



*Anatomy
Passion*



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Done By: 23

EMBRYOLOGY

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Embryology:

Is the science that deals with the study of the origin and development of human beings from the process of fertilization to the process of birth.

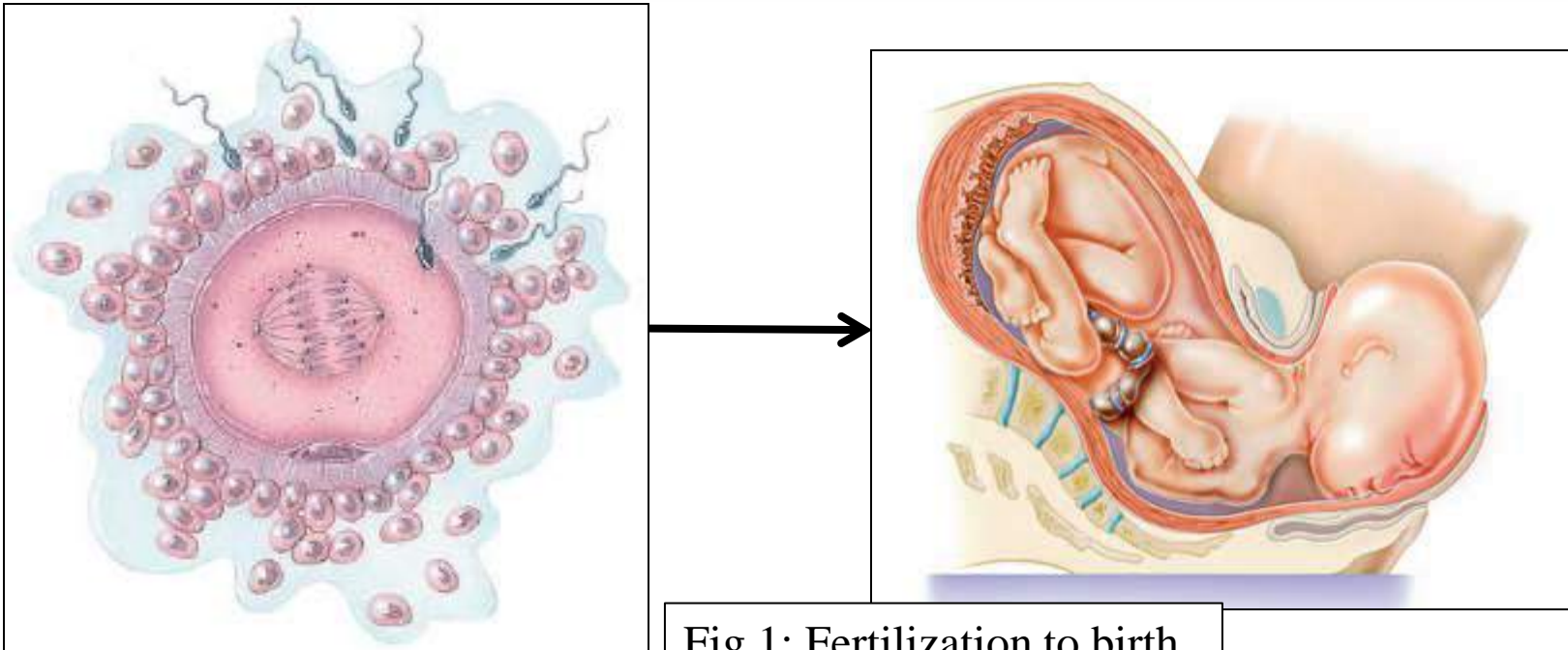


Fig.1: Fertilization to birth.

Developmental periods:

Embryonic period:

The time from fertilization to the end of the 8th week of development. During this period, the developing human is called **Embryo**.

Fetal period:

The time from the beginning of the 9th week until birth. During this period, the developing human is called **Fetus**.

Sometimes, the period from fertilization until implantation is called **Pre-embryonic period**.

Fertilization

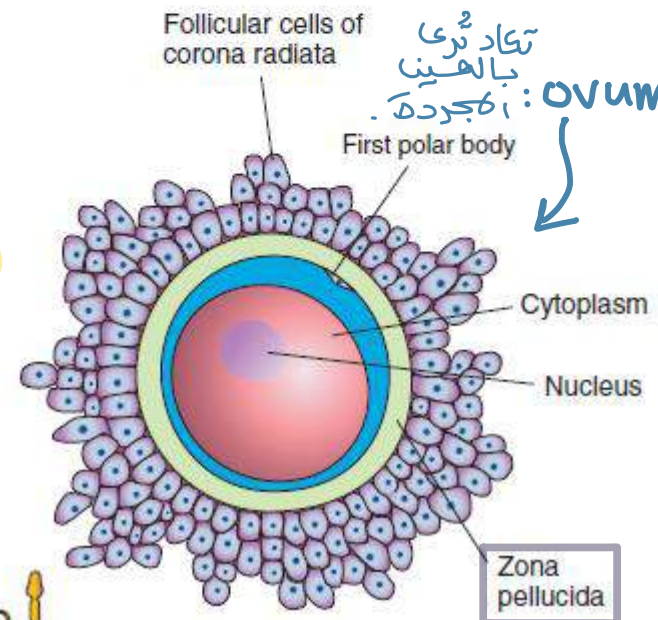
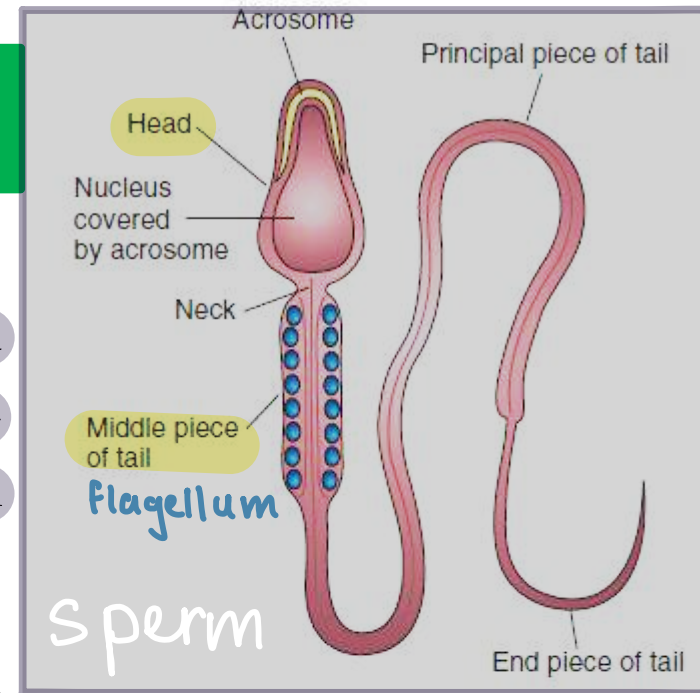
- Is the process by which the **haploid male gamete (the sperm)** unites with the **haploid female gamete (oocyte)** to form the **diploid zygote**.
- It usually takes place in the **ampulla** of the uterine tube.

Diploid: the normal number of chromosomes → 46

Haploid: half the normal number of chromosomes → 23

Zygote = yolk (= joined together).

Fig.2: Top: sperm. Bottom: oocyte (close to the oocyte, a sperm is drawn to, approximately, the same scale as the oocyte).



