

Ovulation :

- Ovulation begins in females around the age of 12.
- Ovulation occurs at the **14th day** of the female reproductive cycle under the influence of **LH**.
- The secondary oocyte is released by the ovary into the uterine tube in anticipation of fertilization and stays viable for **relatively 24 hours**.
- Secondary oocytes are covered by 2 layers :
 - Corona Radiata
 - Zona Pellucida
- The secondary oocyte aims to reach the uterine cavity (**endometrium**) while still in the **secretory phase**.

Fertilization :

❖ **Definition :** The process by which haploid male gametes and haploid female gametes unite to give a diploid nucleus known as Zygote.

❖ **Date of occurrence:** Normally 12 - 24 hours after ovulation.

➤ From the 300 million sperm cells ejaculated, only 300 reach the uterine tube (the **ampulla** is the most common site for fertilization) and only **one** will fertilize the secondary oocyte.

➤ The trip from the cervix to the uterine tube needs a **minimum of 2 -7 hours**.

➤ The sperm cells then need **another 7 hours** to adapt to the new environment of the female genital tract in a process called **Capacitation**.

- **Capacitation :** Epithelial interactions between sperm and mucosal surface of the uterine tube.

➤ According to the professor, in the case of non-mutual affection between couples, conditioning (Capacitation) won't happen. Also, pregnancy cannot occur because the female body thickens the mucosal surface, slowing down the speed of sperm cells.

- There are 3 phases to fertilization :
- 1 - Penetration of Corona Radiata
 - 2 - Penetration of Zona Pellucida
 - 3 - Fusion of membranes



According to the professor, the phases are :

1- Capacitation

2- Penetration of Zona Pellucida

3 - Fusion of membranes

Phase	Events
Penetration of the Corona Radiata	<ul style="list-style-type: none"> • Only capacitated sperm can penetrate Corona Radiata and undergo acrosomal reaction
Penetration of the Zona Pellucida	<ul style="list-style-type: none"> • Zona Pellucida has receptors that have a type of glycoprotein called Zona Pellucida 3 (ZP3) • Once inside the Corona Radiata, the sperm binds to the species-specific ZP3 receptor on the egg's glycoprotein coat. This triggers the acrosomal reaction, or the release of enzymes stored in the sperm's acrosome (e.g. Acrosin). These enzymes help the sperm "drill through" the Zona Pellucida.
Fusion of membranes	<ul style="list-style-type: none"> • Both the head and the tail of the sperm cell enter the cytoplasm of the oocyte, but the plasma membrane is left behind on the oocyte surface. • The tail degenerates in the cytoplasm so that we are left with a head only. • The sperm's nucleus becomes swollen and forms the male pronucleus. • The two gametes contact and their membranes fuse.

- ❖ After the fusion of cell membranes, the oocyte will respond by :
 - The oocyte's membrane changes structure to prevent Polyspermy (Penetration of more than one sperm into the oocyte) through :
 - **Depolarization** of the cell's membrane (Closing the door)
 - **Inactivation of ZP3** (Closing with a key)
 - Resumption **of second meiotic division** to produce a female pronucleus (**Remember** that the secondary oocyte was previously arrested in the metaphase of the second meiotic division)
 - **Metabolic activation** of the oocyte
- ❖ Results of Fertilization :
 - Restoration of the **diploid number** of chromosomes (46)
 - Stimulation of the secondary oocyte to **complete meiosis**
 - **Determination of the sex** of the new individual
 - **Initiation of cleavage** division about **24 hours after** fertilization

Cleavage :

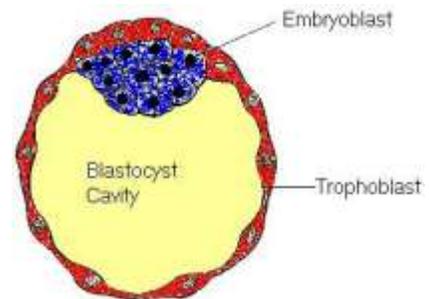
- Nuclear membranes contact and **fuse** in order to give one nucleus (**Zygote**).
- Male and female chromosomes **intermingle** to give a **diploid** zygote.
- Division will continue through **mitosis**.

