Implantation and Second Week of Development

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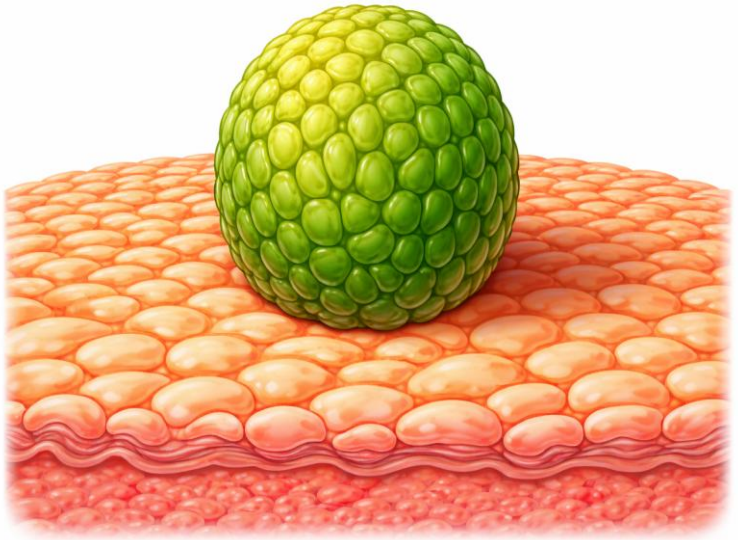
Implantation غرس

It is the process by which blastocyst is embedded in the endometrium.

Timing: starts around the 7th day and is completed by about day 10–12 after fertilization, when the blastocyst is fully embedded within the endometrium and the surface epithelium is restored.

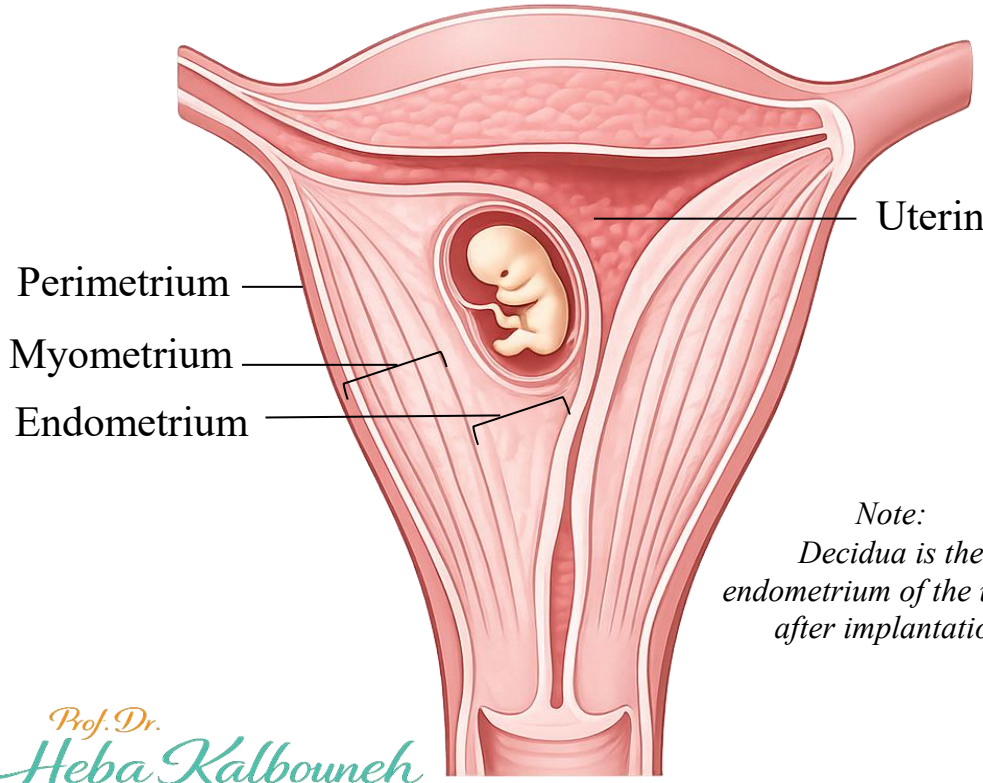
Site: usually at upper part of uterus near fundus.

Blastocyst

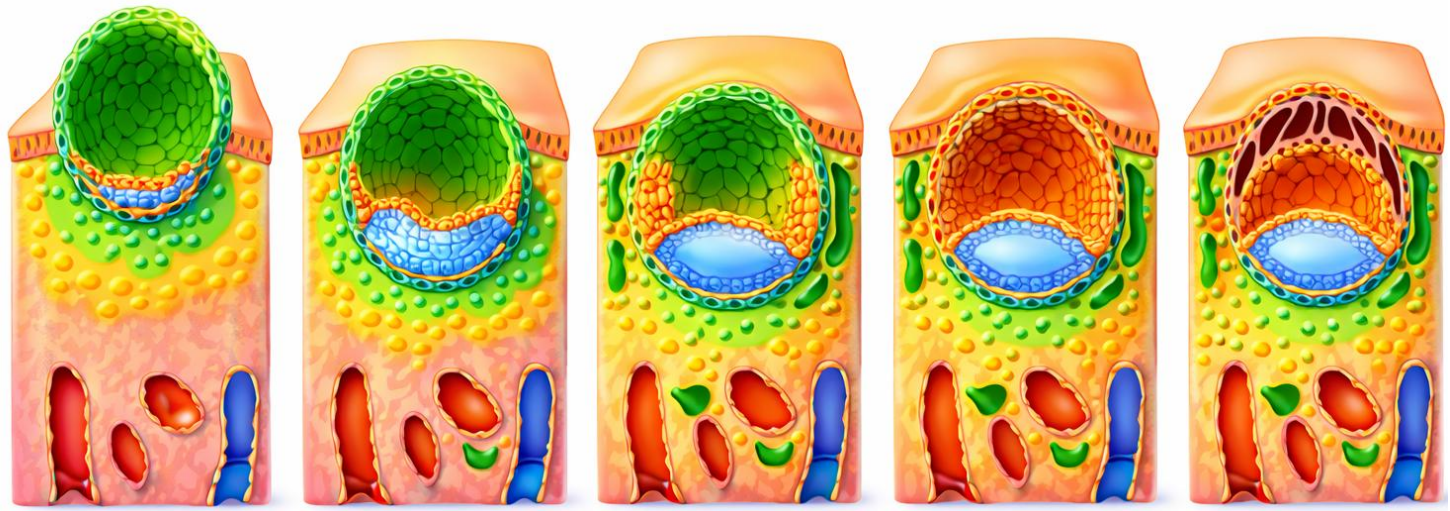


An implanted embryo is detected by the presence of increased levels of human chorionic gonadotropin (hCG) in a pregnancy test.

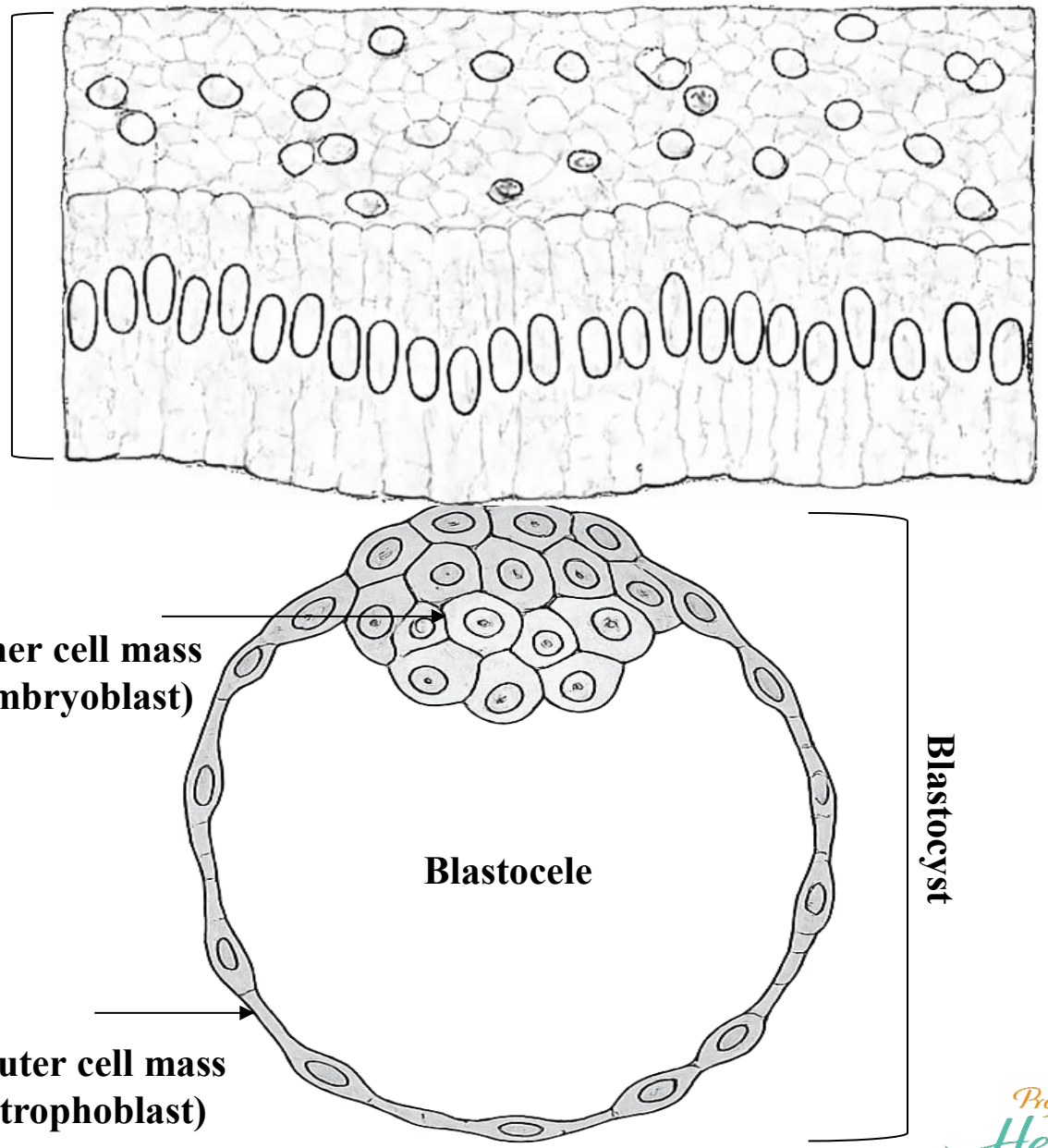
Implantation begins approximately on day 20–21 of a regular 28-day menstrual cycle.



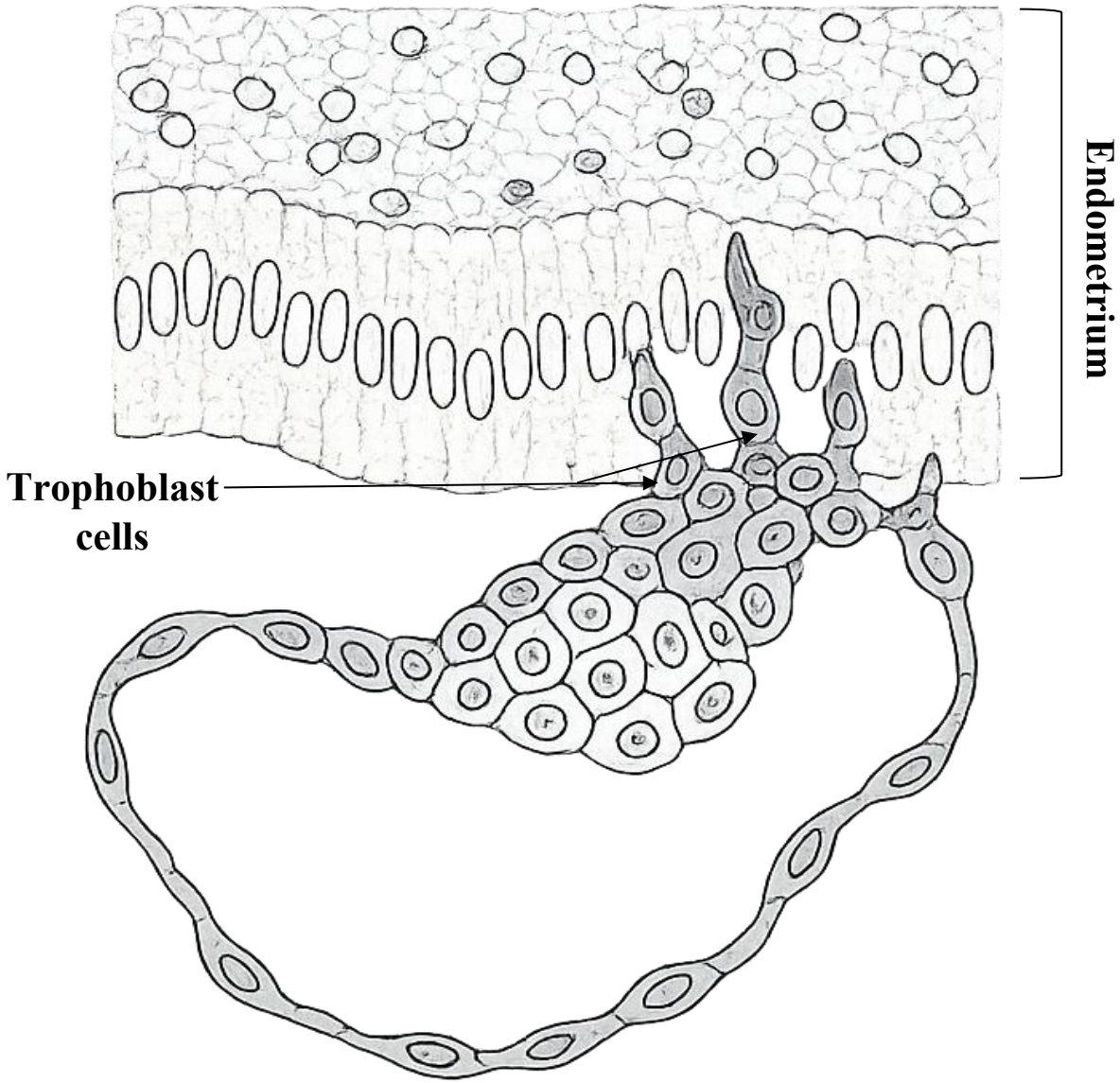
Note:
Decidua is the endometrium of the uterus after implantation



Day 6



Day 7



Day 8

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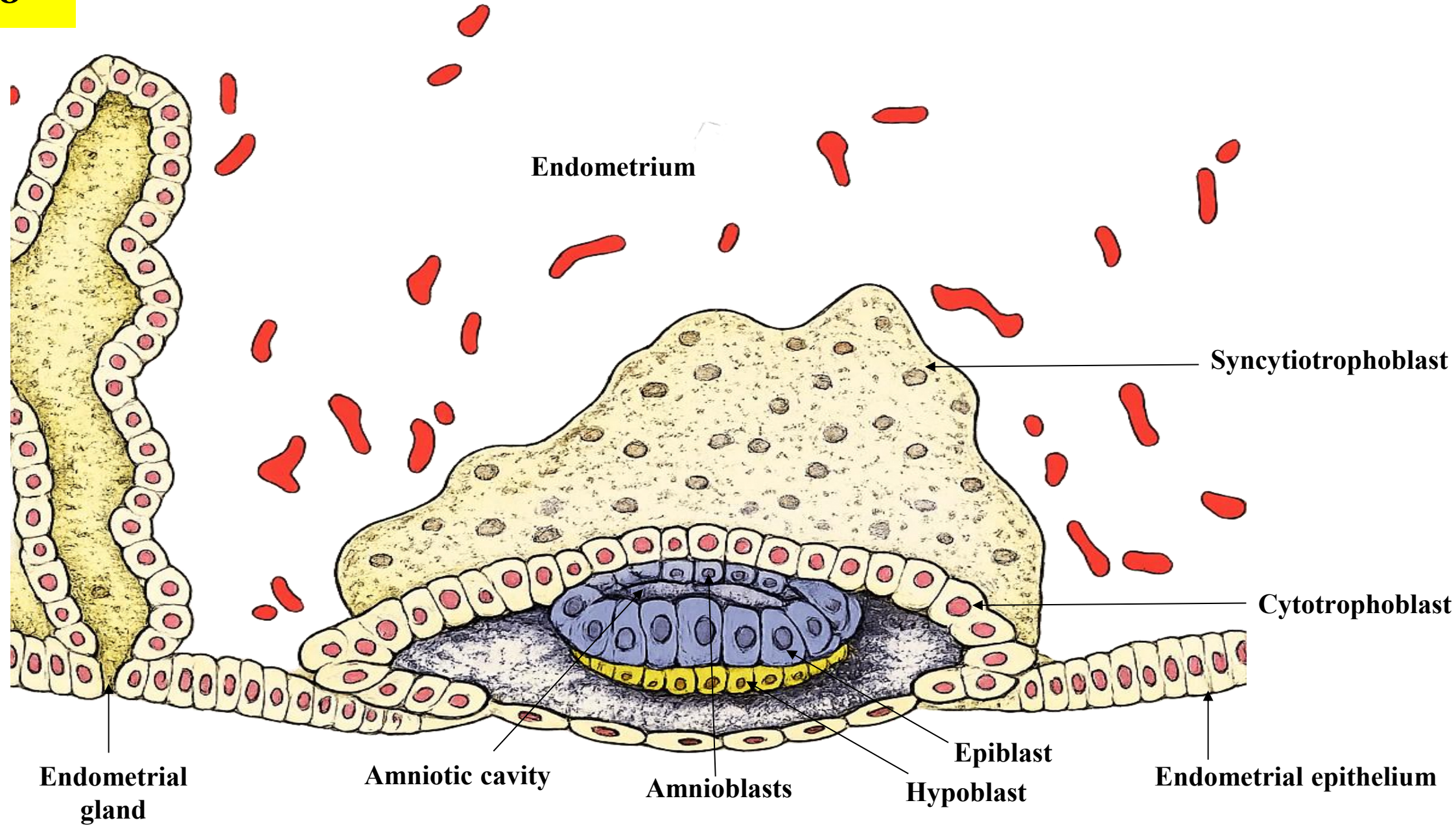
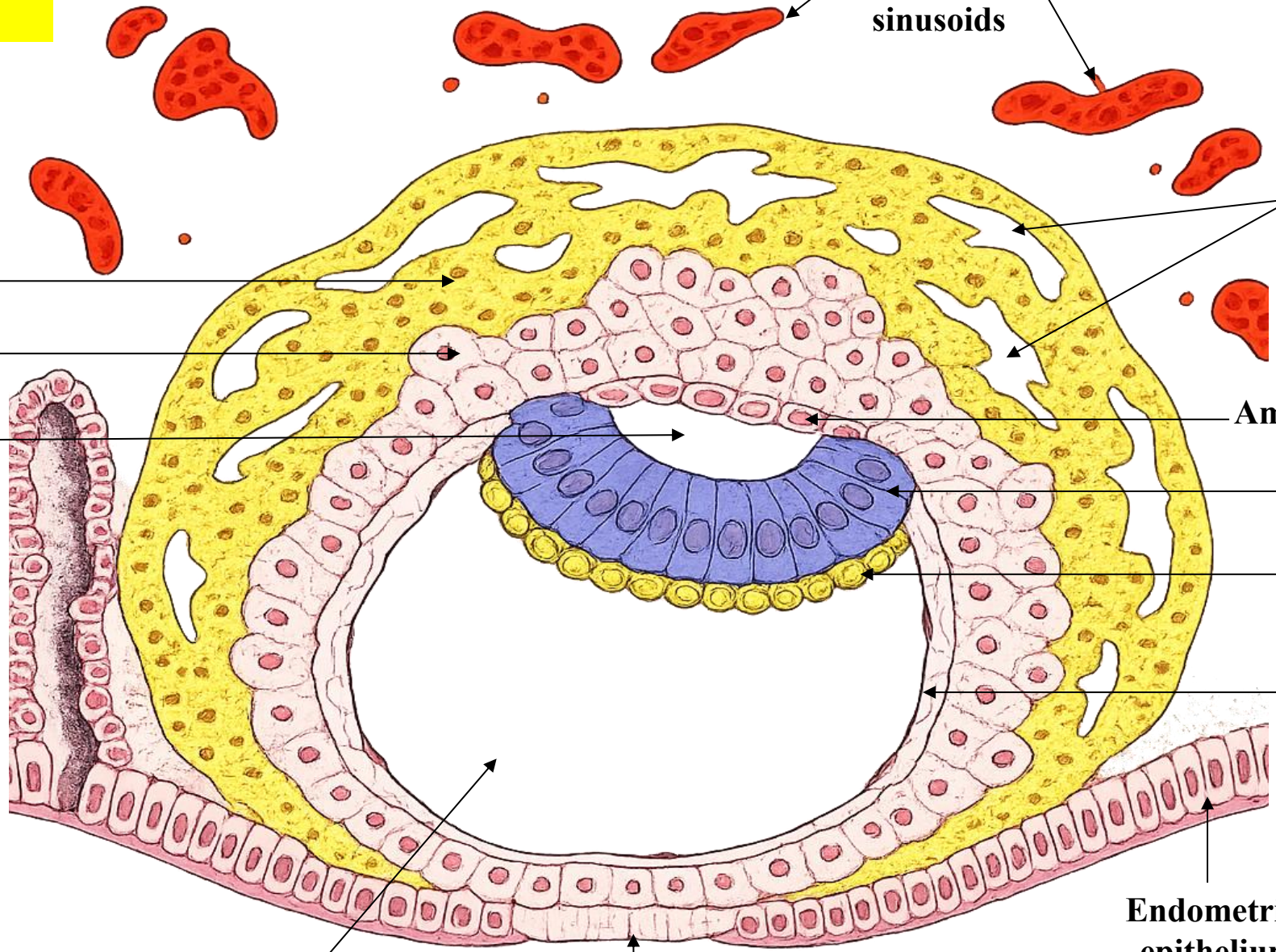


Days 9–10



Days 11–12

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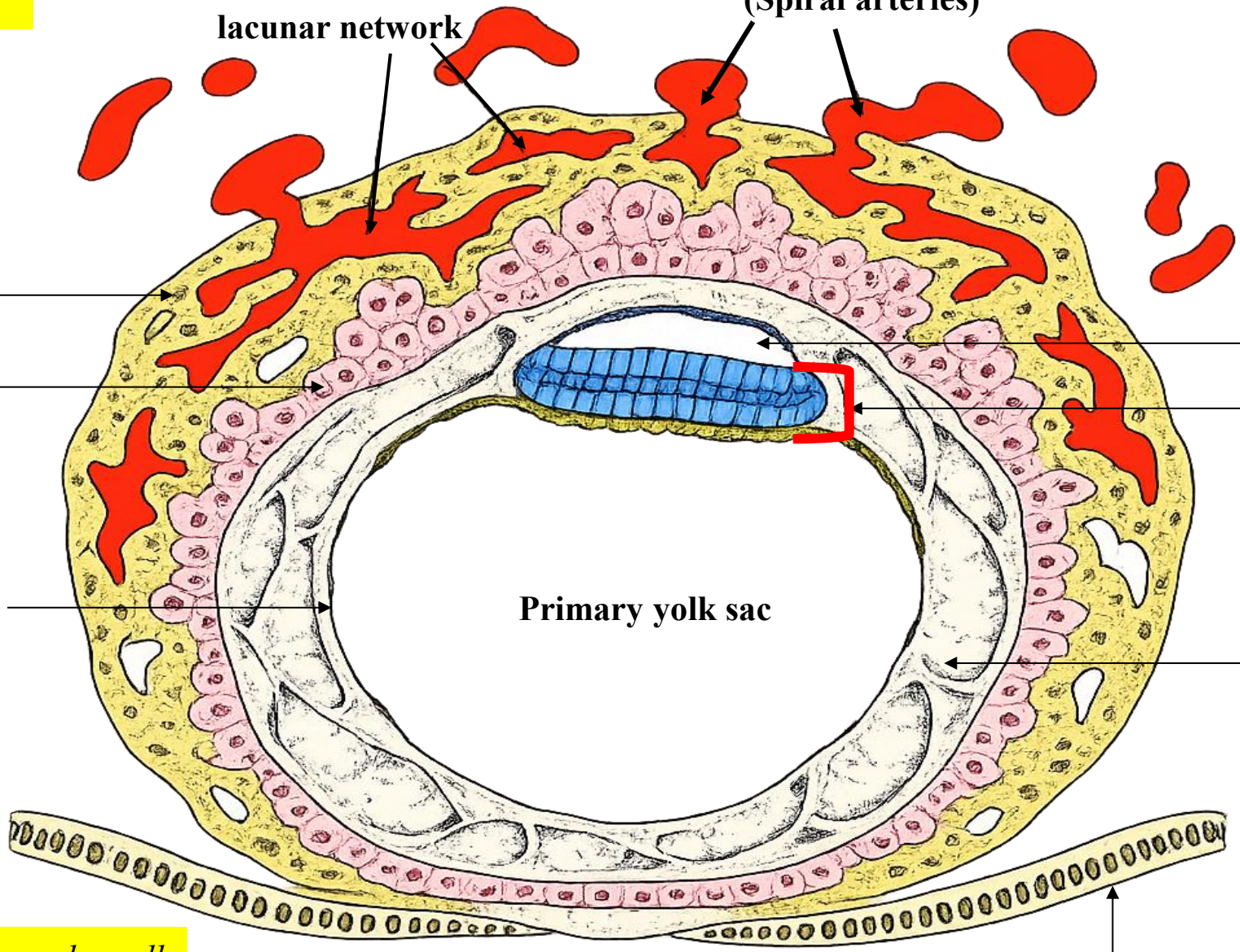

NOTE: the blastocyst is covered on all sides by the endometrium (decidua).

