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SCIENCES

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COURSE: GENERAL EMBRYOLOGY

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## **GENERAL EMBRYOLOGY ASSIGNMENT**

### 1) Discuss ovulation

Ovulation is the release of a secondary oocyte from the ovarian follicle. Ovulation is the release of eggs from the ovaries. In women, this event occurs when the ovarian follicles rupture and release the secondary oocyte ovarian cells. After ovulation, during the luteal phase, the egg will be available to be fertilized by sperm. In addition, the uterine lining (endometrium) is thickened to be able to receive a fertilized egg. If no conception occurs, the uterine lining as well as blood will be shed during menstruation. Around the middle of the ovarian cycle, the ovarian follicle, under the influence of follicle stimulating hormone and luteinizing hormone undergoes a sudden growth spurt, producing a cystic swelling or bulge on the surface of the ovary. A small avascular spot, the stigma soon appears on this swelling. Before ovulation, the secondary oocyte and some cells of the cumulus oophorus, detach from the interior of the distended follicle. The secondary follicle grows rapidly to a diameter about 25mm to become a mature vesicular / mature secondary or Graafian follicle. There is an abrupt increase in LH coincident with final development of the vesicular follicle that causes the primary oocyte to enter meiosis 1 and the follicle to ensure the preovulatory mature vesicular stage. Meiosis 2 is also initiated but the secondary oocyte is arrested in metaphase approximately 3 hours before ovulation. For the oocyte to be released, 2 events occur which are caused by LH surge: it increases collagenase activity resulting in digestion of collagen fibers surrounding the follicle and prostaglandin levels also increase in response to the LH surge and cause local muscular contractions in the ovarian

wall. These contractions extrude the oocyte which together with its surrounding follicular (granulosa) cells from the region of the cumulus oophorus and this causes ovulation in which the oocyte floats out of the ovary. Ovulation is triggered by a surge of LH production. Ovulation 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 vesicles. The stigma soon ruptures, expelling the secondary oocyte with the follicular fluid. Expulsion of the oocyte is the result of intrafollicular pressure, and possibly by contraction of smooth muscle in the theca external (sheath) owing time stimulation by prostaglandins. Mitogen-activated protein kinases 3 and 1 (MAPK 3/1), also known as extracellular signal-regulated kinases 1 and 2 (ERK 1/2), in ovarian follicular cells seem to regulate signaling pathways that control ovulation.

### **CLINICAL CORRELATES:**

During ovulation, some women feel a variable amount of abdominal pain called mittelschmerz also known as middle pain because it normally occurs near the middle of the menstrual cycle.

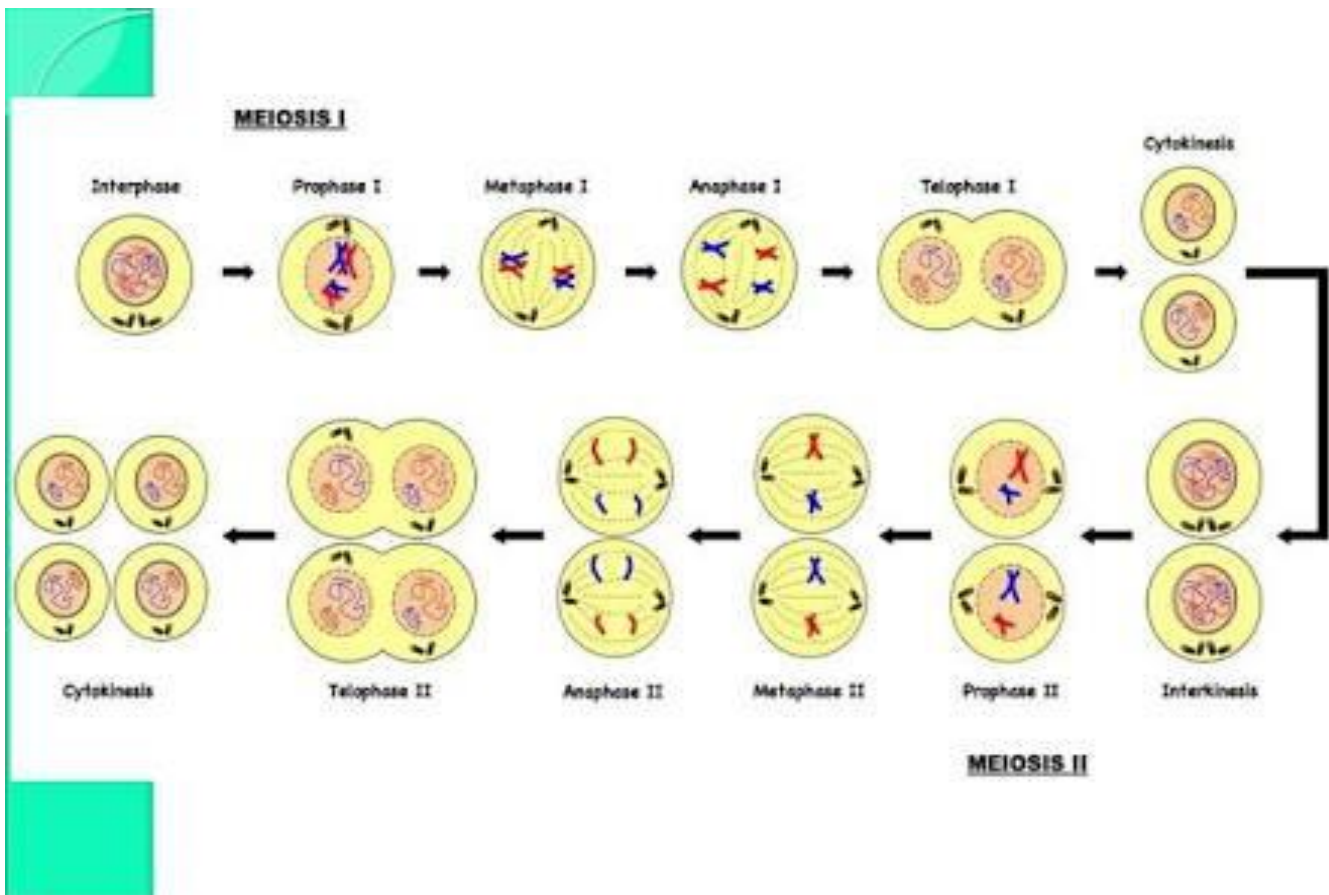
Other signs of ovulation include:

