

B.Sc. Part -1: Paper II: Group -B: Developmental Biology

Oogenesis

Definition: The process of maturation and differentiation of primordial germ cell (PGC) to oogonia, primary oocytes, secondary oocyte and to mature ova in the female genital tract.

Location: Ovary (Ovarian cortex)

Peculiarities of oogenesis:

- Starts before birth
- Stops in the middle (birth to puberty)
- Restart at puberty (11 to 13 years)
- Continues up to menopause (45 to 50 years)

Process

- Mitosis
- Meiosis
- Growth of follicles
- Differentiation of follicles

The ovarian cortex contains many large round cells called “oogonia”. All the oogonia to be utilized throughout the life of a woman are produced at a very early stage (possibly before birth) and do not multiply thereafter.

On arrival in the gonad the primordial germ cells differentiate into oogonia.

The oogonia pass through the stages of primary and secondary oocyte, and finally forms the ovum.

Oogenesis at different phases of life can be described as:

Before third month:

The primordial germ cells undergo mitosis to form oogonia. No more oogonia are added after birth.

Before 7th month:

The oogonia continues to divide mitotically. The oogonia are surrounded by a layer of flat epithelial cells. Some of the oogonia enlarge to form primary oocytes. The oogonia are diploid(2n) in chromosome content.

7th month to birth:

Formation of primordial follicles (primary oocyte with its surrounding flat epithelial cells) and multiplication of primary oocyte to produce millions of germ cells occurs.

Primary oocyte enters prophase I of meiosis I, at that phase the meiosis is arrested by oocyte maturation inhibitor (OMI) factor.

Many of these oogonia and primary oocyte degenerate before birth.

Birth to puberty:

There will be both maturation and degeneration of primordial follicles which results in the decrease in the number of primary oocytes.

At the time of birth all primary oocyte is in the prophase of first meiotic division. At the time of birth approximately 2 lakh primary oocyte in primordial follicles are present in each ovary. The primary oocyte now enters prolonged resting stage and further no development takes place

Each primary oocyte gets surrounded by granulosa cells and now they are called primary follicles.

At puberty only about 60,000 to 80,000 primary follicles are left in each ovary.

After puberty:

Remaining primary oocyte do not complete their first meiotic division instead remain in prophase.

They resume their development when the female attains maturity or puberty.

The primary oocyte starts developing one at a time and once in a month.

The primary oocyte enlarges and completes the meiosis I, resulting in the formation of a large secondary oocyte and small polar body, called as first polar body

The first polar body receives little cytoplasm but a full set of chromosomes.

Secondary oocyte proceeds to metaphase stage of meiosis II.

Ovulation takes place while the oocyte is in metaphase.

The secondary oocyte remains arrested in metaphase till fertilization occurs.

Further division will proceed only if fertilization takes place.

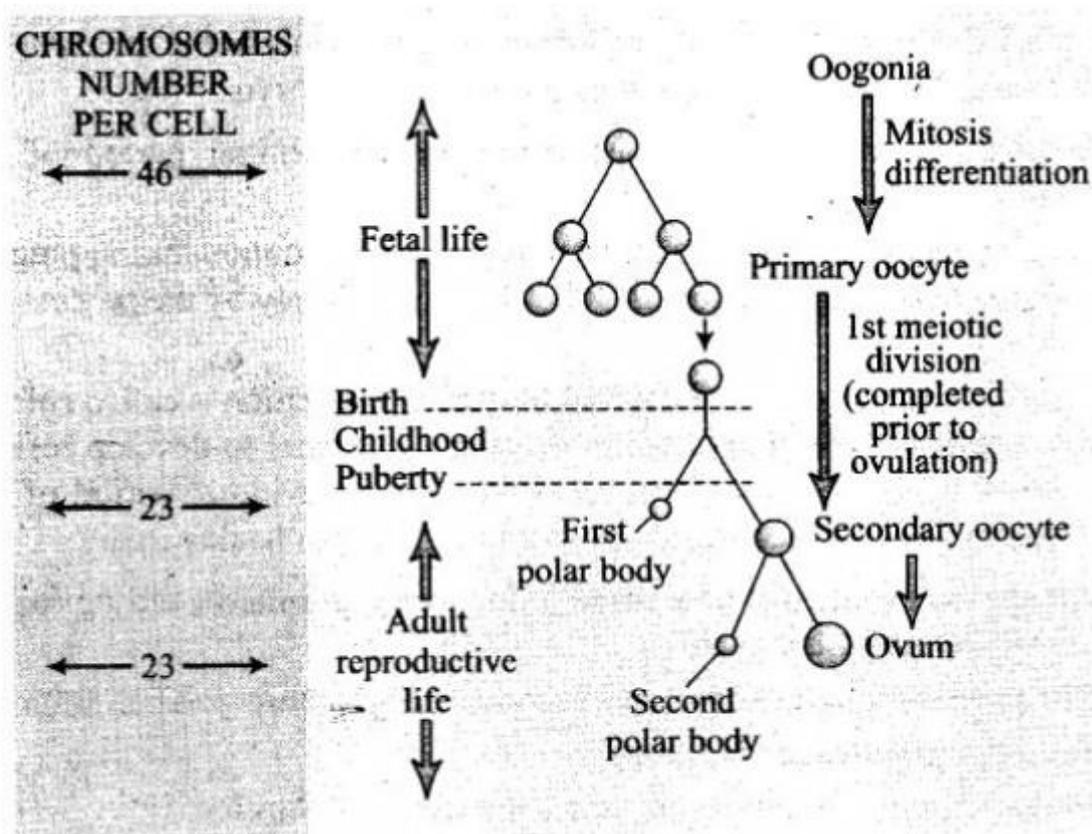
Entry of the sperm restart the cell cycle breaking down MPF (Metaphase promoting factor) and APC starts (Anaphase Promoting complex).

Completion of this division (meiosis II) results in two unequal daughter cells.

The largest cell is called the ovum. The smaller daughter cell is called second polar body.

The first polar body may also divide during the second meiotic division, making a total of three polar bodies.

The secondary oocyte fails to complete the second meiotic division if fertilization does not take place. Secondary oocyte degenerates within 24 hours if fertilization does not occur.



Schematic representation of Oogenesis

Hormonal Regulation of Oogenesis:

- The hypothalamus releases GnRH (gonadotropin releasing hormone).
- The pituitary gland releases FSH: this stimulates the development of follicles within the ovary.
- Anterior pituitary also secretes LH (luteinizing hormone), It stimulates the ovarian follicular cells to burst during ovulation.

Significance of oogenesis:

- One ovum is produced along with three polar bodies.
- Polar bodies have small amount of cytoplasm.
- Formation of polar bodies maintains the half no. of chromosome in ovum.
- During meiosis first crossing over takes place which brings about variation.

Source: Book: Inderbir Singh's human embryology