حجه أمیر بکشر هن البورینه

- Thousands of sperms usually reach the oocyte in the uterine tube. **One sperm, however, will fertilize the ovum.**

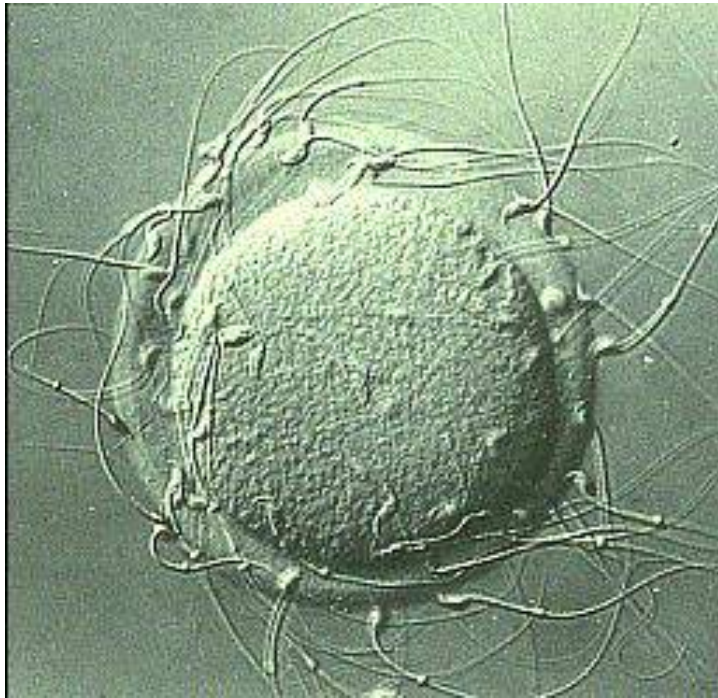
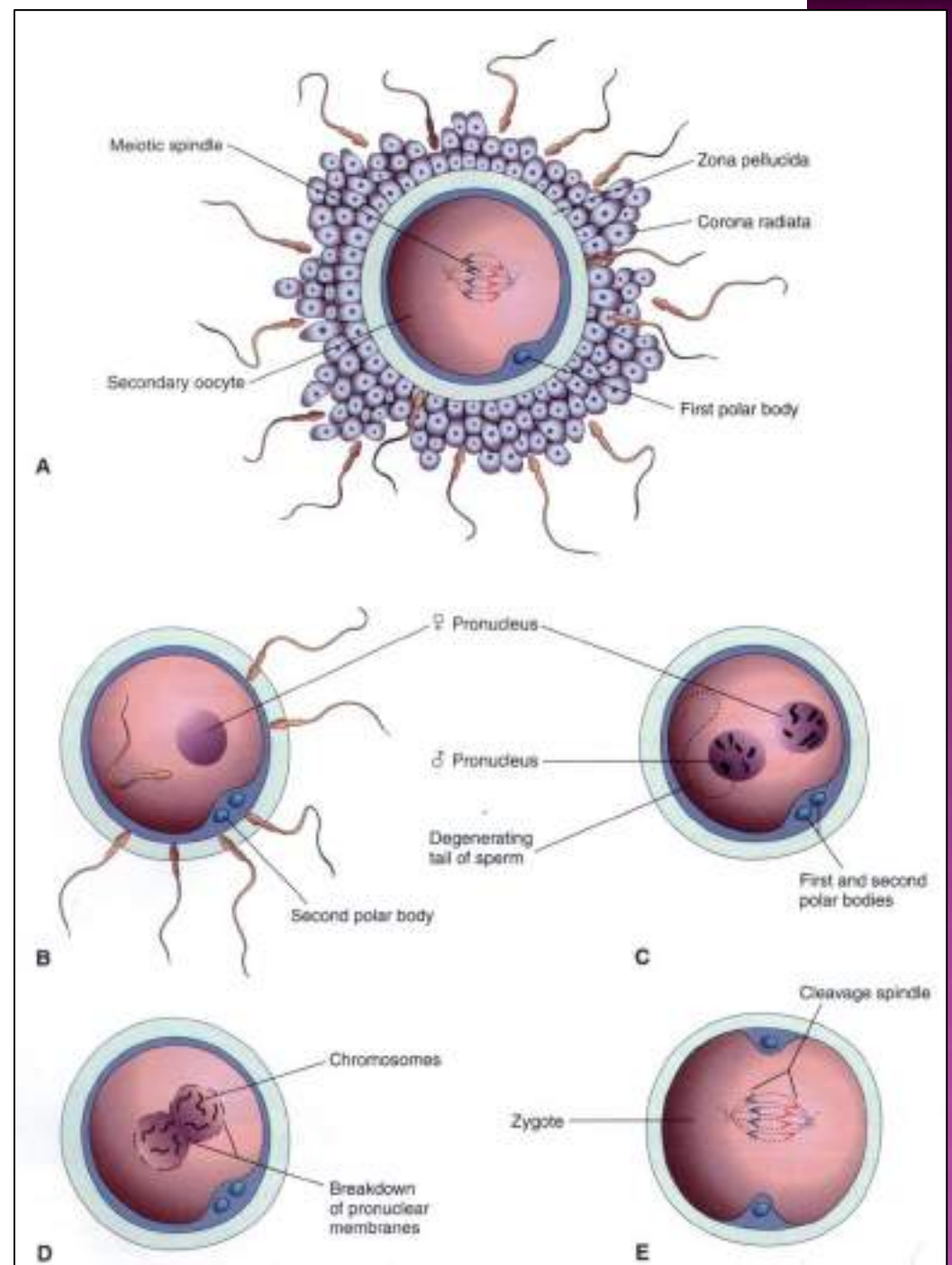


Fig.3: Process of Fertilization



Results of Fertilization

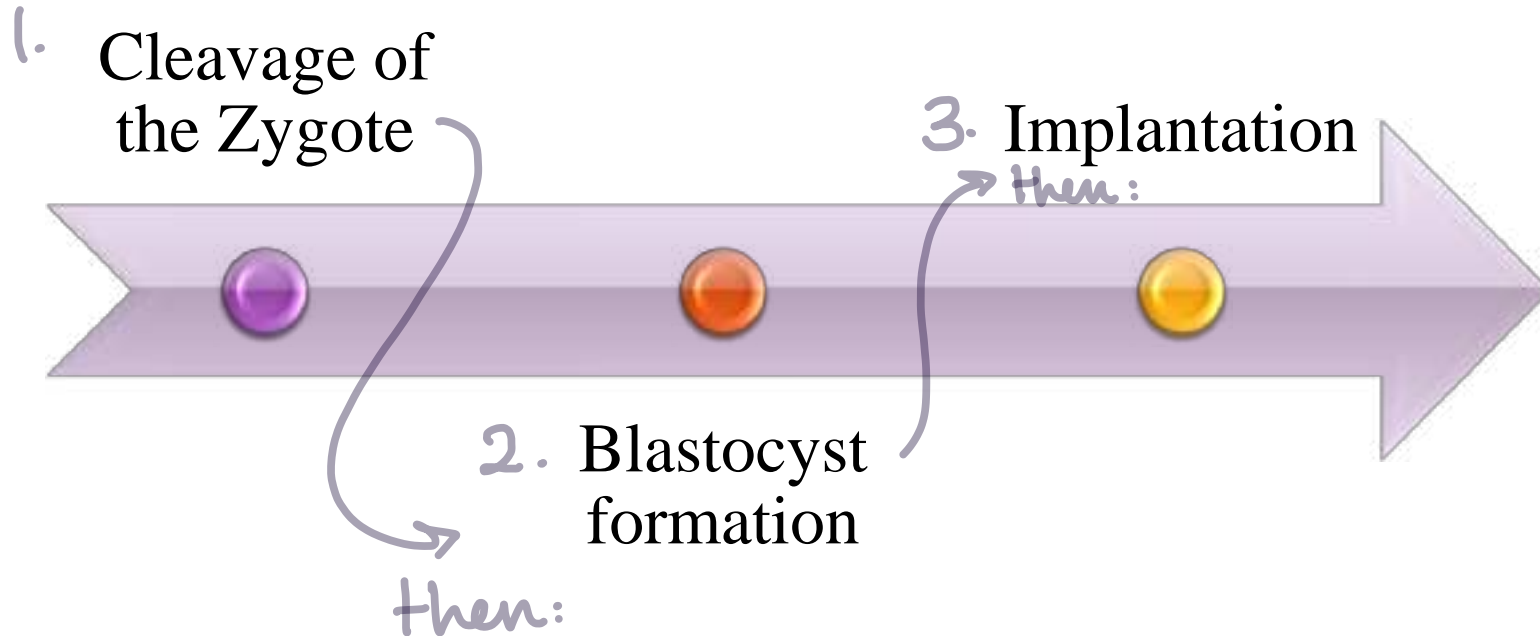
1. Restoration of the diploid number of chromosomes.
$$\left[\begin{array}{c} \text{sperm} \\ 23 \\ \text{chromosomes} \end{array} + \begin{array}{c} \text{oocyte} \\ 23 \\ \text{chromosomes} \end{array} \right] \rightarrow 46$$
2. Determination of the chromosomal sex of the embryo. $XX : \text{Female} / XY : \text{male}$
3. Variation in the human species due to the **(1) mingling of chromosomes** from two different individuals, the **(2) crossing-over** of chromosomes, and **(3) mutations**.
أي ان الشخص له كروموسوماته من أمه / وال له الآخر من أبيه
عبور : انتقاله جزء منه
الجينات بين كروموسومين متجاورين
حزبات
4. Metabolic activation that initiates the cleavage of the zygote. \downarrow here starts the 1st week of development

العمليات
التي تؤدي
إلى اختلاف

After fertilization.

