FERTILIZATION

- It is the process during which a male gamete (**sperm**) unites with a female gamete (**oocyte**) to form a single cell (**ZYGOTE**).

- Occurs when chromosomes from male and female gametes come together within the ovum
- Fertilized egg is called zygote
- Zygote initiates cleavage after fertilization

FERTİLİZATİON

- Sexual reproduction occurs through fertilization, during which two haploid gametes fuse to produce a genetically unique individual. Fertilization, the process by which the spermatozoon and the egg unite, occurs in the ampullary region of the oviduct.

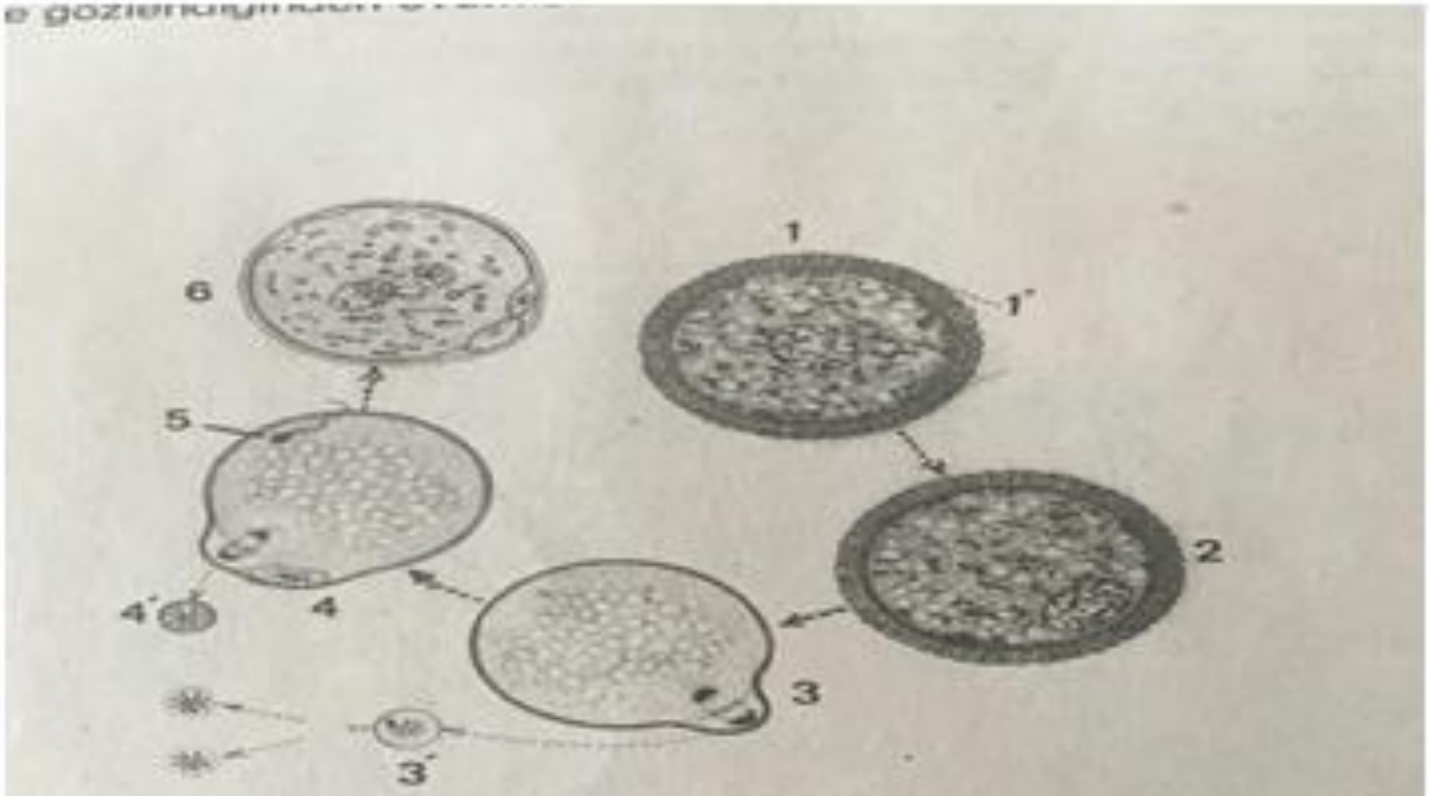
- The mammalian egg complex, which is ovulated and enters the oviduct via the infundibulum, consists of three components:.

