Formation of Bilaminar Embryonic Disc (Second Week of Development)

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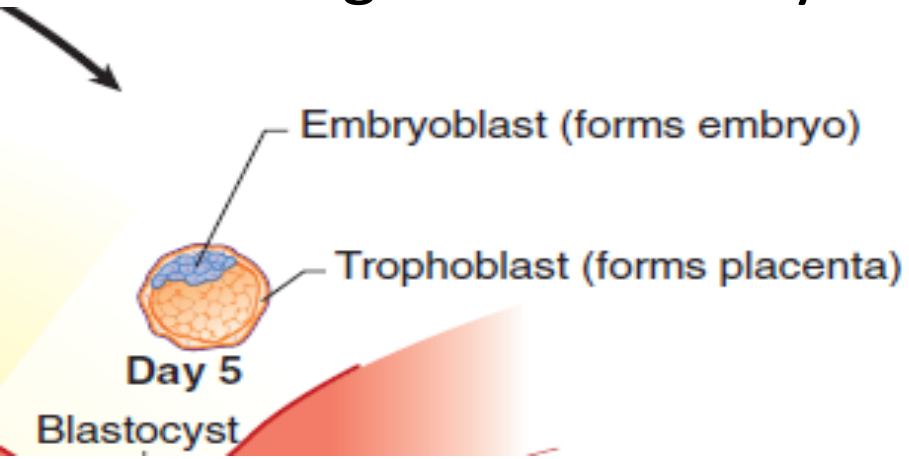
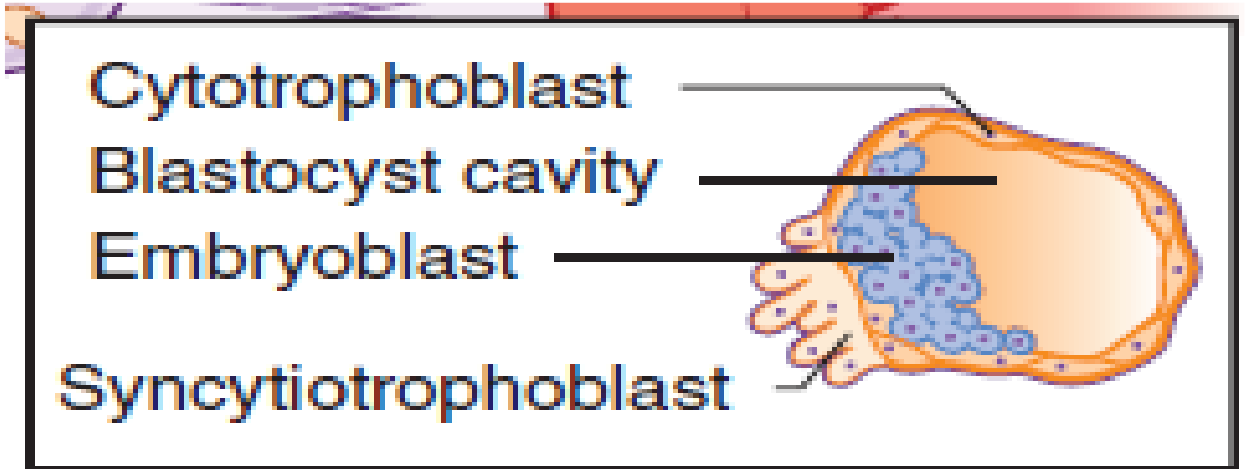
- day-by-day account of the major events of the second week of development
- embryos of the same fertilization age do not necessarily develop at the same rate
- Implantation of the blastocyst is completed by the end of the second week
- occurs during time period 6 to 10 days after ovulation
- **embryonic disc** gives rise to the germ layers that form all the tissues and organs of the embryo
- Extraembryonic structures forming during the second week are the **amniotic cavity**, **amnion**, **umbilical vesicle (yolk sac)**, **connecting stalk**, and **chorionic sac**

Blastocyst

Day 8 after fertilization

- blastocyst is partially embedded in the endometrial stroma
- As the blastocyst implants, more trophoblast contacts the endometrium
- **Trophoblast** differentiate into two
  - **Cytotrophoblast**: a inner layer of cells that is mitotically active and forms new cells that migrate into the increasing mass of syncytiotrophoblast
  - **Syncytiotrophoblast**: outer multinucleated zone without distinct cell boundaries, where they fuse and lose their cell membranes
- Mitotic figures seen in cytotrophoblast and not syncytiotrophoblast





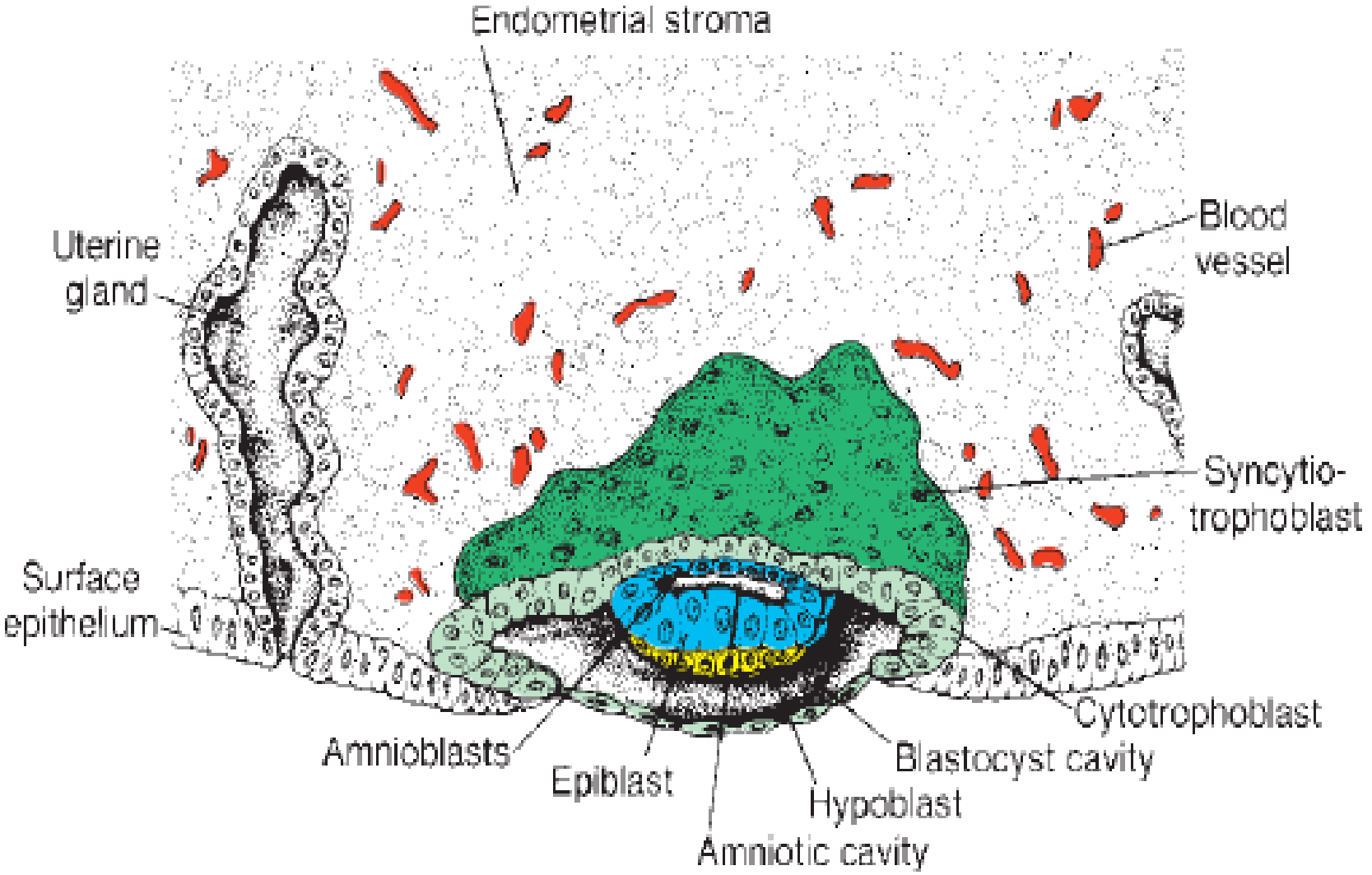
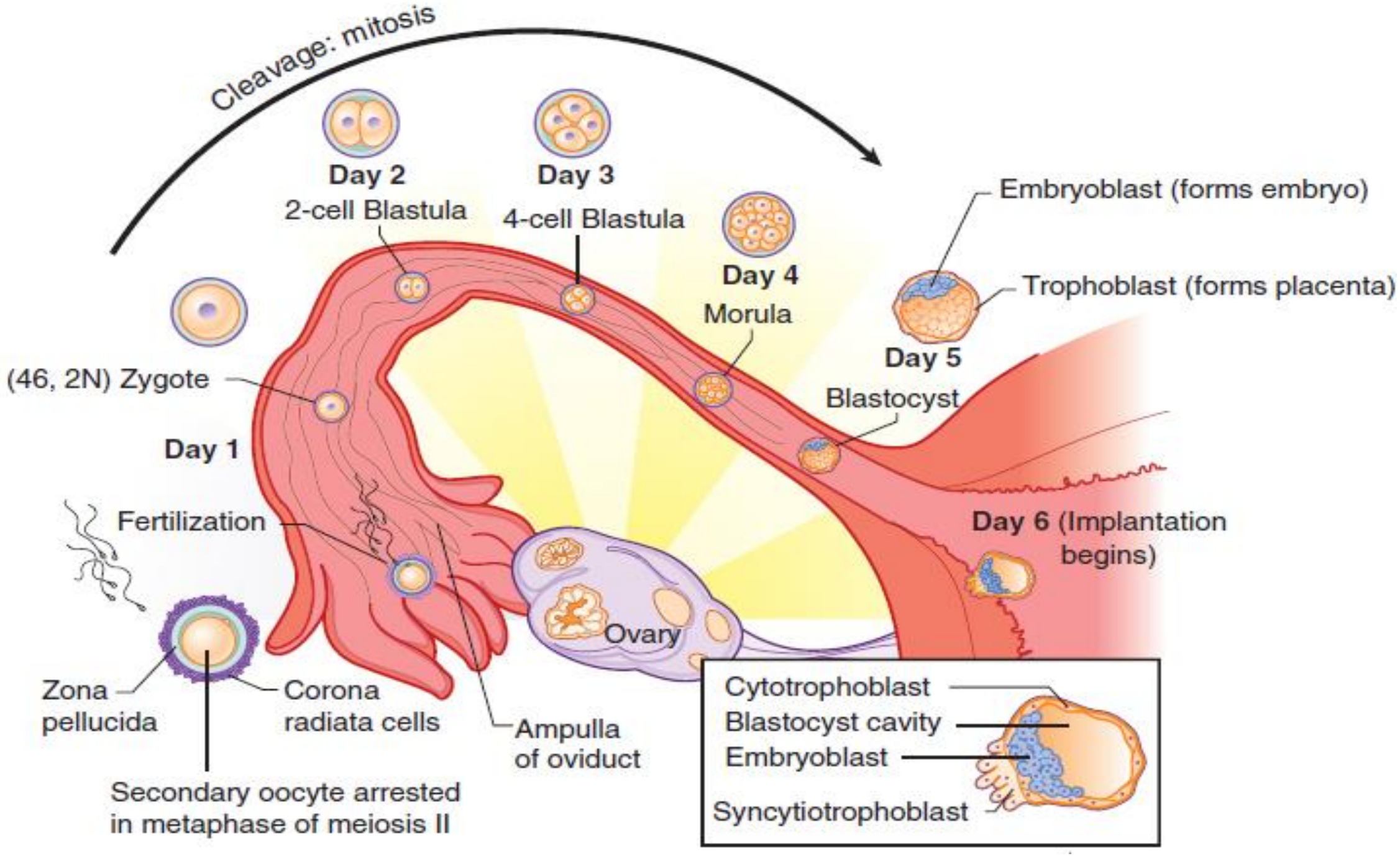
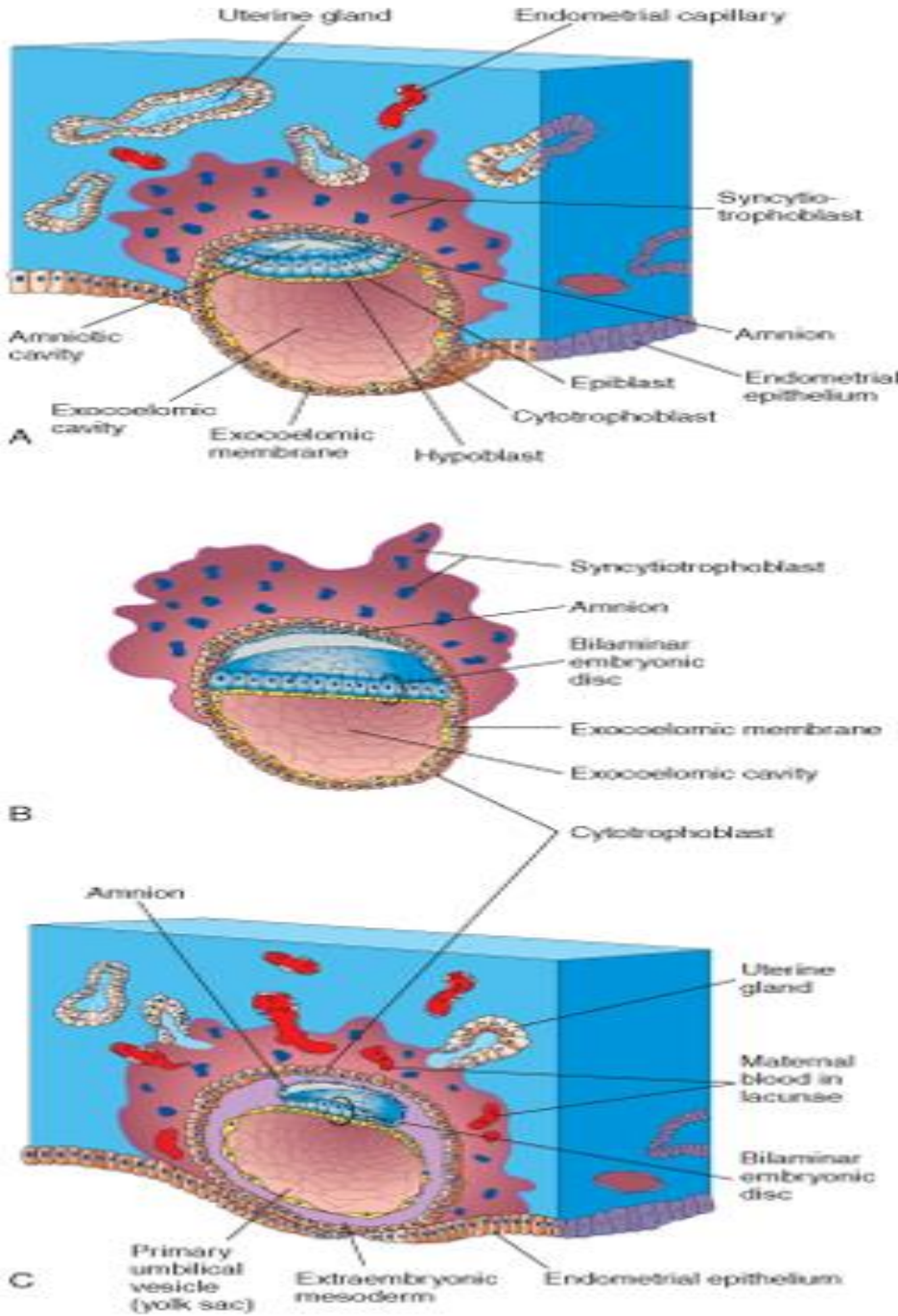


