HUMAN REPRODUCTIVE SYSTEM
FERTILISATION AND IMPLANTATION

FERTILIZATION AND ZYGOTE FORMATION:

- During copulation (coitus) semen is released by the penis into the vagina of female, called insemination. Once the sperms are released, they swim through the vagina, cervix, uterus and finally reach the ampulla of the **fallopian tubes.**
- The ovum released by the ovary is also transported to the **ampulla where fertilization occurs.**
- Fertilization can only occur if the ovum and the sperms are transported simultaneously to the ampulla. This is the reason why not all copulations lead to fertilization and pregnancy.
- First mitosis after fertilisation is actual mixing of male & female chromosomes.

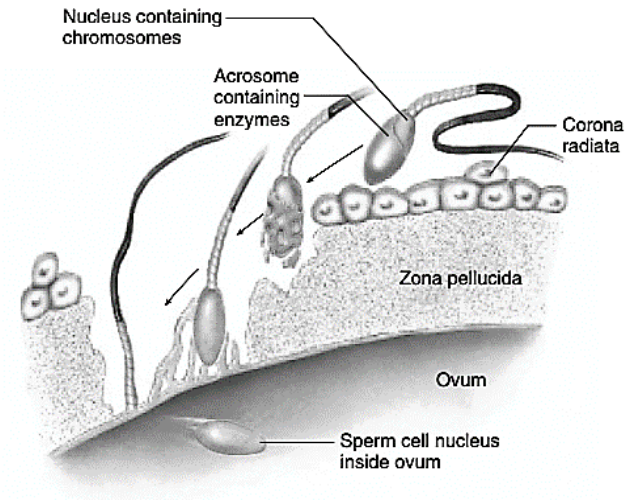


Fig. The process of fertilization.

Movement of Sperms:

- Only a few thousand sperms make their way to fallopian tube.
- Contraction of uterus and fallopian tube assist in movement of sperms. The average speed of sperm is 1.5 to 3 mm/min.

- Flagellar movement is secondary to contractions which help the sperm movement.
- Leucocytes of vaginal epithelia engulf millions of sperms. These sperms can survive in female genital tract for 24-48 hr.

Arrival of secondary oocyte:

- Secondary oocyte is released from the ovary into the abdominal cavity from there it is collected by fimbriae of fallopian tube and propelled by peristaltic movements of fallopian tube towards ampulla.
- Secondary oocyte can be fertilized within 24 hour of its release.

Capacitation of Sperms:

- Capacitation is the process by which the sperms are activated in the vaginal duct. It is done by secretions of female genital tract.
- Cholesterol layer is removed from acrosomal surface of sperm to expose its receptors. Acrosomal receptors bind to ZP2 and ZP3 (zona protein) receptors of ova.
- It takes around 5-6 hour for capacitation. Alkaline medium make sperm more active.
- Sperm can survive in female genital tract for 24-48 hours.

Physio-chemical events of fertilization:

- The process of fusion of a sperm with the ovum is called fertilization. Before fusion of a spermatozoa with the egg, the spermatozoa has to penetrate a few barriers, the egg membranes, which cover the egg. The secretions of **acrosome** help the sperm to enter into the cytoplasm of ovum through zona pellucida and the plasma membrane. All the chemicals are contained in the acrosome located at the tip of the sperm head and the collectively called **sperm lysins** (e.g. corona penetrating enzyme (CPE), Zonalysin (acrosin), Hyaluronidase. For successful acrosomal reaction optimum pH Ca^{2+} & Mg^{2+} concentrations are required. In absence of Ca^{2+} fertilization doesn't occur.

Fast block -

- Usually, only one sperm is successful in penetrating an egg. Electrical changes or depolarization, occurs in an egg's cell membrane after a sperm enters the egg, helps to keep

away other sperm from penetrating the egg, this process is called as **fast block**, it is due to influx of Na^+.

Slow block -

- It is the process in which cortical granules present below plasma membrane of ovum release their contents between plasma membrane and zona pellucida. The enzymes harden zona pellucida which prevent polyspermy.