The 1st Week of Development

series of sequential processes :
(One happens after the other)



Cleavage of the Zygote:

↗ number of chromosomes doesn't change

➤ Is the repeated mitotic division of the zygote resulting in a rapid increase in the number of cells with a decrease in their size.

الخلية الناتجة عن الانقسام

➤ The resulting cells are called **Blastomeres**.

➤ Not all cells necessarily divide at the same time; so, the number of cells does not follow the mathematical progression 2, 4, 8, 16, 32, ...

مستشرداً كل الخلايا تكمل في الانقسام

Zygote

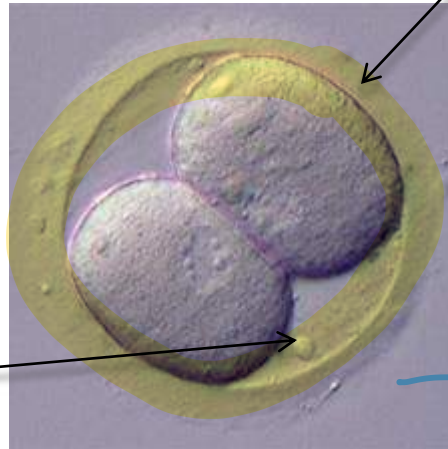
zygote is surrounded by:

Zona Pellucida

divide by mitosis & gives two cells
- occurs 30 hours after

Fertilization - & this is called cell stage

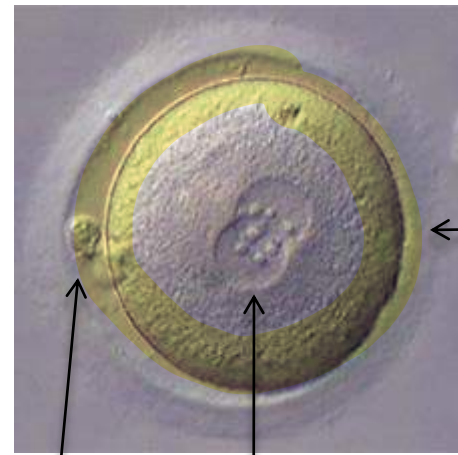
each one divide by mitosis



2-Cell stage (30 HAF)



4-Cell stage



Joined Pronuclei

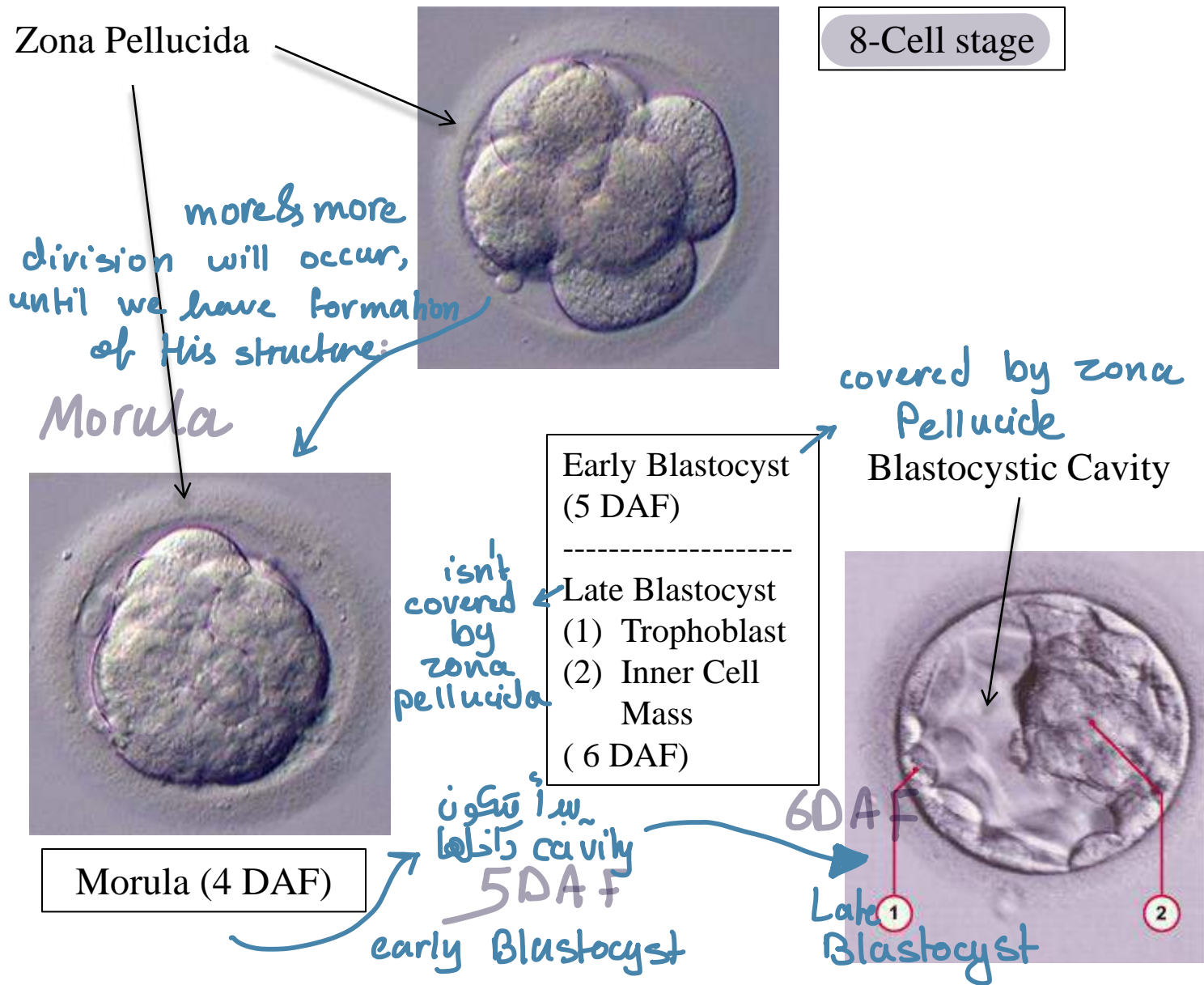
Polar Body

Fig.4: Cleavage of the Zygote. Note how the number of cells increases; however, the overall size of the zygote does not. HAF = hours after fertilization

& their size decrease

yellow colored circles

Fig.4 (continued): Note how the zona pellucida is not present around the late blastocyst.



- **Zona pellucida**: a layer of glycoprotein that surrounds the oocyte. It continues to surround the dividing zygote until the late blastocyst stage (6 days after fertilization). ←

غير جوفاء - ٤ -

- **Morula**: is a solid sphere of blastomeres that forms about 4 days after fertilization.



Fig.5: Morula, a ball of blastomeres.

