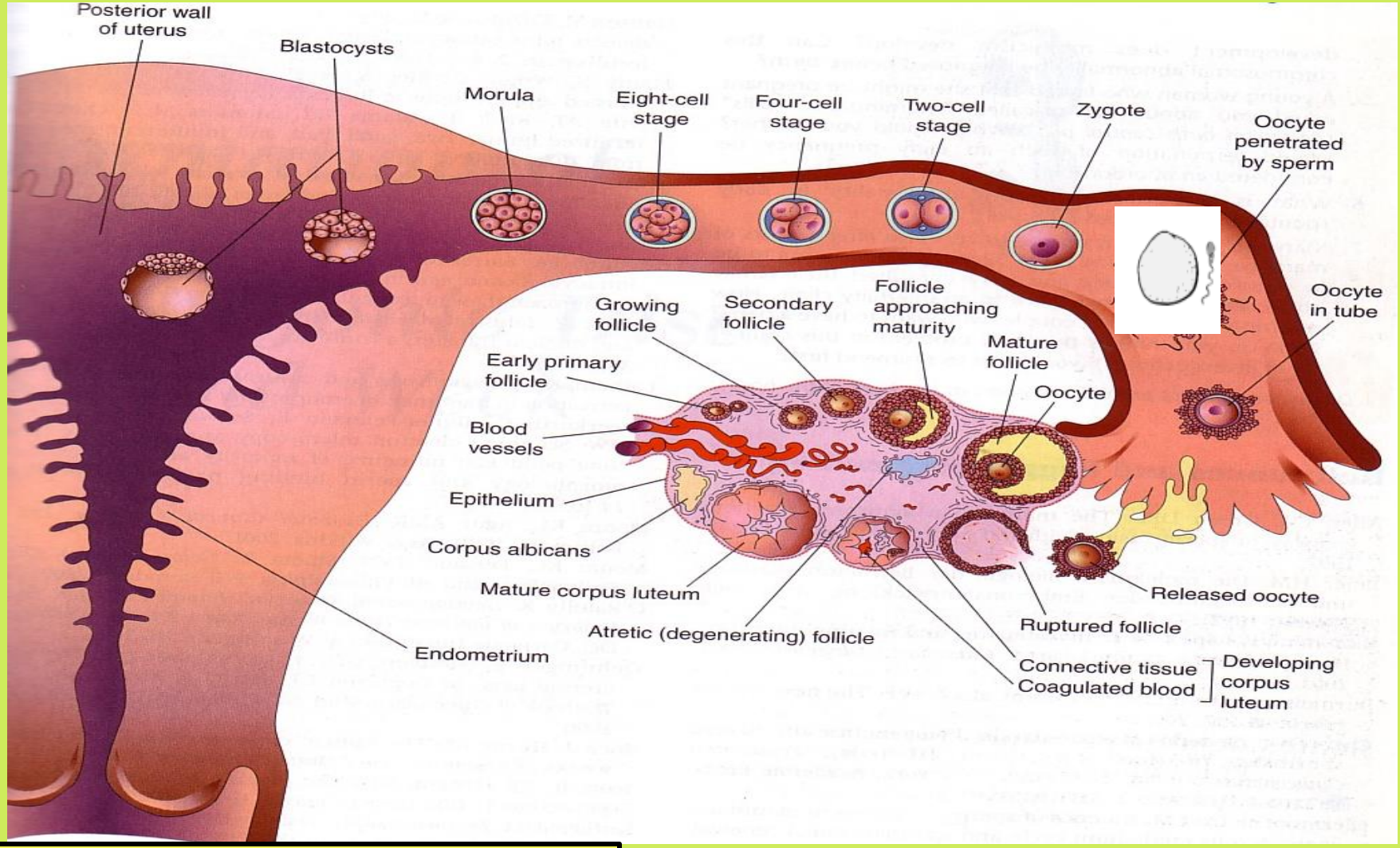
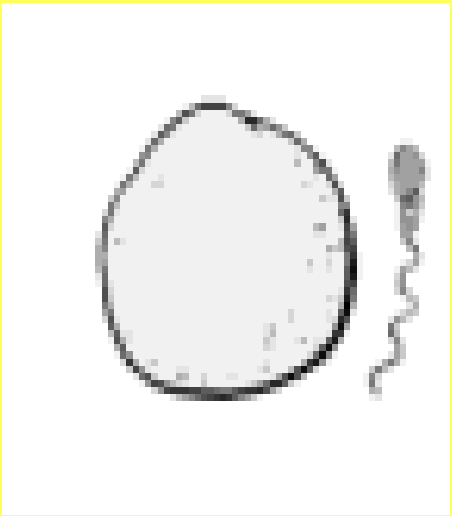
FERTILIZATION & IMPLANTATION



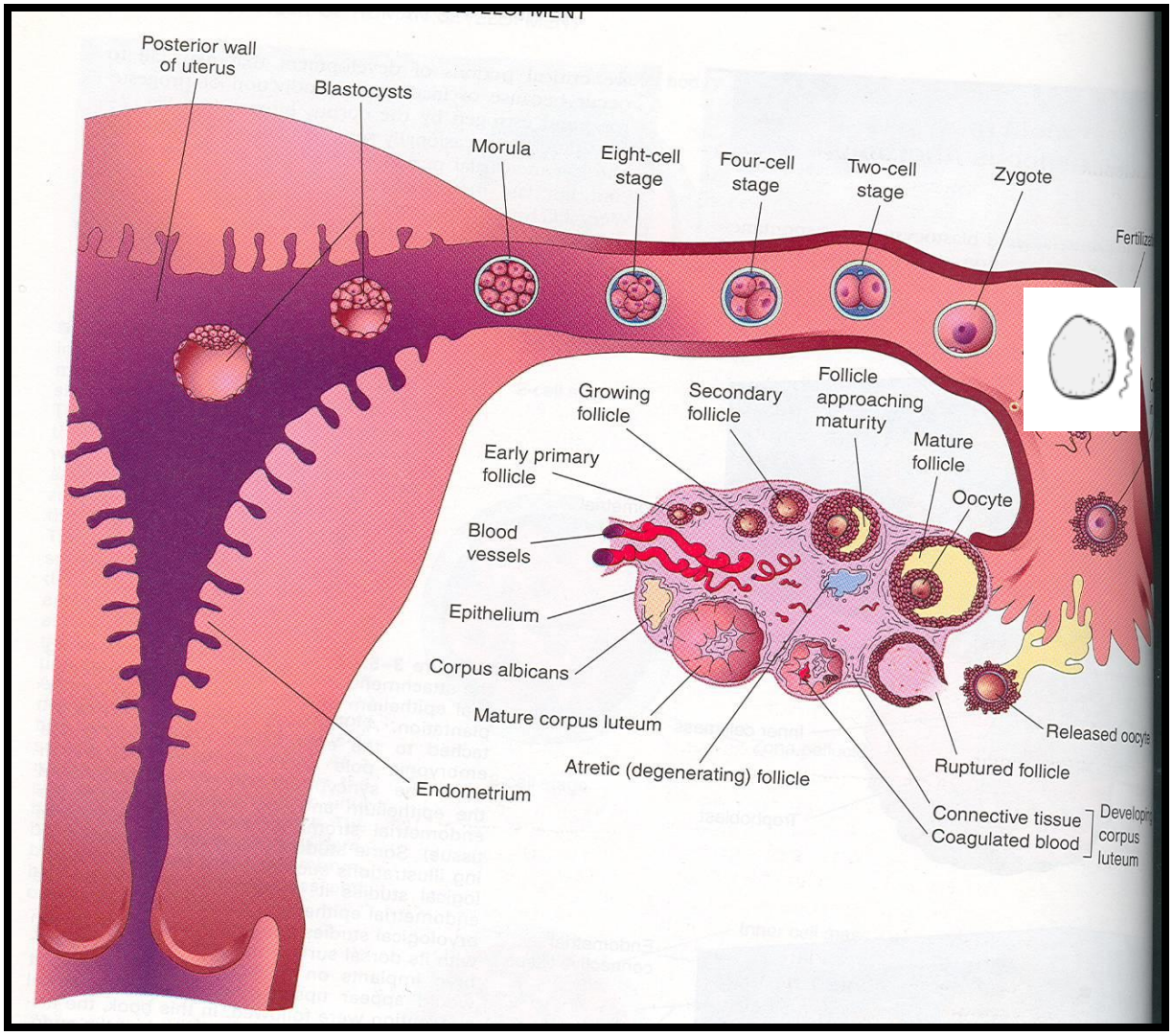
Prof. Saeed Abuel Makarem

OBJECTIVES

- **By the end of the lecture, you should be able to:**
- Identify **fertilization** and its **site**.
- List the **phases** of fertilization.
- Describe the **results** of fertilization.
- Describe the **formation** of **blastocyst**.
- Identify **implantation** and its **site**.
- Describe the **mechanism** of **implantation.**
- Describe the **formation** of **primary chorionic villi**.
- List the sites of **ectopic pregnancy**.



