

# Fertilization

## Introduction

By **fertilization** we mean the union of egg and sperm. It most often occurs in the area of the ampulla tubae uterinae at the time of ovulation (days 12 - 16 of the cycle). The egg is capable of fertilization only 10-12 hours after ovulation (release from the follicle).

Sperm can last in the female reproductive system for several days, thereby increasing the probability of fertilization. They move through the female reproductive system with the help of **flagellum**, but they are significantly helped by the **muscle contractions** from the surroundings.



## Basic reaction necessary for fertilization

- Capacitation

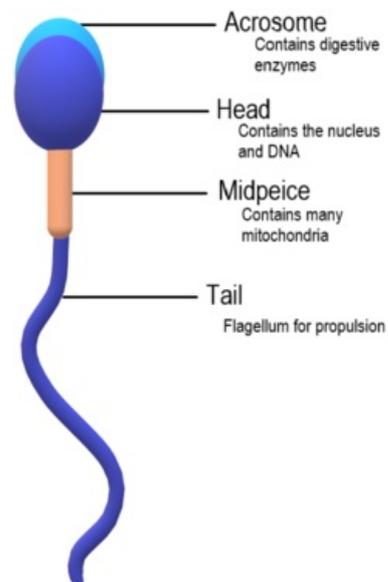
*A change in the properties of the sperm cell membrane, allowing sperm to bind to the zona pellucida. It is the result of the removal of the remains of seminal plasma during passage through the female genital tract.*

- Acrosomal reaction

*Fusion of outer and inner acrosomal membrane and spillage of acrosomal enzymes. It is the result of the interaction between sperm and cumulus oophorus, or zona pellucida.*

- Zone reaction

*It takes place after the penetration of the sperm into the oocyte. Enzymes from cortical granules alter the properties of the zona pellucida.*



Sperm anatomy

## Fertilizations phases

### 1st phase - penetration of the corona radiata

Of the 200-300 million sperm in the vagina, only 300 to 500 reach the egg. Only a single sperm fertilizes the egg, the others help break down the egg's protection. Only those sperm that have undergone *capacitation* are able to overcome the corona radiata.

### 2nd phase - penetration of the zona pellucida

The zona pellucida is *glycoprotein* covering of the egg. It allows the sperm to attach and indicates the start of the acrosomal reaction. The enzyme **acrosin** will allow the sperm to pass through the zona. As soon as the sperm touches the oocyte, the **zona reaction** begins.

### Zona reaction

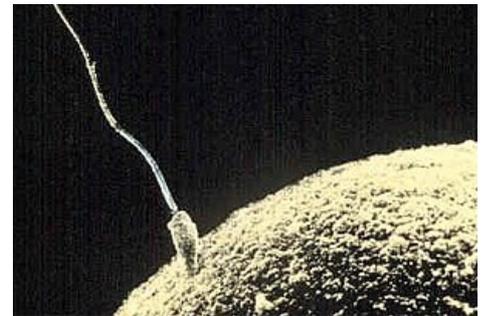
After the contact of the sperm and the oocyte, the contents of the so-called cortical granules are poured into the space between the zona and the membrane of the oocyte. The enzymes contained in them change the physical properties of the zona pellucida. They inactivate specific receptors for spermatozoa on the surface of the zona pellucida. This ensures that only one sperm penetrates the egg, other sperm remain *inactive in the zona pellucida* or do not penetrate the zona at all (block against polyspermy)

### 3rd phase - fusion of oocyte and sperm

First, *membrane integrins* begin to interact and **adhesion** of both cells occurs. Then the two membranes *fuse*. At this stage, the sperm attaches "sideways" to the oocyte, because after the capacitation it lacks the membrane above the acrosome, which is needed for adhesion. In the next phase, the head and flagellum of the sperm insert into the oocyte, but the sperm membrane remains outside.

The oocyte responds to these reactions with **the zonal reaction** (protection against polyspermy), **the resumption of the second meiotic division** (it completes it as soon as the sperm enters and forms the female pronucleus) and **the metabolic activation of the egg** (the activating factor arrives with the sperm). Mitochondria, which the sperm will bring to the egg during fertilization, are actively eliminated.

Meanwhile, the spermatozoon approaches the female pronucleus, its nucleus enlarges and forms *the male pronucleus*. The sperm flagellum *degenerates*. During pronuclei growth, their DNA is replicated and they organize as in mitosis.



A sperm cell fertilizing an egg cell

## Fertilization results

- Restoring the diploid chromosome number.

*The zygote contains half of the chromosomes from the father and half from the mother, its chromosome combination is different from both parents.*

- Determining the sex of a new individual.

*Depending on whether the sperm carries a Y or X chromosome.*

- Cleavage initiation.

*Without fertilization, the oocyte would degenerate within 24 hours after the ovulation.*

The fusion of the nucleus of the egg and the nucleus of the sperm creates a *zygote*. The zygote divides by cleavage into a multicellular structure (*morula*), further division produces a *blastula*, which travels through the fallopian tube into the uterine cavity. The mucous membrane of the uterus is in the secretory phase ready for its nesting = nidation - this occurs around the 5th - 7th day after fertilization. The embryo develops from the germinal plate; placenta and fetal membranes develop from surface cells.

## Links

### Related articles

- In vitro fertilization
- Stages of embryo and fetus development
- First week of human development
- Cleavage of the egg

### External links

- Fertilization (english wikipedia)

### References

- SADLER, T. W - LANGMAN, Jan. *Langman's medical embryology*. 11. edition. Lippincott Williams & Wilkins, 2010. 383 pp. ISBN 978-0-7817-9069-7.