zygote division starts in uterine tube

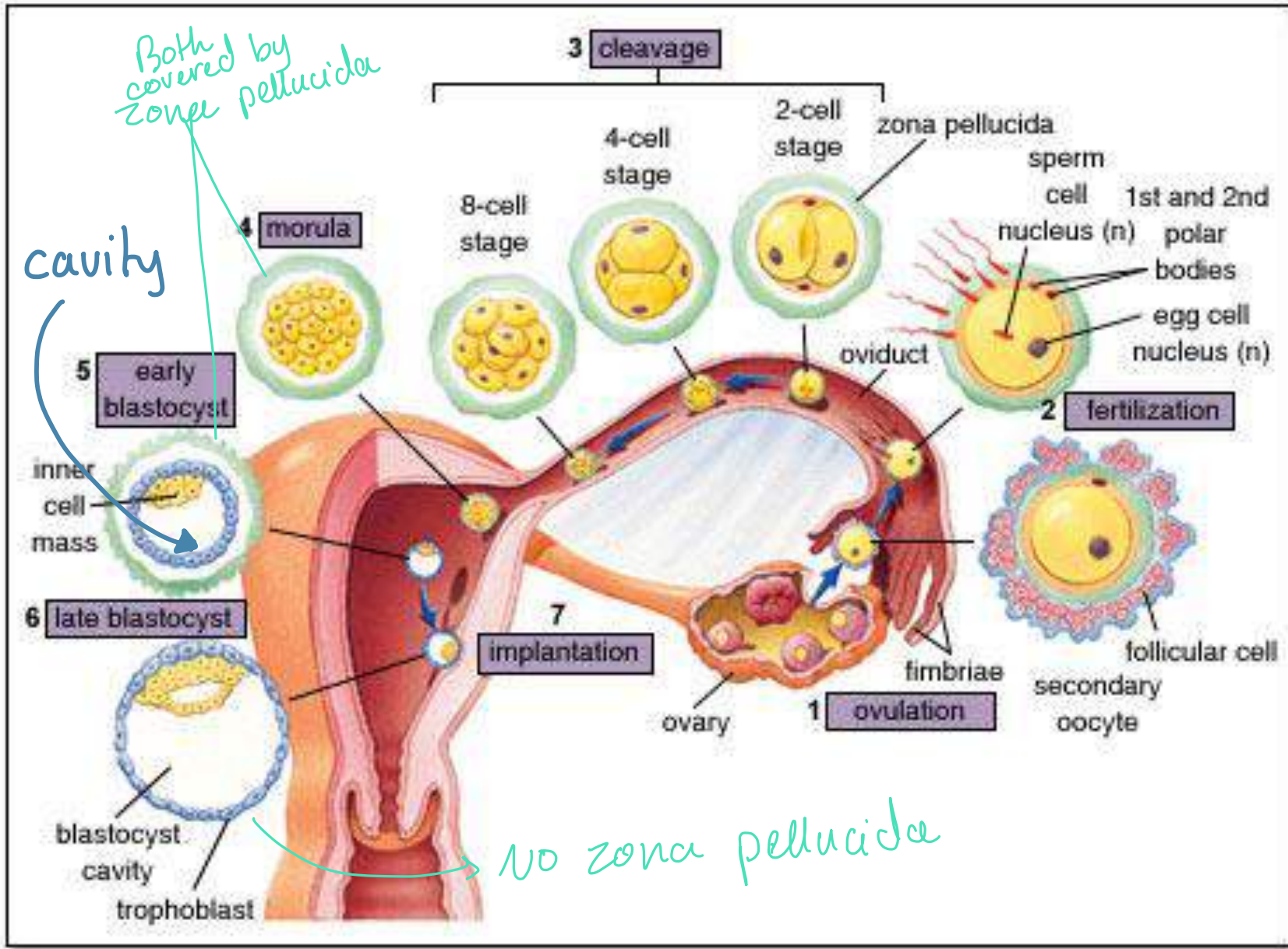


Fig.6: The cleavage of the zygote begins in the uterine tube and ends in the uterus.

The uterine tube is lined by simple columnar **ciliated** epithelium , **and that helps the zygote to move through the uterine tube to the uterus .**

Blastocyst Formation:

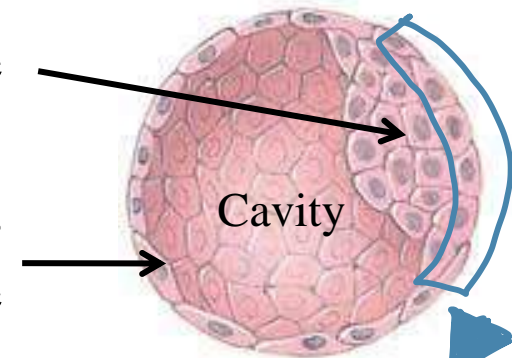
- early Blastocyst stage:
 - At about 5 DAF, fluid starts to accumulate within the zygote ^{morula.} → formation of a fluid filled cavity called Blastocystic cavity. The zygote at this stage is called **Blastocyst**. *still surrounded by zona pellucida
- late Blastocyst stage:
 - The blastocyst emerges from the surrounding zona pellucida by a process called **Hatching**.

Fig.7: The blastocyst and its hatching.



6 DAF

- In the blastocyst, the cells form two groups:
 - The inner cell mass (**embryoblast**) on the inside which will form the embryo.
 - Surrounding the blastocyst is a layer of cells called the ^{nutrients} **trophoblast** which will form the embryonic part of the placenta and part of the chorion.



مستقبلات عن / trophoblasts: will form the
تغذية ال embryo / structures that will nourish
the embryo

starts as soon as the blastocyst leaves the late blastocyst stage.

Implantation:

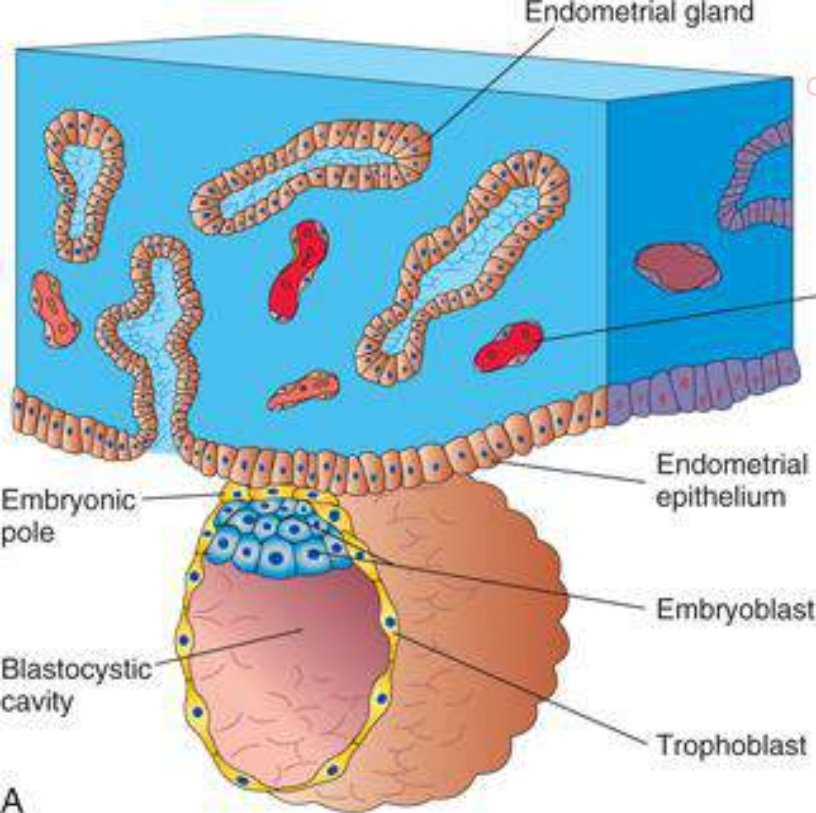
❖ Implantation is the ¹ attachment of the trophoblast (near the embryoblast) to the endometrium of the uterus and the subsequent ² embedding of the embryo within the endometrium. It usually occurs in the fundus or body of the uterus and begins about 6 DAF.

❖ At this stage, the trophoblast will form two layers of cells:

a. **Cytotrophoblast**: the inner layer. (single layer)

b. **Syncytiotrophoblast**: this is the outer layer near the embryoblast. It consists of several cells that fuse together to form a multinucleated syncytium. [lost their CMs]
*acts as a single unit.

❖ At this time, a layer of cuboidal cells appears on the embryoblast. This is called the **hypoblast**.



epithelium & connective tissue

uterine wall:

- inner layer [endometrium]
- muscular layer [myometrium]
- outer layer.