Days 12–13

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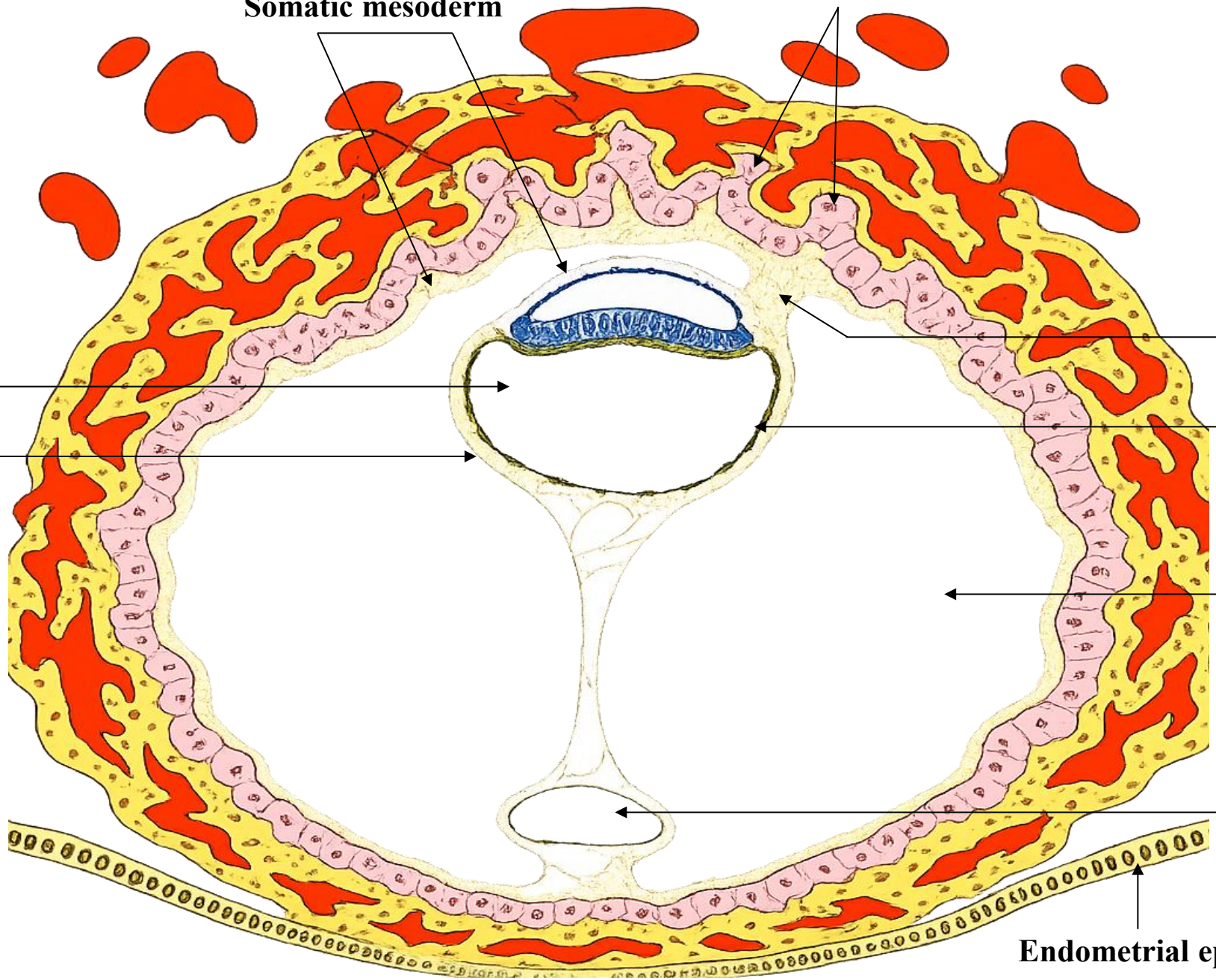
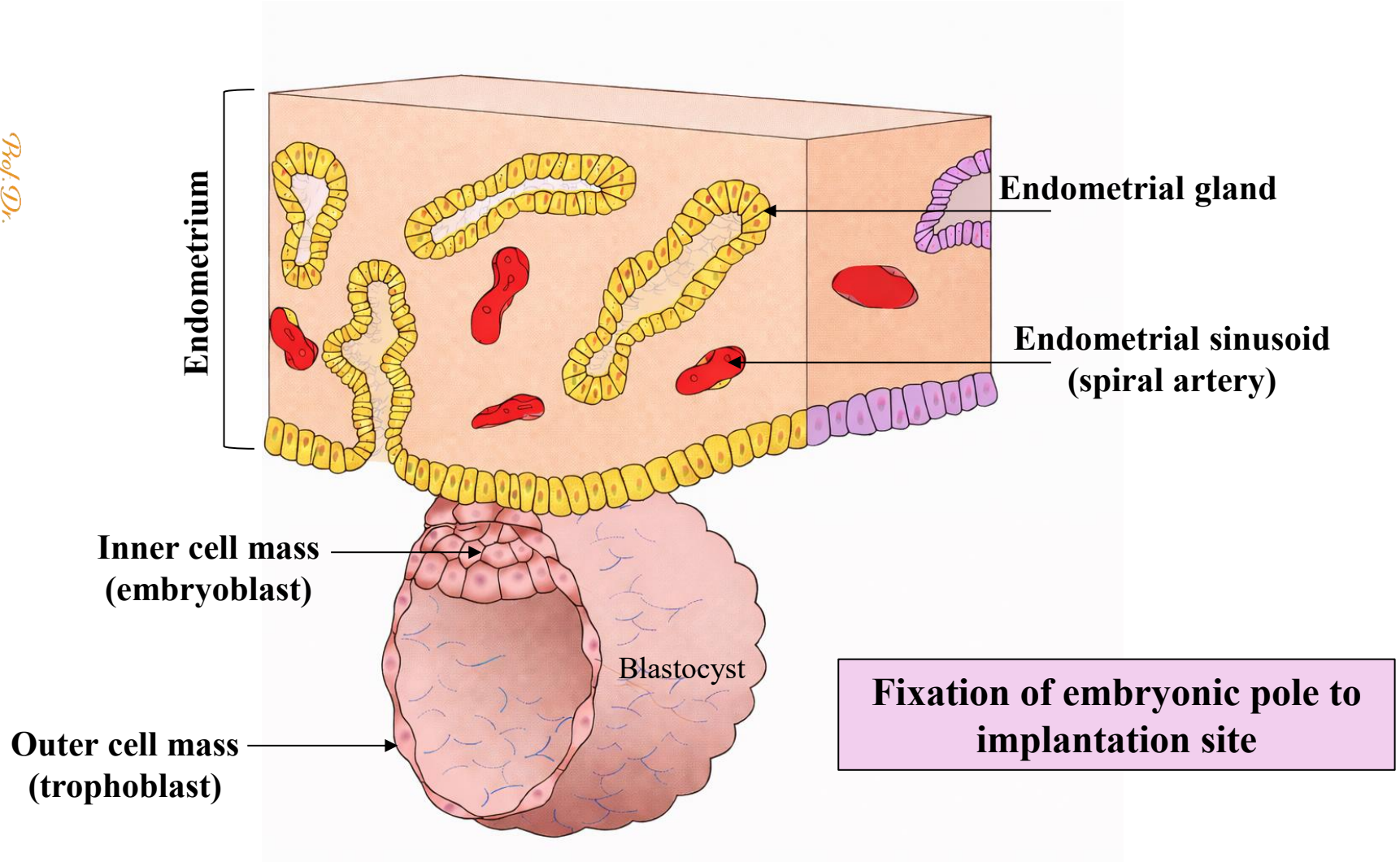


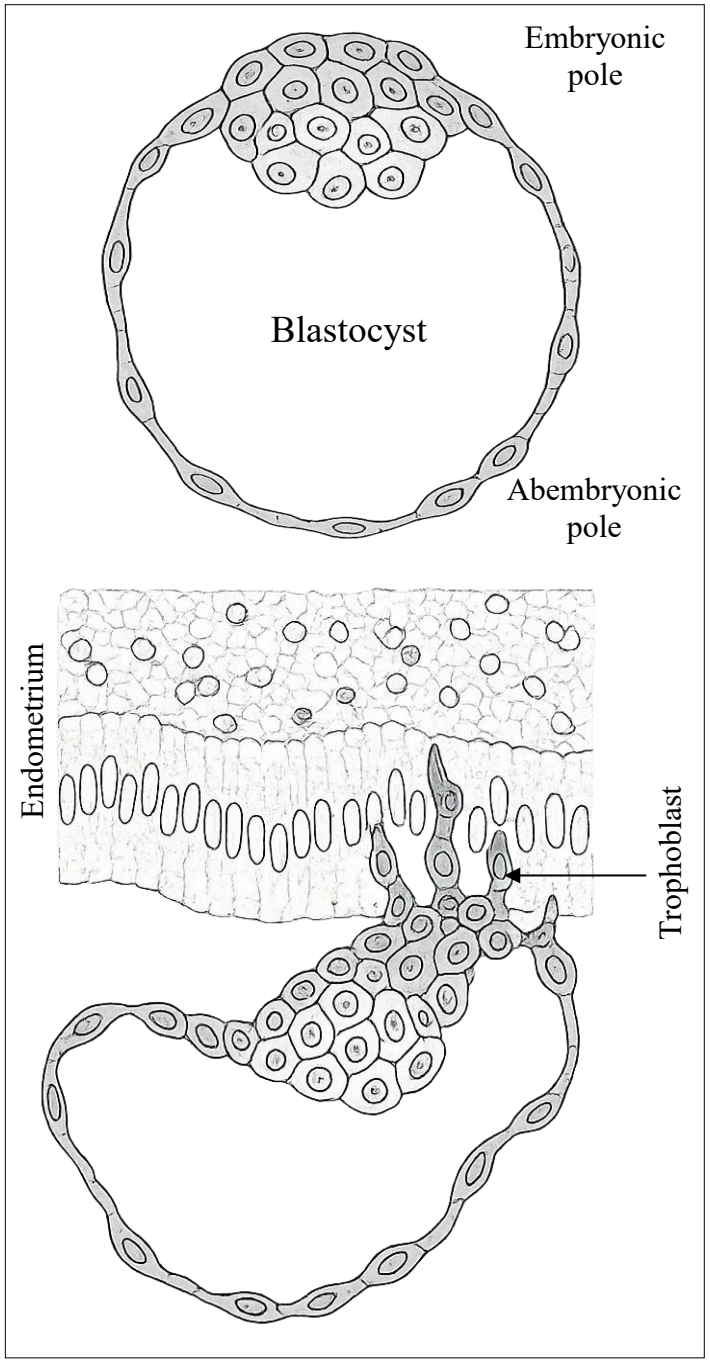
Now blastocyst is called **chorionic vesicle**

Days 6-7

- The blastocyst attaches to the endometrial epithelium, usually at the embryonic pole.
- Trophoblast cells proliferate and begin to differentiate.



Fixation of embryonic pole to implantation site



Day 8

- ✓ The blastocyst is partially embedded in the endometrium.
- ✓ The trophoblast differentiates into two layers:
  - **Cytotrophoblast**: inner layer of mononucleated cells (mitotically active).
  - **Syncytiotrophoblast**: outer multinucleated mass with no distinct cell boundaries, which invades the endometrium.

Syncytium / syncytio- means "cells joined together."

- ✓ The embryoblast differentiates into two layers, forming the **bilaminar germ disc**:

Epiblast (primary ectoderm)
Hypoblast (primary endoderm)

- ✓ A small cavity appears within the epiblast, and epiblast-derived cells (amnioblasts) line its roof, leading to the formation of the **amniotic cavity** above the bilaminar disc.

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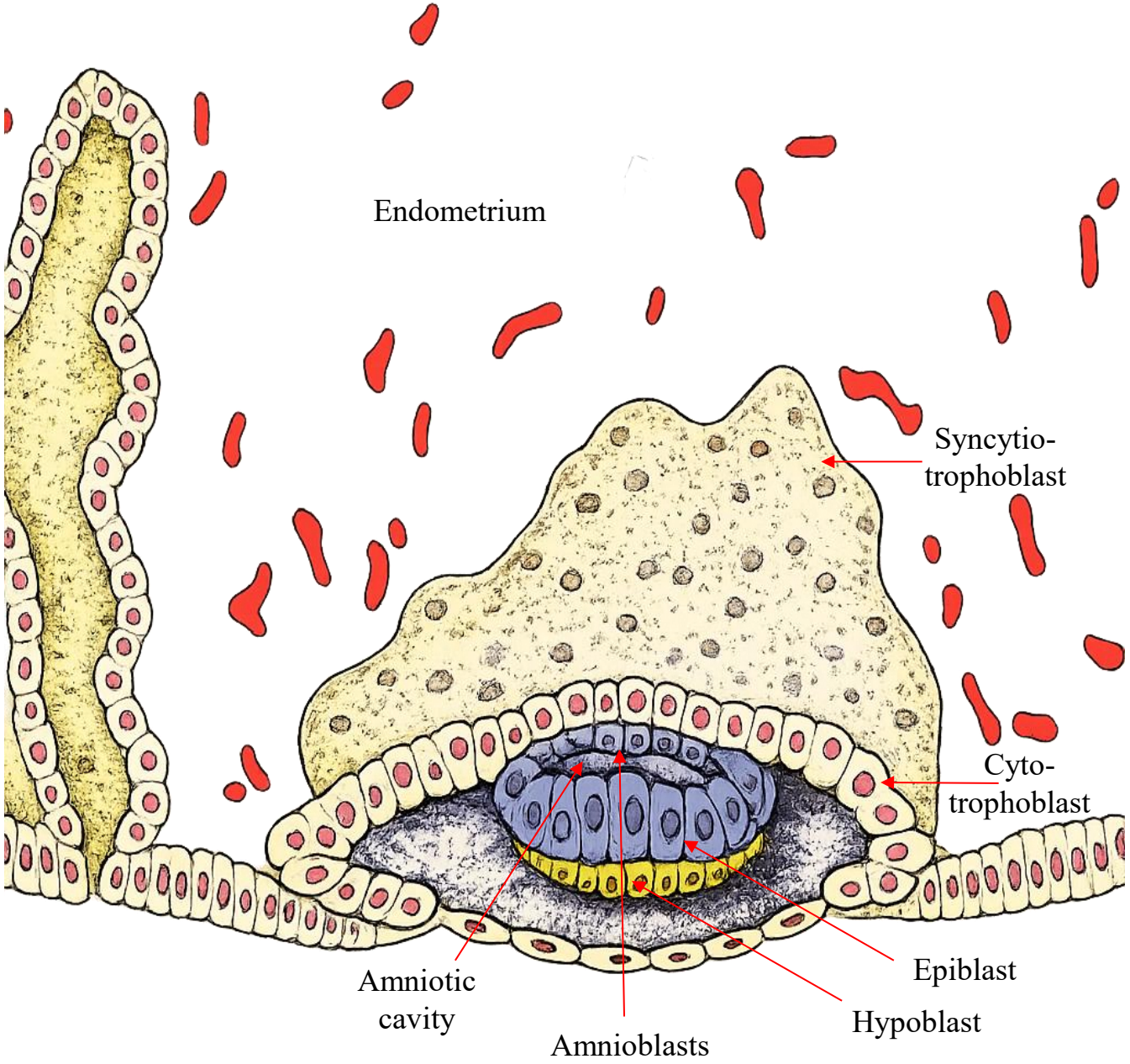
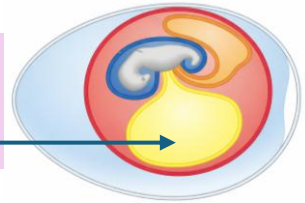


Day 9

- ✓ Implantation is completed, and the penetration defect in the endometrial epithelium is sealed by a fibrin clot.
- ✓ The primitive yolk sac (exocoelomic cavity) is formed.

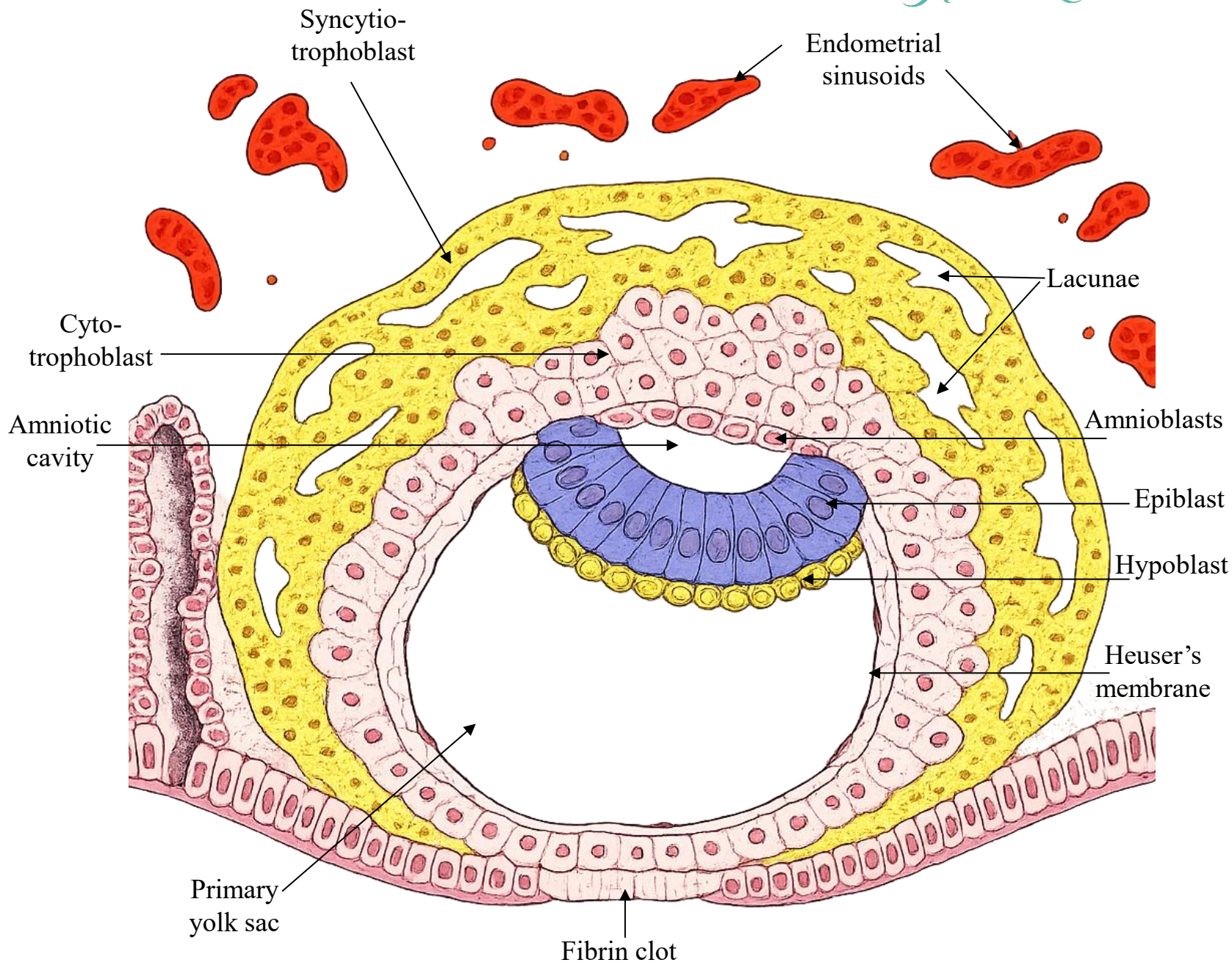
This occurs by proliferation of hypoblast cells, which migrate and line the inner surface of the cytotrophoblast, forming the exocoelomic (Heuser's) membrane that encloses the original blastocyst cavity.

*Exocoelomic cavity = outside cavity. The exocoelomic cavity is located outside the embryo (*yolk sac)



Day 10

Lacunae appear within the syncytio-trophoblast, marking the beginning of the lacunar stage of implantation.



Days 11–12

- The syncytiotrophoblast expands, and lacunae enlarge and interconnect to form a **lacunar network**.
- Maternal endometrial capillaries (sinusoids) are eroded.
- Maternal blood enters the lacunae, establishing the early uteroplacental circulation.
- The conceptus becomes completely embedded within the endometrium and the surface epithelium of the endometrium is restored.
- Formation of **extraembryonic mesoderm:**

Extraembryonic mesoderm appears between the cytotrophoblast and the amnion/Heuser's membrane.

*Surrounding the **amniotic cavity and the primary yolk sac**.*

The **conceptus** refers to all the products of conception at any stage of pregnancy, including the embryo or fetus and the extra-embryonic structures such as the amnion, chorion, yolk sac, placenta, and umbilical cord.

Lacunae: small intercellular spaces

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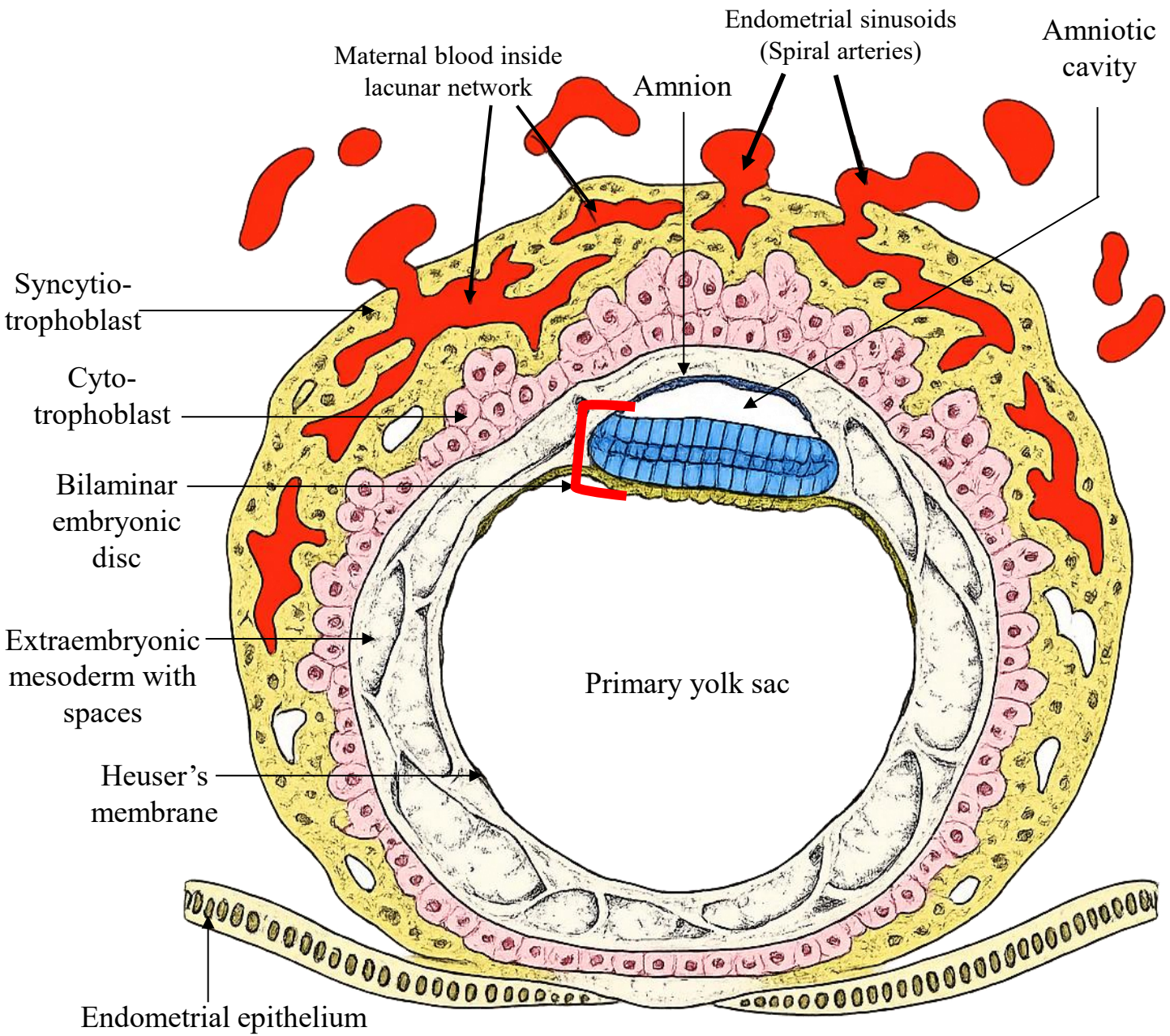

Days 12–13

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- ✓ Large spaces appear in the extraembryonic mesoderm and coalesce to form the **extraembryonic coelom (chorionic cavity),** except at part connected to caudal end of embryo called connecting stalk.
- ✓ The extraembryonic mesoderm splits into:
  - **Somatic (parietal) layer**
  - **Splanchnic (visceral) layer**

coelom = a cavity.

The chorionic cavity surrounds the amniotic cavity and yolk sac, except at the connecting stalk

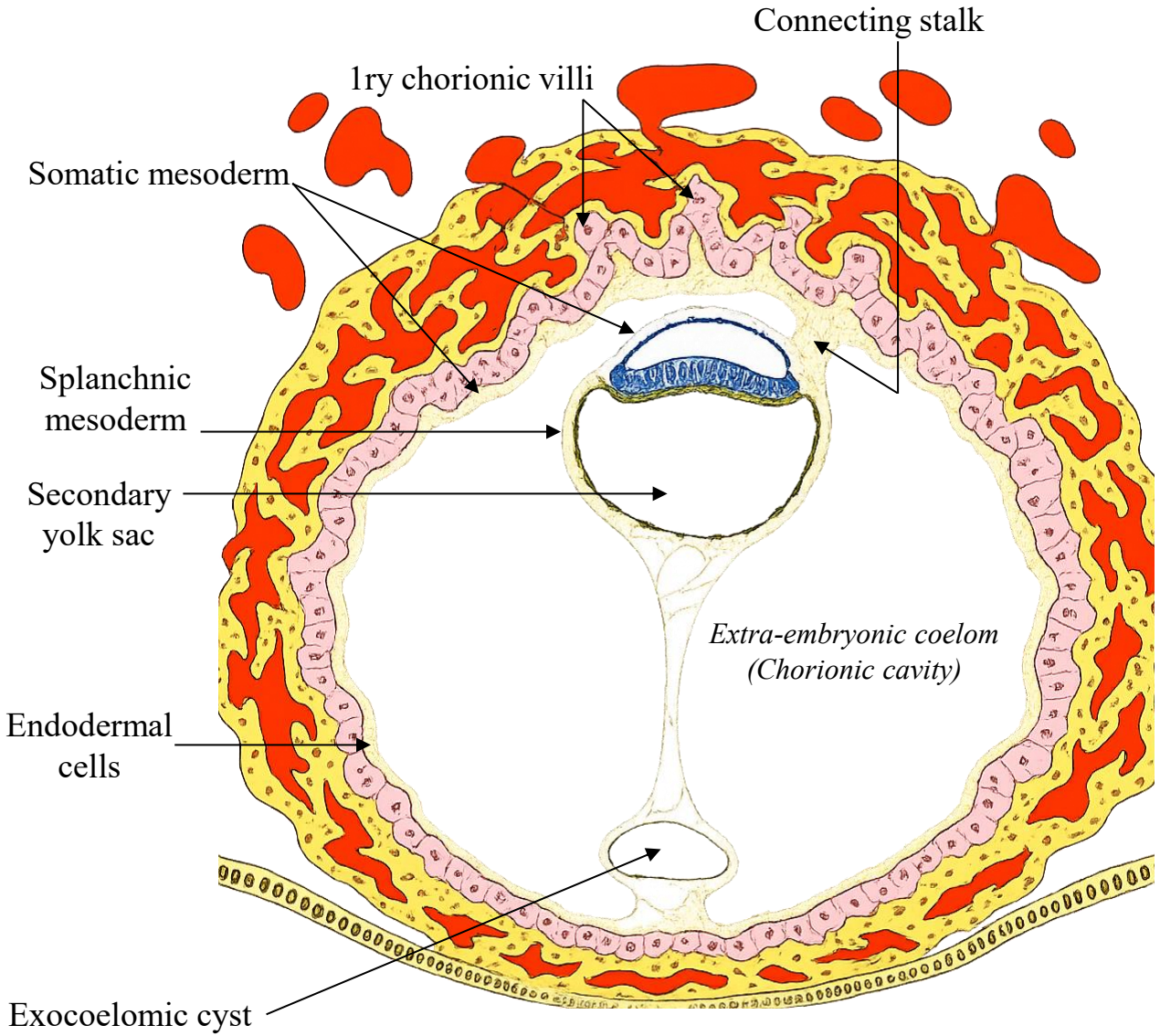
Connecting stalk is a band of extra-embryonic mesoderm connecting embryo to chorion. It is the precursor of the umbilical cord.

- ✓ Formation of the **secondary (definitive) yolk sac:** forms when part of the primary yolk sac is pinched off.