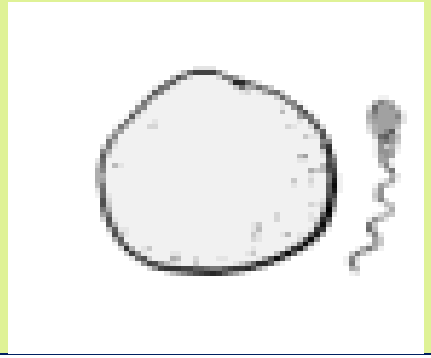
FERTILIZATION

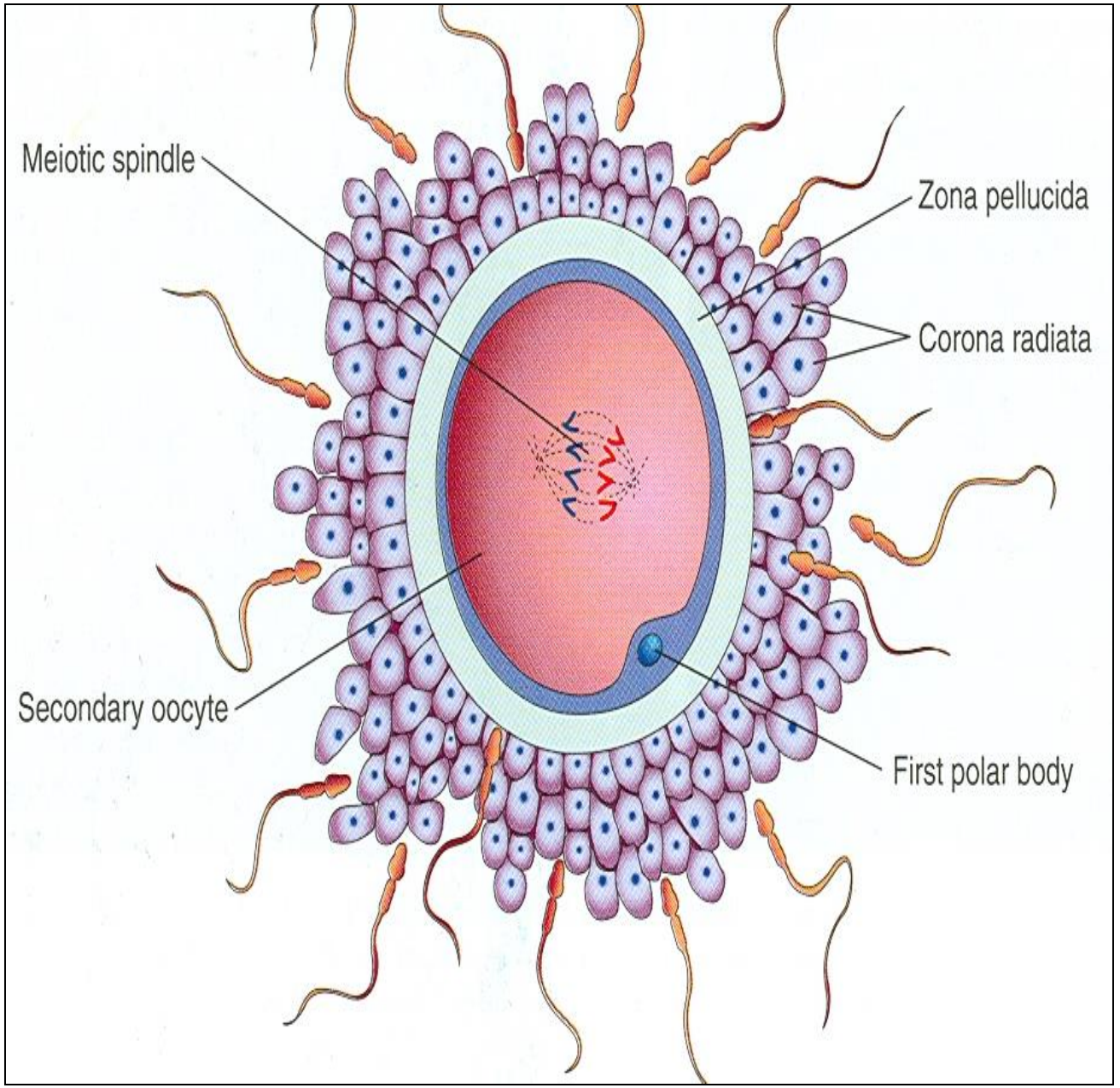


- **Definition:**
- It is the process during which a male gamete (**sperm**) unites with a female gamete (**oocyte**) to form a single cell (**ZYGOTE**).

Fertilization

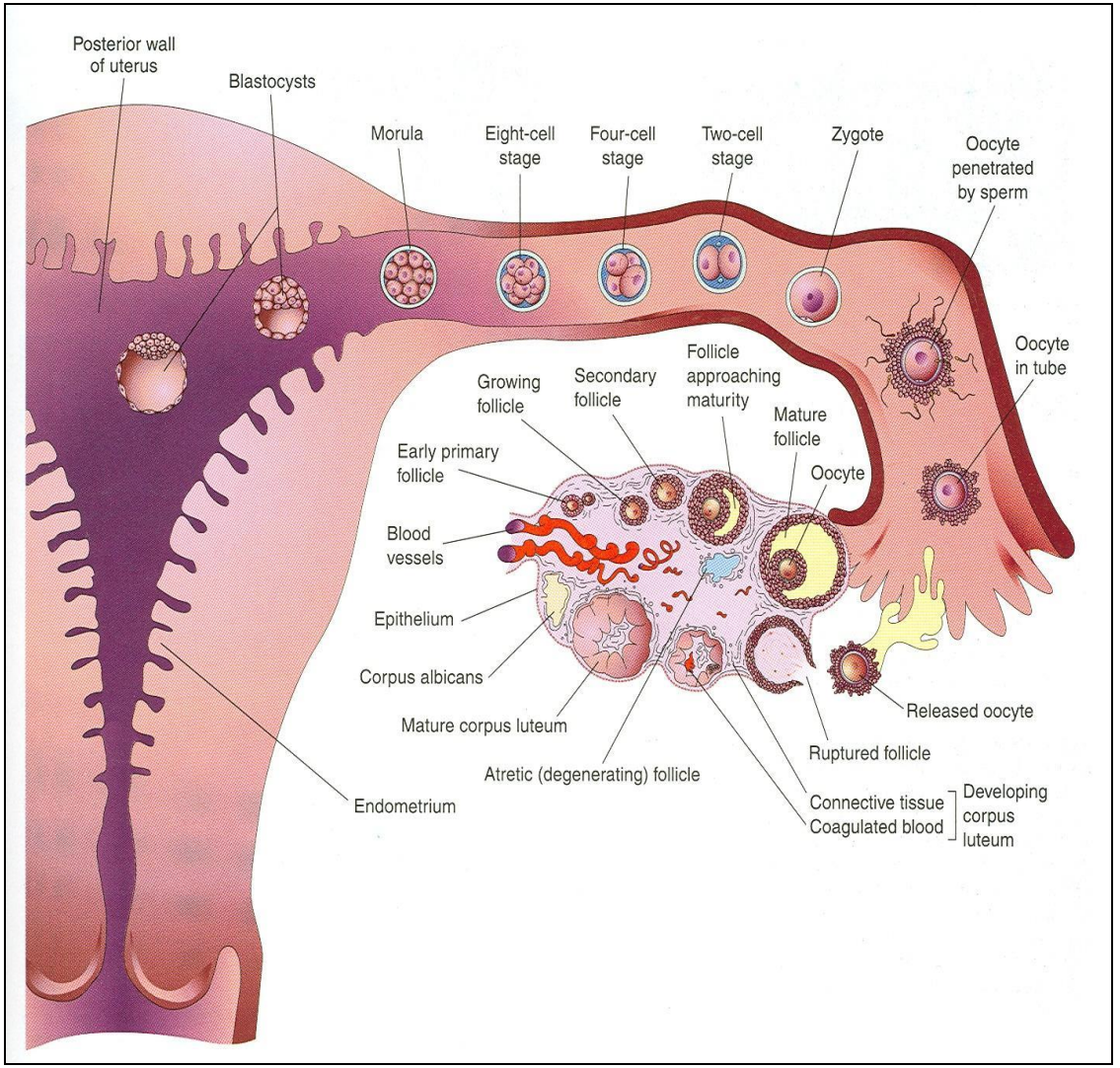
- It is a complex process.
- It begins with a **contact** between sperm & ovum.
- Ends up with **intermingling** of the maternal and paternal chromosomes.





Site of Fertilization

- **Usually** in the ampulla of uterine tube.
- **Ampulla** is the widest part of the tube.
- **Fertilization** may occur in any other part of tube.
- **Never occurs in the uterine cavity.**
- **Chemical signal** from oocyte attracts the sperms.



Sperm Capacitation

- Occurs in the female genital tract before fertilization.
- It is stimulated by secretions in the vagina, uterus, and uterine tubes.
- Naturally it takes 6-7 hours.
- Results in capability of the sperm to pass through the corona radiata.
- Involves removal of surface coatings and changes in plasma membrane.
- Can be produced *in vitro* by washing with special solution.

Phases of Fertilization

1- Passage of the sperm through the cells of the *corona radiata* by **the effect of:**

a) *Hyaluronidase enzyme* secreted from the sperms.

b) *By* movement of its tail.

2- Penetration of the **zona pellucida by acrosine (a substance secreted from acrosomal cap).**

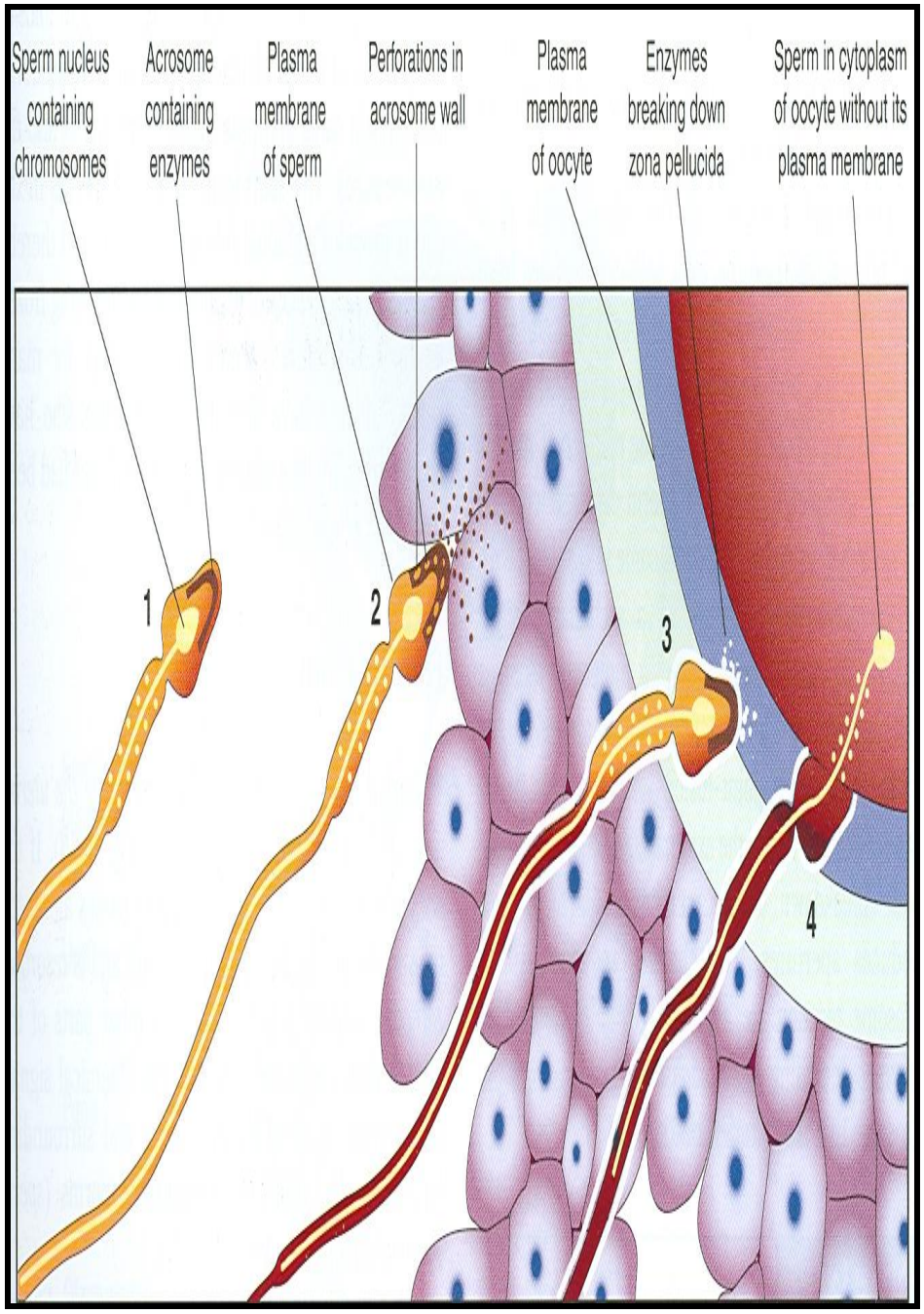
3- Fusion of the plasma membranes of the oocyte and the sperm.

