

CHAPTER 5. FERTILIZATION

1. Definition

Fertilization is the process of fusion between two highly specialized, mature haploid gametes—an ovum and a spermatozoon—resulting in a single, diploid, mononucleated, undifferentiated cell called the **zygote**.

Site of Fertilization: is **Ampulla** or lateral one-third of the **uterine (fallopian) tube**.

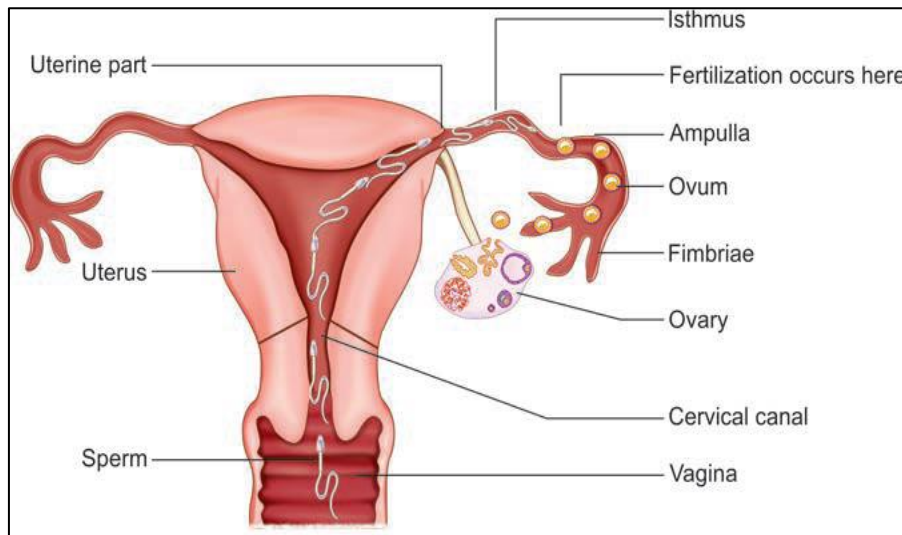


Fig. 23: Path taken by the sperm and ovum, for fertilization

➤ Key Highlights

- Fertilization marks **completion of the second meiotic division** of the oocyte.
- It involves **fusion of male and female pronuclei**, forming 23 pairs (46 total) of chromosomes.
- Fertilization triggers **mitotic division** of the zygote, making it the **antithesis of cell division**.

2. Stages of Fertilization

2.1. Approximation of Gametes

Transport of male and female gametes to the site of fertilization.

a. Sperm Transport

- **Semen composition:**
 - Seminal vesicle: 60% (rich in fructose)
 - Prostate: 25% (contains ions, acid phosphatase, fibrinogen)
 - Bulbourethral glands: 5% (lubrication)
 - Spermatozoa: 10%
 - Normal ejaculate: 2–3 ml, 100 million sperm/ml
 - pH: 7.2–7.6 (maintained by spermine)
- **Maturation & Motility:**
 - Tail movements enable penetration of ovum barriers.
 - Capacitation enhances fertilizing capability.
- **Transport:**
 - Assisted by tail movement and **uterine peristalsis** stimulated by **prostaglandins** in semen.
 - Time to reach uterus: 5–45 minutes.
 - From 200–500 million deposited, only ~300–500 reach the ampulla.
- **Chemotaxis:**
 - Sperm are attracted by chemicals from follicular cells.
- **Capacitation:**
 - Occurs in female tract over ~7 hours.
 - Involves membrane changes, calcium influx, and acrosomal enzyme release.
 - Enables sperm to bind to zona pellucida (ZP).

b. Ovum Transport

- **Structure at ovulation:**
 - Secondary oocyte (23 chromosomes), surrounded by:
 1. **Vitelline membrane**
 2. **Zona pellucida**

3. Corona radiata

- **Transport to ampulla:**
 - Fimbriae sweep the ovum into the uterine tube via **ciliary action** and **muscle contractions**.
 - Time: ~25 minutes.
- **Viability:**
 - Ovum survives 24–48 hours post-ovulation.

