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Medicine and Health Science

Medicine and Surgery

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EMBRYOLOGY

1. Ovulation is described as the process that occurs usually once in every menstrual cycle, when hormone changes trigger an ovary to release an egg. At birth, a female fetus has 1 to 2 million immature eggs called oocytes inside her ovaries, which is all the eggs she will ever produce.

   By the time a girl enters puberty about 300,000 of these eggs remain. Approximately 300 to 400 of the remaining will be ovulated during a woman's reproductive lifetime.

   - As the girl approaches ovulation, her body produces increasing amounts of a hormone called estrogen which causes the lining of the uterus to thicken which helps to create a sperm friendly environment.
   - These high estrogen levels trigger a sudden increase in another hormone called luteinizing hormone (LH). The 'LH' surge causes the release of the mature egg from the ovary- this is ovulation. When a mature egg leaves a woman's ovary and travels into the fallopian tube a sperm cell can fertilize the egg here.
   - The egg can only be fertilized for up to 24 hours after ovulation. If it isn't fertilized the lining of the womb is shed (the egg is lost with it) and your period begins. This marks the start of the next menstrual cycle.

2.

   - Meiosis I begins with one diploid parent cell and ends with two haploid daughter cells, halving the number of chromosomes in each cell. Meiosis II starts with two haploid parent cells and ends with four haploid daughter cells, maintaining the number of chromosomes in each cell.
   - Homologous pairs of cells are present in meiosis I and separate into chromosomes before meiosis II. In meiosis II, these chromosomes are further separated into sister chromatids.
   - Meiosis I includes crossing over or recombination of genetic material between chromosome pairs, while meiosis II does not.

For a more detailed differentiation between meiosis I and II. The following differences are provided in a tabular form:

Meiosis I	Meiosis II
Reductive division	Equational division
Complicated division process	Simple division process
Long duration	Short duration
Preceded by S-phase and G-phase	Preceded by only G-phase
Prophase is split into 5 sub-phases	Prophase does not have sub-phases
Equatorial plane is centered	Equatorial plane is rotated 90 degrees
Sister chromatids in prophase have convergent arms	Sister chromatids in prophase have divergent arms

3. Human fertilization is the union of a human egg and sperm, usually occurring in the ampulla of the fallopian tube. The result of this union is the production of a zygote cell or fertilized egg, initiating prenatal development. We can also say that it is the fusion of haploid gametes, egg and sperm to form diploid zygote.

Fertilization process requires about 24 hours. During the 24 hours of fertilization, the following stages take place:

- Passage of a sperm through the corona radiata:

  For sperms to pass through the corona radiata, they must have been capacitated (removal of the glycoprotein coat and seminal plasma proteins from the plasma membrane that overlies the acrosomal region of the spermatozoa). Only capacitated sperms can pass freely through the corona radiata.

- 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. The intact acrosome of the sperm binds with a zona glycoprotein (zona protein 3) on the zona pellucida. Release of acrosomal enzymes (acrosin) allows sperm to penetrate the zona pellucida, thereby coming in contact with the plasma membrane of the

oocyte. As soon as the head of a sperm comes in contact with the oocyte surface, the permeability of the zona pellucida changes. When a sperm comes in contact with the oocyte surface, lysosomal enzymes are released from cortical granules lining the plasma membrane of the oocyte. In turn, these enzymes alter properties of the zona pellucida to prevent sperm penetration and inactivate binding sites for spermatozoa on the zona pellicida surface.

- 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.

- 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. The nucleus of the mature ovum/oocyte is now called the female pronucleus.

- 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. Since all sperm mitochondria degenerate, all mitochondria within the zygote are of maternal origin. Morphologically, the male and female pronuclei are indistinguishable. The oocyte now contains 2 pronuclei, each having haploid number of chromosomes (23). The oocyte containing two haploid pronuclei is called an ootid.

- The 2 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 in preparation for cleavage of the zygote

4. Monozygotic and dizygotic twins are two types of offspring produced by the same pregnancy. The main difference between monozygotic and dizygotic twins is that monozygotic twins are developed from one embryo, splitting into two

embryos whereas dizygotic twins are developed from two different eggs, which are fertilized by sperms separately.

For a more detailed differentiation between Monozygotic and dizygotic twins. The following differences are provided in a tabular form:

Monozygotic Twins	Di-zygotic Twins
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
Cause is not known	Caused by IVF, certain fertility drugs, hereditary predisposition.
Bear a high risk of TTTS	Bear a low risk of TTTS
One third of the twins in the world are monozygotic	Two thirds of the twins in the world are dizygotic