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**COLLEGE: COLLEGE OF MEDICAL AND HEALTH SCIENCES**

**DEPARTMENT: MEDICINE AND SURGERY**

**LEVEL: 200**

**COURSE: ICBS (ANATOMY)**

1. **Discuss ovulation**

**ANSWER**

Ovulation In the days immediately preceding ovulation, under the influence of FSH and LH, the vesicular follicle grows rapidly to a diameter of 25 mm to become a mature vesicular (graafian) follicle. Coincident with final development of the vesicular follicle, there is an abrupt increase in LH that causes the primary oocyte to complete meiosis I and the follicle to enter the preovulatory mature vesicular stage. Meiosis II is also initiated, but the oocyte is arrested in metaphase approximately 3 hours before ovulation. In the meantime, the surface of the ovary begins to bulge locally, and at the apex, an avascular spot, the stigma, appears. The high concentration of LH increases collagenase activity, resulting in digestion of collagen fibers surrounding the follicle. Prostaglandin levels also increase in response to the LH surge and cause local muscular contractions in the ovarian wall. Those contractions extrude the oocyte, which together with its surrounding granulosa cells from the region of the cumulus oophorus breaks free (ovulation) and floats out of the ovary. Some of the cumulus oophorus cells then rearrange themselves around the zona pellucida to form the corona radiata.

**Corpus Luteum** After ovulation, granulosa cells remaining in the wall of the ruptured follicle, together with cells from the theca interna, are vascularized by surrounding vessels. Under the influence of LH, these cells develop a yellowish pigment and change into lutein cells, which form the corpus luteum and secrete estrogens and progesterone. Progesterone, together with some estrogen, causes the uterine mucosa to enter the progestational or secretory stage in preparation for implantation of the embryo.

**Oocyte Transport** Shortly before ovulation, fimbriae of the uterine tube sweep over the surface of the ovary, and the tube itself begins to contract rhythmically. It is thought that the oocyte, surrounded by some granulosa cell, is carried into the tube by these sweeping movements of the fimbriae and by motion of cilia on the epithelial lining. Once in the tube, cumulus cells withdraw their cytoplasmic processes from the zona pellucida and lose contact with the oocyte. Once the oocyte is in the uterine tube, it is propelled by peristaltic muscular contractions of the tube and by cilia in the tubal mucosa with the rate of transport regulated by the endocrine status during and after ovulation. In humans, the fertilized oocyte reaches the uterine lumen in approximately 3 to 4 days.

**Corpus Albicans** If fertilization does not occur, the corpus luteum reaches maximum development approximately 9 days after ovulation. It can easily be recognized as a yellowish projection on the surface of the ovary. Subsequently, the corpus luteum shrinks because of degeneration of lutein cells (luteolysis) and forms a mass of fibrotic scar tissue, the corpus albicans. Simultaneously, progesterone production decreases, precipitating menstrual bleeding. If the oocyte is fertilized, degeneration of the corpus luteum is prevented by human chorionic gonadotropin, a hormone secreted by the syncytiotrophoblast of the developing embryo. Ihe corpus luteum continues to grow and forms the corpus luteum of pregnancy Ruptured fOIIicIe (corpus luteum graviditatis). By the end of the third month, this structure may be one-third to one-half of the total size of the ovary. Yellowish luteal cells continue to secrete progesterone until the end of the fourth month; thereafter, they regress slowly as secretion of progesterone by the trophoblastic component of the placenta becomes adequate for maintenance of pregnancy. Removal of the corpus luteum of pregnancy before the fourth month usually leads to abortion.

1. **Differentiate between meiosis 1 and meiosis 2**

**ANSWER**

**Difference between Meiosis 1 and Meiosis 2**

**Homotypic/Heterotypic Division** Meiosis 1: Meiosis 1 is a heterotypic division, reducing the chromosome number in the daughter cell by half, compared to the parent cell. Meiosis 2: Meiosis 2 is a homotypic division, equalizing the chromosome number of both parent and daughter cells.

**Chromosomes** Meiosis 1: Homologous chromosomes are present at the beginning of meiosis 1.9 Meiosis 2: Individual, bivalent chromosomes are present at the beginning of meiosis 2.