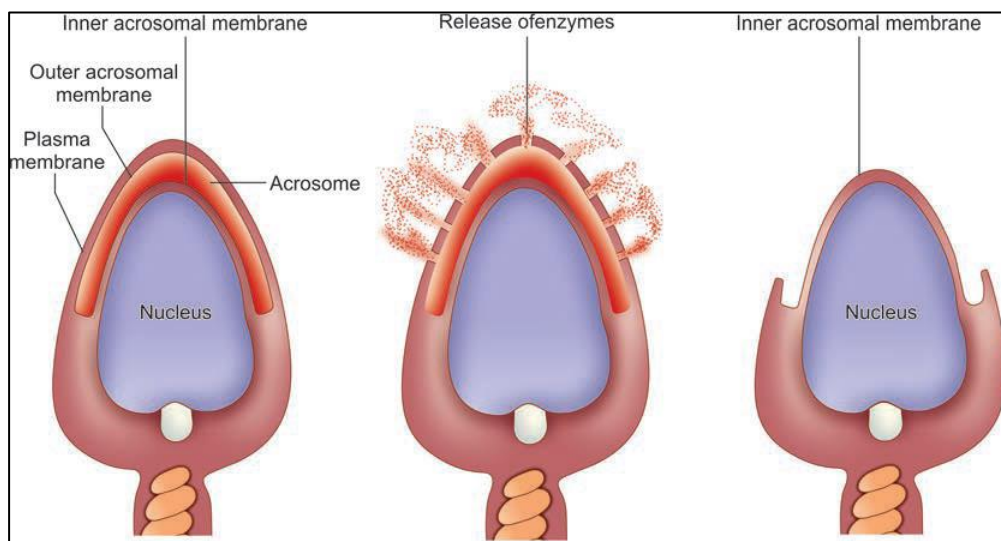
2.2. Contact and Fusion of Gametes

Sperm must penetrate three barriers:

1. Corona radiata
2. Zona pellucida

a. Acrosome Reaction

- **Definition:** Fusion between plasma and outer acrosomal membranes of sperm head, releasing enzymes to penetrate ovum barriers.
- **Enzymes released:**
 - Hyaluronidase
 - Acrosin
 - Acid phosphatase



Figs 25: Covering of acrosome and release of acrosomal enzymes

b. Disintegration of Barriers

- **Corona radiata:** Digested by hyaluronidase and aided by sperm tail movement.
- **Zona pellucida:**
 - Sperm binds via ZP2 and ZP3 receptors.
 - Acrosin facilitates digestion.
 - Zona reaction (via cortical granule enzymes) prevents polyspermy.

