

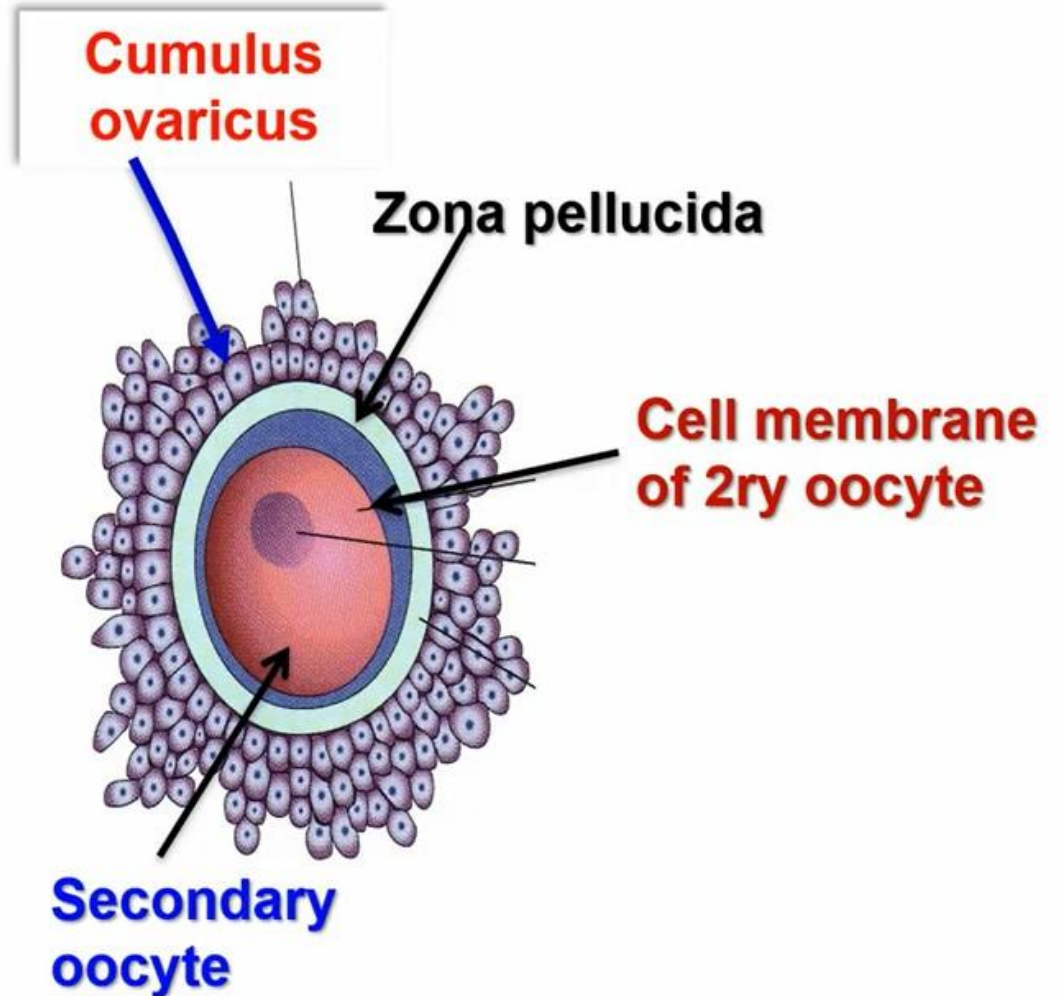
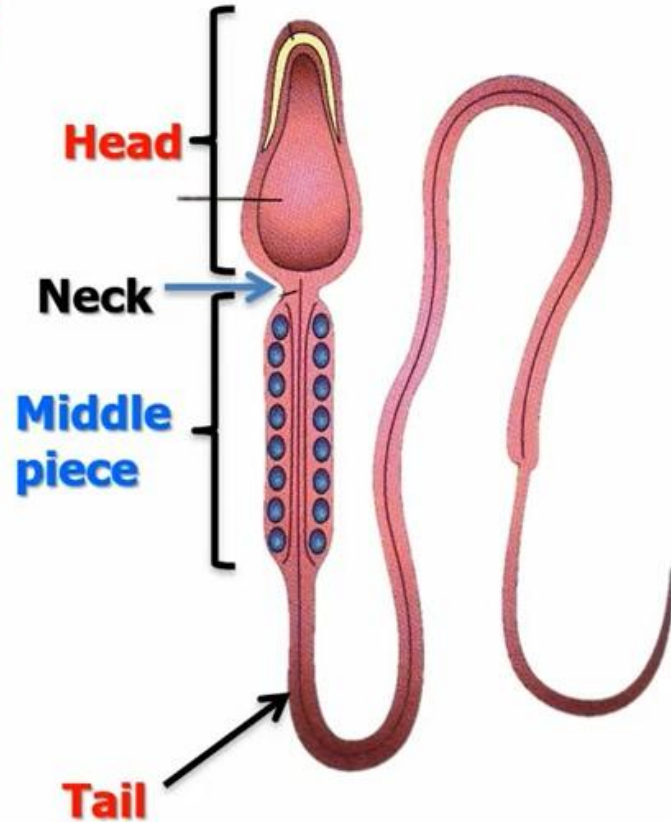
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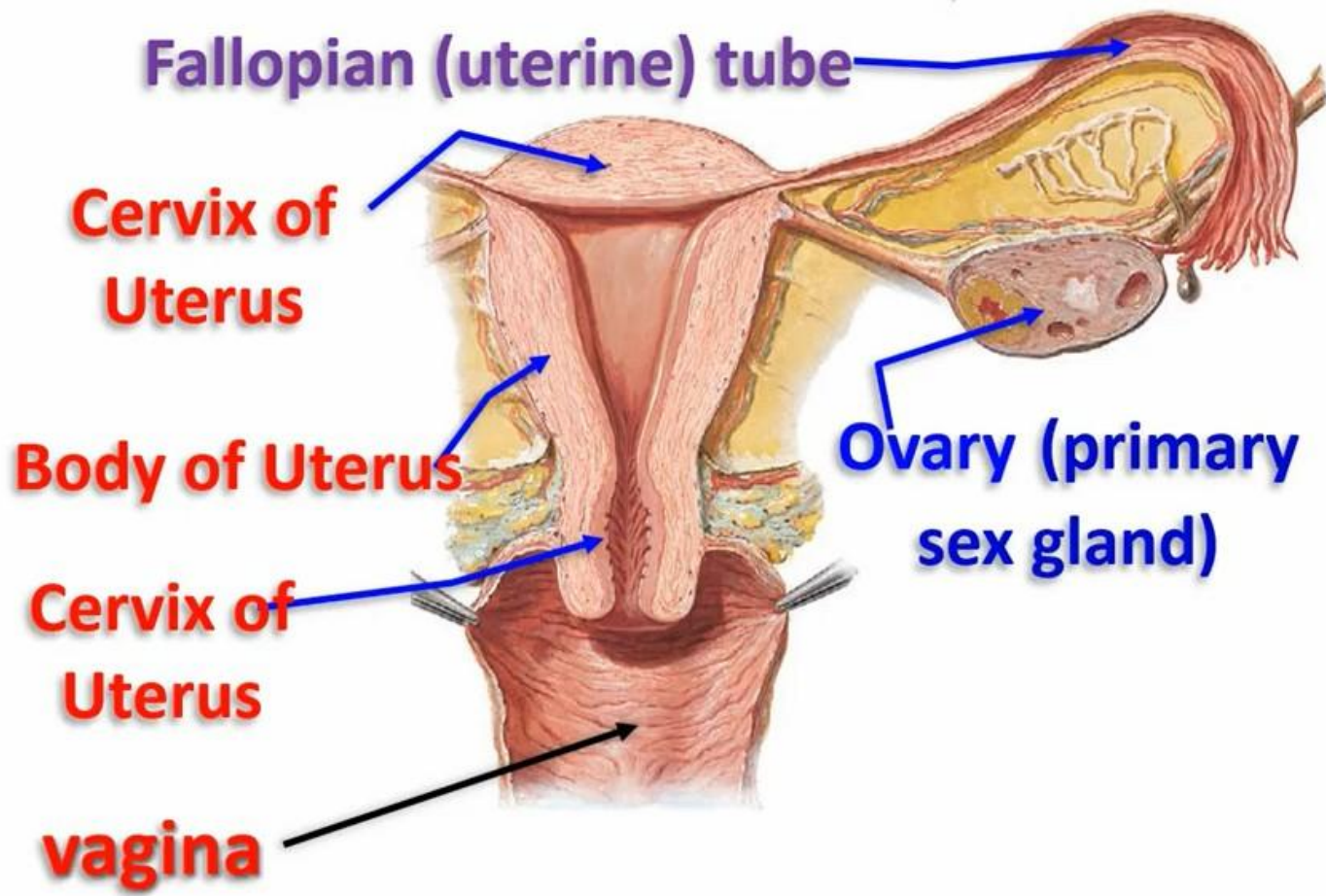
Fertilization

