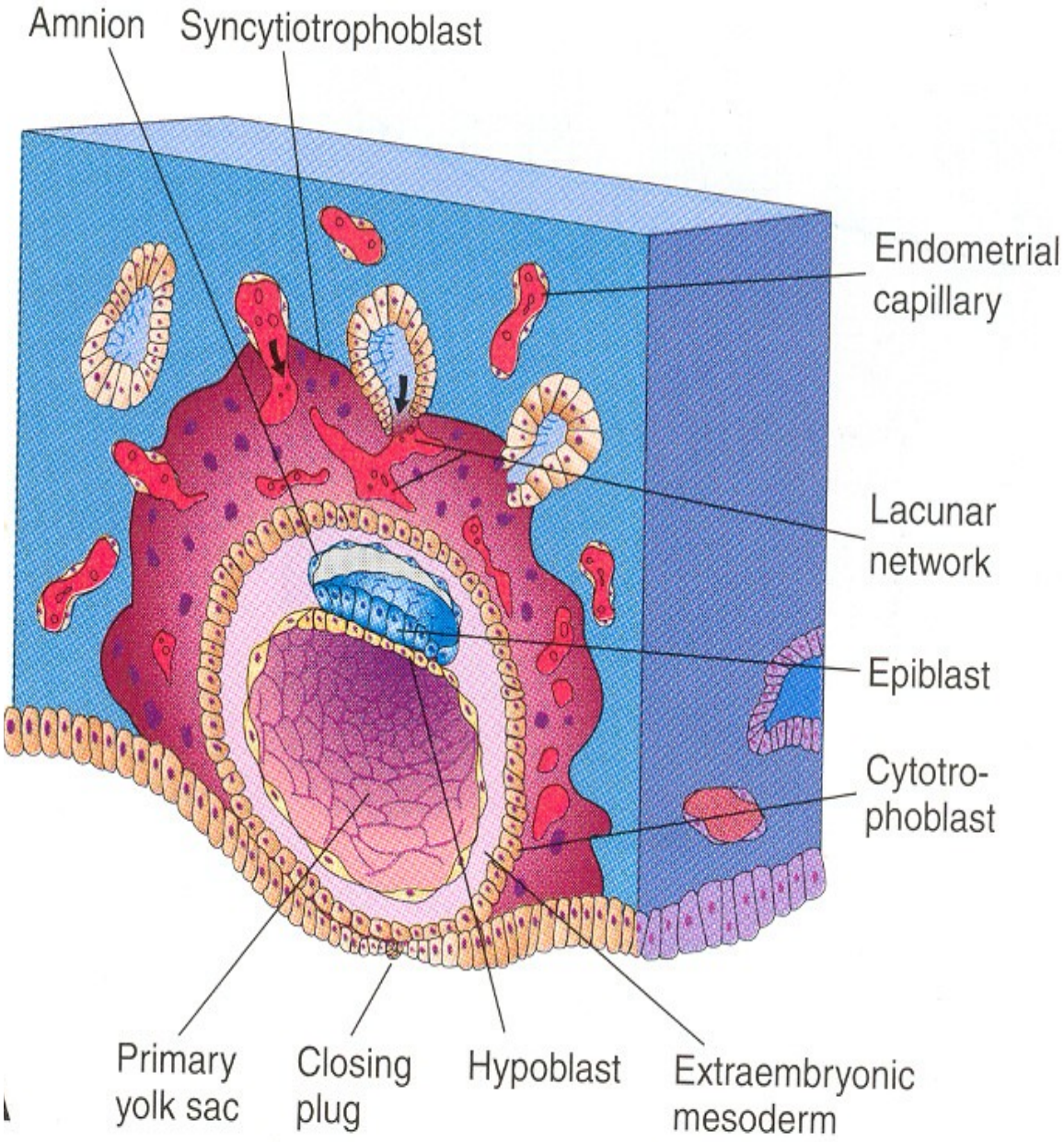
- Soon fluid filled spaces appear between the trophoblast & epiblast – AMNIOTIC CAVITY.
- The fluid is called Liquor Amnii or Amniotic Fluid.
- The amniotic cells get differentiated from the epiblast & line the inside of the amniotic cavity - Amnioblasts.
- The amniotic cavity is now lined by amnioblasts in the roof & walls & by epiblast in its floor.



- The hypoblast cells then proliferate & line the inside of the blastocyst cavity – Heuser's membrane.
- The blastocyst cavity is now called as PRIMARY YOLK SAC or EXO COELOMIC CAVITY.