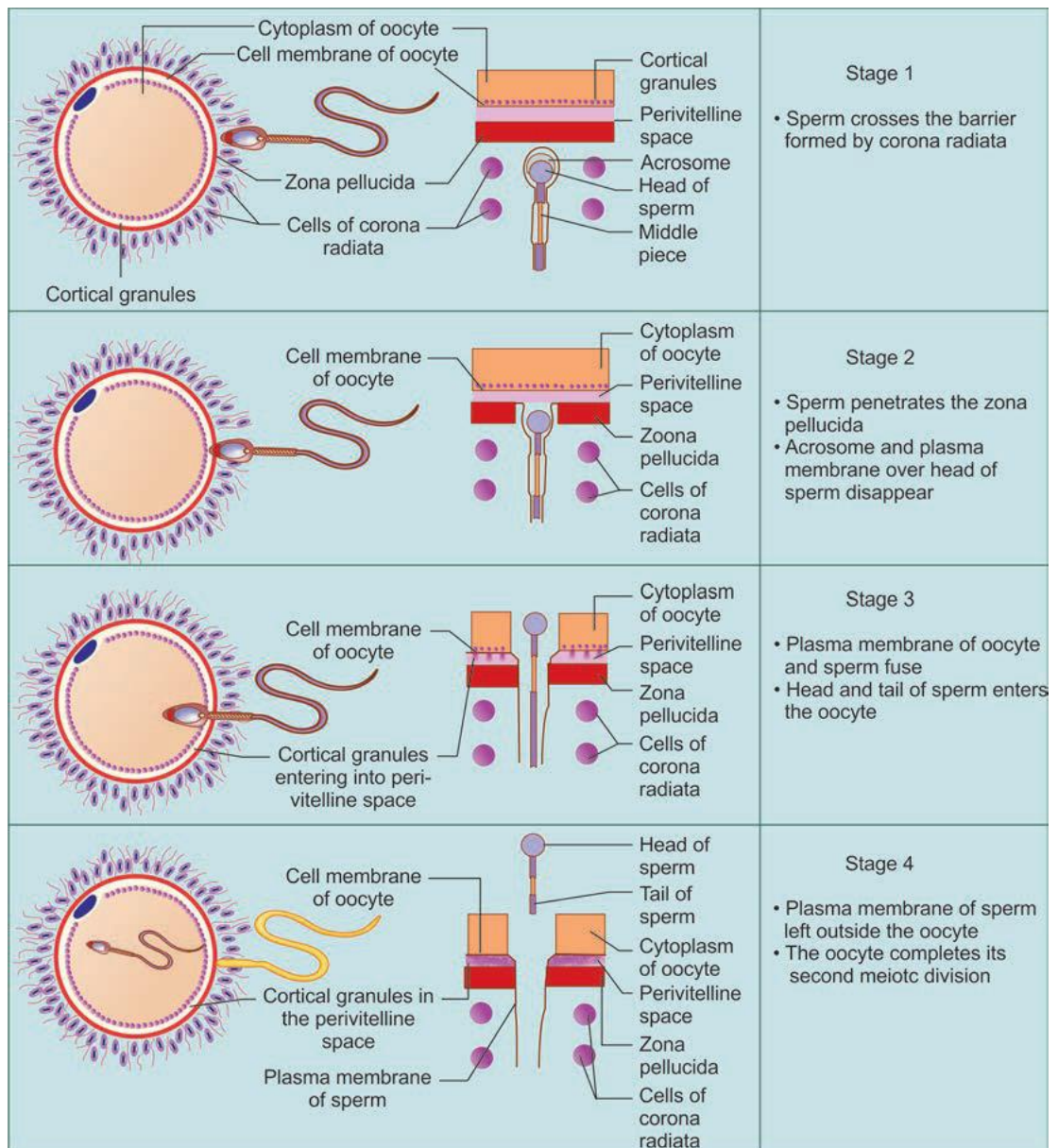


Fig. 24: Stages in penetration of a spermatozoon into an ovum

c. Calcium Wave in Oocyte

Triggered by sperm contact:

- Resumption of **second meiotic division**
- Cortical granule release → vitelline block (prevents polyspermy)
- Activation of egg metabolism

d. Nuclear Fusion

- Sperm head (excluding membrane) enters oocyte.
- Female pronucleus forms post second meiotic division.
- Male pronucleus forms from sperm nucleus.
- Pronuclei lose membranes, chromosomes pair, spindle forms.
- First mitotic division creates **two-cell embryo**.