- **Fertilization** is the fusion of male gamete (haploid sperm) & female gamete (haploid ovum) to form the **diploid zygote**.
- **Time of fertilization:** during the ovulation that occurs roughly at the 14th day of the ovarian cycle

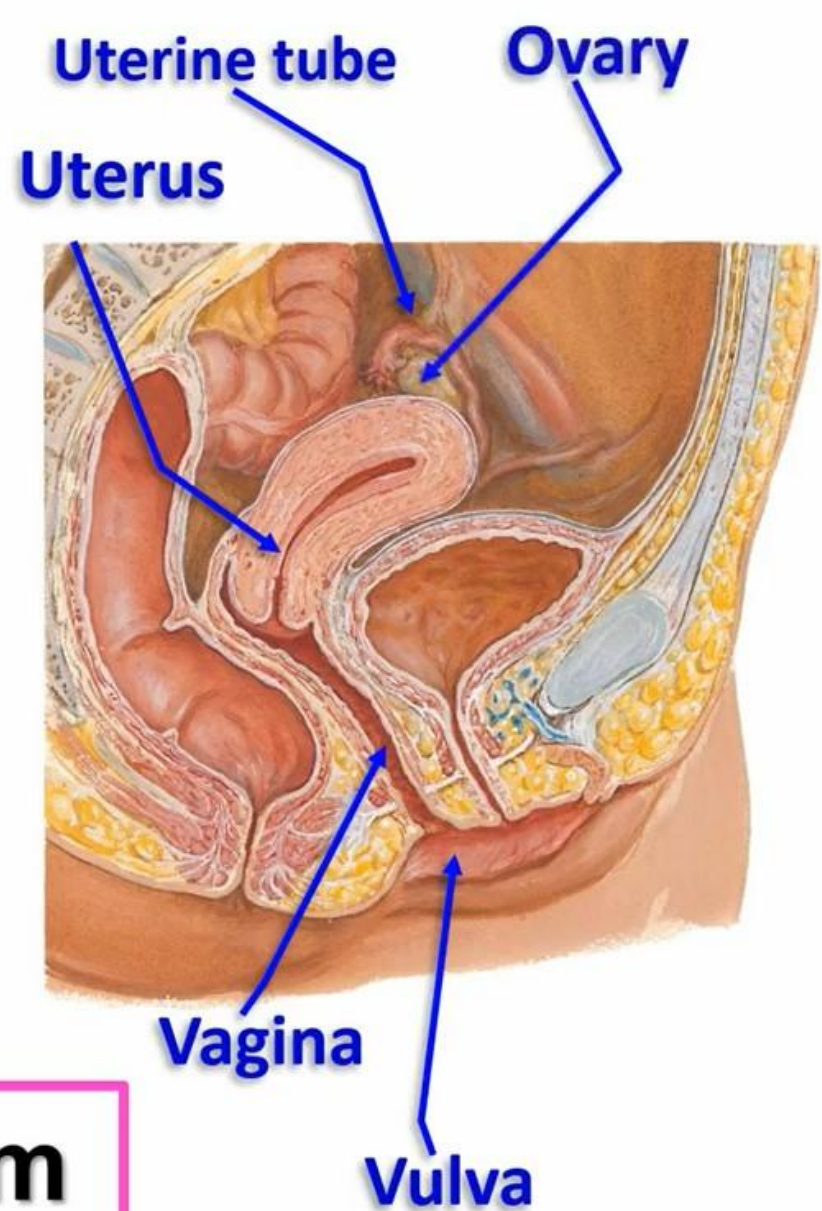
Sperm & Corona radiata (ovum)

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Female Reproductive System



Site of fertilization: at ampulla of uterine tube (lateral 1/3 of uterine tube)
The lifespan of the ovum is **24 - 48 hour**

Ampulla of uterine tube

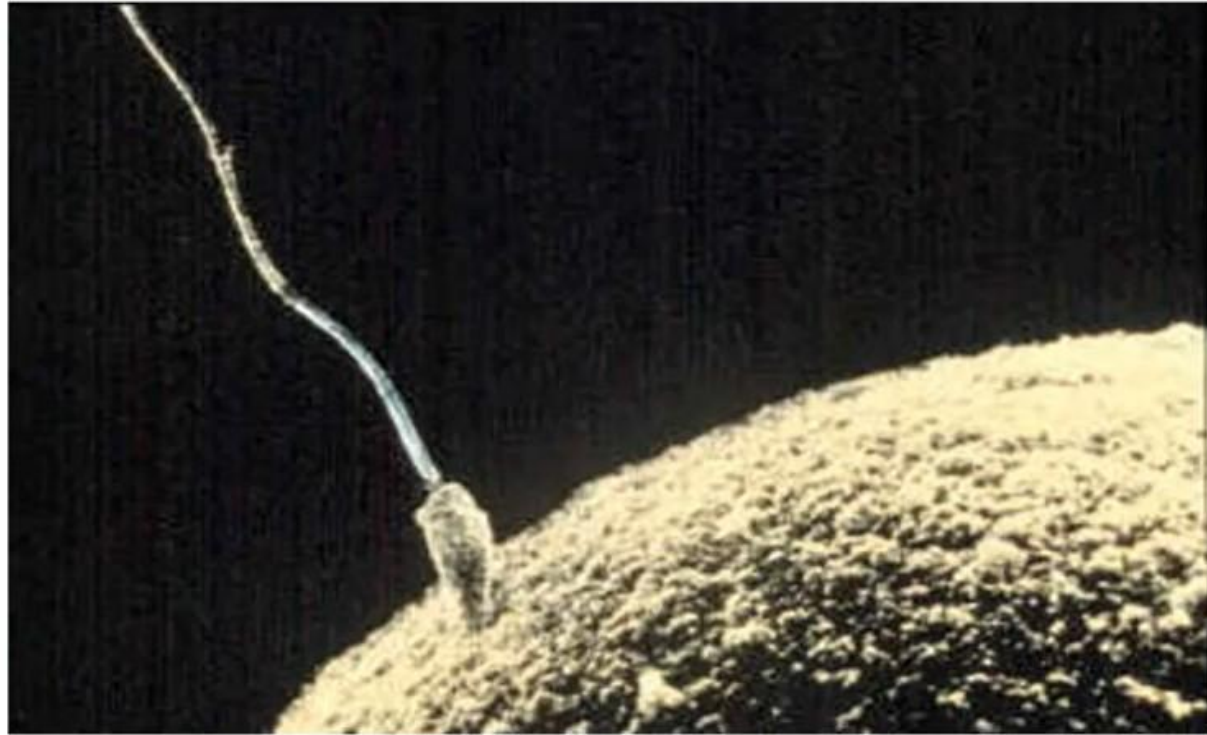
**** The sperms reach lateral 1/3 of the fallopian tube by;**

1- Movement of tails of the sperms.

2- Contraction of smooth muscle of the uterus and fallopian tubes.

3- Movement of the cilia of the uterine tube.

4- At ovulation, increase amount of **secretion** and become **less viscid**, making it more favorable for sperm transport.



