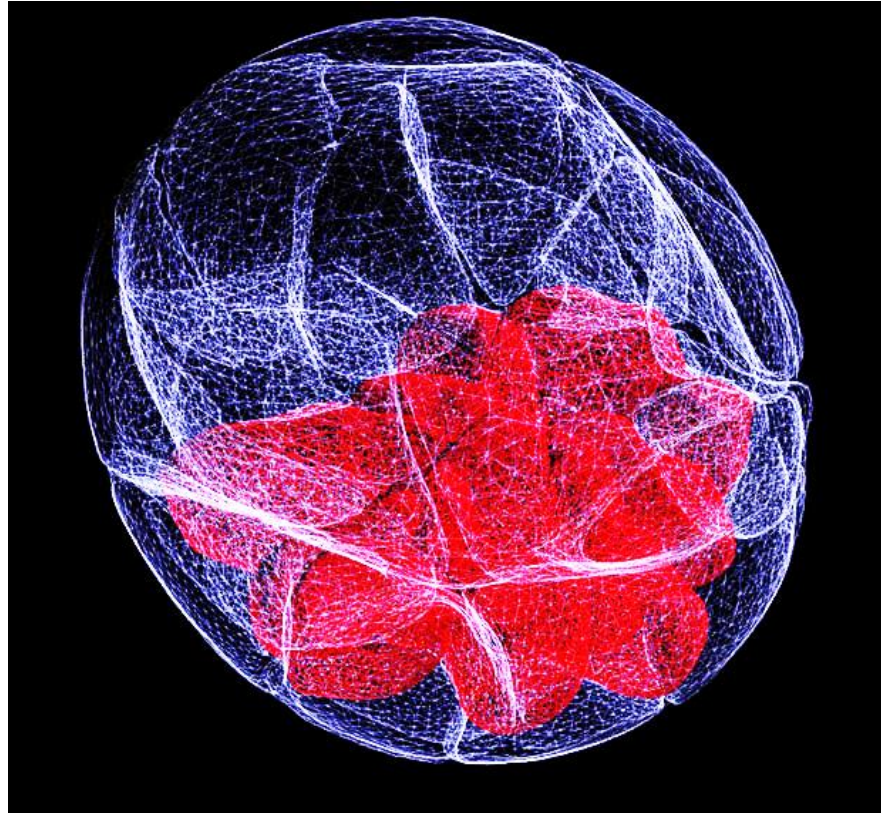


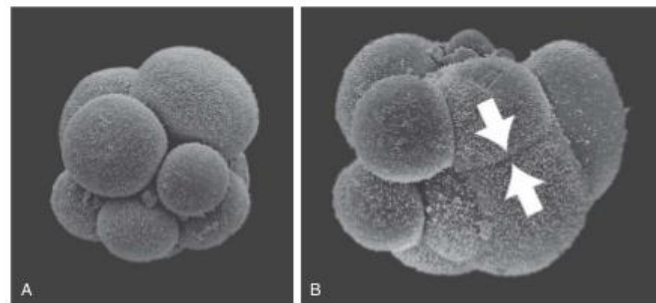
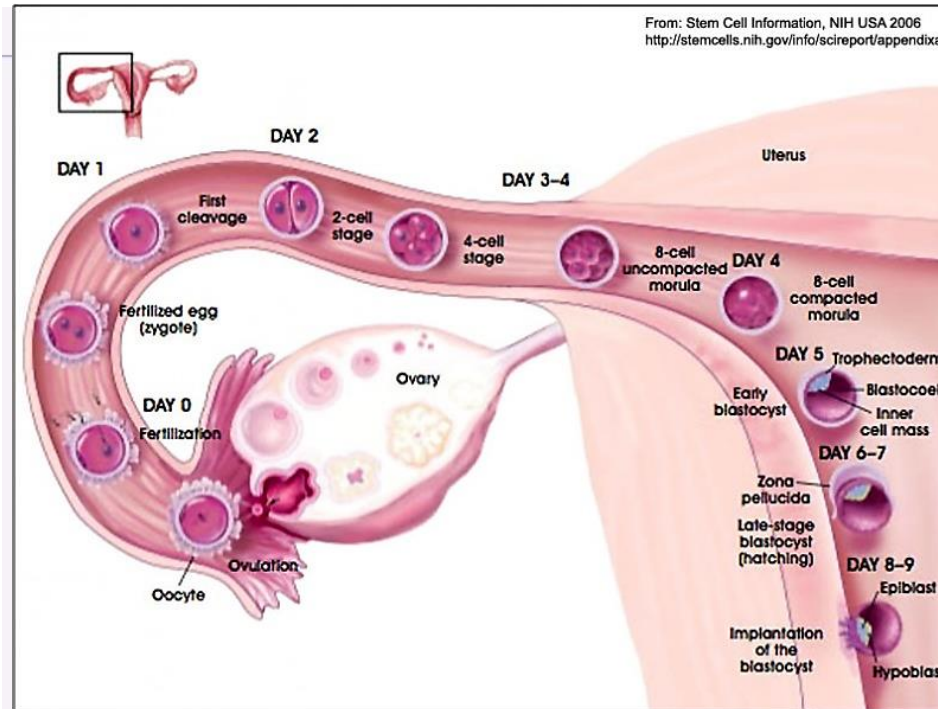
# Blastulation, implantation, decidua



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Semmelweis University, Department of Anatomy, Histology and Embryology

# Development of the morula



**Figure 1-17.** Compaction. *A*, Scanning electron micrograph of 10-cell human embryo before compaction. Note deep intercellular clefts. *B*, Scanning electron micrograph of 10-cell human embryo during process of compaction. Note absence of deep intercellular clefts between some of the blastomeres (arrows). The zona pellucida was mechanically removed from both embryos.

# The blastocyst

abembryonic pole



embryonic pole

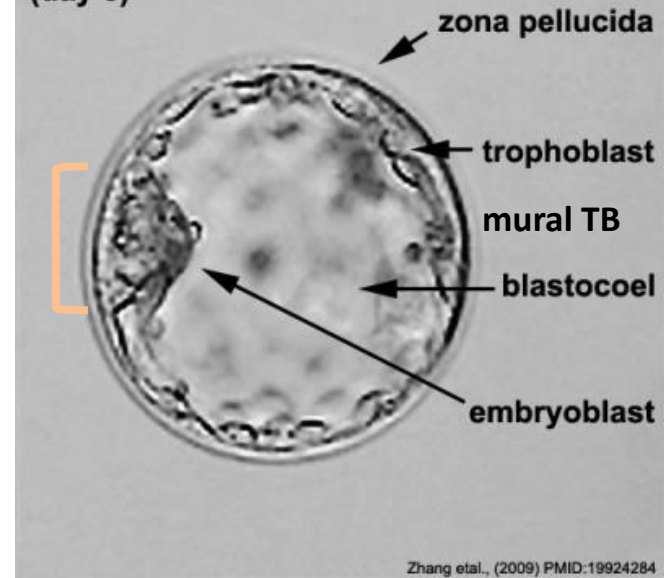
Inner cell mass  
(epithelial cells)

Outer cell mass (epithelial cells)

Active: Na<sup>+</sup> pumps, passive: blastocoelic fluid

**Human Blastocyst**  
(day 5)

polar TB



zona pellucida

trophoblast

mural TB

blastocoel

embryoblast

Zhang et al., (2009) PMID:19924284

## Trophoblast (TB):

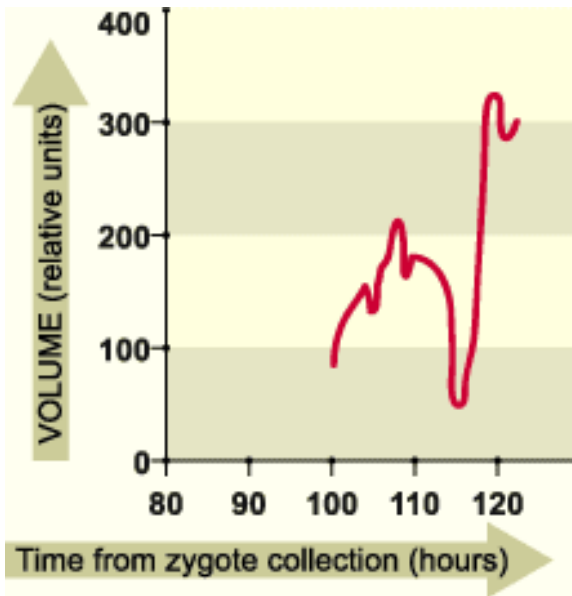
- outermost fetal membrane (chorion)
- fetal side of the placenta

## Embryoblast:

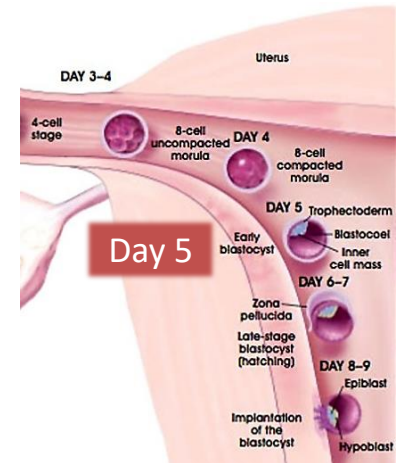
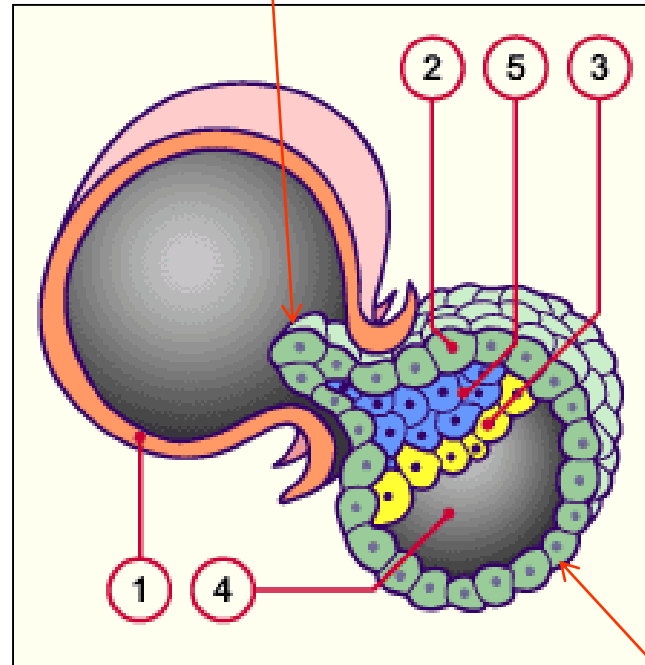
germ layers,  
innermost fetal membrane (amnion)

