Lec. 1 Embryology Dr. Lubna Al Khafaji

Embryology: is the branch of biology that studies the development of gametes (sex cells), fertilization and development of embryo and fetuses. Also study the congenital disorders that occur before birth.

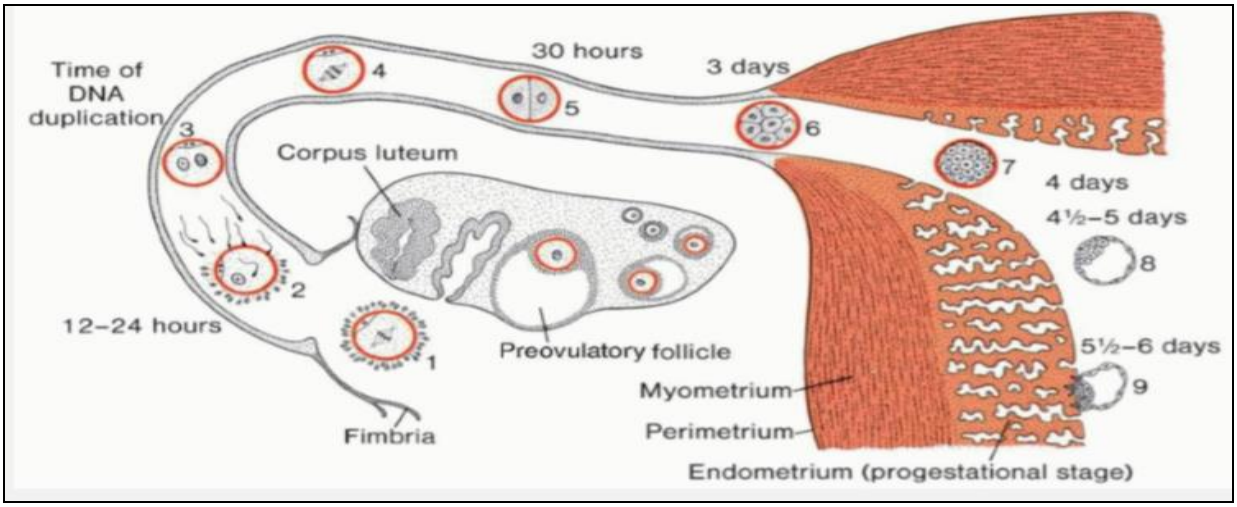
Human Embryology: is the study of this development during the first 8 weeks after fertilization. The normal period of gestation (pregnancy) is 9 months or 38 weeks.

Human Embryogenesis: is the process of cell division and cellular differentiation of the embryo that occur during the early stage of development. It covers the first 8 weeks of development and at the begining of the 9 week the embryo is termed **Fetus.**

Female reproductive system (female genital system)

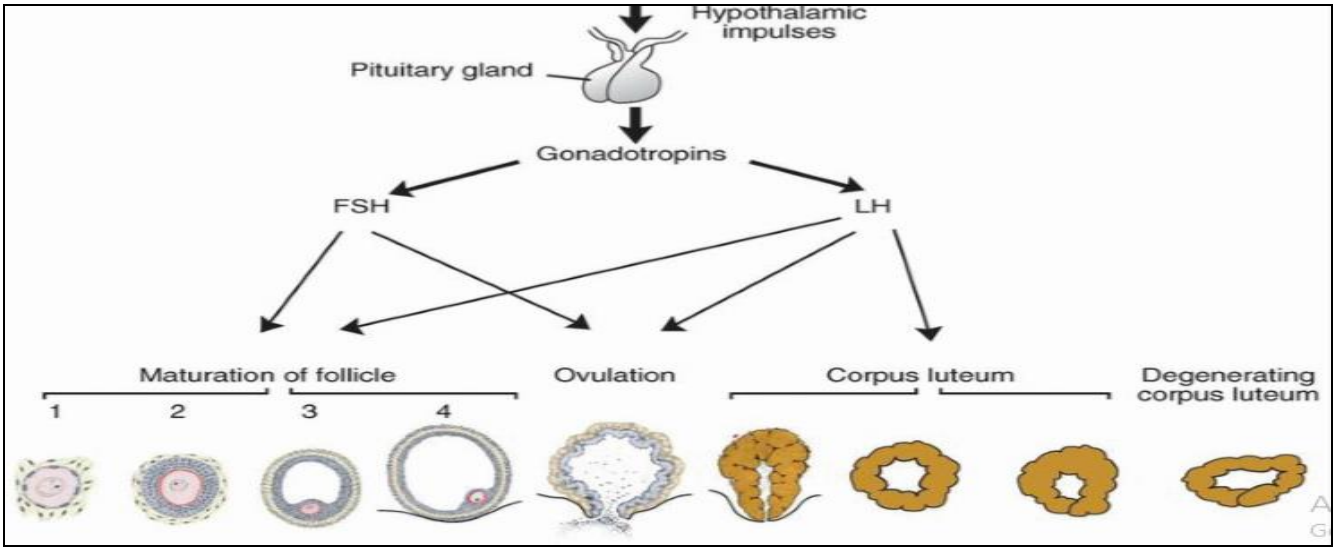
Is made up of internal and external sex organs that function in human reproduction. This system is immature at birth and develops to maturity at puberty to e able to produce gametes and to carry the fetus to full term.
The human Female reproductive system performs the following functions:

