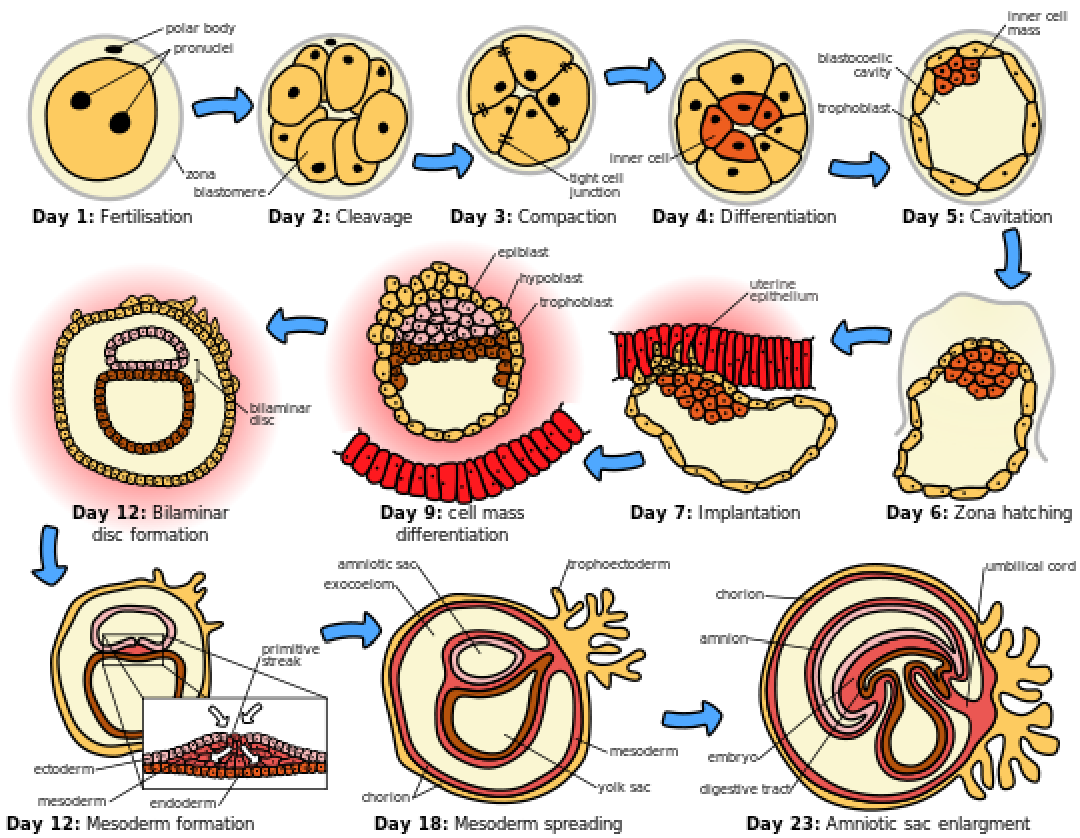
Embryology1 **_Dr.Ban_**

Human embryology is the study of this development during the first eight weeks after fertilisation. The normal period of gestation (pregnancy) is nine months or 38 weeks. Embryogenesis covers the first eight weeks of development; at the beginning of the ninth week the embryo is termed a fetus.

Human embryogenesis refers to the development and formation of the human embryo. It is characterised by the process of cell division and cellular differentiation of the embryo that occurs during the early stages of development.

In comparison to the embryo, the fetus has more recognizable external features and a more complete set of developing organs



Human embryogenesis

First week of development:

At puberty, the female begins to undergo regular monthly cycles controlled by the hypothalamus which secretes 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 to 20, follicles are stimulated to grow under the influence of FSH. Under normal conditions, only one of these follicles reaches full maturity, and only one oocyte is discharged; the others de- generate and become atretic. When a follicle becomes atretic, the oocyte and surrounding follicular cells degenerate and are replaced by connective tissue.

