Fertilization and Early Development of Embryo

Fertilization

- occurs in ampullary region of uterine tube - movement of sperm from cervix to the oviduct is propelled bey uterine contractions and it can take upto 30 mins - 6 days. Sperms becomes immobile once they reach the isthmus & more rapidly upon ovulation (attracted by chemoattractants released by cummulus cells of ovary)

- Sperms need to undergo 2 major steps before fertilisation occurs -

A) Capacitation

- period of conditioning

- takes 7 hours

- Occurs in uterine tube

- interaction b/w sperm & mucosal surface of the tube results in removal of glycoprotein coat and seminal plasma proteins

- sperms can now cross the corona radiata and undergo acrosome reaction

B) Acrosome Reaction

- occurs after binding to zona proteins

- initiated by zona proteins ZP3 , ZP4

-results in release of enzymes like acrosin and trypsin to penetrate zona pellicuda

Phases of Fertilization

1. Penetration of Corona Radiata - Out of 200 - 300 million spermatozoa deposited into the female tract , only 500 reach the site of fertilization and only 1 fertilizes the egg. The others aid the fertilizing sperm in penetrating the barriers protecting the female gamete.
2. Penetration of Zona Pellicuda - The zona pellucida, a glycoprotein shell surrounding the egg, facilitates sperm binding and induces the acrosome reaction via ZP3. Upon contact with the oocyte surface, sperm release acrosomal enzymes, penetrating the zona. Subsequently, lysosomal enzymes from the oocyte alter the zona's properties, preventing further sperm penetration and inactivating receptor sites.
3. Fusion of Oocyte and Sperm cell membranes - Fusion of the oocyte and sperm cell membranes occurs following initial adhesion mediated by integrins on the oocyte and disintegrins on sperm, leading to the entry of the spermatozoon into the oocyte's cytoplasm. Upon sperm entry, the oocyte undergoes cortical and zona reactions, releasing lysosomal enzymes that render the oocyte membrane impenetrable to other spermatozoa and alter the zona pellucida's structure to prevent polyspermy. The oocyte resumes its second meiotic division, forming a definitive oocyte and a second polar body, while the spermatozoon contributes to the metabolic activation of the egg, initiating early embryogenesis. Subsequently, the male pronucleus forms, and eventually, both male and female pronuclei merge, lose their nuclear envelopes, and replicate their DNA in preparation for mitotic division. Results of Fertilization include Restoration of the diploid number of chromosomes , initiation of cleavage and helps in the determination of the sex of the new individual.

Early Development of Human Embryo

The early development of a human embryo is a sequence of events that gives rise to a complex and fully formed organism.

It involves several steps like fertilisation , cleavage , blastocyst formation , implantation , gastrulation , neurulation , organogenesis and fetal development

Cleavage

- After fertilization, the zygote undergoes a series of mitotic divisions, resulting in the formation of blastomeres, which are progressively smaller with each cleavage division.
- By the eight-cell stage, blastomeres form a loosely arranged clump. However, after the third cleavage, compaction occurs, leading to the formation of a compact ball of cells held together by tight junctions.
- Compaction segregates inner cells, which communicate extensively by gap junctions, from outer cells. Approximately 3 days after fertilization, the compacted embryo forms a 16-cell morula, with inner cells comprising the inner cell mass (ICM) and surrounding cells forming the outer cell mass. The ICM gives rise to tissues of the embryo proper, while the outer cell mass forms the trophoblast, contributing to the placenta.

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1. Langman's Medical Embryology Textbook