Fertilizin-Antifertilizin concept:

- According to this concept egg secrete fertilizin which is a glycoprotein. On the other hand sperm secrete antifertilizin which is a protein and composed of acidic amino acids.
- Binding of fertilizin and antifertilizin is called **agglutination**.

Sperm entry:

- At the point, first sperm contact secondary oocyte, it develop fertilization cone/ cone of reception.
- **The entry of sperm into the ovum induces completion of the meiotic division of the secondary oocyte.** The second meiotic division is also unequal and results in the formation of a **second polar body** and a **haploid ovum** (ootid).
- Soon the haploid nucleus of the sperm and that of ovum fuse together to form a **diploid zygote.**

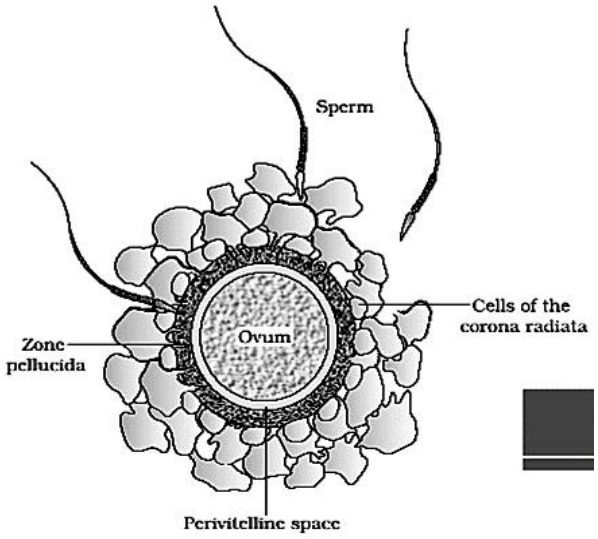


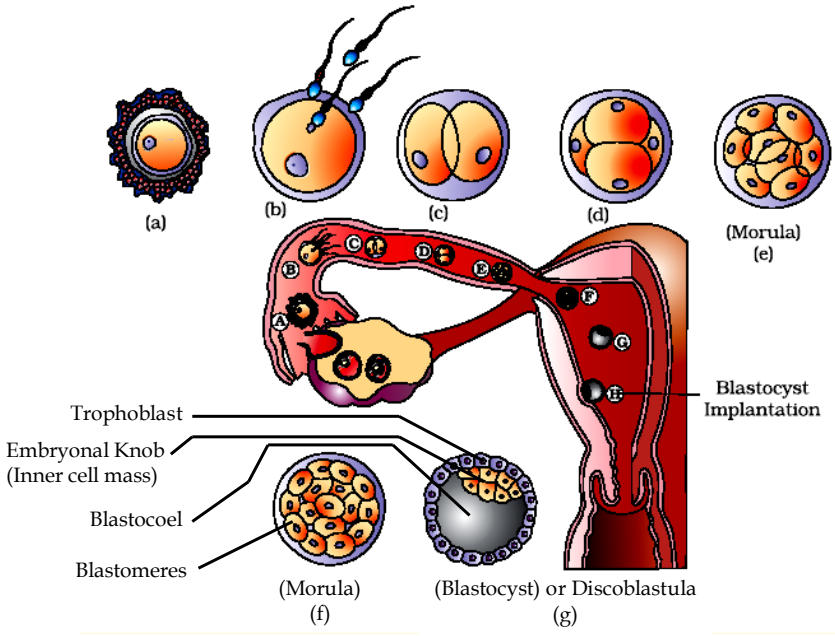
Fig. Ovum surrounded by few sperms

Each gamete contains 23 chromosomes, the haploid (n) number. Thus fusion of a sperm nucleus and an egg nucleus makes a zygote that have 46 chromosomes, thus restoring the diploid (2n) number.