**Blastocoel:** fluid – filled cavity in the blastocyst

# Hatching is prerequisite ( 5th day) to implantation



polar trophoblast



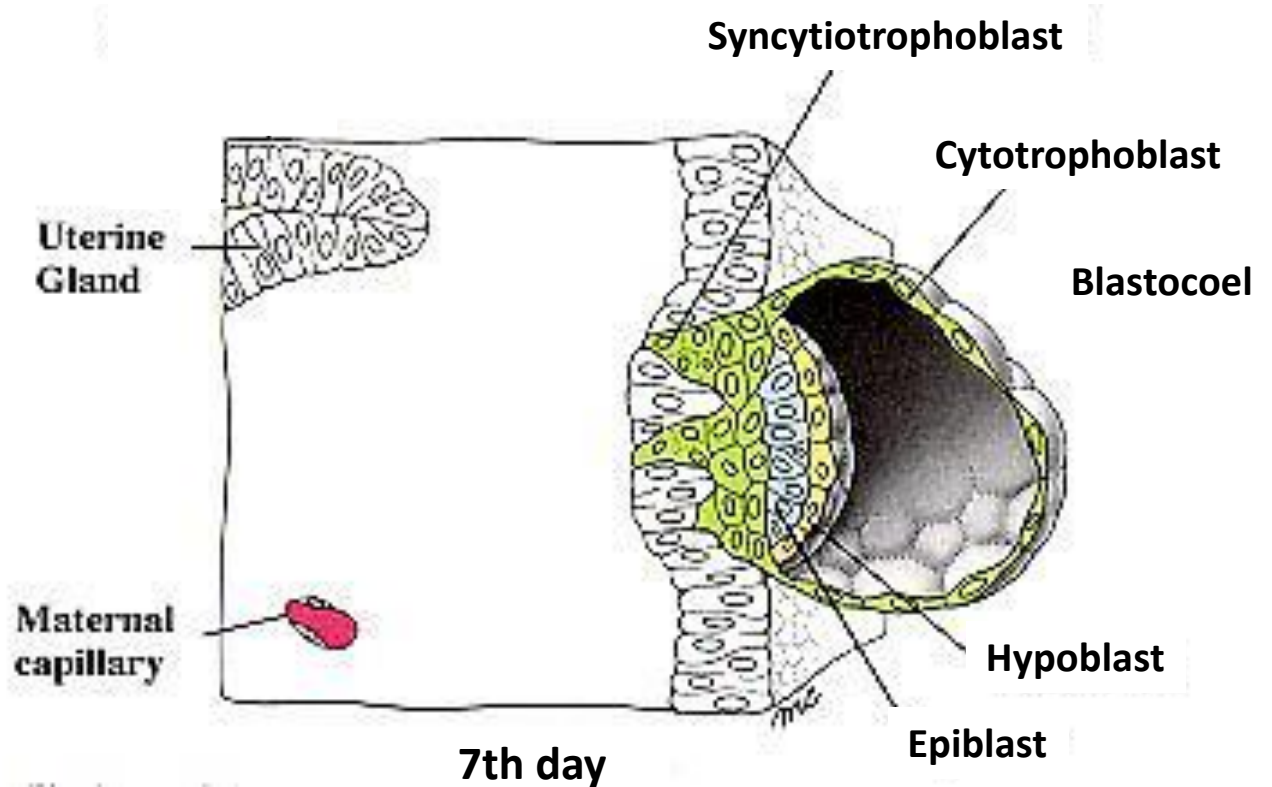
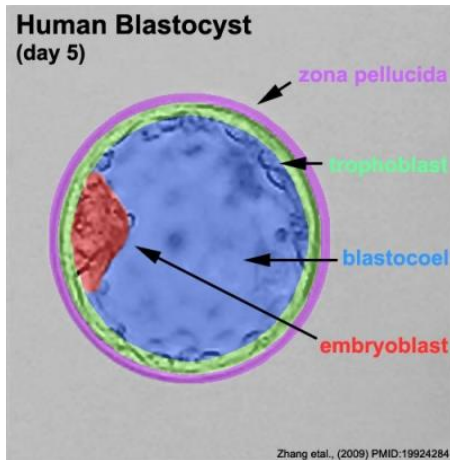
1. Zona pellucida
  2. Trophoblast
  3. Hypoblast
  4. Blastocoel
  5. Epiblast
- mural trophoblast

## Advantages of hatching :

- further growing is not restricted
- more efficient absorption of nutrients
- attachment, implantation



# Differentiation of the trophoblast and the embryoblast



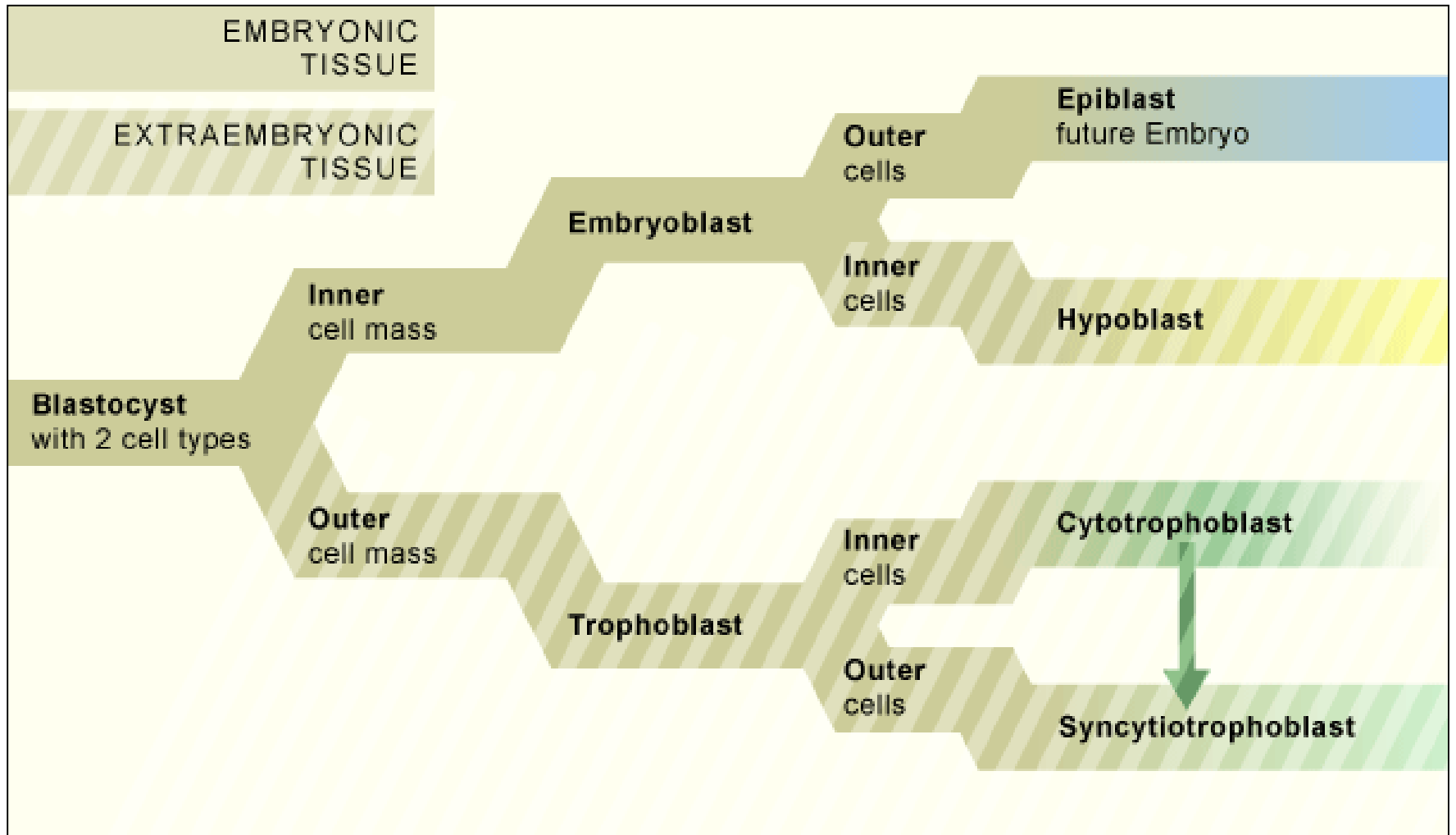
## Trophoblast:

- syncytiotrophoblast (external layer, multinuclear)
- ↑ cytotrophoblast, internal layer, mitotic activity, mononuclear

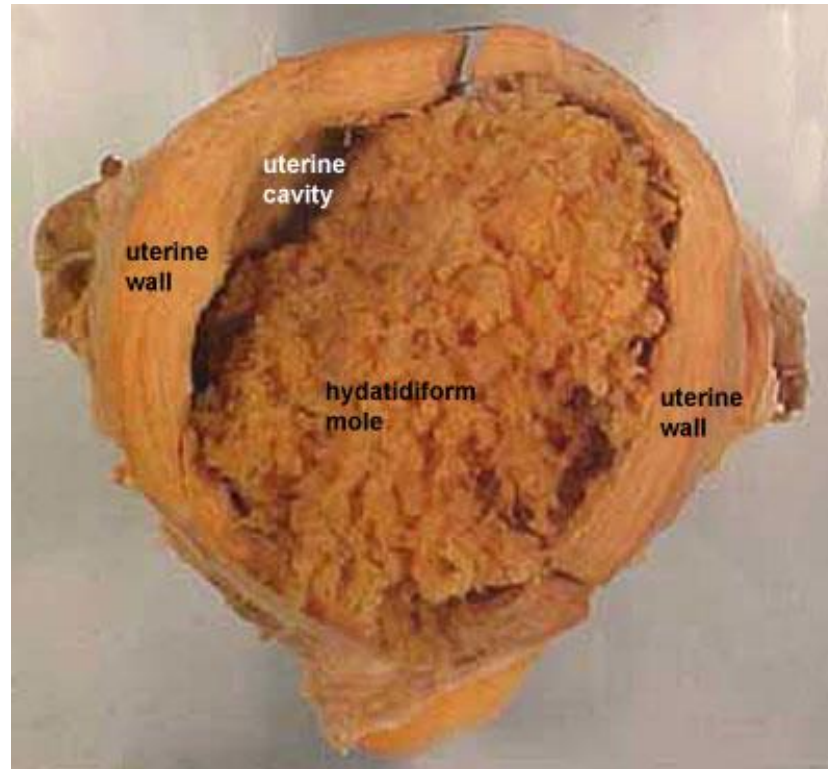
## Embryoblast → bilaminar germ disk

- epiblast layer (columnar cells → future embryo)
- hypoblast layer (cuboid cells → extraembryonic tissues)





# Molar pregnancy



## Hydatidiform Mole

### Hydatidiform Mole

- Partial ( $3n$  or  $4n$ ) or complete molar (CM) pregnancy ( $2n$ , androgenetic: only paternal genes)
- abnormal placenta and some, or no fetus

### Gestational trophoblastic tumors:

- **Invasive mole** (chorioadenoma destruens) - a type of neoplasm, benign
- **Choriocarcinoma** – 16% of patients with CM proceed to develop malignant disease
- **Placental site trophoblastic tumor**, benign or malign.