- 1) Changes in the cervical mucus
- 2) Increase libido/increase urge for sex
- 3) Tenderness of breast
- 4) Swollen vagina / vulva
- 5) Slight drop in the basal body temperature

Also the use of ovulation predictor kits (OPKs) help to detect the LH surge, which occurs 12 to 36 hours before ovulation, you can be sure to have sex at just the right time for conception. Some women may fail to ovulate, this is called **anovulation** because of the low concentration of gonadotropins.

2) Differentiate between meiosis 1 and meiosis 2

DIFFERENCES	MEIOSIS 1	MEIOSIS 2
DEFINITION	Meiosis 1 is the first cell division of meiosis	Meiosis 2 is the second cell of division
SUBPHASES	Prophase 1, metaphase1, anaphase 1 and telophase1	Prophase 2,metaphase2,anaphase 2and telophase 2
NUMBER OF CELLS PROUCED	Two	Four
CHROMOSOME NUMBER	Becomes half	Does not divide into half
CHROMOSOME SEPARATION	Homologous chromosomes separate from each other.	Sister chromatids separate from each other
NATURE	Heterotypic division	Homotypic division
CROSSING OVER AND GENETIC RECOMBINATION	Crossing over and genetic recombination occur	Crossing over and genetic recombination does not occur
DURATION	Longer	Shorter
SPLITTING OF CENTROMERES OF CHROMOSOMES	Does not take place	Centromeres split and sister chromatids separate
INTERPHASE BEFORE 1	There is interphase before meiosis 1	There is no interphase between meiosis 1 and 2



### **CLINICAL SIGNIFICANCE OF MEIOSIS 1 AND 2**

- 1) Responsible for the formation of sex cells or gamete that are responsible for sexual reproduction
- 2) Activates the genetic information for the development of sex cells and deactivates the sporophytic information
- 3) Maintains the constant number of chromosomes by having the same.

However, chromosome abnormalities can be numerical and structural. They include down syndrome, patau syndrome, cri du chat syndrome, angelman syndrome etc.

### 3) Discuss the stages involved in fertilization

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

It is a sequence of coordinated events which include the following stages:

#### 1) Passage of a sperm through the corona radiata:

Dispersal of the follicular cells of the corona radiata surrounding the oocyte and zona pellucida appears to result mainly from the action of the enzyme hyaluronidase released from the acrosome of the sperm. For sperms to pass through the corona radiata, they must be capacitated (removal of glycoprotein coat and seminal plasma proteins from the plasma membrane that overlies the acrosome region of the spermatozoa)

#### 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. The intact acrosome of the sperm binds with a zona glycoprotein (ZP3/ Zona protein) on the zona pellucida. Release of acrosomal enzymes (acrosin) allows the sperm to bind the zona pellucida thereby coming in contact with the plasma membrane of the oocyte. As soon as the head of the sperm comes in contact with oocyte surface, the permeability of the zona pellucida changes. When the sperm comes in contact with the oocyte surface, lysosomal enzymes are released from the cortical granules lining the plasma membrane of the oocyte. In turn the enzyme also alter the properties of the zona pellucida to prevent sperm penetration and inactivate binding sites for spermatozoa on the zona pellucida surface making it seem that only one sperm can penetrate the oocyte.

#### 3) Fusion of the plasma membranes of the oocyte and sperm:

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.

