Structure of Chromosomes, Cell Cycle & Cell Division

- **Nucleus**
  - It controls all the cellular activities of cell.
  - It consists of the following.
    a. **Nuclear membrane –** It has perforations called nuclear pores.
    b. **Nucleoplasm**
    c. **Nucleolus**
  - **Nucleolus** is the site of ribosomal RNA formation.
  - Network of nucleoprotein fibres are called the chromatin.
  - Chromatin contains DNA, histones (basic proteins), non-histone proteins, and RNA.
  - Chromatin threads condense and organize to form chromosome.
  - The primary constriction in the chromosome is called centromere.

- Based on the position of centromere, chromosomes are of four types:
  - **Metacentric:** Centromere is located at the middle of chromosome.
  - **Sub-metacentric:** Centromere is slightly away from the middle of chromosome.
  - **Acrocentric:** Centromere is situated close to the end of chromosome.
  - **Telocentric:** Centromere is located at the terminal end.

- A small chromosomal segment separated from the main body of the chromosome by a secondary constriction is called satellite.
- **Structure of DNA**
  - It has a double-helix structure, similar to ladder.
  - It is made up of nucleotides.
  - Nuclotides are made of sugar, phosphate groups and nitrogen bases
- **Components of DNA**
  - Sugar
  - Phosphate groups
  - Nitrogen bases
- **Genes**
  - It is a unit of DNA.
  - Located on Chromosomes.
  - Controls the development of one or more traits.
  - It is the basis of Inheritrance.
  - It can acquire mutation leading to variation.

- **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_1 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_2 phase –** It involves protein synthesis and further growth of cell, which prepares it for division.
- **G_0 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 a type of cell division that produces sex cells or gametes.
- It occurs in the reproductive organs.

Significance of meiosis:

- Chromosome number is halved.
- It helps in mixing up of genes.

Differences between Mitosis and Meiosis

Mitosis	Meiosis
It occurs in the body cells	It occurs in the reproductive cells during

throughout the life.	reproductive age.
Parent chromosome and daughter cell genes are identical.	Parent chromosome and daughter cell genes are randomly assorted causing genetic variation.
It helps in growth and replacement.	It helps in gamete formation.
Full set of chromosome is passed.	Only half of the total chromosomes is passed.
Two daughter cells are formed.	Four daughter cells are formed.
Single nuclear division occurs after duplication of chromosome.	Double nuclear division occurs after duplication of chromosome.