B.A and B.Sc

ANTHROPOLOGY

SEMESTER IV, PAPER 7

PROCESS OF GAMETOGENESIS,

Gametogenesis, the production of sperm and eggs, takes place through the process of meiosis. During meiosis, two cell divisions separate the paired chromosomes in the nucleus and then separate the chromatids that were made during an earlier stage of the cell's life cycle. Meiosis produces haploid cells with half of each pair of chromosomes normally found in diploid cells. Many principles of gametogenesis are the same in both males and females, and will be considered first. Both spermatogenesis and oogenesis comprise similar phases of sequential changes viz.,

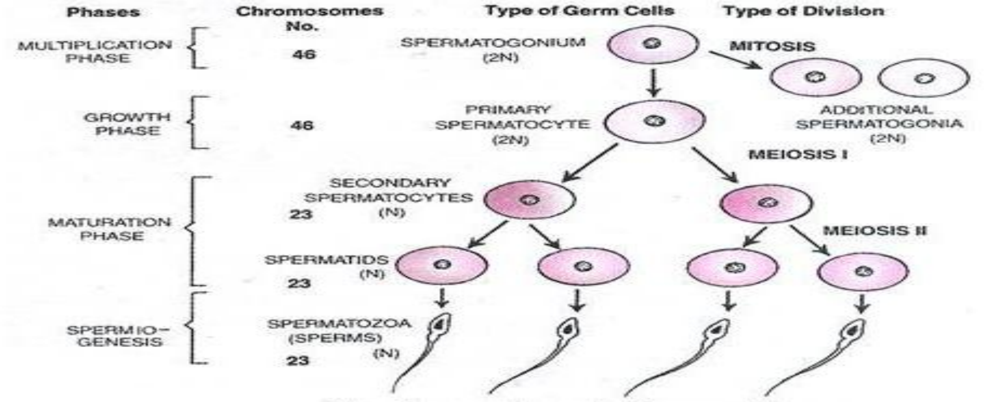
(i) multiplication phase,

(ii) growth phase and

(iii) maturation phase.

Spermatogenesis-

It is the process of formation of sperm in **testis.** The process of formation of sperms is called spermatogenesis. It occurs in the seminiferous tubules of the testes. The seminiferous tubules are lined by germinal epithelium. The germinal epithelium consists largely of cuboidal primary or primordial germ cells (PGCs) and contains certain tall somatic cells called Sertoli cells (= nurse cells). Spermatogenesis includes formation of spermatids and formation of spermatozoa.



Stages in spermatogenesis (diagrammatic).

(i) Formation of Spermatids:

It includes the following phases.

(a) Multiplication Phase:

At sexual maturity, the undifferentiated primordial germ cells divide several times by mitosis to produce a large number of spermatogonia (Gr. sperma = seeds, gonos- generation). Spermatogonia (2N) are of two types: type A spermatogonia and type B spermatogonia. Type A spermatogonia serve as the stem cells which divide to form additional spermatogonia. Type B spermatogonia are the precursors of sperms.

(b) Growth Phase:

Each type B spermatogonium actively grows to a larger primary spermatocyte by obtaining nourishment from the nursing cells.

(c) Maturation Phase:

Each primary spermatocyte undergoes two successive divisions, called maturation divisions. The first maturation division is reductional or meiotic. Hence, the primary spermatocyte divides into two haploid daughter cells called secondary spermatocytes. Both secondary spermatocytes now undergo second maturation division which is an ordinary mitotic division to form, four haploid spermatids, by each primary spermatocyte.

(ii) Formation of Spermatozoa from Spermatids (Spermatogenesis):

The transformation of spermatids into spermatozoa is called spermiogenesis or spermateliosis. The spermatozoa are later on known as sperms. Thus four sperms are formed from one spermatogonium. After spermiogenesis sperm heads become embedded in the Sertoli cells and are finally released from the seminiferous tubules by the process called spermiation.

Hormonal Control of Spermatogenesis:Spermatogenesis is initiated due to increase in gonadotropin-releasing hormone (GnRH) by the hypothalamus. GnRH acts on the anterior lobe of pituitary gland to secrete luteinizing hormone (LH) and follicle stimulating hormone (FSH). LH acts on the Leydig’s cells of the testes to secrete testosterone.

FSH acts on Sertoli cells of the seminiferous tubules of the testes to secrete an androgen binding protein (ABP) and inhibin. ABP concentrates testosterone in the seminiferous tubules. Inhibin suppresses FSH synthesis. FSH acts on spermatogonia to stimulate sperm production.

Significance of Spermatogenesis:

(i) During spermatogenesis, one spermatogonium produces four sperms, (ii) Sperms have half the number of chromosomes. After fertilization, the diploid chromosome number is restored in the zygote. It maintains the chromosome number of the species, (iii) During meiosis I crossing over takes place which brings about variation, (iv) Spermatogenesis occurs in various organisms. Thus it supports the evidence of the basic relationship of the organisms.

Spermatozoon (Sperm):

The sperms are microscopic and motile cells. Sperms remain alive and retain their ability to fertilize an ovum (egg) from 24 to 48 hours after having been released in the female genital tract. A typical mammalian sperm consists of a head, neck, middle piece and tail.