- Formation of eggs
- production and transportation of gametes
- Production of sex hormones.
- Providing a conducive environment that facilitates the fertilization of ova by sperm
- Support the development of offspring during pregnancy and infancy by providing shelter and nourishment to the growing embryo.



First week of development (ovulation and implantation)

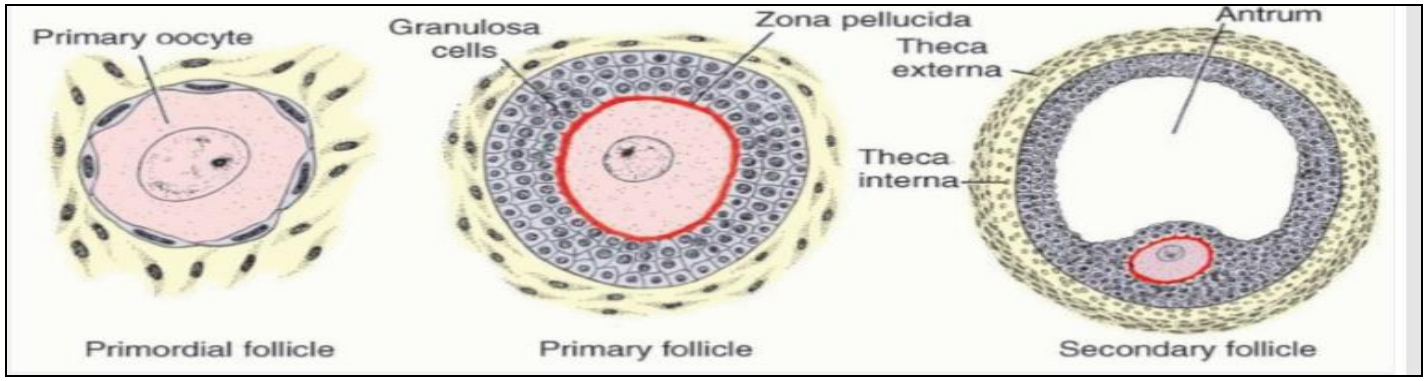
At puberty, the female begins to undergo regular monthly cycles. These sexual cycles are controlled by the hypothalamus.
Gonadotropin – releasing hormone (GnRH), produced by the hypothalamus, acts on cells of the anterior lobe of the pituitary gland, which inturn secrete gonadotropins. These hormones, follicle-stimulating hormone (FSH) and luteinizing hormone (LH), stimulate and control cyclic changes in the ovary.
At the beginning of each ovarian cycle, 15-20 follicles are stimulated to grow under the influence of FSH.
Under normal conditions, only one of these follicles reaches its full maturity, and only one oocyte is discharged, the others degenerate and become atretic.
In the next cycle, another group of primary follicles is recruited, and again, only one follicle reaches maturity.
Consequently most follicles degenerate without ever reaching full maturity. When follicle becomes atretic, the oocyte and surrounding follicular cells degenerate and are replaced by connective tissue.



Ovulation

In the days immediately preceding ovulation, under the influence of FSH and LH, the secondary follicle grows rapidly to a diameter of 25 mm, and as they mature, they pass throughthree stages:
(1) primary or preantral,(2)secondary or antral (vesicular Graafian),(3) preovulatory.
the surface of the ovary begins to bulge locally, and at the apex, an avascular spot, **the stigma,** appears. The high concentration of LH increases collagenase activity, resulting in digestion of collagen fibers surrounding the follicle. Prostaglandin levels also increase in response to the LH surge and cause local muscular contractions in the ovarian wall. Those contractions extrude

the oocyte with follicular fluid , which together with its surrounding granulosa cells from the region of the cumulus oophorus, breaks free (ovulation) and floats out of the ovary. Some of the cumulus oophorus cells then rearrange themselves around the zona pellucid to form the **coronaradiata** (is a cluster of cells that surround the oocyte both in the ovarian follicle and after ovulation).



