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COURSE: EMBRYOLOGY

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QUESTIONS

- Discuss ovulation
- Differentiate between meiosis I and meiosis II
- Discuss the stages involved in fertilization
- Differentiate between monozygotic and dizygotic twins

ANSWERS

OVULATION:

Introduction: The typical female pelvis has two ovaries, one on either side of the uterus. Each ovary is attached to the uterus by its utero ovarian ligament, and to the pelvic sidewall by the infundibulopelvic ligament, which carries the ovarian vessels. Ovaries contain oocytes, or eggs, which are female gametes. Females are born with a lifetime supply of immature oocytes, each ovary containing one million to two million eggs. While the number of eggs declines with time, within a typical female lifespan, about 300 to 500 eggs mature and progress through ovulation, the process of mature egg release from the ovary into the adjacent fallopian tube, through which the egg is carried into the uterus.

Definition: Ovulation can be defined as the release of an oocyte from the ovarian follicles. Ovulation occurs at about day 14 of a typical 28-day cycle. Estrogen levels rise as a result of increasing estrogen production by hormonally active cells within the follicle. Estrogen levels reach a critical point at which estrogen begins to exert positive feedback on the hypothalamus and pituitary, leading to an LH surge. The LH surge increases intrafollicular proteolytic enzymes, weakening the wall of the ovary and allowing for the mature follicle to pass through.

Shortly before ovulation, the secondary follicle grows quickly to a diameter of approximately 25mm under the influence of follicle stimulating hormone and luteinizing hormone to become the graafian follicle. As the vesicular follicle develops finally, there is an abrupt increase in the luteinizing hormone that causes; the primary oocyte to enter the preovulatory mature vesicular stage and the primary oocyte to complete meiosis I.

Meiosis II begins but is arrested in metaphase II approximately three hours before ovulation. As this occurs, the surface of the ovary begins to bulge locally and at the apex an avascular spot, the stigma appears. Before the oocyte is released, two events which are caused by the luteinizing hormone occur. The collagenase activity resulting in digestion of collagen fibers surrounding the follicle increase, the levels of prostaglandin in response to luteinizing hormone surge increase and cause local muscular contractions in the ovarian wall. Those contractions extrude the oocyte which together with its surrounding follicular cells from the region of the cumulus oophorous which causes the OVULATION in which the oocyte floats out of the ovary.

Hormones involved in ovulation include:

Gonadotropin-releasing hormone (GnRH) is a tropic peptide hormone made and secreted by the hypothalamus. It is a releasing hormone that stimulates the release of FSH and LH from the anterior pituitary gland. Low-frequency GnRH pulses are responsible for FSH secretion whereas high-frequency pulses are responsible for LH secretion.

Follicle-Stimulating Hormone (FSH) is a gonadotropin synthesized and secreted from the anterior pituitary gland in response to GnRH. It is involved in reproductive processes of both males and females. FSH stimulates the growth and maturation of immature oocytes into mature (Graafian) follicles before ovulation.

Luteinizing Hormone (LH) is a gonadotropin synthesized and secreted by the anterior pituitary gland in response to GnRH. Like FSH, LH is involved in reproductive processes in both males and females. When follicle maturation is complete, an LH surge triggers ovulation.

Progesterone is a steroid hormone that is responsible for preparing the endometrium for uterine implantation of the fertilized egg. If a fertilized egg implants, the corpus luteum secretes progesterone in early pregnancy until the placenta develops and takes over progesterone production for the remainder of the pregnancy.

Estrogen is a steroid hormone that is responsible for the growth and regulation of the female reproductive system and secondary sex characteristics. Estrogen is produced by the granulosa cells of the developing follicle and exerts negative feedback on LH production in the early part of the menstrual cycle. However, once

estrogen levels reach a critical level as oocytes mature within the ovary in preparation for ovulation, estrogen begins to exert positive feedback on LH production, leading to the LH surge. Estrogen also has many other effects which are important for bone health and cardiovascular health in premenopausal patients.

