NAME: OJO, IYESENI PRISCILLA

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DEPARTMENT: MEDICINE AND SURGERY

COURSE: EMBRYOLOGY

COLLEGE: MEDICINE AND HEALTH SCIENCES

Question 1: Discuss ovulation

Ovulation is a phase of the female menstrual cycle that involves the release of an egg (ovum) from one of the ovaries. New life begins if the ovum meets with a sperm during its journey down the fallopian tube.

Ovulation depends on a complex interplay of glands and their hormones, and generally occurs about two weeks before the onset of the menstrual period. It typically happens during the 14^{th} day of a 28 day menstrual cycle. However, not everyone has a 28 day cycle, so the exact timing can vary

Part of the ovary called the ovarian follicle discharges an egg. The egg is also known as an ovum, oocyte, or female gamete. It is only released on reaching maturity.

After release, the egg travels down the fallopian tube, where it may be met by a sperm and become fertilized.

Ovulation and hormonal release during the menstrual cycle are controlled by a part of the brain called the hypothalamus. It sends signals instructing the anterior lobe and pituitary gland to secrete luteinizing hormone (LH) and follicle-stimulating hormone (FSH). The hormones are produced between days 6 and 14 of your menstrual cycle. The hormone helps the egg inside the ovary to mature in preparation to release the egg later.

When the egg becomes mature, your body releases a surge of luteinizing hormone, triggering the egg's release. Ovulation may happen between 28 to 36 hours after the LH surge.

Ovulation typically stops after menopause, between the ages of around 50 to 51 years on average, but it still occurs in the time leading up to menopause. This is referred to as peri-menopause. Glands involved in the ovulation process include the; hypothalamus, pituitary, and ovaries.

Signs of ovulation

The female body shows several signs of ovulation. You may experience some or all of these signs, including:

- regular menstrual cycles – menstrual periods that arrive every 24–35 days are more likely to be ovulatory than periods that occur more or less often
- mucus changes – about two weeks before menstruation, if you are ovulating you may notice slick and slippery cervical mucus
- Abdominal pain – some women experience pain during ovulation. The pain may be general or localized to one side of the abdomen
- premenstrual symptoms – ovulation may accompany premenstrual symptoms such as breast enlargement and tenderness, abdominal bloating and moodiness
- Temperature rise – women who use a natural family planning method of contraception will notice a small rise in their basal temperature after ovulation has occurred. The temperature rise is about half a degree Celsius. This temperature rise does not predict ovulation – it suggests that ovulation has already taken place.

Question 2: Differentiate between meiosis 1 and meiosis 2

	Meiosis 1	Meiosis 2
Homotypic/Heterotypic division	this is a heterotypic division, reducing the chromosome number in the daughter cell by half, compared to the parent cell	This is a homotypic division, equalizing the number of chromosomes of both parent and daughter cell
Chromosomes	Homologous chromosomes are present at the beginning	Individual, bivalent chromosomes are present at the beginning
Number of daughter cells at the end	Two daughter cells are produced from a single parent cell	The two daughter cells produced at meiosis 1 are separately divided to produce 4 cells
Cross over	Chromosomal cross-over occurs during prophase 1, by exchanging the genetic material between non-sister chromatids	No chromosomal cross-over occurs during prophase 1
Interphase	Interphase is followed by meiosis 1	No interphase takes place prior to the meiosis 2. A resting phase, interkinesis occurs
Prophase	Splits into 5 sub phases	Does not have sub phases
Division	Reductive	Equational
Time taken	Time taken in meiosis 1 is more since it is a complex division	Comparatively simple, and less time is taken for this division