Oogenesis

The process of formation of a mature female gamete (ovum) is called oogenesis. It occurs in the ovaries (female gonads). It consists of three phases: multiplication, growth and maturation.

(a) Multiplication phase:

In the foetal development, certain cells in the germinal epithelium of the ovary of the foetus are larger than others. These cells divide by mitosis, producing a couple of million egg mother cells or oogonia in each ovary of the foetus. No more oogonia are formed or added after birth. The oogonia multiply by mitotic divisions forming the primary oocytes.

(b) Growth phase:

This phase of the primary oocyte is very long. It may extend over many years. The oogonium grows into a large primary oocytes. Each primary oocyte then gets surrounded by a layer of granulosa cells to form primary follicle. A large number of these follicles degenerate during the period from birth to puberty. So at puberty only 60,000- 80,000 primary follicles are left in each ovary. The fluid filled cavity of the follicle is called antrum.

(c)* Maturation *phase:

Like a primary spermatocyte, each primary oocyte undergoes two maturation divisions, first meiotic and the second meiotic. The results of maturation divisions in oogenesis are, however, very different from those in spermatogenesis. In the first, meiotic division, the primary oocyte divides into two very unequal haploid daughter cells— a large secondary oocyte and a very small first polar body or polocyte.

In the second maturation division, the first polar body may divide to form two second polar bodies. The secondary oocyte again divides into unequal daughter cells, a large ootid and a very small second polar body. The ootid grows into a functional haploid ovum. Thus from one oogonium, one ovum and three polar bodies are formed. The ovum, is the actual female gamete. The polar bodies take no part in reproduction and, hence, soon degenerate.

In human beings, ovum is released from the ovary in the secondary oocyte stage. The maturation of secondary oocyte is completed in the mother’s oviduct (Fallopian tube) usually after the sperm has entered the secondary oocyte for fertilization.

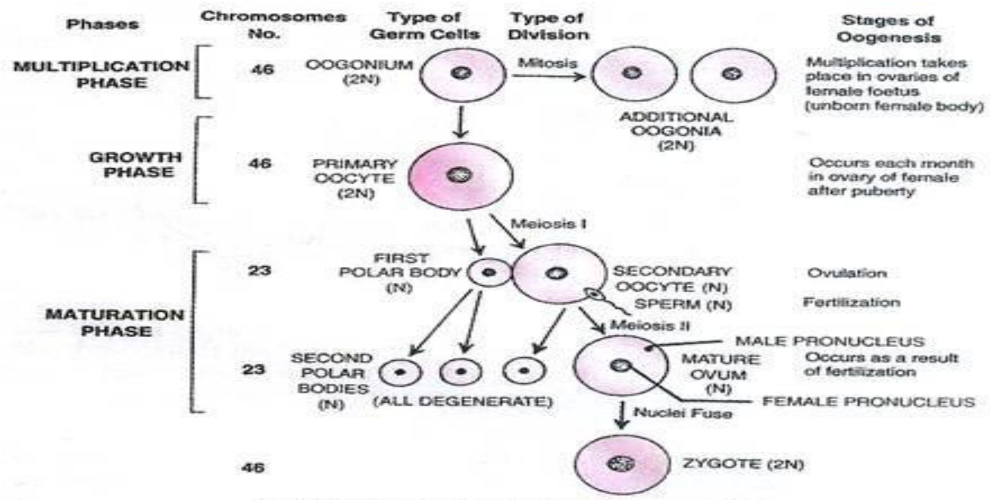


Fig. 3.18. Stages in oogenesis (diagrammatic).

In humans (and most vertebrates), the first polar body does not undergo meiosis II, whereas the secondary oocyte proceeds as far as the metaphase stage of meiosis II. However, it then stops advancing any further; it awaits the arrival of sperm for completion of meiosis II.

Entry of the sperm restarts the cell cycle breaking down MPF (M-phase promoting factor) and turning on APC (Anaphase promoting complex). Completion of meiosis II converts the secondary oocyte into a fertilized ovum (egg) or zygote (and also a second polar body).

Hormonal Control of Oogenesis:

GnRH secreted by the hypothalamus stimulates the anterior lobe of pituitary gland to secrete LH and FSH. FSH stimulates the growth of Graafian follicles and also the development of egg/oocyte within the follicle to complete the meiosis I to form secondary oocyte. FSH also stimulates the formation of oestrogens.

LH induces the rupture of the mature Graafian follicle and thereby the release of secondary oocyte. Thus LH causes ovulation. In brief ovulation in human beings may be defined as the release of the secondary oocyte from the Graafian follicle. The remaining part of the Graafian follicle is stimulated by LH to develop into corpus luteum (“yellow body”). The rising level of progesterone inhibits the release of GnRH, which in turn, inhibits production of FSH, LH and progesterone.

Significance of Oogenesis:

(i) One oogonium produces one ovum and three polar bodies.

(ii) Polar bodies have small amount of cytoplasm. It helps to retain sufficient amount of cytoplasm in the ovum which is essential for the development of early embryo. Formation of polar bodies maintains half number of chromosomes in the ovum.

(iii) During meiosis first crossing over takes place which brings about variation.

(iv) Oogenesis occurs in various organisms. Therefore, it supports the evidence of basic relationship of the organisms.