- (1) the oocyte, arrested at metaphase of meiosis II in most domestic mammals (with the exception of dogs, where the final maturation to metaphase II occurs in the oviduct),

- (2) the zona pellucida, an extracellular matrix surrounding the oocyte, consisting of glycoproteins that are synthesized by both the oocyte and the surrounding cumulus cells in domestic animals, and

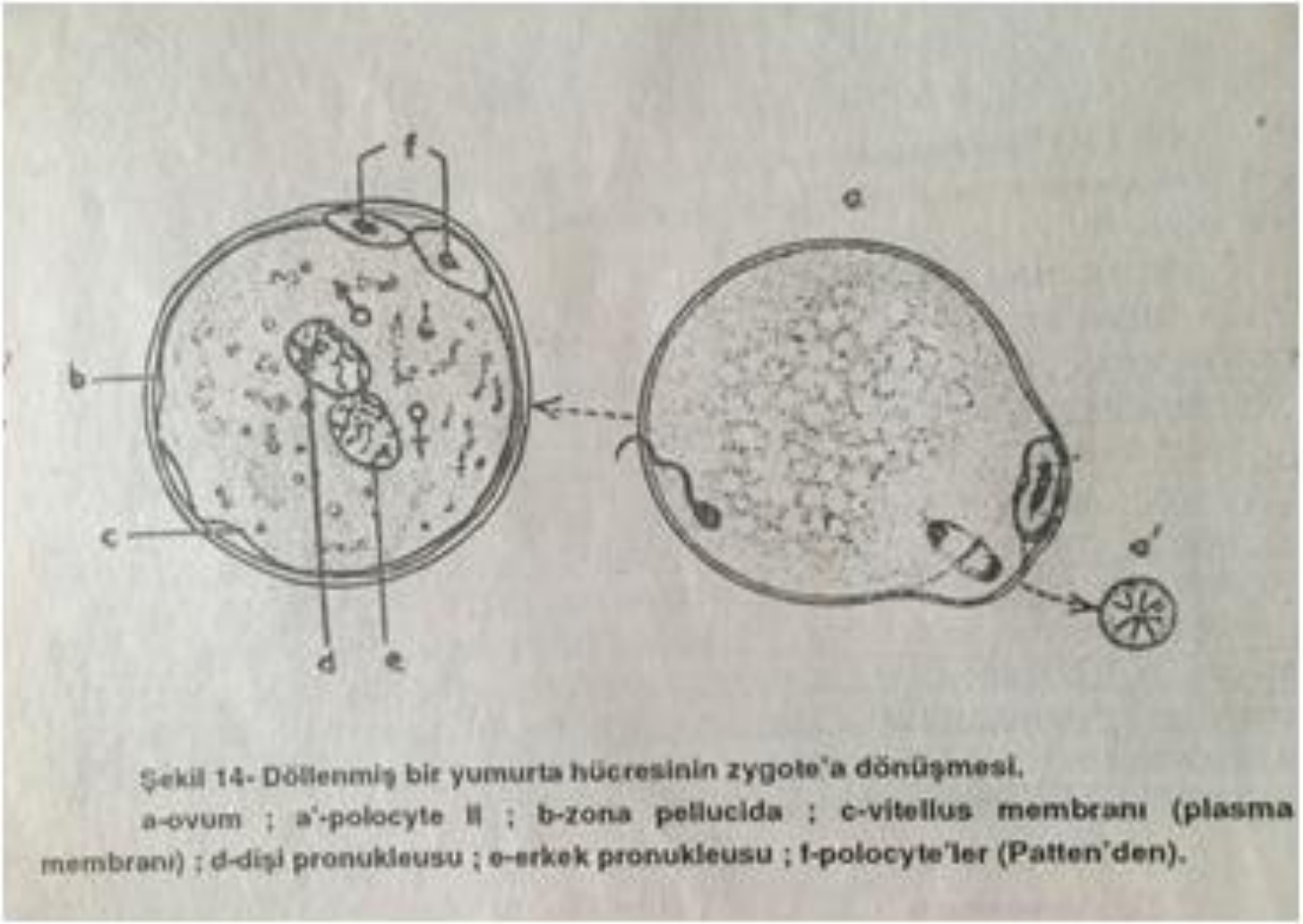
- (3) the cumulus cells, consisting of several layers of cells from the cumulus oophorus embedded in an extracellular matrix, composed mainly of hyaluronic acid

Following ovulation …fertilization



- Memeli hayvanlarda dişi eşey hücresinin olgunlaşması ve döllen
brona radiata'lı primer oocyte (ovarium'da) ; 2-primer oocyte (bö
nukleusu perifere kaymış durumdadır) ; 3, 3'-birinci olgunlaşma bö
(ovarium'da) ; 4, 4'-ikinci olgunlaşma bölünmesi ve polocyte
spermatozoon ; 6-döllenmiş yumurta hücresi (Patten'den).

