CELL CYCLE AND CELL DIVISION

- The process of formation of a new cell from the pre-existing cell is called cell division.

Types of cell division

Cell division further divide into two types-

- direct and
- indirect cell

- Direct (Amitosis)-
  - Nuclear material divides directly without the appearance and without formation of spindle fibre.
  - Amitosis is discovered by Ramak in 1855.
  - It is observed in prokaryotic cell and during cell division in endosperm.
- Indirect –
  - Nuclear material divides indirectly in different phase by appearance of chromosomes and formation of spindle fibre.
  - It is two types
    1. Mitosis
    2. Meiosis

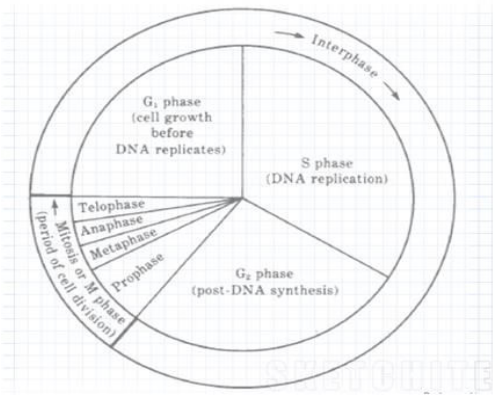
Cell cycle

- **Cell** cycle was discovered by Howard in *viciafaba.*
- Every dividing cell must pass through cell cycle.
- Cell cycle is the cyclic change in a cell by which it duplicate its contents and finally divide into new cell.
- It is genetically controlled phenomenon and is complete into phase .

Phases of Cell cycle

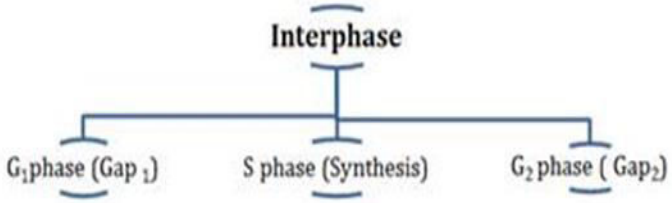
Human cell divides once in approximately 24 hours, which may vary in different organisms. In E.coli it takes about 90 minutes to complete the cell division process.

Cell cycle is divided into two basic phases-



1. **Interphase**–
   - it is the period between the end of one cell division to the beginning of the next cell division.
   - During this phase cell prepare itself for both cell growth and replication in an orderly manner, it is also known as preparation phase.
   - Interphase lasts for 95% of a cell cycle.

- Interphase is further divided into following three phase :-



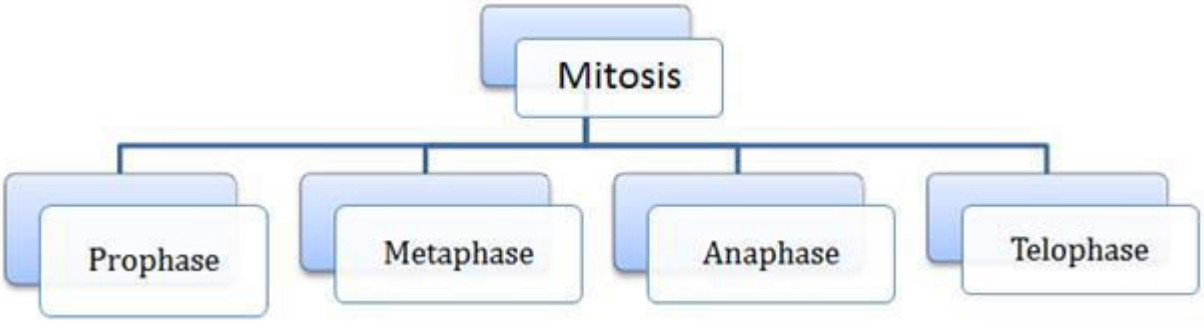
1. **G1 phase**:- This phase represents the interval between mitosis and initiation of DNA replication. Cell is continuously active and grows in size.
2. **S- phase**:- During synthesis phase, replication or synthesis of DNA takes place and amount of DNA get doubles per cell.
   If the initial amount of DNA is 2c,it will become 4c.
3. This phase also called post synthetic or pre-mitotic phase. DuringG2 phase protein is synthesized in preparation for mitosis.