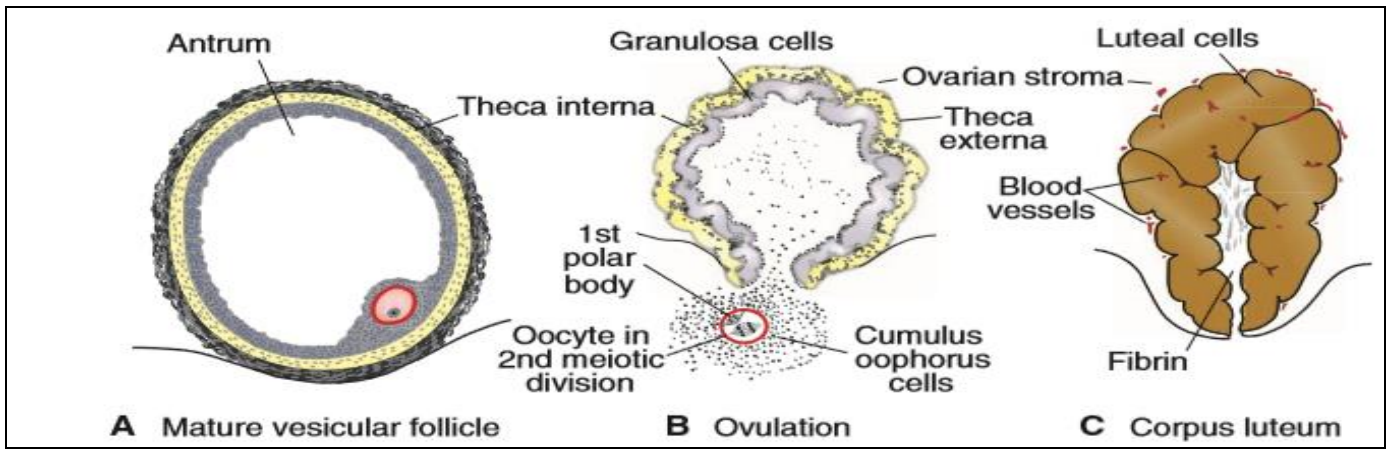
Corpus Luteum

After ovulation, granulosa cells remaining in the wall of the ruptured follicle, together with cells from the theca interna, are vascularized by surrounding vessels. Under the influnce of LH, these cells develop a yellowish pigment and change into conical yellowish cell(lutein cells), which form the corpus luteum and secrete estrogens and progesterone (serve as temporary endocrine gland). Progesterone, together with some estrogen, causes the uterine mucosa to enter the progestational or secretory stage in preparation for implantation of the embryo.

Corpus Albicans

If fertilization does not occur, the corpus luteum reaches maximum development approximately (9 days) after ovulation. It can easily be recognized as a yellowish projection on the surface of the ovary. Subsequently, the corpus luteum shrinks because of degeneration of lutean cells (luteolysis) and forms a mass of fibrotic scar tissue**, the corpus albicans.**

While the follicle and ovum are maturing, the follicle secretes hormones that prepare the uterine lining (endometrium) that get thicker and is well supplied with blood vessels.
If there are no viable sperm present in the uterine tube as the ovum moves along from the ovary to the uterus, then the ovum will not be fertilized.
If fertilization does not occur, or for any reason a blastocyst (future embryo) fails to implant within the endometrium, the built up endometrial lining degenerates and is shed.



The ovarian cycle has 2 distinct phases:

1- The follicular phase (days 1-14): characterized by follicle development and growth, one follicle matures and releases an egg at the time of ovulation, around day 14 of the female cycle. The remaining immature follicle go through stages of degeneration and disappear due to death, during the reproductive years of the females, this phenomena is referred to **follicular atresia**.

2- The luteal phase (days 14-28).

The egg that is released is picked up by the **Fimbriae** of the uterine tube (finger like projections at the end of the fallopian tubes, through which eggs move from the ovaries to the uterus), and the egg is transported toward the uterus. If fertilization does not occur, the egg degenerates, and menstruation occurs.