Luteal Phase

The luteal phase lasts from day 14 to 28 of a typical cycle. It begins with formation of the corpus luteum and ends in pregnancy or luteolysis (destruction of the corpus luteum). FSH and LH stimulate what remains of the mature follicle after ovulation to become the corpus luteum. The corpus luteum grows and secretes progesterone and some estrogen, which make the endometrium more receptive to implantation. If fertilization does not occur, progesterone and estrogen levels fall, and the corpus luteum dies. These falling hormone levels stimulate FSH to begin recruiting follicles for the next cycle. If fertilization does occur, human chorionic gonadotropin (hCG) produced by the early placenta preserves the corpus luteum, maintaining progesterone levels until the placenta is able to make sufficient progesterone to support the pregnancy.

Clinical correlates of ovulation

Mittelschmerz

1. Mittelschmerz is one-sided, lower abdominal pain that affects some women. It occurs at or around the time when an egg is released from the ovaries (ovulation)
2. One in five women have pain around the time of ovulation. This is called mittelschmerz. The pain may occur just before, during, or after ovulation.
3. This pain can be explained in several ways. Just before the ovulation, the growth of the follicle where the egg develops may stretch the surface of the ovary. This can cause pain. At the time of ovulation, fluid or blood is released from the ruptured egg follicle. This may irritate lining of the abdomen.

Symptoms

- Mittelschmerz may be felt on one side of the body during one month and then switch to the other side during the next month. It may also occur on the same side for many months in a row.
- Symptoms include lower-abdominal pain that:
- Occurs only on one side.
- Goes on for minutes to a few hours. It can last up to 24 to 48 hours.
- Feels like a sharp, cramping pain unlike other pain.
- May switch sides from month to month.
- Begins midway through the menstrual cycle

Changes in body temperature

Basal body temperature (BBT) refers to the temperature you have when you first wake up in the morning prior to moving your body at all. Basal body temperature rises by about 1°F or less during the 24-hour window after ovulation occurs. This is caused by the secretion of progesterone, the hormone which helps your uterine lining become spongy and thick in preparation for implantation of an embryo.

Changes in cervical mucus

Cervical mucus (CM) is made up primarily of water. Triggered by surging estrogen levels, it changes in consistency during fertile window and may provide clues about ovulation.

Produced by the glands of the cervix, CM is the conduit which helps transport sperm to an egg. During your fertile window, this nutrition-rich, slippery fluid increases in volume. It also becomes thinner, stretchy in texture, and clear in color. CM is often referred to as having an egg white consistency during this time.