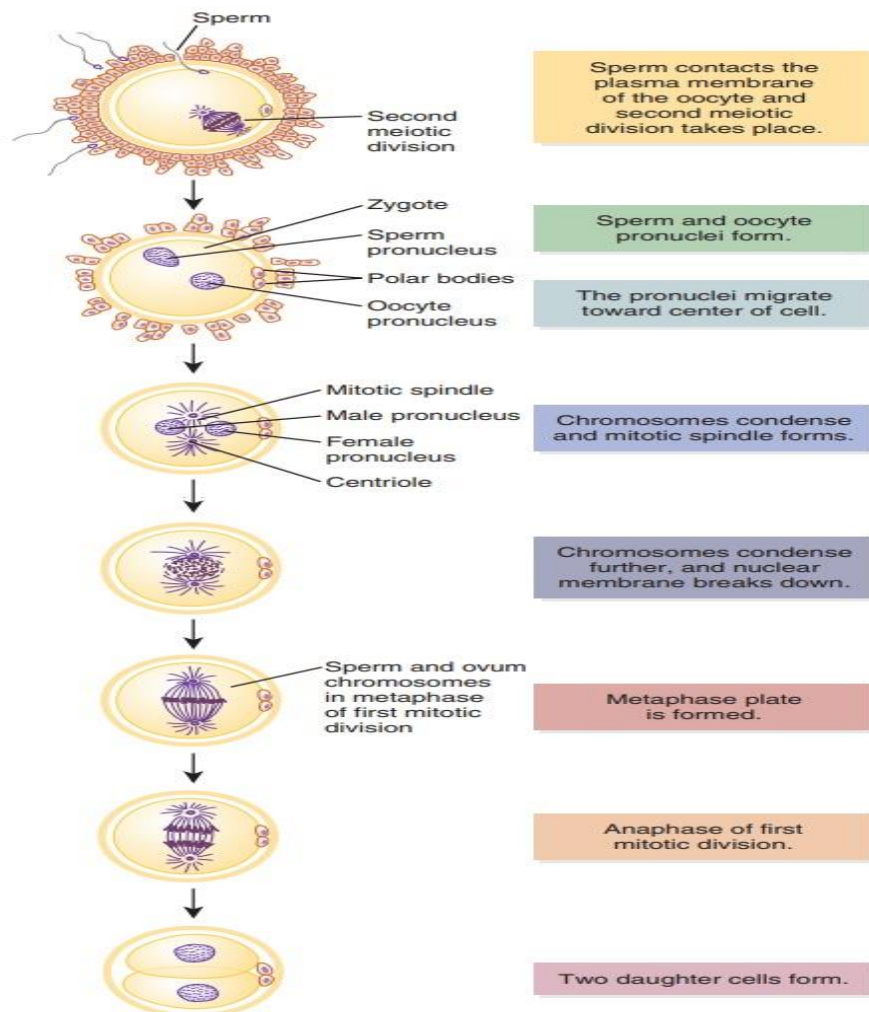
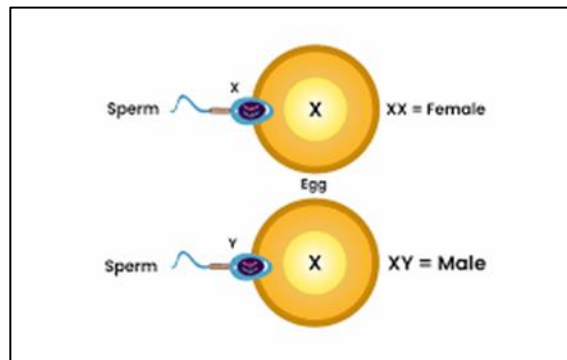


FIGURE 26-2 Fertilization and the first mitotic division.

2.3. Results of Fertilization

- Completion of **second meiotic division**
 - Restoration of **diploid number (46 chromosomes)**
 - **Determination of chromosomal sex:** It is the **process by which an individual's sex (male or female) is determined by chromosomes** from the moment of fertilization. This depends on the **type of sex chromosomes inherited from the parents.**
1. Humans have **23 pairs of chromosomes**, including **one pair of sex chromosomes**:
 - **XX → Female**
 - **XY → Male**
 2. **Source of sex chromosomes:**
 - The **egg (ovum)** always carries an **X chromosome**.
 - The **sperm** can carry either **X or Y**.
 - The sex of the offspring is determined by which sperm fertilizes the egg:
 - **X sperm + X egg → XX → Female**
 - **Y sperm + X egg → XY → Male**



- Initiation of **cleavage (mitotic) division**
- Establishment of **polarity and bilateral symmetry**
- Creation of **genetic diversity**
- Embryo contains only **maternal mitochondria**