EXTRA EMBRYONIC MESODERM

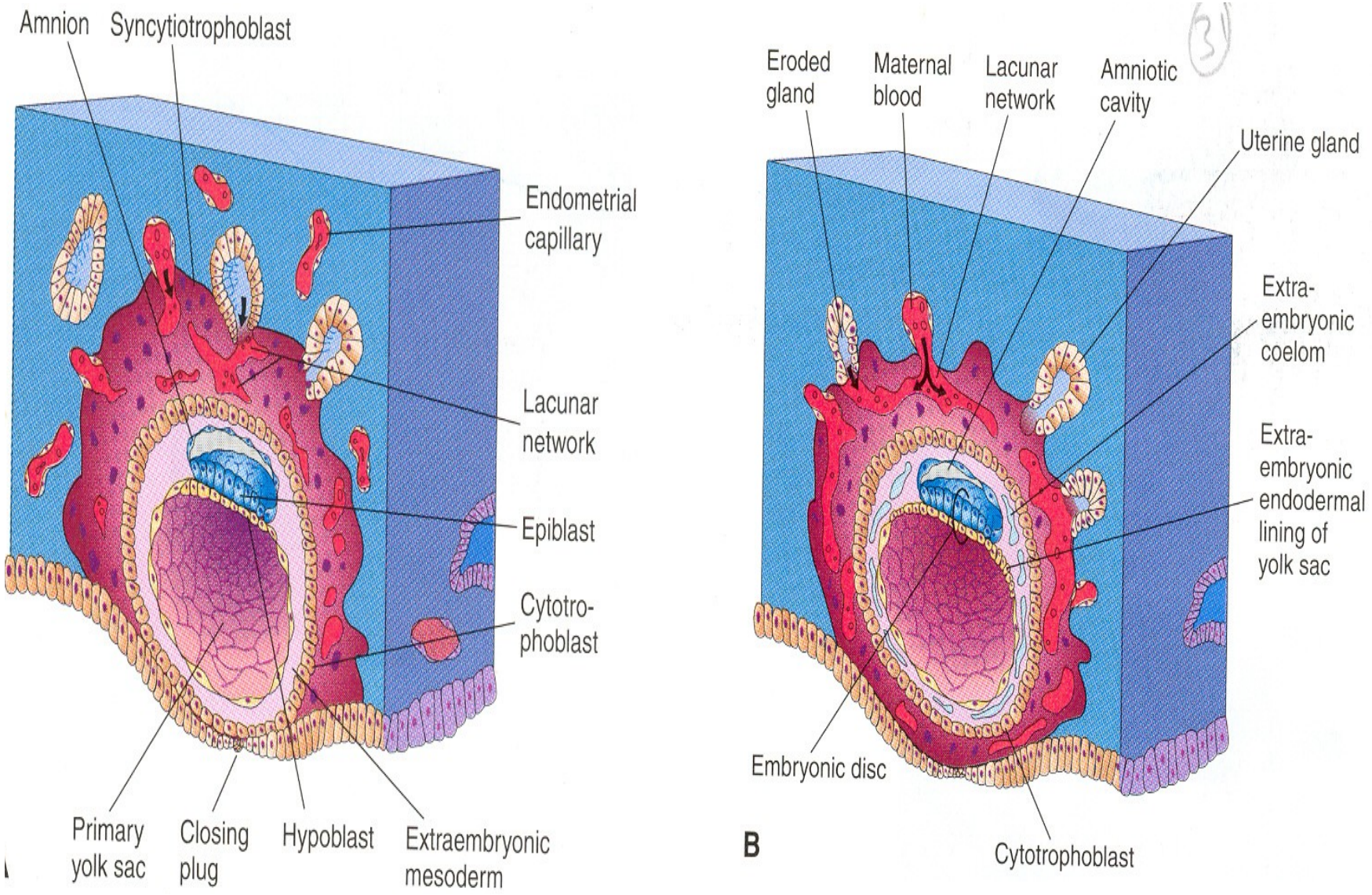
- A new population of cells are formed between the cytotrophoblast & primary yolk sac – EXTRAEMBRYONIC MESODERM.
- These cells proliferate rapidly
  & separate the amniotic cavity & yolk sac from cytotrophoblasts cells.



- The embryonic disc now lies between the amniotic cavity and the umbilical vesicle). Cells from the vesicle endoderm form a layer of connective tissue, the **extraembryonic mesoderm** which surrounds the amnion and umbilical vesicle.
- The umbilical vesicle and amniotic cavities make morphogenetic movements of the cells of the embryonic disc possible.

- As the amnion, embryonic disc, and primary umbilical vesicle form, isolated cavities-**lacunae**-appear in the syncytiotrophoblast.
- The lacunae soon become filled with a mixture of maternal blood from ruptured endometrial capillaries and cellular debris from eroded uterine glands.
- The fluid in the lacunar spaces-*embryotroph* (Greek, *trophe*, nourishment)-passes to the embryonic disc by diffusion and provides nutritive material to the embryo.

- The communication of the eroded endometrial capillaries with the lacunae establishes the **primordial uteroplacental circulation**.
- When maternal blood flows into the lacunae, oxygen and nutritive substances are available to the embryo.
- *Oxygenated blood* passes into the lacunae from the *spiral endometrial arteries*, and *poorly oxygenated blood* is removed from them through the endometrial veins.


