

CHAPTER III. GAMETOGENESIS

I. Gametogenesis :

Gametogenesis is the biological mechanism by which gametes are formed in the organism. It produces haploid cells from diploid cells. In the mammals, this is known as ovogenesis in females and spermatogenesis in males.

The cell division that takes place during gametogenesis and which changes the cell from diploid to haploid is called meiosis.

II. Gametes :

A gamete is a haploid reproductive cell that has completed meiosis and cytoplasmic differentiation.

In humans, as in most animals, the female gametes are the ovum and the male gametes are the spermatozoa. The gamete-producing organs are called gonads, which are the ovaries in females and the testes in males.

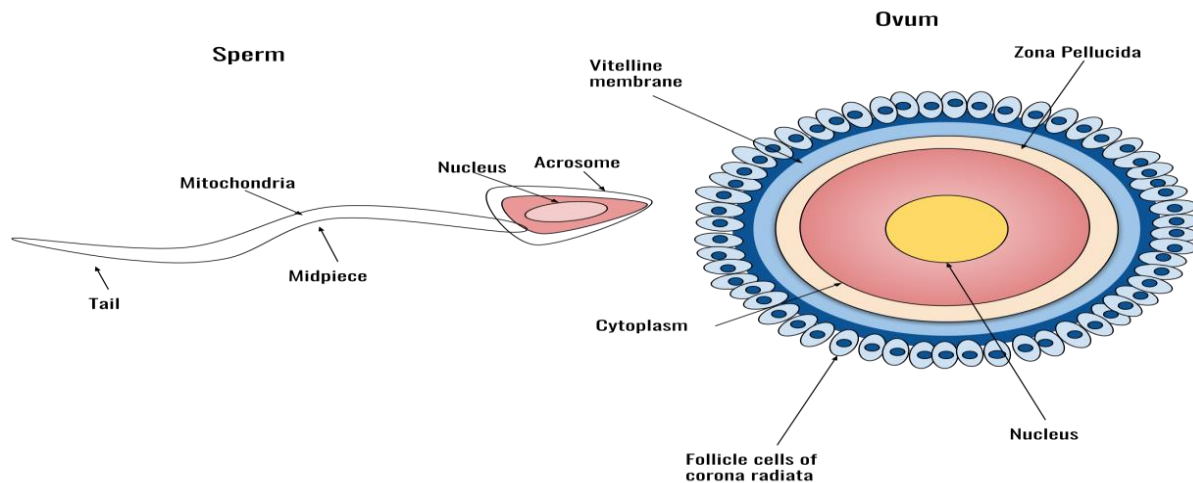


Figure 01: Male and female gamete

SPERMATOGENESIS

This is the formation of spermatozoa in the male. It takes place in the seminiferous tubules of the testes.

- It is stimulated at puberty by pituitary hormones under the influence of the hypothalamus and by the hormones FSH and LH.
- Sperm are produced from stem cells (spermatogonia) and millions of sperm are synthesised every day.
- It is permanent and not cyclical like ovogenesis.

I. The stages of spermatogenesis :

Spermatogenesis takes place in the seminiferous tubules and comprises 3 stages Fig.02. :

I.1 The multiplication phase :

This concerns the spermatogonia, diploid stem cells located at the periphery of the tube, against the clean membrane. These cells undergo a succession of mitoses (maintenance of the spermatogonia pool), the last of which results in the formation of primary spermatocytes (spermatocyte I), also diploid.

I.2 The maturation phase :

This corresponds to meiosis and concerns both generations of spermatocytes (primary I or secondary II).

A spermatocyte I with $2n$ chromosomes passes through the first division of meiosis to give 2 spermatocytes II with n chromosomes. Each spermatocyte II makes the second division of meiosis and gives 2 spermatids with n chromosomes.

A spermatocyte I has therefore given 4 spermatids at the end of meiosis.