Fertilization



Şekil 14- Döllenmiş bir yumurta hücresinin zygote'a dönüşmesi.
a-ovum ; a'-polocyte II ; b-zona pellucida ; c-vitellus membranı (plasma membranı) ; d-dişi pronukleusu ; e-erkek pronukleusu ; f-polocyte'ler (Patten'den).

- Transport of spermatozoa to the ampulla of the oviduct is primarily the result of elevated tone and motility of the tunica muscularis of the female genital tract. It can be divided into two phases, a rapid and a sustained transport phase.

- Within a few minutes after mating, spermatozoa have already reached the oviduct. Although male gametes are close to the oocyte after a very short period, ***these spermatozoa are not viable and do not play a role in fertilization***; it is the sustained phase of sperm transport that is important for successful fertilization.

- ***Spermatozoa are not able to fertilize the oocyte immediately after arrival in the female genital tract***; to acquire fertility they must reside there for a certain period of time. The changes that occur during this period constitute **capacitation of spermatozoa**.

- capacitation probably begins in the uterus and ends in the isthmus of the oviduct. Capacitation encompasses a number of complex processes. It has been clearly shown that the plasma membrane of the spermatozoon (particularly of the head) undergoes marked changes during capacitation.

- ***Male and female pronuclei approach each other***, helped by the cytoskeleton of the zygote. Eventually, they come into close contact and lose their nuclear envelopes, which apparently dissolve into smooth endoplasmic reticulum.

- Upon dismantling of the nuclear envelopes, ***the male and female haploid genomes become united in the centre of the zygote***. This mixing is referred to as karyogamy or synkaryosis. It should be noted that, in contrast to what occurs at fertilization in some lower orders, the pronuclei in mammals do not actually fuse.

- During the migration of the pronuclei, the S-phase of the first post-fertilization cell cycle is completed and, at the dissolution of the nuclear envelopes of the pronuclei, the chromatin condenses to form the prophase of the first mitotic division.

Acrosome reaction

Sperm undergo the acrosome reaction as a result of which hydrolytic enzymes are released from the acrosome of the sperm head. This permits the spermatozoon to penetrate the ZP matrix by a combination of enzymatic digestion of the ZP glycoproteins and vigorous propulsion by the tail of the spermatozoon.

- The acrosome reaction, induced by the ZP glycoproteins, consists of an orderly fusion of the plasma membrane of the spermatozoon and the outer acrosomal membrane..