Amnion
Syncytiotrophoblast
Endometrial capillary
Lacunar network
Epiblast
Cytotro-phoblast
Primary yolk sac
Closing plug
Hypoblast
Extraembryonic mesoderm
Eroded gland
Maternal blood
Lacunar network
Amniotic cavity
Uterine gland
Extra-embryonic coelom
Extra-embryonic endodermal lining of yolk sac
Embryonic disc
Cytotrophoblast
B

- *The 10-day human conceptus (embryo and extraembryonic membranes) is completely embedded in the endometrium*.
- For approximately 2 days, there is a defect in the endometrial epithelium that is filled by a **closing plug**, a fibrinous coagulum of blood.
- By day 12, an almost completely regenerated uterine epithelium covers the closing plug.

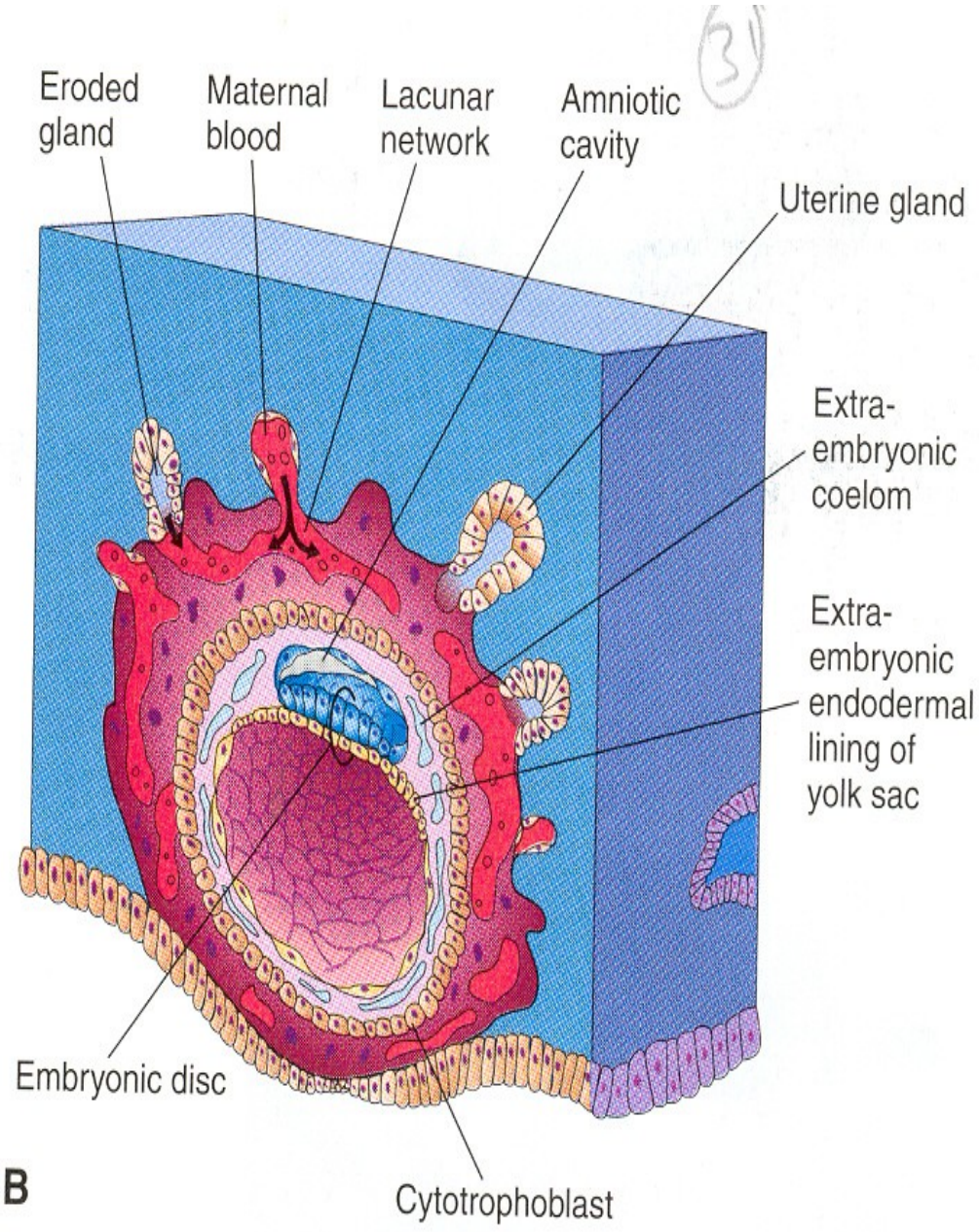
- As the conceptus implants, the endometrial connective tissue cells undergo a transformation, the **decidual reaction.**
- After the cells swell because of the accumulation of glycogen and lipid in their cytoplasm, they are known as **decidual cells.**
- The primary function of the decidual reaction is to provide nutrition for the early embryo and an **immunologically privileged site for the conceptus.**

- In a **12-day embryo**, adjacent syncytiotrophoblastic lacunae have fused to form **lacunar networks** giving the syncytiotrophoblast a spongelike appearance.
- The lacunar networks, particularly obvious around the embryonic pole, are the primordia of the intervillous spaces of the placenta
- The endometrial capillaries around the implanted embryo become congested and dilated to form *sinusoids*, thin-walled terminal vessels that are larger than ordinary capillaries.