Time (Fertilization as reference)	Number of Cells/Blastomeres	Notes
About 24 hours later (Day 1)	1	Called a zygote
About 48 hours later (Day 2)	2	Usually referred to as the "Two-Cell Stage"
About 72 hours later (Day 3)	16	Tightly connected cells form a compacted ball of cells held together by tight junctions and called "Early Morula"
Day 4	32	Usually referred to as "Late Morula" and it reaches the proximal end of the uterine tube

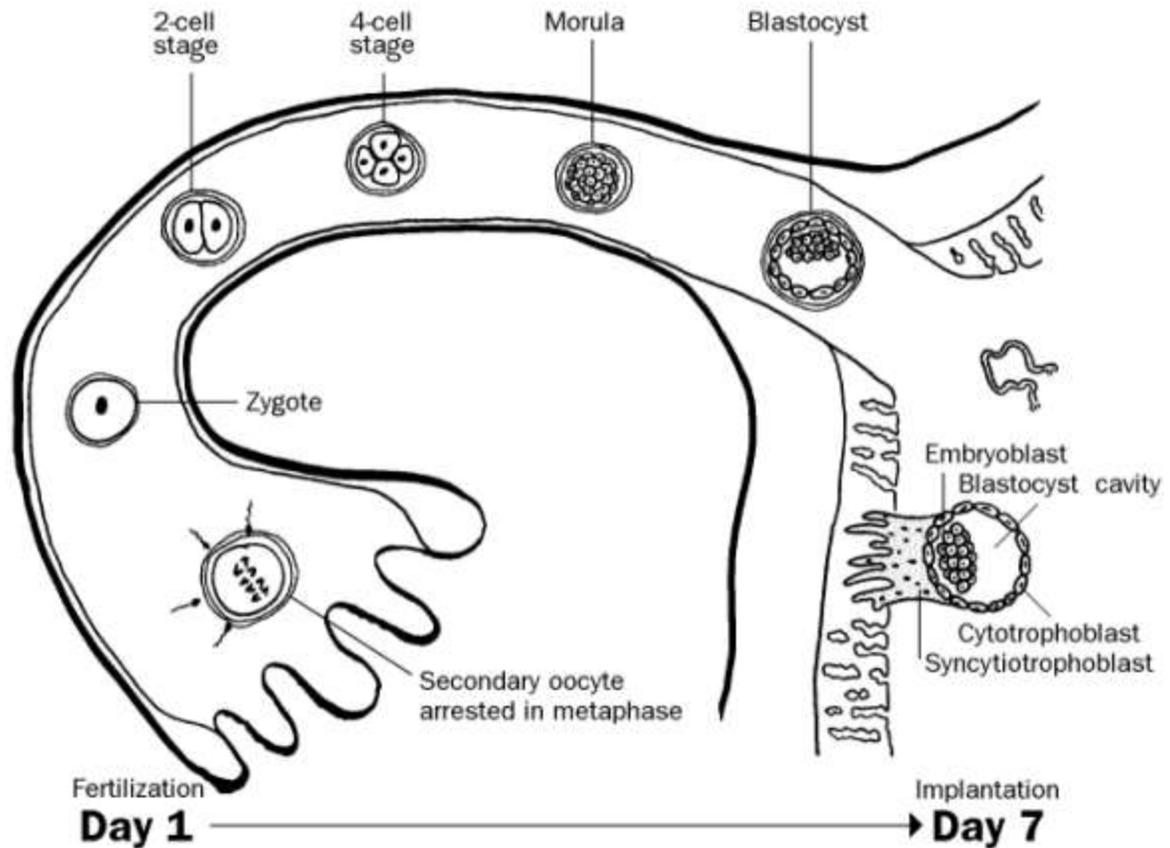
- ✓ Blastomeres are the cells resulting from the division of the zygote.
- ✓ Only the **number** of the cells in the zygote changes, **not the size** because every new cell formed is **half the size of its parent cell**.
- ✓ Morula means **mulberry**, it is called thus because of its **shape**.
- ✓ Until the eighth-cell stage, Blastomeres form a **loosely arranged clump**.
- ✓ After **three** divisions, Blastomeres undergo **compaction** to become tightly grouped ball of cells with inner and outer layers.

- By the time the Late Morula **enters the uterine cavity** (*Day 5 of fertilization. Day 20 or 21 of female reproductive cycle*), **fluids begin to penetrate** through it and enter between the cells (It's now called a **"Blastocyst"** because it has a cavity and **"Wandering/Free Blastocyst"** because it's looking for the best place to implant itself) then it separates them into :

- **Outer cell mass** : Also called **"Trophoblast"** as it **provides nutrition** and will give rise to the **placenta** after implantation.
- **Inner cell mass** : Also called **"Embryoblast"** as it will give rise to the **embryo**.