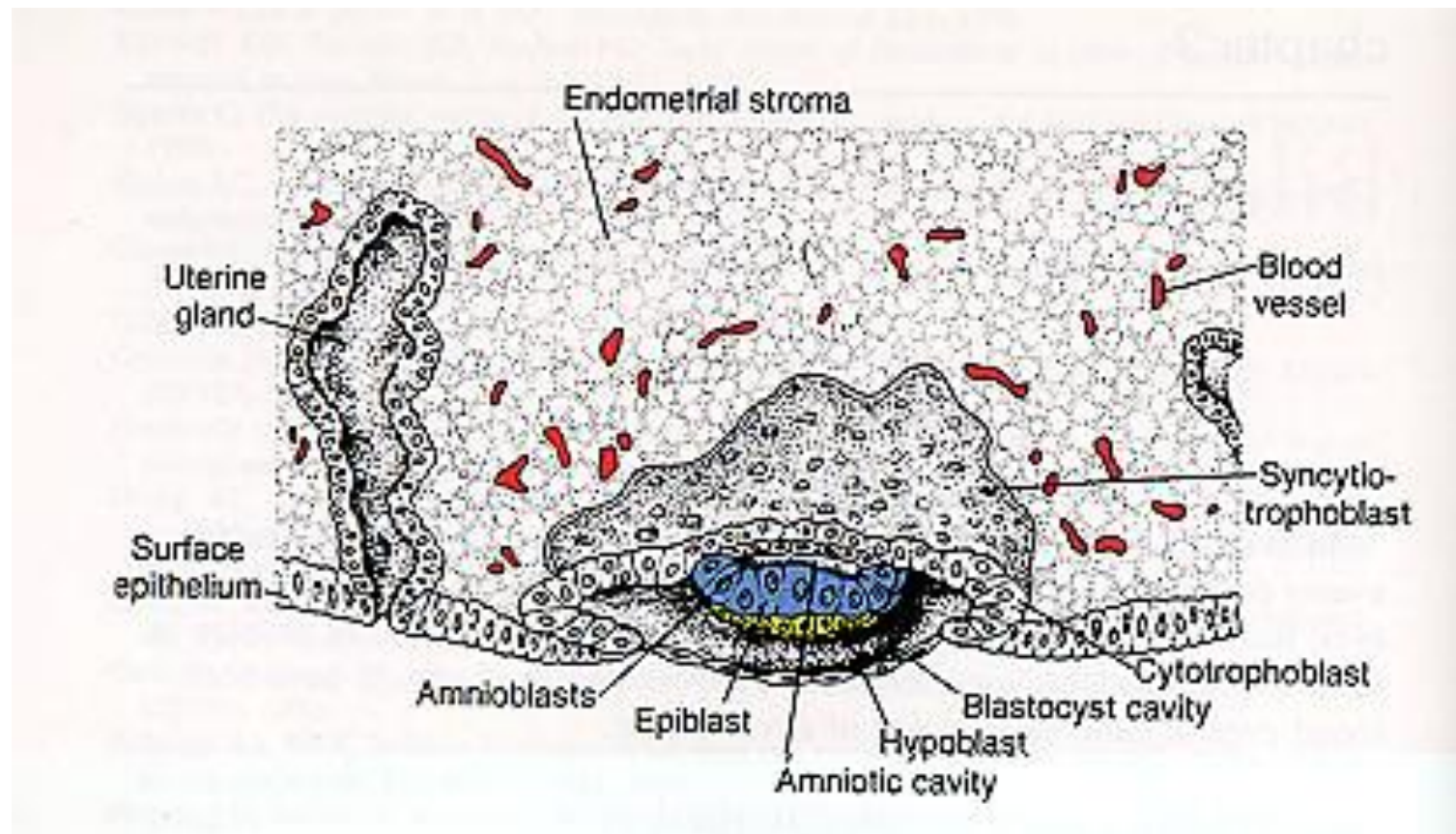


Implantation: 6th -7th day

Implantation: 6th -7th day

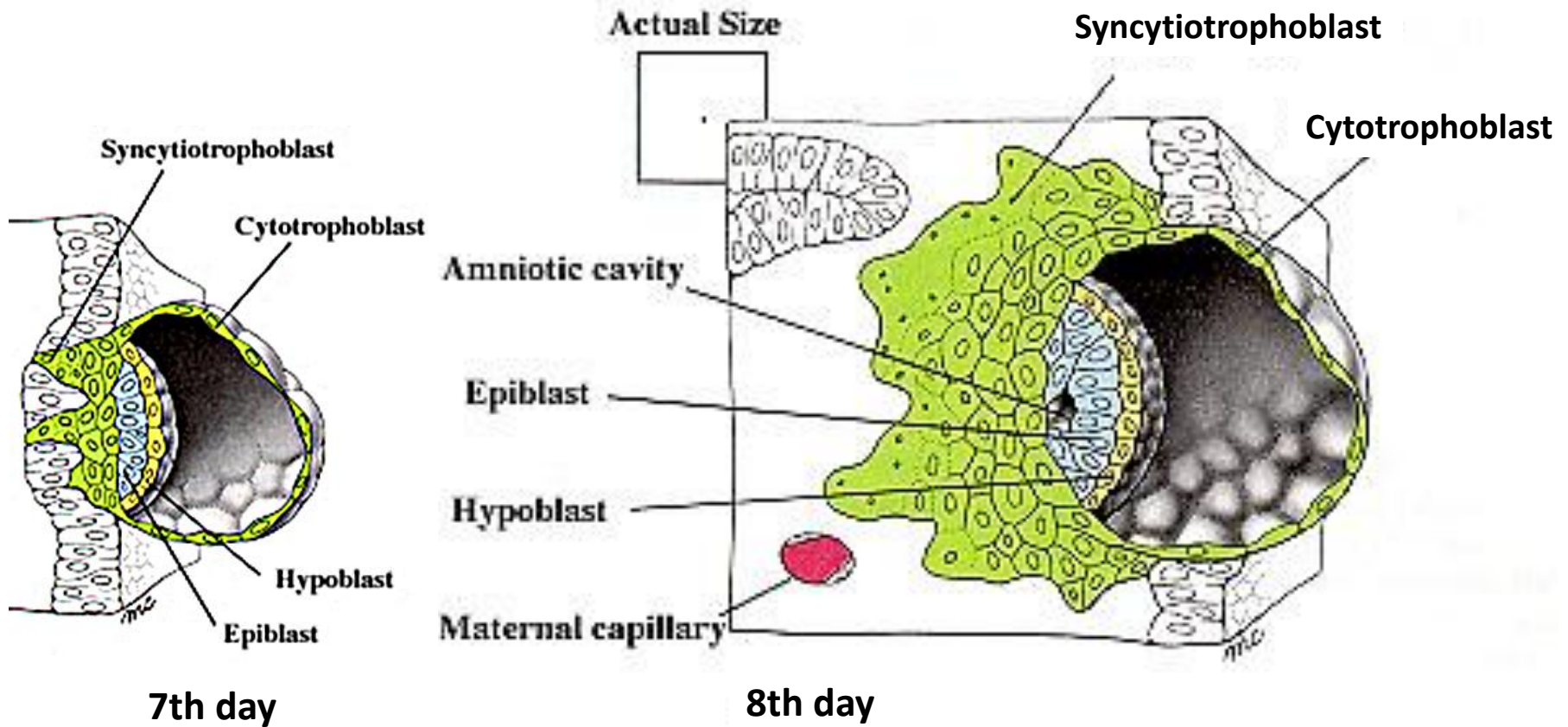
Implantation: 6th -7th day

# Implantation



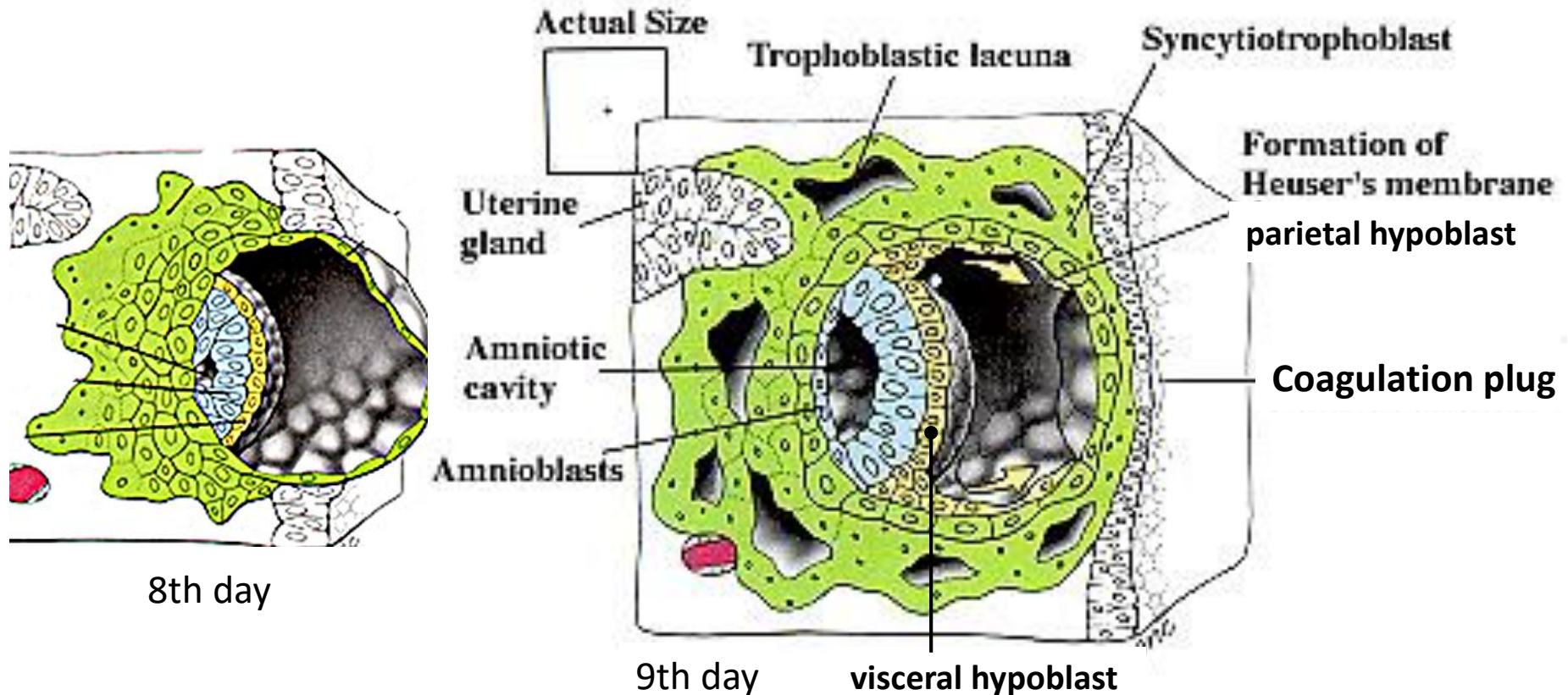
- ST continues its invasive activity
- Blastocyst secretion: secretions loosen decidual cells from each other
- Total implantation lasts approximately 11-14 days

# The amniotic cavity forms within the epiblast



**Implantation:** as the syncytiotrophoblast grows covers the blastocyst more and more.

# Proliferation of amnioblasts and the Heuser's membrane



**Amnioblast:** a cell layer separating the amniotic cavity from the cytotrophoblast

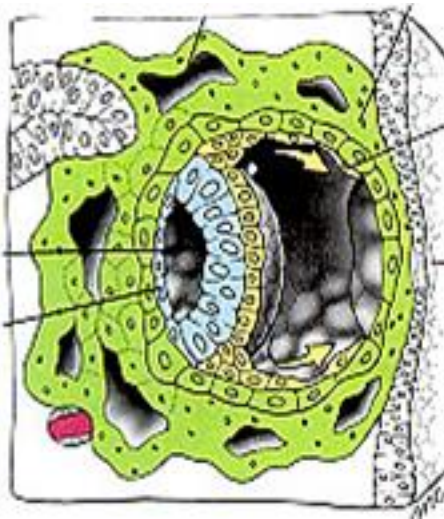
**Heuser's membrane:** parietal hypoblast cells along the cytotrophoblast