Figure 4.1 A 7.5-day human blastocyst, partially embedded in the endometrial stroma. The trophoblast consists of an inner layer with mononuclear cells, the cytotrophoblast, and an outer layer without distinct cell boundaries, the syncytiotrophoblast. The embryoblast is formed by the epiblast and hypoblast layers. The amniotic cavity appears as a small cleft.

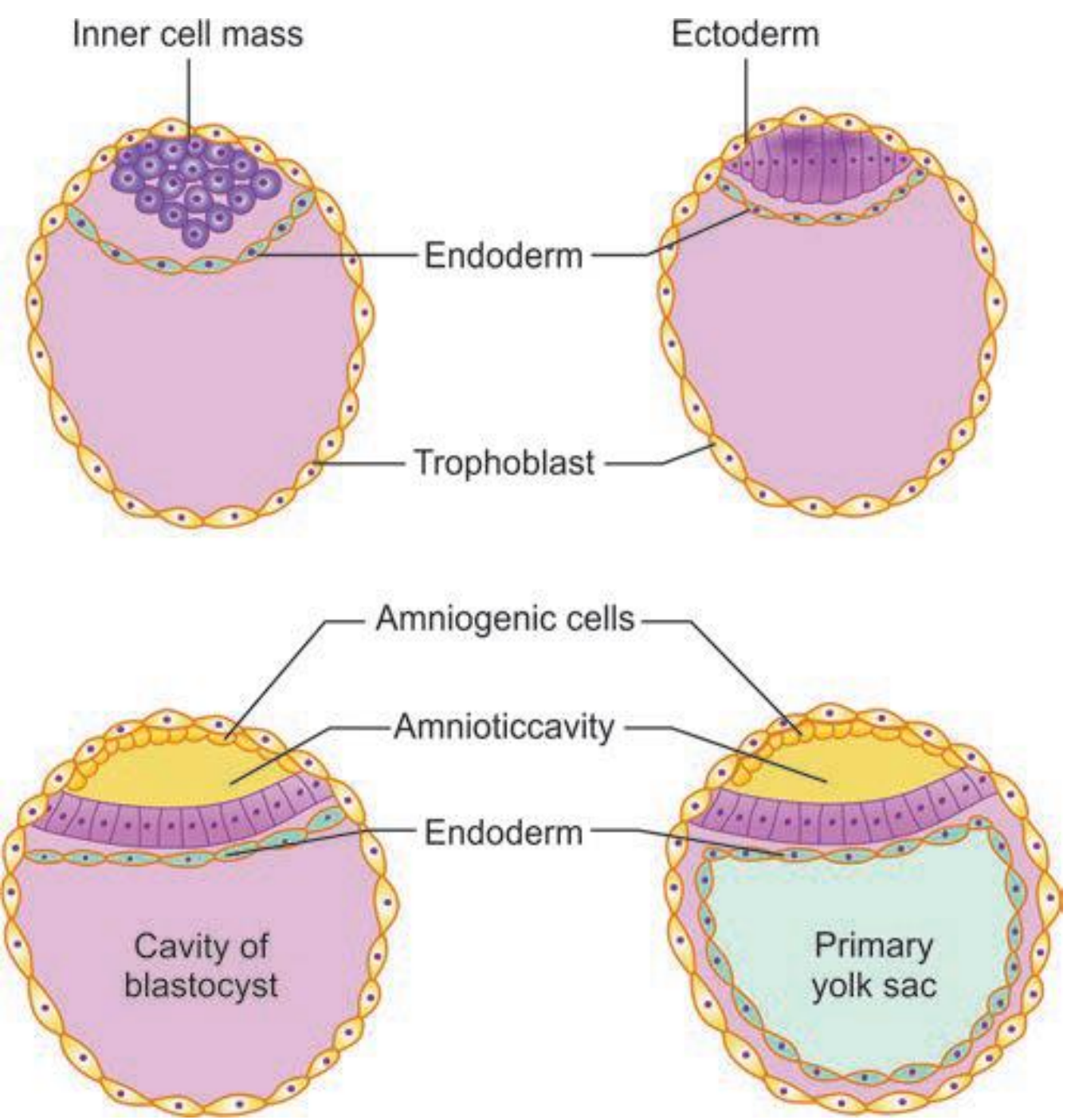
- Important structure during implantation- **syncytiotrophoblast**
- secretes enzymes that digest and liquefy the endometrial cells so the blastocyst can penetrate the uterine lining
- The molecular mechanisms of implantation involve synchronization between the invading blastocyst and a receptive endometrium
- 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

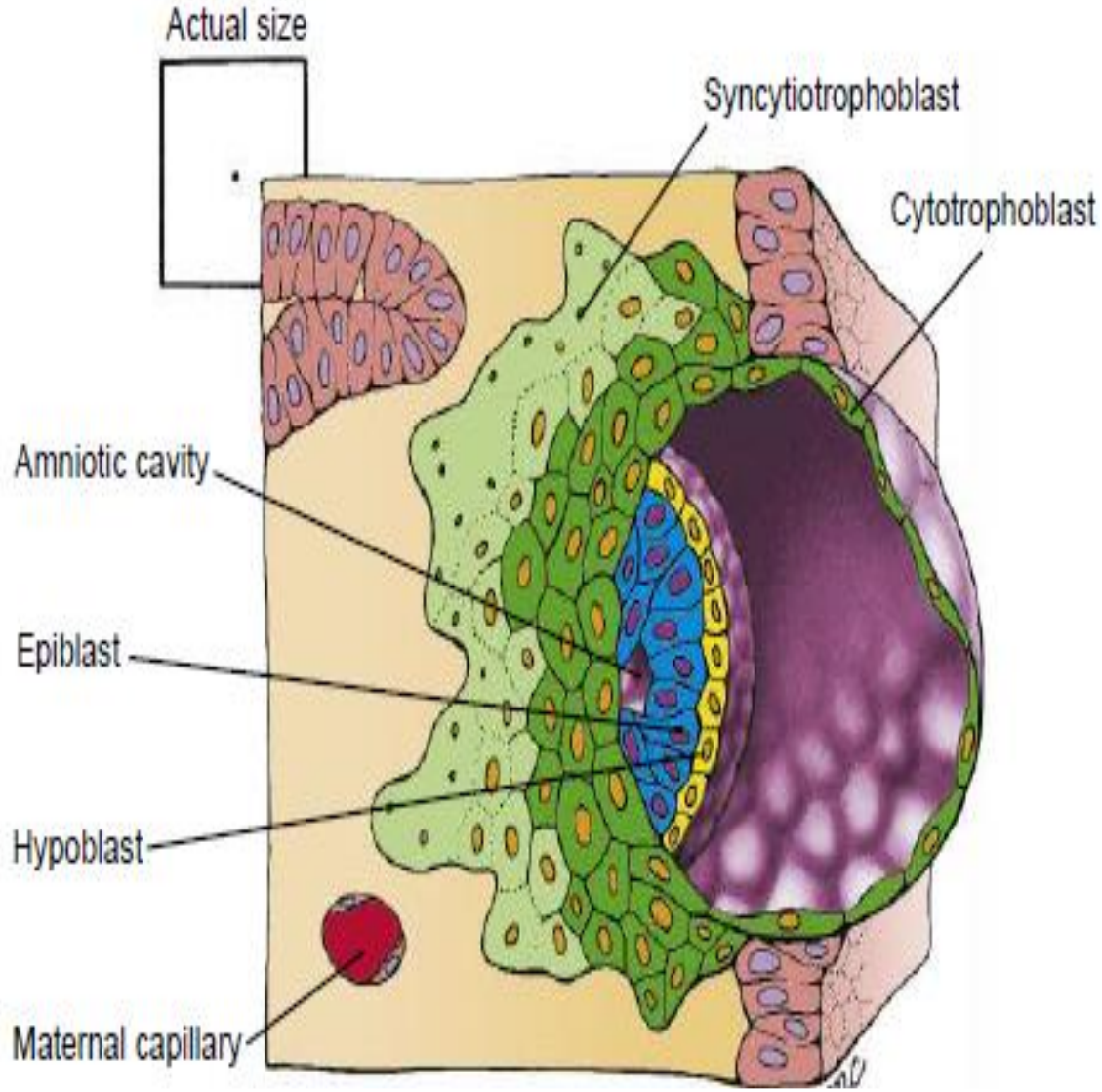

Cleavage: mitosis
Day 2
2-cell Blastula
Day 3
4-cell Blastula
Day 4
Morula
Day 5
Embryoblast (forms embryo)
Trophoblast (forms placenta)
Blastocyst
(46, 2N) Zygote
Day 1
Fertilization
Day 6 (Implantation begins)
Ovary
Zona pellucida
Corona radiata cells
Ampulla of oviduct
Secondary oocyte arrested in metaphase of meiosis II
Cytotrophoblast
Blastocyst cavity
Embryoblast
Syncytiotrophoblast

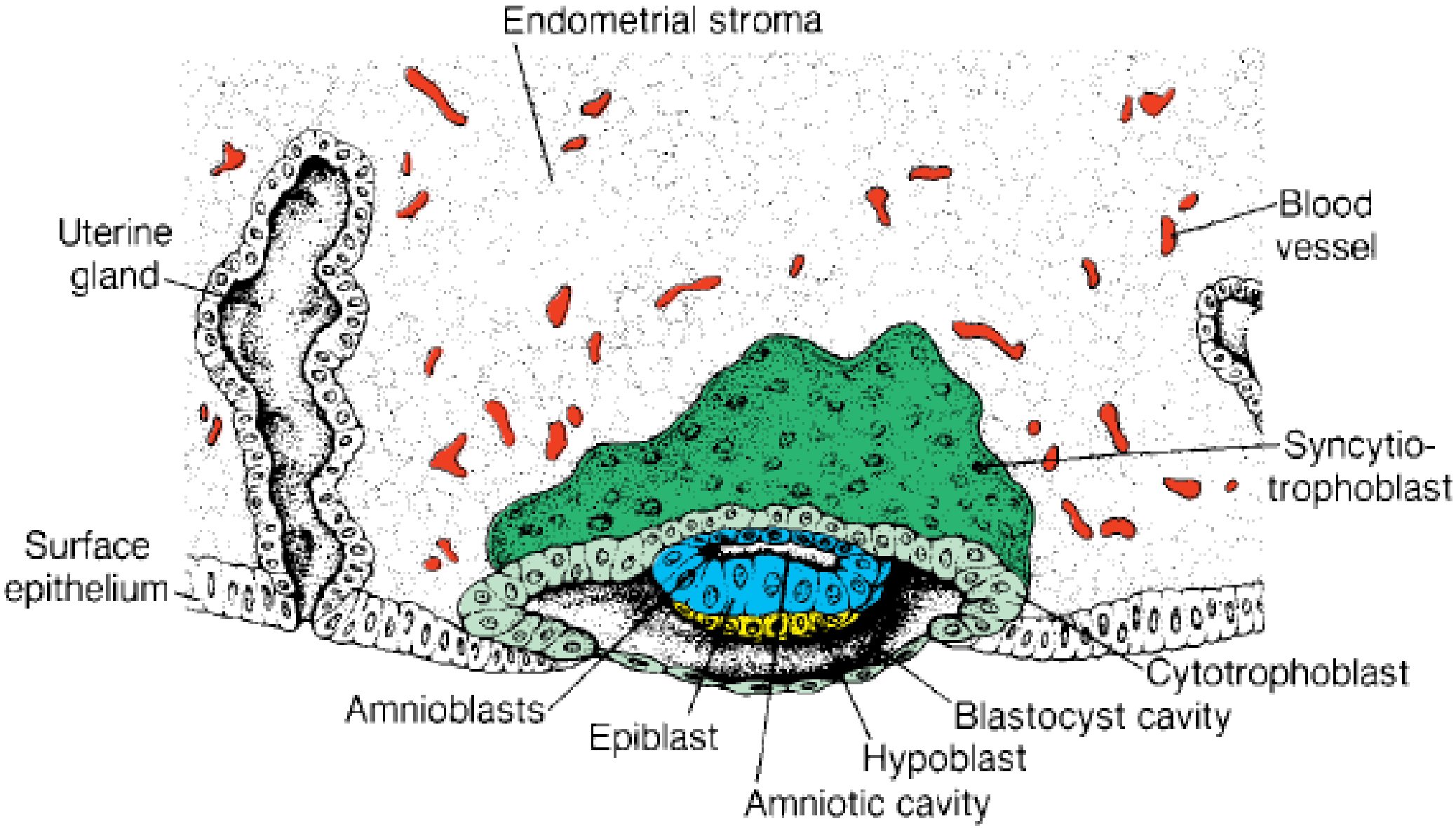


- syncytiotrophoblast produces a hormone:-
- ***human chorionic gonadotrophin*** **(hCG)**, which enters the maternal blood via lacunae (Latin, hollow cavities) in the syncytiotrophoblast
- hCG maintains the hormonal activity of the corpus luteum in the ovary during pregnancy
- corpus luteum is an endocrine glandular structure that secretes estrogen and progesterone to maintain the pregnancy