- The syncytiotrophoblast **erodes the sinusoids**, and maternal blood flows freely into the lacunar networks.
- The trophoblast absorbs nutritive fluid from the lacunar networks, which is transferred to the embryo.
- Growth of the bilaminar embryonic disc is slow compared with growth of the trophoblast .The implanted 12-day embryo produces a minute elevation on the endometrial surface that protrudes into the uterine lumen.

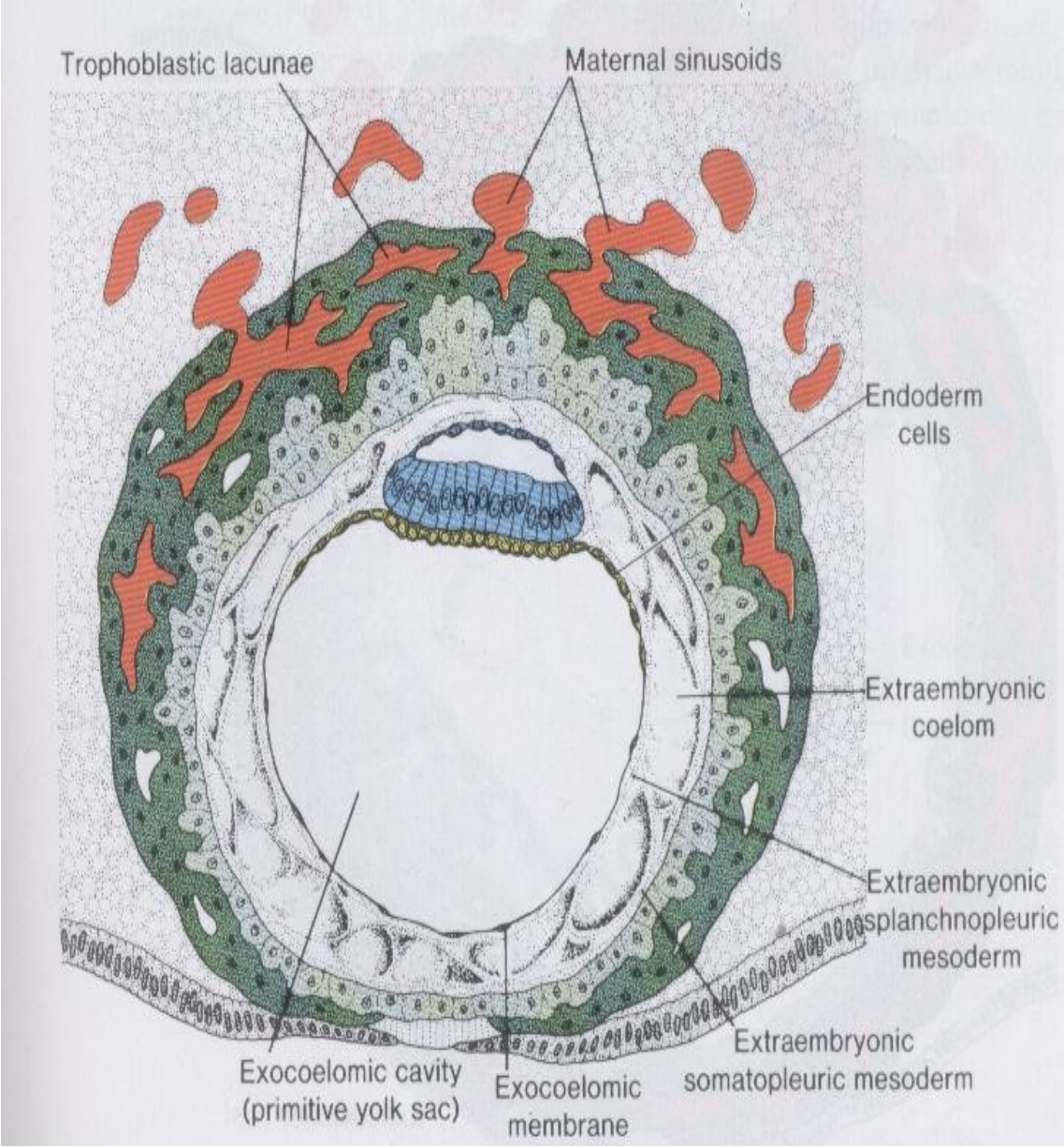
- As changes occur in the trophoblast and endometrium, the extraembryonic mesoderm increases and isolated **extraembryonic coelomic spaces** appear within it.
- These spaces rapidly fuse to form a large isolated cavity, the **extraembryonic coelom.**