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- **About 200–300 sperms reach the site of fertilization in the uterine tube**
- **Most of sperms able to fertilization within 48 hours.**
- **Only one can penetrate the secondary oocyte**

Steps of Fertilization

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graph TD; A[Steps of Fertilization] --> B[Changes of the sperm during migration in the female genital tract (preparation of sperm)]; A --> C[Actual step]; B --- D["1- Sperm Capacitation<br/>2- Acrosomal reaction"]; C --- E["1- Penetration of corona radiata cells (cumulus ovaricus)<br/>2- Penetration of the Zona Pellucida<br/>3- Fusion of plasma membranes of the gametes"];
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Changes of the sperm during migration in the female genital tract (**preparation of sperm**)

- 1- Sperm Capacitation
- 2- Acrosomal reaction

Actual step

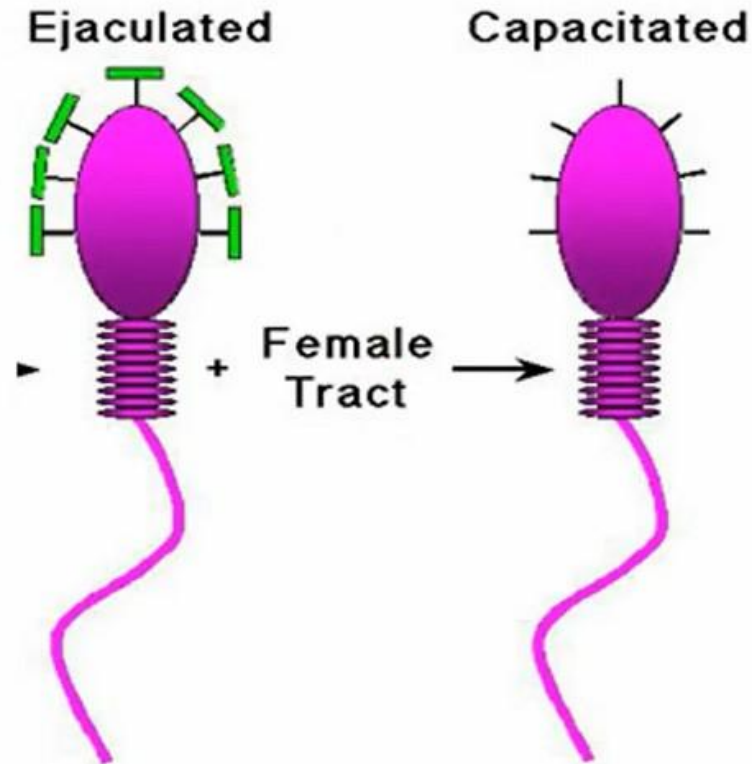
- 1- Penetration of corona radiata cells (cumulus ovaricus)
- 2- Penetration of the Zona Pellucida
- 3- Fusion of plasma membranes of the gametes

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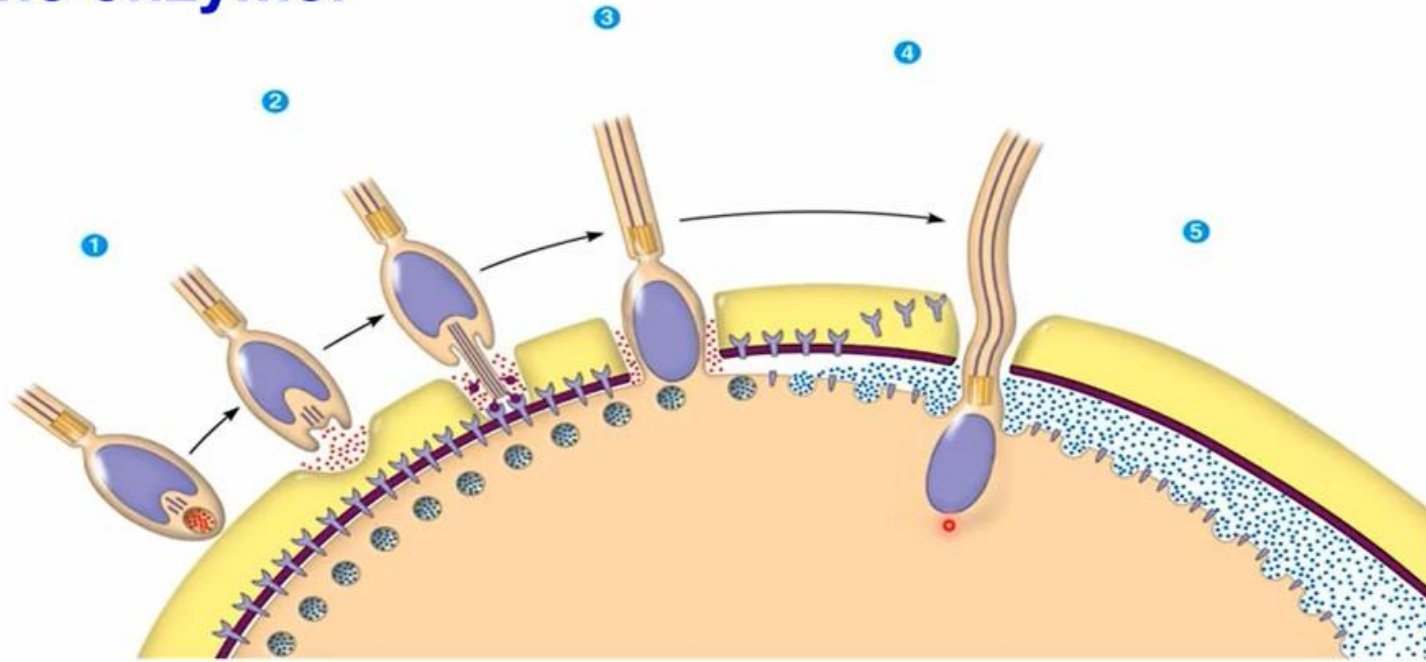
Steps of Fertilization

- **Capacitation, loss of** the glycoprotein coat from the acrosomal cap of the sperm head

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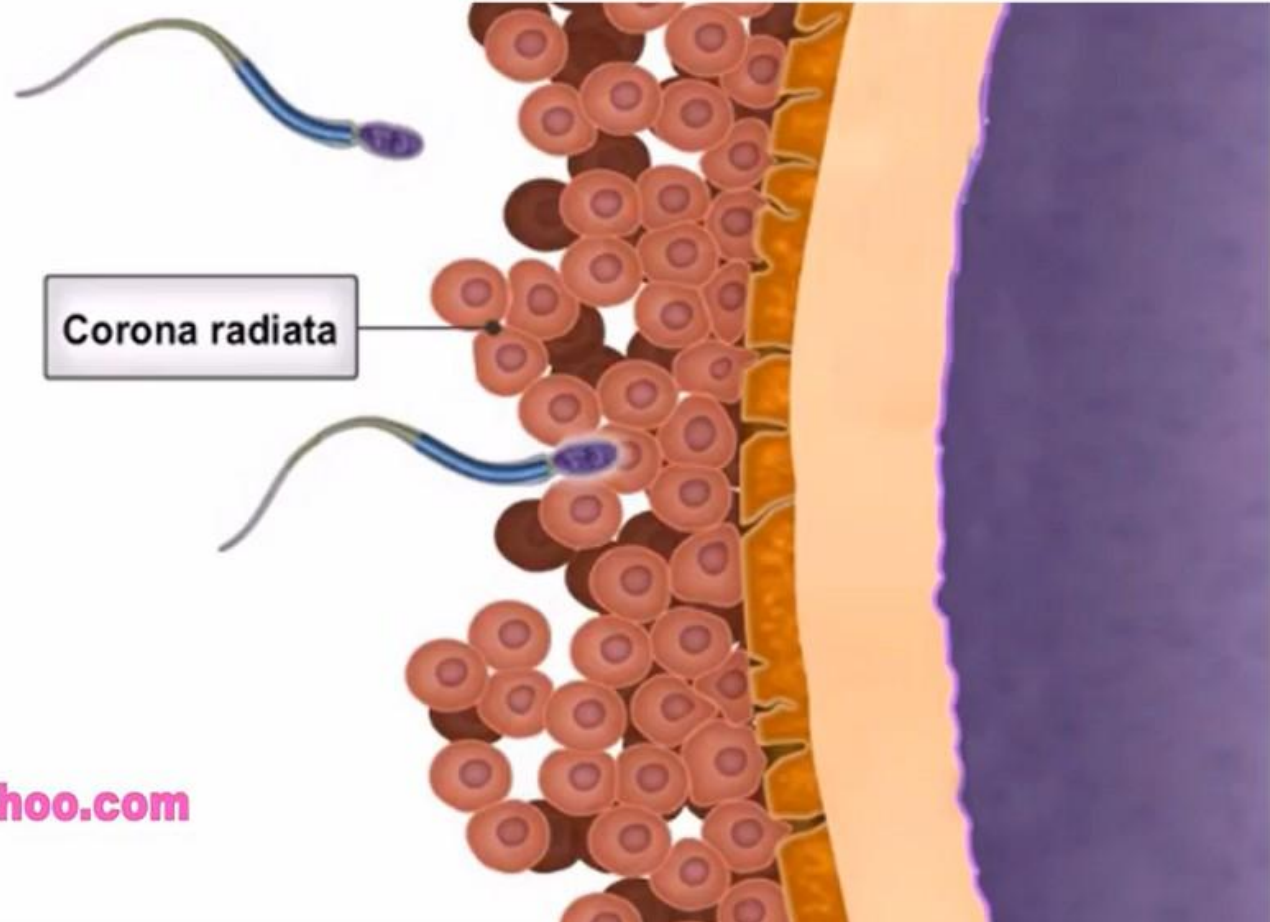
- **Acrosomal reaction**; release of the **proteolytic enzymes** from the acrosomal cap to help penetration of the sperm to the ovum.
 - They include **hyaluronidase enzyme, trypsin like enzyme and zona lysine enzyme.**