- **Day 8 after fertilization**
- Cells of the inner cell mass or embryoblast also differentiate into two layers:
  - **hypoblast layer(primitive endoderm):** layer of small cuboidal cells adjacent to the blastocyst cavity
  - **epiblast layer(primitive ectoderm)**: layer of high columnar cells adjacent to the amniotic cavity
- Together, the layers form a flat disc(bilaminar embryonic disc)
- small cavity appears within the epiblast= **amniotic cavity.**
- cells adjacent to the cytotrophoblast are called **amnioblasts –Which line the cavity and are known the as amnion**


Inner cell mass
Ectoderm
Endoderm
Trophoblast
Amniogenic cells
Amnioticcavity
Endoderm
Cavity of blastocyst
Primary yolk sac


Actual size
Syncytiotrophoblast
Cytotrophoblast
Amniotic cavity
Epiblast
Hypoblast
Maternal capillary


Endometrial stroma
Uterine gland
Blood vessel
Syncytio-trophoblast
Surface epithelium
Cytotrophoblast
Amnioblasts
Epiblast
Hypoblast
Blastocyst cavity
Amniotic cavity

- The **amniotic cavity** that becomes filled with amniotic fluid.
- Amniotic fluid is initially derived from maternal blood.
- Later fetus contributes to the fluid by excreting urine into the amniotic cavity
- Amniotic fluid serves as :-

❖a shock absorber for the fetus,

❖helps regulate fetal body temperature

❖helps prevent the fetus from drying out

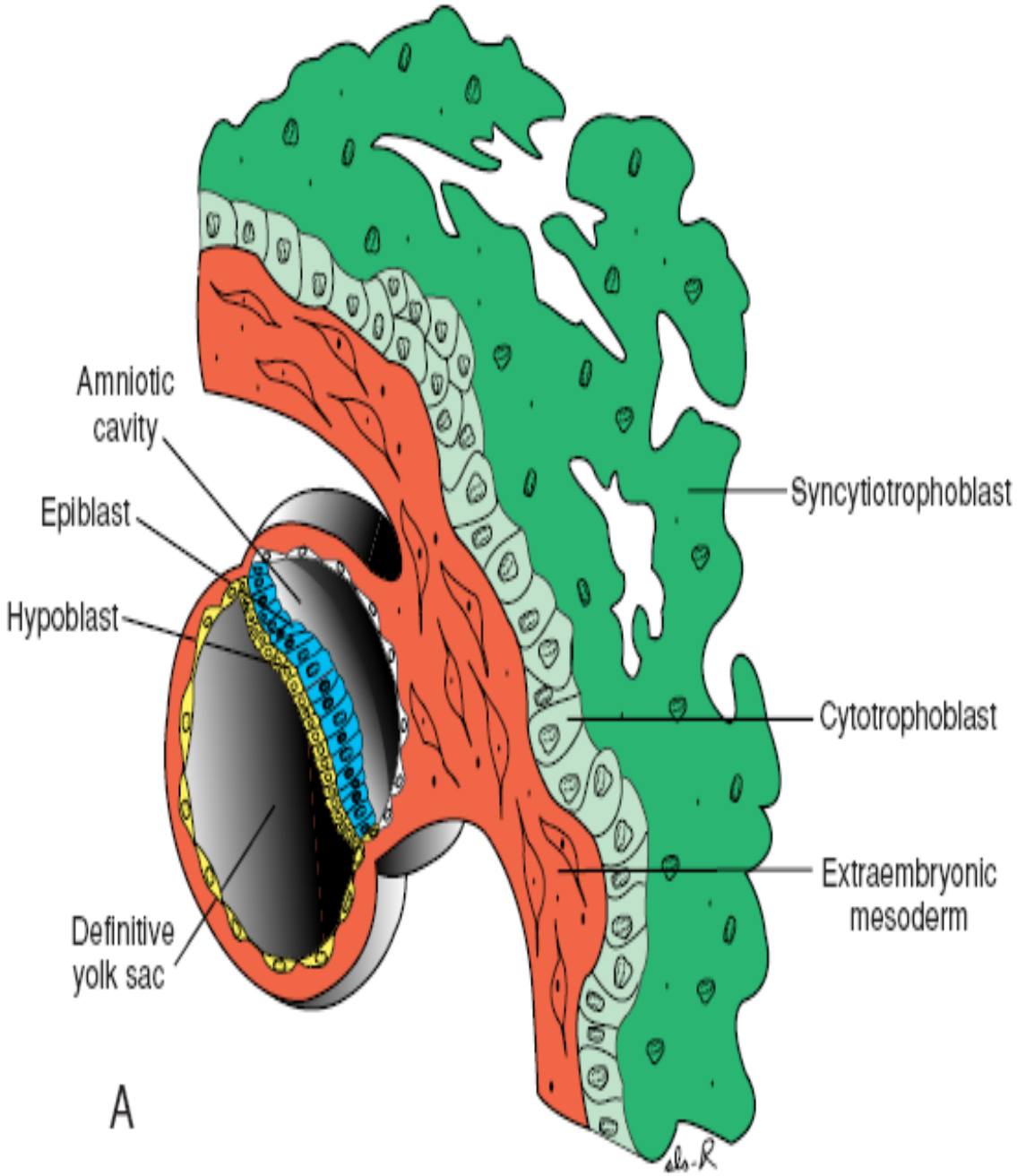
❖ prevents adhesions between the skin of the fetus and surrounding tissues

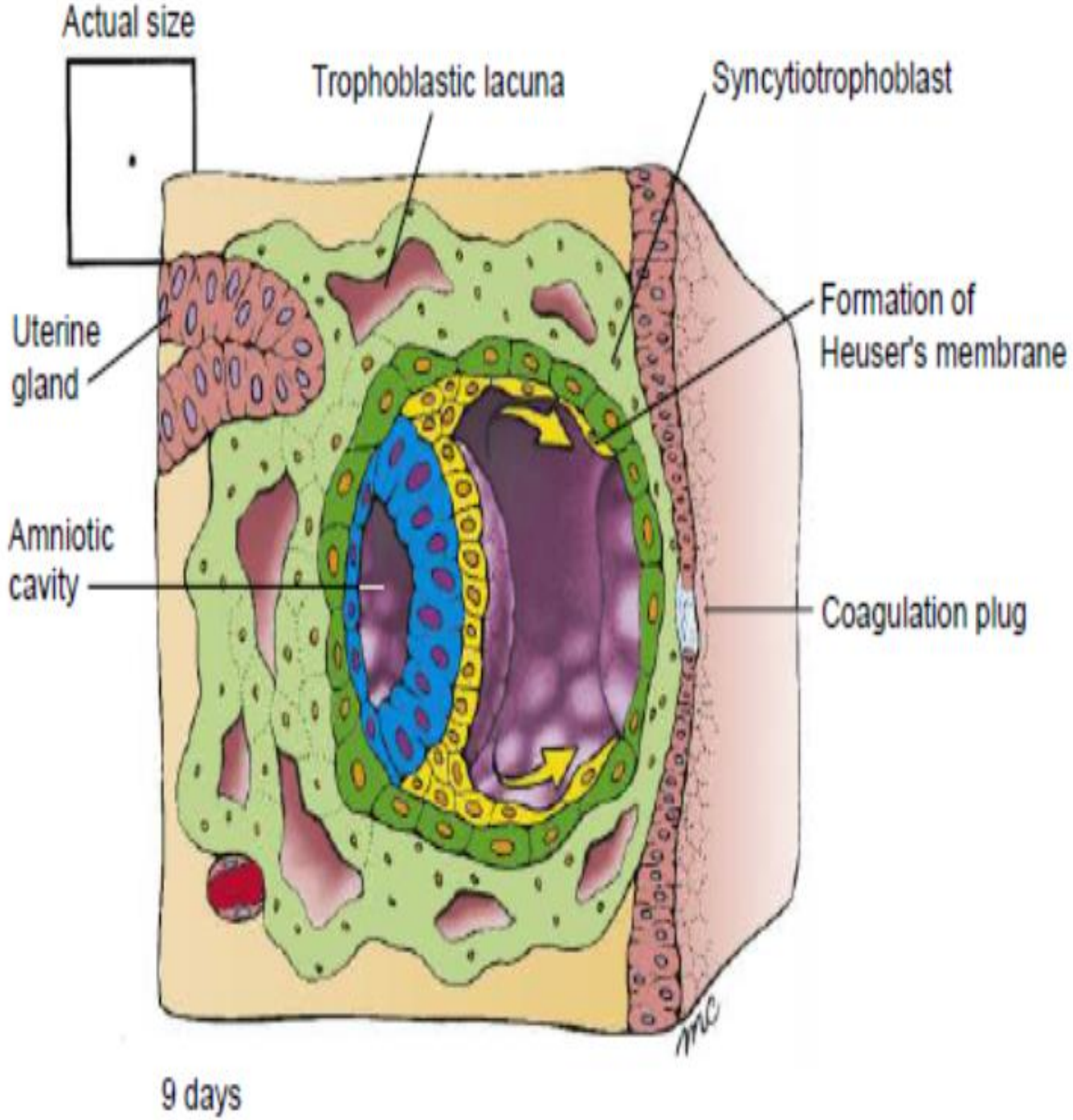
❖Permits symmetrical external growth of the embryo

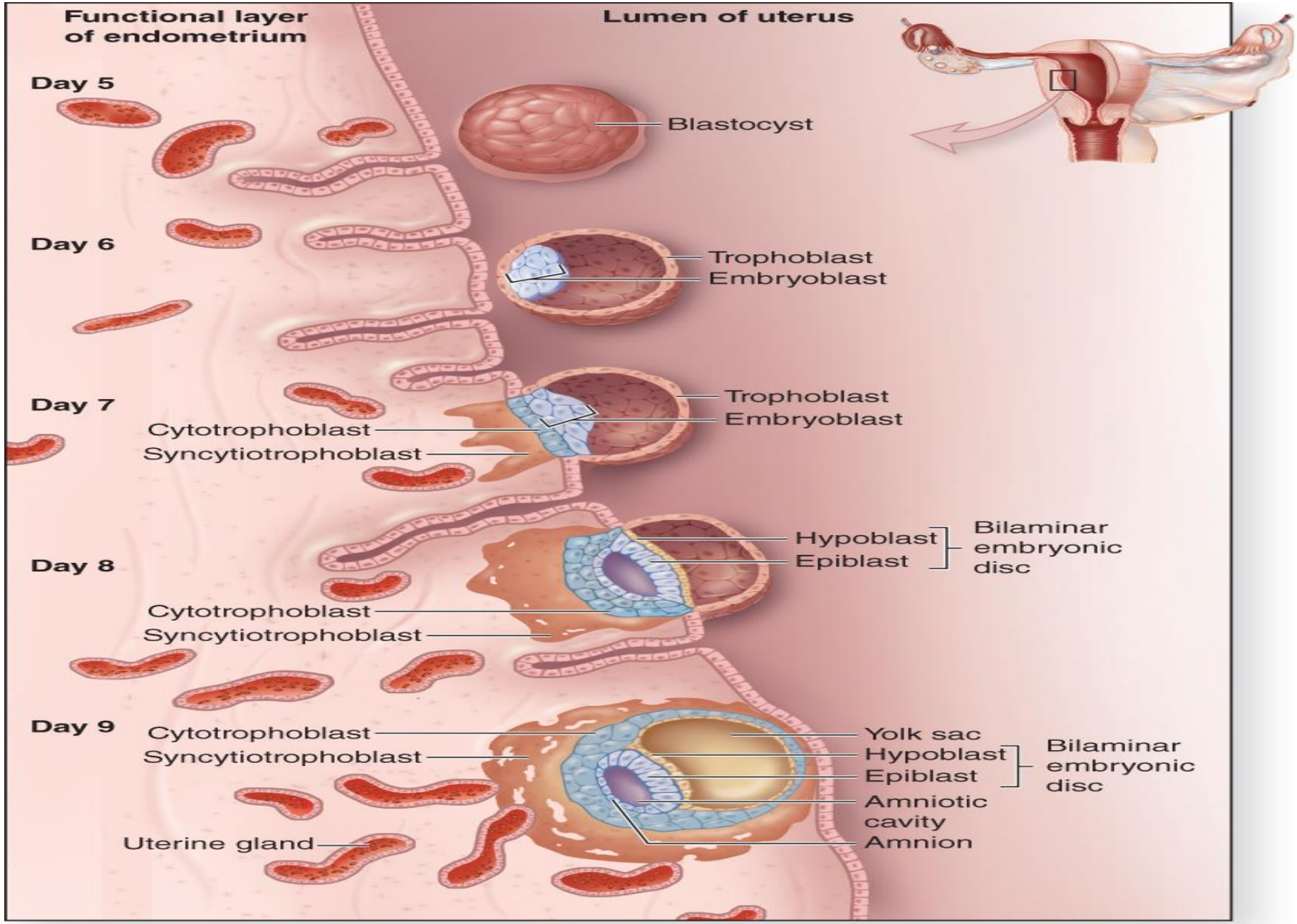
❖ Forms hydrostatic bag (bag of waters), which helps in dilatation of cervix during birth

