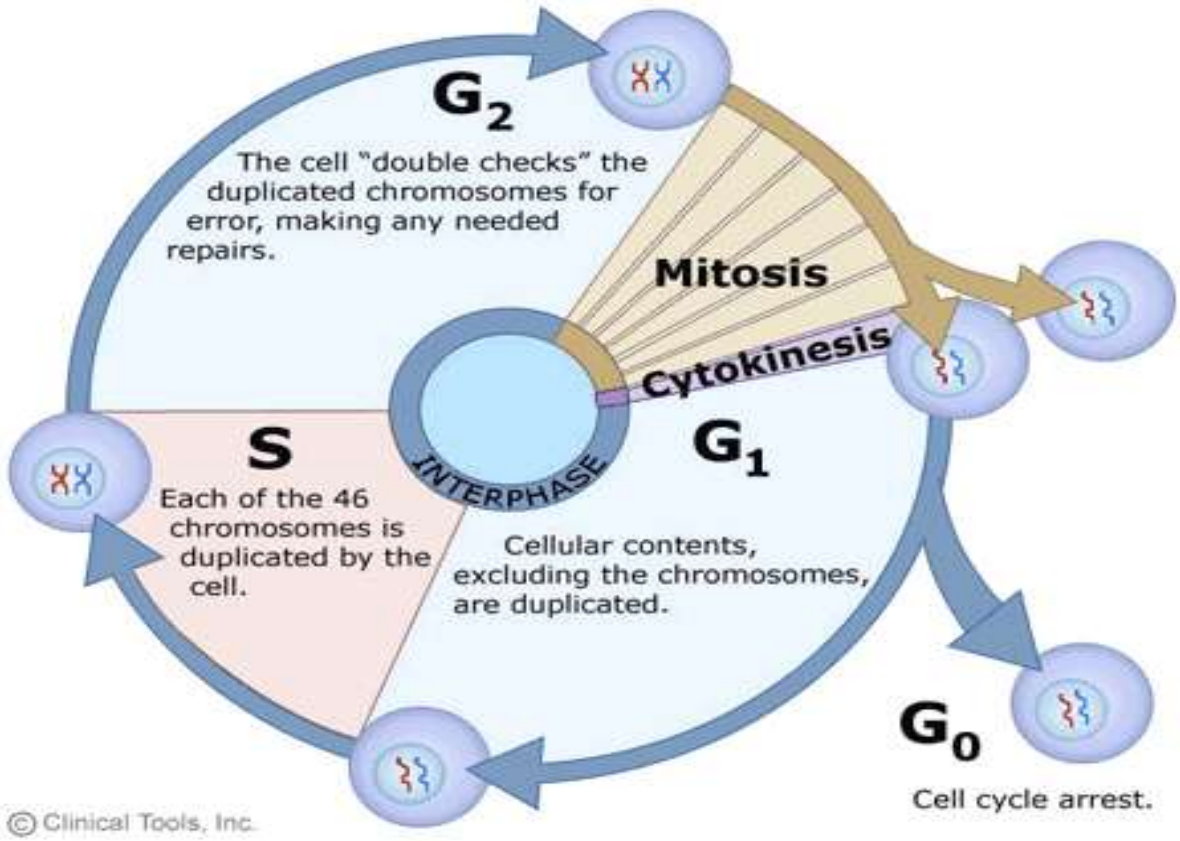
Cell division

Cell division or cell cycle is a very important process in all living organisms. Its sequence of event by which, DNA replication and cell growth also take place and eventually cell divides into two daughter cells, all these events are under genetic control. Cell cycle is divided into two periods, interphase, mitotic (M) phase and followed by cytokines. For example, through cell cycle, the single-celled fertilized egg develops into a mature organism, as well as by this process, hair, skin, blood cells, and some internal organs are renewed.