Ovulation

In the days immediately preceding ovulation, under influence of FSH and LH, the follicle grows rapidly to become a mature vesicular (graafian follicle),the surface of the ovary begins to bulge locally, and at the apex, an avascular spot, the stigma, appears. Before ovulation, the oocyte and some cells of the cumulus oophorus (*Cumulus oophorus is a cluster of cells that surround the oocyte both in the ovarian follicle and after ovulation*) dettach from the inside of the distended follicle.

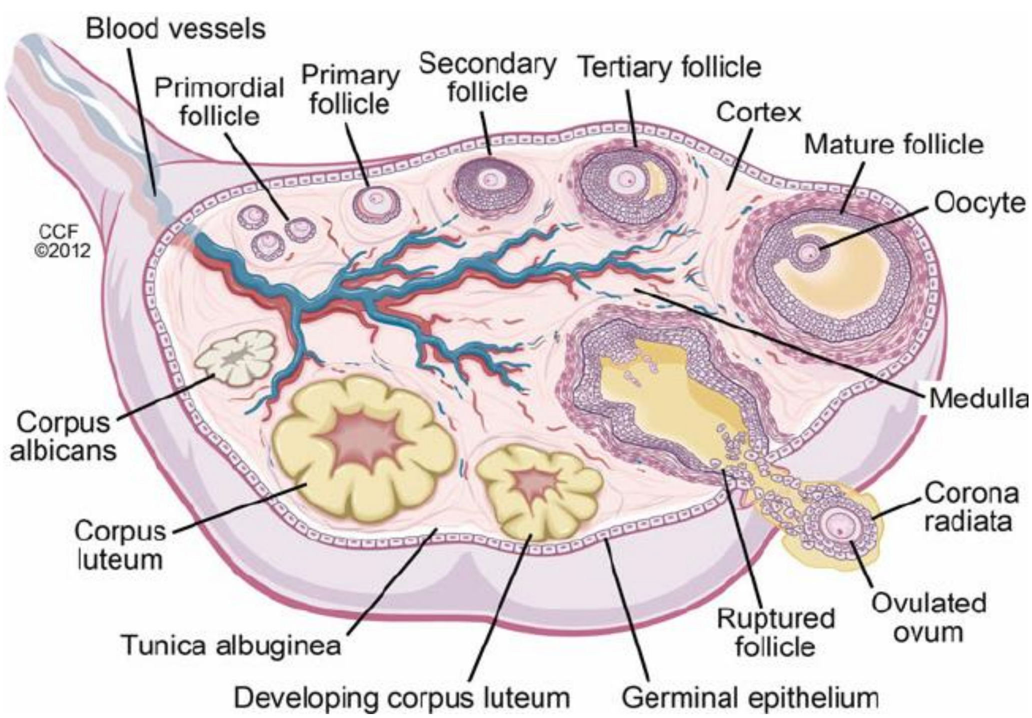
At ovulation, there is a "surge" of LH release, the stigma balloons out, forming a surface vesicle, then it ruptures, expelling the oocyte with follicular fluid.

The oocyte is covered by the **zona pellucida** and one or more layers of follicular cells which radially arrange themselves as the **corona radiate**.

After ovulation the follicle turns into the corpus luteum which is made up of large conical yellowish cells. Corpus luteum serves as a temporary endocrine gland, by releasing female sex hormones namely progesterone and estrogen.

While the follicle and ovum are maturing, the follicle secretes hormones that prepare the uterine lining (the endometrium). The endometrium gets thicker and is well supplied with blood vessels.If fertilization does not occur, or for any other reason a blastocyst (future embryo) fails to implant within the endometrium, the built-up endometrial lining degenerates .The corpus luteum reaches máximum 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 and forms a mass of fibrotic scar tissue, the Corpus albicans.

The egg that is released is picked up by the fimbriae of the uterine tube(*fingerlike 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.



