Name: Onjewu Claire
Matriculation Number: 18/MHS01/306
College: College of Medicine and Health Sciences
Department: Department of Medicine and Surgery
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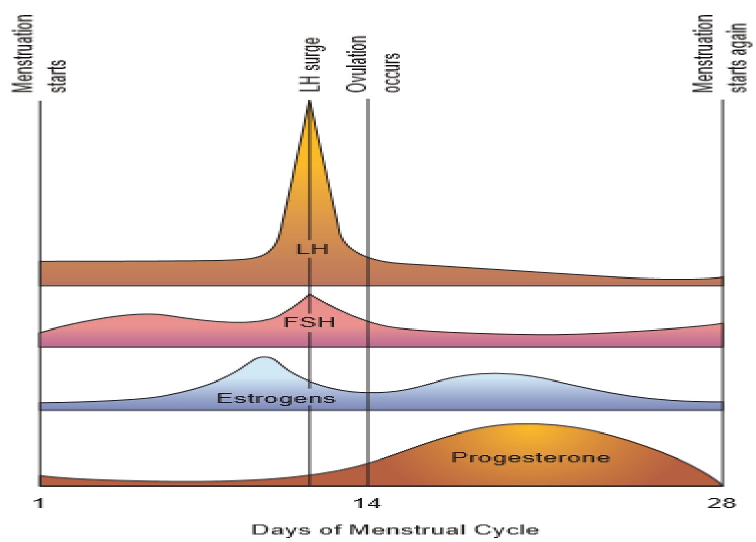
Assignment Questions

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

Answers

1. In a few days before ovulation, the mature vesicular follicle grows rapidly to about 25mm.



Source: Keith Moore et al (2016). The Developing Human Clinically Oriented Embryology 10th Edition

This rapid growth is induced by both the Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH). The increase in Luteinizing Hormone causes the primary oocyte to complete the first meiotic division and the follicles to enter the preovulatory mature vesicular stage. The oocyte begins the second meiotic division, at about three hours to ovulation it is arrested at Metaphase II by cytostatic factors. On the surface of the ovary there is a swelling, an avascular stigma then appears. The concentration of Luteinizing Hormone then increases the release and activity of the enzyme collagenase which will break down the collagen fibers around the secondary oocyte. Also the Luteinizing Hormone surge increases the Prostaglandin levels which cause the contraction of the ovarian walls thereby compressing the ovary to extrude the oocyte. During the development of the follicles the oocyte is surrounded by the cumulus oophorus, as such these cells also are extruded with the secondary oocyte. Some the cells of the cumulus oophorus rearrange themselves around the secondary oocyte to form the corona radiata. This process is referred to as ovulation. Ovulation can then be defined as the release of a secondary oocyte from the mature ovarian follicle into the ovary. It is a cyclic change that occurs in the ovarian cycle. The ovarian cycle coincides with the menstrual cycle, invariably so does ovulation. Hence at the middle of the menstrual cycle ovulation occurs.

Clinical Correlates

i. During ovulation some women may experience pain in the lower abdomen this is referred to as mittleschmerz which means middle pain. This is because ovulation occurs at the middle of the menstrual cycle.
ii. Ovulation is generally accompanied with:
   An increase in basal body temperature.
   Changes in the cervical mucus.
   A heightened sense of smell.
   Tenderness of soreness of breasts.
   Mild pelvic or abdominal pain.
   Light spotting.
   Libido changes.
   Changes in the cervix as it becomes more open.

2. The table below highlights some differences between Meiosis I and Meiosis II

S/N	Meiosis I	Meiosis II
1	Meiosis I is preceded by Interphase.	Interphase does not take place in Meiosis II.
2	Meiosis I is the first cell division of meiosis.	Meiosis II is the second cell division of meiosis.
3	Two daughter cells are produced at the end of Meiosis I.	Four daughter cells are produced at the end of Meiosis II.
4	The sub-phases of Meiosis I include: Prophase I, Metaphase I, Anaphase I and Telophase I.	The sub-phases of Meiosis II include: Prophase II, Metaphase II, Anaphase II and Telophase II.
5	Synapsis occurs in Meiosis I	Synapsis does not occur in Meiosis II
6	Crossing over of genetic materials occur in Meiosis I.	Crossing over of genetic materials does not occur in Meiosis II.
7	Chiasma formation occurs in Meiosis I.	Chiasma formation does not occur in Meiosis II.
8	In Meiosis I homologous chromosomes separate from one another.	In Meiosis II homologous chromosomes do not separate from one another.
9	In Meiosis I sister chromatids do not separate from each other.	In Meiosis II sister chromatids separate from each other.
10	In Meiosis I centromere does not split.	In Meiosis II centromere split.