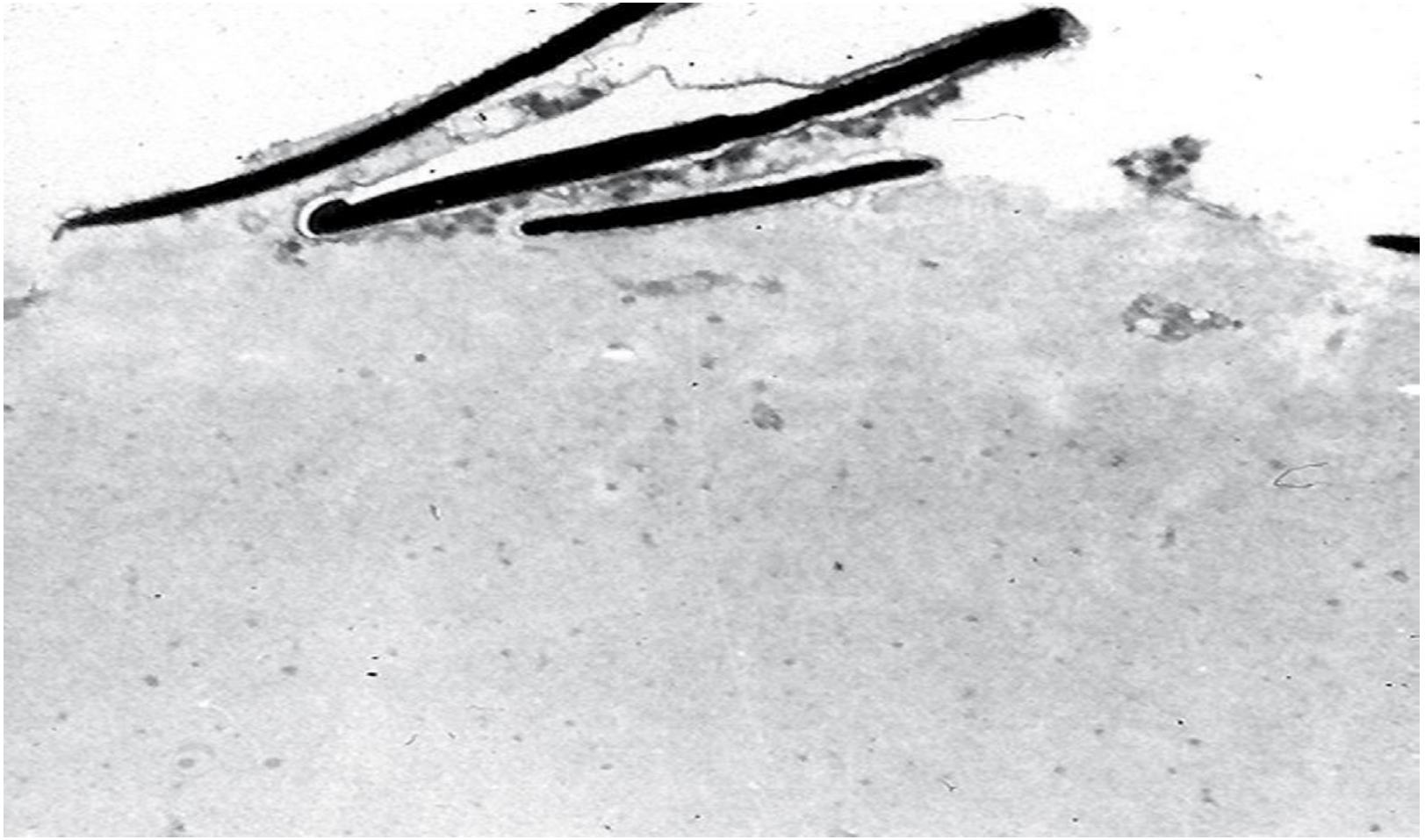
- It begins when the plasma membrane forms multiple fusion sites with the outer acrosomal membrane resulting in the formation of many small vesicles (vesiculation). After vesiculation has occurred, the enzymatic content of the acrosome is dispersed and the sperm nucleus remains covered by only the inner acrosomal membrane

Acrosome reaction

Acrosin and hyaluronidase are enzymes released during the acrosomal reaction. Acrosin hydrolyzes ZP proteins and also enhances the ability of the spermatozoa to bind to these proteins.