4- Completion of the second meiotic division of the oocyte .

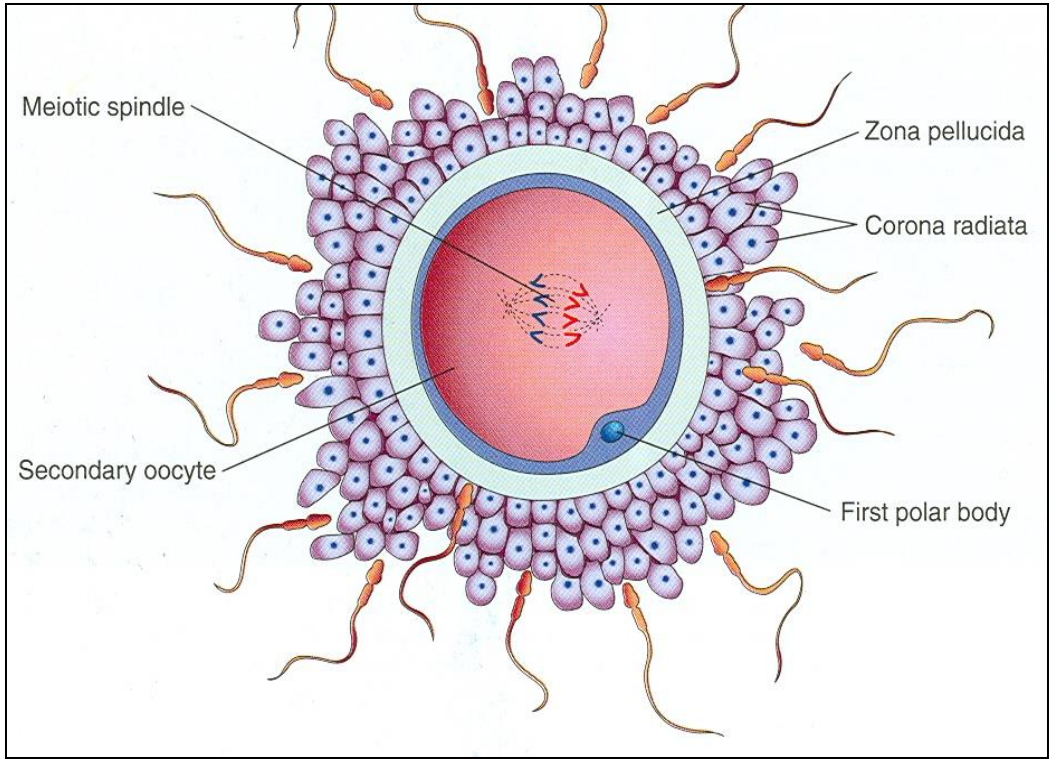
5- Formation of **female** pronucleus.

6- Formation of **male** pronucleus.

7- Union of the 2 pronuclei.



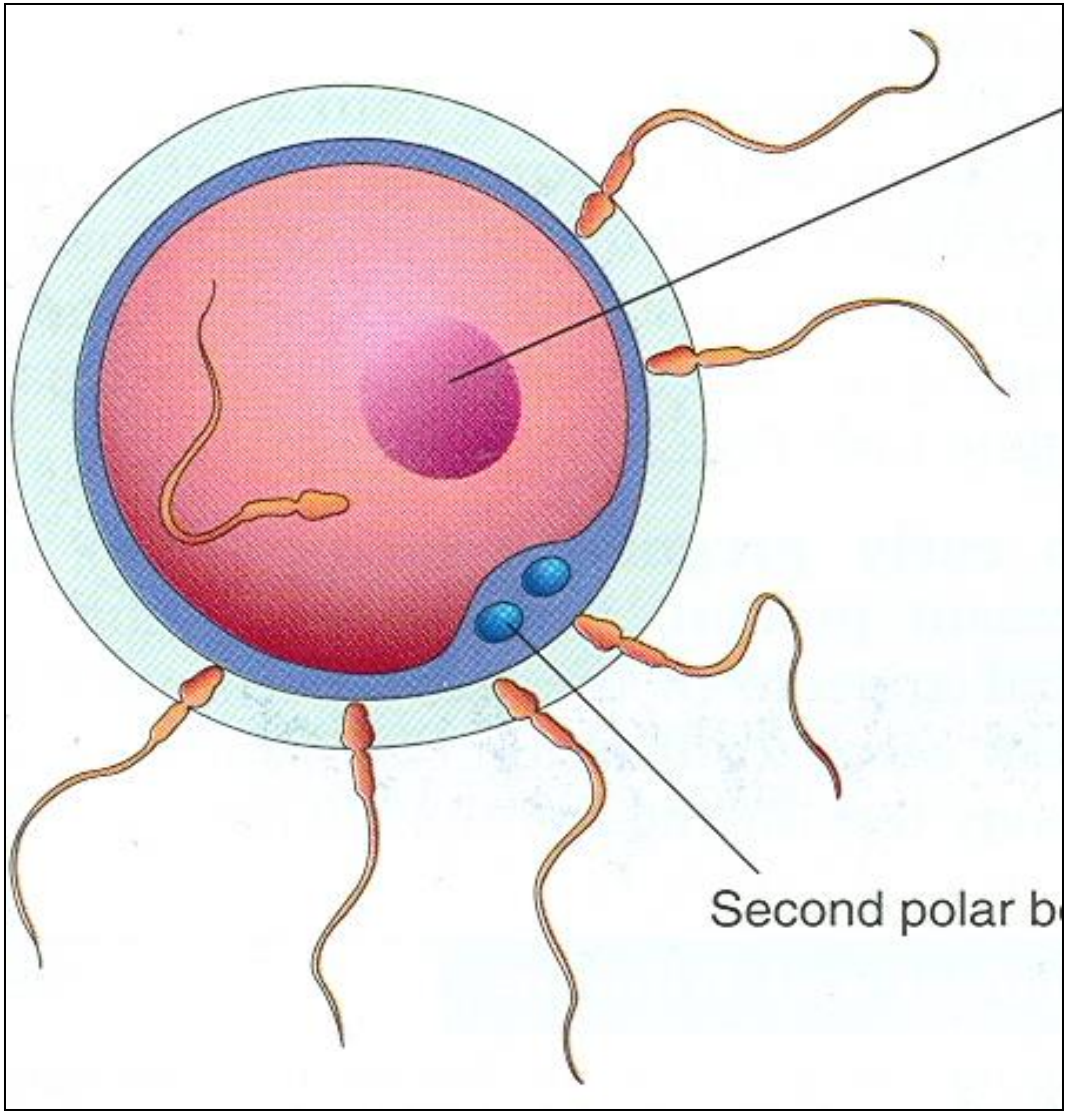
CHROMOSOMES



- Zygote is genetically **unique.**
- Half of its **chromosomes** comes from the father and the other half comes from the mother.
- New combination is formed which is different from either of the parents.
- This mechanism forms **biparental inheritance** and leads to variation of the human species.

