CHAPTER 10
CELL CYCLE AND CELL DIVISION

Cell cycle

It is a series of events that takes place in a cell, leading to the formation of two daughter cells from a single mother cell.

Phases of cell cycle -
Cell cycle is divided into two basic phases**: Interphase and M phase**

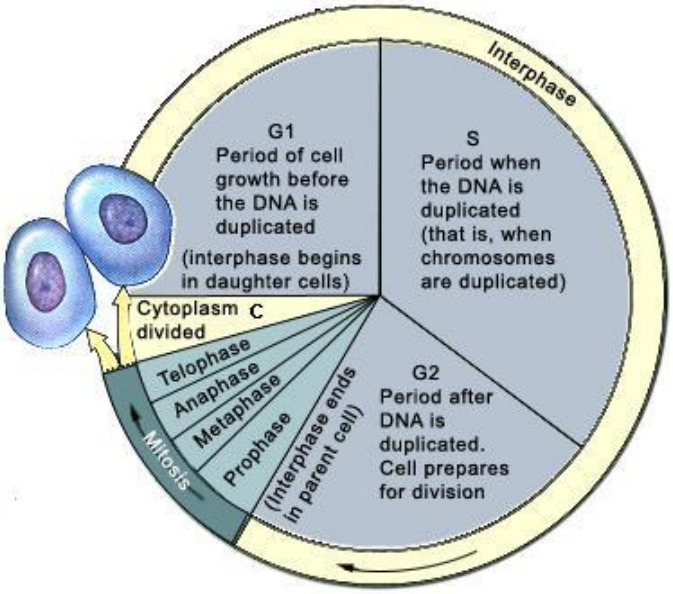
- Interphase
- M phase (mitosis phase) karyokinesis and cytokinesis

Interphase

- G1 phase
- S phase
- G2 phase
- Go phase-quiescent stage

Mitotic phase

- Karyokinesis (nuclear division): – Prophase, Metaphase, Anaphase and Telophase.
- Cytokinesis(division of cytoplasm)



Interphase

Interphase involves a series of changes that prepares the cell for division. It involves the period of cell growth and cell division in an orderly manner.

It is divided into three phases:

- **G1 phase** – It involves growth of cell and preparation of DNA for replication.
- **S phase** – It involves DNA synthesis. The amount of DNA doubles, but the chromosome number remains the same.
- **G2 phase** – It involves protein synthesis and further growth of cell, which prepares it for division.
- **G0 pha**se or Quiescent phase – It is the stage when metabolically active cell remains quiescent for long period of time.

I Mitosis

- It is a process of cell division where chromosomes replicate and get equally distributed into two daughter cells. Hence, it is also called equational division.
- The process of mitosis keeps the chromosome number equal in daughter as well as parental cell.
- Mitosis usually takes place in somatic cells.

Mitosis involves four stages:

Prophase

- It involves initiation and condensation of chromosomes.
- Nucleolus and nuclear membrane disappears.

Metaphase

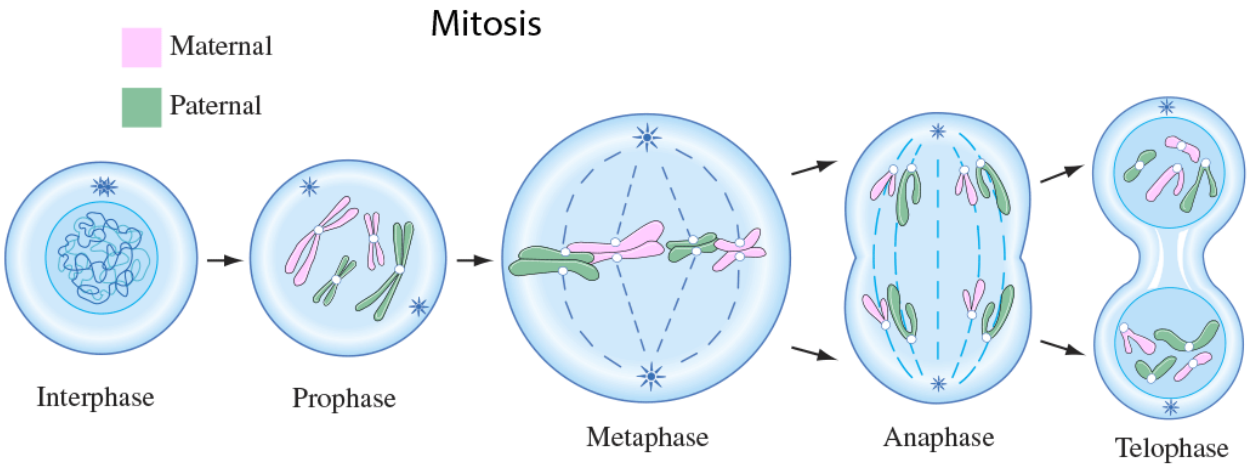
- Spindle fibres attach to kinetochores of chromosomes.
- Chromosomes are moved to spindle equator and get aligned along metaphase plate through spindle fibres to both poles