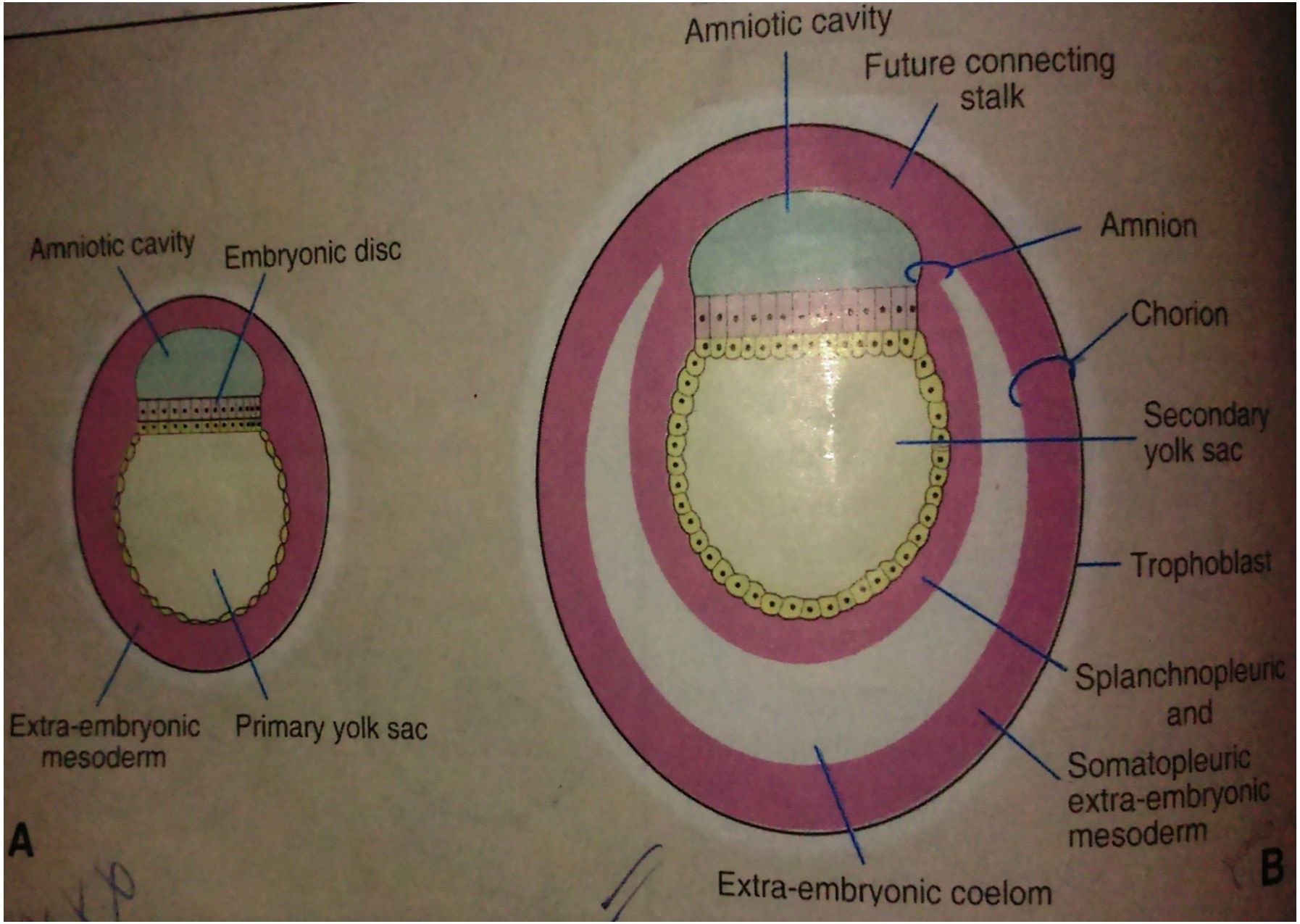
- Large fluid filled spaces now appear within the extra embryonic mesoderm.
- These coalesce to form **EXTRA EMBRYONIC COELOMIC CAVITY or CHORIONIC CAVITY.**
- With the formation of EE coelomic cavity the EE mesoderm is divided into two layers.