Sex of the Embryo

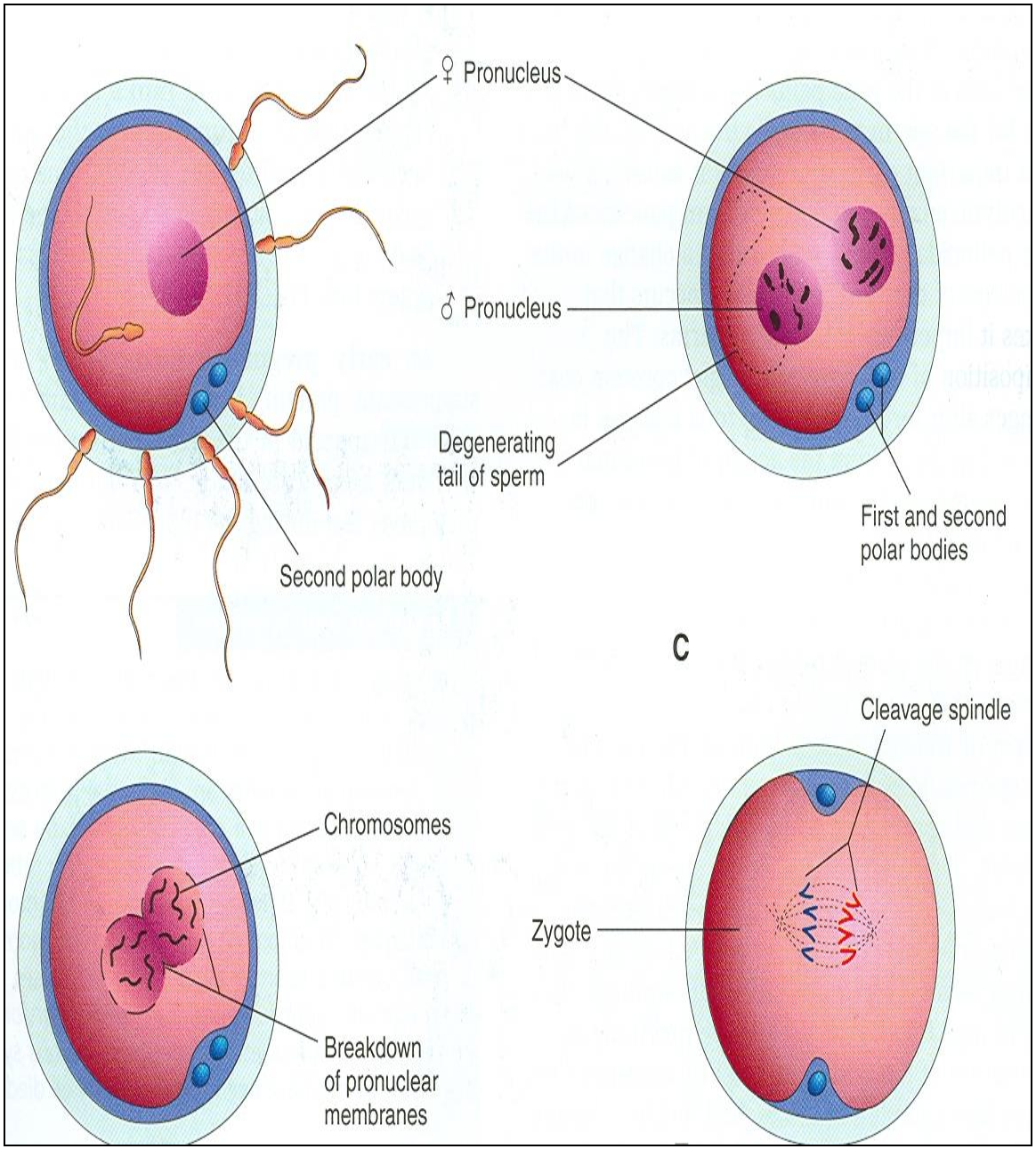
- Embryo's chromosomal sex is determined at the time of fertilization.
- Sex is determined by the type of sperm (**X or Y**) that fertilizes the oocyte.
- So, it is the **father** whose gamete decides the sex.



❖**Zonal reaction :** it is a change in properties of zona pellucida that makes it **impermeable** to other sperms.

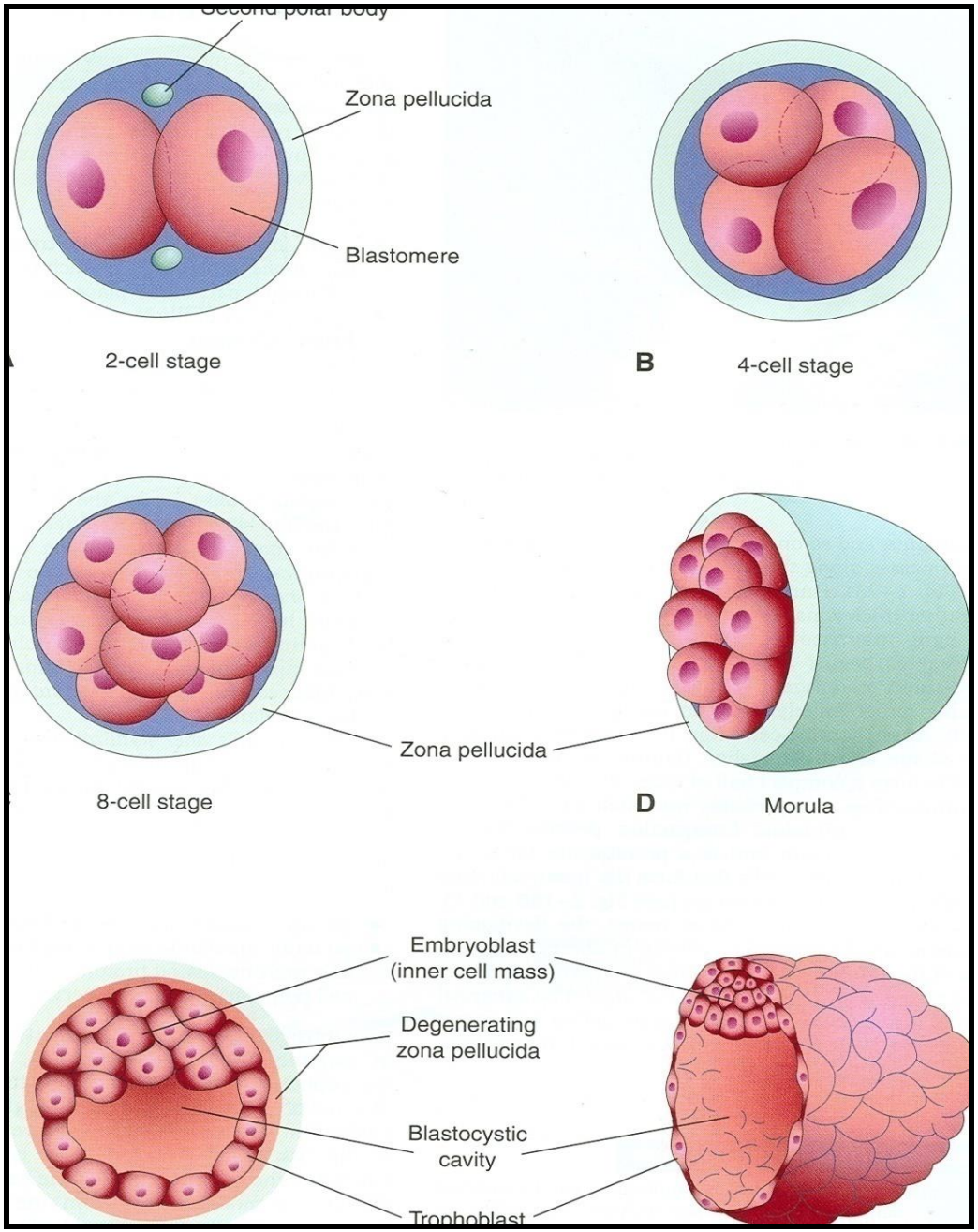
Results of Fertilization

1. Stimulates the penetrated oocyte to complete its 2nd meiotic division.
2. Restores the normal **diploid** number of chromosomes.
3. Determines the sex of the embryo.
4. Initiates cleavage (cell division) of the zygote.



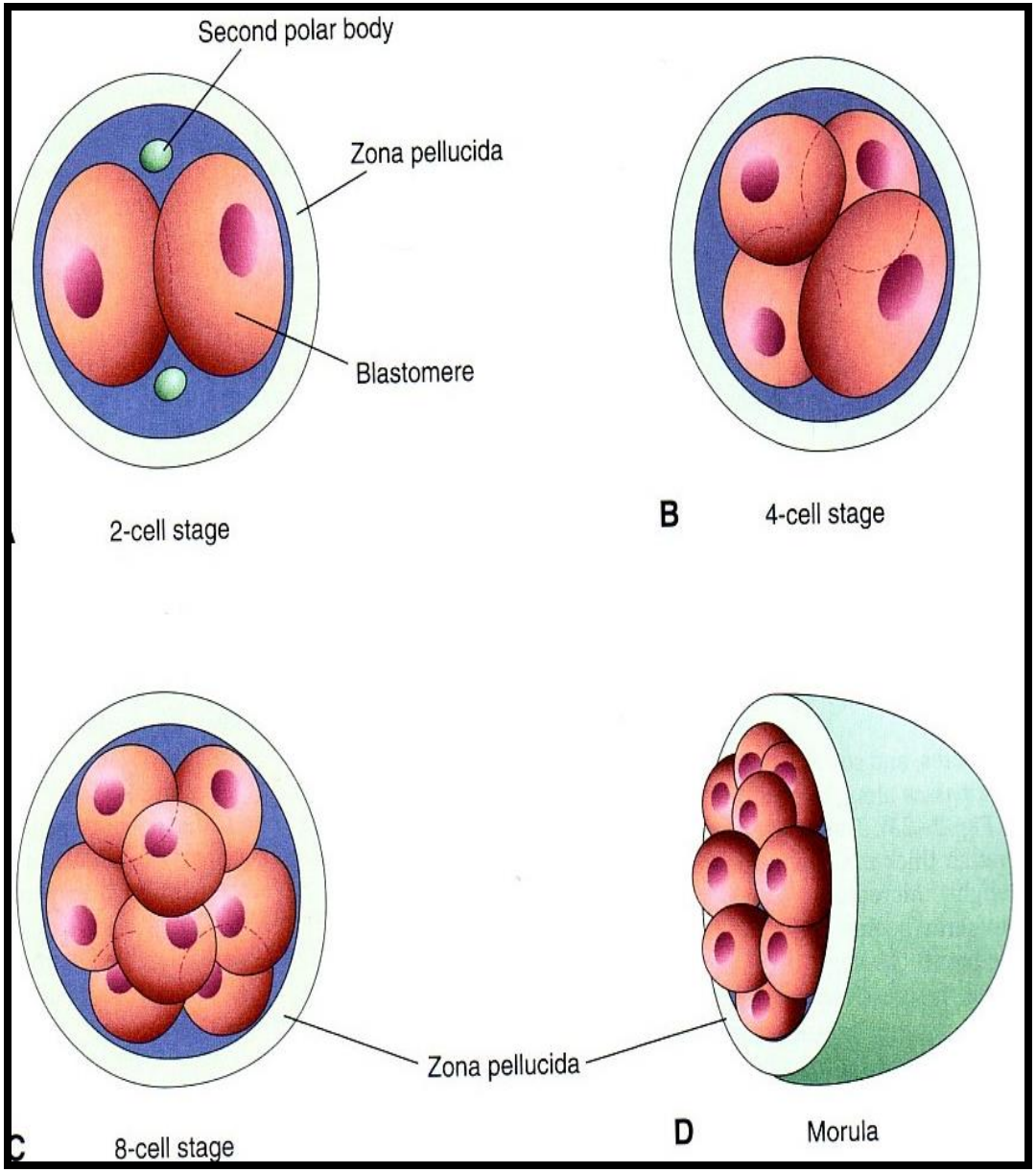
Cleavage of Zygote

- It is the repeated mitotic divisions of the zygote.
- Normally occurs in the uterine tube.
- Rapid increase in the number of the cells.
- These smaller embryonic cells are now called, ***Blastomeres***.