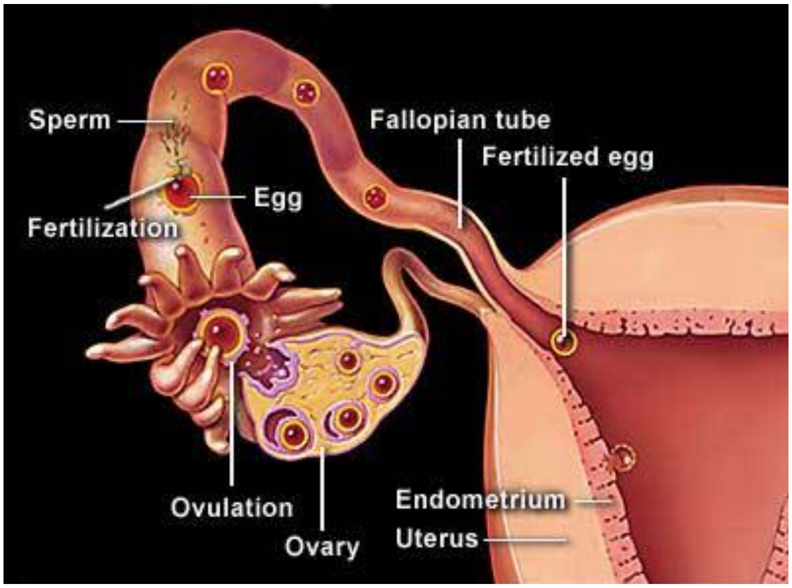
Fertilization

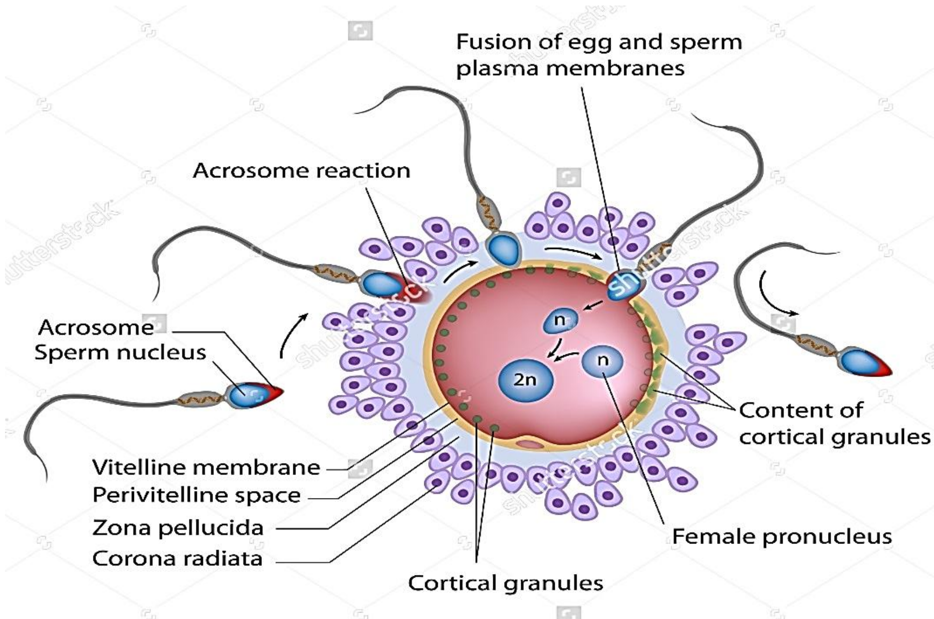
Fertilization, the process by which male and female gametes fuse, occurs in the ampulary regián of the uterine tube(*the widest part of the tube and is clóse to the ovary*).Spermatozoa are not able to fertilize the oocyte immediately upon arrival in the female genital tract but must undergo (1) capacitatíon and (2) the acrosome reaction to acquire this capability.

Capacitatíon is a period of conditioning in the female reproductive tract .Much of this conditioning during capacitation occurs in the uterine tube and involves epithelial interactions between the sperm and the mucosal surface of the tube.. Only capacitated sperm can pass through the corona cells and undergo the acrosome reaction.

