Chapter 02: Embryogenesis

Pregnancy and embryonic development are the complex series of events that allow a single cell to become a human being.

Terminology of embryogenesis
• **Embryogenesis:** Embryogenesis corresponds to the development of the individual from the zygote stage (after fertilization) until its birth or hatching, in animals, or until germination, for plants. • **Pregnancy:** All the events that take place between fertilization and the birth of the child. • **Product of conception:** A child developing within the body of a pregnant woman • **Gestation period:** The period of development of the product of conception. This is the interval between the last menstrual period and delivery. It lasts approximately 280 days (40 weeks/9 months).
The name of the design product evolves according to the development
• **Zygote:** or fertilized egg at the time of fertilization • **Embryo:** name given to the product of conception of fertilization at the 8th week, we speak of the "embryonic period" • **Fetus:** name given to the product of conception between the 9th week and birth, we speak of the fetal period • **Baby:** affectionate name given to a 9-month-old fetus ready to be born or newborn.

Part 01: Fertilization

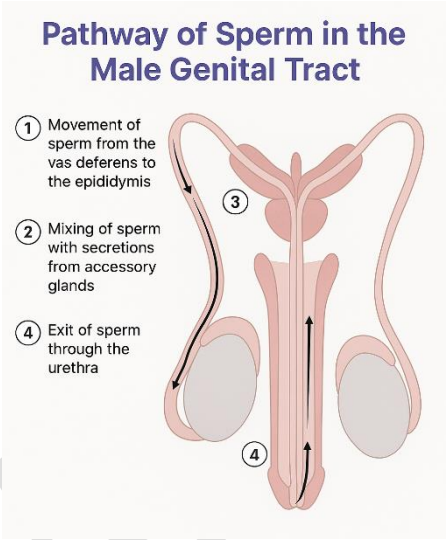
1. **Definition:** It occurs when the chromosomes of a sperm fuse with those of an egg to form a fertilized egg or zygote. The zygote is the first cell of each individual

For fertilization to be possible, the sperm must reach the second-order oocyte. This oocyte is viable for 12 to 24 hours after its expulsion from the ovary. Beyond this period, the probability of pregnancy is almost zero. Thus, for fertilization to be possible, several conditions must be met.

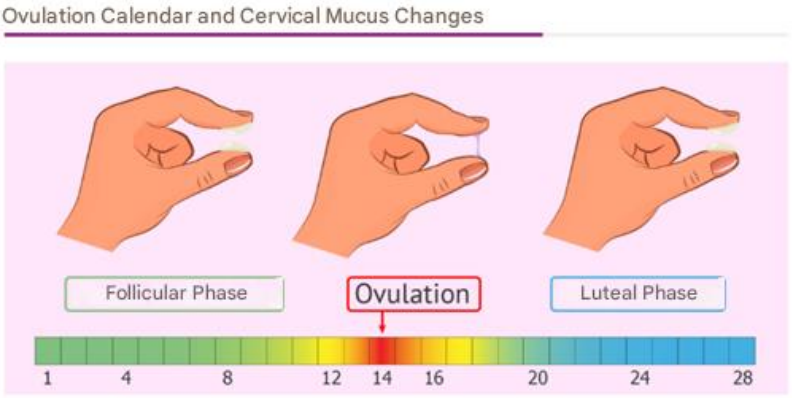
2. Phenomena before fertilization:

2.1. Before fertilization: In male

- From the testicle, sperm travel through the genital tract (epididymis, vas deferens, ejaculatory duct and urethra).
- During this journey, they mix with secretions from the accessory glands (seminal vesicles and prostate), the whole constituting sperm.
- During this journey, the spermatozoa acquire their mobility, but they are rendered unfit for fertilization (decapacitation) during their epididymal transit .
- During sexual intercourse, at the time of ejaculation, 2 to 5 cm3 of sperm are deposited in the woman's genital tract, i.e. 100 to 200 million spermatozoa, some of which are near the external orifice of the cervix.

