

Unit 4: Cell Reproduction

Cell Cycle and Cell Division

Cell Cycle

The cell cycle is a series of events that a cell undergoes to divide and produce two identical daughter cells. It consists of two main stages: **Interphase** and **Cell Division**.

1. **Interphase:** This is the phase where the cell prepares for division. It is divided into three stages:
 - **G1 Phase (First Gap):** The cell grows and accumulates the building blocks for DNA synthesis. It also stores energy needed for DNA replication.
 - **S Phase (Synthesis):** DNA replication occurs. Each chromosome is duplicated, resulting in two sister chromatids connected at the centromere.
 - **G2 Phase (Second Gap):** The cell continues to grow and prepares for mitosis. It synthesizes proteins necessary for chromosome movement and duplicates organelles.
2. **Cell Division:** This includes:
 - **Mitosis (Karyokinesis):** Nuclear division that distributes duplicated chromosomes into two daughter nuclei.
 - **Cytokinesis:** Cytoplasmic division that results in two separate daughter cells.

Mitosis

Mitosis is the process of nuclear division that results in two identical daughter cells. It is divided into four phases:

1. **Prophase:**
 - Chromosomes condense and become visible.
 - The nuclear membrane breaks down.
 - Spindle fibers emerge from centrosomes and begin to move towards opposite poles.
2. **Metaphase:**
 - Chromosomes align at the cell's equatorial plane (metaphase plate).
 - Spindle fibers attach to the centromeres of chromosomes.
3. **Anaphase:**

- Centromeres split, and sister chromatids are pulled apart to opposite poles by spindle fibers.
- 4. **Telophase:**
 - Nuclear membranes reform around each set of chromosomes at the poles.
 - Chromosomes de-condense back into chromatin.
 - The spindle fibers break down.

Cytokinesis follows mitosis and differs between animal and plant cells:

- **Animal Cells:** The cytoplasm pinches inwards, dividing the cell into two separate daughter cells.
- **Plant Cells:** A cell plate forms between the daughter cells, developing into a new cell wall.

Meiosis

Meiosis is a type of cell division that reduces the chromosome number by half to form gametes (sperm and egg cells). It consists of two successive divisions: Meiosis I and Meiosis II.

1. **Meiosis I:**
 - **Prophase I:** Chromosomes condense, and homologous chromosomes pair up and exchange genetic material (crossing over).
 - **Metaphase I:** Homologous chromosome pairs align at the metaphase plate.
 - **Anaphase I:** Homologous chromosomes are pulled to opposite poles. Sister chromatids remain together.
 - **Telophase I:** Nuclear membranes form around each set of chromosomes. Cells divide into two haploid cells.
2. **Meiosis II:**
 - **Prophase II:** Chromosomes condense, and spindle fibers form in each haploid cell.
 - **Metaphase II:** Chromosomes align at the metaphase plate.
 - **Anaphase II:** Centromeres divide, and sister chromatids are pulled to opposite poles.
 - **Telophase II:** Nuclear membranes reform around each set of chromosomes. The cells divide, resulting in four haploid gametes.

Importance: Meiosis ensures genetic diversity through recombination and reduces chromosome numbers to maintain species' stability across generations.

Summary:

- The **cell cycle** includes Interphase (G1, S, G2) and Cell Division (Mitosis and Cytokinesis).
- **Mitosis** results in two identical daughter cells, crucial for growth and repair.
- **Meiosis** produces four genetically diverse gametes with half the chromosome number, essential for sexual reproduction.

Understanding these processes is fundamental to grasp how organisms grow, reproduce, and maintain genetic continuity.

Renowned Ethiopian Geneticist: Dr. Melaku Worede

Dr. Melaku Worede:

Dr. Melaku Worede is a celebrated geneticist and agronomist known for his significant contributions to agriculture and genetics in Ethiopia. His work has focused on preserving indigenous seeds and improving agricultural practices to benefit poor farmers.

Key Contributions:

- **Seed Conservation:** Dr. Worede is renowned for his efforts to save Africa's indigenous seeds from extinction. He was awarded the "Right Livelihood Award" in 1989 for his work in preserving Ethiopia's genetic resources.
- **Plant Genetic Resource Centre:** He played a crucial role in establishing the Plant Genetic Resource Centre in Addis Ababa, where he served as Director from 1979 for over 14 years.
- **Native Seed Conservation:** After retirement, Dr. Worede continued his work on conserving and utilizing native seeds. He successfully developed and cultivated locally adapted seeds, such as durum wheat, without the use of commercial fertilizers or chemicals. His methods demonstrated that these native seeds yielded 10-15% more than high-input varieties and 20-25% more than original farmers' cultivars.

Unit Summary:

- **Cell Cycle:** The cell cycle is a sequence of events in a parent cell that leads to the formation of daughter cells. It consists of two main phases: Interphase and Cell Division.
- **Interphase:** This phase includes:
 - **G1 Phase:** Cell growth and accumulation of DNA building blocks.
 - **S Phase:** DNA replication.

- **G2 Phase:** Further cell growth, energy replenishment, and preparation for cell division.
- **Cell Division:** Includes nuclear division (either by mitosis or meiosis) followed by cytoplasmic division (cytokinesis).
 - **Mitosis:** This process divides somatic (body) cells into two identical daughter cells. It involves four stages:
 - **Prophase:** Chromosomes condense, nuclear membrane breaks down, and spindle fibers form.
 - **Metaphase:** Chromosomes align at the cell's equatorial plane.
 - **Anaphase:** Sister chromatids are pulled apart to opposite poles.
 - **Telophase:** Nuclear membranes re-form around each set of chromosomes, and the cell prepares to divide.
 - **Meiosis:** This process produces sex cells (gametes) with half the number of chromosomes of the parent cell. It involves two divisions:
 - **Meiosis I:** Homologous chromosomes separate, reducing the chromosome number from diploid ($2n$) to haploid (n).
 - **Meiosis II:** Sister chromatids separate, resulting in four haploid daughter cells.

Conclusion: Cell division is fundamental for growth, repair, and reproduction. Mitosis produces identical cells for growth and repair, while meiosis generates gametes for sexual reproduction.