After its formation, the secondary yolk sac is lined internally by endodermal (hypoblast-derived) cells.

- ✓ Primary chorionic villi start to form when cytotrophoblast cells multiply and grow outward into the syncytiotrophoblast, forming small finger-like projections.

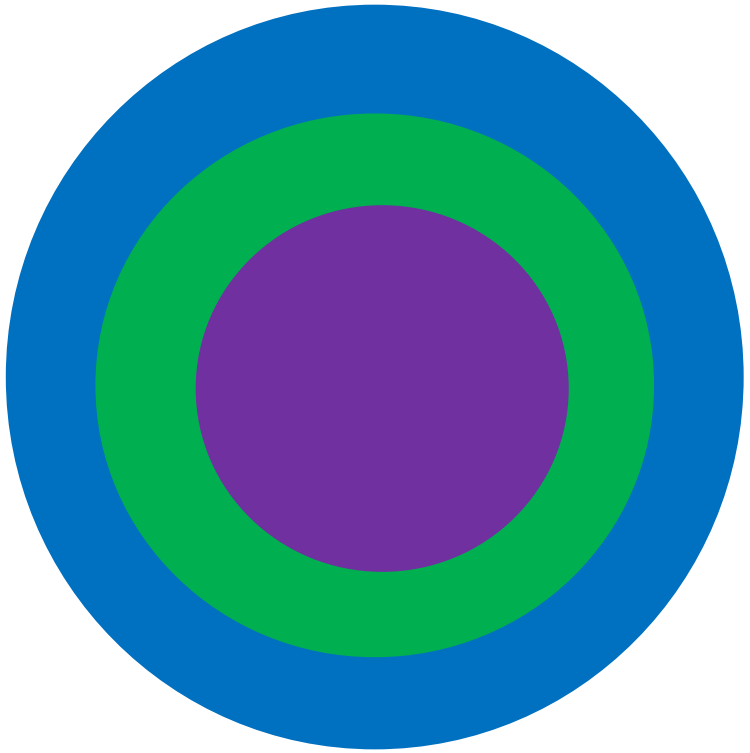
Extraembryonic coelom (chorionic cavity)
A cavity outside the embryo that encloses other cavities (amniotic + yolk sac)



*Note: As the chorionic cavity expands: The embryo becomes suspended inside it. Now blastocyst is called **chorionic vesicle***

Learning in Layers

Layer 1 → Basic concepts
Layer 2 → Structural details
Layer 3 → Integration & significance



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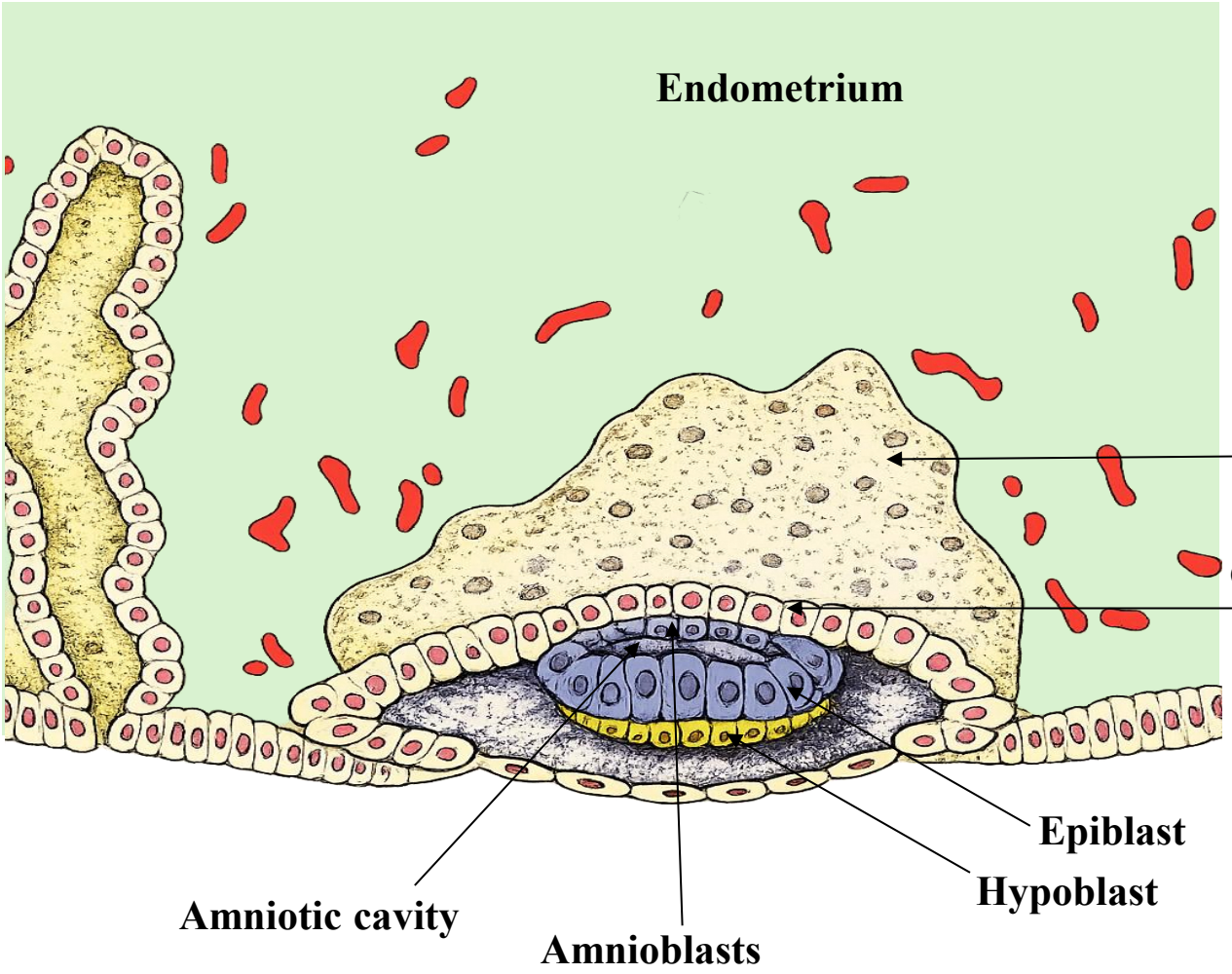
Day 8



At the 8th day of development the blastocyst is partially embedded in the endometrial stroma. In the area over the embryoblast, trophoblast has differentiated into two layers: (a) an inner layer of mononucleated cells, the cytotrophoblast; and (b) an outer multinucleated zone without distinct cell boundaries, the syncytiotrophoblast

The syncytiotrophoblast secretes proteolytic enzymes that erode maternal tissues, allowing the blastocyst to invade the endometrium.

↓ ↓ ↓ ↓

The implanted blastocyst gets its nourishment from the eroded maternal tissues

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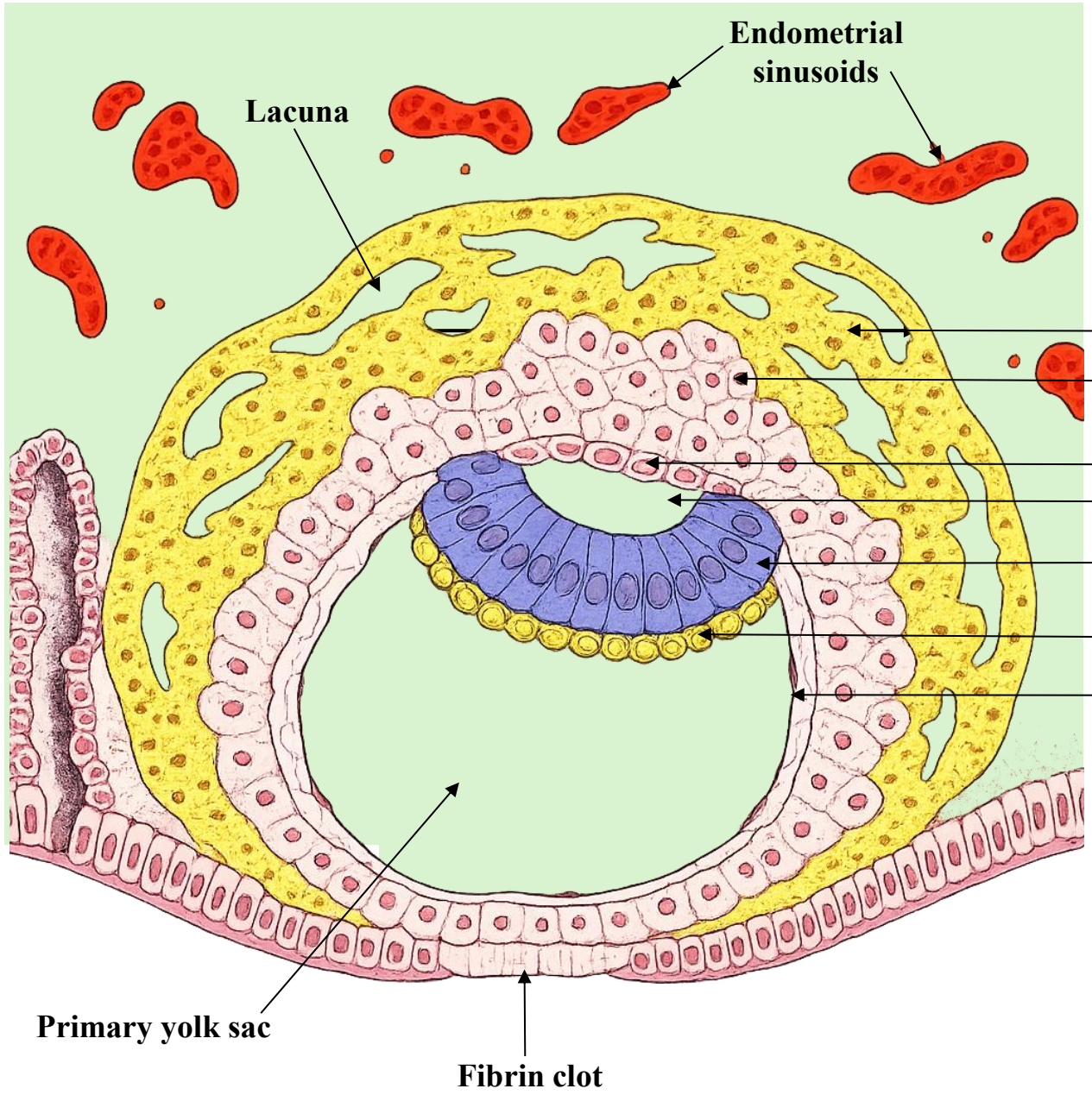
Cells of the inner cell mass (embryoblast) also differentiate into two layers: (a) a layer of small cuboidal cells adjacent to the blastocyst cavity, known as the **hypoblast layer**; and (b) a layer of high columnar cells adjacent to the amniotic cavity, the **epiblast layer**. Cells of each germ layer form a flat disc and together are known as the **bilaminar germ disc**. At the same time a small cavity appears within the epiblast. This cavity enlarges to become the amniotic cavity. Epiblast cells adjacent to the cytotrophoblast are called **amnioblasts**; together with the rest of the epiblast, they line the amniotic cavity.

Note: The endometrial stroma adjacent to the implantation site is edematous and highly vascular. The large, tortuous glands secrete abundant glycogen and mucus.

Decidua reaction

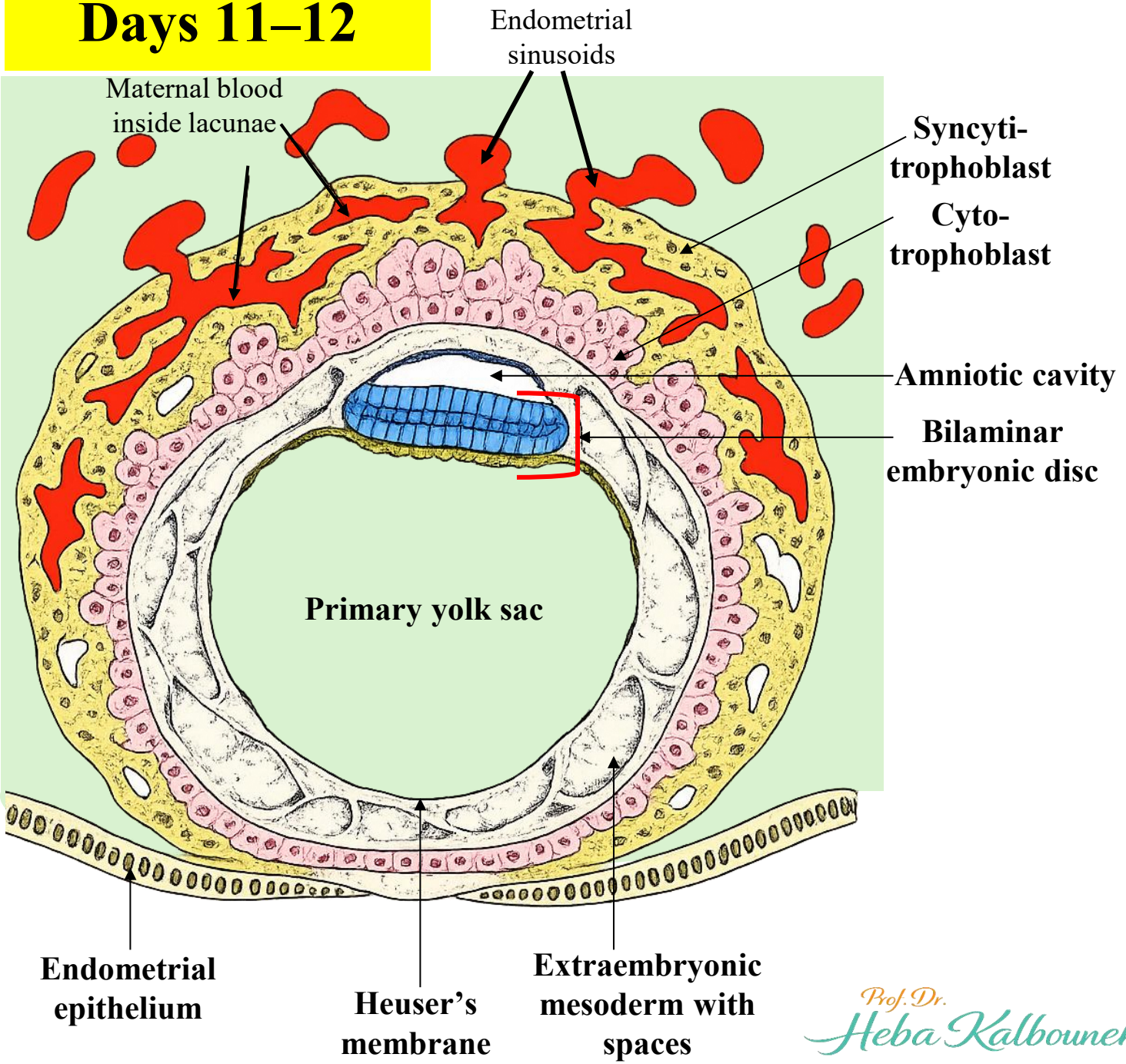
Days 9–10



The blastocyst is more deeply embedded in the endometrium, and the penetration defect in the surface epithelium is closed by a **fibrin clot**. The trophoblast shows considerable progress in development, particularly at the embryonic pole, where vacuoles appear in the syncytium. When these vacuoles fuse, they form large lacunae, and this phase of trophoblast development is therefore known as the **lacunar stage**.

At the abembryonic pole, meanwhile, flattened cells (originating from the hypoblast) form a thin membrane, the **exocoelomic (Heuser's) membrane**, that lines the inner surface of the cytotrophoblast. This membrane, together with the hypoblast, forms the lining of the **exocoelomic cavity**, or **primary yolk sac.**

Days 11–12



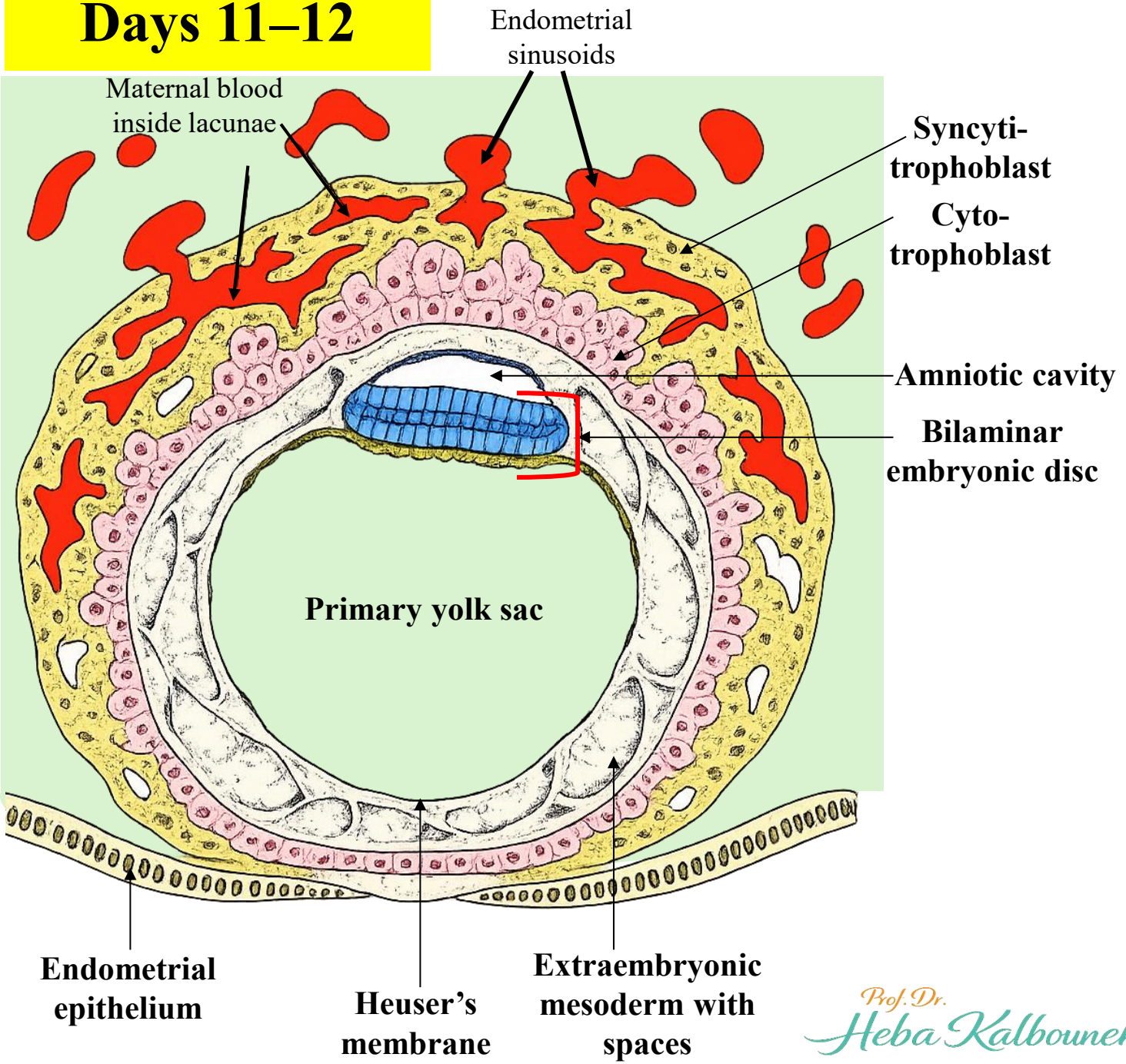
By the 11th to 12th day of development, the blastocyst is completely embedded in the endometrial stroma, and the surface epithelium almost entirely covers the original defect in the uterine wall.

The trophoblast is characterized by lacunar spaces in the syncytium that form an intercommunicating network. This network is particularly evident at the embryonic pole.

Concurrently, cells of the syncytiotrophoblast penetrate deeper into the stroma and erode the endothelial lining of the maternal capillaries. These capillaries, which are congested and dilated, are known as sinusoids. The syncytial lacunae become continuous with the sinusoids, and maternal blood enters the lacunar system.

As the trophoblast continues to erode more and more sinusoids, maternal blood begins to flow through the trophoblastic system, establishing the uteroplacental circulation.

Days 11–12



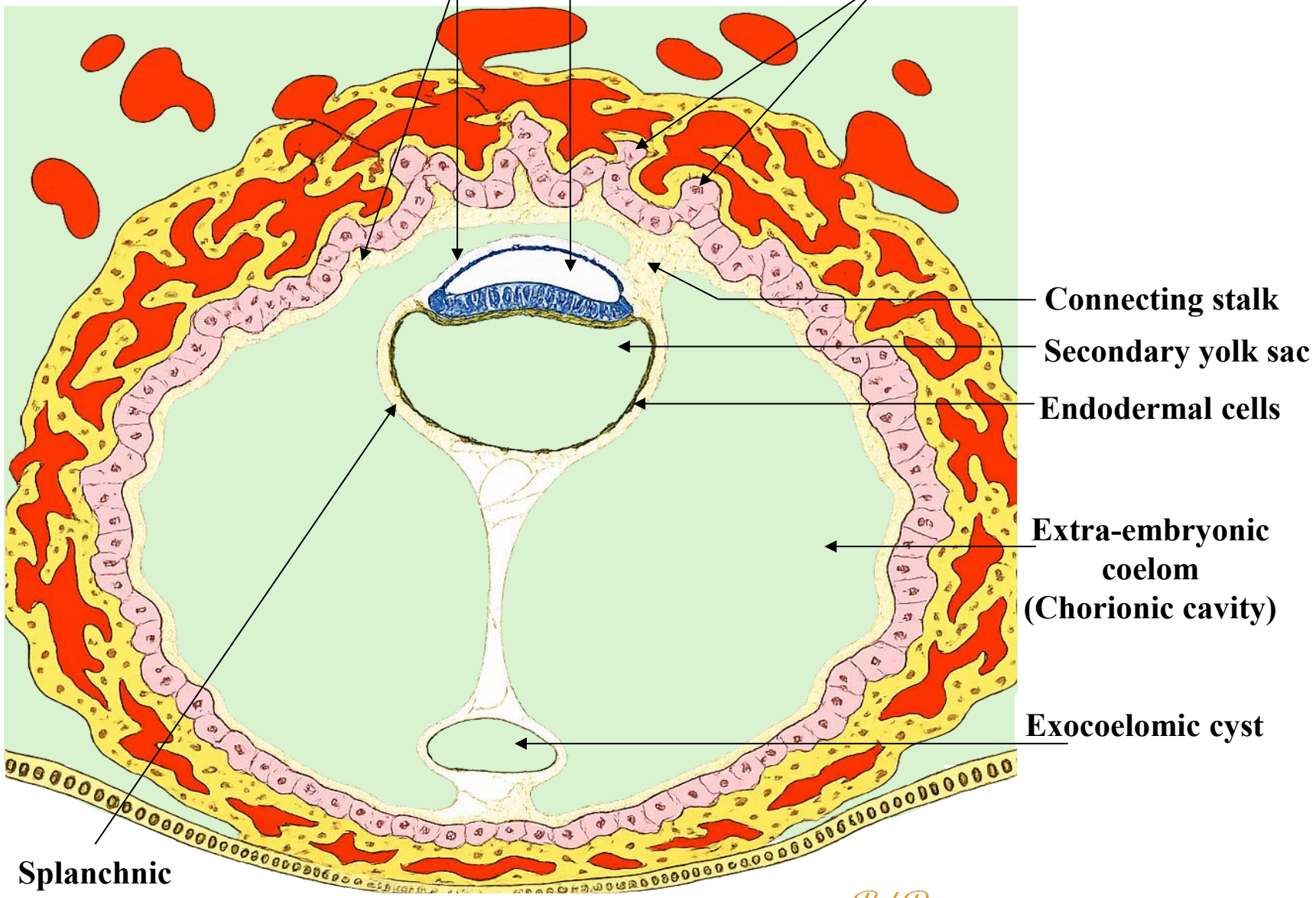
In the meantime, a new population of cells appears between the inner surface of the cytotrophoblast and the outer surface of the amniotic cavity and primary yolk sac. These cells eventually fills all of the space between the trophoblast externally and the amnion and Heuser's membrane internally.

Extraembryonic mesoderm

Meanwhile, the cells of the endometrium change their shape and become more rounded (polyhedral). They accumulate large amounts of glycogen and lipids as stored nutrients. Fluid leaks from nearby blood vessels and fills the spaces between the cells, making the tissue swollen (edematous).
These structural and functional changes of the endometrium are called the **decidual reaction**.

Decidua is the endometrium of the uterus after implantation.

Days 12–13



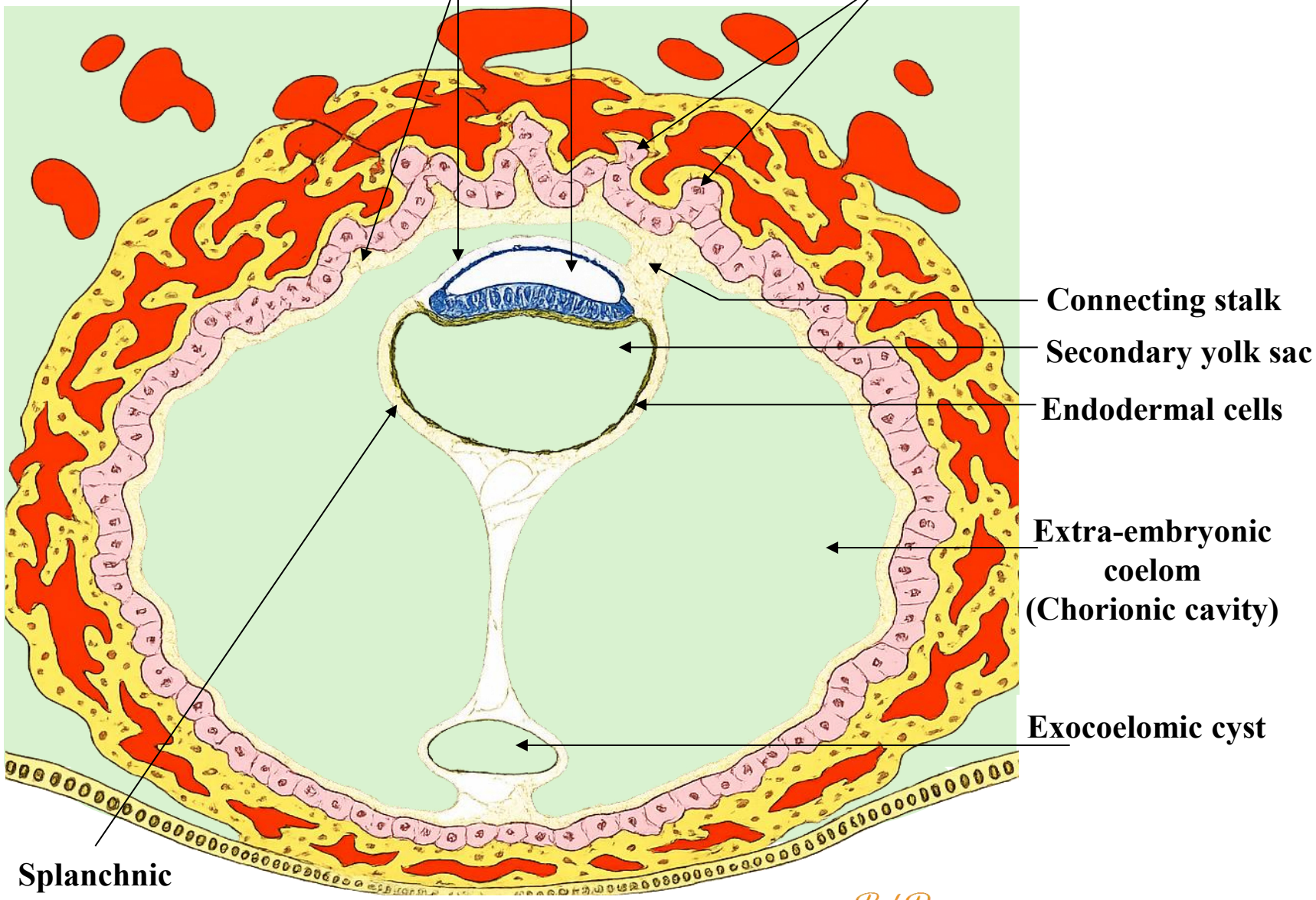
Large cavities develop in the extraembryonic mesoderm, and when these become confluent, they form a new space known as the **extraembryonic coelom, or chorionic cavity.**

This space surrounds the primary yolk sac and amniotic cavity except where the germ disc is connected to the trophoblast by the connecting stalk.