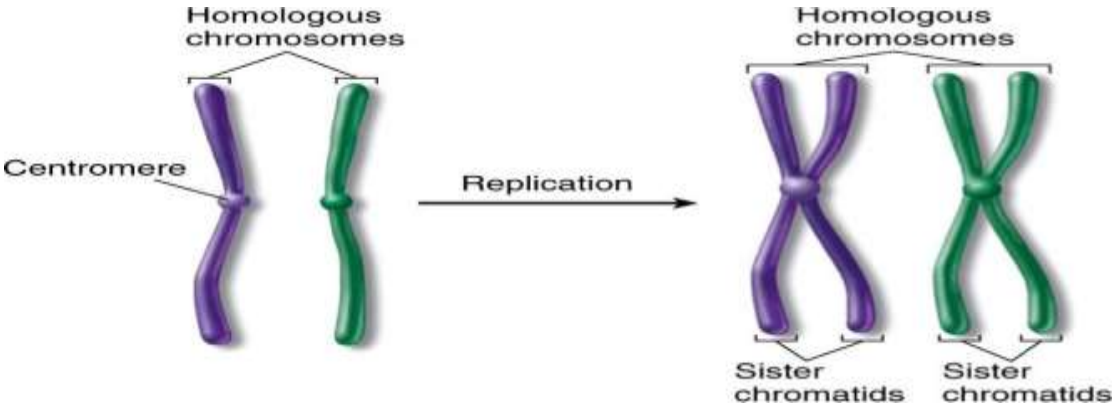


Resting phase (G0): in which the cell has left the cycle and has stopped dividing.

Inter phase: It is note that in the 24 hour average duration of cell cycle of a human cell, cell division proper lasts for only about an hour. The interphase lasts more than 95% of the duration of cell cycle. Interphase is divided to:

1- Gap1 (G_1): in this phase**,** Cells increase in size and growth, but does not replicate its DNA, the G_1 checkpoint control mechanism ensures that everything is ready for DNA synthesis.

2- Synthesis phase (S phase): in this phase, DNA replication begins in the nucleus, the amount of DNA per cell doubles, and the centriole duplicates in the cytoplasm.



3- Gap 2(G2): During this phase, proteins are synthesized in preparation for mitosis while cell growth continues. So, the cell check the replicated chromosome foe error and making any needed repairs.

Mitosis phase (M phase): Mitosis is divided into the following four stages:
Prophase, Metaphase, Anaphase and Telophase

1- Prophase

Prophase which is the first stage of mitosis follows the S and G2 phases of interphase.

- Prophase is marked by the initiation of condensation of chromosomal material. The chromosomal material becomes untangled during the process of chromatin condensation
- The centriole, now begins to move towards opposite poles of the cell.
- Chromosomes are seen to be composed of two chromatids attached together at the centromere.
- Initiation of the assembly of mitotic spindle, the microtubules, the proteinaceous components of the cell cytoplasm help in the process. Cells at the end of prophase, when viewed under the microscope, do not show golgi complexes, endoplasmic reticulum, nucleolus and the nuclear envelope.

Metaphase

The chromosomes are spread through the cytoplasm of the cell. By this stage, condensation of chromosomes is completed and they can be observed clearly under the microscope. At this stage, metaphase chromosome is made up of two sister

chromatids, which are held together by the centromere. Small disc-shaped structures at the surface of the centromeres are called kinetochores. These structures serve as the sites of attachment of spindle fibers to the chromosomes that are moved into position at the center of the cell. Hence, the metaphase is characterized by all the chromosomes coming to lie at the equator with one chromatid of each chromosome connected by its kinetochore to spindle fibers from one pole and its sister chromatid connected by its kinetochore to spindle fibers from the opposite pole . The plane of alignment of the chromosomes at metaphase is referred to as the **metaphase plate.** The key features of metaphase are:

- Spindle fibers attach to kinetochores of chromosomes.
- Chromosomes are moved to spindle equator and get aligned along metaphase plate through spindle fibers to both poles.

Anaphase

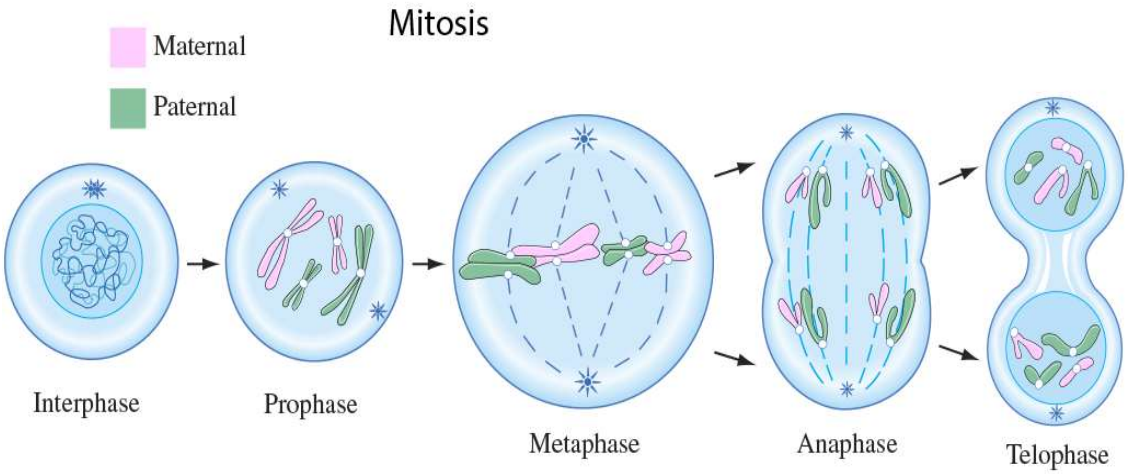
Its shortest stage of mitosis. The centromeres divide, and **the sister chromatids of each chromosome are pulled apart and move to the opposite ends of the cell**, pulled by spindle fibers attached to the kinetochore regions. The separated sister chromatids are now referred to as daughter chromosomes.