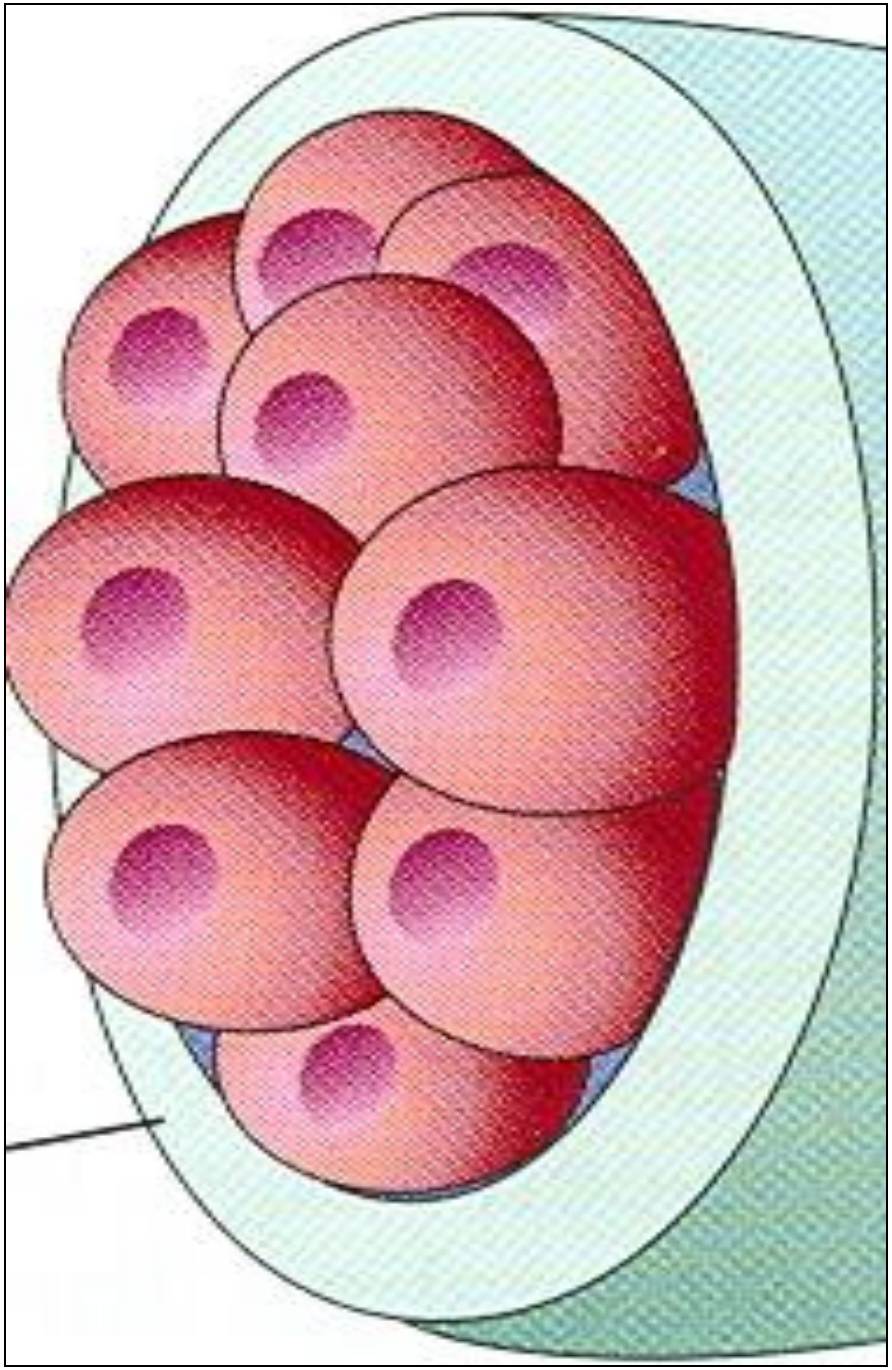
Cleavage of Zygote

- It begins about **30 hours** after fertilization.
- Zygote divides into 2, then 4, then 8, then 16 cells.
- Zygote lies within the thick zona pellucida during cleavage.
- Zygote migrates in the uterine tube during cleavage from lateral to medial.
- **Under the microscope, the zona pellucida is a translucent membrane.**



Morula

- When there are 16-32 blastomeres the developing human is called **MORULA.**
- The **Morula** reaches the uterine cavity at this stage.
- The spherical **Morula is** formed about **3** days <u>after fertilization.</u>
- It resembles mulberry or blackberry.

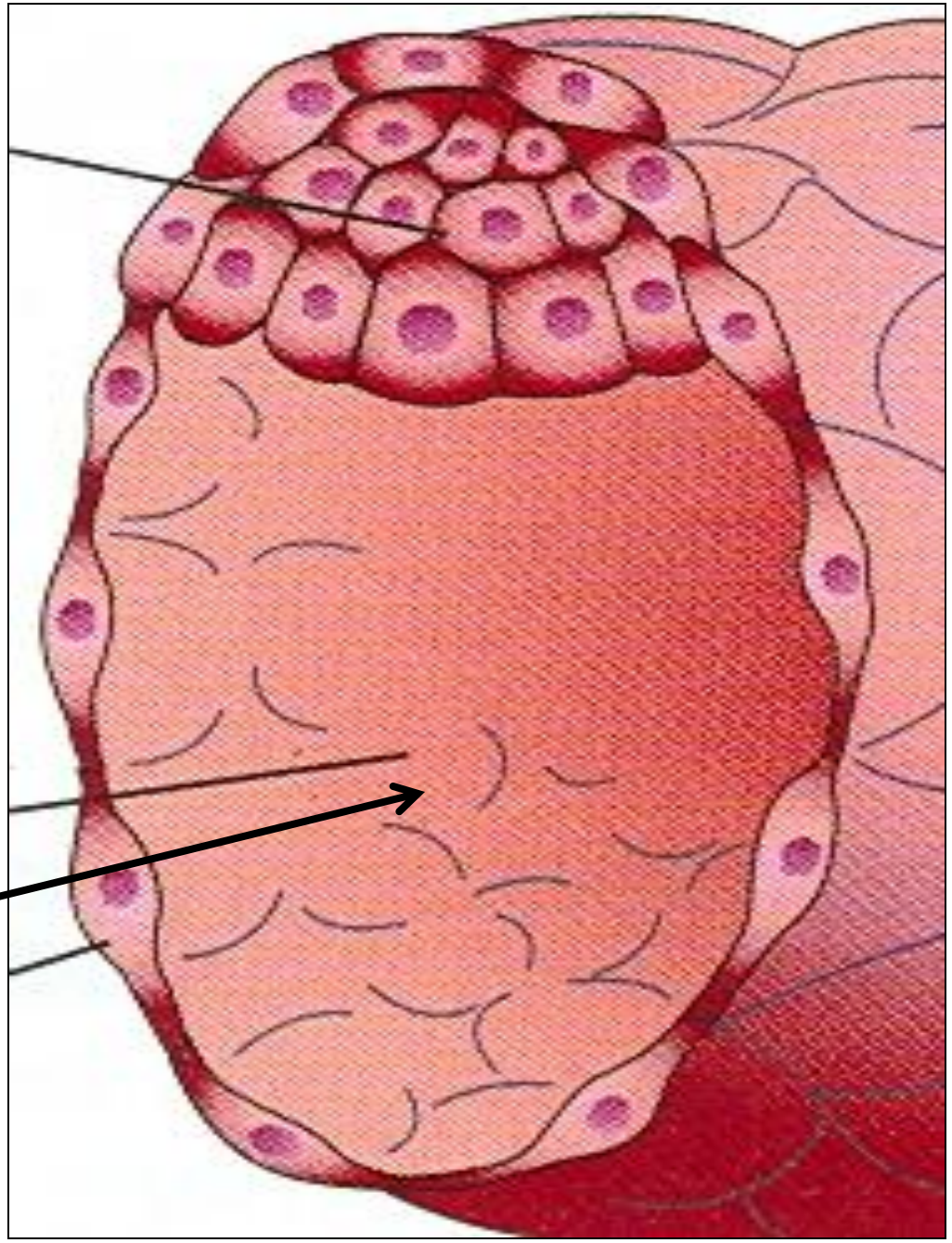


BLASTOCYST

A **cavity** appears within the morula dividing its cells into 2 groups:

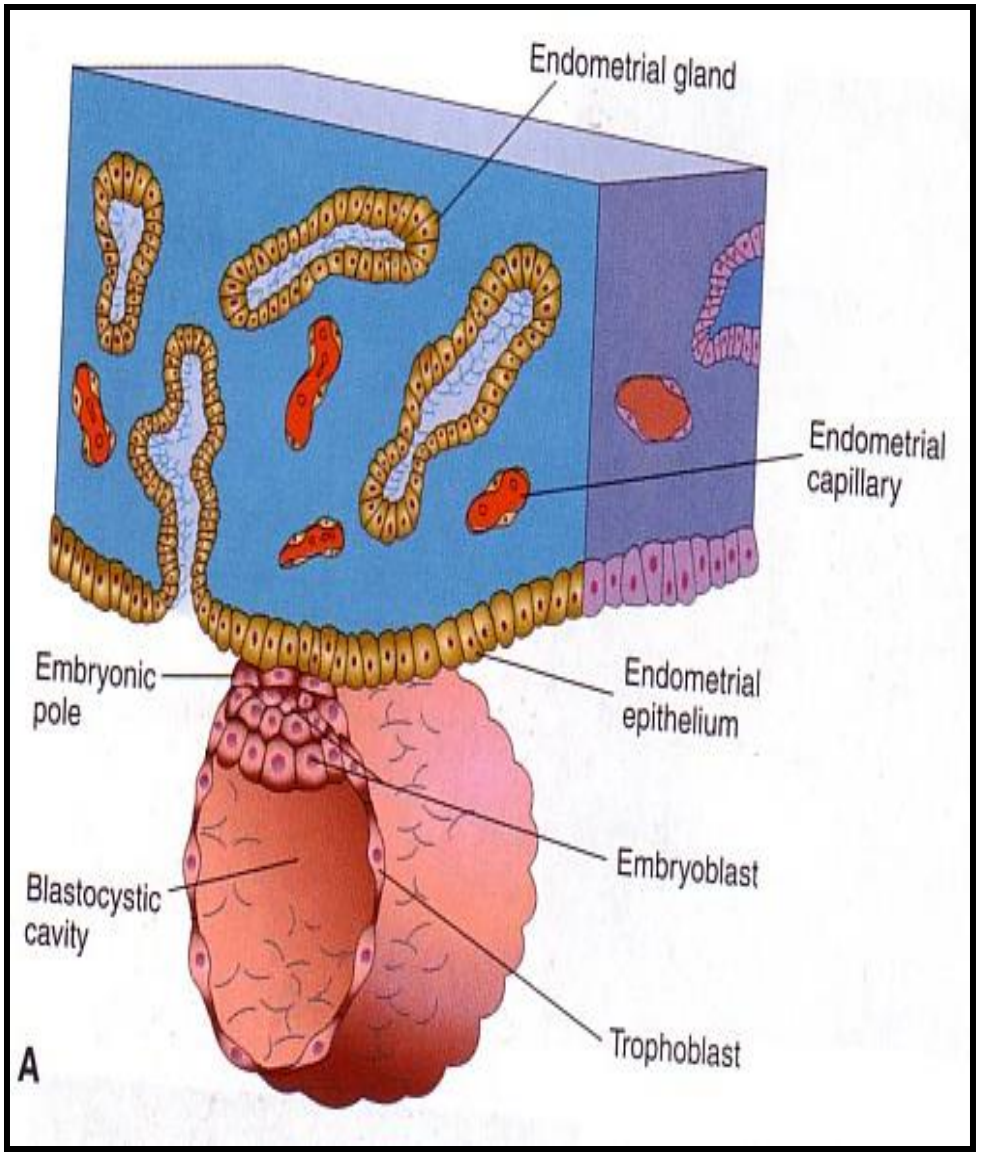
1. Outer cell layer called trophoblast.
2. Inner cell layer (mass) attached to one of the poles of the blastocyst.

The cavity is called blastocystic cavity or blastocele.

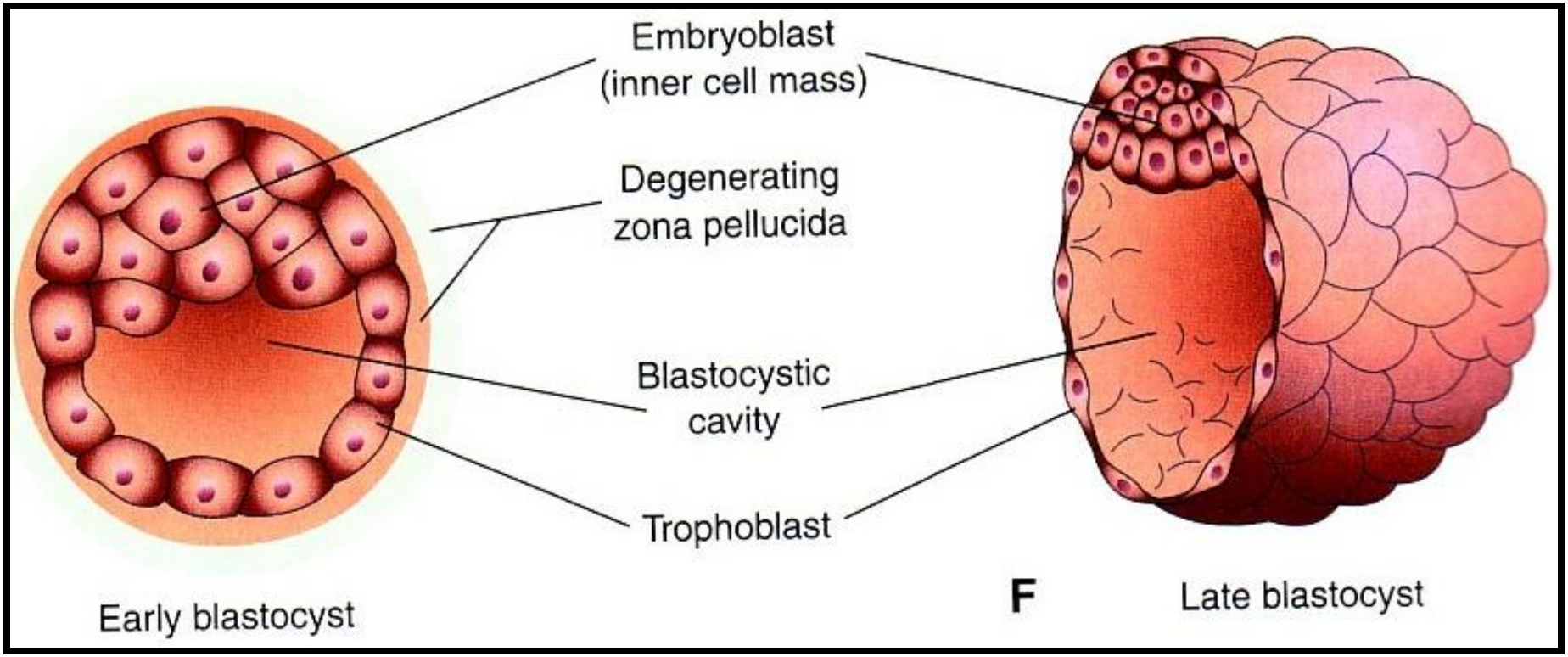


IMPLANTATION

- ***Definition :***
- It is the process by which the **Blastocyst** penetrates the **superficial** (Compact) layer of the endometrium of the uterus.
- ***Site:***
- The normal site of ***implantation*** is the **posterior wall of the body of the uterus near the fundus.**
- ***Time:***
- It **begins** about the **6th day** after fertilization.
- It is **completed** by the 11th or 12th day.



- *Mechanism:*
- The Morula reaches the uterine cavity by the 4th day after fertilization, & remains free for one or two days.
- **Fluid** passes from uterine cavity to the Morula.
- Now the Morula is called ***Blastocyst***, its cavity is called blastocystic cavity, its cells divided into Embryoblast & Trophoblast.



By the **5th day** the Zona pellucida degenerates.

Blastocyst begins **implantation** by the **6th** day.

Trophoblast cells penetrate the epithelium of the endometrium.

Penetration results from proteolytic enzymes (eg.COX-2) produced by the **trophoblast**.

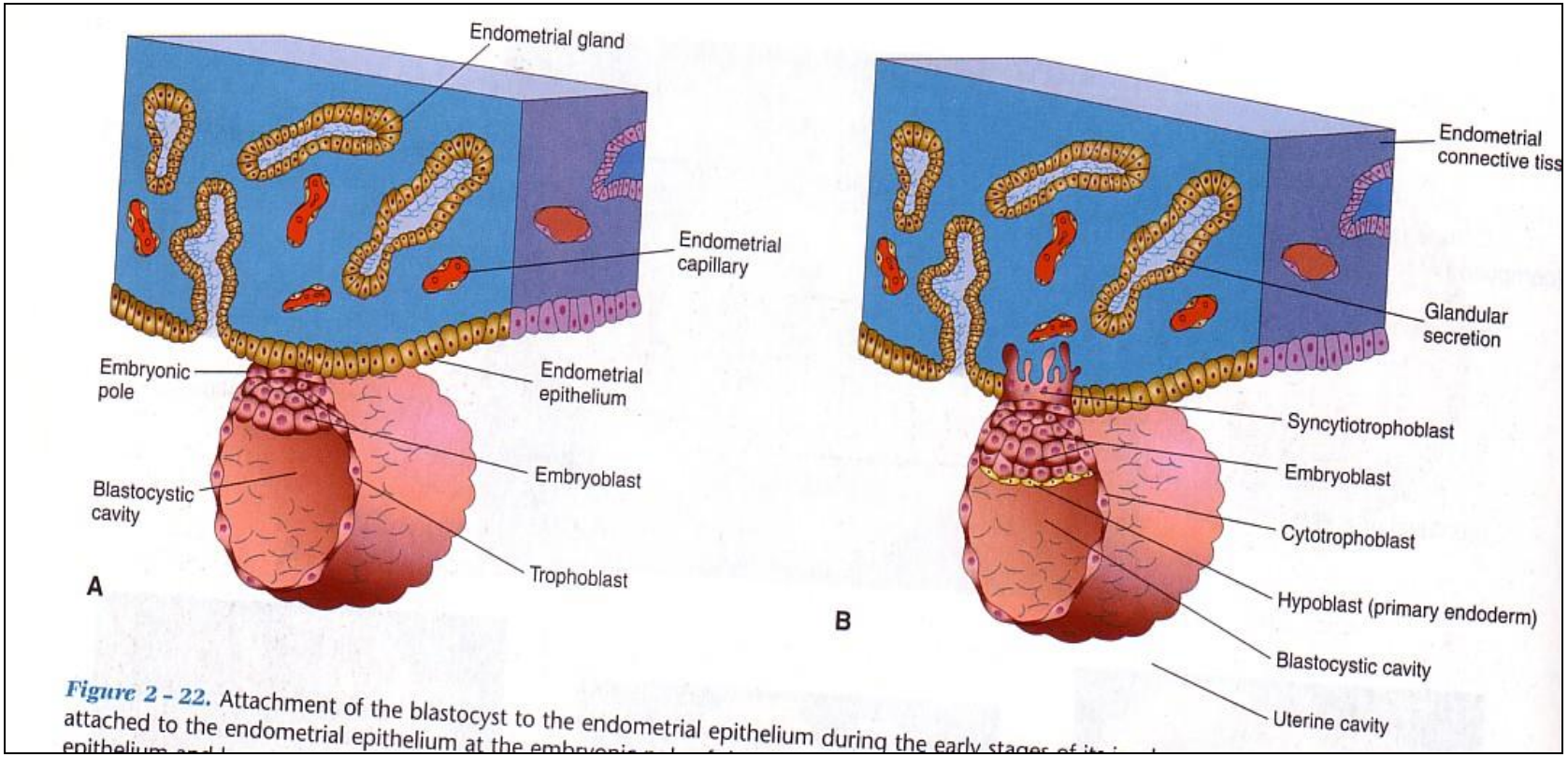


Figure 2 - 22. Attachment of the blastocyst to the endometrial epithelium during the early stages of its
attached to the endometrial epithelium at the embryonic

- **Zona pellucida** degenerates & disappears by the **5th** day to allows the **blastocyst** to increase in size and penetrates the endometrium.
- *The **embryoblast*** projects into the blastocystic cavity, while the trophoblast forms the wall of the blastocyst.
- By **6th** day the blastocyst adheres to the endometrium
- By **7th** day, T*rophoblast* differentiated into 2 layers:

  Cytotrophblast, inner layer, mitotically active.