Anaphase

Centromere splits and chromosomes move apart towards two opposite poles due to shortening of spindle fibres.

Telophase

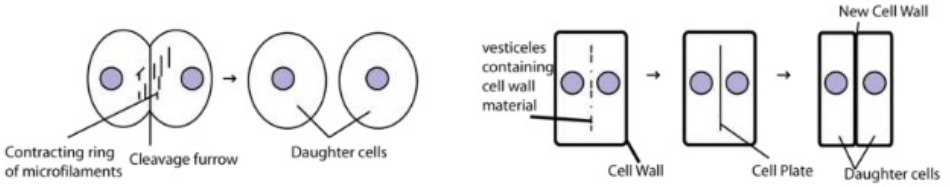
- Chromosomes finally reach their respective poles.
- Nuclear envelope assembles around each chromosome clusters.
- Nucleolus and other organelles reform.



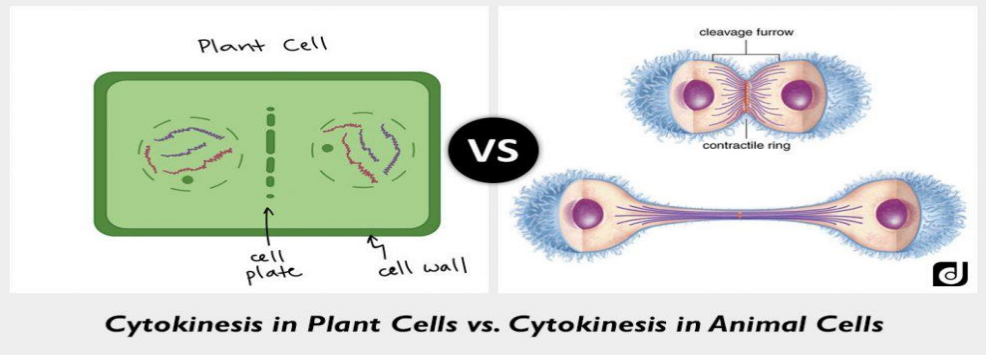
Karyokinesis and Cytokinesis

- Karyokinesis is the division of nucleus during mitosis or meiosis which is followed by cytokinesis.
- Cytokinesis involves the division of cytoplasm of a cell.
- Cytokinesis is achieved in animal cell by cleavage, which deepens and divides the cell into two.
- It is achievedin plant cell by cell plate formation.
- When karyokinesis is not followed by cytokinesis, a multinucleated condition arises. This is called *Syncytium*.

1.6.3 Cytokinesis occurs after mitosis and is different in plant and animal cells.



Animal Cells	Plant Cells
• A ring of **contractile protein** (microfilaments) immediately inside the plasma membrane at the equator pulls the plasma membrane inward. • The inward pull on the plasma membrane produces the characteristic **cleavage furrow**. • When the cleavage furrow reaches the centre of the cells it is pinched apart to form two daughter cells.	• During telophase, membrane-enclosed **vesicles** derived from the Golgi apparatus migrate to the center of cell. • Vesicles fuse to form tubular structures which form two layers of plasma membrane (i.e. the cell plate) • The **cell plate** continues to develop until it connects with the existing cell's plasma membrane. • This completes the division of the cytoplasm and the formation of two daughter cells. • Both daughter cell secrete cellulose to form their new adjoining cell walls.