❖Allows free movements of the fetus for proper development of musculoskeletal system

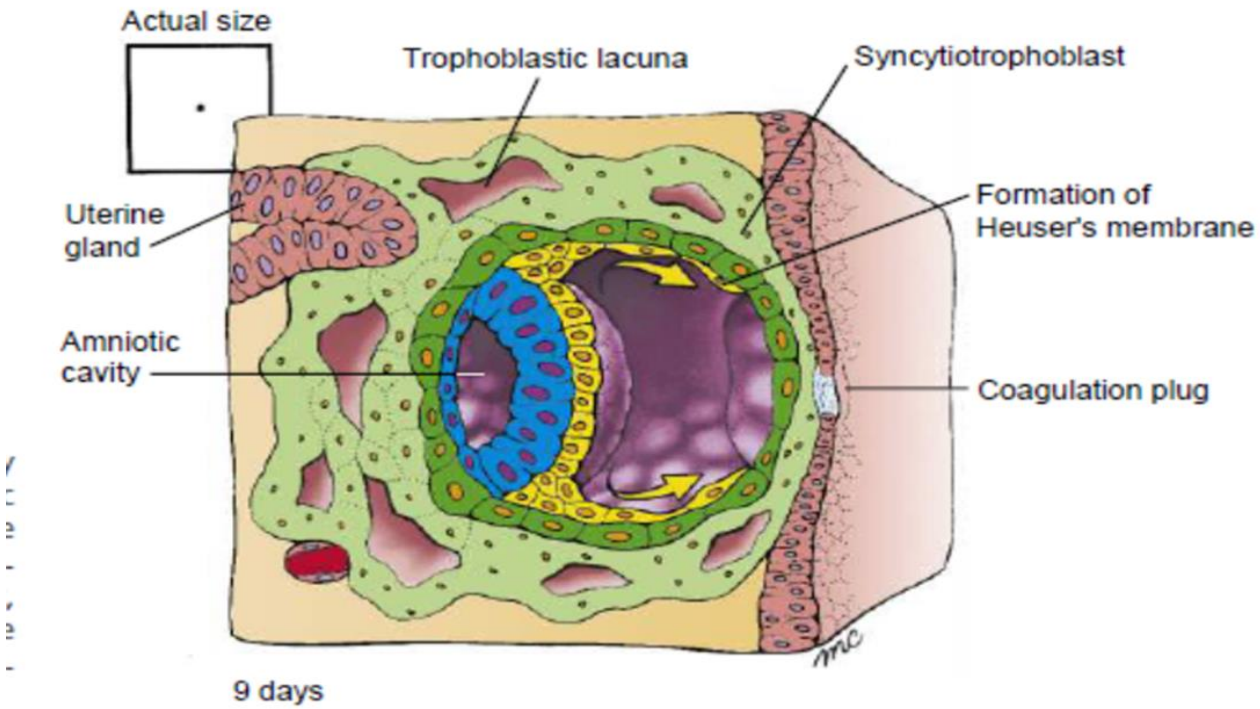
- **Day 9/10**
- blastocyst is more deeply embedded in the endometrium, and the penetration defect in the surface epithelium is closed by a **fibrin coagulum**
- **lacunar stage-**vacuoles appear in the syncytiotrophoblast which fuse to form **large lacunae**
- lacunae soon become filled with a mixture of maternal blood from ruptured endometrial capillaries and cellular debris from eroded uterine glands
- fluid in the lacunar spaces**-*embryotroph***-passes to the embryonic disc by diffusion and provides nutritive material to the embryo


Amniotic cavity
Epiblast
Hypoblast
Definitive yolk sac
Syncytiotrophoblast
Cytotrophoblast
Extraembryonic mesoderm
A

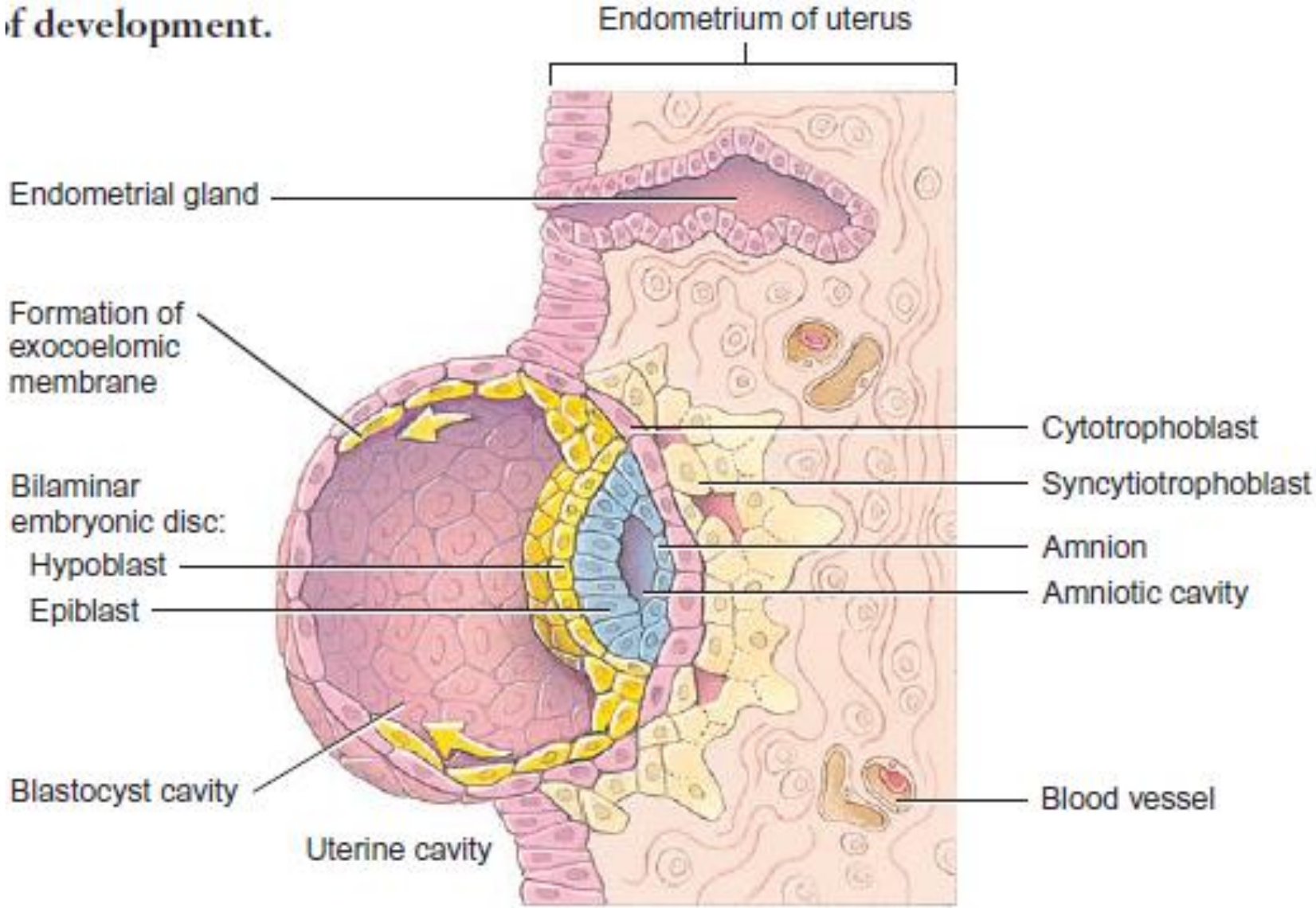

Actual size
Trophoblastic lacuna
Syncytiotrophoblast
Uterine gland
Formation of Heuser's membrane
Amniotic cavity
Coagulation plug
9 days


Functional layer of endometrium
Lumen of uterus
Day 5
Blastocyst
Day 6
Trophoblast
Embryoblast
Day 7
Trophoblast
Embryoblast
Cytotrophoblast
Syncytiotrophoblast
Day 8
Hypoblast
Epiblast
Bilaminar embryonic disc
Cytotrophoblast
Syncytiotrophoblast
Day 9
Cytotrophoblast
Syncytiotrophoblast
Yolk sac
Hypoblast
Epiblast
Bilaminar embryonic disc
Amniotic cavity
Amnion
Uterine gland

- ***Formation of primary yolk sac*:**
- Flattened cells arising from the hypoblast (or, according to some, from trophoblast), spread and line the inside of the blastocystic cavity
- (This lining of flattened cells is called **"Heuser's membrane"**)
- a cavity, lined on all sides by cells of endodermal origin, is formed.
- Cavity is called the ***primary yolk sac or* exocoelomic cavity**
- Exocoelomic membrane together with the hypoblast forms the lining of the exocoelomic cavity, or primitive yolk sac



f development.



(a) Frontal section through endometrium of uterus showing blastocyst, about 8 days after fertilization

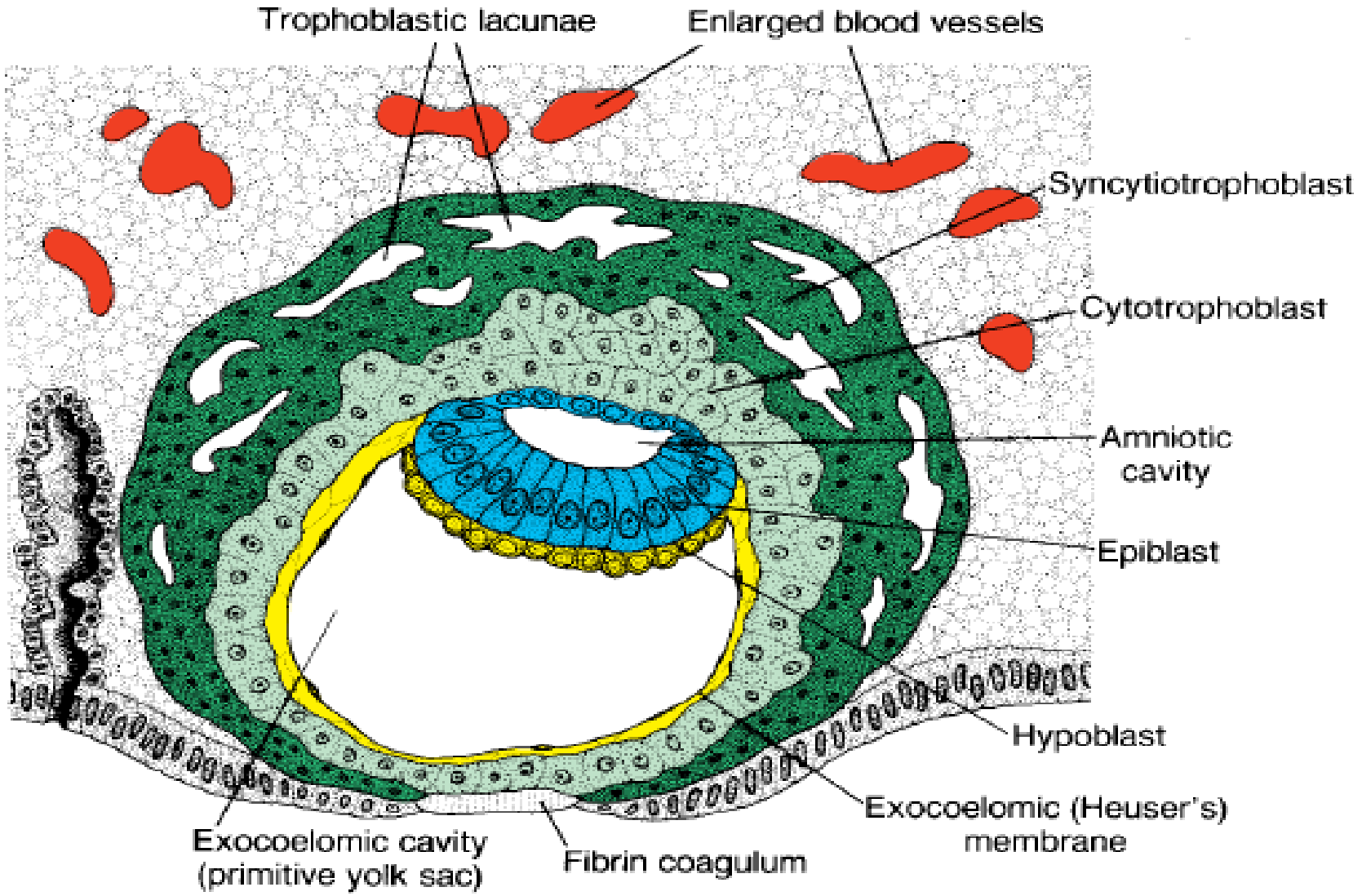


Figure 3.3 A 9-day human blastocyst. The syncytiotrophoblast shows a large number of lacunae. Flat cells form the exocoelomic membrane. The bilaminar disc consists of a layer of columnar epiblast cells and a layer of cuboidal hypoblast cells. The original surface defect is closed by a fibrin coagulum.