The process of prenatal development occurs in three main stages:

1- **Germinal stage** :The first two weeks after conception **,** refers to the time from fertilization , through the development of the early embryo until implantation is completed in the uterus
2- **Embryonic stage**: The third through the 8 (eight) week
3- **Fetal period:** the time from the ninth week until birth.

Fertilization

The process by which male and female gametes fuse, occurs in the ampullary region of the uterine tube. This is the widest part of the tube and is close to the ovary. Spermatozoa may remain viable in the female reproductive tract for several days. Spermatozoa are not able to fertilize the oocyte immediately upon arrival in the female genital tract but must undergo (1) Capacitation (2) Acrosome reaction to acquire this capability.

Capacitation: is a period of conditioning in the female reproductive tract that in the human lasts approximately 7 hours. Much of this conditioning, which occurs in the uterine tube, and involve epithelial interactions between the sperm and mucosal surface of the tube. During this time, a glycoprotein coat and seminal plasma proteins are removed from the plasma membrane that overlies the acrosomal region of the spermatozoa. Only capacitated sperm can pass through the corona cells and undergo the acrosome reaction.

The acrosome reaction: during which acrosin- and trypsin-like substances are released to penetrate the zona pellucida During fertilization, the spermatozoon must penetrate enters the uterus on the third or fourth day after fertilization, a cavity begins to appear, and the blastocyst forms.

The phases of fertilization include

- Phase 1, penetration of the corona radiata
- Phase 2, penetration of the zona pellucida
- Phase 3, fusion of the oocyte and sperm cell membranes Phase

Phase 1: Penetration of the Corona Radiata of the 200 to 300 million spermatozoa normally deposited in the female genital tract, only 300 to 500 reach the site of fertilization. Only one of these fertilizes the egg. It is thought that the others aid the fertilizing sperm in penetrating the barriers protecting the female gamete. Capacitated sperm pass freely through corona cells

Phase 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. Release of acrosomal enzymes (acrosin) allows sperm to penetrate the zona, thereby coming in contact with the plasma membrane of the oocyte. Permeability of the zona pellucida changes when the head of the sperm comes in contact with the oocyte surface. This contact results in release of lysosomal enzymes from cortical granules lining the plasma membrane of the oocyte. In turn, these enzymes alter properties of the zona pellucida (zona reaction) .

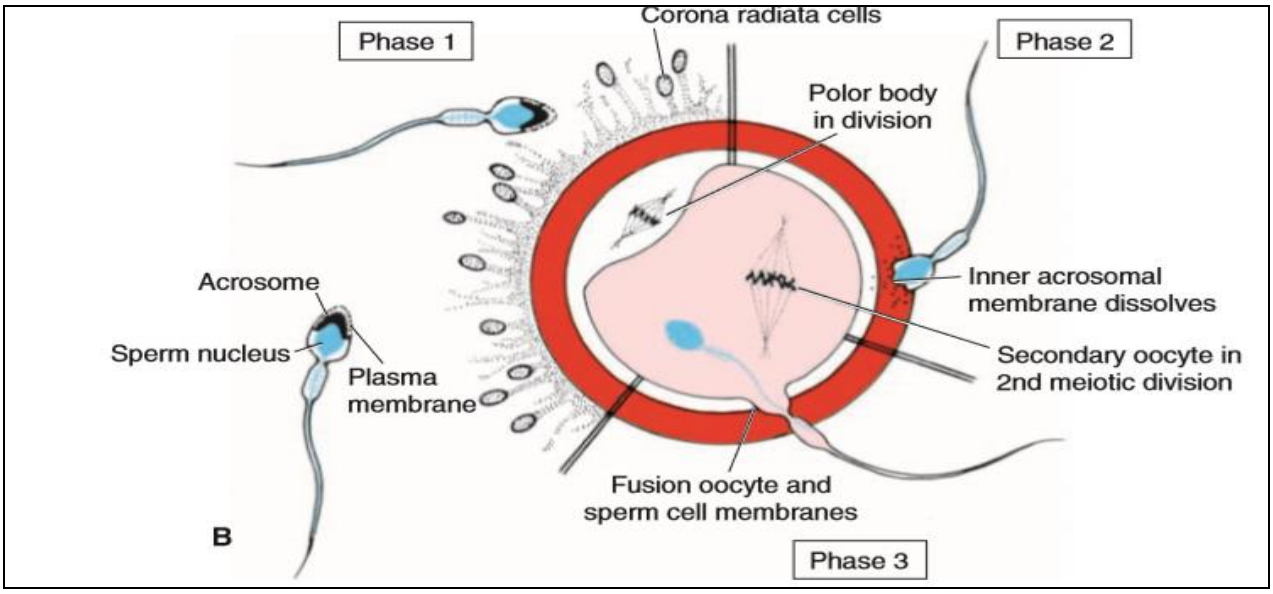
Phase 3: Fusion of the Oocyte and Sperm Cell Membranes : After adhesion, the plasma membranes of the sperm and egg fuse. Because the plasma membrane covering the acrosomal head cap disappears during the acrosome reaction, actual fusion is accomplished between the oocyte membrane and the membrane that covers the posterior region of the sperm head.