Penetration of the corona radiata cells

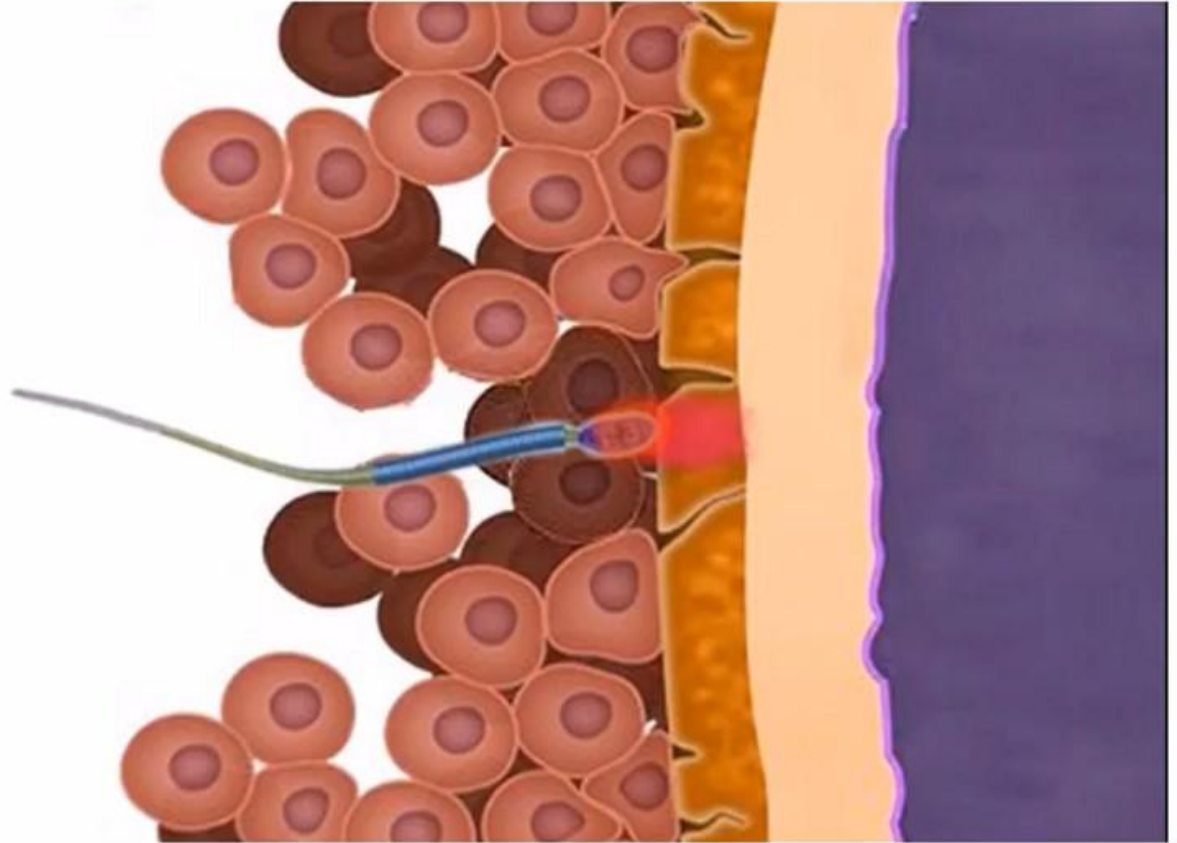
Penetration of corona radiata cells by :

- 1) Hyaluronidase enzyme of sperms.
- 2) Mucous secretion of fallopian tube.



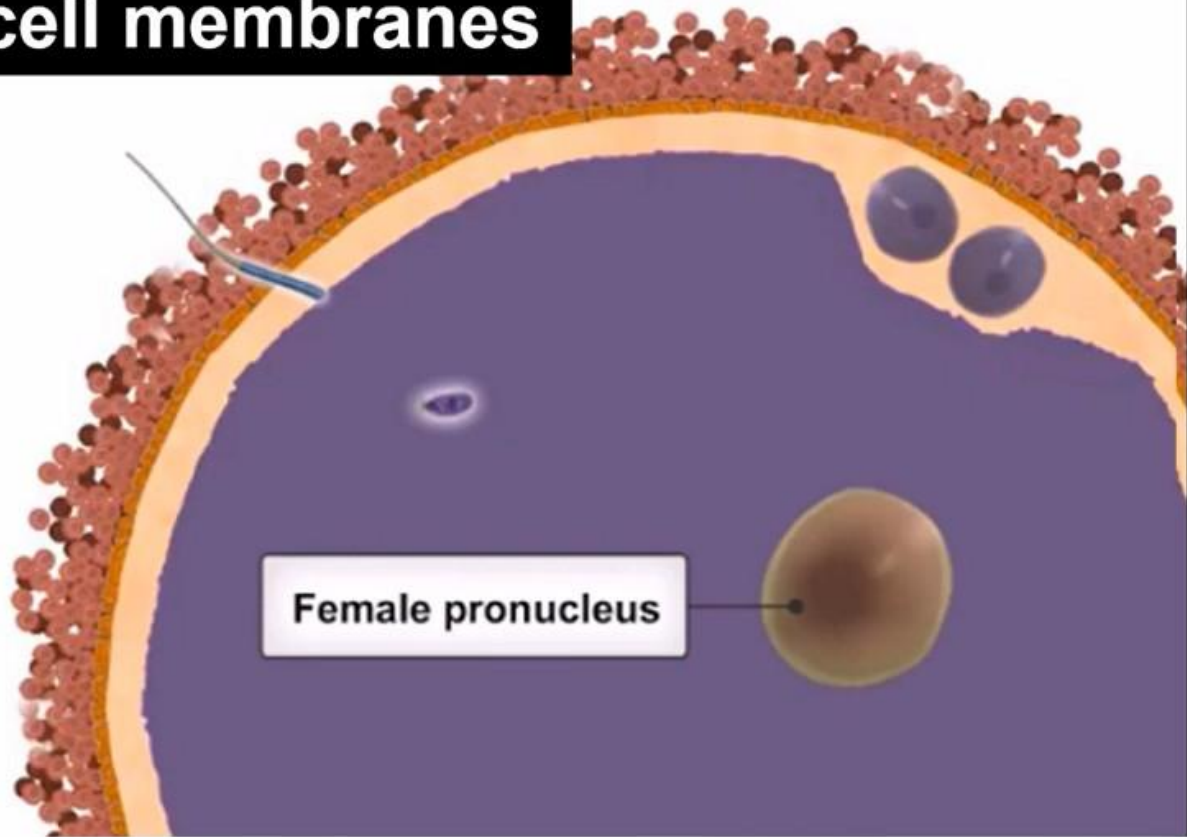
Penetration of the Zona Pellucida

- **Penetration of the zona pellucida** by the **zona lysine enzyme** and **trypsin like enzyme** of the sperms.
- **Zona reaction:** After penetration of the sperm, the zona pellucida changes its **chemical composition** to prevent entry of other sperms.