Question 3: Discuss the stages involved in fertilization

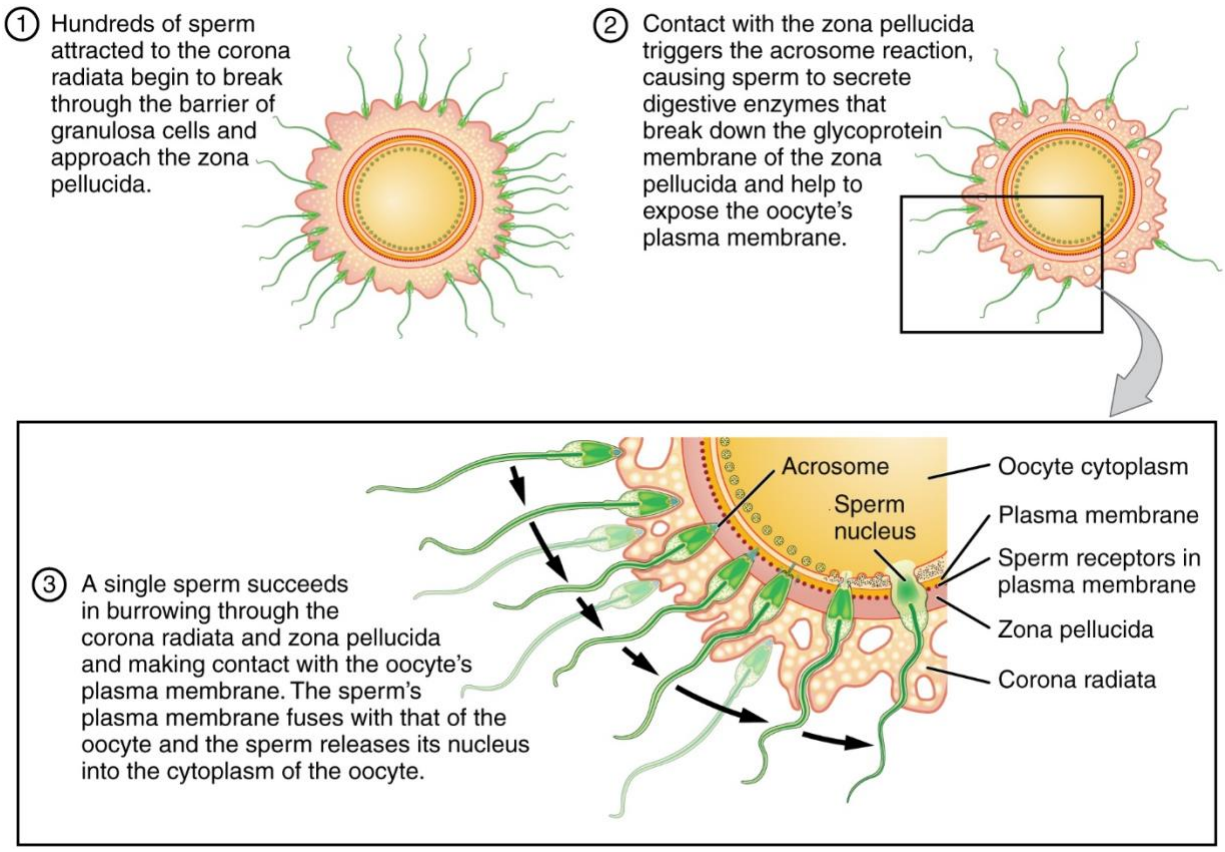
Fertilization is the union of the human egg (oocyte) and sperm, usually occurring at the ampulla of the fallopian tube. The result of this union is the production of a zygote cell, initiating prenatal development.

The stages of fertilization include the following:

1. **Passage of the sperm through the *corona radiata***: The corona radiata is an outer layer of follicular (granulosa) cells that form around a developing oocyte in the ovary and remain with it upon ovulation. For sperms to pass through the corona radiata, they must have been capacitated (process that occurs in the female reproductive tract in which sperm are prepared for fertilization; leads to increased motility and changes in their outer membrane that improve their ability to release enzymes capable of digesting an oocyte's outer layers);
2. **Penetration of the *zona pellucida*:** the *zona* is a transparent, but thick glycoprotein membrane that surrounds the cell's plasma membrane which facilitates and maintains sperm binding and induces the acrosome reaction. The sperm first burrow through the cells of the corona radiata. Then, upon contact with the zona pellucida, the sperm bind to receptors in the zona pellucida. This initiates a process called the acrosomal reaction in which the enzyme-filled "cap" of the sperm, called the acrosome, releases its stored digestive enzymes. These enzymes clear a path through the zona pellucida that allows sperm to reach the oocyte. 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. Only one sperm seems to be able to penetrate the oocyte.
3. **Fusion of the plasma membranes of the oocyte and sperm**: Finally, a single sperm makes contact with sperm-binding receptors on the oocyte's plasma membrane. The plasma membrane of that sperm then fuses with the oocyte's plasma membrane, and the head and mid-piece of the "winning" sperm enter the oocyte interior. The head and

tail of the sperm enter the cytoplasm of the oocyte, but the sperm's plasma membrane remains behind .

