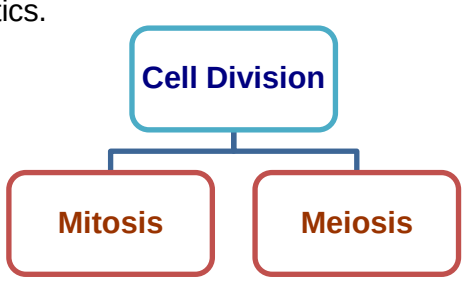
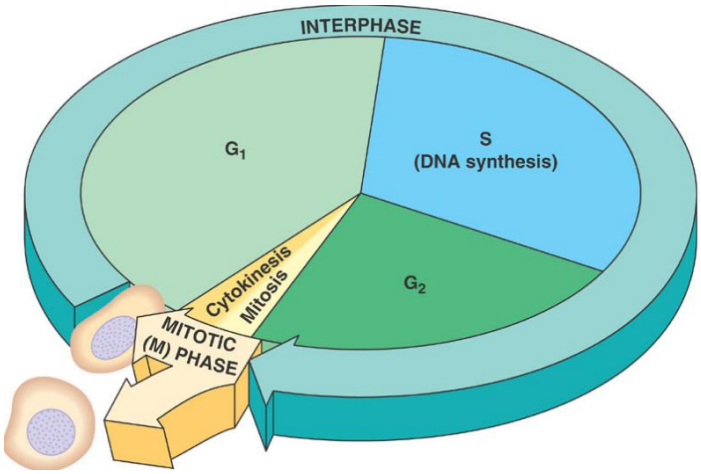
Cell Cycle, Cell Division and Structure of Chromosomes

- Cell division is a process by which a mature cell divides and forms daughter cells which resemble the parent cell in several characteristics.

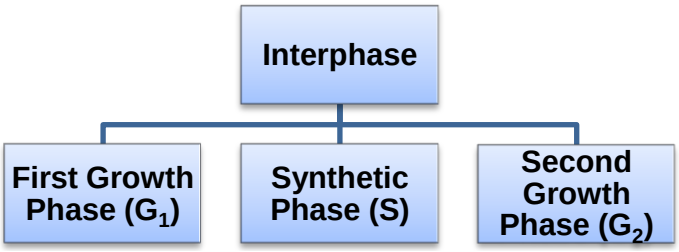


- **Phases of Cell Cycle:** The cell cycle consists of a long non-dividing interphase and a short dividing mitotic phase or M phase.



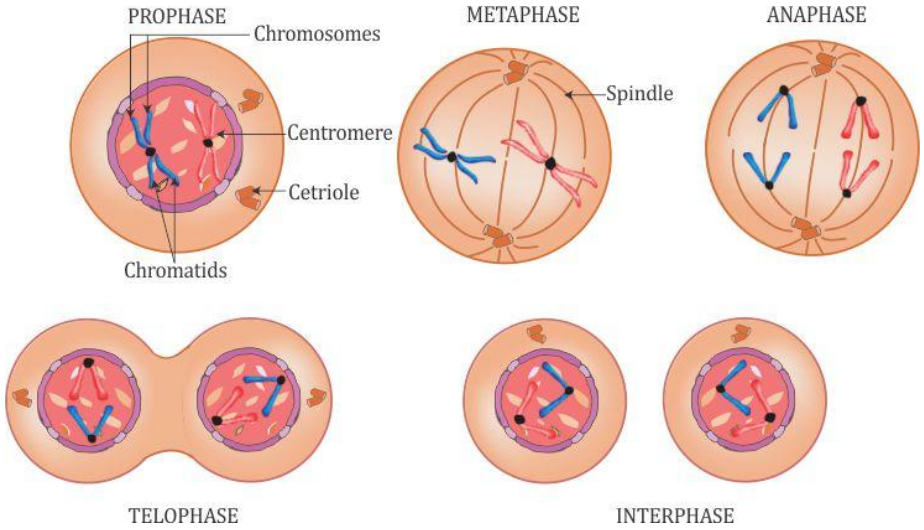
Cell Cycle

  - **Interphase:** In interphase, cells grow in size, volume and prepare for the next cell division. Because interphase is a non-dividing phase, it is also known as **resting phase**.