**Phase**s Meiosis 1: Prophase 1, metaphase 1, anaphase 1 and telophase 1 are the four phases in the meiosis 1. Meiosis 2: Prophase 2, metaphase 2, anaphase 2 and telophase 2 are the four phases in the meiosis 2.

**Result** Meiosis 1: Individual chromosomes are present in the daughter nuclei. Meiosis 2: Sister Chromosomes, which are derived from sister chromatids are present in the daughter nuclei.

**Number of Daughter Cells at the End** Meiosis 1: Two daughter cells are produced from a single parent cell. Meiosis 2: The two daughter cells produced at meiosis 1 are separately divided to produce four cells.

**Cross­over** Meiosis 1: Chromosomal cross­over occurs during prophase 1, by exchanging the genetic material between non­sister chromatids. Meiosis 2: No chromosomal cross­over occurs during prophase 2.

**Complexity and Time Taken** Meiosis 1: Meiosis 1 is a more complex division. Thus, it takes more time. Meiosis 2: Meiosis 2 is comparatively simple and less time is taken for the division

**Interphase** Meiosis 1: Interphase is followed by meiosis 1. Meiosis 2: No interphase takes place prior to the meiosis 2. A resting phase, interkinesis can occur.

**Cleavage of the Cohesin Complex** Meiosis 1: Cohesin protein complexes at the arms of the homologous chromosomes are cleaved Meiosis 2: Cohesins at the centromeres are cleaved in order to separate the two sister chromatids

1. **Discuss the stages involved in fertilization**

**ANSWER**

* Phase 1, penetration of the corona radiata
* Phase 2, penetration of the zona pellucida
* Phase 3, fusion of the oocyte and sperm cell membranes

**Phase 1: Penetration of the Corona Radiata**

Of the 200 to 300 million spermatozoa normally deposited in the female genital tract, only 300 to 500 reach the site of fertilization. Only one of these fertilizes the egg. It is thought that the others aid the fertilizing sperm in penetrating the barriers protecting the female gamete. Capacitated sperm pass freely through corona cells.

**Phase 2: Penetration of the Zona Pellucida**

The zona is a glycoprotein shell surrounding the egg that facilitates and maintains sperm binding and induces the acrosome reaction. Both binding and the acrosome reaction are mediated by the ligand ZP3, a zona protein. Release of acrosomal enzymes (acrosin) allows sperm to penetrate the zona, thereby coming in contact with the plasma membrane of the oocyte. Permeability of the zona pellucida changes when the head of the sperm comes in contact with the oocyte surface. This contact results in release of lysosomal enzymes from **cortical granules** lining the plasma membrane of the oocyte. In turn, these enzymes alter properties of the zona pellucida **(zona reaction)** to prevent sperm penetration and inactivate species-specific receptor sites for spermatozoa on the zona surface. Other spermatozoa have been found embedded in the zona pellucida, but only one seems to be able to penetrate the oocyte.

**Phase 3: Fusion of the Oocyte and Sperm Cell Membranes**

The initial adhesion of sperm to the oocyte is mediated in part by the interaction of integrins on the oocyte and their ligands, disintegrins, on sperm. After adhesion, the plasma membranes of the sperm and egg fuse. Because the plasma membrane covering the acrosomal head cap disappears during the acrosome reaction, actual fusion is accomplished between the oocyte membrane and the membrane that covers the posterior region of the sperm head. In the human, both the head and the tail of the spermatozoon enter the cytoplasm of the oocyte, but the plasma membrane is left behind on the oocyte surface. As soon as the spermatozoon has entered the oocyte, the egg responds in three ways:

**1.** **Cortical and zona reactions**: As a result of the release of cortical oocyte granules, which contain lysosomal enzymes, (1) the oocyte membrane becomes impenetrable to other spermatozoa, and (2) the zona pellucida alters its structure and composition to prevent sperm binding and penetration. These reactions prevent polyspermy (penetration of more than one spermatozoon into the oocyte).