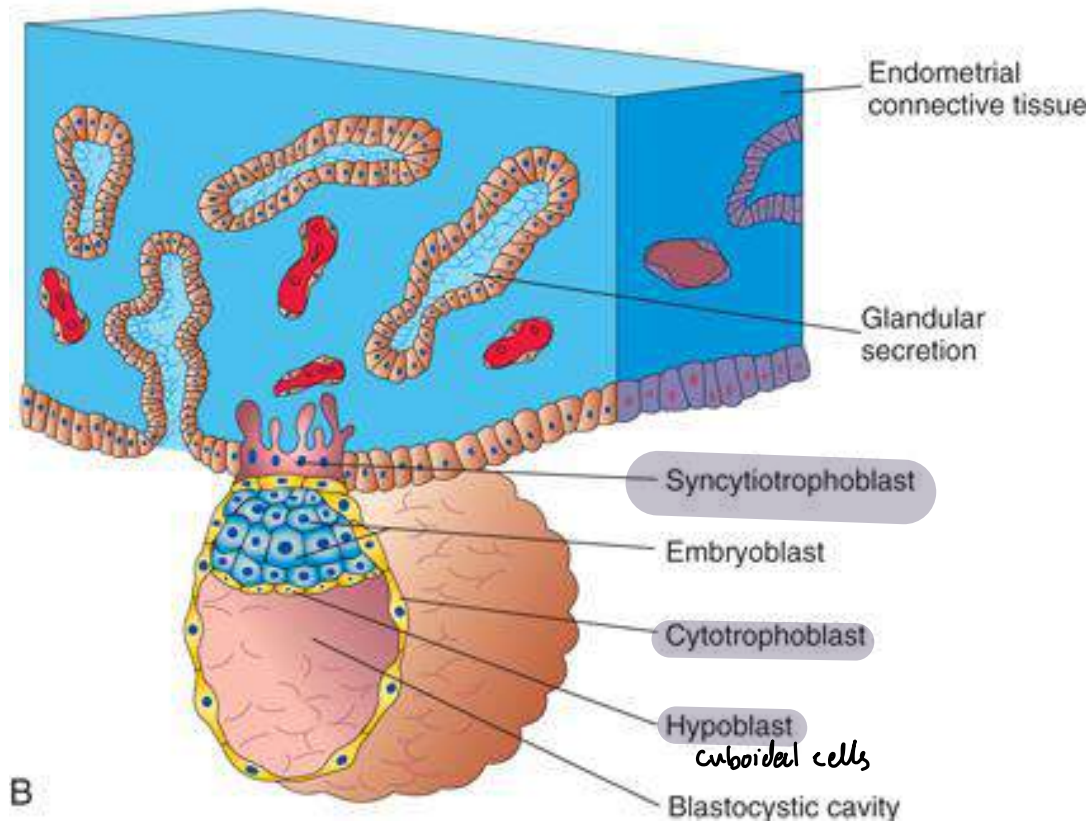


Fig.8: Implantation of the embryo. In (b), note the division of the trophoblast into two layers. Also note the formation of the hypoblast.

B

The 2nd Week of Development

*all occur
at the same
time
* together **



Completion of
Implantation

Formation of the
Bilaminar Disc

Development of
the Chorionic Sac

Completion of Implantation → occurs in the endometrium

بالأسبوع الأول كان يادوب
داخل سكريتين داخل جدار الرحم

* الجنين يتكون في الطبقة الداخلية للرحم فقط ، لا يصل للطبقة العضلية
وإذا وصل ← مشكلة تؤدي إلى severe bleeding & pain

From syncytiotrophoblast

- By the activity of certain enzymes, the syncytiotrophoblast will continue to invade the uterine wall until the whole embryo is embedded in the wall (About 10 DAF).

* يدخل كله إلى جدار الرحم *

* the embryo gets completely in the endometrium of uterus.

- Up to this moment, the embryo was nourished by secretions from the mucosa of the uterine tube and uterus.

أثناء انتقاله ال
zygote
من U.T
إلى U
وحتى يست يدخل
U
...

- As implantation happens, some cells in the connective tissue of the uterine wall will enlarge and become filled with glycogen and lipids. These cells (called **Decidual cells**) will be engulfed by the syncytiotrophoblast and their contents are used to nourish the embryo.

small spaces

- Multiple lacunae will appear in the syncytium. These will be connected with each other to form a network. The syncytiotrophoblast will erode the **enlarged endometrial capillaries** and **glands** and maternal blood and glandular secretions will pour into these lacunae. The blood and the secretions will provide nutrition for the embryo.

* when the syncytiotrophoblast invades in the uterus, they will destroy blood vessels & glands, and their content will pass into the lacunae

- By the end of the 2nd week, extensions from the cytotrophoblast will protrude into the overlying layer of syncytiotrophoblast forming the ***primary chorionic villi***.

destroy
↓
these secretions are used to nourish the embryo.

Nourishment of embryo:

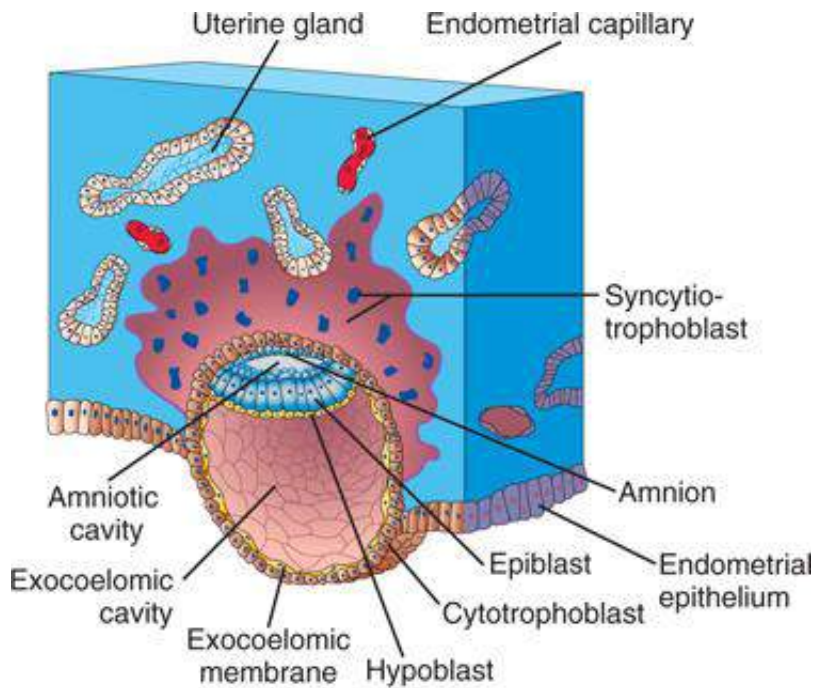
1) secretions from uterine tube / 2) secretions of uterus

3) Implantation, ^{some} changes in the uterus occur : 1) ^{formation of} Decidual cells
2) enlargement of Blood vessels + Glands

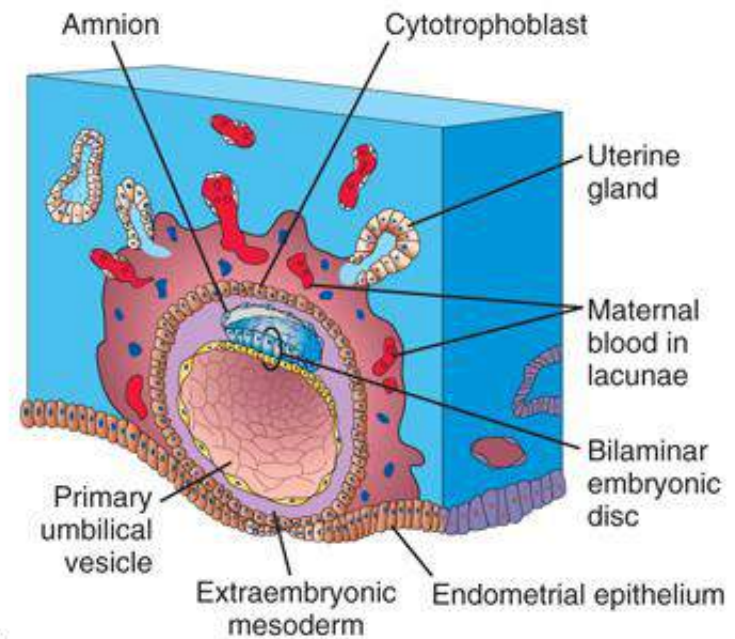
when syncytiotrophoblast invades

A. the decidual cells will be destroyed → ^{تدمير الخلايا} _{الغشاء}

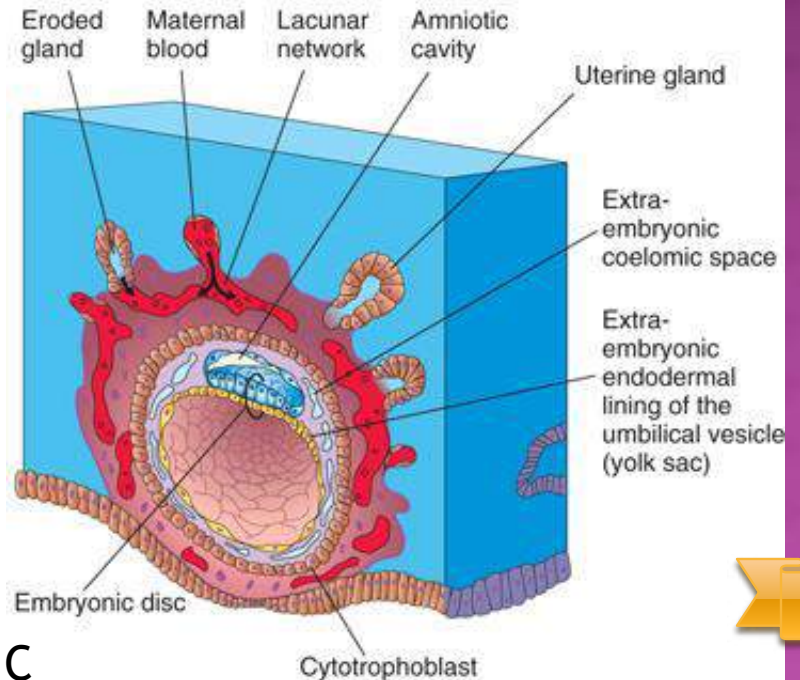
B. when the lacunae form, the syncytiotrophoblast will destroy the enlarged glands & BV → their content will pass into the lacunae → used for nourishment by diffusion