Cytokinesis in Plant Cells vs. Cytokinesis in Animal Cells

Significance of mitosis

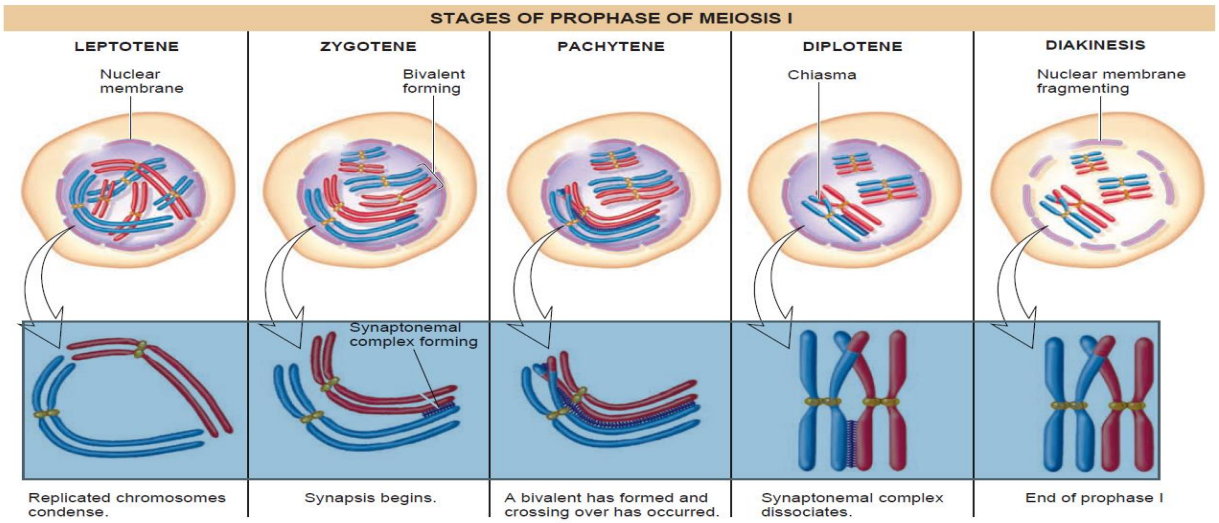
- Results in formation of diploid genetically identical daughter cells
- Growth of the body takes place by mitosis.
- Cell repair and replacement of worn out tissues
- Maintenance of nucleo-cytoplasmic ratio
- Vegetative reproduction in plants takes place by mitosis.

II Meiosis

- It is the process which involves the reduction in the amount of genetic material.
- It mainly occurs in germ cells.
- At the end of meiosis II, four haploid cells are formed.
- It is comprised of two successive nuclear and cell division with a single cycle of DNA replication.
- The phases of meiosis are as shown below-

Meiosis I

1. **Prophase I** – It comprises of 5 stages:



i. Leptotene- Chromosomes start condensing.

ii. Zygotene

Pairing of chromosomes called synapsis occurs.
A pair of synapsed homologous chromosomes is called bivalent or tetrad.

iii. Pachytene

Exchange of geneticmaterial (crossing over) between non-sister chromatids occurs.
Chiasmata formation