Acrosome reaction

The acrosome reaction, which occurs after binding to the zona pellucida, is induced by zona proteins. This reaction culminates in the release of enzymes needed to penetrate the zona pellucida, including acrosin- and trypsin-like substances .





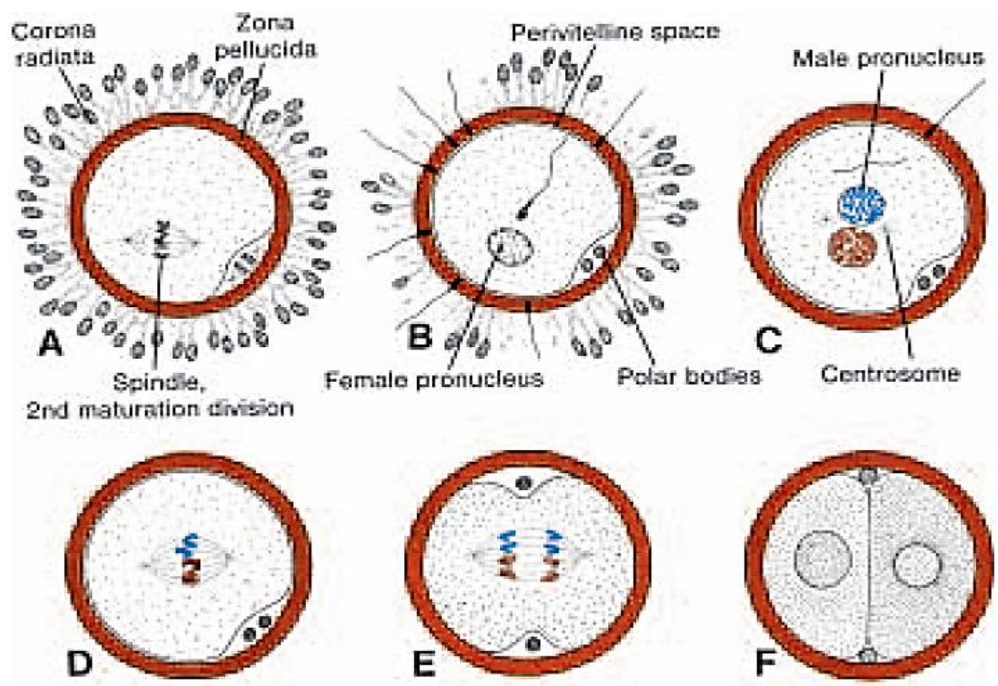


Figure 2.6 A. Oocyte immediately after ovulation, showing the spindle of the second meiotic division. **B.** A spermatozoon has penetrated the oocyte, which has finished its second meiotic division. Chromosomes of the oocyte are arranged in a vesicular nucleus, the female pronucleus. Heads of several sperm are stuck in the zona pellucida. **C.** Male and female pronuclei. **D** and **E.** Chromosomes become arranged on the spindle, split longitudinally, and move to opposite poles. **F.** Two-cell stage.

Phases of fertílization :

PhaseI: Penetration of the corona radiata

Of the 200 to 300 million spermatozoa 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

.**PhaseII** : 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).

PhaseIII :Fusion of oocyte and sperm cell membrane

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.

Results of fertilization :

A- 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.

B -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. Hence, the chromosomal sex of the embryo is determined at fertilization.

C- Initiation of cleavage.