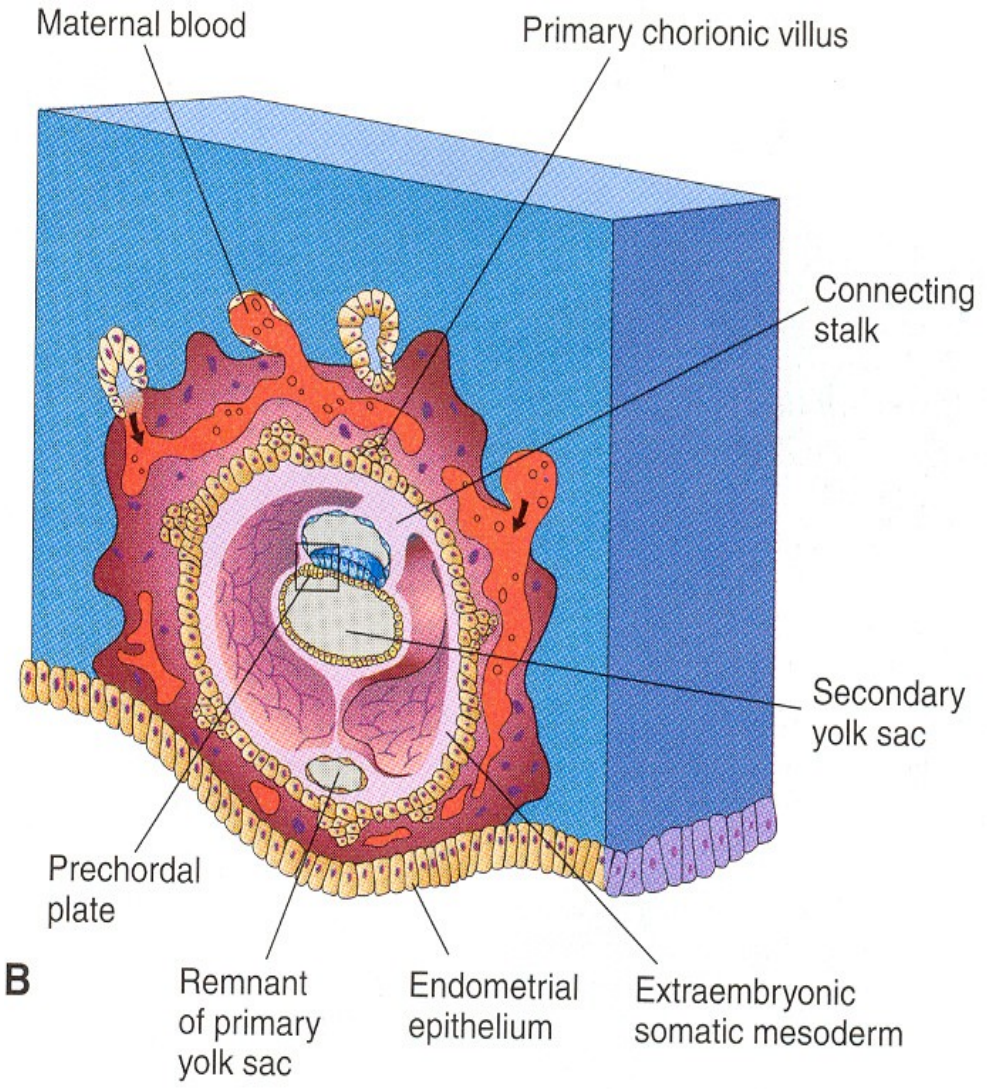
SOMATOPLEURIC EXTRA EMBRYONIC MESODERM – The Ext. Emb. mesoderm lining the inside of Cyto trophoblast cells.

SPLANCHNOPLEURIC EXTRA EMBRYONIC MESODERM – The Ext.Emb.mesoderm lining the outside of yolk sac & amniotic cavity.




Amniotic cavity
Embryonic disc
Extra-embryonic mesoderm
Primary yolk sac
A
Amniotic cavity
Future connecting stalk
Amnion
Chorion
Secondary yolk sac
Trophoblast
Splanchnopleuric and
Somatopleuric extra-embryonic mesoderm
Extra-embryonic coelom
B

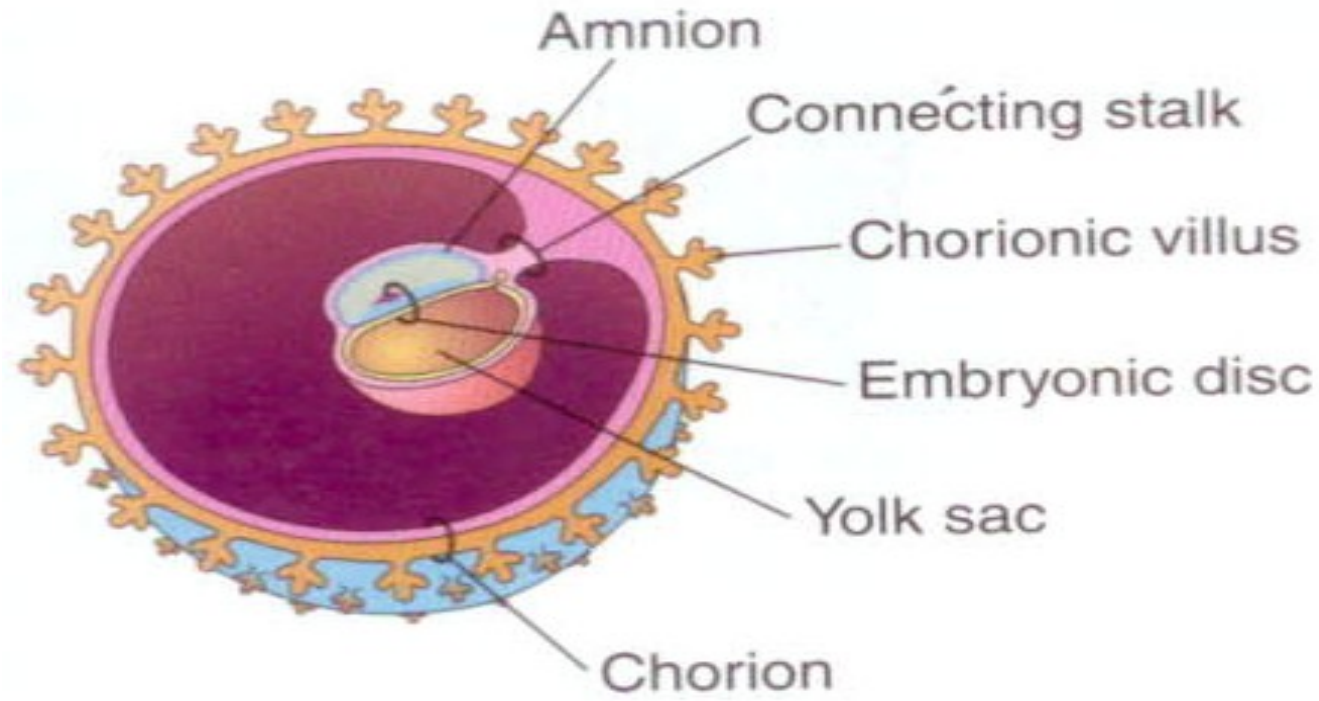
- The extra embryonic coelomic cavity however does not extend into the part of Ext. Emb. Mesoderm attaching the amniotic cavity to the trophoblast.
- This site where both the two layers of extra embryonic mesoderm are continuous - **CONNECTING STALK.**



