Lec.2
Embryology
DR. HULAL SALEH SAHIB

FERTILIZATION

Fertilization, the process by which male and female gametes fuse, occurs in the **ampullary region of the uterine tube** (the widest part of the tube and is close to the ovary).

Spermatozoa may remain viable in the female reproductive tract for several days. The trip from cervix to oviduct can occur as rapidly as 30 minutes or as slow as 6 days.

Spermatozoa are not able to fertilize the oocyte immediately upon arrival in the female genital tract but must undergo (1) **capacitation** and (2) the **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. It 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.

The **acrosome reaction**, this reaction culminates in the release of the enzymes needed to penetrate the zona pellucida.

The phases of fertilization include;

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.

Phase 2: Penetration of the Zona Pellucida

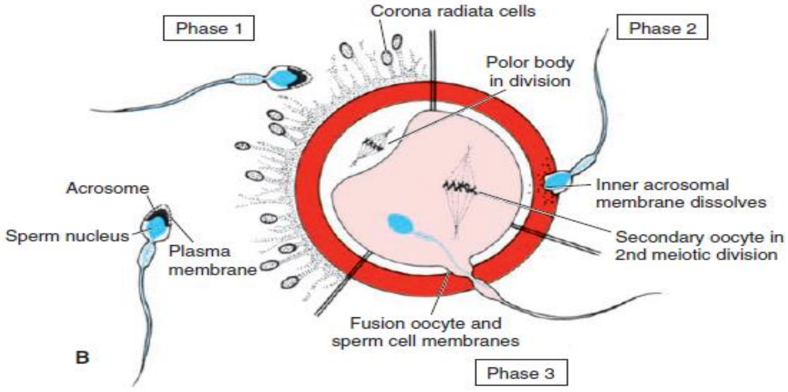
The zona is a glycoprotein shell surrounding the egg that facilitates and maintains sperm binding.

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, these enzymes alter properties of the zona pellucida **(zona reaction)** to prevent sperm penetration.

Phase 3: Fusion of the Oocyte and Sperm Cell Membranes

After adhesion, the plasma membranes of the sperm and egg fuse. In the human, both the head and the tail of the spermatozoon enter the cytoplasm of the oocyte, but the plasma membrane is left behind on the oocyte surface.

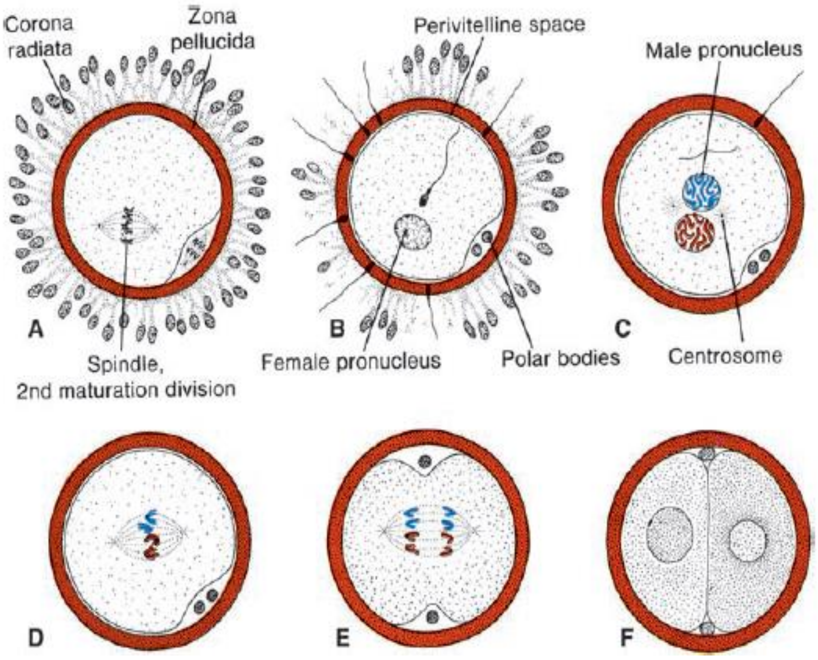
As soon as the spermatozoon has entered the oocyte**, Resumption of the second meiotic division.** The oocyte finishes its second meiotic division immediately after entry of the spermatozoon.

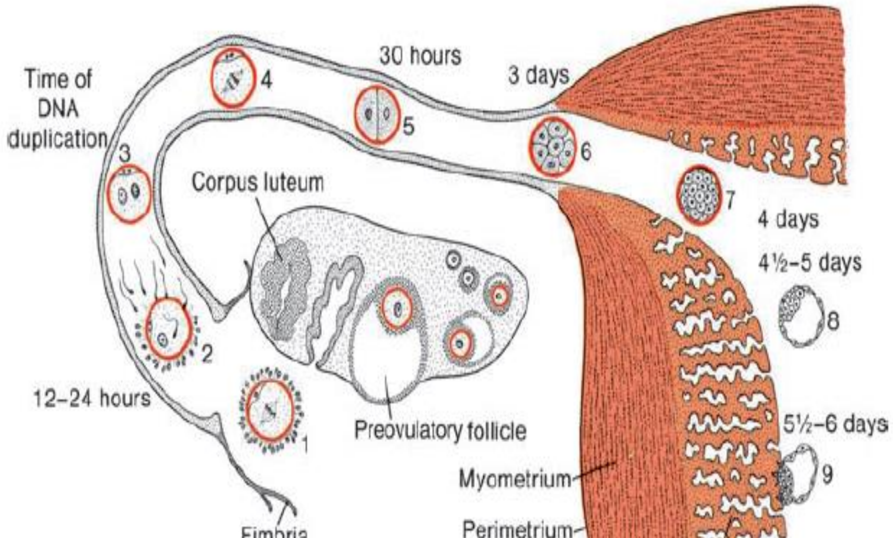


Morphologically, the male and female pronuclei are indistinguishable, and eventually, they come into close contact and lose their nuclear envelopes.