Telophase

Its final stage of mitosis and a reversal of many of the processes observed during prophase. The nuclear membrane reforms around the chromosomes grouped at either pole of the cell, the chromosomes uncoil and become diffuse, and the spindle fibers disappear, nucleolus, Golgi complex and ER reform.

Cytokines

In this stage the nuclei, cytoplasm, organelles and cell membrane are divided into two cells containing roughly equal shares of these cellular components. Cytokinesis is not a phase of mitosis, it is a separate process necessary for completing cell division.



Mitosis is a form of eukaryotic cell division that produces two daughter cells with the same genetic component as the parent cell. Chromosomes replicated during the S phase are divided in such a way as to ensure that each daughter cell receives a copy of every chromosome. In actively dividing animal cells, the whole process takes about one hour.

Meiosis

Meiosis is the form of eukaryotic cell division that produces **haploid** sex cells or gametes (which contain a single copy of each chromosome) from **diploid** cells (which contain two copies of each chromosome). The process takes the form of one DNA replication followed by two successive nuclear and cellular divisions (Meiosis I and Meiosis II). As in mitosis, meiosis is preceded by a process of DNA replication that converts each chromosome into two sister chromatids.

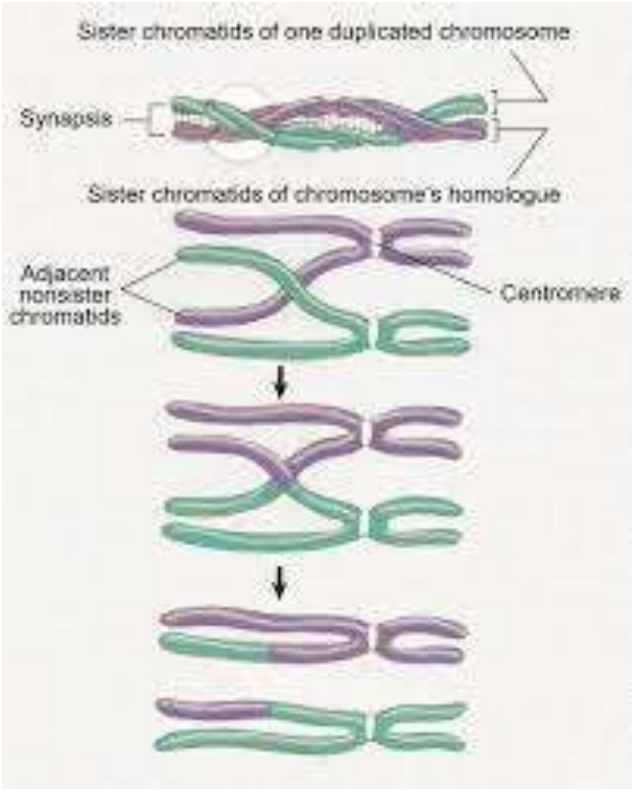
Meiosis 1

Which divided to:

1- Prophase1

The chromosomes become gradually visible under the light microscope. During this stage chromosomes start pairing together and this process of association is called synapsis. Such paired chromosomes are called homologous chromosomes (each chromosome consist of two identical chromatids), and each pair of synapsed of homologous chromosomes is called a **bivalent** or a tetrad.

Also this stage is characterized by the process, **crossing over** between non-sister chromatids of the homologous chromosomes. Crossing over is the exchange of genetic material between two homologous chromosomes, after that the recombined homologous chromosomes of the bivalents to separate from each other except at the sites of crossovers, these X shaped structures, are called **chiasmata.** During this phase the chromosomes are fully condensed and the meiotic spindle is assembled to prepare the homologous chromosomes for separation, the nucleolus disappears and the nuclear envelope also breaks down.



Prophase

Metaphase 1

The spindle fibers are form, the bivalent chromosomes align on the center of the cell (equatorial plate) and the centromeres become attached to spindle fibers.

Anaphase 1

The homologous chromosomes separate, while sister chromatids remain associated at their centromeres, this is different to what happens in mitosis and meiosis II.

Telophase 1

The chromosomes complete their move to the opposite poles of the cell, each pole of the cell a full set of chromosomes gather together and the nuclear membrane and nucleolus reappear, then, the cytokinesis follows it to form two daughter cells with 23 chromosomes (23 pairs of chromatids).