The only place where the extraembryonic mesoderm remains attached through the chorionic cavity is at the **connecting stalk**. As blood vessels develop within it, the connecting stalk later forms the **umbilical cord**.

The extraembryonic mesoderm lining the cytotrophoblast and amnion is called the **extraembryonic somatic mesoderm**; that covering the yolk sac is known as the **extraembryonic splanchnic mesoderm**.

Days 12–13



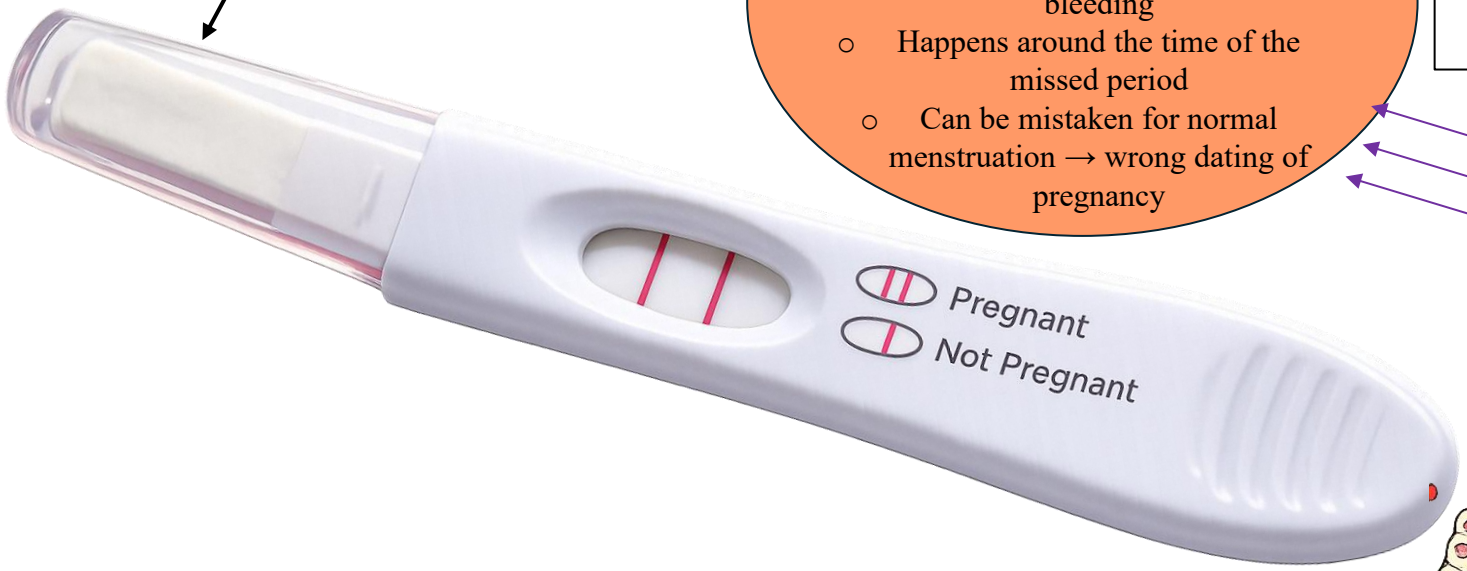
In the meantime, the hypoblast produces additional cells that migrate along the inside of the **primary yolk sac** lining. These cells multiply and gradually form a new, smaller cavity within the primary yolk sac. This new cavity is called the **secondary (definitive) yolk sac**.

The secondary yolk sac is much smaller than the original primary yolk sac. During its formation, large parts of the primary yolk sac are pinched off. These separated portions form small cysts, which are often found in the extraembryonic coelom (chorionic cavity).

Exocoelomic cyst

Cells of the cytotrophoblast proliferate locally and penetrate into the syncytiotrophoblast, forming cellular columns surrounded by syncytium. Cellular columns with the syncytial covering are known as **primary chorionic villi**

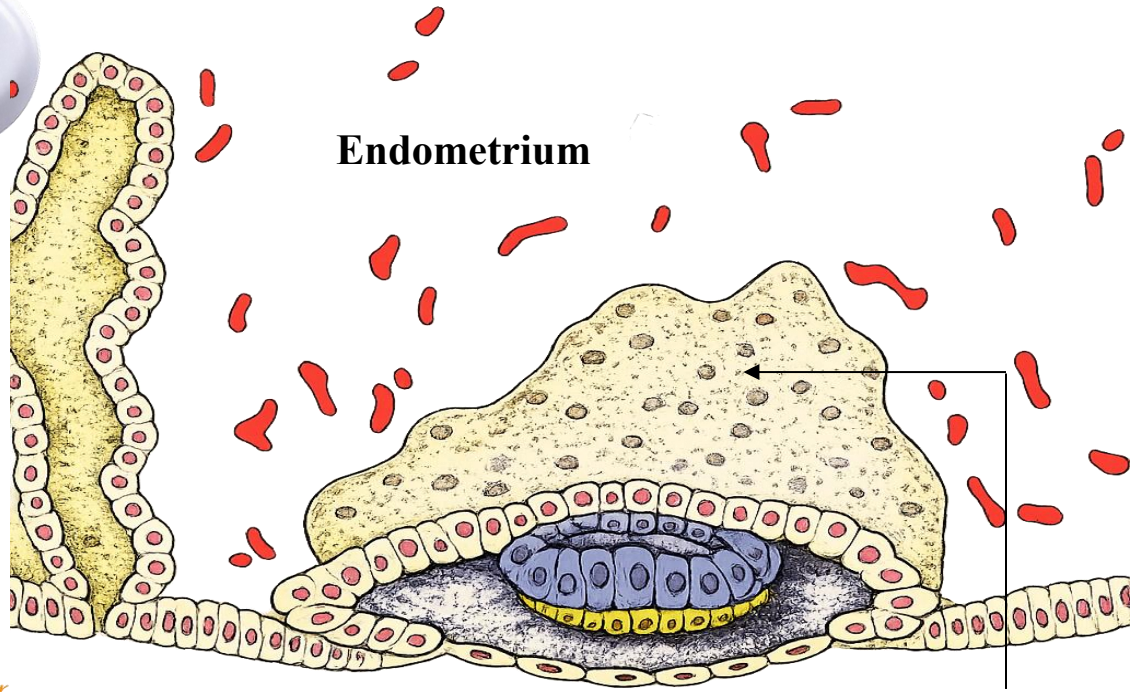
Absorbent tip
(urine sample applied here)



- When the developing embryo invades the uterus, small maternal vessels open
- Blood may leak → implantation bleeding
- Happens around the time of the missed period
- Can be mistaken for normal menstruation → wrong dating of pregnancy

The syncytiotrophoblast is responsible for production of human chorionic gonadotropin (**hCG).** By the end of the second week, quantities of this hormone are sufficient to be detected by radioimmunoassay, which serve as the basis for pregnancy testing.

Occasionally, increased maternal blood flow into the lacunar spaces may cause slight bleeding, known as **implantation bleeding**.
This occurs approximately 12–14 days after fertilization, around the expected time of menstruation, and may lead to confusion in determining the estimated date of delivery.



Note:
The syncytiotrophoblast:
- ✓ Erodes maternal tissue
- ✓ Invades blood vessels
- ✓ Begins secreting **human chorionic gonadotropin (hCG)**

This hormone:
- ✓ Maintains the corpus luteum
- ✓ Prevents menstruation
- ✓ Is the basis of pregnancy tests

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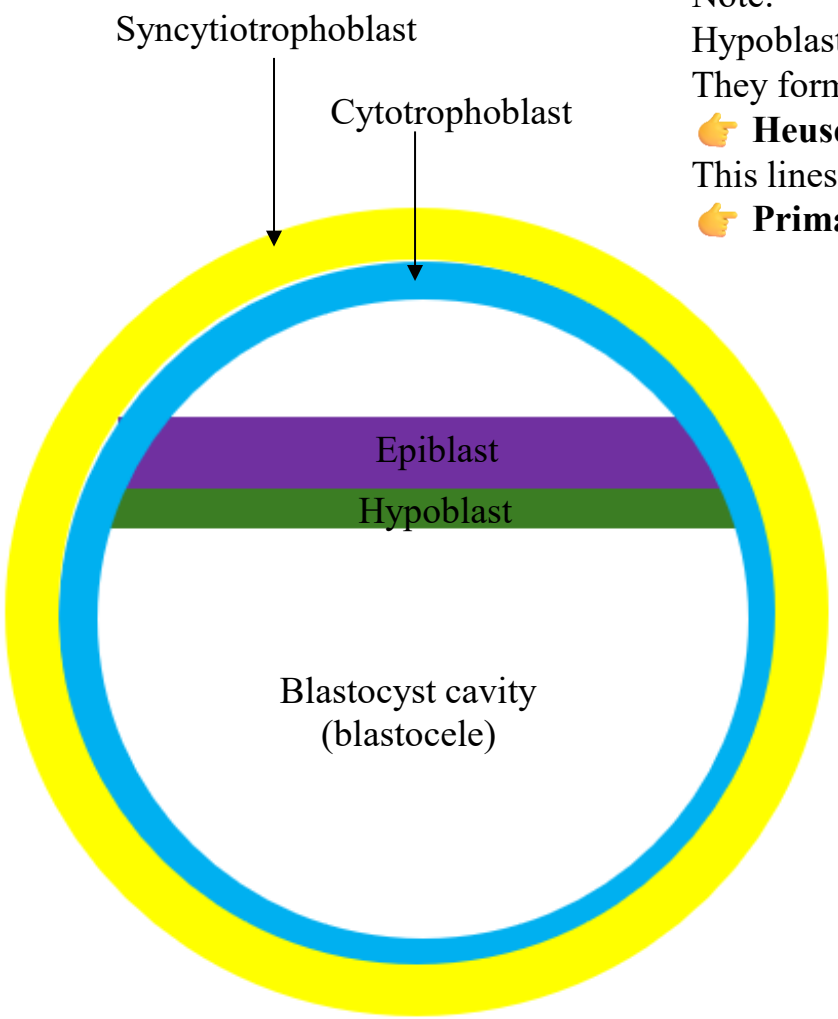
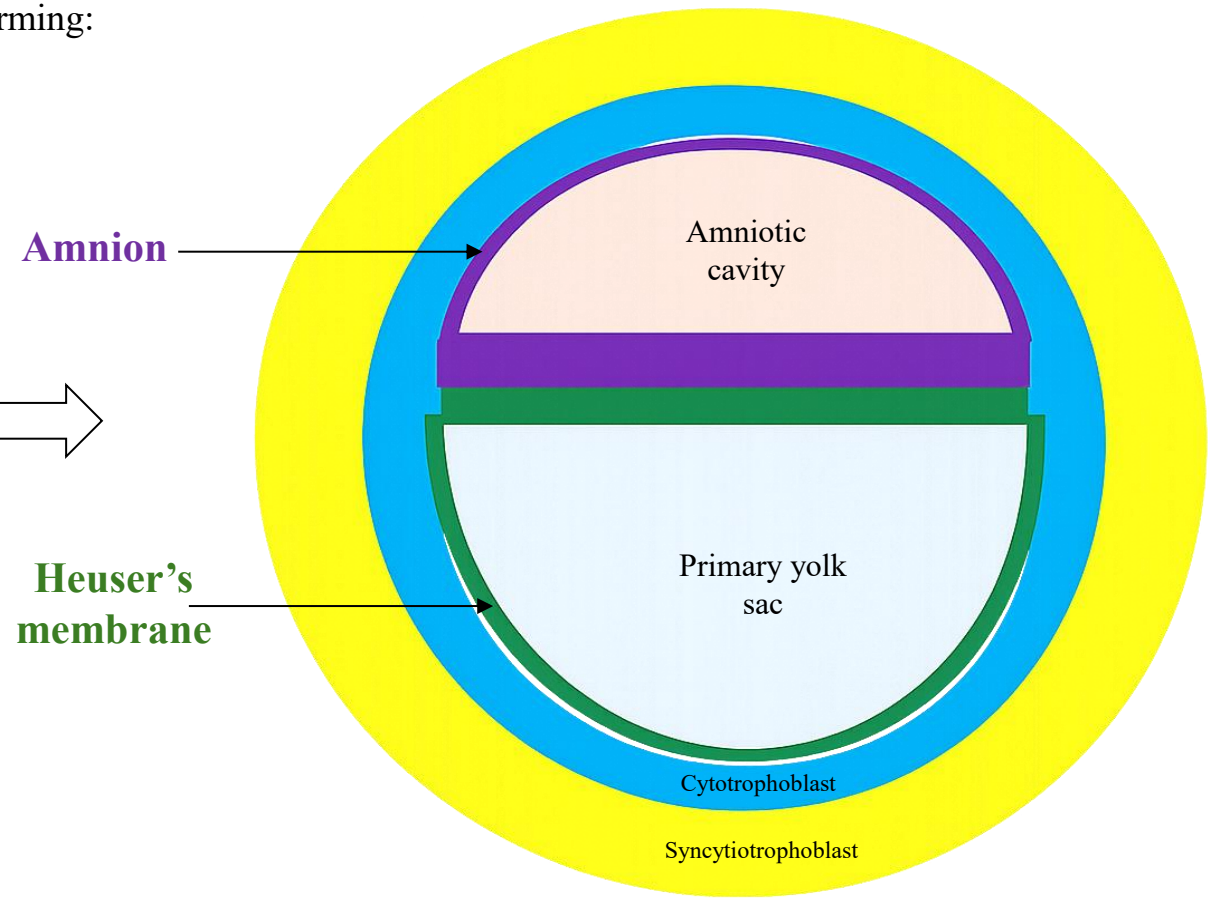
Note:
Hypoblast cells migrate along the inner surface of the cytotrophoblast.
They form:
👉 **Heuser's membrane (exocoelomic membrane)**
This lines the blastocyst cavity, forming:
👉 **Primary yolk sac**



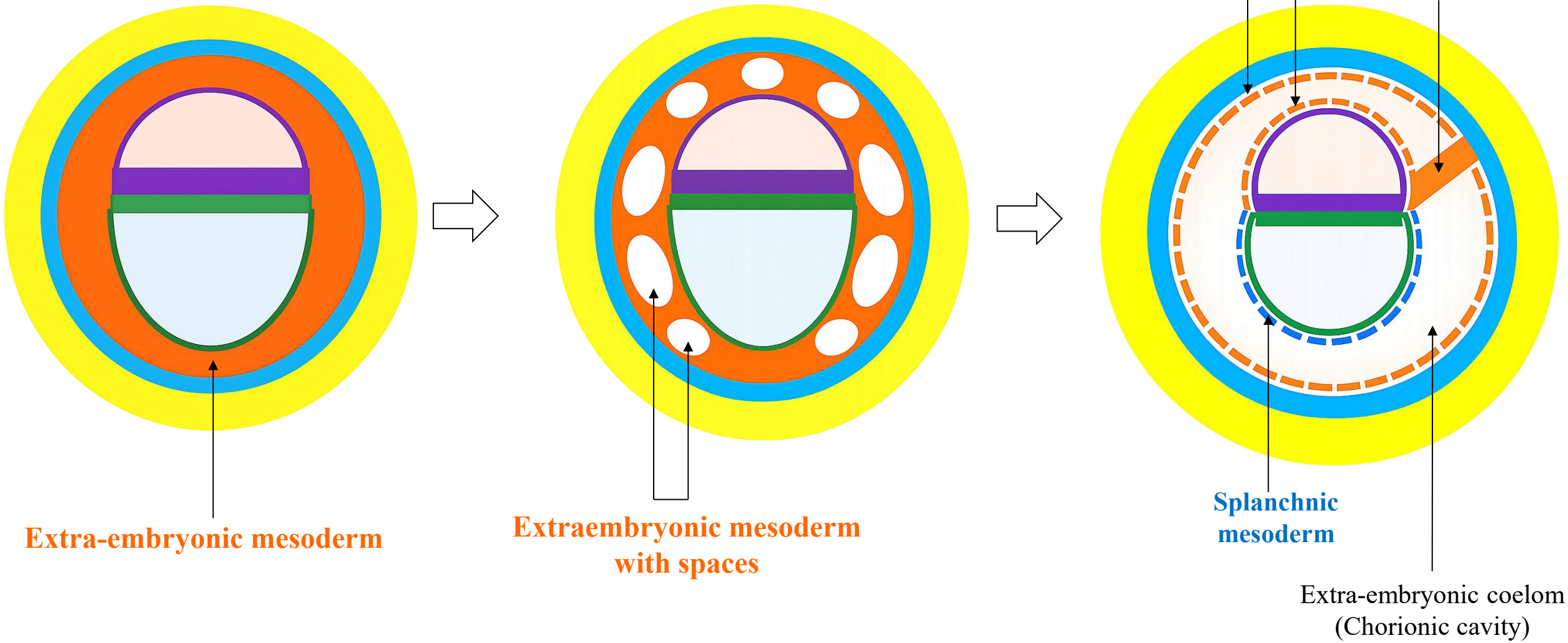


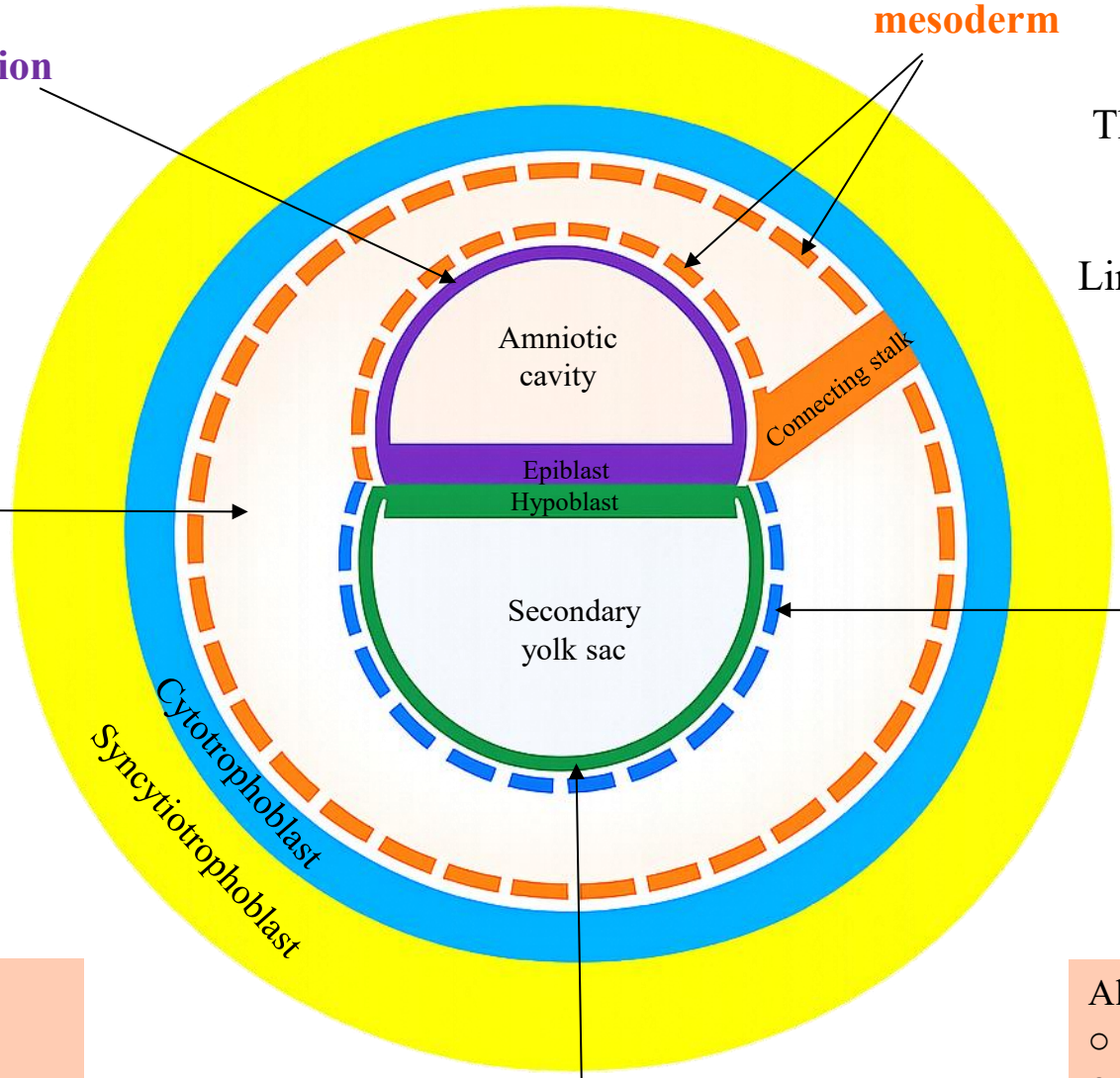
Note:
Epiblast
- ✓ Columnar cells
- ✓ Facing amniotic cavity

Hypoblast
- ✓ Cuboidal cells
- ✓ Facing blastocyst cavity

Important:
In humans, the yolk sac:
- ✓ Does NOT store yolk *(play a role in early nutrient transfer!!)*
- ✓ Is the first site of hematopoiesis
- ✓ Is the source of primordial germ cells

Note:
The amniotic cavity will eventually:
- ✓ Surround the embryo
- ✓ Fill with amniotic fluid
- ✓ Protect the developing fetus





Note:
The chorionic cavity splits extraembryonic mesoderm into:
Somatic (parietal) layer
Lines cytotrophoblast and surrounds amnion
Splanchnic (visceral) layer
Surrounds yolk sac

Alternative names
- Extraembryonic somatic mesoderm
- Parietal extraembryonic mesoderm
- Extraembryonic somatopleuric mesoderm
- Somatopleure (extraembryonic)
- Somatopleuric layer

Alternative names
- Extraembryonic splanchnic mesoderm
- Visceral extraembryonic mesoderm
- Extraembryonic splanchnopleuric mesoderm
- Splanchnopleure (extraembryonic)
- Splanchnopleuric layer

Summary of the Second Week of Development

(Days 8–14)

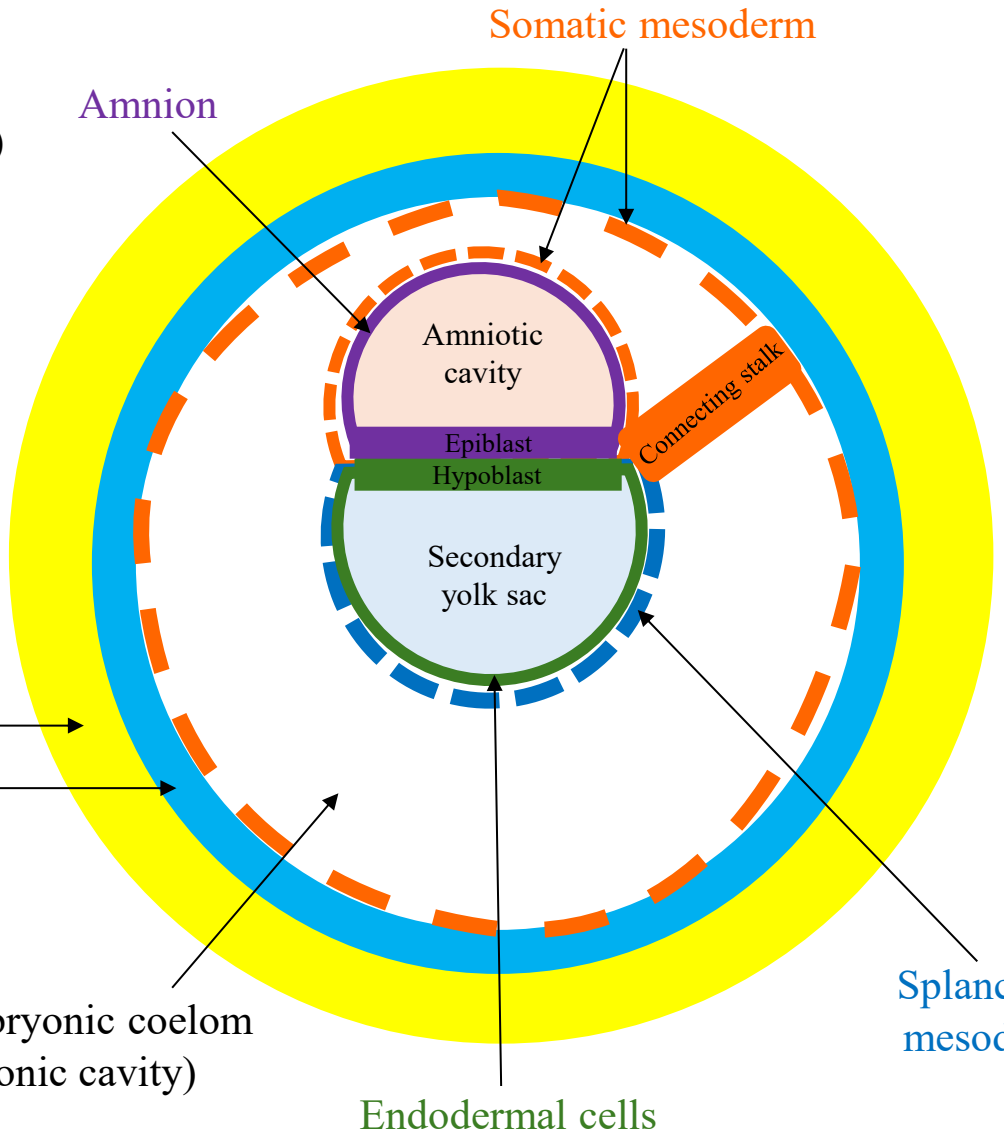
The second week is often called:
👉 ***"The Week of Twos"***
Because almost everything divides into two layers, two cavities, or two components.