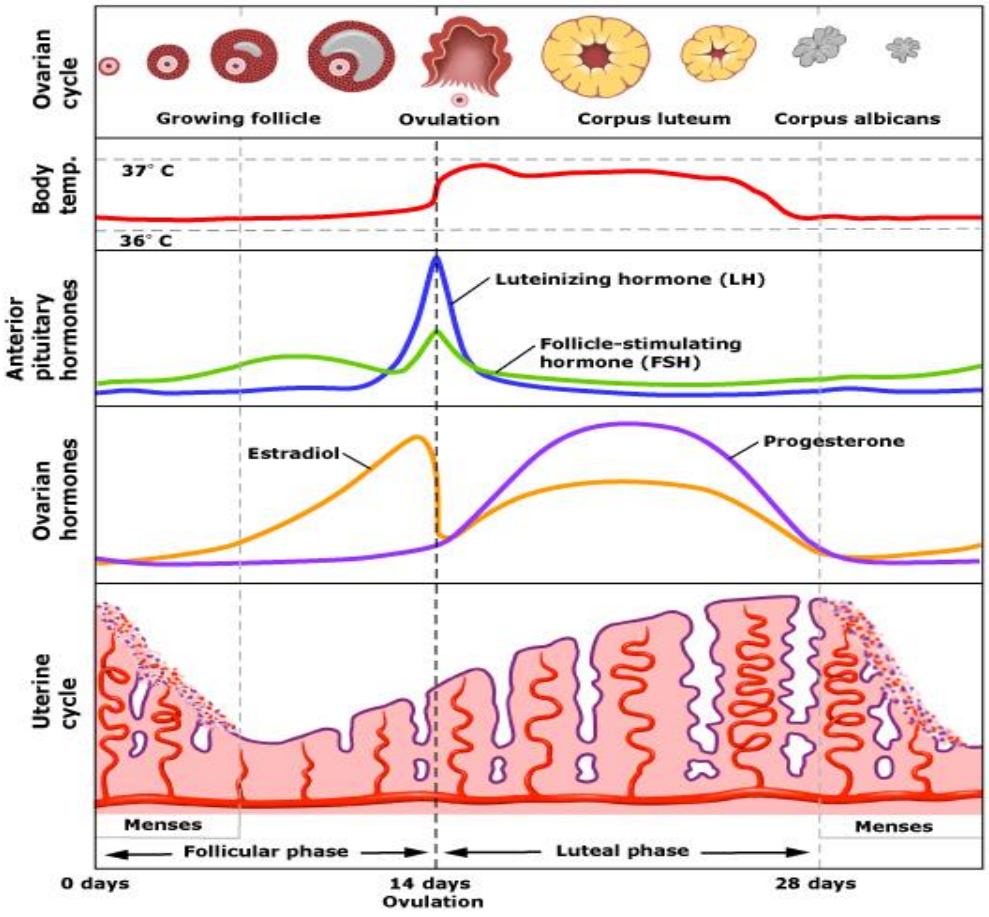
In the days leading up to ovulation, more discharge than usual may be noticed. This is caused by an increase in CM volume.

Ovulation prediction kit

There are several different types of at-home ovulation predictor kits and fertility home monitors. Many of these measures the luteinizing hormone in urine. LH rates increase one to two days before ovulation takes place. This is known as the LH surge.

The LH surge is typically a good predictor of ovulation.

Other indicators of ovulation include; increase libido, tenderness of breast and swollen vagina or vulva.



DIFFERENTIATE BETWEEN MEIOSIS I & MEIOSIS II:

S/N	***MEIOSIS I***	***MEIOSIS II***
1	*Synapsis occurs*	*Synapsis is absent*
2	*Crossing over takes place*	*Crossing over is absent*
3	*Chiasma formation occurs*	*Chiasma formation is absent*
4	*Is a heterotypic division*	*Is a homotypic division*

STAGES INVOLVED IN FERTILIZATION

Fertilization refers to the fusion or joining of female or male gametes to form a zygote. There are five stages of fertilization. This occurs in the ampulla of the uterine tube and takes about 24 hours.

It has four stages which will be discussed below.

1. **Passage of a sperm through the corona radiata;**

The first stage is the penetration of **corona radiata**, by releasing hyaluronidase from the acrosome to digest cumulus cells surrounding the oocyte and exposing acrosin attached to the inner membrane of the **sperm**. ... It is necessary for the acrosome reaction to occur before the **sperm** cell reaches the zona pellucida.

It results from:

1- Action of an enzyme called hyaluronidase released from the acrosome of the sperm which helps in dispersal of corona radiata cells.