- The yolk sac has several important functions in humans.

❖It supplies nutrients to the embryo during the second and third weeks of development

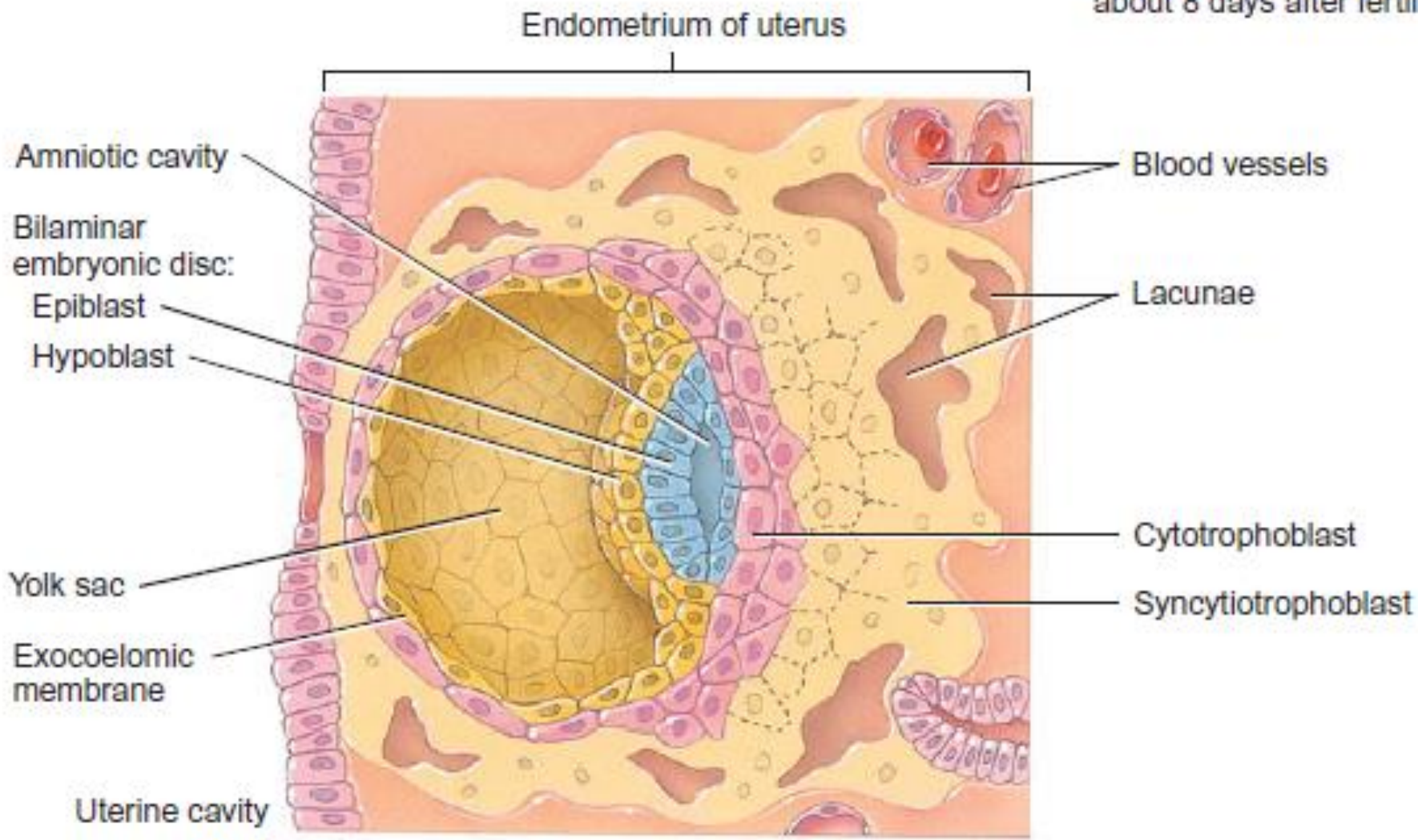
❖ Is the source of blood cells from the third through sixth weeks

❖Contains the first cells (*primordial germ cells*) that will eventually migrate into the developing gonads and differentiate into gametes

❖Forms part of the gut (gastrointestinal tract)

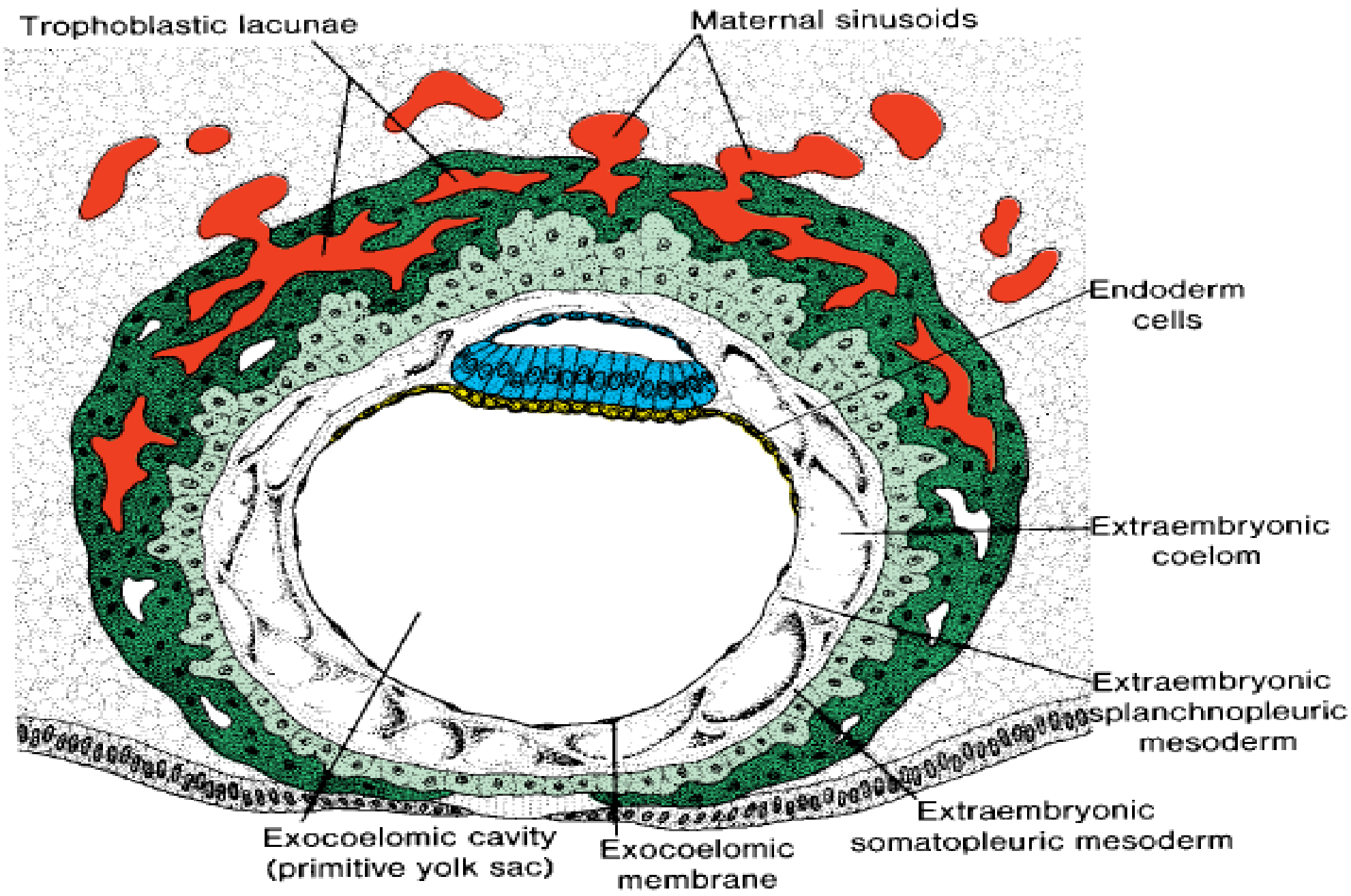
❖Helps prevent drying out of the embryo

(a) Frontal section thro
about 8 days after fertil



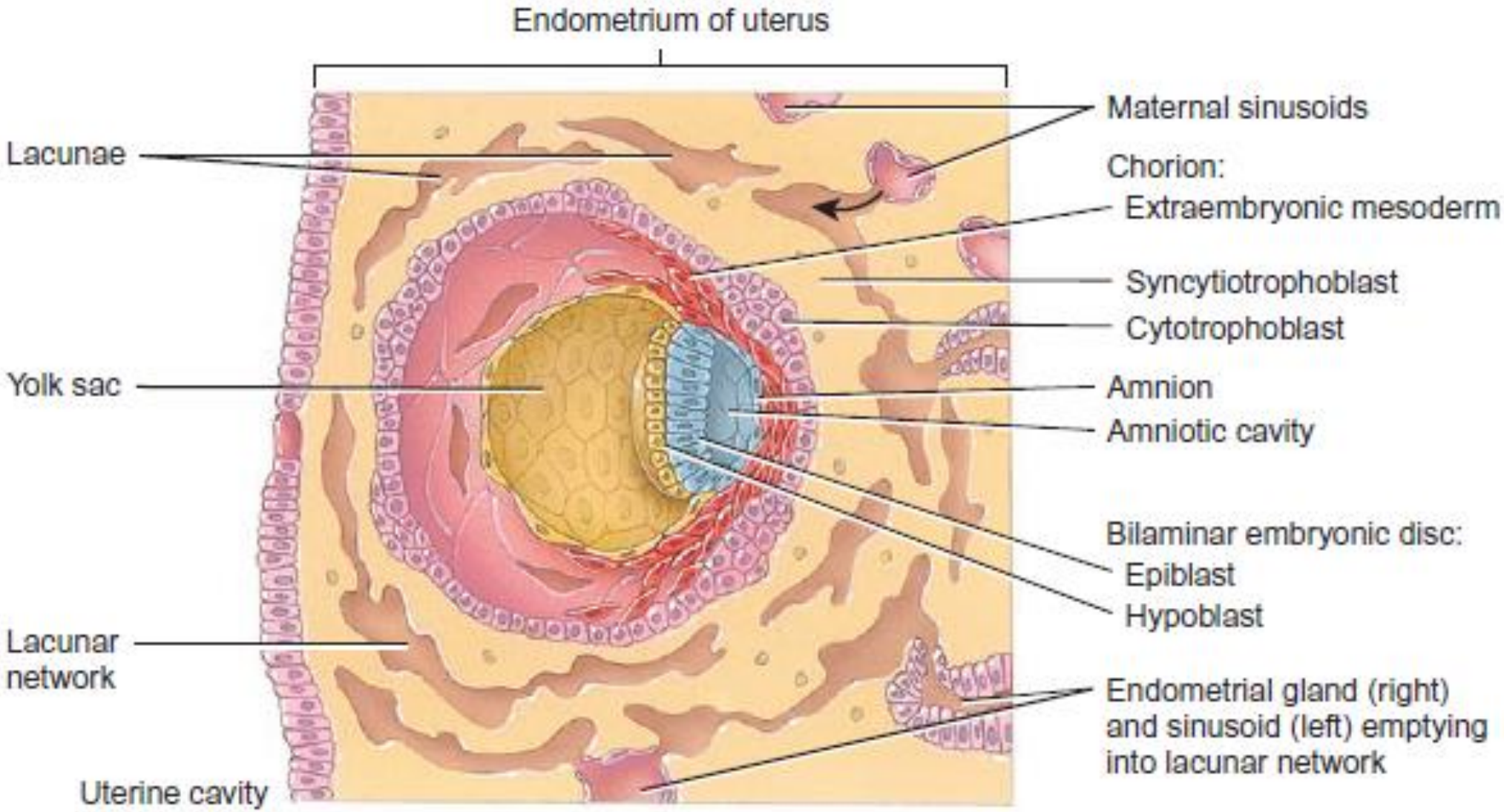
(b) Frontal section through endometrium of uterus showing blastocyst, about 9 days after fertilization

- **Days 11 and 12**
- the blastocyst is completely embedded in the endometrial stroma
- lacunar spaces in the syncytium that form an intercommunicating network with eroded the endometrial capillaries
- maternal blood begins to flow through the trophoblastic system, establishing the **uteroplacental circulation**
- 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***
- *poorly oxygenated blood* is removed from them through the endometrial veins