   Note:-In adult animals, some cells do not divide or may divide occasionally. These cells do not divide further and exits the G1 phase to enter an inactive stage called **Quiescent Stage** (G0) of cell cycle.

2. **M Phase:**–
   - After the interphase ,the cell enters the M phase or mitotic phase.

MITOSIS

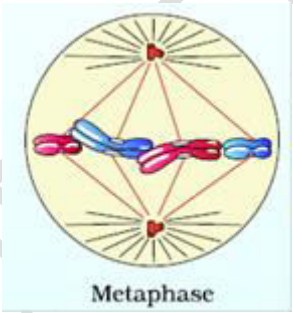
- The term mitosis was coined by W.flemming.
- Mitosis was discovered by Strassburger in plant cell and by W.flemming in animal cell.
- It is the cell division in which chromosome replicate themselves and gets equally distributed into daughter nuclei.
- It also known as somatic cell division because it always occur in somatic cell.
- It starts with karyokinesis (nuclear division) or duplication of chromosome and end with cytokinesis or division of cell matrix (cytoplasm division)
- In animals mitotic division is present in only somatic diploid cells but in plants it is seen in both haploid and diploid cells.
- Mitosis cell division is also known as **equational division** because the numbers of chromosome remain same in parental and progeny cells.



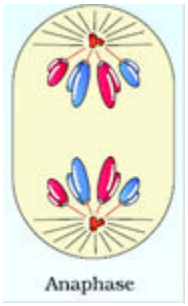
- **Prophase:-**This is the first phase of mitosis followed by G2 phase.
  It involves following events-

- Initiation of condensation of chromosomal materials.
- Movement of centrioles towards opposite poles of the cell.
- At the end of prophase, endoplasmic reticulum, nuclear membrane, Golgi complex disappears.

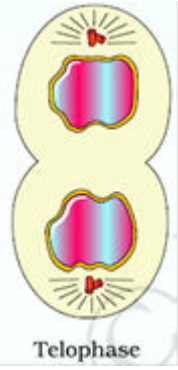
- **Metaphase:-**This starts with complete disappearance of nuclear membrane. The most suitable stage for study of morphology of chromosomes.
  It involves:-
- Condensation of chromosomal materials in to compact and distinct chromosomes made up of two sister chromatids attached with spindle fibres with kinetochores.
- Chromosomes arrange at centre of cell called metaphase plate.



- **Anaphase:-**It involves following steps:
- Splitting of each chromosome at centromere into two sister chromatids.
- Two chromatids start moving towards opposite poles.



- **Telophase:-**This is the last stage of mitosis which involves:-
- Chromosomes reach at opposite poles and loose its identity as discrete unit.
- Nuclear membrane reassembles around the chromosome clusters.
- Nucleolus, Golgi complex and ER reappear.



- **Cytokinesis:-**this is the division of cytoplasm of a cell after karyokinesis (division of chromosome) into two daughter cells. In animal cells, appearance of furrows in plasma membrane that deepens gradually and joins to divide cytoplasm into two parts.
- In plant cells, wall formation starts at the centre and grows outwards to meet lateral walls. The formation of cell wall begins with formation of **cell plate**.

Significance of Mitosis

- Mitosis produces diploid daughter cells with identical genetic complement.
- It helps in repair of cells, especially in lining of gut and blood cells.
- Meristematic division in apical and lateral cambium results in continuous growth of plants.