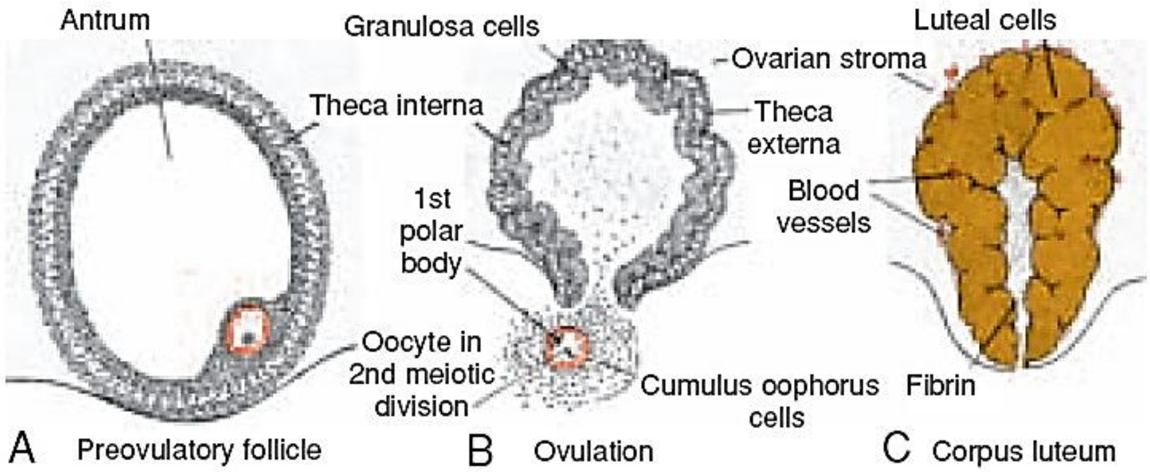


Figure 2.2 A. Preovulatory follicle bulging at the ovarian surface. **B.** Ovulation. The oocyte, in metaphase of meiosis II, is discharged from the ovary together with a large number of cumulus oophorus cells. Follicular cells remaining inside the collapsed follicle differentiate into lutean cells. **C.** Corpus luteum. Note the large size of the corpus luteum, caused by hypertrophy and accumulation of lipid in granulosa and theca interna cells. The remaining cavity of the follicle is filled with fibrin.

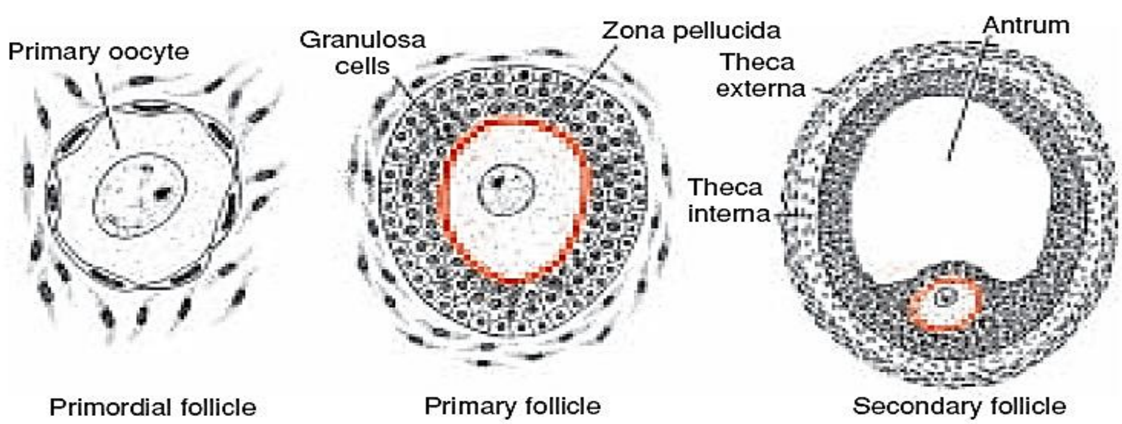


Figure 2.1 From the pool of primordial follicles, every day some begin to grow and develop into secondary (preantral) follicles, and this growth is independent of FSH. Then, as the cycle progresses, FSH secretion recruits primary follicles to begin development into secondary (antral, Graafian) follicles. During the last few days of maturation of secondary follicles, estrogens, produced by follicular and thecal cells, stimulate increased production of LH by the pituitary (Fig. 2.13), and this hormone causes the follicle to enter the preovulatory stage, to complete meiosis I, and to enter meiosis II where it arrests in metaphase approximately 3 hours before ovulation.