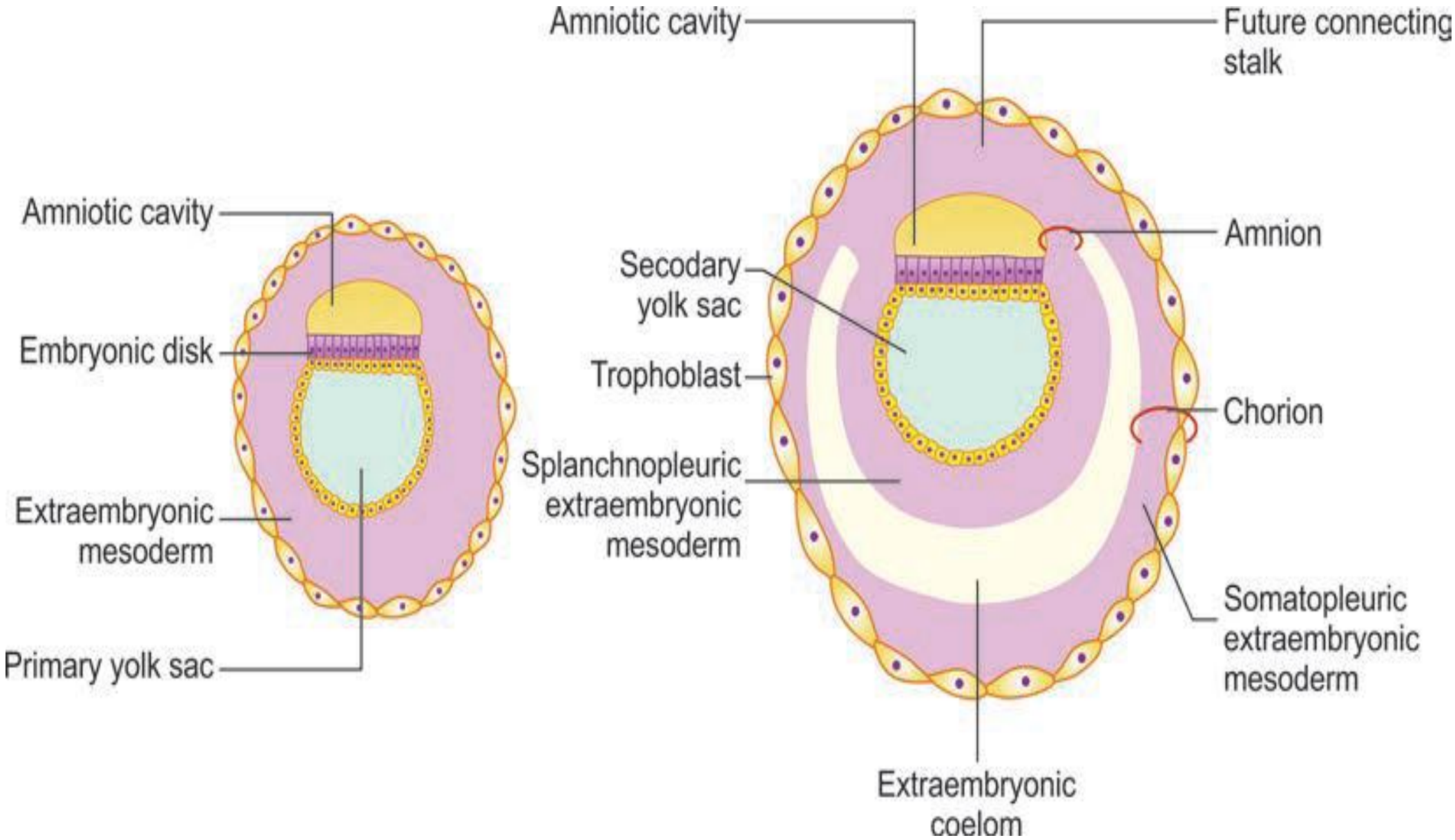

Trophoblastic lacunae
Maternal sinusoids
Endoderm cells
Extraembryonic coelom
Extraembryonic splanchnopleuric mesoderm
Extraembryonic somatopleuric mesoderm
Exocoelomic cavity (primitive yolk sac)
Exocoelomic membrane

- **Days 11 and 12 continues**
- As the conceptus implants, the endometrial connective tissue cells undergo a transformation, the **decidual reaction**
- the cells swell because of the accumulation of glycogen and lipid in their cytoplasm, they are known as **decidual cells**
- primary function of the decidual reaction is to provide nutrition for the early embryo and an immunologically privileged site for the conceptus or embryo from being rejected

- ***Formation of extraembryonic mesoderm*:**
- The cells of the trophoblast give origin to a mass of cells called the **extraembryonic mesoderm** (or primary mesoderm)
- These cells come to lie between the trophoblast and the flattened endodermal cells lining the yolk sac, separating them from each other
- These cells also separate the wall of the amniotic cavity from the trophoblast
- mesoderm is called “extraembryonic” because it lies outside the embryonic disc
- It does not give rise to any tissues of the embryo



(c) Frontal section through endometrium of uterus showing blastocyst, about 12 days after fertilization


Amniotic cavity
Embryonic disk
Extraembryonic mesoderm
Primary yolk sac
Amniotic cavity
Future connecting stalk
Amnion
Secodary yolk sac
Trophoblast
Chorion
Splanchnopleuric extraembryonic mesoderm
Somatopleuric extraembryonic mesoderm
Extraembryonic coelom

- ***Formation of extraembryonic coelom***:
- Small cavities appear in the extraembryonic mesoderm
- These join together to form larger spaces and, ultimately, one large cavity is formed
- cavity is called the **extraembryonic coelom** also called the **chorionic cavity**
- With its formation, the extraembryonic mesoderm is split into two layers
- part lining the inside of the trophoblast, and the outside of the amniotic cavity, is called the **parietal** or **somatopleuric extraembryonic mesoderm** (It is also referred to as the chorionic plate)
- part lining the outside of the yolk sac is called the **visceral** or **splanchnopleuric extraembryonic mesoderm**

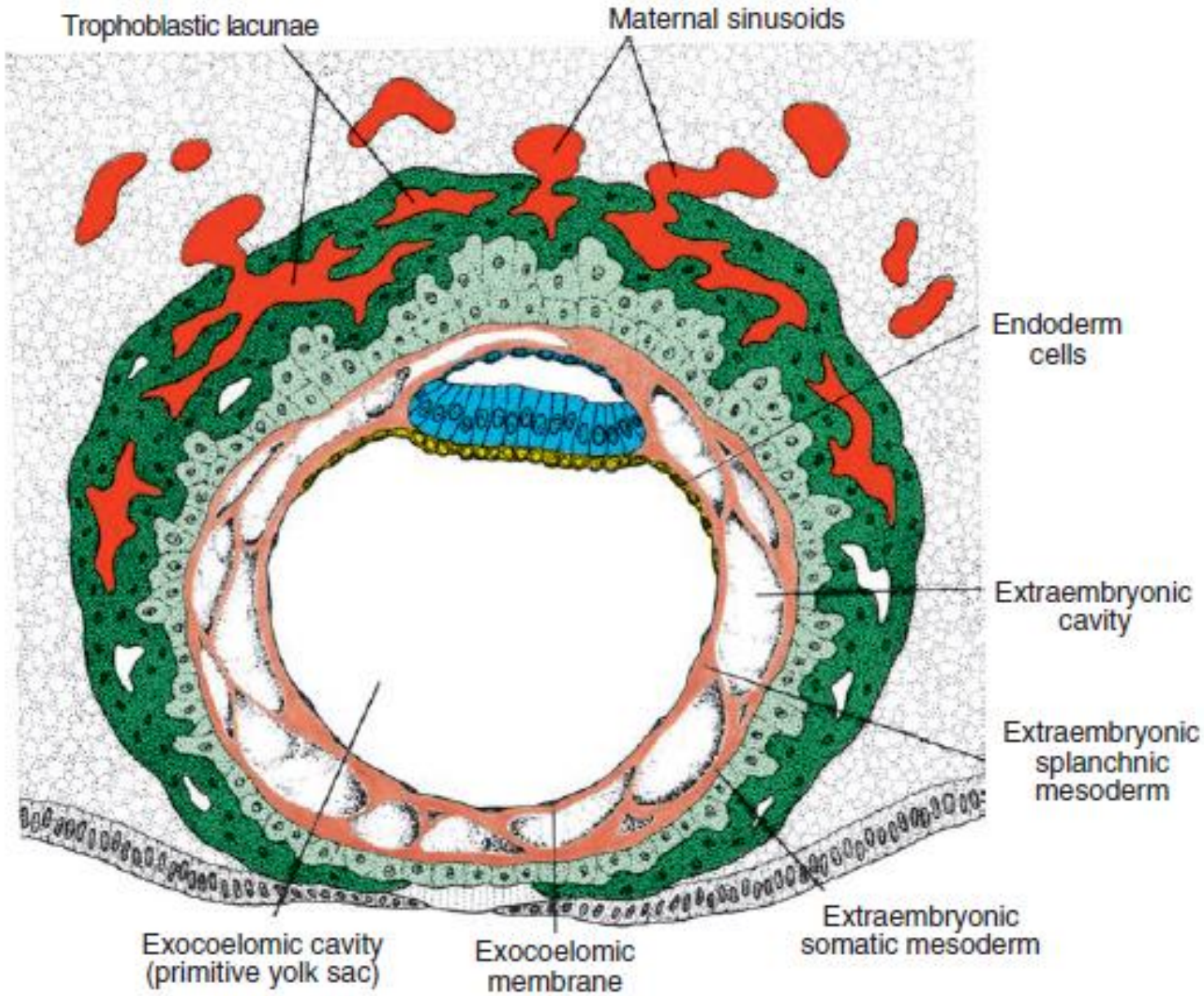


Figure 4.4 Human blastocyst of approximately 12 days. The trophoblastic lacunae at the embryonic pole are in open connection with maternal sinusoids in the endometrial stroma. Extraembryonic mesoderm proliferates and fills the space between the exocoelomic membrane and the inner aspect of the trophoblast.

Day 13

- By the 13th day of development, the surface defect in the endometrium has usually healed
- Occasionally, bleeding occurs at the implantation site as a result of increased blood flow into the lacunar spaces.
- Because this bleeding occurs near the 28th day of the menstrual cycle, it may be confused with normal menstrual bleeding and, therefore, cause inaccuracy in determining the expected delivery date

- **primary villi** Cellular columns with the syncytial covering originating from the cytotrophoblast
- ***Formation of secondary yolk sac*:**
- the appearance of the extraembryonic mesoderm
- later of the extraembryonic coelom, the yolk sac becomes much smaller than before and is now called the *secondary yolk sac* or **definitive yolk sac**
- alteration in size is accompanied by a change in the nature of the lining cell
- They are no longer flattened but become cubical