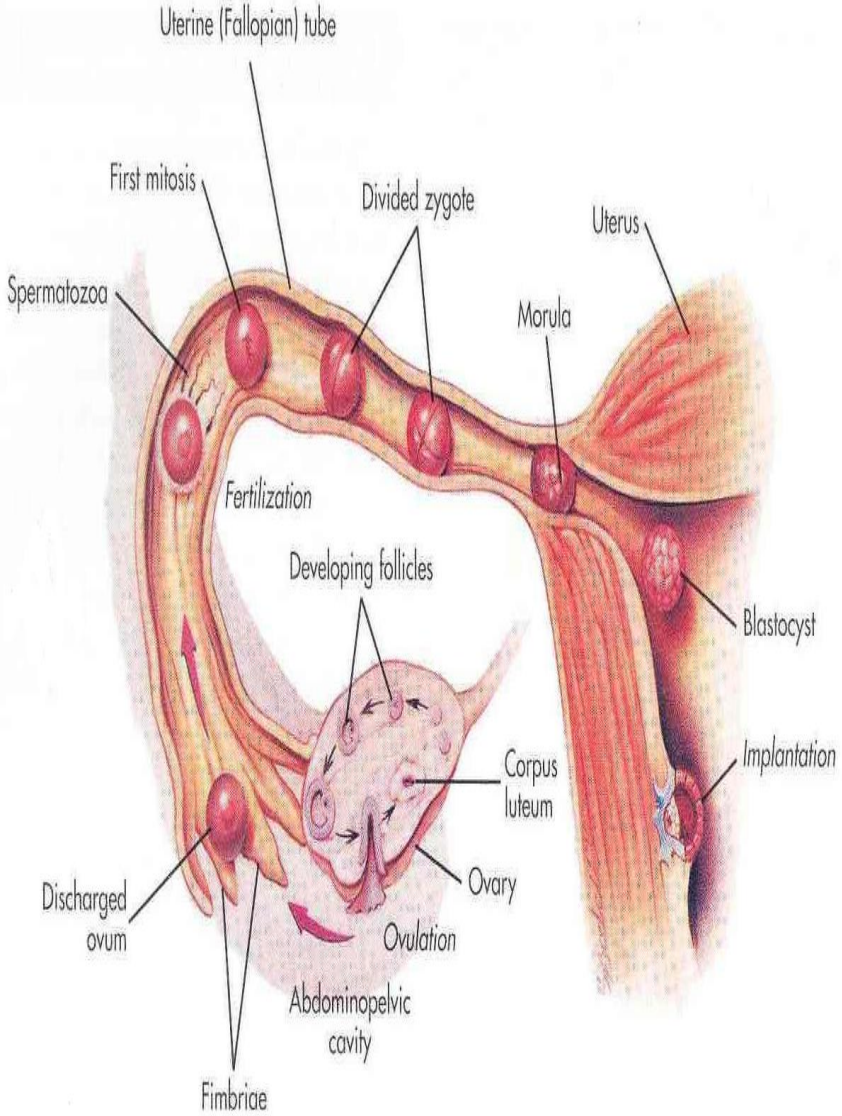
During the process of ZP penetration, acrosome-reacted spermatozoa are temporarily bound and released by the ZP glycoproteins via secondary binding mechanisms involving proacrosin. The sperm are also pushed forward by the vigorously beating tail towards the perivitelline space. Proacrosin is the inactive form of the enzyme acrosin and has a strong affinity for the ZP. Thus, proacrosin aids in binding to the zona as the acrosomal reaction proceeds. As proacrosin is converted to acrosin, the spermatozoon penetrates by using the enzyme to digest a small hole in the zona and passing through it.

Bovine spermatozoa undergoing the acrosome reaction on the surface of the zona pellucida



Cleavage

- Repeated mitotic division of the zygote.
- Begins about 30 hours after fertilization.
- There is rapid increase in the number of cells.
- The cells which is called (blastomeres) become smaller with each division.
- Normally occurs as the zygote passes along the uterine tube to the uterus
- During cleavage, zygote is within the zona pellucida.



- It begins about **30** hours after fertilization.
- Zygote divides into 2, then 4, then 8, then 16 cells.
- Zygote lies within the thick **zona pellucida** during cleavage.
- Zygote migrates in the uterine tube from its lateral end to its medial end.
- **Zona pellucida** is translucent under light microscope.

- ***Formation of blastocyst :***
- **The Morula** reaches the uterine cavity by the 4^{th} day after fertilization, & remains free for one or two days.

  Fluid passes from uterine cavity to the Morula.
- Now the Morula is called ***Blastocyst***, its cavity is called blastocystic cavity, its cells divided into **Embryoblast** & **Trophoblast.**

- The fertilised ovum with a diameter of 80-120 mikron is one of the largest mammalian cells and has a large amount of cytoplasm relative to the size of nucleus. For structural development to take place , the zygote must divide.

- This series of mitotic divisions is referred to as cleavage or segmentation. As cleavage proceeds, division of the cytoplasm follows nuclear division and the two daugther cells produced are referred to as blastomeres.The two blastomeres divide repeatedly producing four, eight,16and 32 cells and dvision continues until a spherical mass of cells , termed a morula is formed

- Division of the fertilized ovum is usually regular with the plane of the first division orientated vertically, passing through the main axis of the ovum from the animal pole at the top of the vegetal pole below.

- The succeeding division, which is also vertical and passes through the main axis at a right angle to the first division, results in four blastomeres.The third division takes places in the equatorial plane.As a consequence of the planes in which division take place eight blastomeres are formed, four in the animal hemisphere and four in the vegetal hemisphere.

- Ova with a small amounth of evenly distributed yolk are referred to as isolecithal (Mammalian and amphioxus)ova. When the amounth of yolk present displaces the embryo-forming cytoplasm into a small area at the animal pole.

- Such ova are referred to as telolecithal (insect). The term mesolecithal (frog) is applied to ova with a moderate amounth of yolk . Based on the abundance and distribution of the yolk, cleavage can be classified in a number of ways.

- In fish,reptiles and birds the types of ova are referred to polylecithal (bird ,fish).this type of division referred to as a partial cleavage. Because the site of cleavage is confined to a disc-shaped area at the animal pole.

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