3. Fertilization is the process by which a male gamete fuses with a female gamete. It occurs in the ampulla of the uterine tube. It is an important event that occurs in the first week of human development.

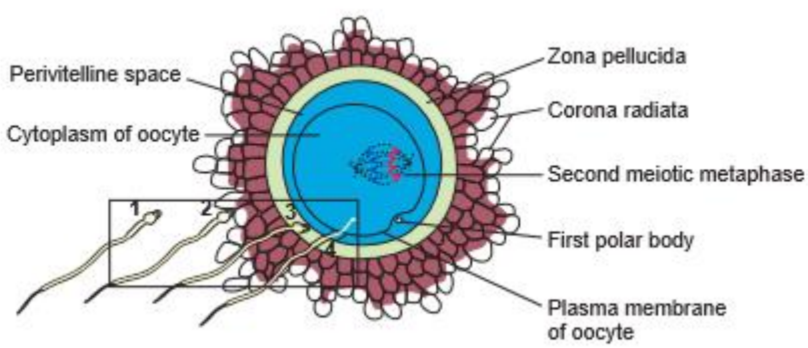
   Fertilization is a sequence of coordinated events Aand it takes approximately 24 hours to occur.

Stages of Fertilisation

Fertilization is a sequence of events. The following are the stages involved:

i. Passage of a sperm through the corona radiata: The sperm does not immediately fertilize the oocyte. It most first undergo capacitation – which is the removal of the glycoprotein coat and seminal plasma proteins that overlies the acrosome region of the sperm. Only a capacitated sperm can pass the corona radiata.

ii. Penetration of 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 esterase, acrosin, and neuraminidase appear to cause lysis (dissolution or loosening) of the zona pellucida, thereby forming a path for the sperm to enter 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.



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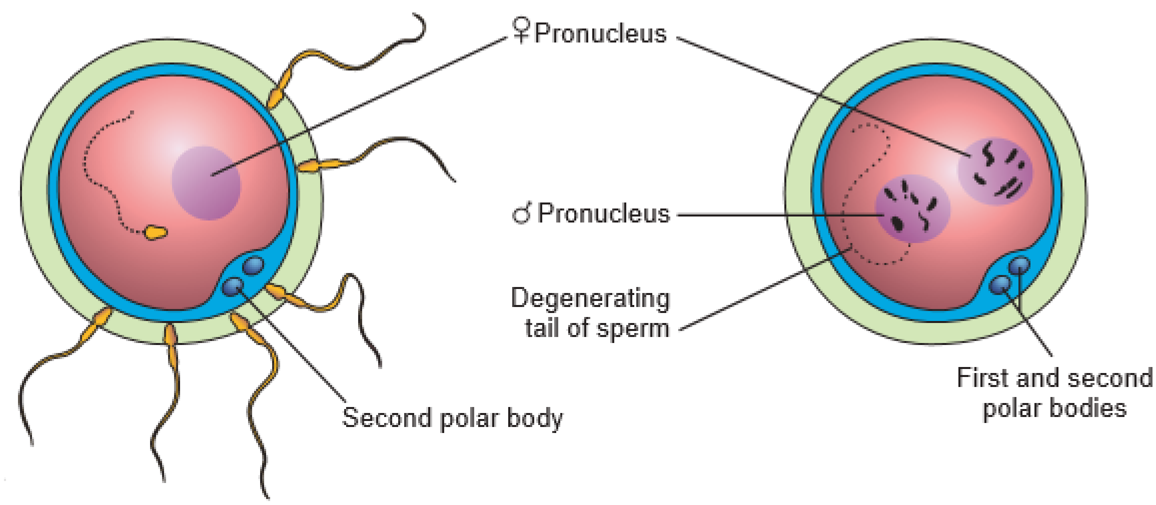
iii. Fusion of plasma membrane of the sperm and the oocyte: The plasma or cell membranes of the oocyte and sperm fuse and break down in the area of fusion.