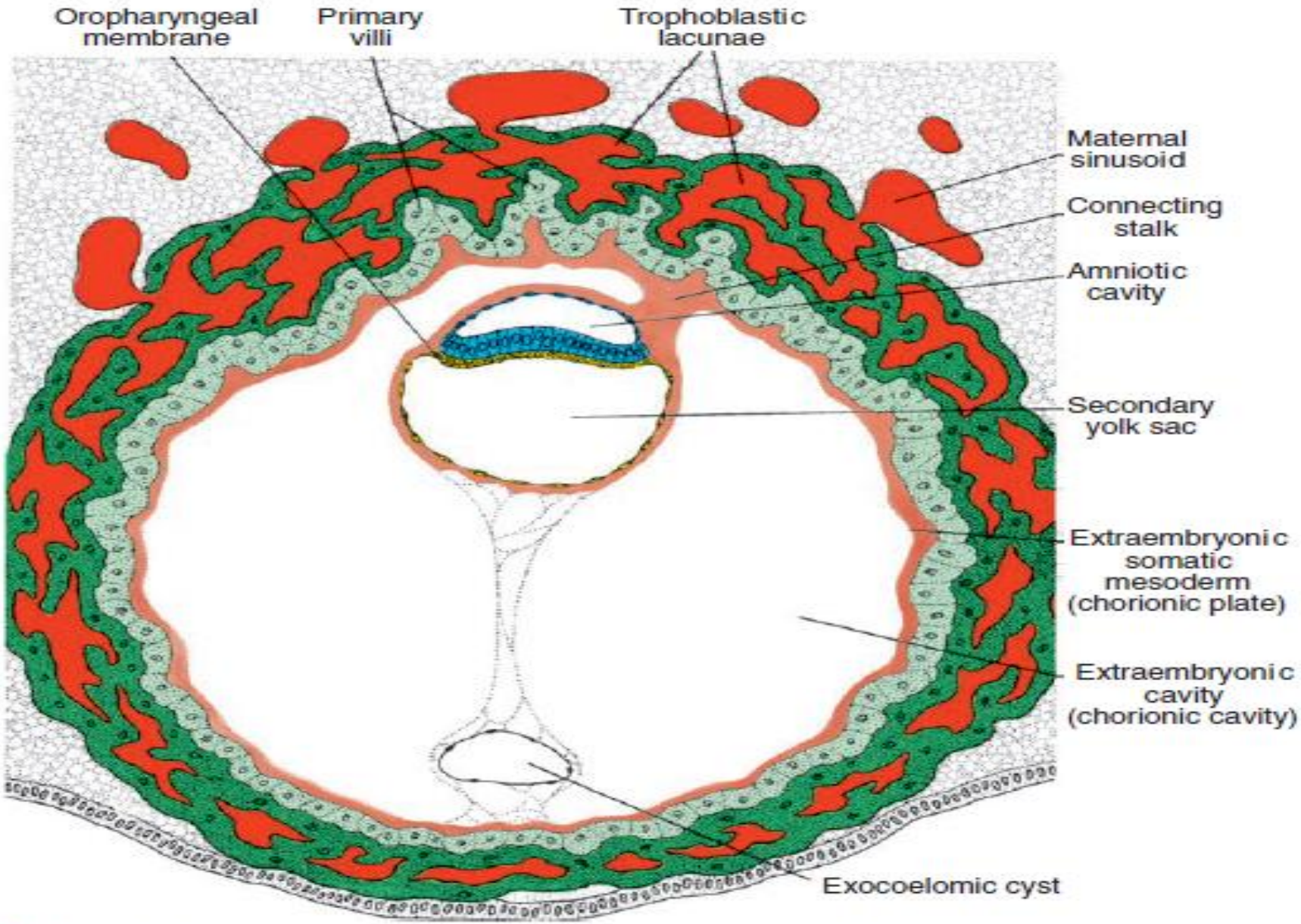
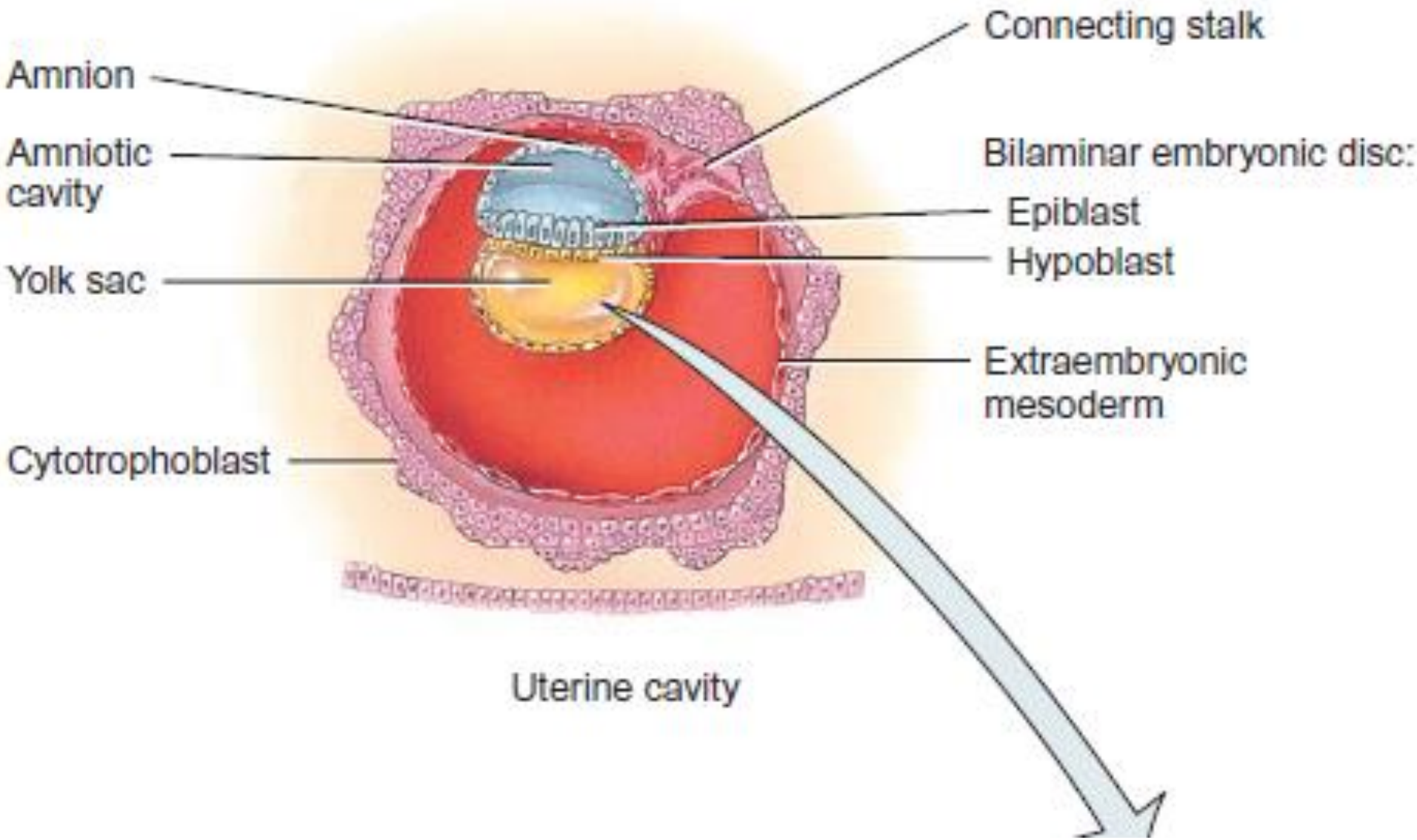


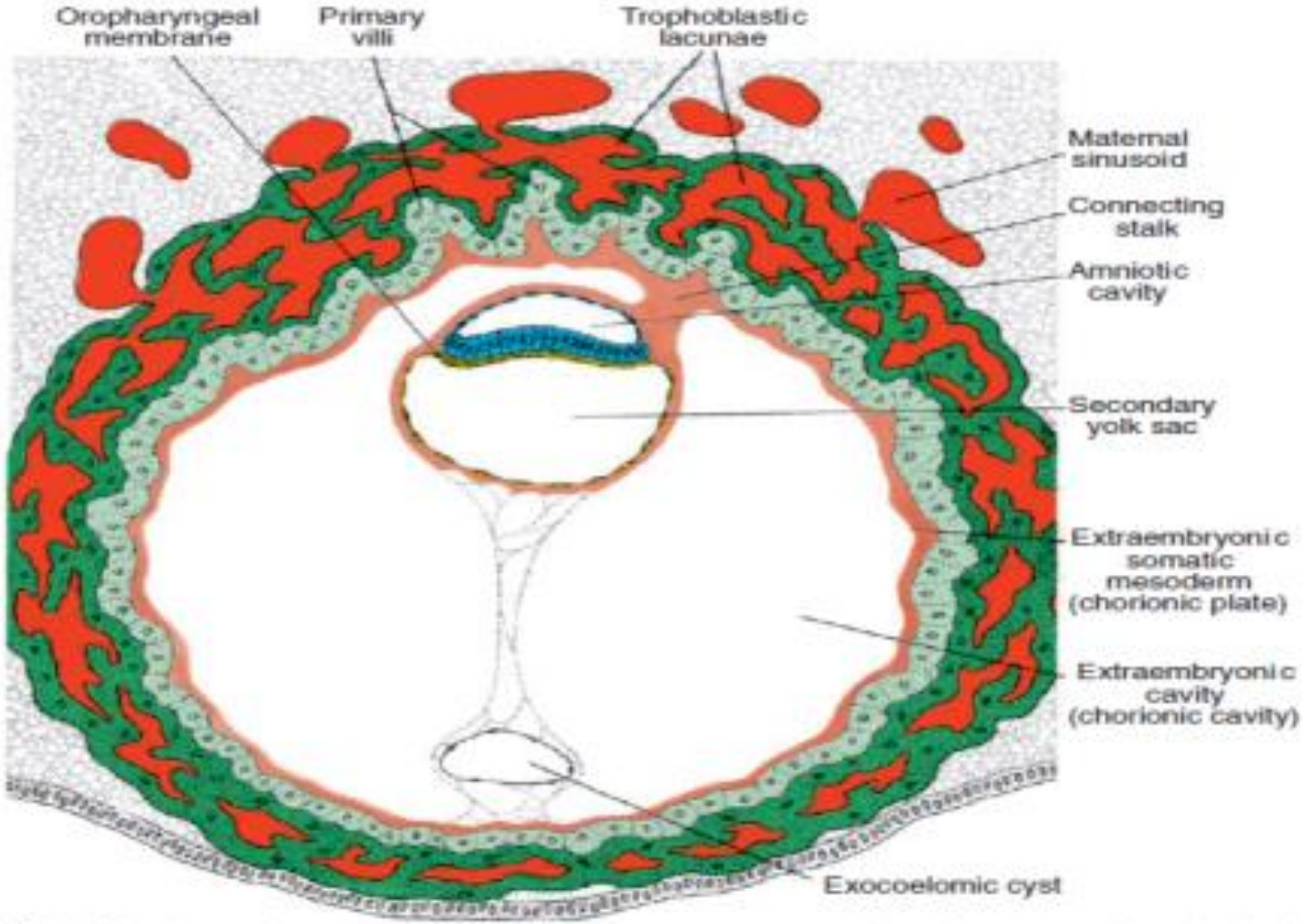
Figure 4.6 A 13-day human blastocyst. Trophoblastic lacunae are present at the embryonic as well as the abembryonic pole, and the uteroplacental circulation has begun. Note the primary villi and the extraembryonic coelom or **chorionic cavity**. The secondary yolk sac is entirely lined with endoderm.

- ***Formation of chorionic plate and amnion***
- The **somatopleuric extraembryonic mesoderm** and the two layers of the trophoblast (the **cytotrophoblast** and **the syncytiotrophoblast**) together form the **chorion**
- The chorion becomes principal embryonic part of the placenta, the structure for exchange of materials between mother and fetus
- Other is the ***amnion*** which is constituted by amniogenic cells forming the wall of the amniotic cavity (excluding the ectodermal floor)
- These cells are derived from the trophoblast
- amnion is covered by the parietal extraembryonic mesoderm, and that the connecting stalk is attached to it

- chorion also protects the embryo and fetus from the immune responses of the mother in two ways:
- (1) It secretes proteins that block antibody production by the mother
- (2) it promotes the production of T lymphocytes that suppress the normal immune response in the uterus
- Finally, the chorion produces human chorionic gonadotropin (hCG), an important hormone of pregnancy
- Inner layer of the chorion eventually fuses with the amnion.
- With the development of the chorion, the extraembryonic coelom is now referred to as the **chorionic cavity**

- ***Formation of connecting stalk***
- extraembryonic coelom does not extend into that part of the extraembryonic mesoderm which attaches the wall of the amniotic cavity to the trophoblast
- developing embryo, with the amniotic cavity and the yolk sac, is now suspended in the extraembryonic coelom, and is attached to the wall of the blastocyst unsplit part of the extraembryonic mesoderm
- By the end of the 2nd week bilaminar embryonic disc is connected to the trophoblast by a band of extraembryonic mesoderm called the **connecting (body) stalk** the future umbilical cord
- With development of blood vessels, the stalk becomes the **umbilical cord.**


Amnion
Amniotic cavity
Yolk sac
Cytotrophoblast
Connecting stalk
Bilaminar embryonic disc:
Epiblast
Hypoblast
Extraembryonic mesoderm
Uterine cavity



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- ***Circular embryonic disc*:**
- At this stage, the embryo proper is a circular disc composed of two layers of cells:
- (1) the upper layer (toward amniotic cavity) is the epiblast, the cells of which are columnar
- (2) the lower layer (toward yolk sac) is the hypoblast, made up of cubical cells.
- There is no indication yet of a head or tail end of the embryonic disc

The second week of development is the week of twos, because of the following:

- The trophoblast differentiates into 2 layers, cytotrophoblast & syncytiotrophoblast
- The inner cell mass differentiates into 2 layers, epiblast & hypoblast.
- The primary mesoderm splits into somatopleuric primary mesoderm & splanchnopleuric primary mesoderm.
- Starting of formation of the amniotic and yolk sac cavities.

Clinical application

- The syncytiotrophoblast secretes human chorionic gonadotrophin hormone (β-hCG) which prevents the degeneration of the corpus luteum.
- It also stimulates the production of progesterone which in turn is important in sustaining the placenta.
- By the end of the 2nd week, the amount of this hormone will be sufficient to be detected in the maternal blood and urine.
- This is the basis of pregnancy test

Home pregnancy test

Abnormal Implantation

Abnormal implantation sites of the blastocyst:

1. implantation in the abdominal cavity. The ovum most frequently implants in the rectouterine cavity (Douglas' pouch) but may implant at any place covered by peritoneum.