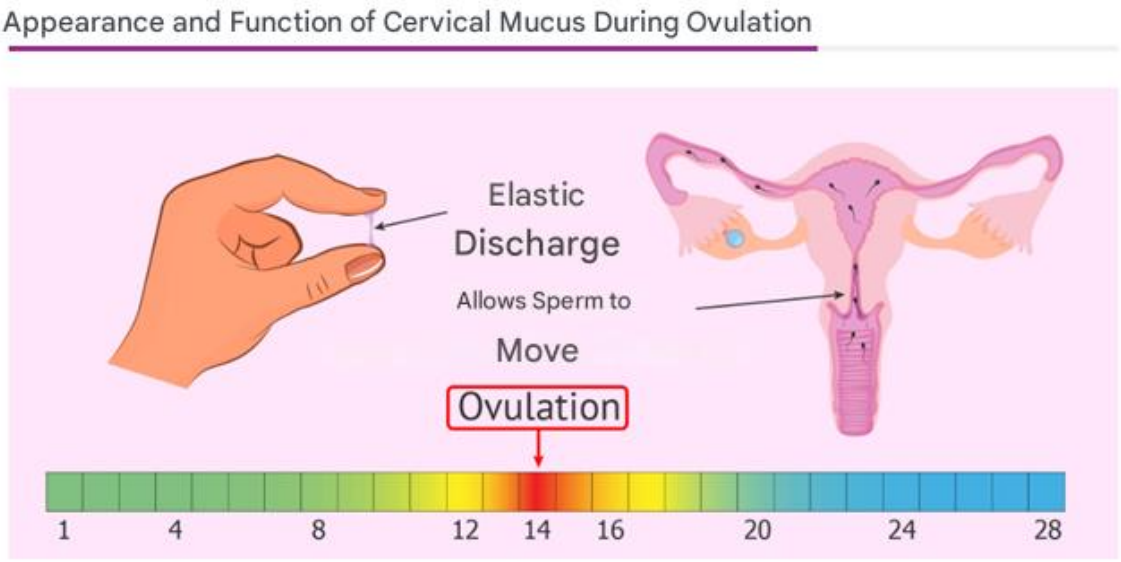


2.2. Before fertilization: In women



At the cervix: a few days before ovulation, the cervical glands (endocervix) secrete a mucous cervical mucus.

This mucus protects the sperm located at the external orifice of the cervix from vaginal acidity and facilitates the migration of sperm that move due to their own mobility (flagellum). Migration will be facilitated if the mucus has a low viscosity (rich in water) and an alkaline pH.



3. Conditions of fertilization

- Ejaculation reaching the cervical orifice and of good quality: normal viscosity of seminal fluid
- Aseptic sperm (absence of infection in the male genital tract)
- Sperm at normal pH (7 to 8.7)
- Number and quality of spermatozoa (40 to 100 million/cm3)
- Cervical mucus of good viscosity and alkaline pH
- Intercourse-ovulation interval less than 3-4 days
- Tubal patency (absence of infection of the female genital tract).

4. Stages of fertilization:

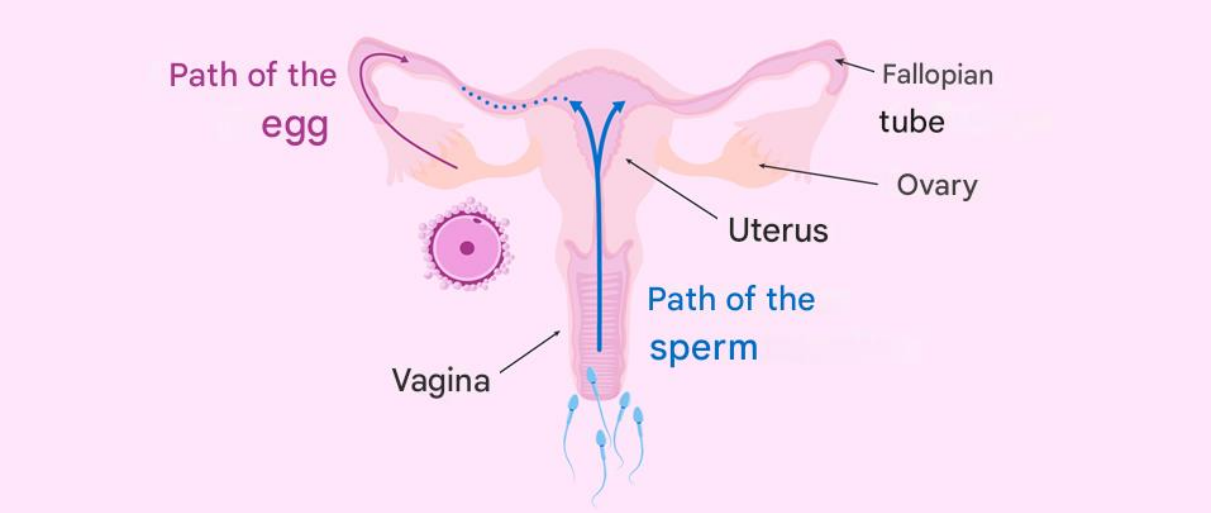
The sperm must reach the second-order oocyte. The oocyte is viable 12 to 24 hours after its expulsion from the ovary and the sperm retain their fertilizing power 24 to 48 hours after ejaculation. To allow fertilization, sexual intercourse must take place at the earliest 2 days before ovulation and at the latest 24 hours after.