  - **Mitosis:** Mitosis is the division of somatic cells in which two identical daughter cells are produced by the division of one parent cell.
    Mitosis is also known as **equational division** or **somatic cell division** because during the process daughter cells receive an equal number of chromosomes and the division occurs in the body cells or somatic cells.
  - Mitosis consists of the following phases:
    A. **Karyokinesis**: It is the division of the nucleus during cell division.
    B. **Cytokinesis**: It is the division of the cytoplasm during cell division.

- Karyokinesis occurs in four phases:
  1. Prophase
  2. Metaphase
  3. Anaphase
  4. Telophase



1. Prophase	• During prophase, chromatin fibres condense and thick chromosomes are visible. • The nucleolus and nuclear membrane disappear. • A pair of centrioles duplicates. • Spindle apparatus starts forming.
2. Metaphase	• Chromosomes are arranged on the metaphase plate or equatorial plane.
3. Anaphase	• The centromere divides, and the sister chromatids separate from each other. • Spindle fibres contract and pull chromatids towards opposite poles.
4. Telophase	• Spindle apparatus disappears. • Chromosomes become thin and turn into chromatin fibres. • Nuclear membranes and nucleoli reappear.
Cytokinesis	• The furrow continues to deepen in the cell, and it finally divides the cytoplasm forming two new daughter cells. • In plant cells, a cell plate appears at the equatorial plane.

Significance of Mitosis

- It is important for the growth of organisms.
- Repair of damaged and wounded tissues occurs through mitosis.
- Old or worn out cells are replaced during normal body functioning.

Meiosis

Meiosis is the cell division in which each daughter cell receives half set of chromosomes. Hence, in meiosis, haploid daughter cells (n) are formed from a diploid parent cell (2n).
Therefore, meiosis is also known as **reductional division**.
Meiosis consists of two successive divisions—meiosis I and meiosis II.

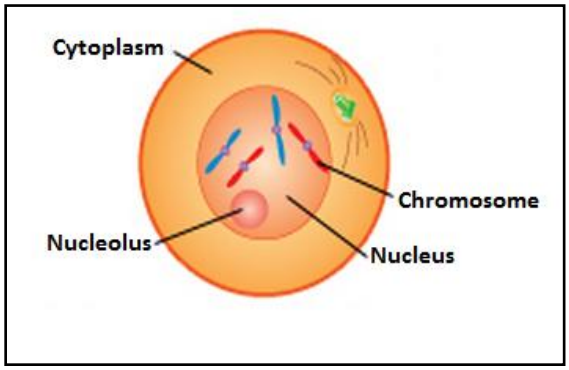
Meiosis I

Meiosis I is a reduction division. In this division, the chromosome number is reduced to half (n).

Meiosis I is divided into four phases:

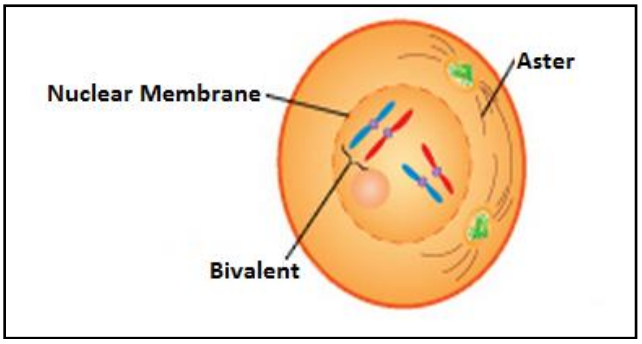
1. **Prophase I:** It is the longest phase and consists of five sub-stages.

   a. **Leptotene or Leptonema:**
   - The chromatin network condenses and centrioles duplicate.



Leptotene

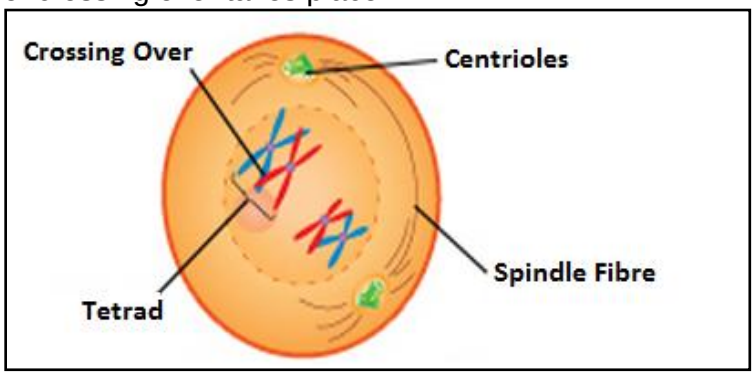
   b. **Zygotene or Zygonema:**
   - Pairing of homologous chromosomes occurs.