Fusion of gametes cell membranes

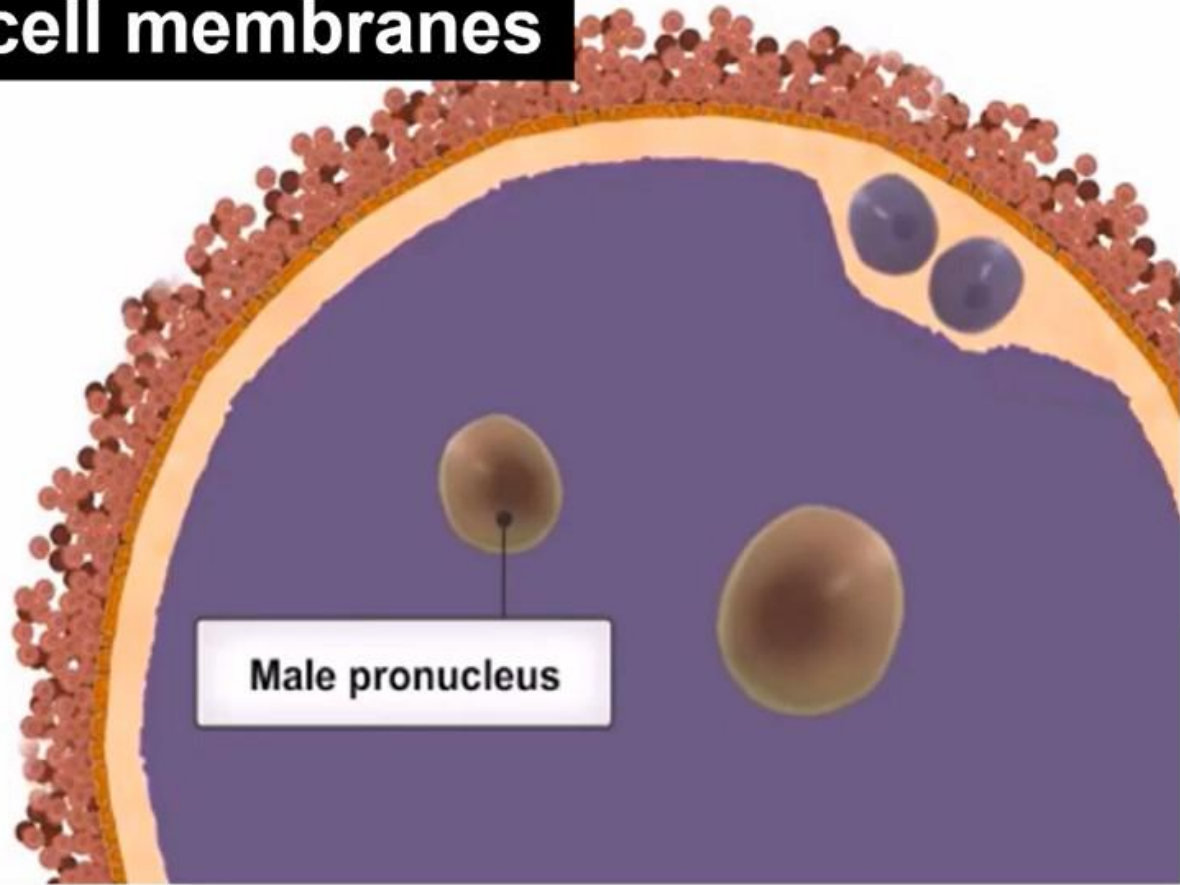
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- Cortical reaction:** after penetration of the sperm to the cell membrane of the $2n$ oocyte, It alters its **chemical composition** to prevent entry of other sperm.
- The $2n$ oocyte completes the **2nd meiotic division** giving rise to definitive **ovum** and 2nd polar body. The nucleus of the ovum enlarged to form **female pronucleus**.

Fusion of gametes cell membranes

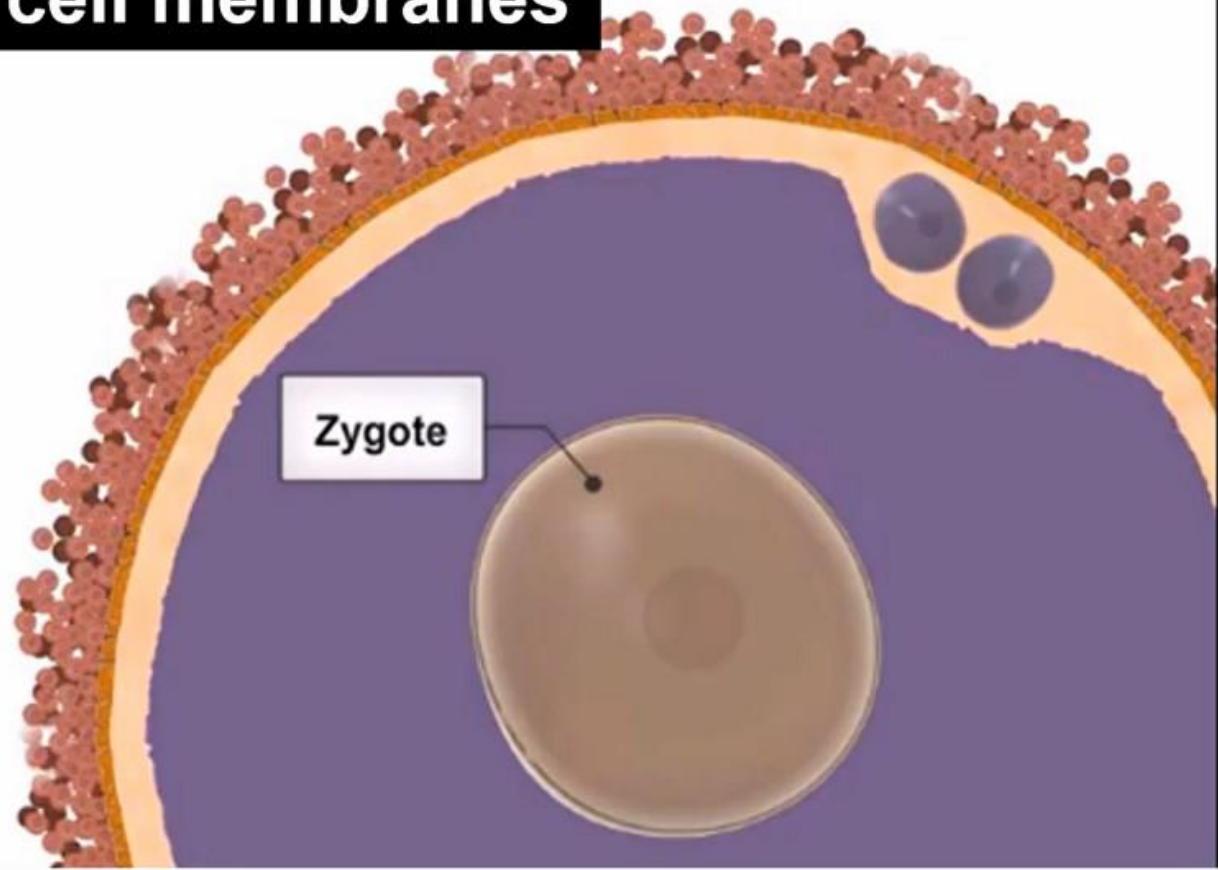
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Only one sperm penetrates the ovum. **The head of the sperm swells and forms the male pronucleus**

Fusion of gametes cell membranes

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- Both male and female pronuclei become in contact with each other and fuse together to form the **zygote** (46 chromosomes).