The head and tail of the sperm enter the cytoplasm of the oocyte but the sperm's cell membrane (plasma membrane) and mitochondria remain behind.

iv. Completion of the 2nd meiotic division and formation of the 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.

v. Formation of 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. The oocyte containing the two haploid pronuclei is called an ootid, the nearly mature oocyte after the first meiotic divisions have been completed.



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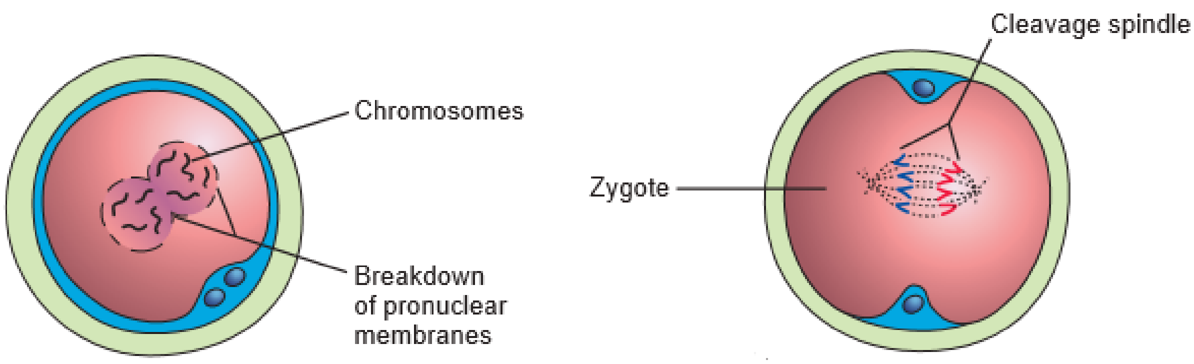
vi. Formation of zygote: The chromosomes in the zygote become arranged on a cleavage spindle in preparation for cleavage of the zygote. The zygote is genetically unique because half of its chromosomes come from the mother and half from the father. The zygote contains a new combination of chromosomes 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. Meiosis allows independent assortment of maternal and paternal chromosomes among the germ cells.



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Clinical Correlates

Fertilization in modern times can be made possible through various means they include:

In Vitro Fertilization (IVF): IVF of oocytes and transfer of cleaving zygote has made it possible for women who are sterile to have children. Cryopreservation of embryos resulting from IVF is a fertilization technique.

Intracytoplasmic Sperm Injection: A sperm can be injected directly into the cytoplasm of a mature oocyte. This technique has been successfully used for the treatment of couples for whom IVF failed, or in cases where there are too few sperms available.

Assisted In Vivo Fertilization: A technique enabling fertilization to occur in the uterine tube is called gamete intrafallopian (intratubal) transfer. It involves superovulation (similar to that used for IVF), oocyte retrieval, sperm collection, and laparoscopic placement of several oocytes and sperms into the uterine tubes. Using this technique, fertilization occurs in the ampulla, its usual location.

Surrogate Mothers: Some women produce mature oocytes but are unable to become pregnant. In these cases, IVF may be performed and the embryos transferred to another woman's uterus for fetal development and delivery.

4. In the table below are differences between monozygotic and dizygotic twins.

S/N	Monozygotic Twins	Dizygotic Twins
1	Monozygotic twins are genetically identical	Dizygotic twins are not genetically dentical.
2	In monozygotic twins one sperm fertilizes the oocyte	In dizygotic twins two sperms fertilize two different oocytes.
3	Monozygotic twins share a placenta	Dizygotic twins have separate placenta.
4	Monozygotic twins will have the same gender.	Dizygotic twins are of different genders.
5	Monozygotic twins share the same amniotic sac.	Dizygotic twins have separate amniotic sac
6	Monozygotic twins share the same chorionic sac.	Dizygotic twins have separate chorionic sac
7	Monozygotic twins are less common.	Dizygotic twins are more common.
8	Monozygotic twins have similar resemblance.	The resemblance in dizygotic twins is like that of any other sibling.
9	The zygote forms one blastocyst in monozygotic twins.	The two zygotes form two different blastocyst in dizygotic twins.
10	The embryoblast split into two in monozygotic twins.	The embryoblasts in each blastocyst do not split in dizygotic twins
11	Monozygotic twins are usually conjoined twins.	Dizygotic twins are not conjoined twins.

Reference

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