During week 2 we formed:

- Two trophoblast layers (inner cytotrophoblast and outer syncytiotrophoblast)
- Two embryonic layers (epiblast and hypoblast)
- Two cavities (amniotic cavity and yolk sac)
- Two layers of extraembryonic mesoderm
- Two yolk sacs (primary and secondary)

And we established:

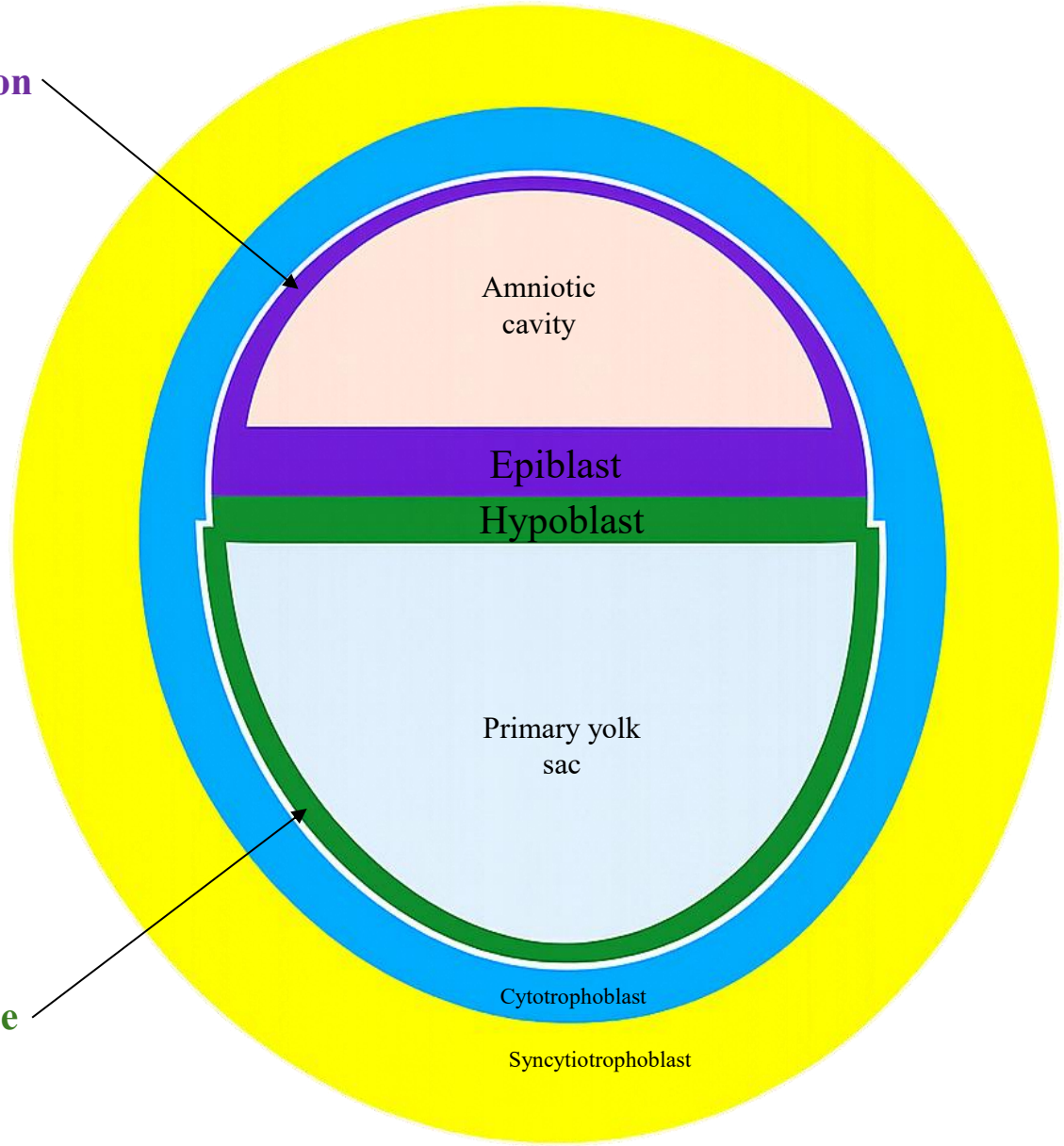
- Early uteroplacental circulation
- The connecting stalk
- Primary chorionic villi



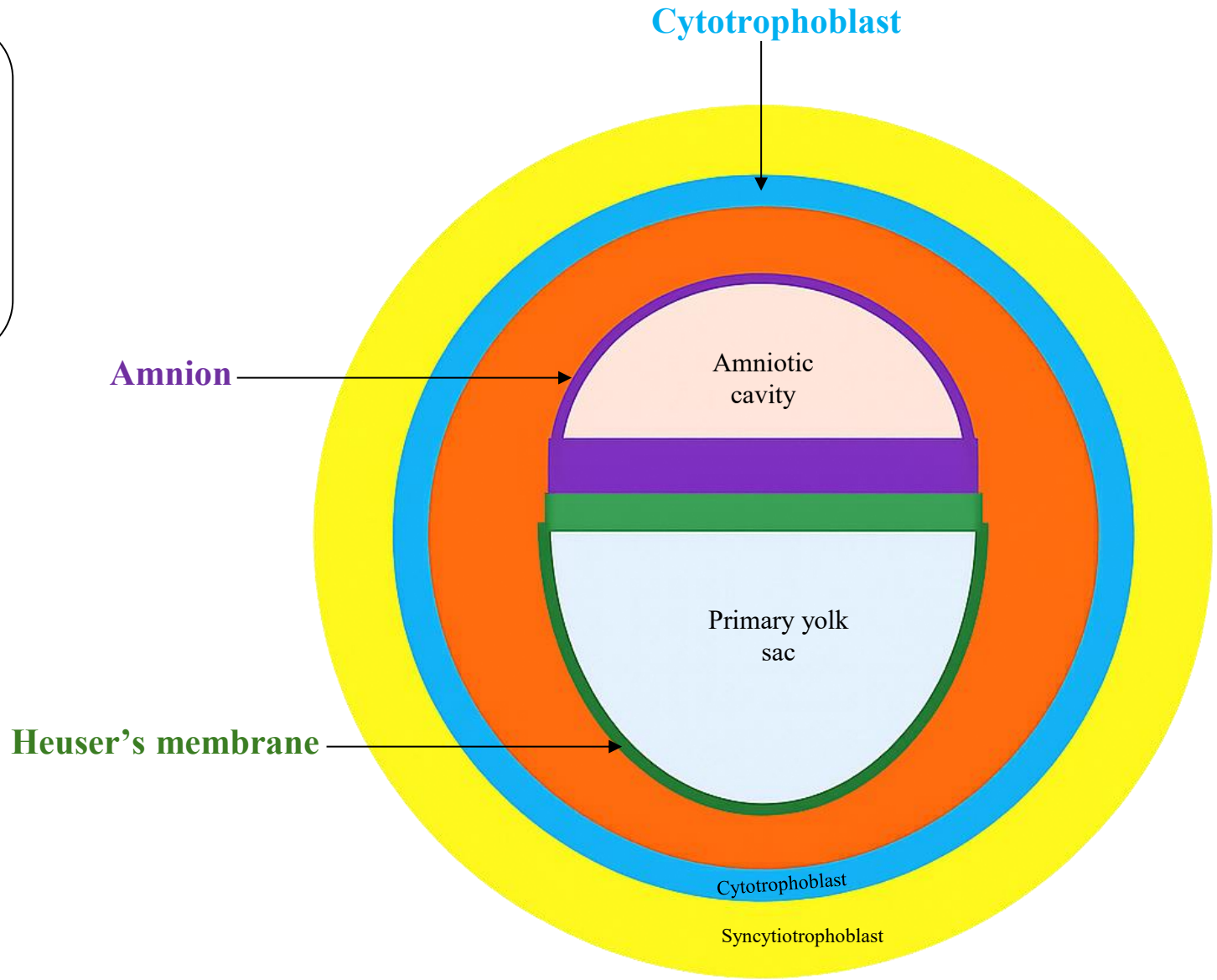
The embryo itself is still just a bilaminar disc —
But the support system is rapidly forming.

Amnion: a thin extraembryonic membrane that surrounds the embryo and forms the wall of the amniotic cavity.
It is formed by amnioblasts (from epiblast) + somatic extraembryonic mesoderm

Heuser's membrane (exocoelomic membrane): is a thin membrane formed by hypoblast-derived cells that lines the inner surface of the cytotrophoblast, enclosing the primary yolk sac.



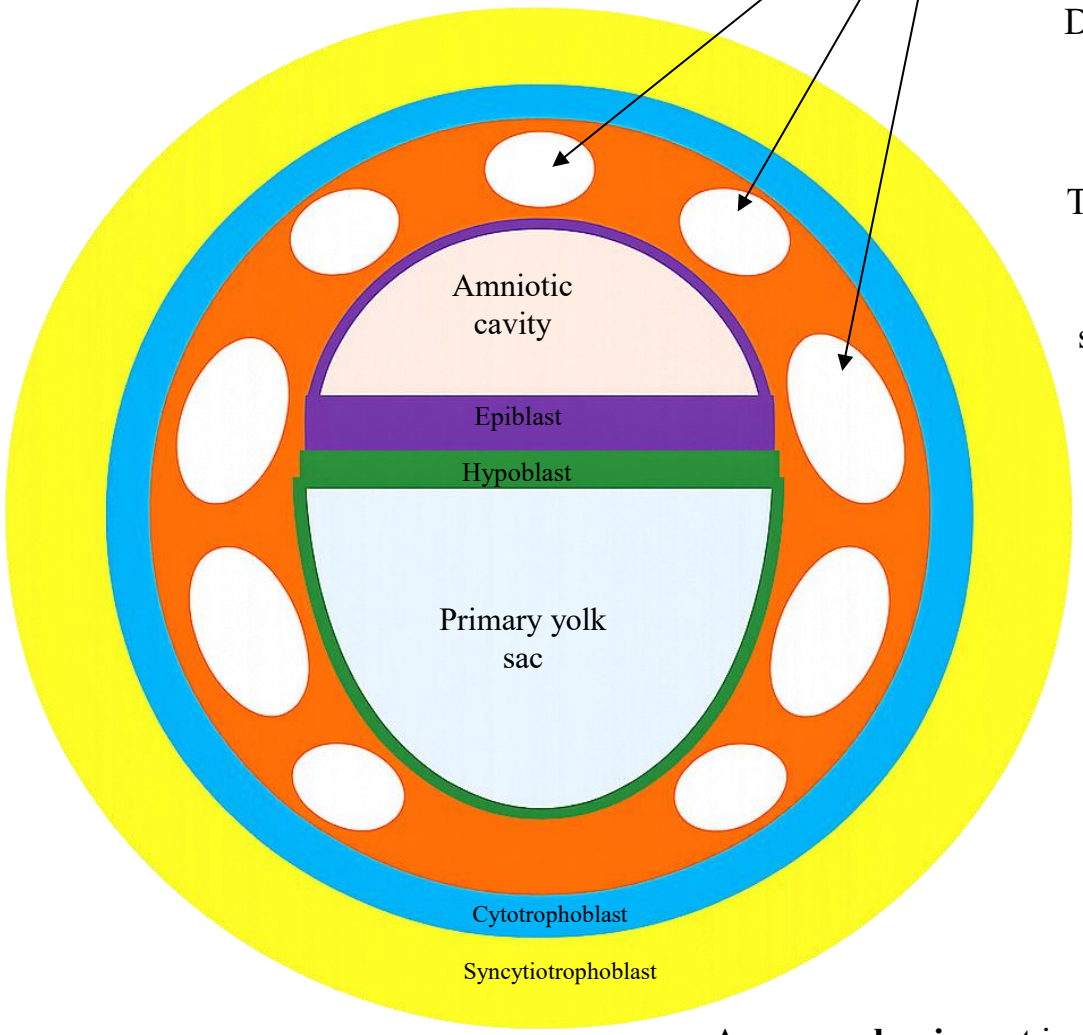
Extraembryonic mesoderm: is a layer of loose connective tissue that appears outside the embryo, between the cytotrophoblast externally and the amnion and yolk sac internally, during the second week of development.



Note: The amnion is the wall and the amniotic cavity is the space inside it

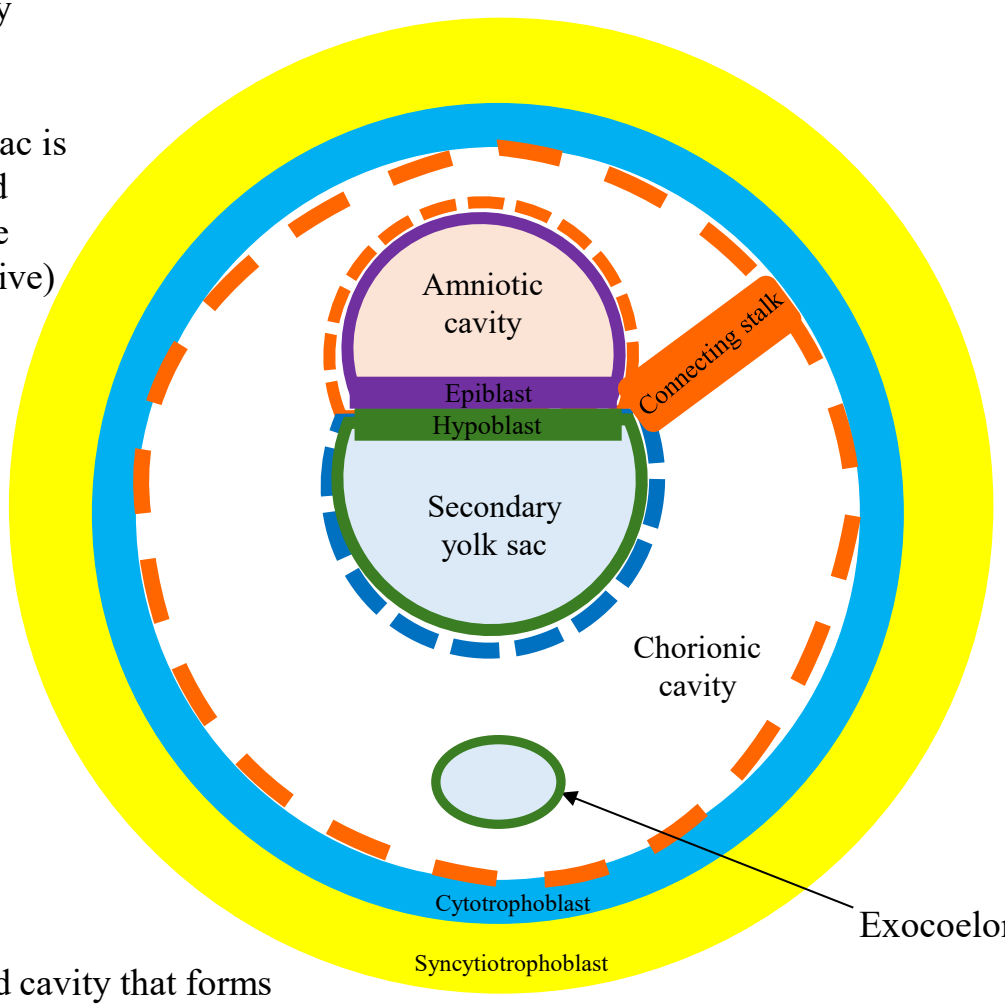
Formation of extra-embryonic coelom and connecting stalk

Note: Cavities (vacuoles) appear within the extraembryonic mesoderm, except at the connecting stalk, and coalesce to form the extraembryonic coelom (chorionic cavity).



During formation of the chorionic cavity

The primary yolk sac is pinched off and reduced and the secondary (definitive) yolk sac forms



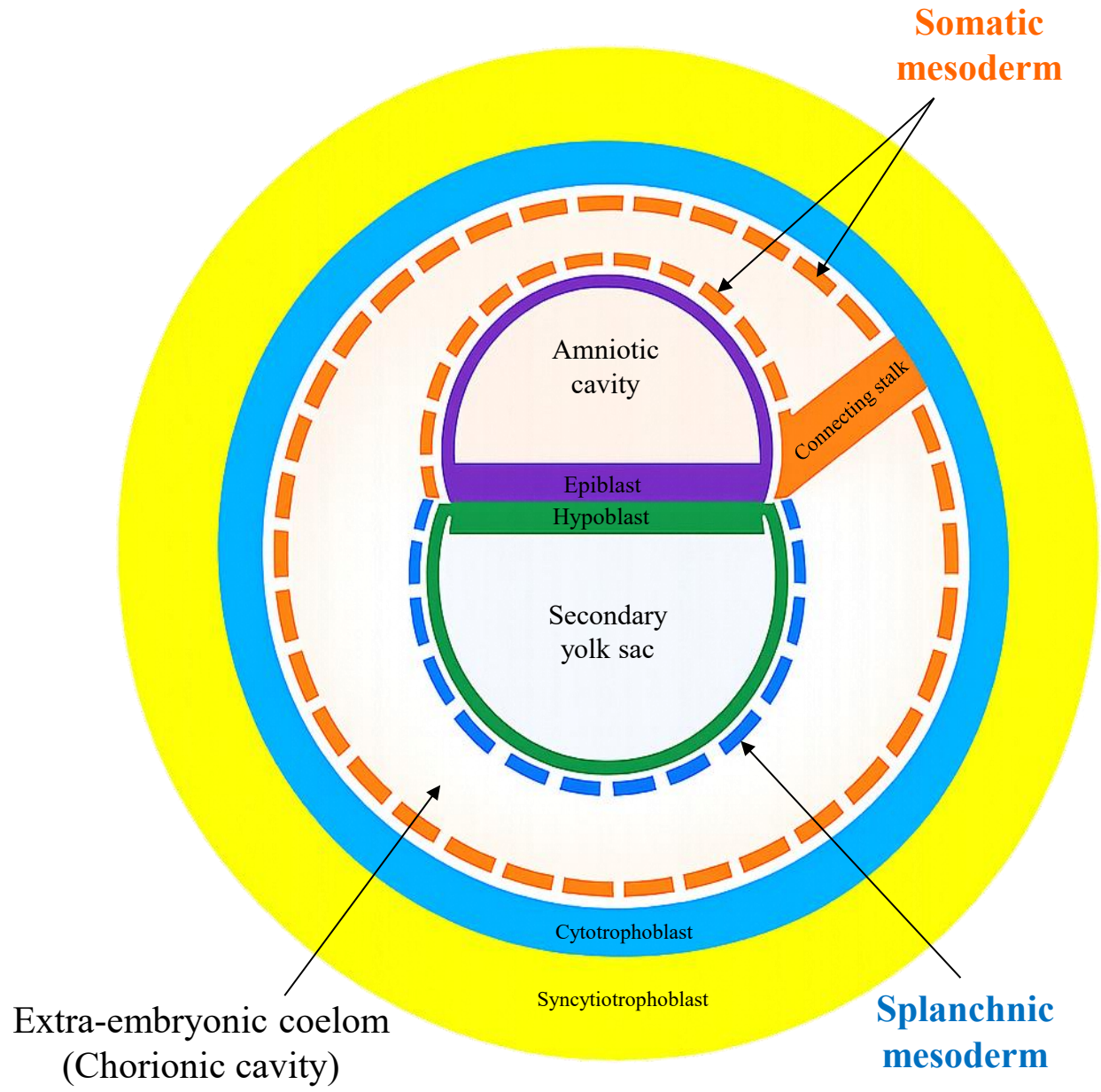
An **exocoelomic cyst** is a small, fluid-filled cavity that forms within the chorionic cavity during the second week of development as a remnant of the primary yolk sac.

Extraembryonic coelom (chorionic cavity): is a fluid-filled space that forms within the extraembryonic mesoderm during the second week of development, as this mesoderm splits into somatic (parietal) and splanchnic (visceral) layers.

Somatic (parietal) layer of extraembryonic mesoderm (Extraembryonic somatic mesoderm): is the layer of extraembryonic mesoderm that lines the inner surface of the cytotrophoblast and covers the outer surface of the amnion.

Splanchnic (visceral) layer of extraembryonic mesoderm (Extraembryonic splanchnic mesoderm): is the layer of extraembryonic mesoderm that covers the outer surface of yolk sac.

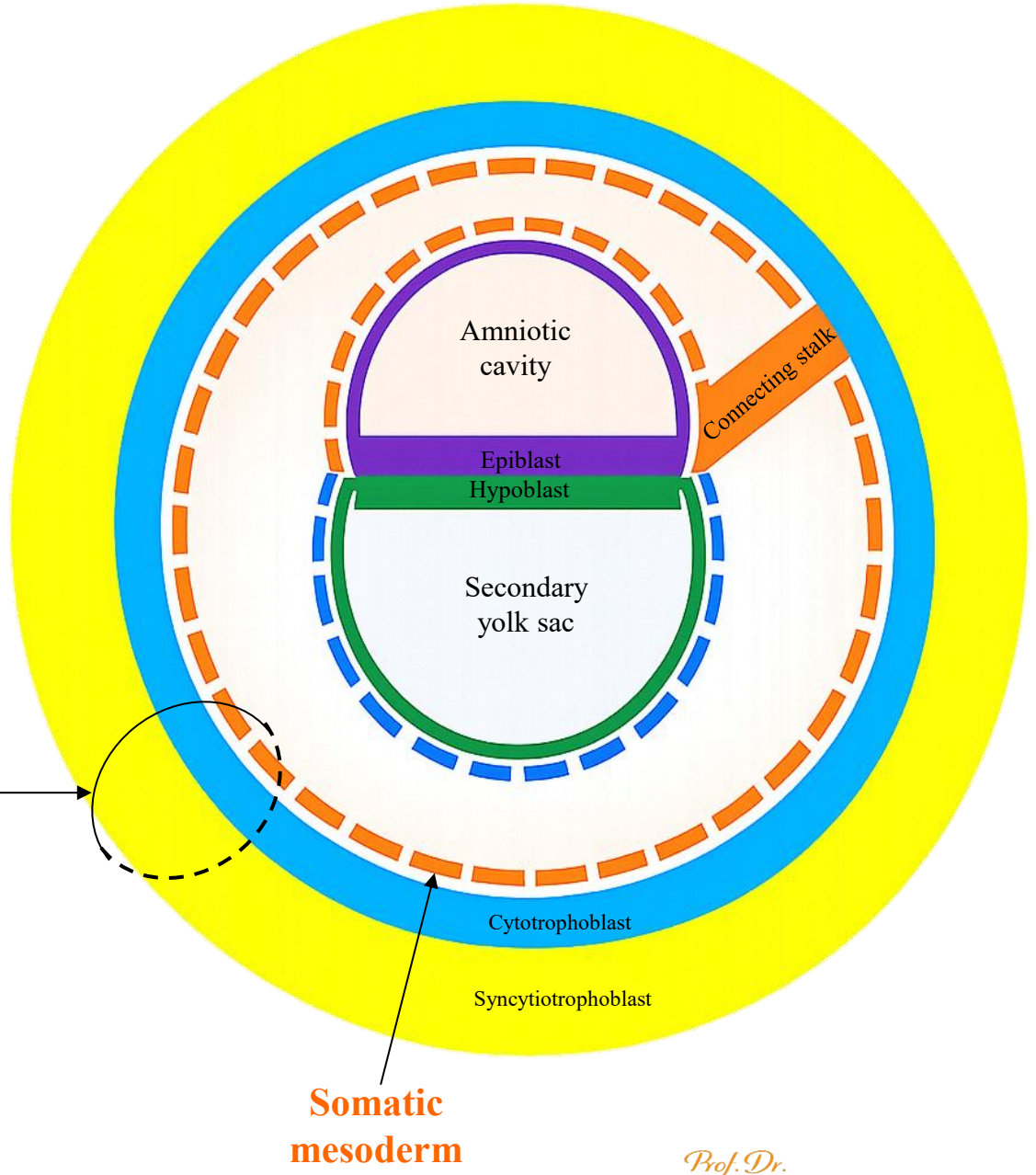
Note:
The extraembryonic mesoderm persists only in three places:
1- Extraembryonic somatic mesoderm
2- Extraembryonic splanchnic mesoderm
3- Connecting stalk



Connecting stalk is a band of extra-embryonic mesoderm connecting embryo to chorion. It is the precursor of the umbilical cord.

Chorion is the outermost fetal membrane that surrounds the embryo and contributes to placenta formation.
It is formed by:

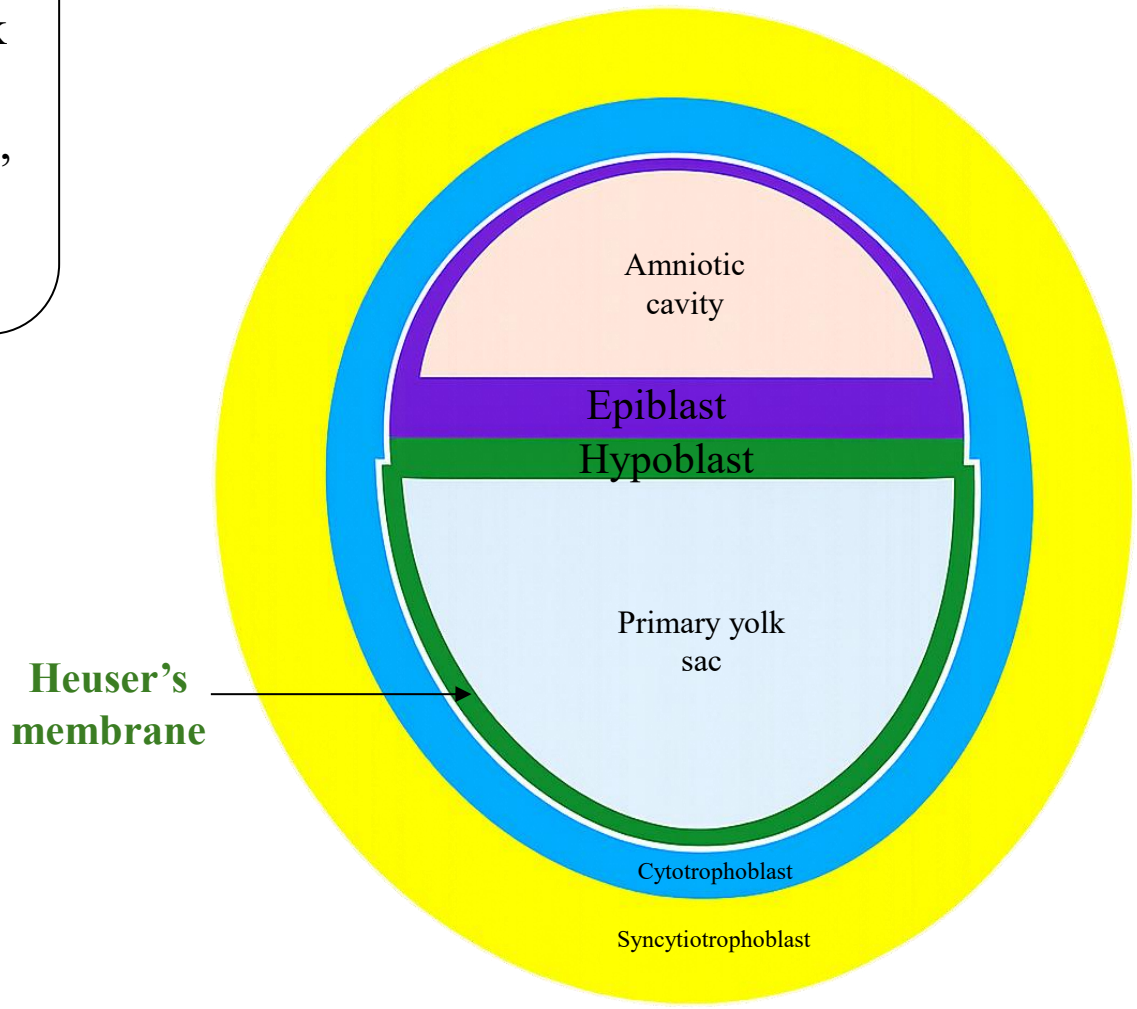
1. Cytotrophoblast
2. Syncytiotrophoblast
3. Extra-embryonic somatic mesoderm



Primary yolk sac

It is the first yolk sac that forms during the second week of development, when Heuser's (exocoelomic) membrane lines the inner surface of the cytotrophoblast, enclosing a large cavity beneath the embryonic disc.