4) Completion of the second meiotic division of the oocyte and the formation of female pronucleus :

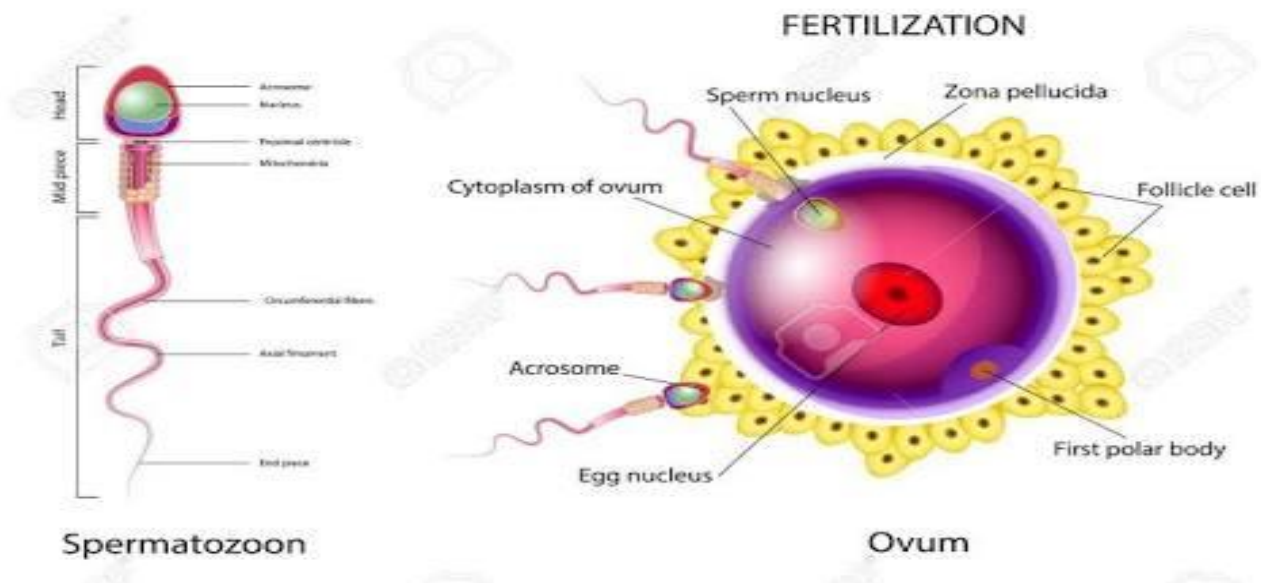
Penetration of the oocyte by a sperm activates the oocyte into completing the second meiotic division and forming a mature oocyte and a second polar body. The nucleus of the mature ovum/oocyte is now called the female pronucleus.

5) 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. The oocyte now contains 2 pronuclei, each having haploid number of chromosomes (23). The oocyte containing two haploid pronuclei is called ootid

6) 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.



**CLINICAL CORRELATES:**

- 1) Ectopic tubal pregnancy: occurs when the blastocyst implants within the uterine tube due to delayed transport. The ampulla of the uterine tube is the most common site of ectopic tubal pregnancy
- 2) In vitro fertilization: is a process by which an egg is fertilized by a sperm outside the body in vitro (outside) in a glass.
- 3) Intracytoplasmic sperm injection : a sperm can be injected directly into the cytoplasm of a mature oocyte which is done when a sperm has difficulty penetrating the egg



4) Differentiate between monozygotic and dizygotic twins;

DIFFERENCES	MONOZYGOTIC TWIN	DIZYGOTIC TWIN
DEFINITION	Monozygotic twins are the two offspring that develops from one zygote	Dizygotic twins are the two offspring that develop from two separate zygote
GENETIC COMPOSITION	They originate from the same fertilized egg and fertilized by the same sperm so they share the same DNA. Resemblance is similar.	They originate from two fertilized egg and fertilized by two sperm therefore they do not share the same DNA. Resemblance is just like any other two siblings.
PLACENTA, AMNIOTIC SAC AND CHORION SAC	Zygote only share the outer layer of the amniotic sac and have the two placentas but changes if divided within 4-8 days	Have a separate placenta, amniotic sac and chorion.
CAUSE	Due to the random splitting of the zygote into two embryos	Due to two separate eggs fertilized by two sperms

GENDER	Same gender	Can be different or the same gender
APPEARANCE OF TWINS	Monozygotic twins almost have the same appearance	Dizygotic twins may have the same appearance or different appearance
CHARACTERISTICS	Monozygotic twins have the chance for same characters, developments	Dizygotic twins don't have the same characters, developments
HEREDITARY	Not hereditary	Hereditary
INCIDENCE	Incidence is more common	Incidence is less common
ANOTHER NAME	Also known as identical twins	Also known as fraternal twins

**CLINICAL CORRELATES:**

- 1) **CONJOINT (SIAMESE) TWINS:** It occurs when the inner cell mass (embryoblast) does not completely split. In this condition, the 2 fetuses are joined to each other by a tissue bridge. It can be classified into four based on site and extent of fusion and they include craniophagus, thoracophagus, cephalophagus and pygophagus.
- 2) **PARASITIC TWINS:** It occurs when one member of conjoint twins remains rudimentary due to diminished blood supply and grows like a parasite from the body of the well developed co-twin.
- 3) **SUPERFECUNDATION:** It is the fertilization of two or more oocytes at different times. Although, it is rare in humans.

**MONOZYGOTIC AND DIZYGOTIC TWIN**