**Implantation:**

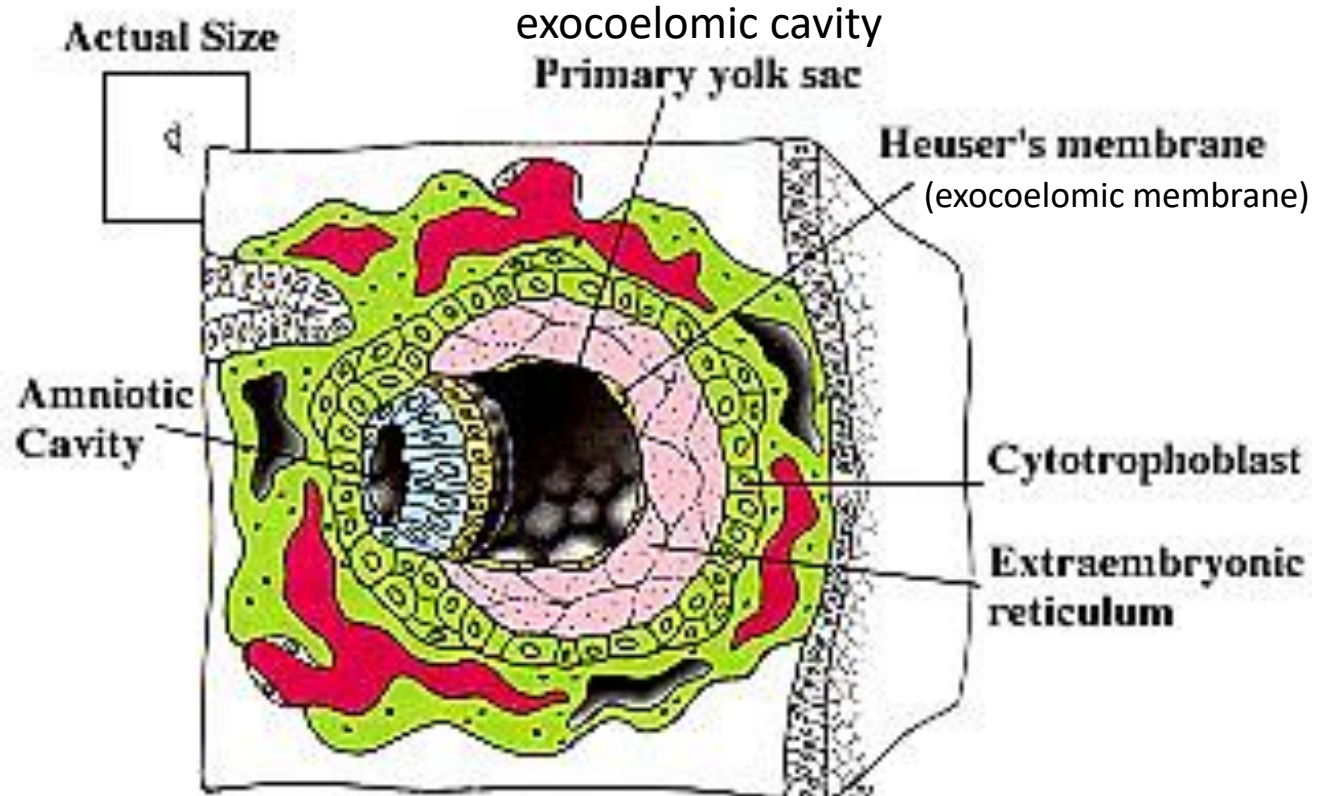
- The syncytiotrophoblast is all around the conceptus, lacunae develop in ST
- A transient coagulation plug appears in the endometrial surface



# The primary yolk sac



9th day



10th-11th days

- An acellular extraembryonic reticulum forms between Heuser's membrane and the mural cytotrophoblast

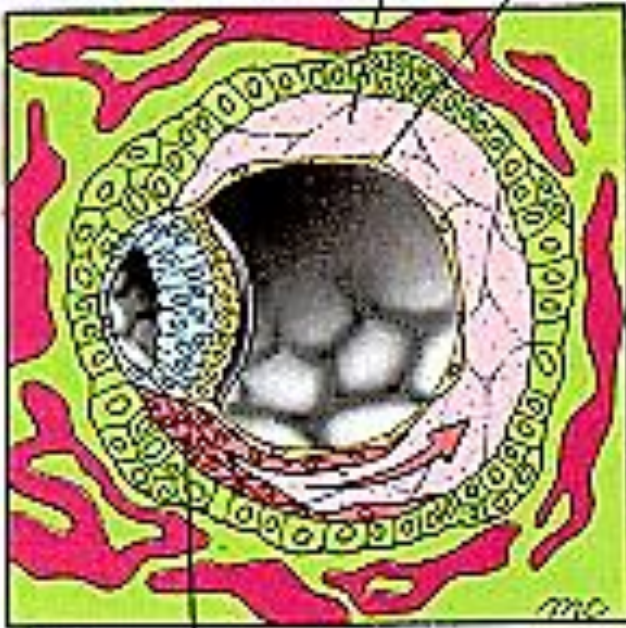
**Implantation:** lacunae in ST fuse together with sinusoids in the decidua- **uteroplacental circulation starts**