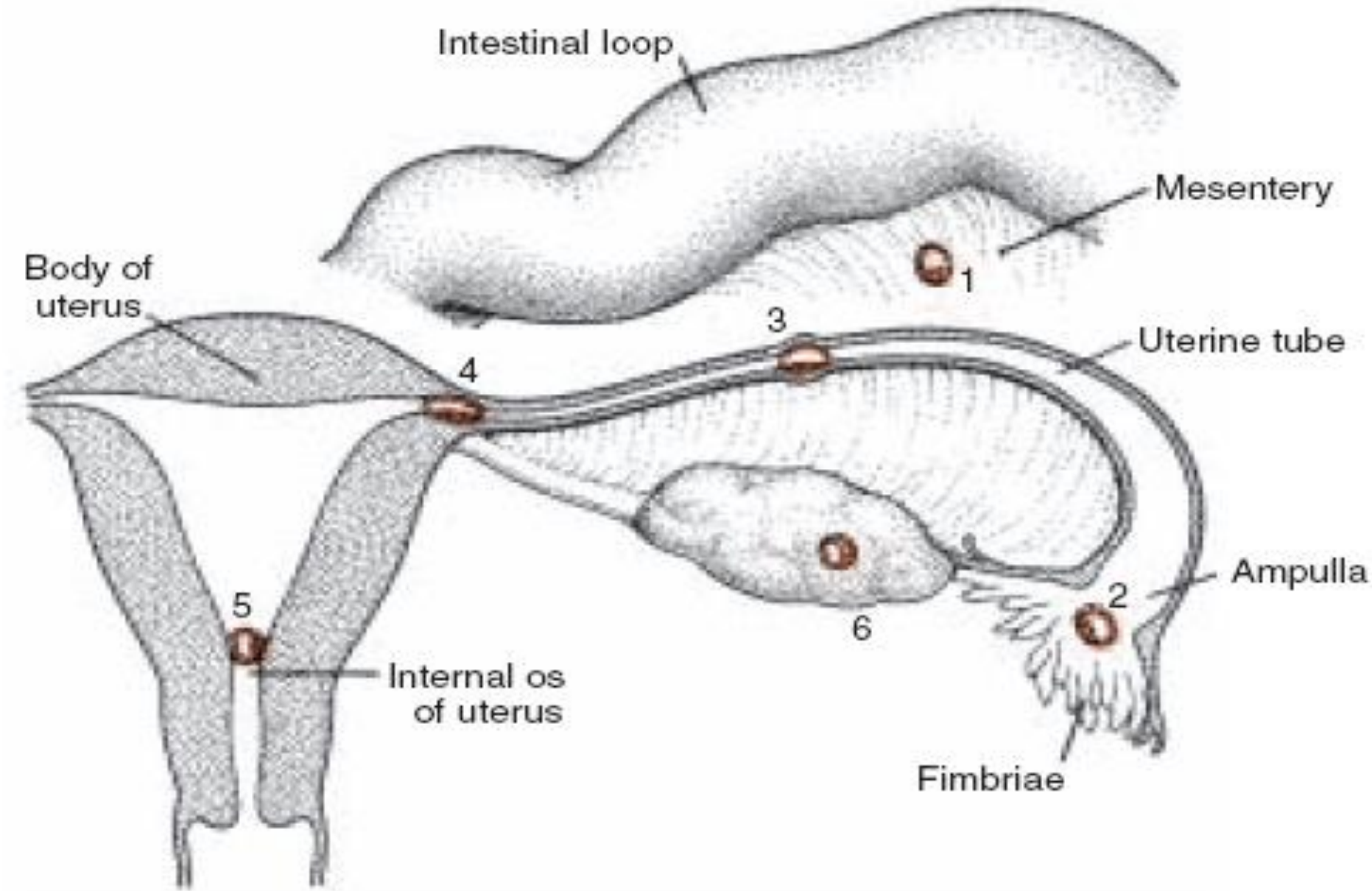
2. implantation in the ampullary region of the tube.

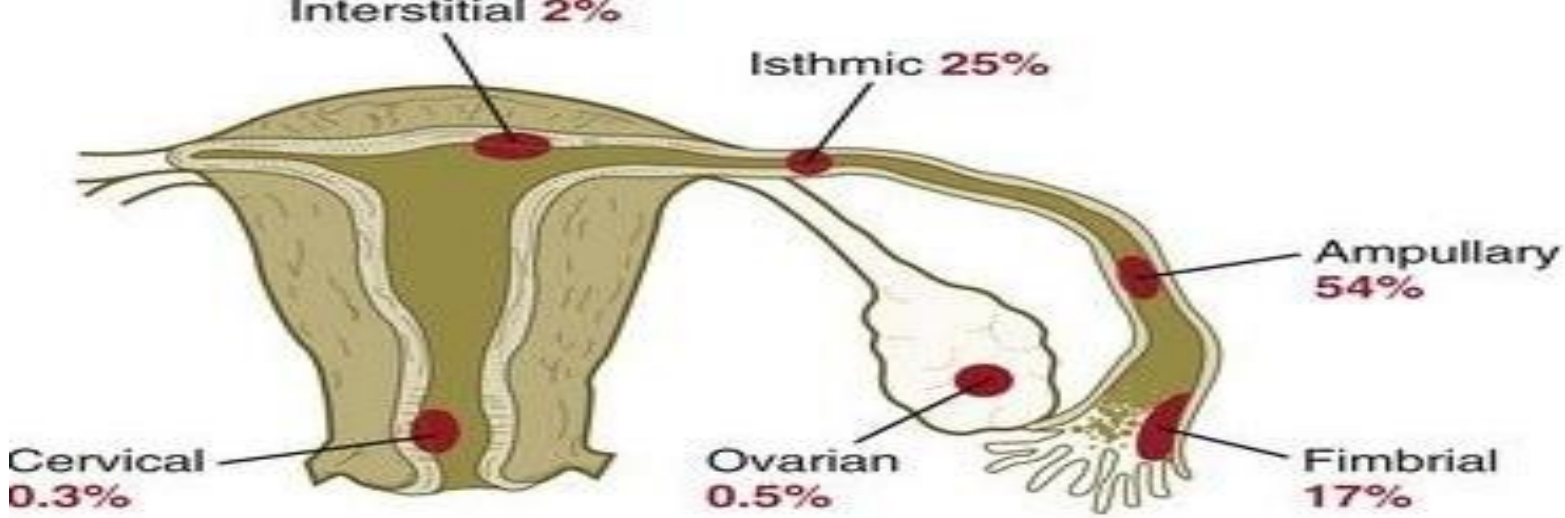
3. tubal implantation.

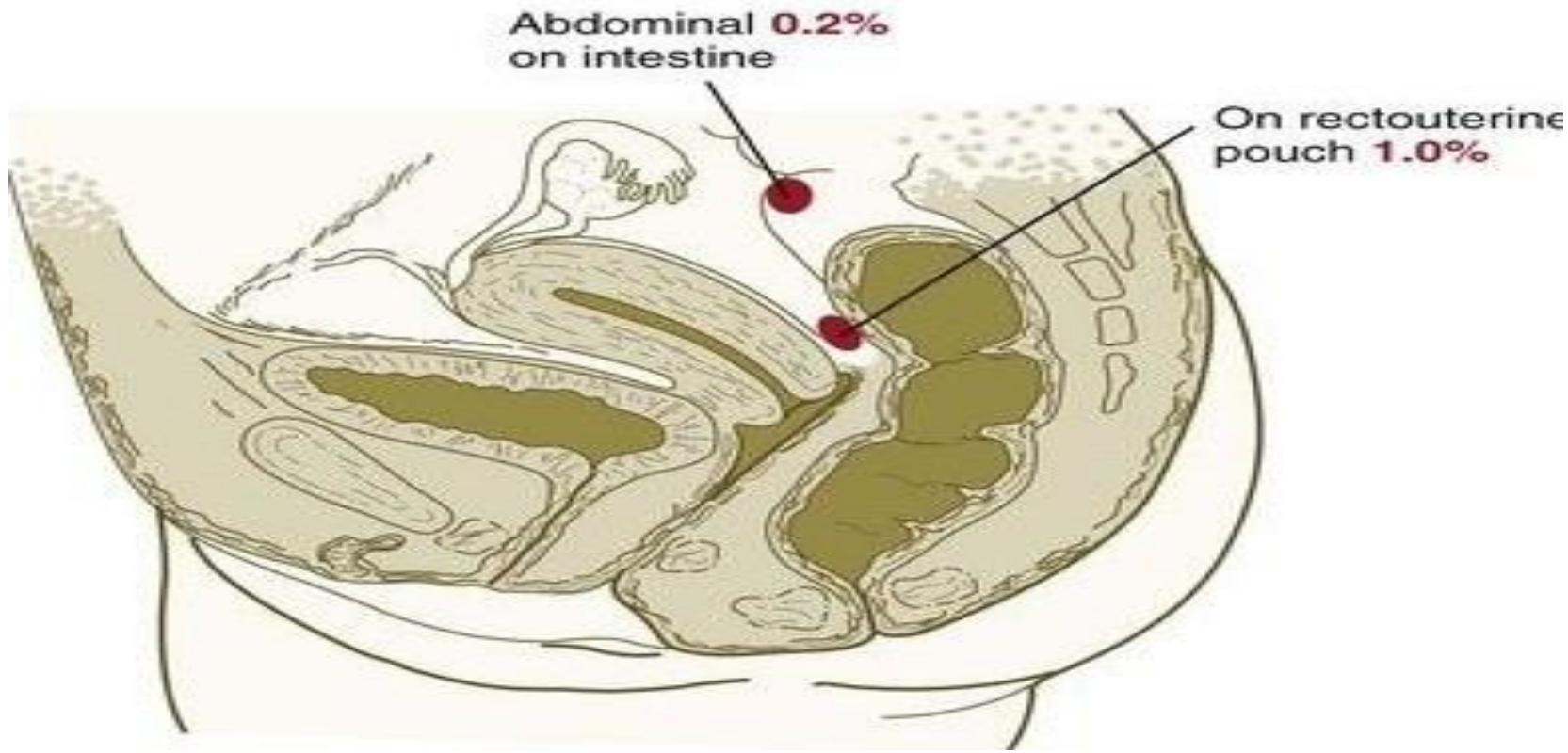
4. interstitial implantation, that is, in the narrow portion of the uterine tube.

5. implantation in the region of the internal os, frequently resulting in placenta previa.

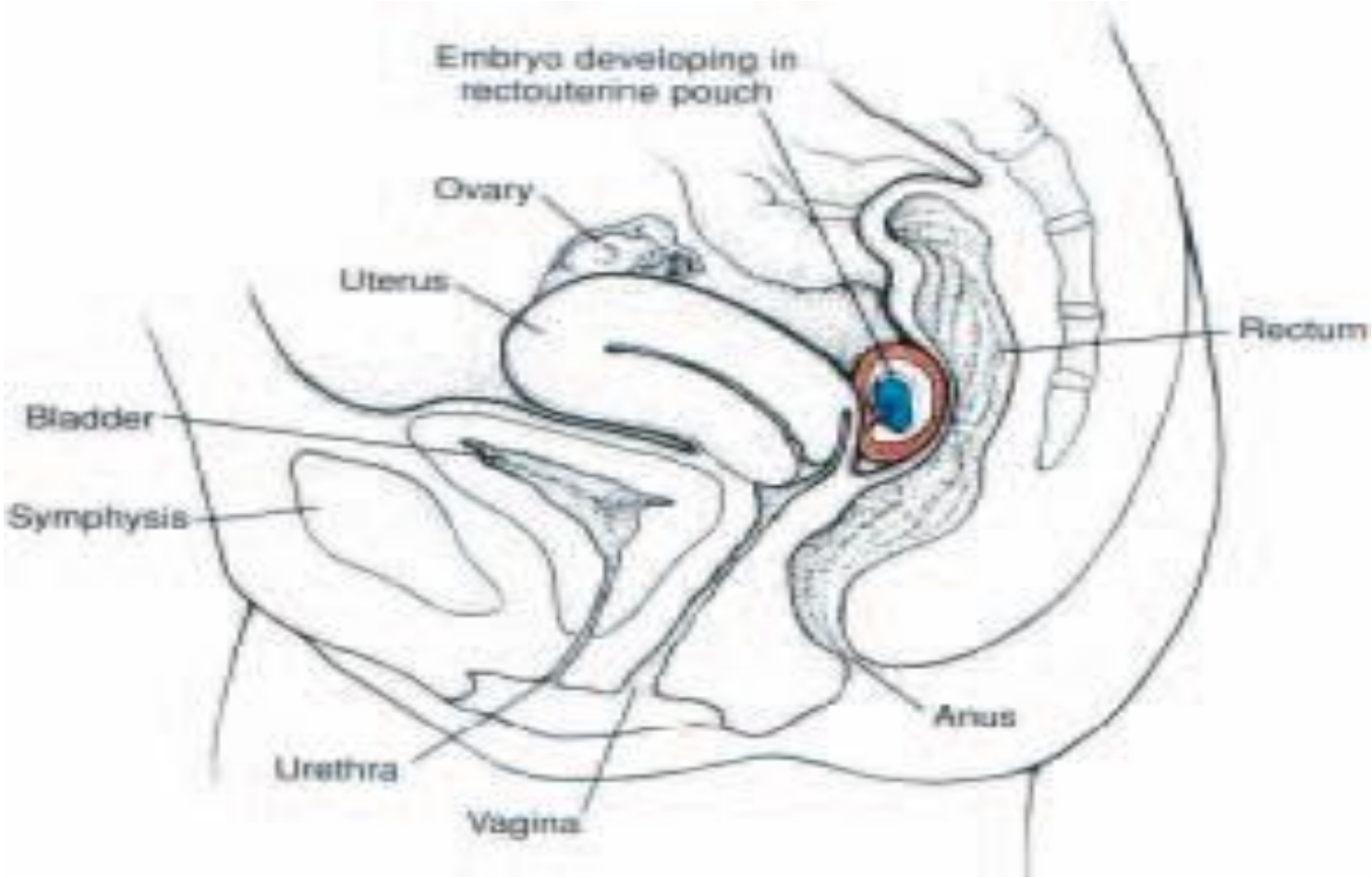
6. ovarian implantation.


Intestinal loop
Mesentery
Body of uterus
1
3
Uterine tube
4
Ampulla
2
6
5
Internal os of uterus
Fimbriae


Interstitial 2%
Isthmic 25%
Ampullary
54%
Cervical
0.3%
Ovarian
0.5%
Fimbrial
17%


Abdominal 0.2%
on intestine
On rectouterine
pouch 1.0%

Abnormal Implantation



Sagital section of bladder, uterus, and rectum to show an abdominal pregnancy in the rectouterine (Douglas') pouch

Molar Pregnancy

- Molar pregnancies are categorized into: ***partial*** and ***complete moles***:

  complete moles have no identifiable embryonic or fetal tissues and arise when an empty egg with no nucleus is fertilized by a normal sperm,

  a partial mole occurs when a normal egg is fertilized by two spermatozoa
- hydatidiform mole: because of its trophoblastic origin secrete human chorionic gonadotropin (hCG) and mimics the initial stages of pregnancy.

- Most moles are aborted early in pregnancy

Clinical application

- tissue present in the uterus, and embryo-derived cells are either absent or present in small numbers
- In some cases, trophoblastic tissue is the only
- Such a condition is termed a hydatidiform mole