4.1.Sperm transport

During ejaculation, hundreds of millions of spermatozoa enter the vagina at high speed. Most of them do not reach the egg, which is 12 cm away. Of the hundreds of millions of spermatozoa contained in the ejaculate, only a few thousand, sometimes barely a hundred, reach the fallopian tubes because they encounter several obstacles:

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- Sperm flow without being deposited
- Destruction by acidic vaginal environment (sperm pH 7/vaginal pH 3-4)
- Cervical mucus too thick
- Destruction by phagocytes of the endometrium (immune system).



4.2.Sperm capacitation

Sperm that have reached the vagina are unable to penetrate the oocyte. They must undergo a "capacitation" lasting 8 to 10 hours, caused in part by contact with estrogens. Cervical mucus allows the elimination of decapacitation proteins that cover the sperm as well as the loss of membrane cholesterol that will fluidify the plasma membrane.

This mechanism helps prevent early release of acrosomal enzymes that could cause autolysis and self-digestion of the male genitals.

Capacitation thus allows for improved mobility and weakening of the membrane to allow the release of enzymes from the acrosome. Even if the sperm reaches the oocyte in a few minutes it must wait for capacitation to occur.

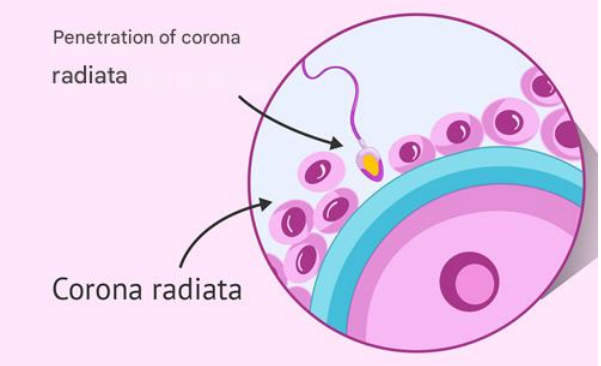
4.3.How does the sperm find the egg?

This question is the subject of much research. One hypothesis suggests that the sperm has olfactory receptors and that the egg releases chemical signals. In this way, the sperm would be able to "smell" the egg and let itself be guided to find it.

4.4.The meeting

The mechanism of union between the egg and the sperm seems very simple, however several processes and transformations of the two gametes must occur for fertilization to take place.

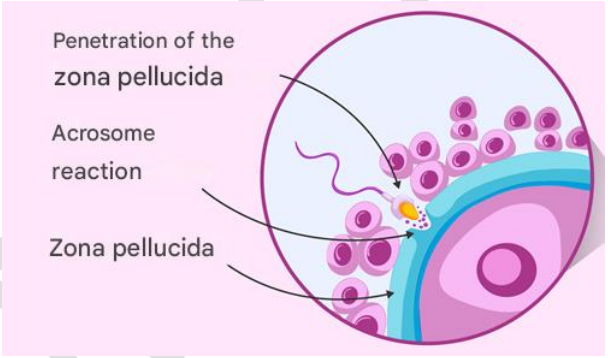
- **Penetration of the "corona radiata "**



The fertilization process begins with the penetration of sperm into the layer of follicular cells that surround the oocyte: *the corona radiata* .

Sperm pass through this group of cells thanks to the release of hyaluronidase enzymes and the movements of their flagellum (the tail of the sperm).

- **Recognition between gametes**

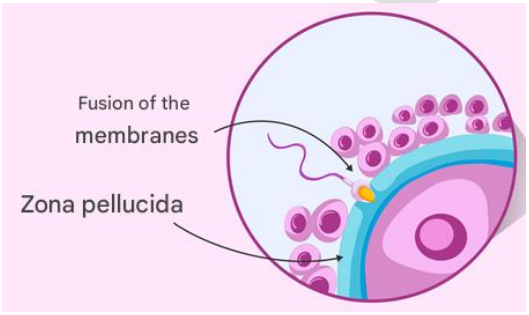


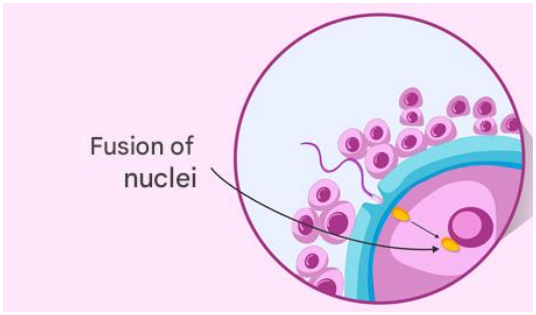
Sperm bind to receptors located in the zona pellucida . The acrosome reaction occurs. The acrosome releases its enzymatic contents (acrosin) which locally hydrolyzes and liquefies the zona pellucida.