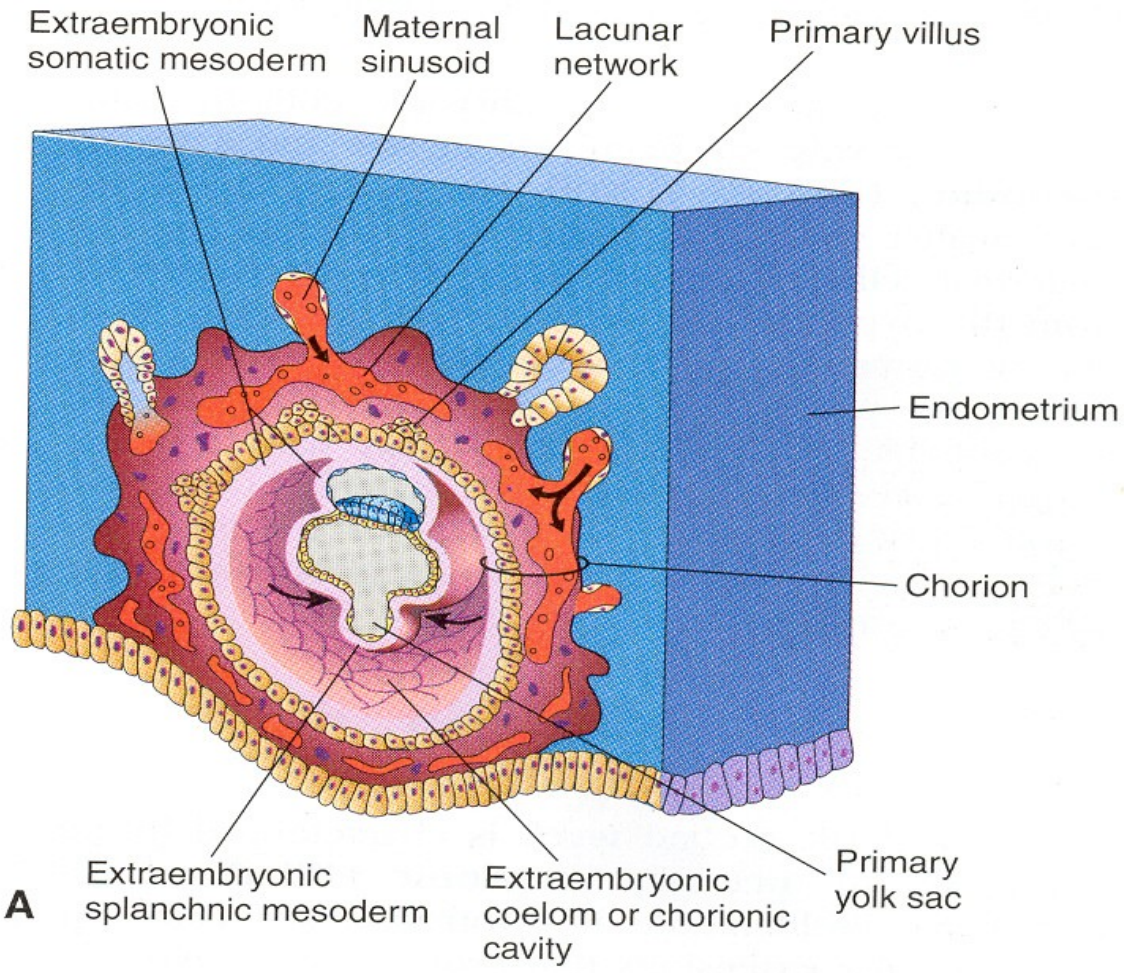
- **CHORION**: The somatopleuric extra embryonic mesoderm with the cytotrophoblast.
  Forms the lining of chorionic cavity.