# The extraembryonic mesoderm

11th-12th days

Extraembryonic reticulum

Heuser's membrane

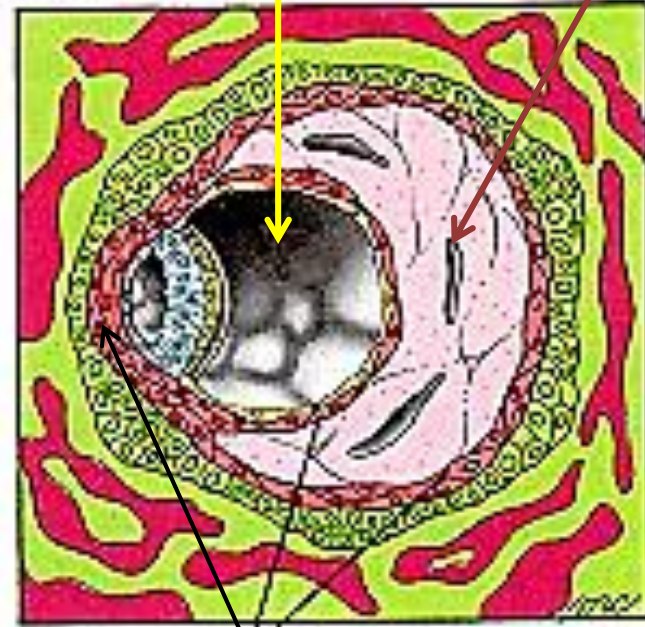


Epiblast proliferating to form extraembryonic mesoderm

primary yolk sac

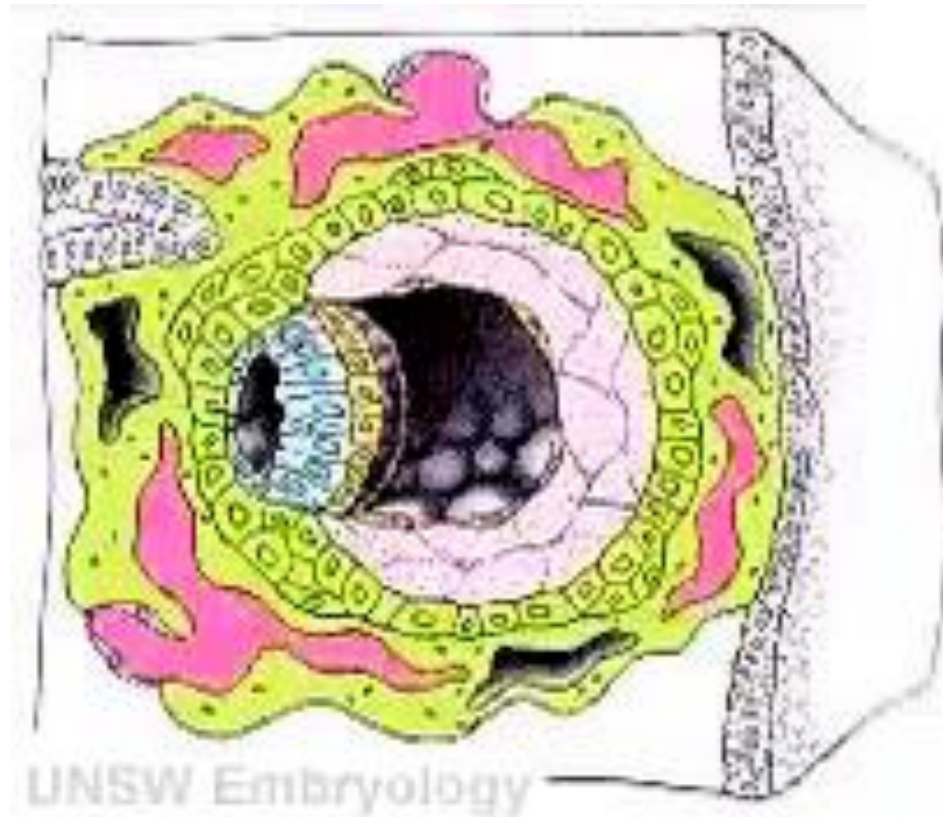
Exocoelomic cavity

lacunae



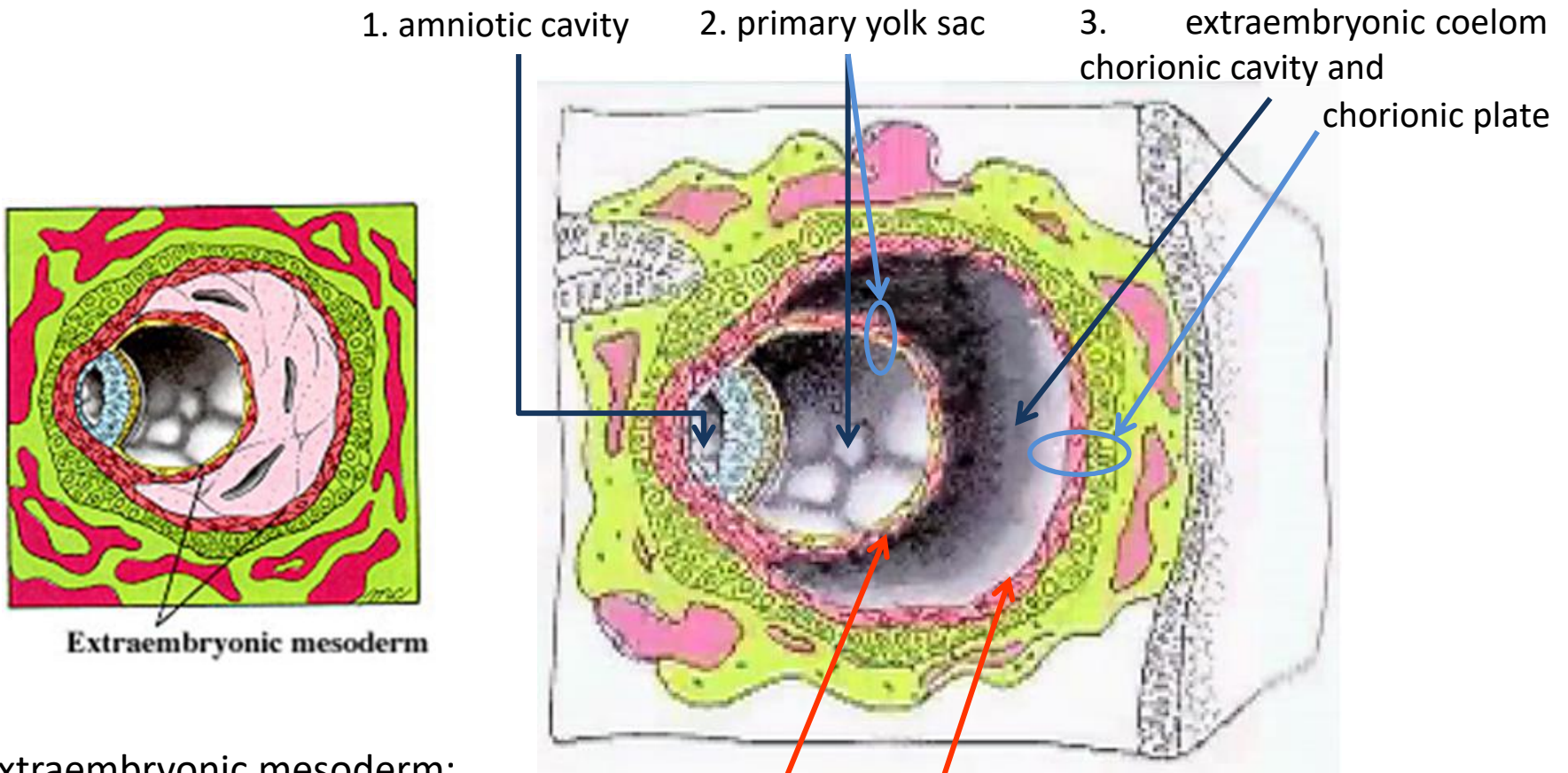
Extraembryonic mesoderm

**The extraembryonic coelom forms within the extraembryonic mesoderm**





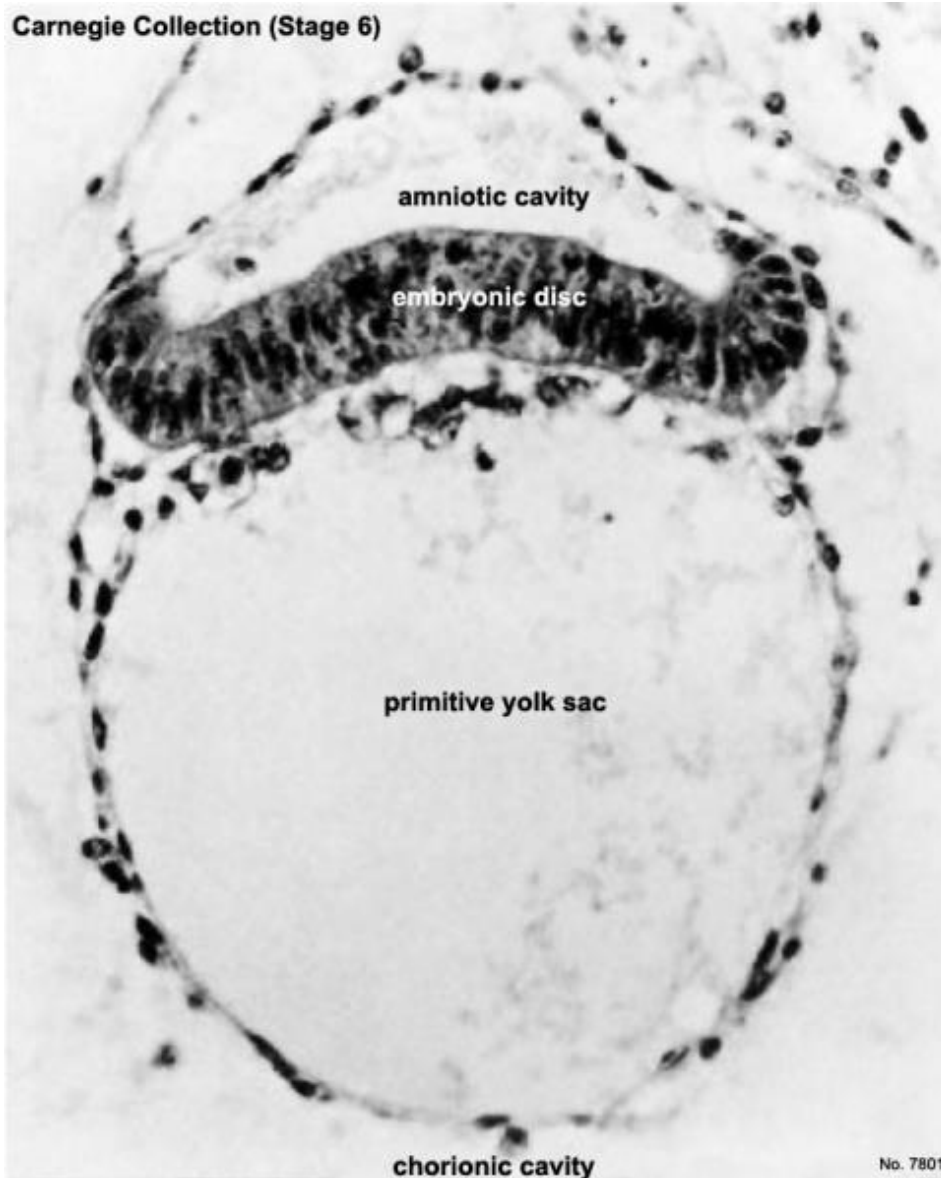
# The extraembryonic coelom forms within the extraembryonic mesoderm



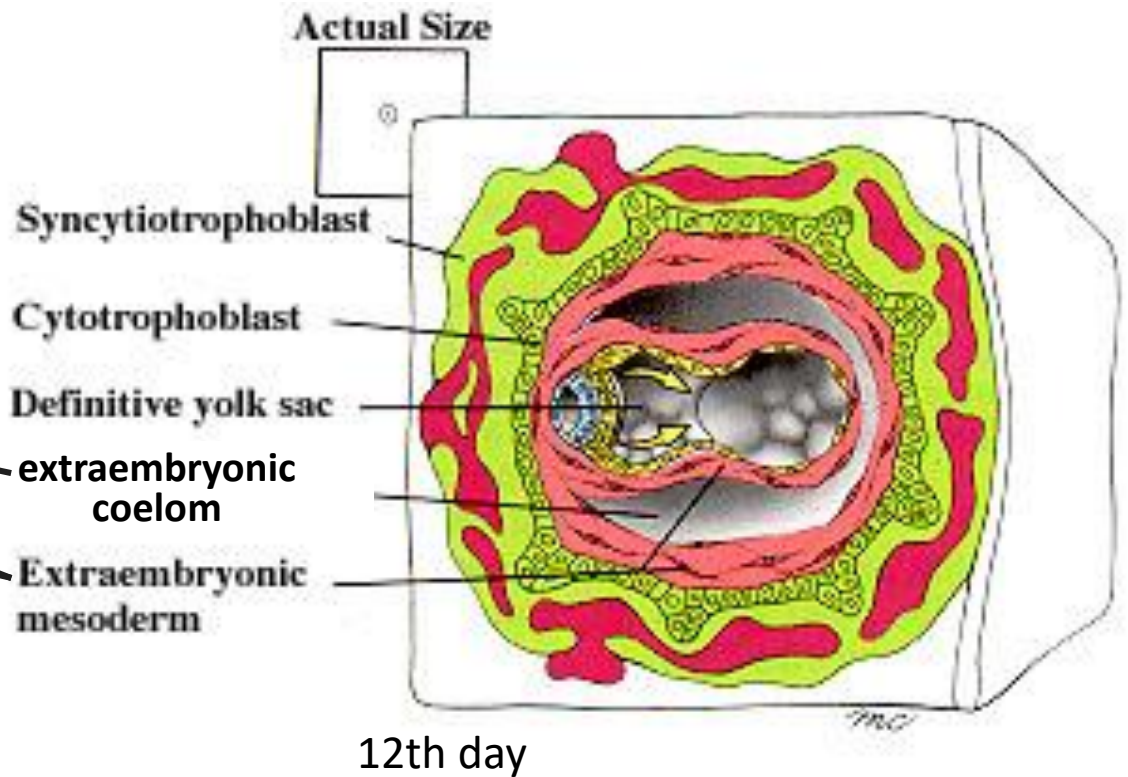
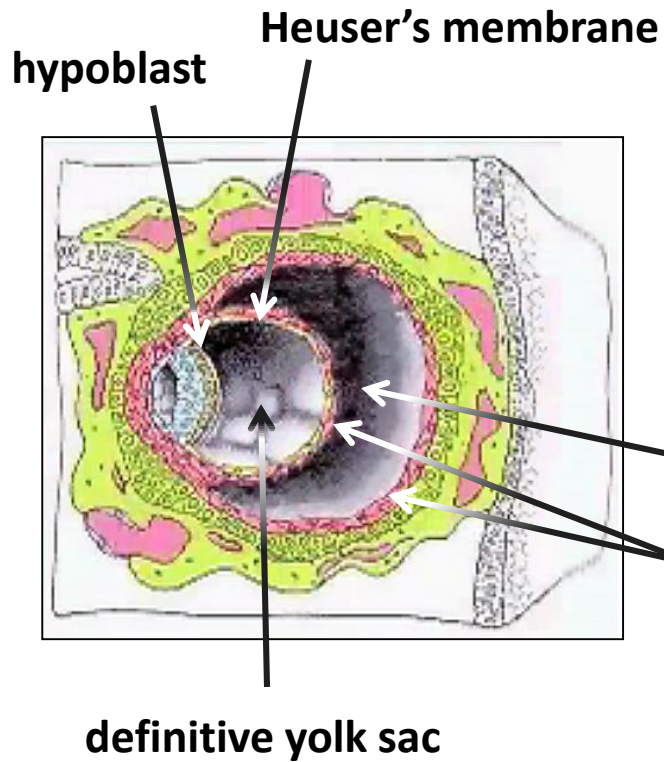
Extraembryonic mesoderm:

1. extraembryonic splanchnopleuric mesoderm
2. extraembryonic somatopleuric mesoderm