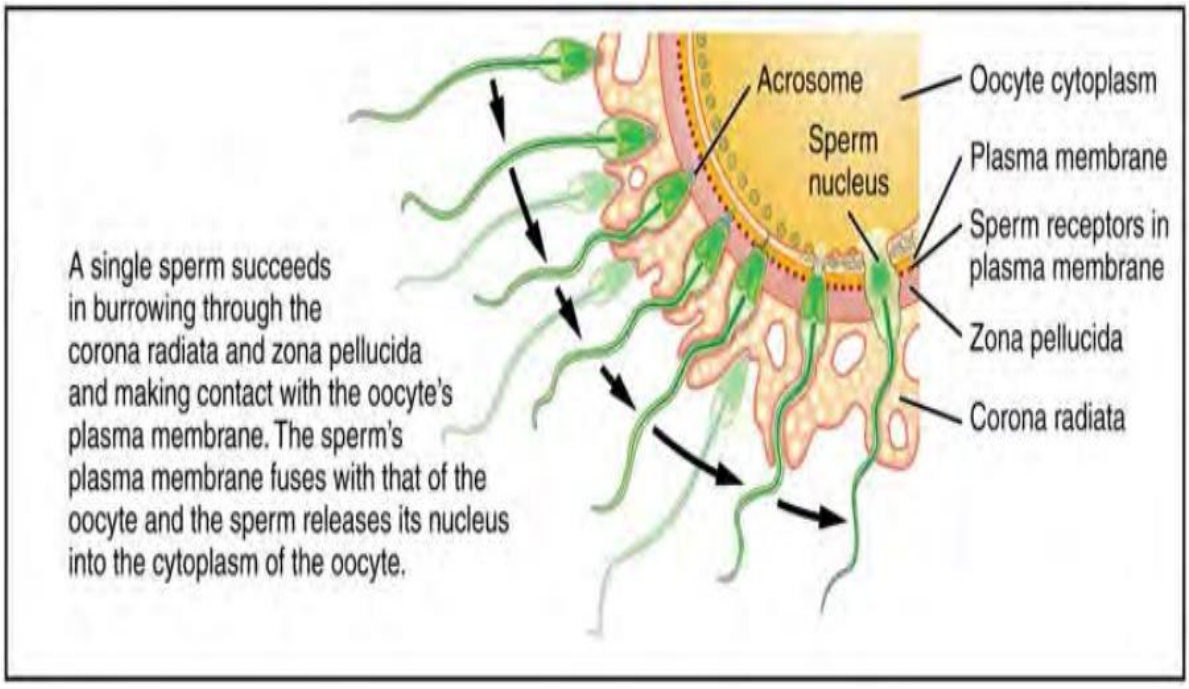
2- Constant propulsive force of the sperm's tail.

2. Penetration of the zona pellucida

The **zona pellucida** is the extracellular coat of the mammalian oocyte, it ia glycoprotein shell that surrounds the egg.It acts as a selective filter before fertilization that can only be penetrated by sperm that have completed the acrosome reaction.

