

FERTILISATION AND IMPLANTATION

All the events of sexual reproduction that take place before the fusion of gametes (syngamy) are included under pre-fertilization events.

Gametogenesis and gamete transfer are two main pre-fertilisation events.

The process of formation of male and female gametes is known as gametogenesis. Gametes are haploid cells. In humans, the parent body is diploid thus, the gametes are formed by the process of meiosis. In humans, the male and female gametes are morphologically dissimilar hence, they are called heterogametes. The male gamete is called sperm and female reproductive gamete is known as egg or ovum. Though all our somatic cells are diploid, only the gonads i.e. the ovaries in the females and the testes in males have some specialised cells which take part in the production of gametes i.e. gametogenesis. These cells are called as meiocytes. During gametogenesis, meiocytes undergo meiotic division due to which, the number of chromosomes in the daughter cells get reduced to half in number and thus from the diploid meiocytes, four haploid gametes are formed. Gametogenesis in the males is known as spermatogenesis and in females it is called oogenesis. The spermatogenesis in males gets started at puberty and oogenesis in females gets started at the embryonic stage before birth. Spermatogenesis takes place in the testes of male reproductive system. The process of spermatogenesis takes place at a temperature less than that of body temperature that's why the testes are present in the scrotal pouch which is located outside the body. In the testis, the process takes place in seminiferous tubules, where the spermatogonial cells undergo division which leads to the formation of primary spermatocytes (immature) which then undergo spermiation in the Sertoli cells to develop into spermatids as the Sertoli cells are the nurse cells which provide nutrition to primary spermatocytes to form the functional spermatids. These spermatids then reach epididymis and get temporarily stored in it till the ejaculation. Spermatids undergo spermiogenesis to produce sperms. Oogenesis takes place in the ovary and starts with the development of primary oocytes, from oogonia. Oogenesis is complete either before or shortly after birth. Primary oocytes reach their maximum development at 20th week of gestational age, at that time approximately seven million primary oocytes have been created; however, at the birth of a female, this number gets reduced to approximately 1-2 million. Thus at birth the human female has all its future ova arrested at primary oocyte stage. After menarche (starting of menses at puberty) under the influence of pituitary hormones, these primary oocytes begin to develop again and, as a result of meiosis I, the primary oocyte develops into the secondary oocyte and the first polar body. This completes meiosis I, and the secondary oocyte undergoes meiosis II immediately. This process is also halted at the metaphase II stage until fertilization. Every month, the secondary oocyte is released by the ovary and waits for one day i.e. 24 hours for the sperm for fertilization, if the egg doesn't get sperm for fertilization then it gets released during menses and the secondary oocyte does not complete meiosis II. But if fertilization takes place then meiosis II gets completed. As a result the mature ovum with all the cytoplasmic contents and the maternal complement of chromosomes and another polar body is formed (at this stage both secondary oocyte and polar body are haploid). Both the polar bodies disintegrate at the end of Meiosis II, leaving only the fertilised ovum with the full complement of 46 chromosomes from the sperm and egg.