I.3. The differentiation phase :

Also known as spermiogenesis, this phase does not involve division but differentiation of the spermatids into spermatozoa (development of the acrosome and flagellum), which are released into the lumen of the seminiferous tube.

The spermatozoa produced migrate to the epididymis where they complete their maturation and are stored.

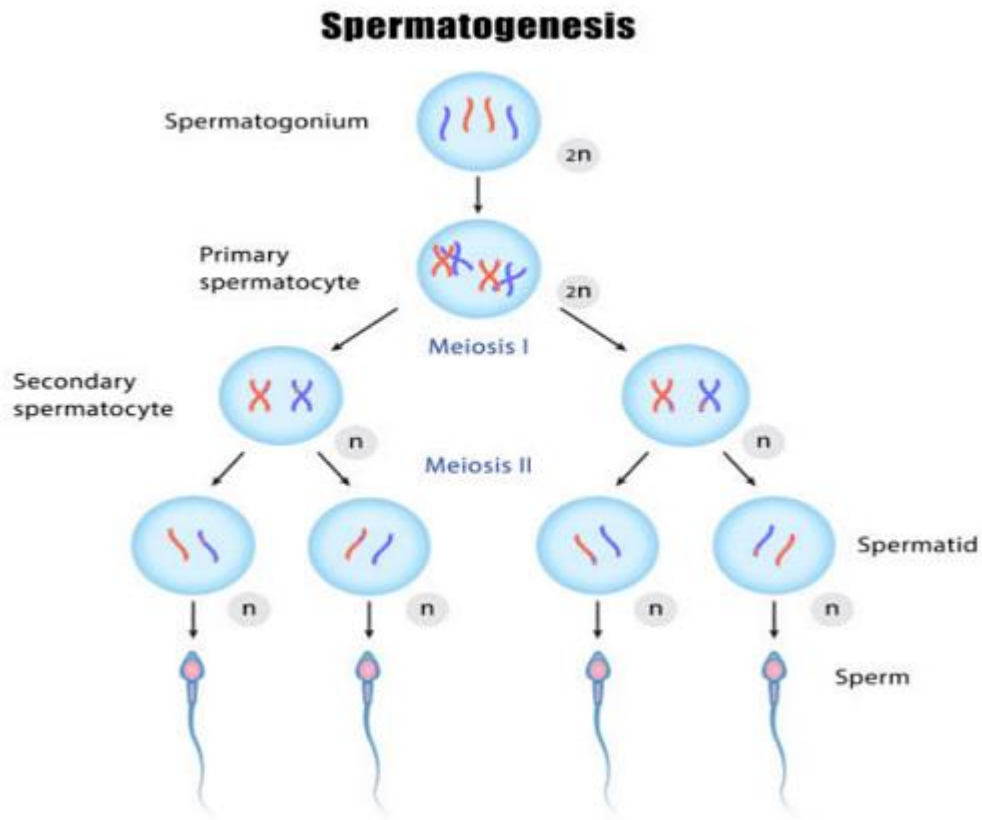


Figure 02: The stages of spermatogenesis

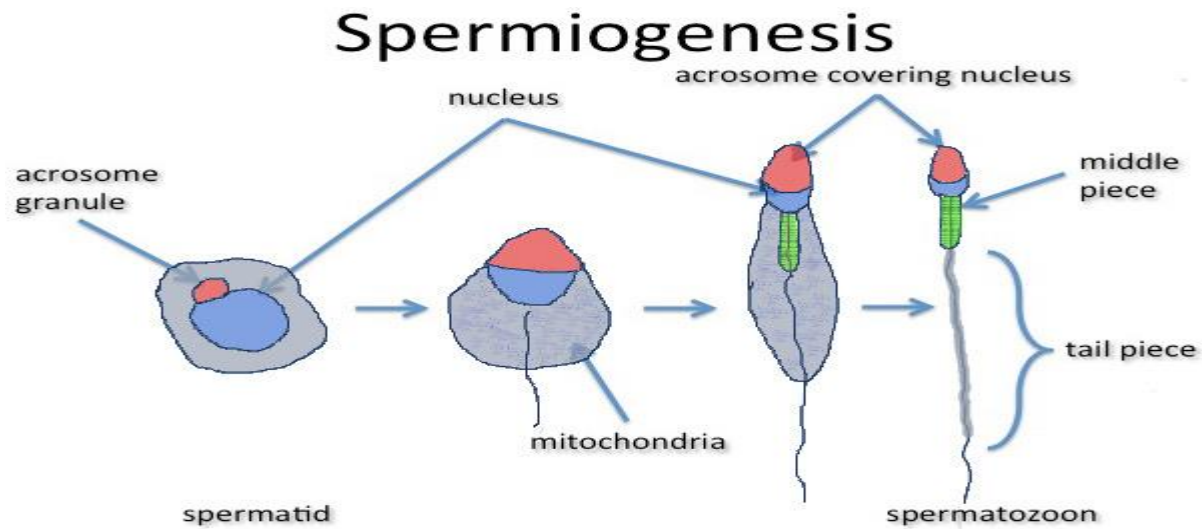


Figure 03: Final stage of spermatogenesis (spermiogenesis)

II. The spermatozoon : the sperm cell :

II.1 Morphology :

The spermatozoon is a very elongate cell made up of 3 parts visible under the light microscope: the head, the flagellum and the intermediate region.

Head: contains an acrosomal vesicle (the acrosome) rich in phospholipids and glycoproteins, as well as lytic enzymes.

Intermediate part: contains the base of the flagellum and the energy apparatus (mitochondria).

Flagella: ensures sperm motility.

II.2 Physiological characteristics :

A. Mobility :

Spermatozoa are able to move around as a result of the movements of their flagellum; this is an essential property, which conditions their fertilising power.

