FERTILIZATION

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Fertilization is a co-ordinated sequence of molecular and cellular process which begins with the contact of oocyte and sperm and ends with the inter-mingling of maternal and paternal chromosomes at metaphase of first mitotic division of the zygote (unicellular embryo).

PARTS OF FALLOPIAN/ UTERINE TUBE

1. Infundibulum – catch the ovum
2. Fimbriae – finger like projections
3. Ampula – most common site for fertilization
4. Isthmus – part close to the uterus

Both ovum and sperm needs to be transported towards the ampula of fallopian tube.

TRANSPORT OF OVUM

Ovum is immotile. The ovum comes out from the surface of ovary along with corona radiata. Corona radiata cells are held together by connective tissue which have hyaluronic acid. At the time of ovulation, the fimbriae becomes very active and start sweeping over the ovary and this movement of fimbriae is hormonally controlled (estrogen, LH)

Two processes help move the ovum from ovary to the fallopian tube:

1. Sweeping movement of fimbriae of fallopian tube on the surface of ovary
2. Within the fimbriae, the mucosal lining of cells are ciliated. These cilia produce small fluid currents which help the fimbriae to pick up the secondary ovum from the ovary.

Ovum is then transported within the uterine tube/ fallopian tube towards the ampula by the peristaltic contractions of the fallopian tube.

TRANSPORT OF SPERM

On average 200-500 million sperms are deposited inside the vagina. Sperms make about 10% of the semen. An enzyme named vesiculase (secreted by seminal vesicle) coagulates the semen and helps the sperms to hold on in the vagina.

Sperms are motile. Though they are more motile in the uterus than in the vagina because vagina is acidic due to the presence of lactobacillus and in acidic environment sperm movement slows down. Uterus has alkaline environment so sperms are more motile in the uterus.

The shortest possible time for a sperm to move from vagina to ampula is 5 minutes. Others may also take upto 45 minutes. Out of 500 million sperms, about 200-500 sperms reach the ampula. Many others disintegrates along the way and are absorbed by genital mucosa.

Factors favoring movement of sperm:

1. Cervical mucus
2. Sperm tail
3. Smooth muscle contractions
4. Prostaglandins
5. Chemo-attractants from ovum

CERVICAL MUCUS

Around the time of ovulation, the mucus plug in the cervix become thin, stringy and more abundant and favors the movement of sperm.

There are some mucosal folds in the cervical region where some sperms may hide for some time and come out later.

SPERM TAIL

Semen is rich in fructose. This fructose provide energy to the sperm to produce ATP and help the sperm to propel from the vagina to the uterus.

All the mitochondria of spermatogonia come together and make middle piece which generates ATP thus helping the sperm flagellum to propel the sperm forward.

SMOOTH MUSCLE CONTRACTIONS

Uterine smooth muscle contractions and fallopian tube smooth muscle contractions also assist the movement of sperm.

PROSTAGLANDINS

Prostaglandins present in semen also stimulate the contraction of uterine tube which help in sperm movement.

CHEMO-ATTRACTANTS FROM OVUM

Most of the sperms when reach the isthmus region of fallopian tube, stops moving. These sperms will start moving when the ovum and corona radiata cells begin secreting chemo-attractants.

Before fertilization, sperm has to undergo two important processes:

1. Capacitation Reaction
2. Acrosome Reaction

CAPACITATION REACTION

Special type of sperm conditioning within the female reproductive tract. It takes about 7 hours.

The acrosome has glycoproteins and some seminal plasma proteins on its surface due to which the sperm can’t fuse with the ovum. The enzymatic and ciliary action of the fallopian tube remove the

glycoproteins and makes the sperm ready to fertilize. Only capacitated sperms can pass through corona radiata.

ACROSOME REACTION

Acrosome reaction is induced by zona pellucida. As soon as sperm touches the zona pellucida, acrosome reaction takes place. The inner membrane and acrosome membrane of the sperm fuse at multiple points and melt away at point of fusion producing apertures through which enzymes are released for digesting zona pellucida. These enzymes include acrosin, trypsin-like substance and hyaluronidases.

During this process, the sperm loses its membrane from anterior region of head. The posterior membrane of sperm head and membrane of ovum fuses. The membrane of ovum has integrin proteins on its surface while membrane of sperm has disintegrin proteins. As soon as the two membranes touch each other, the interaction between integrin and disintegrin molecules interlock the two membranes.

THE RESPONSE OF OVUM TO ARRIVAL OF SPERM:

1. Cortical and zona reactions
2. Completion of second meiotic division
3. Metabolic activation of ovum takes place

CORTICAL AND ZONA REACTIONS

In the zona pellucida, there are multiple specie-specific receptor sites for attachment of sperm. As soon as first sperm membrane touch the ovum membrane, the cortical granules (containing lysosomal enzymes) present in ovum move to the surface of ovum and lysosomal enzymes are released to the zona pellucida due to which zona pellucida inactivate specie-specific receptors and become impermeable to other remaining sperms.

COMPLETION OF SECOND MEIOTIC DIVISION

The outer membrane of sperm is left outside the ovum while the rest of the sperm enters the ovu and its tail degenerates. As the sperm touches the ovum, secondary ovum completes its second meiotic division and matures into definitive ovum

FUSION OF GAMETES

Before the fusion of nuclei of sperm and egg, DNA replication of both nuclei (male pro-nucleus and female pro-nucleus) take place and the single-structured chromosomes are now double-structured. This process of doubling of genetic material is called Growth of nuclei. Nuclear membrane appears around both maternal and paternal chromosomes and the cell is now called zygote (2n).