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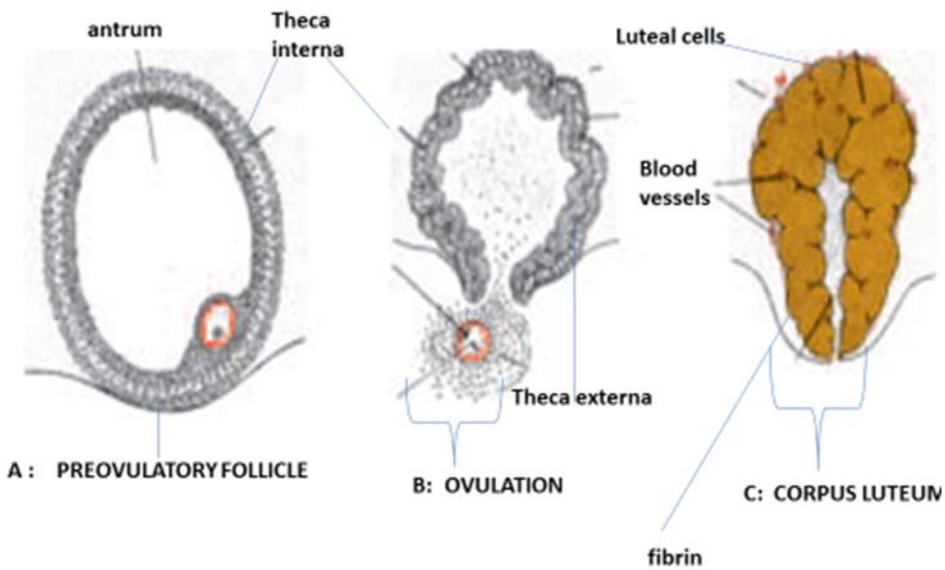
COURSE: Embryology

Discuss ovulation

Ovulation is the release of eggs from the ovaries. It is the release; it is the release of a secondary oocyte from the ovarian follicle. This event occurs in women when the ovarian follicles rupture and release the secondary oocyte ovarian cells. In a few days before ovulation, under the influence of FSH [Follicle-Stimulating Hormone] and LH [Luteinizing Hormone], the secondary follicle grows rapidly to a diameter of about 25 mm to become mature vesicular/ mature secondary or 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 secondary 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. Due to the high concentration of LH collagenase activity increases, this results in digestion of collagen fibers surrounding the follicle. The prostaglandin levels also increase in response to the surge in LH causing local muscular contractions in the ovarian wall. Those contractions extrude the oocyte, which together with its surrounding granulosa (follicular) cells from the region of the cumulus oophorus, causing ovulation in which oocyte floats out of the ovary and some of the cumulus oophorus cells then rearrange themselves around the zona pellucida to form the corona radiate.

Therefore, it is notable to say that ovulation is triggered by a surge of LH production, it 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. Ovulation marks the end of the follicular phase of the ovarian cycle and the start of the luteal phase. After ovulation, during the luteal phase the egg will be available for fertilization by the sperm. In addition, the uterine lining (endometrium) is thickened to receive a fertilized egg. However, if no conception occurs, the uterine lining as well as blood will shed during a process called menstruation.



Clinical significance

During ovulation, some women feel a slight amount of abdominal pain called **middle pain** [also known as mittelschmer], this is because it normally occurs near the middle of the menstrual cycle. In these cases, ovulation results in slight bleeding into the peritoneal cavity, which results in sudden constant pain in the lower abdomen. Ovulation is also generally accompanied by a rise in basal temperature, which can be tracked and monitored to aid in determining when the release of oocyte occurs.

Some women fail to ovulate, this is called **anovulation**. Anovulation is the absence of ovulation when it would be normally expected in a post-menarchal, premenopausal female. It usually manifests itself as irregularity of menstrual periods, that is, unpredictable variability in duration and intervals. Anovulation occurs as a result of a low concentration in 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 risk of multiple pregnancies is 10 times higher in these women than in the general population.

DIFFERENTIATE BETWEEN MEIOSIS 1 AND MEIOSIS 2

- Homotypic/Heterotypic division

Meiosis 1: Meiosis 1 is a heterotypic division, reducing the chromosomal 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.

- RESULT

Meiosis1: 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 in meiosis 1 are divided to produce four daughter cells.

- CROSSING OVER, SYNAPSIS AND CHIASMA FORMATION

Meiosis 1: Crossing over takes place in meiosis 1 during prophase 1, an exchange of genetic materials between non sister chromatids occur. Synapsis and chiasma formation also occurs in the prophase 1 phase.

Meiosis 2: Crossing over, synapsis and chiasma formation do not occur in meiosis 2 during the prophase 2 phase.

- COMPLEXITY AND TIME TAKEN

Meiosis 1: Meiosis 1 is a more complex division, hence, it takes more time.