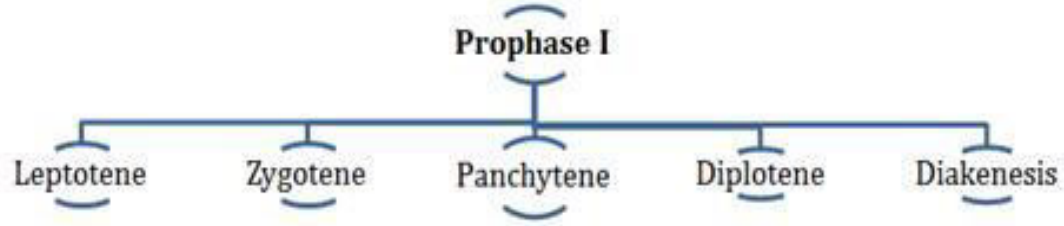
Meiosis

- The term meiosis was coined by Farmer and Moore.
- It was discovered by von Benden and Winiwarter.
- Meiosis is a double division in which four (haploid) daughter cells are formed.
- This division occur in only reproductive cell.
- In this type of cell division ,the number of chromosome in daughter cell reduces to half of the parent mother cell.
- The cell division that reduces the number of chromosome into half and results in the production of haploid daughter cells is called meiosis.
- It helps in production of haploid phase in the life cycle of sexually reproducing organism.
- It involves following events.
  - Two sequential cycles of nuclear and cell division called meiosis I and meiosis II but single cycle of DNA replication.
  - It involves pairing of homologous chromosome and recombination of them.
  - Four haploid cells are formed at the end of meiosis II

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II

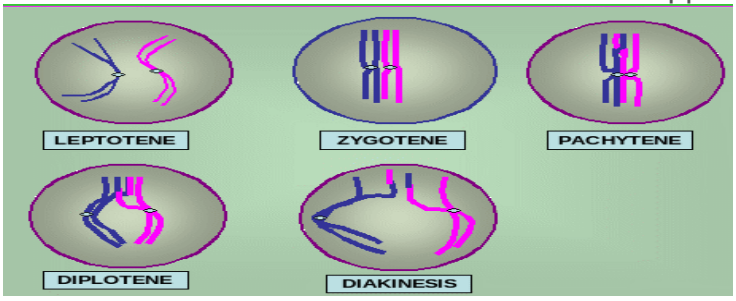
Meiosis I

- **Prophase I**:-In meiosis prophase further divided into following phase

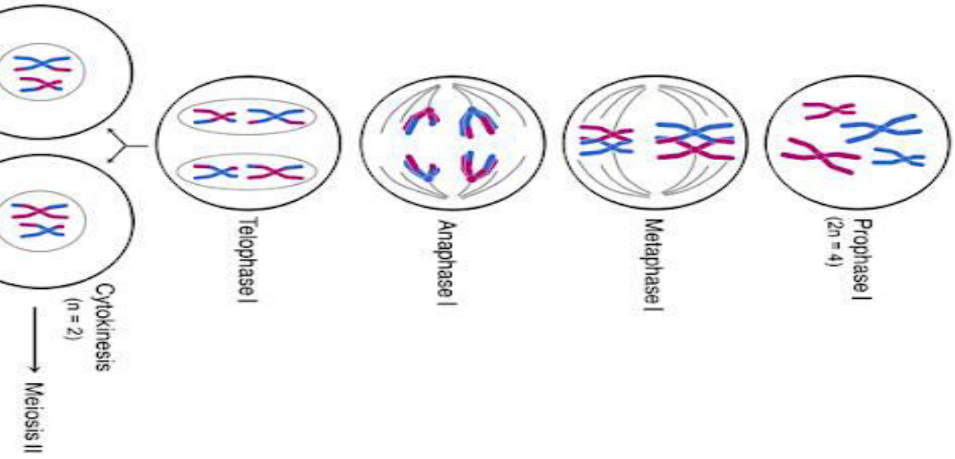


- **Leptotene:-**,
  - The chromosome becomes distinct and visible under microscope.
  - Centriole stsrt moving toward opposite poles and develops astral rays .
  - Each chromosomes is attached to the nuclear envelope through the attachment plate at both of its ends.

