Cell live Cycle:

The **cell cycle**, or **cell-division cycle**, is the series of events that take place in a cell that cause it to divide into two daughter cells. These events include the duplication of its DNA and some of its organelles, and subsequently into two daughter cells in a process called cell division.

In cells with nuclei (eukaryotes, i.e., animal, plant, fungal, and protist cells), the cell cycle is divided into two main stages: interphase and the mitotic (M) phase (including mitosis and cytokinesis).

In cells without nuclei (prokaryotes, i.e., bacteria and archaea), the cell cycle is divided into the B, C, and D periods. The B period extends from the end of cell division to the beginning of DNA replication. DNA replication occurs during the C period. The D period refers to the stage between the end of DNA replication and the splitting of the bacterial cell into two daughter cells.

Mitosis: It is a process of nuclear **division** in eukaryotic **cells** that occurs when a parent **cell** divides to produce two identical daughter cells. During **cell division**, **mitosis** refers to the separation of the duplicated genetic material carried in the nucleus. The major purpose of **mitosis** is for growth and to replace worn out cells.

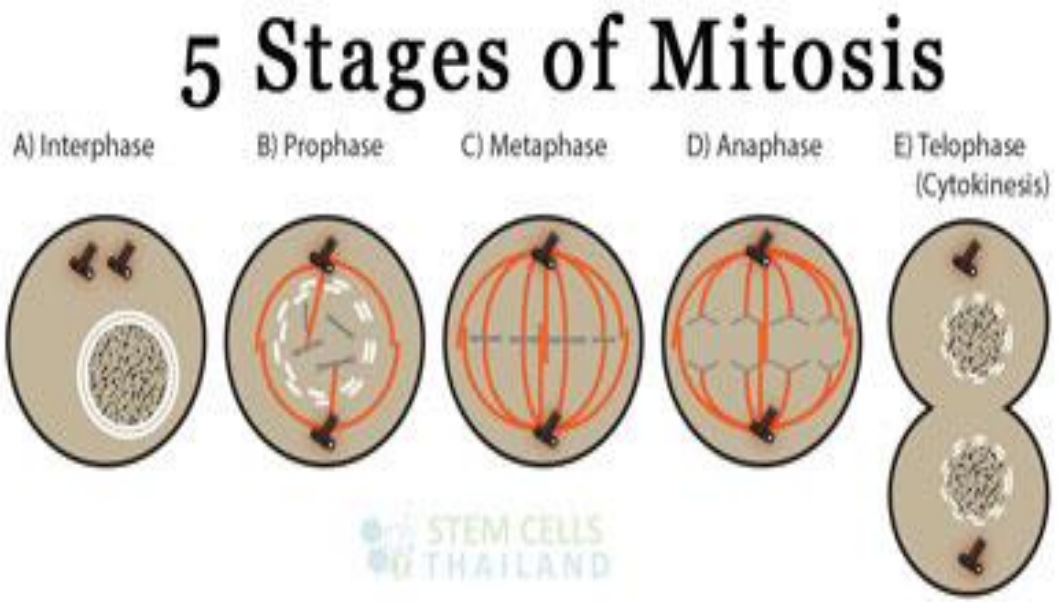
Mitosis is process include five-stages, and is integral to a cell's life cycle. Single-celled organisms like bacteria duplicate to make two new organisms, many rounds of mitosis are required for the growth and development of multicellular organisms like humans and other mammals. The five-stages are:

Interphase: During interphase, the cell is preparing itself for division. Cells contain many proteins and structures called organelles that it must replicate in preparation for doubling. The DNA of the cell is also duplicated during this phase, creating two copies of each strand of DNA called a chromosome. The majority of the cell's lifespan is spent in interphase.

Prophase: In this phase, the duplicated chromosomes from the previous phase condense, meaning they become compacted and more tightly. An apparatus known as a mitotic spindle forms on the edges of the dividing cell. The mitotic spindle is made up of proteins called microtubules that gradually lengthen during prophase, which drives the division of the cell by elongating it.

Metaphase: During metaphase the membrane, or nuclear envelope, surrounding the chromosomes breaks down, allowing the condensed chromosomes to direct contact with the microtubules of the mitotic spindle. Upon entering metaphase, the pairs of condensed chromosomes line up along the equator of the elongated cell.

Anaphase: During anaphase, the pairs of chromosomes, also called sister chromatids, are drawn to opposite poles of the elongated cell. Therefore, duplicate copies of the cell's DNA are now on either side of the cell and are ready to divide completely. At this stage the microtubules get shorter, which begins to allow the cell to separate.



Telophase: The most important characteristic of telophase is that the nuclear envelope, which had previously broken down to allow the microtubules to access and recruit the chromosomes to the equator of the dividing cell. The complete division of the cell, however, is not complete until cytokinesis takes place. Cytokinesis is the process by which the elongated cell is finally pinched into two new cells by a ring of proteins called actin and myosin, at this point, the cytoplasm, is equally divided between the two new daughter cells.