Results of Fertilization

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- **Formation of zygote.**
- **Restoration of diploid number (46 chromosomes).**
- **Cleavage (segmentation) starts.**
- **Determination of sex.**
- **Determination of general features** by the autosomes chromosomes.
- **Inhibition** of further ovulation and menstrual cycles

- Mitosis (cell division) in the new zygote uses **centrioles derived from the sperm** but the **oocyte has no centrioles**.
- The **sperm's mitochondria** degenerate with the formation of the male pronucleus.
- **SO, all mitochondria in humans are of maternal origin.**

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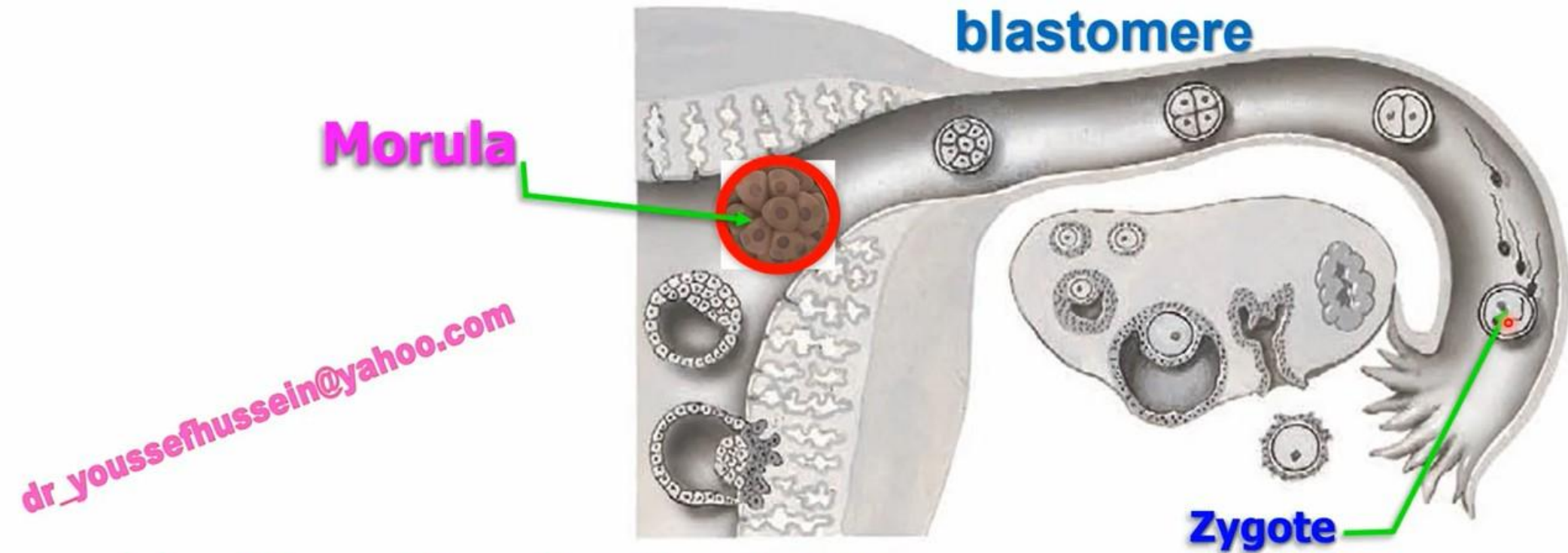


The first week



Cleavage (Segmentation)

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- **Segmentation (Cleavage) Formation of morula** التوتية
 - The **zygote** divides repeatedly by **mitotic divisions** leading to an increasing number of cells.
 - **Blastomere** is a type of cell produced during cleavage after fertilization and is essential for formation of the morula
 - **Morula is a solid mass and formed of 16 cells surrounded by zona pellucida.**
 - The morula reaches the uterine cavity at the **3rd - 4th days** after fertilization.

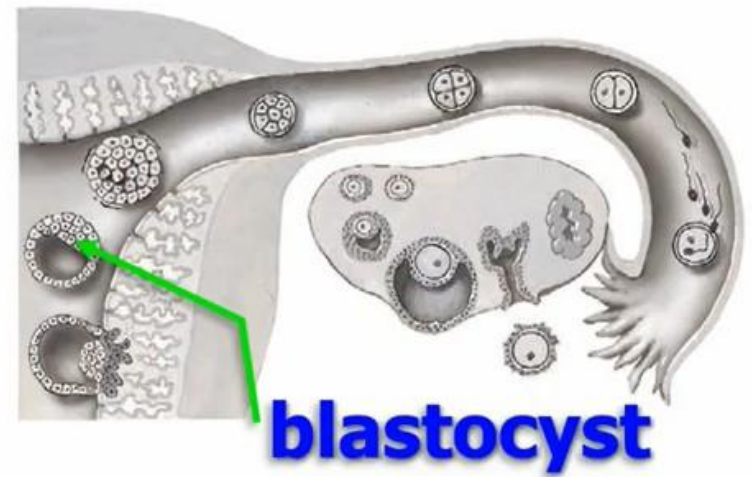
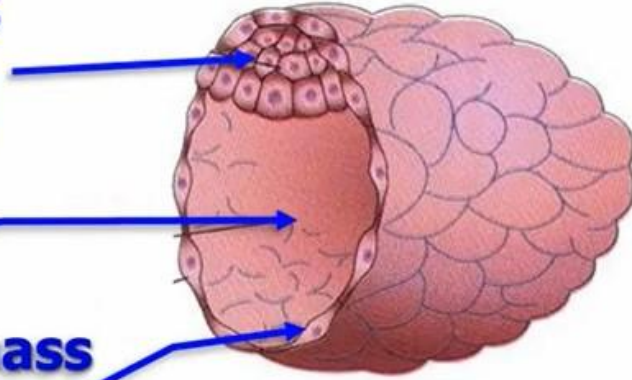
Formation of Blastocyst

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**Inner cell mass
(Embryoblast)**

Blastocele

**Outer cell mass
(Trophoblast)**



- **Formation of blastocyst**

- The **blastocyst** (cystic structure) is formed at the **5th days** after fertilization.
- The cells of the morula rapidly proliferate and forming a large number of cells.
- Fluid collects between the cells and form a single cavity called **blastocele**
- The blastocyst is divided by blastocele cavity into;
 - a- **Outer layer** of flat cells called **trophoblast** that forms the **placenta**.
 - b- **Inner** cell mass (**embryoblast**). This mass will form the **embryo**.