👉 It is temporary and later regresses.



Secondary (definitive) yolk sac

It is the smaller yolk sac that forms when the primary yolk sac is pinched off and reduced, and is lined by endodermal cells and covered externally by extraembryonic splanchnic mesoderm.

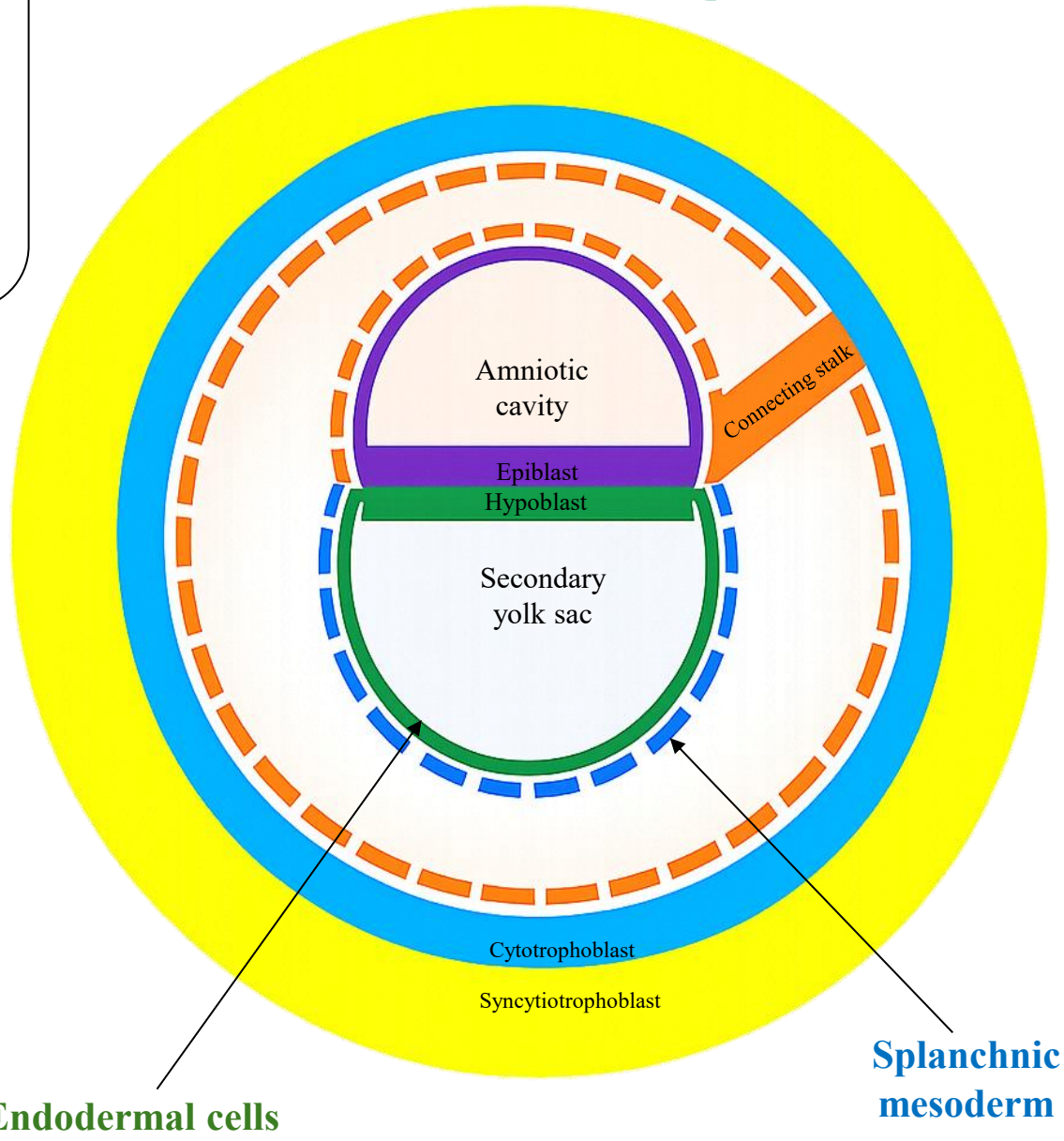
👉 It persists longer and plays important roles in hematopoiesis, and as a source of primordial germ cells.

Note:

As the primary yolk sac is pinched off and reduced, the secondary (definitive) yolk sac forms, accompanied by degeneration of Heuser's membrane; the secondary yolk sac is lined by new hypoblast-derived **endodermal cells**, not by Heuser's membrane itself.

Heuser's membrane → *primary yolk sac only*

Secondary yolk sac → *newly formed hypoblast-derived* ***endodermal cells + extraembryonic splanchnic mesoderm***



Decidua is the endometrium of the uterus after implantation, when it becomes thick, vascular, and specialized to support pregnancy. It is shed after the birth of the fetus.

The decidua is divided into three parts, based on their relationship to the implanted embryo:

Decidua basalis

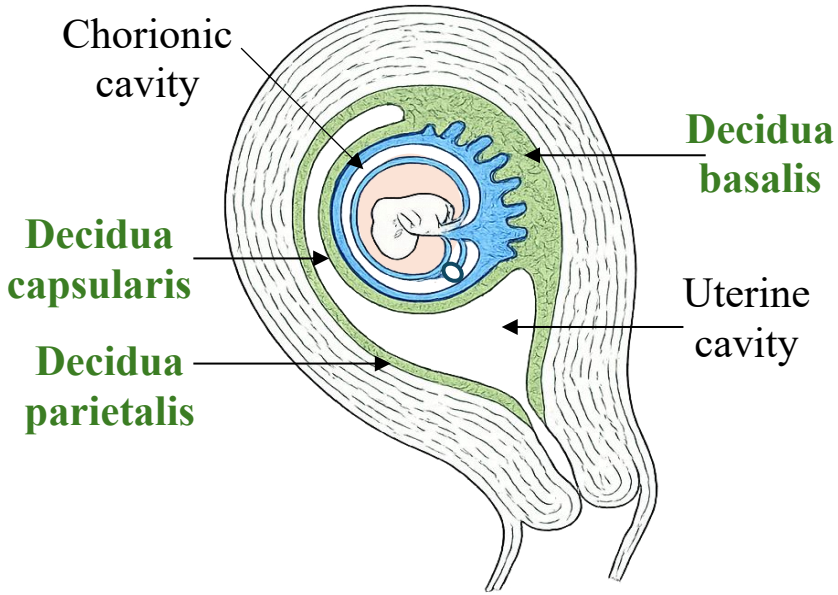
- ✓ The part of the decidua beneath the implanted embryo
- ✓ Contributes to formation of the maternal part of the placenta

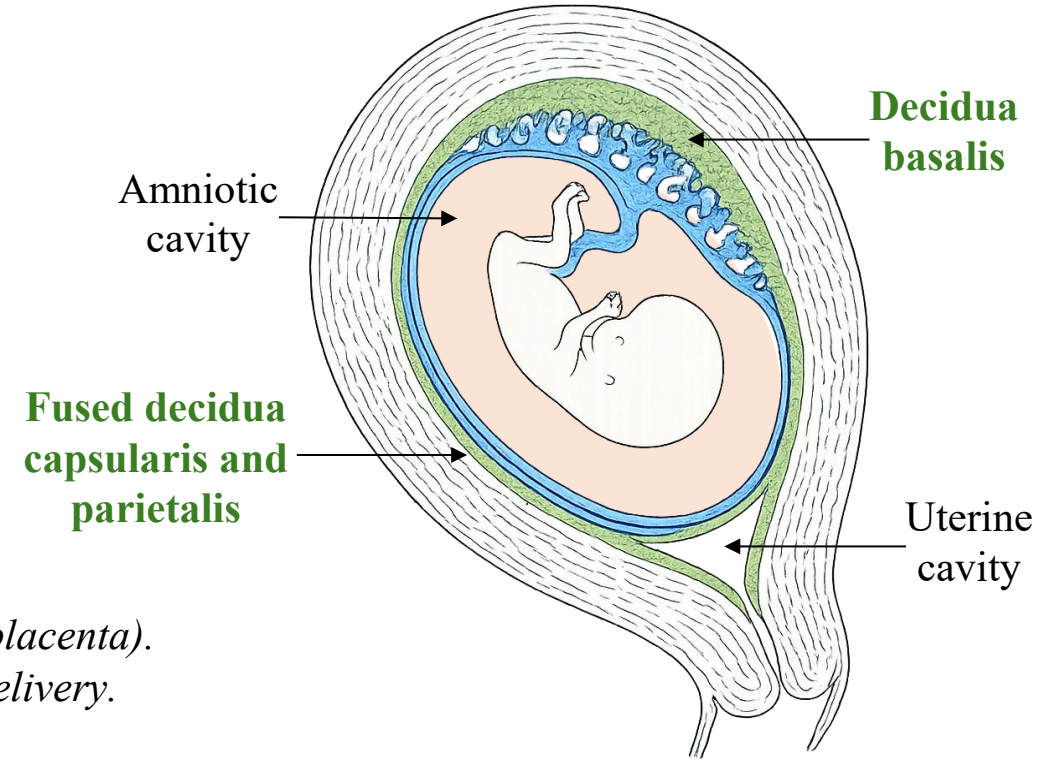
Decidua capsularis

- ✓ The part of the decidua that covers the embryo toward the uterine cavity
- ✓ Becomes thin as pregnancy progresses

Decidua parietalis

- ✓ The remaining lining of the uterus not involved in implantation
- ✓ Lines the rest of the uterine cavity



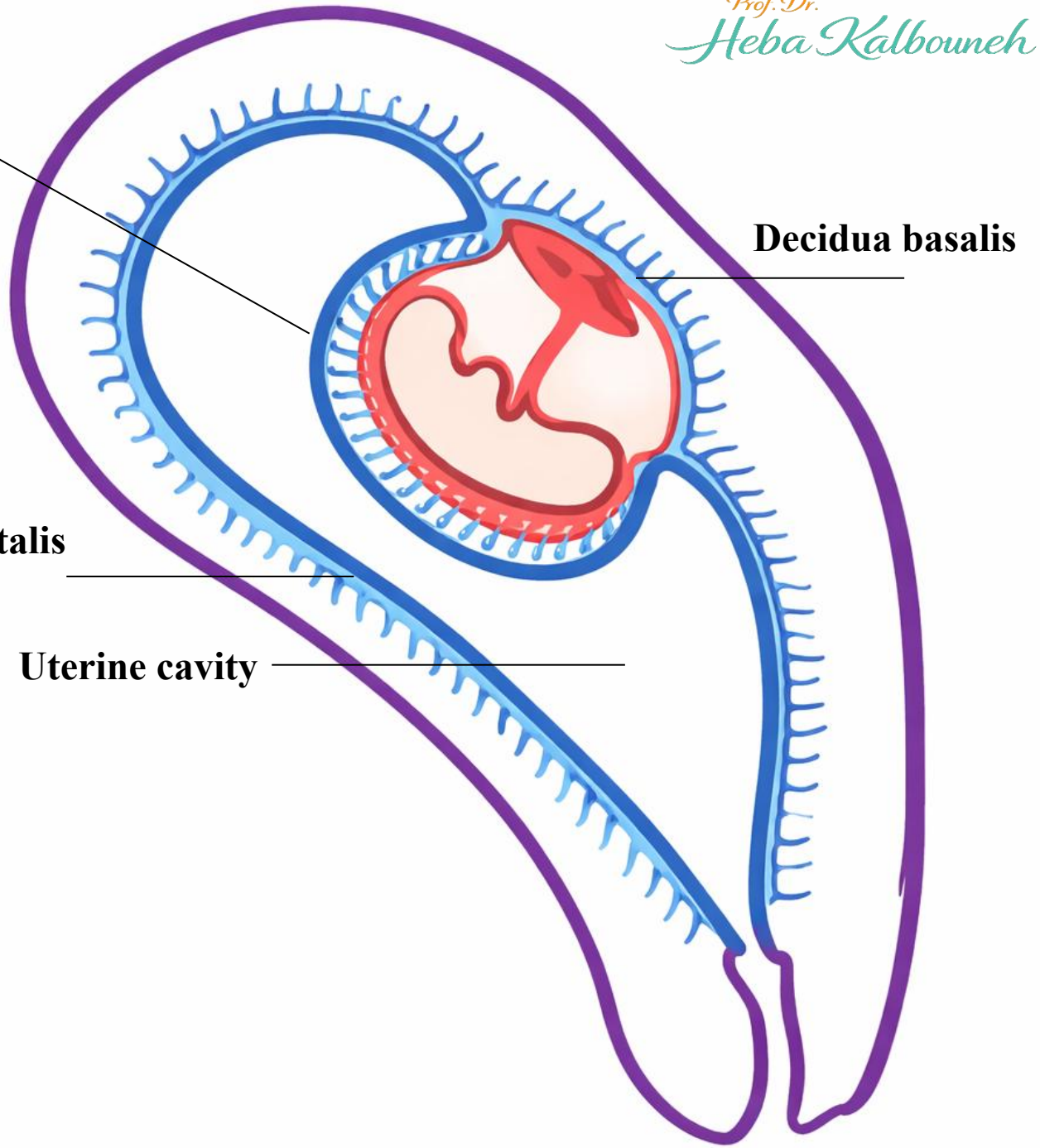


Fate of decidua:

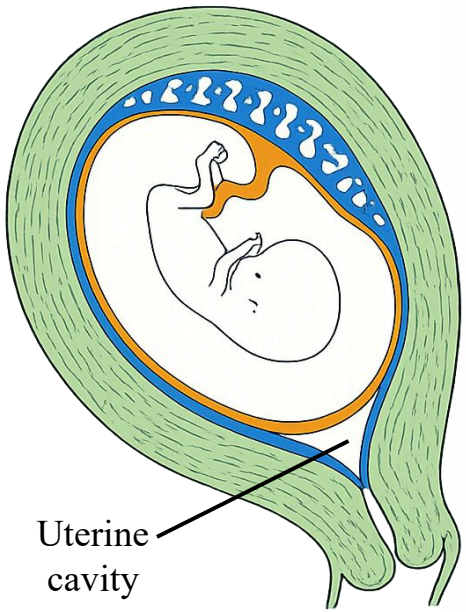
Decidua basalis shares in the formation of placenta (forms the maternal part of placenta).

Decidua capsularis and parietalis fuse together and shed with placenta after delivery.

The decidua is the uterine lining during pregnancy that nourishes and supports the embryo.
👉 *Basalis = below, Capsularis = covers, Parietalis = the rest*



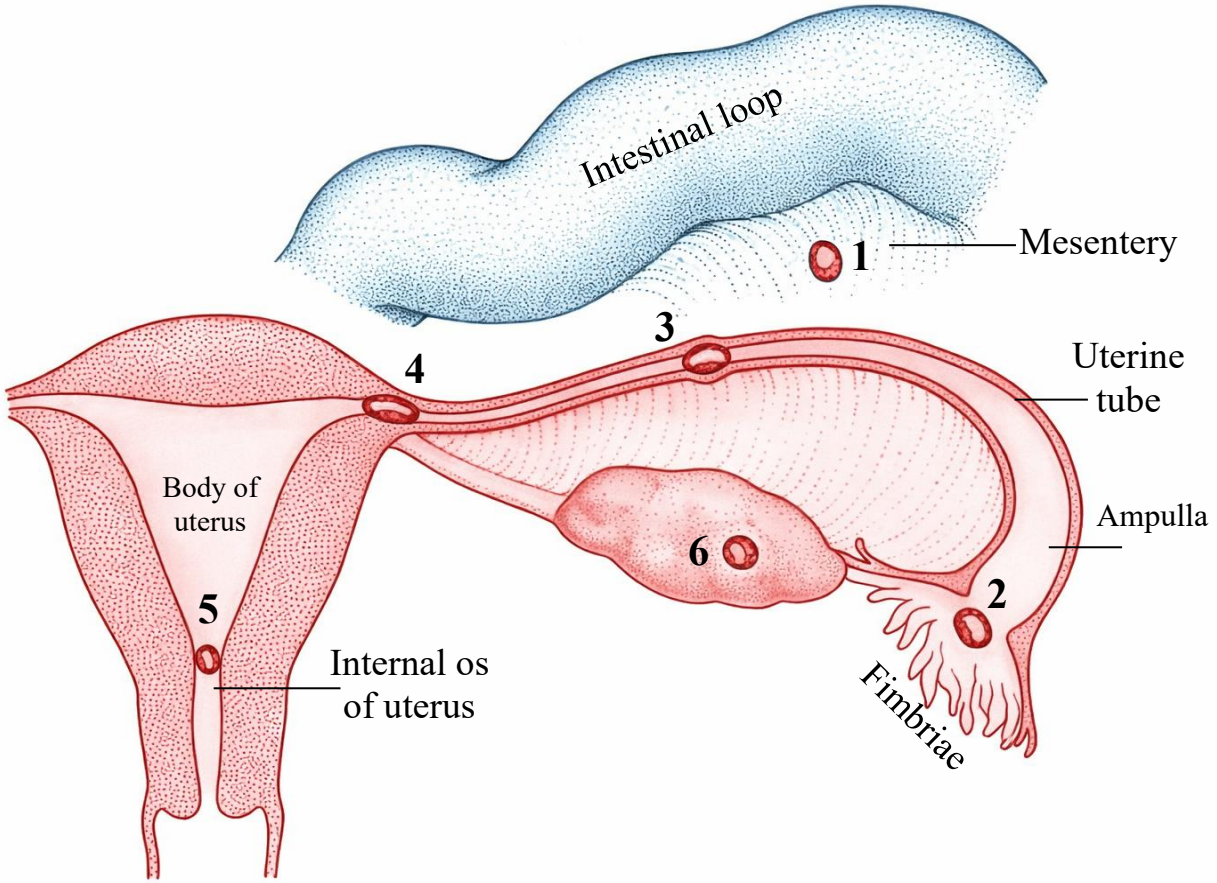
As pregnancy progresses, the gestational sac enlarges and the decidua capsularis becomes stretched and thins out. Eventually, it comes into contact with and fuses with the decidua parietalis, which obliterates the uterine cavity.

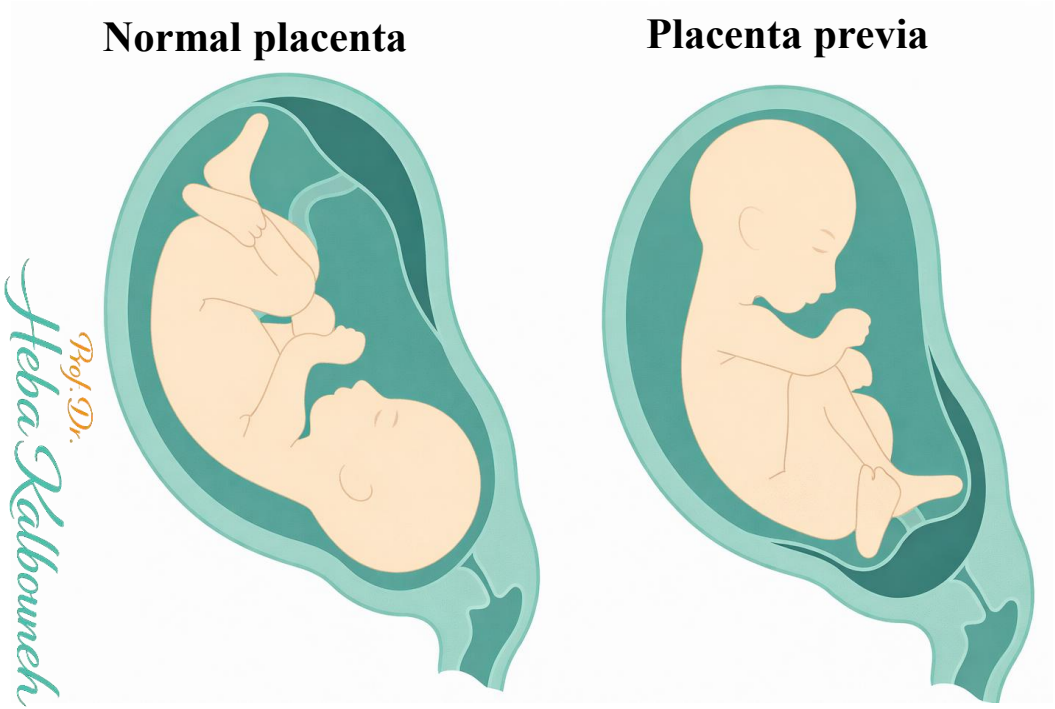


Abnormal Sites of Implantation:

1- **Ectopic pregnancy:** is a condition in which a fertilized egg implants outside the uterus, instead of implanting in the uterine cavity.

- ✓ Most commonly occurs in the uterine tube
- ✓ The uterus is the only place where a pregnancy can grow normally
- ✓ This leads to embryonic death or early abortion and can result in rupture of the uterine tube with severe internal hemorrhage.

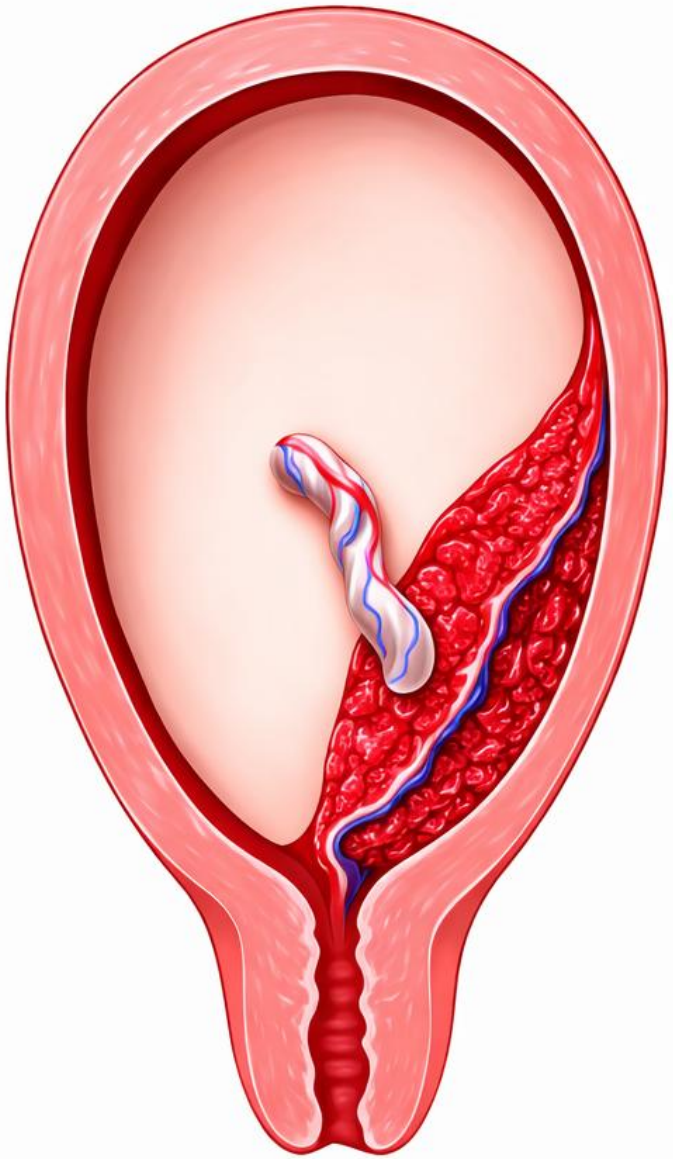




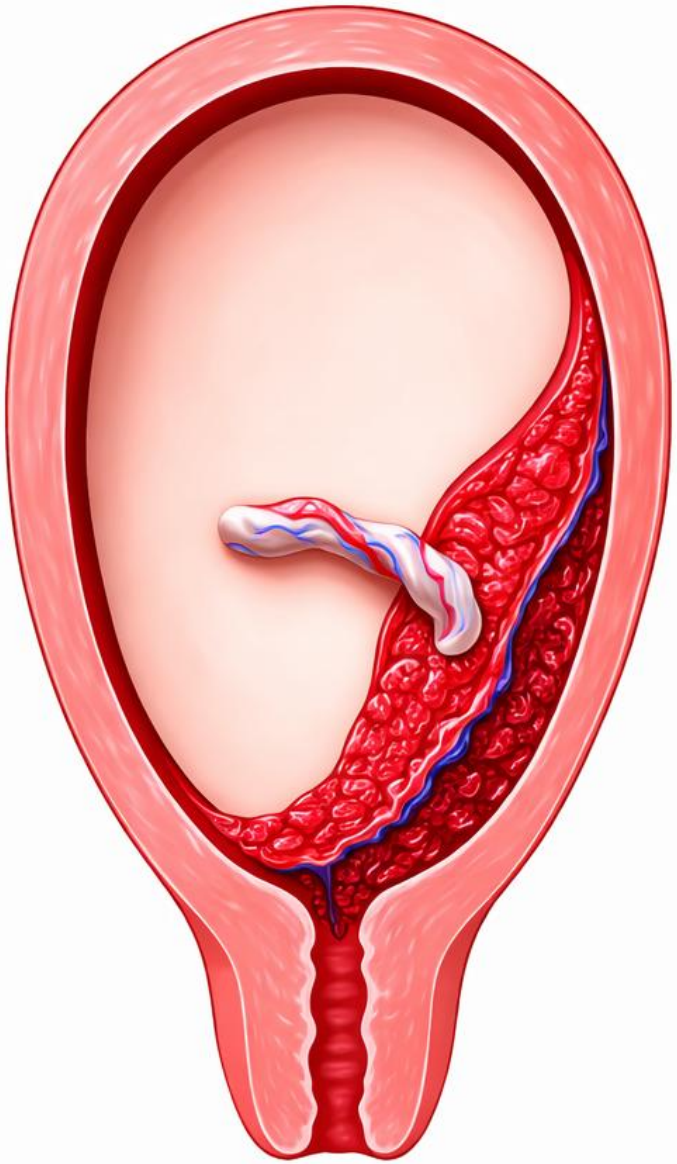
2- **Placenta previa:** is a condition in which the placenta is located low in the uterus, near or over the opening of the cervix instead of being in the upper uterus.