iv. Diplotene

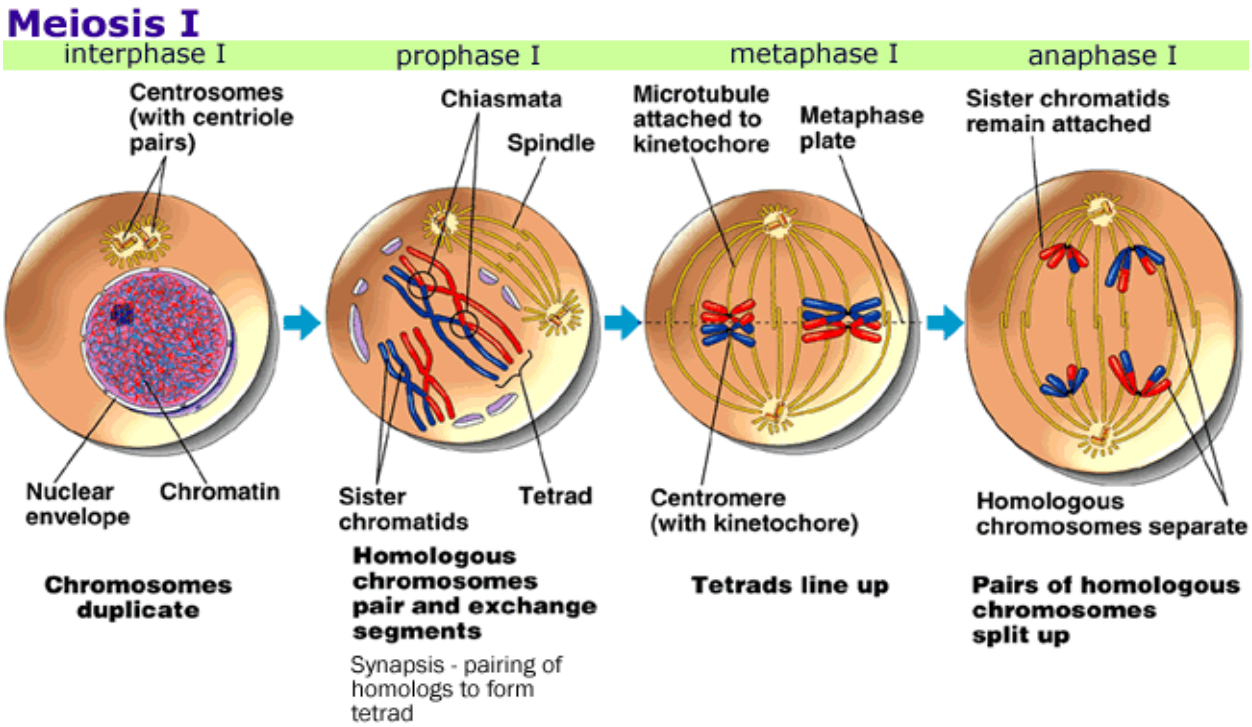
Bivalents formed during pachytene separate from each other (except at chiasmata) due to dissolution of synaptonemal complex.

V. Diakinesis

Terminalisation of chiasmata can be observed.
By the end of this stage, the nucleolus disappears and the nuclear envelope breaks.

2. Metaphase I

Bivalents (tetrad) get aligned along metaphase plate through spindle fibres.