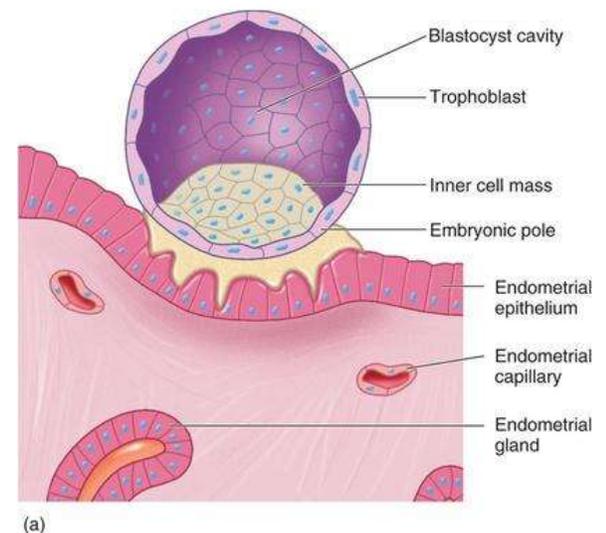


- Once the L. Morula enters the uterine cavity, it **sheds its Zona Pellucida** and replaces it by the Trophoblast to **prepare the blastocyst for implantation**.



Implantation :

- Early implantation usually occurs at **day 6 or 7 of fertilization**.
- The Trophoblast at the embryonic pole **extends finger-like projections into the endometrium** (Penetrates the Mucosa and underlying tissue).
- This penetration can sometimes be bleeding (Tiny drops) that can be mistaken for a menstrual cycle but is actually not and is called "**Show of Pregnancy**".
- Full implantation finishes **after 14 days**.



*Advices to give to women trying to get pregnant in order to help with the **implantation of the free Blastocyst in the posterior wall of uterus** :*

- *Avoid walking*
- *Avoid standing up for too long*
- *Avoid carrying heavy things*
- *Lay in bed on you back*

*Causes for **repeated miscarriages** :*

- *Excessive movement and heavy-lifting.*
- *Incomplete shedding of Zona Pellucida*
- *Incomplete implantation*

Ectopic Pregnancy :

- **Definition** : The blastocyst implants in a location other than the uterus.
- **Most common place** : **95 %** of ectopic pregnancies occur in the upper and middle parts of the uterine tube (**Fallopian channel**), this is called Tubal Implantation.
 - Usually happens because the embryo lost its Zona Pellucida prematurely.
 - Must be extracted immediately or it **will cause profuse bleeding** since the finger-like extensions of the Trophoblast will penetrate through its tissue.
- Can also occur in the **ovary** If the secondary oocyte was **never released**
- **Placenta Previa** : The embryo implants in the lower part of the uterus towards the cervix (**Internal os**). This makes it easy for the placenta to tear, and the mother can die from **hemorrhage**, or the placenta may grow to obstruct the cervical canal. This is diagnosed with ultrasound, and the baby is delivered via **Cesarean section**.
- **Pregnancy in the abdominal cavity** : Probably caused by defect in **egg capture process**. Rarely, an asymptomatic ectopic fetus can die and calcify to become a Lithopedeon ("stone baby").

Great Luck on Saturday ☺



Feel Good Test:

1. A secondary oocyte is developing normally. At which of the following times does the second maturation division of meiosis become completed?
 - A. In the ovarian cortex
 - B. During ovulation
 - C. At fertilization**
 - D. In the blastocyst
 - E. Upon implantation
 - F. Placentation
2. True regarding fertilization is/are :
 - A. Occurs in ampulla of Fallopian tube
 - B. Ovum is viable for 24 hours after ovulation
 - C. Second polar body forms after fertilization
 - D. Induces chemical changes in Zona Pellucida, preventing Polyspermy
 - E. All of the above**
3. The most correct sequence of early development following fertilization is:
 - A. zygote, Blastomeres, morula, blastocyst**
 - B. oocyte, zygote, morula, blastocyst
 - C. zygote, conceptus, blastocyst
 - D. polar bodies, zygote, conceptus, blastocyst
 - E. None of the above
4. Once an egg cell has been fertilized, it prevents other sperm cells from reaching it by changing :
 - A. Their motility
 - B. The pH of the female genital tract
 - C. The number of tight junctions between the granulose cells that surround it.
 - D. the viscosity of its Zona Pellucida.**
5. _____ is cell division without growth.
 - A. Conjugation
 - B. Fertilization
 - C. Cleavage**
 - D. Development
 - E. Differentiation
6. In the lancelet, the zygote undergoes cleavage forming a solid ball of cells of uniform size, called:
 - A. Morula**
 - B. Blastula
 - C. Gastrula
 - D. Zygote
 - E. Two-cell stage
7. After how many days of ovulation embryo implantation occurs?
 - A. 3 - 5 days
 - B. 7 - 9 days**
 - C. 10 - 12 days
 - D. 13 - 15 days
 - E. 24 hours