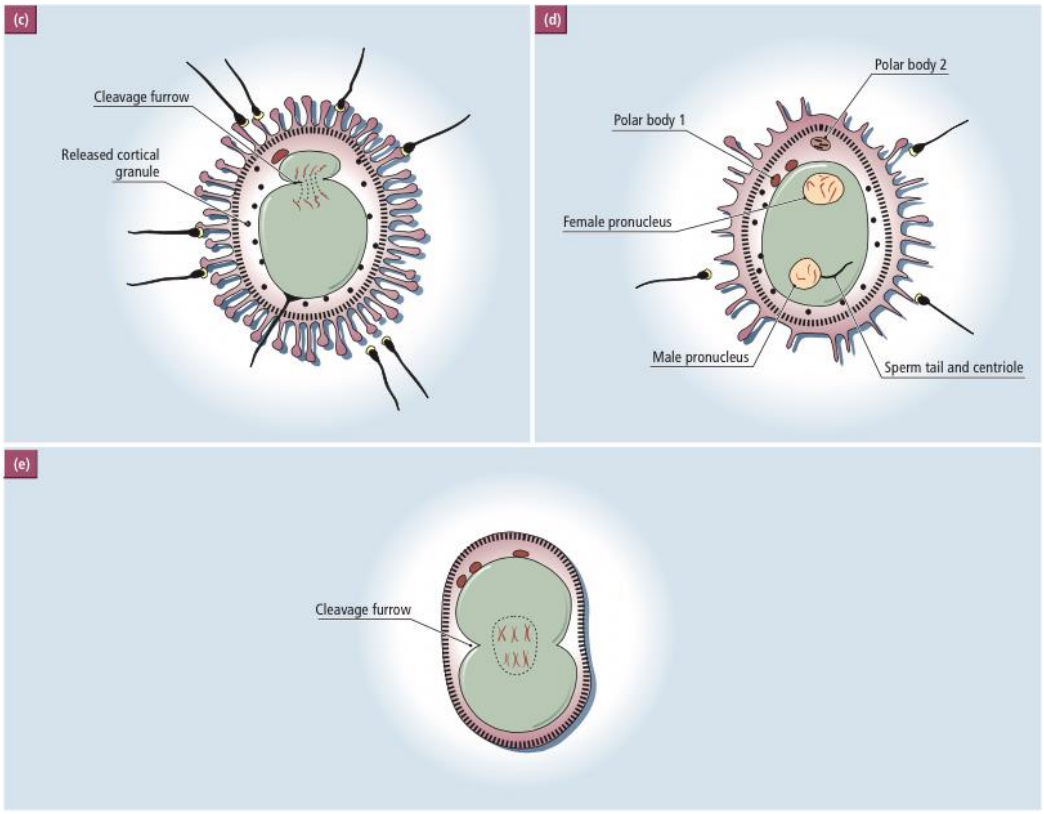
Constant propulsive force from the sperm's flagellating tail.acrosomal enzymes (esterases, acrosin & neuraminidase) allow the sperm to create a tract through the zona pellucida.

When the head of the a sperm comes in contact with the oocyte surface, the permeability of the zona pellucida changes.



3. Fusion of plasma membranes of the oocyte and sperm

During fertilization, **membrane** merging (hereafter referred to as "**membrane fusion**") occurs between the **plasma membranes** of the **sperm** and **egg**. After this **membrane fusion**, several **sperm** factors enter the **egg** and activate cellular signaling in the **egg**.



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

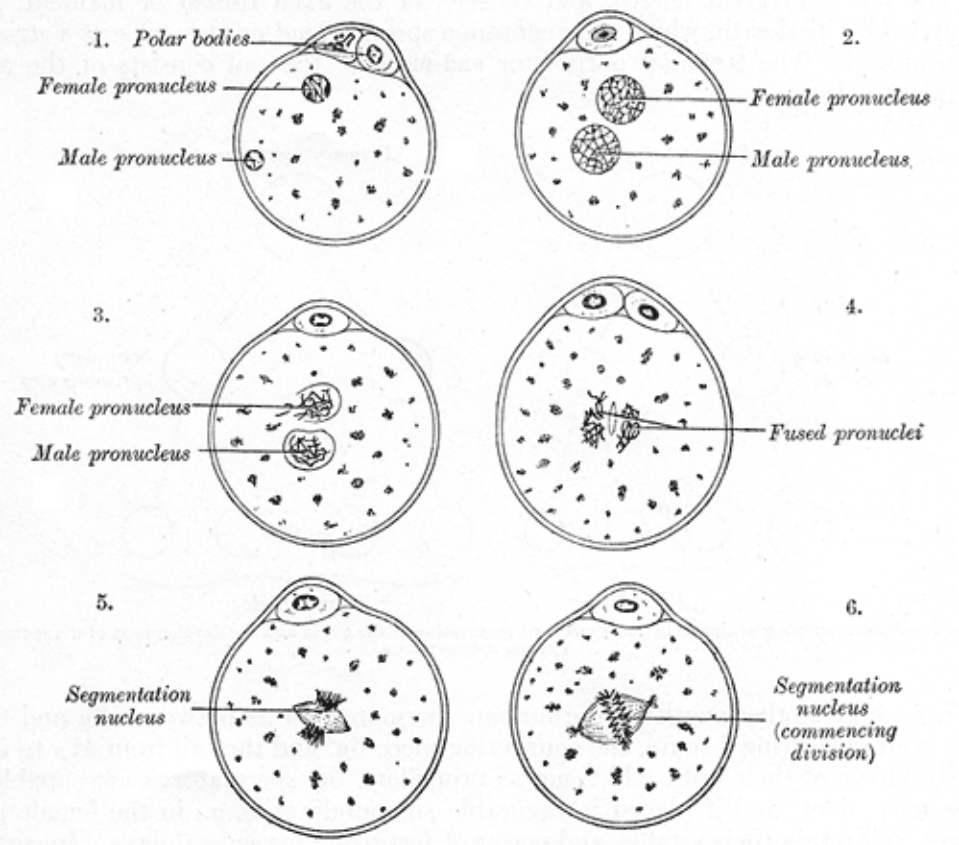
The sperm penetrating the oocyte, activates the oocyte into completing the second meiotic division and forming a mature oocyte and a second polar body. The female pronucleus can be defined as the nucleus that remains in a **female** gamete