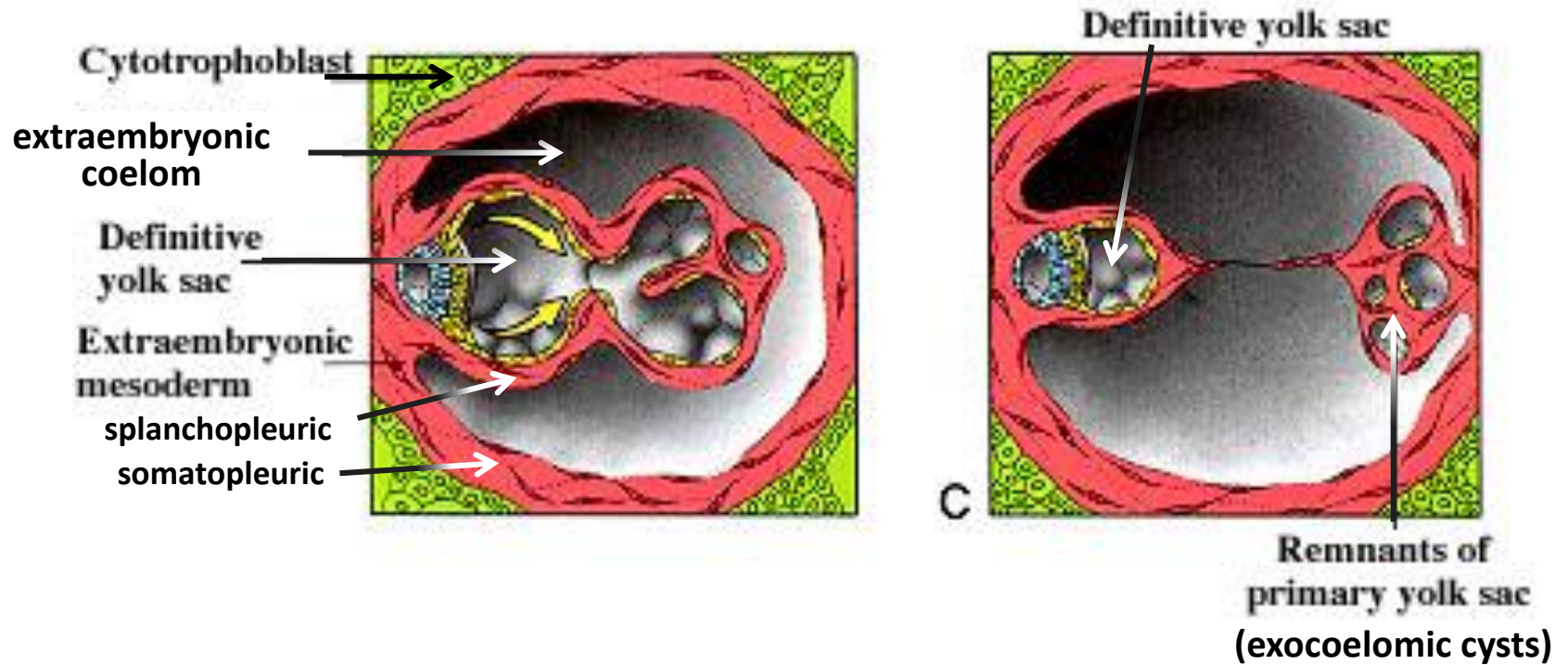
# Conceptus at the end of week 2



# Differentiation of the hypoblast



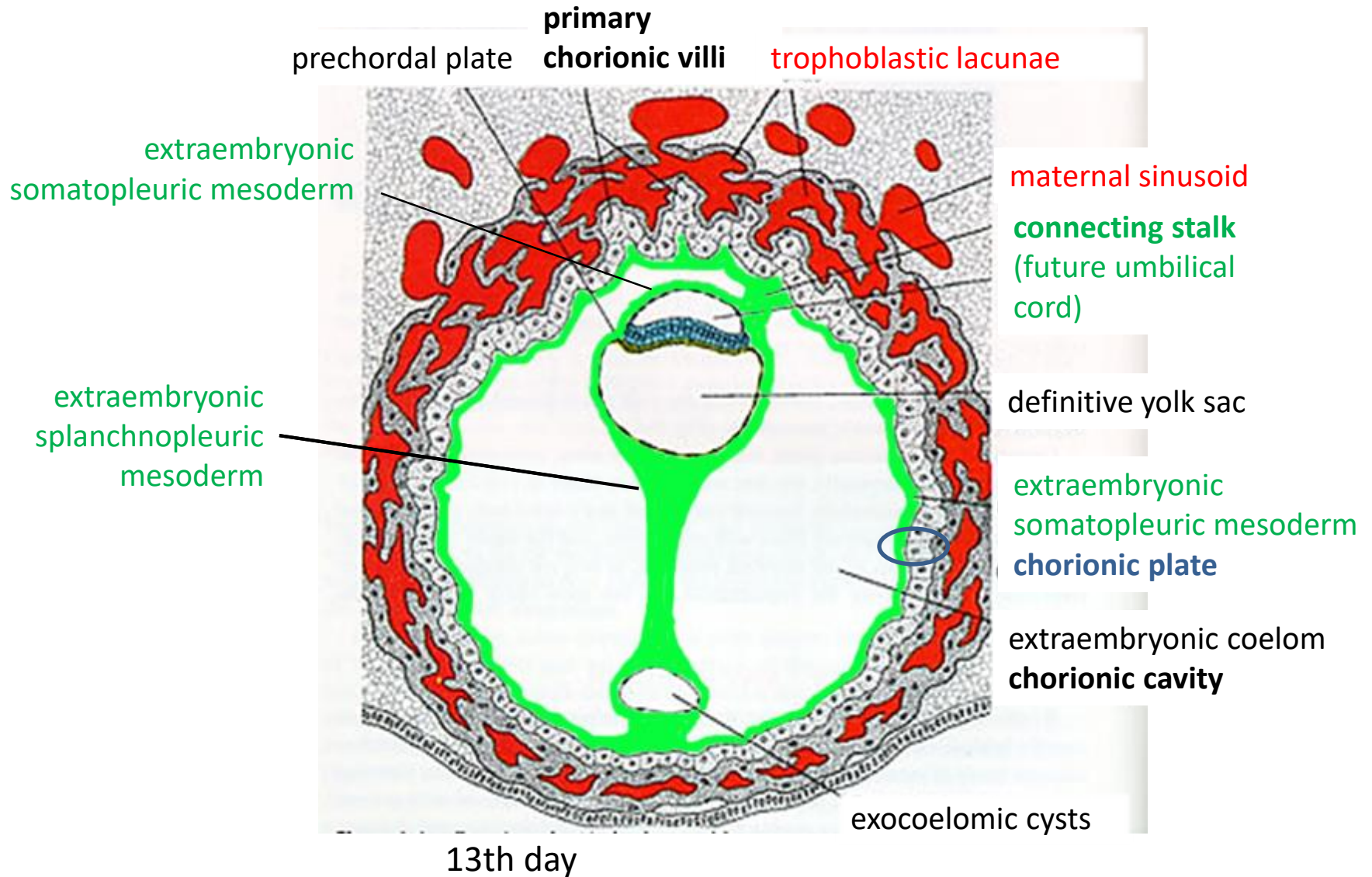
# Regression of the primary yolk sac



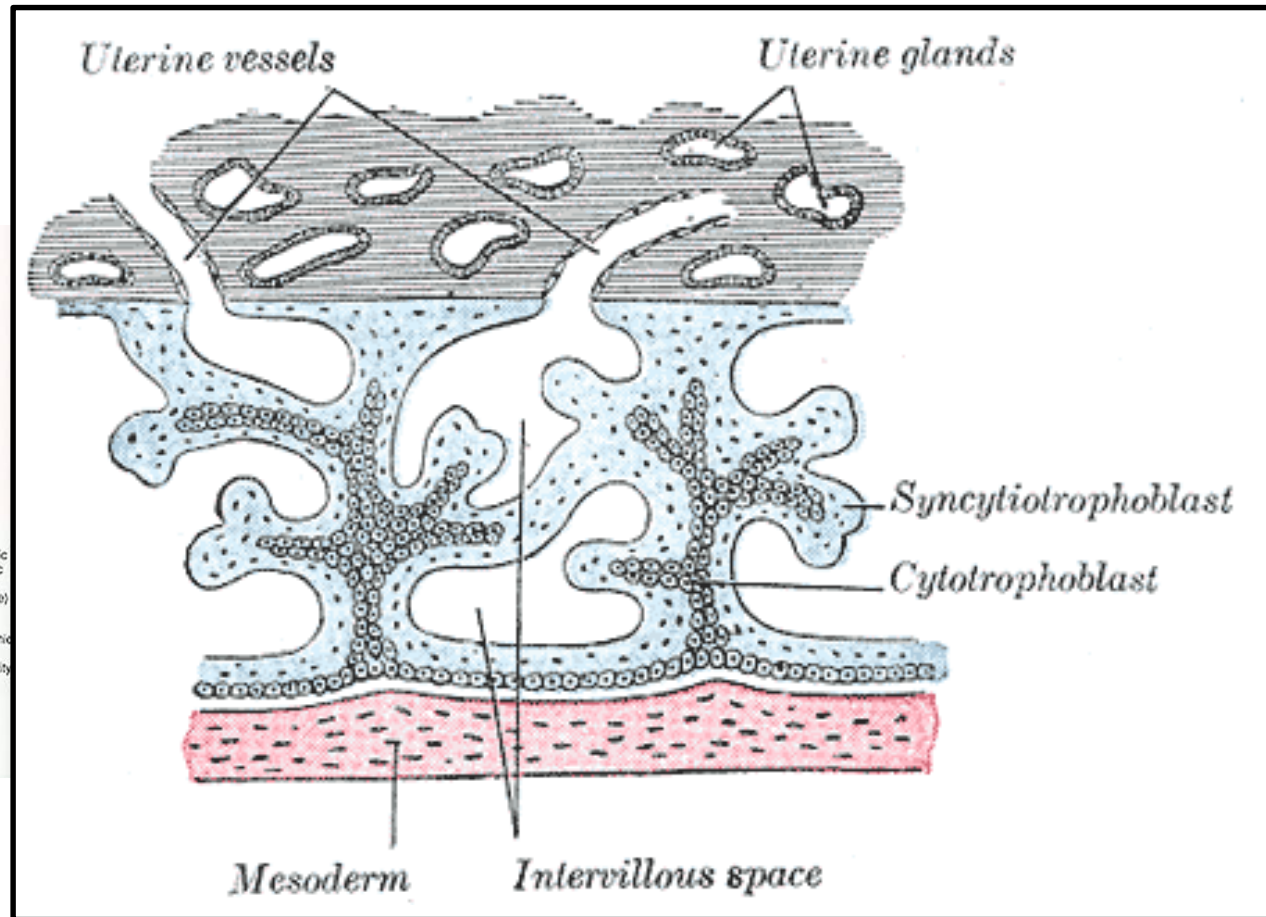
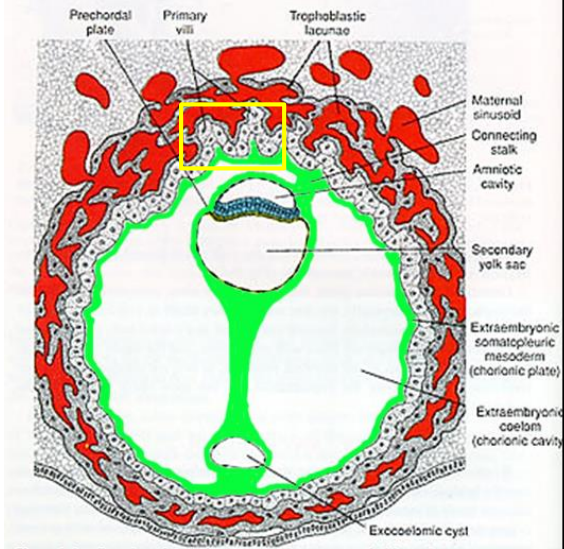
12th-13th days



# 13 day Blastocyst



# Primary chorionic villi at the end of Week 2



- Before the uteroplacental circulation starts the embryo is nourished by uterine secretions
- Chorion frondosum, chorion leave.



# Implantation: summary of days 6-14.

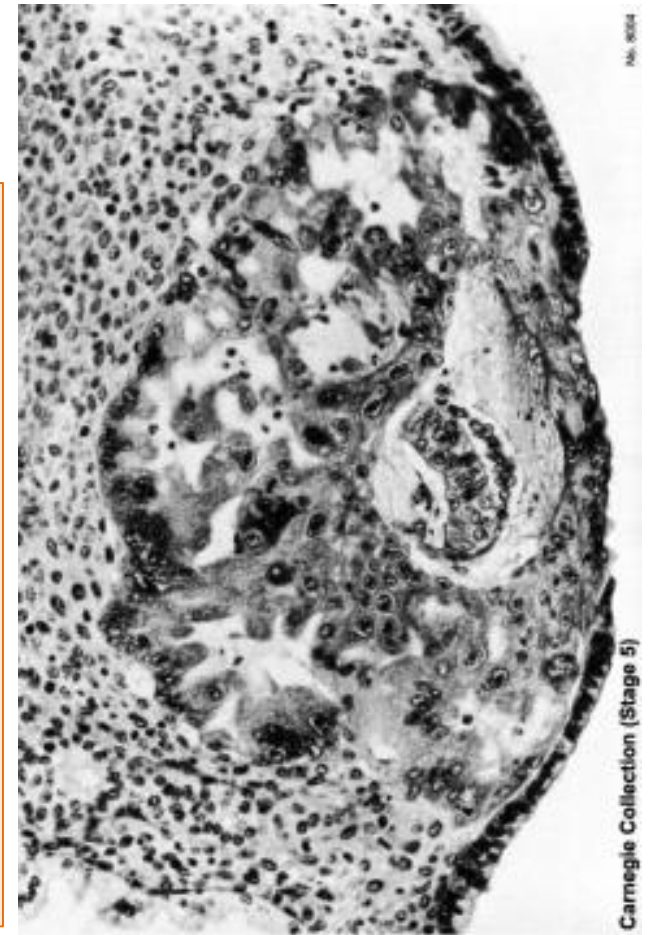
## Requirements:

1. **Zona –free blastocyst (hatching)**
2. **Adplantation**

## Steps:

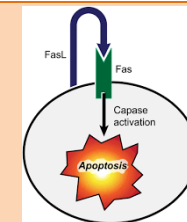
1. **Adplantation (days 6-7)**
  - *blastocyst - endometrium adhesion interaction (integrins)*
  - "receptive window" (about days 20 -24 of the cycle)
    - loose adherence
    - decrease of motility
    - „rolling" to the eventual site
    - firm adherence; the trophoblast connects to the epithelium of the endometrium, alignment of the inner cell mass
2. **Implantation** – ST erodes the endometrium, proteolytic degradation ( matrix metalloproteinases)
3. **Coagulation plug**- left where the blastocyst has entered the uterine wall (days 12-14).

