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QUESTIONS

1. Discuss Ovulation
2. Differentiate between meiosis 1 and meiosis 2
3. Discuss the stages involved in fertilization
4. Differentiate between monozygotic twins and dizygotic twins

**OVULATION**

Ovulation is the release of eggs from the ovaries. Around the middle of the ovarian cycle, the ovarian follicle, under the influence of FSH and LH, undergoes a sudden growth spurt, producing a cystic swelling or bulge on the surface of the ovary. A small avascular spot, the stigma, soon appears on this swelling. Before ovulation, the secondary oocyte and some cells of the cumulus oophorus detach from the interior of the distended follicle.

Ovulation is triggered by a surge of LH production. Ovulation usually follows the LH production. Ovulation usually follows the LH peak by 12 to 24 hours. The LH surge, elicited by the high estrogen level in the blood, appears to cause the stigma to balloon out, forming a vesicle. The stigma soon ruptures, expelling the secondary oocyte with the follicular fluid. Expulsion of the oocyte is the result of intrafollicular pressure, and possibly by contraction of smooth muscle in the theca externa(sheath) owing to stimulation by prostaglandins.

Mitogen-activated protein kinases 3 and 1(MAPK 3/1), also known as extracellular signal-regulated kinases 1 and 2 (ERK 1/2), in ovarian follicular cells seem to regulate signaling pathways that control ovulation. Plasmins and matrix metalloptoteins appear also to play a role in controlling rupture of the follicle. The expelled secondary oocyte is surrounded by the zona pellucida and one or more layers of follicular cells, which are radially arranged as the corona radiata, forming the oocyte-cumulus complex. The LH surge also seems to induce resumption of the first meiotic division of the primary oocyte. Hence, mature ovarian follicles contain secondary oocytes. The zona pellucida is composed of three glycoproteins (ZPA, ZPB, ZPC), which usually form a network of filaments with multiple pores. Binding of the sperm to the zona pellucida (sperm-oocyte interactions) is a complex and critical event during fertilization.

During ovulation, some women feel a slight pain called mittelschimerz because it normally occurs near the middle of the menstrual cycle. Ovulation is also accompanied by a rise in basal temperature which can be monitored to aid couples in becoming pregnant or preventing pregnancy. Some women fail to ovulate because of a low concentration of gonadotropins. In these cases, administration of an agent to stimulate gonadotropin release, and hence ovulation can be employed. Although such drugs are effective, they often produce multiple ovulations, so that the likelihood of multiple pregnancies is 10 times higher in these women than in the general population.

**DIFFERENCES BETWEEN MEIOSIS 1 AND MEIOSIS 2**

| **MEIOSIS 1** | **MEIOSIS 2** |
|---|---|
| Homologous chromosomes separate | Sister chromatids separate |
| Meiosis 1 produces 2 diploid daughter cells | Meiosis 2 produces 4 haploid daughter cells |
| Crossing over occurs | Crossing over does not occur |
| Prophase 1, metaphase 1, anaphase 1 and telophase 1 are the four phases | Prophase 2, metaphase 2, anaphase 2 and telophase 2 are the four phases |
| Preceded by interphase | No interphase takes place |
| Individual chromosomes are present in the daughter nuclei | Sister chromosomes are present in the daughter nuclei |
| A complex division and takes more time | Comparatively less simple and takes less time |
| Cohesin protein complexes at the arms of the homologous chromosomes are cleaved | Cohesins at the centromeres are cleaved in order to separate the two sister chromatids |

Meiosis 1 is preceded by S-phase and G-phase while meiosis 2 is preceded only by G-phase.

In meiosis 1, prophase splits into 5 sub phases and prophase does not have sub phases.

**STAGES INVOLVED IN FERTILIZATION**

The usual site of fertilization is in the ampulla of the uterine tube. If the oocyte is not fertilized here, it slowly passes along the tube to the body of the uterus, where it degenerates

and is resorbed. Although fertilization may occur in other parts of the tube, it does not occur in the body of the uterus. The stages involved in fertilization are:

1. **PASSAGE OF A SPERM THROUGH THE CORONA RADIATA**: Dispersal of the follicular cells of the corona radiata surrounding the oocyte and zona pellucida appears to result mainly from the action of the enzyme hyaluronidase released from the acrosome of the sperm, but the evidence of this is not uneqivocal. Tubal mucosal enzymes also appear to assist the dispersal. Movements of the tail of the sperm are also important in its penetration of the corona radiata.
2. **PENETRATION OF THE ZONA PELLUCIDA**: Passage of a sperm through the zona pellucida is the important phase in the initiation of fertilization. Formation of a pathway also results from the action of enzymes released from the acrosome. The enzymes esterases, acrosin, and neuraminidase appear to cause lysis of the zona pellucida, thereby forming a path for the sperm to follow to the oocyte. The most important of these enzymes is acrosin, a proteolytic enzyme. Once the sperm penetrates the zona pellucida, a zona reaction-a change in the properties of the zona pellucida-occurs that makes it impermeable to other sperms. The composition of this extracellular glycoprotein coat changes after fertilization. The zona reaction is believed to result from the action of lysosomal enzymes released by cortical granules near the plasma membrane of the oocyte. The contents of these granules, which are released into the perivitelline space, also cause changes in the plasma membrane that make it impermeable to other sperms.
3. **FUSION OF PLASMA MEMBRANES OF THE OOCYTE AND SPERM**: The plasma or cell membranes of the oocyte and sperm fuse and break down at the area of fusion. The head and tail of the sperm enter the cytoplasm of the oocyte, but the sperm's plasma membrane remains behind.
4. **COMPLETION OF THE SECOND MEIOTIC DIVISION OF OOCYTE AND FORMATION OF FEMALE PRONUCLEUS**: Penetration of the oocyte by a sperm activates the oocyte into completing the second meiotic division and forming a mature oocyte and a second polar body. Following decondensation of the maternal chromosomes, the nucleus of the mature oocyte becomes the female pronucleus.
5. **FORMATION OF THE MALE PRONUCLEUS**: Within the cytoplasm of the oocyte, the nucleus of the sperm enlarges to form the male pronucleus and the tail of the sperm

degenerates. Morphologically, the male and female pronuclei are indistinguishable. During growth of the pronuclei, they replicate their DNA-1 n (haploid), 2 c (two chromatids). The oocyte containing two haploid pronuclei is called an ootid.

6. **AS THE PRONUCLEI FUSE INTO A SINGLE DIPLOID AGGREGATION OF CHROMOSOMES, THE OOTID BECOMES A ZYGOTE**: The chromosomes in the zygote become arranged on a cleavage spindle.

The zygote is genetically unique because half of its chromosomes came from the mother and half from the father. The zygote contains a new combination of chromosomes that is different from those in the cells of either of the parents. This mechanism forms the basis of biparental inheritance and variation of the human species.

**MONOZYGOTIC AND DIZYGOTIC TWINS**

| **MONOZYGOTIC** | **DIZYGOTIC** |
|---|---|
| They are developed by the splitting of a fertilized embryo into two | They are developed by two separate simultaneous fertilization events |
| Cause is unknown | Caused by either IVF, certain fertility drugs or hereditary predisposition |
| Genetic codes are nearly identical | Genetic codes are same as any other sibling |
| Gender is the same | Gender is different |
| Blood types are the same | Blood types are different |
| Appearance is extremely similar but may be affected by environmental factors | Appearance is similar as any other siblings |
| Can be either Di- Di, Mono- Di or Mono-Mono twins | Only Di- Di twins |
| Bear a risk of Twin-to-Twin Syndrome | Bear a low risk of Twin-to-Twin Syndrome |