  Syncytiotrophoblast (outer multinucleated mass, with *indistinct* cell boundary.

  By **8th** day the blastocyst is superficially embedded in the compact layer of the endometrium.

- Blood-filled Lacunae appear in the **Syncytiotrophoblast**

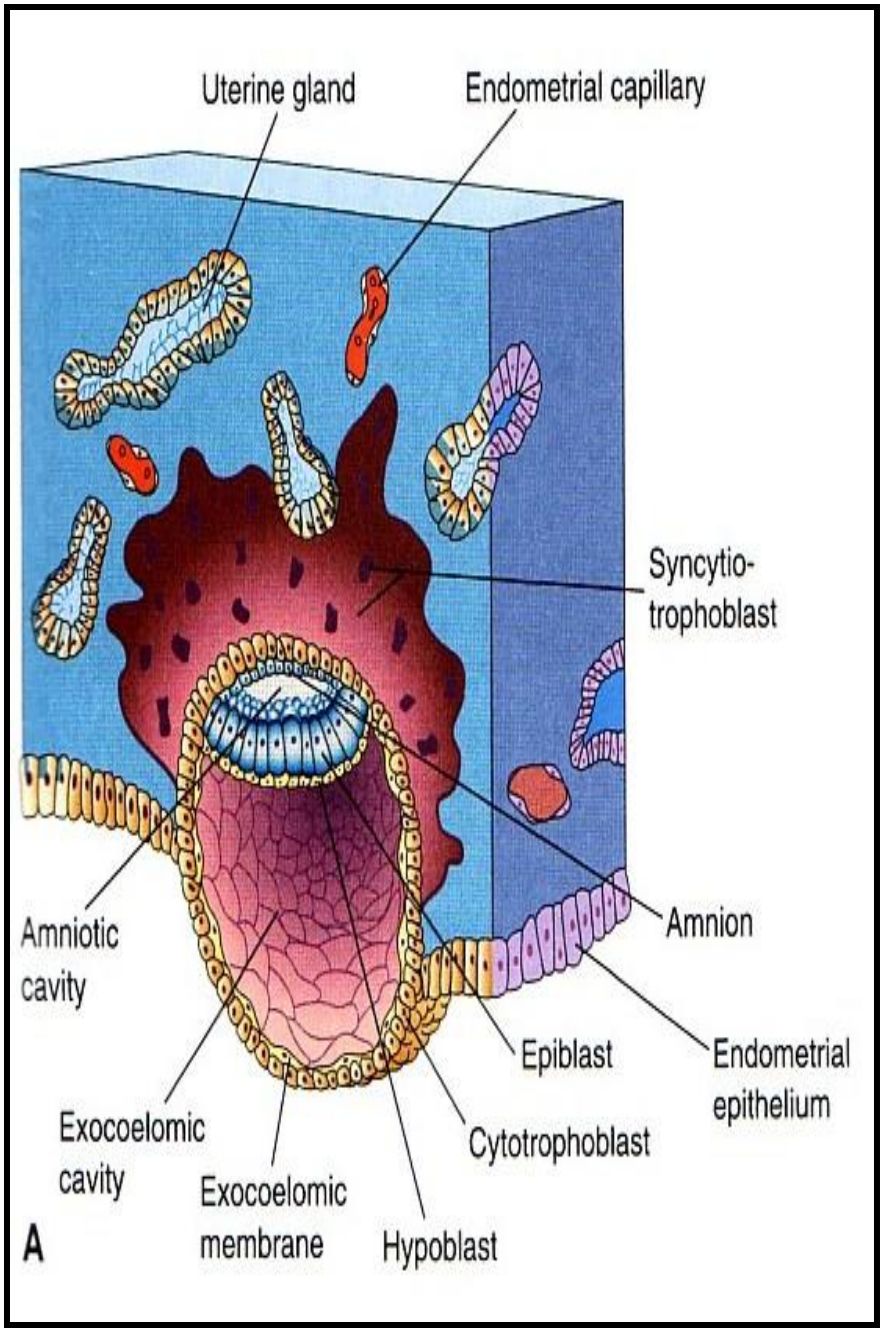
  which communicate forming a network by the 10th or 11th day.
- **Syncytiotrophoblast**

  erodes the endothelial lining of the maternal capillaries which known as sinusoids.

  Now blood of maternal capillaries reaches the lacunae so

  Uteroplacental circulation

  is established by **11th or 12th day.**



Endometrial cells undergo a process called apoptosis (programmed cell death) to facilitates invasion of endometrium by the **Syncytiotrophoblast.**

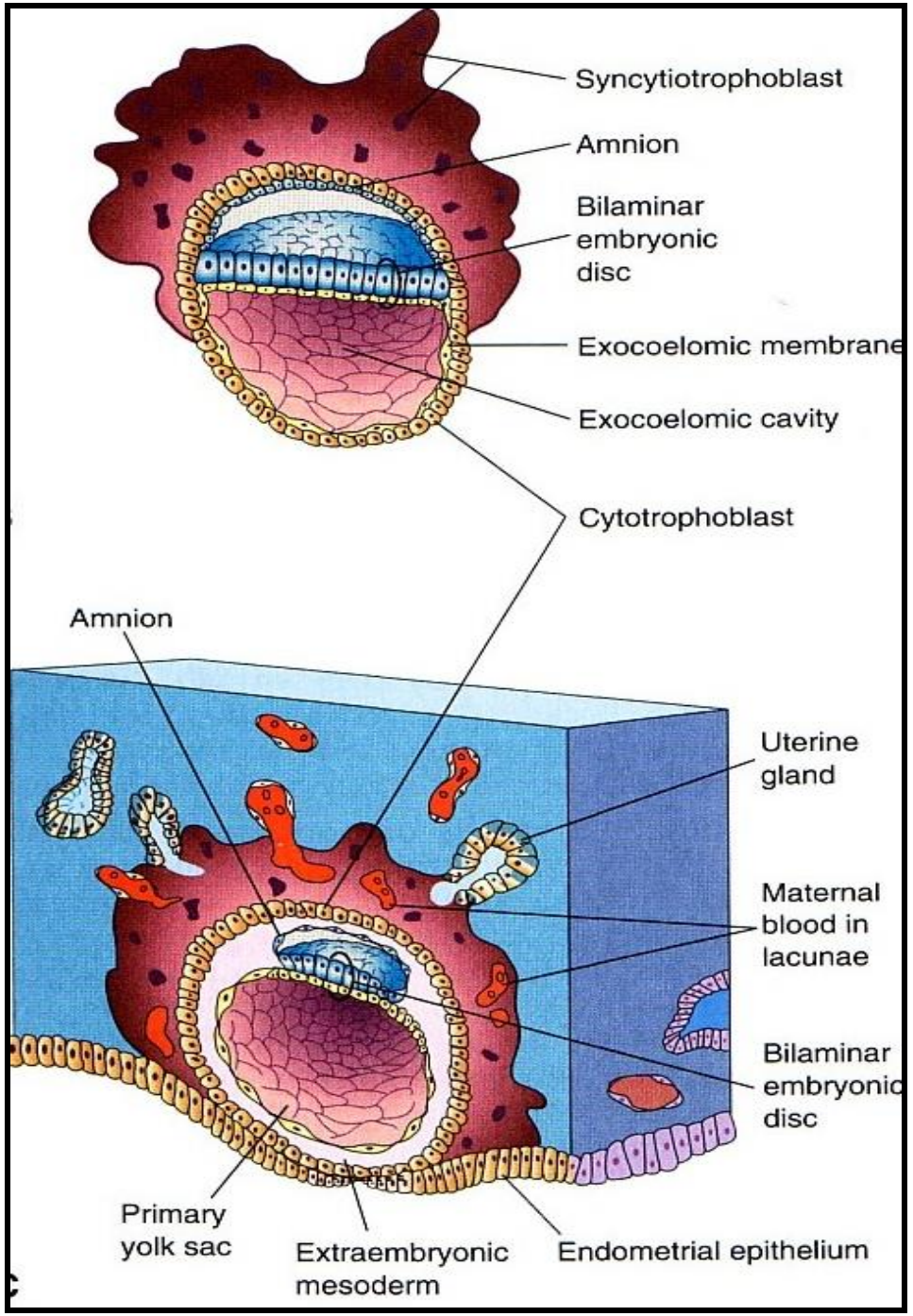
Syncytiotrophoblast engulf these degenerated cells for nutrition of the embryo.

Implantation

can be **detected** by:

1- Ultrasonography.

2- hCG (human chorionic gonadotrophin which is secreted by the Syncytiotrophoblast) about the **end** of 2nd week.