→ *Implantation in the lower uterine segment, close to the internal os of the cervix.*

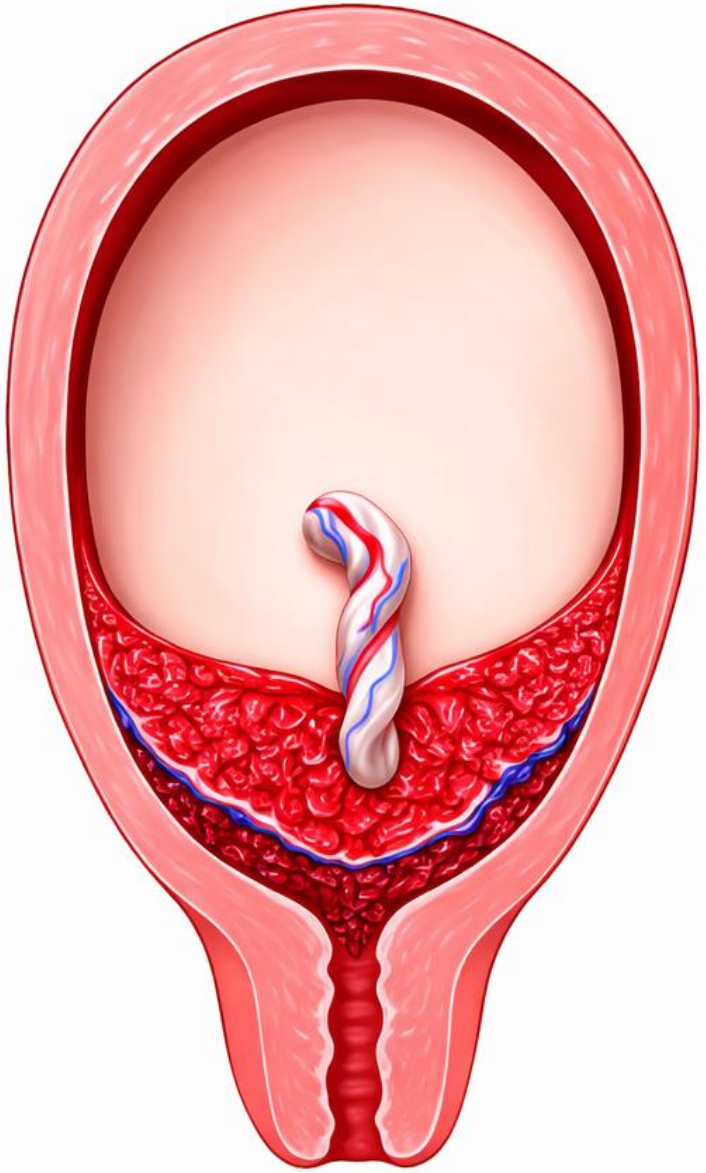
Thus, the placenta will precede the fetus at delivery (normally, the fetus delivered first, followed by the placenta. Previa= before the fetus.



Placenta previa parietalis

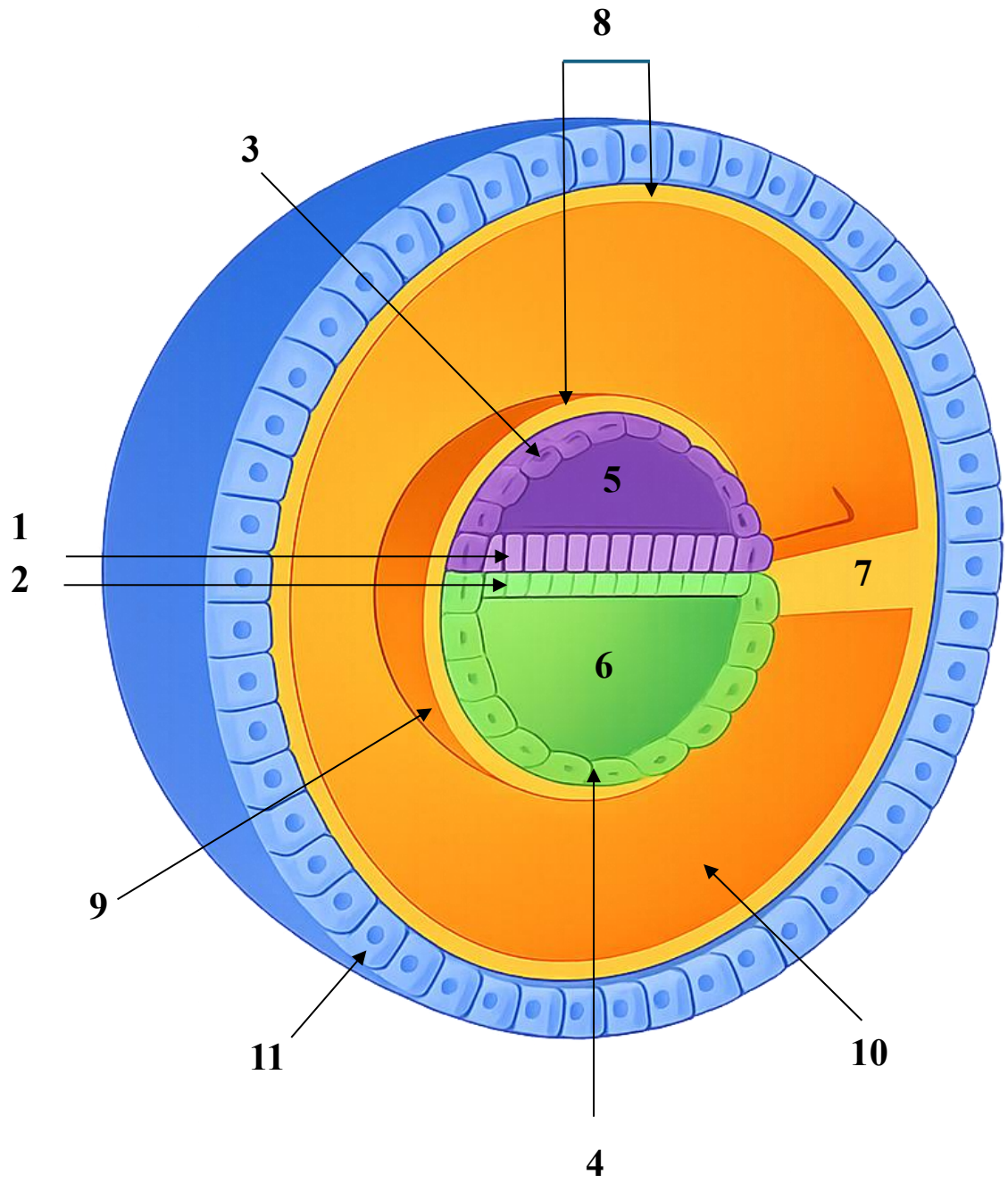


Placenta previa marginalis



Placenta previa centralis

Identify



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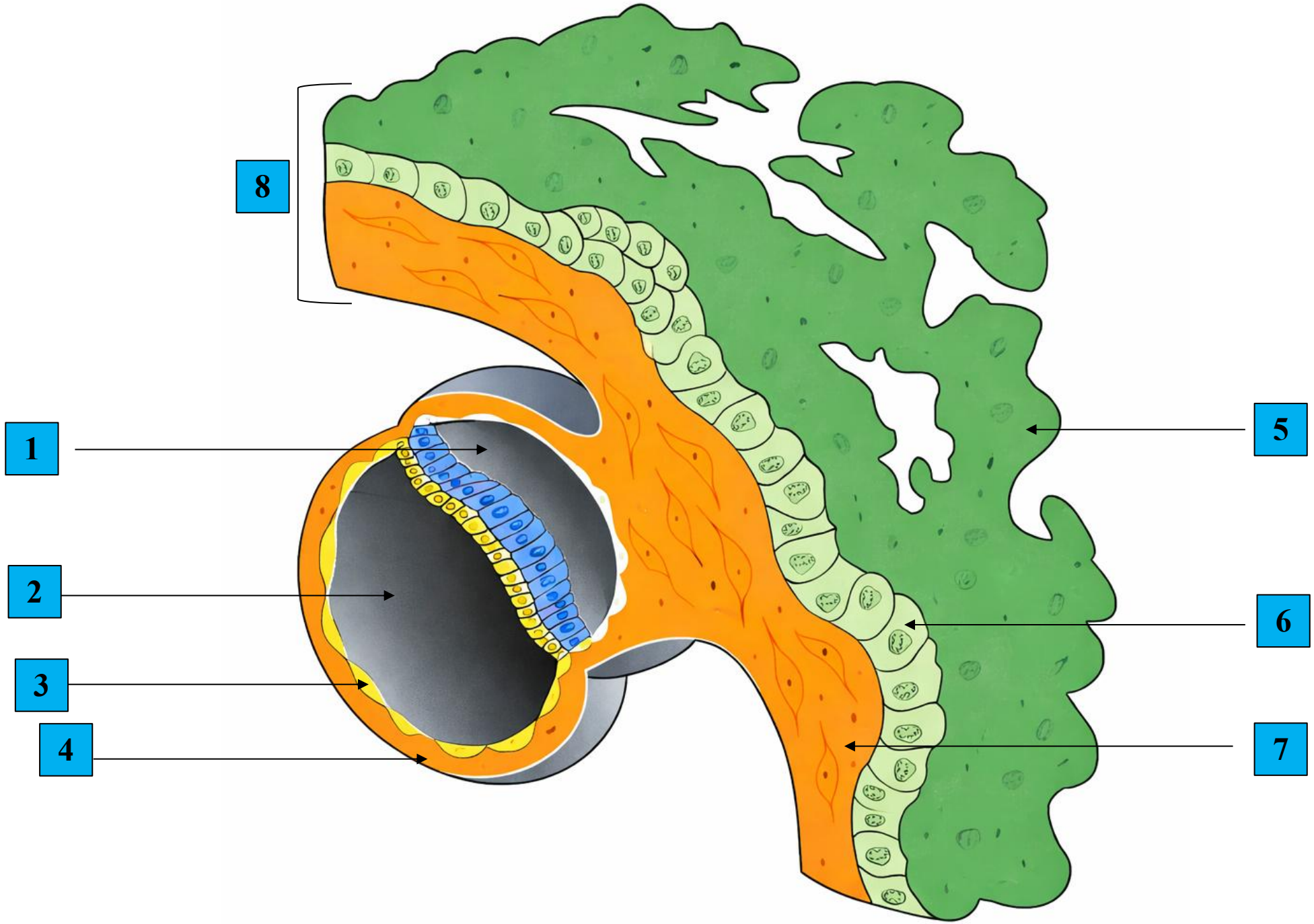

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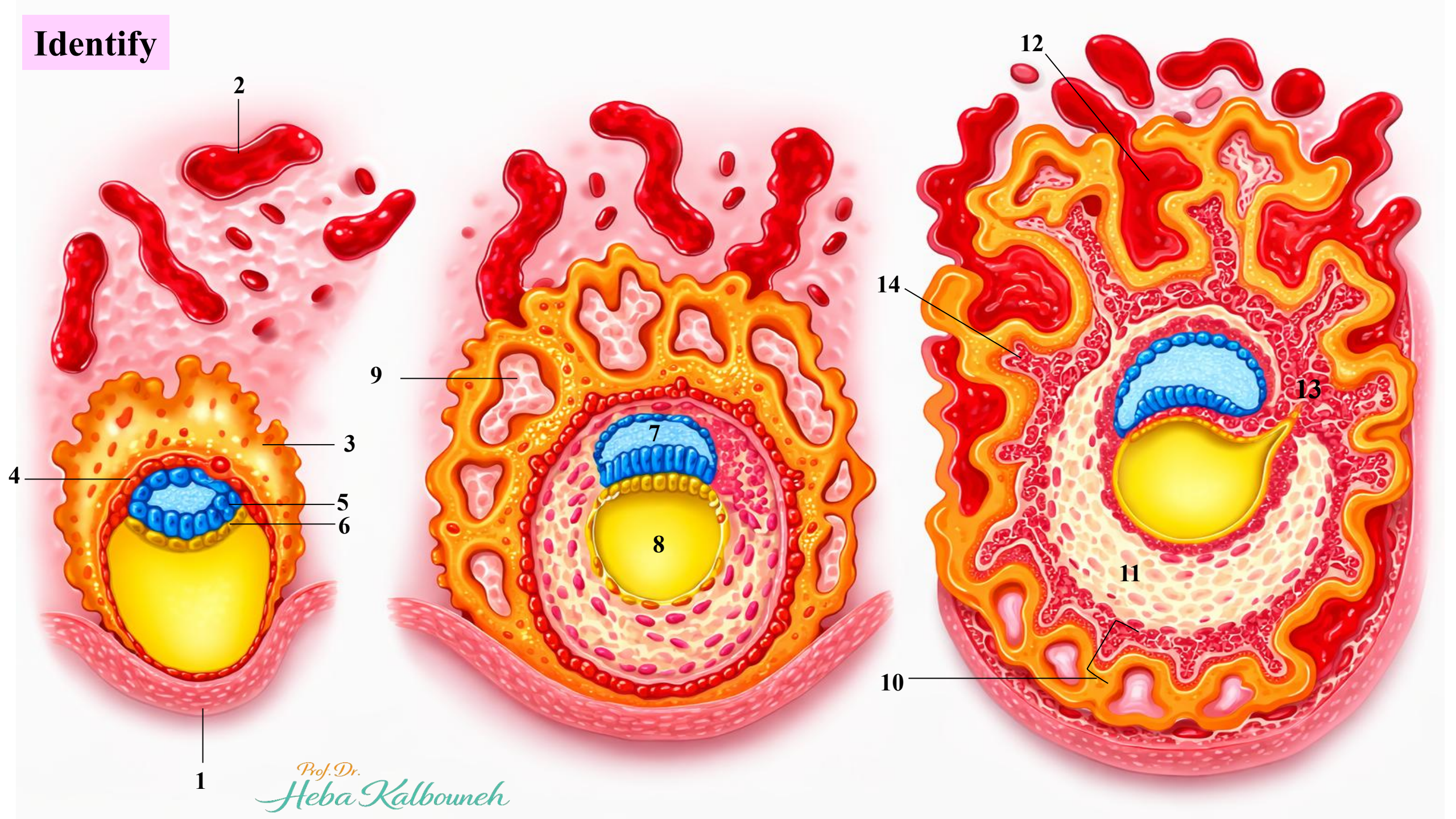

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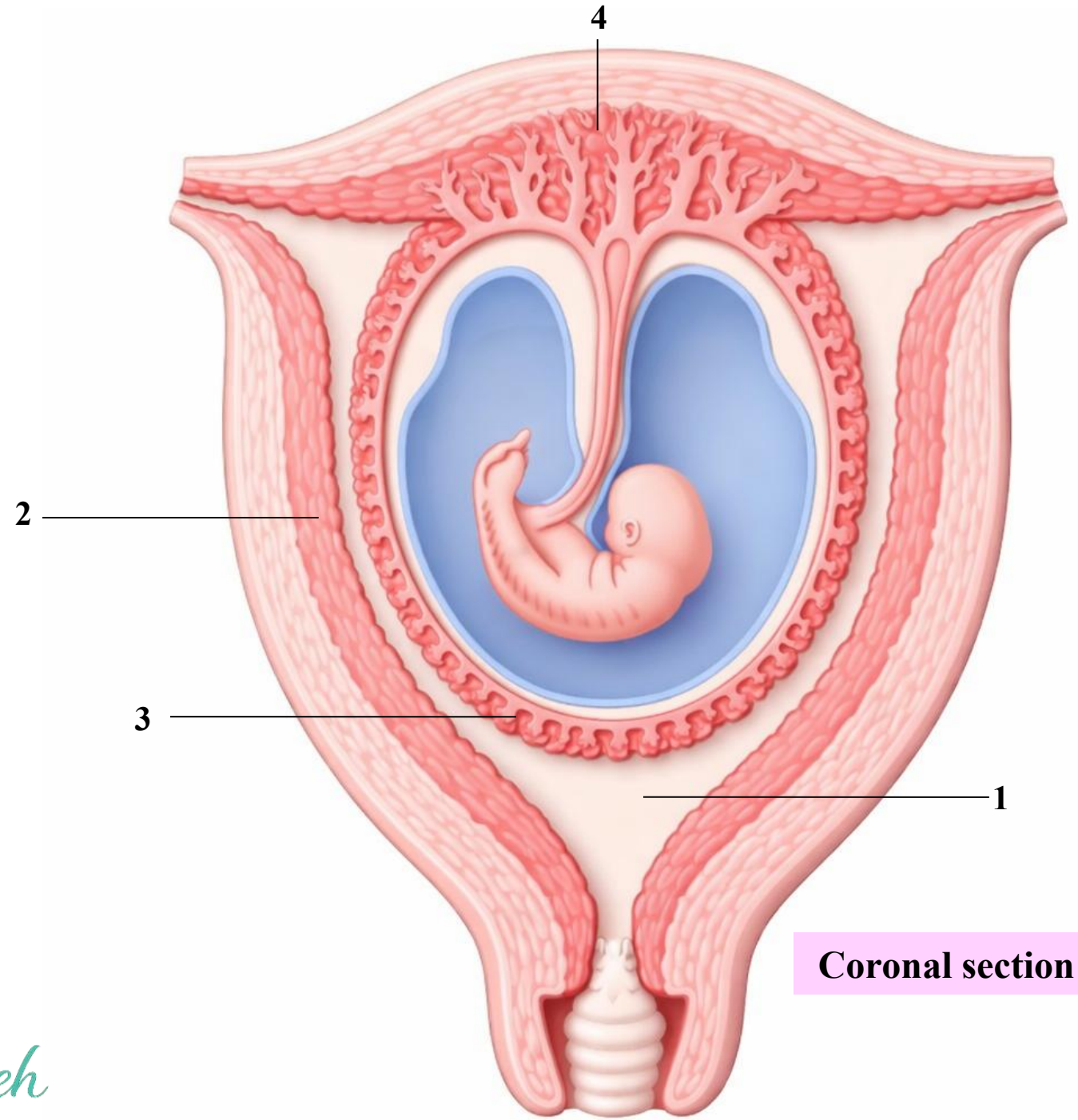

Coronal section

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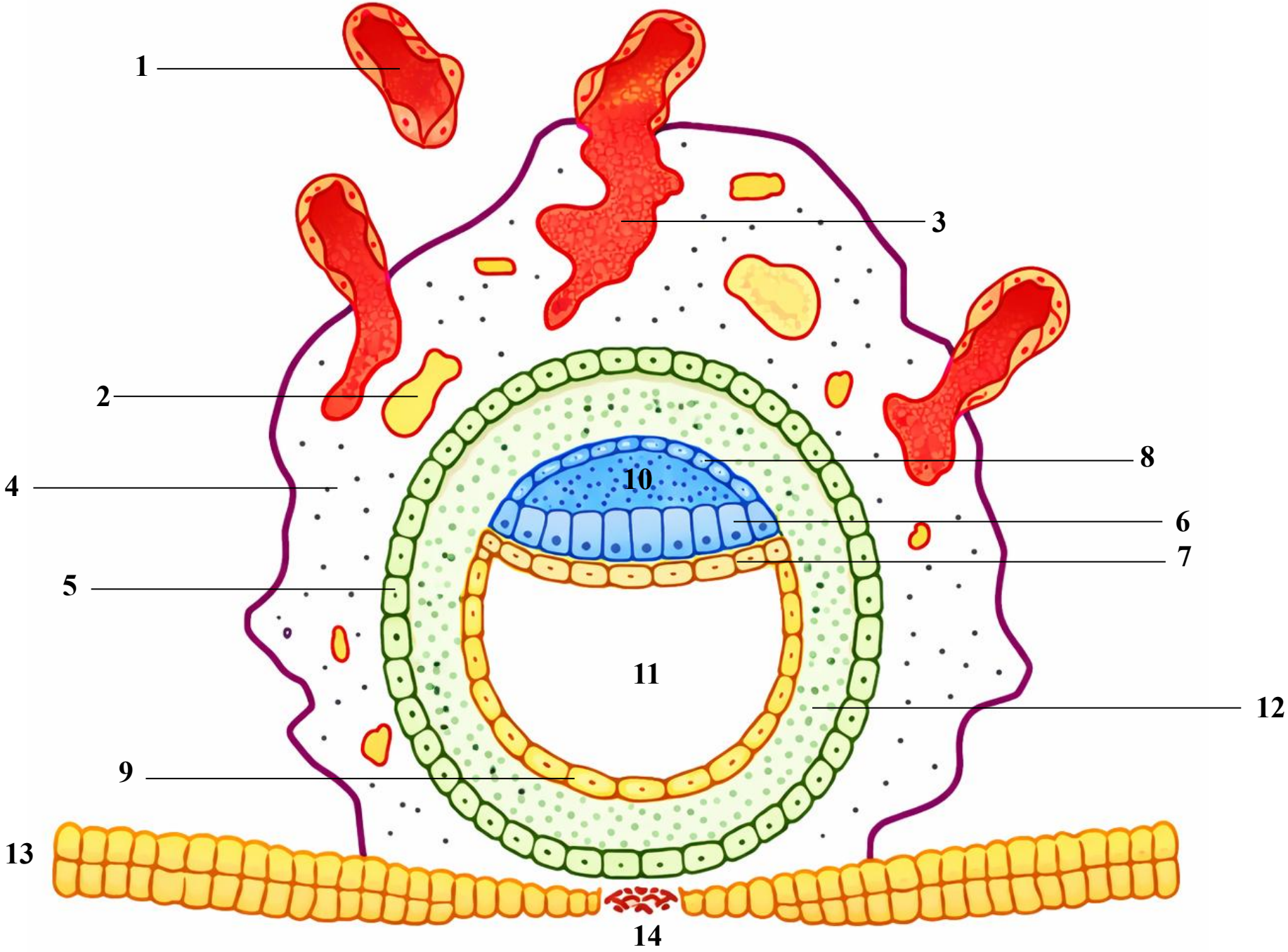
Identify



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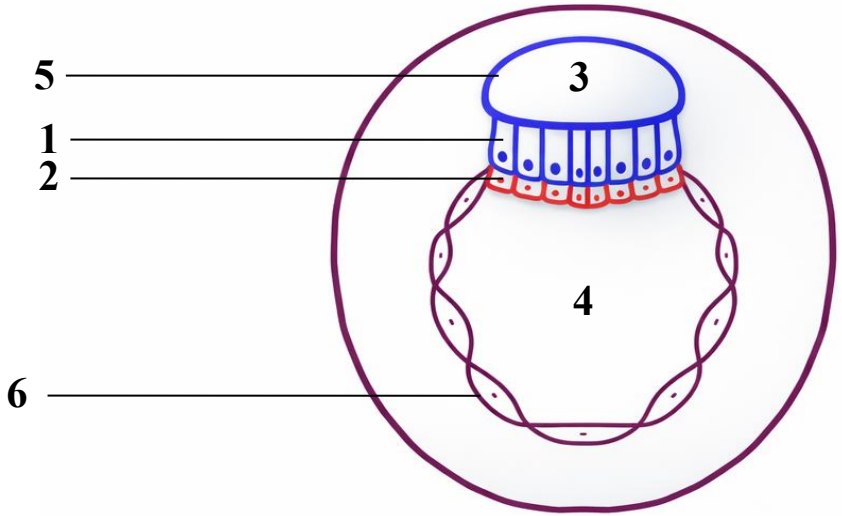