A

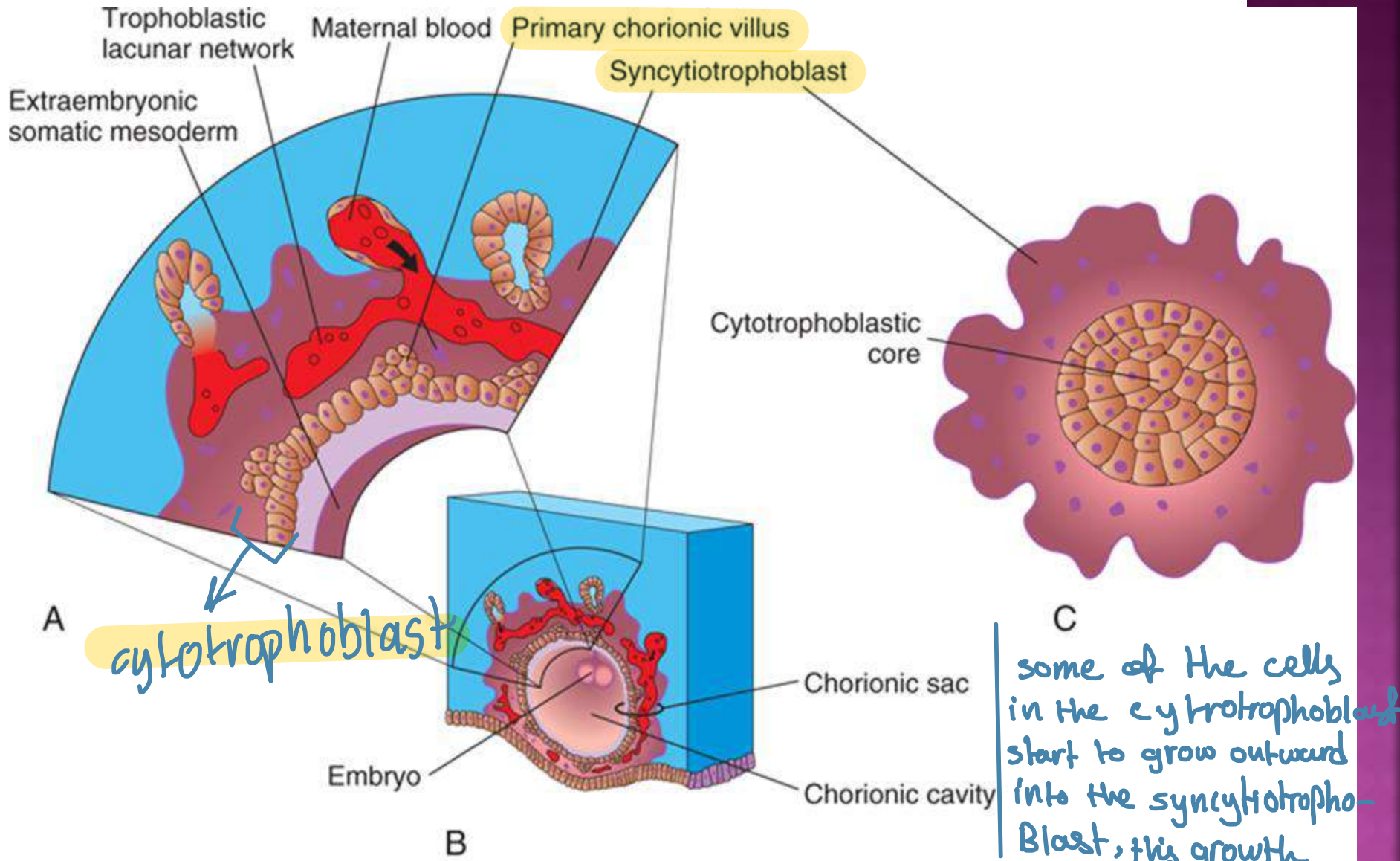


B



C

Fig.9: Completion of implantation. In (b), we have lacunae within the syncytium. In (c), the lacunae formed a network. Note how maternal blood and glandular secretions pass into these lacunae.



cytotrophoblast

some of the cells in the cytotrophoblast start to grow outward into the syncytiotrophoblast, this growth is called

Fig.10: Primary chorionic villi.

occurs by the end of 2nd week

Formation of the Bilaminar Disc

- ❑ As implantation progresses, changes occur in the embryoblast.
- ❑ The embryoblast will form a flattened, almost circular disc. This disc is formed of 2 layers (Bilaminar). These are:

a. Epiblast: thicker, formed of *long* columnar cells, related to amniotic cavity.

b. Hypoblast: thinner, formed of *small* cuboidal cells, related to exocoelomic cavity.