2. **Resumption of the second meiotic division:** The oocyte finishes its second meiotic division immediately after entry of the spermatozoon. One of the daughter cells, which receive hardly any cytoplasm, is known as the second polar body; the other daughter cell is the definitive oocyte. Its chromosomes (22 plus X) arrange themselves in a vesicular nucleus known as the female pronucleus.

**3. Metabolic activation of the egg**: The activating factor is probably carried by the spermatozoon. Activation encompasses the initial cellular and molecular events associated with early embryogenesis.

The spermatozoon, meanwhile, moves forward until it lies close to the female pronucleus. Its nucleus becomes swollen and forms the male pronucleus; the tail detaches and degenerates. Morphologically, the male and female pronuclei are indistinguishable, and eventually, they come into close contact and lose their nuclear envelopes. During growth of male and female pronuclei (both haploid), each pronucleus must replicate its DNA. If it does not, each cell of the two-cell zygote has only half of the normal amount of DNA. Immediately after DNA synthesis, chromosomes organize on the spindle in preparation for a normal mitotic division. The 23 maternal and 23 paternal (double) chromosomes split longitudinally at the centromere, and sister chromatids move to the opposite poles, providing each cell of the zygote with the normal diploid number of chromosomes and DNA. As sister chromatids move to opposite poles, a deep furrow appears on the surface of the cell, gradually dividing the cytoplasm into two parts.

The main results of fertilization are as follows:

* **Restoration of the diploid number of chromosomes,** half from the father and half from the mother. Hence the zygote contains a new combination of chromosomes different from both parents.
* **Determination of the sex of the new individual:** An X-carrying sperm produces a female (XX) embryo, and a y-carrying sperm produces a male (XY) embryo. Therefore, the chromosomal sex of the embryo is determined at fertilization.
* **Initiation of cleavage:** without fertilization, the oocyte usually degenerates 24 hours after ovulation.
1. **Differentiate between monozygotic and dizygotic twins**

**ANSWER**

**Difference between Monozygotic and Dizygotic Twins**

**Development** Monozygotic Twins: Monozygotic twins are developed by the splitting of a fertilized embryo into two. Dizygotic Twins: Dizygotic twins are developed by two separate fertilization events occurring at the same time.

**Causes:**  Monozygotic Twins: The cause for monozygotic twins is not known. Dizygotic Twins: Dizygotic twins are caused either by IVF, certain fertility drugs or hereditary predisposition due to the hyper­ovulation**.**

**Called as**: Monozygotic Twins: Monozygotic twins are called identical twins. Dizygotic Twins: Dizygotic twins are called fraternal twins.

**Genetic Code** Monozygotic Twins: The genetic codes of the monozygotic twins are nearly identical. Dizygotic Twins: The genetic codes of the dizygotic twins are same as any other sibling.

**Gender of Twins** Monozygotic Twins: The genders of monozygotic twins are same. Dizygotic Twins: The genders of dizygotic twins are different.

**Blood Type** Monozygotic Twins: The blood types of monozygotic twins are the same. Dizygotic Twins: Dizygotic twins may have different blood types.

**Appearance** Monozygotic Twins: Monozygotic twins are extremely similar. But, they may vary depending on the environmental factors. Dizygotic Twins: The appearance of dizygotic twins is similar as any other sibling.

**Likelihood** Monozygotic Twins: The likelihood of the monozygotic twins is uniform around the world. Dizygotic Twins: The likelihood of the dizygotic twins varies by country.

**Occurrence** Monozygotic Twins: One­third of the twins in the world are monozygotic twins. Dizygotic Twins: Two­thirds of the twins in the world are dizygotic twins.

**Hereditary** Monozygotic Twins: Monozygotic twins are not hereditary. Dizygotic Twins: Dizygotic twins are hereditary.

**Inside the Uterus**  Monozygotic Twins: Monozygotic twins can be either Di­Di, Mono­Di or Mono­Mono twins. Dizygotic Twins: Dizygotic twins are only Di­Di twins.

**Risk of Twin­to­Twin Transfusion Syndrome (TTTS):**  Monozygotic Twins: Monozygotic twins bear high risk for TTTS. Dizygotic Twins: Dizygotic twins bear a low risk for TTTS compared to monozygotic twins.