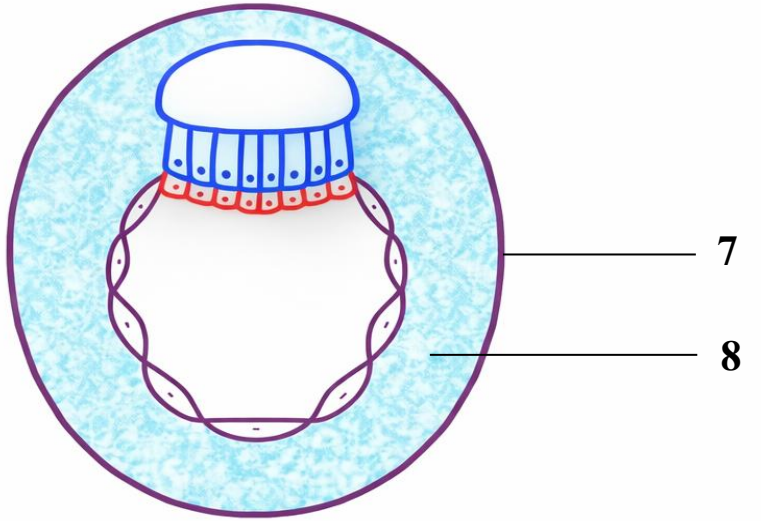

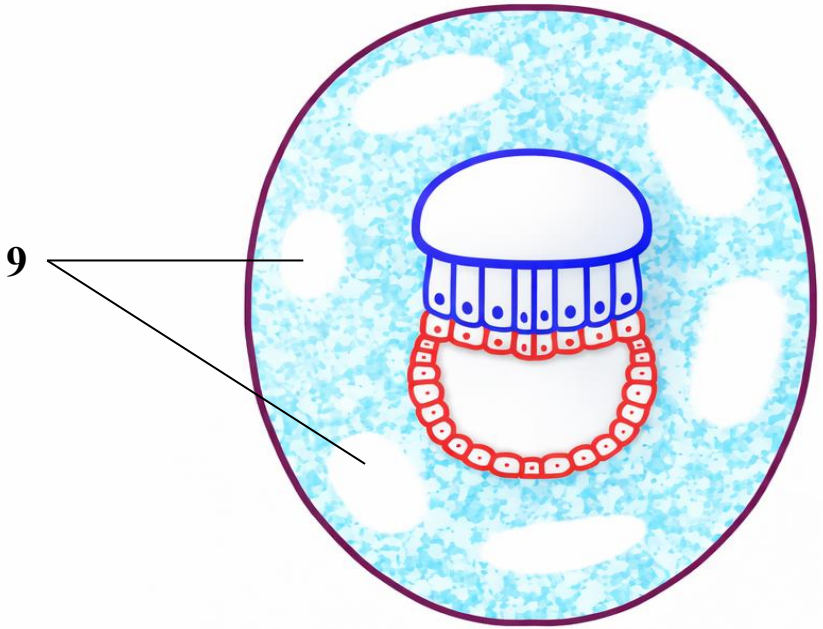

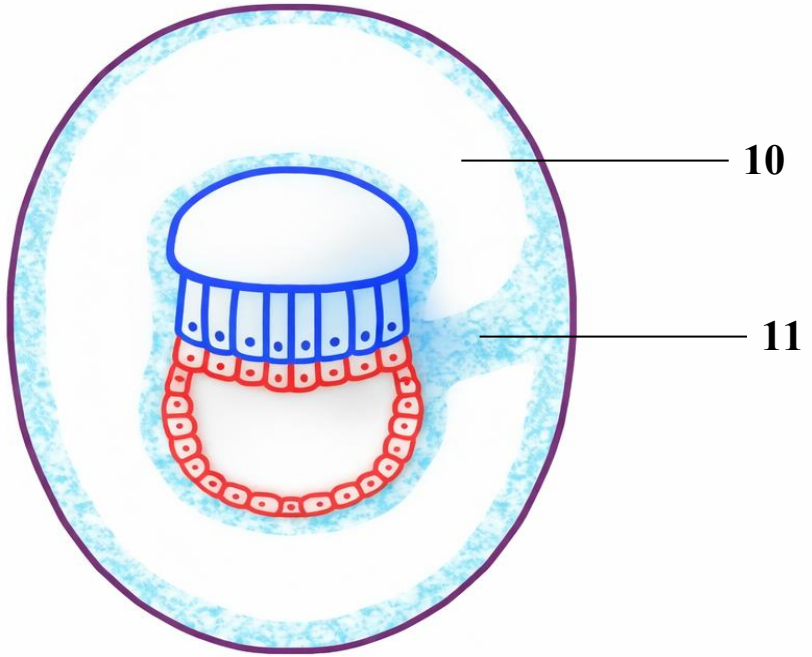

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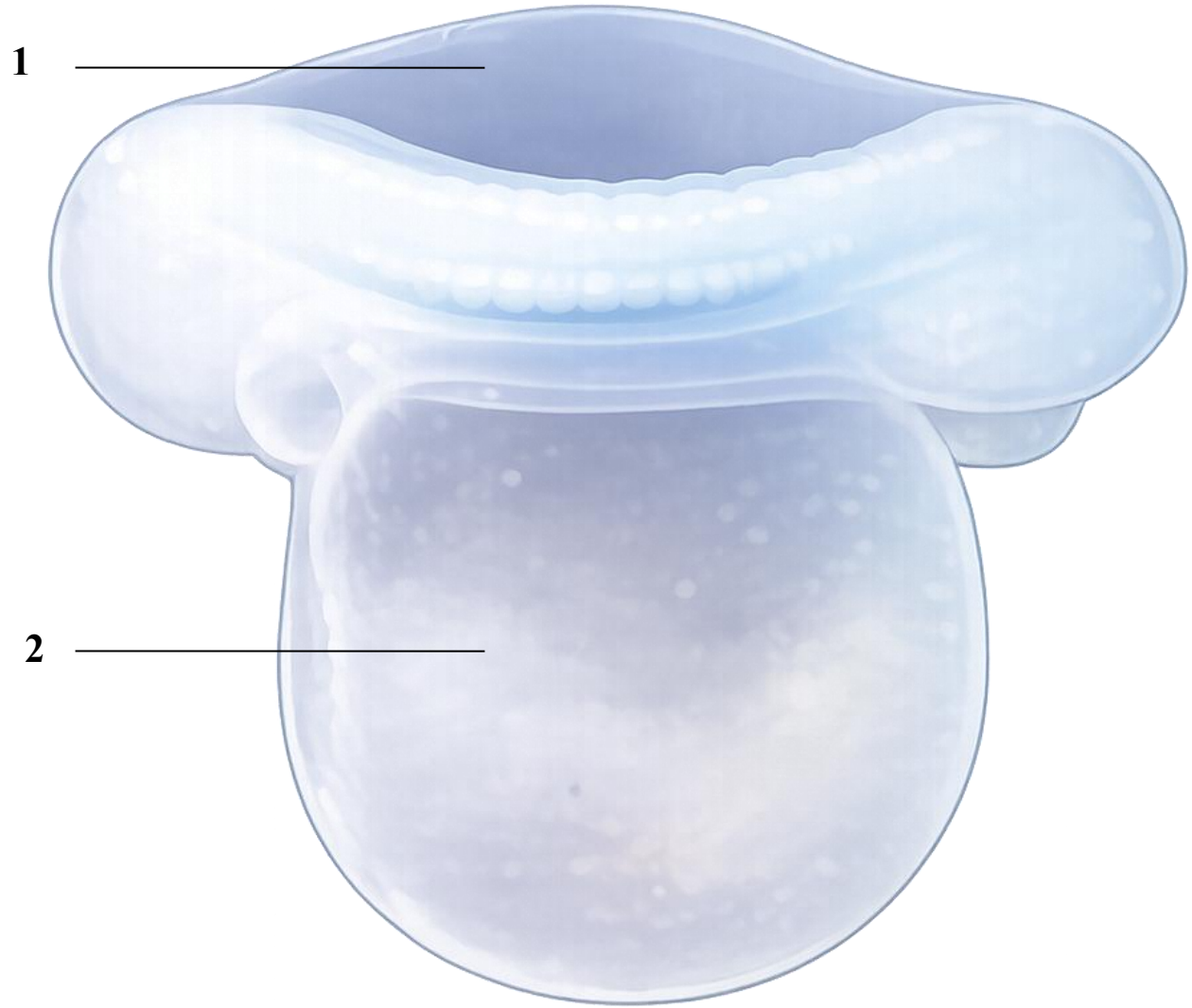
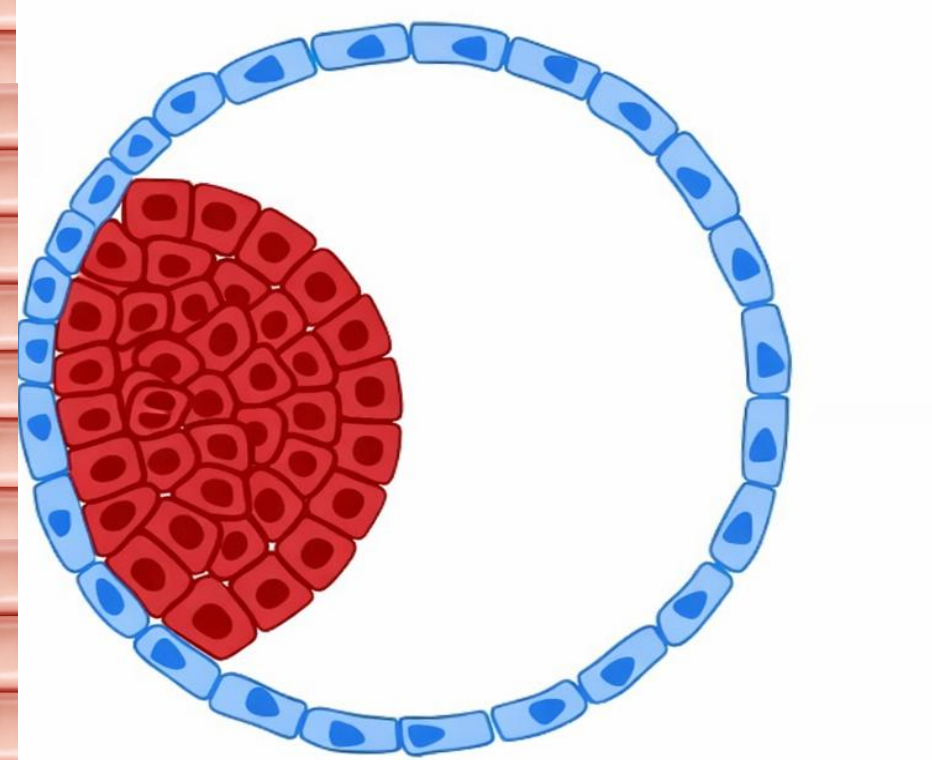


Learning Task

1. Label all visible structures in each image
2. Follow each structure through the sequence and describe its development over time
3. Which structures persist, and which disappear?



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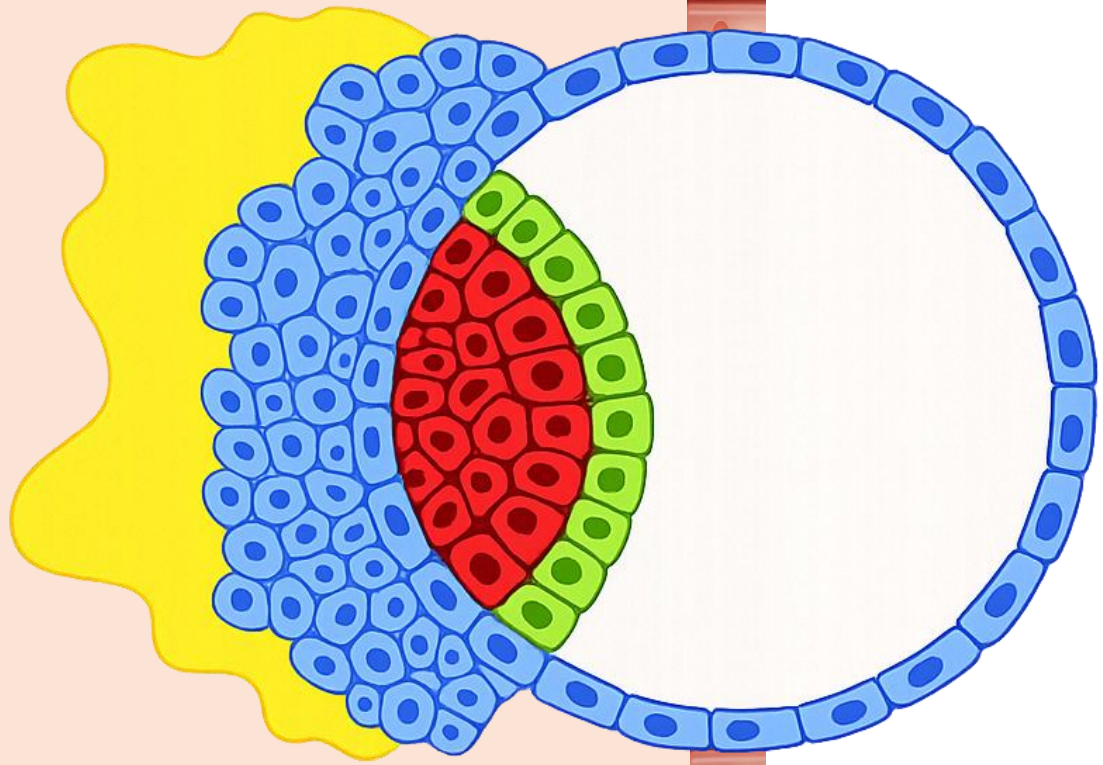

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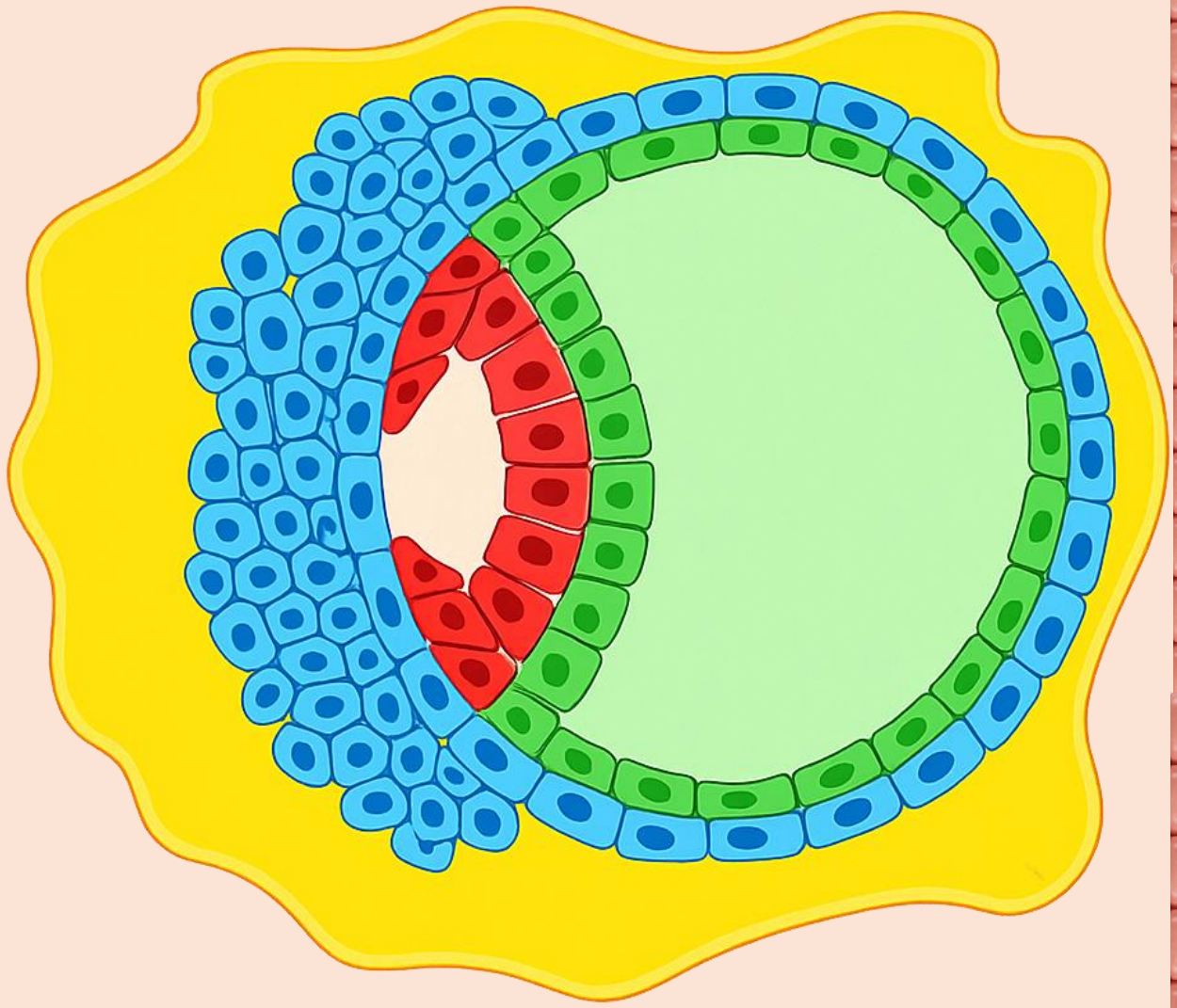

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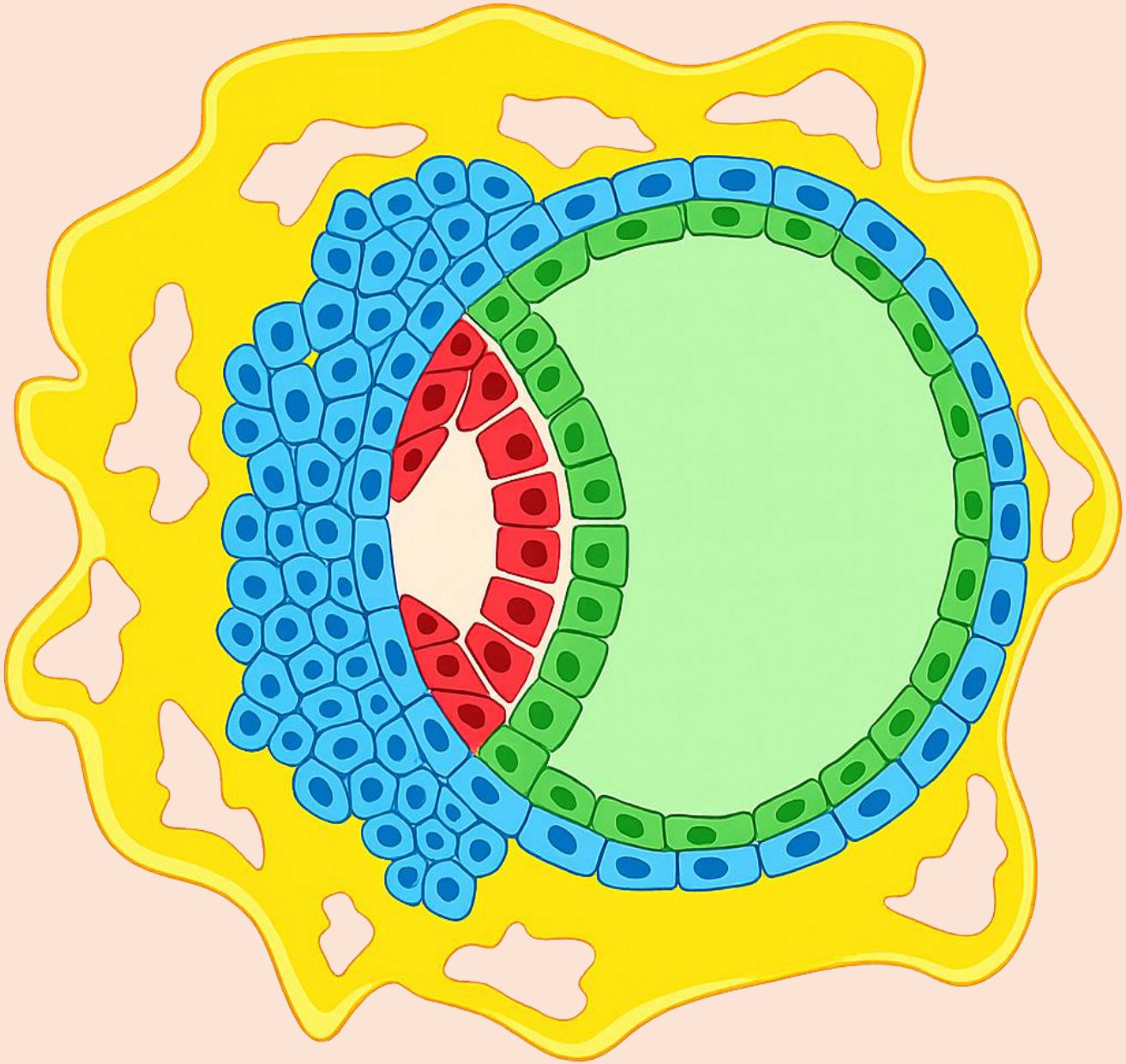

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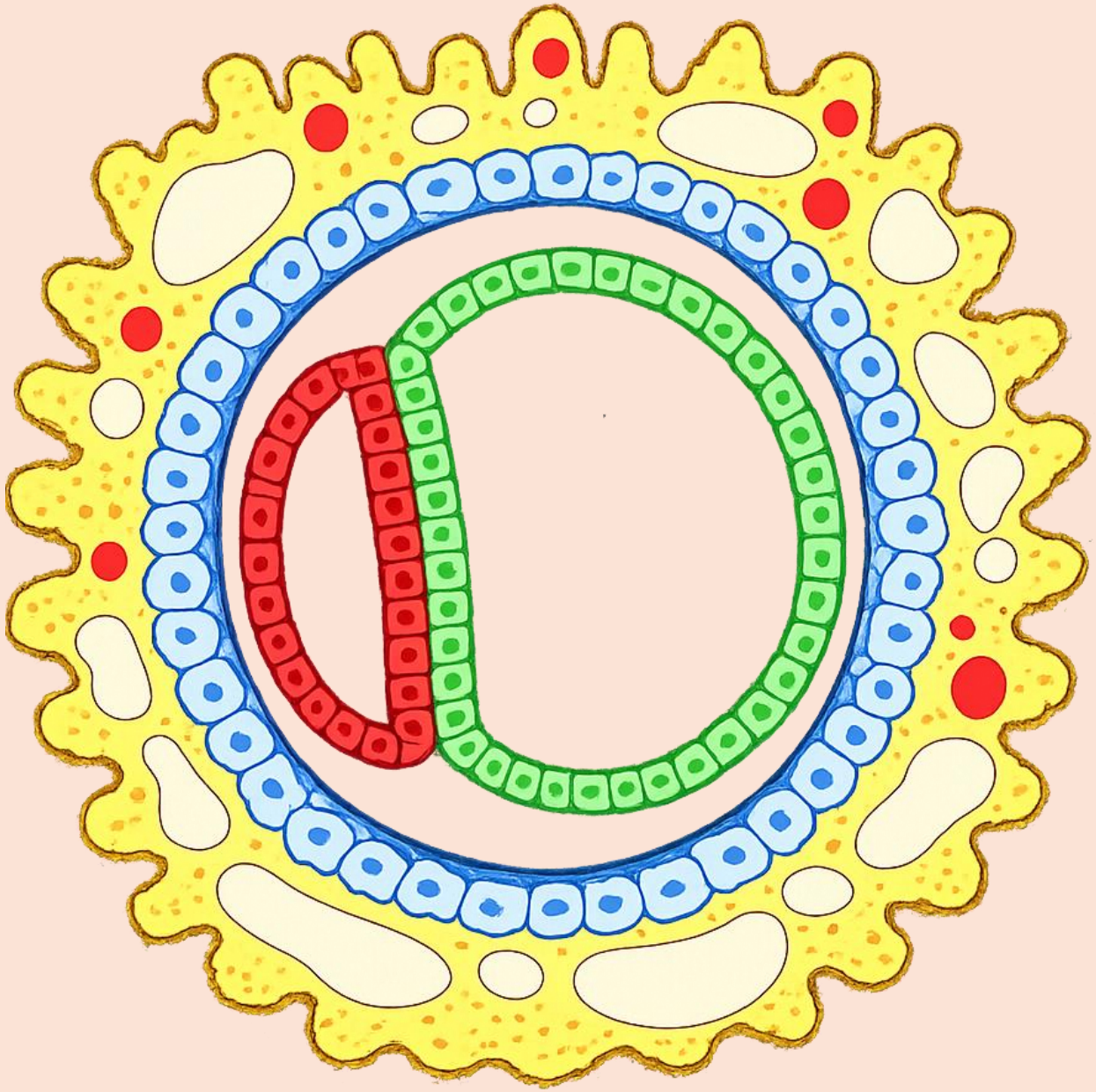

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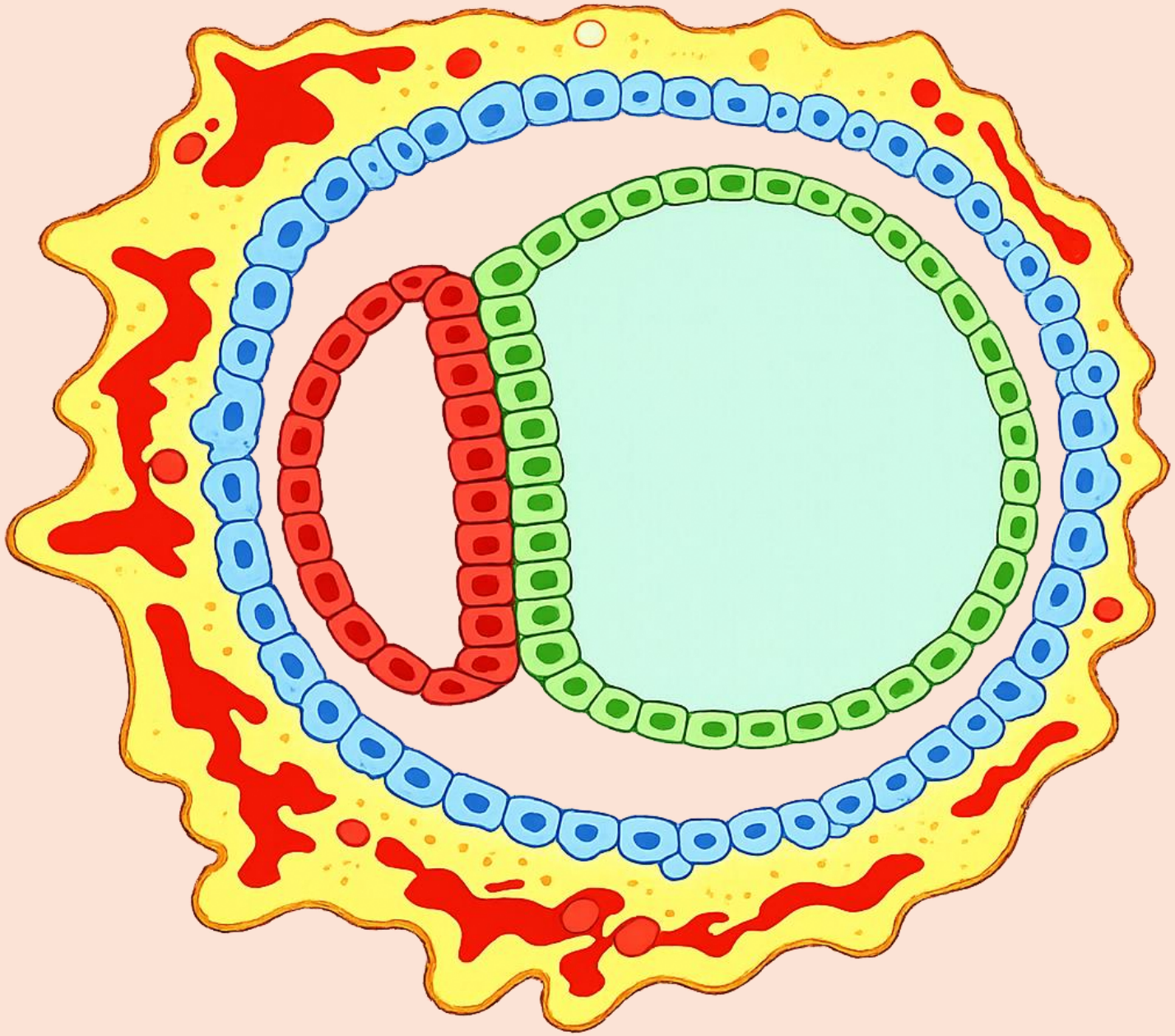

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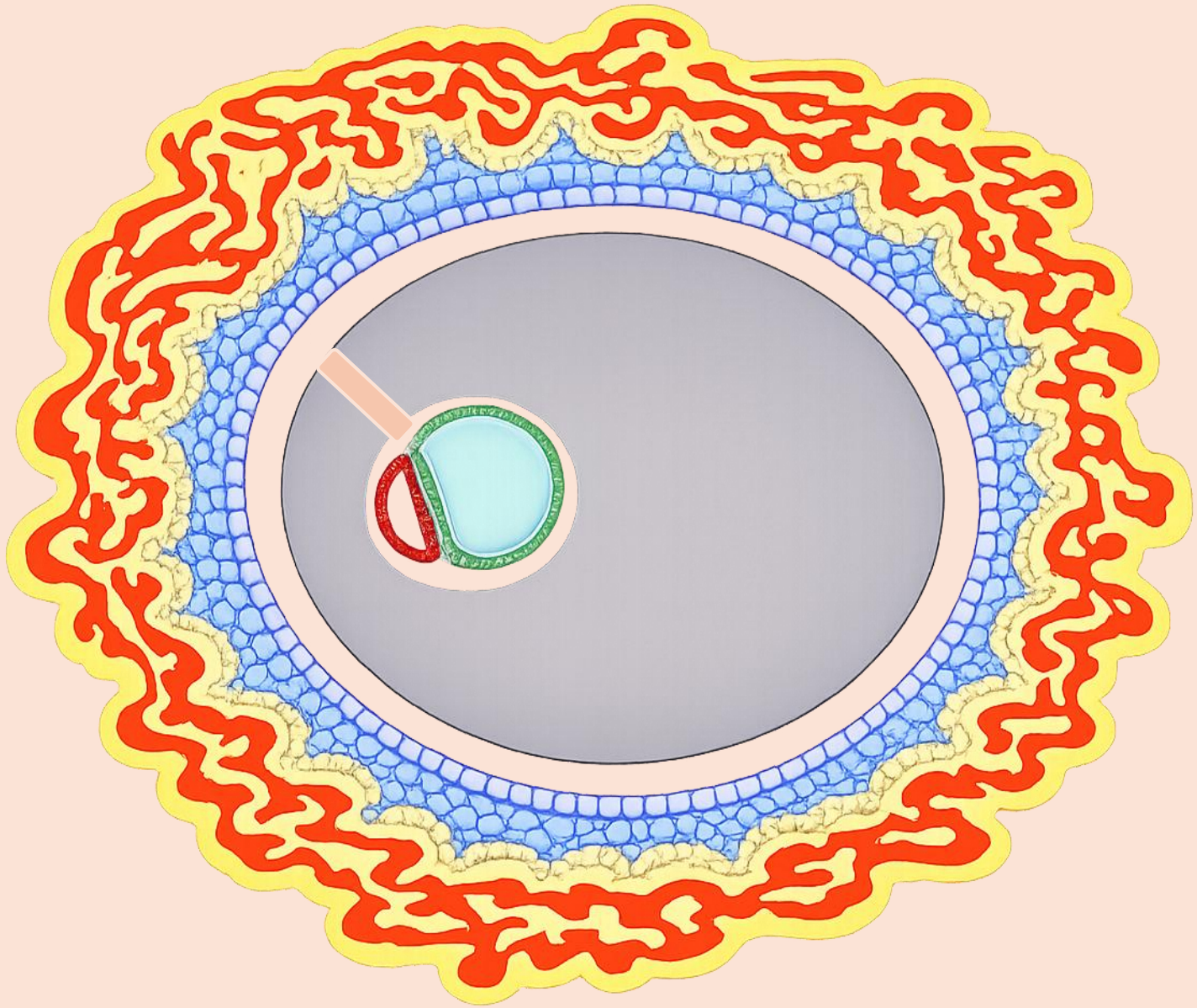

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