Flagellar movement is undulatory.

B. Fertility :

This rather imprecise term refers to all the properties of the sperm that make it suitable for all stages of fertilisation, which therefore implies at least that it is morphologically normal and has good progressive mobility. Not all spermatozoa in a semen are fertilising.

Human Sperm Cell Diagram

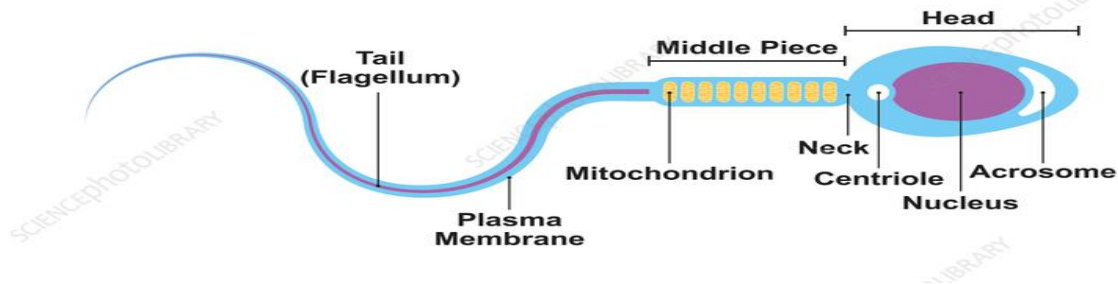


Figure 04: Human spermatozoon

OVOGENESIS

Is all the processes involved in the formation of female gametes: egg cells.

- It begins at puberty and continues until the menopause under the influence of the pituitary hormones FSH and LH.
- It takes place cyclically in the ovaries.

I. The stages of oogenesis

Oogenesis takes place in three phases:

I.1 The multiplication phase:

This begins and ends definitively during foetal life.

During this phase, the ovogonia ($2n=46$) multiply by mitosis.

I.2 Growth phase:

This begins during foetal life: all the ovogonia ($2n=46$) increase slightly in volume due to the accumulation of reserves and become oocytes I ($2n=46$).

It stops during infancy.