The main results of fertilization are as follows:

● Restoration of the diploid number of chromosomes, half from the father and half from the mother. Hence, the zygote contains a new combination of chromosomes different from both parents.

● Determination of the sex of the new individual. An X-carrying sperm produces a female (XX) embryo, and a Y-carrying sperm produces a male (XY) embryo. Therefore, the chromosomal sex of the embryo is determined at fertilization.

● Initiation of cleavage. Without fertilization, the oocyte usually degenerates 24 hours after ovulation.



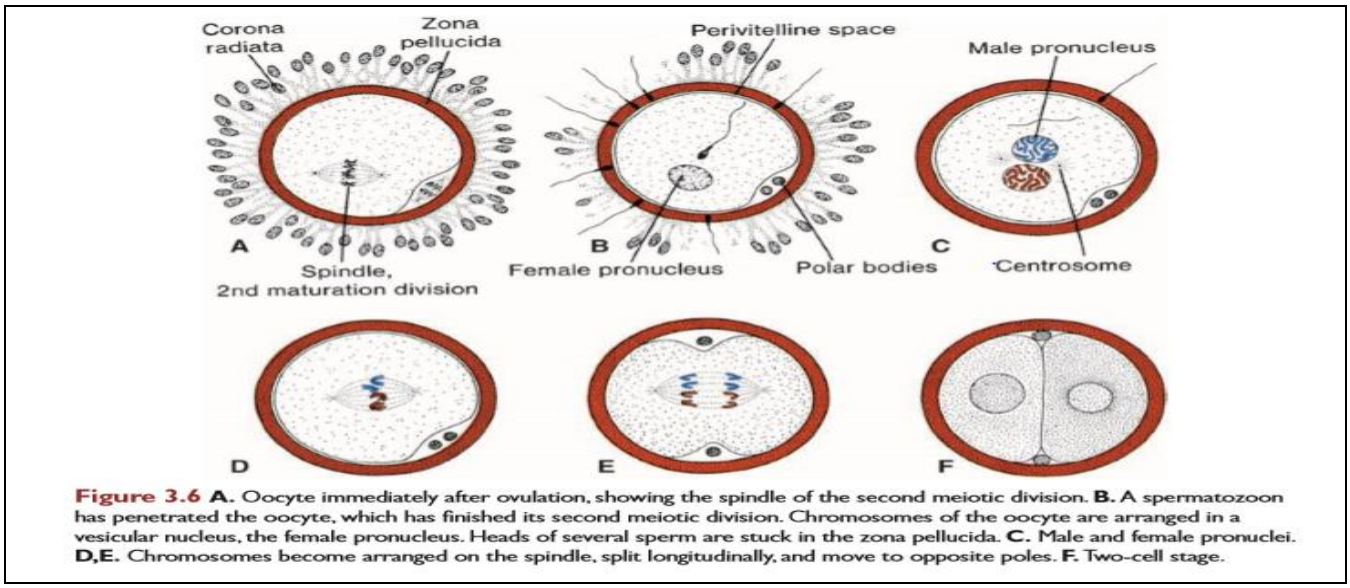


Figure 3.6 A. Oocyte immediately after ovulation, showing the spindle of the second meiotic division. **B.** A spermatozoon has penetrated the oocyte, which has finished its second meiotic division. Chromosomes of the oocyte are arranged in a vesicular nucleus, the female pronucleus. Heads of several sperm are stuck in the zona pellucida. **C.** Male and female pronuclei. **D,E.** Chromosomes become arranged on the spindle, split longitudinally, and move to opposite poles. **F.** Two-cell stage.