**19/MHS01/445**

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**MEDICINE AND SURGERY**

**EMBRYOLOGY ASSIGNMENT**

**QUESTIONS**

1. Discuss ovulation

2. Differentiate between meiosis 1 and meiosis 2

3. Discuss the stages involved in fertilization

4. Differentiate between monozygotic and dizygotic twins

**ANSWERS**

1. Discuss ovulation

Ovulation is the release of secondary oocyte from the ovary into the fallopian tube, through which the oocyte is carried into the uterus.

Ovulation occurs about midway through the [menstrual cycle](https://en.wikipedia.org/wiki/Menstrual_cycle%22%20%5Co%20%22Menstrual%20cycle). The time from the beginning of the [last menstrual period](https://en.wikipedia.org/wiki/Last_menstrual_period%22%20%5Co%20%22Last%20menstrual%20period) until ovulation is, on average, 14 days. The process of ovulation is controlled by the [hypothalamus](https://en.wikipedia.org/wiki/Hypothalamus%22%20%5Co%20%22Hypothalamus) of the brain and through the release of hormones secreted in the [anterior lobe](https://en.wikipedia.org/wiki/Anterior_pituitary%22%20%5Co%20%22Anterior%20pituitary) of the [pituitary gland](https://en.wikipedia.org/wiki/Pituitary_gland%22%20%5Co%20%22Pituitary%20gland), [luteinizing hormone](https://en.wikipedia.org/wiki/Luteinizing_hormone) (LH) and [follicle-stimulating hormone](https://en.wikipedia.org/wiki/Follicle-stimulating_hormone%22%20%5Co%20%22Follicle-stimulating%20hormone) (FSH).

As the matured vesicular follicle develops, there is a sudden increase in luteinizing hormone being released from the pituitary gland as a result of estrogen peaking. This surge causes two events;

* The primary oocyte completes meiosis I and becomes the secondary oocyte.
* The follicle enters the pre-ovulatory mature vesicular stage (Graafian follicle)

Also, meiosis II is initiated, but the secondary oocyte is arrested in metaphase approximately 3 hours before ovulation. This arrest is caused by cytostatic factors which are cytoplasmic factors found in an oocyte.

A local bulge forms on the surface of the ovary. At the apex of this bulge, an avascular area, the stigma, appears. The stigma is formed as a result of luteinizing hormone surge, as a result of thinning of the oocyte’s cellular and extracellular matrix layers.

There is an increases collagenase activity, resulting in digestion of collagen fibers (connective tissue) surrounding the follicle. There are also local muscular contractions in the ovarian wall caused by increase in Prostaglandin. These actions are also caused by the surge in luteinizing hormone.

The contractions extrude the oocyte, which together with its surrounding follicular (granulosa) cells from the region of the cumulus oophorus. A corona radiata is formed from cells of the cumulus oophorus cells which rearrange around the zona pellucida.

2. Differentiate between meiosis 1 and meiosis 2

Meiosis is the cell division that takes place in the germ cells to generate male and female gametes, sperm and egg cells, respectively.

**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.

Meiosis 2: Individual, bivalent chromosomes are present at the beginning of meiosis 2.

**Phases** 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.

3. Discuss the stages involved in fertilization

Fertilization is the union of the sperm and oocyte. The usual site of fertilization is the ampulla of the uterine tube. It process takes approximately 24 hours

Stages of fertilization

* Passage of a sperm through the corona radiate
* Penetration of the zona pellucida:
* Fusion of plasma membranes of the oocyte and sperm
* Completion of the second meiotic division of oocyte and formation of female pronucleus
* Formation of the male pronucleus
* The 2 pronuclei fuse into a single diploid aggregation of chromosomes, the ootid becomes a zygote

 **Passage of a sperm through the corona radiate**

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)

**Penetration of the zona pellucida**

The zona pellucida 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 (ZP3/ 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 (i.e., all mitochondrial DNA is 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. Differentiate between monozygotic and dizygotic twins

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Twinning is the nurturing of 2 conceptuses at the same time. They can be monozygotic and dizygotic.

**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 is 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.

**Gender of Twins**

Monozygotic Twins: The gender of monozygotic twins are same.

Dizygotic Twins: The gender of dizygotic twins are different.

**Blood Type**

Monozygotic Twins: The blood type 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.