after the meiotic reduction division and extrusion of polar bodies and contains only one half the number of chromosomes characteristic of its species.

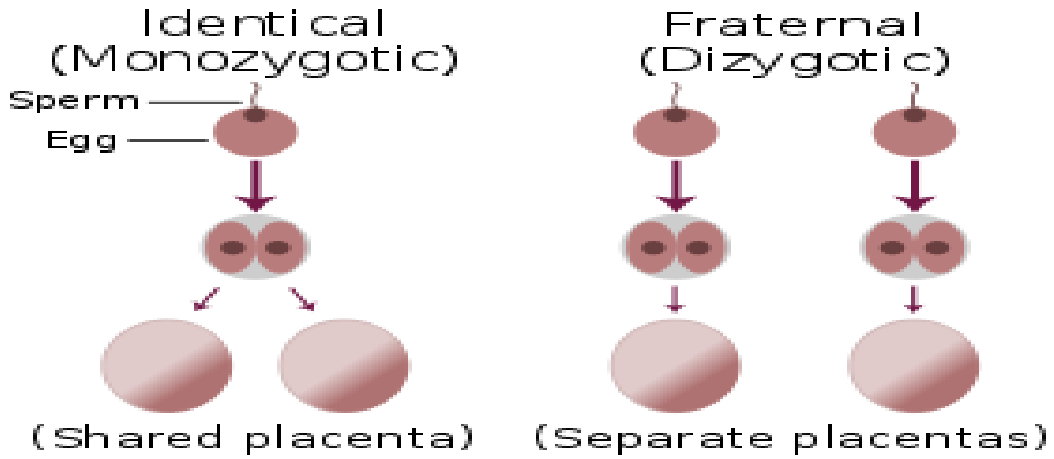
Formation of the male pronucleus

The nucleus of the sperm enlarges in the cytoplasm with the tail degenerating to form the male pronucleus.

The male and female pronuclei then fuse into a single diploid aggregation of chromosomes. The ootid becomes a zygote.



DIFFERENTIATE BETWEEN MONOZYGOTIC AND DIZYGOTIC TWINS



S/N	***MONOZYGOTIC TWINS***	***DIZYGOTIC TWINS***
1	*Developed be a singular fertilized embryo splitting into 2*	*Developed Through two independent but simultaneous fertilization events*
2	*They are genetically identical*	*They are genetically unidentical*
3	*They are always the same gender*	*They can be different gender*
4	*They always have the same blood group*	*They can have different blood types*
5	*Resemblance is similar*	*Resemblance is just like any other two siblings*
6	*Mostly diamniotic and monochorionic*	*Mostly have 2 amnions and 2 chorions*
7	*Are often called conjoined twins*	*Not seen as conjoined twins*