- **Zygotene**:-
  - in this stagechromosomes start pairing together (**synapsis**).
  - The paired chromosomes are called **homologous chromosome**.
  - Synaptonemal complex formed by a pair of homologous chromosome is called bivalent or a tetrad.
- **Pachytene:-**
  - in this stage crossing over between non-sister chromatids of homologous chromosome occurs for exchange of genetic materials.
  - The crossing over is enzyme –mediated process which involves enzyme recombinase.
- **Diplotene:-**
  - this is recognized by dissolution of synaptonemal complex and tendency to separation of bivalent except at the site of crossing over.
  - This forms an X like structure called **chiasmata**.
- **Diakenesis:-**
  - this is marked by terminalisation of chiasmata.
  - The nuclear membrane breaks and nucleolus disappear.



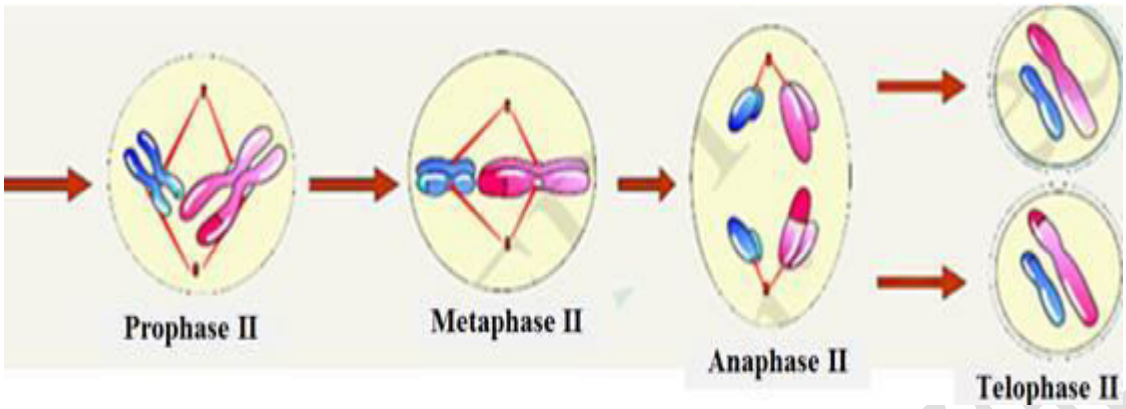
- **metaphase I:-**the bivalent chromosome align at equatorial plate and microtubules from the opposite poles of the spindle get attached to the pair of homologous chromosomes.
- **Anaphase I –** homologous chromosome separate but sister chromatids remain attached at centromere.
- **Telophase I**:- the nuclear membrane and nucleolus reappears and cytokinesis follows. This is called as diad of the cells.



Meiosis II

- It is initiated immediately after cytokinesis before chromosome gets elongated.
- **prophase II:-**, nuclear membrane disappears and chromosome becomes compact.
- **metaphase II**:- in this stagethe chromosomes align at equator and microtubules attach with kinetochores of sister chromatids.

- **Anaphase II**:- this phase start with splitting of centromere of each chromosome to move towards opposite poles.



- **Meiosis ends with Telophase II:-** in thisthe two groups of chromosomes get enclosed by nuclear membrane followed by cytokinesis to form tetrad of cells (four haploid daughter cells).

Significance of meiosis–

1. Meiosis forms the gametes that are essential for sexual reproduction.
2. Crossing over introduces new recombination of traits.
3. Helps in maintenance of chromosome number of sexually reproducing organism.
4. Provides evidence of basic relationship of organisms.

Difference between Mitosis and meiosis

Mitosis	**Meiosis**
1. Takes place in the somatic cells. 2. It is a single division which produces two cells. 3. Haploid and diploid both kind of cells may undergo mitosis. 4. Crossing over absent. 5. Pairing of chromosome does not occur.	1. Takes place in reproductive cells. 2. It is a double division which produces four cells. 3. Only diploid cells undergo meiosis cell division. 4. Crossing over takes place. 5. Pairing of homologous chromosome occurs.