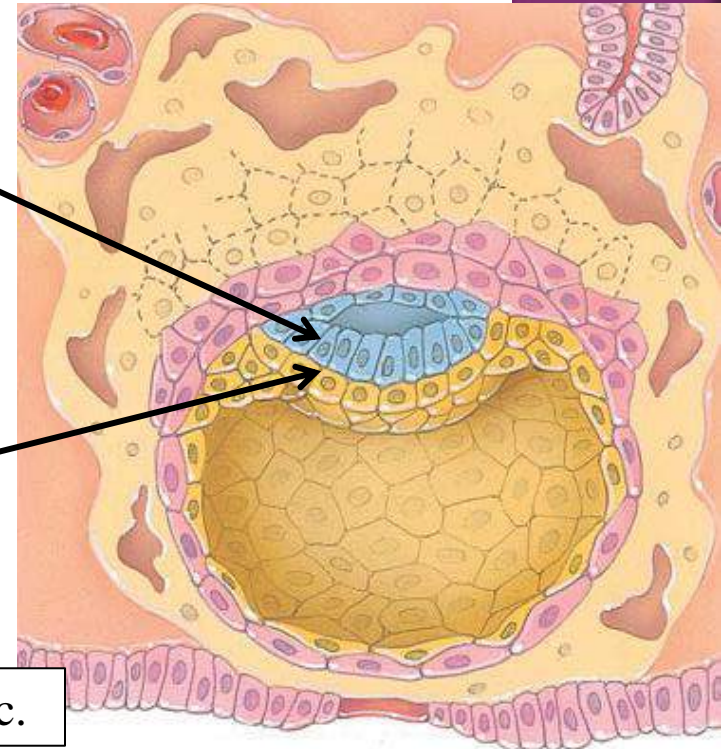


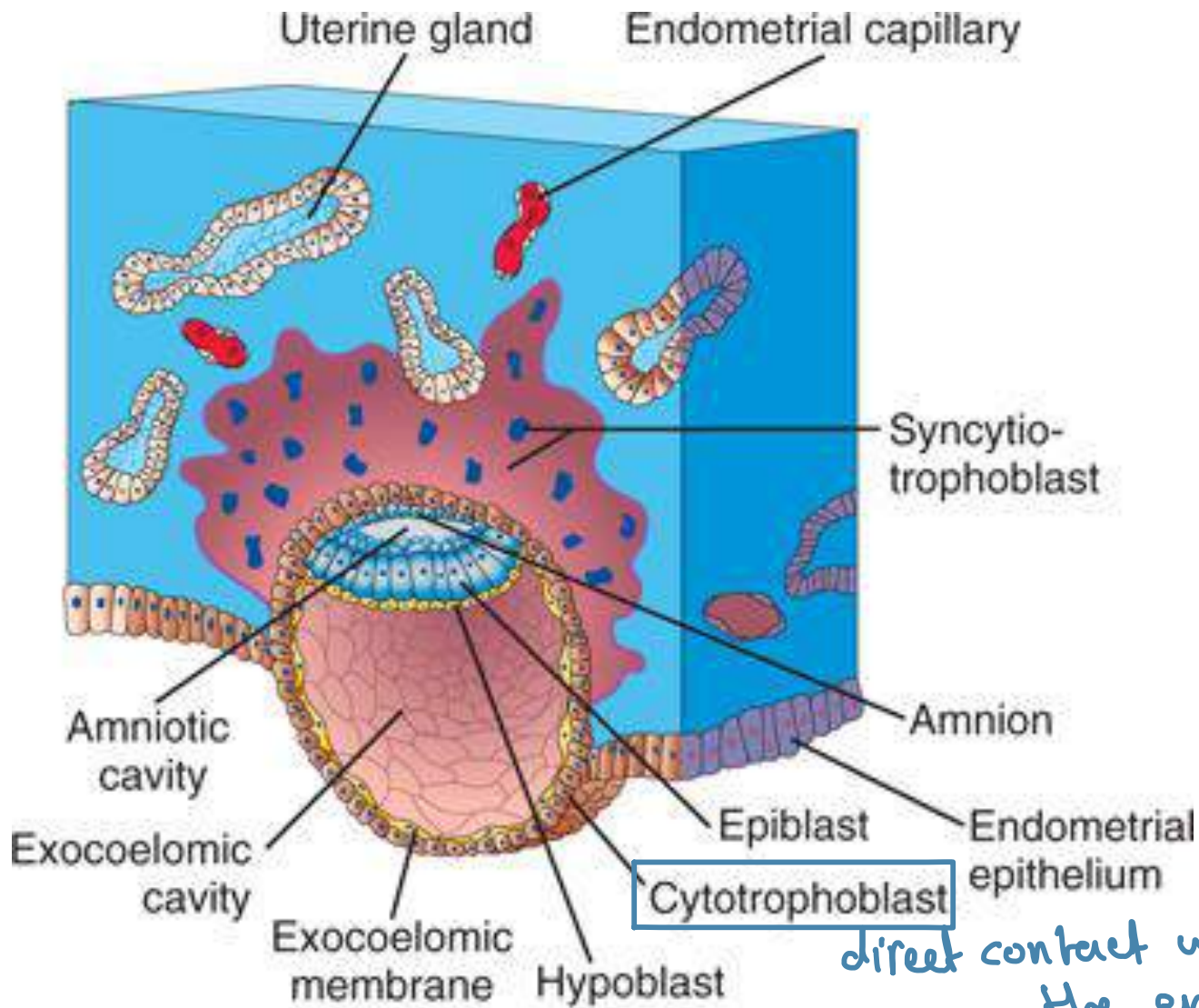
Fig.11: The bilaminar disc.

□ At the same time, a cavity appears in the embryoblast called the **Amniotic cavity**. ^{btw 2 layers} The epiblast forms its floor. Cells derived from the epiblast form the amniotic membrane (or **amnion**) that covers the amniotic cavity. _{↓ Squamous cells}

Squamous cells

□ Cells derived from the ^{2nd week} hypoblast will line the cytotrophoblast, thus, covering the blastocystic cavity. These cells form what's called the **exocoelomic membrane** and the cavity is now called the **exocoelomic cavity**.

Blastocystic cavity



direct contact with
the embryo &
exocoelomic
membrane

Fig.12: The bilaminar embryonic disc and the two cavities.

* CT is embryo called mesoderm.

- A layer of connective tissue will be formed. This layer (called the *extraembryonic mesoderm*) will surround the amnion and the *exocoelomic cavity* (which is now called the *primary umbilical vesicle*).

btw embryo & cytotrophoblast.

- Soon, several small spaces will appear in the extraembryonic mesoderm. These spaces will fuse to form a single cavity called the *extraembryonic coelom*. This completely surrounds the amnion and umbilical vesicle except at the connecting stalk .

- As this new cavity enlarges, a part of the primary umbilical vesicle is pinched off (this will later disappear). The *remaining vesicle* is called the *secondary umbilical vesicle*.

محافظة
أي ان
ينقطع
جزء
منها ويتبقى

Development of the Chorionic Sac

✓ The extraembryonic coelom will divide the extraembryonic mesoderm into 2 layers:

a. **Extraembryonic somatic mesoderm**: this covers the amnion and connecting stalk and lines the trophoblast.

cyto

related to visceral

b. **Extraembryonic splanchnic mesoderm**: this covers the umbilical vesicle.

→ مخلف في تكوين الجنين

✓ The extramembryonic **somatic** mesoderm and the two layers of the trophoblast form the **Chorion**.

✓ By the end of the 2nd week, the primary chorionic villi and the secondary umbilical vesicle are formed. At this time, the extraembryonic coelom is called the **chorionic cavity**.

✓ The embryo (with its amniotic cavity) and the umbilical vesicle are suspended in the chorionic cavity by the **connecting stalk**.

✓ Some cells of the hypoblast will become columnar to form the **prechordal plate** (future site of mouth).

last thing in 2nd week

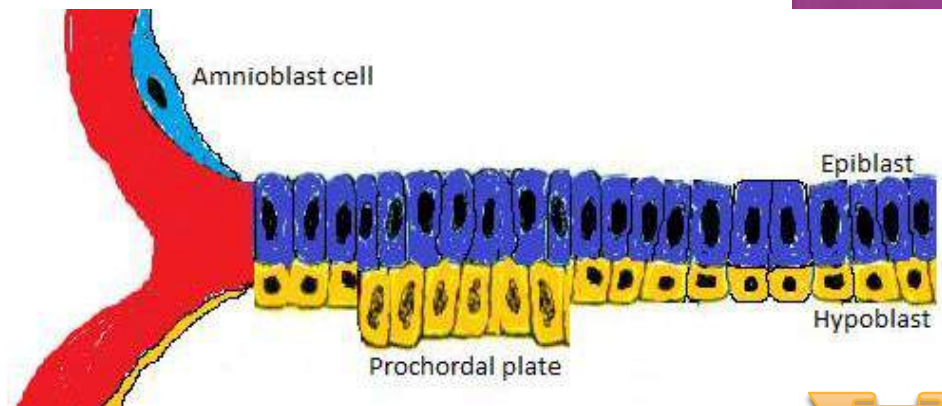


Fig.13: The prechordal plate.