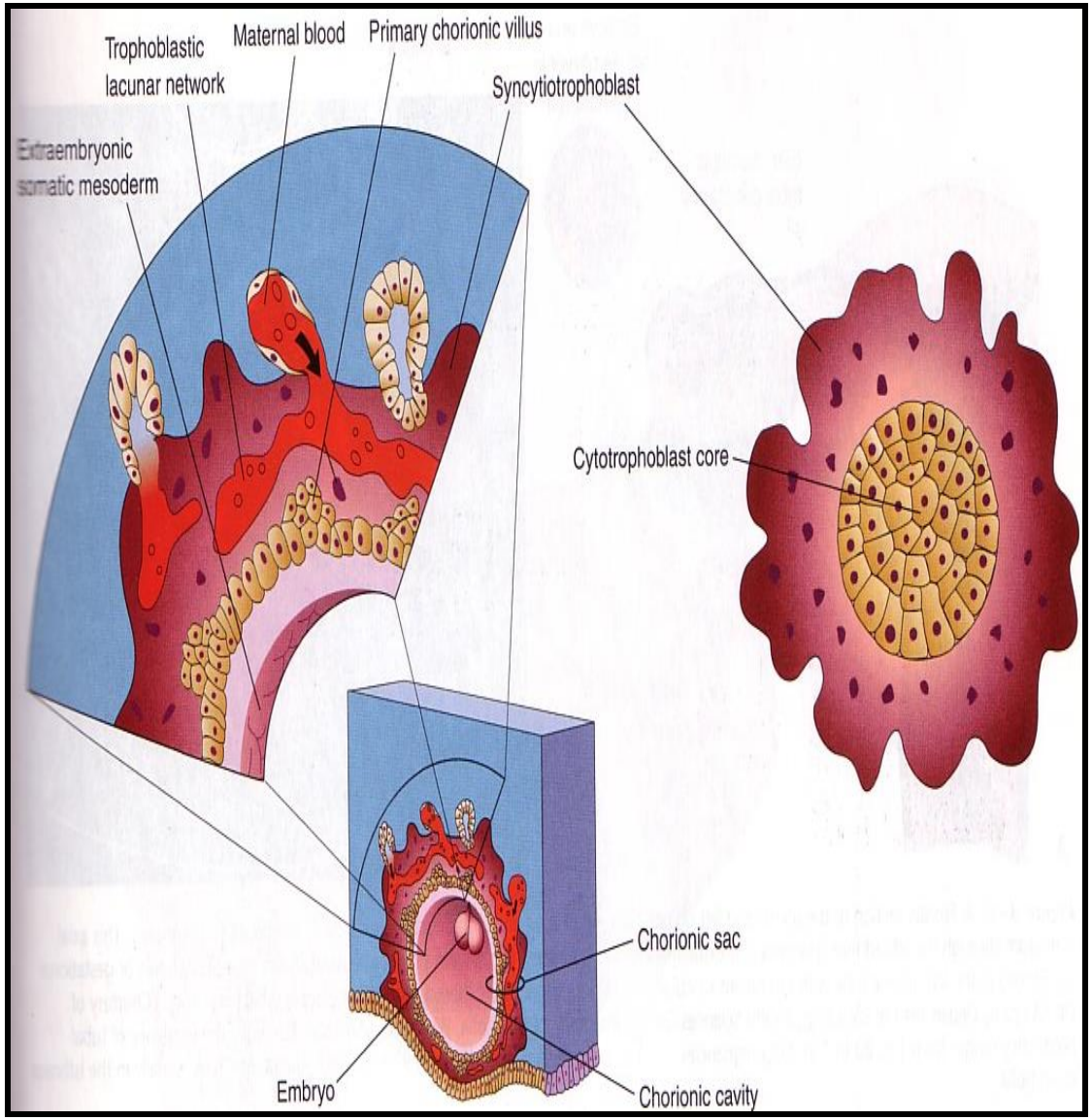


Early Pregnancy Factor

- Is an immunosuppressant protein.
- Secreted by trophoblast cells.
- Appears in maternal serum within 24-48 hrs., after **implantation.**
- It is the basis for **EPT** (Early pregnancy test) in the first 10 days of development.

Formation of The Primary Chorionic villi

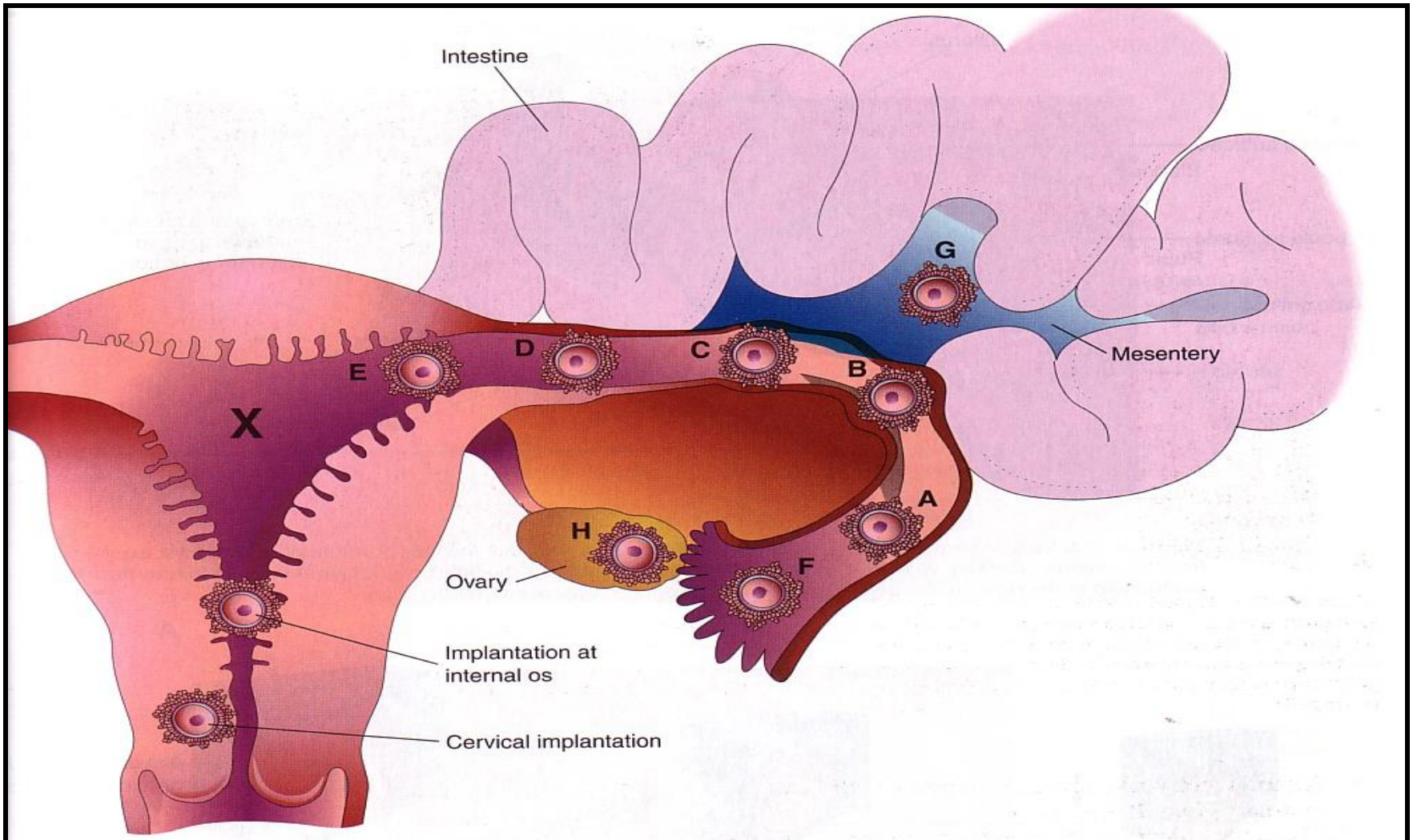
- By the 13th day *Proliferation* of Cytotrophblast cells produce extension inside the **Syncytiotrophoblast** to form the primary chorionic villi.



Doctor's Note

- At the 14th day, the mesoderm will appear within the center of the cytotrophoblast (Secondary chorionic villi).
- At the 15th day, few blood capillaries appear within the mesoderm (Tertiary chorionic villi).

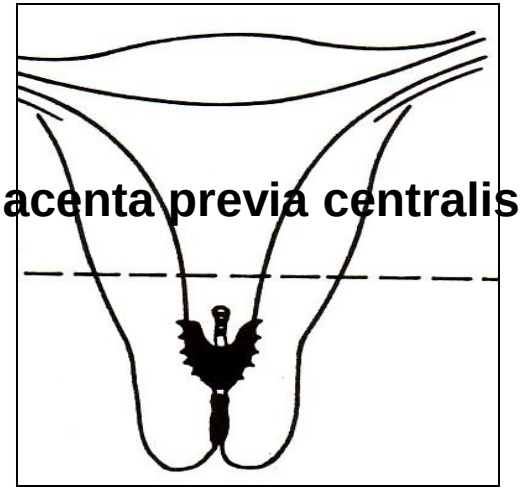
Ectopic Implantation (Pregnancy)



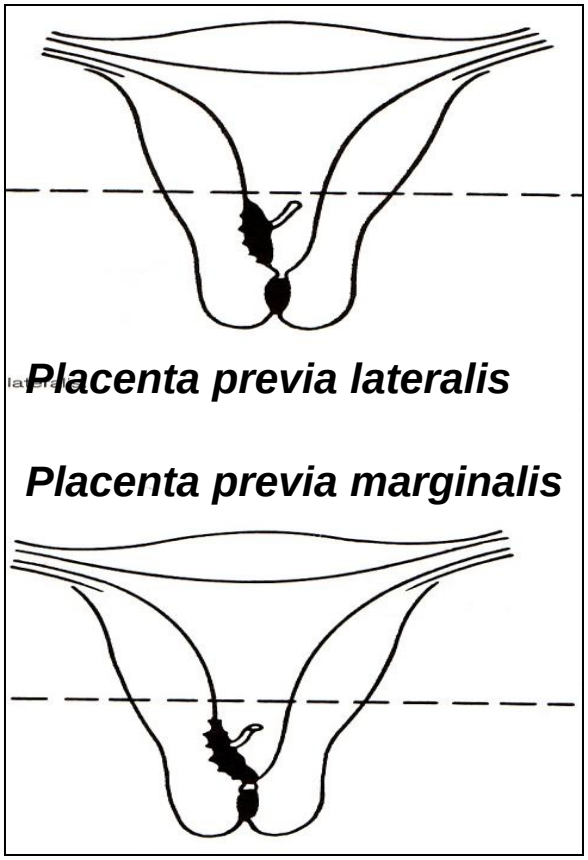
3 - 10. Implantation sites of blastocysts. The usual site in the posterior wall of the uterus is indicated by an X. The approximate order of ncy of ectopic implantations is indicated alphabetically (*A*, most common, *H*, least common). *A* to *F*, Tubal pregnancies. *G*, Abdominal ancy. *H*, Ovarian pregnancy. Tubal pregnancies are the most common type of ectopic pregnancy. Although appropriately included with uterine ancy sites, a cervical pregnancy is often considered to be an ectopic pregnancy.

Ectopic Pregnancy

- It means implantation outside the uterine cavity.
- 95 to 97% of ectopic pregnancies occurs in the uterine tube.
- Most are in the ampulla & isthmus.
- **Placenta previa:**
- Implantation occurs in the lower uterine segment.



Placenta previa centralis



Placenta previa lateralis

Placenta previa marginalis

Ectopic Pregnancy:

1- Placenta Previa.
2- Tubal.
3- Ovarian.
4- Abdominal.
5- Pelvic.
6- Cervical.