CLEAVAGE, MORULA AND BLASTOCYST

Cleavage and Implantation

- Within few hours after fertilization (while zygote is still in the fallopian tube), the zygote begins a series of mitotic divisions known as **cleavage** and forms 2,4,8,16 daughter cells **blastomeres.**
- The embryo with 8 to 16 blastomeres is called **morula.** A solid ball of cells whose size is same as that of zygote. The cells of morula continue to divide and transforms into blastocyst as it moves further into the uterus. Size of morula is same as that of zygote.
- At the end of 4th day embryo reaches to uterus.
- A **Blastocyst** is a ball of almost 64 cells with a large, fluid-filled cavity called **blastocoel.** The **blastomeres** in the **blastocyst** are arranged into an outer layer called **trophoblast** and inner mass of cells (attached to trophoblast) called the **inner cell mass.**
- Side of blastocyst where inner cell mass is present is called embryonic pole, while opposite to it is abembryonic pole.
- Zona pellucida is broken on 5th day, blastocyst is implanted on 7th day.
- Cells of trophoblast, which are in contact with inner cell mass are called cells of Rauber.



- Zona pellucida breaks down after the formation of blastocyst exposing the highly sticky, plasma membrane for implantation, because implantation cannot occur with it.
- Trophoblast or trophoectoderm does not take part in the formation of embryo proper. It forms foetal portion of the placenta which provides food to the developing embryo.
- Cells of inner mass are destined to form the body of the developing embryo. So, the trophoblast layer gets attached to the endometrium and the inner mass gets differentiated as embryo. After attachment, the uterine cells divide rapidly and covers the blastocyst.
- Approximately, **one week** after fertilization, the blastocyst embeds itself in the thickened wall of the uterus, a process called **implantation**, and pregnancy is established.

IMPLANTATION

Implantation is the attachment of the blastocyst to the uterine wall. It occurs after 7 days of fertilization. About 8 days after fertilization, the trophoblast develops into two layers in the region of contact between the blastocyst and endometrium.

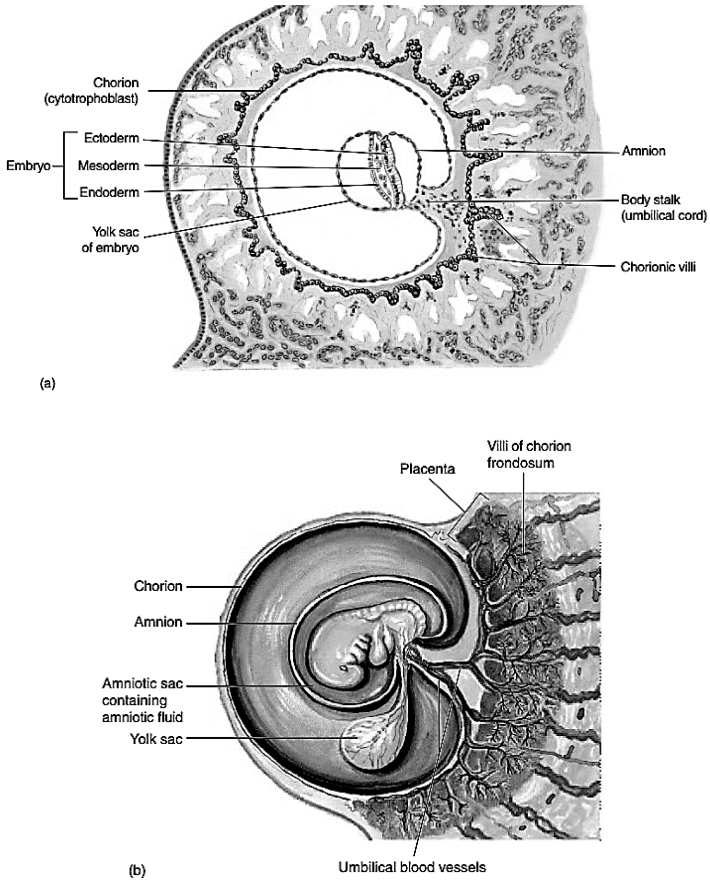


Fig. The extraembryonic membranes.