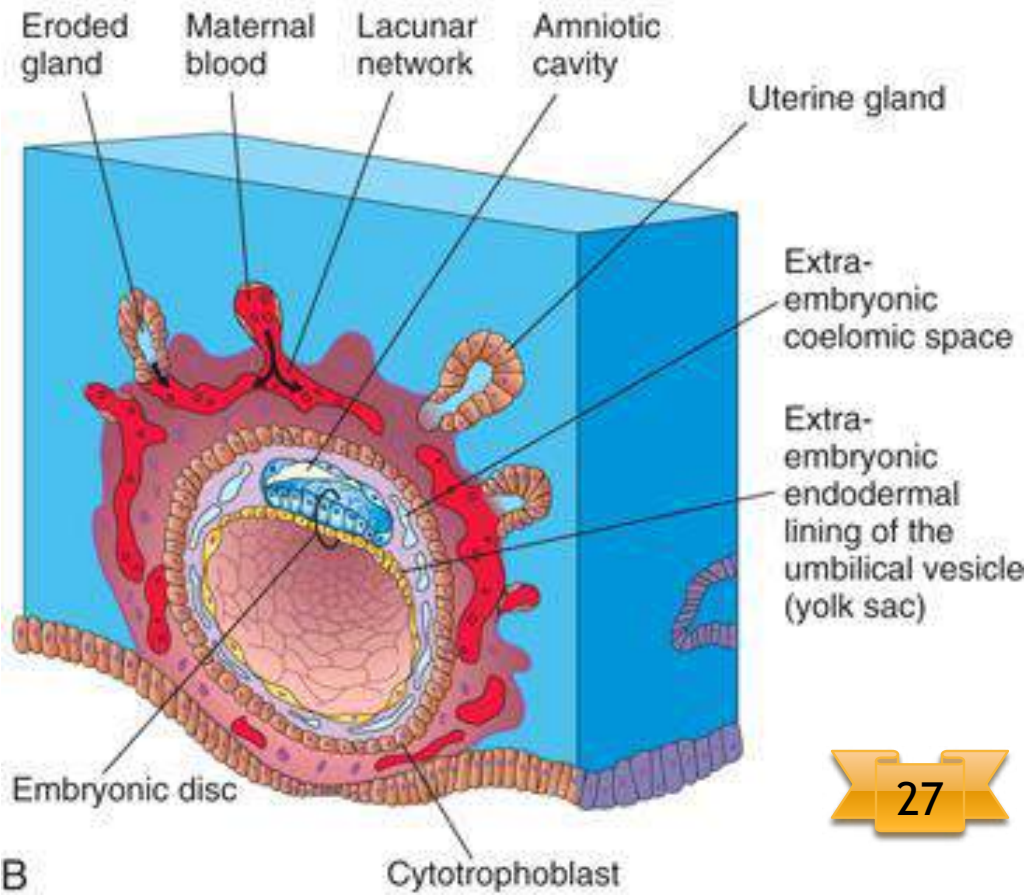
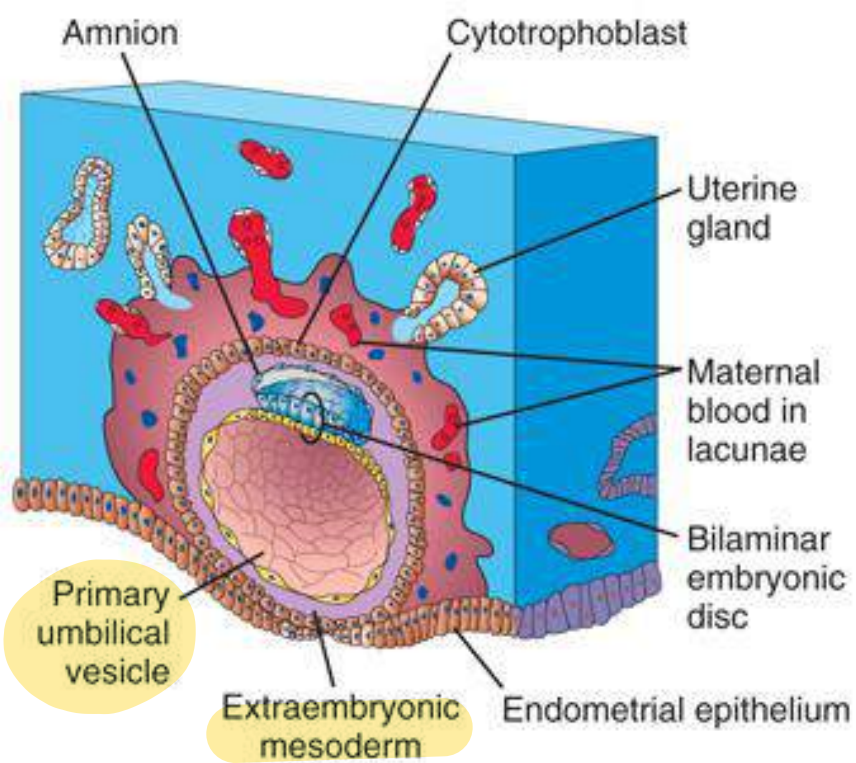
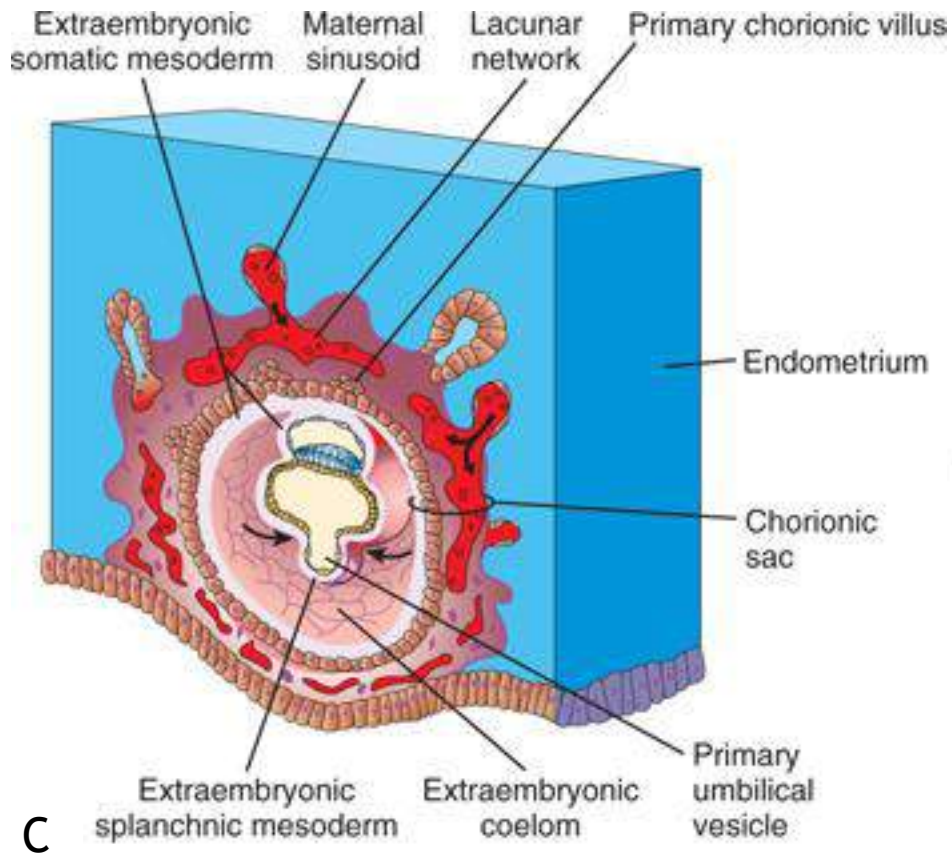
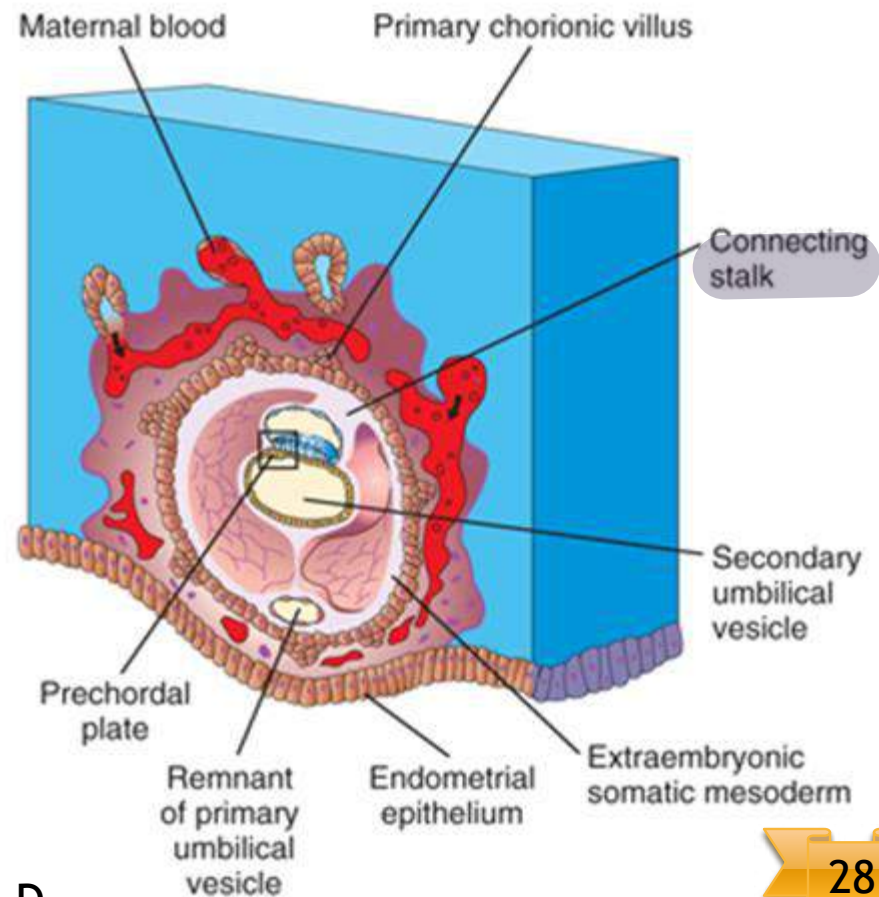


Fig.14: Events late in the 2nd week. In (A), note the formation of the extraembryonic mesoderm. In (B), the extraembryonic coelomic spaces appear.



C



D

Fig.14 (continued): Events late in the 2nd week. In (C), note the division of the extraembryonic mesoderm into two parts. In (D), the chorionic cavity is formed.