Implanted conceptus



## Mechanisms to avoid maternal immune rejection:

- **Killing maternal immune cells**- CRH, Fas/FasL pathway
- **Removing the attraction of maternal immune cells (effector T)**
  - chemokine gene silencing in decidual stromal cells

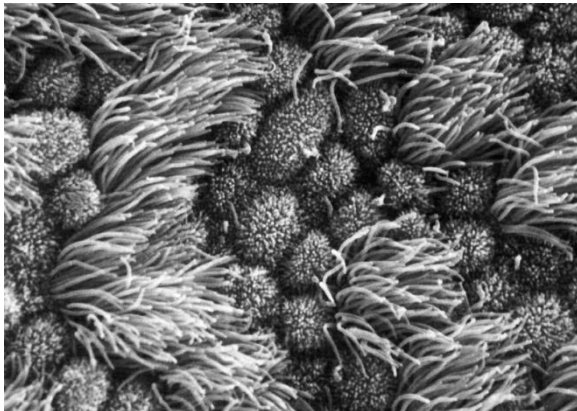


# Ectopic pregnancy

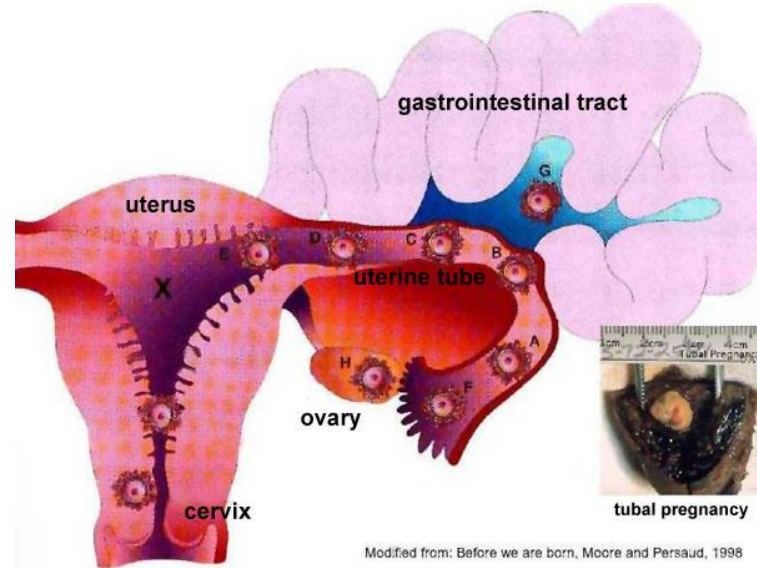
## Normal implantation



Implantation to the anterior, posterior or upper part of the uterus wall



## Abnormal implantation

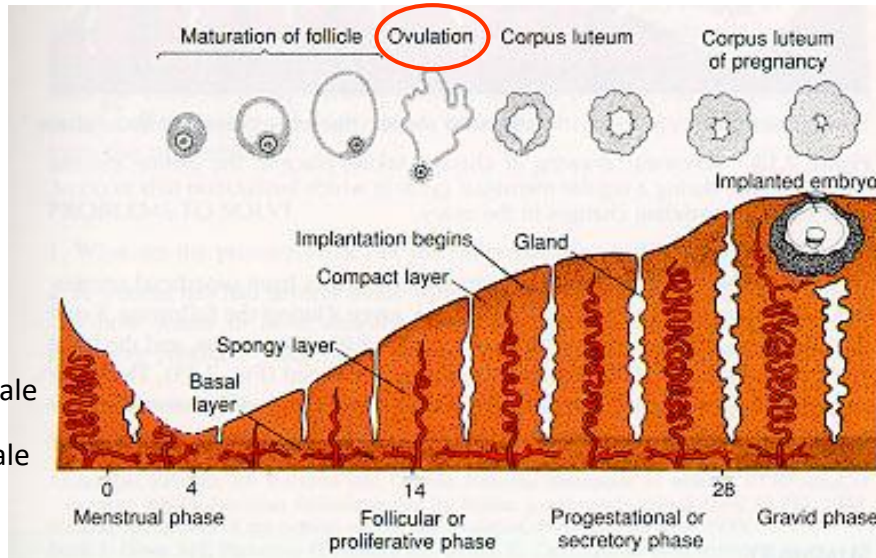


- Nomenclature according to the anatomical location, 94% tubal pregnancy
- Risk factors : zona pellucida is lost too early, tubal damage (pelvic inflammatory disease, smoking)
- Spontaneous/ surgical abortion

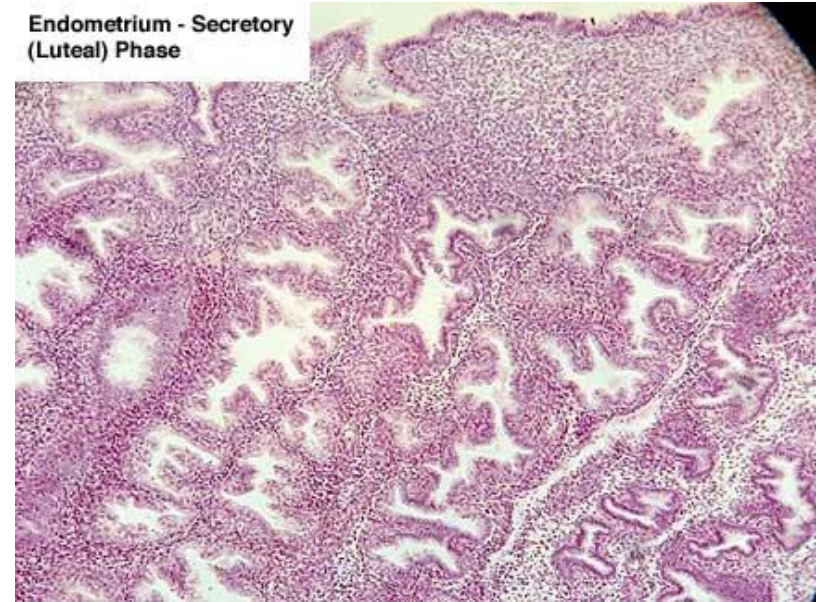
**Placenta previa:** placenta partially or totally covers the mother's cervix . It can cause severe bleeding during pregnancy and delivery.

Ciliae in the tubal surface, promote proceeding of the conceptus.

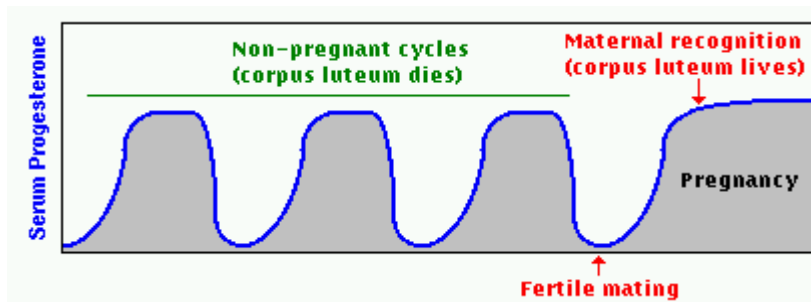
# Uterine mucosa in cycling women



Endometrium - Secretory (Luteal) Phase



str. functionale  
str. basale



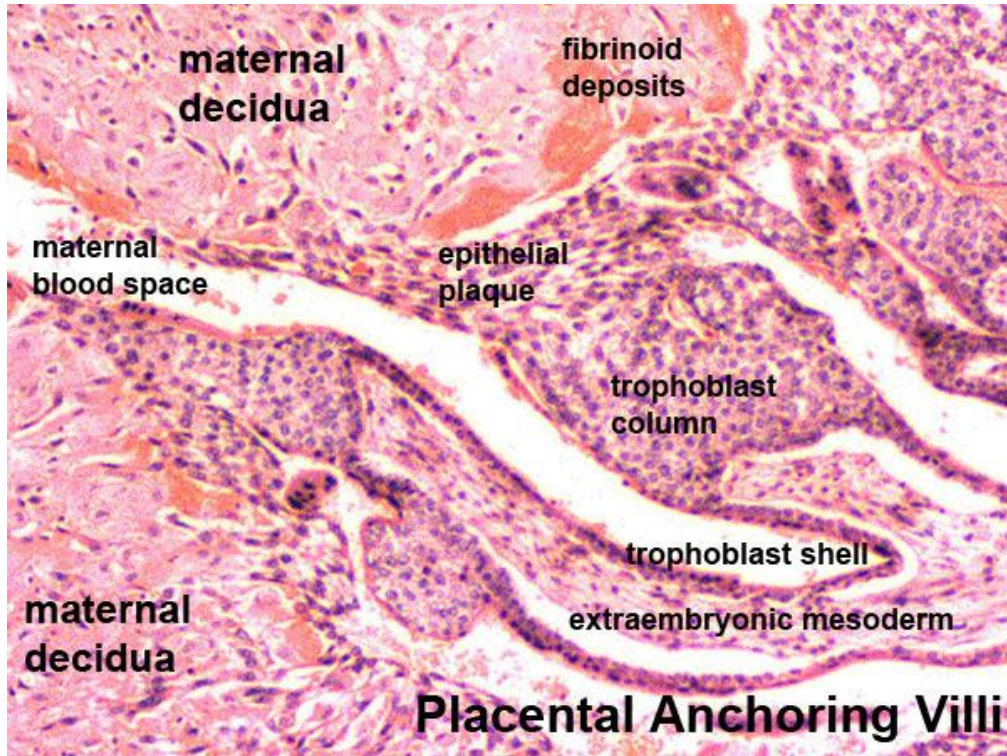
Stratum functionale:

- Stroma: pseudo - decidual cells
- Spiral arteries are more coiled, reach almost the surface
- Secretory activity and size of glands increases

- Blastocyst: HCG production - luteum *graviditatis*- progesterone secretion
- HCG: similar to LH, binds to LH receptors.