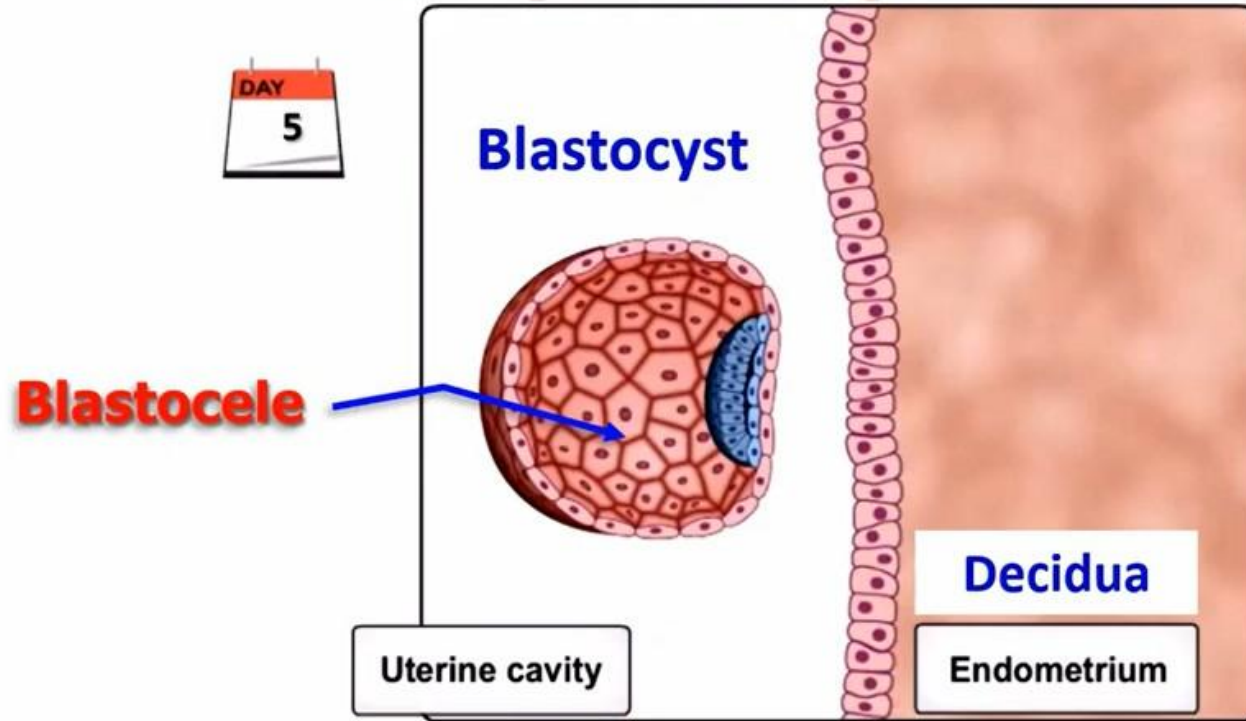
Implantation

Implanted blastocyst



- **Definition:** It is the entrance of the **blastocyst** into the thick endometrium of the uterus (**decidua**) .
- **Site of implantation:** into the middle of the upper part of the posterior wall of the uterus.
- **Timing:** Starts at **6th - 8th day** and completed at **11th day**.

Steps of implantation

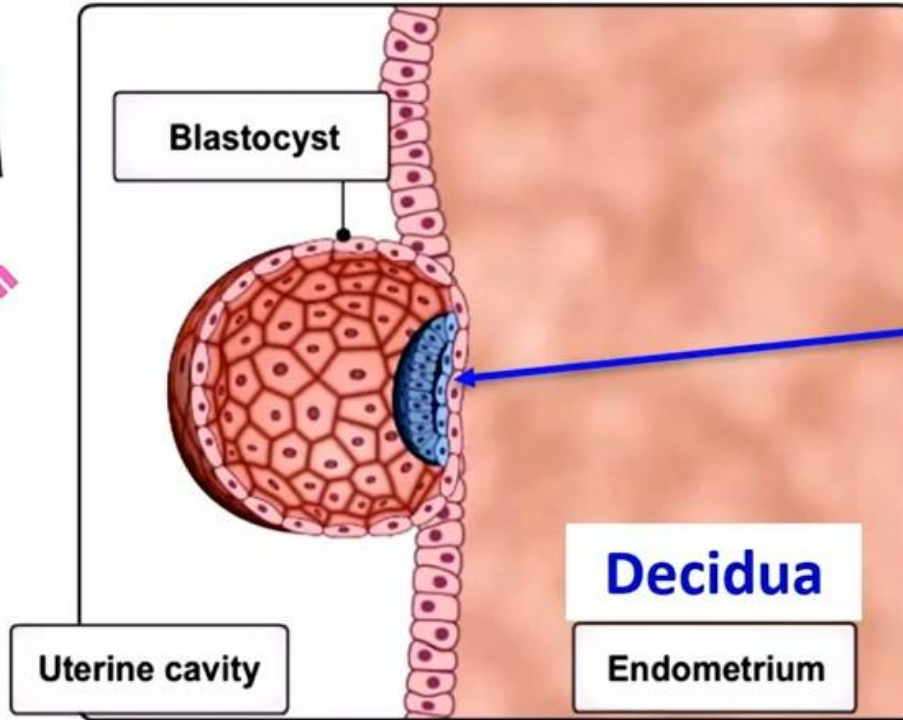


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1- Rupture of the zona pellucida around **blastocyst** due to increase amount of fluid in the blastocele cavity

Steps of implantation

DAY
6



Trophoblast

Decidua

Endometrium

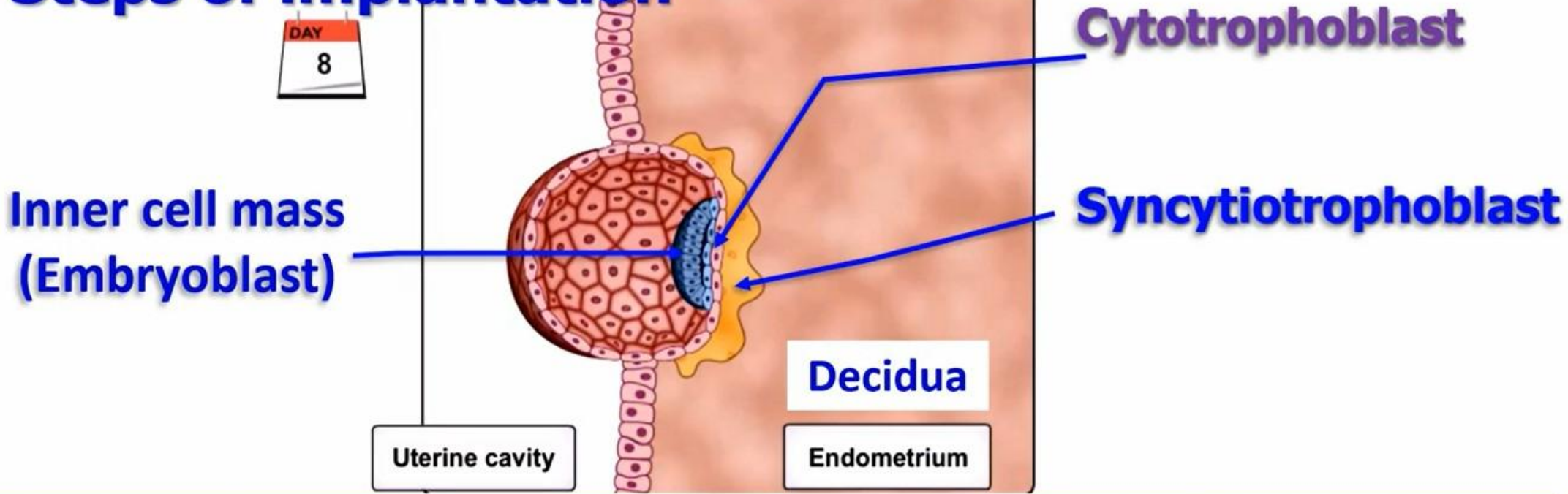
Uterine cavity

Blastocyst

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2- The **trophoblast** (outer layer) of the blastocyst **adherent** to the endometrium (**decidua**) .