Meiosis 2: Meiosis 2 is comparatively simple and less time is taken for the division.

- CLEVAGE OF THE COHESIN COMPLEX

Meiosis 1: Cohesin protein complexes at the arms of the homologous chromosomes are cleaved.

Meiosis 2: Cohesin at the centromeres are cleaved in order to separate the two sister chromatids.

- PRECEDING PHASES

Meiosis 1: Meiosis 1 is preceded by the S-phase and G-phase

Meiosis 2: Meiosis 2 is preceded only by the G-phase

- ARMS

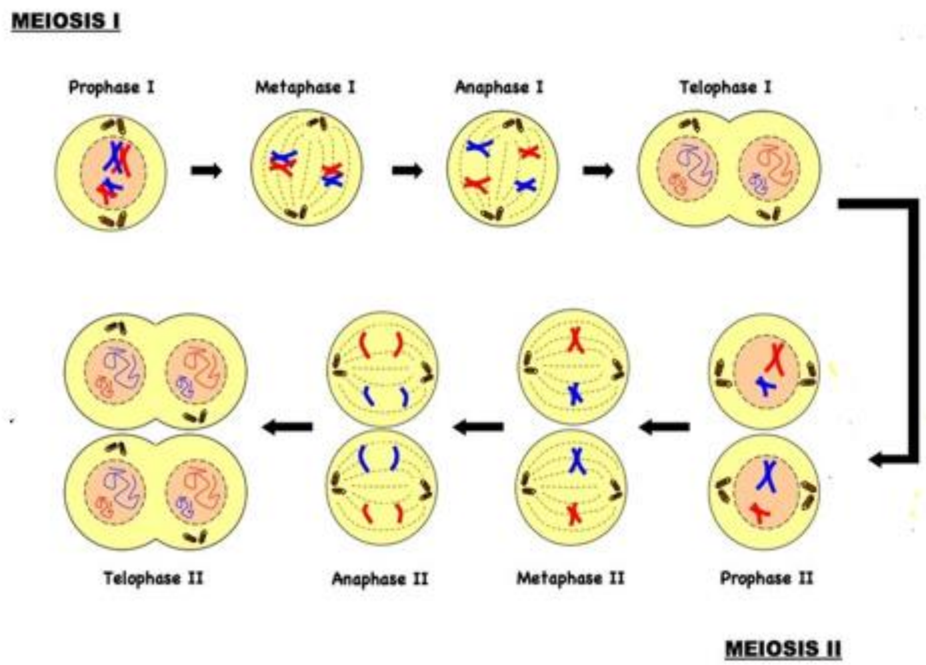
Meiosis 1: Sister chromatids in the prophase phase of meiosis 1 have convergent arms.

Meiosis 2: Sister chromatids in the prophase phase of meiosis 2 have divergent arms.

- EQUATORIAL PLANE

Meiosis 1: In meiosis 1 the equatorial plane is centered

Meiosis 2: In meiosis 2, the equatorial plane is rotated 90̊.



DISCUSS THE STAGES INVOVED IN FERTILIZATION

Fertilization is the union of the sperm and oocyte, it is the process by which male and female gametes fuse. It occurs in the **ampulla region** of the uterine tube. This is the widest part of the tube and is close to the ovary. The fertilization process takes approximately 24 hours; It is a sequence of coordinated events which include the following stages:

I 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.

II 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 (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, inactivate binding sites for spermatozoa on the zona pellucida surface and only one sperm seems to be able to penetrate the oocyte.

III. 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.

IV 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 f**emale pronucleus.**

V 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.**

VI 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.

DIFFERENTIATE BETWEEN MONOZYGOTIC AND DIZYGOTIC TWINS

- FREQUENCY

Monozygotic twins: It is rare; it does not occur frequently.

Dizygotic twins: It is the more common form of twinning.

- FORMATION

Monozygotic twins: Monozygotic twins are developed by the splitting of a fertilized embryo into two.

Dizygotic twins: Dizygotic twins are formed when two different sperms fertilize two different oocytes.

- GENETICS

Monozygotic twins: Monozygotic twins are genetically identical, there is a high level of resemblance.

Dizygotic twins: Dizygotic twins are not genetically identical, they do not look alike

- GENDER

Monozygotic twins: Monozygotic twins are always of the same gender.

Dizygotic twins: Dizygotic twins can be of different gender

- BLOOD TYPES

Monozygotic twins: Monozygotic twins have the same blood types

Dizygotic twins: Dizygotic twins are of different blood types

- PAIRING

Monozygotic twins: Monozygotic twins share the same amniotic sac and chorionic sac but, they have different umbilical cords.

Dizygotic twins: Dizygotic twins do not share amniotic sac, chorionic sac, and umbilical cord each of them have theirs separate from the other.