During growth of male and female pronuclei (both haploid), each pronucleus must replicate its DNA. If it does not, each cell of the two-cell zygote has only half of the normal amount of DNA. Immediately after DNA synthesis, chromosomes organize on the spindle in preparation for a normal mitotic division.

The 23 maternal and 23 paternal (double) chromosomes split longitudinally at the centromere, and sister chromatids move to opposite poles, providing each cell of the zygote with the normal diploid number of chromosomes and DNA. As sister chromatids move to opposite poles, a deep furrow appears on the surface of the cell, gradually dividing the cytoplasm into two parts.



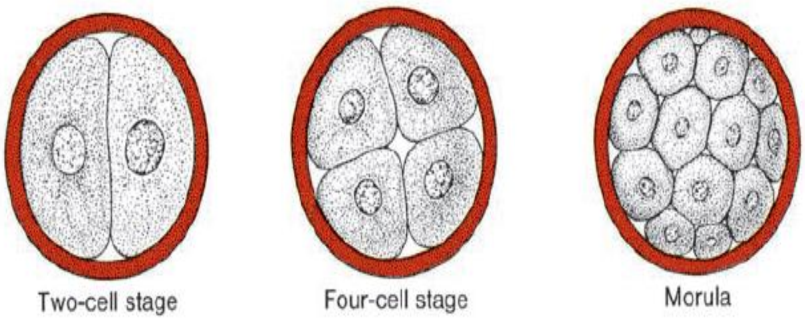


CLEAVAGE

Once the zygote has reached the two-cell stage, it undergoes a series of mitotic divisions, increasing the numbers of cells. These cells, which become smaller with each cleavage division, are known a **blastomeres**. Until the eight-cell stage, they form a loosely arranged clump.

After the third cleavage, however, blastomeres maximize their contact with each other, forming a compact ball of cells held together by tight junctions **(compaction**).

Approximately 3 days after fertilization, cells of the compacted embryo divide again to form a 16-cell **morula** (mulberry). Inner cells of the morula constitute the **inner cell mass**, and surrounding cells compose the **outer cell mass**.The inner cell mass gives rise to tissues of the **embryo proper**, and the outer cell mass forms the **trophoblast**, which later contributes to the **placenta**.



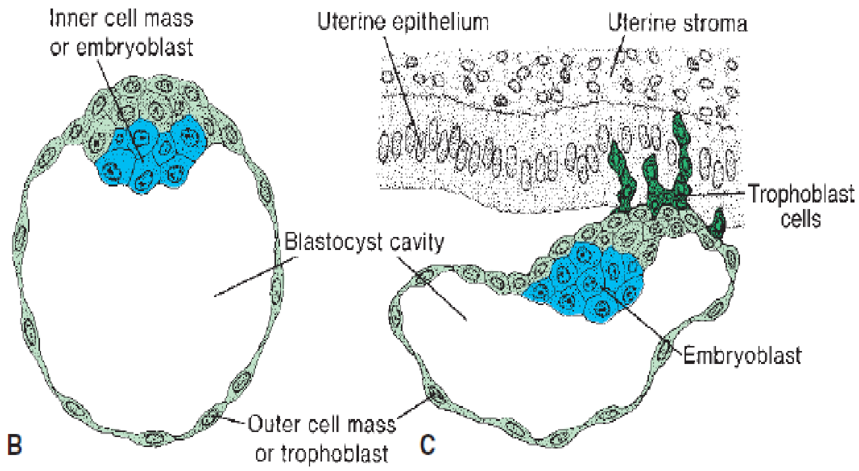
Blastocyst Formation

About the time the morula enters the uterine cavity, fluid begins to penetrate through the zona pellucida into the intercellular spaces of the inner cell mass. Gradually the intercellular spaces become confluent, and finally a single cavity, the **blastocele,** forms.

At this time, the embryo is a **blastocyst.** Cells of the inner cell mass, now called the **embryoblast,** are at one pole, and those of the outer cell mass, or **trophoblast**.

The zona pellucida has disappeared, allowing implantation to begin. In the human, trophoblastic cells over the embryoblast pole begin to penetrate between the epithelial cells of the uterine mucosa about the sixth day.

Hence, by the end of the first week of development, the human zygote has passed through the morula and blastocyst stages and has begun implantation in the uterine mucosa. the outer cell mass forms the **trophoblast**, which later contributes to the **placenta**.



The uterus at the time of implantation is in the secretory phase, and the blastocyst implants in the endometrium along the anterior or posterior wall. If fertilization does not occur, then the menstrual phase begins and the spongy and compact endometrial layers are shed. The basal layer remains to regenerate the other layers during the next cycle.