Nuclear Division:

Mitosis is a process of nuclear division in eukaryotic cells that occurs when **a parent cell divides to produce two identical daughter cells**. During cell division, mitosis refers to the separation of the duplicated genetic material carried in the nucleus.

Mitosis and meiosis are both forms of division of the nucleus in eukaryotic cells. Mitosis is a single nuclear division that results in two nuclei that are usually partitioned into two new cells. The nuclei resulting from a mitotic division are genetically identical to the original nucleus. They have one set of chromosomes of haploid cells and two sets in the case of diploid cells. In most plants and all animal species, it is typically diploid cells that undergo mitosis to form new diploid cells. In contrast, meiosis consists of two nuclear divisions resulting in four nuclei that are usually partitioned into four new cells. The nuclei resulting from meiosis are not genetically identical and they contain one chromosome set only. This is half the number of chromosome sets in the original cell, which is diploid.

Cytoplasmic Divition: **Cytokinesis** is the part of the cell division process during which the cytoplasm of a single eukaryotic cell divides into two daughter cells. Cytoplasmic division begins during or after the late stages of nuclear division in mitosis and meiosis. Plant cytokinesis differs from animal cytokinesis, partly because of the rigidity of plant cell walls.

Meiosis, the process by which sexually reproducing organisms generate gametes (sex cells), the primary function of meiosis is the reduction of the ploidy (number of chromosomes) of the gametes from diploid (2n) to haploid (1n).

In females, the process of meiosis is called oogenesis, since it produces oocytes and ultimately yields mature ova (eggs). The male counterpart is spermatogenesis, the production of sperm.

Cell Division (**Meiosis):** It is a type of **cell division** that reduces the number of chromosomes in the parent cell by half and produces four gamete cells. **Meiosis** is essential for sexual reproduction and therefore occurs in all eukaryotes that reproduce sexually. This process is required to produce egg and sperm cells for sexual reproduction. Meiosis begins with a parent cell that is diploid, meaning it has two copies of each chromosome. Since cell division occurs twice during meiosis, one starting cell can produce four gametes (eggs or sperm). In each round of division, cells go through four stages: prophase, metaphase, anaphase, and telophase.

Meiosis is result in four cells only one copy of each chromosome (haploid). Later on, during fertilization, the haploid cells will fuse to create a cell with two copies of each chromosome again, the zygote. Meiosis I and II are each divided into the stages of meiosis I (prophase I, metaphase I, anaphase I, telophase I) and meiosis II (prophase II, metaphase II, anaphase II, telophase II).

Meiosis I: segregates homologous chromosomes, which are joined as (2n), producing two haploid cells chromosomes, 23 in humans which each contain chromatid pairs (1n). **Meiosis II:** is an equational division analogous to mitosis, in which the sister chromatids are segr*eg*ated, creating four haploid daughter cells (1n).

Prophase I: Prophase I is typically the longest phase of meiosis. During prophase, homologous chromosomes pair exchange genetic information. This process facilitates pairing between homologous chromosomes. The new combinations of DNA created during crossover are a significant source of genetic variation, and result in new combinations of alleles, which may be beneficial.

Metaphase I: The pairs of chromosomes become arranged on the metaphase plate and attached to the fully formed meiotic spindle.

Anaphase I: Kinetochore microtubules shorten, pulling homologous chromosomes (which each consist of a pair of sister chromatids) to opposite poles. Nonkinetochore microtubules lengthen, pushing the centrosomes farther apart. Unlike in mitosis, the cohesion surrounding the centromere remains protected by a protein named Shugoshin. This allows the sister chromatids to remain together while homologs are segregated.

TelophaseI: The first meiotic division effectively ends when the chromosomes arrive at the poles. The microtubules that make up the spindle network disappear, and a new nuclear membrane surrounds each haploid set, to completing the creation of two daughter cells.

Meiosis II: Meiosis II is the second meiotic division, and usually involves separation of sister chromatids. Mechanically, the process is similar to mitosis, though its genetic results are fundamentally different. The end result is production of four haploid cells (n chromosomes, 23 in humans). The four main steps of meiosis II are: prophase II, metaphase II, anaphase II, and telophase II.

Prophase II: disappearance of the nucleoli and the nuclear envelope again as well as the shortening and thickening of the chromatids. Centrosomes move to the Polar Regions and arrange spindle fibers for the second meiotic division.