Adhesion and fusion of the plasma membranes of two gametes occurs and the spermatozoon infancy in the oocyte cytoplasm.

- **Fusion of the Pronuclei**

The pronuclei are the nuclei of gametes, which contain half as many chromosomes as the nuclei of other cells in the body due to meiosis. Once the male and female pronuclei are formed, the maternal and paternal chromosomes become visible and are arranged together to give rise to the nucleus of the zygote.





5. Consequences of sperm penetration

periovular fluid under the zona pellucida, constituting a space around the oocyte separating the oocyte from the zona pellucida.

The content of the granules seems to modify the composition of the zona pellucida and could explain the blocking of spermatozoa present in the periphery, the zona pellucida would thus ensure the control of monospermia.

An activation of the cytoplasm accompanies this cortical reaction: metabolisms increase with in particular a notable synthesis of RNA

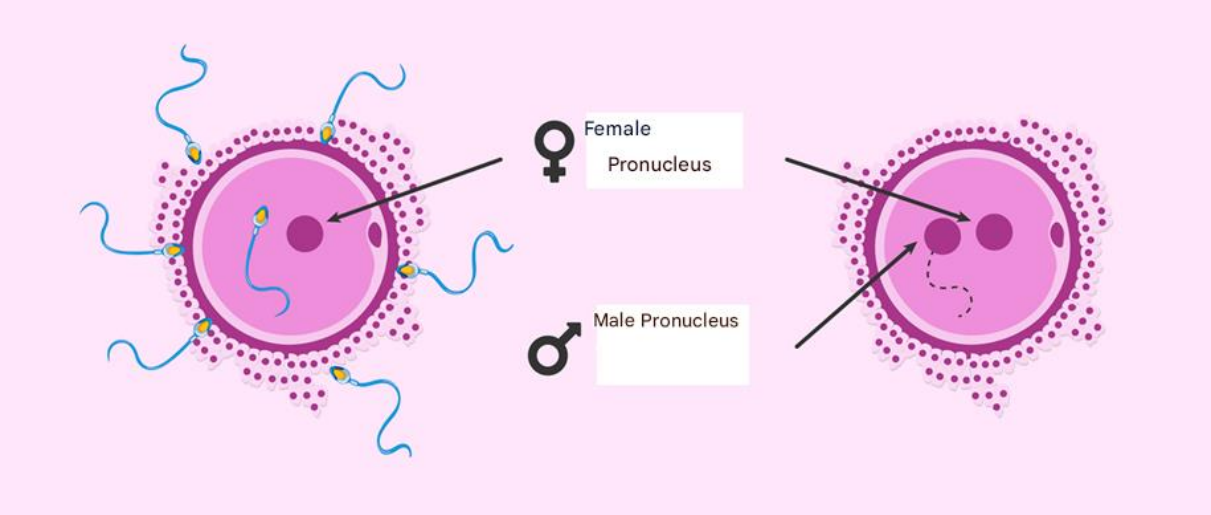
An influx of Ca2+ causes meiosis to resume with the completion of the second division and the expulsion of the 2nd polar body. The sperm nucleus swells and transforms into the male pronucleus and the egg nucleus swells and transforms into the female pronucleus.

The two nuclei come closer together and the mitotic spindle is established. The membranes of the nuclei are broken, thus releasing the chromosomes: This is *FERTILIZATION*

6. Amphimixis (karyogamy)

- Amphimixis or karyogamy results from the fusion of the pronuclei, it marks the completion of fertilization and resembles cell division. The two pronuclei come closer together.
- From the proximal centriole of the spermatozoon the spindle elements develop.
- In each pronucleus, decondensation and replication of DNA occur, the chromosomes become individualized.
- The membranes of the pronuclei disappear and the split chromosomes group together in an equatorial plate in the center of the spindle, while the polar globules are placed perpendicular to the spindle axis.

The chromosomes reach each of the spindle poles where a cell is reconstituted. This results in the formation of an egg or zygote with two cells called blastomeres.



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