4. **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.
5. **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).
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.

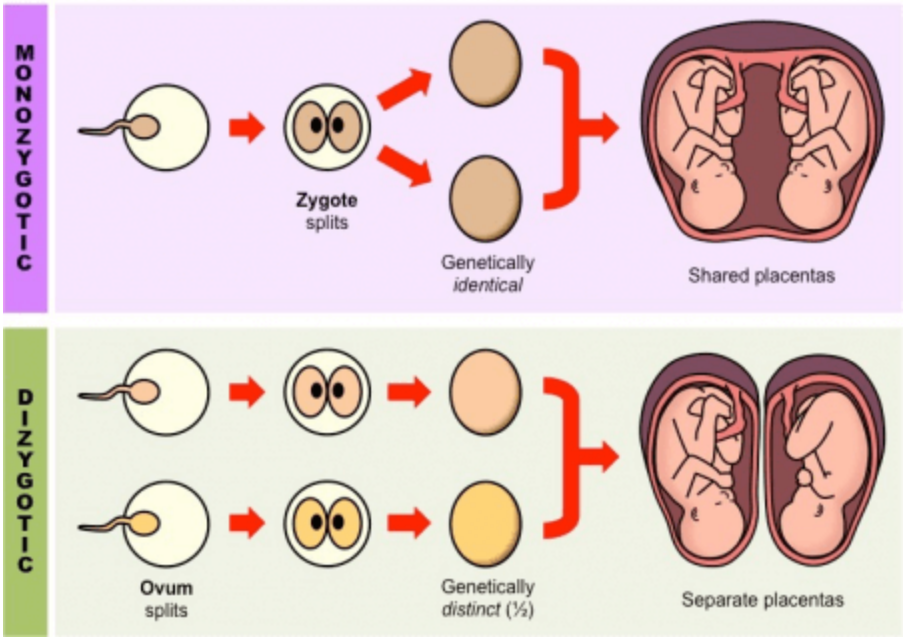


Question 4: Differentiate between monozygotic twins and dizygotic twins

Monozygotic twins are developed by the splitting of a fertilized embryo. The embryo is developed from the zygote, which is formed by the fusion of one egg with one sperm. Both individuals share the same chromosome since they were developed by the splitting of an embryo. Therefore the genetic code of monozygotic twins is considered as the same. Hence, monozygotic twins are called as identical twins.

Dizygotic twins are developed by separate fertilizations of two eggs by two sperms. They are genetically varied as any two siblings. Hence, their gender is also different from each other. They can either be girl/boy, boy/boy or girl/girl. Therefore, they are called fraternal twins.

	Monozygotic twins	Dizygotic twins
Genetic code	The genetic codes are nearly identical	The genetic codes are the same as any other sibling
Development	The twins are developed by the splitting of a fertilized embryo into two	They are developed by two separate fertilization events occurring at the same time
Gender	Genders are the same	Genders may or may not be the same
Blood type	Blood type are usually the same	Blood type may not be the same
Appearance	They are extremely similar but may vary depending on the environmental factors	The appearance is similar as any other sibling
Inside the uterus	They can either be Di-Di, Mono-Di or Mono-Mono twins	They are only Di-Di twins
Causes	The cause for this type of twins is unknown	This is caused by IVF, certain fertility drugs or hereditary predisposition due to the hyper-ovulation


MONOZYGOTIC
Zygote
splits
Genetically
identical
Shared placentas
DIZYGOTIC
Ovum
splits
Genetically
distinct (½)
Separate placentas