- **AMNION** : The splanchno pleuric extra embryonic mesoderm with the amniotic cells .

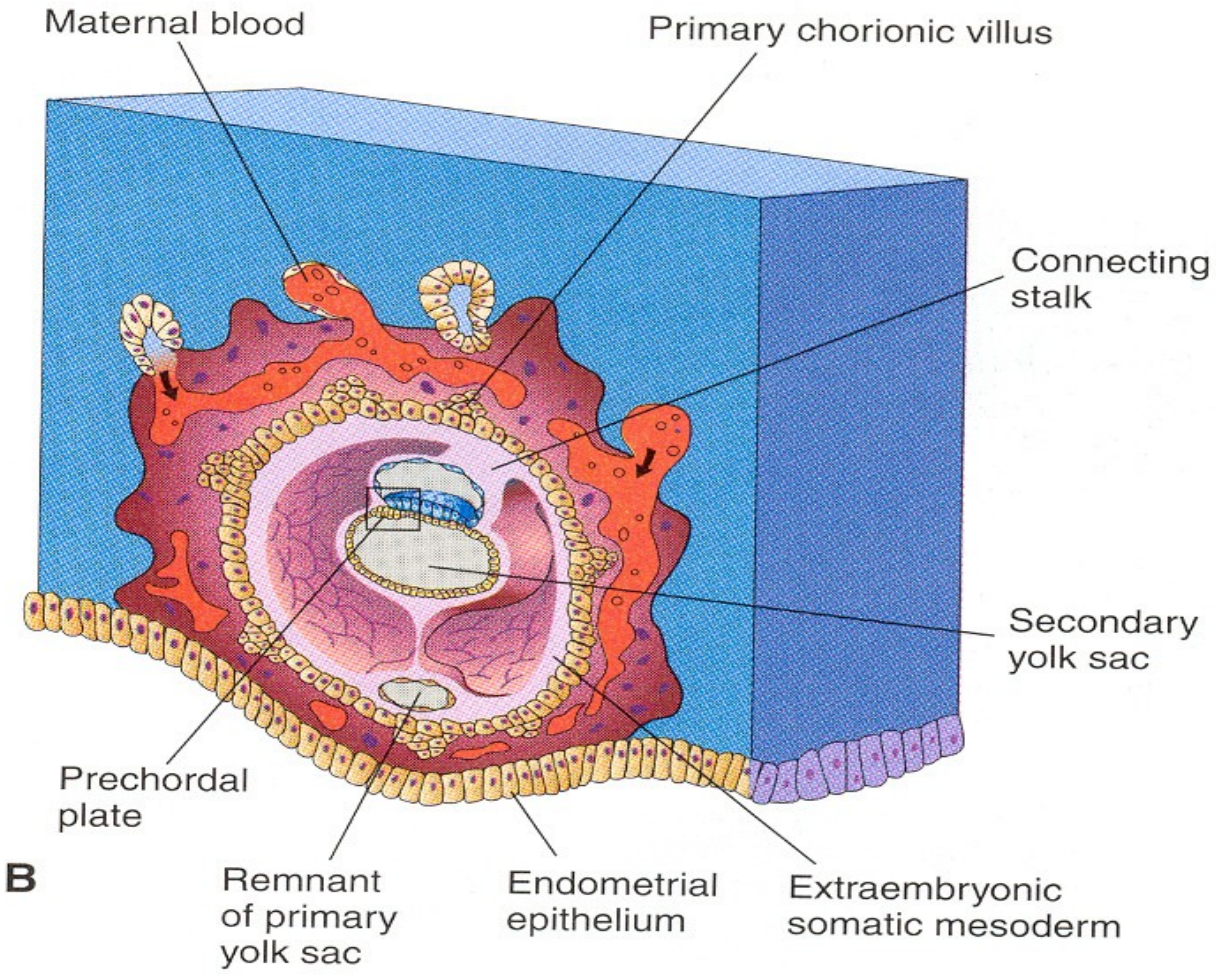
  Forms the lining of amniotic cavity.

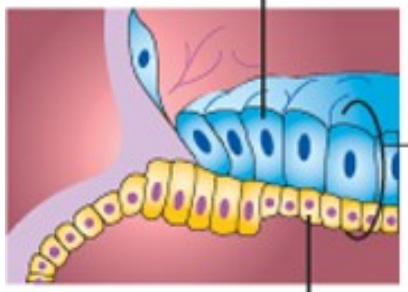


- With the formation of extra embryonic mesoderm & coelomic cavity & their rapid increase in size the primary yolk sac is very much reduced.



- The smaller primary yolk sac lined by endoderm & splanchno pleuric extra embryonic mesoderm is called - **SECONDARY YOLK SAC.**





Bilaminar embryonic disc

Epiblast

Ectoderm of amnion

Embryonic ectoderm

Primitive streak (see Chapter 4)

Extraembryonic mesoderm

Embryonic mesoderm

Notochordal process

Embryonic endoderm

Hypoblast

Endoderm of umbilical vesicle

Extraembryonic mesoderm