It continues from puberty onwards and cyclically at the menopause: a few Oocytes I complete their growth, but only one oocyte I (sometimes two or more) will reach maturity (it is found in a mature follicle or De Graaf follicle).

I.3 The maturation phase :

This occurs at the same time as the follicle matures.

Each month between puberty and the menopause, in a follicle that is reaching maturity, oocyte I completes the 1st division of meiosis (reduction division), giving two haploid cells ($n=23$) of unequal size: a small cell (1st polar globule) and a large cell (oocyte II).

The 2nd division of meiosis begins immediately.

When it is expelled from the ovary by ovulation, oocyte II is stuck in metaphase of the 2nd division.

There are two possible situations:

- If there is no fertilisation: oocyte II remains at this stage of meiosis and then rapidly degenerates.
- If there is fertilisation: oocyte II completes its maturation (the 2nd division of meiosis) giving two haploid cells ($n=23$): a small cell (2nd polar cell) and a large cell (ovoid or egg cell). During maturation, the oocyte increases in size.

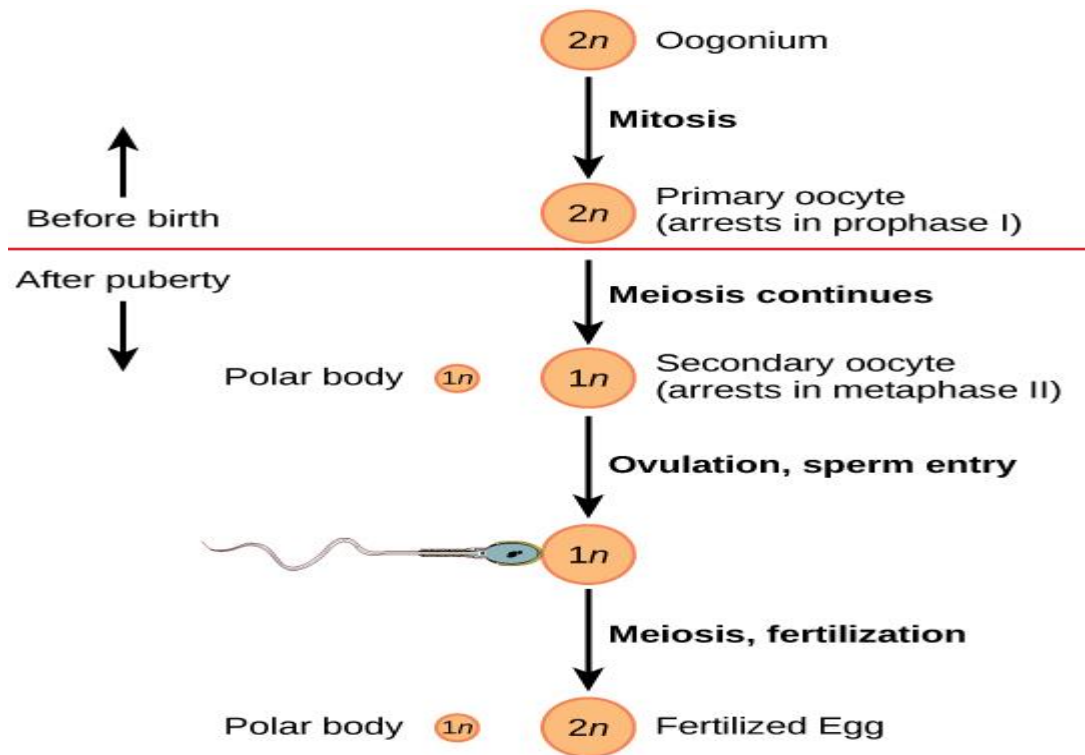


Figure 01: General diagram of ovogenesis

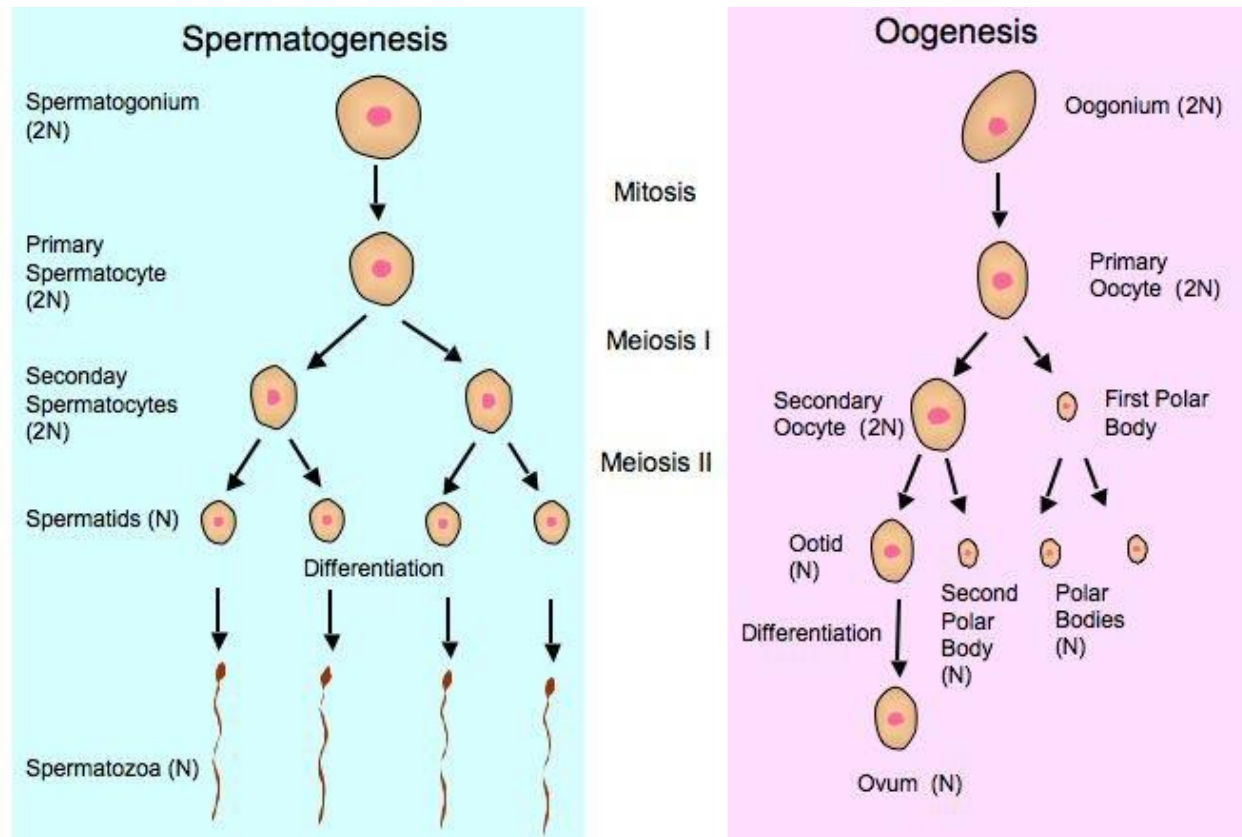


Table 02: Differences between oogenesis and spermatogenesis

There are differences between spermatogenesis and oogenesis

	Spermatogenesis	Ovogenesis
Organ	Testis (seminiferous tubules)	Ovary
Number of gametes produced	4 spermatozoa	1 egg + 3 polar globules which degenerate
Type of chromosome	Half of spz → X Half of spz → Y	All → X eggs
Gamete longevity	4 days	24 hours
Duration of gamete production	From puberty to advanced age Spermatogonia are renewed by mitosis.	Puberty → menopause (age 50). The ova are not renewed. The girl is born with her capital (700,000 approx).
Production rate	Daily (Millions /d) of spz	Monthly (1 egg/month)
Size	Small cell	Large cell
Mobility	+ → flagellate	-