Steps of implantation

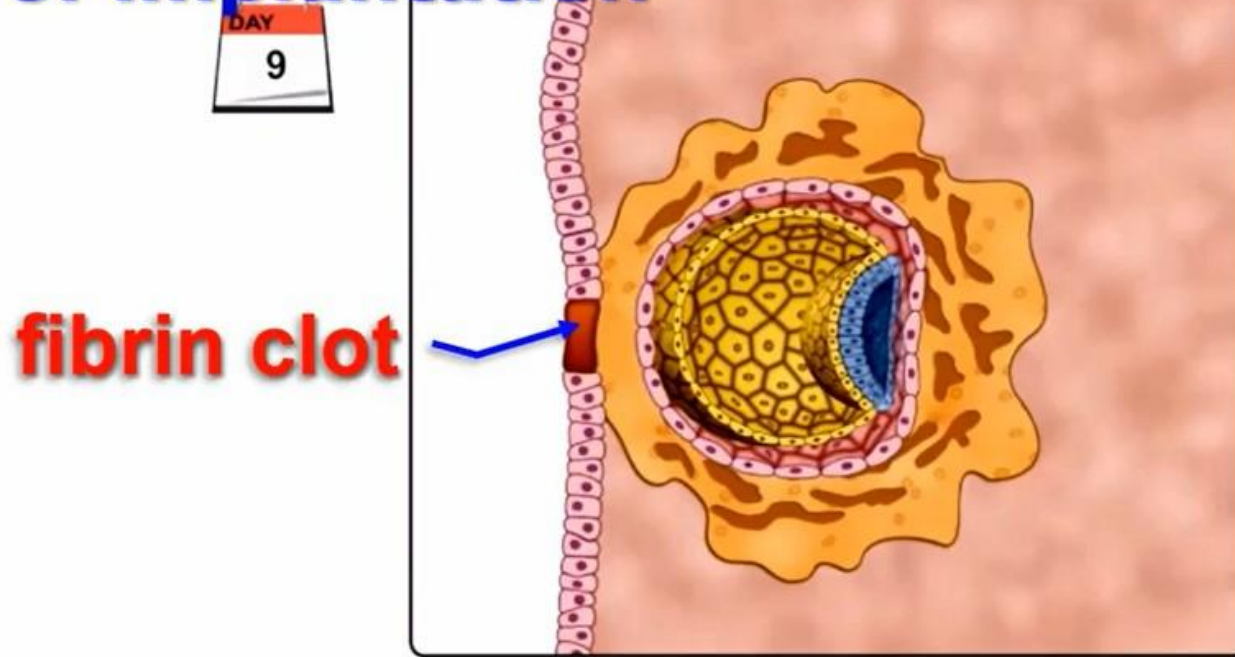


3- The trophoblast covering the inner cell mass **adherent** to the endometrium, and differentiates into **2 layers**: **1)** An inner layer called **cytotrophoblast**.

2) An outer layer called **syncytiotrophoblast**.

- The syncytiotrophoblasts have a **phagocytic** function.
- They **erode** the endometrium (**decidua**) and gradually **sink** into it at the side of embryoblast.

Steps of implantation



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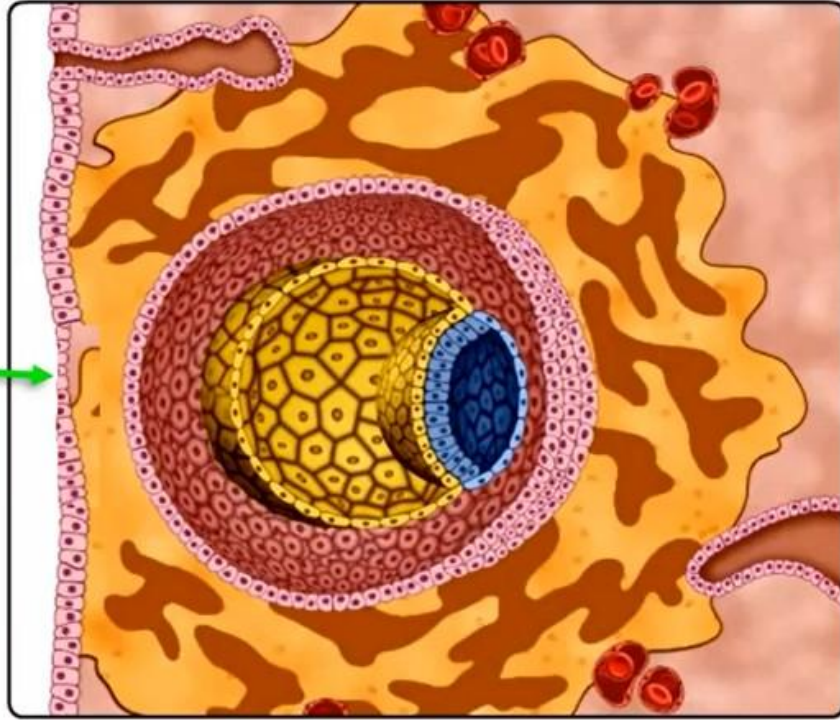
4- The **blastocyst** becomes completely embedded into the endometrium (**decidua**) .

- The site of implantation is closed by a **fibrin clot**.

Steps of implantation



Surface epithelium covers the original defect



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5- By the 11th to the 12th day of development, **the blastocyst is completely embedded in the endometrium (decidua)** and the surface epithelium covers the original defect in the uterine wall

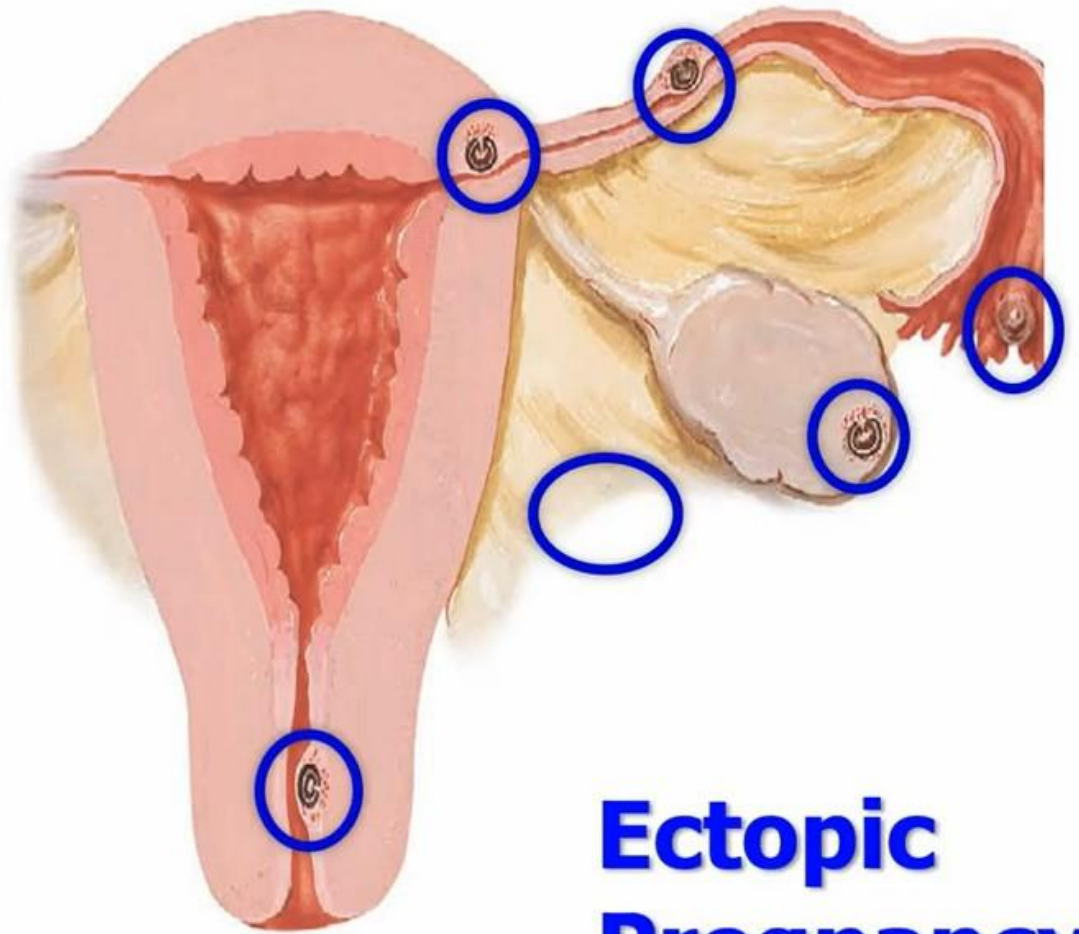
Abnormal implantation

(1) Intrauterine abnormal implantation:

- Implantation at any site rather than the normal site
- In this case, the placenta is called **placenta previa**.

(2) Extra uterine abnormal implantation (ectopic pregnancy):

- 1- Tubal pregnancy (uterine tube).
- 2- Ovarian pregnancy (in ovary).
- 3- Peritoneal cavity.



**Ectopic
Pregnancy**