Zygotene

c. Pachytene or Pachynema:

- Chromosomes remain paired up at points called chiasmata.
- The process of crossing over takes place.



Pachytene

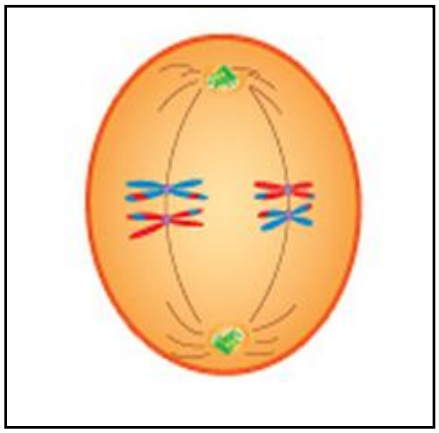
d. Diplotene or Diplonema:

- Homologous chromosomes repel and go away from each other except at the chiasmata.

e. Diakinesis

- The nuclear membrane and nucleolus disappear.
- Formation of the spindle fibre begins.

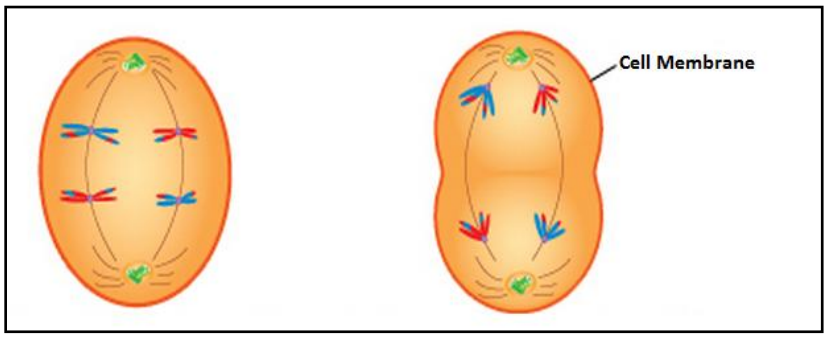
2. Metaphase I



Metaphase I

- Homologous chromosomes are arranged at the equatorial plane.

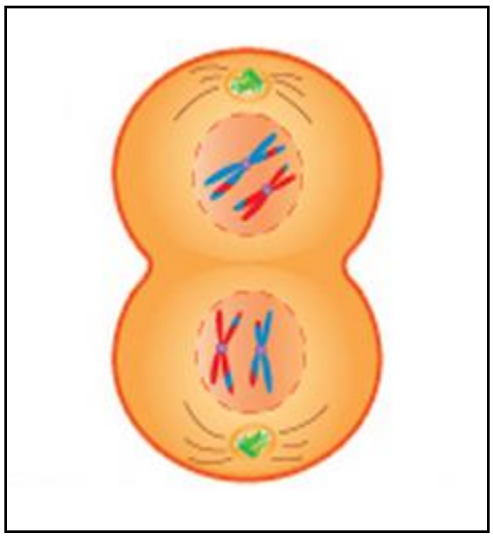
3. Anaphase I



Anaphase I

- Homologous chromosomes after crossing over start moving to the opposite poles.

4. Telophase I

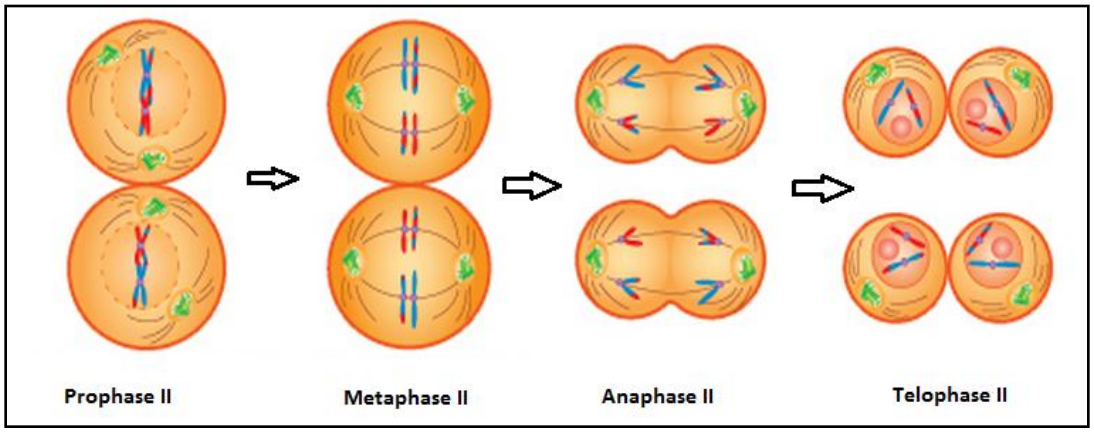


Telophase I

- The nuclear membrane and nucleoli reappear.

