AGHEDO PEACE EGHOGHO

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MBBS

OVULATION

Ovulation is the release of oocyte from the female ovary which occurs in the middle of the menstrual cycle. For ovulation to occur, it involves some important hormones. Gonadotropin releasing hormone (GnRH) is secreted by the hypothalamus and it stimulates the release of follicle stimulating hormone (FSH) and luteinizing hormone (LH) from the anterior pituitary gland. Hypothalamus secrets GnRH in pulsatile fashion; low frequency GnRH is responsible for FSH secretion and high frequency pulse for LH secretion.

After birth, the primary oocytes are dormant in the ovary as the primordial follicle. At puberty; secretion for FSH and LH begins.FSH stimulates the growth and maturation of immature oocytes. At puberty, a large number of primordial follicles begin process of maturation into primary follicles; with the help of FSH, the primary follicles transform from small, simple, flat follicular cell to stratified cuboidal cells. The zona pellucida also develops at this stage.

The secondary follicle is recognised by the development of the fluid filled antrum; this phase is gonadotropin dependent. Selection of a dominant follicle for ovulation is gonadotropin dependent. The Increasing estrogen levels send a negative feedback signal decreasing the circulating levels of FSH. Large follicles will remain sensitive to the decreasing levels of FSH. The other small follicles that are developing will degenerate because their small size decreases its sensitivity to FSH.

Follicular cells of the Graafian follicle develop estrogen in preparation for ovulation allowing estrogen levels rise. Estrogen levels reach a critical point at which estrogen exerts a positive feedback on the hypothalamus and pituitary leading to an LH surge. LH surge occurs 12-24 hours before ovulation and the LH surge allows the primary oocyte to complete meiosis 1 and enter meiosis 2. It allows the follicle to enter the preovulatory phase; it increases collagenase activity resulting in digestion of connective tissue collagen, prostaglandin levels increase allowing muscular contraction of the ovary and for the avascular stigma to bulge out.

Meiosis 1 and Meiosis 2

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| Features | Meiosis 1 | Meiosis 2 |
| Disjunction(Anaphase) | Homologous chromosome pair separate | Sister chromatids separate |
| Synapsis (prophase) | Pairing of homologous chromosomes occur to form synapsis called tetrad | No synapsis |
| Crossing over (prophase) | Homologous chromosomes in tetrad cross over to interchange genetic material | No homologous recombination |
| Duration | Takes longer time duration | Short duration |
| S phase (Interphase) | Preceded by S (synthesis) phase | Not preceded by S phase |
| Prophase | Prophase is split into 5 sub-phases | Prophase does not have sub-phases |
| Telophase | Has 2 daughter cells | 4 daughter cells |
| Division type | Heterotypic division | Homotypic division |
| Chiasma formation (prophase) | Formation of cross shaped configuration | No chiasma formation |
| Prophase | Begins with homologous chromosome pairs | Begins with sister chromatids |
| Division | Begins with one diploid parent cell and ends with 2 haploid daughter cells | Begins with two haploid parent cells and ends with four haploid daughter cells. |

Fertilization

The first step in fertilization is sperm capacitation; capacitation includes multiple physiological and biochemical modifications. The biochemical changes include efflux of cholesterol from the plasma membrane to increase membrane fluidity and permeability of bicarbonate and calcium ions among others. Capacitation involves changes to the cell membrane of the sperm. Sperms are decapacitated in the epididymis. The reality is that freshly ejaculated sperm are decapacitated and therefore unable to fertilize. Rather, they must first undergo a series of changes (capacitation) which is associated with removal of adherent seminal plasma proteins, reorganisation of membrane lipids and proteins. Capacitation takes place during sperm transport and it takes about 7 hours. Sperms that have undergone capacitation are said to become hyperactivated and display hyperactivated motility. It appears to destabilize the sperm membrane to prepare it for the acrosome reaction.

1. Passage of sperm through the corona radiata: only capacitated sperms are able to pass through the corona radiata to get to the region of the zona pellucida.
2. Penetration of zona pellucida: zona pellucida is a glycoprotein coat formed around the oocyte. Binding of the sperm to the zona pellucida is a receptor-ligand interaction. The carbohydrate groups on the zona pellucida glycoprotein function as sperm receptors. After binding comes the acrosomal reaction, capacitation of the sperm leaves the acrosome exposed at the anterior of the cell. The zona protein (ZP3) that serves as a cell receptor also stimulates a series of events that lead to fusion. Membrane fusion and vesiculation expose the acrosomal content leading to leakage of acrosomal enzymes. As the acrosome reaction progresses the sperm is able to penetrate through the zona pellucida. The constant propulsive force from the flagellum (hyperactivity of capacitated sperm) in combination with the acrosomal enzymes, allow the sperm to penetrate the zona pellucida.
3. Fusion of plasma membrane of oocyte and sperm: as soon as the sperm penetrates the zona pellucida, the plasma membrane of the sperm fuses with the oocyte plasma membrane as the head and tail of the sperm enter the oocyte.
4. Completion of second meiotic division and formation of female pronucleus: prior to fertilization, the oocyte is arrested in metaphase of the second meiotic division but upon binding of the sperm, the oocyte undergoes some metabolic and physical changes called egg activation. There is a rise in cell calcium level, completion of 2nd meiotic division and cortical reaction. Cortical reaction is exocytosis of cortical granules. Cortical granules diffuse into the zona pellucida altering its structure; it hardens the zona pellucida and inactivates sperm receptors on its surface preventing polyspermy. The oocyte is activated and completes 2nd meiotic division and forms a mature oocyte. The nucleus of a mature oocyte is called the female pronucleus.
5. Formation of male pronucleus: in the oocyte, the head enlarges and the tail disintegrates to give rise to the male pronucleus.
6. The two pronuclei fuse into a single diploid aggregation of chromosomes, the ootid becomes a zygote: an oocyte containing two pronuclei is called an ootid. The nuclear membranes of the pronuclei disappear and the chromosomes are drawn towards each other to form a diploid zygote.

Monozygotic twins are identical. They are formed from a single fertilized egg. They begin as a single egg that has been fertilized by a single sperm and they may or may not share an amniotic sac or placenta depending on how early the single fertilized egg divides into two. They are of the same gender

Dizygotic twins are fraternal twins. They are from two separate fertilized eggs; when an egg is released from each ovary simultaneously during ovulation. They develop two separate amniotic sac, placentas and supporting membranes.