# 4. Cell Division

#### Cell cycle

- It is defined as a series of events that takes place in a cell, leading to the formation of two daughter cells.
- The average duration of a cell cycle for a human cell is about 24 hours and for yeast cell, it is about 90 minutes
- Cell cycle is divided into two basic phases: Interphase and M phase

### Interphase

- Interphase involves a series of changes that prepares the cell for division. It involves the period of cell growth and DNA replication in an orderly manner.
- It is divided into three phases:
- G<sub>1</sub> phase It involves growth of cell and preparation of DNA replication.
- **S phase** It involves DNA replication. The amount of DNA doubles, but the chromosome number remains the same.
- G<sub>2</sub> phase It involves protein synthesis and further growth of cell, which prepares it for division.
- G<sub>0</sub> phase or quiescent phase It is the stage when metabolically active cell remains quiescent for long period of time.

### • Significance of Cell Division

- It is the mean of asexual reproduction in unicellular organisms.
- It is essential for the growth of a single celled zygote into a whole new multicellular organism.
- It helps in the repair of injuries and worn out tissues.
- It replaces dead cells of the body and thus is essential for growth of organism.
- In sexual reproduction, meiosis occurs. This type of cell division not only results in production of gametes, but also brings new combinations of genes, thus resulting in variations among a population. This also leads to evolution of a species.

#### 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 disappear.

## Metaphase

• Chromosomal material condenses to form compact chromosomes that get aligned in the middle of nucleus at equatorial plate.

#### 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 cluster.





• Nucleolus and other organelles reform.

### Karyokinesis and Cytokinesis

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

## Significance of mitosis

- It results in the formation of diploid daughter cells with identical genetic material.
- Mitosis plays a significant role in cell repair, growth, and healing.

#### 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 genetic material (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
- o 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.

#### Telophase I

- Nucleolus and nuclear membrane reappear around chromosome cluster at each pole.
- **Interkinesis** It is the stage between two meiotic divisions.

#### • Meiosis II

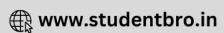
### • 1. Prophase II

- 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 reforms around the chromosome clusters.
- After meiosis II, the process of cytokinesis results in the formation of four haploid cells (tetrad of cells).

## • Significance of meiosis:

It brings about variation.

It maintains the chromosome number constant from generation to generation.