Meiosis II

Meiosis II is a mitotic division.



Significance of Meiosis

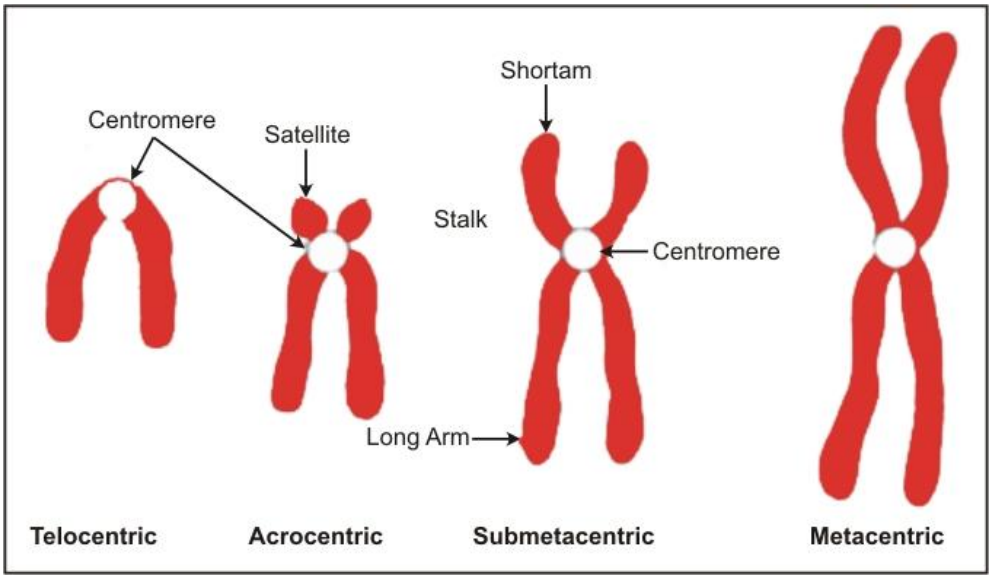
- The original number of chromosomes is restored, i.e. 2n.
- Meiosis provides variation in the next generation.
- Meiosis provides the basis for evolution.

Differences between Mitosis and Meiosis

Sr. No.	Mitosis	Meiosis
i.	Occurs in somatic cells.	Occurs in reproductive cells only.
ii.	Cells divide only once at a time.	Cells divide twice in two successive divisions, i.e. meiosis I and meiosis II.
iii.	It is also called equational division, because the daughter cells have identical genetic material as the parent cell.	It is also called reductional division, because the daughter cells have half the number of chromosomes as the parent cell.
iv.	Two diploid daughter cells are formed.	Four haploid daughter cells are formed.

Structure of Chromosomes

- Chromosomes play a vital role in hereditary, variation and evolutionary development of the species.
- They were discovered by the German scientist **Walther Fleming** in 1882.
- Each chromosome has a centromere which holds together the two sister chromatids.
- Based on the position of the centromere, there are four morphological types of chromosomes:



- Based on the function, two kinds of chromosomes are found in the human body:
  i. Autosomes (Non-sex chromosomes)
  ii. Heterosomes or allosomes (Sex chromosomes) – Responsible for sex determination
- Chromatin is formed of **DNA** and **Histones**.

- The DNA strand winds around a core of eight histone molecules. This complex is known as a **nucleosome**.

Structure of DNA

- DNA is a macromolecule composed of two complementary strands twisted around each other.
- A nucleotide is made of phosphate, deoxyribose sugar and a nitrogenous base.
- There are four nitrogenous bases—Adenine (A), Cytosine (C), Thymine (T) and Guanine (G).

Structure of DNA

Formation of New DNA

Formation of new DNA occurs by the process of **replication**.

DNA Replication