Meiosis II

Meiosis II is initiated immediately after cytokinesis, usually before the chromosomes have fully elongated. In contrast to meiosis I, meiosis II resembles a normal mitosis.

Prophase II

Nuclear envelope and the nucleolus disappearing, the centrioles duplicate and the meiotic spindle forms again.

Metaphase II

At this stage the chromosomes align at the equator and the spindle fibers at each pole of the cell attach to each of the sister chromatids.

Anaphase II

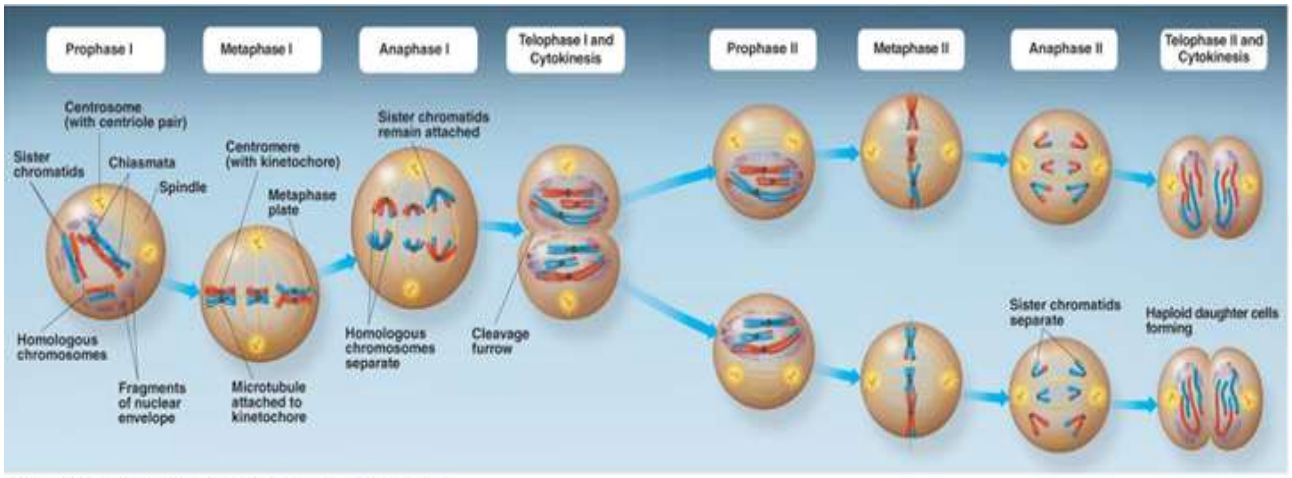
It begins with splitting of the centromere of each chromosome (which was holding the sister chromatids together), allowing them to move toward opposite poles of the cell.

Telophase II

Two groups of chromosomes once again get enclosed by a nuclear envelope, cytokinesis follows resulting in the formation of tetrad of cells, four haploid daughter cells.

Importantce of meiosis

Meiosis is the mechanism by which conservation of specific chromosomes number of each species is achieved across generations in sexually reproducing organisms, results in reduction of chromosome number by half. It also increases the genetic variability in the population of organisms from one generation to the next. Variations are very important for the process of evolution. In mitosis, the producing cells are completely identical to mother cell, while, in meiosis, the producing cells are differ from the parent type.



Mitosis	Meiosis
1. Mitosis occurs continuously in the body or somatic cells.	1. Meiosis occurs in the germ cells during the process of gametogenesis.
2. The whole process complete in one sequence or phase after one round of DNA replication.	2. The whole process completes in two successive divisions which occur one after the other.
3.The prophase is of short duration and does not include any sub stage.	3. The prophase is of longer duration and it complete in six successive stages.
4. The homologous chromosomes duplicate into two chromatids ,the chromatids separate and form new chromosomes.	4. Out of the two homologous chromosomes only one type of chromosome either maternal or paternal moves to the daughter cells.
5. No pairing or synapsis takes place between the homologous chromosomes.	5. Pairing or synapsis occurs between the homologous chromosomes.
6. Duplication of chromosomes takes place in the early prophase.	6. Duplication or splitting of chromosomes takes place in late prophase.
7. No chiasma formation or crossing over takes place.	7. Chiasma formation or crossing over takes place during meiosis.
8. The exchange of the genetic material between the homologous chromosomes does not occur.	8. The exchange of genetic material takes place between the chromatids of homologous chromosomes.
9. The chromosome number remains the same in the newly formed daughter cells.	9. Chromosome number is reduced into half in the newly formed daughter cells.
10. Two daughter cells are formed.	10. Four daughter cells are formed.