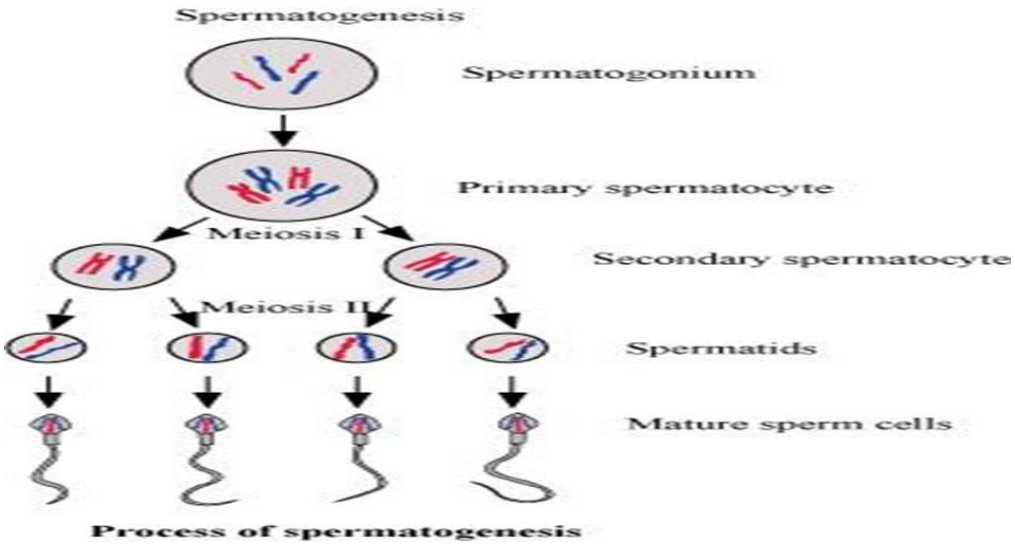
Metaphase II: Centromeres contain two kinetochores that attach to spindle fibers from the centrosomes at opposite poles.

Anaphase II: in this phase the centromeric cohesin, not protected by Shugoshin anymore, allowing the sister chromatids to segregate. The sister chromatids are now called sister chromosomes as they move toward opposing poles.

Telophase II: The process ends with this phase which is similar to telophase I, and is marked by decondensation and lengthening of the chromosomes and the disassembly of the spindle. Nuclear envelopes re-form and produces four daughter cells, each with a haploid set of chromosomes.

Spermatogenesis: is the process in which an animal produces spermatozoa from spermatogonial stem cells by way of mitosis and meiosis. The initial cells in this pathway are called spermatogonia, which yield primary spermatocytes by mitosis. The primary spermatocyte divides (Meiosis I) into two secondary spermatocytes; each secondary spermatocyte divides into two spermatids by Meiosis II. These develop into mature spermatozoa, also known as sperm cells. Thus, the primary spermatocyte gives rise to two cells, the secondary spermatocytes, and the two secondary spermatocytes by their subdivision produce four spermatozoa.

Spermatozoa are the mature male gametes in many sexually reproducing organisms. Thus, spermatogenesis is the male version of gametogenesis, of which the female equivalent is oogenesis.

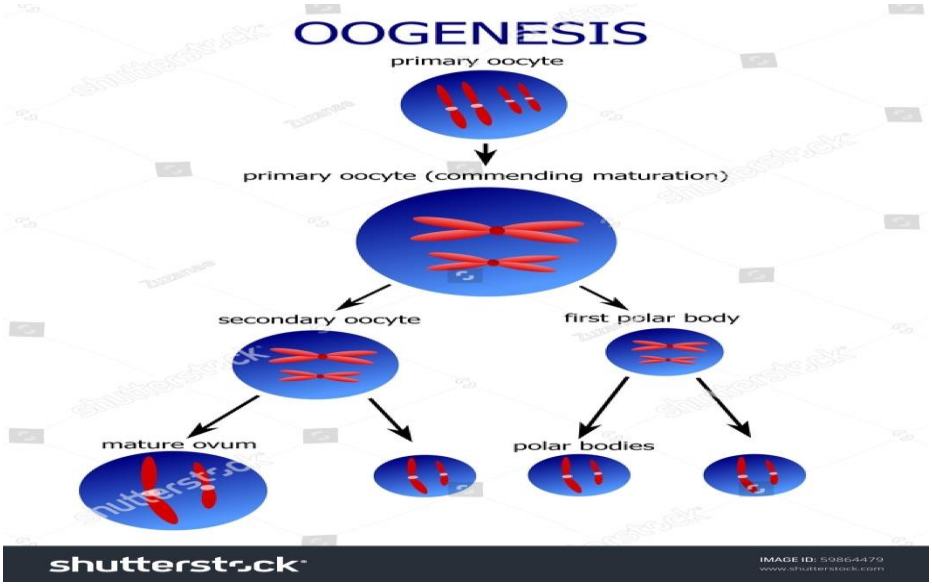


Process of spermatogenesis

Oogenesis:

In mammals, the first part of oogenesis starts in the germinal epithelium, which gives rise to the development of ovarian follicles, the functional unit of the ovary.

Oogenesis consists of several sub-processes: oocytogenesis, ootidogenesis, and finally maturation to form an ovum.



Oogenesis starts with the process of developing oogonia, which occurs via the transformation of primordial follicles into primary oocytes, a process called oocytogenesis. Oocytogenesis is complete either before or shortly after birth.