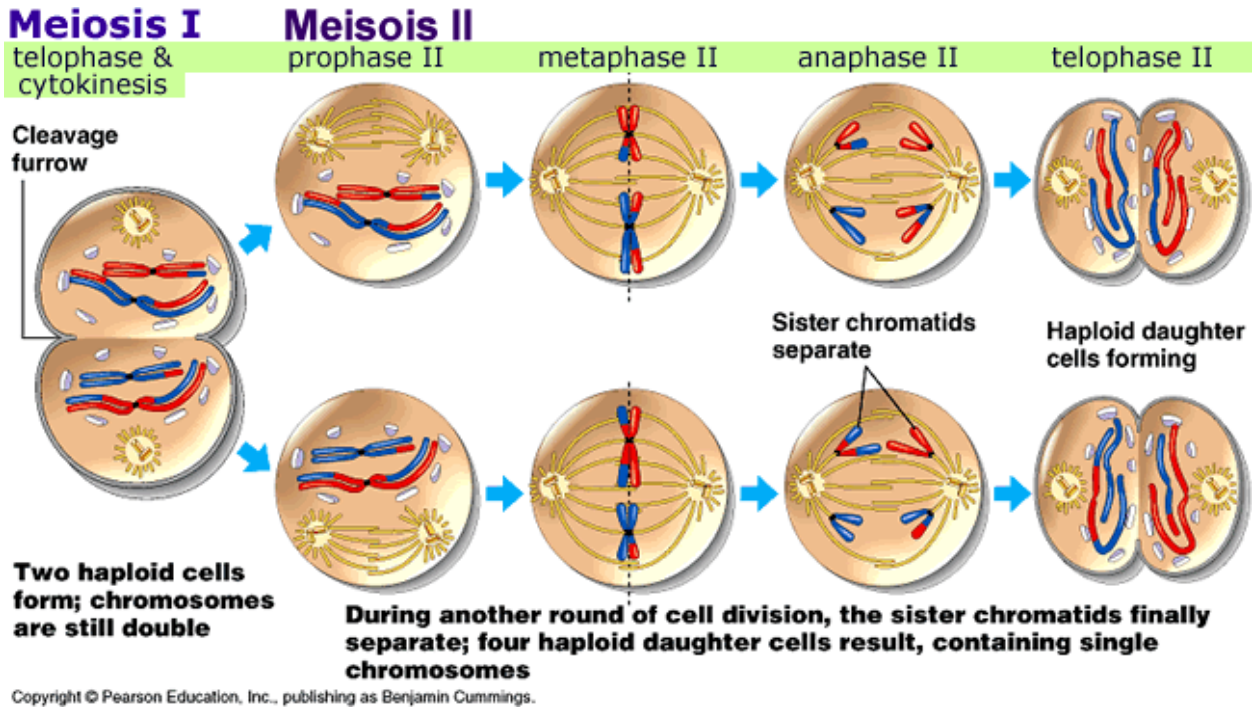
3. Anaphase I

Homologous chromosomes separate while chromatids remain attached at their centromere.

4. Telophase

Nucleolus and nuclear membrane reappear around chromosome clusters at each pole.
Inter-kinesis – It is the stage between two meiotic divisions.

Meiosis II



1. Prophase II

- Chromosomes become compact.
- Nuclear membrane disappears.

2. Metaphase II

- Chromosomes align at the equator.
- Kinetochores of sister chromatids attach to spindle fibres at each pole.

3. Anaphase II

- Chromatids separate by splitting of centromere.
- As a result, chromatids move towards their respective poles in the cell.

4. Telophase II

Nuclear envelope and nucleolus reform around the chromosome clusters.

Cytokinesis:

After meiosis II, the process of cytokinesis results in the formation of four haploid cells.

Significance of meiosis:

- It results in reduction of chromosome number by half in gametes, which again doubles during fertilization. Therefore, it helps to conserve the chromosome number of species from generation to generation.
- Crossing-over, occurring in pachytene stage of meiosis I, is a source of genetic variation in sexually reproducing organisms.
- The variation thus formed helps in evolution.

Differences between Mitosis and Meiosis:

	Mitosis		Meiosis
1	Occurs in somatic cells	1	Occurs in reproductive cells.
2	Each DNA or chromosome replication is followed by one nuclear division, thereby maintaining the amount of DNA and the number of chromosomes per cell remains constant from generation to generation.	2	Each DNA or chromosome replication is followed by two successive divisions of the nucleus. Thus, each of the daughter cells contains half as many chromosomes and half as much DNA as its parent cell.
3	All chromosomes behave independently of each other.	3	Homologous chromosomes get paired together.
4	The chromosomes at the metaphase are arranged in such a way that the centromeres lie at the metaphase plate and the arms of chromosomes are free.	4	The chromosomes at the metaphase are arranged in such a way that the centromeres of homologous chromosomes lie on either side of the metaphase plate, pointing towards the opposite poles.
5	There is no crossing-over or exchange of parts of chromatids between homologous chromosomes.	5	Crossing-over or exchange of parts of chromatids between homologous chromosomes is a rule, than exception.
6	Two daughter nuclei are produced from a single parental nucleus.	6	Four daughter nuclei are produced from a single parental nucleus.
7	Centromeres divide thereby separating the two chromatids.	7	Centromeres do not divide during the metaphase-I Homologous chromosomes rather than chromatids separate. Centromeres divide during the metaphase II.

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