Gamete Transfer In humans

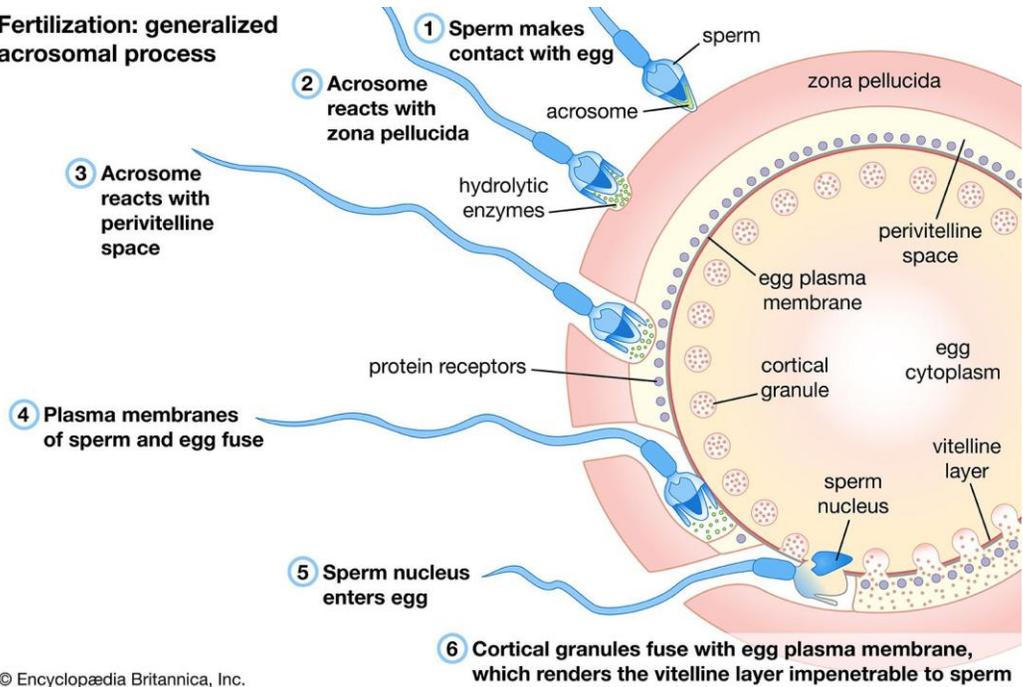
The male gametes are motile and the female gametes are stationary. After gamete formation, male and female gametes should come in physical association for fusion of gametes. During gamete transfer a large number of male gametes fail to reach the female gametes so, to fulfill this loss, the number of male gametes produced is several thousand times the number of female gametes. The process of transfer of male gamete into female genital tract is known as insemination.

Fertilisation

The process of fusion of male gametes (sperm) with the female gametes (ovum) is called fertilization or syngamy. It usually takes place in the ampullary-isthmus junction of oviduct in the uterus. It results in the formation of zygote. Now let us discuss about the mechanism of fertilisation. After insemination process, the sperm undergoes a series of changes, as freshly ejaculated sperm is unable or poorly able to fertilize the egg. The sperm undergoes capacitation in the female reproductive tract over several hours, which increases its motility and destabilizes its membrane, preparing it for the acrosomal action which helps it in the penetration of the egg's tough membrane, the zona pellucida, which surrounds the oocyte. When the sperm reaches the ovum (secondary oocyte), it invades the follicular cells (Fig.16.4). An enzyme hyaluronidase is released from the acrosome of the sperm head. This enzyme removes the extracellular matrix and disperses the corona radiata cells. Another enzyme acrosin digests a path for the sperm through the zona pellucida. In the acrosome of the sperm this trypsin like enzyme is inactive and needs to be activated by a glycoprotein in the female reproductive tract. Once a sperm passes through the zona pellucida, this covering becomes impenetrable by other sperms. This is known as the zona reaction. The structure of the membrane changes and lysosomal enzymes are released from the secondary oocyte that prevent other sperms from attaching to the membrane. Usually only one sperm enters the ovum. Two sperms may participate in fertilization under an abnormal process known as dispermy. The resulting embryo contains 69 chromosomes and may appear normal, but it is always aborted. Sometimes a triploid infant may be born but it dies shortly. Thus polyspermy does not produce viable embryos.

After penetration of sperm in the cytoplasm of the oocyte, the tail and the outer covering of the sperm disintegrate and the cortical reaction starts to prevent polyspermy. The oocyte undergoes second meiotic division and results in the formation of the haploid ovum and releases a polar body. The sperm nucleus then fuses with the ovum which results in fertilization.

Fertilization: generalized acrosomal process



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After fertilization, the cytoplasm of sperm and ovum fuse. Then fusion of their nucleus takes place that results in the formation of zygote. After the formation of zygote, it starts moving towards the uterus and ultimately results in the formation of blastocyst which undergoes implantation. Then, embryogenesis takes place which ultimately leads to formation of fully developed baby.