# The uterine endometrium during pregnancy is called decidua



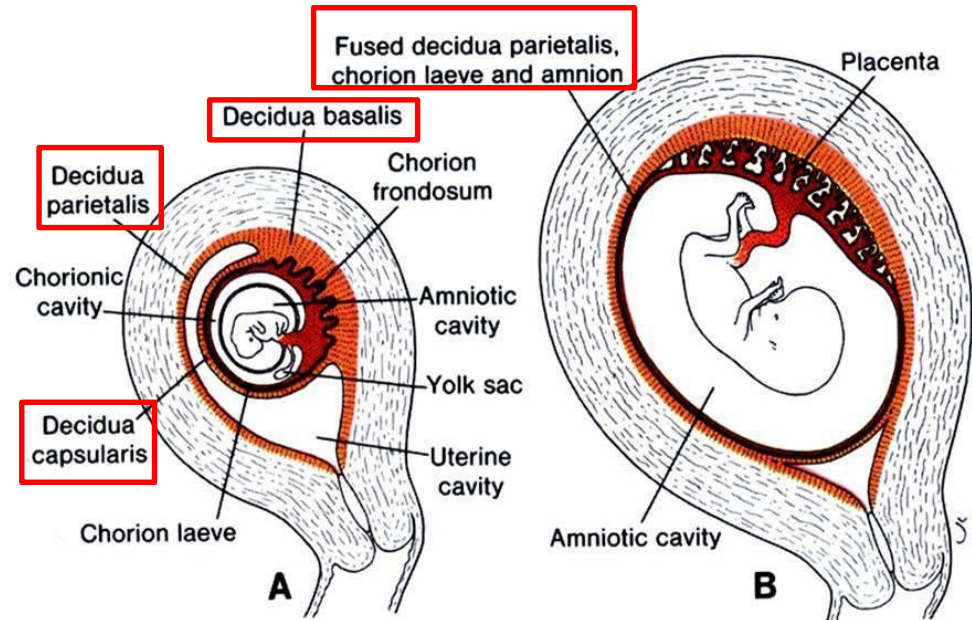
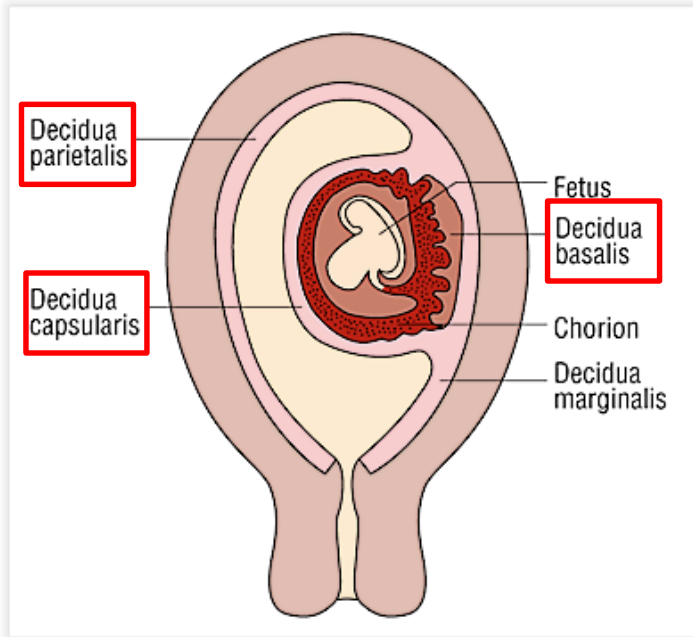
## Roles:

- Forms the maternal placenta.
- Protects against maternal immune rejection.
- Inhibits invasion of the trophoblast.

## Decidual reaction

- All but the deepest layer of endometrium is included.
- Transformation is triggered by hormones.
- Starts at the site of implantation and spreads over, except at the cervix:
  - Proliferation of stromal cells – large, polygonal, epitheloid
  - Fibrinoid (Nitabuch's layer), deposition of fibrinoid and glycogen and epithelial plaque formation at anchoring villi
  - New population of leukocytes and lymphocytes
  - Strong vascularisation, permeability increases

# Parts of the decidua



1. Decidua basalis: between the embryo and myometrium → placenta materna.
2. Decidua capsularis: covers the ovum.
3. Decidua parietalis (vera): lines the remainder of the body of the uterus
4. Decidua marginalis: where the parts meet

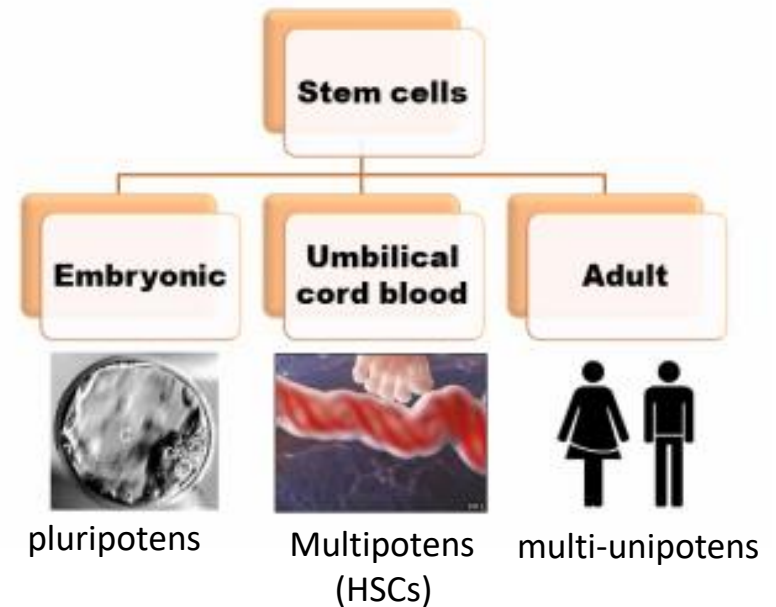
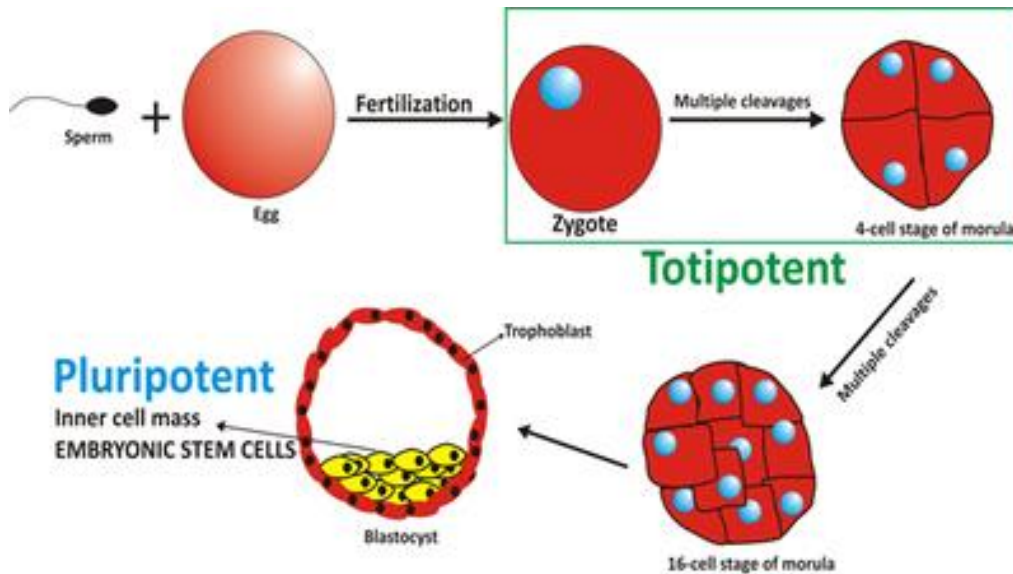
By the third month the decidua capsularis is thinned and extended and the space between it and the decidua parietalis then it degenerates.





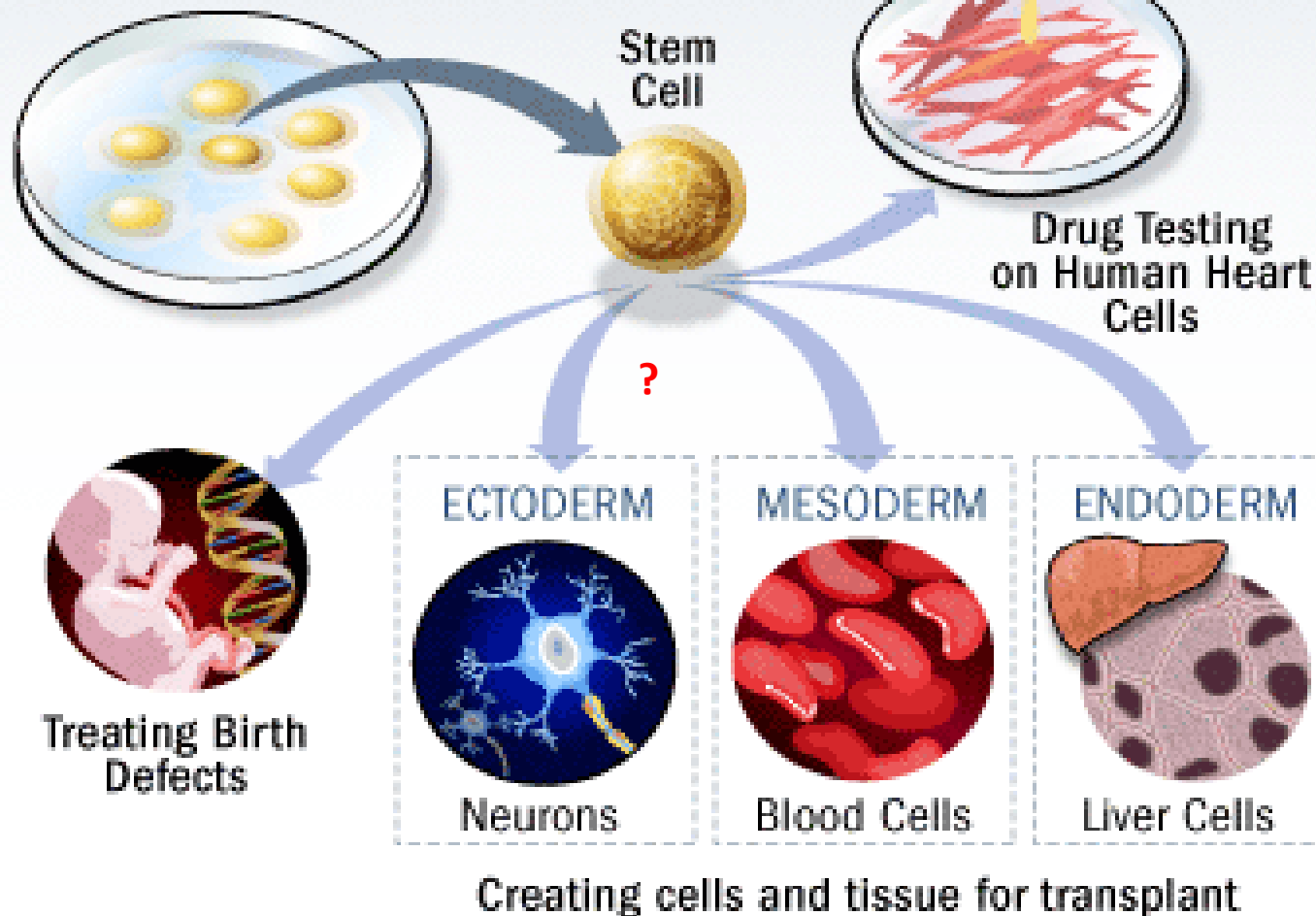
Thank you!

# Types of stem cells according to their regeneration potential



- **Totipotent:** capable of forming all types of embryonic and extraembryonic cells and tissues.
- **Pluripotent:** capable of differentiating into all cell lineages of the three germ layers.
- **Multipotent:** can develop into a restricted subset of cell lineages, ie: neuronal stem cell → neurons, glia,
- **Oligopotent:** able to differentiate into a few cell types, ie.lymphoid stem cell → B and T cells.
- **Unipotent:** can only differentiate into a single type of specialized cells or cell lineage, ie: hepatoblast.

# Stem Cell Applications ©2010 HowStuffWorks



- Ethical debate: ES research involves the creation, usage, and destruction of human embryos.
- Other concerns: rejection, tumor formation